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BULLETIN 17

Regional bedrock geology for Coal River map area (NTS 95D), southeast Yukon

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with contributions from Jim Crowley, Sandy McCracken, Godfrey Nowlan, Mike Orchard and Leanne Pyle

2015

YUKON GEOLOGICAL SURVEY

Yukon
Energy, Mines and Resources

2009 field crew at Grizzly Creek Lodge, upper Toobally Lake - (*back row, left to right*) Lee Pigage, Mike Dorsey and Grant Abbott; (*middle row, left to right*) Kristen Kennedy, Beth Hunt and Charlie Roots; (*front row, left to right*) Gavin Clarkson, Martina Bezzola and Casey Cardinal.

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Cover photo: Waterfall in upper part of Beaver River (NTS 95D/10), immediately upstream from field station 09TOA146 (636 644 E, 6 719 278 N). Cliffs consist of thick-bedded Sunblood Formation.

FOREWORD

Recent collaborative geological mapping by Yukon Geological Survey (YGS) and Geological Survey of Canada (GSC) through the Central Foreland NATMAP project (fieldwork 2000-2002) provided a new and enhanced stratigraphic and structural framework for bedrock and surficial geology in southeast Yukon. Subsequent detailed geological mapping sponsored by YGS (fieldwork 2003-2007) further elaborated on an improved understanding of the bedrock geology for reassessing its mineral and hydrocarbon potential.

This report documents the revised bedrock geology of the Coal River map area (NTS 95D) in southeast Yukon, expanding upon the earlier studies. It results from a helicopter-supported 2009 collaborative mapping project between YGS and GSC which was funded through the Geoscience for Energy and Minerals (GEM) program of Natural Resources Canada. Isotopic dating and paleontology were organized by GSC; geochemical analysis of the igneous rocks was funded by YGS. In 2010, YGS sponsored one week of fieldwork as a follow-up to stratigraphic and structural questions from the 2009 project.

The current publication provides a contemporary bedrock geology framework of the Coal River map area which straddles the southern margin of Selwyn basin and occurs at the southeast end of the 'Tintina gold belt'. Both mineral domains constitute significant mineral resource provinces of Yukon. Bedrock geology consists of Neoproterozoic to Eocene stratigraphic units comprising 6 depositional successions and is described in a lithologic and paleogeographic context. Numerous small Cretaceous granitoid bodies have been identified in the northern half of the map area.

Mineral occurrences include Irish-type and Mississippi Valley-type Zn-Pb replacements in carbonate rock, massive sulfide mantos, tungsten and base metal skarns, and scattered intrusion-related precious-metal veins and replacements. For much of the area, carbonaceous sedimentary rocks appear to be over-mature as hydrocarbon source rocks although potential may exist for unconventional tight-shale gas; a coal resource has been identified locally.

Maurice Colpron

Senior Project Geologist
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ABSTRACT

Coal River map area (NTS 95D) encompasses the southern extent of the early Paleozoic Selwyn basin, with Macdonald platform to the south. Neoproterozoic to Triassic strata constitute miogeoclinal sedimentary rocks deposited on the passive margin of Laurentia. Cambrian-Ordovician strata define an east-west facies change from silty limestone in the west to impure quartzose sandstone in the east. Alkali basalt occurs in multiple stratigraphic horizons within Cambro-Ordovician strata. Silurian-middle Devonian strata record a facies change from platform carbonate rocks in the south to deep marine carbonaceous shale in the north. Middle Devonian to Triassic shale and sandstone sequences record three transgressive/regressive cycles. Eocene strata consist of post-orogenic fluvial mudstone, siltstone and sandstone with interbedded coal seams preserved in an extensional half-graben.

Most of the small Cretaceous granitic stocks are highly magnetic and coincide with positive aeromagnetic anomalies. Other aeromagnetic anomalies may correspond to buried or unmapped intrusions.

The Coal River map area is characterized by steeply dipping, northwest to northeast-trending faults and folds. Contractional deformation structures and axial planar fabrics decrease in intensity from west to east. Late extensional deformation is manifested by normal faults. The largest of these structures is the Rock River fault which forms the western margin of the upper Eocene Rock River basin half-graben. Metamorphic mineral assemblages in the pelites regionally range from muscovite-chlorite zone in lower greenschist facies to biotite-garnet-staurolite-chloritoid zone in lower amphibolite facies. Higher grade rocks occur in a northeast-trending belt from the west-central to north-central part of the map area. Deformation and metamorphism are part of the Cordilleran orogeny, a manifestation of the amalgamation of Laurentia with allochthonous terranes.

Southeast Yukon is under-explored although it is geographically situated at the south margin of Selwyn basin and the southeast tail of the Tintina gold belt. Sediment-hosted mineralization may include sedimentary exhalative Zn-Pb ± Ba deposits in black shale (SEDEX) and Irish-type or MVT Zn-Pb replacement deposits in carbonate rocks. Intrusion-related mineralization may include massive sulphide mantos, tungsten and base metal skarns, precious metal veins, sheeted veins and replacement deposits.

Carbonaceous sedimentary successions are overmature for source hydrocarbon potential. Conventional oil or gas reservoirs are probably not present. Potential does exist for unconventional tight shale gas resource. Coal resources have been identified in the late Eocene Rock River basin sediments.

TABLE OF CONTENTS

PLATES

Plate 1. Bedrock geology of Coal River map area (NTS 95D), Yukon (1:250 000 scale). Yukon Geological Survey, Open File 2011-1

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES - APPENDICES

INTRODUCTION

Recent fieldwork by the Yukon Geological Survey and the Geological Survey of Canada (Pigage, 2006; Pigage and MacNaughton, 2004; Pigage, 2009) in southeast Yukon resulted in major revisions to the previously reported stratigraphy and igneous history. Southeast Yukon includes rocks which regionally host SEDEX, MVT/Irish-type and intrusion-related mineralization. The mineral potential of southeast Yukon is under-evaluated both scientifically and economically relative to the central part of the territory; additional discoveries are possible with an updated geological information base.

To this end the Yukon Geological Survey and Geological Survey of Canada completed a helicopter-assisted bedrock mapping program in the Coal River (NTS 95D[1]) map area between late June and early August 2009 using federal funds provided by the 'Geo-Mapping for Energy and Minerals' program administered by Natural Resources Canada. A Bell206B helicopter provided daily set-outs of traverse pairs and enabled spot-checking of isolated rock exposures. An inflatable boat with jet outboard motor provided access to outcrops along the Coal River. The 10-person crew was based for 2 weeks at a mineral exploration camp on the south shore of Quartz (Hulse) Lake, and then at a private facility on the east side of the northernmost (upper) of the Toobally Lakes.

In 2010 the Yukon Geological Survey funded five days of helicopter-assisted field checks to resolve geological inconsistencies arising from the 2009 fieldwork. The 2009-2010 project produced a preliminary bedrock map (Plate 1) and surficial geology report (Kennedy, 2010) as well as a regional aeromagnetic map of the Yukon portion of the adjacent map area immediately to the north (Flat River, NTS 95E; Kiss, 2010a,b,c,d).

This report complements the 1:250 000-scale bedrock geological map (Plate 1) for the Coal River map area by providing descriptions of the rock units, structures, mineral occurrences and discussion of their geologic context; it should be read in conjunction with the bedrock geological map, Yukon Geological Survey Open File 2011-1 (included as Plate 1).

LOCATION, PHYSIOGRAPHY AND ACCESS

The area of study is approximately 100 km east of Watson Lake, Yukon with bounding geographic coordinates of 60° and 61°N latitude and 126° and 128°W longitude (Fig. 1). It occurs largely within southeast Yukon with the northeast corner being in the Northwest Territories. Most of the map area is within the Hyland Highland physiographic region with the northwest corner being within the Logan Mountains (Mathews, 1986). Most of the 12 100 km^2 area consists of rounded, forest-covered hills with incised stream drainages. The map area is characterized by three broad, north-trending valleys extending the entire length of the area. The Coal (west valley) and Rock (central valley) rivers flow south into the Liard River. The east valley contains the Smith River (south flowing), Beaver River (southeast flowing) and Caribou River (northeast flowing). All rivers ultimately flow into the Mackenzie River and Arctic Ocean. Elevations range from 550 m (1800 ft) to 1980 m (6500 ft). Bedrock exposures constitute about 3% of the area and are restricted largely to ridge tops above timberline, rivers and glacial meltwater channels.

The Alaska Highway traverses the southwest corner of Coal River map area. Abandoned logging roads locally radiate northward from the highway. A few unpaved tracks and winter haulage trails (referred to as the Sulpetro and Smith River trails) cross the southern and central parts of the map area. Extensive forest cover limits places where helicopters can land. The upper Coal, West Coal and Rock rivers are

1 National Topographic System: https://www.nrcan.gc.ca/earth-sciences/geography/topographic-information/maps/9763

amenable to shallow-draft boats, as is the stream connecting the Toobally Lakes. The Smith River is boulder-strewn and rapid-filled, and class 3 and 4 rapids in downstream canyons on the Coal River prevent boat access from the Alaska Highway. A 500 m long gravel airstrip located near the head of Otter Creek was utilized for mineral exploration (Mel, Jeri, Jeri North, Joni). Float-equipped planes have used Hulse (Quartz), Roy, Gusty and the Toobally lakes to supply camps.

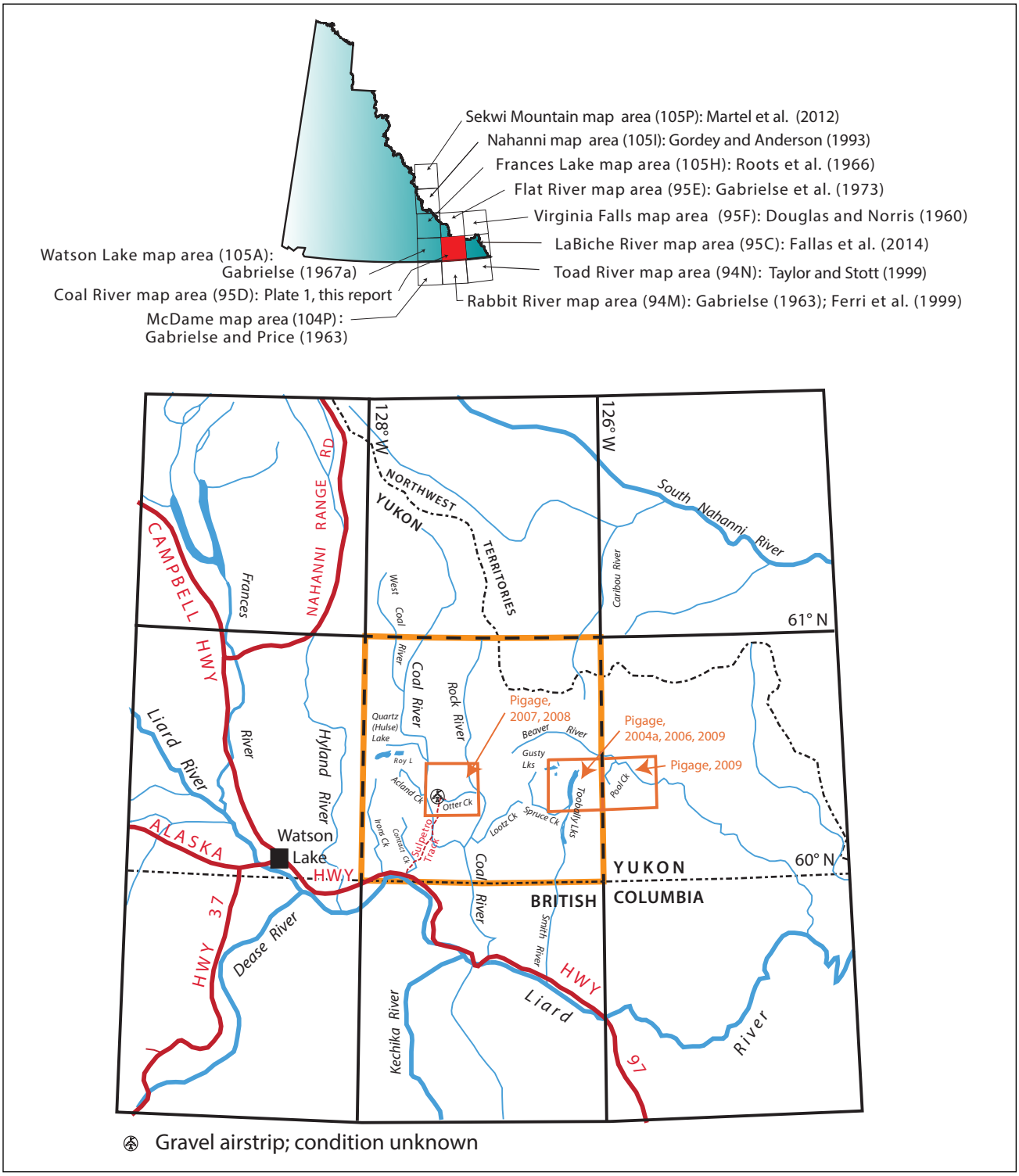

Figure 1. *Map areas (with reference to geological reports), roads and water courses surrounding Coal River map area.*

GLACIAL HISTORY

Central and southern Yukon has a complex Pleistocene glacial history. Bostock (1966) and Duk-Rodkin *et al.* (2004) documented multiple advances of the Cordilleran ice sheet. Immediately to the west (in the Watson Lake area) Klassen (1987) described a lengthy glacial history with four till units interbedded with four non-glacial units. The uppermost till unit records late Wisconsinan glacial ice that flowed northeastward from the Cordilleran Ice Sheet. He also completed a surficial geology reconnaissance of the west half of the Coal River map area, documenting extensive glaciofluvial and glaciolacustrine sediments (Klassen, 1983). Surficial mapping, to the east of the Coal River project area, by Smith (2000) demonstrated that the continental Laurentide Ice Sheet advanced west and coalesced with the Cordilleran Ice Sheet just east of the Coal River map area along the western margin of the LaBiche River map area during the Wisconsinan glacial maximum. Coalescence resulted in thickening of the ice sheets that likely covered all but the highest peaks in the region (Kennedy, 2010).

Kennedy (2010) indicated that most of the glacial geomorphic features in the Coal River map area are probably related to the most recent Wisconsinan McConnell advance of the Cordilleran Ice Sheet. McConnell Glaciation attained its maximum extent around 23 000 ^{14}C years BP (Duk-Rodkin *et al.*, 1996) with much of it disappearing by approximately 13 000 ^{14}C years BP (Jackson *et al.*, 1991). Deglaciation in the Coal River area resulted in the deposition of extensive glaciolacustrine and glaciofluvial deposits associated with glacial lakes formed by the Cordilleran and Laurentide ice masses blocking south and east-flowing drainages. Deep, east-trending meltwater channels became incised and resulted in the formation of large deltas as the meltwater channels debouched into the major south-trending drainages and glacial lakes. The northwest and north-central parts of the map area possibly remained unglaciated during the Cordilleran glacial advances (Klassen, 1987; Kennedy, 2010).

PREVIOUS WORK

Reconnaissance geological mapping by the Geological Survey of Canada (GSC), mostly during 1967, resulted in an outcrop style geology map at 1:253,440 scale and an accompanying report (Gabrielse and Blusson, 1968, 1969). Abbott (1981) conducted a regional mapping program in 1978-1979 which was largely north of the Coal River area, overlapping into the northwestern part of NTS 95D. Subsequent government-sponsored research was limited to visits to mineral exploration camps, until two regional total-field aeromagnetic surveys using a line spacing of 800 m (Natural Resources Canada, 2009) were completed in 1995 and 1996. Yukon Geological Survey conducted detailed (1:50 000 scale) bedrock geology mapping near Toobally Lakes (NTS 95D/8) and surrounding the Mel Pb-Zn occurrence (NTS 95D/6) between 2003 and 2008 (Pigage, 2004a, 2006, 2007, 2008; Pigage and MacNaughton, 2004), culminating in a final report (Pigage, 2009).

Mineral exploration occurred intermittently from the 1960s into the 2000s, but the poor exposure, difficult access and moderately promising results discouraged more extensive activity. As a result regional exploration has been limited, and detailed exploration has focused on the few known targets, namely the McMillan Pb-Zn-Ag replacement deposit (Yukon MINFILE 095D 006), the Hyland Gold intrusion-related Au replacement deposit (Yukon MINFILE 095D 011) and the Mel Pb-Zn-Ba MVT/Irish-type replacement deposit (Yukon MINFILE 095D 005 and associated occurrences - Yukon MINFILE 095D 027, 032, 035). Grassroots regional exploration targets include tungsten skarn, intrusion-related gold, and sediment-hosted zinc, lead and barite.

REGIONAL GEOLOGIC SETTING

The Coal River map area is located along the northwest (present orientation) passive continental margin of Laurentia which formed after the breakup of the Proterozoic supercontinent Rodinia (Colpron *et al.*, 2002). An aggregate total of >14 000 m of miogeoclinal sedimentary and minor volcanic rocks

of Neoproterozoic through Triassic age are present in various parts of the map area. Most of the formations or their time-equivalent correlatives extend along the ancient margin, from east-central Alaska along the Mackenzie and Rocky mountains through the United States into Mexico. They were uplifted and exposed as a result of eastward contraction during the Cordilleran orogeny (Middle Jurassic to Paleocene fold-and-thrust belt; *e.g.*, Gabrielse *et al.*, 1991).

The main Neoproterozoic to Middle Devonian geographic elements (Fig. 2) are shallow water carbonate and clastic strata transitioning westerly to southwesterly to deeper water strata, constituting Selwyn basin (Gabrielse, 1967b; re-defined by Cecile, 1982, and Gordey and Anderson, 1993). Selwyn basin is a 900 km long, up to 350 km wide, northwest-trending area of the central and eastern Yukon underlain by Late Proterozoic to Middle Devonian dark clastic strata. It is flanked to the north and east by the time-equivalent, carbonate-dominant Mackenzie platform (Lenz, 1972; *a.k.a.*, Blackwater platform of Cecile *et al.*, 1997; Mackenzie-Peel shelf of Morrow, 1999). A southern extension of relatively deep-water strata about 50 km wide continues 600 km farther south and is known as Kechika trough (Douglas *et al.*, 1970); it is flanked to the east by Macdonald platform. The southwest margin of both Selwyn basin and Kechika trough is the Tintina fault, and the fault-offset equivalent strata are present in central Alaska (McGrath quadrangle). Coal River is located at the northern margin of Macdonald platform and the southern edge of Selwyn basin.

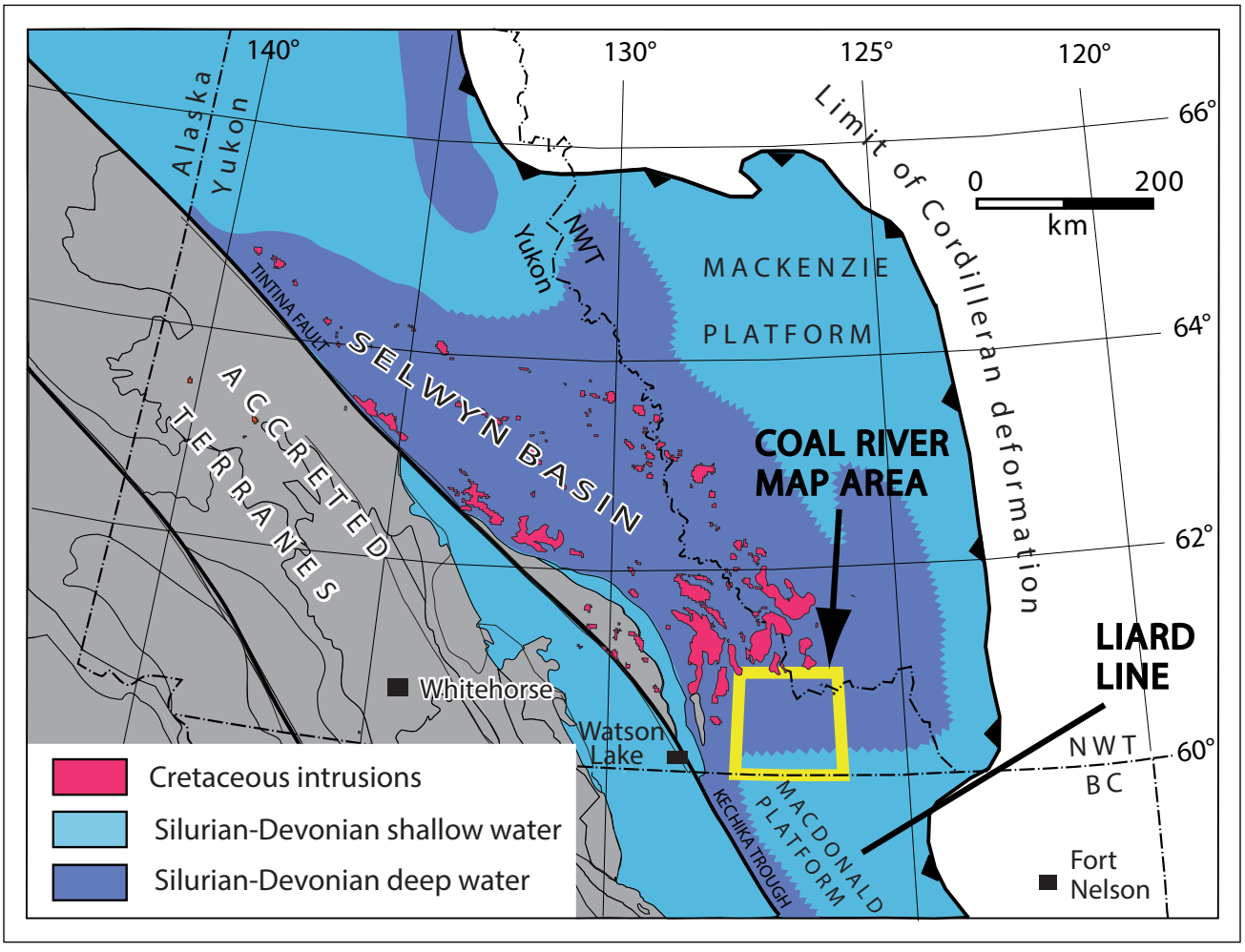

Figure 2. *Paleozoic (Silurian-Devonian) tectonic elements of eastern Yukon and northern BC. Accreted terranes are undifferentiated (grey) and movement of Tintina fault is not restored. Terranes adapted from Wheeler and McFeely (1991). Cretaceous intrusions from Gordey and Makepeace (2003).*

Middle Devonian to Mississippian transgressive, carbonaceous shale and chert overlying the Mackenzie and Macdonald platform shelf carbonate rocks denote a major change in depositional environment and tectonics (Abbott *et al.*, 1986) and represent the cessation of the Selwyn basin-Mackenzie and Macdonald platform paleogeography. Extensional rifting during this time is indicated by locally sourced conglomerate and the presence of depositional growth faults within the former Selwyn basin (Abbott *et al.*, 1986; Gordey *et al.*, 1982). Late Mississippian deposition in the Coal River area is dominated by silts and sands of a large, prograding marine and fluvial delta complex.

Deposition in Pennsylvanian through Triassic time delineates multiple transgressive-regressive cycles of fine-grained clastic rocks and chert of relatively shallow water, marine origin separated by unconformities (Abbott *et al.*, 1986).

Jurassic-Paleocene deformation is manifested primarily by widely spaced, high-angle reverse faults and asymmetric folds. Intensity of deformation and depth of burial exposed at surface increase from east to west, with penetrative fabrics being well developed only in the west. Metamorphism associated with deformation ranges from lowermost greenschist facies (muscovite-chlorite zone) in the east to upper greenschist facies (biotite-garnet zone) and locally lower amphibolite facies (staurolite zone) in the west.

Numerous small, undeformed, approximately circular Cretaceous intrusions are scattered across the northern half of the map area (Plate 1). These intrusions represent the southeast extent of the Tay River plutonic suite (Mortensen *et al.*, 2000; Plate 1; Fig. 2). Post-orogenic (Upper Eocene) fine-grained, fluvial and lacustrine, coal-bearing deposits occupy a north-trending half graben in the centre of the map area (Rock River basin; Long and Sweet, 1994).

The Coal River map area lies north of the Liard Line (Fig. 2), a northeast-trending zone defined primarily by the absence of Orodovician to Lower Devonian strata southward (Cecile *et al.*, 1997). The Liard Line is interpreted as an ancestral transfer fault zone across which there is an interpreted reversal in the asymmetry direction of the original rift zone along the western edge of Laurentia (Cecile *et al.*, 1997). North of the Liard Line, Selwyn basin exposures are interpreted as being in the footwall of the continental marginal rift, and the Macdonald platform exposures to the south are thought to be in the hanging wall of the continental marginal rift. There is no surface expression of the Liard Line, and its location is poorly constrained.

STRATIGRAPHY OF COAL RIVER MAP AREA

This report divides the miogeoclinal strata into six formation-delineated 'successions' of strata ranging in age from Neoproterozoic through late Eocene (Fig. 3). Each succession consists of one or more formations with related lithologic facies and depositional environments (Table 1). Tectono-stratigraphic relationships markedly differ between successions (*cf.*, Morrow and Geldsetzer, 1991). Internally the successions may locally contain unconformities. North and east-striking schematic correlation charts (Fig. 4) illustrate the regional distribution and stratigraphic relationships of the formations and sedimentary successions.

Succession 1 consists of Neoproterozoic-lower Cambrian siliciclastic sedimentary rocks (Yusezyu, Narchilla and Vampire formations, and an interval of silty phyllite and limestone interbeds considered equivalent to the Sekwi Formation) that are exposed throughout the western half of the map area. Mafic volcanic rocks occur locally near the top of this succession. A small isolated occurrence of Neoproterozoic(?) conglomerate (Toobally Formation) occurs in the immediate hanging wall of the Toobally fault in the east-central part of the map area.

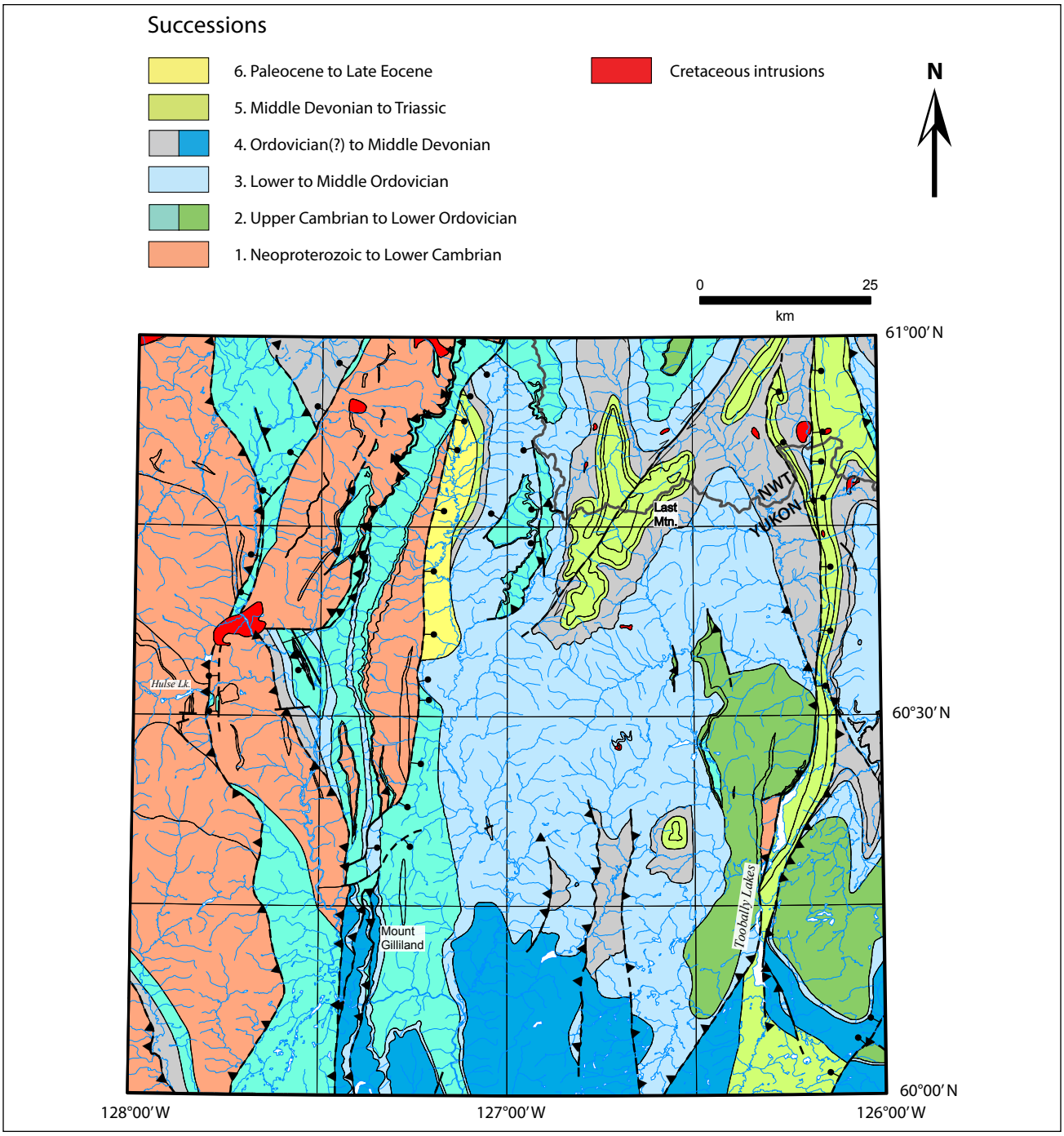

Figure 3. *Coal River map area, showing the six stratigraphic successions and Cretaceous intrusions, based upon 2009-2010 fieldwork and previous mapping by Gabrielse and Blusson (1969). The map area at 1:250 000 scale is shown in Plate 1.*

Succession 2 is upper Cambrian through Lower Ordovician in age; it exhibits a dramatic facies change from limestone and silty limestone in the west (Otter Creek and Rabbitkettle formations) to shallow water and subaerial strata dominated by subarkosic sandstone and maroon siltstone in the east (Crow Formation). Both facies contain intervals of mafic volcanic rocks.

Succession 3 is presently exposed throughout the eastern two-thirds of the map area and consists of Lower to Middle Ordovician shallow, platformal carbonate (Sunblood Formation). This succession is absent in the southwest and northwest corners of the Coal River map area.

Table 1. Formations in Coal River map area.

Succession	Map Unit	Main Lithology	Thickness (m)
6	Rock River (ERRs)	mudstone	>445 - 1100 ?
6	Paleocene clastic (Pssc)	siltstone, sandstone and conglomerate	160
5	Toad and Grayling (TGT)	shale	>240
5	Fantasque (PF)	shale	1000 - 1700
5	Mattson (MM)	sandstone	500 - 1450
5	Besa River (DMBR)	shale	300
4	Siluro-Devonian carbonate (SDc)	dolostone	100 - 1000
4	Road River (SDRR, SMRR)	shale, siltstone	2000
4	Ordovician-Silurian sandstone (OSs)	sandstone to pebbly sandstone	220
3	Sunblood (Osu)	dolostone or limestone	0 - 2700
2	Rabbitkettle (ЄOR-n, ЄOR-lp, ЄOR-v)	limestone, calc-phyllite	300 - 1500
2	Otter Creek (ЄOoc)	limestone	65 - 500
2	Crow (ЄOc, ЄOc-v)	sandstone	? - >5000
1	Sekwi-correlative (Єs)	phyllite to siltstone, sandstone	400
1	Vampire and Narchilla (PЄVN, PЄVN-m, PЄVN-l, PЄVN-v)	phyllite to pelite	0 - 2500
1	Yusezyu (PY)	sandstone, pebbly sandstone	3500 ?
1	Toobally (PT)	pebbly mudstone	>1800

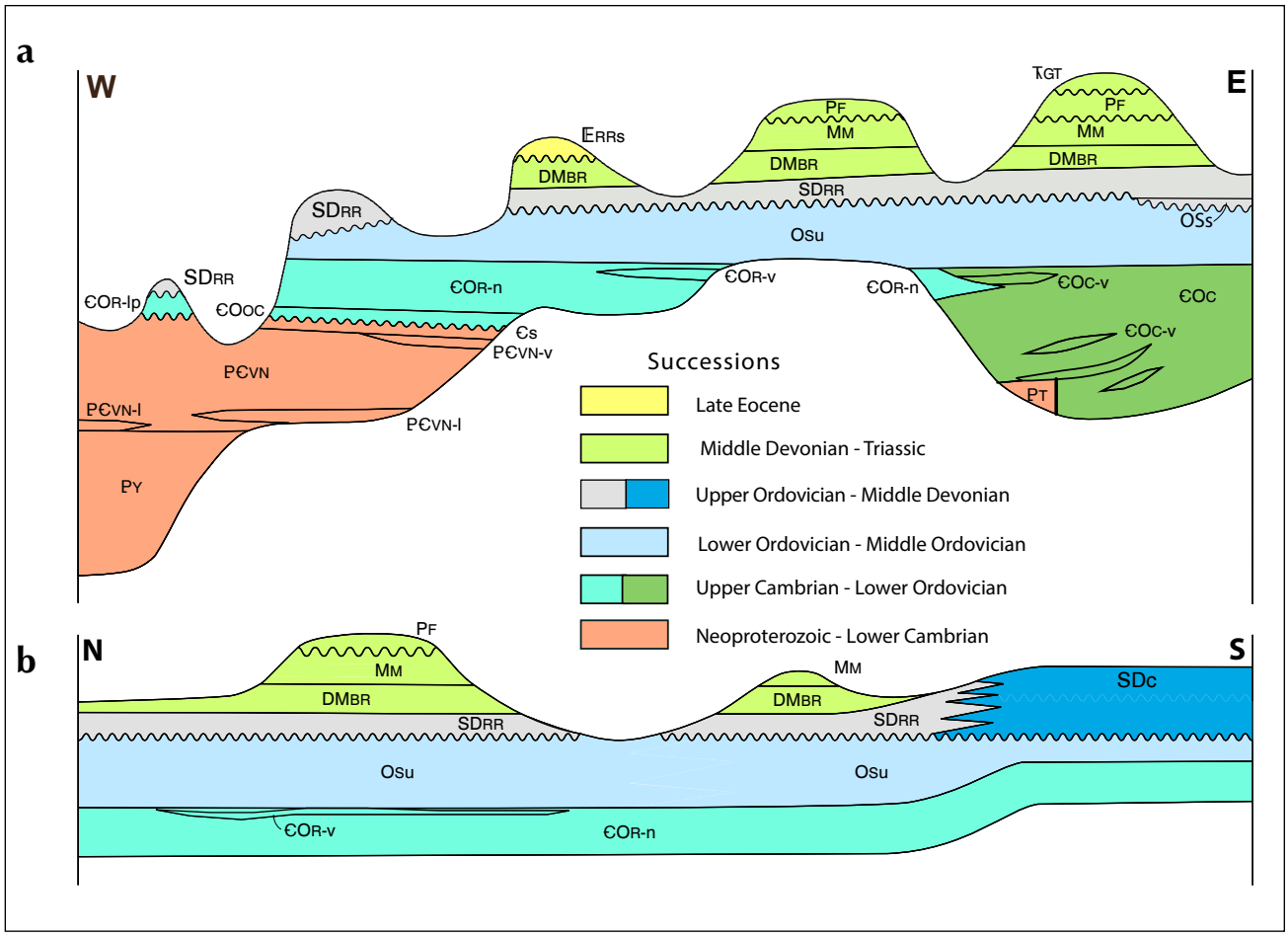

Figure 4. *Schematic correlation diagrams of stratigraphic successions, from* ***(a)*** *west to east and* ***(b)*** *north to south across the Coal River map area.*

Succession 4 includes the lateral transition from lower Silurian to Middle Devonian carbonate platformal sedimentary rocks of Macdonald platform (single map unit combining the Nonda, Muncho-McConnell, Stone and Dunedin formations) in the southern third of the map area, to fine clastic, basinal sedimentary rocks of Selwyn basin (Road River Group, undivided) northward. A basal coarse-grained, siliciclastic unit (Oss) occurs only in the eastern part of the map area.

Succession 5 comprises Middle Devonian through Triassic shallow marine shale, siltstone and sandstone (Besa River, Mattson, Fantasque and undivided Grayling-Toad formations) that represent multiple regional transgressive-regressive cycles separated by unconformities.

Succession 6 consists of the late Eocene fluvial strata and coal in the intermontane Rock River basin occurring in the north-central part of the map area and a single occurrence of Paleocene basalt and fluvial sediments on the far eastern edge of the map area.

The descriptions of these lithologic units augment those previously published for southeast Yukon (Pigage, 2006, 2009). Regional correlations include more recent information from adjacent regions (specifically northeastern British Columbia). Geographic place names used in the following descriptions are indicated on Plate 1 and Figure 1.

SUCCESSION 1 - NEOPROTEROZOIC TO LOWER CAMBRIAN

Predominantly siliciclastic sediments and minor carbonate and volcanic rocks are exposed extensively in the western third of the Coal River map area. A smaller exposure lies west of the upper Toobally Lake in the east-central part of the area. The western region includes Yusezyu and Narchilla formations of the Hyland Group, Vampire Formation, and silty phyllite, sandstone, and limestone considered equivalent to Sekwi Formation. The areally limited exposures in the east comprise the Toobally Formation. Proterozoic sandstone (unit Ps of Pigage, 2009) and argillite (unit Pa of Pigage, 2009) are exposed immediately east of Coal River map area, and possibly underlie the Toobally Lakes region.

Toobally Formation (PT)

Introduction

The Toobally Formation (Pigage and MacNaughton, 2004) occurs in scattered exposures immediately west of upper Toobally Lake. It consists of a monotonous succession of orange-weathering, polymictic, matrix-supported conglomerate to pebbly mudstone (Fig. 5) with a minimum thickness of 1800 m (assuming a regional 45° dip). The lower contact is structural as the unit occurs in the immediate hanging wall of the east-verging Toobally reverse fault. The upper contact with the overlying Crow Formation is unconformable.

Figure 5. *Pebbly mudstone of the Toobally Formation, with slaty cleavage, dipping to the left (west). Hammer handle is 33 cm long. West of upper Toobally Lake, station 03LP006.*

Composition

Bedding generally cannot be seen at outcrop scale. In rare cases, normally graded to indistinctly gradational beds can be recognized within the unit. It contains a moderately developed, pervasive slaty cleavage which gradually becomes more intense toward the Toobally fault to the east.

The matrix for the conglomerate to mudstone consists of dark brown to dark grey, brown, buff, or orange-weathering silty shale to siltstone and accounts for 50 to 80% of the total rock volume. Clasts are most commonly within the granule to pebble size range; cobbles are rarely present. They are angular to subrounded, without preferred orientation. Numerous clast compositions were observed, including quartzitic meta-sandstone, calcareous sandstone, lithic sandstone, mudstone, massive lime mudstone and dolo-mudstone, laminated lime mudstone, massive grainstone and rare fragments of vesicular to amygdaloidal basalt. At one locality the formation contains a large olistolith of orange-weathering, unfossiliferous, microcrystalline to very finely crystalline, thinly bedded dolostone at least 20 m thick. The upper contact of the dolostone has not been observed; the lower contact is sharp and stained red (*see* Pigage, 2009, p. 22, for more description).

The Toobally Formation is cut by dark green, orange-weathering, fine-grained, diabase to gabbro dikes and sills from less than 10 cm to greater than 10 m thick (too small to show on the map). In many outcrops the dikes and sills are extensively altered to a pale grey, orange-weathering, pyritic carbonate-sericite assemblage. The geochemistry of the dikes and sills is similar to that for the Crow Formation volcanic rocks, and they are considered to be feeders for the overlying Crow Formation volcanic rocks (Pigage, 2009); the analyses are listed in Appendix C but are not included in the discriminant diagrams.

Age, Correlation and Depositional Setting

Fieldwork in 2003 (Pigage and MacNaughton, 2004) found no definitive evidence for glacial deposition (*i.e.*, dropstone and lonestone in associated sediment, till pellets, striated clasts). This polymictic lithotype can be deposited under glacial or non-glacial conditions (Eyles, 1990). Pigage and MacNaughton (2004) interpreted the Toobally Formation as being deposited from relatively viscous, sediment-gravity flows in a marine slope to toe-of-slope setting.

Pigage (2009) discussed possible depositional ages for this stratigraphic unit. One detrital zircon sample contained a youngest detrital zircon age of about 650 Ma (2 grains; *see* Pigage, 2009). The preferred depositional age is late Neoproterozoic (post-650 Ma). Rare basaltic clasts indicate an earlier period of volcanism in the paleo-drainage (Pigage, 2009).

In spite of the lack of direct evidence for the Toobally Formation being a glacial deposit, Pigage and MacNaughton (2004) noted that the unit resembles Neoproterozoic Sturtian and Marinoan glacial diamictites previously documented in northwestern Canada: the Shezal Formation (Eisbacher, 1978, 1981) and the Ice Brook Formation (Aitken, 1991). A recent U-Pb single grain dating (CA-ID-TIMS) on a volcanic tuff within the Sayeuni Formation stratified diamictites resulted in a date of 716.5 ± 0.2 Ma for the earlier Sturtian glaciation (Macdonald *et al.*, 2010). A Re-Os date of 662.4 ± 3.9 Ma for the Twitya Formation (Rooney *et al.*, 2014) places a maximum age constraint on the Ice Brook Formation (Marinoan glaciation). Detrital zircon results for the Toobally Formation (see above) are consistent with correlation of the Toobally Formation with the Ice Brook Formation of the Windermere Supergroup.

Hyland Group

The Hyland Group (Gordey and Anderson, 1993) is the oldest widely exposed unit of Selwyn basin. It outcrops nearly continuously from the Alaska-Yukon border north of the Yukon River, southeast to

the Northwest Territories-Yukon border, and extends 130 km into northern British Columbia and the headwaters of the Tuchodi River (59°N; Wheeler and McFeely, 1991). Where defined in the southern Little Nahanni River map area (140 km northwest along structural grain from the northwest corner of Coal River map area; Fig. 1) it consists of pebbly sandstone with interbedded shale of the Yusezyu Formation, overlain by greyish green and maroon shale of the Narchilla Formation. The uppermost part of the Yusezyu Formation contains numerous discontinuous orange-weathering, dark, shaly to silty limestone lenses that Gordey and Anderson (1993) informally called the limestone member. This middle carbonate is increasingly prominent northward, and Cecile (2000) formally established the Algae Formation in Niddery Lake map area (400 km north of Coal River). Regionally the Yusezyu Formation is Neoproterozoic (Ediacaran), and the Narchilla Formation is Neoproterozoic (Ediacaran) to possibly lower Cambrian (Fortunian; uppermost stage 2?).

The Hyland Group strata are the oldest strata in the western third of the Coal River map area. Only the Narchilla and Yusezyu formations are recognized; a mappable Algae Formation is not present and mappable calcareous strata occur entirely within the Narchilla Formation.

Yusezyu Formation (Hyland Group) (PY)

Introduction

The Yusezyu Formation (Gordey and Anderson, 1993) is exposed in two northwest-trending belts in the westernmost Acland thrust fault panel of the Coal River map area (Plate 1). The base of the formation was not observed; the upper contact with the overlying Narchilla Formation is gradational, although locally faulted (Plate 1). The contact with the overlying Narchilla Formation was placed at the gradational transition demarcated by an up-section decrease in the amount of pebbly sandstone and quartz sandstone and a corresponding increase in green and/or maroon, noncalcareous, silty phyllite; this transition occurs over an interval of tens of metres to hundreds of metres.

At the type section (in the Little Nahanni River map area), the Yusezyu Formation is at least 3000 m thick (Gordey and Anderson, 1993). In the Coal River map area only the upper part of the formation is exposed, and a lack of marker horizons make structural repetition difficult to recognize. An inferred thickness of approximately 3500 m is used in the cross section interpretation (Plate 1).

Composition

In Coal River the Yusezyu Formation consists predominantly of noncalcareous, grey to cream sandstone to pebbly sandstone (Fig. 6) interbedded with brown-weathering, non-calcareous, medium to pale green phyllite and rare fine-grained, grey limestone. In the pebbly sandstones the predominant coarse clasts are clear to bluish quartz with lesser subangular, white feldspar. Bedding is on a scale of centimetres to metres; exposures typically have gentle dips. In contrast to the type area of the Yusezyu Formation (Gordey and Anderson, 1993) no limestone is present at the top of the Yusezyu Formation in the Coal River map area.

Figure 6. *Yusezyu Formation sandstone, showing the bedding contact between coarse and fine-grained beds. White granules are quartz in a noncalcareous, coarse-sand matrix. Black bars on scale at right are in cm. From 20 km north of Hulse (Quartz) Lake, station 09RAS058.*

Age, Correlation and Depositional Setting

In the Coal River map area the Yusezyu Formation is unfossiliferous. Regionally the upper part of the formation is of latest Precambrian age (Ediacaran) based on primitive trace fossils reported by Fritz *et al.* (1983).

The pebbly sandstone of the Yusezyu Formation is correlated by Fritz *et al.* (1983) with the lower member of the Backbone Ranges Formation (*cf.* MacNaughton *et al.*, 2008) on the basis of trace fossils in overlying strata and stratigraphic position. Moynihan (2014) correlated the Yusezyu Formation with an uppermost member of the Blueflower Formation in the northernmost Selwyn basin area. These two correlations are compatible only if the entire Backbone Ranges Formation indicated by Moynihan corresponds to only the upper member of the Backbone Ranges Formation.

The Yusezyu Formation is a thick succession of coarse-grained turbidite flows that reflect rapid erosion of a sedimentary source terrane of unknown extent and location (Gordey and Anderson, 1993). Scarce paleocurrent indicators suggest that the source area is located to the northwest. The suggested depositional environment is a series of upper or mid-fan submarine channels in shallow to moderate water depth (Gordey and Anderson, 1993).

One sample of Yusezyu Formation (09LP014) from the west side of the Coal River map area was submitted for detrital zircon study. The table of analyses from this sample is contained in Appendix B (Tables B2a,b,c). Figure 7 illustrates the Concordia diagram and the probability distribution plot for the sample. The sample contains two Neoproterozoic to Mesoproterozoic ages, 631 ± 29 Ma and 1115 ± 109 Ma. All other dates are Paleoproterozoic and Archean. The probability distribution plot has a dominant peak centred on 1859 Ma and a lesser peak at 2719 Ma. Scattered peaks range between 1937 Ma and 2606 Ma. The oldest dated grain has an Archean age of 2745 ± 51 Ma. The dominant age distribution of detrital zircons corresponds to the Laurentia Type I signature identified by Hadlari *et al.* (2012); the zircons could be derived from the Wopmay orogen and the Archean Slave province east and northeast (current orientation) of the Coal River map area.

This interpretation contrasts with a northwestern source indicated by the limited paleocurrent data of Gordey and Anderson (1993). The western extent of the Yusezyu Formation is unknown because it is truncated by the Tintina fault. As a result the provenance of Yusezyu Formation remains unresolved.

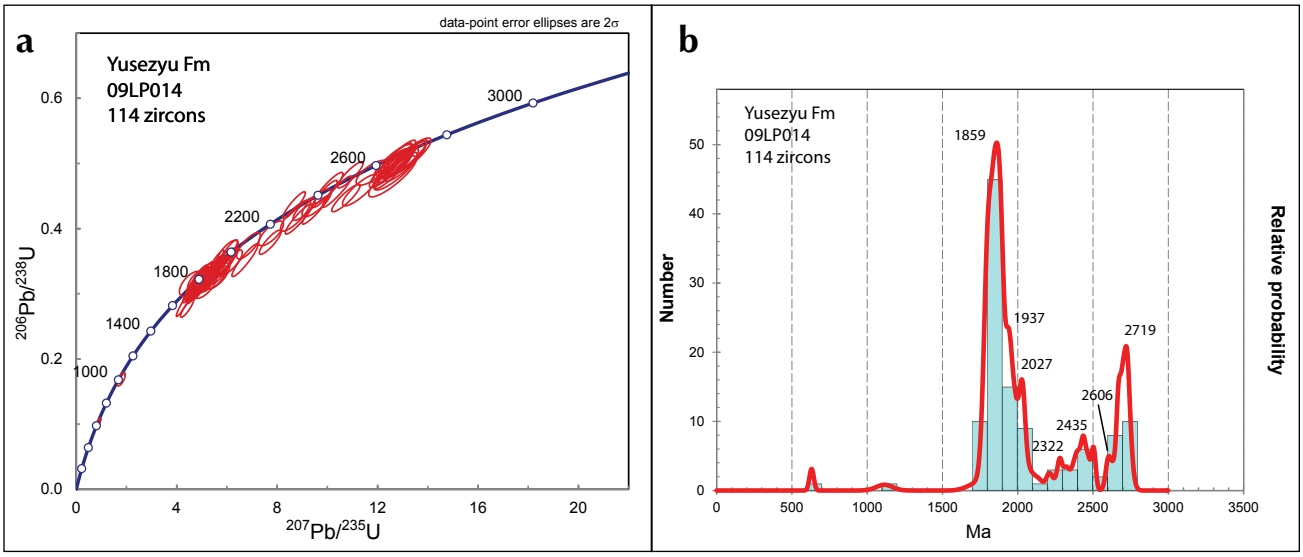

Figure 7. *Results of geochronological analysis of 114 detrital zircon grains from sample 09LP014 of Yusezyu Formation sandstone:* ***(a)*** *concordia diagram;* ***(b)*** *probability distribution diagram. Data and methods are shown in Appendix B (Table B2).*

Vampire-Narchilla unit (Hyland Group) (PЄVN, PЄVN-m, PЄVN-l, PЄVN-v)

Introduction

Shaly strata lithologically similar to both the Narchilla Formation (Gordey and Anderson, 1993) and Vampire Formation (Fritz, 1982) are exposed in the western third of the map area. Observations of previous workers in the northern part of the Coal River map area (Abbott, 1981) and in areas farther north (Fritz, 1982; Gordey and Anderson, 1993) indicate a west-to-east transition from Narchilla Formation (dominantly slate to phyllite) through Vampire Formation (dark weathering siltstone interbedded with quartzose sandstone) to the upper member of the Backbone Ranges Formation (sandstone; MacNaughton *et al.*, 2008). In 2009 we were unable to consistently differentiate the Vampire and Narchilla formations. Consequently we chose to map these units as an undivided Vampire-Narchilla unit.

The lower contact with the Yusezyu Formation is poorly exposed but appears to be a gradational decrease up-section in the amount of subarkosic pebbly sandstone and a corresponding increase in shale and siltstone. In the central part of the map area immediately west of the Rock River, the unit is conformably overlain by siltstone, sandstone and carbonate rocks of unit Ꞓs, the lower Cambrian Sekwi-correlative unit. The undivided Vampire-Narchilla unit is unconformably overlain by the late Cambrian to Early Ordovician Rabbitkettle or Otter Creek formations in the western part of the map area.

The thickness of the Narchilla Formation at the type section is 828 m (Gordey and Anderson, 1993). The type section of the Vampire Formation is 930 m thick (Fritz, 1982). In the Coal River area the thickness of the Vampire-Narchilla unit is interpreted to be significantly greater, based upon the geometric requirements of a structurally plausible cross section; the thickness of this unit could be as much as 2500 m.

Composition

The predominant lithology (Fig. 8) is a pale olive green, rusty brown-weathering, noncalcareous, laminated, silty phyllite (PЄVN). Bedding within the phyllite is denoted by colour variations and is on the scale of centimetres to metres. Locally the pale green phyllite contains interbeds of reddish maroon to dark maroon phyllite (PЄVN-m; Fig. 9); this maroon phyllite is regionally characteristic of the Narchilla Formation. West of the West Coal River, maroon interbeds are common within the green silty phyllites. In contrast maroon interbeds are rare in the southwestern quadrant of the map area. No maroon intervals were observed in the silty phyllite immediately west of the Rock River.

The phyllite contains interbeds of medium to dark grey, cream-weathering siltstone, cream-weathering, quartzose sandstone (Fig. 10), cream-weathering, pebbly quartzose sandstone and pale to medium grey, thick-bedded to massive limestone (PЄVN-l). The sandstone, pebbly sandstone and limestone intervals locally reach thicknesses of 100 m or more without apparent structural repetition. Only the interbedded limestone units have been differentiated as separate lithologies in the legend.

The Vampire-Narchilla unit consistently displays a pervasive slaty cleavage (Figs. 8, 9, 10). Locally it also contains a later, spaced crenulation cleavage. Throughout most of the area the phyllite contains sericite and chlorite, placing it in the lower greenschist facies of metamorphism. In a north to northeast-trending linear zone extending from south of Roy Lake northeastward to Mt. Skonseng, the phyllite contains ubiquitous biotite with local garnet and staurolite (Fig. 11). The areal extent of the biotite-bearing phyllite was not well defined by the few traverses completed in 2009.

Figure 8. *Olive green, silty phyllite of the undivided Vampire-Narchilla map unit. Slaty cleavage (steeply dipping north-northeast) offsets the horizontal bedding, which is marked by a thin, recessive siltstone layer. From 20 km northwest of the eastward bend of the Coal River, station 09LP028. Hammer handle is 33 cm long.*

Figure 9. *Banded maroon and green phyllite of the undivided Vampire-Narchilla map unit. The colour change represents oxidation-reduction fronts during diagenesis of the muddy sediment and typically follows layering. From east of Coal River and west of the headwaters of Otter Creek, station 07LP003.*

Figure 10. *Phyllitic siltstone interbedded with light brown quartz sandstone in the undivided Vampire-Narchilla map unit. Note the centimetre-scale cross-beds (mostly dipping to the left in the photograph) in the sandstone beds and slaty cleavage in the phyllitic siltstone beds (dipping to the right). Outcrop 20 km north of Alaska Highway, station 09LP022.*

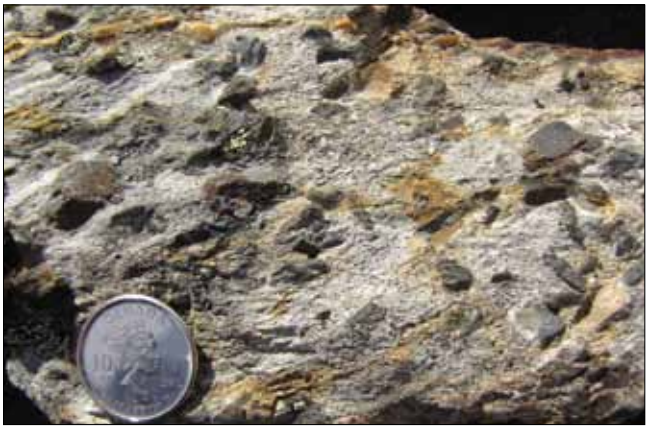

Figure 11. *Staurolite-garnet-biotitite schist of the undivided Vampire-Narchilla map unit. From 30 km northeast of Roy Lake, station 09TOA076. The coin is 2.5 cm in diameter.*

In the central Coal River map area, immediately west of the Rock River, the upper part of the Vampire-Narchilla unit contains extensive greyish-green to green, fine-grained, locally amygdaloidal to vesicular basalt which we have differentiated as a separate unit (PЄVN-v). Lower and upper contacts are not exposed; these could be flows or sills. Locally the basalt is intruded by fine to medium-grained, equigranular, chloritized hornblende diabase that likely represents feeders. The basalt and diabase form a mappable unit up to 1300 m thick. Their geochemistry is discussed in the section on Cambro-Ordovician alkali basalt (see p. 42).

Age, Correlation and Depositional Setting

We did not recognize any fossils in the Vampire-Narchilla unit in the Coal River map area. Regionally the Vampire Formation contains ichnofossils from biozones Rusophycus avalonensis and Cruziana tenella (Fritz *et al.*, 1983; MacNaughton and Narbonne, 1999). The first appearance (datum) of trilobites and archeocyathids occurs within the very uppermost Vampire Formation and the overlying Sekwi Formation (Handfield, 1968). The age of the Vampire-Narchilla unit is therefore early Cambrian (Terreneuvian: Stages Fortunian and 2). Occurrences of the ichnofossil Oldhamia radiata in the upper part of the unit in Niddery Lake map area (Hofmann and Cecile, 1981) are consistent with the upper portion of the unit being within Cambrian Stage 2 (Herbosch and Verniers, 2011).

Time-correlative formations north of the Coal River map area display a complex succession of interlayered coarse and fine siliciclastic formations (Fig. 12) deposited in Selwyn basin.

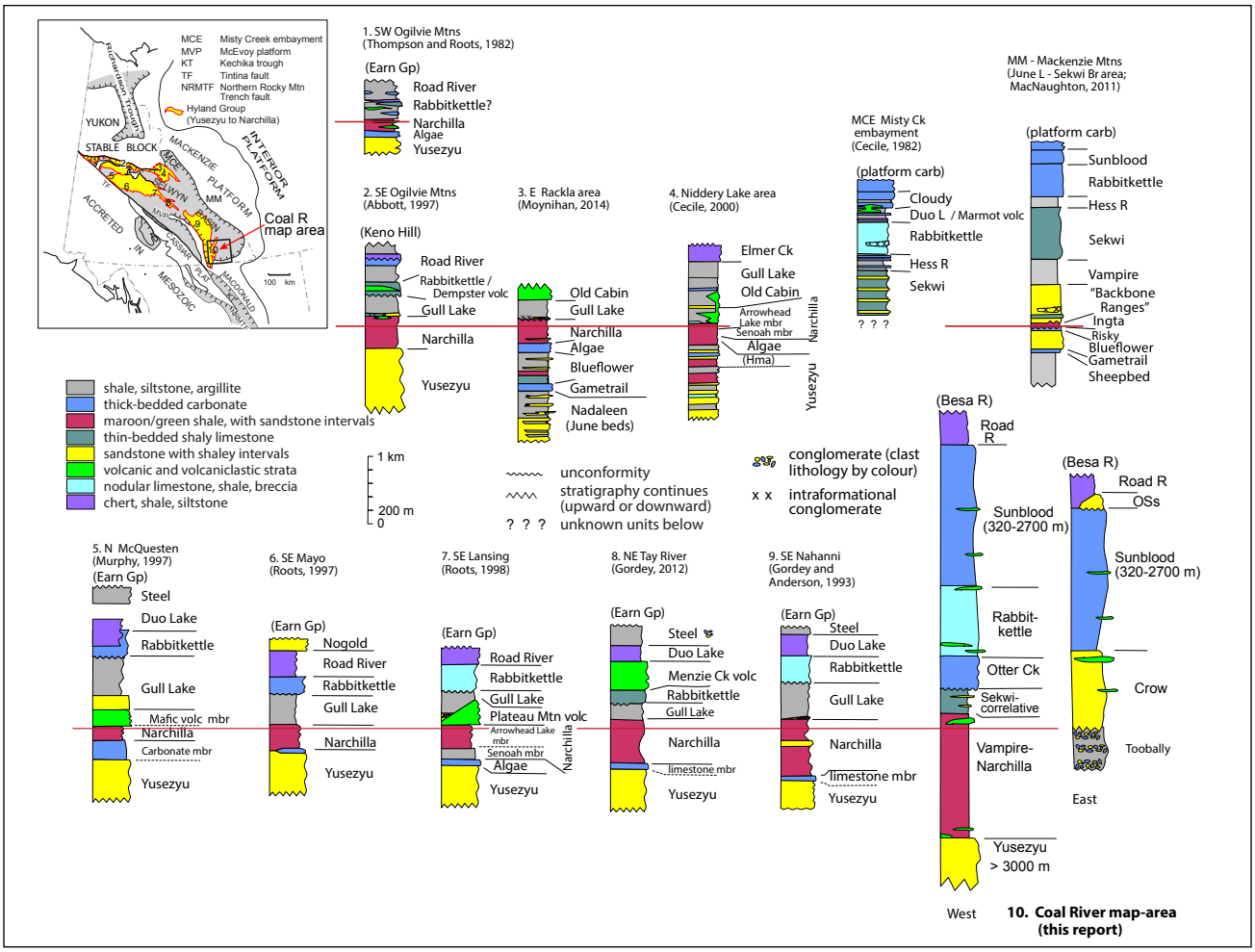

Figure 12. *Regional correlation of stratigraphic units that compose Selwyn basin (and Mackenzie Mountains [MM] for comparison). Representative columns were selected from the numbered areas and depict thicknesses as given in the citations; the datum is approximately the Cambrian-Precambrian boundary. Overlying units are labeled in parentheses. This figure is modified from Figure 36 in Gordey and Anderson (1993) and Figure 5 in Cecile (2000).*

Two sandstone samples from the undivided Vampire-Narchilla unit were examined for detrital zircon geochronology (09TOA098 and 09TOA094). Results are tabulated in Appendix B (Tables B3 and B4) and illustrated in Figures 13 and 14. Four zircon grains from sample 09TOA098 indicate a maximum

age of 644 Ma, and one grain from sample 09TOA094 indicates a maximum age of 560 Ma for the unit.

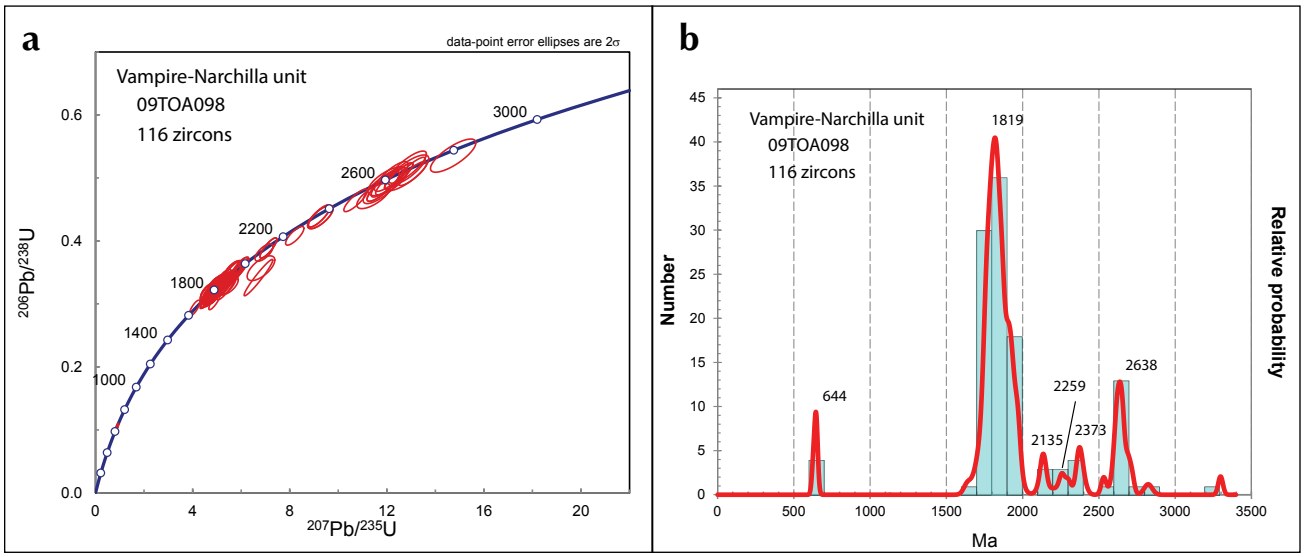

Figure 13. *Results of geochronological analysis of 116 detrital zircon grains from sample 09TOA098 of undivided Vampire-Narchilla map unit sandstone:* ***(a)*** *Concordia diagram;* ***(b)*** *probability distribution diagram. Data and methods are shown in Appendix B (Table B3).*

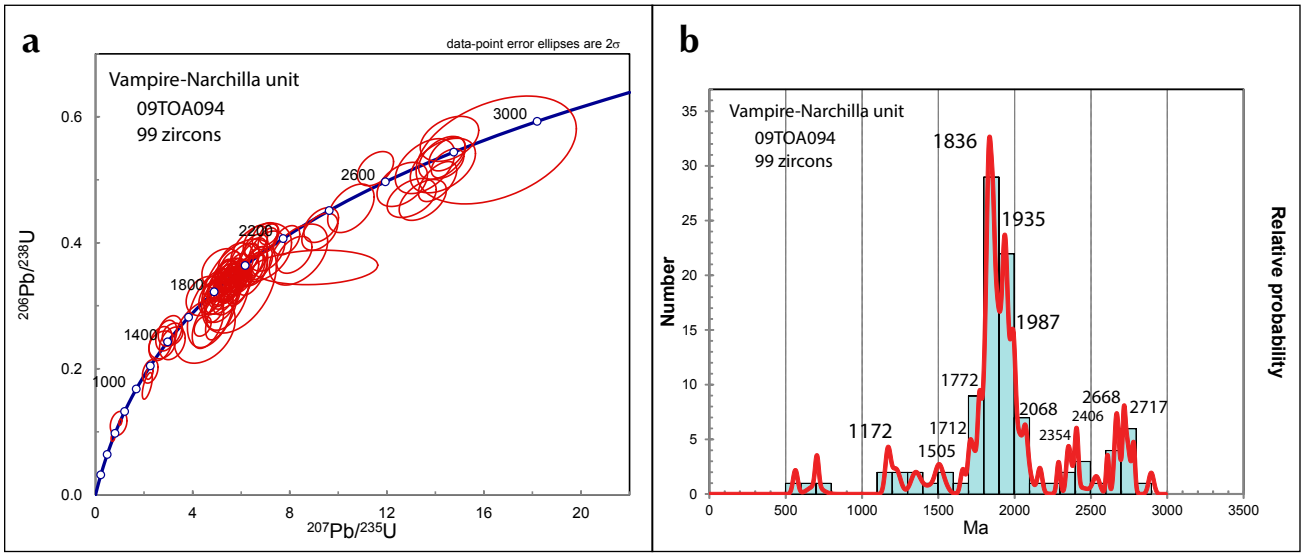

Figure 14. *Results of geochronological analysis of 99 detrital zircon grains from sample 09TOA094 of undivided Vampire-Narchilla map unit sandstone:* ***(a)*** *Concordia diagram;* ***(b)*** *probability distribution diagram. Data and methods are shown in Appendix B (Table B4).*

Sample 09TOA098 has a similar probability plot to that of the Yusezyu Formation with a major peak at 1819 Ma and lesser peaks at 2373 Ma and 2638 Ma. In contrast, sample 09TOA094 contains a different zircon age distribution. About 15% of the analyzed grains are within the interval from 1000-1550 Ma. More than 30% of the grains are between 1700 and 1800 Ma.

Hadlari *et al.* (2012) identified two major detrital zircon signatures for Cambrian strata in the Northwest Territories. These signatures closely match those identified above for samples 09TOA094 and 09TOA098. The Laurentia type I signature (sample 09TOA098) is dominated by Paleoproterozoic and Archean detrital zircon ages with potential sources including the Great Bear magmatic zone, Fort

Simpson terrane, Hottah terrane, Coronation margin and Slave craton. The Laurentia type II signature (sample 09TOA094) contains abundant Mesoproterozoic ages. The source area is dominated by Grenville-aged detrital zircons; proximate sources are most likely Proterozoic strata of the Mackenzie Mountains and Shaler supergroups. The fewer grains of Paleoproterozoic and Archean age could have the same source area as the Laurentia type I signature. Both of these source areas are east to northeast of the Coal River map area.

In summary, detrital zircon ages from the two samples are consistent with erosion of Paleoproterozoic and Archean bedrock in northern Alberta and Northwest Territories. A small number of zircon grains are most likely recycled from exposed Mackenzie Mountains Supergroup strata at the time of deposition of this Vampire-Narchilla unit. An easterly source was also determined for the Backbone Ranges Formation (Leslie, 2009).

Although we chose to assign these lithologies to a combined Vampire-Narchilla map unit, in a broader context the Narchilla and Vampire formations are differentiated regionally (Abbott, 1981; Fritz, 1982). For consistency with the regional treatment of this stratigraphic interval we assign our combined map unit to different formations in the Yukon-wide geology compilation according to the structural panel in which it appears. The western-most domain A structural panel is considered to be the Narchilla Formation, and exposures in the two more easterly structural panels have been assigned to the Vampire Formation.

Unit Ꞓs (Sekwi-correlative unit)

Introduction

Ridges west of the Rock River in the north-central map area contain exposures of silty phyllite, silty, archeocyathid-bearing limestone, arkosic sandstone and quartzose sandstone. We have informally called this unit the 'Sekwi-correlative' unit because it is correlative in time with the Sekwi Formation. We are not calling it the Sekwi Formation because lithologies in the Coal River area differ from the predominant carbonate rocks described for the Sekwi Formation at the type section (Handfield, 1968) located 300 km to the north.

Unit Ꞓs conformably overlies the Vampire-Narchilla unit and is unconformably overlain by carbonate rocks of the upper Cambrian-lower Ordovician Otter Creek Formation. The overall thickness of unit Ꞓs is approximately 400 m where it is most completely exposed. The unit could not be traced beyond a strike length of 22 km; this is a minimum extent because we were unable to recognize it with our limited traverses. Alternatively it may have been removed by the unconformity beneath the overlying Otter Creek Formation.

Composition

Unit Ꞓs consists predominantly of pale green to tan, brown-weathering, laminated, locally calcareous, silty phyllite (Fig. 15). Interbedded with the silty phyllite are rusty brown-weathering, thin bedded arkosic sandstone, cream-weathering, fine-grained quartzose sandstone and laminated, silty limestone. The lower contact with the Vampire-Narchilla unit is denoted by the first appearance of recessive-weathering limestone nodules in the siltstone (Fig. 15), the occurrence of trilobites, and the presence of green, argillaceous siltstone. A silty limestone bed occurs at this basal contact. Arkosic sandstone intervals up to 10 m thick occur throughout the lower part of the unit. A cream-weathering, noncalcareous, quartzose sandstone forms a distinctive thick-bedded unit 70 m thick at the top of the unit. Medium to dark grey and orange-weathering limestone near the middle of the unit contains archeocyathids (Fig. 16) and occurs locally as bioherms or bioclastic sediments (Handfield, 1971). Trilobites were found in the silty phyllite stratigraphically below and above the archeocyathid-bearing limestone (Handfield, 1971).

Figure 15. *Light brown-weathering, grey, calcareous phyllite at the base of the Sekwi-correlative unit. Dark hollows up to 3 cm long are recessive-weathering carbonate nodules. From 17 km northeast of the confluence of Quartz Creek with Coal River, station 09TOA15. Scale card at top edge of photo is in cm.*

Figure 16. *Thick limestone near the middle of the Sekwi-correlative unit (Ꞓs) containing archeocyathids. Outcrop is 3 km northeast of the confluence of Quartz Creek with Coal River, station 09TOA017.*

Age, Correlation and Depositional Setting

The trilobite and archeocyathid fossils (see Appendix A) indicate the formation is lower Cambrian, contemporaneous with the Sekwi Formation. Although differing in detail, the trilobite identifications by Handfield (1971) and L. Bohach (pers. comm. 2009) indicate the age of unit Ꞓs is lower Cambrian Series 2 (Stage 3 or Stage 4). Fritz (1972) delineated three trilobite zones within the type Sekwi Formation (Fallotaspis, Nevadella and Bonnia-Olenellus zones); these correspond to Stages 3 and 4 in Series 2 of lower Cambrian (Peng *et al.*, 2012).

Unit Ꞓs is a deeper water facies-equivalent of the Sekwi Formation. In the Selwyn basin area, the lower Cambrian shale facies is known as Gull Lake Formation (Fig. 12; Gordey and Anderson, 1993), but the strata in Coal River map area is more calcareous and siltier than Gull Lake Formation. The unit is envisaged to have been deposited on a westward deepening, homoclinal ramp, similar to that described in Sekwi Mountain map area 100 km to the north (Fischer and Pope, 2012).

The northern part of the Kechika trough southwest of the Coal River map area, contains a facies change from interbedded early Cambrian siliciclastic rocks and carbonate rocks eastward to deeper water siliciclastic rocks, possibly indicative of the western edge of Kechika trough (Ferri *et al.*, 1999). Archeocyathids in the carbonate intervals indicate the package is correlative with the Sekwi Formation (and with Unit Ꞓs in the Coal River map area).

Two samples (09TOA095 and 09TOA096) from this unit were analyzed for detrital zircon geochronology. Analytical results are illustrated in figures 17 and 18; analytical tables are listed in Appendix B (Tables B5 and B6). The zircons of both samples can be grouped into three clusters: those consistent with Mesoproterozoic Grenville age (1.0-1.5 Ga); those of Paleoproterozoic age possibly derived from the Hottah terrane and Great Bear Magmatic zone (1.8-2.1 Ga); and those of Archean Slave craton (>2.5 Ga) age. The detrital zircons indicate a mix of the Laurentia type I and type II signatures as identified by Hadlari *et al.* (2012). All three clusters can be attributed to basement and Mackenzie Mountain Supergroup sources that are exposed to the east in Alberta and Northwest Territories.

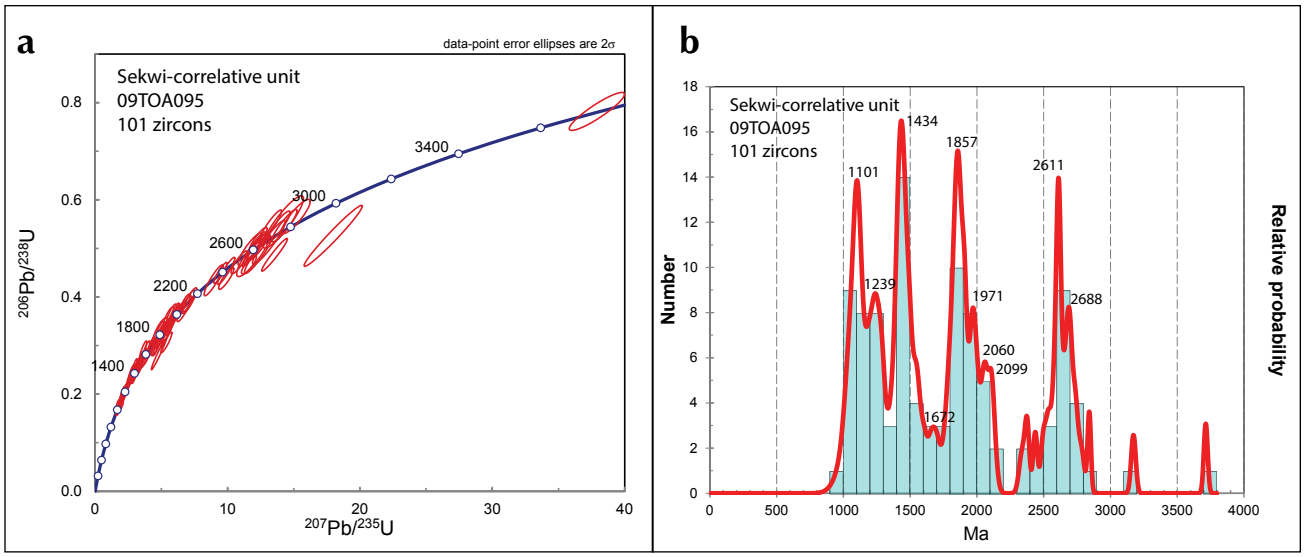

Figure 17. *Results of geochronological analyses of 101 detrital zircon grains from sandstone in Sekwi-correlative unit:* ***(a)*** *Concordia diagram;* ***(b)*** *probability distribution diagram. Data and methods are shown in Appendix B (Table B5), station 09TOA095.*

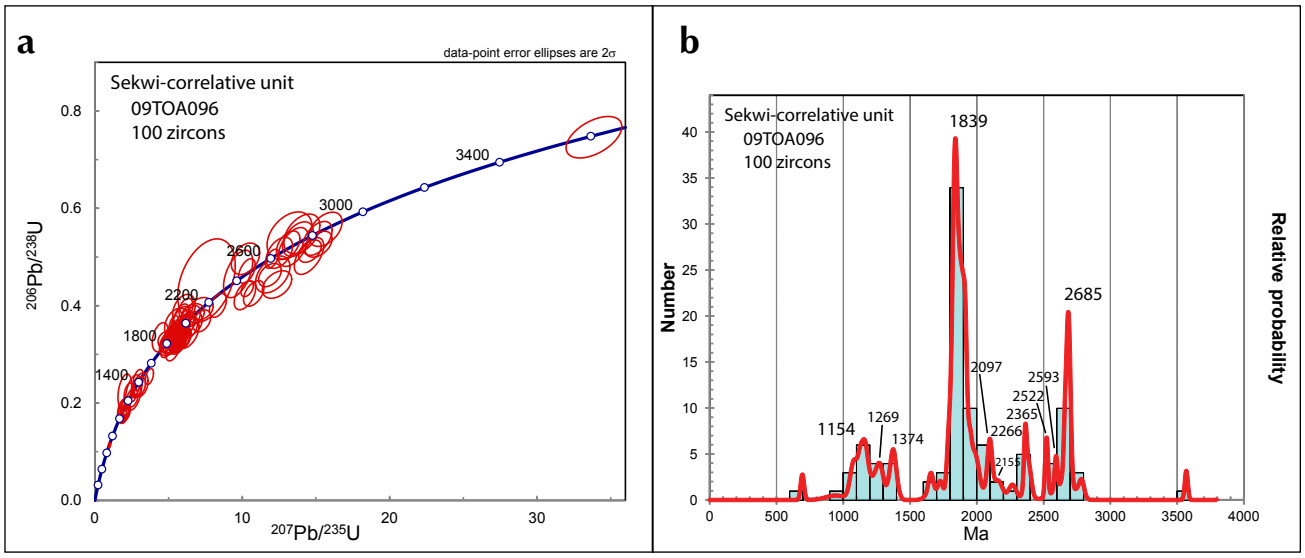

Figure 18. *Results of geochronological analysis of 100 detrital zircon grains from uppermost sandstone of Sekwi-correlative unit:* ***(a)*** *Concordia diagram;* ***(b)*** *probability distribution diagram. Data and methods are shown in Appendix B (Table B6), sample 09TOA096.*

SUCCESSION 2 – UPPER CAMBRIAN TO LOWER ORDOVICIAN

Succession 2 consists of three stratigraphic units having a composite age range of late Cambrian through Early Ordovician and a combined thickness of approximately 5000 m. The lowermost unit in the succession is a thick-bedded to massive limestone and dolostone, outcropping largely in the central part of the map area; this unit is defined in this report as the Otter Creek Formation. Silty to phyllitic limestone of the Rabbitkettle Formation conformably overlies the Otter Creek Formation. The western half of the Coal River map area contains two facies of the Rabbitkettle Formation. In the eastern half of the map area quartzose sandstone of the Crow Formation appears to interdigitate with the time-equivalent Rabbitkettle Formation. The lower contact of this entire succession is unconformable, and the upper contact is conformable.

Otter Creek Formation (ЄOOC) *[new]*

Introduction

This unit comprises massive limestone and lesser dolostone (mapped by Gabrielse and Blusson (1969) as unit 5, presumed lower Cambrian), here defined as the Otter Creek Formation. Several narrow belts of exposure lie between the Rock and Coal rivers (Plate 1). The type area for the formation is in NTS 95D/06 at the Mel property (UTM NAD83 587 950 E/6 692 150 N) where a complete section of this formation is exposed (Fig. 19) in the overturned steep limb of an east-verging, asymmetric anticline-syncline fold couplet. The type area is located near the headwaters of Otter Creek, after which the formation is named.

Figure 19. *Massive limestone of Otter Creek Formation in the overturned steep limb of an asymmetric syncline. View northward at the head of Otter Creek, near the MEL occurrence, from station 06LP008. This is the proposed type location for the Otter Creek Formation.*

Both upper and lower contacts are recessive and not observed at surface in the dense vegetation cover. The contacts were recognized in diamond drill holes on the Mel property. The lower contact is sharp and interpreted as a major unconformity above the lower Cambrian Vampire-Narchilla unit. The conformable upper contact with the calcareous shale and silty limestone of the Rabbitkettle Formation is sharp.

On the Mel property, the Otter Creek Formation is approximately 160 m thick. Thickness estimates in the Coal River map area range from 65 m on the Jeri North property (Yukon MINFILE 095D 035) to 500 m in outcrops west of the Rock River in the northern part of the Coal River map area.

Composition

The Otter Creek Formation weathers light grey to off-white, and consists of finely crystalline, indistinctly bedded to massive, resistant limestone (Fig. 20) with lesser interbeds of buff to tan-weathering dolostone. The limestone typically contains ghosted white calcite and tan siderite veinlets. In at least one location the limestone has ghost textures reminiscent of burrow mottling. In the type area the limestone contains small, irregular lenses of pale green to cream, noncalcareous phyllite to mudstone (Fig. 21).

Dolostone lenses have a massive, sucrosic texture. Miller (1977) described three stratiform, discontinuous dolostone intervals up to 30 m thick and ranging from 60 to 500 m in length. One dolostone occurrence, up to 30 m thick, occurs adjacent to a late steep fault and clearly crosscuts primary bedding.

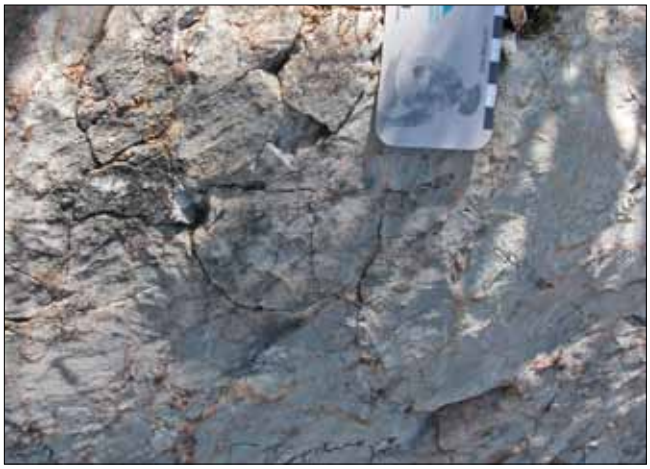

Figure 20. *Light coloured, massive, fine-grained limestone with irregular network of buff to tan-weathering dolostone veinlets, Otter Creek Formation. From the headwaters of Otter Creek near the MEL occurrence, station 06LP008.*

Figure 21. *Olive-green mudstone with limestone (light grey), Otter Creek Formation. Drill core from 254 ft depth in Hole 74-6 (Bostock core collection) at the MEL mineral occurrence. Scale bar is in cm.*

Age, Correlation and Depositional Setting

Identified brachiopods and trilobite fragments (Norford, 1984; Miller and Wright, 1986) from the limestone are late Cambrian to Early Ordovician; on this basis Pigage (2008) describes the limestone as a basal member of the Rabbitkettle Formation. Additional occurrences recognized during regional mapping in 2009 prompts its reinterpretation as a distinct carbonate unit underlying silty limestone of the Rabbitkettle Formation.

Gordey and Anderson (1993) describe a Cambrian-Ordovician to Silurian dolostone, the Haywire Formation, partially underlying Rabbitkettle Formation in the Little Nahanni River map area. Otter Creek Formation is considered correlative with the lowermost part of the Haywire Formation. It represents the western margin of the shallow carbonate platform during late Cambrian to Early Ordovician.

Rabbitkettle Formation (ЄOR-n, ЄOR-lp, ЄOR-v)

Introduction

Rabbitkettle Formation, as defined by Gabrielse *et al.* (1973) in southwestern Mackenzie Mountains, is a silty limestone widely recognized in Selwyn basin. It occurs in north-trending belts in the western and central Coal River map area, in the core of the Caribou anticline, and in one exposure near the Gusty Lakes. Fissile carbonate outcrops in the northeast corner of the map area were visually identified from the helicopter as Rabbitkettle.

In the western part of the map area, the Rabbitkettle Formation unconformably overlies the undivided Vampire-Narchilla unit and is in turn unconformably overlain by carbonaceous strata of the Road River Group. In the central part of the map area the lower contact with the Otter Creek Formation and the upper contact with the Sunblood Formation are both conformable.

A well-exposed section of the Rabbitkettle Formation, between the Coal and Rock rivers in the north-central part of the map area, is estimated to be 1500 m thick. Its thickness in the Mel property area ranges from 300 to 1050 m.

Composition

The predominant unit of the eastern facies (ЄORn) consists of a light grey to brownish grey-weathering, silty to argillaceous, nodular limestone (Fig. 22). Nodules are typically up to 10 cm long and 5 cm thick and consist of pale grey, recessive-weathering, fine-grained limestone which is locally parallel laminated. The limestone contains a well-developed, but discontinuous, slaty cleavage which anastamoses around the nodules; because of this texture the formation has previously been informally termed the 'wavy-banded limestone'. The nodular limestone commonly contains lesser interbeds of pale grey, fine-grained, massive limestone up to 2 m thick which constitute 50% or less of any outcrop (Fig. 23). Locally the nodular limestone contains intervals of grey-weathering, interbedded argillaceous limestone and laminated limestone up to tens of metres thick. Alternation of these two limestone types in an outcrop is on a scale of 5-30 cm.

Figure 22. *A characteristic texture of Rabbitkettle Formation; eastern facies is nodular limestone with mud-silt interbeds up to 2 cm thick. Near the MEL occurrence at the headwaters of Otter Creek (station 06LP021).*

Figure 23. *Two massive limestone interbeds within recessive weathering, nodular limestone of the Rabbitkettle Formation. Outcrop at headwaters of Otter Creek near the MEL occurrence (station 07LP010).*

West of the Coal River, the Rabbitkettle Formation has a distinctive shaly facies (ЄORlp) which consists of a light to medium grey, silvery-weathering, thin-bedded, phyllitic limestone (Fig. 24). This western facies contains a well-developed, pervasive slaty cleavage; primary bedding is only commonly observed in small intervals within the slaty cleavage. Yellow-weathering, silty, laminated limestone exposed along the Coal River near the Sulpetro Road (NTS 95D/03) has been included within the Rabbitkettle Formation shaly facies. In the northwestern Coal River map area, outcrops of typical Rabbitkettle phyllitic limestone are overlain by a dark grey, orange-weathering, pin-striped, silty limestone (Fig. 25); this unit is also included within the western shaly facies of the Rabbitkettle Formation.

Siltstone and silty limestone near the top of the Crow Formation are more than 700 m thick in a stream flowing east to upper Toobally Lake. These strata are considered a tongue of Rabbitkettle Formation within pinkish sandstone of the upper Crow Formation near its western extent (Pigage, 2009). In the Caribou anticline a similar thickness of Rabbitkettle Formation overlies a thin sandstone unit reinterpreted as Crow Formation (see next section).

Figure 24. *Grey, phyllitic limestone of the west facies of the Rabbitkettle Formation, showing slaty cleavage. View northward at roadcut on the Alaska Hwy at Contact Creek, south edge of the map area (station 09RAS150).*

Figure 25. *Calcareous, grey mudstone with yellow-weathering silt laminae, assigned to the Rabbitkettle Formation (west facies). Spaced slaty cleavage dips gently to the left in the photograph. Outcrop beside rapids on the Coal River, 15 km north of its confluence with the West Coal River (station 09RAS050). Scale bar (right side) in cm.*

A horizon of medium green, silvery green-weathering, alkali basalt, breccia and lithic tuff (ЄOR-v) occurs near the base of the Rabbitkettle Formation on the Jeri North property (Pigage, 2007; this volcanic horizon is too small to show on the map at 1:250 000 scale). East of the Rock River in the northern Coal River map area, an extensive volcanic horizon is discontinuously exposed for 30 km near the upper contact of the Rabbitkettle Formation; this occurrence is the informal 'Coal River volcanics' of Goodfellow *et al.* (1995). It locally contains pillowed basalt flows. Breccia textures with angular basalt clasts in a chloritic fine-grained matrix are common (Fig. 26). Tuffs are interlayered with the flows and coarse breccias. The geochemistry of the basalt is discussed in the section on Cambro-Ordovician alkali basalt.

Figure 26 (right). *Angular basalt blocks in a chloritic fine-grained matrix in the volcanic horizon at the top of Rabbitkettle Formation. View northward, on the Yukon-Northwest Territories border, east of the Rock River (station 09TOA164).*

Age, Correlation and Depositional Setting

The Rabbitkettle Formation is sparsely fossiliferous. Regionally the brachiopod and conodont collections range from late Cambrian through late Middle Ordovician (Gabrielse *et al.*, 1973; Tipnis *et al.*, 1978; Cecile, 1982; Gordey and Anderson, 1993). Conodont collections in 2007 and 2009 from the Coal River map area are all Early Ordovician, ranging from early Tremadocian to late Floian (Plate 1; Appendix A in this report).

Regionally Rabbitkettle Formation extends across the Selwyn basin during late Cambrian-Early Ordovician time (see Fig. 12). South of the Nahanni River (150 km northwest of Coal River map area) nodular, silty limestone changes southwestward to evenly laminated, argillaceous limestone (Gordey and Anderson, 1993). Shallow shelf (Mackenzie platform) correlatives of Rabbitkettle Formation are

the Broken Skull and Franklin Mountain formations (Gabrielse *et al.*, 1973; Gordey and Anderson, 1993; Martel *et al.*, 2012). South of the Coal River map area and along structural grain, Rabbitkettle correlates with the early Ordovician Kechika Formation. This grey, phyllitic, calcareous shale and thin-bedded, argillaceous limestone and grainstone (Pyle and Barnes, 2000) thickens from 200 to 1400 m in a westerly direction.

Fossil collections (Appendix A in this report) indicate that Rabbitkettle Formation in the northern Coal River map area is laterally correlative with Sunblood Formation in the east-central Coal River map area.

Fine lamination and the dark colour of the carbonate indicate that Rabbitkettle deposition was in a quiet water, sub-wave base, off-shelf setting. Analogous to the Kechika trough located to the south, it accumulated on a broad, gentle ramp, transitioning from shallow to deeper water facies (Cecile and Norford, 1979). These upper Cambrian to Ordovician basinal strata reflect post-rift passive margin thermal subsidence following Neoproterozoic to middle Cambrian extension (Pyle and Barnes, 2000).

Crow Formation (ЄOc, ЄOc-v)

Introduction

The Crow Formation (Pigage, 2009) forms two large exposures flanking the Toobally Lakes in the eastern Coal River map area. There it consists of a thick sequence of bedded sandstone with interbeds of amygdaloidal alkali basalt, and maroon, silty argillite.

A third occurrence, in the core of the Caribou anticline, is a 30 m-thick interval of sandy dolostone beneath the Rabbitkettle Formation and above a volcanic and volcaniclastic unit. Gabrielse and Blusson (1969) assigned this latter exposure to the Sekwi Formation. The underlying volcanic rocks are chemically similar to the Rabbitkettle and Crow volcanic rocks, but distinct from the volcanic rocks within the Vampire-Narchilla unit (*see* section on Cambro-Ordovician alkali basalt). On the strength of general stratigaphic position and the correlation of the underlying volcanic strata, we here reassign the sandy dolostone and the volcanic strata to the upper Crow Formation.

In a limited area immediately west of the upper Toobally Lake, the Crow Formation unconformably overlies the Toobally Formation. Elsewhere in the map area the lower contact of the Crow Formation is not observed; it is truncated by the Toobally fault (western exposure) or a parallel reverse fault east of the Toobally fault (eastern exposure). To the east, the Crow Formation unconformably overlies Proterozoic strata and intrusive rocks (Pigage, 2009). It is conformably overlain by the Sunblood Formation. A minimum thickness of 5000 m is inferred from the extensive outcrops of Crow Formation on the west side of upper Toobally Lakes (Pigage 2009) if the outcrops are considered to be a monoclinal succession dipping westward at 45°; the succession may have been thickened by unmapped thrust fault repetition.

Composition

Pinkish, indistinctly bedded, quartzose to subarkosic sandstone is the predominant lithology (Fig. 27) with interbeds of maroon, noncalcareous, argillaceous siltstone (Fig. 28) up to several tens of metres thick occurring throughout. Bedding thickness of the sandstone typically ranges from 20 to 70 cm. Locally the sandstone contains scattered argillite and quartz pebble clasts (Fig. 29). In several locations the sandstone has well-developed crossbeds; other areas exhibit mudcracks.

West of the upper Toobally Lake, we have interpreted a thick limestone and dolostone interval as being within the upper part of the formation. Alternatively this carbonate horizon may be basal Sunblood Formation structurally overlain by Crow Formation (*see* Pigage *et al.*, 2012 for discussion). A tongue of

nodular limestone of the Rabbitkettle Formation, within the upper part of the Crow Formation, is also documented in the same general area (Pigage, 2009).

Figure 27. *Pink, thick-bedded, quartzose to subarkosic sandstone of the Crow Formation. View looking west, 11 km west-northwest of upper Toobally Lake (station 05LP075).*

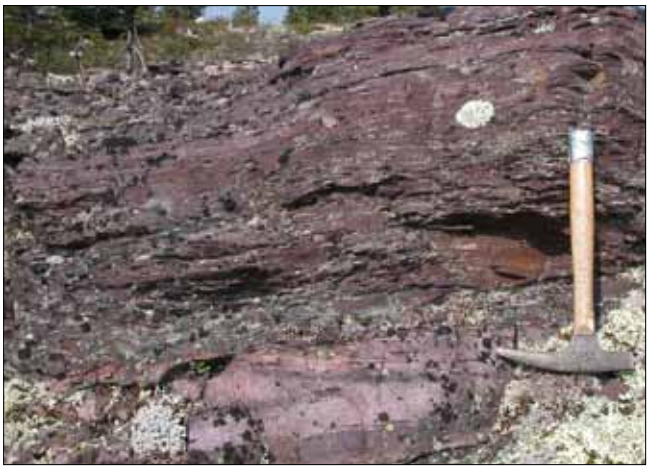

Figure 28. *Maroon, non-calcareous, argillaceous siltstone constitutes up to several metre-thick interbeds within Crow Formation sandstone. From ridge approximately 8 km west of north end of upper Toobally Lake (station 04LP053).*

Figure 29 (right). *Argillite and quartz pebble clasts within sandstone of the Crow Formation. From ridge approximately 8 km west of north end of upper Toobally Lake (station 05LP057).*

Pigage (2009) mapped four alkali basalt horizons (ЄOc-v) within the Crow Formation. Massive to pillowed, amygdaloidal flows and lapilli tuffs are the predominant lithologies. These horizons have previously been informally termed the Gusty Lakes and Toobally volcanics (Gabrielse and Blusson, 1969; Goodfellow *et al.*, 1995). The geochemistry of the basalt was presented in Pigage (2009) and is further described in the subsequent section on Cambro-Ordovician alkali basalt.

A 2 m-thick interval of medium green, fine-grained, porphyritic, rhyolitic tuff occurs along the Beaver River within sandstone of the Crow Formation (*see* Appendix C, Table C2c, sample 10TOA024), slightly below the uppermost alkali basalt horizon. It contains approximately 15% K-feldspar phenocrysts and 15% subhedral quartz phenocrysts, both 1-3 mm in diameter. About 25% of the tuff consists of brown, fine-grained volcanic lithic fragments containing feldspar microlites and small broken quartz microphenocrysts. The matrix consists of a fine-grained mixture of chlorite and sericite with small broken phenocrysts of K-feldspar and quartz. Flow banding and spheroidal textures are apparent in hand sample and thin section.

A basalt occurrence at this stratigraphic level in the core of the Caribou anticline in the northeast corner of the Coal River map area (McDougall, 1976; Stammers, 1983) is included in unit ЄOc-v. Both amygdaloidal flows and several lithic tuff horizons (Fig. 30) are present. The lower contact of the basalt is not exposed, and its thickness is undetermined.

Figure 30. *Planar cross-bedded tuff in the core of Caribou anticline, assigned to Crow Formation because it underlies a thin sandstone unit. The subangular to subrounded basalt clasts are enclosed in a fine-grained, chlorite-rich matrix. Outcrop is 2 km northwest of the main fork in the upper Caribou River (station 09LP083). Scale card is 9 cm wide.*

Age, Correlation and Depositional Setting

Conodont collections from the Crow Formation in the Coal River area are Early to Middle Ordovician (Pigage, 2009; Plate 1; Appendix A). Zircon grains from the rhyolite tuff (sample 10TOA024), interpreted as primary volcanic crystals, give a weighted mean $^{206}Pb/^{238}U$ age of 491.04±0.13 Ma (Early Ordovician or late Cambrian; Pigage *et al.*, 2012). The Crow Formation is time correlative with the Rabbitkettle Formation (*see* Fig. 12) and the two are interpreted to be interdigitated in the subsurface of the eastern Coal River map area.

Mud cracks and ripple marks in the Crow Formation indicate deposition in a shallow water to subaerial environment (Pigage, 2009). The limited lateral extent and unusual thickness of the Crow Formation suggest deposition in a river delta complex with sediments derived from a granitic and quartz-rich source. Detrital zircon studies from the Crow Formation (Pigage, 2009) indicate that the zircon provenance could be the Archean Slave province and the adjacent Wopmay orogen. A small number of zircon grains from one Crow Formation sample (05LP034) are ~1000-1350 Ma, similar in age to those found in the Mackenzie Mountains Supergroup, possibly representing erosion of these strata (Hadlari *et al.*, 2012; Rainbird *et al.*, 1992, 1997).

SUCCESSION 3 – LOWER TO MIDDLE ORDOVICIAN

Succession 3 consists solely of the Sunblood Formation which records shallow water carbonate deposition in a shelf environment. The carbonate unit is exposed in the central and eastern part of the Coal River map area; in the western third it is not present, and carbonaceous shale of the Road River Group occurs in the same stratigraphic position.

Sunblood Formation (Osu, Osu-v)

Introduction

The Sunblood Formation (Kingston, 1951; the updated reference section by Gabrielse *et al.*, 1973 is 110 km north of the Coal River map area) outcrops extensively along the Rock River and several smaller streams and meltwater channels in the central and eastern parts of the map area. In the west-central part of the map area it is preserved in north-trending synclinal fold keels. Gabrielse and Blusson (1969) concluded that the Sunblood Formation was presumably removed by erosion beneath unit SDc in the southern quarter of the Coal River map area. Mapping in 2009, however, confirmed that the unit is thin but present beneath unit SDc, and probably extends farther south into British Columbia. Sunblood Formation is not present in the southwestern corner of the map area (Irons Creek drainage) and the northwest corner of the map area (Coal River and West Coal River drainage). In both areas black shale

of the Road River Group overlies the Rabbitkettle Formation and is likely a facies equivalent of the Sunblood Formation.

The Sunblood Formation conformably overlies the Rabbitkettle Formation in the west and the Crow Formation in the east within the map area. It is unconformably overlain by a dolomitic sandstone unit (OSs) in the east, while in the southern part of the area it is unconformably overlain by massive carbonate (SDc). Elsewhere it is unconformably overlain by shales of the Road River Group. The Sunblood Formation ranges from 2700 m thick in the Caribou anticline northeast part of map area to 320 m thick near Mount Gilliland in the southwest part of the map area. It attains its greatest thickness in the central part of the map area. Immediately to the east in NTS 95C/5 it has a minimum thickness of 150 m (Pigage, 2006).

Composition

In the northern part of the Coal River map area, the Sunblood Formation consists of medium grey, thick-bedded, finely crystalline limestone (Fig. 31). The limestone is typically tan to pink, flaggy or platy, with silty intervals and chert nodules locally. Bedding ranges from 2 to 60 cm in thickness. Bedding planes have a mottled appearance indicating extensive bioturbation (Fig. 32a,b). Macrofossils, including brachiopods, bryozoans, trilobites, ostracods, cephalopods, and gastropods (especially *Maclurites* sp.) are common (Gabrielse and Blusson, 1969). Recent karst solution cavities are conspicuous on limestone-topped ridges north of the Beaver River.

Figure 31. *Well-bedded limestone of the Sunblood Formation. Bedding planes are mottled grey and tan from bioturbation. This unit locally develops modern, karst sinkholes. From ridge 5 km north of upper Beaver River (station 09LP075). Hammer for scale.*

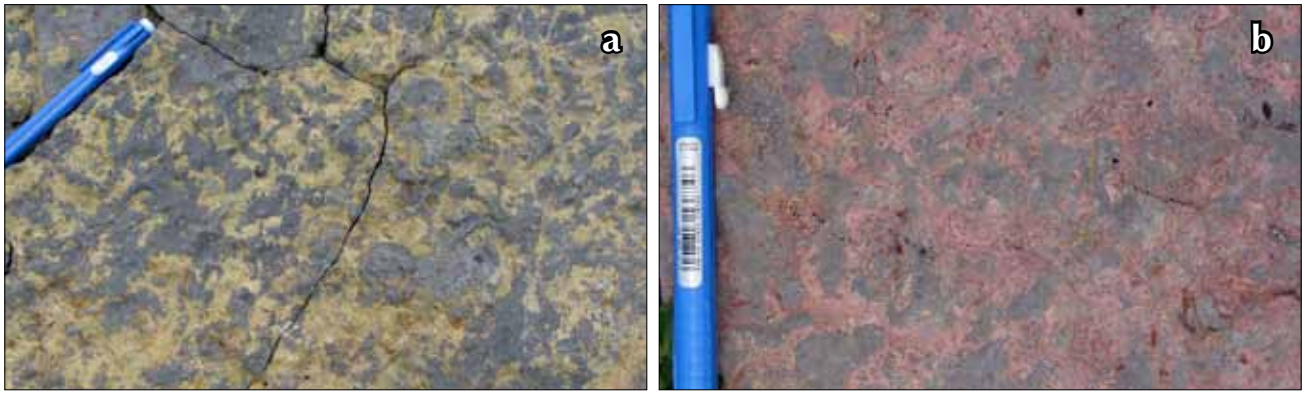

Figure 32. *Bioturbation on bedding plane of Sunblood Formation limestone;* ***(a)*** *tan-weathering;* ***(b)*** *pink weathering; a defining characteristic of this formation farther north (Gabrielse et al., 1973). From ridge 5 km north of upper Beaver River (station 09LP075). Eraser for scale is 1 cm wide.*

In the southern part of the Coal River map area, the Sunblood Formation consists largely of thick-bedded, pale grey, laminated to bioturbated dolostone interbedded with thick-bedded, dark grey, bioturbated dolostone (Fig. 33). Bedding ranges from 10 cm to 2 m in thickness. These rocks are

typically tan to buff-weathering, although locally they weather to a brownish-orange (the distinctive colour of the Sunblood Formation where it was named in the Nahanni River region). Bedding planes have a mottled appearance due to bioturbation (similar to the limestone). This southward transition from limestone to dolostone is attributed to secondary dolomitization of the primary limestone.

The Sunblood Formation contains green, brown-weathering, alkali basalt breccia and flows (OSu-v) in two localities, one near the headwaters of Spruce Creek and the other northeast of Lootz Lake. Flows are commonly pillowed. Breccia consists of angular clasts in a dark green, fine-grained, chloritic matrix (Fig. 34). The volcanic rocks in the headwaters of Spruce Creek occur at the top of the unit. North of Lootz Lake the volcanic rocks occur at a lower stratigraphic level within the Sunblood Formation. The chemistry of the basalt occurrences is described further in the Cambro-Ordovician alkali basalt section.

Figure 33. *Pale grey, tan-weathering, laminated dolostone interbedded with dark grey, orange-grey-weathering, bioturbated dolostone, Sunblood Formation. Cliff is approximately 70 m high. From Rock River 3 km north of the mouth of Otter Creek (station 06LP043).*

Figure 34. *Altered basalt breccia within the Sunblood Formation. Looking north at outcrop (2 m high), 12 km northeast of Lootz Lake (station 08RAS304).*

Age, Correlation and Depositional Setting

In the type area the Sunblood Formation is of Middle Ordovician age (Gabrielse *et al.*, 1973; Ludvigsen, 1975). Age dating of conodonts collected more recently from the Coal River (NTS 95D) and LaBiche River (NTS 95C) map areas document an age range from Early Ordovician (Tremadocian) to Late Ordovician (Sandbian) (Pigage, 2009; Plate 1; Appendix A). The range in fossil ages for the Sunblood and Rabbitkettle formations indicates that the basal Sunblood contact is diachronous, varying in age from Tremadocian to Floian. The older Tremadocian ages occur in the east-central part of the area (NTS 95D/8 and 10); the younger Floian ages are represented farther north (NTS 95D/10 and 15) and south (NTS 95D/02 and 03). The diachroneity means that lower Sunblood Formation overlying the Crow Formation in the east-central part of the map area undergoes a lateral facies transition to Rabbitkettle Formation in the northeast part of the map area. Pohler and Orchard (1990) described a similar lateral transition between Haywire Formation and Rabbitkettle Formation north of Coal River map area. An analogous diachronous age variation of the lower contact of the Sunblood Formation was noted in Pigage (2009), varying easterly from Tremadocian to Floian.

Conodont collections from near the top of the formation suggest an Upper Ordovician (Sandbian to Katian) age for the upper contact in the eastern part of the map area. This younger age is also recorded in some of the fossil samples in the Pool Creek map area immediately to the east (Pigage, 2009). The

youngest ages for the upper contact appear to be restricted to the same general area as the older ages for the lower contact. The variation in age range for the upper contact can be interpreted to indicate that the Sunblood carbonate platform was restricted to a small geographic area in Upper Ordovician time, or that subsequent erosion has removed younger Sunblood strata in most areas except for the eastern Coal River and western LaBiche River map areas.

The Sunblood Formation is absent in the southwestern and northwestern parts of the map area. Although the contact is not exposed, carbonaceous, siliciclastic sediments of the Road River Group appear to directly overlie Rabbitkettle calcareous phyllite in these areas. An early Ordovician age for Road River Group strata north of Coal River (Abbott, 1981) indicates that the absence of Sunblood Formation in northwest Coal River results from a lateral facies change from Sunblood carbonate rocks to Road River Group clastic strata on the western margin of the Ordovician Sunblood carbonate platform.

The Sunblood Formation was deposited in a widespread sub-tidal, carbonate platform environment up to 100 km wide (Ludvigsen, 1975). It records a transgressive high-stand tract which terminated with a period of erosion in latest Ordovician-Early Silurian time.

It is widely distributed in the southeast Yukon and southwest Northwest Territories. Its western limit lies in the Coal River map area where Road River Group shale occurs in the same stratigraphic position (overlying Rabbitkettle Formation). In the Little Nahanni River map area (150 km northwest) it is in part correlative with the Cambro-Ordovician to Silurian Haywire Formation (Gordey and Anderson, 1993) that is an outer-shelf equivalent of the Rabbitkettle, Broken Skull, Sunblood, and possibly Whittaker formations (Gabrielse *et al.*, 1973). The schematic relations of these units are shown in Figure 17 of Gordey and Anderson (1993) where the Sunblood conformably overlies Broken Skull Formation and is unconformably overlain by Whittaker Formation. All three are relatively thick shelf carbonate units.

On the Macdonald platform in northeastern British Columbia, thick-bedded dolostone of the Middle Ordovician Skoki Formation is equivalent to the Sunblood Formation (Cecile and Norford, 1979; Pyle and Barnes, 2000).

The Sunblood Formation, in the Coal River map area, represents a westward extension of the Mackenzie platform during early and middle Ordovician, including overlap of the Crow Formation. It may also represent a northward extension of the Macdonald platform during the same time interval. Conodont fauna from near its base document its local transgression (expansion) away from the east-central part of the Coal River map area during the early Ordovician to middle Ordovician.

SUCCESSION 4 – ORDOVICIAN(?) TO MIDDLE DEVONIAN

Succession 4 indicates a south to north facies transition, from thick-bedded carbonate of the Macdonald platform in the south to siliciclastic, marine shale, laminated to thin-bedded limestone, and sandstone of Selwyn basin in the north. In the Coal River map area, carbonate rocks are represented by the undivided Nonda, Muncho-McConnell, Stone and Dunedin formations (collectively map unit SDc) which comprise Macdonald platform. The carbonaceous shale and limestone belong to the Road River Group (map units SDRR and part of SMRB) which represent the southeastern extent of the classic Selwyn basin (*see* below). In the east-central part of the map area, the Road River Group is underlain by a thin succession of quartzose sandstone to pebbly sandstone (unit OSs) of uncertain age.

Sandstone of Ordovician and/or Silurian age (OSs)

Introduction

Creamy white, tan to pale grey-weathering, fine-grained, dolomitic sandstone (Unit OSs; Fig. 35) is discontinuously exposed near the eastern edge of the Coal River map area and extends farther east into the adjacent map area. In contrast to Pigage (2009), this unit is assigned to Succession 4 because it is interpreted to represent easterly derived clastic sedimentation in concert with the eastward transgressive extension of Selwyn basin. Known as Meilleur River embayment (Basset and Stout, 1966), this eastward expansion began north of the Coal River map area in the Middle Ordovician and extended more than 200 km into the southwestern Northwest Territories during the Silurian (Cecile and Norford, 1993).

Figure 35 (right). *Pale grey and light brown-weathering, dolomitic sandstone of Ordovician and/or Silurian age (map unit OSs). From the north bank of a west-flowing stream, 30 km east of Last Mountain and 5 km west of east edge of map area (station 09LP096).*

The base of unit OSs is an abrupt change from thick-bedded dolostone of the Sunblood Formation to sandstone, and is probably unconformable (*see* Fig. 12). At the top, the unit is overlain by the Road River Group. A maximum thickness of 220 m has been estimated from mapping along the Beaver River (Fig. 36, below; NTS 95D/09).

Figure 36 (left). *Dark-weathering sandstone of unit OSs is estimated to be 220 m thick in this exposure just north of the Beaver River, 1 km northeast of upper Toobally Lake.*

Composition

Quartz-rich, non-calcareous to slightly calcareous, quartzose to arkosic sandstone forms beds from 10 cm to 2 m thick. The sandstone weathers with a tan to orange-brown surface coating. Fine to medium, subround to round, sand clasts are predominantly monocrystalline quartz. Other clasts, in minor amounts, include black shale, quartz sandstone, K-feldpar, plagioclase, volcanic rock and chert.

Interbedded with the sandstone are lesser amounts of recessive-weathering, bioturbated, dolomitic siltstone and minor pebbly sandstone to conglomerate. The dolomitic siltstone is light grey and weathers tan. It contains minor, discontinuous, dark grey, shaly partings. Pebbles in the pebbly sandstone to conglomerate consist predominantly of white, blue and lesser pale green quartz pebbles in a quartz sand matrix. Typically they are matrix-supported, although locally they are extensive enough to be clast-supported.

Age, Correlation and Depositional Setting

Diagnostic fossils constraining the depositional age have not been found. The unit is broadly constrained by the known ages of the underlying Sunblood Formation (Middle Ordovician) and overlying Road River Group (early Silurian). Its age range is probably much less as the lower contact is an unconformity.

In northeastern British Columbia, a 180 m-thick interval of interbedded shale and quartzite with minor dolostone occurs in the Road River Group (unit ORD of Cecile and Norford, 1979; Ware member of the Ospika Formation of Pyle and Barnes, 2000); it is of upper Middle Ordovician to Upper Ordovician age and may be a correlative unit. Sandstone is also present on the Macdonald platform within lower Silurian strata in places where the Nonda Formation rests directly on Precambrian basement rocks (Cecile and Norford, 1993).

Unit OSs coarse sandstone and conglomerate are proximal clastic facies, representing a transitional depositional environment from platform carbonate sedimentation to euxinic, basinal siliciclastic sedimentation. Abundant bioturbation in shaly intervals (Pigage, 2009) indicate a below-wave base environment. The unit is missing to the west in the central Coal River map area, and the source provenance is considered to be to the north or east. Primary sedimentary features indicating source direction were not observed.

Detrital zircon geochronology on one sample from unit OSs (09LP093) is shown on a probability density plot and concordia diagram (Fig. 37; analyses in Appendix B). This age distribution corresponds to the Laurentia type I signature of Hadlari *et al.* (2012), consistent with a Canadian Shield provenance.

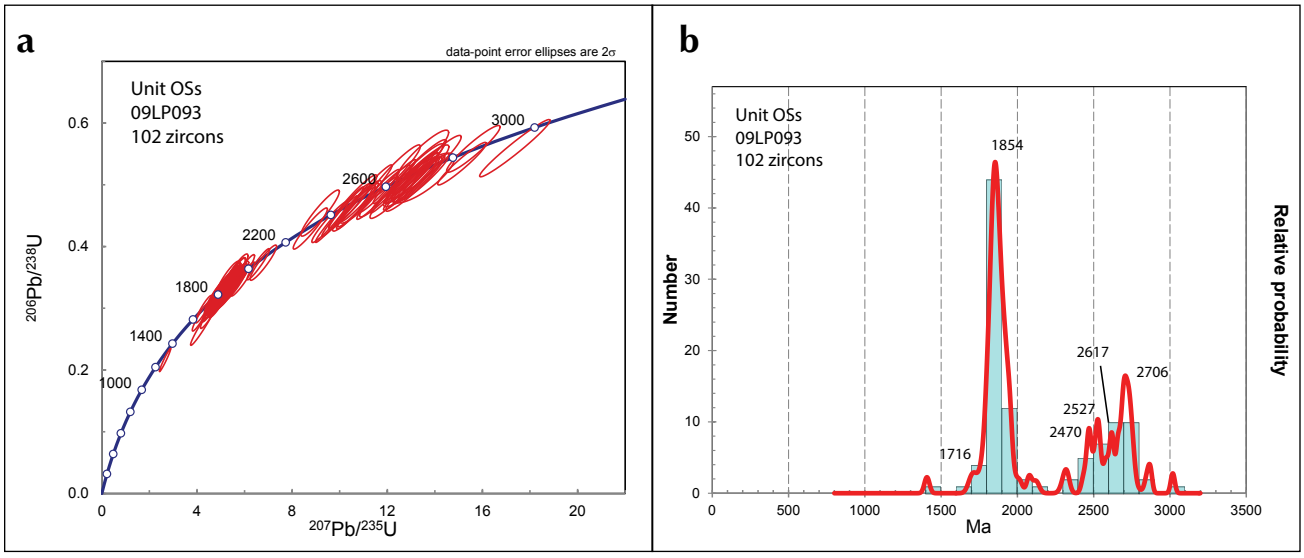

Figure 37. *Results of geochronological analysis of 102 detrital zircon grains from OSs unit sandstone (sample 09LP093):* ***(a)*** *Concordia diagram;* ***(b)*** *probability distribution diagram. Data and methods are shown in Appendix B (Table B7).*

Silurian-Devonian massive carbonate (SDc)

Introduction

The southern part of the Coal River area contains cliff-forming exposures of thick-bedded, pale grey to cream-weathering dolostone and limestone (Fig. 38), representing the northern extent of the Macdonald platform. They form resistant ridges which exhibit modern karst features. The medium to coarsely crystalline secondary dolostone alteration obliterates distinction of the Nonda, Muncho-McConnell, Stone and Dunedin formations described for the Macdonald platform to the south (Thompson, 1989; Cecile and Norford, 1991, 1993; Taylor and MacKenzie, 1970).

Figure 38 (right). *Thick-bedded, pale grey to cream-weathering limestone of unit SDc forms the high-standing hills that constitute the northern extent of the Macdonald platform along the south edge of the map area. Looking northeast near Barney Lake (station 09TOA120).*

The lower contact with the underlying Sunblood Formation is sharp. The upper contact is eroded from much of the southern half of the Coal River map area. The thickness of the remaining strata is approximately 1000 m near Mount Gilliland, immediately east of the Coal River fault. In the southeast, near Smith River, the carbonate succession is many tens to hundreds of metres thick; the upper contact with the overlying Besa River Formation is abrupt.

Composition

Bedding in the carbonate rocks is locally visible and generally ranges from 1-10 m in thickness. Metre-scale, convex-upward domes in the beds likely represent algal mounds, while darker bands commonly contain lighter-coloured macrofossils, including pelecypods, brachiopods, corals and crinoid hash. Areas of white to grey dolostone are totally recrystallized and sucrosic in places, reflecting diagenetic alteration. Post-depositional brecciation (Fig. 39) is extensive, with development of vugs up to 2 cm across. Vugs and clasts commonly are enclosed by cream hydrothermal dolomite.

Figure 39. *Limestone of the undifferentiated SDc unit that has been brecciated with abundant secondary calcite (white). Hilltop 1 km northwest of Mount Gilliland (station 09TOA178). Hammer handle is 45 cm long.*

Internal stratigraphic divisions within the carbonate could not be readily distinguished in the Coal River area. Strata comprising this unit can be separated into multiple formations to the east (*e.g.*, Pigage, 2009) and to the south on the Macdonald platform (*e.g.*, Taylor and MacKenzie, 1970; Morrow, 1978; Ferri *et al.*, 1999).

Age, Correlation and Depositional Setting

Two fossil collections in the lower part of the unit northwest of Mount Gilliland are of Silurian age (Appendix A); Road River shale and limestone in the same stratigraphic position contain Silurian graptolites. A collection near the top of Mount Gilliland is Early Devonian. Near Tropical Creek, in the southeast, the carbonate locally contains recognizable crinoid columns with twin axial canals (2-hole crinoids), indicating their Early to Middle Devonian age. Contiguous carbonate in the Rabbit River map area to the south are of Early and Middle Devonian age (Gabrielse, 1963).

Unit SDc constitutes the northern edge of the Macdonald platform, which in British Columbia ranges in age from Ordovician through Middle Devonian. It includes the Nonda, Muncho-McConnell, Stone and Dunedin formations as a dominantly carbonate tract extending 500 km south-southeast from the Coal River map area. Regionally the Macdonald platform strata unconformably overlie Cambrian and older units (*e.g.*, McMechan *et al.*, 2012), implying preceding uplift and erosion. The northward transition to Road River Group shale appears to be abrupt with the shale facies being present near Lootz Lake. Time-equivalent rocks of the Mackenzie platform (nearest point is 260 km north of unit SDc) include the Camsell, Sombre, Arnica, Grizzly Bear, Funeral, Delorme, Whittaker, Tsetso, Mount Kindle, Franklin Mountain, Nahanni, Headless, Bear Rock, Hume and Natla formations (Gabrielse *et al.*, 1973; Gordey and Anderson, 1993; Cecile and Norford, 1993; Morrow and Geldsetzer, 1991).

Road River Group (SDRR, SMRB)

Introduction

Jackson and Lenz (1962) defined the Road River Formation as Lower Cambrian to Lower Devonian strata in northern Yukon (Richardson trough) with a type section where the base was faulted. Gabrielse *et al.* (1973) extended the unit into the Selwyn basin and later into the Northern Rocky Mountains. Fritz (1985) and Gordey and Anderson (1993) elevated the Road River Formation to formal group status, although some regional publications (*e.g.*, Cecile, 2000) avoid the term in favour of more precise formation nomenclature. In this report the breadth of Road River Group is appropriate because internal stratigraphic boundaries and defining paleontologic control are lacking.

Recessive weathering, carbonaceous, silty shale, limestone, dolostone, siltstone, and chert of the Road River Group are exposed along rivers, streams and glacial meltwater channels in the Coal River map area. The base is abrupt and marked by the first appearance of a carbonaceous, locally graptolitic unit. In most areas it unconformably overlies the Sunblood Formation. In areas where Unit OSs is present, carbonaceous strata abruptly overlie this sandstone unit. In the westernmost part of the map area it abruptly overlies the Rabbitkettle Formation. In much of the northern Coal River area carbonaceous shale of the Road River Group is conformably overlain by carbonaceous shale of the Besa River Formation.

In northern British Columbia the Kwadacha Formation (Pyle and Barnes, 2000) consists of tan-weathering, dolomitic, bioturbated siltstone forming the uppermost unit in the Road River Group. The Steel Formation (Gordey and Anderson, 1993) in the Little Nahanni map area (NTS 105I) is a similar unit that occurs in the same stratigraphic position. This distinctive lithology is a useful marker horizon for delineating the top of the Road River Group and the base of the overlying shale (like the Besa River Formation). Tan-weathering siltstone outcrops that resemble the Steel Formation were observed along the Coal River in the northwest corner of the map area. We were not able to identify this siltstone unit along Spruce Creek and in the northern part of the map area, resulting in the use of a combined map unit (SMRB) encompassing Road River and Besa River strata.

Near Spruce Creek the estimated thickness of the Road River Group is approximately 200 m and the estimated thickness of the Besa River Formation in the same general area is approximately 300 m. The combined unit has a similar thickness in the Last Mountain area. In the northeastern quadrant of the map area its broad extent and deep exposure in the Caribou River canyon suggests structural thickening by internal reverse faults and folds.

Composition

The dominant lithology of the Road River Group in Coal River map area is a dark grey to black, noncalcareous to calcareous, locally graptolitic, silty shale (Fig. 40). Another major lithology is a dark grey, thin-bedded, silty limestone or dolostone (Fig. 41), locally containing thin black, discontinuous chert lenses or beds (Fig. 42). Intervals of dark grey to black, bedded chert also occur locally. The common distinctive characteristics of the Road River Group are the dark grey to black colour related to high organic material and the local occurrence of graptolites, especially near the base of the unit.

Figure 40. *Dark grey, locally graptolitic, silty shale of the Road River Group. From glacial meltwater channel about 9 km north of Lootz Lake (station 09LP074).*

Figure 41. *Dark grey, silty, parallel-laminated limestone of Road River Formation. From 7.5 km north of Lootz Lake (station 09LP062).*

Age, Correlation and Depositional Setting

Fossil collections from previous work in the Coal River and LaBiche River map areas indicate an age range of lower Silurian to Lower Devonian for the Road River Group (Gabrielse and Blusson, 1969; Pigage, 2009). Fossil collections from the 2009 fieldwork are consistent with that age assignment (Appendix A). Lenses of limestone containing two-hole crinoids (Fig. 43) were observed in outcrops on the Coal River in the northwest part of the Coal River map area, indicating an Early to early Middle Devonian (Emsian to Eifelian) age. Abbott (1981) reported a Lower Ordovician conodont sample collected from the Road River Group from NTS 95E (north of the Coal River area), indicating that in the northwestern part of the Coal River map area

Figure 42. *Grey dolostone with discontinuous black chert layers, Road River Group. On Spruce Creek (station 09LP091). Scale divisions are in cm.*

the lower Road River Group probably includes Ordovician carbonaceous strata. Northwestward across Selwyn basin Road River Group is widespread, in some areas divided into Duo Lake or Elmer Creek formations, overlain by Steel Formation (*see* Fig. 12).

Figure 43. *Limestone containing two hole crinoids indicative of Early to Middle Devonian age, undivided Road River-Besa River map unit. Outcrop on the Coal River 4 km west of Mt. Skonseng (station 10TOA005). Canadian coin is 2.5 cm in diameter.*

The Macdonald platform units – Skoki, Nonda, Muncho-McConnell, Wokkpash, Stone and Dunedin formations (Morrow and Geldsetzer, 1991) are time-correlative with Road River Group. On the Mackenzie platform, Camsell, Sombre, Arnica, Grizzly Bear, Bear Rock, Funeral and Natla formations (Morrow and Geldsetzer, 1991) are time-correlative with Road River Group.

Road River Group abruptly overlies sandstone and carbonate, attesting to a rapid change to a deeper water depositional environment. The dark, thin-bedded shale reflects reduced conditions, although the presence of deep-water limestone indicates deposition above the carbonate compensation depth. Chert deposition suggests that the basin was relatively starved of clastic input.

SUCCESSION 5 – MIDDLE DEVONIAN TO TRIASSIC

The single depositional entity Selwyn basin was destroyed by uplift (locally block faulting) in Middle Devonian time (Gordey and Anderson, 1993). Subsequent Middle Devonian through Triassic strata are preserved in the eastern half of the Coal River map area as three sequences separated by regional unconformities. They record alternating regional transgressions and regressions in a broad, shallow marine depositional environment. Map units are the Middle Devonian to Lower Mississippian Besa River Formation (DMBR, SMRB), the Mississippian Mattson Formation (MM), the Permian Fantasque Formation (PF) and the Triassic undivided Grayling and Toad formations (ŦGT).

Besa River Formation (DMBR, SMRB)

Introduction

Recessive, dark grey to black, pale grey-weathering, noncalcareous, silty shale with lesser interbeds of tan-weathering sandstone and limestone (Fig. 44) outcrop extensively along streams and rivers in the southeast part of the map area, constituting the Besa River Formation (Kidd, 1963). In the southeast Coal River map area, the lower contact with the underlying SDc unit of the Macdonald carbonate platform is sharp. In the northern Coal River map area, the similar units of the Besa River Formation and the underlying Road River Group mean that the lower contact of the Besa River Formation is not accurately located, and the nature of the contact is unknown. Exposures of dark silty shale lacking stratigraphic context could not be attributed with certainty to either Road River Group or Besa River Formation and thus were mapped as a combined unit (SMRB). The upper contact with the overlying

Mattson Formation is gradational over tens of metres; the contact is placed at the first major bed of indurated, grey, quartzose sandstone.

The type section, about 200 km southeast of Coal River map area, is 672 m thick (Kidd, 1963). Besa River Formation thins northwestward (Bamber *et al.*, 1968) and a thickness of greater than 300 m is estimated from exposures in the Spruce Creek area. Greater thicknesses in the northern part of the map area most likely result from structural thickening.

Figure 44. *Outcrop exposure of the Besa River Formation, consisting of brown and grey-weathering, noncalcareous, silty shale with interbeds of tan-weathering sandstone and limestone. Looking northward at cliffs above Spruce Creek, 14 km west of Toobally Lakes (station 09TOA131).*

Composition

The predominant lithology consists of dark grey to black, thin-bedded, noncalcareous, silty shale that locally is pale grey or rusty brown-weathering (Fig. 45). Bedding is typically on a scale of 1-5 cm. Some intervals are siliceous enough to be considered porcellanites. The silty shale commonly contains limestone nodules up to 2 m in diameter (Fig. 46). Interbeds of dark grey limestone up to 10 m thick occur locally.

Figure 45. *Rusty brown to dark grey-weathering exposure of black, silty shale of the undivided Road River-Besa River map unit. Outcrop is 3 m high. Exposure on the Beaver River 2 km north of upper Toobally Lake (station 09LP077).*

Figure 46. *Limestone nodules or concretions in silty shale of the undivided Road River-Besa River map unit in the headwaters of the Coal River (southern Flat River map area; station 10TOA006). Hammer handle is 45 cm long.*

Age, Correlation and Depositional Setting

Two conodont samples collected immediately east of Coal River map area are Devonian to Mississippian (Table IV-10 in Pigage, 2009). Both upper and lower contacts are diachronous with the age range decreasing in an eastward direction (Bamber and Mamet, 1978; Richards, 1989); the maximum age range is from Middle Devonian (Giventian) to Middle Mississippian (Viséan). Bamber and Mamet (1978) described the westward shaleout of Dunedin Formation carbonate rocks to Besa River Formation in northeastern British Columbia.

In southeast Yukon and southwest Northwest Territories Besa River Formation is laterally equivalent to the carbonate rocks of the Pekisko, Prophet and Flett formations and the clastic sediments of the Yohin, Clausen and Golata formations (Richards, 1989). In northeastern British Columbia, Besa River Formation is correlative with carbonate rocks of the Upper Keg River, Slave Point, Kakiska, Trout River, Tetcho, Kotcho, Banff, Pekisko, Shunda and Debolt formations and with shales of the Horn River, Muskwa, Fort Simpson, Exshaw and Golata formations (Ferri *et al.*, 2011). In Selwyn basin and Kechika trough, Besa River Formation is laterally equivalent to the Earn Group (Gordey, 1991; Ferri *et al.*, 2011).

The western margin of Laurentia was inundated by dark clastic sediments between Middle Devonian and Middle Mississippian time; this diachronous transgression eastward extended well into the North American interior. The dark clastic sediments overlie early Paleozoic platform and basin depositional elements.

Three Devonian-Mississippian clastic assemblages were deposited in Yukon: the Earn assemblage, the Imperial assemblage and the Besa River assemblage (Gordey, 1991). In northern Yukon the Imperial assemblage shale, siltstone and sandstone delineate the westward and southwestward influx of coarse foreland clastic sediments from the Ellesmerian orogeny (Pugh, 1983; Norris, 1985). Northwest and southwest of the Coal River map area the Earn assemblage consists of black shale and siltstone interbedded with sandstone and chert pebble conglomerate; the clasts were derived from eroded Selwyn basin units and deposited in submarine channels and fans (Gordey *et al.*, 1982; Gordey and Anderson, 1993; Gordey, 2013). Extension and local contraction in the outer parts of Selwyn basin and Kechika trough (Abbott *et al.*, 1986; Gordey *et al.*, 1982) during rifting or transtensional extension can account for the northwest to west provenance of Earn Group sediments. In contrast the Besa River Formation occurs immediately northwest (outboard) of barrier reefs (Ferri *et al.*, 2011) with extensive back-reef evaporates and sediments to the southeast. Richards (1989) considered the fine-grained, clastic sediments of the Besa River Formation to be derived from a north to northeast source.

Mattson Formation (MM)

Introduction

Pale grey and rusty-brown-weathering sandstone interbedded with shale is exposed in the Caribou syncline and comprises a strip trending north from Toobally Lakes. These are the westernmost outliers of the Mattson Formation (Patton, 1958) that is widely exposed in southeast Yukon and eastward to the Liard River in the Franklin Mountains. Reddish orange transported gossans are common where streams incise this unit.

The lower contact is conformable, placed at the base of the first major sandstone bed (Fig. 47) above Besa River shale. Shale-rich strata of the middle Permian Fantasque Formation unconformably overlie the Mattson Formation. Near Last Mountain the Mattson Formation is estimated to be 500 m thick. At the type locality, 31 km west of Nahanni Butte, it is 1138 m thick (Patton, 1958), and the greatest known thickness, 1410 m (Richards, 1989), is 60 km east of the Coal River map area near the Yukon-NWT border.

Composition

Grey, thick-bedded, fine-grained, quartz sandstone (Fig. 48) is the predominant lithology. Bedding is rarely observed and few other primary sedimentary features are visible in the sandstone. The sandstone contains minor interbeds of dark grey to black, noncalcareous shale. In the northeastern part of the map area, the middle of the formation consists of thick, noncalcareous, black shale with quartzose sandstone above and below it. The Last Mountain barite occurrence is at, or near, the base of the Mattson Formation.

Figure 47. *Grey and brown-weathering sandstone interbedded with recessive shale of the Mattson Formation. Looking northward at Last Mountain, northeast Coal River map area.*

Figure 48. *Thick-bedded, quartz sandstone of Mattson Formation. From ridgetop 5 km north of Spruce Creek (station 09LP090).*

Age, Correlation and Depositional Setting

Fossils were not found in the Mattson Formation in the Coal River map area. East of the map area conodonts from the carbonate-bearing upper part of the formation are Viséan to Serpukhovian (Table IV-4 in Pigage, 2009), similar to those from thicker intervals farther east, indicating a Middle to Late Mississippian age (Richards *et al.*, 1993).

The Mattson Formation correlates with the Stoddart Group (Rutgers, 1958; Bamber and Mamet, 1978) in northeastern British Columbia. Time-equivalent and lithologically identical units to the north and northwest are the Heritage Trail Formation of the Tischu Group (Cecile, 2000; Martel *et al.*, 2012) on the Northwest Territories-Yukon border, and the Keno Hill quartzite, north of Dawson City, Yukon (Tempelman-Kluit, 1970; Gordey and Anderson, 1993).

Regionally the Mattson Formation constitutes a large, south to southwest-prograding delta complex with interbedded eolian sand, coal, fluvial deposits, channel-fill deposits, submarine channels, and delta shoreline deposits (Richards *et al.*, 1993). The scarcity of heavy minerals and non-quartz clasts in the sandstone suggests the grains are multicyclic, representing more than one weathering cycle. Paleocurrents and spatial relationships between delta plain and marine lithofacies indicate a northern provenance (Richards, 1989; Fallas, *et al.*, 2002).

Detrital zircon geochronology was completed on one sandstone sample (09LP090) from the Mattson Formation. Analytical results are listed in Appendix B; the probability distribution and Concordia plots are shown in Figure 49. The youngest zircons form a peak at 432 Ma. The distribution of zircon grain ages, from Mesoproterozoic to Archean, is consistent with the Laurentia type II signature of Hadlari

et al. (2012); the detrital zircon grains are likely recycled from erosion of Paleozoic and Proterozoic strata. Lemieux *et al.* (2011), Beranek, *et al.* (2010) and Leslie (2009) noted that early Paleozoic to Neoproterozoic detrital zircon ages first appear in Cordilleran strata in Late Devonian to Mississippian time with the influx of clastic sediments from a northern exotic source region contributing detrital zircons. Suggested exotic source regions include Baltica, Siberia, or the east Greenland Caledonides (Lemieux *et al.*, 2011; Beranek *et al.*, 2010).

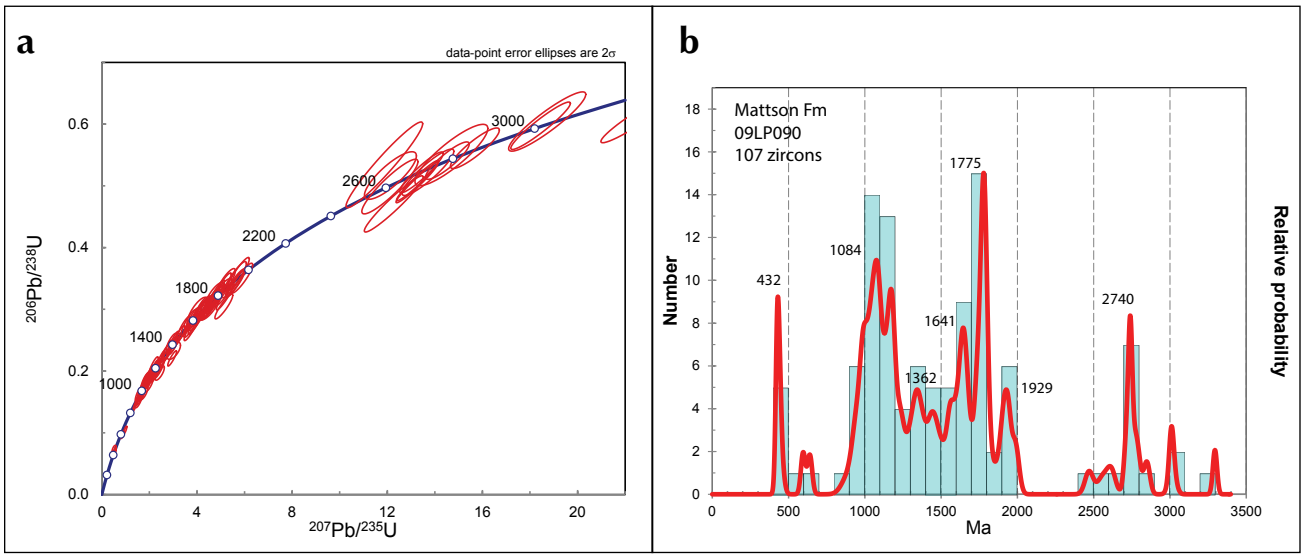

Figure 49. *Results of geochronological analysis of 107 detrital zircon grains from Mattson Formation sandstone (sample 09LP090):* ***(a)*** *Concordia diagram;* ***(b)*** *probability distribution diagram. Data and methods are shown in Appendix B (Table B8).*

Fantasque Formation (PF)

Introduction

Rusty brown-weathering, dark grey, siliceous shale in the eastern part of the Coal River map area is assigned to the Permian Fantasque Formation (Harker, 1961). It unconformably overlies the Mattson Formation and is in turn unconformably overlain by the Triassic Grayling-Toad unit. Its thickness ranges from 1000 m (northeast Coal River map area) to 1700 m (upper Toobally Lake area). At its type section (about 100 km east of Toobally Lakes) however, its thickness is 180 m. It is therefore possible that in the Coal River map area it is tectonically thickened or may include some of the underlying Tika unit (K. Fallas, pers. comm., 2014).

Composition

The formation consists predominantly of rusty brown-weathering, dark grey, siliceous shale (Fig. 50). The shale is internally bedded on a scale of 5 to 20 cm. Beds with abundant limestone nodules are scattered through the shale succession (Figs. 50 and 51). In the upper Toobally Lakes area the formation contains a thin-bedded, dark grey limestone interval estimated to be 800 m thick (Pigage 2009); poor outcrop precludes determining where this carbonate interval occurs within the formation. This limestone was not encountered elsewhere in the Coal River map area.

Figure 50. *Rusty brown-weathering, dark grey, siliceous shale of the Fantasque Formation. Bedding dips steeply to the right in the photograph; slaty cleavage dips moderately to the left. Limestone nodules visible locally. From the core of the Skinboat syncline, in northeastern Coal River area (station 09TOA203).*

Figure 51. *Large limestone nodule in siliceous shale of Fantasque Formation. From 700 m east of upper Toobally Lake (station 04LP013). Hammer head is 20 cm long.*

Age, Correlation and Depositional Setting

A conodont sample from the east side of upper Toobally Lake was broadly Permian; another three were of indeterminate age (Table IV-12 in Pigage, 2009). Regionally the Fantasque Formation is upper Artinskian through Wordian (early Permian through middle Permian) (Bamber *et al.*, 1968; Henderson *et al.*, 1993). Sponge spicules are the diagnostic fauna for this unit although an elasmobranch fish impression was found near the base of the formation (Harker, 1961).

The Fantasque Formation is a thin but laterally persistent unit from Pine Pass throughout northeastern British Columbia and extends to the southern Mackenzie Mountains. Regionally the shale is typically interbedded with chert, and siltstone interbeds contain lag deposits of phosphate, chert pebbles, and chert nodules. It reflects a slope to basinal environment.

Correlative strata in the Rocky Mountains to the southeast include the Ranger Canyon and Mowitch formations of the Ishbel Group (Henderson *et al.*, 1993). In central Yukon correlative strata include the Mount Christie Formation, defined in Little Nahanni River map area (100 km north of the Coal River), consisting of buff to orange weathering shale, siliceous shale, chert, and minor sandstone of Early Permian age (Gordey and Anderson, 1993). In the southern Ogilvie Mountains correlative units are a mid-Permian limestone, the Takhandit Formation, and overlying green and red slate with minor chert (Green, 1972). The Fantasque Formation was deposited in a shallow water marine environment, below wave base.

Undivided Grayling and Toad formations (ŦGT)

Introduction

A single locality of Triassic strata in the Coal River map area occurs on the northwest side of upper Toobally Lake in the immediate footwall of the Toobally reverse fault. Outcrops of Triassic strata are sparse in southeast Yukon and previously mapped as undivided Grayling and Toad formations (Kindle, 1944; Fallas and Lane, 2001). It lies unconformably on the Fantasque Formation (Permian), and is unconformably overlain by Cretaceous strata to the east. In its type area, Grayling Formation (Lower

Triassic) is 305 m thick, conformably overlain by up to 730 m of Toad Formation (Middle Triassic) (Kindle, 1944).

Composition

The exposure consists of dark grey, soft, recessive shale (Fig. 52) and lesser interbedded thin, tan-weathering sandstone. Mica is locally visible on the slaty cleavage surfaces of the shale. Thin interbeds of greenish grey, very fine grained sandstone reveal small load clasts, possible gutter casts and poorly preserved horizontal burrows. Both the shale and sandstone are locally concretionary (Pigage, 2009).

Figure 52. *Dark grey, soft, recessive shale interbedded with thin, tan-weathering sandstone comprise the undivided Grayling-Toad unit. In the immediate footwall of the Toobally fault on the west side of upper Toobally Lake (station 03LP008).*

Age, Correlation, and Depositional Setting

Pollen samples for this unit in the Coal River area were identified as Lower Triassic with abundant Middle and Upper Devonian reworked spores (Pigage, 2009).

The unit is unlikely to be present elsewhere in the eastern Coal River map area, but is extensive (although poorly exposed) to the east and southeast. Correlation in the subsurface to the southeast includes the gas-bearing Montney and Doig formations (Gibson, 1993; Dixon, 2009). Northwest of the Coal River map area, the Jones Lake Formation, of late Middle to Late Triassic (Ladinian to Norian) age, is a correlative siltstone, sandstone and shale unit about 750 m thick (Gordey and Anderson, 1993).

Five facies associations are recognized in detailed sections measured to the east in NTS 95C/1 and NTS 95C/2 (MacNaughton, 2002). These facies associations are interpreted to represent depositional environments on a wave-dominated shelf, ranging from relatively distal, sand-poor settings below storm wave base to high-energy, proximal sand-rich, mid to upper shoreface settings. Sandstone from the Jones Lake Formation yielded Mississippian detrital zircons, a likely indication that Yukon-Tanana terrane elements were contributing to the shallow marine shelf sediments (Beranek *et al.*, 2010).

SUCCESSION 6 – PALEOCENE TO LATE EOCENE

Two widely separated exposures constitute this succession. The western tip of an east-trending ridge projects into the Coal River map area at 60°28'N. In the north-central part of the map area, the Rock River valley contains exposures of poorly consolidated sediments over a 50 by 4 km area.

Paleocene unconsolidated sediments (ℙssc)

Introduction

A greater than 160 m-thick succession of flat-lying, siltstone, sandstone and conglomerate unconformably overlies folded Road River Group strata. The upper extent of the unit is eroded.

Composition

This outcrop extends eastward into the Pool Creek map area (NTS 95C/5), where its greater exposure permitted more thorough observation of bedding and lithologic variation (Pigage, 2009). There it consists predominantly of poorly consolidated pebbly sandstone with thinner interbeds of clay siltstone to mudstone and highly variable 'red beds'. Siltstone intervals are discontinuous across the section, occurring as thin lenses up to 20 m long. The uppermost sedimentary unit is a coarse, clast-supported conglomerate up to 21 m thick. The dominant clast component in the conglomerate is grey quartzite. The succession is capped by remnants of a Paleocene trachytic, locally columnar-jointed, olivine alkali basalt flow up to 20 m thick.

Age, Correlation and Depositional Setting

A whole rock sample of the basalt flow was dated at 56.7 ± 0.7 Ma using $^{39}Ar/^{40}Ar$ methods (Pigage, 2009), providing a minimum late Paleocene age for the sediments.

The strata indicate a subaerial, fluvial depositional environment. Imbrication and bar forms indicate an east to southeast paleoflow direction (Pigage, 2009).

Eocene Rock River basin, coal-bearing sediments (𝔼RR)

Introduction

Eocene strata are poorly exposed along the banks of the Rock River, and in diamond drill core from coal exploration in the Rock River valley in 1986 and 2006. Drill holes penetrated Cenozoic sediments to a depth of 445 m (Aurora Geosciences Ltd., personal communication 2014). Gravity surveys on east-west lines were used to calculate an 1100 m thickness for the poorly consolidated sediments overlying lower Paleozoic sedimentary rocks in the northern part of the basin (Wright and Miller, 1986). The lower contact is unconformable, and there are no overlying units recognized.

Composition

The succession is dominated by drab, dark to light grey, poorly consolidated mudstone with thin sandstone beds and thick lenses of coal (Long and Sweet, 1994; Wright and Miller, 1986). The coal horizon in the single outcrop exposure is over 5 m thick; in two drill holes, coal seams up to 4.7 m thick amounted to about 50% of the core (Wright and Miller, 1986). Bedding in the single outcrop of Tertiary strata dips about 15° westward.

Age, Correlation and Depositional Setting

Cenozoic strata encountered in the drill holes have a late Eocene age based on palynology (Long and Sweet, 1994). They were deposited in floodplains or wetlands associated with a stable single or multiple-channel fluvial system (Long and Sweet, 1994).

In early Cenozoic time several intermontane depositional basins or half-grabens developed along active extensional faults in eastern Yukon and adjacent Northwest Territories (320 km north-northwest; *see* Martel *et al.*, 2012). The west side of the poorly consolidated sediments in the north-central part of the Coal River map area is a postulated normal fault; the eastern limit is eroded. We interpret these to be remnants of a depositional basin whose strike length is approximately 50 km (based upon its gravity expression; Wright and Miller, 1986), and maximum width is 4 km.

IGNEOUS ROCKS

Introduction

Coal River map area contains several volcanic rock horizons within Proterozoic through Late Ordovician strata. The exposures range from approximately 50 m to about 1300 m thick, consisting of multiple flow units, breccia and tuff. Similar textural characteristics and geochemistry warrant their treatment together in this section.

Fifteen plutons are currently known in the northern half of the Coal River map area. Most are small and poorly exposed, underlying heavily forested areas. Age dating and chemical analysis indicate that most of the plutons have a similar chemistry, with crystallization ages between 97 Ma and 100 Ma (Pigage *et al.*, 2014).

Cambrian-Ordovician Alkali Basalt (PЄVN-v, ЄOC-v, ЄOR-v, and OSu-v)

Introduction

Lenticular belts of volcanic rock are present within the undivided Vampire-Narchilla unit, Crow Formation, Rabbitkettle Formation, and Sunblood Formation. Based upon the ages of the sedimentary units that overlie and underlie them they range from early Cambrian to Late Ordovician, thus representing a protracted interval of intermittent volcanism. Texturally the flows include massive, pillowed, and autobrecciated variants; these intercalations have been described previously with their respective stratigraphic units. Their volumetric abundance is minor and few dikes were noted outside of the immediate area of the volcanic rocks. It is surmised that these occurrences are remnants from many isolated extrusions, rather than a few eruptions of widespread extent.

The geochemical character of the different volcanic units is presented in this section. Whole rock and trace element analyses were completed on samples from the different volcanic units (Fig. 53); the analyses are presented in Appendix C. Samples were selected to avoid amygdules, veins, or alteration in fractures. All volcanic exposures contain secondary minerals, likely resulting from seawater alteration and burial and subsequent metamorphism. Volcanic rocks in the map area have been metamorphosed to at least lower greenschist facies based upon ubiquitous chlorite. Typical alteration includes modification of the alkali content, increase in carbonate and water (volatiles) and oxidation of the iron content (*e.g.*, Rollinson, 1993). The moderate to large loss-on-ignition (LOI) contents in these samples attest to mobilization of some major and trace elements. Immobile elements during alteration and metamorphism have been utilized to minimize the effects of alteration and metamorphism and eliminate errors of classification (Pearce and Cann, 1973; Wood, 1980; Jenner, 1996).

Undivided Vampire-Narchilla unit volcanic rocks (PЄVN-v)

Two diabase dike samples and two samples from a flow within the Vampire-Narchilla unit differ in subtle ways from the other Paleozoic igneous rocks. They were selected from outcrops in a 17 km long, 1300 m wide area of this unit west of the Rock River fault (Plate 1). Based upon these samples, the total-iron to magnesium ratio is ~4; Cr and Ni content are below 20 ppm; and Nb is low (80-115 ppm).

TiO_2 is low (2.06-2.8%) and Zr ranges from 24 to 401 ppm (the latter may reflect the presence of a zircon crystal in the sample). These rocks contain high Ba (826-1095 ppm), and the Na_2O to K_2O ratio is 1.5-2. On the Zr/Ti vs Nb/Y composition plot (Pearce, 1996) these few samples occupy the alkali basalt field (Fig. 54a); trace element values normalized to primitive mantle broadly have an ocean island basalt (OIB) signature; the samples show significant depletions in Zr, Hf and Ti (Fig. 54b). The low vanadium content of all samples places them well away from the volcanic arc trend (Fig. 54c; Shervais, 1982).

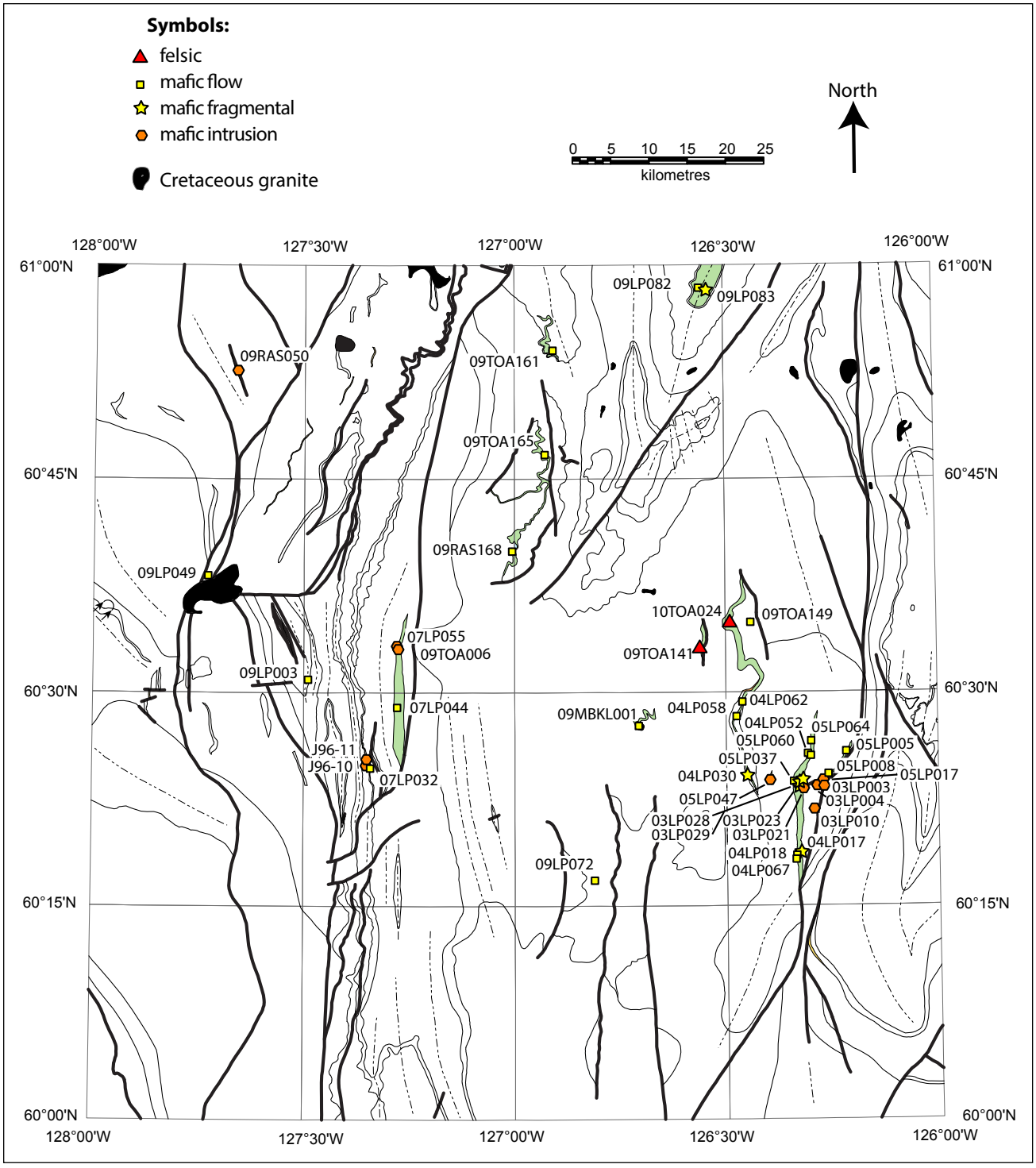

Figure 53. *Distribution of volcanic rocks intercalated within four formations of the Coal River map area. Numbers indicate sample locations for geochemistry (Appendix C, Tables C1-C4).*

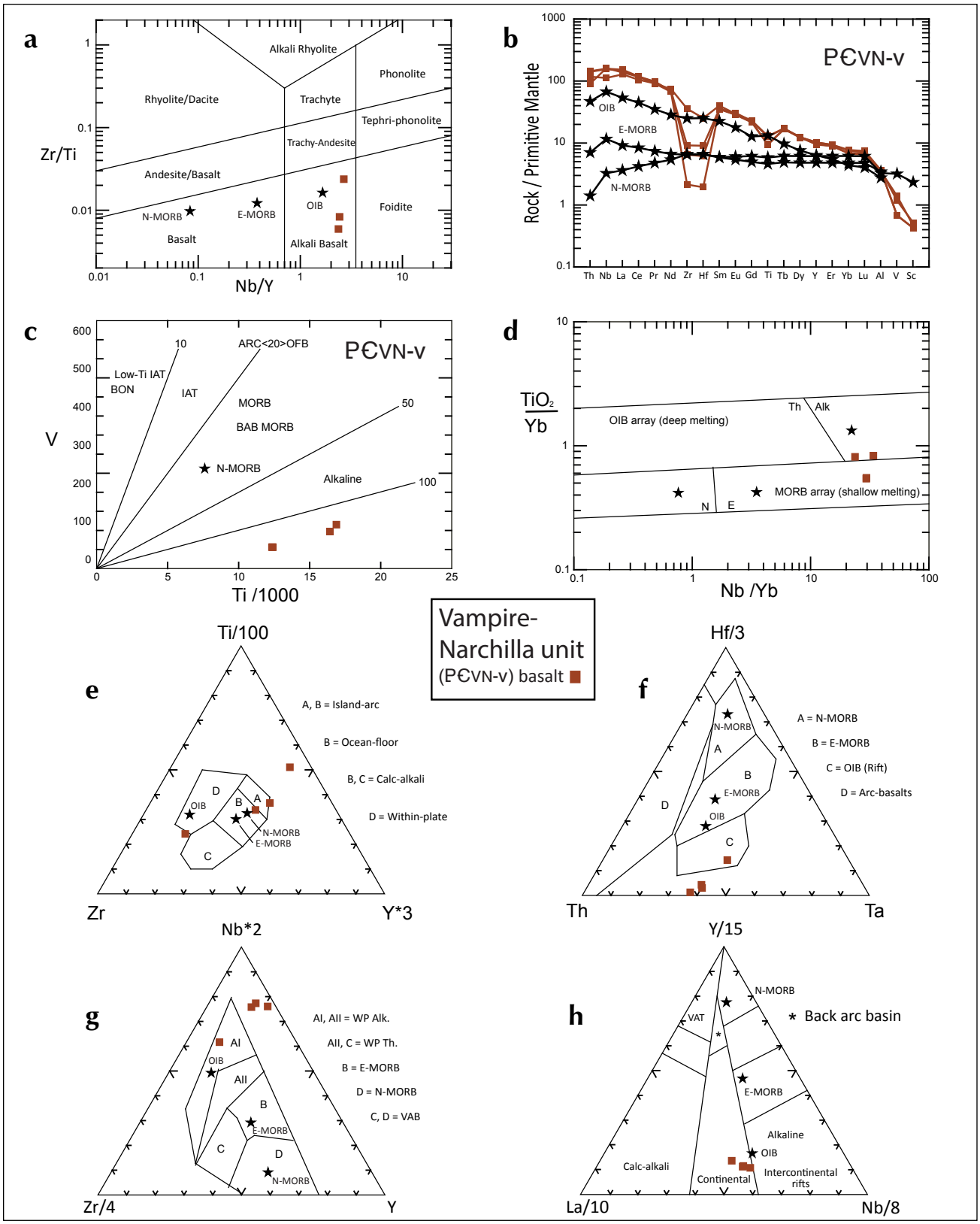

Figure 54. *Geochemical and tectonic discriminant diagrams for volcanic rocks of the undivided Vampire Narchilla unit:* ***(a)*** *Zr/TiO2-Nb/Y diagram of Winchester and Floyd (1977), as modified by Pearce (1996);* ***(b)*** *primitive mantle-normalized, multi-element diagram;* ***(c)*** *Ti/V diagram of Shervais (1982);* ***(d)*** *TiO2/Yb-Nb/Y diagram of Pearce (2008);* ***(e)*** *Zr-Ti-Y diagram of Pearce and Cann (1973) for tholeiitic basalt;* ***(f)*** *Th-Hf-Ta diagram of Wood (1980);* ***(g)*** *Zr-Nb-Y diagram of Meschede (1986); and* ***(h)*** *La-Y-Nb diagram of Cabanis and Lecolle (1989) for basalt.*

In general these rocks are poorly discriminated on ternary diagrams (Fig. 54e-h). They straddle multiple fields on the ternary Ti-Zr-Y plot designed for tholeiitic basalt (Fig. 54e; Pearce and Cann, 1973), and are so low in Hf and Zr that most plot outside the established fields on the other diagrams (Fig. 54f,g).

The alkali basalt designation is confirmed by Figure 54a,c,d. Figure 54b and d suggest an enriched mantle source with minimal to no crustal contamination; limited crustal contamination of the magma suggests rapid extrusion from the mantle source area.

Crow Formation volcanic rocks (ЄOc-v)

Volcanic rocks form narrow belts of exposure within the Crow Formation west of upper Toobally Lake and in the core of the Caribou anticline (Plate 1). The previous study of Pigage (2009) is augmented by additional analyses here. Analyses on eight samples returned a loss-on-ignition (LOI) greater than 10% [flows: 05LP008, 04LP018-1, 05LP060; altered dikes/sills: 03LP003, 03LP010, 03LP017; altered breccia: 03LP023, 04LP017]. The high volatile content likely reflects metamorphism and alteration. These samples also have anomalous CaO (indicative of secondary carbonate); they were not included in the diagrams. Two samples (09TOA141 and 10TOA024) have SiO_2 compositions indicative of andesite to rhyolite; these samples are included in the Appendix C tables but are also excluded from the discriminant and composition diagrams that are appropriate for basaltic rocks.

The total iron to magnesium ratio ranges from 1.5-4, with variable Cr (below 20 to 528 ppm), Ni (69-198 ppm) and uniform Nb (23-48 ppm). TiO_2 is low (1.4-3.3%) as is Zr (87-413 ppm), and P_2O_5 content is low to moderate (0.18-1.12%). K_2O is equal to or greater than Na_2O in half the samples; Ba is either low (<50 ppm) or relatively high (300-946 ppm). From the composition and discriminant plots these rocks are clearly alkaline basalt (Fig. 55a,b,c) in the 'within plate' and OIB fields (Fig. 55e,f,g) with a few samples near the boundary between continental and intercontinental rifts (Fig. 55h). Trace-element and rare earth element (REE) patterns normalized to primitive mantle range between OIB and enriched mid-ocean ridge basalt (E-MORB).

The tectonic discriminant diagrams indicate deep melting of enriched mantle with minimal contamination from crust during ascent (Pearce, 2008; and others listed in the caption for Fig. 54).

Rabbitkettle Formation volcanic rocks (ЄOr-v)

Five flows, one sill and two undefined samples (from drill core at Jeri-North prospect) represent the igneous component of the Rabbitkettle Formation. Volatile contents range from 3% to 8%; silica contents are typical of basalt. The total iron to magnesium ratio approaches 2, and all have low Nb (10-57 ppm), Cr (40-470 ppm, by ICP-MS) and Ni (below 20 to 240 ppm). TiO_2 ranges from 0.67 to 3.2%, and Zr from 131-272 ppm. The rocks are sodic (Na_2O: K_2O is 3-10), and some contain appreciable Ba (up to 1591 ppm).

On the Zr/Ti vs Nb/Y composition diagram the Rabbitkettle volcanic samples are andesitic basalt to alkali basalt (Fig. 56a), the samples plot in both the alkaline, OIB and MORB fields (Fig. 56c,d). On ternary discriminant diagrams, the samples occupy the 'within plate' and OIB fields (Fig. 56e,f,g), although the high La in the samples pulls them into the calc alkaline field (Fig. 56h).The composition normalized to primitive mantle indicates depletions in Nb and Ti for some of the samples (Fig. 56b), suggesting slight crustal contamination for the basalt; this indication of crustal contamination is also suggested by several of the samples plotting above the MORB array in Figure 56d. A continental, within-plate, extensional environment with slight crustal contamination of an enriched mantle source is suggested.

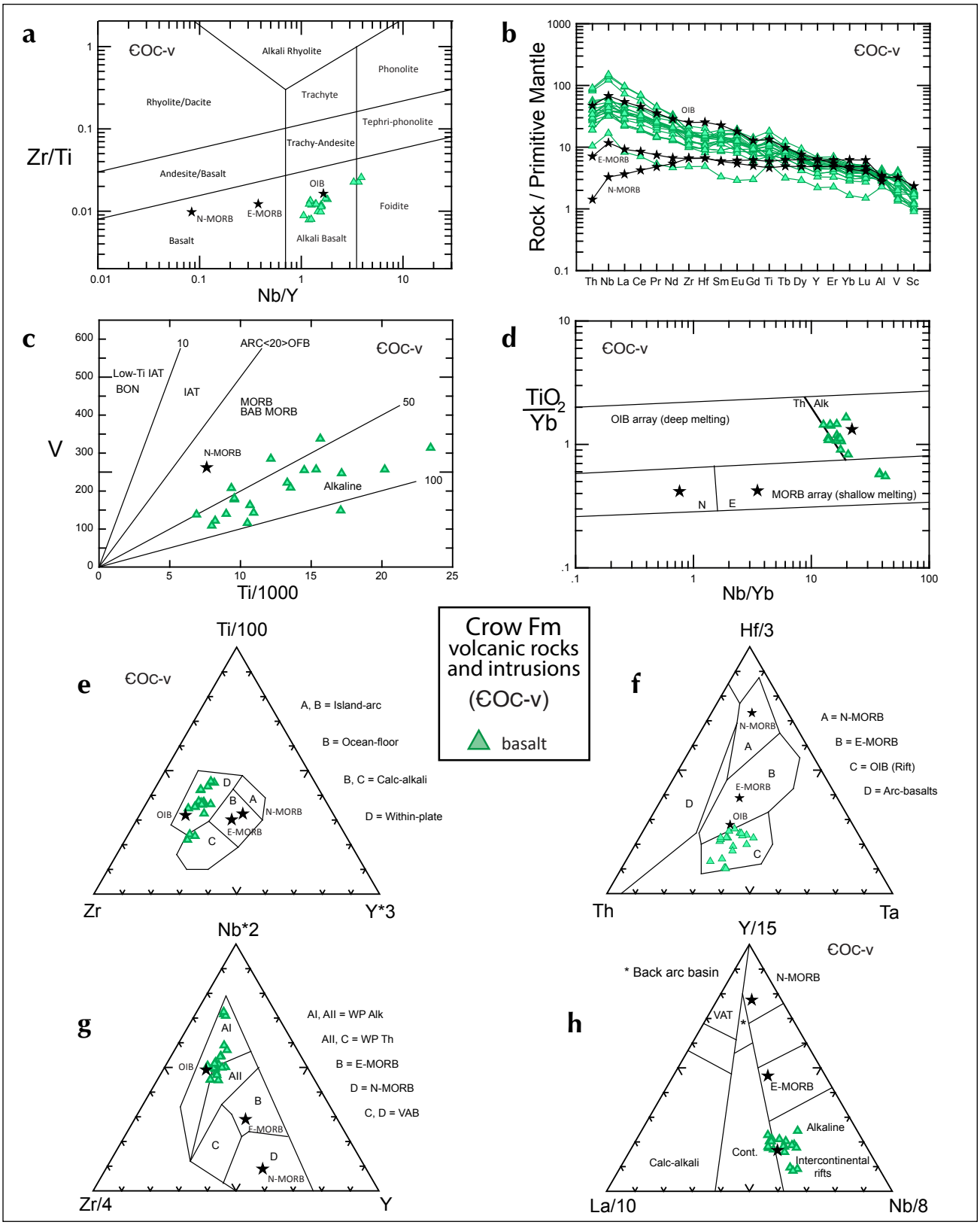

Figure 55. *Geochemical and tectonic discriminant diagrams for volcanic rocks and intrusions of the Crow Formation:* ***(a)*** *Zr/TiO2-Nb/Y diagram of Winchester and Floyd (1977), as modified by Pearce (1996);* ***(b)*** *primitive mantle-normalized, multi-element diagram;* ***(c)*** *Ti/V diagram of Shervais (1982);* ***(d)*** *TiO2/Yb-Nb/Y diagram of Pearce (2008);* ***(e)*** *Zr-Ti-Y diagram of Pearce and Cann (1973) for tholeiitic basalt;* ***(f)*** *Th-Hf-Ta diagram of Wood (1980);* ***(g)*** *Zr-Nb-Y diagram of Meschede (1986); and* ***(h)*** *La-Y-Nb diagram of Cabanis and Lecolle (1989) for basalt.*

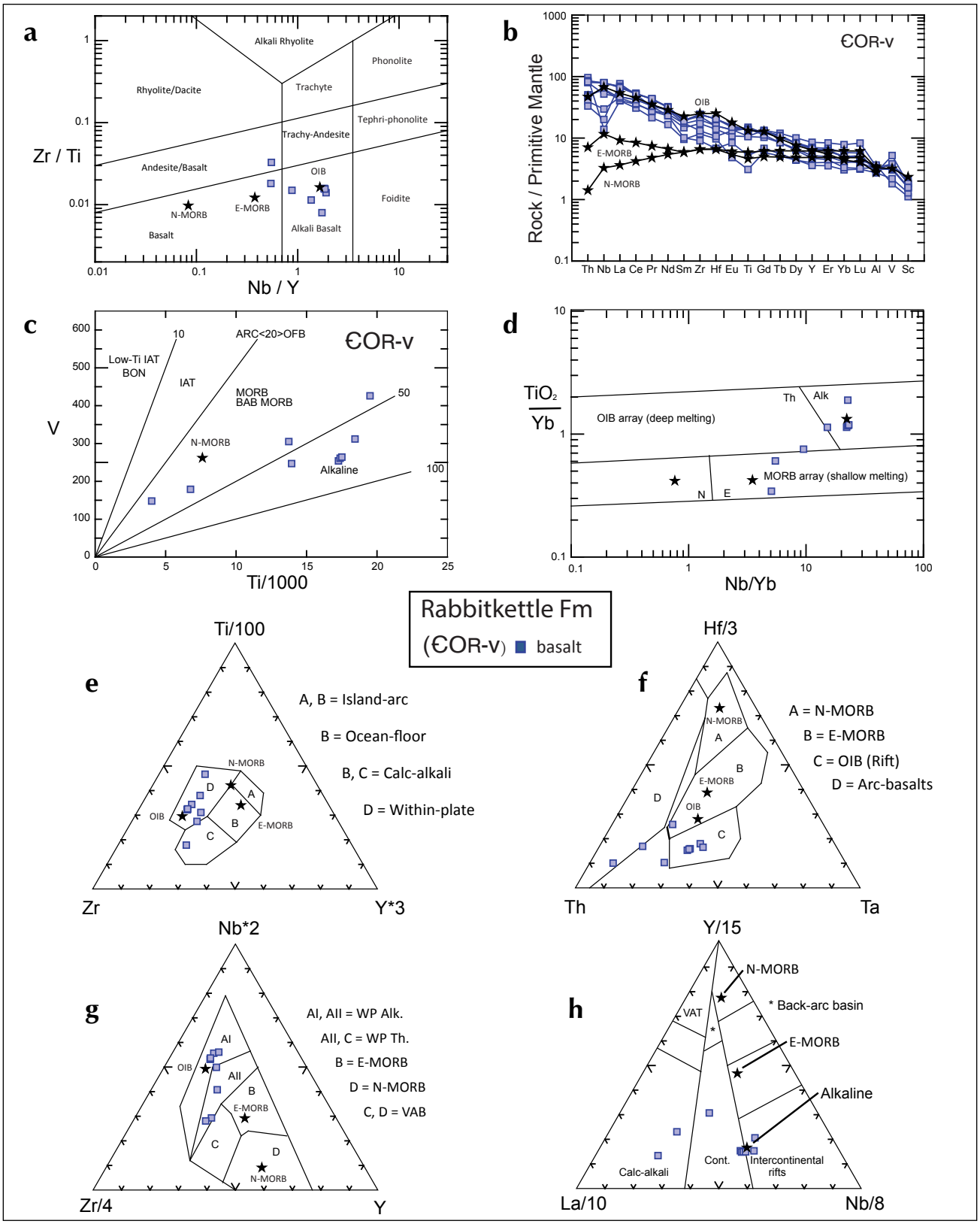

Figure 56. *Geochemical and tectonic discriminant diagrams for volcanic rocks of the Rabbitkettle Formation:* ***(a)*** *Zr/TiO2-Nb/Y diagram of Winchester and Floyd (1977), as modified by Pearce (1996);* ***(b)*** *primitive mantle-normalized, multi-element diagram;* ***(c)*** *Ti/V diagram of Shervais (1982);* ***(d)*** *TiO2/Yb-Nb/Y diagram of Pearce (2008);* ***(e)*** *Zr-Ti-Y diagram of Pearce and Cann (1973) for tholeiitic basalt;* ***(f)*** *Th-Hf-Ta diagram of Wood (1980);* ***(g)*** *Zr-Nb-Y diagram of Meschede (1986); and* ***(h)*** *La-Y-Nb diagram of Cabanis and Lecolle (1989) for basalt.*

Sunblood Formation volcanic rocks (OSu-v)

Two samples were selected from flows within the Sunblood Formation. The composition of one may be less reliable because its carbonate and hydrous mineral content amounted to 7.2% LOI. Both samples show roughly equal total iron to magnesium ratios, low Nb (~30 ppm), variable Cr (69-348 ppm) and Ni (40-160 ppm). One sample has high K_2O (5.2%) but lower Ba (517 ppm, in contrast to 875 ppm in the other) suggestive of alteration, given its high volatile content. On the Zr/Ti vs Nb/Y composition diagram the samples plot within the alkali basalt field (Fig. 57a). Trace element patterns normalized to primitive mantle match that of OIB (Fig. 57b), and the samples plot neatly within the OIB and 'within-plate' fields on various discriminant diagrams (Fig. 57c-h), similar to those for the Crow and Rabbitkettle formations.

Discussion

The volcanic rocks in the Coal River map area are part of a widespread assemblage of mafic volcanic rocks of similar ages and composition that are distributed throughout Selwyn basin and adjacent Mackenzie platform (Goodfellow *et al.*, 1995), as well as more sparsely along the eastern half of the southern Canadian Cordillera. The chemistry of the assemblage indicates an enriched mantle source, similar to OIB, but reflects intermittent extension within unstable, thinned continental crust of the outer continental margin.

Dominantly mafic, submarine volcanic rocks from lower Cambrian to Middle Devonian age form lenticular occurrences in east central Alaska, eastward and southeast to the Coal River map area (Goodfellow *et al.*, 1995). Significant exposures include the southern Ogilvie Mountains (Roots, 1988), the axis of the Misty Creek embayment (Marmot Formation; Cecile, 1982) and the Anvil Range north of Faro (Menzie Creek formation; Jennings and Jilson, 1986; Pigage, 2004b).

Locally quartz and feldspar-phyric flows and intrusions occur in the western Ogilvie mountains, near the Dempster Highway (Roots, 1988), near the Marg VMS deposit northeast of Mayo and in Crow and Rabbitkettle formations within the Coal River map area (this report). Their composition is rhyolite, with high K_2O and Ba, although these elements may be secondarily enriched.

The mafic localities have similar depositional environment and tectonic settings. They dominantly form subaqueous, low magma volume volcanic edifices (individual occurrences estimated to contain <20 km^2; greatest thicknesses are in Misty Creek embayment (500 m in Porter Puddle Complex; Goodfellow *et al.*, 1995) and at Fossil Creek (610 m; Wheeler *et al.*, 1986)). They overlie and are intercalated with clastic sediments of the upper Hyland Group (typically Narchilla formation), Rabbitkettle Formation and Road River Group (e.g., Hess River, Rabbitkettle, Elmer Creek/Duo Lake and Steel formations). Many occurrences are overlapped by limestone patch reefs, although the Sunblood Formation of southeast Yukon is one of only two regionally widespread platform carbonate units to contain volcanic horizons (the other is the Haywire Formation). Typically, flows low in the volcanic successions are pillowed, while some upper sections contain conglomerate and maroon breccia that indicate emergence (Roots, 1988; Goodfellow *et al.*, 1995). The preservation of subaerial facies between flow units and relatively deep water sediments indicates rapid subsidence of parts of the volcanic edifice.

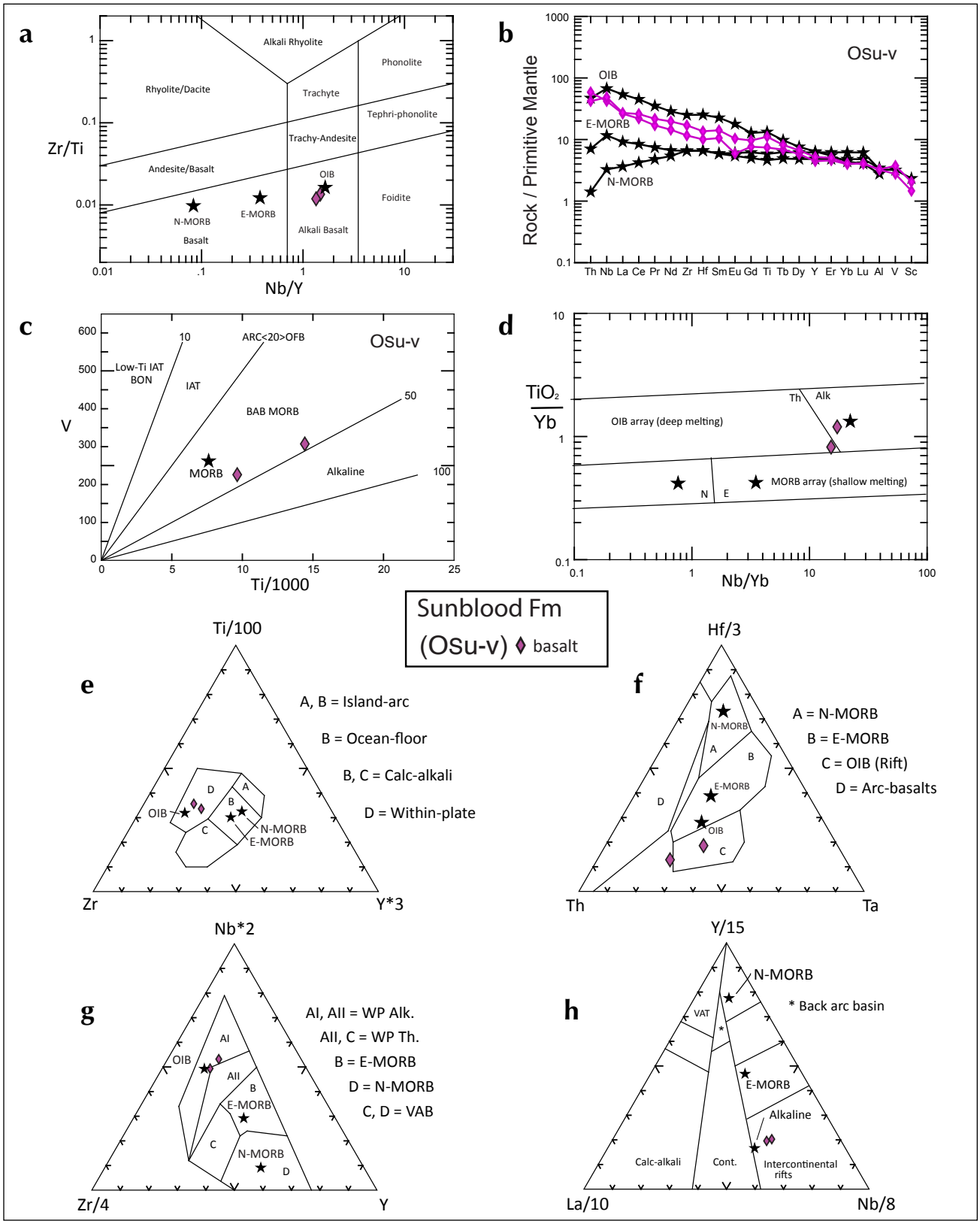

Figure 57. *Geochemical and tectonic discriminant diagrams for volcanic rocks of the Sunblood Formation:* ***(a)*** *Zr/TiO2-Nb/Y diagram of Winchester and Floyd (1977), as modified by Pearce (1996);* ***(b)*** *primitive mantle-normalized, multi-element diagram;* ***(c)*** *Ti/V diagram of Shervais (1982);* ***(d)*** *TiO2/Yb-Nb/Y diagram of Pearce (2008);* ***(e)*** *Zr-Ti-Y diagram of Pearce and Cann (1973) for tholeiitic basalt;* ***(f)*** *Th-Hf-Ta diagram of Wood (1980);* ***(g)*** *Zr-Nb-Y diagram of Meschede (1986); and* ***(h)*** *La-Y-Nb diagram of Cabanis and Lecolle (1989) for basalt.*

The discontinuous and interdigitating nature of the volcanic outcrops suggests that they issued from fissures; their primary geometry is masked by subsequent folding and faulting and poor exposure. The range in age suggests that Selwyn basin (*i.e.*, early Paleozoic continental margin) underwent episodic tensional stress that reactivated deep fractures in the continental margin. Their alkalic nature and within-plate chemistry are consistent with this extensional tectonic regime (Barberi *et al.*, 1982; Bailey, 1985). The volcanic magma was sourced from enriched mantle, and ascended with only minor crustal contamination. Slight differences in the chemistry of the Coal River volcanic rocks attest to heterogeneity in the source region, with no indication of progressive change over time.

Cretaceous Intrusions (mKg)

Fifteen plutons (Table 2) are scattered across the northern half of the map area where they generally occupy low lying, heavily forested areas. Nine were either discovered during this program or were previously only recorded on industry maps. The intrusions are typically subcircular and range from 335 m to about 8380 m across. Aeromagnetic anomalies aided detection and mapping of the intrusions (Fig. 58).

Since the intrusive bodies are poorly exposed, their full size, contact relationships and metamorphic effects such as hornfelsing, skarn development and alteration remain unclear and poorly documented. The Kostiuk, Spork and Ivo-Salivo plutons consist of the southern portions of large plutons primarily located in adjacent Frances Lake (NTS 105H) and Flat River (NTS 95E) map areas.

The plutons of the Coal River map area consist predominantly of biotite ± hornblende, metaluminous granodiorite to quartz monzodiorite. Textures range between porphyritic and equigranular. Porphyritic variants are typically crowded with plagioclase phenocrysts up to 5 mm across in a fine-grained, grey matrix; hornblende, biotite, and minor quartz also occur as phenocrysts. The Main pluton is the only body which contains primary muscovite. Many of the intrusions are incipiently to extensively altered, with chlorite replacing hornblende and biotite, and sericite dust occurring within feldspar.

Geochronology and geochemistry of the plutons are described in Pigage *et al.* (2014). All sampled intrusions (except for the Main pluton; see discussion below) belong to the Tay River suite as outlined by Rasmussen (2013; *see* also Heffernan, 2004; Hart *et al.*, 2004; Mortensen *et al.*, 2000). They are the southernmost exposures of the Tay River suite, a belt of contemporaneous and compositionally coherent intrusions extending 450 km northwest.

Crystallization ages for nine of the plutons were determined using CA-TIMS geochronology on single zircon grains. These ages are tightly clustered, ranging from 97.70 ± 0.03 Ma to 99.80 ± 0.03 Ma. Pigage *et al.* (2014) described their compositions, suggesting that the intrusions are partial melts from a reasonably homogenous, igneous, infracrustal source rock. They further suggested that partial melting was related to subduction with flattening of the subducting slab resulting in the Tay River plutonic suite being 400 km inboard of the postulated subduction trench.

The Gabe, Main and Spork plutons occur within the north to northeast-trending belt defined by a positive aeromagnetic anomaly (Fig. 58) and rocks of higher metamorphic grade. The aeromagnetic anomaly may be caused by the presence of metamorphic pyrrhotite or magnetite in the thermal aureole of a large intrusion, or a magnetic phase of a buried pluton.

Table 2. Intrusions in Coal River map area. Coordinates are UTM zone 9N, NAD83 datum.

Name	UTM East (m)	UTM North (m)	Age Ma ± 2 sigma*	Reference
Powers	658 872	6 743 596	98.2 ± 1.3	Rasmussen *et al.*, 2007
Jorgensen	645 250	6 751 550	98.35 ± 0.13	Pigage *et al.*, 2014
Last 1	621 360	6 751 642	-	
Last 2	620 192	6 745 800	98.52 ± 0.13	Pigage *et al.*, 2014
Gabe	570 761	6 722 414	97.83 ± 0.13	Pigage *et al.*, 2014
Kostiuk	555 895	6 762 820	99.39 ± 0.13	Pigage *et al.*, 2014
Oudder	625 672	6 723 074	97.70 ± 0.13	Pigage *et al.*, 2014
Lookout	655 673	6 752 196	98.20 ± 0.13	Pigage *et al.*, 2014
Spork	597 672	6 764 282	98.09 ± 0.13	Pigage *et al.*, 2014
Main	586 791	6 754 152	-	
Gusty	626 261	6 704 777	99.79 ± 0.13	Pigage *et al.*, 2014
Balsam	655 415	6 737 047	-	
Caribou	652 311	6 752 434	98.27 ± 0.13	Pigage *et al.*, 2014
Patterson	631 695	6 751 436	97.5 ± 0.5	Heffernan, 2004
Ivo-Salivo	606 595	6 764 260	-	

* For a discussion of error, *see* Pigage *et al.* (2014).

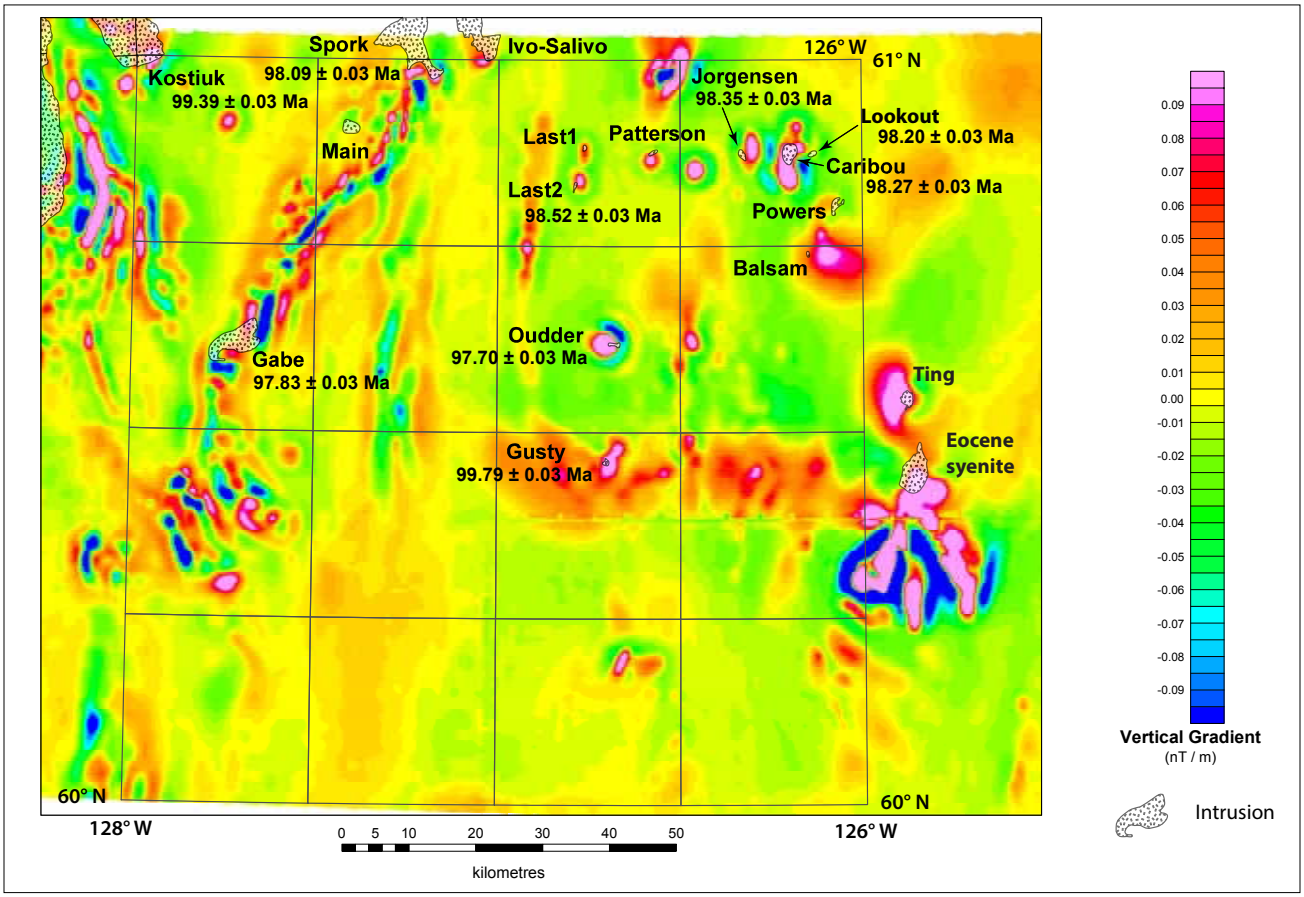

Figure 58. *First vertical derivative of regional aeromagnetic survey with Cretaceous and Cenozoic granitic intrusions superimposed. Eocene syenite from Pigage (2009). Ting intrusions from Harrison (1982).*

The sample from the Main pluton is a medium-grained, equigranular, foliated, medium grey, muscovite-tourmaline-garnet granite. The feldspar is exclusively plagioclase. Subhedral plagioclase and interstitial quartz constitute approximately 90% of the mode. Staining reveals very minor, fine-grained, interstitial K-feldspar. The chemistry is also significantly different from the other plutonic samples (Pigage *et al.*, 2014). The Main sample (sample10TOA019) yielded such poor quality zircon that isotopic dating was not attempted (Pigage *et al.*, 2014).

Another linear positive magnetic anomaly extends westerly from the eastern boundary of the map area to very near the Rock River (Fig. 58). It may also represent a series of buried plutons. The eastern end of this anomaly, in the Pool Creek map area (NTS 95C/5), contains exposures of a magnetite-bearing, Eocene biotite syenite (Pigage, 2009). Boulders of granite (Gusty pluton) were found over the most magnetic part of the anomaly. Elsewhere along this trend the surface exposures are siliciclastic and carbonate rocks with little to no magnetic expression.

STRUCTURE

Introduction

The Coal River map area is characterized by steeply dipping, northwest to northeast-trending faults and folds. It has been divided into four domains (domains A-D, Fig. 59), and structural measurements are plotted on equal area stereonets (Figs. 60-63). The domains, described here from west to east, reflect decreasing intensity of deformation and waning penetrative structural fabrics.

In domains A and B and the western part of domain C folds are associated with a penetrative axial planar slaty cleavage in argillaceous units. Second-phase refolding of earlier contractional structures by north-trending, open cross-folds (domains A, B and C) resulted in the local development of an axial planar crenulation cleavage in argillaceous units. A penetrative slaty cleavage fabric is not readily visible in domain D.

Domain A

The westernmost structural domain A is bounded to the east by the interpreted east-verging Acland thrust fault. Stratigraphic units in the domain are the Yusezyu Formation, undivided Vampire-Narchilla unit, Rabbitkettle Formation, and Road River Group. The domain is characterized by northwest-trending, southwest-verging, asymmetric folds with an associated pervasive, axial planar, slaty cleavage. Poles to bedding form a broad girdle with a best-fit trend/plunge of 330/11 (Fig. 60a). The axial planar slaty cleavage is dominantly steep (Fig. 60b); lineations plunge both to the northwest and southeast with a mean trend/plunge of 328/11. Locally these early folds are refolded with the development of later, small, north-trending, east-verging, open folds with an associated axial planar crenulation cleavage.

Lack of stratigraphic markers in the Yusezyu Formation hinder recognition of structures larger than outcrop scale. Consistent bedding and structural orientations over fairly large areas hint at the existence of large-scale folds. Northwest-trending anticlines cored by Yusezyu Formation have been interpreted in domain A on the basis of these structural relations between bedding and the pervasive slaty cleavage.

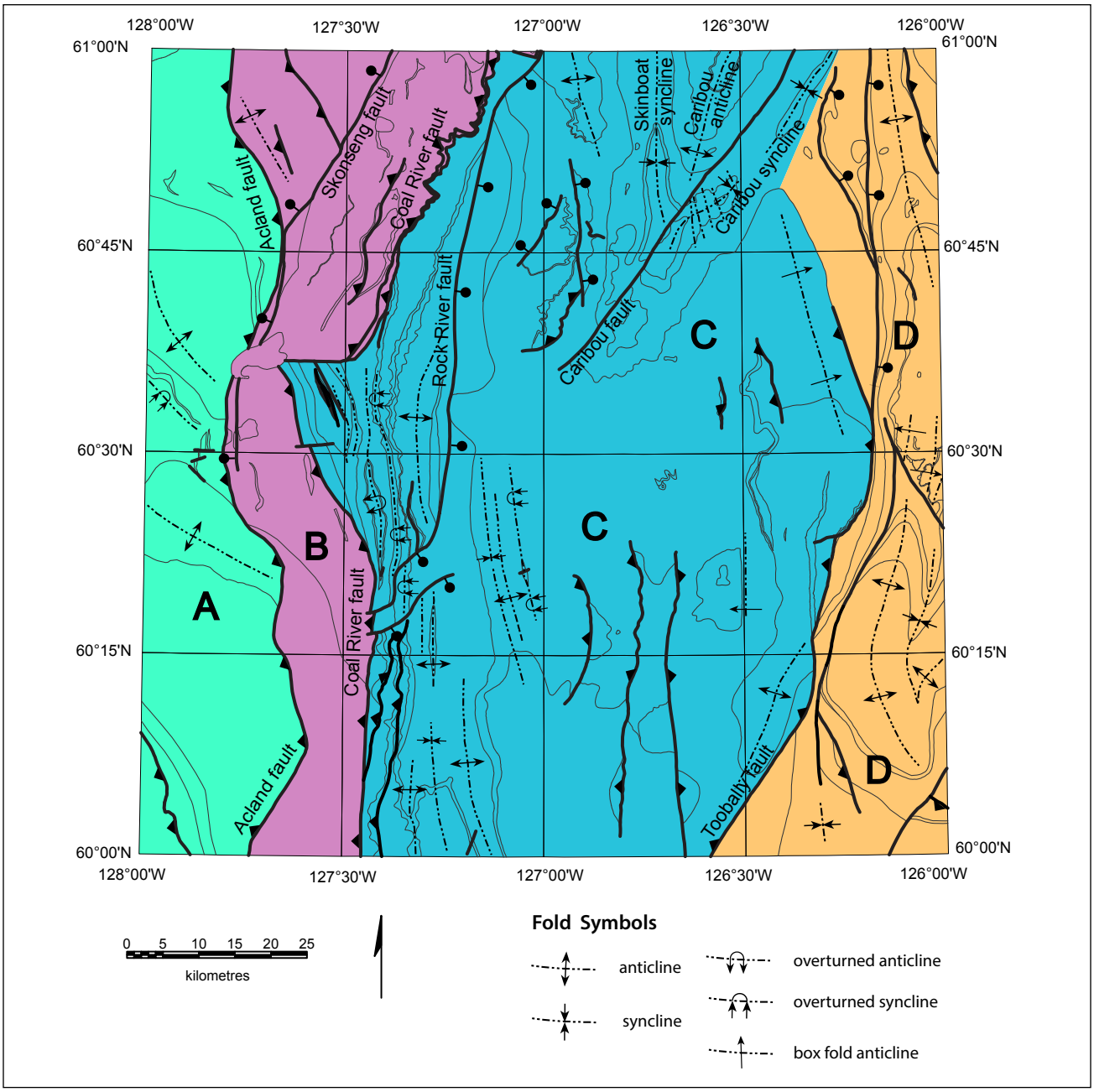

Figure 59. *Structural domains in Coal River map area.*

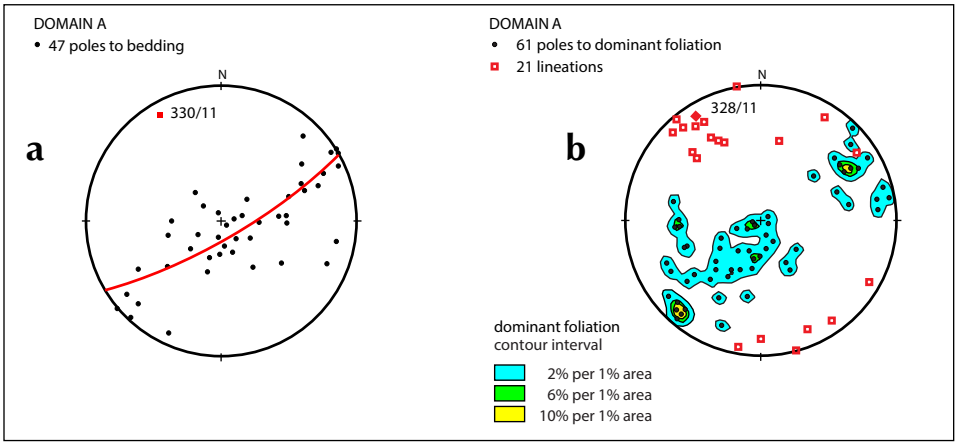

Figure 60. *Structural domain A structural fabrics;* ***(a)*** *poles to bedding;* ***(b)*** *poles to dominant foliation, lineations associated with dominant foliation.*

Domain B

The next structural panel to the east is cored by the undivided Vampire-Narchilla unit and bounded to the east by the Coal River thrust fault array. Bedding and foliation measurements are dispersed (Fig. 61), but generally correspond with trends of the aeromagnetic anomalies. Documented early folding consists of north-trending, east-verging, large-scale, tight, asymmetric folds with steep to vertical limbs and gently west-dipping limbs (Fig. 61a); poles to bedding form a broad girdle with a best fit pole of 188/11. Rocks in these folds have an associated pervasive, axial planar, slaty cleavage dipping moderately to the west (Fig. 61b); associated lineations plunge gently to the north-northeast and south-southwest with an average trend/plunge of 196/14. Structural domain B also contains locally extensive development of later, small-scale, north-trending, east-verging folds with an associated axial planar crenulation cleavage which refolds the earlier folds (Fig. 61c); the crenulation cleavage dips gently to moderately to the west. Associated lineations plunge gently to the north-northeast and southwest.

The Skonseng fault in the northwest corner of the map area separates rocks containing muscovite-chlorite (west) from rocks containing biotite-staurolite-garnet (east). The change in metamorphic grade is abrupt and is interpreted as a post-peak metamorphism normal fault.

The Coal River fault array consists of two or more closely spaced east-verging reverse faults. Rock units between the faults in the northern part of the map area are strongly foliated, suggesting that the reverse faults developed in hinge zones of tight folds. The faults are locally well exposed towards their north end, and dip moderately west. Displacement is estimated to be 2000-3000 m.

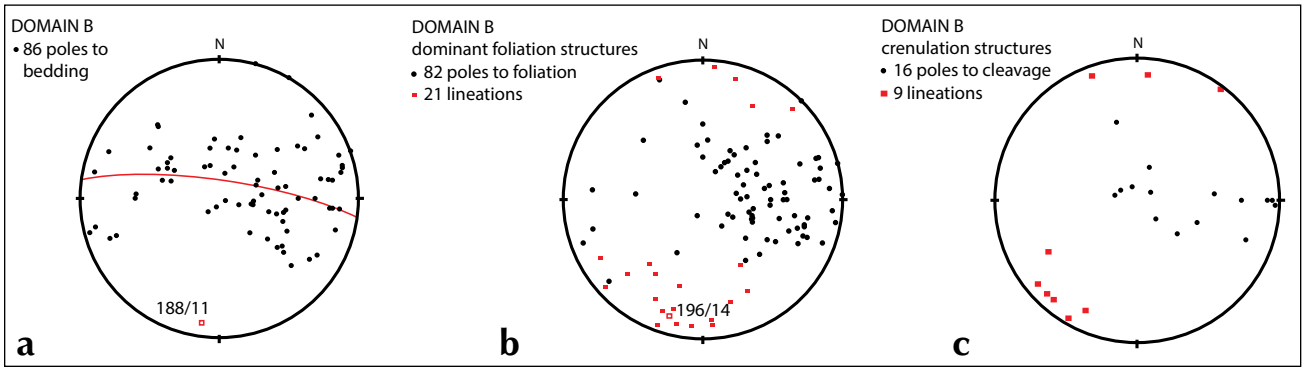

Figure 61. *Structural domain B structural fabrics,* ***(a)*** *poles to bedding;* ***(b)*** *poles to dominant foliation, lineations associated with dominant foliation;* ***(c)*** *poles to crenulation cleavage, lineations associated with crenulation cleavage.*

Domain C

Domain C underlies the central part of the map area and is bounded by the Coal River reverse fault to the west and the Toobally reverse fault to the east. It is characterized by asymmetric to overturned, east-verging folds with associated pervasive, west-dipping, axial planar, slaty cleavage in the west-central part of the map area. These folds are particularly well developed in the immediate Otter Creek area (Mel mineral occurrence - Yukon MINFILE 95D 005). To the south, the folds decrease in intensity and become more open and symmetrical; to the north the folds are replaced by east-verging reverse faults separated by west-dipping sedimentary strata. To the east, folding becomes less intense and transitions to a generally west-dipping, homoclinal stratigraphic succession with locally developed, macro-scale, east-verging reverse faults and box-style folds. Some small-scale, west-verging reverse faults and/or normal extensional faults are also present; these structures generally trend northerly.

Poles to bedding indicate a predominant, moderate west dip (Fig. 62a). The pervasive axial planar cleavage dips steeply to the west (Fig. 62b); associated lineations plunge gently to north and south (Fig. 62b).

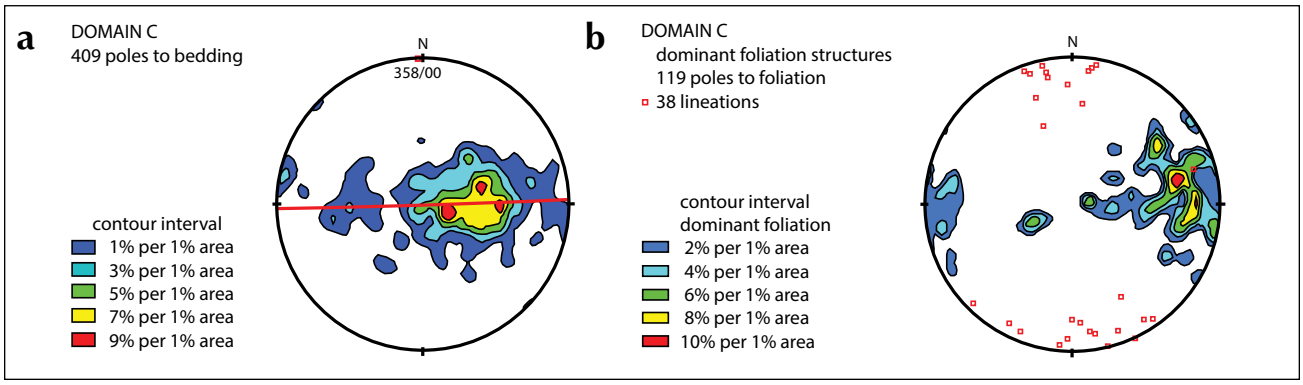

Figure 62. *Structural domain C structural fabrics;* ***(a)*** *poles to bedding;* ***(b)*** *poles to dominant foliation, lineations associated with dominant foliation.*

The northern part of domain C is dominated by the Caribou anticline (Gabrielse and Blusson, 1969) and its associated adjacent synclines. The Caribou anticline is a south-plunging, symmetrical structure. The herein named Skinboat syncline immediately west of the Caribou anticline is a tight, symmetrical, south-plunging syncline cored by the Permian Fantasque Formation.

In contrast, the Caribou syncline (Gabrielse and Blusson, 1969), located southeast of the Caribou anticline, is open and northeast-trending with very gently dipping limbs. The Caribou syncline is refolded by open, north-trending cross folds.

In the upper Toobally Lake area the east-verging Toobally fault (Gabrielse and Blusson, 1969) places the Proterozoic(?) Toobally Formation and the Cambrian-Ordovician Crow Formation in the hanging wall structurally on top of the undivided Triassic Grayling-Toad formations in the footwall. Structural displacement across this fault is difficult to determine because of differences in the thicknesses of the formations between structural panels C and D. Displacement across the Toobally fault decreases both to the north and south away from upper Toobally Lake.

The Rock River fault (Gabrielse and Blusson, 1969) forms the west margin of the Eocene Rock River basin sediments. Gabrielse and Blusson (1969) interpret it as an east-verging thrust fault. In contrast we propose that an east-dipping normal fault would permit deposition of Eocene sediments in a north-trending, extensional half-graben.

Domain D

The easternmost domain D is bounded on the west by the Toobally fault in the south and central parts of the map area, and the Caribou syncline in the northern part of the map area. In the north it is dominated by a north-plunging anticline cored by Mattson Formation and Sunblood Formation in the centre. Immediately north of the Toobally-Crow fault it has a box-fold style with a wide flat hinge zone and straight, moderately dipping limbs. South of the Toobally-Crow fault a similar, doubly plunging anticline is cored by Crow Formation. Slaty cleavage is not generally developed in argillaceous units in this domain.

Poles to bedding outline a girdle with trend/plunge of 189/07 (Fig. 63). The predominant bedding dip is moderately to the west.

Domain D also contains several north-trending faults with small displacements. In the north, the faults have been interpreted as normal; one fault in the central area has been interpreted as a west-verging, small-scale, back-thrust.

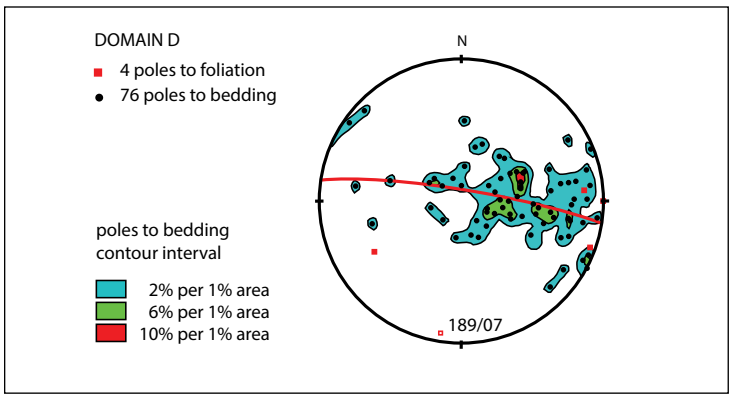

Figure 63. *Structural domain C structural fabrics; poles to bedding, poles to dominant foliation.*

Late Extensional Deformation

Extensional deformation is manifested by normal faults documented in the Coal River area. These structures are late-stage because they displace and offset earlier contractional fold and fault structures. The largest of these extensional features is the Rock River fault which forms the western margin of the upper Eocene sedimentary rocks. Because the upper Eocene sedimentary rocks east of the Rock River fault dip gently west, movement on the fault is inferred to be syn-late Eocene with faulting being concurrent with deposition of the late Eocene Rock River basin strata. The Rock River fault juxtaposes undivided Vampire-Narchilla unit against Road River Group and Eocene strata. A minimum displacement across the fault is at least 450 m (the known thickness of Eocene strata); a possible thickness of 1100 m for the Eocene strata (Wright and Miller, 1986) suggests a significantly greater minimum displacement across the fault.

Discussion

Fold structures and associated slaty cleavage in domain A trend northwest and are truncated by the north-trending Acland reverse fault, suggesting the contractional deformation associated with the folding in this domain predates the predominant north to northeast-trending folds occurring in the other domains. We infer that the locally developed, north-trending, east-verging minor folds and associated axial planar crenulation cleavage in domain A are correlated with the predominant fold and fault structures occurring in the other domains. The timing of the earlier deformation is poorly constrained to being post-lower Cambrian strata and pre-middle Cretaceous thrust faults.

The predominant contractional deformation (in domains B, C, D) at this structural level (now at surface) is constrained to post-Early Triassic time because Triassic and older argillaceous strata are folded and contain the pervasive slaty cleavage. It is further constrained to pre-middle Cretaceous time as the mid-Cretaceous plutons that crosscut fold and fault structures regionally are undeformed (Gordey and Anderson, 1993). Contractional structures are inferred to flatten into a shallow, west-dipping detachment located in pre-Hyland Group strata (cross section on Plate 1). Displacement at depth on this detachment may well have continued after emplacement of the Cretaceous intrusions.

Deformation in the Coal River area is considered to be part of the Cordilleran orogen (Gabrielse *et al.*, 1991; Nelson and Colpron, 2007; Nelson *et al.*, 2013), a manifestation of the amalgamation of Laurentia with allochthonous terranes.

The Rock River fault and associated half-graben occurred when east-directed compressional deformation ceased in Paleocene or Eocene, and dextral motion was initiated on the northwest-trending Tintina fault (Nelson *et al.*, 2013).

METAMORPHISM

Metamorphic mineral assemblages in the pelitic rocks regionally range from muscovite-chlorite zone in lower greenschist facies to biotite-garnet-staurolite-chloritoid zone in lower amphibolite facies (Table 3). All mineral assemblages in the basaltic volcanic rocks contain epidote, calcite and chlorite. The biotite-garnet-staurolite grade rocks occur in a northeast-trending belt extending from near the Hyland Gold MINFILE occurrence (Roy Lake) to north of the Coal River map area. The aluminosilicate minerals (andalusite, kyanite, sillimanite) were not observed in the pelitic rocks.

The dominant foliation (S1) and the later crenulation cleavage (S2) are delineated by matrix muscovite, chlorite and biotite. The porphyroblastic minerals garnet, staurolite, biotite and chloritoid contain planar inclusion trails which pass into the external, dominant foliation; the S2 crenulation cleavage wraps around the porphyroblasts. These different textures indicate maximum metamorphic conditions occurred during, or after, the formation of the S1 foliation, and before the formation of the S2 cleavage.

Table 3. Metamorphic assemblages in Vampire-Narchilla unit, Coal River map area. Coordinates are UTM zone 9N, NAD83 datum.

Station	UTM East (m)	UTM North (m)	Mineral Assemblage
09LP001	570 845	6 706 095	quartz-muscovite
09LP050	583 278	6 742 306	quartz-muscovite-chlorite-biotite
09LP051	582 745	6 742 319	quartz-muscovite-biotite
09LP055	580 956	6 743 751	quartz-muscovite-biotite
09RAS048	591 454	6 758 267	quartz-muscovite-biotite-garnet-staurolite
09RAS085	591 270	6 762 014	quartz-muscovite-biotite
09RAS086	590 101	6 762 277	quartz-muscovite-biotite-staurolite
09TOA009	595 171	6 714 622	quartz-plagioclase-muscovite
09TOA084	577 859	6 738 819	quartz-muscovite-chlorite-biotite-garnet-staurolite
09TOA090	580 872	6 738 795	quartz-muscovite-chlorite-biotite
09TOA098	582 139	6 742 420	quartz-feldspar-muscovite-biotite
09TOA109	577 140	6 733 039	quartz-muscovite-biotite-garnet-staurolite
09TOA110	576 299	6 733 094	quartz-chlorite-biotite-garnet-chloritoid
09TOA111	576 053	6 733 332	quartz-muscovite-chlorite-garnet-staurolite

MINERAL OCCURRENCES AND METALLOGENY

The Coal River map area offers potential for sediment-hosted base metal and intrusion-related base and precious metal mineralization. Sediment-hosted mineralization may include both sedimentary exhalative Zn-Pb ± Ba in black shale (SEDEX) and Irish-type or MVT Zn-Pb replacements in carbonate rock. Intrusion-related mineralization may include massive sulphide mantos, tungsten and base metal skarns, precious metal veins, sheeted veins, and replacement deposits.

The basinal facies within both Selwyn basin and Kechika trough are characterized by stratiform mineral deposits. In the latter, 200 km south of Coal River map area, stratiform barite-lead-zinc deposits are hosted in sub-basins along the platform margin within Middle Ordovician, Lower Silurian and Upper Devonian strata (MacIntyre, 1992), including the Cirque, Fluke, and Elf deposits in the Gataga district (MacIntyre, 1992). In the former, stratiform barite-lead-zinc and barite deposits are hosted within Cambrian, Silurian, Devonian, and Mississippian carbonaceous shale (Abbott *et al.*, 1986).

The lower Paleozoic platform-to-basin transition of the Macdonald platform also hosts Mississippi Valley type (MVT) deposits, the most important is at Robb Lake (Macqueen and Thompson, 1978; Paradis *et al.*, 1999).

The recognition of nine additional plutons in the Coal River map area results in more exploration target areas for intrusion-related, base and precious metal mineralization.

The following mineral occurrence descriptions are summarized from government-maintained databases (Yukon MINFILE and NWT NORMIN; Fig. 64) with interpretation and clarification in light of recent fieldwork. MINFILE occurrences with no apparent economic significance are excluded from the following discussion. The 2009 mapping refined the geological setting of some of these occurrences and identified four new potential exploration targets.

Sedimentary exhalative (SEDEX) mineralization

Although the Road River Group has previously been considered a favourable host for SEDEX mineralization in the Coal River map area, no SEDEX occurrences have yet been found. A few MINFILE occurrences record elevated zinc concentrations, but these are considered to be typical values for much of the Road River Group and not related to SEDEX mineralization. In the eastern part of the map area the black shale is limited in extent and overlies thick sequences of Rabbitkettle and Sunblood carbonate rocks. Possibly, the carbonate prevented the formation of SEDEX deposits by reacting with expelled basinal fluids to form replacement deposits such as the MEL before they could reach the surface. More favourable environments may exist farther west along the Coal River, where the Road River Group is more extensive than previously thought and older strata are primarily siliciclastic.

Black shale of the Besa River Formation, although equivalent to the well-mineralized Devono-Mississippian Earn Group, contains no known sedimentary exhalative sulphide deposits. This may be for the same reasons cited above for the Road River Group. Alternatively it may be because of an apparent lack of syndepositional tectonism as indicated by the absence of Devonian-Mississippian coarse siliciclastic facies and volcanism in this area.

Bedded barite is known in one locality in the Northwest Territories at the Last Mountain (NORMIN 095DNE0003) occurrence. There, finely laminated, but thick-bedded to massive barite between 3 and 10 m thick occurs in a structurally complex zone on the eastern limb of the Skinboat syncline. It has not been traced along strike due to lack of outcrop. The barite occurs close to the contact with basal quartzite of the Mattson Formation but whether it lies above or below the quartzite could not be determined due to poor exposure and cryptic structures. The Mattson Formation is Middle and

Late Mississippian in age; therefore the barite is likely to be Mississippian as well. The Tea deposit near Macmillan Pass (Dawson and Orchard, 1982) is another barite deposit of roughly equivalent age.

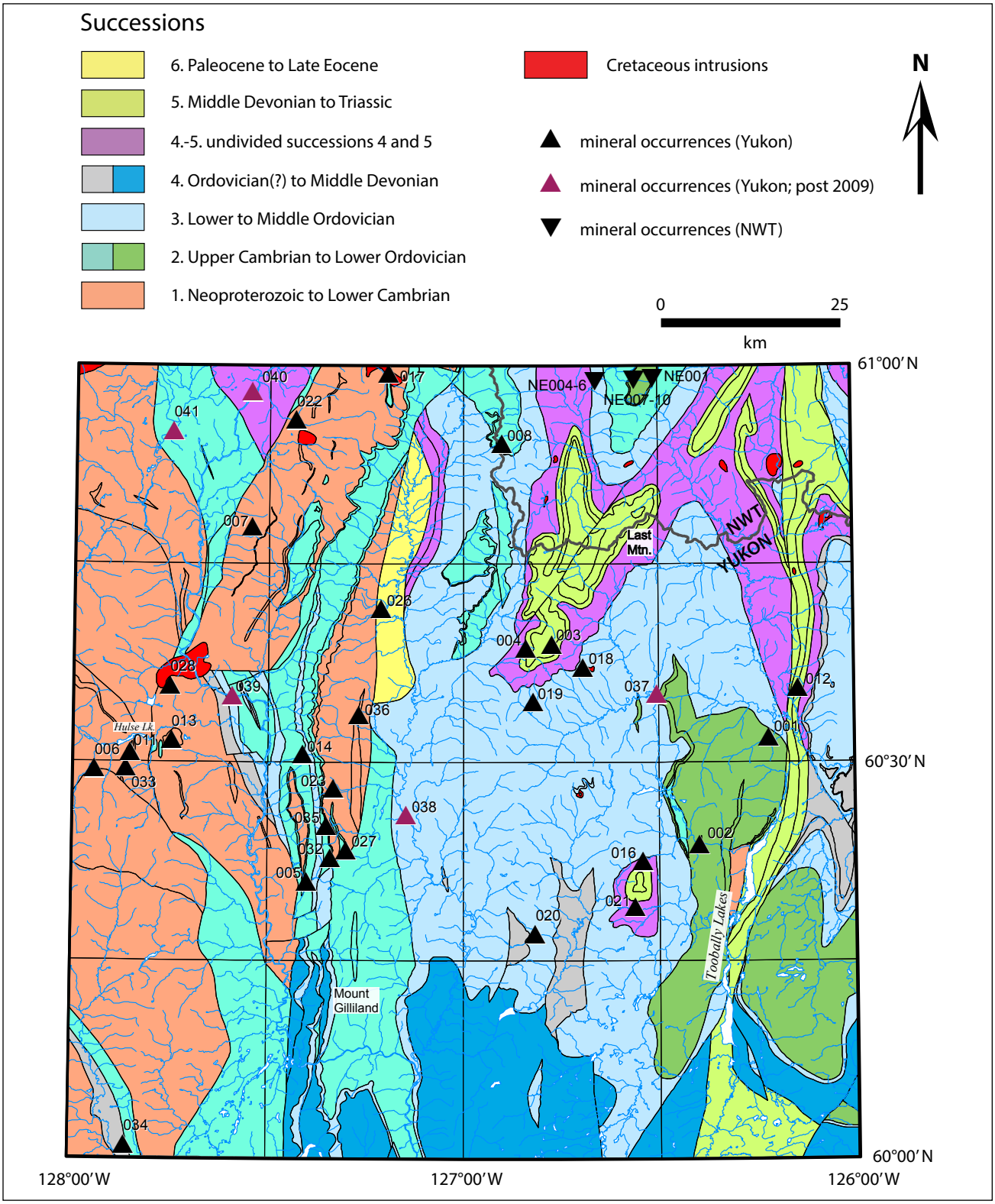

Figure 64. *Mineral occurrences in Coal River map area. Numbers refer to Yukon MINFILE for 95D and NORMIN database (2010), and are referred to in the text.*

Carbonate replacement (MVT, Irish type) mineralization

Four epigenetic, stratabound zinc ± lead ± barite deposits and showings (Yukon MINFILE 095D 005, 095D 027, 095D 032 and 095D 035) are located in NTS 95D/6. Each of these mineral occurrences is now considered to be hosted in massive, fine-grained limestone of the Otter Creek Formation at the contact with the overlying argillaceous limestone of the Rabbitkettle Formation. The following summary is condensed from a comprehensive description and discussion of the origin of these deposits by Pigage (2008).

The Mel (Yukon MINFILE 095D 005) is the largest of these deposits with a published, pre-NI43-101, drill-indicated reserve of 6.78 MT (million tonnes) grading 54.69% barite, 7.10% Zn, and 2.03% Pb (King, 1995). It is a stratabound lens about 800 m long and up to 22 m thick near its centre, and it remains open at depth. It consists of very coarse grained, white barite and reddish-brown, coarse-grained sphalerite with late, interstitial galena occurring along fractures and as selvages.

The Mel-East showing (Yukon MINFILE 095D 027) is poorly exposed for a strike length of 170 m. True width is unknown but may exceed 3 m. Mineralization consists of disseminated smithsonite blebs ranging from less than 1 mm to 20 mm in size that are associated with dolomitization and silicification of the massive limestone over a width of 10 m.

The Jeri occurrence (Yukon MINFILE 095D 032), consists of smithsonite in silicified dolostone at three localities. The smithsonite forms veins and discontinuous masses up to 1 m thick with the total width of mineralization exceeding 11 m.

The Jeri North occurrence (Yukon MINFILE 095D 035) is located north of the Jeri zone along strike. Mineralization consists of coarse brown sphalerite and quartz infilling fractures in strongly silicified limestone.

The Mel and nearby deposits are probably Devono-Mississippian in age on the basis of lead isotope data (Godwin and Sinclair, 1982; Godwin *et al.*, 1988), and best classified as epigenetic Irish-type replacement or MVT deposits (Pigage, 2008). Similar deposits may occur elsewhere in the Otter Creek Formation or other carbonate units. Limestone of unit SDc is commonly replaced by hydrothermal dolomite. Modern sinkholes and karst features demonstrate the susceptibility of unit SDc to dissolution and cavity formation, making it a possible candidate for MVT or Irish type mineralization. One possible target for Mel-type mineralization is the Watsit (Yukon MINFILE 095D 014) occurrence, located on strike to the north of the Mel. There, a zinc soil geochemical anomaly up to 4500 ppm is located above limestone of the Rabbitkettle Formation near the contact with dolostone of the Sunblood Formation (Yukon MINFILE).

Volcanic-related mineralization

The Grant (Normin 095DNE0001), Chuck (Normin 095DNE0009), Gabe (Yukon MINFILE 095D 008), and Gusty (Yukon MINFILE 095D 002) copper occurrences are in Cambrian and Ordovician mafic volcanic rocks. All consist of scattered disseminations of chalcopyrite ± bornite and malachite. None of these are known to have significant size or potential.

Intrusion-related mineralization

The McMillan massive sulphide replacement deposit (Yukon MINFILE 095D 006) consists of two zones. The Main Zone contains pre-NI 43-101 reserves of 1.1 MT grading 8.3% Zn, 4.1%Pb, and 62g/t Ag, and the South Zone contains 0.4 MT grading 9.3%Pb, 1.7% Zn, and 214g/t Ag (Vaillancourt, 1983). The Main Zone forms a gently east dipping tabular body in quartzite and massive grey limestone.

Nearby maroon and green phyllite are associated with the quartzite and limestone, and the assemblage has herein been assigned to the Vampire-Narchilla unit. Textural relationships clearly show that mineralization is discordant to bedding. Lead isotopes (Godwin, *et al.*, 1988) indicate a Cretaceous age for mineralization.

The Hyland Gold mineralization (Yukon MINFILE 095D 011) is a low-grade, oxidized, fault-controlled Au deposit. Quartzite, phyllite and limestone host rocks resemble the host rocks to the McMillan deposit 5 km to the west and are assigned to the Vampire-Narchilla unit. A NI43-101 inferred resource of 12.5 MT grading 0.9 g/t Au and 5.6 g/t Ag (using a 0.6 g/t Au equivalent cutoff; Armitage and Gray, 2012) has been identified in the Main Zone. Mineralization is controlled primarily by north-trending faults, but occurs in four settings: 1) breccia zones mainly in quartzite; 2) north-trending fault zones; 3) limestone replacement bodies up to 40 m thick containing pyrite, pyrrhotite, arsenopyrite and siderite; and 4) narrow quartz veins containing erratic pods of massive jamesonite.

The Cuz gold occurrence (Yukon MINFILE 095D 033) is about 4 km south of the Hyland Gold deposit in a quartzite and granular sandstone-dominated assemblage that is herein assigned to the Yusezyu Formation of the Hyland Group. The mineralized zone is not well defined and consists primarily of float. Two types of mineralization have been recognized: 1) grey chalcedonic quartz veins containing fine-grained arsenopyrite in brecciated and altered host rock and 2) silicified and leached quartzite and conglomerate. Results from assays of specimens of Type 1 are as high as 9.0 g/t while Type 2 are as high as 3.7 g/t (Carne, 1996).

Six kilometres east of the Hyland Gold deposit, stratabound disseminations and veinlets of sphalerite replace coarse-grained marble and staurolite-chlorite schist in the Hulse (Yukon MINFILE 095D 013) occurrence. Channel sampling results returned up to 0.85% Zn, 0.15% Pb and 2.7 g/t Ag over 0.9 to 5.5 m widths (Stockwell, 1975).

The McMillan, Hyland Gold, Cuz and Hulse occurrences represent different styles of epigenetic mineralization typically associated with granitic intrusions, suggesting that they are related to one or more intrusions occurring at depth. Alteration is widespread between the McMillan and Hyland deposits; high temperature metamorphism is only seen at the Hulse. There is no pronounced magnetic anomaly in the area; therefore the hypothetical pluton would have a low magnetic susceptibility, like the Gabe pluton located 10 km to the north-northeast. Alternatively, the Hyland and Cuz occurrences might be considered 'orogenic' and related to a large, deep-seated fault system (Hart and Lewis, 2006).

The Chuck (Normin Occurrences 095NE0007, 8 and 9) gold occurrence consists of east-trending quartz veins 4-10 cm wide in volcanic and carbonate rocks with low grades of gold and arsenic. Silt samples from a creek draining the area returned values greater than 500 ppb gold. Float in the creek included skarn fragments and subangular vein quartz up to 50 cm across which returned values up to 50 ppb Au and 212 ppb As (Vulimiri, 1986). A strong aeromagnetic anomaly coincides with the occurrence. The SITE 1,2,3 placer gold occurrence (Normin 095DNE0004, 5 and 6) is probably derived from it. The style of mineralization and association with a positive aeromagnetic anomaly suggests the Chuck occurrences are associated with a buried intrusion. Placer and lode gold occurrences are associated with the Macleod and Big Charlie plutons located 8 and 25 km respectively to the north (Rasmussen *et al.*, 2007).

The Herpes (Yukon MINFILE 095D 022) and Oudder (Yukon MINFILE 095D 018) exploration targets record anomalous values of scheelite in stream sediment and soil respectively near poorly exposed intrusions. No associated bedrock occurrences are known.

The Toobally (Yukon MINFILE 095D 001) occurrence is a large alteration zone exposed along a north-trending creek. Sandstone of the Crow Formation is pervasively altered to white clay. A rusty, vertical,

east-trending limonite zone is located near the centre of the alteration zone. Early work reported anomalous lead values from the limonite. An assay from a sample of limonite taken in 2009 returned anomalous values for Pb (38 ppm), Zn (218 ppm), Ni (95 ppm), Co (90 ppm), Mn (>10 000 ppm), Fe (33.2%) and As (185 ppm). An RGS sample and a silt sample taken in 1999 from the mouth of the creek contained no anomalous values, but they may not have been representative of the creek drainage because they were located well into the valley of the Beaver River. No aeromagnetic anomaly is associated with the alteration, but the most likely explanation for it is a buried intrusion.

New exploration targets

The localities described below arose from field work in 2007, 2009 and 2010.

Gusty occurrence (Yukon MINFILE 095D 037)

An extensive alteration zone and colour anomaly in the Sunblood Formation is located in a small creek draining into the Beaver River. Dolostone is completely decalcified and disaggregated to sand. No anomalous values were obtained from geochemical analysis of the material or from a silt sample from the creek. The alteration zone coincides with a small aeromagnetic anomaly.

Blood occurrence (Yukon MINFILE 095D 038)

Highly fractured dolostone of the Sunblood Formation exposed on the banks of the Rock River contains veins and replacement lenses of fine-grained nodular pyrite.

Ferricrete occurrence (Yukon MINFILE 095D 039)

On the banks of the Coal River, ferricrete is draped over highly fractured dolostone of the Sunblood Formation along an inferred small fault zone.

Argil occurrence (Yukon MINFILE 095D 040)

On the banks of the upper Coal River, a small outcrop of shattered cherty olive green argillite tentatively assigned to the Road River Group contains breccia zones cemented by fine-grained pyrite and manganese stained fractures. An assay of pyrite breccia returned anomalous values for Mo (8.57 ppm), Cu (110.6 ppm), Ni (198.4 ppm), Mn (>10 000 ppm) and Fe (24.35%).

Toe-in occurrence (Yukon MINFILE 095D 041)

A small outcrop on the banks of the West Coal River consists of fine grained, altered biotite granodiorite (Cretaceous?) intruding rusty-weathering pyritic, cherty hornfelsed sediment assigned to the Rabbitkettle Formation. Skarn and granodiorite coincide with a regional magnetic high.

HYDROCARBON POTENTIAL

Oil and Gas potential

The Kotaneelee gas field in southeast Yukon is the only producing gas field in Yukon. Gas in the Kotaneelee field is located in stratigraphic traps related to karsting, diagenetic dolomitization and subsequent burial of Devonian carbonate rocks (Morrow *et al.*, 1990). Similar stratigraphy exists at

surface in the southern part of the Coal River map area. Carbonaceous shale and limestone in the Road River Group and Besa River Formation are possible hydrocarbon source rocks for conventional gas or oil reservoirs.

Carbonaceous silty shale and limestone from surface outcrops were collected and tested at the Geological Survey of Canada Organic Geochemistry Laboratory in Calgary for potential as hydrocarbon source rocks using Rock-Eval/TOC pyrolysis. The Rock-Eval 6 instrument provides information on type, maturity and quantity of organic matter present in the sample (Espitalié *et al.*, 1977). Appendix D presents results for the analyses; operating conditions during analysis are described in Pigage (2009).

All analyzed samples are from the Road River Group and/or Besa River Formation. Kirk Osadetz (GSC Calgary, personal communication 2009) kindly provided the following summary. Samples 09LP039, 09LP074, and 09LP062 have insufficient TOC to infer anything other than a lack of source rock potential. Samples 09CYA010, 09RAS106, 09LP093 and 09LP077 are overmature source rocks with S1 and S2 values below 0.2 mg/gm. The low S2 values mean the results may not be meaningful (Peters, 1986). Sample 09LP058 was flagged as being anomalous with an unusual low Tmax value. It was suggested that this sample was possibly contaminated by an organic fluid. Sample 10TOA035 is from the formation in the same general geographic area. Analytical results for 10TOA035 indicate an overmature source rock with low S1 and S2 values.

Organic-rich rocks in the Coal River map area have been subjected to temperatures which have essentially destroyed their capability of generating oil or gas locally. Any conventional hydrocarbon reservoir in the Coal River area would have to form through extensive lateral migration into the map area from a source area which has not been subjected to these higher temperatures. It is inferred that conventional reservoir potential in the map area is very limited.

Several of the samples analysed with rock-eval contain several percent total organic carbon. Although overmature, the samples could potentially have generated gas which could still be present if the formation was impermeable to gas migration. The possibility of a tight shale unconventional gas resource has not been tested in the Coal River area.

Coal potential

The Eocene Rock River basin in the north-central Coal River area contains a 5 m-thick outcrop of lignite coal along a tributary of the Rock River. Five diamond drill holes were completed in 1981 by Sulpetro Minerals Ltd. to test the regional extent of the coal seams (Wright and Miller, 1986). Significant near-surface coal was intersected in two of the holes. The coal ranges from lignite A to sub-bituminous C rank. Thermal content was reported as 6645 Btu/lb with 17.6% ash and 1.09% sulphur at equilibrium moisture of 26.3%. Maximum depth penetrated by drilling was 162 m. In contrast, the depth of Tertiary sediment based on gravity data was interpreted as being up to 1100 m (Wright and Miller, 1986), thus indicating the potential for coal seams at greater depth.

SUMMARY

Bedrock geological mapping in 2009-2010 succeeded in redefining the understanding of the geologic history and mineral potential of southeastern Yukon. The area contains six successions of sedimentary rocks, ranging from Proterozoic to Eocene in age with a composite thickness exceeding 14 000 m. These strata record the evolution of the Laurentia passive continental margin, lateral facies changes associated with the development of Selwyn basin, and subsequent deformation and plutonism. Figure 65 schematically portrays the stratigraphic history, igneous history, tectonic evolution and setting of mineral occurrences in the region.

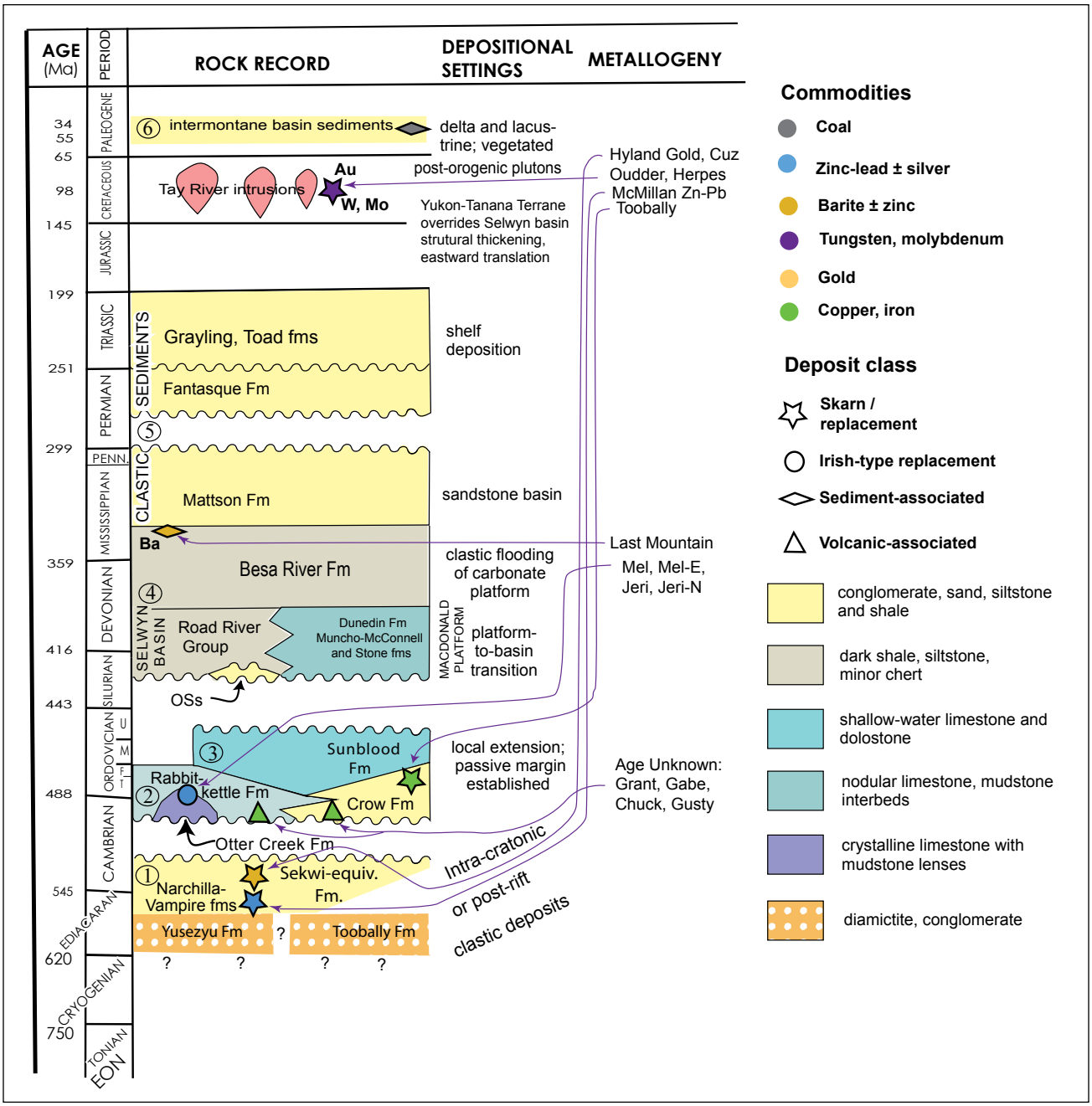

Figure 65. *Summary of stratigraphic history and tectonic evolution in Coal River map area, and the geological relationship to mineral occurrences.*

The earliest exposed deposition consists of Neoproterozoic to early Cambrian, dominantly siliciclastic sedimentary units documenting the initiation of rifting of Rodinia to form the western passive continental margin of Laurentia.

Deposition in late Cambrian to Middle Ordovician chronicles the initiation of an extensive continental carbonate platform along the western margin of Laurentia. The Sunblood Formation first developed near upper Toobally Lake in earliest Ordovician time and expanded laterally. Rabbitkettle Formation, coeval with both Crow and lower Sunblood formations, represents the gentle ramp-slope deposition of carbonate debris away from the Sunblood carbonate platform. The thick but aerially restricted siliciclastic Crow Formation defines a delta complex fed by a large river draining the east and northeast.

The Silurian through Middle Devonian carbonate platform lacks a ramp facies; it is an abrupt northward change to carbonaceous, fine-grained sediment of the locally anoxic deeper water of Selwyn basin. In Middle Devonian through Mississippian time the platform was flooded and deposition of carbonaceous sediment extended eastward. A mid-Mississippian regression then led to sandstone (Mattson Formation) as a westward-prograding delta.

Thin Permian and Triassic successions record marine deposition in a shallow water, shelf setting. These successions are separated from other units by hiatuses.

Jurassic and Early Cretaceous strata are absent from the Coal River map area. This time interval coincides with the Cordilleran orogeny (Nelson *et al.*, 2013), manifested by deformation and thickening of the sedimentary succession through folding and thrust faulting. Cretaceous silt and sand depositional basins located immediately east of the map area record development of foreland basins associated with deformation and uplift in the hinterland (including Coal River map area). Deformation was accompanied by low-grade to medium-grade regional metamorphism, as well as exhumation and erosion of earlier sedimentary formations. At the presently exposed structural level, deformation had essentially ceased before the intrusion of only slightly deformed mid-Cretaceous granitic stocks.

Farther east in Northwest Territories and Alberta, thrust faulting continued into the Paleocene. The entire exposed Coal River stratigraphy is presumed to have passively moved eastward along a basal detachment located at an unknown deeper structural level. Consequently the exposed early Paleozoic alkali basalt and the Cretaceous intrusions are structurally separated from their deep sources of partial melting.

Extension along south-trending, post-orogenic, normal faults locally preserved Eocene fluvial sediment with coal horizons (Rock River basin sediment). Intermontane basins in the Cordillera formed between major thrust sheets and along dextral strike-slip faults. These latter may be a response to re-orientation of relative movement between the Pacific and North American tectonic plates.

Mineral occurrences include Irish-type or MVT Zn-Pb replacements in carbonate rocks, massive sulphide mantos, tungsten and base metal skarns, and precious metal, intrusion-related veins and replacement deposits. Potential exists for sedimentary exhalative Zn-Pb ± Ba deposits, although none have been noted to date.

Carbonaceous sedimentary successions are overmature for source hydrocarbon potential. Conventional oil or gas reservoirs are probably not present. Potential does exist for unconventional tight shale gas resource. Coal resources have been identified in the late Eocene Rock River basin sediments.

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Sandy McCracken and Godfrey Nowlan (both GSC) undertook the conodont fossil identification. Jim Crowley (Boise State University) completed the isotopic geochronology of the intrusions and tuff in the area. The manuscript was reviewed by David Moynihan, Yukon Geological Survey, and Karen Fallas, Geological Survey of Canada.

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APPENDIX A - PALEONTOLOGY

Table A1. Fossil collections, arranged by formation.

Paleontology - NTS 95D				
Map ID	**GSC ID**	**Fossil Type**	**Age Range**	**Reference**
Unit Ꞓs				
1	73840, 68958, 68957, 68956, 68955	trilobite; archeocyathid	Early Cambrian (Series 2; Stage 3)	Handfield (1971)
2		trilobite	Early Cambrian (Series 2; Stage 4)	Bohach, L. (2009 pers comm)
Unit ꞒOOC				
3	C-092627	trilobite; brachiopod	Cambrian (Furongian) - Early Ordovician (Tremadocian)	Miller and Wright (1986); Norford (1984)
4	C-061554	trilobite; brachiopod	Cambrian (Furongian) - Early Ordovician (Tremadocian)	Miller and Wright (1986); Norford (1984)
5	C-535898	conodont	late Early Ordovician (Floian) - Late Ordovician (Sandbian)	Nowlan (2010c)
Unit ꞒOC				
6	C-417157	conodont	Early Ordovician (Tremadocian)	Pigage (2009); Pyle (2004)
7	C-535867	conodont	Middle Ordovician (Dapingian)	Orchard (2010); Nowlan (2010a)
Unit ꞒOR				
8	O-081023	brachiopod; trilobite	Early Ordovician (Tremadocian - Floian)	Norford (1968a)
9	O-081025	brachiopod; trilobite	Early Ordovician (late Tremadocian - early Floian)	Gabrielse and Blusson (1969)
10	O-081026	trilobite	Early Ordovician (late Tremadocian - early Floian)	Norford (1968a)
11	V-000005	conodont	Early Ordovician (early Tremadocian)	Nowlan (2010b)
12	C-535864	conodont	Early Ordovician (late Floian)	Nowlan (2010a)
13	V-000386	conodont	Early Ordovician	Orchard (2009b)
14	C-535939	conodont	Early Ordovician (early Tremadocian)	Nowlan (2010c)
15	C-535940	conodont	Early Ordovician (early to middle Floian)	Nowlan (2010c)
16	C-535951	conodont	Early Ordovician (Tremadocian)	Nowlan (2010c)
17	C-535953	conodont	Early Ordovician (late Tremadocian - Floian)	Nowlan (2010c)
18	C-535881	conodont	Early Ordovician (late Tremadocian - Floian)	Orchard (2010); Nowlan (2010a)
19	C-535963	conodont	Early Ordovician (late Tremadocian - early Floian)	Nowlan (2010c)
20	C-535964	conodont	Early Ordovician (late Floian)	Orchard (2010); Nowlan (2010c)
21	C-535966	conodont	Early Ordovician (late Tremadocian - early Floian)	Nowlan (2010c)

Table A1, *continued*. Fossil collections, arranged by formation.

Paleontology - NTS 95D				
Map ID	**GSC ID**	**Fossil Type**	**Age Range**	**Reference**
Unit OSu				
22	O-079251	gastropod	Late Ordovician (late Sandbian - late Katian)	Gabrielse and Blusson (1969)
23	O-079252	gastropod	Middle Ordovician (Dapingian) - Late Ordovician (Sandbian)	Gabrielse and Blusson (1969)
24	O-079253	brachiopod; gastropod	Early Ordovician (Floian) - Late Ordovician (early Katian)	Gabrielse and Blusson (1969)
25	O-079254	gastropod; brachiopod	Late Ordovician (late Sandbian - early Katian)	Gabrielse and Blusson (1969)
26	O-079153	trilobite; brachiopod	Middle Ordovician (Dapingian) - Late Ordovician (Sandbian)	Gabrielse and Blusson (1969)
27	O-079246	brachiopod	Cambrian (Furongian) - Devonian	Norford (1968b)
28	O-079247	brachiopod	Ordovician - Present	Norford (1968b)
29	C-417165	conodont	Early Ordovician (middle Tremadocian)	Pigage (2009); Pyle (2004)
30	C-417159	conodont	Middle Ordovician (Darriwilian)	Pigage (2009); Pyle (2004)
31	C-417166	conodont	Early Ordovician (Floian) - Middle Ordovician (Darriwilian)	Pigage (2009); Pyle (2004)
32	C-417167	conodont	Early Ordovician (Floian) - Middle Ordovician (Dapingian)	Pigage (2009); Pyle (2004)
33	C-417163	conodont	Late Ordovician (Sandbian)	Pigage (2009); Pyle (2004)
34	C-307428	conodont	Middle Ordovician (Dapingian)	Nowlan (2008)
35	C-307626	conodont	Ordovician	Nowlan (2008)
36	C-307629	conodont	Middle Ordovician (Dapingian)	Nowlan (2008)
37	C-307630	conodont	Early Ordovician - Middle Ordovician (Dapingian)	Nowlan (2008)
38	C-307631	conodont	Middle Ordovician (Darriwilian)	Nowlan (2008)
39	C-307632	conodont	Middle Ordovician (Dapingian)	Nowlan (2008)
40	V-000007	conodont	Middle Ordovician - Middle Devonian	Nowlan (2010b)
41	V-000387	conodont	Early Ordovician	Orchard (2009b)
42	C-535932	conodont	earliest Middle Ordovician (early Dapingian)	Nowlan (2010c)
43	C-535866	conodont	Middle Ordovician (Dapingian)	Orchard (2010); Nowlan (2010a)
44	C-535934	conodont	late Early Ordovician (Floian)	Nowlan (2010c)
45	C-535869	conodont	Middle Ordovician (Dapingian)	Orchard (2010); Nowlan (2010a)
46	C-535870	conodont	Middle Ordovician (Dapingian - Darriwilian)	Orchard (2010); Nowlan (2010a)

Table A1, *continued*. Fossil collections, arranged by formation.

Paleontology - NTS 95D				
Map ID	**GSC ID**	**Fossil Type**	**Age Range**	**Reference**
Unit OSu (continued)				
47	C-535878	conodont	Early Ordovician (Tremadocian - Floian)	Orchard (2010); Nowlan (2010a)
48	C-535942	conodont	Early Ordovician (Tremadocian - Floian)	Nowlan (2010c)
49	C-535943	conodont	Early Ordovician (late Tremadocian - Floian)	Nowlan (2010c)
50	C-535945	conodont	Early Ordovician (late Tremadocian - early Floian)	Nowlan (2010c)
51	C-535949	conodont	late Early Ordovician (Floian)	Nowlan (2010c)
52	C-535872	conodont	Early Ordovician - Middle Ordovician	Orchard (2010); Nowlan (2010a)
53	C-535874	conodont	Middle Ordovician (Dapingian)	Orchard (2010); Nowlan (2010a)
54	C-535959	conodont	late Early Ordovician (late Floian)	Nowlan (2010c)
55	C-535883	conodont	Early Ordovician - early Middle Ordovician	Orchard (2010); Nowlan (2010a)
56	C-535888	conodont	latest Early Ordovician (latest Floian)	Nowlan (2010c)
57	C-535960	conodont	Early Ordovician (late Tremadocian - early Floian)	Nowlan (2010c)
58	C-535890	conodont	latest Early Ordovician (latest Floian)	Nowlan (2010c)
59	C-535961	conodont	earliest Early Ordovician (Tremadocian)	Nowlan (2010c)
60	C-535892	conodont	latest Early Ordovician (late Floian)	Nowlan (2010c)
61	C-535893	conodont	late Early Ordovician (middle - latest Floian)	Nowlan (2010c)
62	C-535894	conodont	Early Ordovician (Floian)	Nowlan (2010c)
63	C-535901	conodont	late Middle Ordovician (middle Darriwilian) - early Late Ordovician (early Sandbian)	Nowlan (2010c)
64	C-535904	conodont	earliest Middle Ordovician (early Dapingian)	Nowlan (2010c)
65	C-535908	conodont	Early Ordovician (Tremadocian)	Nowlan (2010c)
66	C-535909	conodont	Early Ordovician (middle to late Floian)	Nowlan (2010c)
67	C-535910	conodont	Early Ordovician (Floian) - Late Ordovician (Sandbian)	Nowlan (2010c)
Unit SDc				
68	O-079240	coral	Silurian	Gabrielse and Blusson (1969)
69	O-079241	coral	Middle Ordovician - Permian	Norford (1968b)
70	V-000008	conodont	Early Devonian?	Orchard (2009a)

Table A1, *continued*. Fossil collections, arranged by formation.

Paleontology - NTS 95D				
Map ID	**GSC ID**	**Fossil Type**	**Age Range**	**Reference**
Unit SDc (continued)				
71	C-537288	conodont	Middle Ordovician - Middle Devonian	Orchard (2010); McCracken (2010a)
72	C-535948	conodont	Middle Ordovician - Middle Devonian	McCracken (2010b)
73	C-535891	conodont	Early Devonian (Lochkovian - Emsian)	McCracken (2010b)
74	C-535906	conodont	Early Devonian (early to late Emsian)	McCracken (2010b)
75	C-535907	conodont	Silurian	Nowlan (2010c)
76		2-hole crinoid	Early Devonian (Emsian) - Middle Devonian (Eifelian)	visual identification
77		2-hole crinoid	Early Devonian (Emsian) - Middle Devonian (Eifelian)	visual identification
Unit SDRR				
78	O-079161	graptolite	Silurian (late Llandovery - Telychian)	Gabrielse and Blusson (1969); Norford (1967)
79	O-081024	tentaculitid; graptolite	Early Devonian	Gabrielse and Blusson (1969)
80	O-081032	coral	Late Ordovician - Silurian (Pridoli)	Gabrielse and Blusson (1969)
81	O-079154	graptolite	Silurian (late Llandovery - Telychian)	Gabrielse and Blusson (1969); Norford (1967)
82	O-081028	graptolite; tentaculitid	Early Devonian	Gabrielse and Blusson (1969)
83	O-081027	graptolite; tentaculitid	Early Devonian (early Emsian)	Gabrielse and Blusson (1969)
84	O-079155	graptolite	Early Devonian (Emsian)	Gabrielse and Blusson (1969); Norford (1967)
85	O-079243	graptolite	Silurian (late Llandovery - Telychian)	Gabrielse and Blusson (1969); Norford (1967)
86	O-079244	graptolite; brachiopod	Silurian (late Llandovery - Telychian)	Gabrielse and Blusson (1969); Norford (1967)
87	O-079245	graptolite; brachiopod	Silurian	Gabrielse and Blusson (1969); Norford (1967)
88	O-079242	graptolite	Early Devonian	Gabrielse and Blusson (1969); Norford (1967)
89	O-079249	graptolite	Early Devonian	Gabrielse and Blusson (1969); Norford (1967)
90	C-535933	conodont	Early Devonian (late Emsian) - latest Middle Devonian	McCracken (2010b)
91	C-535861	conodont	Silurian (late Pridoli) - Early Devonian (early Lockhovian)	Orchard (2010); McCracken (2010a)
92		graptolite		visual identification
93		graptolite		visual identification

Table A1, *continued*. Fossil collections, arranged by formation.

Paleontology - NTS 95D				
Map ID	**GSC ID**	**Fossil Type**	**Age Range**	**Reference**
94		graptolite		visual identification
Unit SMRB				
95	O-079151	graptolite	Silurian (late Llandovery - Telychian)	Gabrielse and Blusson (1969); Norford (1967)
96	O-079152	graptolite	Silurian (late Llandovery - Telychian)	Gabrielse and Blusson (1969); Norford (1967)
97	C-535902	conodont	Middle Devonian	McCracken (2010b)
98	C-535903	conodont	Middle Devonian	McCracken (2010b)
99	C-535876	conodont	Middle Devonian (Eifelian - Givetian)	McCracken (2010a)
100	C-535956	conodont	Middle Devonian (latest Eifelian - Givetian)	McCracken (2010b)
101		2-hole crinoid	Early Devonian (Emsian) - Middle Devonian (Eifelian)	visual identification
Unit PF				
102	C-417156	conodont	Permian	Pigage (2009); Pyle (2004)
103	C-535965	conodont	Pennsylvanian - Early Permian, possibly Late Permian	McCracken (2010b)
Unit TRGT				
104	C-404735	palynology	Early Triassic	Pigage (2009); Utting (2006)
Unit ERRS	(all samples taken from diamond drill holes)			
105	C-082595	palynology	Late Eocene (Priabonian)	Long and Sweet (1994)
106	C-082596	palynology	Late Eocene (Priabonian)	Long and Sweet (1994)
107	C-082597	palynology	Late Eocene (Priabonian)	Long and Sweet (1994); Sweet, 1983

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APPENDIX B - DETRITAL ZIRCON ANALYSES

Table B1. Detrital zircon sample locations.

Sample ID	Field Station	Unit	UTM East	UTM North	Longitude	Latitude	Analytical Laboratory
09LP014-1	09LP014	PY	569497	6695908	-127.7390	60.3936	Isotope Geology Laboratory, Boise State University
09TOA098	09TOA098	PЄVN	582139	6742420	-127.4903	60.8087	Isotope Geology Laboratory, Boise State University
09TOA094	09TOA094	PЄVN	593057	6724637	-127.2982	60.6467	TERRA, Memorial University
09TOA095	09TOA095	Єs	590771	6723883	-127.3403	60.6404	Isotope Geology Laboratory, Boise State University
09TOA096	09TOA096	Єs	590449	6724166	-127.3461	60.6430	TERRA, Memorial University
09LP093-1	09LP093	OSs	658912	6734865	-126.0870	60.7114	Isotope Geology Laboratory, Boise State University
09LP090-2	09LP090	MM	634909	6692950	-126.5550	60.3505	Isotope Geology Laboratory, Boise State University

All coordinates are NAD83 datum, zone 9.

LA-ICPMS Methods, Isotope Geology Laboratory, Boise State University

Zircon grains were separated from rocks using standard techniques and mounted in epoxy and polished until the centres of the grains were exposed. Cathodoluminescence (CL) images were obtained with a JEOL JSM-1300 scanning electron microscope and Gatan MiniCL. Zircon was analysed by laser ablation inductively coupled plasma mass spectrometry (LA-ICPMS) using a ThermoElectron X-Series II quadrupole ICPMS and New Wave Research UP-213 Nd:YAG UV (213 nm) laser ablation system. In-house analytical protocols, standard materials, and data reduction software were used for acquisition and calibration of U-Pb dates and a suite of high field strength elements (HFSE) and rare earth elements (REE). Zircon was ablated with a laser spot width of 25 µm using fluence and pulse rates of 5 J/cm^2 and 10 Hz, respectively, during a 45 second analysis (15 sec gas blank, 30 sec ablation) that excavated a pit ~25 µm deep. Ablated material was carried by a 1.2 L/min He gas stream to the nebulizer flow of the plasma. Dwell times were 5 ms for Si and Zr; 100 ms for ^{49}Ti and ^{207}Pb, 40 ms for ^{238}U, ^{232}Th, ^{202}Hg, ^{204}Pb, ^{206}Pb and ^{208}Pb isotopes; and 10 ms for all other HFSE and REE. Background count rates for each analyte were obtained prior to each spot analysis and subtracted from the raw count rate for each analyte. Ablation pits that appear to have intersected glass or mineral inclusions were identified by time-resolved data that show large fluctuations in Ti or P, and were rejected. Similarly, pits that appear contaminated by common Pb were rejected based on an intensity of mass 204 above baseline. For concentration calculations, background-subtracted count rates for each analyte were internally normalized to ^{29}Si and calibrated with respect to NIST SRM-610 and -612 glasses as the primary standards. Temperature was calculated from the Ti-in-zircon thermometer (Watson et al., 2006). Because there are no constraints on the activity of TiO_2 in the source rocks, an average value in crustal rocks of 0.6 was used.

For U-Pb and ^{207}Pb/^{206}Pb dates, instrumental fractionation of the background-subtracted ratios was corrected and dates were calibrated with respect to interspersed measurements of the Plesovice zircon

standard (Sláma et al., 2008). Two analyses of Plesovice were done for every 10 analyses of unknown zircon; a polynomial fit to the standard analyses yields each sample-specific fractionation factor. Signals at mass 204 were indistinguishable from zero following subtraction of mercury backgrounds measured during the gas blank (<1000 cps ^{202}Hg), and thus dates are reported without common Pb correction. Radiogenic isotope ratio and age error propagation for all analyses includes uncertainty contributions from counting statistics and background subtraction. For spot analyses that are individually interpreted (e.g., detrital zircon analyses), the uncertainty from the standard calibration is propagated into the error on each date. This uncertainty is the standard deviation of the time-varying U/Pb fractionation factor and the standard error of the mean of the time-invariant, smaller ^{207}Pb/^{206}Pb fractionation factor. For groups of analyses that are collectively interpreted from a weighted mean date, a weighted mean date is first calculated using Isoplot 3.0 (Ludwig, 2003) using errors on individual dates that do not include the standard calibration uncertainties, and then the standard calibration uncertainty is propagated into the error on the weighted mean date. Data were collected from samples 09LP014 and 09TOA098 in one experiment in May 2011 (experiment 1), and from samples 09LP090, 09LP093, and 09TOA095 in three experiments (experiments 2-4) in one session in July 2012. Standard calibration uncertainties for ^{207}Pb/^{206}Pb dates are 0.9, 0.9, 0.7, and 0.8% (2σ) for experiments 1-4, respectively. Standard calibration uncertainty for ^{206}Pb/^{238}U dates are 3.3, 3.3, 4.8, and 1.8% (2σ) for experiments 1-4, respectively. Age interpretations are based on ^{207}Pb/^{206}Pb dates for >1000 Ma zircon. These analyses are <17% discordant. The ^{206}Pb/^{238}U dates are used for <1000 Ma zircon. Errors on the ^{207}Pb/^{206}Pb and ^{206}Pb/^{238}U dates from individual LA-ICPMS analyses are given at 2σ, as are the errors on the weighted mean dates.

Two zircon secondary reference materials were treated as unknowns to assess accuracy, interspersed as groups of two analyses for every 20 unknown analyses. Weighted mean dates are calculated using Isoplot 3.0 (Ludwig, 2003) from errors on individual dates that do not include the standard calibration uncertainties. However, errors on weighted mean dates include the standard calibration uncertainties within each experiment (propagated in quadrature) and are given at 2σ. FC1 zircon (1098 Ma from unpublished chemical abrasion thermal ionization mass spectrometry (CA-TIMS) data, Boise State University) yielded weighted mean ^{207}Pb/^{206}Pb dates of 1105 ± 15 (MSWD=1.5, n=24), 1098 ± 20 (MSWD=0.4, n=4), 1117 ± 38 (MSWD=1.2, n=4), and 1087 ± 21 (MSWD=1.0, n=4) from experiments 1-4, respectively. Weighted mean ^{206}Pb/^{238}U dates are 1131 ± 34 (MSWD=1.0, n=24), 1121 ± 37 (MSWD=0.9, n=4), 1124 ± 52 (MSWD=0.3, n=4) and 1122 ± 24 (MSWD=0.3, n=4) from experiments 1-4, respectively. Seiland zircon (530 Ma from unpublished CA-TIMS data, Boise State University) yielded weighted mean ^{206}Pb/^{238}U dates of 540 ± 19 (MSWD=1.4, n=10), 537 ± 25 (MSWD=1.2, n=10), and 534 ± 10 (MSWD=0.5, n=10) from experiments 2-4, respectively. These results show that accurate ^{207}Pb/^{206}Pb and ^{206}Pb/^{238}U dates were obtained.

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LAM-ICP-MS Methods, INCO Innovation Centre, Memorial University

Analyses were completed at the INCO Innovation Centre at Memorial University, St. John's, Newfoundland. The data set was acquired through Laser Ablation Microprobe Inductively Coupled Plasma Mass Spectrometry (LAM ICP-MS). Bennett and Tubrett (2010) present a detailed description of the methodology; this section summarizes from that more complete description.

Zircon grains were extracted using standard crushing techniques, a Wilfley™ table, heavy liquids, a Frantz™ isodynamic separator, and hand-picking in ethanol under a binocular microscope. The grains were mounted in epoxy with standard reference materials and polished to expose grain cores to a 0.25 µm finish using an automated Struers Tegrasytem™ polisher.

U/Pb and Pb/Pb isotopic ratios were measured using a Finnigan ELEMENT XR double focusing magnetic sector field ICP-MS coupled to a Geolas 193 nm excimer laser. A 10 µm laser beam was rastered over the sample surface at a velocity of 10 µm/second to create a 20 µm x 20 µm to 40 µm x 40 µm square. Laser energy was set at 5J/cm2 with a laser repetition rate of 10 Hz.

An internal standard tracer solution introduced during laser ablation of the solid sample was used to correct for instrumental mass bias. Data were collected on the unknown zircon grains and several reference standards. Typically 10 unknown grains were measured for every 6-8 analyses of the reference materials. During ablation U and Pb isotopes and tracer solution signals were acquired in time-resolved, peak-jumping, pulse-counting mode with one point measured per peak. Raw data were corrected for dead time of the electron multiplier and processed off line in the Excel spreadsheet program LAMdate (Košler et al., 2002). No common Pb correction was applied to the data.

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Table B2a. Detrital zircon U-Pb geochronologic analyses from sample **09LP014** in the Yusezyu Formation (PY) - Isotope Geology Laboratory, Boise State University

Analysis	U (ppm)	Th (ppm)	Pb^* (ppm)	Th/U	Corrected isotope ratios												Apparent ages (Ma)						% disc.
					$\frac{^{206}Pb^*}{^{207}Pb^*}$	±2σ (%)	$\frac{^{207}Pb^*}{^{235}U^*}$	±2σ (%)	$\frac{^{206}Pb^*}{^{238}U}$	±2σ (%)	error corr.	$\frac{^{238}U}{^{206}Pb^*}$	±2σ (%)	$\frac{^{207}Pb^*}{^{206}Pb^*}$	±2σ (%)	error corr.	$\frac{^{207}Pb^*}{^{206}Pb^*}$	±2σ (Ma)	$\frac{^{207}Pb^*}{^{235}U}$	±2σ (Ma)	$\frac{^{206}Pb^*}{^{238}U^*}$	±2σ (Ma)	
09LP014-1 L 50	46.47	26.63	29.97	0.57	5.255	3.095	12.598	6.174	0.480	5.342	0.87	2.083	5.342	0.190	3.095	0	**2745**	**51**	2650	58	2528	112	8
09LP014-1 L 79	80.84	56.61	56.18	0.70	5.275	2.211	13.080	5.090	0.500	4.584	0.90	1.998	4.584	0.190	2.211	0	**2739**	**36**	2685	48	2616	99	4
09LP014-1 L 85	29.30	46.86	22.76	1.60	5.290	2.796	12.721	5.580	0.488	4.828	0.87	2.049	4.828	0.189	2.796	-0.0	**2734**	**46**	2659	53	2562	102	6
09LP014-1 L 90	39.15	14.31	25.99	0.37	5.299	2.513	13.297	5.129	0.511	4.472	0.87	1.957	4.472	0.189	2.513	-0.0	**2731**	**41**	2701	48	2661	97	3
09LP014-1 L 39	100.14	70.61	71.36	0.71	5.309	2.126	13.180	4.749	0.507	4.246	0.89	1.971	4.246	0.188	2.126	0	**2728**	**35**	2693	45	2646	92	3
09LP014-1 XL 2	132.46	183.71	107.62	1.39	5.314	1.906	13.191	4.873	0.508	4.485	0.92	1.967	4.485	0.188	1.906	0.0	**2726**	**31**	2693	46	2650	97	3
09LP014-1 L 43	118.28	105.94	84.08	0.90	5.322	1.512	12.619	4.581	0.487	4.324	0.94	2.053	4.324	0.188	1.512	0	**2724**	**25**	2652	43	2558	91	6
09LP014-1 XL 17	21.44	16.39	15.45	0.76	5.383	3.252	12.831	5.077	0.501	3.899	0.77	1.996	3.899	0.186	3.252	0.0	**2705**	**54**	2667	48	2618	84	3
09LP014-1 L 92	76.51	42.54	51.17	0.56	5.391	2.070	12.716	4.831	0.497	4.365	0.90	2.011	4.365	0.186	2.070	-0.0	**2703**	**34**	2659	45	2602	93	4
09LP014-1 L 13	122.91	78.65	84.67	0.64	5.396	1.696	12.854	4.602	0.503	4.278	0.93	1.988	4.278	0.185	1.696	0.0	**2701**	**28**	2669	43	2627	92	3
09LP014-1 L 95	121.61	172.06	97.45	1.41	5.402	1.719	12.646	5.148	0.495	4.853	0.94	2.019	4.853	0.185	1.719	0	**2699**	**28**	2654	48	2594	104	4
09LP014-1 L 63	41.94	59.03	33.23	1.41	5.430	2.335	12.450	5.100	0.490	4.534	0.89	2.039	4.534	0.184	2.335	0	**2691**	**39**	2639	48	2572	96	4
09LP014-1 L 16	130.57	130.21	94.41	1.00	5.490	1.771	12.469	4.578	0.496	4.222	0.92	2.014	4.222	0.182	1.771	0	**2673**	**29**	2640	43	2598	90	3
09LP014-1 L 33	118.09	37.81	77.09	0.32	5.490	1.866	12.823	4.423	0.511	4.010	0.91	1.958	4.010	0.182	1.866	0	**2672**	**31**	2667	42	2659	87	0
09LP014-1 L 8	60.17	42.95	42.59	0.71	5.492	2.563	12.629	4.993	0.503	4.284	0.86	1.988	4.284	0.182	2.563	-0.0	**2672**	**42**	2652	47	2627	92	2
09LP014-1 XL 7	155.31	133.71	115.94	0.86	5.507	1.467	12.807	3.518	0.512	3.198	0.91	1.955	3.198	0.182	1.467	-0.0	**2667**	**24**	2666	33	2663	70	0
09LP014-1 L 84	145.95	85.27	89.98	0.58	5.601	2.616	11.300	5.021	0.459	4.285	0.85	2.179	4.285	0.179	2.616	-0.0	**2639**	**43**	2548	47	2435	87	8
09LP014-1 XL 12	32.21	23.63	22.01	0.73	5.688	2.979	11.776	4.371	0.486	3.198	0.73	2.058	3.198	0.176	2.979	0	**2614**	**50**	2587	41	2553	67	2
09LP014-1 XL 1	174.32	53.14	98.31	0.30	5.738	1.914	10.737	4.284	0.447	3.833	0.89	2.238	3.833	0.174	1.914	-0.0	**2599**	**32**	2501	40	2381	76	8
09LP014-1 L 76	184.73	91.67	111.34	0.50	6.064	1.585	10.386	4.570	0.457	4.286	0.94	2.189	4.286	0.165	1.585	-0.0	**2507**	**27**	2470	42	2425	87	3
09LP014-1 XL 18	93.40	68.31	62.90	0.73	6.096	1.740	10.914	3.826	0.482	3.408	0.89	2.073	3.408	0.164	1.740	0	**2498**	**29**	2516	36	2538	72	-2
09LP014-1 L 71	139.25	164.85	91.07	1.18	6.208	1.610	9.508	4.357	0.428	4.048	0.93	2.336	4.048	0.161	1.610	0.0	**2467**	**27**	2388	40	2297	78	7
09LP014-1 XL 15	104.11	67.10	64.45	0.64	6.312	1.735	9.900	4.121	0.453	3.737	0.91	2.206	3.737	0.158	1.735	0	**2439**	**29**	2425	38	2410	75	1
09LP014-1 XL 4	32.88	45.54	23.07	1.39	6.329	3.043	9.573	4.972	0.439	3.932	0.79	2.276	3.932	0.158	3.043	0	**2434**	**52**	2395	46	2348	77	4
09LP014-1 XL 6	74.61	43.70	46.16	0.59	6.343	1.958	10.055	4.604	0.463	4.167	0.91	2.162	4.167	0.158	1.958	-0.0	**2431**	**33**	2440	43	2451	85	-1
09LP014-1 L 26	108.74	57.82	59.21	0.53	6.454	1.922	8.857	4.928	0.415	4.538	0.92	2.412	4.538	0.155	1.922	-0.0	**2401**	**33**	2323	45	2236	86	7
09LP014-1 XL 10	56.51	65.20	36.92	1.15	6.534	2.223	9.078	3.995	0.430	3.319	0.83	2.324	3.319	0.153	2.223	0.0	**2380**	**38**	2346	37	2307	64	3
09LP014-1 L 38	45.16	34.45	26.25	0.76	6.631	3.090	8.733	5.579	0.420	4.645	0.83	2.381	4.645	0.151	3.090	0.0	**2355**	**53**	2311	51	2260	89	4
09LP014-1 L 44	124.76	85.25	62.82	0.68	6.768	2.236	7.723	4.572	0.379	3.988	0.87	2.638	3.988	0.148	2.236	0	**2320**	**38**	2199	41	2072	71	11
09LP014-1 XL 11	88.57	47.16	49.97	0.53	6.929	1.747	8.674	4.249	0.436	3.873	0.91	2.294	3.873	0.144	1.747	0.0	**2280**	**30**	2304	39	2332	76	-2
09LP014-1 L 31	44.72	52.07	26.67	1.16	6.979	3.387	7.758	5.205	0.393	3.952	0.76	2.547	3.952	0.143	3.387	-0.0	**2267**	**58**	2203	47	2135	72	6
09LP014-1 L 62	77.38	63.59	38.04	0.82	7.217	2.353	6.714	6.274	0.351	5.817	0.93	2.846	5.817	0.139	2.353	0	**2209**	**41**	2074	55	1941	98	12
09LP014-1 XL 9	22.95	24.38	12.52	1.06	7.510	3.484	6.861	5.630	0.374	4.423	0.79	2.676	4.423	0.133	3.484	0	**2140**	**61**	2094	50	2047	78	4
09LP014-1 L 82	102.94	165.79	57.78	1.61	7.740	3.150	6.213	5.327	0.349	4.295	0.81	2.867	4.295	0.129	3.150	0	**2087**	**55**	2006	47	1929	72	8
09LP014-1 L 81	55.30	50.14	25.04	0.91	7.944	3.096	5.643	5.294	0.325	4.294	0.81	3.076	4.294	0.126	3.096	0	**2041**	**55**	1923	46	1815	68	11
09LP014-1 L 89	239.58	308.64	125.20	1.29	7.973	1.802	5.972	4.674	0.345	4.313	0.92	2.896	4.313	0.125	1.802	-0.0	**2035**	**32**	1972	41	1912	71	6
09LP014-1 L 101	141.47	84.30	64.98	0.60	7.987	2.048	6.058	4.720	0.351	4.252	0.90	2.850	4.252	0.125	2.048	0.0	**2032**	**36**	1984	41	1939	71	5
09LP014-1 L 75	122.59	84.79	57.17	0.69	8.007	2.571	5.995	5.506	0.348	4.869	0.88	2.872	4.869	0.125	2.571	-0.0	**2027**	**46**	1975	48	1926	81	5
09LP014-1 L 70	97.53	35.96	41.49	0.37	8.023	2.726	5.880	5.018	0.342	4.213	0.84	2.923	4.213	0.125	2.726	0.0	**2024**	**48**	1958	44	1897	69	6
09LP014-1 L 61	37.40	32.22	17.52	0.86	8.030	4.957	5.621	7.025	0.327	4.977	0.71	3.055	4.977	0.125	4.957	-0.0	**2022**	**88**	1919	61	1826	79	10
09LP014-1 L 25	97.48	63.61	44.11	0.65	8.052	2.143	5.909	4.801	0.345	4.296	0.89	2.898	4.296	0.124	2.143	0.0	**2017**	**38**	1963	42	1911	71	5
09LP014-1 L 96	49.47	38.41	22.39	0.78	8.080	3.654	5.697	5.861	0.334	4.582	0.78	2.995	4.582	0.124	3.654	0	**2011**	**65**	1931	51	1857	74	8

Table B2a, *continued*. Detrital zircon U-Pb geochronologic analyses from sample **09LP014** in the Yusezyu Formation (PY) - Isotope Geology Laboratory, Boise State University

Analysis	U (ppm)	Th (ppm)	Pb^* (ppm)	Th/U	Corrected isotope ratios												Apparent ages (Ma)						% disc.
					$\frac{^{206}Pb^*}{^{207}Pb^*}$	±2σ (%)	$\frac{^{207}Pb^*}{^{235}U^*}$	±2σ (%)	$\frac{^{206}Pb^*}{^{238}U}$	±2σ (%)	error corr.	$\frac{^{238}U}{^{206}Pb^*}$	±2σ (%)	$\frac{^{207}Pb^*}{^{206}Pb^*}$	±2σ (%)	error corr.	$\frac{^{207}Pb^*}{^{206}Pb^*}$	±2σ (Ma)	$\frac{^{207}Pb^*}{^{235}U}$	±2σ (Ma)	$\frac{^{206}Pb^*}{^{238}U^*}$	±2σ (Ma)	
09LP014-1 L 17	49.22	31.08	22.41	0.63	8.168	3.363	5.900	5.853	0.349	4.790	0.82	2.861	4.790	0.122	3.363	-0.0	**1992**	**60**	1961	51	1932	80	3
09LP014-1 L 69	235.40	121.84	96.83	0.52	8.194	1.804	5.394	4.660	0.321	4.296	0.92	3.120	4.296	0.122	1.804	0.0	**1986**	**32**	1884	40	1792	67	10
09LP014-1 L 14	116.14	78.21	55.18	0.67	8.272	2.341	6.036	5.223	0.362	4.669	0.89	2.762	4.669	0.121	2.341	-0.0	**1969**	**42**	1981	45	1992	80	-1
09LP014-1 L 15	173.80	140.93	78.04	0.81	8.306	2.084	5.582	4.721	0.336	4.236	0.90	2.974	4.236	0.120	2.084	0	**1962**	**37**	1913	41	1869	69	5
09LP014-1 XL 8	24.42	17.97	12.01	0.74	8.323	3.853	6.010	5.813	0.363	4.352	0.75	2.756	4.352	0.120	3.853	0	**1958**	**69**	1977	51	1995	75	-2
09LP014-1 L 91	135.78	66.83	58.02	0.49	8.356	2.493	5.535	5.241	0.335	4.610	0.88	2.981	4.610	0.120	2.493	0.0	**1951**	**45**	1906	45	1865	75	4
09LP014-1 L 97	165.87	96.70	70.08	0.58	8.358	2.102	5.336	5.893	0.323	5.505	0.93	3.091	5.505	0.120	2.102	0	**1951**	**38**	1875	50	1807	87	7
09LP014-1 L 49	31.26	34.75	14.32	1.11	8.364	5.119	5.151	7.236	0.312	5.113	0.71	3.200	5.113	0.120	5.119	0.0	**1950**	**91**	1845	62	1753	78	10
09LP014-1 XL 13	88.18	135.96	49.25	1.54	8.397	2.064	5.728	4.234	0.349	3.697	0.87	2.867	3.697	0.119	2.064	0	**1943**	**37**	1936	37	1929	62	1
09LP014-1 L 60	207.03	77.54	86.89	0.37	8.397	1.701	5.578	4.792	0.340	4.480	0.93	2.944	4.480	0.119	1.701	0	**1943**	**30**	1913	41	1885	73	3
09LP014-1 L 51	62.47	67.05	29.00	1.07	8.443	2.771	5.341	5.674	0.327	4.952	0.87	3.057	4.952	0.118	2.771	-0.0	**1933**	**50**	1876	49	1824	79	6
09LP014-1 L 27	136.48	102.82	61.59	0.75	8.447	2.295	5.456	4.611	0.334	3.999	0.87	2.991	3.999	0.118	2.295	0	**1932**	**41**	1894	40	1859	65	4
09LP014-1 L 11	249.64	86.18	104.01	0.35	8.478	1.637	5.530	4.539	0.340	4.233	0.93	2.941	4.233	0.118	1.637	0.0	**1926**	**29**	1905	39	1887	69	2
09LP014-1 L 19	43.95	21.07	17.40	0.48	8.505	4.012	5.173	5.891	0.319	4.314	0.73	3.134	4.314	0.118	4.012	-0.0	**1920**	**72**	1848	50	1785	67	7
09LP014-1 L 93	62.78	12.49	23.44	0.20	8.552	2.793	5.112	5.168	0.317	4.349	0.84	3.154	4.349	0.117	2.793	0	**1910**	**50**	1838	44	1775	67	7
09LP014-1 L 46	265.76	93.35	109.49	0.35	8.608	1.612	5.402	4.966	0.337	4.697	0.95	2.965	4.697	0.116	1.612	0	**1898**	**29**	1885	43	1873	76	1
09LP014-1 L 88	77.24	24.82	29.85	0.32	8.612	3.087	5.122	5.327	0.320	4.341	0.81	3.126	4.341	0.116	3.087	0.0	**1897**	**56**	1840	45	1789	68	6
09LP014-1 L 37	108.96	67.75	44.31	0.62	8.624	2.228	4.956	4.565	0.310	3.985	0.87	3.226	3.985	0.116	2.228	-0.0	**1895**	**40**	1812	39	1741	61	8
09LP014-1 L 100	151.93	80.66	61.25	0.53	8.626	2.017	5.033	5.045	0.315	4.625	0.92	3.176	4.625	0.116	2.017	-0.0	**1894**	**36**	1825	43	1765	71	7
09LP014-1 L 78	98.04	35.82	36.88	0.37	8.631	2.302	4.932	5.226	0.309	4.692	0.90	3.239	4.692	0.116	2.302	0.0	**1893**	**41**	1808	44	1734	71	8
09LP014-1 XL 14	203.23	86.98	88.38	0.43	8.646	1.891	5.559	4.687	0.349	4.289	0.91	2.869	4.289	0.116	1.891	0	**1890**	**34**	1910	40	1928	71	-2
09LP014-1 XL 19	76.48	35.80	31.67	0.47	8.671	2.921	5.222	4.556	0.328	3.496	0.77	3.045	3.496	0.115	2.921	0.0	**1885**	**53**	1856	39	1831	56	3
09LP014-1 L 45	71.47	12.64	26.45	0.18	8.682	3.292	4.999	5.752	0.315	4.716	0.82	3.177	4.716	0.115	3.292	0	**1883**	**59**	1819	49	1764	73	6
09LP014-1 L 42	97.50	59.16	41.31	0.61	8.690	2.657	5.106	5.259	0.322	4.539	0.86	3.107	4.539	0.115	2.657	-0.0	**1881**	**48**	1837	45	1799	71	4
09LP014-1 L 55	417.47	356.72	152.21	0.85	8.694	2.362	4.417	4.896	0.278	4.289	0.88	3.591	4.289	0.115	2.362	0	**1880**	**43**	1715	41	1584	60	16
09LP014-1 L 59	126.00	92.93	54.05	0.74	8.712	2.088	5.065	5.251	0.320	4.818	0.92	3.125	4.818	0.115	2.088	-0.0	**1876**	**38**	1830	45	1790	75	5
09LP014-1 L 57	196.20	71.75	76.60	0.37	8.712	1.547	5.040	4.584	0.318	4.315	0.94	3.140	4.315	0.115	1.547	0.0	**1876**	**28**	1826	39	1782	67	5
09LP014-1 L 74	167.20	55.16	65.18	0.33	8.742	2.199	5.041	5.258	0.320	4.776	0.91	3.129	4.776	0.114	2.199	0.0	**1870**	**40**	1826	45	1788	75	4
09LP014-1 L 86	64.03	30.89	25.22	0.48	8.749	3.753	4.981	6.473	0.316	5.274	0.81	3.164	5.274	0.114	3.753	0	**1869**	**68**	1816	55	1770	82	5
09LP014-1 L 29	97.47	39.85	37.80	0.41	8.751	2.310	4.896	4.776	0.311	4.181	0.88	3.218	4.181	0.114	2.310	-0.0	**1868**	**42**	1801	40	1744	64	7
09LP014-1 L 56	157.06	5.75	55.44	0.04	8.760	2.392	4.936	4.911	0.314	4.289	0.87	3.188	4.289	0.114	2.392	0	**1866**	**43**	1808	41	1759	66	6
09LP014-1 L 34	140.10	77.97	56.26	0.56	8.762	2.189	4.886	4.678	0.310	4.134	0.88	3.221	4.134	0.114	2.189	0.0	**1866**	**40**	1800	39	1743	63	7
09LP014-1 L 58	158.73	85.11	63.41	0.54	8.790	2.025	4.888	4.654	0.312	4.190	0.90	3.209	4.190	0.114	2.025	-0.0	**1860**	**37**	1800	39	1749	64	6
09LP014-1 L 24	110.25	47.41	41.98	0.43	8.796	2.534	4.803	5.239	0.306	4.586	0.88	3.264	4.586	0.114	2.534	-0.0	**1859**	**46**	1785	44	1723	69	7
09LP014-1 L 87	85.48	33.46	32.88	0.39	8.796	3.299	4.888	5.707	0.312	4.657	0.82	3.207	4.657	0.114	3.299	0.0	**1859**	**60**	1800	48	1750	71	6
09LP014-1 XL 3	71.66	23.29	28.18	0.33	8.816	2.778	5.056	4.688	0.323	3.776	0.81	3.093	3.776	0.113	2.778	0.0	**1855**	**50**	1829	40	1806	59	3
09LP014-1 L 72	156.63	24.15	57.82	0.15	8.823	2.336	4.955	5.328	0.317	4.788	0.90	3.154	4.788	0.113	2.336	0.0	**1854**	**42**	1812	45	1775	74	4
09LP014-1 L 22	50.68	19.88	19.66	0.39	8.833	3.554	4.912	5.827	0.315	4.618	0.79	3.177	4.618	0.113	3.554	0.0	**1852**	**64**	1804	49	1764	71	5
09LP014-1 XL 16	127.39	64.57	51.60	0.51	8.843	2.287	4.921	4.072	0.316	3.370	0.83	3.168	3.370	0.113	2.287	0	**1850**	**41**	1806	34	1768	52	4
09LP014-1 L 40	189.32	43.76	71.01	0.23	8.851	2.108	4.897	4.504	0.314	3.980	0.88	3.181	3.980	0.113	2.108	0	**1848**	**38**	1802	38	1762	61	5
09LP014-1 L 36	30.67	32.25	14.10	1.05	8.855	4.022	4.895	5.923	0.314	4.348	0.73	3.181	4.348	0.113	4.022	0.0	**1847**	**73**	1801	50	1762	67	5
09LP014-1 XL 5	39.54	6.16	14.58	0.16	8.858	3.280	4.923	5.279	0.316	4.136	0.78	3.162	4.136	0.113	3.280	0	**1846**	**59**	1806	45	1771	64	4

Table B2a, *continued*. Detrital zircon U-Pb geochronologic analyses from sample **09LP014** in the Yusezyu Formation (PY) - Isotope Geology Laboratory, Boise State University

Analysis	U (ppm)	Th (ppm)	Pb^* (ppm)	Th/U	Corrected isotope ratios												Apparent ages (Ma)						% disc.
					$\frac{^{206}Pb^*}{^{207}Pb^*}$	±2σ (%)	$\frac{^{207}Pb^*}{^{235}U^*}$	±2σ (%)	$\frac{^{206}Pb^*}{^{238}U}$	±2σ (%)	error corr.	$\frac{^{238}U}{^{206}Pb^*}$	±2σ (%)	$\frac{^{207}Pb^*}{^{206}Pb^*}$	±2σ (%)	error corr.	$\frac{^{207}Pb^*}{^{206}Pb^*}$	±2σ (Ma)	$\frac{^{207}Pb^*}{^{235}U}$	±2σ (Ma)	$\frac{^{206}Pb^*}{^{238}U^*}$	±2σ (Ma)	
09LP014-1 L 98	106.59	83.25	43.98	0.78	8.859	2.341	4.694	5.103	0.302	4.534	0.89	3.315	4.534	0.113	2.341	0.0	**1846**	**42**	1766	43	1699	68	8
09LP014-1 L 80	293.97	128.77	114.58	0.44	8.864	1.818	4.879	4.616	0.314	4.243	0.92	3.188	4.243	0.113	1.818	-0.0	**1845**	**33**	1799	39	1759	65	5
09LP014-1 L 23	119.74	71.63	48.92	0.60	8.873	2.605	4.924	5.038	0.317	4.312	0.86	3.156	4.312	0.113	2.605	-0.0	**1843**	**47**	1806	43	1775	67	4
09LP014-1 L 66	150.56	79.04	63.85	0.52	8.895	1.947	5.097	5.438	0.329	5.077	0.93	3.041	5.077	0.112	1.947	0	**1839**	**35**	1836	46	1833	81	0
09LP014-1 L 64	169.97	187.89	77.30	1.11	8.970	1.990	4.745	4.573	0.309	4.117	0.90	3.239	4.117	0.111	1.990	0.0	**1824**	**36**	1775	38	1734	63	5
09LP014-1 L 6	89.30	26.87	35.20	0.30	8.972	2.337	4.992	4.565	0.325	3.922	0.86	3.079	3.922	0.111	2.337	0	**1823**	**42**	1818	39	1813	62	1
09LP014-1 L 1	100.78	72.74	44.41	0.72	8.979	2.468	5.063	4.792	0.330	4.107	0.86	3.033	4.107	0.111	2.468	0	**1822**	**45**	1830	41	1837	66	-1
09LP014-1 L 47	119.22	69.66	48.13	0.58	8.985	2.380	4.837	5.528	0.315	4.989	0.90	3.173	4.989	0.111	2.380	0.0	**1821**	**43**	1791	47	1766	77	3
09LP014-1 L 21	97.57	109.54	42.07	1.12	8.986	2.617	4.691	5.573	0.306	4.921	0.88	3.271	4.921	0.111	2.617	0.0	**1820**	**47**	1766	47	1720	74	6
09LP014-1 L 20	71.36	37.77	27.85	0.53	8.988	2.997	4.774	5.386	0.311	4.475	0.83	3.213	4.475	0.111	2.997	-0.0	**1820**	**54**	1780	45	1747	68	4
09LP014-1 L 65	87.09	77.80	37.72	0.89	8.997	2.597	4.719	4.866	0.308	4.116	0.85	3.248	4.116	0.111	2.597	-0.0	**1818**	**47**	1771	41	1730	62	5
09LP014-1 L 28	39.12	13.59	14.90	0.35	9.028	4.044	4.766	6.103	0.312	4.570	0.75	3.205	4.570	0.111	4.044	0.0	**1812**	**73**	1779	51	1751	70	3
09LP014-1 L 3	179.83	79.80	72.13	0.44	9.034	1.805	4.874	4.505	0.319	4.128	0.92	3.131	4.128	0.111	1.805	-0.0	**1811**	**33**	1798	38	1787	64	1
09LP014-1 L 73	32.14	15.30	13.06	0.48	9.043	4.005	4.923	6.269	0.323	4.823	0.77	3.097	4.823	0.111	4.005	0.0	**1809**	**73**	1806	53	1804	76	0
09LP014-1 L 12	148.32	66.37	60.08	0.45	9.053	1.859	4.955	4.582	0.325	4.188	0.91	3.074	4.188	0.110	1.859	0.0	**1807**	**34**	1812	39	1816	66	-0
09LP014-1 L 54	470.34	3.05	160.84	0.01	9.072	2.316	4.673	5.325	0.307	4.795	0.90	3.252	4.795	0.110	2.316	-0.0	**1803**	**42**	1762	45	1728	73	4
09LP014-1 L 53	112.40	32.51	41.06	0.29	9.072	3.316	4.672	6.024	0.307	5.029	0.83	3.253	5.029	0.110	3.316	-0.0	**1803**	**60**	1762	50	1728	76	4
09LP014-1 L 77	71.15	35.61	27.52	0.50	9.079	2.716	4.642	5.241	0.306	4.482	0.86	3.272	4.482	0.110	2.716	0	**1802**	**49**	1757	44	1719	68	5
09LP014-1 L 35	69.49	63.62	30.17	0.92	9.097	4.159	4.715	6.120	0.311	4.489	0.73	3.215	4.489	0.110	4.159	0	**1798**	**76**	1770	51	1746	69	3
09LP014-1 L 5	96.45	33.12	38.64	0.34	9.122	2.370	4.957	4.692	0.328	4.049	0.86	3.049	4.049	0.110	2.370	-0.0	**1793**	**43**	1812	40	1828	64	-2
09LP014-1 L 7	26.48	6.33	10.07	0.24	9.131	5.218	4.834	6.771	0.320	4.314	0.64	3.124	4.314	0.110	5.218	0	**1791**	**95**	1791	57	1790	67	0
09LP014-1 L 4	54.73	10.50	20.98	0.19	9.131	3.043	4.932	5.053	0.327	4.034	0.80	3.062	4.034	0.110	3.043	-0.0	**1791**	**55**	1808	43	1822	64	-2
09LP014-1 L 2	297.88	25.82	108.01	0.09	9.131	1.658	4.806	4.627	0.318	4.320	0.93	3.142	4.320	0.110	1.658	-0.0	**1791**	**30**	1786	39	1782	67	1
09LP014-1 L 48	105.00	60.54	43.35	0.58	9.135	2.316	4.869	5.352	0.323	4.825	0.90	3.100	4.825	0.109	2.316	0.0	**1791**	**42**	1797	45	1802	76	-1
09LP014-1 L 9	205.80	143.13	77.93	0.70	9.141	2.039	4.339	6.690	0.288	6.372	0.95	3.477	6.372	0.109	2.039	0.0	**1789**	**37**	1701	55	1630	92	9
09LP014-1 L 32	89.55	38.31	34.90	0.43	9.166	2.485	4.706	4.688	0.313	3.975	0.85	3.197	3.975	0.109	2.485	-0.0	**1784**	**45**	1768	39	1755	61	2
09LP014-1 L 67	200.19	150.19	80.76	0.75	9.237	2.017	4.485	4.386	0.300	3.895	0.89	3.328	3.895	0.108	2.017	-0.0	**1770**	**37**	1728	36	1694	58	4
09LP014-1 L 10	13.63	22.00	6.99	1.61	9.546	6.270	4.553	7.991	0.315	4.953	0.62	3.172	4.953	0.105	6.270	-0.0	**1710**	**115**	1741	67	1766	77	-3
09LP014-1 L 99	43.41	0.41	7.90	0.01	13.030	5.455	1.787	7.360	0.169	4.942	0.67	5.922	4.942	0.077	5.455	-0.0	**1115**	**109**	1041	48	1006	46	10
09LP014-1 L 83	245.61	107.09	30.17	0.44	15.783	4.858	0.898	6.843	0.103	4.820	0.70	9.724	4.820	0.063	4.858	0	720	103	651	33	**631**	**29**	12

Notes:

Yellow highlighted rows are samples that intersected inclusions.
Isotope ratios and ages are NOT corrected for initial common Pb.
Isotope ratio and apparent age errors include systematic calibration errors of 6.37100499011343% ($^{208}Pb/^{232}Th$), 0.452188693209402% ($^{207}Pb/^{206}Pb$), 1.63033394062177% ($^{206}Pb/^{238}U$) (all 1-sigma).
Sweep-by-sweep downhole fractionation of U/Pb ratios NOT corrected via Si/Zr fractionation factor.
Backgrounds were monitored during sweeps 8 to 18. Sample counts were integrated from sweeps 35 to 80.
Ablation used a laser spot size of 25 microns, and a laser firing repitition rate of 10 Hz.

Table B2b. Detrital zircon trace element analyses from sample **09LP014** in the Yusezyu Formation (PY) - Isotope Geology Laboratory, Boise State University

Analysis	Concentrations (ppm)																						
	P	Ti	Y	Zr	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	Th	U
09LP014-1 L 50	163.307	23.218	402.360	557124.758	0.788		5.006	0.080	1.215	2.766	0.287	8.334	3.530	40.809	13.972	60.707	15.470	163.691	19.692	8891.877	0.427	26.627	46.469
09LP014-1 L 79	212.787	13.174	454.012	495112.414	0.857		12.247		1.635	2.311	0.291	12.576	3.757	47.216	15.251	63.818	15.475	159.029	19.124	9185.667	0.631	56.610	80.840
09LP014-1 L 85	279.777	24.229	911.969	560122.689	1.068	0.014	20.343	0.106	5.033	6.002	2.192	34.287	9.759	101.893	34.147	132.623	30.989	317.742	39.610	8896.344	0.399	46.856	29.300
09LP014-1 L 90	145.676	9.415	218.682	506504.615	0.377	0.008	3.067		0.354	0.126	0.211	3.209	1.150	19.338	7.524	35.473	9.183	116.503	14.794	8151.327	0.317	14.308	39.155
09LP014-1 L 39	137.732	11.694	776.445	484744.540	1.326		11.262	0.346	6.341	7.833	0.807	31.153	8.906	91.906	27.506	107.296	24.638	265.025	27.030	7529.700	0.847	70.612	100.136
09LP014-1 XL 2	104.408	22.203	642.696	571351.231	0.643		28.331	0.486	8.548	14.098	2.276	35.357	8.437	77.452	22.976	83.762	19.432	186.897	23.118	8614.077	0.272	183.712	132.455
09LP014-1 L 43	160.859	6.659	377.944	473604.783	1.183		60.632	0.112	1.702	5.370	2.134	17.970	4.478	41.080	12.406	42.774	10.796	118.331	13.755	7737.021	0.542	105.942	118.283
09LP014-1 XL 17	145.980	14.023	470.677	537478.223	0.646		7.833	0.021	0.521	2.093	0.800	15.619	4.495	48.490	16.184	70.824	17.585	201.267	23.676	7992.129	0.348	16.393	21.440
09LP014-1 L 92	157.849	15.311	328.296	500163.254	0.795		13.606	0.070	1.144	1.928	0.417	9.381	2.816	34.416	11.175	48.230	12.208	138.060	16.464	8671.606	0.594	42.537	76.514
09LP014-1 L 13	201.607	7.500	719.112	502739.988	1.995		24.511	0.002	1.788	3.149	0.892	16.379	5.600	68.088	26.741	114.454	29.402	347.164	42.775	8058.438	0.985	78.651	122.911
09LP014-1 L 95	200.366	15.845	818.156	482746.020	1.072		38.934	0.435	10.525	18.153	4.000	47.527	11.474	105.314	29.481	102.567	23.368	260.472	28.806	7055.745	0.482	172.063	121.612
09LP014-1 L 63	404.510	14.906	892.033	471977.679	4.111	0.023	25.543	0.123	1.497	3.923	0.273	23.845	7.734	91.407	32.674	133.873	32.539	353.104	38.476	8699.128	1.143	59.028	41.944
09LP014-1 L 16	135.518	11.943	348.766	531772.376	1.058	0.046	40.130	0.039	1.516	2.933	0.835	14.342	3.190	37.555	12.061	46.420	11.539	129.508	15.533	8946.661	0.540	130.214	130.567
09LP014-1 L 33	260.646	14.469	503.250	493119.332	0.510	0.120	3.619		1.111	2.296	0.162	13.081	4.111	51.804	18.914	73.935	19.383	205.334	21.884	8669.692	0.382	37.811	118.093
09LP014-1 L 8	147.603	7.426	283.165	476089.698	0.422	0.026	11.082		0.479	0.821	0.423	6.401	1.857	25.845	9.850	43.826	12.003	137.180	16.737	8010.902	0.264	42.950	60.169
09LP014-1 XL 7	220.353	14.038	197.565	508495.311	0.516	0.167	1.438	0.016	1.707	3.288		14.074	3.410	31.273	7.585	21.530	4.400	35.840	3.660	10003.483	0.149	133.710	155.311
09LP014-1 L 84	342.428	8.324	1365.113	532965.535	2.696	0.020	15.032	0.356	6.836	12.463	0.337	53.675	15.426	162.771	50.919	196.739	42.866	436.100	51.354	10000.800	1.546	85.272	145.951
09LP014-1 XL 12	220.448	8.151	519.226	548835.318	0.596	0.130	8.034	0.070	0.517	2.312	1.129	11.537	4.235	45.486	18.520	80.746	21.329	242.297	29.654	7329.561	0.241	23.634	32.205
09LP014-1 XL 1	399.363	1.196	949.902	562152.234	0.592		4.816		0.097	1.938	0.111	12.495	5.662	82.775	33.307	151.674	40.156	449.839	61.438	12480.851	0.513	53.144	174.319
09LP014-1 L 76	107.226	5.188	348.717	483875.252	1.115	0.064	11.164	0.040	0.828	1.165	0.269	8.799	2.491	34.030	12.449	54.924	14.854	172.551	20.364	8161.163	0.685	91.673	184.734
09LP014-1 XL 18	206.284	22.249	541.800	503635.631	0.896		7.996	0.007	1.341	3.672	0.610	17.042	5.109	61.158	19.893	80.467	19.861	215.253	23.633	7454.882	0.705	68.307	93.397
09LP014-1 L 71	782.954	19.495	1735.425	473928.542	0.780	0.287	13.628	1.239	21.497	25.447	2.034	78.089	20.696	217.420	66.004	245.978	54.841	556.560	59.224	8000.228	0.286	164.855	139.252
09LP014-1 XL 15	99.399	12.107	353.159	514527.883	3.089		33.556	0.052	0.805	1.987	0.329	9.918	2.918	33.523	12.846	55.983	13.079	160.986	18.113	8728.814	1.600	67.101	104.112
09LP014-1 XL 4	88.769	11.053	275.716	564036.913	1.167	0.143	16.577	0.047	1.246	3.190	0.319	10.882	2.945	30.463	10.271	40.772	10.216	110.440	14.096	8727.868	0.530	45.540	32.880
09LP014-1 XL 6	121.082	9.243	198.363	526193.740	0.899		13.583		0.281	0.915	0.344	5.215	1.582	19.620	7.410	30.772	7.404	87.877	10.865	9511.084	0.600	43.698	74.608
09LP014-1 L 26	142.747	10.272	315.840	507797.658	0.138	0.197	2.387			0.484	0.084	5.317	1.831	25.845	10.188	50.456	12.670	157.727	19.270	7623.538	0.209	57.818	108.735
09LP014-1 XL 10	236.469	15.656	304.288	519574.791	1.840		13.188	0.033	2.488	4.706	0.030	12.091	3.829	34.811	11.754	43.434	10.892	122.489	13.219	9259.810	0.898	65.200	56.508
09LP014-1 L 38	203.211	8.083	338.056	484773.255	1.907	0.140	2.523	0.071	0.763	2.275	0.187	9.825	2.959	39.960	12.568	50.339	12.002	124.503	13.489	8564.222	0.833	34.452	45.161
09LP014-1 L 44	202.013	8.733	492.723	482128.855	0.528	0.025	6.292	0.048	0.773	1.613	0.589	12.881	4.144	48.408	16.990	77.547	19.653	225.600	27.374	8112.814	0.429	85.249	124.759
09LP014-1 XL 11	106.008	2.921	474.909	572691.902	0.865	0.139	5.780		0.397	1.532	0.177	7.447	3.122	40.760	16.633	74.387	19.748	219.883	27.172	10466.736	0.795	47.164	88.569
09LP014-1 L 31	355.350	15.349	476.652	480315.513	0.813	0.028	3.130	0.150	3.456	8.696	0.178	27.762	7.090	66.362	17.476	56.168	11.223	104.086	9.731	8356.258	0.310	52.071	44.716
09LP014-1 L 62	199.901	19.583	384.651	487147.841	1.182		5.061	0.015	1.214	2.409	0.244	13.850	3.605	44.577	13.847	56.526	12.495	133.331	13.621	8900.799	0.755	63.590	77.382
09LP014-1 XL 9	100.742	4.444	737.875	523981.223	2.858		3.264	0.193	3.747	7.379	1.152	28.949	8.596	97.589	30.320	116.272	26.270	263.863	30.660	6899.870	1.154	24.382	22.952
09LP014-1 L 82	337.087	32.535	805.454	517831.368	2.642		21.410	0.211	2.580	5.718	0.343	23.868	8.787	90.316	28.808	117.382	27.673	277.928	31.727	9453.386	0.999	165.785	102.936
09LP014-1 L 81	197.919	4.727	421.016	511167.428	2.725		6.674	0.179	1.967	3.114	0.098	15.049	4.069	46.546	15.267	59.724	14.370	146.773	16.772	9593.064	1.606	50.143	55.296
09LP014-1 L 89	392.706	11.346	856.589	503454.852	3.600		27.726	0.092	2.759	5.796	0.462	26.745	8.441	89.750	31.154	121.932	28.166	297.691	33.766	9726.638	1.289	308.636	239.579
09LP014-1 L 101	168.844	15.414	404.100	493336.565	1.561		13.131	0.048	0.292	1.799	0.218	8.787	3.446	40.292	14.629	62.322	15.551	177.933	21.126	9141.126	0.921	84.296	141.474
09LP014-1 L 75	193.504	20.822	509.495	481276.202	1.487	0.035	10.522		0.889	2.391	0.217	10.742	4.185	53.884	18.085	72.316	17.643	189.572	20.864	9167.477	0.996	84.785	122.593
09LP014-1 L 70	141.752	17.844	279.395	479100.730	1.572		5.293	0.022	0.606	1.020	0.160	5.958	2.162	26.725	9.630	43.168	11.688	131.002	15.597	9177.845	1.099	35.956	97.531
09LP014-1 L 61	~~181.998~~	~~57.636~~	~~353.102~~	~~459544.175~~	~~2.499~~	~~2.931~~	~~29.900~~	~~0.581~~	~~2.914~~	~~1.661~~	~~0.432~~	~~11.203~~	~~2.849~~	~~36.778~~	~~13.342~~	~~56.456~~	~~15.285~~	~~176.835~~	~~20.830~~	~~7163.561~~	~~0.757~~	~~32.220~~	~~37.400~~
09LP014-1 L 25	272.076	25.890	851.248	503468.101	3.592		5.957	0.114	2.159	5.303	0.372	24.368	8.919	92.786	31.986	124.707	30.166	305.699	34.167	9120.982	1.783	63.615	97.484
09LP014-1 L 96	215.891	23.159	497.703	487443.435	1.391		7.473	0.059	0.350	2.443	0.220	14.710	4.698	52.246	17.664	71.995	17.578	202.982	21.986	8140.236	0.575	38.406	49.469
09LP014-1 L 17	151.509	10.783	428.159	528427.877	1.804		6.909		1.181	2.229	0.179	8.770	3.872	47.390	15.860	65.076	16.014	168.542	20.746	9730.432	0.998	31.081	49.220

Table B2b, *continued*. Detrital zircon trace element analyses from sample **09LP014** in the Yusezyu Formation (PY) - Isotope Geology Laboratory, Boise State University

Analysis	Concentrations (ppm)																						
	P	Ti	Y	Zr	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	Th	U
09LP014-1 L 69	603.969	13.335	1393.158	485518.356	1.239	0.022	4.352	0.093	1.591	5.613	0.699	32.769	12.549	149.176	51.695	214.107	53.332	566.901	60.810	9685.940	0.473	121.839	235.405
09LP014-1 L 14	212.219	19.387	588.473	510648.572	1.318		9.037	0.068	1.180	1.315	0.172	13.540	4.892	57.420	20.979	88.958	22.581	240.497	28.482	9535.483	0.825	78.209	116.142
09LP014-1 L 15	~~309.495~~	~~41.009~~	~~785.485~~	~~517099.886~~	~~1.839~~		~~11.832~~	~~0.095~~	~~1.169~~	~~4.107~~	~~0.668~~	~~18.394~~	~~6.887~~	~~86.232~~	~~29.678~~	~~120.011~~	~~28.805~~	~~311.132~~	~~36.338~~	~~10023.080~~	~~1.236~~	~~140.927~~	~~173.804~~
09LP014-1 XL 8	321.469	25.358	614.137	528119.590	2.612	0.080	11.424	0.098	1.266	3.235	0.675	18.266	5.157	62.355	21.346	97.717	23.420	258.646	30.065	8666.565	1.081	17.972	24.422
09LP014-1 L 91	236.891	9.226	414.917	507104.106	0.594	0.151	2.672	0.043	1.405	2.641		11.910	4.441	47.104	14.698	57.001	13.115	128.266	13.928	9710.696	0.594	66.829	135.777
09LP014-1 L 97	208.540	25.583	252.120	478281.236	0.995	0.073	4.104	0.143	3.215	8.211	0.026	25.377	5.911	42.567	9.070	21.182	3.198	21.968	1.438	9580.075	0.598	96.696	165.867
09LP014-1 L 49	188.586	12.266	988.910	534511.334	1.408		44.895	0.188	2.605	7.124	2.328	30.003	9.635	109.952	36.929	139.363	34.068	347.045	43.679	8144.209	0.632	34.750	31.256
09LP014-1 XL 13	281.001	0.598	915.422	539109.156	3.092		8.436	0.216	3.763	6.700	0.327	27.215	8.948	103.461	35.236	139.288	32.485	328.599	37.783	9231.170	1.199	135.957	88.179
09LP014-1 L 60	282.009	21.614	367.235	496160.294	0.579		5.791	0.086	1.955	2.965	0.223	12.130	3.613	42.687	13.733	54.441	14.411	156.921	17.097	9109.864	0.350	77.544	207.028
09LP014-1 L 51	218.296	6.679	1116.382	587427.430	1.309	0.089	5.017	0.278	5.903	9.286	0.531	38.834	11.553	131.097	43.432	154.263	35.856	334.852	42.623	10509.153	0.892	67.049	62.474
09LP014-1 L 27	267.231	18.226	357.071	486247.772	0.584	0.086	5.246	0.047	1.829	3.749	0.186	11.111	3.816	43.180	13.512	54.688	13.653	149.463	16.558	9378.390	0.368	102.823	136.483
09LP014-1 L 11	208.565	8.838	516.334	497376.656	1.498	0.033	6.783	0.014	0.885	3.109	0.141	17.635	5.574	62.458	18.811	59.146	10.630	89.229	7.601	11639.882	1.357	86.181	249.642
09LP014-1 L 19	136.994	7.088	576.368	580778.446	1.007	0.061	9.419	0.075	0.680	2.176	0.679	15.046	4.381	58.061	20.213	86.964	21.390	232.487	32.808	9219.741	0.818	21.066	43.946
09LP014-1 L 93	98.248	2.066	439.121	494503.777	0.209	0.195	0.627	0.029	0.200	1.137	0.564	7.527	2.436	35.108	14.603	71.993	20.944	291.836	39.661	6921.642	0.129	12.490	62.783
09LP014-1 L 46	160.623	14.456	145.343	505983.413	0.715	0.038	9.015	0.053	1.050	1.954	0.398	6.128	2.043	17.957	5.307	16.881	3.586	35.427	4.032	8891.705	0.679	93.351	265.760
09LP014-1 L 88	136.176	8.372	572.046	519614.024	0.543	0.019	6.593	0.144	2.558	5.092	1.764	18.111	4.791	56.294	19.359	80.229	22.074	262.199	35.044	7636.201	0.305	24.823	77.240
09LP014-1 L 37	177.482	12.701	743.176	480158.630	0.463		27.108	0.546	9.007	13.196	2.939	37.628	9.123	86.719	26.163	100.758	23.706	258.771	30.363	7217.822	0.313	67.749	108.956
09LP014-1 L 100	250.166	9.537	596.332	483786.604	2.228		13.798	0.041	0.829	1.286	0.398	15.664	4.917	64.315	21.340	93.693	22.757	257.535	30.119	9267.862	1.491	80.657	151.927
09LP014-1 L 78	300.551	5.379	1375.686	514112.887	1.330		7.837	0.021	1.447	4.153	1.410	19.732	7.757	117.276	47.272	212.907	56.472	646.746	81.135	7414.917	0.551	35.820	98.040
09LP014-1 XL 14	207.142	8.106	189.108	525705.927	0.683	0.009	2.589	0.031	1.804	3.462	0.148	12.057	3.302	29.674	6.914	17.316	2.919	25.879	2.132	11832.269	0.374	86.983	203.233
09LP014-1 XL 19	173.518	15.622	294.622	559932.216	0.229	0.043	20.724	0.031	0.993	2.288	0.650	10.177	3.078	31.728	9.414	37.974	9.917	102.577	13.141	8652.333	0.256	35.799	76.480
09LP014-1 L 45	120.555	4.391	233.504	482791.629	0.098	0.054	2.542		0.451	1.325	0.163	7.226	1.988	24.476	8.076	36.602	8.412	95.919	12.503	10471.704	0.140	12.639	71.469
09LP014-1 L 42	195.640	11.104	403.196	492262.092	0.578		9.354		0.501	2.118	0.335	9.247	3.329	41.379	14.924	61.449	14.644	167.597	18.919	8231.148	0.530	59.156	97.504
09LP014-1 L 55	525.273	9.804	1899.035	519755.772	1.823	0.102	11.984	0.237	2.653	8.012	0.944	43.823	16.022	197.801	71.326	294.633	74.476	790.198	90.457	10601.004	1.032	356.722	417.469
09LP014-1 L 59	204.741	20.176	597.090	508759.085	1.346		13.635	0.051	1.067	2.798	0.444	15.378	4.593	57.038	20.589	86.963	21.987	237.178	28.779	8386.526	0.992	92.930	126.004
09LP014-1 L 57	169.433	5.631	573.598	509274.453	2.503		6.096	0.058	0.601	1.364	0.082	10.169	4.235	54.694	20.803	90.100	23.081	249.032	29.432	10117.957	1.908	71.754	196.204
09LP014-1 L 74	117.144	3.282	179.478	475627.641	0.497	0.095	3.526		0.618	0.621	0.305	4.109	1.333	18.274	6.033	26.105	7.033	88.175	10.807	6282.091	0.350	55.164	167.197
09LP014-1 L 86	178.184	11.875	392.058	534755.599	0.735	0.076	16.820	0.030	1.347	2.174	0.717	14.667	4.092	43.033	14.016	55.200	12.823	137.564	18.429	8455.517	0.312	30.889	64.032
09LP014-1 L 29	246.412	17.802	452.452	478343.555	0.768		16.334	0.146	2.453	5.415	0.787	18.781	5.129	52.754	16.876	60.467	14.480	161.444	17.280	7396.642	0.397	39.846	97.470
09LP014-1 L 56	61.290	3.477	111.959	523403.556	0.207		1.504		0.241	0.344	0.311	2.414	1.089	11.573	3.742	13.348	2.874	27.841	2.612	9008.408	0.267	5.754	157.056
09LP014-1 L 34	187.224	14.478	812.648	495876.565	0.459		31.038	0.353	9.044	10.658	3.627	37.587	9.264	92.597	28.679	112.908	27.003	298.851	32.819	7370.113	0.274	77.974	140.103
09LP014-1 L 58	485.633	16.593	966.765	500254.420	1.472		7.553	0.050	1.390	3.723	0.390	20.987	7.430	96.768	36.206	151.249	38.657	415.292	49.015	9261.144	0.761	85.110	158.732
09LP014-1 L 24	173.994	10.976	366.798	523988.259	0.775	0.013	18.592		0.404	2.293	0.487	10.648	3.140	37.421	12.774	51.833	14.692	164.497	20.188	8920.851	0.419	47.407	110.251
09LP014-1 L 87	175.600	11.248	322.122	529006.660	0.390		11.711	0.047	0.514	2.002	0.699	10.072	2.703	29.713	10.467	47.085	11.882	143.887	19.190	8585.077	0.291	33.463	85.482
09LP014-1 XL 3	280.531	17.300	548.749	555178.897	0.489	0.165	5.034		0.762	1.548	0.616	10.751	3.435	50.875	19.465	83.528	21.410	243.528	29.855	8703.969	0.435	23.293	71.664
09LP014-1 L 72	105.930	6.602	409.981	463842.549	0.988		5.631	0.029	0.079	1.143	0.352	8.928	3.226	37.659	14.709	65.527	16.892	205.490	23.887	7868.289	0.453	24.148	156.630
09LP014-1 L 22	149.557	8.348	310.548	543743.625	0.482	0.025	5.133		0.621	0.928	0.448	6.925	2.337	25.693	10.125	47.936	13.295	162.784	23.210	7763.073	0.212	19.885	50.679
09LP014-1 XL 16	226.627	2.656	463.641	515314.475	1.276	0.013	20.736	0.178	3.781	6.528	1.428	19.918	5.456	50.994	16.038	63.280	14.768	167.762	18.024	7417.907	0.321	64.573	127.391
09LP014-1 L 40	547.941	7.285	1028.120	467804.217	1.111	0.080	3.468		0.758	2.067	0.121	16.175	7.005	98.564	37.401	167.770	46.640	527.876	59.941	9914.928	1.041	43.759	189.320
09LP014-1 L 36	247.531	33.942	557.979	497653.443	0.865		18.961	0.166	3.939	5.810	1.449	20.767	5.828	63.883	21.252	82.696	20.954	227.685	25.442	6874.006	0.354	32.246	30.669
09LP014-1 XL 5	114.700	4.035	117.011	547690.496	0.347	0.063	3.341	0.006		0.173	0.303	2.870	1.110	11.332	3.932	17.149	5.041	53.417	6.741	8109.947	0.136	6.157	39.545
09LP014-1 L 98	186.135	14.287	758.937	485245.141	0.423		13.630	0.464	7.476	10.898	2.785	36.643	9.225	96.426	27.631	101.642	24.530	261.234	26.418	7858.351	0.135	83.245	106.588
09LP014-1 L 80	605.075	7.699	1261.516	510474.303	1.344	0.116	5.321	0.061	1.290	4.672	0.468	29.179	10.502	127.286	46.848	190.835	47.191	512.189	61.357	10013.292	0.888	128.765	293.974

Table B2b, *continued.* Detrital zircon trace element analyses from sample **09LP014** in the Yusezyu Formation (PY) - Isotope Geology Laboratory, Boise State University

Analysis	Concentrations (ppm)																						
	P	Ti	Y	Zr	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	Th	U
09LP014-1 L 23	360.504	11.113	802.946	526729.035	1.256	0.009	9.185	0.045	0.394	2.809	0.179	18.862	6.082	75.428	30.833	120.888	31.180	352.320	44.414	10359.339	0.668	71.630	119.737
09LP014-1 L 66	385.228	6.231	896.048	490560.697	0.751		6.703	0.043	1.250	4.104	0.444	20.615	7.607	91.725	33.142	138.324	34.106	367.890	42.700	8827.487	0.560	79.038	150.563
09LP014-1 L 64	128.610	8.633	276.598	476855.116	0.941		11.657	0.157	2.588	5.209	2.044	18.789	4.636	39.215	10.255	29.329	6.391	58.433	6.097	8284.555	0.870	187.891	169.972
09LP014-1 L 6	158.133	8.932	332.018	473572.021	0.372		9.010	0.044	0.726	1.804	0.678	8.465	2.729	30.281	11.516	48.608	12.848	162.170	20.122	7377.272	0.335	26.873	89.302
09LP014-1 L 1	193.872	17.521	459.480	473710.253	1.202		12.949	0.041	1.063	2.636	0.304	11.533	3.861	47.495	16.393	69.155	17.323	193.626	22.885	7897.739	0.709	72.743	100.784
09LP014-1 L 47	153.961	18.024	897.327	511842.431	1.057	0.011	22.090	0.409	7.503	13.840	2.240	42.176	10.761	105.552	32.202	125.524	30.247	311.434	37.675	8580.749	0.344	69.659	119.221
09LP014-1 L 21	279.729	11.822	1406.464	569602.219	1.881		12.640	0.324	5.687	11.426	1.999	52.778	14.386	156.505	52.494	202.035	46.272	452.410	54.235	9413.816	0.981	109.539	97.573
09LP014-1 L 20	90.675	17.800	312.654	572265.209	0.724	0.077	19.327	0.067	1.244	1.575	0.513	9.609	2.507	30.094	10.875	44.447	10.918	117.297	14.899	9996.496	0.573	37.766	71.359
09LP014-1 L 65	250.053	19.491	1137.454	485462.098	1.544		11.152	0.193	5.275	11.120	1.228	42.782	12.016	128.931	44.066	166.286	38.915	418.147	43.631	7551.138	0.394	77.799	87.087
09LP014-1 L 28	137.749	4.747	186.304	509805.329	0.554	0.051	5.970		0.239	0.568	0.341	3.713	1.315	15.327	5.952	24.852	6.986	86.659	10.401	8124.782	0.255	13.588	39.125
09LP014-1 L 3	259.627	4.092	433.463	460459.756	1.160	0.162	22.896	0.029	1.700	4.776	1.152	16.631	5.047	45.564	15.554	57.133	14.493	167.249	18.787	7814.864	0.650	79.798	179.834
09LP014-1 L 73	352.085	10.384	635.961	487324.048	0.414	0.110	11.971	0.121	2.932	4.197	0.237	21.326	5.911	68.449	23.164	92.098	25.023	281.104	33.457	6836.750	0.204	15.303	32.136
09LP014-1 L 12	625.644	11.137	1350.953	509957.450	0.938	0.038	6.236	0.006	1.502	3.985	0.434	30.164	9.800	127.390	49.229	212.563	54.212	605.082	70.767	10067.922	0.739	66.365	148.322
09LP014-1 L 54	402.615	2.226	451.084	543879.151	0.259		0.446		0.616	3.026	0.120	17.660	5.460	51.170	15.510	61.163	16.399	193.920	24.498	14487.594	0.475	3.055	470.343
09LP014-1 L 53	316.292	12.941	612.552	543501.077	0.841		1.771	0.080	1.136	2.870	0.073	18.216	6.106	65.274	22.146	88.475	20.366	214.441	27.244	9766.717	0.445	32.513	112.398
09LP014-1 L 77	184.350	13.855	270.902	504177.460	0.772	0.060	3.073		0.230	1.148	0.100	6.180	2.315	25.803	9.965	42.364	10.941	131.419	15.400	8965.993	0.503	35.606	71.146
09LP014-1 L 35	182.900	15.664	591.581	492231.268	3.391	0.037	51.994	0.052	0.911	2.195	0.678	14.445	4.478	58.727	22.744	91.218	23.573	286.016	32.612	8027.505	1.172	63.620	69.492
09LP014-1 L 5	303.642	16.905	841.498	458169.188	0.937	0.030	7.105	0.143	2.868	5.087	1.158	24.784	8.322	88.323	31.207	129.286	33.141	361.192	38.725	7899.913	0.516	33.120	96.446
09LP014-1 L 7	161.326	8.354	176.158	484364.378	0.699	0.030	3.881	0.023	0.527	0.840	0.536	5.095	1.486	15.533	5.924	25.110	7.076	93.497	11.974	5495.140	0.530	6.327	26.484
09LP014-1 L 4	117.788	6.233	283.471	463566.369	0.568		6.773		0.589	1.038	0.137	4.619	2.222	24.192	9.925	41.927	10.942	126.814	13.764	8049.774	0.303	10.502	54.727
09LP014-1 L 2	182.332	10.456	104.634	476072.879	0.221	0.016	2.355	0.015	2.256	4.331	0.458	15.848	2.945	19.244	4.444	10.731	1.666	14.554	1.442	8478.961	0.017	25.819	297.878
09LP014-1 L 48	152.500	12.707	699.467	513251.988	0.526	0.064	12.607	0.110	3.784	6.832	1.261	27.872	7.494	77.320	24.513	96.190	22.365	245.257	27.849	8278.832	0.247	60.536	104.997
09LP014-1 L 9	281.011	15.996	1198.869	480441.154	1.308		3.735	0.114	1.862	6.559	0.911	41.146	12.064	138.137	46.509	175.635	41.762	433.226	46.879	8721.082	0.912	143.129	205.801
09LP014-1 L 32	203.171	18.158	488.431	485757.056	0.974		17.031	0.191	1.884	5.051	1.772	21.400	4.977	56.123	17.878	69.080	16.973	192.838	21.924	7415.883	0.322	38.310	89.551
09LP014-1 L 67	163.871	15.312	1249.336	482964.924	0.864	0.002	10.296	0.503	8.579	12.821	1.627	44.826	13.503	147.691	47.584	187.385	41.676	439.935	47.714	8454.266	0.683	150.193	200.191
09LP014-1 L 10	279.218	49.660	566.752	497969.662	0.844		20.243	0.251	3.883	6.717	1.909	22.311	6.018	64.316	21.608	84.336	18.949	209.333	24.867	6687.570	0.356	21.996	13.634
09LP014-1 L 99	46.019	0.786	190.213	506345.039	0.359	0.022	0.020					0.714	0.426	7.930	5.580	39.094	16.567	274.230	44.064	12709.898	0.583	0.414	43.409
09LP014-1 L 83	106.596	6.062	893.510	528000.356	29.841	0.072	13.732	0.065	1.089	3.151		22.693	7.712	93.102	33.878	134.180	32.305	340.661	37.328	10501.252	12.705	107.090	245.608

Notes:

Yellow highlighted rows are samples that intersected inclusions.
Trace element concentrations in ppm, calculated using mean count rate method.
Sweep-by-sweep downhole fractionation of U/Pb ratios NOT corrected via Si/Zr fractionation factor.
Backgrounds were monitored during sweeps 8 to 18. Sample counts were integrated from sweeps 35 to 80.
Ablation used a laser spot size of 25 microns, and a laser firing repitition rate of 10 Hz.

Table B2c. Detrital zircon calculated ratios and values from sample **09LP014** in the Yusezyu Formation (PY) - Isotope Geology Laboratory, Boise State University

Analysis	CI chondrite normalizing values from Sun and McDonough (1989)														Ti-in-zircon T (°C)	Ce/Ce*	Eu/Eu*	(Sm/Nd) cn	(Lu/Nd) cn	Lu/Hf	Nb/Ta	Nb/U	Th/U	Th/Y	Y/Hf
	0.237	0.612	0.095	0.467	0.153	0.058	0.206	0.037	0.254	0.057	0.166	0.026	0.17	0.025											
	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu											
09LP014-1 L 50	0.021	8.181	0.845	2.601	18.078	4.956	40.557	94.376	160.665	246.854	366.810	606.666	962.89	775.275	891	18.89	0.17	6.95	298.08	0.00	1.85	0.02	0.57	0.07	0.05
09LP014-1 L 79		20.012	0.782	3.502	15.102	5.013	61.199	100.457	185.891	269.456	385.607	606.863	935.47	752.928	826		0.13	4.31	215.01	0.00	1.36	0.01	0.70	0.12	0.05
09LP014-1 L 85	0.059	33.240	1.120	10.778	39.226	37.789	166.849	260.931	401.154	603.299	801.346	1215.262	1869.07	1559.453	896	56.39	0.37	3.64	144.69	0.00	2.68	0.04	1.60	0.05	0.10
09LP014-1 L 90	0.034	5.012	0.169	0.758	0.821	3.646	15.614	30.739	76.133	132.929	214.339	360.099	685.31	582.446	790	49.31	0.44	1.08	768.43	0.00	1.19	0.01	0.37	0.07	0.03
09LP014-1 L 39	0.091	18.401	3.643	13.579	51.198	13.921	151.596	238.142	361.837	485.974	648.314	966.199	1558.97	1064.183	813	9.85	0.14	3.77	78.37	0.00	1.57	0.01	0.71	0.09	0.10
09LP014-1 XL 2	0.128	46.292	5.119	18.304	92.141	39.245	172.052	225.587	304.927	405.940	506.116	762.053	1099.40	910.148	886	17.64	0.30	5.03	49.72	0.00	2.37	0.00	1.39	0.29	0.07
09LP014-1 L 43	0.029	99.072	1.176	3.644	35.095	36.788	87.448	119.723	161.733	219.190	258.456	423.376	696.06	541.537	756	164.38	0.60	9.63	148.62	0.00	2.18	0.01	0.90	0.28	0.05
09LP014-1 XL 17	0.006	12.799	0.220	1.116	13.677	13.789	76.006	120.181	190.906	285.943	427.942	689.624	1183.92	932.143	832	113.37	0.31	12.26	835.48	0.00	1.86	0.03	0.76	0.03	0.06
09LP014-1 L 92	0.018	22.231	0.734	2.450	12.603	7.198	45.648	75.298	135.497	197.437	291.420	478.760	812.12	648.182	842	59.07	0.25	5.14	264.54	0.00	1.34	0.01	0.56	0.13	0.04
09LP014-1 L 13	0.001	40.050	0.020	3.830	20.580	15.376	79.705	149.746	268.064	472.463	691.565	1153.029	2042.14	1684.074	767	3836.80	0.31	5.37	439.75	0.01	2.03	0.02	0.64	0.11	0.09
09LP014-1 L 95	0.115	63.618	4.575	22.537	118.645	68.962	231.276	306.792	414.620	520.873	619.738	916.373	1532.19	1134.106	846	27.13	0.39	5.26	50.32	0.00	2.22	0.01	1.41	0.21	0.12
09LP014-1 L 63	0.097	41.737	1.297	3.206	25.642	4.701	116.035	206.787	359.870	577.273	808.899	1276.024	2077.08	1514.788	839	59.91	0.07	8.00	472.44	0.00	3.60	0.10	1.41	0.07	0.10
09LP014-1 L 16	0.195	65.572	0.409	3.247	19.169	14.400	69.792	85.282	147.853	213.092	280.482	452.500	761.81	611.531	815	216.81	0.32	5.90	188.33	0.00	1.96	0.01	1.00	0.37	0.04
09LP014-1 L 33	0.505	5.913	0.531	2.378	15.008	2.797	63.655	109.914	203.953	334.166	446.734	760.114	1207.85	861.591	836	11.41	0.07	6.31	362.32	0.00	1.33	0.00	0.32	0.08	0.06
09LP014-1 L 8	0.110	18.109	0.229	1.025	5.366	7.298	31.146	49.648	101.752	174.026	264.812	470.724	806.94	658.950	766	106.87	0.40	5.24	643.09	0.00	1.60	0.01	0.71	0.15	0.04
09LP014-1 XL 7	0.703	2.349	0.169	3.654	21.489		68.489	91.166	123.122	134.019	130.092	172.539	210.82	144.100	833	5.39		5.88	39.43	0.00	3.45	0.00	0.86	0.68	0.02
09LP014-1 L 84	0.083	24.562	3.752	14.638	81.457	5.818	261.192	412.457	640.831	899.626	1188.753	1681.008	2565.30	2021.827	778	12.81	0.03	5.56	138.12	0.01	1.74	0.02	0.58	0.06	0.14
09LP014-1 XL 12	0.550	13.127	0.732	1.108	15.113	19.460	56.143	113.242	179.079	327.201	487.894	836.441	1425.27	1167.478	776	20.48	0.55	13.64	1054.05	0.00	2.47	0.02	0.73	0.05	0.07
09LP014-1 XL 1		7.869	0.046	0.207	12.669	1.921	60.802	151.379	325.887	588.471	916.457	1574.752	2646.11	2418.809	614		0.05	61.07	11658.94	0.00	1.15	0.00	0.30	0.06	0.08
09LP014-1 L 76	0.269	18.242	0.418	1.772	7.611	4.646	42.817	66.616	133.977	219.955	331.864	582.494	1015.01	801.751	732	53.13	0.18	4.29	452.41	0.00	1.63	0.01	0.50	0.26	0.04
09LP014-1 XL 18	0.002	13.066	0.078	2.871	24.001	10.518	82.930	136.603	240.781	351.460	486.208	778.881	1266.19	930.420	886	328.77	0.20	8.36	324.06	0.00	1.27	0.01	0.73	0.13	0.07
09LP014-1 L 71	1.211	22.269	13.046	46.032	166.322	35.071	379.993	553.376	855.985	1166.140	1486.270	2150.616	3273.88	2331.635	870	3.12	0.13	3.61	50.65	0.01	2.72	0.01	1.18	0.09	0.22
09LP014-1 XL 15	0.014	54.830	0.543	1.724	12.987	5.667	48.265	78.031	131.980	226.968	338.266	512.890	946.98	713.096	816	197.13	0.19	7.53	413.65	0.00	1.93	0.03	0.64	0.19	0.04
09LP014-1 XL 4	0.603	27.087	0.492	2.668	20.847	5.497	52.952	78.731	119.932	181.473	246.355	400.644	649.65	554.974	807	49.48	0.15	7.81	208.00	0.00	2.20	0.04	1.39	0.17	0.03
09LP014-1 XL 6		22.194	0.134	0.601	5.978	5.928	25.378	42.306	77.244	130.911	185.935	290.355	516.93	427.764	788		0.38	9.95	711.99	0.00	1.50	0.01	0.59	0.22	0.02
09LP014-1 L 26	0.830	3.900		0.324	3.161	1.455	25.873	48.968	101.752	180.006	304.870	496.873	927.81	758.650	799		0.10	9.77	2344.16	0.00	0.66	0.00	0.53	0.18	0.04
09LP014-1 XL 10	0.009	21.550	0.345	5.328	30.759	0.518	58.836	102.372	137.051	207.660	262.443	427.138	720.52	520.421	845	121.84	0.01	5.77	97.67	0.00	2.05	0.03	1.15	0.21	0.03
09LP014-1 L 38	0.592	4.122	0.746	1.633	14.870	3.230	47.809	79.119	157.321	222.046	304.161	470.674	732.37	531.068	775	6.16	0.10	9.10	325.16	0.00	2.29	0.04	0.76	0.10	0.04
09LP014-1 L 44	0.104	10.281	0.510	1.656	10.539	10.154	62.682	110.803	190.584	300.174	468.562	770.708	1327.06	1077.730	782	33.47	0.28	6.37	650.89	0.00	1.23	0.00	0.68	0.17	0.06
09LP014-1 XL 11	0.585	9.445	0.190	0.850	10.010	3.053	36.239	83.476	160.473	293.868	449.470	774.442	1293.43	1069.772	683	24.37	0.13	11.78	1258.83	0.00	1.09	0.01	0.53	0.10	0.05
09LP014-1 L 31	0.116	5.115	1.582	7.400	56.837	3.069	135.093	189.568	261.269	308.755	339.381	440.125	612.27	383.105	842	6.02	0.03	7.68	51.77	0.00	2.62	0.02	1.16	0.11	0.06
09LP014-1 L 62	0.004	8.270	0.161	2.599	15.746	4.212	67.395	96.386	175.500	244.655	341.546	490.000	784.30	536.278	871	100.19	0.10	6.06	206.32	0.00	1.57	0.02	0.82	0.17	0.04
09LP014-1 XL 9	0.051	5.333	2.030	8.025	48.230	19.859	140.872	229.833	384.209	535.696	702.548	1030.200	1552.14	1207.085	718	5.12	0.21	6.01	150.42	0.00	2.48	0.12	1.06	0.03	0.11
09LP014-1 L 82	0.056	34.984	2.220	5.525	37.371	5.906	116.146	234.945	355.574	508.982	709.257	1085.205	1634.87	1249.111	934	30.75	0.08	6.76	226.08	0.00	2.64	0.03	1.61	0.21	0.09
09LP014-1 L 81	0.047	10.905	1.881	4.212	20.356	1.695	73.233	108.809	183.252	269.728	360.872	563.520	863.37	660.312	724	11.31	0.04	4.83	156.77	0.00	1.70	0.05	0.91	0.12	0.04
09LP014-1 L 89	0.024	45.303	0.970	5.907	37.880	7.967	130.147	225.692	353.347	550.424	736.752	1104.567	1751.12	1329.373	809	91.09	0.09	6.41	225.04	0.00	2.79	0.02	1.29	0.36	0.09
09LP014-1 L 101	0.013	21.457	0.501	0.625	11.757	3.751	42.759	92.136	158.630	258.458	376.565	609.844	1046.67	831.740	843	83.64	0.14	18.82	1331.41	0.00	1.69	0.01	0.60	0.21	0.04
09LP014-1 L 75	0.149	17.192	0.425	1.903	15.625	3.747	52.271	111.888	212.144	319.529	436.954	691.892	1115.13	821.419	878	59.90	0.11	8.21	431.68	0.00	1.49	0.01	0.69	0.17	0.06
09LP014-1 L 70	0.006	8.649	0.235	1.298	6.669	2.766	28.993	57.810	105.216	170.147	260.833	458.345	770.60	614.048	860	71.95	0.16	5.14	473.05	0.00	1.43	0.02	0.37	0.13	0.03
09LP014-1 L 61	~~12.367~~	~~48.856~~	~~6.114~~	~~6.240~~	~~10.853~~	~~7.446~~	~~54.516~~	~~76.176~~	~~144.795~~	~~235.732~~	~~341.122~~	~~599.427~~	~~1040.20~~	~~820.094~~	~~1014~~	~~5.29~~	~~0.23~~	~~1.74~~	~~131.43~~	~~0.00~~	~~3.30~~	~~0.07~~	~~0.86~~	~~0.09~~	~~0.05~~
09LP014-1 L 25	0.030	9.734	1.203	4.623	34.660	6.422	118.580	238.479	365.300	565.125	753.518	1182.988	1798.23	1345.154	905	15.79	0.08	7.50	290.95	0.00	2.01	0.04	0.65	0.07	0.09
09LP014-1 L 96	0.016	12.211	0.625	0.750	15.967	3.786	71.584	125.611	205.693	312.085	435.015	689.332	1194.01	865.577	891	38.11	0.09	21.29	1153.93	0.00	2.42	0.03	0.78	0.08	0.06

Table B2c, *continued*. Detrital zircon calculated ratios and values from sample **09LP014** in the Yusezyu Formation (PY) - Isotope Geology Laboratory, Boise State University

Analysis	CI chondrite normalizing values from Sun and McDonough (1989)														Ti-in-zircon T (°C)	Ce/Ce*	Eu/Eu*	(Sm/Nd) cn	(Lu/Nd) cn	Lu/Hf	Nb/Ta	Nb/U	Th/U	Th/Y	Y/Hf
	0.237	0.612	0.095	0.467	0.153	0.058	0.206	0.037	0.254	0.057	0.166	0.026	0.17	0.025											
	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu											
09LP014-1 L 17		11.289	0.565	2.529	14.566	3.078	42.675	103.519	186.574	280.217	393.207	628.020	991.43	816.785	804		0.11	5.76	322.97	0.00	1.81	0.04	0.63	0.07	0.04
09LP014-1 L 69	0.091	7.111	0.975	3.407	36.686	12.060	159.462	335.545	587.308	913.345	1293.699	2091.447	3334.71	2394.103	827	13.34	0.12	10.77	702.61	0.01	2.62	0.01	0.52	0.09	0.14
09LP014-1 L 14	0.018	14.766	0.713	2.526	8.595	2.970	65.886	130.796	226.065	370.649	537.513	885.533	1414.69	1121.343	869	40.41	0.08	3.40	443.97	0.00	1.60	0.01	0.67	0.13	0.06
09LP014-1 L 15	0.025	19.334	1.001	2.504	26.844	11.509	89.508	184.150	339.496	524.339	725.140	1129.606	1830.19	1430.615	965	37.70	0.20	10.72	571.27	0.00	1.49	0.01	0.81	0.18	0.08
09LP014-1 XL 8	0.338	18.666	1.031	2.711	21.147	11.634	88.883	137.898	245.491	377.138	590.433	918.436	1521.45	1183.666	902	27.28	0.21	7.80	436.56	0.00	2.42	0.11	0.74	0.03	0.07
09LP014-1 L 91	0.636	4.366	0.455	3.008	17.263		57.958	118.738	185.447	259.676	344.419	514.307	754.50	548.335	788	8.00		5.74	182.32	0.00	1.00	0.00	0.49	0.16	0.04
09LP014-1 L 97	0.306	6.707	1.506	6.884	53.667	0.443	123.488	158.036	167.586	160.240	127.991	125.393	129.22	56.596	903	7.40	0.00	7.80	8.22	0.00	1.66	0.01	0.58	0.38	0.03
09LP014-1 L 49	0.050	73.358	1.979	5.578	46.562	40.132	146.001	257.627	432.883	652.458	842.071	1335.987	2041.44	1719.645	818	72.33	0.42	8.35	308.28	0.01	2.23	0.05	1.11	0.04	0.12
09LP014-1 XL 13	0.057	13.784	2.271	8.058	43.789	5.634	132.432	239.263	407.325	622.540	841.622	1273.919	1932.94	1487.526	567	11.84	0.06	5.43	184.61	0.00	2.58	0.04	1.54	0.15	0.10
09LP014-1 L 60	0.023	9.463	0.902	4.187	19.378	3.845	59.029	96.616	168.058	242.637	328.951	565.157	923.06	673.105	882	20.46	0.10	4.63	160.75	0.00	1.65	0.00	0.37	0.21	0.04
09LP014-1 L 51	0.376	8.198	2.923	12.640	60.694	9.147	188.974	308.901	516.132	767.356	932.105	1406.119	1969.72	1678.061	756	4.97	0.07	4.80	132.76	0.00	1.47	0.02	1.07	0.06	0.11
09LP014-1 L 27	0.364	8.572	0.491	3.916	24.502	3.214	54.069	102.044	170.000	238.735	330.439	535.414	879.20	651.890	862	20.04	0.08	6.26	166.46	0.00	1.59	0.00	0.75	0.29	0.04
09LP014-1 L 11	0.139	11.083	0.151	1.896	20.320	2.431	85.814	149.038	245.898	332.347	357.376	416.858	524.88	299.269	784	76.55	0.05	10.72	157.88	0.00	1.10	0.01	0.35	0.17	0.04
09LP014-1 L 19	0.258	15.391	0.793	1.456	14.222	11.700	73.216	117.150	228.588	357.127	525.461	838.834	1367.57	1291.656	762	29.30	0.27	9.77	887.09	0.00	1.23	0.02	0.48	0.04	0.06
09LP014-1 L 93	0.822	1.025	0.306	0.428	7.433	9.729	36.628	65.145	138.219	258.009	435.006	821.317	1716.68	1561.461	655	1.82	0.44	17.36	3646.88	0.01	1.62	0.00	0.20	0.03	0.06
09LP014-1 L 46	0.160	14.731	0.559	2.249	12.773	6.854	29.821	54.627	70.697	93.755	102.000	140.621	208.39	158.738	836	40.95	0.32	5.68	70.58	0.00	1.05	0.00	0.35	0.64	0.02
09LP014-1 L 88	0.082	10.773	1.516	5.478	33.282	30.422	88.132	128.100	221.631	342.040	484.767	865.659	1542.35	1379.687	778	13.49	0.50	6.08	251.85	0.00	1.78	0.01	0.32	0.04	0.07
09LP014-1 L 37	0.144	44.295	5.751	19.288	86.246	50.680	183.105	243.935	341.414	462.249	608.812	929.646	1522.19	1195.412	822	15.03	0.38	4.47	61.98	0.00	1.48	0.00	0.62	0.09	0.10
09LP014-1 L 100	0.011	22.546	0.426	1.775	8.407	6.862	76.224	131.473	253.208	377.030	566.121	892.415	1514.91	1185.783	791	103.18	0.16	4.74	668.03	0.00	1.49	0.01	0.53	0.14	0.06
09LP014-1 L 78	0.006	12.806	0.224	3.099	27.144	24.313	96.020	207.406	461.717	835.188	1286.449	2214.584	3804.39	3194.280	736	111.44	0.39	8.76	1030.79	0.01	2.42	0.01	0.37	0.03	0.19
09LP014-1 XL 14	0.036	4.231	0.324	3.863	22.626	2.550	58.670	88.286	116.827	122.152	104.631	114.477	152.23	83.918	775	23.47	0.06	5.86	21.72	0.00	1.82	0.00	0.43	0.46	0.02
09LP014-1 XL 19	0.183	33.863	0.330	2.125	14.953	11.202	49.522	82.305	124.912	166.334	229.449	388.920	603.40	517.373	844	132.04	0.35	7.04	243.44	0.00	0.89	0.00	0.47	0.12	0.03
09LP014-1 L 45	0.227	4.154	0.216	0.965	8.662	2.805	35.161	53.162	96.361	142.681	221.160	329.886	564.23	492.243	717	18.77	0.13	8.97	510.03	0.00	0.70	0.00	0.18	0.05	0.02
09LP014-1 L 42		15.283	0.240	1.072	13.845	5.780	44.998	89.008	162.911	263.673	371.294	574.269	985.87	744.844	807		0.20	12.91	694.60	0.00	1.09	0.01	0.61	0.15	0.05
09LP014-1 L 55	0.431	19.581	2.492	5.681	52.368	16.271	213.251	428.399	778.746	1260.175	1780.259	2920.629	4648.22	3561.300	794	13.40	0.12	9.22	626.91	0.01	1.77	0.00	0.85	0.19	0.18
09LP014-1 L 59	0.013	22.279	0.538	2.284	18.288	7.647	74.832	122.803	224.558	363.755	525.456	862.220	1395.17	1133.045	874	80.81	0.16	8.01	496.05	0.00	1.36	0.01	0.74	0.16	0.07
09LP014-1 L 57	0.015	9.960	0.613	1.287	8.917	1.415	49.483	113.224	215.332	367.546	544.411	905.138	1464.90	1158.749	740	31.71	0.05	6.93	900.68	0.00	1.31	0.01	0.37	0.13	0.06
09LP014-1 L 74	0.400	5.761	0.296	1.324	4.060	5.264	19.994	35.647	71.944	106.599	157.735	275.785	518.68	425.488	692	16.55	0.44	3.07	321.39	0.00	1.42	0.00	0.33	0.31	0.03
09LP014-1 L 86	0.320	27.483	0.315	2.885	14.211	12.371	71.375	109.402	169.420	247.640	333.535	502.865	809.20	725.558	814	86.58	0.29	4.93	251.49	0.00	2.35	0.01	0.48	0.08	0.05
09LP014-1 L 29	0.038	26.689	1.533	5.252	35.393	13.561	91.390	137.142	207.691	298.159	365.358	567.835	949.67	680.322	859	33.96	0.21	6.74	129.54	0.00	1.93	0.01	0.41	0.09	0.06
09LP014-1 L 56		2.457	0.116	0.517	2.248	5.369	11.745	29.105	45.562	66.120	80.654	112.725	163.77	102.844	697		0.77	4.35	198.94	0.00	0.78	0.00	0.04	0.05	0.01
09LP014-1 L 34	0.093	50.715	3.718	19.367	69.661	62.538	182.905	247.690	364.557	506.698	682.225	1058.944	1757.95	1292.085	836	26.61	0.50	3.60	66.72	0.00	1.67	0.00	0.56	0.10	0.11
09LP014-1 L 58	0.013	12.341	0.531	2.976	24.333	6.719	102.125	198.670	380.976	639.685	913.893	1515.961	2442.89	1929.716	851	45.36	0.11	8.18	648.41	0.01	1.94	0.01	0.54	0.09	0.10
09LP014-1 L 24	0.057	30.380	0.193	0.866	14.988	8.402	51.814	83.964	147.325	225.682	313.190	576.147	967.63	794.799	806	243.03	0.25	17.31	918.01	0.00	1.85	0.01	0.43	0.13	0.04
09LP014-1 L 87	0.012	19.135	0.490	1.101	13.083	12.048	49.012	72.265	116.980	184.938	284.501	465.957	846.39	755.501	809	76.23	0.39	11.88	686.34	0.00	1.34	0.00	0.39	0.10	0.04
09LP014-1 XL 3	0.697	8.225	0.365	1.633	10.116	10.620	52.316	91.840	200.294	343.899	504.701	839.599	1432.52	1175.399	856	15.49	0.34	6.20	719.92	0.00	1.13	0.01	0.33	0.04	0.06
09LP014-1 L 72	0.008	9.202	0.304	0.169	7.467	6.074	43.445	86.269	148.263	259.883	395.931	662.436	1208.77	940.428	755	59.00	0.24	44.29	5578.05	0.00	2.18	0.01	0.15	0.06	0.05
09LP014-1 L 22	0.104	8.388	0.297	1.331	6.068	7.728	33.696	62.482	101.155	178.893	289.645	521.355	957.55	913.783	778	41.78	0.39	4.56	686.67	0.00	2.27	0.01	0.39	0.06	0.04
09LP014-1 XL 16	0.056	33.883	1.871	8.096	42.668	24.629	96.927	145.884	200.766	283.351	382.356	579.146	986.83	709.620	675	35.18	0.35	5.27	87.65	0.00	3.97	0.01	0.51	0.14	0.06
09LP014-1 L 40	0.337	5.667	0.363	1.623	13.508	2.093	78.710	187.290	388.047	660.796	1013.715	1829.004	3105.15	2359.892	764	16.20	0.05	8.32	1454.24	0.01	1.07	0.01	0.23	0.04	0.10
09LP014-1 L 36	0.044	30.982	1.748	8.434	37.971	24.984	101.054	155.835	251.509	375.468	499.676	821.714	1339.32	1001.647	940	34.59	0.36	4.50	118.76	0.00	2.44	0.03	1.05	0.06	0.08
09LP014-1 XL 5	0.268	5.459	0.065	0.116	1.131	5.220	13.966	29.691	44.613	69.471	103.621	197.681	314.22	265.389	710	32.75	0.69	9.77	2291.26	0.00	2.54	0.01	0.16	0.05	0.01

Table B2c, *continued*. Detrital zircon calculated ratios and values from sample **09LP014** in the Yusezyu Formation (PY) - Isotope Geology Laboratory, Boise State University

Analysis	CI chondrite normalizing values from Sun and McDonough (1989)														Ti-in-zircon T (°C)	Ce/Ce*	Eu/Eu*	(Sm/Nd) cn	(Lu/Nd) cn	Lu/Hf	Nb/Ta	Nb/U	Th/U	Th/Y	Y/Hf
	0.237	0.612	0.095	0.467	0.153	0.058	0.206	0.037	0.254	0.057	0.166	0.026	0.17	0.025											
	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu											
09LP014-1 L 98	0.122	22.272	4.881	16.010	71.229	48.025	178.312	246.662	379.631	488.187	614.151	961.951	1536.67	1040.094	834	8.90	0.38	4.45	64.97	0.00	3.14	0.00	0.78	0.11	0.10
09LP014-1 L 80	0.487	8.695	0.641	2.763	30.538	8.077	141.992	280.810	501.126	827.699	1153.085	1850.646	3012.88	2415.641	770	15.42	0.09	11.05	874.43	0.01	1.51	0.00	0.44	0.10	0.13
09LP014-1 L 23	0.039	15.008	0.472	0.844	18.361	3.081	91.785	162.620	296.960	544.752	730.440	1222.727	2072.47	1748.577	807	58.73	0.06	21.76	2072.68	0.00	1.88	0.01	0.60	0.09	0.08
09LP014-1 L 66	0.011	10.953	0.455	2.678	26.826	7.663	100.319	203.398	361.123	585.549	835.794	1337.474	2164.06	1681.115	749	47.00	0.12	10.02	627.84	0.00	1.34	0.00	0.52	0.09	0.10
09LP014-1 L 64	0.042	19.048	1.657	5.543	34.044	35.237	91.432	123.960	154.392	181.180	177.214	250.645	343.72	240.040	781	22.43	0.56	6.14	43.31	0.00	1.08	0.01	1.11	0.68	0.03
09LP014-1 L 6	0.012	14.723	0.464	1.556	11.793	11.692	41.191	72.971	119.216	203.465	293.707	503.827	953.94	792.187	785	61.91	0.44	7.58	509.24	0.00	1.11	0.00	0.30	0.08	0.05
09LP014-1 L 1	0.011	21.158	0.435	2.276	17.229	5.245	56.121	103.234	186.987	289.634	417.853	679.347	1138.98	901.002	858	94.88	0.14	7.57	395.87	0.00	1.70	0.01	0.72	0.16	0.06
09LP014-1 L 47	0.045	36.096	4.301	16.067	90.460	38.619	205.238	287.722	415.559	568.945	758.454	1186.160	1831.96	1483.268	861	16.61	0.26	5.63	92.32	0.00	3.08	0.01	0.58	0.08	0.10
09LP014-1 L 21	0.085	20.654	3.408	12.178	74.682	34.458	256.828	384.658	616.163	927.454	1220.755	1814.607	2661.23	2135.250	814	11.83	0.21	6.13	175.33	0.01	1.92	0.02	1.12	0.08	0.15
09LP014-1 L 20	0.323	31.580	0.707	2.664	10.292	8.838	46.759	67.025	118.482	192.132	268.561	428.170	689.98	586.586	859	61.30	0.31	3.86	220.18	0.00	1.26	0.01	0.53	0.12	0.03
09LP014-1 L 65	0.051	18.223	2.034	11.296	72.679	21.178	208.186	321.292	507.603	778.544	1004.751	1526.090	2459.69	1717.758	870	17.48	0.15	6.43	152.07	0.01	3.92	0.02	0.89	0.07	0.15
09LP014-1 L 28	0.214	9.755	0.114	0.512	3.711	5.873	18.071	35.171	60.342	105.163	150.161	273.971	509.76	409.494	724	59.36	0.54	7.25	799.76	0.00	2.18	0.01	0.35	0.07	0.02
09LP014-1 L 3	0.685	37.412	0.305	3.640	31.219	19.864	80.931	134.957	179.385	274.807	345.214	568.342	983.82	739.649	711	75.53	0.35	8.58	203.18	0.00	1.79	0.01	0.44	0.18	0.06
09LP014-1 L 73	0.466	19.560	1.272	6.279	27.430	4.092	103.778	158.055	269.483	409.258	556.486	981.308	1653.55	1317.194	800	22.51	0.06	4.37	209.78	0.00	2.03	0.01	0.48	0.02	0.09
09LP014-1 L 12	0.160	10.190	0.066	3.216	26.046	7.476	146.782	262.025	501.535	869.775	1284.369	2125.958	3559.31	2786.113	808	90.21	0.09	8.10	866.25	0.01	1.27	0.01	0.45	0.05	0.13
09LP014-1 L 54		0.729	0.295	1.319	19.779	2.073	85.934	145.977	201.456	274.030	369.564	643.089	1140.71	964.478	661		0.04	14.99	730.96	0.00	0.55	0.00	0.01	0.01	0.03
09LP014-1 L 53	0.021	2.894	0.839	2.434	18.757	1.264	88.642	163.251	256.983	391.280	534.595	798.686	1261.42	1072.599	824	6.73	0.02	7.71	440.76	0.00	1.89	0.01	0.29	0.05	0.06
09LP014-1 L 77	0.254	5.021	0.110	0.492	7.501	1.732	30.072	61.907	101.588	176.054	255.975	429.040	773.05	606.301	831	27.58	0.09	15.25	1232.81	0.00	1.53	0.01	0.50	0.13	0.03
09LP014-1 L 35	0.156	84.957	0.542	1.951	14.345	11.696	70.294	119.740	231.209	401.830	551.166	924.451	1682.44	1283.923	845	243.32	0.28	7.35	658.03	0.00	2.89	0.05	0.92	0.11	0.07
09LP014-1 L 5	0.125	11.609	1.510	6.142	33.248	19.964	120.603	222.505	347.728	551.359	781.187	1299.631	2124.66	1524.591	853	14.20	0.26	5.41	248.23	0.00	1.82	0.01	0.34	0.04	0.11
09LP014-1 L 7	0.128	6.341	0.241	1.129	5.490	9.239	24.795	39.731	61.155	104.668	151.722	277.492	549.98	471.432	778	34.32	0.61	4.86	417.48	0.00	1.32	0.03	0.24	0.04	0.03
09LP014-1 L 4		11.068	0.282	1.262	6.786	2.367	22.479	59.407	95.242	175.360	253.337	429.102	745.97	541.895	749		0.16	5.38	429.52	0.00	1.87	0.01	0.19	0.04	0.04
09LP014-1 L 2	0.068	3.848	0.158	4.832	28.305	7.897	77.118	78.743	75.762	78.523	64.842	65.335	85.61	56.776	801	34.14	0.15	5.86	11.75	0.00	12.90	0.00	0.09	0.25	0.01
09LP014-1 L 48	0.271	20.599	1.158	8.103	44.652	21.744	135.629	200.372	304.411	433.086	581.206	877.052	1442.69	1096.415	822	28.83	0.24	5.51	135.30	0.00	2.13	0.01	0.58	0.09	0.08
09LP014-1 L 9	0.030	6.103	1.201	3.987	42.870	15.708	200.223	322.558	543.848	821.715	1061.239	1637.725	2548.39	1845.634	847	9.91	0.13	10.75	462.86	0.01	1.43	0.01	0.70	0.12	0.14
09LP014-1 L 32	0.050	27.828	2.005	4.034	33.013	30.558	104.135	133.068	220.956	315.870	417.399	665.615	1134.34	863.132	862	27.08	0.45	8.18	213.99	0.00	3.02	0.01	0.43	0.08	0.07
09LP014-1 L 67	0.010	16.824	5.295	18.370	83.794	28.054	218.133	361.049	581.462	840.703	1132.236	1634.359	2587.85	1878.488	842	6.34	0.19	4.56	102.26	0.01	1.27	0.00	0.75	0.12	0.15
09LP014-1 L 10	0.066	33.076	2.647	8.314	43.904	32.912	108.568	160.897	253.212	381.768	509.585	743.095	1231.37	979.033	992	24.38	0.43	5.28	117.76	0.00	2.37	0.06	1.61	0.04	0.08
09LP014-1 L 99	0.094	0.033					3.473	11.389	31.219	98.595	236.216	649.681	1613.12	1734.817	585					0.00	0.62	0.01	0.01	0.00	0.01
09LP014-1 L 83	0.304	22.439	0.679	2.333	20.595		110.426	206.209	366.544	598.545	810.758	1266.844	2003.89	1469.588	747	45.65		8.83	630.01	0.00	2.35	0.12	0.44	0.12	0.09

Notes:

Activity (SiO_2) = 1; activity (TiO_2) = 0.6.
Yellow highlighted rows are samples that intersected inclusions.
Trace element concentrations in ppm, calculated using mean count rate method.
Sweep-by-sweep downhole fractionation of U/Pb ratios NOT corrected via Si/Zr fractionation factor.
Backgrounds were monitored during sweeps 8 to 18. Sample counts were integrated from sweeps 35 to 80.
Ablation used a laser spot size of 25 microns, and a laser firing repitition rate of 10 Hz.

Table B3a. Detrital zircon U-Pb geochronologic analyses from sample **09TOA098** in the undivided Vampire-Narchilla unit (PЄVN) - Isotope Geology Laboratory, Boise State University

Analysis	U (ppm)	Th (ppm)	Pb^* (ppm)	Th/U	Corrected isotope ratios												Apparent ages (Ma)						% disc.
					$\frac{^{206}Pb^*}{^{207}Pb^*}$	±2σ (%)	$\frac{^{207}Pb^*}{^{235}U^*}$	±2σ (%)	$\frac{^{206}Pb^*}{^{238}U}$	±2σ (%)	error corr.	$\frac{^{238}U}{^{206}Pb^*}$	±2σ (%)	$\frac{^{207}Pb^*}{^{206}Pb^*}$	±2σ (%)	error corr.	$\frac{^{207}Pb^*}{^{206}Pb^*}$	±2σ (Ma)	$\frac{^{207}Pb^*}{^{235}U}$	±2σ (Ma)	$\frac{^{206}Pb^*}{^{238}U^*}$	±2σ (Ma)	
09TOA098 M 158	127.28	73.88	119.47	0.58	3.724	1.956	24.593	4.086	0.664	3.587	0.878	1.505	3.587	0.269	1.956	-0.0	**3297**	**31**	3292	40	3284	92	0
09TOA098 L 138	24.50	14.01	17.89	0.57	5.010	3.275	14.734	5.180	0.535	4.014	0.775	1.868	4.014	0.200	3.275	0.0	**2823**	**53**	2798	49	2764	90	2
09TOA098 L 102	131.75	102.57	94.36	0.78	5.353	1.904	13.062	3.610	0.507	3.068	0.850	1.972	3.068	0.187	1.904	0	**2714**	**31**	2684	34	2644	67	3
09TOA098 L 110	118.15	104.23	86.84	0.88	5.436	1.759	13.006	3.636	0.513	3.183	0.875	1.950	3.183	0.184	1.759	0	**2689**	**29**	2680	34	2669	70	1
09TOA098 L 121	28.03	19.58	19.47	0.70	5.464	3.553	12.824	5.771	0.508	4.547	0.788	1.968	4.547	0.183	3.553	0.0	**2680**	**59**	2667	54	2649	99	1
09TOA098 L 109	22.54	20.71	16.86	0.92	5.546	2.846	12.855	4.939	0.517	4.036	0.817	1.934	4.036	0.180	2.846	-0.0	**2656**	**47**	2669	47	2687	89	-1
09TOA098 M 174	127.34	158.38	97.89	1.24	5.553	1.742	12.489	3.824	0.503	3.404	0.890	1.988	3.404	0.180	1.742	0.0	**2654**	**29**	2642	36	2627	73	1
09TOA098 M 203	127.34	158.38	97.89	1.24	5.553	1.742	12.489	3.824	0.503	3.404	0.890	1.988	3.404	0.180	1.742	0.0	**2654**	**29**	2642	36	2627	73	1
09TOA098 L 128	74.86	42.76	49.38	0.57	5.616	1.946	12.123	3.922	0.494	3.405	0.868	2.025	3.405	0.178	1.946	-0.0	**2635**	**32**	2614	37	2587	73	2
09TOA098 L 119	68.58	76.70	49.87	1.12	5.652	2.458	12.042	4.673	0.494	3.974	0.850	2.026	3.974	0.177	2.458	-0.0	**2624**	**41**	2608	44	2586	85	1
09TOA098 M 191	48.07	46.86	33.86	0.97	5.657	2.382	11.856	4.612	0.486	3.949	0.856	2.056	3.949	0.177	2.382	-0.00	**2623**	**40**	2593	43	2555	83	3
09TOA098 M 221	48.07	46.86	33.86	0.97	5.657	2.382	11.856	4.612	0.486	3.949	0.856	2.056	3.949	0.177	2.382	-0.0	**2623**	**40**	2593	43	2555	83	3
09TOA098 M 153	22.91	151.34	32.33	6.61	5.660	3.378	11.846	5.659	0.486	4.540	0.802	2.056	4.540	0.177	3.378	0	**2622**	**56**	2592	53	2555	96	3
09TOA098 L 139	21.19	6.68	13.29	0.32	5.668	4.034	12.037	5.529	0.495	3.781	0.684	2.021	3.781	0.176	4.034	0	**2620**	**67**	2607	52	2591	81	1
09TOA098 M 160	40.38	50.80	28.99	1.26	5.672	3.505	11.456	4.930	0.471	3.468	0.703	2.122	3.468	0.176	3.505	0.0	**2618**	**58**	2561	46	2489	72	5
09TOA098 M 155	45.97	96.35	39.64	2.10	5.685	2.596	12.183	4.638	0.502	3.843	0.829	1.991	3.843	0.176	2.596	0.0	**2615**	**43**	2619	44	2624	83	-0
09TOA098 M 163	189.83	88.02	114.20	0.46	5.975	1.954	10.716	3.703	0.464	3.146	0.850	2.153	3.146	0.167	1.954	0.0	**2531**	**33**	2499	34	2459	64	3
09TOA098 M 186	93.56	103.32	59.24	1.10	6.518	3.100	9.263	4.630	0.438	3.439	0.743	2.284	3.439	0.153	3.100	-0.0	**2384**	**53**	2364	42	2341	68	2
09TOA098 M 216	93.56	103.32	59.24	1.10	6.518	3.100	9.263	4.630	0.438	3.439	0.743	2.284	3.439	0.153	3.100	-0.0	**2384**	**53**	2364	42	2341	68	2
09TOA098 M 198	77.97	45.79	44.99	0.59	6.576	2.277	9.214	3.963	0.439	3.244	0.819	2.275	3.244	0.152	2.277	0	**2369**	**39**	2360	36	2348	64	1
09TOA098 M 227	77.97	45.79	44.99	0.59	6.576	2.277	9.214	3.963	0.439	3.244	0.819	2.275	3.244	0.152	2.277	0	**2369**	**39**	2360	36	2348	64	1
09TOA098 M 166	107.84	74.36	59.14	0.69	6.857	2.288	8.207	3.747	0.408	2.968	0.792	2.450	2.968	0.146	2.288	-0.0	**2298**	**39**	2254	34	2207	55	4
09TOA098 M 171	152.05	191.30	77.99	1.26	7.022	2.008	6.711	7.175	0.342	6.888	0.960	2.926	6.888	0.142	2.008	0.0	**2257**	**35**	2074	63	1895	113	16
09TOA098 L 126	62.08	78.57	34.78	1.27	7.216	5.125	6.815	6.816	0.357	4.494	0.659	2.804	4.494	0.139	5.125	-0.0	**2210**	**89**	2088	60	1966	76	11
09TOA098 M 180	165.72	111.85	85.70	0.67	7.528	2.119	7.122	3.978	0.389	3.367	0.846	2.572	3.367	0.133	2.119	0	**2136**	**37**	2127	35	2117	61	1
09TOA098 M 209	165.72	111.85	85.70	0.67	7.528	2.119	7.122	3.978	0.389	3.367	0.846	2.572	3.367	0.133	2.119	0	**2136**	**37**	2127	35	2117	61	1
09TOA098 L 111	57.58	82.59	34.38	1.43	7.578	3.209	6.942	4.361	0.382	2.952	0.677	2.621	2.952	0.132	3.209	0.0	**2124**	**56**	2104	39	2083	53	2
09TOA098 M 169	44.27	68.36	24.74	1.54	8.257	2.590	5.968	4.701	0.357	3.923	0.835	2.798	3.923	0.121	2.590	-0.0	**1973**	**46**	1971	41	1970	67	0
09TOA098 M 172	135.28	98.73	63.61	0.73	8.271	1.613	5.888	3.802	0.353	3.443	0.906	2.831	3.443	0.121	1.613	-0.0	**1970**	**29**	1959	33	1950	58	1
09TOA098 L 115	25.36	46.93	13.88	1.85	8.307	4.918	5.469	6.142	0.329	3.680	0.599	3.035	3.680	0.120	4.918	0.0	**1962**	**88**	1896	53	1836	59	6
09TOA098 M 165	72.66	80.80	37.26	1.11	8.312	2.830	5.882	5.186	0.355	4.346	0.838	2.820	4.346	0.120	2.830	0	**1961**	**50**	1959	45	1957	73	0
09TOA098 L 122	105.38	76.28	48.43	0.72	8.320	2.676	5.750	4.668	0.347	3.824	0.819	2.882	3.824	0.120	2.676	-0.0	**1959**	**48**	1939	40	1920	64	2
09TOA098 L 118	125.60	178.93	61.13	1.42	8.386	3.082	5.392	6.163	0.328	5.337	0.866	3.049	5.337	0.119	3.082	-0.0	**1945**	**55**	1884	53	1828	85	6
09TOA098 M 189	246.96	276.96	117.75	1.12	8.444	2.325	5.432	4.436	0.333	3.778	0.852	3.006	3.778	0.118	2.325	-0.0	**1933**	**42**	1890	38	1851	61	4
09TOA098 M 219	246.96	276.96	117.75	1.12	8.444	2.325	5.432	4.436	0.333	3.778	0.852	3.006	3.778	0.118	2.325	-0.0	**1933**	**42**	1890	38	1851	61	4
09TOA098 L 103	20.45	26.20	10.15	1.28	8.469	4.718	5.380	6.396	0.330	4.319	0.675	3.026	4.319	0.118	4.718	0.0	**1927**	**85**	1882	55	1841	69	4
09TOA098 M 177	117.12	69.90	49.47	0.60	8.518	2.580	5.295	4.313	0.327	3.456	0.801	3.057	3.456	0.117	2.580	0	**1917**	**46**	1868	37	1824	55	5
09TOA098 M 206	117.12	69.90	49.47	0.60	8.518	2.580	5.295	4.313	0.327	3.456	0.801	3.057	3.456	0.117	2.580	0	**1917**	**46**	1868	37	1824	55	5
09TOA098 L 145	55.38	24.90	23.61	0.45	8.529	3.815	5.498	5.091	0.340	3.370	0.662	2.940	3.370	0.117	3.815	-0.0	**1915**	**68**	1900	44	1887	55	1
09TOA098 L 106	232.07	282.27	103.01	1.22	8.532	2.003	4.896	3.818	0.303	3.251	0.851	3.301	3.251	0.117	2.003	0.0	**1914**	**36**	1801	32	1706	49	11
09TOA098 M 188	26.21	40.72	14.13	1.55	8.556	3.458	5.614	5.595	0.348	4.399	0.786	2.870	4.399	0.117	3.458	-0.0	**1909**	**62**	1918	48	1927	73	-1
09TOA098 M 218	26.21	40.72	14.13	1.55	8.556	3.458	5.614	5.595	0.348	4.399	0.786	2.870	4.399	0.117	3.458	-0.0	**1909**	**62**	1918	48	1927	73	-1

Table B3a, *continued*. Detrital zircon U-Pb geochronologic analyses from sample **09TOA098** in the undivided Vampire-Narchilla unit (PЄVN) - Isotope Geology Laboratory, Boise State University

Analysis	U (ppm)	Th (ppm)	Pb* (ppm)	Th/U	Corrected isotope ratios												Apparent ages (Ma)						% disc.
					$^{206}Pb^*/^{207}Pb^*$	±2σ (%)	$^{207}Pb^*/^{235}U^*$	±2σ (%)	$^{206}Pb^*/^{238}U$	±2σ (%)	error corr.	$^{238}U/^{206}Pb^*$	±2σ (%)	$^{207}Pb^*/^{206}Pb^*$	±2σ (%)	error corr.	$^{207}Pb^*/^{206}Pb^*$	±2σ (Ma)	$^{207}Pb^*/^{235}U$	±2σ (Ma)	$^{206}Pb^*/^{238}U^*$	±2σ (Ma)	
09TOA098 L 105	50.65	14.56	19.86	0.29	8.576	2.637	5.217	4.300	0.324	3.397	0.790	3.082	3.397	0.117	2.637	0.0	**1905**	**47**	1855	37	1812	54	5
09TOA098 M 182	29.30	9.77	12.45	0.33	8.578	4.268	5.656	5.788	0.352	3.910	0.676	2.842	3.910	0.117	4.268	-0.0	**1904**	**77**	1925	50	1943	66	-2
09TOA098 M 212	29.30	9.77	12.45	0.33	8.578	4.268	5.656	5.788	0.352	3.910	0.676	2.842	3.910	0.117	4.268	-0.0	**1904**	**77**	1925	50	1943	66	-2
09TOA098 M 195	130.47	110.99	60.00	0.85	8.618	2.635	5.385	4.570	0.337	3.734	0.817	2.971	3.734	0.116	2.635	0.0	**1896**	**47**	1883	39	1870	61	1
09TOA098 M 225	130.47	110.99	60.00	0.85	8.618	2.635	5.385	4.570	0.337	3.734	0.817	2.971	3.734	0.116	2.635	0.0	**1896**	**47**	1883	39	1870	61	1
09TOA098 M 193	128.30	248.26	72.39	1.94	8.632	2.391	5.327	4.507	0.334	3.820	0.848	2.998	3.820	0.116	2.391	0.0	**1893**	**43**	1873	39	1855	62	2
09TOA098 M 223	128.30	248.26	72.39	1.94	8.632	2.391	5.327	4.507	0.334	3.820	0.848	2.998	3.820	0.116	2.391	0.0	**1893**	**43**	1873	39	1855	62	2
09TOA098 L 140	247.91	307.12	121.07	1.24	8.758	1.586	5.191	3.494	0.330	3.113	0.891	3.033	3.113	0.114	1.586	0.0	**1867**	**29**	1851	30	1837	50	2
09TOA098 M 181	199.47	233.90	90.93	1.17	8.769	2.194	4.912	3.887	0.312	3.209	0.826	3.201	3.209	0.114	2.194	-0.0	**1865**	**40**	1804	33	1752	49	6
09TOA098 M 210	199.47	233.90	90.93	1.17	8.769	2.194	4.912	3.887	0.312	3.209	0.826	3.201	3.209	0.114	2.194	-0.0	**1865**	**40**	1804	33	1752	49	6
09TOA098 L 130	80.54	37.79	31.75	0.47	8.807	2.757	4.926	4.258	0.315	3.245	0.762	3.178	3.245	0.114	2.757	0	**1857**	**50**	1807	36	1763	50	5
09TOA098 L 113	141.87	96.87	60.00	0.68	8.815	2.336	4.996	4.099	0.319	3.368	0.822	3.131	3.368	0.113	2.336	0	**1855**	**42**	1819	35	1787	53	4
09TOA098 M 178	53.88	16.89	20.47	0.31	8.816	2.789	4.939	4.695	0.316	3.777	0.804	3.167	3.777	0.113	2.789	0.0	**1855**	**50**	1809	40	1769	58	5
09TOA098 M 207	53.88	16.89	20.47	0.31	8.816	2.789	4.939	4.695	0.316	3.777	0.804	3.167	3.777	0.113	2.789	0.0	**1855**	**50**	1809	40	1769	58	5
09TOA098 M 192	125.00	28.88	48.58	0.23	8.820	2.078	5.140	4.513	0.329	4.006	0.888	3.042	4.006	0.113	2.078	-0.0	**1854**	**38**	1843	38	1832	64	1
09TOA098 M 222	125.00	28.88	48.58	0.23	8.820	2.078	5.140	4.513	0.329	4.006	0.888	3.042	4.006	0.113	2.078	-0.0	**1854**	**38**	1843	38	1832	64	1
09TOA098 L 120	162.28	91.93	69.83	0.57	8.841	2.154	5.305	4.170	0.340	3.570	0.856	2.940	3.570	0.113	2.154	0	**1850**	**39**	1870	36	1887	58	-2
09TOA098 M 168	56.58	18.11	22.62	0.32	8.853	3.023	5.139	4.591	0.330	3.456	0.753	3.030	3.456	0.113	3.023	-0.0	**1847**	**55**	1843	39	1838	55	0
09TOA098 M 161	162.40	48.23	62.27	0.30	8.865	2.665	4.982	4.680	0.320	3.847	0.822	3.122	3.847	0.113	2.665	-0.0	**1845**	**48**	1816	40	1791	60	3
09TOA098 L 144	39.16	8.93	14.37	0.23	8.883	3.447	4.870	5.054	0.314	3.697	0.731	3.188	3.697	0.113	3.447	0.0	**1841**	**62**	1797	43	1759	57	4
09TOA098 L 124	126.71	55.43	50.08	0.44	8.887	2.544	4.943	4.265	0.319	3.423	0.803	3.139	3.423	0.113	2.544	0.0	**1840**	**46**	1810	36	1783	53	3
09TOA098 M 154	56.44	17.80	21.96	0.32	8.895	3.795	5.033	5.659	0.325	4.197	0.742	3.080	4.197	0.112	3.795	0.0	**1839**	**69**	1825	48	1813	66	1
09TOA098 L 116	152.94	43.89	59.57	0.29	8.903	1.770	5.019	3.881	0.324	3.454	0.890	3.086	3.454	0.112	1.770	-0.0	**1837**	**32**	1822	33	1810	54	2
09TOA098 M 202	71.18	64.98	31.66	0.91	8.903	3.335	5.009	5.038	0.323	3.777	0.750	3.092	3.777	0.112	3.335	0	**1837**	**60**	1821	43	1807	60	2
09TOA098 M 230	71.18	64.98	31.66	0.91	8.903	3.335	5.009	5.038	0.323	3.777	0.750	3.092	3.777	0.112	3.335	0.00	**1837**	**60**	1821	43	1807	60	2
09TOA098 L 108	76.79	33.34	30.94	0.43	8.936	3.028	5.022	4.711	0.325	3.609	0.766	3.073	3.609	0.112	3.028	0	**1831**	**55**	1823	40	1816	57	1
09TOA098 M 162	110.17	52.72	42.82	0.48	8.946	2.141	4.784	4.304	0.310	3.733	0.867	3.222	3.733	0.112	2.141	0	**1829**	**39**	1782	36	1743	57	5
09TOA098 L 134	103.32	19.57	40.60	0.19	8.946	2.515	5.179	4.266	0.336	3.446	0.808	2.976	3.446	0.112	2.515	0	**1829**	**46**	1849	36	1868	56	-2
09TOA098 M 173	213.87	124.48	89.47	0.58	8.951	1.742	5.041	3.910	0.327	3.501	0.895	3.056	3.501	0.112	1.742	0.0	**1828**	**32**	1826	33	1825	56	0
09TOA098 L 107	195.87	108.82	80.64	0.56	8.952	1.586	4.958	3.711	0.322	3.355	0.904	3.106	3.355	0.112	1.586	-0.0	**1827**	**29**	1812	31	1799	53	2
09TOA098 M 190	139.25	121.77	59.64	0.87	8.968	2.472	4.827	4.790	0.314	4.103	0.857	3.185	4.103	0.112	2.472	-0.0	**1824**	**45**	1790	40	1760	63	4
09TOA098 M 220	139.25	121.77	59.64	0.87	8.968	2.472	4.827	4.790	0.314	4.103	0.857	3.185	4.103	0.112	2.472	-0.0	**1824**	**45**	1790	40	1760	63	4
09TOA098 L 114	162.57	107.10	69.86	0.66	8.979	2.340	5.025	3.990	0.327	3.233	0.810	3.056	3.233	0.111	2.340	0.0	**1822**	**42**	1824	34	1825	51	-0
09TOA098 L 136	159.28	30.32	62.05	0.19	8.983	2.282	5.112	4.415	0.333	3.780	0.856	3.002	3.780	0.111	2.282	0	**1821**	**41**	1838	37	1853	61	-2
09TOA098 M 156	90.82	82.67	41.38	0.91	9.018	2.313	5.137	4.707	0.336	4.099	0.871	2.976	4.099	0.111	2.313	0	**1814**	**42**	1842	40	1867	66	-3
09TOA098 L 133	343.32	176.01	138.17	0.51	9.028	1.846	4.873	4.080	0.319	3.638	0.892	3.134	3.638	0.111	1.846	-0.0	**1812**	**34**	1798	34	1785	57	1
09TOA098 M 167	202.30	101.22	81.33	0.50	9.034	1.812	4.895	3.888	0.321	3.440	0.885	3.118	3.440	0.111	1.812	0.0	**1811**	**33**	1801	33	1793	54	1
09TOA098 L 129	166.88	172.24	76.12	1.03	9.034	2.058	4.930	4.029	0.323	3.464	0.860	3.096	3.464	0.111	2.058	0.0	**1811**	**37**	1807	34	1804	55	0
09TOA098 L 142	203.05	107.07	79.76	0.53	9.078	2.219	4.714	4.384	0.310	3.781	0.862	3.222	3.781	0.110	2.219	-0.0	**1802**	**40**	1770	37	1743	58	3
09TOA098 M 184	318.74	38.93	114.03	0.12	9.089	1.901	4.742	4.148	0.313	3.687	0.889	3.199	3.687	0.110	1.901	0	**1800**	**35**	1775	35	1753	57	3
09TOA098 M 214	318.74	38.93	114.03	0.12	9.089	1.901	4.742	4.148	0.313	3.687	0.889	3.199	3.687	0.110	1.901	0	**1800**	**35**	1775	35	1753	57	3
09TOA098 L 137	102.46	45.70	41.01	0.45	9.102	2.510	4.877	4.346	0.322	3.548	0.816	3.106	3.548	0.110	2.510	0	**1797**	**46**	1798	37	1799	56	-0

Table B3a, *continued*. Detrital zircon U-Pb geochronologic analyses from sample **09TOA098** in the undivided Vampire-Narchilla unit (PЄVN) - Isotope Geology Laboratory, Boise State University

Analysis	U (ppm)	Th (ppm)	Pb* (ppm)	Th/U	Corrected isotope ratios												Apparent ages (Ma)						% disc.
					$^{206}Pb^*/^{207}Pb^*$	±2σ (%)	$^{207}Pb^*/^{235}U^*$	±2σ (%)	$^{206}Pb^*/^{238}U$	±2σ (%)	error corr.	$^{238}U/^{206}Pb^*$	±2σ (%)	$^{207}Pb^*/^{206}Pb^*$	±2σ (%)	error corr.	$^{207}Pb^*/^{206}Pb^*$	±2σ (Ma)	$^{207}Pb^*/^{235}U$	±2σ (Ma)	$^{206}Pb^*/^{238}U^*$	±2σ (Ma)	
09TOA098 L 141	231.53	288.06	107.34	1.24	9.111	1.870	4.767	4.123	0.315	3.675	0.891	3.175	3.675	0.110	1.870	0	**1795**	**34**	1779	35	1765	57	2
09TOA098 L 131	29.58	48.54	14.43	1.64	9.149	4.514	4.696	6.332	0.312	4.441	0.701	3.209	4.441	0.109	4.514	0	**1788**	**82**	1767	53	1748	68	2
09TOA098 M 183	186.06	109.57	77.18	0.59	9.157	2.174	4.896	3.934	0.325	3.278	0.833	3.075	3.278	0.109	2.174	-0.0	**1786**	**40**	1802	33	1815	52	-2
09TOA098 M 213	186.06	109.57	77.18	0.59	9.157	2.174	4.896	3.934	0.325	3.278	0.833	3.075	3.278	0.109	2.174	-0.0	**1786**	**40**	1802	33	1815	52	-2
09TOA098 M 175	51.99	12.62	19.52	0.24	9.170	3.708	4.775	5.013	0.318	3.373	0.673	3.149	3.373	0.109	3.708	0	**1784**	**68**	1780	42	1778	52	0
09TOA098 M 204	51.99	12.62	19.52	0.24	9.170	3.708	4.775	5.013	0.318	3.373	0.673	3.149	3.373	0.109	3.708	0	**1784**	**68**	1780	42	1778	52	0
09TOA098 M 176	42.09	50.16	19.29	1.19	9.172	2.982	4.700	4.799	0.313	3.760	0.784	3.198	3.760	0.109	2.982	0.0	**1783**	**54**	1767	40	1754	58	2
09TOA098 M 205	42.09	50.16	19.29	1.19	9.172	2.982	4.700	4.799	0.313	3.760	0.784	3.198	3.760	0.109	2.982	0.0	**1783**	**54**	1767	40	1754	58	2
09TOA098 M 194	229.70	105.02	91.76	0.46	9.189	2.361	4.823	4.382	0.321	3.691	0.842	3.111	3.691	0.109	2.361	0	**1780**	**43**	1789	37	1797	58	-1
09TOA098 M 224	229.70	105.02	91.76	0.46	9.189	2.361	4.823	4.382	0.321	3.691	0.842	3.111	3.691	0.109	2.361	0	**1780**	**43**	1789	37	1797	58	-1
09TOA098 M 159	264.20	61.96	102.62	0.23	9.210	2.059	4.963	4.177	0.332	3.634	0.870	3.016	3.634	0.109	2.059	0.0	**1776**	**38**	1813	35	1846	58	-4
09TOA098 L 117	79.45	37.03	31.95	0.47	9.214	3.197	4.908	5.394	0.328	4.344	0.805	3.049	4.344	0.109	3.197	-0.0	**1775**	**58**	1804	46	1829	69	-3
09TOA098 M 185	42.20	14.35	16.83	0.34	9.219	3.885	4.930	5.210	0.330	3.471	0.666	3.033	3.471	0.108	3.885	-0.0	**1774**	**71**	1807	44	1837	55	-4
09TOA098 M 215	42.20	14.35	16.83	0.34	9.219	3.885	4.930	5.210	0.330	3.471	0.666	3.033	3.471	0.108	3.885	-0.0	**1774**	**71**	1807	44	1837	55	-4
09TOA098 M 197	216.11	96.82	81.94	0.45	9.235	1.924	4.564	3.866	0.306	3.353	0.867	3.271	3.353	0.108	1.924	0.0	**1771**	**35**	1743	32	1719	51	3
09TOA098 M 226	216.11	96.82	81.94	0.45	9.235	1.924	4.564	3.866	0.306	3.353	0.867	3.271	3.353	0.108	1.924	0.0	**1771**	**35**	1743	32	1719	51	3
09TOA098 L 132	52.28	17.14	20.69	0.33	9.254	3.499	4.875	5.128	0.327	3.748	0.731	3.056	3.748	0.108	3.499	0	**1767**	**64**	1798	43	1825	60	-3
09TOA098 L 143	60.00	16.19	22.53	0.27	9.270	3.645	4.711	4.813	0.317	3.143	0.653	3.157	3.143	0.108	3.645	-0.0	**1764**	**67**	1769	40	1774	49	-1
09TOA098 M 199	17.79	22.84	8.43	1.28	9.311	5.608	4.725	6.889	0.319	4.001	0.581	3.134	4.001	0.107	5.608	0.0	**1756**	**103**	1772	58	1785	62	-2
09TOA098 M 228	17.79	22.84	8.43	1.28	9.311	5.608	4.725	6.889	0.319	4.001	0.581	3.134	4.001	0.107	5.608	0.0	**1756**	**103**	1772	58	1785	62	-2
09TOA098 M 201	139.41	45.63	52.90	0.33	9.315	2.415	4.650	4.106	0.314	3.321	0.809	3.183	3.321	0.107	2.415	-0.0	**1755**	**44**	1758	34	1761	51	-0
09TOA098 M 229	139.41	45.63	52.90	0.33	9.315	2.415	4.650	4.106	0.314	3.321	0.809	3.183	3.321	0.107	2.415	-0.0	**1755**	**44**	1758	34	1761	51	-0
09TOA098 L 125	264.48	118.23	100.12	0.45	9.317	1.739	4.523	3.881	0.306	3.469	0.894	3.272	3.469	0.107	1.739	0	**1754**	**32**	1735	32	1719	52	2
09TOA098 L 112	188.64	19.25	67.04	0.10	9.337	2.201	4.600	3.906	0.311	3.227	0.826	3.210	3.227	0.107	2.201	-0.0	**1751**	**40**	1749	33	1748	49	0
09TOA098 M 157	116.53	66.00	46.52	0.57	9.411	2.754	4.654	4.700	0.318	3.809	0.810	3.148	3.809	0.106	2.754	0.0	**1736**	**50**	1759	39	1778	59	-2
09TOA098 M 187	149.23	74.07	58.71	0.50	9.583	2.990	4.574	4.572	0.318	3.460	0.757	3.146	3.460	0.104	2.990	0	**1703**	**55**	1744	38	1779	54	-4
09TOA098 M 217	149.23	74.07	58.71	0.50	9.583	2.990	4.574	4.572	0.318	3.460	0.757	3.146	3.460	0.104	2.990	0	**1703**	**55**	1744	38	1779	54	-4
09TOA098 L 127	86.56	87.74	35.30	1.01	9.916	2.689	4.081	4.390	0.294	3.471	0.790	3.407	3.471	0.101	2.689	-0.0	**1640**	**50**	1651	36	1659	51	-1
09TOA098 L 123	543.07	255.96	69.46	0.47	16.281	2.768	0.895	4.662	0.106	3.751	0.805	9.462	3.751	0.061	2.768	0	654	59	649	22	**648**	**23**	1
09TOA098 M 179	577.19	428.43	78.67	0.74	16.343	2.703	0.888	4.350	0.105	3.408	0.783	9.498	3.408	0.061	2.703	0.0	646	58	645	21	**645**	**21**	0
09TOA098 M 208	577.19	428.43	78.67	0.74	16.343	2.703	0.888	4.350	0.105	3.408	0.783	9.498	3.408	0.061	2.703	0.0	646	58	645	21	**645**	**21**	0
09TOA098 M 170	1309.28	768.36	166.89	0.59	16.378	1.536	0.860	3.698	0.102	3.364	0.910	9.785	3.364	0.061	1.536	0.0	641	33	630	17	**627**	**20**	2

Notes:

Yellow highlighted rows are samples that intersected inclusions.
Isotope ratios and ages are NOT corrected for initial common Pb.
Isotope ratio and apparent age errors include systematic calibration errors of 6.37100499011343% ($^{208}Pb/^{232}Th$), 0.452188693209402% ($^{207}Pb/^{206}Pb$), 1.63033394062177% ($^{206}Pb/^{238}U$) (all 1-sigma).
Trace element concentrations in ppm, calculated using mean count rate method.
Sweep-by-sweep downhole fractionation of U/Pb ratios NOT corrected via Si/Zr fractionation factor.
Backgrounds were monitored during sweeps 8 to 18. Sample counts were integrated from sweeps 35 to 80.
Ablation used a laser spot size of 25 microns, and a laser firing repitition rate of 10 Hz.

Table B3b. Detrital zircon trace element analyses from sample **09TOA098** in the undivided Vampire-Narchilla unit (PЄVN) - Isotope Geology Laboratory, Boise State University

Analysis	Concentrations (ppm)																						
	P	Ti	Y	Zr	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	Th	U
09TOA098 M 158	395.046	2.032	903.583	528811.071	1.992		6.821	0.061	0.578	2.008	0.196	17.285	6.231	83.597	32.513	143.839	36.854	393.730	50.948	10465.260	0.844	73.876	127.275
09TOA098 L 138	147.441	4.898	157.910	507791.068	0.178		6.009		0.296	0.358	0.256	3.087	0.984	14.134	5.543	27.111	6.762	81.767	10.140	8609.810	0.068	14.010	24.498
09TOA098 L 102	290.347	4.813	804.178	484463.378	2.886		8.394		0.445	1.702	0.176	9.006	4.873	66.273	28.393	130.223	33.538	386.844	43.321	9488.241	1.471	102.571	131.752
09TOA098 L 110	110.894	12.846	307.564	481647.076	1.016		35.071	0.074	1.206	3.414	0.586	13.427	3.571	36.520	10.872	42.151	10.655	123.235	13.849	7563.303	0.663	104.234	118.150
09TOA098 L 121	146.467	14.657	452.132	525731.119	0.346		5.327	0.042	0.471	2.106	0.533	10.279	4.149	46.830	17.056	69.460	17.371	180.260	21.802	8157.333	0.357	19.582	28.031
09TOA098 L 109	258.857	8.822	686.197	492951.337	1.115		21.488	0.007	2.302	3.600	0.987	19.010	6.307	75.024	25.042	106.221	26.610	288.147	32.843	7236.642	0.490	20.708	22.541
09TOA098 M 174	193.149	13.419	318.841	506437.791	0.897	0.038	50.253	0.247	2.327	4.811	1.355	14.912	4.052	37.916	10.705	43.193	10.128	111.039	13.561	8661.522	0.613	158.381	127.341
09TOA098 M 203	193.149	13.419	318.841	506437.791	0.897	0.038	50.253	0.247	2.327	4.811	1.355	14.912	4.052	37.916	10.705	43.193	10.128	111.039	13.561	8661.522	0.613	158.381	127.341
09TOA098 L 128	213.567	9.586	562.714	494844.285	2.244		6.377	0.028	1.054	2.969	0.176	13.052	4.905	60.261	21.098	84.944	20.660	217.591	24.675	8439.062	1.314	42.755	74.859
09TOA098 L 119	99.100	8.541	328.043	534899.593	0.184		31.570	0.023	2.168	3.760	1.625	13.624	3.325	35.328	10.303	42.057	10.379	113.108	14.578	6864.552	0.074	76.699	68.578
09TOA098 M 191	~~274.312~~	~~11.000~~	~~609.686~~	~~510777.647~~	~~0.562~~		~~19.998~~	~~0.176~~	~~2.966~~	~~6.178~~	~~1.463~~	~~22.374~~	~~5.901~~	~~66.906~~	~~21.073~~	~~87.580~~	~~21.400~~	~~241.756~~	~~28.689~~	~~8269.733~~	~~0.313~~	~~46.864~~	~~48.069~~
09TOA098 M 221	274.312	11.000	609.686	510777.647	0.562		19.998	0.176	2.966	6.178	1.463	22.374	5.901	66.906	21.073	87.580	21.400	241.756	28.689	8269.733	0.313	46.864	48.069
09TOA098 M 153	302.306	51.572	80.503	532256.575	0.482		3.120	0.207	4.174	8.000	0.072	21.859	3.156	17.033	2.938	7.160	0.903	7.812	0.656	10479.068	0.089	151.341	22.913
09TOA098 L 139	221.721	20.416	240.100	513605.482	0.558		6.072	0.016	0.490	0.559	0.254	7.175	2.192	24.539	7.808	34.741	8.911	92.804	10.949	12379.791	0.114	6.679	21.188
09TOA098 M 160	300.350	17.124	676.963	534388.056	2.622		13.127	0.118	1.974	3.635	0.381	17.839	5.985	68.491	24.780	105.157	24.831	259.816	31.368	8641.539	0.832	50.796	40.380
09TOA098 M 155	284.559	16.813	431.616	534067.881	0.464		6.826		0.259	3.362	0.067	15.943	5.551	54.154	15.596	56.632	11.957	105.992	11.687	10524.833	0.346	96.353	45.967
09TOA098 M 163	194.614	9.324	664.502	505755.856	0.894	0.140	6.785	0.031	1.088	3.068	0.305	16.915	6.263	69.722	25.561	104.088	24.181	244.860	28.709	8471.192	0.632	88.020	189.834
09TOA098 M 186	192.733	15.171	584.827	524939.235	2.254	0.021	6.999	0.053	2.374	2.004	0.212	19.581	5.450	60.741	21.068	87.459	18.913	187.460	21.060	9859.844	1.047	103.321	93.556
09TOA098 M 216	192.733	15.171	584.827	524939.235	2.254	0.021	6.999	0.053	2.374	2.004	0.212	19.581	5.450	60.741	21.068	87.459	18.913	187.460	21.060	9859.844	1.047	103.321	93.556
09TOA098 M 198	170.877	14.069	170.254	505725.867	0.374		6.001		0.389	0.506	0.135	5.745	1.701	19.206	5.694	22.881	5.687	61.368	7.046	9382.688	0.211	45.788	77.972
09TOA098 M 227	170.877	14.069	170.254	505725.867	0.374		6.001		0.389	0.506	0.135	5.745	1.701	19.206	5.694	22.881	5.687	61.368	7.046	9382.688	0.211	45.788	77.972
09TOA098 M 166	80.758	9.374	134.119	499521.713	1.114		19.307	0.021	1.001	2.073	0.288	5.592	1.645	15.914	4.716	18.997	4.430	50.307	5.973	9499.153	0.707	74.362	107.840
09TOA098 M 171	403.309	20.246	624.423	496033.807	0.995	0.188	13.092	0.829	14.397	19.875	2.662	52.458	11.011	92.786	23.982	79.649	17.760	173.523	18.948	8802.665	0.228	191.296	152.053
09TOA098 L 126	278.477	61.522	588.972	478238.802	1.433	0.079	11.623	0.114	1.152	2.619	0.238	16.646	5.634	63.327	21.243	87.187	21.562	226.537	25.765	9398.908	0.785	78.566	62.076
09TOA098 M 180	346.653	7.195	891.418	515807.718	1.613	0.024	13.276	0.053	1.056	1.690	0.555	15.293	6.167	71.684	30.577	144.490	37.594	434.709	54.748	8021.022	0.918	111.851	165.723
09TOA098 M 209	346.653	7.195	891.418	515807.718	1.613	0.024	13.276	0.053	1.056	1.690	0.555	15.293	6.167	71.684	30.577	144.490	37.594	434.709	54.748	8021.022	0.918	111.851	165.723
09TOA098 L 111	287.078	6.687	346.523	487504.887	0.359	0.108	5.828	0.162	2.830	5.383	0.170	21.046	4.821	45.991	12.461	48.100	10.121	99.377	11.041	9099.616	0.111	82.586	57.579
09TOA098 M 169	220.015	18.480	539.908	513591.303	2.836		21.492	0.058	0.773	2.175	0.245	12.436	4.475	56.419	20.000	84.870	23.110	245.268	29.912	9549.892	1.487	68.356	44.274
09TOA098 M 172	226.274	21.927	425.233	498543.557	1.381	0.088	8.964		0.644	2.843	0.185	9.681	3.262	45.080	15.494	65.257	15.367	177.275	20.508	9445.540	0.786	98.733	135.283
09TOA098 L 115	~~355.486~~	~~33.015~~	~~1224.015~~	~~490986.108~~	~~0.999~~		~~5.494~~	~~0.705~~	~~11.681~~	~~16.671~~	~~0.999~~	~~50.990~~	~~14.859~~	~~148.760~~	~~48.092~~	~~170.542~~	~~41.205~~	~~404.119~~	~~43.003~~	~~8011.925~~	~~0.503~~	~~46.933~~	~~25.364~~
09TOA098 M 165	173.799	13.372	458.032	486585.645	1.854		21.490	0.044	0.366	1.258	0.200	9.102	3.028	41.770	15.425	72.774	18.828	211.697	26.361	8842.950	0.969	80.801	72.656
09TOA098 L 122	264.028	16.726	594.461	525425.361	1.151		10.646	0.055	0.882	2.442	0.248	14.634	5.230	66.423	21.629	91.493	21.249	219.944	25.846	9923.152	1.074	76.279	105.377
09TOA098 L 118	195.049	3.552	1167.208	502532.956	2.924	0.030	7.643	0.150	2.887	9.001	0.536	40.911	12.126	134.728	44.585	178.069	39.497	395.345	46.962	9869.761	1.256	178.932	125.600
09TOA098 M 189	409.019	11.438	890.152	526447.659	2.465		14.146	0.141	1.398	5.457	0.235	28.829	8.704	96.457	33.145	130.773	31.429	314.703	36.580	11819.693	0.921	276.958	246.964
09TOA098 M 219	409.019	11.438	890.152	526447.659	2.465		14.146	0.141	1.398	5.457	0.235	28.829	8.704	96.457	33.145	130.773	31.429	314.703	36.580	11819.693	0.921	276.958	246.964
09TOA098 L 103	265.509	24.784	679.641	507976.785	1.840		3.568	0.220	2.332	3.868	0.284	17.207	5.952	67.502	24.762	101.163	25.265	270.348	31.700	8780.596	1.019	26.202	20.447
09TOA098 M 177	550.096	5.764	536.054	496330.397	0.197		4.781	0.369	5.779	12.102	0.283	39.788	9.775	79.862	20.352	62.113	12.522	114.164	11.329	9503.584	0.045	69.899	117.120
09TOA098 M 206	550.096	5.764	536.054	496330.397	0.197		4.781	0.369	5.779	12.102	0.283	39.788	9.775	79.862	20.352	62.113	12.522	114.164	11.329	9503.584	0.045	69.899	117.120
09TOA098 L 145	227.504	10.146	583.661	524792.079	1.009	0.012	8.592	0.024	1.414	2.237	0.746	12.080	4.342	49.902	19.920	94.085	23.932	264.949	34.093	7310.486	0.734	24.897	55.379
09TOA098 L 106	518.851	12.682	1133.139	485092.059	2.440		14.723	0.116	2.851	6.860	1.311	41.166	12.632	135.448	43.778	168.345	42.325	433.134	49.568	9094.507	0.965	282.265	232.070
09TOA098 M 188	465.840	46.715	783.123	538129.922	0.943		4.256	0.233	3.887	4.950	0.388	27.689	8.172	92.744	28.318	112.627	24.598	246.110	27.992	9517.788	0.750	40.723	26.209
09TOA098 M 218	465.840	46.715	783.123	538129.922	0.943		4.256	0.233	3.887	4.950	0.388	27.689	8.172	92.744	28.318	112.627	24.598	246.110	27.992	9517.788	0.750	40.723	26.209
09TOA098 L 105	181.481	4.451	262.694	499447.102	0.556		3.788	0.059	0.620	0.935	0.525	6.025	1.657	19.905	8.013	40.960	12.729	180.720	28.062	7295.777	0.434	14.561	50.649

Table B3b, *continued.* Detrital zircon trace element analyses from sample **09TOA098** in the undivided Vampire-Narchilla unit (PЄVN) - Isotope Geology Laboratory, Boise State University

Analysis	Concentrations (ppm)																						
	P	Ti	Y	Zr	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	Th	U
09TOA098 M 182	90.625	8.523	126.450	526476.777	0.175	0.020	1.511					1.253	0.622	10.345	4.405	20.150	5.974	77.507	11.242	7822.132	0.070	9.773	29.304
09TOA098 M 212	90.625	8.523	126.450	526476.777	0.175	0.020	1.511					1.253	0.622	10.345	4.405	20.150	5.974	77.507	11.242	7822.132	0.070	9.773	29.304
09TOA098 M 195	305.418	15.222	419.527	495120.947	0.386		3.977	0.151	1.729	3.857	0.215	11.225	4.091	46.213	15.226	65.016	15.957	170.773	18.636	9996.641	0.318	110.988	130.465
09TOA098 M 225	305.418	15.222	419.527	495120.947	0.386		3.977	0.151	1.729	3.857	0.215	11.225	4.091	46.213	15.226	65.016	15.957	170.773	18.636	9996.641	0.318	110.988	130.465
09TOA098 M 193	294.900	10.144	787.401	486217.725	4.549	0.052	35.220	0.140	2.832	5.501	0.239	27.299	8.153	85.639	29.110	113.681	27.515	292.298	32.129	9719.253	1.812	248.259	128.298
09TOA098 M 223	294.900	10.144	787.401	486217.725	4.549	0.052	35.220	0.140	2.832	5.501	0.239	27.299	8.153	85.639	29.110	113.681	27.515	292.298	32.129	9719.253	1.812	248.259	128.298
09TOA098 L 140	666.568	11.129	1312.952	505095.149	3.299		18.664	0.136	5.890	8.875	0.804	40.924	12.938	141.247	47.872	196.571	48.338	492.638	56.055	9401.483	1.654	307.121	247.909
09TOA098 M 181	302.432	13.656	549.518	508145.121	2.524	0.059	9.640	0.130	2.989	4.688	0.634	21.475	6.444	69.801	20.332	69.206	14.874	132.050	14.968	11405.386	0.636	233.898	199.472
09TOA098 M 210	302.432	13.656	549.518	508145.121	2.524	0.059	9.640	0.130	2.989	4.688	0.634	21.475	6.444	69.801	20.332	69.206	14.874	132.050	14.968	11405.386	0.636	233.898	199.472
09TOA098 L 130	179.112	12.647	299.185	496989.559	0.701		20.749	0.029	1.386	2.998	0.561	9.179	3.077	33.582	10.346	41.762	11.100	116.645	14.564	7626.195	0.250	37.795	80.544
09TOA098 L 113	108.610	7.622	410.731	471616.082	0.023		8.151	0.349	4.394	4.095	2.204	16.885	3.847	43.599	14.224	57.669	14.795	167.799	21.001	7211.936	0.150	96.866	141.874
09TOA098 M 178	166.767	15.495	412.099	502274.171	0.916		11.758	0.056	1.332	3.188	1.124	13.417	4.157	44.116	15.698	63.040	14.719	166.241	21.199	7123.924	0.447	16.894	53.877
09TOA098 M 207	166.767	15.495	412.099	502274.171	0.916		11.758	0.056	1.332	3.188	1.124	13.417	4.157	44.116	15.698	63.040	14.719	166.241	21.199	7123.924	0.447	16.894	53.877
09TOA098 M 192	89.407	3.186	505.366	514973.020	0.919	0.126	5.526		0.749	1.411	0.206	9.827	3.191	43.510	16.996	78.297	21.311	261.334	33.532	8703.843	0.649	28.884	125.001
09TOA098 M 222	89.407	3.186	505.366	514973.020	0.919	0.126	5.526		0.749	1.411	0.206	9.827	3.191	43.510	16.996	78.297	21.311	261.334	33.532	8703.843	0.649	28.884	125.001
09TOA098 L 120	191.036	13.731	466.556	541088.149	0.643	0.046	8.063	0.044	1.318	3.247	0.428	14.197	4.417	48.452	16.742	68.087	15.599	169.590	20.665	9776.775	0.567	91.925	162.282
09TOA098 M 168	172.038	10.863	242.135	508464.891	0.668		7.471	0.007	0.195	1.103	0.141	5.705	1.880	23.157	8.260	37.311	9.568	109.466	14.300	8541.323	0.304	18.112	56.583
09TOA098 M 161	199.943	9.009	422.397	515264.581	1.325	0.010	11.431		0.105	1.219	0.091	7.215	2.888	38.068	14.673	70.255	18.812	219.670	27.746	11020.189	0.780	48.234	162.397
09TOA098 L 144	141.266	8.065	203.116	521842.922	0.369	0.147	5.326			0.321	0.181	4.234	1.301	17.394	7.582	28.966	8.074	94.803	11.903	8578.662	0.121	8.926	39.159
09TOA098 L 124	192.376	13.553	405.446	500138.741	0.895		27.373		2.153	3.646	1.056	15.263	4.230	42.709	14.167	58.903	15.121	165.857	19.671	8153.979	0.545	55.433	126.706
09TOA098 M 154	164.812	13.821	335.646	519151.281	0.351	0.011	10.573	0.008	0.135	1.686	0.876	9.621	2.899	33.122	11.179	45.149	11.321	126.213	15.888	8786.340	0.318	17.804	56.441
09TOA098 L 116	214.464	8.472	626.870	489262.865	0.438		1.539	0.074	1.304	3.490	0.211	16.532	5.421	63.609	24.143	101.110	26.743	277.606	32.428	7401.976	0.448	43.887	152.939
09TOA098 M 202	2602.032	16.248	542.516	516745.136	4.088	163.194	358.694	52.089	283.363	56.821	0.959	50.900	9.151	73.565	21.259	80.054	17.671	189.456	22.539	9128.809	1.321	64.976	71.176
09TOA098 M 230	~~2602.032~~	~~16.248~~	~~542.516~~	~~516745.136~~	~~4.088~~	~~163.194~~	~~358.694~~	~~52.089~~	~~283.363~~	~~56.821~~	~~0.959~~	~~50.900~~	~~9.151~~	~~73.565~~	~~21.259~~	~~80.054~~	~~17.671~~	~~189.456~~	~~22.539~~	~~9128.809~~	~~1.321~~	~~64.976~~	~~71.176~~
09TOA098 L 108	111.698	6.862	424.752	493643.923	0.212		11.982	0.063	0.874	2.711	1.041	15.813	4.053	49.978	15.650	62.423	14.929	157.347	17.549	8016.853	0.170	33.344	76.788
09TOA098 M 162	1779.042	16.830	586.345	506506.706	0.742	4.558	33.166	2.960	20.970	9.974	1.790	28.274	6.814	68.373	21.173	80.913	18.634	206.846	24.203	7479.859	0.347	52.725	110.165
09TOA098 L 134	168.606	0.348	187.988	509756.223	0.189		3.808		0.281	0.899	0.542	3.422	1.112	14.950	6.011	28.127	8.737	111.096	16.679	7304.136	0.319	19.570	103.320
09TOA098 M 173	163.672	11.812	350.385	505305.592	1.410	0.088	31.846	0.036	1.504	2.377	0.452	15.419	3.696	38.626	12.241	50.545	11.940	125.194	15.592	8621.991	0.566	124.481	213.870
09TOA098 L 107	224.500	0.866	461.507	495307.620	1.193		8.996		0.277	2.077	0.114	11.782	3.654	46.545	15.757	67.450	17.419	189.180	22.619	10331.599	0.800	108.824	195.865
09TOA098 M 190	195.020	6.483	807.068	515871.971	3.601		53.488	0.083	1.239	5.384	0.665	19.060	6.537	78.119	28.270	130.449	34.524	360.004	44.115	8970.509	1.350	121.768	139.246
09TOA098 M 220	195.020	6.483	807.068	515871.971	3.601		53.488	0.083	1.239	5.384	0.665	19.060	6.537	78.119	28.270	130.449	34.524	360.004	44.115	8970.509	1.350	121.768	139.246
09TOA098 L 114	231.001	13.605	577.569	481710.703	1.335		11.108	0.104	1.700	2.713	0.766	14.768	4.404	54.751	21.301	85.527	22.003	258.249	30.664	7515.704	0.958	107.098	162.573
09TOA098 L 136	207.928	5.796	451.805	494111.456	1.144		6.475		0.746	1.713	0.389	9.415	2.891	37.060	15.704	74.492	21.079	277.586	38.301	7197.652	0.561	30.321	159.282
09TOA098 M 156	192.875	8.509	696.656	535636.116	1.799		9.924		1.566	2.277		16.632	5.884	71.031	25.793	106.456	26.933	261.951	32.833	9172.486	0.805	82.672	90.822
09TOA098 L 133	153.200	10.903	593.829	506086.162	0.292	0.143	10.091	0.133	3.083	7.525	0.970	31.057	7.642	69.636	20.805	74.191	17.646	180.330	19.760	7569.471	0.222	176.009	343.316
09TOA098 M 167	123.322	8.410	300.176	496235.379	1.697		11.881	0.037	0.319	0.814	0.180	5.702	2.041	28.704	10.441	47.553	13.533	153.906	17.791	9613.344	1.153	101.219	202.299
09TOA098 L 129	223.732	10.353	1038.551	502228.858	0.928		17.163	0.015	1.001	3.361	0.856	25.992	8.721	104.225	37.971	158.372	38.790	402.405	47.678	9067.355	0.516	172.236	166.876
09TOA098 L 142	361.665	11.842	756.701	496063.208	3.389		18.848		1.449	3.573	0.425	17.213	6.144	73.516	26.876	118.704	30.619	340.431	39.147	8907.126	1.271	107.074	203.054
09TOA098 M 184	688.325	4.134	1080.464	525257.385	0.608		1.078	0.076	0.672	1.995	0.053	19.440	7.749	94.205	35.352	156.099	40.568	394.856	40.910	10916.827	0.557	38.928	318.735
09TOA098 M 214	688.325	4.134	1080.464	525257.385	0.608		1.078	0.076	0.672	1.995	0.053	19.440	7.749	94.205	35.352	156.099	40.568	394.856	40.910	10916.827	0.557	38.928	318.735
09TOA098 L 137	105.228	10.127	357.382	505769.194	0.573		19.267	0.038	0.803	3.460	0.929	12.420	3.733	40.206	13.070	50.515	12.930	136.541	16.277	7872.595	0.421	45.695	102.461
09TOA098 L 141	133.393	0.563	1912.672	507091.636	3.188	0.018	71.428	0.447	5.805	9.297	1.227	34.662	11.665	153.663	60.974	299.283	82.049	948.688	116.531	6591.275	1.054	288.064	231.533
09TOA098 L 131	274.975	22.616	1036.623	517486.577	1.247	0.005	35.102	0.619	12.591	15.285	4.014	45.994	12.102	129.098	38.933	148.106	33.873	354.704	38.070	7335.167	0.426	48.540	29.580

Table B3b, *continued.* Detrital zircon trace element analyses from sample **09TOA098** in the undivided Vampire-Narchilla unit (PЄVN) - Isotope Geology Laboratory, Boise State University

Analysis	Concentrations (ppm)																						
	P	Ti	Y	Zr	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	Th	U
09TOA098 M 183	177.820	13.957	548.063	525192.658	1.109	0.018	15.311	0.169	4.051	5.661	1.169	22.023	6.941	64.217	20.255	79.357	18.404	196.950	22.923	8387.932	0.597	109.571	186.055
09TOA098 M 213	177.820	13.957	548.063	525192.658	1.109	0.018	15.311	0.169	4.051	5.661	1.169	22.023	6.941	64.217	20.255	79.357	18.404	196.950	22.923	8387.932	0.597	109.571	186.055
09TOA098 M 175	219.544	7.925	611.794	511688.070	0.892		4.648		0.913	2.240	0.615	11.573	4.454	53.295	21.159	101.698	27.629	322.629	41.623	7650.709	0.282	12.618	51.993
09TOA098 M 204	219.544	7.925	611.794	511688.070	0.892		4.648		0.913	2.240	0.615	11.573	4.454	53.295	21.159	101.698	27.629	322.629	41.623	7650.709	0.282	12.618	51.993
09TOA098 M 176	252.354	28.668	650.781	503456.111	1.946		39.384	0.179	3.757	6.508	1.804	23.679	7.132	71.744	24.981	99.143	26.011	270.801	32.269	7040.600	0.715	50.156	42.091
09TOA098 M 205	252.354	28.668	650.781	503456.111	1.946		39.384	0.179	3.757	6.508	1.804	23.679	7.132	71.744	24.981	99.143	26.011	270.801	32.269	7040.600	0.715	50.156	42.091
09TOA098 M 194	226.440	8.541	559.430	492494.157	1.009	0.133	9.378	0.070	0.675	3.973	0.387	16.363	4.406	56.744	20.809	85.413	20.966	230.265	25.902	8429.749	0.896	105.020	229.702
09TOA098 M 224	226.440	8.541	559.430	492494.157	1.009	0.133	9.378	0.070	0.675	3.973	0.387	16.363	4.406	56.744	20.809	85.413	20.966	230.265	25.902	8429.749	0.896	105.020	229.702
09TOA098 M 159	584.052	8.344	1289.890	521762.710	1.486		3.509		0.770	2.040	0.077	18.587	8.459	111.671	45.017	219.813	59.395	652.755	82.635	11724.094	1.382	61.965	264.199
09TOA098 L 117	147.463	10.518	328.794	558144.768	0.347	0.027	14.365	0.087	1.207	3.205	0.650	12.770	3.203	35.398	10.881	46.239	11.708	122.775	16.957	8577.811	0.215	37.028	79.449
09TOA098 M 185	190.432	5.164	309.812	539852.330	0.328		3.313		0.473	0.497	0.144	6.020	1.999	28.021	10.624	49.646	14.458	174.806	25.361	7980.781	0.249	14.354	42.205
09TOA098 M 215	190.432	5.164	309.812	539852.330	0.328		3.313		0.473	0.497	0.144	6.020	1.999	28.021	10.624	49.646	14.458	174.806	25.361	7980.781	0.249	14.354	42.205
09TOA098 M 197	282.071	7.570	636.512	485994.791	1.796	0.687	9.682	0.287	1.913	2.432	0.220	16.950	5.219	66.386	23.107	97.605	23.399	249.286	26.984	9268.200	0.954	96.821	216.115
09TOA098 M 226	282.071	7.570	636.512	485994.791	1.796	0.687	9.682	0.287	1.913	2.432	0.220	16.950	5.219	66.386	23.107	97.605	23.399	249.286	26.984	9268.200	0.954	96.821	216.115
09TOA098 L 132	152.543	10.194	211.918	497284.232	0.617		13.213	0.020	0.247	0.902	0.211	6.276	1.788	21.150	7.193	30.456	7.895	90.222	10.690	8372.484	0.274	17.138	52.275
09TOA098 L 143	91.593	4.924	123.825	512452.002	0.143		5.356				0.134	2.962	0.674	10.317	4.117	19.372	5.857	75.236	11.278	9344.759	0.206	16.192	60.004
09TOA098 M 199	279.105	41.726	473.941	511407.729	1.129	0.000	21.848	0.176	2.656	5.101	1.212	16.716	4.758	56.133	17.999	72.590	17.614	188.932	22.147	7277.672	0.416	22.841	17.793
09TOA098 M 228	279.105	41.726	473.941	511407.729	1.129	0.000	21.848	0.176	2.656	5.101	1.212	16.716	4.758	56.133	17.999	72.590	17.614	188.932	22.147	7277.672	0.416	22.841	17.793
09TOA098 M 201	225.915	15.820	374.449	511547.292	0.996		4.475		0.787	0.407		8.194	3.016	38.643	12.720	58.887	14.549	153.445	17.615	9330.524	0.841	45.625	139.412
09TOA098 M 229	225.915	15.820	374.449	511547.292	0.996		4.475		0.787	0.407		8.194	3.016	38.643	12.720	58.887	14.549	153.445	17.615	9330.524	0.841	45.625	139.412
09TOA098 L 125	179.188	7.167	704.783	500187.619	1.967	0.094	9.123		1.172	2.599	0.144	16.972	5.836	71.736	26.321	107.400	26.149	262.220	30.371	9702.181	1.455	118.229	264.477
09TOA098 L 112	~~60.327~~	~~0.838~~	~~394.023~~	~~470230.445~~	~~1.028~~		~~3.910~~			~~0.658~~	~~0.466~~	~~5.779~~	~~2.219~~	~~32.732~~	~~12.937~~	~~61.447~~	~~17.105~~	~~229.598~~	~~28.136~~	~~8084.949~~	~~0.603~~	~~19.253~~	~~188.638~~
09TOA098 M 157	196.007	13.703	673.533	527939.117	1.887	0.123	5.263		1.166	2.653	0.307	16.711	5.926	69.701	24.578	105.547	24.544	243.483	30.862	9142.905	0.970	66.001	116.527
09TOA098 M 187	160.617	8.946	631.854	521943.590	1.698	0.190	5.861		0.291	2.614	0.096	13.379	4.930	60.001	22.031	93.748	22.853	232.266	28.048	9907.455	0.847	74.066	149.227
09TOA098 M 217	160.617	8.946	631.854	521943.590	1.698	0.190	5.861		0.291	2.614	0.096	13.379	4.930	60.001	22.031	93.748	22.853	232.266	28.048	9907.455	0.847	74.066	149.227
09TOA098 L 127	187.065	21.434	462.157	523259.966	2.271		13.969	0.078	1.900	2.527	0.534	13.868	4.014	48.359	16.999	69.000	17.441	176.391	21.836	8393.965	0.906	87.737	86.558
09TOA098 L 123	143.461	1.959	1809.624	509364.946	85.866	0.052	18.102	0.082	1.776	4.570	0.173	36.684	15.907	202.787	72.634	297.895	69.206	676.766	67.830	10646.782	30.419	255.963	543.072
09TOA098 M 179	196.929	6.197	2279.701	514056.505	74.320		17.305	0.237	5.280	12.175	0.204	58.303	22.070	267.884	91.028	353.510	78.820	754.991	76.443	9275.807	23.060	428.429	577.187
09TOA098 M 208	196.929	6.197	2279.701	514056.505	74.320		17.305	0.237	5.280	12.175	0.204	58.303	22.070	267.884	91.028	353.510	78.820	754.991	76.443	9275.807	23.060	428.429	577.187
09TOA098 M 170	147.354	4.180	3461.834	501751.271	133.058	0.212	25.903	0.290	3.685	10.044	0.123	61.965	25.302	332.612	127.244	561.256	133.334	1330.863	138.266	10952.087	42.358	768.358	1309.279

Notes:

Yellow highlighted rows are samples that intersected inclusions.
Trace element concentrations in ppm, calculated using mean count rate method.
Sweep-by-sweep downhole fractionation of U/Pb ratios NOT corrected via Si/Zr fractionation factor.
Backgrounds were monitored during sweeps 8 to 18. Sample counts were integrated from sweeps 35 to 80.
Ablation used a laser spot size of 25 microns, and a laser firing repitition rate of 10 Hz.

Table B3c. Detrital zircon calculated ratios and values from sample **09TOA098** in the undivided Vampire-Narchilla unit (PЄVN) - Isotope Geology Laboratory, Boise State University

Analysis	CI chondrite normalizing values from Sun and McDonough (1989)													
	0.237	0.612	0.095	0.467	0.153	0.058	0.206	0.037	0.254	0.057	0.166	0.026	0.17	0.025
	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
09TOA098 M 158	0.016	11.145	0.645	1.238	13.126	3.377	84.111	166.606	329.122	574.432	869.120	1445.249	2316.057	2005.820
09TOA098 L 138		9.819	0.142	0.634	2.340	4.407	15.024	26.312	55.644	97.940	163.814	265.158	480.984	399.194
09TOA098 L 102		13.716	0.213	0.953	11.124	3.030	43.824	130.303	260.917	501.637	786.845	1315.198	2275.554	1705.561
09TOA098 L 110	0.019	57.306	0.777	2.582	22.315	10.096	65.337	95.494	143.779	192.084	254.687	417.836	724.915	545.227
09TOA098 L 121	0.011	8.704	0.441	1.008	13.765	9.181	50.019	110.930	184.371	301.338	419.701	681.222	1060.353	858.337
09TOA098 L 109	0.002	35.111	0.077	4.930	23.529	17.013	92.506	168.640	295.370	442.431	641.819	1043.516	1694.985	1293.031
09TOA098 M 174	0.161	82.113	2.595	4.982	31.443	23.360	72.565	108.350	149.277	189.142	260.987	397.174	653.171	533.889
09TOA098 M 203	0.161	82.113	2.595	4.982	31.443	23.360	72.565	108.350	149.277	189.142	260.987	397.174	653.171	533.889
09TOA098 L 128	0.007	10.420	0.296	2.258	19.404	3.034	63.515	131.157	237.247	372.753	513.258	810.207	1279.948	971.460
09TOA098 L 119	0.006	51.585	0.244	4.641	24.575	28.016	66.297	88.908	139.085	182.033	254.121	407.020	665.340	573.943
09TOA098 M 191	~~0.046~~	~~32.677~~	~~1.849~~	~~6.351~~	~~40.378~~	~~25.217~~	~~108.874~~	~~157.769~~	~~263.410~~	~~372.309~~	~~529.182~~	~~839.210~~	~~1422.095~~	~~1129.484~~
09TOA098 M 221	0.046	32.677	1.849	6.351	40.378	25.217	108.874	157.769	263.410	372.309	529.182	839.210	1422.095	1129.484
09TOA098 M 153	0.055	5.098	2.176	8.938	52.287	1.242	106.370	84.376	67.059	51.901	43.264	35.407	45.950	25.831
09TOA098 L 139	0.004	9.921	0.170	1.049	3.653	4.379	34.917	58.617	96.610	137.959	209.918	349.452	545.905	431.070
09TOA098 M 160	0.031	21.449	1.238	4.226	23.758	6.576	86.809	160.036	269.651	437.816	635.390	973.780	1528.330	1234.964
09TOA098 M 155		11.153	0.124	0.554	21.971	1.149	77.580	148.432	213.206	275.550	342.186	468.912	623.485	460.109
09TOA098 M 163	0.590	11.086	0.327	2.331	20.052	5.254	82.313	167.448	274.495	451.605	628.933	948.261	1440.355	1130.275
09TOA098 M 186	0.091	11.436	0.561	5.083	13.097	3.660	95.286	145.732	239.138	372.219	528.455	741.696	1102.706	829.119
09TOA098 M 216	0.091	11.436	0.561	5.083	13.097	3.660	95.286	145.732	239.138	372.219	528.455	741.696	1102.706	829.119
09TOA098 M 198		9.806	0.186	0.833	3.305	2.327	27.957	45.475	75.616	100.599	138.251	223.029	360.987	277.418
09TOA098 M 227		9.806	0.186	0.833	3.305	2.327	27.957	45.475	75.616	100.599	138.251	223.029	360.987	277.418
09TOA098 M 166	0.005	31.548	0.218	2.143	13.549	4.959	27.212	43.986	62.652	83.323	114.784	173.721	295.926	235.164
09TOA098 M 171	0.795	21.392	8.722	30.828	129.903	45.890	255.272	294.425	365.301	423.702	481.265	696.464	1020.724	746.004
09TOA098 L 126	0.334	18.992	1.199	2.467	17.120	4.101	81.004	150.632	249.320	375.325	526.811	845.579	1332.569	1014.367
09TOA098 M 180	0.102	21.694	0.557	2.261	11.045	9.575	74.420	164.893	282.221	540.226	873.049	1474.259	2557.112	2155.440
09TOA098 M 209	0.102	21.694	0.557	2.261	11.045	9.575	74.420	164.893	282.221	540.226	873.049	1474.259	2557.112	2155.440
09TOA098 L 111	0.455	9.524	1.708	6.060	35.186	2.927	102.415	128.901	181.068	220.154	290.636	396.897	584.568	434.674
09TOA098 M 169	0.015	35.117	0.610	1.654	14.216	4.227	60.518	119.659	222.123	353.355	512.810	906.271	1442.751	1177.621
09TOA098 M 172	0.372	14.647	0.308	1.379	18.583	3.187	47.109	87.220	177.479	273.750	394.301	602.632	1042.796	807.391
09TOA098 L 115	~~0.186~~	~~8.978~~	~~7.425~~	~~25.013~~	~~108.959~~	~~17.224~~	~~248.126~~	~~397.303~~	~~585.668~~	~~849.681~~	~~1030.465~~	~~1615.885~~	~~2377.169~~	~~1693.017~~
09TOA098 M 165	0.012	35.114	0.460	0.785	8.222	3.446	44.291	80.966	164.448	272.526	439.725	738.341	1245.275	1037.818
09TOA098 L 122	0.014	17.395	0.579	1.888	15.964	4.271	71.209	139.852	261.508	382.132	552.829	833.301	1293.787	1017.545
09TOA098 L 118	0.127	12.489	1.578	6.182	58.829	9.247	199.082	324.215	530.425	787.712	1075.944	1548.914	2325.560	1848.886
09TOA098 M 189	0.037	23.115	1.486	2.993	35.670	4.051	140.289	232.715	379.751	585.604	790.167	1232.510	1851.194	1440.176
09TOA098 M 219	0.037	23.115	1.486	2.993	35.670	4.051	140.289	232.715	379.751	585.604	790.167	1232.510	1851.194	1440.176
09TOA098 L 103	0.058	5.831	2.320	4.993	25.280	4.904	83.733	159.134	265.756	437.486	611.258	990.796	1590.281	1248.031
09TOA098 M 177	0.097	7.812	3.883	12.374	79.095	4.887	193.615	261.375	314.418	359.582	375.305	491.078	671.555	446.029
09TOA098 M 206	0.097	7.812	3.883	12.374	79.095	4.887	193.615	261.375	314.418	359.582	375.305	491.078	671.555	446.029
09TOA098 L 145	0.049	14.040	0.256	3.028	14.620	12.854	58.784	116.090	196.465	351.944	568.491	938.515	1558.523	1342.236
09TOA098 L 106	0.031	24.057	1.220	6.106	44.834	22.597	200.320	337.757	533.261	773.462	1017.187	1659.800	2547.846	1951.486
09TOA098 M 188	0.061	6.954	2.448	8.324	32.354	6.683	134.740	218.504	365.133	500.319	680.526	964.618	1447.706	1102.045
09TOA098 M 218	0.061	6.954	2.448	8.324	32.354	6.683	134.740	218.504	365.133	500.319	680.526	964.618	1447.706	1102.045

Ti-in-zircon (T°C)	Ce/Ce*	Eu/Eu*	(Sm/Nd) cn	(Lu/Nd) cn	Lu/Hf	Nb/Ta	Nb/U	Th/U	Th/Y	Y/Hf
653	33.73	0.07	10.60	1620.17	0.00	2.36	0.02	0.58	0.08	0.09
727		0.51	3.69	629.91	0.00	2.60	0.01	0.57	0.09	0.02
726		0.11	11.68	1790.43	0.00	1.96	0.02	0.78	0.13	0.08
823	143.97	0.23	8.64	211.13	0.00	1.53	0.01	0.88	0.34	0.04
837	38.54	0.29	13.66	851.82	0.00	0.97	0.01	0.70	0.04	0.06
783	886.48	0.29	4.77	262.29	0.00	2.28	0.05	0.92	0.03	0.09
828	59.60	0.45	6.31	107.15	0.00	1.46	0.01	1.24	0.50	0.04
828	59.60	0.45	6.31	107.15	0.00	1.46	0.01	1.24	0.50	0.04
792	68.76	0.07	8.59	430.31	0.00	1.71	0.03	0.57	0.08	0.07
780	412.79	0.62	5.29	123.66	0.00	2.48	0.00	1.12	0.23	0.05
~~806.19~~	~~34.48~~	~~0.34~~	~~6.36~~	~~177.85~~	~~0.00~~	~~1.79~~	~~0.01~~	~~0.97~~	~~0.08~~	~~0.07~~
806	34.48	0.34	6.36	177.85	0.00	1.79	0.01	0.97	0.08	0.07
998	4.57	0.02	5.85	2.89	0.00	5.40	0.02	6.61	1.88	0.01
876	113.94	0.23	3.48	410.76	0.00	4.90	0.03	0.32	0.03	0.02
855	33.80	0.12	5.62	292.22	0.00	3.15	0.06	1.26	0.08	0.08
853		0.02	39.67	830.69	0.00	1.34	0.01	2.10	0.22	0.04
789	24.20	0.10	8.60	484.96	0.00	1.41	0.00	0.46	0.13	0.08
841	35.08	0.07	2.58	163.12	0.00	2.15	0.02	1.10	0.18	0.06
841	35.08	0.07	2.58	163.12	0.00	2.15	0.02	1.10	0.18	0.06
833		0.15	3.97	333.16	0.00	1.77	0.00	0.59	0.27	0.02
833		0.15	3.97	333.16	0.00	1.77	0.00	0.59	0.27	0.02
790	282.94	0.24	6.32	109.73	0.00	1.58	0.01	0.69	0.55	0.01
875	4.50	0.24	4.21	24.20	0.00	4.36	0.01	1.26	0.31	0.07
1024	24.78	0.08	6.94	411.19	0.00	1.83	0.02	1.27	0.13	0.06
763	65.87	0.22	4.88	953.32	0.01	1.76	0.01	0.67	0.13	0.11
763	65.87	0.22	4.88	953.32	0.01	1.76	0.01	0.67	0.13	0.11
756	8.81	0.04	5.81	71.73	0.00	3.25	0.01	1.43	0.24	0.04
864	112.35	0.11	8.59	711.83	0.00	1.91	0.06	1.54	0.13	0.06
884	43.08	0.10	13.48	585.46	0.00	1.76	0.01	0.73	0.23	0.05
~~936~~	~~2.36~~	~~0.10~~	~~4.36~~	~~67.69~~	~~0.01~~	~~1.99~~	~~0.04~~	~~1.85~~	~~0.04~~	~~0.15~~
827	148.97	0.13	10.48	1322.64	0.00	1.91	0.03	1.11	0.18	0.05
852	58.64	0.10	8.45	538.85	0.00	1.07	0.01	0.72	0.13	0.06
699	14.65	0.07	9.52	299.07	0.00	2.33	0.02	1.42	0.15	0.12
810	30.36	0.05	11.92	481.15	0.00	2.68	0.01	1.12	0.31	0.08
810	30.36	0.05	11.92	481.15	0.00	2.68	0.01	1.12	0.31	0.08
899	4.90	0.09	5.06	249.96	0.00	1.81	0.09	1.28	0.04	0.08
742	3.93	0.04	6.39	36.05	0.00	4.36	0.00	0.60	0.13	0.06
742	3.93	0.04	6.39	36.05	0.00	4.36	0.00	0.60	0.13	0.06
798	92.08	0.35	4.83	443.22	0.00	1.37	0.02	0.45	0.04	0.08
821	38.49	0.18	7.34	319.62	0.01	2.53	0.01	1.22	0.25	0.12
984	5.54	0.08	3.89	132.40	0.00	1.26	0.04	1.55	0.05	0.08
984	5.54	0.08	3.89	132.40	0.00	1.26	0.04	1.55	0.05	0.08

Table B3c, *continued.* Detrital zircon calculated ratios and values from sample **09TOA098** in the undivided Vampire-Narchilla unit (PЄVN) - Isotope Geology Laboratory, Boise State University

Analysis	CI chondrite normalizing values from Sun and McDonough (1989)													
	0.237	0.612	0.095	0.467	0.153	0.058	0.206	0.037	0.254	0.057	0.166	0.026	0.17	0.025
	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
09TOA098 L 105	0.015	6.190	0.617	1.328	6.114	9.057	29.317	44.298	78.365	141.566	247.490	499.183	1063.059	1104.817
09TOA098 M 182	0.084	2.469					6.099	16.635	40.730	77.823	121.754	234.268	455.922	442.611
09TOA098 M 212	0.084	2.469					6.099	16.635	40.730	77.823	121.754	234.268	455.922	442.611
09TOA098 M 195	0.040	6.499	1.589	3.702	25.210	3.698	54.625	109.377	181.942	269.004	392.845	625.760	1004.546	733.703
09TOA098 M 225	0.040	6.499	1.589	3.702	25.210	3.698	54.625	109.377	181.942	269.004	392.845	625.760	1004.546	733.703
09TOA098 M 193	0.219	57.549	1.477	6.064	35.957	4.123	132.842	217.998	337.160	514.307	686.894	1079.010	1719.401	1264.930
09TOA098 M 223	0.219	57.549	1.477	6.064	35.957	4.123	132.842	217.998	337.160	514.307	686.894	1079.010	1719.401	1264.930
09TOA098 L 140	0.036	30.496	1.430	12.613	58.005	13.864	199.141	345.935	556.091	845.799	1187.743	1895.598	2897.870	2206.887
09TOA098 M 181	0.249	15.752	1.373	6.400	30.642	10.938	104.503	172.308	274.809	359.222	418.166	583.303	776.765	589.276
09TOA098 M 210	0.249	15.752	1.373	6.400	30.642	10.938	104.503	172.308	274.809	359.222	418.166	583.303	776.765	589.276
09TOA098 L 130	0.008	33.904	0.301	2.968	19.593	9.668	44.667	82.272	132.214	182.799	252.340	435.296	686.146	573.405
09TOA098 L 113	0.092	13.319	3.674	9.409	26.763	38.007	82.167	102.874	171.651	251.302	348.452	580.196	987.055	826.810
09TOA098 M 178	0.015	19.213	0.585	2.853	20.837	19.386	65.290	111.158	173.685	277.351	380.905	577.217	977.890	834.617
09TOA098 M 207	0.015	19.213	0.585	2.853	20.837	19.386	65.290	111.158	173.685	277.351	380.905	577.217	977.890	834.617
09TOA098 M 192	0.530	9.029	0.358	1.604	9.224	3.560	47.821	85.316	171.300	300.282	473.092	835.709	1537.256	1320.172
09TOA098 M 222	0.530	9.029	0.358	1.604	9.224	3.560	47.821	85.316	171.300	300.282	473.092	835.709	1537.256	1320.172
09TOA098 L 120	0.194	13.175	0.466	2.823	21.219	7.381	69.085	118.108	190.757	295.798	411.400	611.711	997.589	813.601
09TOA098 M 168	0.002	12.207	0.075	0.417	7.209	2.425	27.762	50.262	91.169	145.929	225.447	375.234	643.916	563.001
09TOA098 M 161	0.044	18.678	0.050	0.225	7.968	1.577	35.108	77.216	149.873	259.239	424.503	737.733	1292.178	1092.373
09TOA098 L 144	0.621	8.703		0.215	2.101	3.114	20.602	34.788	68.481	133.964	175.022	316.622	557.664	468.619
09TOA098 L 124		44.726	1.030	4.610	23.827	18.207	74.272	113.101	168.145	250.298	355.912	592.983	975.628	774.460
09TOA098 M 154	0.045	17.276	0.082	0.290	11.023	15.111	46.818	77.509	130.403	197.505	272.805	443.970	742.427	625.523
09TOA098 L 116	0.020	2.515	0.779	2.792	22.812	3.641	80.449	144.936	250.429	426.563	610.936	1048.753	1632.975	1276.676
09TOA098 M 202	688.581	586.101	548.302	606.773	371.377	16.530	247.689	244.683	289.625	375.602	483.708	692.985	1114.449	887.345
~~09TOA098 M 230~~	~~688.581~~	~~586.101~~	~~548.302~~	~~606.773~~	~~371.377~~	~~16.530~~	~~247.689~~	~~244.683~~	~~289.625~~	~~375.602~~	~~483.708~~	~~692.985~~	~~1114.449~~	~~887.345~~
09TOA098 L 108	0.017	19.578	0.668	1.872	17.716	17.953	76.947	108.366	196.765	276.498	377.180	585.443	925.569	690.915
09TOA098 M 162	19.230	54.193	31.162	44.903	65.192	30.856	137.584	182.187	269.184	374.082	488.897	730.760	1216.743	952.865
09TOA098 L 134		6.222	0.134	0.601	5.876	9.343	16.650	29.738	58.857	106.201	169.952	342.632	653.505	656.673
09TOA098 M 173	0.372	52.036	0.383	3.222	15.536	7.787	75.030	98.816	152.072	216.268	305.411	468.226	736.435	613.872
09TOA098 L 107		14.699	0.133	0.594	13.572	1.970	57.335	97.690	183.249	278.392	407.556	683.096	1112.822	890.512
09TOA098 M 190	0.022	87.399	0.875	2.653	35.187	11.470	92.750	174.797	307.553	499.467	788.209	1353.885	2117.669	1736.806
09TOA098 M 220	0.022	87.399	0.875	2.653	35.187	11.470	92.750	174.797	307.553	499.467	788.209	1353.885	2117.669	1736.806
09TOA098 L 114	0.028	18.151	1.099	3.640	17.729	13.205	71.865	117.756	215.554	376.335	516.781	862.864	1519.109	1207.236
09TOA098 L 136		10.580	0.357	1.598	11.199	6.706	45.815	77.300	145.906	277.462	450.101	826.635	1632.860	1507.925
09TOA098 M 156		16.216	0.749	3.354	14.884		80.934	157.329	279.651	455.715	643.237	1056.195	1540.890	1292.638
09TOA098 L 133	0.605	16.489	1.403	6.602	49.183	16.727	151.130	204.321	274.158	367.586	448.283	691.985	1060.765	777.935
09TOA098 M 167	0.010	19.413	0.389	0.683	5.322	3.099	27.745	54.561	113.008	184.463	287.332	530.699	905.329	700.419
09TOA098 L 129	0.004	28.044	0.161	2.143	21.964	14.753	126.482	233.181	410.335	670.862	956.931	1521.165	2367.086	1877.092
09TOA098 L 142		30.797	0.693	3.102	23.354	7.332	83.759	164.274	289.434	474.833	717.246	1200.755	2002.538	1541.231
09TOA098 M 184	0.020	1.761	0.800	1.440	13.036	0.915	94.597	207.185	370.884	624.585	943.198	1590.885	2322.682	1610.637
09TOA098 M 214	0.020	1.761	0.800	1.440	13.036	0.915	94.597	207.185	370.884	624.585	943.198	1590.885	2322.682	1610.637
09TOA098 L 137	0.010	31.481	0.398	1.720	22.615	16.017	60.438	99.815	158.292	230.916	305.227	507.044	803.182	640.812

Ti-in-zircon (T°C)	Ce/Ce*	Eu/Eu*	(Sm/Nd) cn	(Lu/Nd) cn	Lu/Hf	Nb/Ta	Nb/U	Th/U	Th/Y	Y/Hf
719	19.56	0.51	4.60	832.02	0.00	1.28	0.01	0.29	0.06	0.04
780					0.00	2.49	0.01	0.33	0.08	0.02
780					0.00	2.49	0.01	0.33	0.08	0.02
842	7.98	0.09	6.81	198.19	0.00	1.21	0.00	0.85	0.26	0.04
842	7.98	0.09	6.81	198.19	0.00	1.21	0.00	0.85	0.26	0.04
798	67.86	0.05	5.93	208.60	0.00	2.51	0.04	1.94	0.32	0.08
798	67.86	0.05	5.93	208.60	0.00	2.51	0.04	1.94	0.32	0.08
807	41.62	0.11	4.60	174.97	0.01	2.00	0.01	1.24	0.23	0.14
829	19.42	0.16	4.79	92.07	0.00	3.97	0.01	1.17	0.43	0.05
829	19.42	0.16	4.79	92.07	0.00	3.97	0.01	1.17	0.43	0.05
821	219.52	0.30	6.60	193.16	0.00	2.81	0.01	0.47	0.13	0.04
769	7.07	0.70	2.84	87.87	0.00	0.16	0.00	0.68	0.24	0.06
844	64.07	0.45	7.30	292.54	0.00	2.05	0.02	0.31	0.04	0.06
844	64.07	0.45	7.30	292.54	0.00	2.05	0.02	0.31	0.04	0.06
690	20.33	0.12	5.75	823.12	0.00	1.41	0.01	0.23	0.06	0.06
690	20.33	0.12	5.75	823.12	0.00	1.41	0.01	0.23	0.06	0.06
830	39.89	0.16	7.52	288.24	0.00	1.13	0.00	0.57	0.20	0.05
805	316.20	0.14	17.27	1348.91	0.00	2.20	0.01	0.32	0.07	0.03
786	397.65	0.07	35.40	4853.27	0.00	1.70	0.01	0.30	0.11	0.04
774		0.27	9.77	2178.35	0.00	3.06	0.01	0.23	0.04	0.02
829		0.37	5.17	167.99	0.00	1.64	0.01	0.44	0.14	0.05
831	271.72	0.52	38.02	2157.85	0.00	1.11	0.01	0.32	0.05	0.04
779	6.30	0.07	8.17	457.32	0.00	0.98	0.00	0.29	0.07	0.08
849	0.95	0.05	0.61	1.46	0.00	3.09	0.06	0.91	0.12	0.06
~~848.92~~	~~0.95~~	~~0.05~~	~~0.61~~	~~1.46~~	~~0.00~~	~~3.09~~	~~0.06~~	~~0.91~~	~~0.12~~	~~0.06~~
759	57.16	0.38	9.46	369.01	0.00	1.25	0.00	0.43	0.08	0.05
853	2.15	0.30	1.45	21.22	0.00	2.14	0.01	0.48	0.09	0.08
534		0.83	9.78	1093.21	0.00	0.59	0.00	0.19	0.10	0.03
814	137.79	0.17	4.82	190.55	0.00	2.49	0.01	0.58	0.36	0.04
592		0.06	22.85	1498.98	0.00	1.49	0.01	0.56	0.24	0.04
753	194.80	0.18	13.26	654.63	0.00	2.67	0.03	0.87	0.15	0.09
753	194.80	0.18	13.26	654.63	0.00	2.67	0.03	0.87	0.15	0.09
829	32.23	0.29	4.87	331.65	0.00	1.39	0.01	0.66	0.19	0.08
743		0.24	7.01	943.55	0.01	2.04	0.01	0.19	0.07	0.06
780			4.44	385.43	0.00	2.24	0.02	0.91	0.12	0.08
805	16.42	0.17	7.45	117.83	0.00	1.32	0.00	0.51	0.30	0.08
779	97.43	0.19	7.79	1025.38	0.00	1.47	0.01	0.50	0.34	0.03
800	339.40	0.20	10.25	875.96	0.01	1.80	0.01	1.03	0.17	0.11
814		0.14	7.53	496.82	0.00	2.67	0.02	0.53	0.14	0.08
712	4.30	0.02	9.05	1118.62	0.00	1.09	0.00	0.12	0.04	0.10
712	4.30	0.02	9.05	1118.62	0.00	1.09	0.00	0.12	0.04	0.10
798	154.25	0.39	13.15	372.53	0.00	1.36	0.01	0.45	0.13	0.05

Table B3c, *continued.* Detrital zircon calculated ratios and values from sample **09TOA098** in the undivided Vampire-Narchilla unit (PЄVN) - Isotope Geology Laboratory, Boise State University

Analysis	CI chondrite normalizing values from Sun and McDonough (1989)													
	0.237	0.612	0.095	0.467	0.153	0.058	0.206	0.037	0.254	0.057	0.166	0.026	0.17	0.025
	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
09TOA098 L 141	0.076	116.712	4.700	12.429	60.764	21.155	168.674	311.895	604.971	1077.275	1808.356	3217.603	5580.520	4587.829
09TOA098 L 131	0.021	57.357	6.514	26.962	99.905	69.214	223.815	323.590	508.262	687.871	894.903	1328.354	2086.497	1498.802
09TOA098 M 183	0.077	25.019	1.781	8.675	37.001	20.164	107.168	185.589	252.824	357.865	479.497	721.737	1158.530	902.466
09TOA098 M 213	0.077	25.019	1.781	8.675	37.001	20.164	107.168	185.589	252.824	357.865	479.497	721.737	1158.530	902.466
09TOA098 M 175		7.594	0.437	1.956	14.642	10.609	56.318	119.083	209.824	373.838	614.487	1083.499	1897.819	1638.712
09TOA098 M 204		7.594	0.437	1.956	14.642	10.609	56.318	119.083	209.824	373.838	614.487	1083.499	1897.819	1638.712
09TOA098 M 176	0.047	64.353	1.883	8.045	42.538	31.107	115.228	190.688	282.458	441.366	599.054	1020.028	1592.948	1270.426
09TOA098 M 205	0.047	64.353	1.883	8.045	42.538	31.107	115.228	190.688	282.458	441.366	599.054	1020.028	1592.948	1270.426
09TOA098 M 194	0.559	15.324	0.734	1.446	25.968	6.666	79.627	117.803	223.401	367.654	516.089	822.180	1354.499	1019.775
09TOA098 M 224	0.559	15.324	0.734	1.446	25.968	6.666	79.627	117.803	223.401	367.654	516.089	822.180	1354.499	1019.775
09TOA098 M 159		5.733	0.368	1.649	13.334	1.326	90.450	226.177	439.651	795.355	1328.177	2329.223	3839.737	3253.346
09TOA098 L 117	0.115	23.473	0.920	2.584	20.949	11.206	62.139	85.644	139.362	192.237	279.392	459.150	722.209	667.593
09TOA098 M 185		5.413	0.226	1.013	3.250	2.479	29.297	53.456	110.319	187.707	299.976	567.000	1028.272	998.484
09TOA098 M 215		5.413	0.226	1.013	3.250	2.479	29.297	53.456	110.319	187.707	299.976	567.000	1028.272	998.484
09TOA098 M 197	2.899	15.821	3.019	4.096	15.897	3.785	82.480	139.546	261.361	408.245	589.757	917.600	1466.390	1062.346
09TOA098 M 226	2.899	15.821	3.019	4.096	15.897	3.785	82.480	139.546	261.361	408.245	589.757	917.600	1466.390	1062.346
09TOA098 L 132	0.005	21.589	0.214	0.529	5.897	3.642	30.539	47.819	83.268	127.079	184.025	309.604	530.715	420.881
09TOA098 L 143		8.752				2.315	14.416	18.018	40.619	72.731	117.051	229.694	442.563	444.027
09TOA098 M 199	0.001	35.699	1.858	5.687	33.337	20.892	81.342	127.223	220.998	318.007	438.613	690.765	1111.362	871.918
09TOA098 M 228	0.001	35.699	1.858	5.687	33.337	20.892	81.342	127.223	220.998	318.007	438.613	690.765	1111.362	871.918
09TOA098 M 201		7.313	0.377	1.686	2.661		39.875	80.642	152.136	224.743	355.815	570.547	902.616	693.502
09TOA098 M 229		7.313	0.377	1.686	2.661		39.875	80.642	152.136	224.743	355.815	570.547	902.616	693.502
09TOA098 L 125	0.398	14.907	0.561	2.510	16.987	2.480	82.587	156.033	282.423	465.029	648.940	1025.437	1542.470	1195.706
09TOA098 L 112		~~6.389~~		~~0.440~~	~~4.300~~	~~8.035~~	~~28.123~~	~~59.341~~	~~128.868~~	~~228.573~~	~~371.284~~	~~670.799~~	~~1350.575~~	~~1107.727~~
09TOA098 M 157	0.517	8.600	0.558	2.496	17.341	5.295	81.316	158.457	274.413	434.237	637.748	962.508	1432.255	1215.033
09TOA098 M 187	0.800	9.576	0.139	0.624	17.087	1.659	65.104	131.822	236.223	389.235	566.454	896.201	1366.270	1104.259
09TOA098 M 217	0.800	9.576	0.139	0.624	17.087	1.659	65.104	131.822	236.223	389.235	566.454	896.201	1366.270	1104.259
09TOA098 L 127	0.021	22.825	0.823	4.068	16.519	9.215	67.485	107.332	190.389	300.330	416.917	683.948	1037.592	859.676
09TOA098 L 123	0.221	29.579	0.860	3.803	29.869	2.989	178.510	425.330	798.373	1283.280	1799.968	2713.971	3980.977	2670.477
09TOA098 M 179	0.062	28.277	2.492	11.306	79.578	3.519	283.715	590.119	1054.660	1608.269	2136.015	3090.994	4441.126	3009.558
09TOA098 M 208	0.062	28.277	2.492	11.306	79.578	3.519	283.715	590.119	1054.660	1608.269	2136.015	3090.994	4441.126	3009.558
09TOA098 M 170	0.893	42.324	3.049	7.892	65.650	2.121	301.531	676.523	1309.495	2248.133	3391.275	5228.770	7828.604	5443.540

Ti-in-zircon (T°C)	Ce/Ce*	Eu/Eu*	(Sm/Nd) cn	(Lu/Nd) cn	Lu/Hf	Nb/Ta	Nb/U	Th/U	Th/Y	Y/Hf
563	48.87	0.18	4.89	369.11	0.02	3.03	0.01	1.24	0.15	0.29
888	17.55	0.43	3.71	55.59	0.01	2.93	0.04	1.64	0.05	0.14
832	26.93	0.28	4.27	104.03	0.00	1.86	0.01	0.59	0.20	0.07
832	26.93	0.28	4.27	104.03	0.00	1.86	0.01	0.59	0.20	0.07
773		0.30	7.49	837.91	0.01	3.16	0.02	0.24	0.02	0.08
773		0.30	7.49	837.91	0.01	3.16	0.02	0.24	0.02	0.08
918	66.68	0.39	5.29	157.91	0.00	2.72	0.05	1.19	0.08	0.09
918	66.68	0.39	5.29	157.91	0.00	2.72	0.05	1.19	0.08	0.09
780	23.71	0.13	17.96	705.21	0.00	1.13	0.00	0.46	0.19	0.07
780	23.71	0.13	17.96	705.21	0.00	1.13	0.00	0.46	0.19	0.07
778		0.03	8.09	1972.84	0.01	1.08	0.01	0.23	0.05	0.11
801	45.35	0.27	8.11	258.32	0.00	1.61	0.00	0.47	0.11	0.04
732		0.15	3.21	985.76	0.00	1.32	0.01	0.34	0.05	0.04
732		0.15	3.21	985.76	0.00	1.32	0.01	0.34	0.05	0.04
768	5.35	0.08	3.88	259.39	0.00	1.88	0.01	0.45	0.15	0.07
768	5.35	0.08	3.88	259.39	0.00	1.88	0.01	0.45	0.15	0.07
798	196.44	0.20	11.15	795.44	0.00	2.25	0.01	0.33	0.08	0.03
728					0.00	0.69	0.00	0.27	0.13	0.01
968	38.41	0.36	5.86	153.31	0.00	2.71	0.06	1.28	0.05	0.07
968	38.41	0.36	5.86	153.31	0.00	2.71	0.06	1.28	0.05	0.07
846			1.58	411.37	0.00	1.19	0.01	0.33	0.12	0.04
846			1.58	411.37	0.00	1.19	0.01	0.33	0.12	0.04
763	31.09	0.05	6.77	476.39	0.00	1.35	0.01	0.45	0.17	0.07
~~589~~		~~0.50~~	~~9.77~~	~~2515.96~~	~~0.00~~	~~1.71~~	~~0.01~~	~~0.10~~	~~0.05~~	~~0.05~~
830	16.00	0.11	6.95	486.75	0.00	1.94	0.02	0.57	0.10	0.07
785	20.39	0.04	27.39	1770.34	0.00	2.00	0.01	0.50	0.12	0.06
785	20.39	0.04	27.39	1770.34	0.00	2.00	0.01	0.50	0.12	0.06
881	54.12	0.22	4.06	211.31	0.00	2.51	0.03	1.01	0.19	0.06
651	54.69	0.03	7.85	702.18	0.01	2.82	0.16	0.47	0.14	0.17
749	22.14	0.02	7.04	266.20	0.01	3.22	0.13	0.74	0.19	0.25
749	22.14	0.02	7.04	266.20	0.01	3.22	0.13	0.74	0.19	0.25
713	21.48	0.01	8.32	689.77	0.01	3.14	0.10	0.59	0.22	0.32

Notes:

Activity (SiO_2) = 1; activity (TiO_2) = 0.6.
Yellow highlighted rows are samples that intersected inclusions.
Trace element concentrations in ppm, calculated using mean count rate method.
Sweep-by-sweep downhole fractionation of U/Pb ratios NOT corrected via Si/Zr fractionation factor.
Backgrounds were monitored during sweeps 8 to 18. Sample counts were integrated from sweeps 35 to 80.
Ablation used a laser spot size of 25 microns, and a laser firing repitition rate of 10 Hz.

Table B4. Detrital zircon U-Pb geochronologic analyses from sample **09LP094** from the undivided Vampire-Narchilla unit (PЄVN) - Memorial University

File Name	Measured Isotopic Ratios							Calculated Ages (Ma)							Concordia age (Ma)	2σ error (Ma)	MSWD (of concordance)	Probability (of concordance)	Th232 (ppm)	U238 (ppm)	Th/U (ratio)
	$\frac{^{207}Pb}{^{235}U}$	1σ error	$\frac{^{206}Pb}{^{238}U}$	1σ error	Rho	$\frac{^{207}Pb}{^{206}Pb}$	1σ error	$\frac{^{207}Pb}{^{235}U}$	1σ error (Ma)	$\frac{^{206}Pb}{^{238}U}$	1σ error (Ma)	$\frac{^{207}Pb}{^{206}Pb}$	1σ error (Ma)	U-Pb/Pb-Pb concordancy (%)							
ap16a31	2.063	0.224	0.145	0.012	0.388	0.116	0.001	1137	74	874	69	1892	14	46	956	125.66	10.01	0.002	1003	918	1.092
ap16a28	4.499	0.513	0.260	0.021	0.354	0.129	0.002	1731	95	1491	107	2085	30	72	1613	174.10	4.17	0.041	59	55	1.082
ap19a33	3.144	0.398	0.212	0.028	0.525	0.104	0.001	1444	98	1238	150	1698	15	73	1413	197.30	2.59	0.107	285	443	0.643
ap16a48	7.673	0.360	0.332	0.017	0.553	0.151	0.002	2193	42	1849	83	2358	18	78	2199	83.75	25.91	0.000	248	152	1.631
ap16a29	4.413	0.143	0.268	0.006	0.371	0.116	0.001	1715	27	1528	33	1899	14	80	1640	50.33	30.01	0.000	418	542	0.772
ap16a60	5.101	0.232	0.283	0.015	0.594	0.123	0.001	1836	39	1609	77	1997	15	81	1850	75.73	13.94	0.000	223	273	0.817
ap16a19	9.047	1.055	0.361	0.011	0.133	0.158	0.005	2343	107	1987	53	2433	58	82	2019	102.67	7.70	0.006	178	323	0.551
ap16a52	0.951	0.141	0.113	0.008	0.234	0.067	0.002	679	73	691	45	824	50	84	689	84.17	0.03	0.865	82	193	0.427
ap19a11	4.630	0.264	0.270	0.016	0.504	0.112	0.001	1755	48	1543	79	1827	13	84	1732	96.28	9.80	0.002	147	276	0.533
ap19a20	4.885	0.157	0.292	0.008	0.417	0.115	0.001	1800	27	1654	39	1887	15	88	1764	52.94	15.58	0.000	113	196	0.580
ap16a04	8.358	0.492	0.381	0.020	0.441	0.152	0.001	2271	53	2082	92	2365	14	88	2248	107.28	5.15	0.023	240	140	1.718
ap19a24	13.482	0.397	0.468	0.013	0.481	0.194	0.001	2714	28	2475	58	2780	9	89	2711	55.81	22.76	0.000	188	186	1.016
ap19a39	13.025	0.413	0.471	0.013	0.423	0.192	0.002	2681	30	2489	55	2759	19	90	2664	60.16	14.85	0.000	84	33	2.521
ap16a61	5.398	0.234	0.315	0.012	0.434	0.119	0.001	1885	37	1763	58	1947	14	91	1864	73.64	5.14	0.023	361	409	0.882
ap19a12	8.189	0.297	0.381	0.012	0.433	0.145	0.001	2252	33	2081	56	2288	11	91	2230	65.73	11.51	0.001	64	175	0.365
ap19a18	5.416	0.364	0.311	0.020	0.487	0.117	0.001	1887	58	1746	100	1918	18	91	1876	115.62	2.64	0.104	212	184	1.154
ap19a30	5.149	0.274	0.306	0.013	0.402	0.115	0.001	1844	45	1719	64	1880	18	91	1813	87.59	4.07	0.044	133	183	0.726
ap16a27	4.829	0.427	0.296	0.026	0.489	0.111	0.001	1790	74	1673	127	1815	16	92	1780	148.90	1.11	0.292	419	346	1.212
ap19a10	3.164	0.217	0.240	0.011	0.322	0.094	0.001	1448	53	1389	55	1501	23	93	1419	88.77	0.88	0.347	50	128	0.387
ap16a07	5.906	0.631	0.331	0.030	0.431	0.122	0.001	1962	93	1845	148	1981	17	93	1943	183.62	0.75	0.388	127	193	0.657
ap19a34	9.240	0.302	0.418	0.012	0.440	0.156	0.001	2362	30	2250	55	2408	10	93	2353	59.98	5.24	0.022	167	247	0.675
ap19a19	2.254	0.131	0.196	0.008	0.335	0.081	0.001	1198	41	1154	41	1218	30	95	1175	67.64	0.87	0.351	46	78	0.582
ap16a09	5.230	0.243	0.325	0.010	0.322	0.117	0.002	1857	40	1814	47	1914	28	95	1841	70.15	0.72	0.396	38	57	0.658
ap16a22	5.101	0.266	0.315	0.012	0.358	0.114	0.001	1836	44	1768	58	1862	19	95	1814	82.01	1.36	0.243	69	119	0.581
ap16a55	5.357	0.309	0.331	0.015	0.384	0.118	0.001	1878	49	1841	71	1931	13	95	1869	94.16	0.28	0.594	257	411	0.625
ap16a70	5.792	0.172	0.335	0.009	0.427	0.120	0.001	1945	26	1865	41	1952	12	96	1933	50.64	4.54	0.033	253	402	0.630
ap16a20	3.178	0.174	0.255	0.007	0.256	0.095	0.002	1452	42	1464	37	1528	30	96	1459	61.97	0.07	0.797	40	89	0.446
ap19a32	6.008	0.146	0.346	0.007	0.400	0.123	0.001	1977	21	1915	32	1997	13	96	1965	41.18	4.06	0.044	160	182	0.879
ap19a22	5.943	0.206	0.333	0.012	0.516	0.118	0.001	1968	30	1855	58	1929	14	96	1966	60.36	5.29	0.021	99	239	0.413
ap19a21	4.844	0.194	0.307	0.009	0.347	0.109	0.001	1793	34	1724	42	1790	22	96	1768	61.46	2.44	0.118	44	76	0.583
ap16a30	6.501	0.235	0.356	0.010	0.390	0.125	0.001	2046	32	1964	48	2032	20	97	2029	61.71	3.19	0.074	107	125	0.854
ap16a05	6.246	0.195	0.354	0.010	0.467	0.124	0.001	2011	27	1956	49	2014	20	97	2007	54.51	1.61	0.205	111	112	0.990
ap16a08	16.509	1.349	0.547	0.035	0.391	0.209	0.002	2907	78	2814	146	2895	17	97	2898	155.58	0.47	0.492	60	84	0.708
ap16a75	2.219	0.062	0.193	0.004	0.378	0.079	0.001	1187	19	1139	22	1169	18	97	1167	34.47	4.22	0.040	177	460	0.384
ap19a26	5.951	0.189	0.340	0.008	0.381	0.119	0.001	1969	28	1889	40	1934	17	98	1949	53.00	4.25	0.039	98	88	1.120
ap19a37	5.545	0.124	0.325	0.007	0.461	0.114	0.001	1908	19	1815	33	1857	16	98	1898	38.48	10.08	0.001	122	196	0.624
ap16a40	5.433	0.190	0.331	0.010	0.429	0.115	0.001	1890	30	1845	48	1886	15	98	1884	58.97	1.03	0.310	65	220	0.293
ap19a23	9.296	0.292	0.428	0.011	0.419	0.150	0.001	2368	29	2298	51	2348	12	98	2360	57.13	2.26	0.132	90	141	0.641
ap16a11	5.808	0.200	0.344	0.008	0.337	0.118	0.002	1948	30	1906	38	1928	26	99	1934	54.41	1.08	0.298	19	63	0.296
ap16a26	14.310	0.549	0.523	0.018	0.441	0.190	0.002	2770	36	2710	75	2739	16	99	2769	72.78	0.81	0.369	90	121	0.744
ap19a04	12.635	0.424	0.493	0.014	0.433	0.175	0.001	2653	32	2582	62	2608	9	99	2649	63.12	1.60	0.205	205	160	1.282

Table B4, *continued*. Detrital zircon U-Pb geochronologic analyses from sample **09LP094** from the undivided Vampire-Narchilla unit (PЄVN) - Memorial University

File Name	Measured Isotopic Ratios							Calculated Ages (Ma)											Th232 (ppm)	U238 (ppm)	Th/U (ratio)
	$^{207}Pb/^{235}U$	1σ error	$^{206}Pb/^{238}U$	1σ error	Rho	$^{207}Pb/^{206}Pb$	1σ error	$^{207}Pb/^{235}U$	1σ error (Ma)	$^{206}Pb/^{238}U$	1σ error (Ma)	$^{207}Pb/^{206}Pb$	1σ error (Ma)	U-Pb/Pb-Pb concordancy (%)	Concordia age (Ma)	2σ error (Ma)	MSWD (of concordance)	Probability (of concordance)			
ap16a38	2.915	0.177	0.253	0.010	0.324	0.092	0.002	1386	46	1452	51	1463	44	99	1413	77.55	1.39	0.238	26	52	0.502
ap16a10	5.014	0.235	0.331	0.008	0.266	0.113	0.002	1822	40	1843	40	1854	34	99	1832	63.15	0.19	0.659	34	36	0.953
ap16a32	4.476	0.304	0.316	0.013	0.297	0.108	0.002	1726	56	1768	62	1774	30	100	1744	94.25	0.35	0.556	91	94	0.969
ap19a09	6.517	0.192	0.359	0.011	0.499	0.121	0.001	2048	26	1975	50	1977	17	100	2047	51.96	2.85	0.091	61	117	0.523
ap16a63	14.502	0.274	0.526	0.009	0.479	0.188	0.002	2783	18	2724	40	2725	14	100	2784	35.78	2.84	0.092	117	139	0.844
ap16a66	5.208	0.090	0.333	0.004	0.368	0.113	0.001	1854	15	1855	21	1850	11	100	1854	27.65	0.00	0.961	195	431	0.452
ap19a07	5.513	0.189	0.330	0.011	0.467	0.112	0.001	1903	29	1838	51	1833	11	100	1897	58.67	2.02	0.155	223	424	0.525
ap19a06	6.576	0.137	0.366	0.008	0.507	0.122	0.001	2056	18	2011	37	1993	13	101	2056	36.81	2.02	0.155	138	246	0.561
ap19a38	7.873	0.221	0.404	0.009	0.418	0.135	0.001	2217	25	2188	44	2165	15	101	2213	49.90	0.52	0.470	119	144	0.827
ap19a05	5.681	0.181	0.338	0.010	0.458	0.113	0.001	1929	28	1877	48	1851	14	101	1924	54.70	1.49	0.223	109	219	0.500
ap19a35	13.574	0.501	0.522	0.018	0.462	0.182	0.001	2720	35	2706	75	2668	12	101	2720	69.78	0.05	0.832	190	134	1.419
ap19a31	5.594	0.110	0.340	0.006	0.440	0.114	0.001	1915	17	1887	28	1858	10	102	1912	33.52	1.18	0.278	639	437	1.462
ap16a42	1.023	0.024	0.115	0.002	0.373	0.062	0.001	715	12	704	12	691	20	102	709	19.72	0.71	0.399	358	1085	0.330
ap19a13	5.629	0.226	0.342	0.008	0.302	0.114	0.002	1921	35	1897	40	1858	25	102	1911	59.80	0.28	0.594	14	42	0.345
ap16a44	5.329	0.126	0.339	0.006	0.374	0.112	0.001	1873	20	1882	29	1840	14	102	1875	38.18	0.09	0.760	161	353	0.454
ap16a15	5.734	0.244	0.344	0.011	0.372	0.114	0.002	1936	37	1907	52	1863	24	102	1929	69.58	0.32	0.573	8	77	0.106
ap19a17	6.723	0.231	0.368	0.011	0.429	0.121	0.002	2076	30	2020	51	1969	22	103	2069	60.17	1.43	0.232	43	44	0.968
ap16a39	5.520	0.159	0.344	0.009	0.479	0.114	0.001	1904	25	1905	45	1856	17	103	1904	49.30	0.00	0.968	74	196	0.376
ap16a37	5.595	0.192	0.351	0.010	0.426	0.114	0.001	1915	30	1937	49	1866	13	104	1918	57.83	0.24	0.627	182	414	0.439
ap16a33	6.171	0.237	0.376	0.009	0.322	0.121	0.001	2000	34	2057	43	1973	19	104	2018	59.98	1.55	0.213	84	120	0.704
ap19a25	5.798	0.127	0.346	0.007	0.439	0.112	0.001	1946	19	1915	32	1832	14	105	1942	37.34	1.16	0.282	67	151	0.445
ap16a72	14.481	0.302	0.541	0.011	0.486	0.181	0.001	2782	20	2788	46	2660	13	105	2782	39.60	0.02	0.882	87	102	0.856
ap16a41	4.698	0.116	0.320	0.007	0.419	0.105	0.001	1767	21	1792	32	1707	17	105	1771	40.16	0.66	0.417	96	195	0.490
ap16a65	5.402	0.237	0.347	0.010	0.333	0.111	0.001	1885	38	1921	49	1822	19	105	1896	67.66	0.51	0.476	29	136	0.215
ap16a53	6.462	0.254	0.374	0.014	0.470	0.119	0.002	2041	35	2049	65	1935	26	106	2041	68.87	0.02	0.891	147	106	1.393
ap16a17	7.093	0.164	0.404	0.008	0.429	0.128	0.005	2123	21	2187	37	2065	67	106	2128	40.47	3.66	0.056	44	113	0.390
ap16a43	11.533	0.304	0.518	0.011	0.405	0.168	0.002	2567	25	2689	47	2535	22	106	2575	48.60	7.81	0.005	203	52	3.899
ap16a50	5.774	0.299	0.367	0.013	0.348	0.116	0.001	1943	45	2017	62	1896	22	106	1961	82.33	1.42	0.234	103	114	0.902
ap16a73	5.208	0.130	0.340	0.007	0.433	0.108	0.001	1854	21	1886	35	1769	11	107	1858	41.61	0.99	0.319	132	506	0.261
ap16a76	6.320	0.165	0.374	0.010	0.522	0.117	0.001	2021	23	2047	48	1912	16	107	2020	45.74	0.39	0.530	255	364	0.700
ap16a62	5.434	0.159	0.354	0.007	0.357	0.112	0.001	1890	25	1956	35	1827	20	107	1906	46.39	3.44	0.064	31	95	0.325
ap16a77	5.905	0.172	0.363	0.008	0.375	0.113	0.001	1962	25	1998	37	1845	15	108	1969	47.90	0.98	0.322	139	308	0.453
ap16a51	7.005	0.224	0.411	0.009	0.330	0.126	0.001	2112	28	2218	40	2038	18	109	2138	51.77	6.84	0.009	93	147	0.634
ap16a54	5.566	0.181	0.363	0.009	0.402	0.112	0.001	1911	28	1996	45	1825	15	109	1923	53.88	4.03	0.045	225	396	0.567
ap16a71	3.071	0.199	0.260	0.010	0.294	0.087	0.002	1425	50	1490	51	1362	39	109	1455	79.77	1.18	0.276	21	63	0.336
ap16a59	5.343	0.172	0.351	0.009	0.408	0.108	0.001	1876	28	1941	44	1768	12	110	1885	53.32	2.47	0.116	144	525	0.273
ap16a16	6.618	0.194	0.395	0.008	0.341	0.119	0.001	2062	26	2144	36	1935	16	111	2082	47.56	5.01	0.025	115	196	0.587
ap16a64	7.137	0.157	0.414	0.007	0.365	0.121	0.001	2129	20	2231	30	1975	14	113	2147	37.06	12.01	0.001	151	249	0.606
ap16a74	2.681	0.196	0.240	0.011	0.313	0.081	0.001	1323	54	1387	57	1224	28	113	1351	89.05	0.96	0.328	55	133	0.409
ap16a49	6.585	0.205	0.402	0.010	0.419	0.118	0.001	2057	27	2177	48	1919	20	113	2068	53.68	7.13	0.008	180	145	1.243

Table B4, *continued*. Detrital zircon U-Pb geochronologic analyses from sample **09LP094** from the undivided Vampire-Narchilla unit (PЄVN) - Memorial University

File Name	Measured Isotopic Ratios							Calculated Ages (Ma)													
	$\frac{^{207}Pb}{^{235}U}$	1σ error	$\frac{^{206}Pb}{^{238}U}$	1σ error	Rho	$\frac{^{207}Pb}{^{206}Pb}$	1σ error	$\frac{^{207}Pb}{^{235}U}$	1σ error (Ma)	$\frac{^{206}Pb}{^{238}U}$	1σ error (Ma)	$\frac{^{207}Pb}{^{206}Pb}$	1σ error (Ma)	U-Pb/Pb-Pb concordancy (%)	Concordia age (Ma)	2σ error (Ma)	MSWD (of concordance)	Probability (of concordance)	Th232 (ppm)	U238 (ppm)	Th/U (ratio)
ap19a08	0.722	0.033	0.091	0.003	0.310	0.057	0.001	552	19	563	15	494	24	114	559	27.30	0.31	0.581	1098	489	2.245
ap16a06	12.459	0.483	0.543	0.020	0.471	0.155	0.002	2640	36	2797	83	2405	20	116	2636	73.09	4.49	0.034	30	80	0.371
ap16a18	6.811	0.493	0.405	0.025	0.423	0.112	0.002	2087	64	2193	114	1825	31	120	2096	125.90	1.01	0.314	20	67	0.291

Table B5a. Detrital zircon U-Pb geochronologic analyses from sample **09TOA095** from the Sekwi correlative unit (Ꞓs) - Isotope Geology Laboratory, Boise State University

Analysis	U (ppm)	Th (ppm)	Pb* (ppm)	Th/U	Corrected isotope ratios												Apparent ages (ma)						% disc.
					$^{206}Pb^*/^{207}Pb^*$	±2σ (%)	$^{207}Pb^*/^{235}U^*$	±2σ (%)	$^{206}Pb^*/^{238}U$	±2σ (%)	error corr.	$^{238}U/^{206}Pb^*$	±2σ (%)	$^{207}Pb^*/^{206}Pb^*$	±2σ (%)	error corr.	$^{207}Pb^*/^{206}Pb^*$	±2σ (Ma)	$^{207}Pb^*/^{235}U$	±2σ (Ma)	$^{206}Pb^*/^{238}U^*$	±2σ (Ma)	
09TOA095 M 264	106.98	70.97	128.86	0.66	2.844	1.894	37.901	4.505	0.782	4.087	0.907	1.279	4.087	0.352	1.894	0.0	**3714**	**29**	3717	45	3724	116	-0
09TOA095 M 253	320.43	203.85	236.74	0.64	4.031	2.177	17.984	9.998	0.526	9.758	0.976	1.902	9.758	0.248	2.177	0.0	**3172**	**35**	2989	96	2724	217	14
09TOA095 M 299	203.40	255.43	148.86	1.26	4.954	1.534	13.550	5.850	0.487	5.646	0.965	2.054	5.646	0.202	1.534	0	**2841**	**25**	2719	55	2557	119	10
09TOA095 M 319	44.73	27.15	35.85	0.61	5.142	2.817	15.164	5.827	0.566	5.101	0.875	1.768	5.101	0.194	2.817	0.0	**2780**	**46**	2826	56	2889	119	-4
09TOA095 M 278	151.04	165.29	128.73	1.09	5.273	2.184	14.294	5.458	0.547	5.002	0.916	1.829	5.002	0.190	2.184	-0.0	**2739**	**36**	2769	52	2811	114	-3
09TOA095 M 306	114.19	28.11	74.38	0.25	5.382	2.803	13.128	7.717	0.512	7.190	0.932	1.951	7.190	0.186	2.803	-0.0	**2705**	**46**	2689	73	2667	157	1
09TOA095 M 303	60.88	66.16	51.45	1.09	5.383	3.936	14.200	8.849	0.554	7.925	0.896	1.804	7.925	0.186	3.936	0	**2705**	**65**	2763	84	2843	182	-5
09TOA095 M 251	132.27	74.99	98.19	0.57	5.429	2.287	13.799	5.516	0.543	5.020	0.910	1.840	5.020	0.184	2.287	-0.0	**2691**	**38**	2736	52	2798	114	-4
09TOA095 M 225	208.36	93.02	137.13	0.45	5.446	2.498	12.312	6.873	0.486	6.403	0.932	2.056	6.403	0.184	2.498	-0.0	**2686**	**41**	2629	65	2555	135	5
09TOA095 M 281	202.29	135.12	134.15	0.67	5.536	2.217	11.615	3.966	0.466	3.288	0.829	2.144	3.288	0.181	2.217	0	**2659**	**37**	2574	37	2467	67	7
09TOA095 M 231	22.50	23.71	16.45	1.05	5.618	4.168	11.946	8.586	0.487	7.506	0.874	2.054	7.506	0.178	4.168	0	**2634**	**69**	2600	80	2557	158	3
09TOA095 M 271	117.74	75.79	82.81	0.64	5.638	2.459	12.312	5.144	0.503	4.518	0.878	1.986	4.518	0.177	2.459	0.0	**2628**	**41**	2628	48	2628	98	-0
09TOA095 M 243	131.55	97.42	94.87	0.74	5.675	1.860	12.054	4.316	0.496	3.895	0.902	2.016	3.895	0.176	1.860	0	**2617**	**31**	2609	40	2597	83	1
09TOA095 M 267	70.10	72.77	58.77	1.04	5.693	1.935	13.248	5.155	0.547	4.778	0.927	1.828	4.778	0.176	1.935	0	**2612**	**32**	2697	49	2813	109	-8
09TOA095 M 247	151.22	82.61	101.02	0.55	5.711	1.758	11.781	4.594	0.488	4.245	0.924	2.049	4.245	0.175	1.758	0.0	**2607**	**29**	2587	43	2562	90	2
09TOA095 M 239	97.28	96.63	76.53	0.99	5.722	2.329	12.217	4.941	0.507	4.358	0.882	1.972	4.358	0.175	2.329	0	**2604**	**39**	2621	46	2644	95	-2
09TOA095 M 316	54.66	46.54	41.38	0.85	5.799	2.094	12.303	4.570	0.517	4.062	0.889	1.933	4.062	0.172	2.094	0	**2581**	**35**	2628	43	2688	89	-4
09TOA095 M 229	74.84	29.53	48.93	0.39	5.865	3.036	11.700	6.299	0.498	5.520	0.876	2.009	5.520	0.171	3.036	0	**2563**	**51**	2581	59	2604	118	-2
09TOA095 M 245	165.49	55.89	100.96	0.34	5.968	2.245	10.886	4.655	0.471	4.078	0.876	2.122	4.078	0.168	2.245	0	**2533**	**38**	2513	43	2489	84	2
09TOA095 M 259	145.37	38.57	78.96	0.27	6.100	2.220	9.902	4.710	0.438	4.154	0.882	2.283	4.154	0.164	2.220	0.0	**2497**	**37**	2426	43	2342	82	6
09TOA095 M 322	265.83	77.04	152.28	0.29	6.320	1.946	9.896	5.393	0.454	5.030	0.933	2.204	5.030	0.158	1.946	0	**2437**	**33**	2425	50	2411	101	1
09TOA095 M 270	225.34	52.57	125.00	0.23	6.547	1.892	9.463	4.356	0.449	3.924	0.901	2.225	3.924	0.153	1.892	0.0	**2377**	**32**	2384	40	2392	78	-1
09TOA095 M 230	125.25	118.55	81.01	0.95	6.687	2.788	8.954	6.587	0.434	5.968	0.906	2.303	5.968	0.150	2.788	-0.0	**2341**	**48**	2333	60	2325	116	1
09TOA095 M 246	41.46	20.80	21.47	0.50	7.582	2.926	7.134	6.252	0.392	5.525	0.884	2.549	5.525	0.132	2.926	-0.0	**2123**	**51**	2128	56	2133	100	-0
09TOA095 M 295	98.70	41.78	49.24	0.42	7.648	2.347	7.062	5.245	0.392	4.690	0.894	2.553	4.690	0.131	2.347	-0.0	**2108**	**41**	2119	47	2131	85	-1
09TOA095 M 226	197.81	151.95	105.49	0.77	7.714	3.066	6.721	6.561	0.376	5.800	0.884	2.659	5.800	0.130	3.066	-0.0	**2093**	**54**	2075	58	2058	102	2
09TOA095 M 304	188.21	112.91	74.70	0.60	7.854	2.697	5.381	6.249	0.307	5.637	0.902	3.262	5.637	0.127	2.697	-0.0	**2061**	**48**	1882	54	1724	85	16
09TOA095 M 327	201.77	113.61	104.01	0.56	7.867	2.373	6.839	4.086	0.390	3.326	0.814	2.563	3.326	0.127	2.373	0	**2058**	**42**	2091	36	2124	60	-3
09TOA095 M 282	155.99	37.64	72.53	0.24	7.994	2.470	6.419	4.849	0.372	4.173	0.861	2.687	4.173	0.125	2.470	0.0	**2030**	**44**	2035	43	2039	73	-0
09TOA095 M 261	217.50	326.17	94.58	1.50	8.107	2.097	4.805	9.594	0.283	9.362	0.976	3.539	9.362	0.123	2.097	-0.0	**2005**	**37**	1786	81	1604	133	20
09TOA095 M 274	240.15	210.46	103.06	0.88	8.213	2.105	5.463	7.520	0.325	7.220	0.960	3.073	7.220	0.122	2.105	0.0	**1982**	**37**	1895	65	1816	114	8
09TOA095 M 296	129.77	111.66	66.76	0.86	8.267	2.469	6.044	5.680	0.362	5.116	0.901	2.759	5.116	0.121	2.469	-0.0	**1970**	**44**	1982	49	1994	88	-1
09TOA095 M 309	136.49	42.25	58.51	0.31	8.282	2.397	5.838	7.471	0.351	7.076	0.947	2.852	7.076	0.121	2.397	0	**1967**	**43**	1952	65	1938	118	1
09TOA095 M 308	184.65	53.41	78.81	0.29	8.357	2.310	5.700	4.821	0.345	4.231	0.878	2.895	4.231	0.120	2.310	-0.0	**1951**	**41**	1931	42	1913	70	2
09TOA095 M 273	139.83	105.94	69.91	0.76	8.475	2.562	5.932	5.707	0.365	5.100	0.894	2.743	5.100	0.118	2.562	0.0	**1926**	**46**	1966	50	2004	88	-4
09TOA095 M 250	287.07	244.97	142.12	0.85	8.557	1.953	5.634	3.912	0.350	3.389	0.866	2.860	3.389	0.117	1.953	-0.0	**1909**	**35**	1921	34	1933	57	-1
09TOA095 M 265	131.77	179.83	68.05	1.36	8.588	2.065	5.410	5.469	0.337	5.064	0.926	2.968	5.064	0.116	2.065	-0.0	**1902**	**37**	1886	47	1872	82	2
09TOA095 M 293	171.95	63.87	71.52	0.37	8.596	2.497	5.358	6.056	0.334	5.517	0.911	2.994	5.517	0.116	2.497	0	**1901**	**45**	1878	52	1858	89	2
09TOA095 M 266	139.70	127.23	65.71	0.91	8.714	2.133	5.249	5.755	0.332	5.345	0.929	3.014	5.345	0.115	2.133	0.0	**1876**	**38**	1861	49	1847	86	2
09TOA095 M 321	74.90	43.84	36.39	0.59	8.731	2.928	5.779	5.250	0.366	4.357	0.830	2.733	4.357	0.115	2.928	0	**1873**	**53**	1943	45	2010	75	-7
09TOA095 M 238	215.79	76.40	91.22	0.35	8.752	2.330	5.284	5.234	0.335	4.686	0.895	2.982	4.686	0.114	2.330	0	**1868**	**42**	1866	45	1864	76	0
09TOA095 M 297	277.64	190.12	105.66	0.68	8.782	2.075	4.698	5.844	0.299	5.464	0.935	3.342	5.464	0.114	2.075	-0.0	**1862**	**37**	1767	49	1687	81	9

Table B5a, *continued*. Detrital zircon U-Pb geochronologic analyses from sample **09TOA095** from the Sekwi correlative unit (Ꞓs) - Isotope Geology Laboratory, Boise State University

Analysis	U (ppm)	Th (ppm)	Pb^* (ppm)	Th/U	Corrected isotope ratios												Apparent ages (ma)						% disc.
					$\frac{^{206}Pb^*}{^{207}Pb^*}$	±2σ (%)	$\frac{^{207}Pb^*}{^{235}U^*}$	±2σ (%)	$\frac{^{206}Pb^*}{^{238}U}$	±2σ (%)	error corr.	$\frac{^{238}U}{^{206}Pb^*}$	±2σ (%)	$\frac{^{207}Pb^*}{^{206}Pb^*}$	±2σ (%)	error corr.	$\frac{^{207}Pb^*}{^{206}Pb^*}$	±2σ (Ma)	$\frac{^{207}Pb^*}{^{235}U}$	±2σ (Ma)	$\frac{^{206}Pb^*}{^{238}U^*}$	±2σ (Ma)	
09TOA095 M 324	273.93	137.32	118.20	0.50	8.854	2.256	5.205	4.764	0.334	4.196	0.881	2.992	4.196	0.113	2.256	0	**1847**	**41**	1853	41	1859	68	-1
09TOA095 M 320	172.94	85.80	70.89	0.50	8.890	2.930	5.000	6.462	0.322	5.760	0.891	3.102	5.760	0.112	2.930	0.0	**1840**	**53**	1819	55	1801	91	2
09TOA095 M 254	116.38	83.96	51.87	0.72	8.908	2.443	5.113	4.546	0.330	3.833	0.843	3.027	3.833	0.112	2.443	0	**1836**	**44**	1838	39	1840	61	-0
09TOA095 M 317	33.03	61.42	20.68	1.86	8.916	3.362	5.542	5.803	0.358	4.729	0.815	2.790	4.729	0.112	3.362	-0.0	**1835**	**61**	1907	50	1975	80	-8
09TOA095 M 241	143.60	371.42	64.43	2.59	8.952	3.058	4.646	6.857	0.302	6.138	0.895	3.315	6.138	0.112	3.058	-0.0	**1827**	**55**	1757	57	1699	92	7
09TOA095 M 272	113.61	102.08	49.13	0.90	8.987	3.276	4.743	5.320	0.309	4.191	0.788	3.235	4.191	0.111	3.276	0.0	**1820**	**59**	1775	45	1737	64	5
09TOA095 M 236	174.57	62.50	70.04	0.36	9.139	2.622	4.877	6.030	0.323	5.430	0.900	3.093	5.430	0.109	2.622	0	**1790**	**48**	1798	51	1806	86	-1
09TOA095 M 288	14.28	25.93	8.09	1.82	9.162	6.630	4.914	10.097	0.327	7.615	0.754	3.062	7.615	0.109	6.630	0	**1785**	**121**	1805	85	1822	121	-2
09TOA095 M 269	62.52	45.77	28.68	0.73	9.272	3.544	4.946	5.543	0.333	4.261	0.769	3.006	4.261	0.108	3.544	-0.0	**1763**	**65**	1810	47	1851	69	-5
09TOA095 M 314	148.49	125.92	61.49	0.85	9.615	2.667	4.196	5.903	0.293	5.266	0.892	3.417	5.266	0.104	2.667	0	**1697**	**49**	1673	48	1655	77	2
09TOA095 M 328	112.50	106.16	47.98	0.94	9.827	2.572	4.151	6.609	0.296	6.088	0.921	3.380	6.088	0.102	2.572	-0.0	**1656**	**48**	1664	54	1671	90	-1
09TOA095 M 257	122.25	89.03	43.88	0.73	10.108	2.559	3.639	4.670	0.267	3.907	0.837	3.748	3.907	0.099	2.559	0.0	**1604**	**48**	1558	37	1525	53	5
09TOA095 M 235	22.96	21.64	9.25	0.94	10.353	7.090	3.641	8.930	0.273	5.430	0.608	3.658	5.430	0.097	7.090	0.0	**1559**	**133**	1559	71	1558	75	0
09TOA095 M 291	265.45	136.19	86.67	0.51	10.394	2.469	3.381	5.024	0.255	4.375	0.871	3.923	4.375	0.096	2.469	0	**1552**	**46**	1500	39	1464	57	6
09TOA095 M 313	74.56	101.97	34.08	1.37	10.406	3.067	3.875	5.627	0.292	4.717	0.838	3.419	4.717	0.096	3.067	-0.0	**1550**	**58**	1609	45	1654	69	-7
09TOA095 M 233	86.09	77.02	33.31	0.89	10.545	3.109	3.526	7.896	0.270	7.258	0.919	3.708	7.258	0.095	3.109	-0.0	**1525**	**59**	1533	62	1539	99	-1
09TOA095 M 222	195.19	73.50	62.33	0.38	10.695	2.457	3.313	5.517	0.257	4.940	0.895	3.891	4.940	0.094	2.457	0	**1498**	**46**	1484	43	1474	65	2
09TOA095 M 256	229.90	78.47	69.22	0.34	10.734	2.007	3.206	4.388	0.250	3.902	0.889	4.007	3.902	0.093	2.007	0.0	**1491**	**38**	1459	34	1436	50	4
09TOA095 M 326	54.55	22.45	17.13	0.41	10.889	4.403	3.178	6.437	0.251	4.696	0.730	3.984	4.696	0.092	4.403	0.0	**1464**	**84**	1452	50	1444	61	1
09TOA095 M 276	160.75	53.81	51.89	0.33	10.926	2.309	3.363	5.773	0.266	5.291	0.917	3.753	5.291	0.092	2.309	0	**1458**	**44**	1496	45	1523	72	-4
09TOA095 M 221	258.01	77.66	78.05	0.30	10.927	2.457	3.158	5.796	0.250	5.250	0.906	3.995	5.250	0.092	2.457	0	**1457**	**47**	1447	45	1440	68	1
09TOA095 M 223	89.18	51.73	28.01	0.58	10.976	2.626	3.012	6.604	0.240	6.059	0.918	4.171	6.059	0.091	2.626	0.0	**1449**	**50**	1411	50	1385	76	4
09TOA095 M 302	66.84	38.11	21.90	0.57	10.989	3.950	3.208	7.113	0.256	5.916	0.832	3.911	5.916	0.091	3.950	-0.0	**1447**	**75**	1459	55	1468	78	-1
09TOA095 M 307	276.78	88.10	85.45	0.32	11.007	2.549	3.211	5.790	0.256	5.199	0.898	3.901	5.199	0.091	2.549	-0.0	**1443**	**49**	1460	45	1471	68	-2
09TOA095 M 286	92.04	42.98	33.70	0.47	11.040	3.034	3.618	6.339	0.290	5.566	0.878	3.451	5.566	0.091	3.034	-0.0	**1438**	**58**	1554	50	1640	81	-14
09TOA095 M 310	123.25	71.05	40.53	0.58	11.100	2.129	3.176	5.848	0.256	5.447	0.931	3.911	5.447	0.090	2.129	-0.0	**1427**	**41**	1451	45	1468	72	-3
09TOA095 M 298	178.14	32.78	53.11	0.18	11.169	2.359	3.191	5.743	0.258	5.236	0.912	3.869	5.236	0.090	2.359	0.0	**1416**	**45**	1455	44	1482	69	-5
09TOA095 M 284	63.41	44.98	21.69	0.71	11.172	5.079	3.133	6.863	0.254	4.616	0.673	3.939	4.616	0.090	5.079	0.0	**1415**	**97**	1441	53	1458	60	-3
09TOA095 M 292	131.05	48.61	38.18	0.37	11.173	2.677	2.934	4.746	0.238	3.919	0.826	4.206	3.919	0.090	2.677	0.0	**1415**	**51**	1391	36	1375	49	3
09TOA095 M 277	165.79	54.90	50.72	0.33	11.234	2.389	3.100	4.579	0.253	3.906	0.853	3.960	3.906	0.089	2.389	0	**1405**	**46**	1433	35	1452	51	-3
09TOA095 M 287	121.52	60.91	37.38	0.50	11.291	3.649	2.957	6.759	0.242	5.690	0.842	4.130	5.690	0.089	3.649	-0.0	**1395**	**70**	1397	51	1398	72	-0
09TOA095 M 242	211.14	65.47	61.22	0.31	11.371	2.609	2.894	6.229	0.239	5.657	0.908	4.191	5.657	0.088	2.609	0	**1381**	**50**	1380	47	1380	70	0
09TOA095 M 258	156.45	63.52	45.22	0.41	11.595	2.563	2.833	5.458	0.238	4.818	0.883	4.197	4.818	0.086	2.563	-0.0	**1344**	**50**	1364	41	1378	60	-3
09TOA095 M 325	196.54	157.67	60.40	0.80	11.929	2.491	2.558	4.897	0.221	4.216	0.861	4.518	4.216	0.084	2.491	0	**1289**	**48**	1289	36	1289	49	-0
09TOA095 M 294	186.75	68.89	57.80	0.37	11.948	2.643	2.943	6.293	0.255	5.711	0.908	3.921	5.711	0.084	2.643	-0.0	**1285**	**51**	1393	48	1464	75	-14
09TOA095 M 285	124.13	49.80	36.10	0.40	11.999	3.588	2.710	6.719	0.236	5.680	0.845	4.240	5.680	0.083	3.588	-0.0	**1277**	**70**	1331	50	1365	70	-7
09TOA095 M 279	47.81	28.57	15.26	0.60	12.124	4.550	2.779	7.191	0.244	5.568	0.774	4.093	5.568	0.082	4.550	0	**1257**	**89**	1350	54	1409	70	-12
09TOA095 M 260	471.83	42.60	107.14	0.09	12.219	2.369	2.286	6.228	0.203	5.760	0.925	4.936	5.760	0.082	2.369	-0.0	**1242**	**46**	1208	44	1189	63	4
09TOA095 M 244	290.80	173.23	66.96	0.60	12.233	2.908	2.005	5.012	0.178	4.083	0.815	5.622	4.083	0.082	2.908	0.0	**1239**	**57**	1117	34	1055	40	15
09TOA095 M 290	65.88	20.21	17.99	0.31	12.265	4.079	2.592	7.623	0.231	6.440	0.845	4.337	6.440	0.082	4.079	-0.0	**1234**	**80**	1298	56	1337	78	-8
09TOA095 M 311	111.53	60.89	29.74	0.55	12.422	3.775	2.363	6.442	0.213	5.220	0.810	4.698	5.220	0.080	3.775	0.0	**1209**	**74**	1231	46	1244	59	-3
09TOA095 M 280	113.23	49.37	28.65	0.44	12.485	3.183	2.248	6.002	0.204	5.088	0.848	4.913	5.088	0.080	3.183	0.0	**1199**	**63**	1196	42	1194	55	0

Table B5a, *continued*. Detrital zircon U-Pb geochronologic analyses from sample **09TOA095** from the Sekwi correlative unit (Ꞓs) - Isotope Geology Laboratory, Boise State University

Analysis	U (ppm)	Th (ppm)	Pb^* (ppm)	Th/U	Corrected isotope ratios												Apparent ages (ma)						% disc.
					$\frac{^{206}Pb^*}{^{207}Pb^*}$	±2σ (%)	$\frac{^{207}Pb^*}{^{235}U^*}$	±2σ (%)	$\frac{^{206}Pb^*}{^{238}U}$	±2σ (%)	error corr.	$\frac{^{238}U}{^{206}Pb^*}$	±2σ (%)	$\frac{^{207}Pb^*}{^{206}Pb^*}$	±2σ (%)	error corr.	$\frac{^{207}Pb^*}{^{206}Pb^*}$	±2σ (Ma)	$\frac{^{207}Pb^*}{^{235}U}$	±2σ (Ma)	$\frac{^{206}Pb^*}{^{238}U^*}$	±2σ (Ma)	
09TOA095 M 224	98.85	173.17	33.70	1.75	12.510	2.836	2.124	7.273	0.193	6.698	0.921	5.190	6.698	0.080	2.836	0	**1195**	**56**	1156	50	1136	70	5
09TOA095 M 234	190.39	76.31	46.73	0.40	12.673	2.913	2.150	6.324	0.198	5.614	0.888	5.061	5.614	0.079	2.913	-0.0	**1170**	**58**	1165	44	1162	60	1
09TOA095 M 248	124.78	100.67	30.58	0.81	12.888	3.649	1.891	6.150	0.177	4.951	0.805	5.658	4.951	0.078	3.649	-0.0	**1136**	**73**	1078	41	1049	48	8
09TOA095 M 275	126.78	110.51	36.26	0.87	12.913	3.093	2.219	5.726	0.208	4.818	0.842	4.812	4.818	0.077	3.093	-0.0	**1133**	**62**	1187	40	1217	53	-7
09TOA095 M 237	154.58	43.22	36.67	0.28	13.033	2.662	2.114	4.527	0.200	3.662	0.809	5.005	3.662	0.077	2.662	-0.0	**1114**	**53**	1153	31	1174	39	-5
09TOA095 M 227	299.32	146.95	68.59	0.49	13.064	2.619	1.899	5.085	0.180	4.358	0.857	5.557	4.358	0.077	2.619	0	**1109**	**52**	1081	34	1067	43	4
09TOA095 M 312	194.61	104.02	45.13	0.53	13.093	2.613	1.921	5.838	0.182	5.221	0.894	5.482	5.221	0.076	2.613	-0.0	**1105**	**52**	1088	39	1080	52	2
09TOA095 M 300	179.73	107.26	42.18	0.60	13.152	4.049	1.897	7.888	0.181	6.769	0.858	5.526	6.769	0.076	4.049	0.0	**1096**	**81**	1080	52	1072	67	2
09TOA095 M 232	108.87	85.84	27.79	0.79	13.163	3.830	1.928	6.805	0.184	5.625	0.827	5.433	5.625	0.076	3.830	0	**1094**	**77**	1091	46	1089	56	0
09TOA095 M 255	153.49	159.52	35.91	1.04	13.176	4.053	1.781	7.706	0.170	6.554	0.851	5.877	6.554	0.076	4.053	0.0	**1092**	**81**	1038	50	1013	61	7
09TOA095 M 305	57.22	27.59	13.17	0.48	13.199	4.321	1.918	6.764	0.184	5.204	0.769	5.447	5.204	0.076	4.321	0.0	**1089**	**87**	1087	45	1087	52	0
09TOA095 M 323	177.66	23.94	39.11	0.13	13.209	2.530	2.036	4.928	0.195	4.229	0.858	5.127	4.229	0.076	2.530	-0.0	**1087**	**51**	1128	34	1149	45	-6
09TOA095 M 240	150.72	95.90	37.75	0.64	13.346	3.503	1.958	7.169	0.190	6.254	0.872	5.275	6.254	0.075	3.503	-0.0	**1067**	**70**	1101	48	1119	64	-5
09TOA095 M 283	228.98	65.58	53.64	0.29	13.518	3.275	2.023	7.123	0.198	6.325	0.888	5.043	6.325	0.074	3.275	-0.0	**1041**	**66**	1123	48	1166	67	-12
09TOA095 M 228	41.40	19.17	10.09	0.46	13.538	3.466	1.978	9.477	0.194	8.821	0.931	5.149	8.821	0.074	3.466	-0.0	**1038**	**70**	1108	64	1144	92	-10
09TOA095 M 262	89.69	46.04	18.70	0.51	13.747	4.356	1.682	6.745	0.168	5.150	0.763	5.962	5.150	0.073	4.356	0.0	**1007**	**88**	1002	43	1000	48	1
09TOA095 M 263	67.91	41.50	15.36	0.61	13.892	6.535	1.786	8.006	0.180	4.624	0.578	5.558	4.624	0.072	6.535	-0.0	**985**	**133**	1040	52	1067	45	-8

Notes:

Yellow highlighted rows are samples that intersected inclusions.
Isotope ratios and ages are NOT corrected for initial common Pb.
Isotope ratio and apparent age errors include systematic calibration errors of 5.88531041610563% ($^{208}Pb/^{232}Th$), 0.384628088162782% ($^{207}Pb/^{206}Pb$), 0.857953833283302% ($^{206}Pb/^{238}U$) (all 1-sigma).
Trace element concentrations in ppm, calculated using mean count rate method.
Sweep-by-sweep downhole fractionation of U/Pb ratios NOT corrected via Si/Zr fractionation factor.
Backgrounds were monitored during sweeps 10 to 27. Sample counts were integrated from sweeps 36 to 69.
Ablation used a laser spot size of 25 microns, and a laser firing repitition rate of 10 Hz.

Table B5b. Detrital zircon trace element analyses from sample **09TOA095** from the Sekwi correlative unit (Cs) - Isotope Geology Laboratory, Boise State University

Analysis	Concentrations (ppm)																						
	P	Ti	Y	Zr	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	Th	U
09TOA095 M 264	281.555	9.307	1213.497	495076.209	1.506	0.017	14.051	0.131	2.163	4.960	2.251	30.842	10.547	130.775	46.838	186.624	46.678	493.134	55.396	6979.491	0.477	70.975	106.982
09TOA095 M 253	224.155	17.359	819.194	478914.187	2.381	0.140	11.744	0.453	5.886	11.332	4.469	35.300	9.299	95.657	28.987	122.267	31.976	376.519	40.725	8152.000	1.050	203.852	320.433
09TOA095 M 299	128.026	6.515	682.830	462815.297	0.530	0.080	4.147	0.331	3.257	6.442	3.174	23.325	6.950	74.673	24.021	101.810	28.520	347.186	39.940	5566.636	0.229	255.427	203.404
09TOA095 M 319	216.627	4.080	607.654	447404.838	0.561		13.390	0.129	2.365	3.474	1.735	15.411	4.924	57.523	21.130	99.555	30.177	387.505	46.151	5472.370	0.292	27.153	44.726
09TOA095 M 278	192.081	4.517	1100.781	448874.719	1.331	0.049	29.602	0.522	7.676	11.596	2.275	42.952	12.691	122.855	41.791	167.719	44.433	487.420	46.735	6245.595	0.678	165.290	151.042
09TOA095 M 306	183.936	9.945	223.153	453397.656	0.362		1.278	0.012	1.576	3.355	0.410	10.363	2.605	25.344	7.390	28.791	7.325	83.879	8.376	7122.123	0.241	28.110	114.187
09TOA095 M 303	128.414	20.889	203.704	486971.943	0.585		1.592	0.102	1.704	3.272	0.072	15.848	4.185	35.986	7.286	18.158	2.660	18.208	1.141	10125.248	0.260	66.158	60.876
09TOA095 M 251	83.567	4.123	177.570	471753.451	0.782		17.520	0.017	0.306	0.529	0.256	3.801	1.564	17.511	5.802	25.065	7.742	99.744	11.194	7686.641	0.506	74.989	132.274
09TOA095 M 225	184.785	6.289	417.794	472486.578	1.467	0.050	9.690	0.019	0.938	1.434	0.248	10.304	3.706	42.804	15.597	66.011	17.116	198.793	20.506	7786.731	1.218	93.022	208.358
09TOA095 M 281	~~125.253~~	~~11.823~~	~~267.956~~	~~443859.738~~	~~0.985~~	~~0.116~~	~~30.780~~	~~0.132~~	~~1.486~~	~~1.765~~	~~1.046~~	~~6.838~~	~~2.027~~	~~23.084~~	~~8.157~~	~~36.984~~	~~11.646~~	~~162.051~~	~~19.370~~	~~6534.153~~	~~0.194~~	~~135.120~~	~~202.286~~
09TOA095 M 231	239.347	20.237	604.968	484869.200	1.872	0.065	7.370	0.041	2.216	4.453	1.790	23.136	6.486	66.033	21.874	84.171	19.995	203.753	22.601	6716.245	0.711	23.714	22.503
09TOA095 M 271	269.544	12.675	699.828	452517.585	2.371	0.867	8.105	0.394	5.577	6.751	0.441	30.332	7.743	88.588	29.478	103.148	26.147	268.478	26.929	6963.115	1.165	75.787	117.737
09TOA095 M 243	223.045	6.848	660.541	444668.121	1.829		29.273	0.083	1.644	4.466	1.007	17.819	5.654	67.866	24.615	102.401	29.726	332.033	33.924	6286.980	1.296	97.418	131.552
09TOA095 M 267	159.705	14.441	406.923	497465.784	0.624		14.628	0.073	2.089	3.454	0.760	12.158	3.854	39.741	13.850	63.846	15.704	182.531	19.365	7557.348	0.550	72.769	70.100
09TOA095 M 247	204.485	8.986	429.573	455281.585	0.699	0.074	10.859	0.062	1.879	3.379	0.482	15.602	4.604	52.364	16.479	64.605	16.128	173.187	18.013	6712.545	0.539	82.607	151.223
09TOA095 M 239	212.975	4.525	490.705	430341.437	1.353	0.145	26.042	0.137	2.193	4.775	1.123	18.487	5.448	55.578	17.506	70.975	19.654	225.156	21.883	6264.816	0.568	96.633	97.277
09TOA095 M 316	165.979	12.132	461.359	446170.086	0.704		17.093	0.104	2.765	4.607	1.156	18.603	5.289	55.125	16.617	65.969	17.768	206.229	20.121	5784.333	0.411	46.542	54.662
09TOA095 M 229	114.933	7.232	453.771	459215.903	1.602		5.282	0.005	0.826	2.643	0.734	13.154	4.075	51.557	18.796	70.008	17.454	191.745	19.771	6296.958	0.646	29.528	74.842
09TOA095 M 245	182.266	10.368	405.447	456705.499	0.921		7.017	0.082	0.497	2.159	0.237	9.029	3.227	41.213	15.578	65.247	16.956	202.905	21.182	7418.305	0.829	55.888	165.486
09TOA095 M 259	~~211.470~~	~~90.312~~	~~425.622~~	~~510815.728~~	~~0.677~~	~~0.151~~	~~3.687~~	~~0.044~~	~~0.988~~	~~1.991~~	~~0.406~~	~~12.285~~	~~3.599~~	~~44.498~~	~~15.957~~	~~73.635~~	~~19.160~~	~~215.172~~	~~25.959~~	~~8857.669~~	~~0.494~~	~~38.569~~	~~145.372~~
09TOA095 M 322	140.228	4.809	475.274	423558.182	3.753	0.197	7.362	0.058	0.527	1.791	0.072	8.788	3.547	42.439	17.540	77.663	22.869	262.286	26.050	7340.157	2.578	77.043	265.827
09TOA095 M 270	439.971	13.791	788.457	455733.889	0.481		2.392	0.039	1.639	4.201	0.172	19.837	7.219	85.199	30.079	117.723	31.185	341.770	34.991	8073.402	0.645	52.573	225.336
09TOA095 M 230	160.549	6.492	555.308	480599.252	3.921		18.740	0.084	1.334	4.136	0.142	18.724	5.879	64.227	21.222	85.497	21.271	219.639	22.485	7555.517	1.819	118.552	125.247
09TOA095 M 246	165.736	18.303	350.395	457356.820	2.210	0.045	2.706	0.026	1.299	2.367	0.334	10.379	3.692	42.720	14.351	54.063	14.039	164.568	16.473	6373.885	0.823	20.799	41.457
09TOA095 M 295	237.294	11.575	531.934	456015.789	1.218	0.001	4.179	0.101	1.284	2.940	0.116	13.516	5.035	59.643	19.888	84.086	22.081	244.139	25.197	7292.080	0.601	41.776	98.698
09TOA095 M 226	202.669	15.284	1056.197	474103.554	2.588		10.544	0.170	4.365	8.199	0.244	35.319	10.475	117.310	38.532	153.573	39.766	398.683	39.797	7670.027	1.293	151.949	197.807
09TOA095 M 304	191.802	13.867	655.120	468463.445	2.840	0.236	32.408	1.339	14.130	15.229	4.080	40.062	9.432	79.432	22.420	85.013	21.481	227.708	22.951	7429.384	1.629	112.914	188.211
09TOA095 M 327	~~346.120~~	~~8.272~~	~~1140.974~~	~~435655.351~~	~~1.545~~	~~8.998~~	~~23.224~~	~~2.677~~	~~19.861~~	~~12.091~~	~~0.872~~	~~42.551~~	~~13.221~~	~~137.562~~	~~45.449~~	~~171.108~~	~~41.079~~	~~448.950~~	~~41.161~~	~~6387.558~~	~~1.025~~	~~113.613~~	~~201.769~~
09TOA095 M 282	83.365	4.306	109.539	422869.152	0.226		4.710	0.006	0.539	0.991	0.415	4.937	1.448	14.269	3.772	13.975	3.764	42.974	4.581	7607.777	0.116	37.640	155.990
09TOA095 M 261	540.417	35.359	2219.711	524704.124	2.781	0.467	75.974	3.440	47.150	76.997	27.262	178.572	40.926	325.406	78.920	263.947	59.453	543.078	59.058	6698.438	1.031	326.169	217.496
09TOA095 M 274	248.182	20.253	771.395	427875.237	2.897		17.066	0.228	3.315	7.584	2.220	30.346	9.016	94.994	28.673	111.479	27.986	307.159	30.673	7026.205	1.612	210.456	240.155
09TOA095 M 296	264.036	18.488	657.748	468241.143	1.716		21.156	0.353	5.282	7.381	0.889	26.963	7.349	76.658	22.817	90.649	23.579	262.609	25.939	6718.367	0.833	111.663	129.774
09TOA095 M 309	135.939	3.958	309.776	465924.448	1.414		4.740	0.012	0.365	0.984	0.265	7.597	2.917	32.366	11.682	51.911	13.783	151.080	15.304	7251.628	0.849	42.246	136.487
09TOA095 M 308	528.327	16.167	1044.745	438656.530	0.721	0.981	4.489	0.242	2.340	2.566	0.112	20.719	8.246	108.566	38.933	161.854	43.541	471.408	46.442	7753.784	0.553	53.412	184.646
09TOA095 M 273	141.345	7.798	435.570	474284.543	1.493	0.156	11.424	0.087	1.126	2.623	0.570	11.102	3.839	45.397	15.999	65.795	17.869	190.600	20.380	6895.335	0.401	105.941	139.831
09TOA095 M 250	325.124	23.262	1101.926	475296.225	2.475	0.878	22.296	0.479	5.543	7.679	1.152	31.503	10.307	115.325	40.495	164.990	44.311	486.144	51.190	6500.312	1.492	244.970	287.070
09TOA095 M 265	269.034	9.493	709.278	493289.629	1.741	0.243	17.801	0.229	3.772	6.889	1.474	28.187	8.073	88.371	27.181	109.905	26.325	277.847	29.893	8667.297	0.750	179.834	131.767
09TOA095 M 293	762.818	17.696	1503.862	464074.170	1.906	0.144	5.620	0.185	1.751	3.655	0.290	24.950	11.233	150.595	56.752	246.336	65.603	741.985	75.931	8957.088	1.342	63.866	171.951
09TOA095 M 266	238.147	21.653	602.131	477632.849	1.914	0.268	22.294	0.229	3.650	5.656	1.023	18.727	5.922	67.115	23.406	95.094	24.508	264.638	31.992	6450.773	0.762	127.225	139.698
09TOA095 M 321	166.307	16.571	369.142	434791.115	3.691		9.523	0.060	1.868	4.280	0.394	14.526	4.645	47.050	14.678	54.806	14.220	151.902	14.583	6051.912	1.416	43.841	74.896
09TOA095 M 238	195.064	7.475	504.146	432771.347	2.009	0.231	7.505	0.091	1.295	2.577	0.098	11.385	3.964	52.218	19.189	75.825	20.861	236.656	22.764	6614.661	1.100	76.399	215.790
09TOA095 M 297	~~558.565~~	~~20.883~~	~~1099.758~~	~~468594.827~~	~~0.870~~	~~0.062~~	~~4.193~~	~~0.394~~	~~5.421~~	~~13.347~~	~~4.454~~	~~45.426~~	~~14.150~~	~~142.527~~	~~42.074~~	~~152.601~~	~~36.339~~	~~384.575~~	~~37.574~~	~~8606.306~~	~~0.335~~	~~190.117~~	~~277.641~~
09TOA095 M 324	247.358	8.611	742.865	438886.448	1.875		8.089	0.076	1.306	3.799	0.199	18.564	6.555	81.688	28.480	113.203	30.039	333.574	31.549	6160.988	1.281	137.318	273.926

Table B5b, *continued.* Detrital zircon trace element analyses from sample **09TOA095** from the Sekwi correlative unit (Ꞓs) - Isotope Geology Laboratory, Boise State University

Analysis	Concentrations (ppm)																						
	P	Ti	Y	Zr	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	Th	U
09TOA095 M 320	210.706	19.058	1096.564	427449.076	0.999	0.088	4.647	0.427	5.523	9.190	0.831	37.718	10.790	122.304	42.218	167.664	45.945	505.861	48.626	5656.457	0.438	85.804	172.935
09TOA095 M 254	198.709	17.697	850.968	498103.723	1.565		7.998	0.256	4.683	8.236	1.085	28.611	8.930	100.482	33.127	127.379	30.800	328.972	34.909	6423.005	0.837	83.956	116.378
09TOA095 M 317	111.035	17.666	154.680	438231.518	1.529	0.026	9.546	0.106	1.783	3.248	0.208	10.454	2.539	24.636	5.882	18.121	3.793	39.159	3.285	7193.634	1.120	61.418	33.027
09TOA095 M 241	~~287.004~~	~~77.036~~	~~872.169~~	~~363443.834~~	~~1.105~~	~~0.411~~	~~16.813~~	~~1.134~~	~~14.177~~	~~24.401~~	~~6.622~~	~~59.628~~	~~15.103~~	~~133.084~~	~~35.460~~	~~124.308~~	~~26.341~~	~~250.840~~	~~29.364~~	~~5157.376~~	~~0.386~~	~~371.419~~	~~143.605~~
09TOA095 M 272	203.003	18.787	539.810	454663.273	2.794	0.088	18.338	0.125	2.103	3.747	0.610	15.629	5.305	58.258	20.493	84.442	21.930	240.718	23.692	7139.438	1.353	102.084	113.609
09TOA095 M 236	232.257	10.136	757.162	438803.641	2.954	0.017	6.955	0.060	0.671	2.645	0.211	16.675	6.033	84.546	29.625	122.443	33.827	372.525	36.184	6953.539	1.491	62.504	174.574
09TOA095 M 288	269.611	35.565	739.442	473497.470	1.339	0.067	8.914	0.485	9.038	13.548	1.521	44.104	10.243	97.948	29.726	105.974	22.644	241.971	23.116	7863.938	0.510	25.932	14.282
09TOA095 M 269	239.796	11.332	587.368	493504.072	1.782		7.787	0.056	1.100	2.203	0.250	12.503	4.997	60.334	22.288	95.919	26.513	304.294	31.541	8263.124	1.073	45.766	62.519
09TOA095 M 314	245.618	14.725	626.153	451856.584	1.312	0.041	26.700	0.052	2.282	3.873	0.715	15.880	5.241	63.672	22.203	94.551	26.781	315.704	32.717	6752.195	0.778	125.917	148.489
09TOA095 M 328	~~761.939~~	~~10.632~~	~~1465.193~~	~~460251.518~~	~~1.428~~	~~0.931~~	~~26.096~~	~~0.769~~	~~8.810~~	~~12.316~~	~~3.593~~	~~47.295~~	~~14.615~~	~~172.486~~	~~57.246~~	~~222.253~~	~~56.314~~	~~614.562~~	~~63.095~~	~~6617.823~~	~~0.678~~	~~106.158~~	~~112.502~~
09TOA095 M 257	193.037	3.840	715.111	528649.335	10.499		7.935	0.007	0.673	1.955	0.144	12.843	5.635	73.867	26.851	120.911	31.089	329.914	37.562	9782.338	5.377	89.034	122.247
09TOA095 M 235	258.970	4.484	567.481	457316.133	0.798		27.632	0.077	2.047	3.356	1.131	17.338	5.286	60.509	21.523	91.758	24.395	280.644	28.365	5721.409	0.342	21.639	22.964
09TOA095 M 291	298.457	13.957	1272.412	455583.734	1.248	0.027	6.000	0.222	5.419	9.210	0.263	40.280	12.571	143.462	50.212	189.643	46.838	495.242	47.458	7495.088	0.946	136.194	265.453
09TOA095 M 313	512.191	12.022	1629.444	455254.174	1.479		37.594	0.316	6.308	11.342	3.128	46.885	15.441	183.320	65.101	253.837	63.206	719.643	74.956	6035.471	0.774	101.966	74.555
09TOA095 M 233	523.699	14.358	1461.434	467215.030	2.800	0.249	27.525	0.210	3.198	5.627	1.743	29.834	10.890	139.585	52.358	245.264	65.080	771.810	81.963	6350.798	1.202	77.020	86.094
09TOA095 M 222	~~915.320~~	~~10.041~~	~~980.169~~	~~464421.843~~	~~1.371~~	~~19.045~~	~~40.389~~	~~5.119~~	~~27.810~~	~~9.002~~	~~0.145~~	~~27.336~~	~~8.573~~	~~105.752~~	~~37.485~~	~~148.019~~	~~39.641~~	~~430.604~~	~~42.833~~	~~7672.212~~	~~0.779~~	~~73.496~~	~~195.187~~
09TOA095 M 256	209.025	8.563	626.868	517460.703	2.425		3.933	0.038	1.174	1.668	0.061	13.214	4.754	62.737	23.183	103.273	27.890	304.434	33.105	10277.267	1.502	78.470	229.897
09TOA095 M 326	184.175	5.801	620.637	451164.042	0.254	0.067	9.970	0.106	2.422	4.656	1.567	21.455	6.274	69.102	22.889	88.995	24.818	269.971	27.951	7491.232	0.177	22.446	54.553
09TOA095 M 276	174.650	8.052	554.237	445303.704	1.773	0.078	5.425		0.647	2.208	0.171	13.396	4.498	63.023	21.353	93.291	24.601	282.245	28.137	7146.662	0.958	53.810	160.754
09TOA095 M 221	202.588	3.394	949.162	466269.913	5.162	1.169	16.059	0.563	3.891	5.129	0.128	22.910	8.102	100.979	36.984	154.070	39.591	433.167	44.353	7270.546	1.698	77.661	258.007
09TOA095 M 223	289.255	4.920	906.216	466086.013	4.234	0.065	29.593	0.260	3.057	6.773	0.359	25.794	8.456	103.648	35.825	145.165	38.689	450.183	47.275	7236.971	1.478	51.731	89.179
09TOA095 M 302	196.357	11.131	507.863	491856.031	0.664	0.008	8.551		0.881	2.143	0.358	12.463	4.289	49.291	17.463	82.887	20.926	237.569	27.098	7746.722	0.334	38.110	66.841
09TOA095 M 307	246.822	4.941	1038.663	458330.172	5.410	0.050	9.323	0.046	1.552	4.294	0.120	23.490	9.233	113.891	42.233	172.306	45.384	502.713	49.287	7224.378	2.332	88.098	276.785
09TOA095 M 286	528.179	10.777	927.289	428426.749	1.069	0.000	4.679	0.022	1.023	2.910	0.140	17.565	7.288	93.970	37.096	156.477	42.098	506.406	53.456	7762.101	0.860	42.977	92.041
09TOA095 M 310	362.612	8.316	1477.200	462617.847	2.094		12.469	0.327	5.232	9.389	1.369	39.897	14.512	165.084	57.970	225.281	58.282	639.083	62.218	6596.779	0.988	71.051	123.248
09TOA095 M 298	149.905	7.890	363.634	468962.927	2.382		7.252	0.015	0.704	1.407	0.130	9.326	3.052	37.843	14.104	61.999	16.488	195.419	19.824	8427.728	1.348	32.779	178.135
09TOA095 M 284	237.655	10.754	648.747	448164.814	1.528		16.560	0.014	1.180	2.679	0.611	14.453	5.044	67.718	24.945	102.148	28.546	343.530	36.031	6854.397	0.760	44.980	63.405
09TOA095 M 292	196.713	4.708	507.945	457271.292	3.259		9.071	0.049	0.924	1.468	0.047	11.561	4.137	54.709	18.433	77.862	21.493	243.216	24.050	8516.140	1.617	48.612	131.047
09TOA095 M 277	169.420	7.846	485.209	435660.356	2.614		5.259	0.029	1.031	2.491	0.076	12.497	4.602	52.178	18.144	74.805	19.839	226.470	21.935	7112.857	1.370	54.898	165.793
09TOA095 M 287	212.742	4.287	950.015	470487.980	3.142	2.312	11.615	1.015	7.739	6.840	0.279	28.836	9.052	100.670	36.045	141.836	37.017	382.287	38.494	6864.727	1.329	60.905	121.524
09TOA095 M 242	168.394	5.587	485.355	440792.134	1.248	0.069	7.161	0.003	0.501	1.160	0.173	10.226	3.220	45.047	16.950	80.102	21.876	268.719	27.533	7858.210	0.773	65.470	211.138
09TOA095 M 258	197.798	5.572	1146.858	526241.187	2.398		8.427	0.101	2.197	4.085	0.473	26.417	9.186	115.681	44.160	183.145	45.862	469.931	55.790	7392.036	0.817	63.522	156.446
09TOA095 M 325	~~232.951~~	~~12.391~~	~~1356.653~~	~~447684.418~~	~~8.990~~	~~0.171~~	~~20.652~~	~~0.411~~	~~5.561~~	~~8.843~~	~~0.618~~	~~44.681~~	~~13.801~~	~~160.784~~	~~55.101~~	~~224.529~~	~~56.104~~	~~608.181~~	~~62.001~~	~~7113.473~~	~~3.401~~	~~157.667~~	~~196.542~~
09TOA095 M 294	190.494	11.185	651.534	459290.543	3.269		7.873	0.040	1.108	2.274	0.087	13.931	5.256	67.215	23.582	100.696	27.240	299.558	28.968	7427.081	1.645	68.888	186.749
09TOA095 M 285	186.625	6.671	648.595	471337.062	1.165	0.006	4.700	0.050	0.558	2.139	0.476	11.979	4.608	60.528	23.438	103.024	30.770	350.197	36.375	7381.312	0.640	49.800	124.130
09TOA095 M 279	219.322	2.699	1065.536	460676.558	2.641	0.036	4.474	0.246	5.363	10.960	0.700	38.999	11.338	123.583	40.108	154.680	37.600	417.896	38.191	6273.713	1.406	28.574	47.810
09TOA095 M 260	72.090	1.449	179.537	544351.054	1.097		5.350		0.086	0.166	0.269	2.780	0.923	13.905	5.878	30.155	9.276	121.461	17.673	11140.147	0.780	42.599	471.830
09TOA095 M 244	~~175.248~~	~~88.431~~	~~604.242~~	~~400122.065~~	~~3.418~~		~~26.291~~	~~0.159~~	~~1.926~~	~~3.637~~	~~1.647~~	~~15.006~~	~~5.188~~	~~60.322~~	~~21.396~~	~~93.874~~	~~27.570~~	~~351.121~~	~~40.150~~	~~6854.318~~	~~1.713~~	~~173.233~~	~~290.802~~
09TOA095 M 290	149.215	12.193	314.709	482291.333	3.145		3.841	0.011	0.161	1.397	0.028	5.438	2.481	31.795	12.177	50.120	14.112	163.481	16.813	7285.882	1.264	20.213	65.882
09TOA095 M 311	276.396	12.526	1274.381	464418.317	1.141	0.415	5.781	0.259	3.036	6.772	1.060	31.586	10.166	129.620	48.121	211.892	54.579	609.067	65.731	6295.606	0.569	60.885	111.528
09TOA095 M 280	173.479	22.940	576.138	471051.747	1.478	0.052	14.226	0.049	1.171	2.603	0.865	12.263	4.911	57.736	21.029	95.981	26.463	302.303	30.757	6658.602	0.780	49.373	113.225
09TOA095 M 224	162.078	17.067	237.807	481626.139	0.756	0.055	42.127	0.187	4.225	6.610	1.916	14.648	3.645	30.268	8.488	30.365	7.631	85.478	8.559	6958.688	0.327	173.166	98.852
09TOA095 M 234	197.357	10.978	645.698	434079.872	4.699		19.161	0.057	0.761	2.989	0.159	12.654	5.408	70.230	24.915	100.222	27.487	330.110	32.276	7807.771	2.158	76.314	190.395

Table B5b, *continued.* Detrital zircon trace element analyses from sample **09TOA095** from the Sekwi correlative unit (Ꞓs) - Isotope Geology Laboratory, Boise State University

Analysis	Concentrations (ppm)																						
	P	Ti	Y	Zr	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	Th	U
09TOA095 M 248	410.647	21.741	1097.821	461554.927	3.147	3.491	33.043	0.841	6.998	7.569	1.372	27.743	9.624	107.772	40.906	169.328	47.025	544.078	59.101	6640.021	1.678	100.674	124.779
09TOA095 M 275	314.837	19.734	751.459	444615.299	3.472	0.040	34.213	0.007	1.267	3.687	0.888	17.752	6.133	74.724	28.895	126.328	33.684	401.639	42.005	7882.190	2.165	110.509	126.779
09TOA095 M 237	167.675	9.501	443.784	448561.080	3.652		6.425		0.837	1.581	0.090	7.969	3.484	45.362	16.390	71.446	21.216	241.439	23.681	7318.088	2.016	43.218	154.585
09TOA095 M 227	196.056	6.640	641.220	440453.022	8.530	0.023	10.979	0.184	3.159	6.453	0.572	23.671	7.469	83.642	25.881	90.063	21.422	230.441	22.213	7049.503	3.019	146.953	299.318
09TOA095 M 312	595.243	16.396	1155.422	449333.440	0.635	0.067	2.393	0.194	4.539	9.690	0.059	41.817	13.177	145.163	45.216	171.073	44.832	485.087	45.409	7667.136	0.359	104.016	194.612
09TOA095 M 300	220.003	13.697	583.967	474911.701	5.739	0.427	35.112	0.200	1.247	2.473	0.429	10.666	4.418	58.843	21.590	97.137	27.632	313.178	34.193	8328.287	3.321	107.258	179.733
09TOA095 M 232	197.082	25.551	609.886	480440.259	2.908	0.087	41.281	0.123	2.264	4.371	1.300	22.197	6.642	74.514	22.634	92.990	24.068	254.770	24.909	6771.026	1.637	85.841	108.866
09TOA095 M 255	~~646.082~~	~~38.988~~	~~1705.622~~	~~479373.021~~	~~6.874~~	~~15.535~~	~~45.575~~	~~5.665~~	~~31.648~~	~~14.794~~	~~1.638~~	~~54.000~~	~~18.066~~	~~200.984~~	~~67.530~~	~~278.508~~	~~68.153~~	~~688.050~~	~~74.281~~	~~6527.157~~	~~2.863~~	~~159.518~~	~~153.494~~
09TOA095 M 305	233.532	19.765	776.951	474346.196	1.699	0.035	2.648	0.064	1.435	4.544	0.223	23.731	7.767	92.790	30.894	120.090	27.758	293.389	28.411	7987.117	0.777	27.589	57.217
09TOA095 M 323	804.902	8.891	1578.501	446417.088	0.250		0.500	0.087	0.749	4.025	0.035	35.093	13.422	173.449	61.502	257.721	64.156	703.206	64.228	7994.335	0.259	23.942	177.663
09TOA095 M 240	222.733	9.226	650.382	425383.832	4.504		31.333	0.073	1.300	2.237	0.384	11.943	4.668	64.710	24.694	107.079	29.899	368.333	39.003	7404.489	2.083	95.895	150.716
09TOA095 M 283	145.727	5.249	586.486	473355.239	2.082		13.164	0.004	1.186	2.292	0.120	18.235	5.821	66.885	22.454	90.749	22.699	243.216	24.016	7895.578	1.195	65.580	228.984
09TOA095 M 228	177.241	20.748	331.119	455893.791	2.027		14.141	0.026	1.585	2.464	0.934	11.326	3.289	41.099	12.231	50.251	12.771	158.740	15.457	6626.069	0.665	19.169	41.400
09TOA095 M 262	191.258	11.144	619.683	508125.834	4.567	0.009	17.092	0.062	1.160	3.306	0.220	14.972	5.200	65.315	22.348	96.284	25.772	280.117	31.484	8278.753	2.039	46.039	89.686
09TOA095 M 263	328.200	31.226	865.774	524849.737	0.779		2.329	0.084	2.767	6.374	0.391	27.554	9.490	103.305	32.903	132.152	34.210	346.083	36.558	8677.677	0.420	41.498	67.911

Notes:

Yellow highlighted rows are samples that intersected inclusions.
Trace element concentrations in ppm, calculated using mean count rate method.
Sweep-by-sweep downhole fractionation of U/Pb ratios NOT corrected via Si/Zr fractionation factor.
Backgrounds were monitored between sweeps 10 to 27. Sample counts were integrated from sweeps 36 to 69.
Ablation used a laser spot size of 25 microns, and a laser firing repitition rate of 10 Hz.

Table B5c. Detrital zircon calculated ratios and values from sample **09TOA095** from the Sekwi correlative unit (Ꞓs) - Isotope Geology Laboratory, Boise State University

Analysis	CI chondrite normalizing values from Sun and McDonough (1989)													
	0.237	0.612	0.095	0.467	0.153	0.058	0.206	0.037	0.254	0.057	0.166	0.026	0.17	0.025
	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
09TOA095 M 264	0.072	22.960	1.376	4.632	32.416	38.808	150.081	281.998	514.864	827.526	1127.639	1830.524	2900.786	2180.940
09TOA095 M 253	0.591	19.189	4.769	12.605	74.066	77.057	171.774	248.627	376.603	512.138	738.771	1253.975	2214.817	1603.330
09TOA095 M 299	0.338	6.776	3.482	6.974	42.102	54.719	113.501	185.832	293.988	424.392	615.164	1118.443	2042.270	1572.447
09TOA095 M 319	0.034	21.879	1.359	5.065	22.707	29.917	74.992	131.664	226.467	373.325	601.539	1183.414	2279.444	1816.961
09TOA095 M 278	0.206	48.369	5.492	16.437	75.793	39.224	209.010	339.322	483.682	738.359	1013.406	1742.489	2867.175	1839.973
09TOA095 M 306	0.003	2.088	0.127	3.376	21.927	7.074	50.430	69.664	99.780	130.566	173.966	287.254	493.409	329.770
09TOA095 M 303	0.027	2.601	1.074	3.648	21.385	1.238	77.117	111.902	141.678	128.736	109.715	104.296	107.104	44.911
09TOA095 M 251	0.004	28.627	0.179	0.656	3.455	4.411	18.494	41.816	68.942	102.516	151.449	303.592	586.732	440.705
09TOA095 M 225	0.212	15.833	0.202	2.009	9.376	4.276	50.142	99.090	168.521	275.573	398.859	671.216	1169.370	807.342
09TOA095 M 281	~~0.490~~	~~50.295~~	~~1.390~~	~~3.181~~	~~11.536~~	~~18.042~~	~~33.277~~	~~54.185~~	~~90.881~~	~~144.108~~	~~223.466~~	~~456.688~~	~~953.242~~	~~762.589~~
09TOA095 M 231	0.273	12.043	0.432	4.746	29.102	30.857	112.584	173.414	259.974	386.468	508.584	784.100	1198.548	889.789
09TOA095 M 271	3.658	13.244	4.148	11.942	44.122	7.609	147.601	207.034	348.771	520.806	623.249	1025.367	1579.284	1060.204
09TOA095 M 243	0.022	47.831	0.875	3.520	29.192	17.366	86.711	151.184	267.188	434.902	618.735	1165.718	1953.133	1335.596
09TOA095 M 267	0.019	23.902	0.765	4.473	22.578	13.098	59.162	103.044	156.460	244.697	385.775	615.858	1073.711	762.404
09TOA095 M 247	0.310	17.743	0.649	4.024	22.085	8.312	75.923	123.091	206.159	291.142	390.361	632.472	1018.744	709.181
09TOA095 M 239	0.611	42.552	1.446	4.696	31.210	19.363	89.962	145.682	218.811	309.290	428.853	770.739	1324.446	861.516
09TOA095 M 316	0.027	27.930	1.090	5.921	30.111	19.923	90.525	141.419	217.026	293.593	398.602	696.799	1213.113	792.177
09TOA095 M 229	0.001	8.630	0.052	1.769	17.273	12.647	64.012	108.957	202.982	332.092	423.011	684.459	1127.910	778.398
09TOA095 M 245	0.022	11.466	0.859	1.065	14.112	4.078	43.937	86.288	162.255	275.231	394.240	664.946	1193.560	833.927
09TOA095 M 259	~~0.639~~	~~6.024~~	~~0.458~~	~~2.115~~	~~13.015~~	~~7.000~~	~~59.781~~	~~96.221~~	~~175.190~~	~~281.934~~	~~444.924~~	~~751.371~~	~~1265.715~~	~~1021.995~~
09TOA095 M 322	0.833	12.029	0.612	1.128	11.708	1.249	42.762	94.849	167.081	309.900	469.261	896.841	1542.857	1025.589
09TOA095 M 270	0.010	3.908	0.412	3.509	27.458	2.962	96.528	193.027	335.431	531.439	711.314	1222.951	2010.412	1377.614
09TOA095 M 230	0.022	30.621	0.887	2.856	27.032	2.452	91.115	157.189	252.861	374.941	516.598	834.170	1291.993	885.229
09TOA095 M 246	0.190	4.422	0.273	2.782	15.473	5.757	50.507	98.715	168.190	253.548	326.663	550.540	968.047	648.535
09TOA095 M 295	0.004	6.829	1.063	2.749	19.219	1.992	65.769	134.625	234.815	351.383	508.071	865.913	1436.111	992.009
09TOA095 M 226	0.045	17.229	1.790	9.348	53.590	4.213	171.866	280.073	461.849	680.770	927.932	1559.467	2345.195	1566.798
09TOA095 M 304	0.997	52.954	14.092	30.257	99.536	70.341	194.949	252.185	312.723	396.110	513.672	842.404	1339.458	903.572
09TOA095 M 327	~~37.968~~	~~37.948~~	~~28.178~~	~~42.529~~	~~79.024~~	~~15.032~~	~~207.059~~	~~353.511~~	~~541.583~~	~~802.985~~	~~1033.888~~	~~1610.950~~	~~2640.885~~	~~1620.516~~
09TOA095 M 282	0.001	7.696	0.060	1.154	6.478	7.157	24.023	38.708	56.176	66.644	84.440	147.613	252.791	180.367
09TOA095 M 261	1.971	124.141	36.209	100.964	503.250	470.042	868.961	1094.283	1281.128	1394.338	1594.845	2331.500	3194.575	2325.127
09TOA095 M 274	0.060	27.886	2.399	7.099	49.568	38.275	147.670	241.066	373.994	506.584	673.589	1097.484	1806.818	1207.585
09TOA095 M 296	0.093	34.569	3.715	11.310	48.244	15.334	131.206	196.492	301.802	403.128	547.726	924.681	1544.761	1021.220
09TOA095 M 309	0.003	7.746	0.127	0.781	6.434	4.573	36.967	77.990	127.425	206.402	313.660	540.495	888.703	602.536
09TOA095 M 308	4.141	7.334	2.553	5.011	16.769	1.923	100.824	220.486	427.424	687.860	977.969	1707.497	2772.986	1828.416
09TOA095 M 273	0.660	18.666	0.919	2.411	17.147	9.819	54.027	102.638	178.728	282.670	397.552	700.732	1121.179	802.378
09TOA095 M 250	3.706	36.432	5.039	11.870	50.186	19.870	153.298	275.588	454.036	715.461	996.917	1737.691	2859.669	2015.356
09TOA095 M 265	1.027	29.087	2.406	8.078	45.026	25.405	137.164	215.857	347.916	480.225	664.080	1032.348	1634.394	1176.890
09TOA095 M 293	0.609	9.183	1.947	3.748	23.889	5.001	121.413	300.345	592.893	1002.685	1488.436	2572.675	4364.619	2989.405
09TOA095 M 266	1.130	36.429	2.415	7.817	36.969	17.642	91.129	158.345	264.233	413.540	574.584	961.088	1556.696	1259.513
09TOA095 M 321	0.016	15.560	0.634	4.001	27.973	6.786	70.687	124.210	185.235	259.330	331.153	557.659	893.539	574.150
09TOA095 M 238	0.976	12.262	0.957	2.774	16.844	1.693	55.401	105.983	205.582	339.029	458.156	818.090	1392.095	896.201
09TOA095 M 297	~~0.260~~	~~6.851~~	~~4.149~~	~~11.607~~	~~87.237~~	~~76.797~~	~~221.049~~	~~378.349~~	~~561.128~~	~~743.361~~	~~922.059~~	~~1425.061~~	2262.207	~~1479.295~~

Ti-in-zircon T (°C)	Ce/Ce*	Eu/Eu*	(Sm/Nd) cn	(Lu/Nd) cn	Lu/Hf	Nb/Ta	Nb/U	Th/U	Th/Y	Y/Hf
789	31.71	0.43	7.00	470.84	0.01	3.16	0.01	0.66	0.06	0.17
857	7.16	0.63	5.88	127.20	0.00	2.27	0.01	0.64	0.25	0.10
754	3.55	0.70	6.04	225.47	0.01	2.32	0.00	1.26	0.37	0.12
711	31.41	0.61	4.48	358.76	0.01	1.92	0.01	0.61	0.04	0.11
720	16.98	0.28	4.61	111.94	0.01	1.96	0.01	1.09	0.15	0.18
796	31.99	0.20	6.50	97.69	0.00	1.50	0.00	0.25	0.13	0.03
878	4.73	0.03	5.86	12.31	0.00	2.25	0.01	1.09	0.32	0.02
712	311.55	0.40	5.27	671.97	0.00	1.55	0.01	0.57	0.42	0.02
750	76.49	0.14	4.67	401.78	0.00	1.20	0.01	0.45	0.22	0.05
~~814~~	~~53.50~~	~~0.81~~	~~3.63~~	~~239.71~~	~~0.00~~	~~5.08~~	~~0.00~~	~~0.67~~	~~0.50~~	~~0.04~~
875	34.17	0.44	6.13	187.50	0.00	2.63	0.08	1.05	0.04	0.09
821	3.39	0.08	3.69	88.78	0.00	2.03	0.02	0.64	0.11	0.10
758	106.62	0.30	8.29	379.41	0.01	1.41	0.01	0.74	0.15	0.11
836	60.93	0.32	5.05	170.44	0.00	1.14	0.01	1.04	0.18	0.05
785	36.98	0.17	5.49	176.23	0.00	1.30	0.00	0.55	0.19	0.06
720	41.38	0.32	6.65	183.46	0.00	2.38	0.01	0.99	0.20	0.08
817	49.98	0.33	5.09	133.80	0.00	1.71	0.01	0.85	0.10	0.08
764	321.01	0.31	9.76	439.93	0.00	2.48	0.02	0.39	0.07	0.07
800	26.04	0.14	13.25	783.19	0.00	1.11	0.01	0.34	0.14	0.05
~~1085~~	~~10.98~~	~~0.19~~	~~6.15~~	~~483.14~~	~~0.00~~	~~1.37~~	~~0.00~~	~~0.27~~	~~0.09~~	~~0.05~~
726	16.65	0.05	10.38	909.38	0.00	1.46	0.01	0.29	0.16	0.06
831	18.50	0.05	7.82	392.56	0.00	0.75	0.00	0.23	0.07	0.10
753	67.36	0.04	9.46	309.95	0.00	2.15	0.03	0.95	0.21	0.07
863	19.11	0.17	5.56	233.09	0.00	2.69	0.05	0.50	0.06	0.05
812	12.80	0.05	6.99	360.91	0.00	2.03	0.01	0.42	0.08	0.07
842	18.78	0.04	5.73	167.62	0.01	2.00	0.01	0.77	0.14	0.14
831	7.02	0.48	3.29	29.86	0.00	1.74	0.02	0.60	0.17	0.09
~~777~~	~~1.15~~	~~0.11~~	~~1.86~~	~~38.10~~	~~0.01~~	~~1.51~~	~~0.01~~	~~0.56~~	~~0.10~~	~~0.18~~
716	251.63	0.47	5.61	156.27	0.00	1.94	0.00	0.24	0.34	0.01
945	6.50	0.69	4.98	23.03	0.01	2.70	0.01	1.50	0.15	0.33
875	22.68	0.39	6.98	170.11	0.00	1.80	0.01	0.88	0.27	0.11
864	18.15	0.17	4.27	90.29	0.00	2.06	0.01	0.86	0.17	0.10
708	119.12	0.21	8.24	771.33	0.00	1.67	0.01	0.31	0.14	0.04
848	2.19	0.03	3.35	364.85	0.01	1.30	0.00	0.29	0.05	0.13
771	23.65	0.28	7.11	332.76	0.00	3.72	0.01	0.76	0.24	0.06
891	8.33	0.20	4.23	169.79	0.01	1.66	0.01	0.85	0.22	0.17
791	16.94	0.28	5.57	145.70	0.00	2.32	0.01	1.36	0.25	0.08
859	7.19	0.07	6.37	797.50	0.01	1.42	0.01	0.37	0.04	0.17
883	20.55	0.28	4.73	161.14	0.00	2.51	0.01	0.91	0.21	0.09
851	47.89	0.14	6.99	143.51	0.00	2.61	0.05	0.59	0.12	0.06
767	12.69	0.05	6.07	323.07	0.00	1.83	0.01	0.35	0.15	0.08
~~878~~	~~3.11~~	~~0.50~~	~~7.52~~	~~127.44~~	~~0.00~~	~~2.60~~	~~0.00~~	~~0.68~~	~~0.17~~	~~0.13~~

Table B5c, *continued*. Detrital zircon calculated ratios and values from sample **09TOA095** from the Sekwi correlative unit (Ꞓs) - Isotope Geology Laboratory, Boise State University

Analysis	CI chondrite normalizing values from Sun and McDonough (1989)													
	0.237	0.612	0.095	0.467	0.153	0.058	0.206	0.037	0.254	0.057	0.166	0.026	0.17	0.025
	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
09TOA095 M 324	0.020	13.217	0.799	2.796	24.830	3.436	90.337	175.255	321.608	503.178	684.006	1178.010	1962.199	1242.095
09TOA095 M 320	0.371	7.592	4.499	11.827	60.066	14.336	183.543	288.495	481.510	745.898	1013.076	1801.778	2975.651	1914.416
09TOA095 M 254	0.067	13.069	2.689	10.029	53.831	18.705	139.227	238.762	395.597	585.275	769.662	1207.825	1935.129	1374.379
09TOA095 M 317	0.109	15.598	1.117	3.818	21.229	3.591	50.871	67.896	96.993	103.920	109.491	148.748	230.345	129.314
09TOA095 M 241	~~1.734~~	~~27.473~~	~~11.933~~	~~30.357~~	~~159.487~~	~~114.165~~	~~290.161~~	~~403.819~~	~~523.952~~	~~626.505~~	~~751.103~~	~~1032.993~~	~~1475.529~~	~~1156.078~~
09TOA095 M 272	0.371	29.964	1.315	4.503	24.487	10.512	76.055	141.842	229.364	362.064	510.223	860.007	1415.986	932.736
09TOA095 M 236	0.072	11.364	0.626	1.437	17.289	3.645	81.146	161.306	332.856	523.410	739.838	1326.558	2191.325	1424.569
09TOA095 M 288	0.285	14.565	5.102	19.354	88.552	26.216	214.617	273.887	385.621	525.200	640.326	888.010	1423.356	910.084
09TOA095 M 269	0.015	12.723	0.588	2.356	14.401	4.309	60.841	133.606	237.536	393.783	579.570	1039.744	1789.962	1241.766
09TOA095 M 314	0.172	43.628	0.551	4.886	25.311	12.324	77.275	140.127	250.678	392.283	571.303	1050.227	1857.084	1288.085
09TOA095 M 328	~~3.930~~	~~42.641~~	~~8.090~~	~~18.866~~	~~80.496~~	~~61.940~~	~~230.147~~	~~390.763~~	~~679.079~~	~~1011.416~~	~~1342.920~~	~~2208.403~~	~~3615.071~~	~~2484.050~~
09TOA095 M 257	0.002	12.966	0.075	1.441	12.777	2.483	62.499	150.671	290.815	474.393	730.581	1219.172	1940.673	1478.834
09TOA095 M 235	0.020	45.151	0.811	4.383	21.936	19.501	84.371	141.325	238.225	380.263	554.429	956.656	1650.848	1116.721
09TOA095 M 291	0.113	9.805	2.333	11.604	60.196	4.535	196.011	336.133	564.813	887.143	1145.878	1836.791	2913.190	1868.423
09TOA095 M 313	0.083	61.428	3.325	13.507	74.133	53.924	228.149	412.867	721.732	1150.191	1533.759	2478.648	4233.195	2951.025
09TOA095 M 233	1.052	44.976	2.214	6.848	36.781	30.051	145.178	291.183	549.546	925.061	1481.956	2552.175	4540.060	3226.900
09TOA095 M 222	~~80.359~~	~~65.995~~	~~53.886~~	~~59.549~~	~~58.839~~	~~2.505~~	~~133.022~~	~~229.217~~	~~416.348~~	~~662.275~~	~~894.372~~	~~1554.553~~	~~2532.964~~	~~1686.341~~
09TOA095 M 256	0.010	6.427	0.395	2.514	10.902	1.050	64.304	127.108	246.997	409.591	624.008	1093.710	1790.789	1303.342
09TOA095 M 326	0.285	16.290	1.118	5.187	30.433	27.026	104.404	167.753	272.054	404.408	537.735	973.242	1588.066	1100.422
09TOA095 M 276	0.328	8.865	0.310	1.386	14.431	2.947	65.187	120.280	248.121	377.261	563.691	964.738	1660.268	1107.737
09TOA095 M 221	4.931	26.240	5.928	8.331	33.522	2.203	111.483	216.620	397.553	653.435	930.934	1552.585	2548.041	1746.187
09TOA095 M 223	0.273	48.354	2.733	6.545	44.269	6.184	125.518	226.098	408.064	632.959	877.132	1517.214	2648.134	1861.211
09TOA095 M 302	0.032	13.972	0.421	1.886	14.005	6.167	60.647	114.681	194.060	308.531	500.831	820.609	1397.464	1066.846
09TOA095 M 307	0.210	15.234	0.486	3.324	28.069	2.074	114.308	246.863	448.391	746.171	1041.126	1779.748	2957.134	1940.451
09TOA095 M 286	0.001	7.646	0.229	2.191	19.022	2.415	85.475	194.862	369.961	655.407	945.481	1650.900	2978.857	2104.579
09TOA095 M 310	0.086	20.375	3.443	11.204	61.364	23.606	194.145	388.017	649.936	1024.206	1361.215	2285.551	3759.314	2449.543
09TOA095 M 298	0.004	11.849	0.159	1.508	9.195	2.238	45.383	81.600	148.990	249.196	374.614	646.599	1149.526	780.464
09TOA095 M 284	0.004	27.059	0.148	2.527	17.511	10.537	70.332	134.855	266.607	440.720	617.210	1119.447	2020.767	1418.563
09TOA095 M 292	0.013	14.822	0.519	1.978	9.596	0.805	56.256	110.610	215.388	325.679	470.464	842.850	1430.684	946.852
09TOA095 M 277	0.008	8.594	0.309	2.208	16.280	1.309	60.813	123.055	205.426	320.563	451.996	777.988	1332.177	863.584
09TOA095 M 287	9.754	18.979	10.686	16.571	44.709	4.807	140.320	242.032	396.340	636.830	857.017	1451.631	2248.746	1515.519
09TOA095 M 242	0.292	11.701	0.027	1.073	7.581	2.991	49.761	86.086	177.352	299.467	484.001	857.870	1580.698	1083.994
09TOA095 M 258	0.027	13.770	1.060	4.704	26.697	8.163	128.552	245.620	455.436	780.206	1106.615	1798.520	2764.300	2196.461
09TOA095 M 325	~~0.720~~	~~33.745~~	~~4.325~~	~~11.909~~	~~57.800~~	~~10.652~~	~~217.427~~	~~369.019~~	~~633.008~~	~~973.512~~	~~1356.670~~	~~2200.167~~	~~3577.535~~	~~2440.976~~
09TOA095 M 294	0.011	12.864	0.425	2.373	14.863	1.508	67.793	140.544	264.628	416.640	608.436	1068.235	1762.107	1140.489
09TOA095 M 285	0.025	7.680	0.522	1.196	13.982	8.213	58.291	123.203	238.301	414.093	622.500	1206.654	2059.984	1432.100
09TOA095 M 279	0.153	7.310	2.586	11.485	71.631	12.061	189.775	303.165	486.548	708.626	934.623	1474.497	2458.210	1503.589
09TOA095 M 260		8.741	0.041	0.184	1.085	4.637	13.526	24.678	54.744	103.854	182.203	363.768	714.478	695.781
09TOA095 M 244	~~0.042~~	~~42.959~~	~~1.676~~	~~4.124~~	~~23.773~~	~~28.405~~	~~73.021~~	~~138.727~~	~~237.490~~	~~378.025~~	~~567.214~~	~~1081.181~~	~~2065.418~~	~~1580.700~~
09TOA095 M 290	0.003	6.277	0.112	0.346	9.131	0.484	26.460	66.341	125.176	215.133	302.841	553.418	961.654	661.939
09TOA095 M 311	1.750	9.446	2.723	6.501	44.263	18.271	153.703	271.808	510.315	850.191	1280.315	2140.361	3582.745	2587.824
09TOA095 M 280	0.220	23.244	0.516	2.508	17.014	14.915	59.676	131.316	227.309	371.530	579.945	1037.748	1778.255	1210.902

Ti-in-zircon T (°C)	Ce/Ce*	Eu/Eu*	(Sm/Nd) cn	(Lu/Nd) cn	Lu/Hf	Nb/Ta	Nb/U	Th/U	Th/Y	Y/Hf
781	32.27	0.06	8.88	444.31	0.01	1.46	0.01	0.50	0.18	0.12
867	3.12	0.12	5.08	161.87	0.01	2.28	0.01	0.50	0.08	0.19
859	9.48	0.19	5.37	137.05	0.01	1.87	0.01	0.72	0.10	0.13
859	25.45	0.10	5.56	33.87	0.00	1.36	0.05	1.86	0.40	0.02
~~1059~~	~~4.02~~	~~0.51~~	~~5.25~~	~~38.08~~	~~0.01~~	~~2.86~~	~~0.01~~	~~2.59~~	~~0.43~~	~~0.17~~
866	35.56	0.21	5.44	207.14	0.00	2.06	0.02	0.90	0.19	0.08
798	32.55	0.07	12.03	991.23	0.01	1.98	0.02	0.36	0.08	0.11
946	5.41	0.17	4.58	47.02	0.00	2.63	0.09	1.82	0.04	0.09
809	42.23	0.11	6.11	527.13	0.00	1.66	0.03	0.73	0.08	0.07
838	120.72	0.24	5.18	263.65	0.00	1.69	0.01	0.85	0.20	0.09
~~803~~	~~7.10~~	~~0.40~~	~~4.27~~	~~131.67~~	~~0.01~~	~~2.11~~	~~0.01~~	~~0.94~~	~~0.07~~	~~0.22~~
706	337.10	0.07	8.87	1026.56	0.00	1.95	0.09	0.73	0.12	0.07
719	108.63	0.37	5.00	254.80	0.00	2.33	0.03	0.94	0.04	0.10
832	8.02	0.04	5.19	161.01	0.01	1.32	0.00	0.51	0.11	0.17
816	36.04	0.36	5.49	218.48	0.01	1.91	0.02	1.37	0.06	0.27
835	27.54	0.33	5.37	471.19	0.01	2.33	0.03	0.89	0.05	0.23
~~797~~	~~0.98~~	~~0.03~~	~~0.99~~	~~28.32~~	~~0.01~~	~~1.76~~	~~0.01~~	~~0.38~~	~~0.07~~	~~0.13~~
780	31.71	0.03	4.34	518.47	0.00	1.61	0.01	0.34	0.13	0.06
743	23.24	0.40	5.87	212.17	0.00	1.43	0.00	0.41	0.04	0.08
774	27.79	0.07	10.41	799.23	0.00	1.85	0.01	0.33	0.10	0.08
695	4.83	0.03	4.02	209.60	0.01	3.04	0.02	0.30	0.08	0.13
728	32.17	0.07	6.76	284.36	0.01	2.86	0.05	0.58	0.06	0.13
807	61.63	0.17	7.42	565.58	0.00	1.99	0.01	0.57	0.08	0.07
728	43.80	0.03	8.45	583.83	0.01	2.32	0.02	0.32	0.08	0.14
804	66.30	0.05	8.68	960.53	0.01	1.24	0.01	0.47	0.05	0.12
778	11.54	0.18	5.48	218.63	0.01	2.12	0.02	0.58	0.05	0.22
772	145.22	0.08	6.10	517.54	0.00	1.77	0.01	0.18	0.09	0.04
804	357.19	0.24	6.93	561.39	0.01	2.01	0.02	0.71	0.07	0.09
724	55.72	0.02	4.85	478.67	0.00	2.02	0.02	0.37	0.10	0.06
772	54.34	0.03	7.37	391.06	0.00	1.91	0.02	0.33	0.11	0.07
715	1.86	0.05	2.70	91.46	0.01	2.36	0.03	0.50	0.06	0.14
739	73.38	0.10	7.07	1010.40	0.00	1.61	0.01	0.31	0.13	0.06
739	25.34	0.11	5.68	466.96	0.01	2.94	0.02	0.41	0.06	0.16
~~819~~	~~13.38~~	~~0.08~~	~~4.85~~	~~204.98~~	~~0.01~~	~~2.64~~	~~0.05~~	~~0.80~~	~~0.12~~	~~0.19~~
808	59.10	0.04	6.26	480.56	0.00	1.99	0.02	0.37	0.11	0.09
756	28.08	0.23	11.69	1197.66	0.00	1.82	0.01	0.40	0.08	0.09
676	5.34	0.09	6.24	130.92	0.01	1.88	0.06	0.60	0.03	0.17
628		0.63	5.89	3775.80	0.00	1.41	0.00	0.09	0.24	0.02
~~1082~~	~~50.00~~	~~0.59~~	~~5.77~~	~~383.33~~	~~0.01~~	~~2.00~~	~~0.01~~	~~0.60~~	~~0.29~~	~~0.09~~
817	109.43	0.03	26.43	1915.76	0.00	2.49	0.05	0.31	0.06	0.04
820	4.22	0.18	6.81	398.06	0.01	2.01	0.01	0.55	0.05	0.20
890	63.22	0.39	6.79	482.90	0.00	1.89	0.01	0.44	0.09	0.09

Table B5c, *continued*. Detrital zircon calculated ratios and values from sample **09TOA095** from the Sekwi correlative unit (Ꞓs) - Isotope Geology Laboratory, Boise State University

Analysis	CI chondrite normalizing values from Sun and McDonough (1989)													
	0.237	0.612	0.095	0.467	0.153	0.058	0.206	0.037	0.254	0.057	0.166	0.026	0.17	0.025
	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
09TOA095 M 224	0.232	68.836	1.971	9.047	43.204	33.031	71.278	97.453	119.167	149.972	183.474	299.274	502.812	336.959
09TOA095 M 234	0.015	31.308	0.600	1.630	19.537	2.737	61.577	144.590	276.496	440.188	605.569	1077.929	1941.825	1270.692
09TOA095 M 248	14.731	53.991	8.853	14.985	49.468	23.661	135.004	257.314	424.298	722.715	1023.127	1844.117	3200.461	2326.821
09TOA095 M 275	0.169	55.904	0.073	2.712	24.100	15.314	86.383	163.977	294.190	510.507	763.314	1320.941	2362.581	1653.751
09TOA095 M 237		10.498	0.401	1.793	10.332	1.554	38.777	93.144	178.589	289.575	431.698	831.982	1420.231	932.331
09TOA095 M 227	0.098	17.940	1.937	6.765	42.180	9.864	115.188	199.695	329.300	457.270	544.188	840.063	1355.533	874.546
09TOA095 M 312	0.282	3.909	2.044	9.720	63.335	1.023	203.491	352.320	571.508	798.864	1033.676	1758.124	2853.451	1787.744
09TOA095 M 300	1.801	57.372	2.106	2.671	16.161	7.392	51.902	118.132	231.666	381.440	586.933	1083.622	1842.222	1346.187
09TOA095 M 232	0.367	67.453	1.299	4.849	28.567	22.408	108.015	177.598	293.364	399.886	561.874	943.853	1498.649	980.666
09TOA095 M 255	~~65.548~~	~~74.468~~	~~59.632~~	~~67.768~~	~~96.690~~	~~28.237~~	~~262.773~~	~~483.061~~	~~791.278~~	~~1193.116~~	~~1682.827~~	~~2672.672~~	~~4047.353~~	~~2924.443~~
09TOA095 M 305	0.148	4.326	0.672	3.073	29.702	3.850	115.480	207.670	365.316	545.836	725.618	1088.565	1725.816	1118.555
09TOA095 M 323	0.023	0.817	0.914	1.603	26.308	0.607	170.769	358.883	682.869	1086.615	1557.225	2515.915	4136.504	2528.648
09TOA095 M 240	0.019	51.197	0.769	2.785	14.618	6.624	58.117	124.814	254.764	436.294	647.004	1172.494	2166.663	1535.546
09TOA095 M 283	0.001	21.510	0.038	2.540	14.979	2.069	88.733	155.635	263.326	396.708	548.335	890.160	1430.681	945.493
09TOA095 M 228	0.007	23.107	0.269	3.395	16.104	16.100	55.115	87.947	161.806	216.091	303.630	500.843	933.763	608.526
09TOA095 M 262	0.038	27.928	0.653	2.483	21.605	3.800	72.859	139.031	257.145	394.832	581.776	1010.682	1647.748	1239.528
09TOA095 M 263	0.022	3.806	0.884	5.925	41.658	6.735	134.084	253.746	406.714	581.323	798.504	1341.583	2035.782	1439.286

Ti-in-zircon T (°C)	Ce/Ce*	Eu/Eu*	(Sm/Nd) cn	(Lu/Nd) cn	Lu/Hf	Nb/Ta	Nb/U	Th/U	Th/Y	Y/Hf
855	62.51	0.58	4.78	37.25	0.00	2.31	0.01	1.75	0.73	0.03
806	101.85	0.07	11.99	779.72	0.00	2.18	0.02	0.40	0.12	0.08
883	4.58	0.26	3.30	155.27	0.01	1.88	0.03	0.81	0.09	0.17
872	461.89	0.28	8.89	609.73	0.01	1.60	0.03	0.87	0.15	0.10
791		0.06	5.76	520.11	0.00	1.81	0.02	0.28	0.10	0.06
756	17.63	0.13	6.23	129.27	0.00	2.83	0.03	0.49	0.23	0.09
850	3.36	0.01	6.52	183.93	0.01	1.77	0.00	0.53	0.09	0.15
830	29.37	0.22	6.05	504.02	0.00	1.73	0.03	0.60	0.18	0.07
903	81.02	0.33	5.89	202.26	0.00	1.78	0.03	0.79	0.14	0.09
~~958~~	~~1.19~~	~~0.16~~	~~1.43~~	~~43.15~~	~~0.01~~	~~2.40~~	~~0.04~~	~~1.04~~	~~0.09~~	~~0.26~~
872	10.56	0.05	9.67	364.03	0.00	2.19	0.03	0.48	0.04	0.10
784	1.74	0.01	16.41	1577.42	0.01	0.96	0.00	0.13	0.02	0.20
788	129.86	0.18	5.25	551.44	0.01	2.16	0.03	0.64	0.15	0.09
733	1091.05	0.04	5.90	372.24	0.00	1.74	0.01	0.29	0.11	0.07
877	167.56	0.45	4.74	179.24	0.00	3.05	0.05	0.46	0.06	0.05
808	80.88	0.08	8.70	499.18	0.00	2.24	0.05	0.51	0.07	0.07
929	8.40	0.08	7.03	242.91	0.00	1.86	0.01	0.61	0.05	0.10

Notes:

Activity (SiO_2) = 1; activity (TiO_2) = 0.6.
Yellow highlighted rows are samples that intersected inclusions.
Trace element concentrations in ppm, calculated using mean count rate method.
Sweep-by-sweep downhole fractionation of U/Pb ratios NOT corrected via Si/Zr fractionation factor.
Backgrounds were monitored between sweeps 10 to 27. Sample counts were integrated from sweeps 36 to 69.
Ablation used a laser spot size of 25 microns, and a laser firing repitition rate of 10 Hz.

Table B6. Detrital zircon U-Pb geochronologic analyses from sample **09TOA096** from the Sekwi correlative unit (Ꞓs) - Memorial University

File Name	Measured Isotopic Ratios							Calculated Ages (Ma)							Concordia age (Ma)	2σ error (Ma)	MSWD (of concordance)	Probability (of concordance)	Th232 (ppm)	U238 (ppm)	Th/U Ratio
	$\frac{^{207}Pb}{^{235}U}$	2σ error	$\frac{^{206}Pb}{^{238}U}$	2σ error	Rho	$\frac{^{207}Pb}{^{206}Pb}$	1σ error	$\frac{^{207}Pb}{^{235}U}$	1σ error (Ma)	$\frac{^{206}Pb}{^{238}U}$	1σ error (Ma)	$\frac{^{207}Pb}{^{206}Pb}$	1σ error (Ma)	U-Pb/Pb-Pb concordancy (%)							
ap29b04	5.106	0.294	0.334	0.016	0.429	0.110	0.001	1837	24	1856	40	1807	21	103	1840	47.81	0.26	0.613	87	109	0.794
ap29b05	13.116	0.648	0.524	0.024	0.455	0.189	0.004	2688	23	2718	50	2736	34	99	2688	46.63	0.46	0.498	126	101	1.251
ap29b06	2.762	0.211	0.232	0.014	0.405	0.083	0.001	1345	29	1344	38	1279	28	105	1345	53.20	0.00	0.971	127	145	0.875
ap29b07	9.720	0.807	0.465	0.040	0.516	0.143	0.002	2409	38	2462	88	2267	26	109	2406	76.25	0.50	0.479	37	55	0.676
ap29b08	5.997	0.215	0.361	0.012	0.451	0.117	0.001	1975	16	1987	28	1910	11	104	1976	30.99	0.21	0.647	172	324	0.529
ap29b09	4.704	0.500	0.386	0.024	0.292	0.090	0.002	1768	45	2103	56	1427	33	147	1861	74.73	31.00	0.000	69	60	1.146
ap29b10	5.567	0.280	0.354	0.012	0.347	0.115	0.001	1911	22	1954	29	1882	18	104	1922	39.73	2.03	0.154	33	127	0.259
ap29b11	5.964	0.308	0.350	0.015	0.412	0.120	0.001	1971	22	1936	36	1949	12	99	1965	43.80	1.07	0.302	166	288	0.578
ap29b12	2.945	0.288	0.247	0.018	0.364	0.088	0.001	1394	37	1424	45	1382	25	103	1404	66.36	0.42	0.515	246	157	1.566
ap29b13	5.870	0.464	0.374	0.024	0.410	0.113	0.001	1957	34	2047	57	1844	21	111	1968	66.61	2.86	0.091	31	134	0.230
ap29b17	6.244	0.455	0.363	0.019	0.361	0.147	0.022	2011	32	1995	45	2315	257	86	2007	59.99	0.12	0.730	73	79	0.923
ap29b18	0.994	0.059	0.114	0.004	0.328	0.062	0.001	701	15	693	13	678	22	102	696	22.32	0.21	0.646	457	589	0.776
ap29b19	5.332	0.451	0.318	0.026	0.475	0.114	0.001	1874	36	1779	62	1864	23	95	1866	72.22	2.99	0.084	68	106	0.641
ap29b20	6.151	0.282	0.374	0.015	0.448	0.129	0.012	1997	20	2047	36	2087	164	98	2001	39.63	2.33	0.127	53	162	0.329
ap29b21	33.866	1.546	0.746	0.035	0.511	0.320	0.002	3606	23	3593	64	3568	11	101	3607	44.20	0.06	0.810	104	217	0.480
ap29b22	5.886	0.361	0.350	0.017	0.389	0.114	0.002	1959	27	1933	40	1863	24	104	1954	51.10	0.46	0.496	71	76	0.931
ap29b23	3.702	0.224	0.254	0.013	0.429	0.102	0.001	1572	24	1461	34	1656	17	88	1544	46.97	11.94	0.001	230	239	0.965
ap29b24	4.990	0.378	0.325	0.020	0.397	0.111	0.001	1818	32	1815	48	1822	15	100	1817	61.35	0.00	0.953	86	242	0.356
ap29b25	5.495	0.346	0.344	0.013	0.312	0.113	0.001	1900	27	1904	32	1846	23	103	1901	47.27	0.01	0.908	113	118	0.959
ap29b26	2.628	0.450	0.222	0.030	0.390	0.088	0.001	1309	63	1290	78	1373	17	94	1302	115.07	0.06	0.814	278	504	0.551
ap29b27	10.319	0.460	0.471	0.021	0.488	0.155	0.002	2464	21	2489	45	2398	17	104	2463	41.27	0.41	0.521	116	95	1.222
ap29b28	4.901	0.330	0.326	0.016	0.367	0.114	0.001	1802	28	1818	39	1864	20	98	1806	52.84	0.16	0.689	119	142	0.841
ap29b29	5.499	0.283	0.337	0.013	0.371	0.118	0.001	1900	22	1871	31	1919	16	97	1893	41.76	0.94	0.331	80	213	0.377
ap29b30	12.022	0.374	0.496	0.016	0.517	0.173	0.003	2606	15	2598	34	2591	32	100	2607	29.02	0.07	0.790	744	434	1.715
ap29b31	5.512	0.441	0.344	0.022	0.392	0.119	0.002	1903	34	1908	52	1943	30	98	1903	65.92	0.01	0.919	61	102	0.605
ap29b34	5.794	0.435	0.337	0.019	0.380	0.123	0.001	1946	33	1872	46	2003	21	93	1927	62.16	2.66	0.103	159	139	1.144
ap29b35	14.045	0.998	0.547	0.033	0.428	0.183	0.002	2753	34	2815	69	2683	14	105	2755	67.08	0.97	0.326	155	112	1.384
ap29b36	4.877	0.368	0.319	0.021	0.436	0.109	0.001	1798	32	1785	51	1787	14	100	1797	62.41	0.08	0.783	153	289	0.530
ap29b38	13.782	0.848	0.537	0.029	0.439	0.181	0.002	2735	29	2769	61	2659	19	104	2736	58.17	0.40	0.528	101	74	1.358
ap29b39	13.456	0.830	0.521	0.033	0.508	0.183	0.001	2712	29	2701	69	2680	9	101	2713	58.00	0.03	0.857	227	327	0.694
ap29b40	1.948	0.333	0.185	0.020	0.316	0.080	0.001	1098	57	1093	54	1185	36	92	1095	90.45	0.00	0.947	140	136	1.030
ap29b41	2.047	0.247	0.189	0.019	0.417	0.078	0.001	1131	41	1118	52	1151	22	97	1127	76.29	0.07	0.796	84	306	0.275
ap29b42	5.197	0.260	0.329	0.014	0.416	0.112	0.001	1852	21	1835	33	1830	14	100	1849	41.50	0.29	0.589	116	278	0.418
ap29b43	5.330	0.382	0.337	0.019	0.384	0.116	0.001	1874	31	1871	45	1898	21	99	1873	58.23	0.00	0.955	32	121	0.266
ap29b46	5.953	0.334	0.359	0.018	0.454	0.116	0.001	1969	24	1975	43	1903	16	104	1970	48.32	0.03	0.872	245	206	1.192
ap29b47	1.985	0.151	0.182	0.013	0.468	0.076	0.001	1110	26	1080	35	1093	21	99	1103	49.45	0.86	0.353	213	403	0.529
ap29b48	5.815	0.213	0.351	0.010	0.397	0.117	0.001	1949	16	1941	24	1913	11	101	1947	30.57	0.11	0.741	384	374	1.027
ap29b49	15.097	0.820	0.538	0.028	0.486	0.195	0.002	2821	26	2776	60	2785	19	100	2823	51.56	0.77	0.381	25	58	0.434
ap29b50	5.827	0.299	0.363	0.014	0.366	0.115	0.001	1950	22	1999	32	1877	15	106	1961	41.70	2.30	0.129	86	241	0.358
ap29b51	6.645	0.424	0.379	0.017	0.357	0.123	0.002	2065	28	2070	40	2001	26	103	2066	52.88	0.01	0.905	55	62	0.885
ap29b52	6.182	0.385	0.394	0.017	0.347	0.115	0.002	2002	27	2142	39	1877	26	114	2032	50.17	12.56	0.000	81	77	1.057

Table B6, *continued*. Detrital zircon U-Pb geochronologic analyses from sample **09TOA096** from the Sekwi correlative unit (Ꞓs) - Memorial University

File Name	Measured Isotopic Ratios							Calculated Ages (Ma)													
	$\frac{^{207}Pb}{^{235}U}$	2σ error	$\frac{^{206}Pb}{^{238}U}$	2σ error	Rho	$\frac{^{207}Pb}{^{206}Pb}$	1σ error	$\frac{^{207}Pb}{^{235}U}$	1σ error (Ma)	$\frac{^{206}Pb}{^{238}U}$	1σ error (Ma)	$\frac{^{207}Pb}{^{206}Pb}$	1σ error (Ma)	U-Pb/Pb-Pb concordancy (%)	Concordia age (Ma)	2σ error (Ma)	MSWD (of concordance)	Probability (of concordance)	Th232 (ppm)	U238 (ppm)	Th/U Ratio
ap29b53	6.030	0.291	0.357	0.017	0.505	0.118	0.001	1980	21	1970	41	1919	16	103	1980	42.07	0.08	0.781	118	218	0.539
ap29b54	5.795	0.585	0.358	0.033	0.452	0.115	0.001	1946	44	1974	78	1880	20	105	1948	86.63	0.16	0.687	220	128	1.717
ap30b03	8.347	0.471	0.401	0.020	0.441	0.152	0.001	2269	26	2172	46	2370	14	92	2261	51.11	5.62	0.018	189	155	1.223
ap30b04	5.168	0.384	0.338	0.018	0.356	0.115	0.002	1847	32	1875	43	1880	30	100	1855	58.36	0.42	0.517	45	47	0.956
ap30b06	5.622	0.289	0.341	0.015	0.436	0.117	0.001	1919	22	1890	37	1912	15	99	1916	43.65	0.79	0.374	148	202	0.731
ap30b07	2.030	0.379	0.224	0.029	0.348	0.070	0.002	1126	64	1302	77	942	72	138	1181	109.77	4.82	0.028	11	20	0.541
ap30b09	5.561	0.676	0.363	0.026	0.293	0.114	0.002	1910	52	1997	61	1866	33	107	1942	88.63	1.65	0.199	11	53	0.198
ap30b10	13.212	1.248	0.544	0.040	0.389	0.180	0.003	2695	45	2799	83	2655	28	105	2703	87.49	1.76	0.185	11	19	0.587
ap30b11	10.337	0.345	0.434	0.013	0.447	0.174	0.001	2465	15	2326	29	2593	10	90	2456	31.00	29.04	0.000	122	288	0.422
ap30b12	6.515	0.368	0.355	0.017	0.434	0.130	0.001	2048	25	1959	41	2098	18	93	2036	49.37	5.47	0.019	142	114	1.239
ap30b15	12.522	0.731	0.508	0.026	0.438	0.184	0.001	2644	27	2650	56	2688	13	99	2645	54.80	0.01	0.908	131	104	1.257
ap30b16	10.783	0.568	0.425	0.021	0.479	0.182	0.001	2505	24	2284	48	2674	11	85	2498	49.20	27.76	0.000	177	180	0.981
ap30b17	5.364	0.276	0.361	0.015	0.411	0.111	0.001	1879	22	1985	36	1822	22	109	1893	42.53	9.88	0.002	27	118	0.232
ap30b18	6.047	0.625	0.392	0.026	0.315	0.114	0.002	1983	45	2132	59	1865	29	114	2024	79.57	5.78	0.016	10	70	0.144
ap30b19	10.218	0.784	0.496	0.026	0.347	0.152	0.002	2455	35	2598	57	2372	20	110	2478	66.98	6.55	0.010	162	97	1.675
ap30b20	5.542	0.471	0.340	0.024	0.420	0.114	0.002	1907	37	1886	58	1858	25	102	1904	71.47	0.16	0.693	16	63	0.245
ap30b21	1.965	0.304	0.182	0.019	0.339	0.080	0.002	1103	52	1075	52	1207	51	89	1089	85.71	0.22	0.638	9	47	0.181
ap30b22	2.300	0.256	0.220	0.017	0.342	0.079	0.002	1212	39	1284	44	1164	44	110	1240	67.05	2.27	0.132	10	72	0.133
ap30b23	7.575	1.596	0.451	0.070	0.369	0.132	0.005	2182	94	2400	156	2121	60	113	2211	179.52	2.09	0.148	10	11	0.933
ap30b24	4.442	0.448	0.335	0.024	0.360	0.102	0.002	1720	42	1864	59	1661	39	112	1753	76.69	5.97	0.015	7	31	0.215
de22a07	10.182	0.595	0.421	0.024	0.493	0.151	0.001	2451	27	2266	55	2362	9	96	2450	54.09	15.34	0.000	81	267	0.305
de22a08	5.516	0.308	0.321	0.013	0.364	0.112	0.001	1903	24	1793	32	1826	11	98	1868	45.21	11.77	0.001	92	266	0.346
de22a09	6.085	0.369	0.334	0.018	0.440	0.116	0.001	1988	26	1857	43	1892	11	98	1969	52.59	11.33	0.001	127	301	0.423
de22a10	5.784	0.498	0.340	0.019	0.331	0.113	0.001	1944	37	1888	47	1847	19	102	1924	67.52	1.30	0.255	20	101	0.195
de22a11	5.464	0.609	0.335	0.022	0.294	0.114	0.002	1895	48	1862	53	1863	26	100	1881	81.14	0.29	0.589	31	45	0.696
de22a12	6.577	0.577	0.363	0.020	0.310	0.121	0.001	2056	39	1998	47	1976	19	101	2034	68.78	1.30	0.255	124	73	1.690
de22a13	5.775	0.296	0.333	0.012	0.351	0.112	0.001	1943	22	1855	29	1839	19	101	1914	41.29	8.74	0.003	99	89	1.114
de22a14	7.256	0.496	0.369	0.018	0.363	0.130	0.001	2143	30	2024	43	2097	15	96	2111	58.33	7.88	0.005	60	119	0.503
de22a15	1.753	0.195	0.171	0.009	0.244	0.075	0.001	1028	36	1018	26	1075	30	95	1021	46.15	0.07	0.791	61	78	0.781
de22a18	5.518	0.398	0.334	0.016	0.331	0.112	0.001	1903	31	1859	39	1828	13	102	1888	55.97	1.19	0.275	54	137	0.396
de22a19	12.360	0.812	0.443	0.023	0.396	0.184	0.001	2632	31	2366	51	2690	9	88	2585	62.32	30.94	0.000	156	237	0.657
de22a20	5.626	0.477	0.327	0.022	0.391	0.112	0.001	1920	37	1824	53	1834	16	99	1897	70.42	3.59	0.058	52	125	0.417
de22a21	12.073	0.951	0.464	0.031	0.423	0.166	0.001	2610	37	2458	68	2522	11	97	2596	74.05	6.09	0.014	187	115	1.630
de22a22	5.690	0.456	0.331	0.023	0.425	0.109	0.001	1930	35	1843	55	1790	17	103	1916	68.11	2.96	0.085	85	94	0.911
de22a23	5.844	0.514	0.335	0.020	0.338	0.114	0.001	1953	38	1863	48	1868	22	100	1921	69.85	3.20	0.074	45	90	0.497
de22a24	6.207	0.696	0.346	0.028	0.358	0.120	0.002	2005	49	1914	66	1952	23	98	1978	92.35	1.86	0.173	63	44	1.428
de22a25	6.657	0.631	0.383	0.018	0.242	0.130	0.002	2067	42	2089	41	2092	25	100	2078	64.91	0.18	0.670	27	41	0.666
de22a26	2.820	0.241	0.226	0.012	0.314	0.084	0.001	1361	32	1312	32	1281	22	102	1335	52.43	1.71	0.191	56	179	0.310
de22a29	6.031	0.316	0.346	0.014	0.386	0.113	0.001	1980	23	1915	34	1844	11	104	1966	43.94	4.11	0.043	100	335	0.300
de22a30	5.653	0.345	0.326	0.015	0.368	0.113	0.001	1924	26	1818	36	1841	11	99	1893	49.81	8.83	0.003	125	244	0.513
de22a31	11.877	0.627	0.463	0.019	0.398	0.166	0.001	2595	25	2452	43	2522	10	97	2576	49.22	12.84	0.000	90	171	0.524
de22a32	5.157	0.438	0.329	0.013	0.235	0.113	0.001	1846	36	1831	32	1848	20	99	1837	53.08	0.11	0.737	89	88	1.004

Table B6, *continued*. Detrital zircon U-Pb geochronologic analyses from sample **09TOA096** from the Sekwi correlative unit (Ꞓs) - Memorial University

File Name	Measured Isotopic Ratios							Calculated Ages (Ma)													
	$\frac{^{207}Pb}{^{235}U}$	2σ error	$\frac{^{206}Pb}{^{238}U}$	2σ error	Rho	$\frac{^{207}Pb}{^{206}Pb}$	1σ error	$\frac{^{207}Pb}{^{235}U}$	1σ error (Ma)	$\frac{^{206}Pb}{^{238}U}$	1σ error (Ma)	$\frac{^{207}Pb}{^{206}Pb}$	1σ error (Ma)	U-Pb/Pb-Pb concordancy (%)	Concordia age (Ma)	2σ error (Ma)	MSWD (of concordance)	Probability (of concordance)	Th232 (ppm)	U238 (ppm)	Th/U Ratio
de22a33	1.873	0.119	0.169	0.006	0.263	0.075	0.001	1072	21	1005	16	1067	21	94	1023	28.27	8.48	0.004	80	228	0.352
de22a34	5.395	0.331	0.327	0.011	0.278	0.112	0.001	1884	26	1826	27	1825	18	100	1855	43.23	3.23	0.072	22	85	0.265
de22a35	7.196	0.683	0.394	0.019	0.252	0.135	0.002	2136	42	2139	44	2163	27	99	2138	67.92	0.00	0.951	16	31	0.500
de22a36	14.530	0.815	0.502	0.031	0.548	0.181	0.001	2785	27	2623	66	2660	9	99	2798	51.89	8.57	0.003	163	166	0.983
de22a37	3.119	0.402	0.237	0.020	0.327	0.088	0.001	1437	50	1373	52	1385	23	99	1406	83.87	1.19	0.275	57	114	0.502
de22a40	15.645	0.925	0.557	0.029	0.436	0.182	0.001	2855	28	2854	59	2674	14	107	2855	56.35	0.00	0.974	231	52	4.480
de22a41	15.183	0.747	0.526	0.022	0.420	0.185	0.001	2827	23	2726	46	2696	10	101	2820	46.90	5.89	0.015	85	125	0.684
de22a42	5.513	0.367	0.330	0.015	0.345	0.111	0.001	1903	29	1837	37	1813	19	101	1881	52.63	2.94	0.086	44	80	0.550
de22a43	2.594	0.120	0.211	0.006	0.308	0.079	0.001	1299	17	1233	16	1165	19	106	1261	27.02	11.45	0.001	116	275	0.423
de22a44	4.982	0.490	0.321	0.020	0.312	0.106	0.001	1816	42	1795	48	1728	19	104	1808	72.22	0.16	0.693	59	92	0.644
de22a45	2.542	0.309	0.211	0.015	0.298	0.082	0.001	1284	44	1232	41	1248	24	99	1254	68.94	1.04	0.307	56	118	0.472
de22a46	3.043	0.315	0.234	0.016	0.339	0.086	0.001	1418	40	1355	43	1348	22	100	1389	68.20	1.79	0.181	45	109	0.413
de22a47	5.287	0.419	0.320	0.015	0.298	0.113	0.001	1867	34	1790	37	1856	23	96	1831	57.76	3.29	0.070	28	51	0.552
de22a48	2.158	0.207	0.182	0.013	0.384	0.077	0.001	1168	33	1079	37	1126	17	96	1127	58.94	5.14	0.023	132	312	0.422
de22a51	14.600	0.623	0.512	0.019	0.429	0.186	0.001	2790	20	2665	40	2703	12	99	2782	40.62	11.98	0.001	32	69	0.459
de22a52	4.801	0.422	0.330	0.014	0.237	0.115	0.002	1785	37	1839	33	1872	33	98	1815	54.40	1.55	0.214	51	41	1.239
de22a53	5.189	0.556	0.322	0.018	0.258	0.112	0.001	1851	46	1800	43	1839	18	98	1823	71.31	0.85	0.357	86	111	0.773
de22a54	2.060	0.195	0.194	0.009	0.245	0.078	0.001	1135	32	1145	24	1145	33	100	1142	43.09	0.07	0.798	43	57	0.758

Table B7a. Detrital zircon U-Pb geochronologic analyses from sample **09LP093** in unit **OSs** - Isotope Geology Laboratory, Boise State University

Analysis	U (ppm)	Th (ppm)	Pb* (ppm)	Th/U	Corrected isotope ratios											Apparent ages (Ma)						% disc.
					$^{206}Pb^*/^{207}Pb^*$	±2σ (%)	$^{207}Pb^*/^{235}U^*$	±2σ (%)	$^{206}Pb^*/^{238}U$	±2σ (%)	error corr.	$^{238}U/^{206}Pb^*$	±2σ (%)	$^{207}Pb^*/^{206}Pb^*$	±2σ (%)	error corr.	$^{207}Pb^*/^{206}Pb^*$	±2σ (Ma)	$^{207}Pb^*/^{235}U$	±2σ (Ma)	$^{206}Pb^*/^{238}U^*$	±2σ (Ma)	
09LP093 L 29	165.71	154.42	143.65	0.93	4.441	1.668	17.366	6.981	0.559	6.779	0.971	1.788	6.779	0.225	1.668	-0.0	**3018**	**27**	2955	67	2864	157	5
09LP093 L 73	334.09	157.44	240.16	0.47	4.865	1.618	15.142	5.517	0.534	5.274	0.956	1.872	5.274	0.206	1.618	0	**2871**	**26**	2824	53	2759	118	4
09LP093 L 57	121.87	79.11	97.21	0.65	4.927	2.000	15.621	5.892	0.558	5.542	0.941	1.792	5.542	0.203	2.000	-0.0	**2850**	**33**	2854	56	2859	128	-0
09LP093 L 1	119.18	59.62	80.57	0.50	5.215	2.030	13.546	6.412	0.512	6.082	0.949	1.952	6.082	0.192	2.030	0.0	**2757**	**33**	2719	61	2666	133	3
09LP093 L 81	38.87	68.48	33.09	1.76	5.217	4.784	13.506	8.025	0.511	6.443	0.803	1.957	6.443	0.192	4.784	-0.0	**2757**	**79**	2716	76	2661	140	3
09LP093 L 28	190.73	75.47	127.49	0.40	5.255	2.322	13.175	7.685	0.502	7.325	0.953	1.991	7.325	0.190	2.322	0.0	**2745**	**38**	2692	73	2623	158	4
09LP093 L 2	169.58	272.87	138.75	1.61	5.256	1.851	13.289	6.314	0.507	6.037	0.956	1.974	6.037	0.190	1.851	0.0	**2744**	**30**	2700	60	2642	131	4
09LP093 L 97	224.54	141.91	156.94	0.63	5.303	1.711	13.212	6.071	0.508	5.825	0.959	1.968	5.825	0.189	1.711	-0.0	**2730**	**28**	2695	57	2649	127	3
09LP093 L 55	107.32	45.33	77.18	0.42	5.317	2.388	13.880	7.242	0.535	6.837	0.944	1.869	6.837	0.188	2.388	-0.0	**2726**	**39**	2742	69	2763	154	-1
09LP093 L 12	211.30	219.96	159.34	1.04	5.328	1.688	12.994	7.248	0.502	7.049	0.973	1.992	7.049	0.188	1.688	0.0	**2722**	**28**	2679	68	2623	152	4
09LP093 L 95	43.31	82.03	37.47	1.89	5.360	3.010	12.946	6.969	0.503	6.285	0.902	1.987	6.285	0.187	3.010	0.0	**2712**	**50**	2676	66	2628	136	3
09LP093 L 53	79.80	46.80	58.52	0.59	5.366	2.701	13.400	7.254	0.522	6.732	0.928	1.917	6.732	0.186	2.701	-0.0	**2710**	**45**	2708	69	2706	149	0
09LP093 L 17	136.81	142.68	106.61	1.04	5.389	1.612	13.160	6.035	0.514	5.815	0.964	1.944	5.815	0.186	1.612	0.0	**2703**	**27**	2691	57	2675	127	1
09LP093 L 90	79.86	72.03	57.92	0.90	5.400	1.981	13.060	6.816	0.512	6.522	0.957	1.955	6.522	0.185	1.981	0.0	**2700**	**33**	2684	64	2663	142	1
09LP093 L 72	141.35	288.59	130.94	2.04	5.419	2.054	13.006	6.932	0.511	6.621	0.955	1.956	6.621	0.185	2.054	0	**2694**	**34**	2680	65	2662	144	1
09LP093 L 46	220.92	193.48	164.07	0.88	5.422	2.283	12.313	6.902	0.484	6.514	0.944	2.065	6.514	0.184	2.283	0.0	**2693**	**38**	2629	65	2546	137	5
09LP093 L 104	69.38	38.42	49.11	0.55	5.464	2.262	13.266	6.715	0.526	6.323	0.942	1.902	6.323	0.183	2.262	0.0	**2680**	**37**	2699	63	2723	140	-2
09LP093 L 35	136.17	78.83	100.37	0.58	5.482	2.261	13.266	7.412	0.527	7.059	0.952	1.896	7.059	0.182	2.261	-0.0	**2675**	**37**	2699	70	2731	157	-2
09LP093 L 10	270.06	254.88	193.38	0.94	5.539	1.325	12.182	6.006	0.489	5.857	0.975	2.043	5.857	0.181	1.325	0	**2658**	**22**	2619	56	2568	124	3
09LP093 L 50	186.61	96.57	139.32	0.52	5.604	2.804	13.482	6.652	0.548	6.032	0.907	1.825	6.032	0.178	2.804	0	**2638**	**47**	2714	63	2817	138	-7
09LP093 L 85	209.47	106.32	137.74	0.51	5.662	1.525	12.302	5.941	0.505	5.742	0.966	1.980	5.742	0.177	1.525	-0.0	**2621**	**25**	2628	56	2636	124	-1
09LP093 L 30	65.28	44.56	45.21	0.68	5.670	2.316	11.913	7.378	0.490	7.006	0.949	2.041	7.006	0.176	2.316	-0.0	**2619**	**39**	2598	69	2570	148	2
09LP093 L 4	104.45	99.72	71.22	0.95	5.697	1.600	11.584	6.122	0.479	5.909	0.965	2.089	5.909	0.176	1.600	-0.0	**2611**	**27**	2571	57	2521	123	3
09LP093 L 71	343.05	175.83	223.13	0.51	5.797	1.717	11.654	6.048	0.490	5.799	0.959	2.041	5.799	0.173	1.717	0	**2582**	**29**	2577	57	2570	123	0
09LP093 L 43	124.70	74.54	91.03	0.60	5.838	2.315	12.314	7.168	0.521	6.784	0.946	1.918	6.784	0.171	2.315	-0.0	**2570**	**39**	2629	67	2705	150	-5
09LP093 L 8	201.17	237.14	138.22	1.18	5.965	1.587	10.682	6.215	0.462	6.009	0.967	2.164	6.009	0.168	1.587	0.0	**2534**	**27**	2496	58	2449	122	3
09LP093 L 27	53.69	31.03	34.63	0.58	5.980	2.823	10.889	6.579	0.472	5.942	0.903	2.118	5.942	0.167	2.823	-0.0	**2530**	**47**	2514	61	2493	123	1
09LP093 L 68	230.89	150.91	149.08	0.65	5.988	1.875	10.768	6.520	0.468	6.245	0.958	2.138	6.245	0.167	1.875	0	**2528**	**31**	2503	61	2473	128	2
09LP093 L 109	159.69	59.11	94.74	0.37	6.010	2.238	10.598	6.913	0.462	6.541	0.946	2.165	6.541	0.166	2.238	0	**2522**	**38**	2489	64	2448	133	3
09LP093 L 65	126.17	68.79	82.51	0.55	6.030	1.828	11.125	7.918	0.487	7.704	0.973	2.055	7.704	0.166	1.828	0.0	**2516**	**31**	2534	74	2556	163	-2
09LP093 L 74	111.35	41.65	65.69	0.37	6.150	1.942	10.408	6.891	0.464	6.612	0.959	2.154	6.612	0.163	1.942	0.0	**2483**	**33**	2472	64	2458	135	1
09LP093 L 33	127.01	52.97	78.69	0.42	6.180	2.378	10.556	7.805	0.473	7.434	0.952	2.114	7.434	0.162	2.378	-0.0	**2475**	**40**	2485	72	2497	154	-1
09LP093 L 5	154.00	120.73	95.09	0.78	6.192	1.413	10.003	6.171	0.449	6.007	0.973	2.226	6.007	0.161	1.413	0	**2471**	**24**	2435	57	2392	120	3
09LP093 L 79	214.03	133.03	127.46	0.62	6.233	1.534	9.990	8.286	0.452	8.142	0.983	2.214	8.142	0.160	1.534	-0.0	**2460**	**26**	2434	76	2402	163	2
09LP093 L 102	227.15	283.21	152.84	1.25	6.325	1.924	9.590	6.493	0.440	6.202	0.955	2.273	6.202	0.158	1.924	0	**2436**	**33**	2396	60	2350	122	4
09LP093 L 36	145.62	61.22	81.53	0.42	6.751	2.150	8.765	6.709	0.429	6.355	0.947	2.330	6.355	0.148	2.150	0	**2324**	**37**	2314	61	2302	123	1
09LP093 L 58	178.59	167.01	119.37	0.94	6.824	2.605	9.177	7.210	0.454	6.723	0.932	2.202	6.723	0.147	2.605	0	**2306**	**45**	2356	66	2414	135	-5
09LP093 L 86	278.65	155.81	132.98	0.56	7.592	2.481	6.790	6.711	0.374	6.235	0.929	2.675	6.235	0.132	2.481	-0.0	**2121**	**43**	2084	59	2048	109	3
09LP093 L 98	370.24	101.60	166.44	0.27	7.785	1.856	6.577	5.853	0.371	5.551	0.948	2.693	5.551	0.128	1.856	-0.0	**2077**	**33**	2056	52	2036	97	2
09LP093 L 7	107.89	103.44	52.35	0.96	8.078	2.345	5.928	6.887	0.347	6.475	0.940	2.879	6.475	0.124	2.345	0.0	**2012**	**42**	1965	60	1922	108	4
09LP093 L 84	89.09	90.56	41.73	1.02	8.315	2.582	5.616	6.798	0.339	6.288	0.925	2.953	6.288	0.120	2.582	0.0	**1960**	**46**	1919	59	1880	103	4
09LP093 L 64	355.01	21.03	143.60	0.06	8.349	2.599	5.861	7.820	0.355	7.376	0.943	2.818	7.376	0.120	2.599	0.0	**1953**	**46**	1955	68	1958	125	-0

Table B7a, *continued*. Detrital zircon U-Pb geochronologic analyses from sample **09LP093** in unit OSs - Isotope Geology Laboratory, Boise State University

Analysis	U (ppm)	Th (ppm)	Pb* (ppm)	Th/U	Corrected isotope ratios											Apparent ages (Ma)						% disc.
					$^{206}Pb^*/^{207}Pb^*$	±2σ (%)	$^{207}Pb^*/^{235}U^*$	±2σ (%)	$^{206}Pb^*/^{238}U$	±2σ (%)	error corr.	$^{238}U/^{206}Pb^*$	±2σ (%)	$^{207}Pb^*/^{206}Pb^*$	±2σ (%)	error corr.	$^{207}Pb^*/^{206}Pb^*$	±2σ (Ma)	$^{207}Pb^*/^{235}U$	±2σ (Ma)	$^{206}Pb^*/^{238}U^*$	±2σ (Ma)	
09LP093 L 93	324.97	200.70	142.90	0.62	8.358	1.542	5.584	6.447	0.338	6.260	0.971	2.954	6.260	0.120	1.542	0	**1951**	**28**	1914	56	1879	102	4
09LP093 L 103	92.31	76.88	41.82	0.83	8.418	2.330	5.335	6.192	0.326	5.737	0.927	3.070	5.737	0.119	2.330	-0.0	**1938**	**42**	1875	53	1818	91	6
09LP093 L 107	195.09	86.89	83.82	0.45	8.441	2.752	5.569	7.990	0.341	7.502	0.939	2.933	7.502	0.118	2.752	-0.0	**1933**	**49**	1911	69	1891	123	2
09LP093 L 48	177.61	71.33	78.97	0.40	8.450	2.758	5.684	7.072	0.348	6.512	0.921	2.871	6.512	0.118	2.758	0.0	**1931**	**49**	1929	61	1927	108	0
09LP093 L 100	156.46	60.96	63.00	0.39	8.455	2.016	5.302	6.779	0.325	6.472	0.955	3.076	6.472	0.118	2.016	-0.0	**1930**	**36**	1869	58	1815	102	6
09LP093 L 18	90.68	162.76	50.53	1.79	8.474	2.670	5.300	6.464	0.326	5.887	0.911	3.070	5.887	0.118	2.670	-0.0	**1926**	**48**	1869	55	1818	93	6
09LP093 L 106	131.21	40.92	53.54	0.31	8.488	2.850	5.453	7.457	0.336	6.891	0.924	2.979	6.891	0.118	2.850	0	**1923**	**51**	1893	64	1866	112	3
09LP093 L 88	93.56	101.30	44.08	1.08	8.491	2.075	5.464	6.184	0.336	5.825	0.942	2.972	5.825	0.118	2.075	0	**1923**	**37**	1895	53	1870	95	3
09LP093 L 20	210.71	137.88	91.41	0.65	8.529	1.658	5.223	6.134	0.323	5.905	0.963	3.095	5.905	0.117	1.658	0.0	**1915**	**30**	1856	52	1805	93	6
09LP093 L 15	241.00	198.91	109.00	0.83	8.598	2.099	5.188	6.161	0.324	5.793	0.940	3.091	5.793	0.116	2.099	0	**1900**	**38**	1851	52	1807	91	5
09LP093 L 62	46.91	46.72	23.56	1.00	8.605	4.239	5.476	7.999	0.342	6.784	0.848	2.926	6.784	0.116	4.239	0.0	**1899**	**76**	1897	69	1895	111	0
09LP093 L 40	169.99	54.23	70.53	0.32	8.607	2.357	5.329	6.487	0.333	6.044	0.932	3.006	6.044	0.116	2.357	-0.0	**1898**	**42**	1874	55	1851	97	2
09LP093 L 16	94.67	62.89	40.60	0.66	8.620	2.471	5.134	6.292	0.321	5.786	0.920	3.115	5.786	0.116	2.471	-0.0	**1896**	**44**	1842	53	1795	91	5
09LP093 L 75	370.84	132.04	155.06	0.36	8.621	1.826	5.480	6.210	0.343	5.936	0.956	2.918	5.936	0.116	1.826	-0.0	**1895**	**33**	1898	53	1899	98	-0
09LP093 L 21	72.37	30.15	30.24	0.42	8.677	2.915	5.266	7.250	0.331	6.638	0.916	3.018	6.638	0.115	2.915	0.0	**1884**	**52**	1863	62	1845	106	2
09LP093 L 101	155.92	69.80	60.43	0.45	8.679	2.747	4.878	6.583	0.307	5.982	0.909	3.257	5.982	0.115	2.747	-0.0	**1883**	**49**	1799	55	1726	91	8
09LP093 L 80	117.09	69.72	49.71	0.60	8.686	1.982	5.332	6.391	0.336	6.076	0.951	2.977	6.076	0.115	1.982	0	**1882**	**36**	1874	55	1867	98	1
09LP093 L 3	85.53	99.44	39.06	1.16	8.698	2.981	5.052	6.903	0.319	6.226	0.902	3.138	6.226	0.115	2.981	-0.0	**1879**	**54**	1828	59	1783	97	5
09LP093 L 87	239.43	107.80	97.45	0.45	8.699	1.646	5.236	5.965	0.330	5.733	0.961	3.027	5.733	0.115	1.646	0	**1879**	**30**	1858	51	1840	92	2
09LP093 L 26	145.98	42.90	57.76	0.29	8.707	2.780	5.139	7.457	0.325	6.920	0.928	3.082	6.920	0.115	2.780	0.0	**1877**	**50**	1843	63	1812	109	3
09LP093 L 38	96.02	56.36	40.47	0.59	8.708	2.837	4.994	8.057	0.315	7.541	0.936	3.171	7.541	0.115	2.837	0.0	**1877**	**51**	1818	68	1767	117	6
09LP093 L 83	166.17	78.84	69.43	0.47	8.724	2.140	5.351	6.927	0.339	6.588	0.951	2.953	6.588	0.115	2.140	0	**1874**	**39**	1877	59	1880	107	-0
09LP093 L 56	171.70	44.55	70.58	0.26	8.743	2.259	5.346	6.765	0.339	6.377	0.943	2.950	6.377	0.114	2.259	-0.0	**1870**	**41**	1876	58	1882	104	-1
09LP093 L 31	52.27	12.32	21.09	0.24	8.751	3.202	5.255	7.786	0.334	7.097	0.912	2.998	7.097	0.114	3.202	-0.0	**1868**	**58**	1862	66	1855	114	1
09LP093 L 59	101.65	78.32	49.88	0.77	8.765	2.743	5.533	7.414	0.352	6.888	0.929	2.843	6.888	0.114	2.743	-0.0	**1866**	**50**	1906	64	1943	116	-4
09LP093 L 60	70.18	75.76	37.79	1.08	8.774	3.168	5.634	7.418	0.359	6.707	0.904	2.789	6.707	0.114	3.168	-0.0	**1864**	**57**	1921	64	1975	114	-6
09LP093 L 94	44.62	24.81	17.72	0.56	8.776	3.429	4.886	6.837	0.311	5.915	0.865	3.216	5.915	0.114	3.429	0	**1863**	**62**	1800	58	1745	90	6
09LP093 L 61	456.72	414.37	217.89	0.91	8.780	2.521	5.201	7.162	0.331	6.703	0.936	3.019	6.703	0.114	2.521	0.0	**1862**	**46**	1853	61	1844	108	1
09LP093 L 63	64.73	31.81	29.02	0.49	8.781	3.849	5.462	8.924	0.348	8.051	0.902	2.875	8.051	0.114	3.849	-0.0	**1862**	**69**	1895	77	1924	134	-3
09LP093 L 76	205.60	169.68	89.59	0.83	8.796	1.545	5.071	6.150	0.324	5.953	0.968	3.091	5.953	0.114	1.545	0.0	**1859**	**28**	1831	52	1807	94	3
09LP093 L 54	230.61	70.66	93.57	0.31	8.816	2.011	5.159	7.476	0.330	7.201	0.963	3.031	7.201	0.113	2.011	0	**1855**	**36**	1846	64	1838	115	1
09LP093 L 42	127.15	22.93	51.45	0.18	8.817	2.541	5.344	6.984	0.342	6.506	0.931	2.926	6.506	0.113	2.541	0	**1855**	**46**	1876	60	1895	107	-2
09LP093 L 96	189.75	102.97	66.99	0.54	8.830	2.569	4.282	10.525	0.274	10.207	0.970	3.647	10.207	0.113	2.569	0.0	**1852**	**46**	1690	87	1562	142	16
09LP093 L 22	165.43	36.41	64.27	0.22	8.834	2.634	5.095	6.925	0.326	6.404	0.925	3.064	6.404	0.113	2.634	0.0	**1851**	**48**	1835	59	1821	102	2
09LP093 L 52	365.79	121.20	132.41	0.33	8.839	2.425	4.552	7.282	0.292	6.867	0.943	3.427	6.867	0.113	2.425	-0.0	**1850**	**44**	1741	61	1651	100	11
09LP093 L 13	300.13	211.20	128.28	0.70	8.858	1.795	4.950	6.992	0.318	6.758	0.966	3.145	6.758	0.113	1.795	-0.0	**1846**	**32**	1811	59	1780	105	4
09LP093 L 91	192.45	79.96	77.17	0.42	8.861	2.104	5.074	6.212	0.326	5.845	0.941	3.067	5.845	0.113	2.104	-0.0	**1846**	**38**	1832	53	1819	93	1
09LP093 L 51	70.12	12.85	28.38	0.18	8.861	2.573	5.328	7.066	0.342	6.581	0.931	2.921	6.581	0.113	2.573	-0.0	**1846**	**47**	1873	60	1898	108	-3
09LP093 L 47	43.74	18.94	18.28	0.43	8.865	3.568	5.040	7.063	0.324	6.095	0.863	3.086	6.095	0.113	3.568	0	**1845**	**65**	1826	60	1809	96	2
09LP093 L 24	146.29	76.52	60.22	0.52	8.877	2.090	4.917	6.581	0.317	6.240	0.948	3.159	6.240	0.113	2.090	-0.0	**1843**	**38**	1805	56	1773	97	4
09LP093 L 34	109.08	78.53	51.70	0.72	8.878	2.745	5.373	7.150	0.346	6.602	0.923	2.890	6.602	0.113	2.745	0	**1842**	**50**	1881	61	1915	109	-4
09LP093 L 78	157.25	15.81	60.25	0.10	8.883	2.008	5.231	7.037	0.337	6.745	0.958	2.967	6.745	0.113	2.008	0.0	**1841**	**36**	1858	60	1872	110	-2

Table B7a, *continued*. Detrital zircon U-Pb geochronologic analyses from sample **09LP093** in unit **OSs** - Isotope Geology Laboratory, Boise State University

Analysis	U (ppm)	Th (ppm)	Pb* (ppm)	Th/U	Corrected isotope ratios											Apparent ages (Ma)						% disc.
					$^{206}Pb^*/^{207}Pb^*$	±2σ (%)	$^{207}Pb^*/^{235}U^*$	±2σ (%)	$^{206}Pb^*/^{238}U$	±2σ (%)	error corr.	$^{238}U/^{206}Pb^*$	±2σ (%)	$^{207}Pb^*/^{206}Pb^*$	±2σ (%)	error corr.	$^{207}Pb^*/^{206}Pb^*$	±2σ (Ma)	$^{207}Pb^*/^{235}U$	±2σ (Ma)	$^{206}Pb^*/^{238}U^*$	±2σ (Ma)	
09LP093 L 67	101.70	59.77	41.75	0.59	8.892	2.733	4.861	6.965	0.313	6.406	0.920	3.190	6.406	0.112	2.733	0.0	**1839**	**49**	1795	59	1758	99	4
09LP093 L 110	199.56	116.50	88.10	0.58	8.928	2.968	5.184	7.016	0.336	6.357	0.906	2.979	6.357	0.112	2.968	0.0	**1832**	**54**	1850	60	1866	103	-2
09LP093 L 105	63.92	56.11	27.71	0.88	8.934	3.070	4.738	6.774	0.307	6.038	0.891	3.257	6.038	0.112	3.070	0.0	**1831**	**56**	1774	57	1726	91	6
09LP093 L 69	386.65	114.73	156.17	0.30	8.941	1.720	5.154	6.559	0.334	6.329	0.965	2.992	6.329	0.112	1.720	0.0	**1830**	**31**	1845	56	1859	102	-2
09LP093 L 66	66.95	26.67	27.38	0.40	8.945	2.638	5.054	7.937	0.328	7.486	0.943	3.050	7.486	0.112	2.638	0.0	**1829**	**48**	1828	67	1828	119	0
09LP093 L 70	134.48	47.98	52.99	0.36	8.968	2.525	4.941	6.702	0.321	6.208	0.926	3.112	6.208	0.112	2.525	0	**1824**	**46**	1809	57	1796	97	2
09LP093 L 25	185.16	93.02	77.21	0.50	8.975	2.205	4.975	6.982	0.324	6.625	0.949	3.088	6.625	0.111	2.205	0	**1823**	**40**	1815	59	1809	104	1
09LP093 L 99	98.35	122.08	46.72	1.24	9.001	3.450	4.847	7.020	0.316	6.113	0.871	3.160	6.113	0.111	3.450	-0.0	**1817**	**63**	1793	59	1772	95	2
09LP093 L 82	274.31	198.46	106.76	0.72	9.023	2.266	4.561	5.976	0.298	5.530	0.925	3.351	5.530	0.111	2.266	-0.0	**1813**	**41**	1742	50	1684	82	7
09LP093 L 45	97.88	69.12	46.96	0.71	9.030	3.687	5.271	8.244	0.345	7.374	0.894	2.897	7.374	0.111	3.687	-0.0	**1812**	**67**	1864	70	1912	122	-6
09LP093 L 49	128.54	42.95	53.23	0.33	9.042	3.013	5.100	6.611	0.334	5.884	0.890	2.990	5.884	0.111	3.013	0.0	**1809**	**55**	1836	56	1860	95	-3
09LP093 L 11	171.26	45.06	62.03	0.26	9.068	1.725	4.621	7.210	0.304	7.000	0.971	3.291	7.000	0.110	1.725	0.0	**1804**	**31**	1753	60	1711	105	5
09LP093 L 41	253.85	87.68	99.82	0.35	9.115	2.394	4.769	7.491	0.315	7.098	0.948	3.171	7.098	0.110	2.394	-0.0	**1794**	**44**	1780	63	1767	110	2
09LP093 L 108	173.80	80.55	70.20	0.46	9.188	2.845	4.826	7.792	0.322	7.254	0.931	3.110	7.254	0.109	2.845	-0.0	**1780**	**52**	1789	66	1797	114	-1
09LP093 L 44	124.74	72.57	53.19	0.58	9.240	2.920	4.741	7.402	0.318	6.802	0.919	3.148	6.802	0.108	2.920	0	**1770**	**53**	1774	62	1778	106	-0
09LP093 L 37	140.08	171.22	62.91	1.22	9.481	2.534	4.171	7.223	0.287	6.763	0.936	3.487	6.763	0.105	2.534	0	**1722**	**47**	1668	59	1626	97	6
09LP093 L 92	151.06	95.93	57.88	0.64	9.620	2.510	4.278	6.585	0.298	6.088	0.925	3.350	6.088	0.104	2.510	0.0	**1696**	**46**	1689	54	1684	90	1
09LP093 L 6	295.02	184.51	80.66	0.63	11.219	1.738	2.657	7.310	0.216	7.100	0.971	4.626	7.100	0.089	1.738	-0.0	**1407**	**33**	1316	54	1262	81	10

Notes:

Yellow highlighted rows are samples that intersected inclusions.
Isotope ratios and ages are NOT corrected for initial common Pb.
Isotope ratio and apparent age errors include systematic calibration errors of 3.69819596935203% ($^{208}Pb/^{232}Th$), 0.334539294582954% ($^{207}Pb/^{206}Pb$), 2.39239549711403% ($^{206}Pb/^{238}U$) (all 1-sigma).
Sweep-by-sweep downhole fractionation of U/Pb ratios NOT corrected via Si/Zr fractionation factor.
Backgrounds were monitored during sweeps 10 to 27. Sample counts were integrated from sweeps 36 to 69.
Ablation used a laser spot size of 25 microns, and a laser firing repitition rate of 10 Hz.

Table B7b. Detrital zircon trace element analyses from sample **09LP093** in unit OSs - Isotope Geology Laboratory, Boise State University

Analysis	Concentrations (ppm)																						
	P	Ti	Y	Zr	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	Th	U
09LP093 L 29	346.823	7.822	2537.430	502367.969	2.155		8.962	0.310	3.768	10.307	2.056	56.780	21.157	260.062	95.550	400.429	104.220	1124.806	120.166	6727.788	1.095	154.423	165.711
09LP093 L 73	179.690	4.717	576.029	557095.817	1.389		8.810		0.684	1.192	0.175	9.140	3.219	47.813	18.923	89.402	25.284	305.190	37.267	9609.782	1.633	157.438	334.085
09LP093 L 57	174.573	3.449	1519.036	455519.920	1.845	0.018	8.294	0.222	5.515	11.444	1.854	53.074	17.015	189.700	62.219	235.343	57.096	605.453	57.374	6106.578	0.837	79.109	121.872
09LP093 L 1	167.134	2.805	711.690	666916.111	1.963	0.063	5.994		1.125	2.023	0.187	13.829	5.210	65.105	24.389	116.771	29.211	301.842	43.658	10173.974	0.906	59.623	119.180
09LP093 L 81	~~319.067~~	~~194.977~~	~~866.869~~	~~658213.741~~	~~2.822~~	~~1.436~~	~~31.996~~	~~0.497~~	~~5.833~~	~~7.281~~	~~1.961~~	~~28.046~~	~~7.859~~	~~93.048~~	~~32.574~~	~~130.535~~	~~30.437~~	~~285.694~~	~~41.567~~	~~9144.418~~	~~1.107~~	~~68.485~~	~~38.868~~
09LP093 L 28	165.631	4.998	605.344	516998.555	1.193	0.053	4.802	0.071	0.833	2.097	0.534	11.330	4.201	53.500	20.740	92.336	26.764	301.488	37.752	7592.760	0.572	75.470	190.734
09LP093 L 2	66.991	1.529	1765.207	642184.664	1.568	0.029	44.631	0.663	11.793	19.439	5.434	67.634	20.701	205.680	62.667	243.946	56.323	521.943	69.549	8985.003	0.661	272.872	169.581
09LP093 L 97	191.267	7.355	323.377	575021.143	0.500		16.963	0.107	1.533	3.866	1.558	14.203	3.750	40.423	12.995	48.909	11.936	130.434	14.939	7727.921	0.421	141.909	224.541
09LP093 L 55	99.307	5.292	145.193	474739.920	1.340	0.102	22.396	0.020	0.642	1.123	0.308	4.600	1.540	15.510	5.097	21.617	6.200	77.175	8.332	8279.965	0.807	45.334	107.322
09LP093 L 12	241.244	5.934	712.801	577186.752	2.337	0.111	18.018	0.135	1.989	3.223	0.372	15.804	5.632	66.917	24.458	113.953	30.166	334.967	43.309	10534.850	1.685	219.960	211.304
09LP093 L 95	234.200	4.432	486.812	589078.163	1.028		17.570	0.054	0.915	2.401	0.149	13.480	4.116	49.405	19.047	74.222	18.610	193.698	22.181	11064.601	0.415	82.027	43.314
09LP093 L 53	222.969	6.107	606.532	474434.755	1.024		8.665	0.010	0.464	2.329	0.190	14.129	5.094	62.677	22.633	93.574	25.624	283.882	27.476	6902.604	0.950	46.801	79.800
09LP093 L 17	150.199	10.399	278.006	562578.194	0.705		22.937		1.603	2.449	0.930	11.577	3.205	31.138	10.815	40.805	11.408	123.409	14.140	8906.148	0.371	142.682	136.815
09LP093 L 90	278.305	7.526	1400.450	640115.593	1.572	0.068	12.458	0.150	3.776	7.790	2.162	40.046	12.534	151.076	53.364	219.481	52.391	537.773	70.085	9132.517	0.757	72.030	79.862
09LP093 L 72	281.732	7.548	1014.358	555320.687	2.526		47.843	0.106	2.521	5.995	0.629	28.087	9.356	106.248	37.114	149.855	36.926	393.537	43.386	9956.860	1.097	288.593	141.355
09LP093 L 46	326.884	5.844	850.900	473761.231	3.985	0.091	14.590	0.027	0.975	3.784	0.141	18.156	6.998	87.773	31.490	126.653	31.635	352.438	34.853	8817.185	1.823	193.483	220.925
09LP093 L 104	175.871	12.112	432.472	535475.131	1.229		8.066	0.052	1.418	3.515	0.314	13.612	4.394	45.810	16.215	70.144	17.988	195.179	22.747	7801.023	0.711	38.424	69.375
09LP093 L 35	189.147	18.776	284.851	475820.198	0.592	0.061	5.575	0.040	0.320	1.487	0.151	9.468	3.090	33.633	10.937	42.560	11.577	133.597	13.422	6963.951	0.376	78.835	136.173
09LP093 L 10	121.898	8.167	235.026	584133.569	1.124	0.007	45.604	0.030	1.446	2.293	0.855	9.516	2.477	24.633	7.210	29.844	8.822	101.121	11.971	9273.112	0.572	254.879	270.063
09LP093 L 50	148.973	4.537	471.651	476976.297	1.357	0.105	7.956	0.078	1.833	3.216	0.205	13.802	4.581	53.060	16.975	70.509	19.916	217.718	22.527	7570.951	1.064	96.569	186.612
09LP093 L 85	123.371	3.036	439.849	675685.726	1.106		11.586		0.042	0.978	0.024	7.518	3.247	39.397	15.890	73.514	18.749	193.086	28.708	13921.873	1.081	106.321	209.470
09LP093 L 30	146.214	5.782	239.747	507697.721	0.867		8.331	0.003	0.855	1.749	0.252	8.160	2.515	27.920	8.957	37.134	9.583	105.046	11.261	8786.576	0.428	44.559	65.276
09LP093 L 4	206.772	15.976	1346.557	664411.172	0.828		8.169	0.408	9.111	13.941	2.076	56.688	15.524	163.016	51.945	194.748	42.067	383.172	52.610	9876.913	0.420	99.718	104.449
09LP093 L 71	245.977	7.394	822.754	555559.537	1.808		17.482	0.079	2.496	7.273	0.611	27.622	7.834	93.416	30.684	127.065	31.772	351.864	38.315	8616.324	1.419	175.830	343.048
09LP093 L 43	223.560	22.138	668.565	446019.643	1.248	0.140	11.681	0.344	5.917	8.210	1.044	22.151	7.242	79.862	27.863	106.149	25.829	312.024	29.873	6097.203	0.832	74.539	124.695
09LP093 L 8	199.209	9.509	1633.378	617763.886	1.822	0.016	19.759	0.516	9.173	13.541	2.409	56.617	15.689	175.318	58.672	244.895	57.979	583.190	78.285	8735.264	1.047	237.145	201.175
09LP093 L 27	152.860	9.600	420.547	520180.379	2.021		6.641	0.063	1.444	3.508	0.356	13.438	4.490	47.761	16.472	66.669	16.765	182.691	19.762	7138.982	0.852	31.034	53.688
09LP093 L 68	~~1692.764~~	~~7.770~~	~~1099.260~~	~~539906.972~~	~~2.080~~	~~38.541~~	~~93.432~~	~~11.519~~	~~60.285~~	~~18.634~~	~~2.455~~	~~45.626~~	~~11.450~~	~~123.791~~	~~43.394~~	~~172.629~~	~~43.825~~	~~486.984~~	~~52.504~~	~~7026.633~~	~~0.996~~	~~150.908~~	~~230.888~~
09LP093 L 109	115.098	6.109	239.545	519347.491	0.655	0.209	11.726	0.078	0.810	1.233	0.473	4.828	1.544	22.020	7.805	38.701	10.801	140.774	17.342	9029.993	0.424	59.109	159.687
09LP093 L 65	184.654	2.834	526.155	506251.271	1.283		15.019	0.071	1.168	3.183	0.512	13.600	4.816	52.426	19.849	84.895	23.834	284.762	32.210	7132.906	0.860	68.786	126.173
09LP093 L 74	171.669	6.461	427.814	582210.357	0.517		5.141	0.004	0.313	1.780	0.391	7.530	3.394	39.753	15.862	69.004	19.192	220.327	28.511	10178.831	0.393	41.650	111.354
09LP093 L 33	199.503	15.455	575.707	493839.260	2.458		5.719	0.006	0.256	1.714	0.194	12.939	4.699	58.125	20.992	91.581	23.971	271.612	28.129	6938.458	1.438	52.972	127.011
09LP093 L 5	205.588	11.976	614.181	642464.123	1.332		19.524	0.098	1.652	4.954	0.754	17.080	5.237	60.042	21.105	90.148	22.954	229.734	33.076	10516.037	0.776	120.725	154.002
09LP093 L 79	294.406	9.079	843.718	636216.129	2.349		4.394	0.157	1.807	6.954	0.255	36.170	10.584	98.428	30.538	104.871	22.241	193.087	22.820	13084.083	1.106	133.034	214.029
09LP093 L 102	238.698	1.794	1117.906	539154.069	2.416		19.863	0.072	2.446	8.662	0.579	37.306	11.984	134.218	44.612	167.729	40.172	409.948	42.378	8617.273	1.089	283.214	227.154
09LP093 L 36	188.383	2.410	409.121	461543.304	2.537		10.096	0.051	1.861	3.262	1.000	16.231	4.284	49.054	14.795	60.466	15.817	189.577	21.129	7493.685	1.464	61.216	145.621
09LP093 L 58	217.331	12.287	1275.389	480128.447	1.717	0.038	20.883	0.343	6.988	12.926	2.228	46.759	14.002	151.814	48.386	187.750	45.538	484.919	46.942	6942.911	1.085	167.009	178.587
09LP093 L 86	~~676.125~~	~~19.855~~	~~1836.422~~	~~659578.861~~	~~3.103~~	~~0.026~~	~~5.436~~	~~0.094~~	~~2.916~~	~~7.839~~	~~1.819~~	~~44.974~~	~~13.994~~	~~186.906~~	~~72.621~~	~~324.013~~	~~81.504~~	~~874.304~~	~~131.910~~	~~10818.816~~	~~1.354~~	~~155.808~~	~~278.652~~
09LP093 L 98	778.338	6.894	1782.453	571013.549	1.386	0.018	1.139	0.026	1.751	6.014	0.046	36.153	14.707	179.444	64.884	283.084	73.904	746.998	79.978	10824.289	1.103	101.601	370.236
09LP093 L 7	143.598	15.207	437.061	624263.248	2.098	0.012	21.979	0.017	1.633	2.351	0.295	9.960	3.476	42.666	15.912	69.728	18.273	179.275	26.751	10993.496	1.280	103.440	107.893
09LP093 L 84	215.685	23.533	404.429	651595.338	1.044		5.812	0.031	1.939	4.222	0.238	15.160	4.484	46.174	15.455	58.245	14.291	127.599	16.860	12036.969	0.604	90.564	89.090
09LP093 L 64	150.848	1.347	539.305	506087.066	7.480	0.008	2.897	0.009	0.042	0.294	0.156	3.099	1.660	31.183	15.565	96.236	35.755	548.915	77.611	9367.576	6.162	21.033	355.013
09LP093 L 93	161.583	16.123	438.554	583282.575	2.338		22.189	0.084	2.135	3.863	0.248	15.088	4.647	51.162	17.197	66.016	16.082	164.828	17.749	10005.180	1.295	200.696	324.968

Table B7b, *continued*. Detrital zircon trace element analyses from sample **09LP093** in unit OSs - Isotope Geology Laboratory, Boise State University

Analysis	Concentrations (ppm)																						
	P	Ti	Y	Zr	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	Th	U
09LP093 L 103	203.147	17.346	611.039	519164.704	4.934	0.168	50.192	0.094	1.696	3.849	0.761	18.094	5.797	62.841	22.185	95.724	26.255	287.911	32.429	7776.252	1.874	76.882	92.308
09LP093 L 107	237.488	11.183	484.163	532726.869	1.603		3.553	0.087	1.308	3.101	0.040	13.786	4.860	53.315	18.058	70.632	17.694	196.176	21.756	8593.785	0.796	86.890	195.086
09LP093 L 48	123.705	12.194	202.422	469000.318	4.366		8.124	0.057	0.857	1.874	0.103	7.824	2.143	23.966	7.959	31.013	8.298	87.612	8.288	8441.176	2.557	71.334	177.608
09LP093 L 100	196.963	10.853	796.185	550740.765	0.584		16.340	0.212	4.238	9.117	1.846	30.076	8.772	90.092	29.561	119.280	29.402	314.834	35.871	8533.413	0.406	60.964	156.460
09LP093 L 18	~~1074.891~~	~~38.851~~	~~998.839~~	~~569055.874~~	~~1.227~~	~~13.106~~	~~50.120~~	~~5.591~~	~~45.154~~	~~30.489~~	~~3.552~~	~~68.381~~	~~17.209~~	~~149.092~~	~~41.524~~	~~140.645~~	~~30.638~~	~~297.824~~	~~30.099~~	~~8883.035~~	~~0.613~~	~~162.764~~	~~90.677~~
09LP093 L 106	189.214	12.977	442.976	535794.901	0.992	0.037	6.538	0.088	0.971	2.329	0.341	13.210	4.004	44.462	15.737	67.685	18.147	210.570	24.518	7438.136	0.572	40.922	131.211
09LP093 L 88	188.649	38.038	603.149	661082.254	3.605	0.129	11.531	0.246	4.459	7.193	0.526	27.564	7.539	78.493	23.862	86.859	19.409	169.863	21.875	11330.815	1.884	101.302	93.564
09LP093 L 20	152.678	4.873	429.458	543190.994	2.033		13.283	0.045	0.833	2.008	0.574	10.867	3.655	47.822	15.421	63.206	17.197	194.082	21.334	9754.289	1.159	137.880	210.707
09LP093 L 15	141.642	9.889	405.218	550587.749	1.545	0.044	32.586	0.061	1.505	3.011	0.412	12.425	3.665	41.932	15.042	61.298	15.622	168.276	19.836	9622.191	1.116	198.914	241.004
09LP093 L 62	196.329	18.867	541.912	476862.134	4.557		5.774	0.013	2.164	4.426	0.386	21.869	6.320	69.670	21.420	81.421	20.575	220.653	22.274	7128.843	1.496	46.720	46.908
09LP093 L 40	148.434	5.560	470.619	458133.124	0.518		4.655		0.615	1.620	0.489	10.459	3.720	48.509	18.517	79.506	23.234	294.278	30.497	7521.797	0.561	54.233	169.992
09LP093 L 16	177.314	13.354	1142.818	561887.300	1.680		8.885	0.573	11.300	16.563	0.905	54.336	14.729	146.423	45.863	165.614	40.534	389.943	41.368	6801.390	0.670	62.891	94.672
09LP093 L 75	72.372	5.567	121.485	580765.623	0.921		18.784		0.603	0.600	0.092	3.594	0.980	10.592	4.116	17.396	5.220	68.058	10.792	11265.895	0.213	132.045	370.845
09LP093 L 21	108.233	4.354	524.111	533073.345	0.228		11.996	0.064	2.276	6.257	1.849	19.975	5.565	55.750	18.499	75.310	20.487	245.061	29.267	8059.290	0.136	30.153	72.373
09LP093 L 101	~~247.828~~	~~19.692~~	~~827.543~~	~~555598.385~~	~~3.853~~	~~0.636~~	~~38.483~~	~~0.183~~	~~2.476~~	~~4.122~~	~~1.066~~	~~21.271~~	~~7.425~~	~~85.307~~	~~30.099~~	~~132.366~~	~~35.209~~	~~385.209~~	~~44.468~~	~~8350.712~~	~~1.973~~	~~69.802~~	~~155.925~~
09LP093 L 80	152.370	12.679	388.902	666389.662	1.243		19.086	0.052	1.705	2.828	0.760	12.755	4.142	40.820	13.447	54.725	13.194	136.018	18.887	10303.620	0.475	69.716	117.092
09LP093 L 3	249.066	28.777	2008.835	679558.838	0.970	0.104	17.294	1.081	17.180	18.012	2.879	74.118	21.169	225.437	75.200	286.340	63.039	558.389	79.235	8282.066	0.848	99.436	85.526
09LP093 L 87	252.278	21.153	743.607	670352.957	0.692	0.037	9.442	0.259	2.933	5.589	0.465	22.930	7.148	76.386	26.683	111.903	27.580	257.124	35.740	9746.794	0.483	107.801	239.427
09LP093 L 26	102.233	5.324	147.016	516611.551	0.863		12.750	0.026	0.352	0.566	0.370	3.382	1.125	14.325	4.992	23.097	6.825	90.287	10.852	7980.949	0.535	42.898	145.981
09LP093 L 38	251.429	9.053	938.208	461558.254	1.788	0.106	17.527	0.436	7.106	12.553	6.151	46.856	12.224	121.335	36.342	135.033	32.806	356.555	35.544	5274.252	0.369	56.364	96.016
09LP093 L 83	127.333	7.647	468.198	676051.070	0.925		31.079	0.106	1.019	3.296	1.107	14.875	4.037	43.059	15.598	64.019	16.358	171.026	25.055	12017.716	0.427	78.837	166.166
09LP093 L 56	164.521	6.339	974.304	468479.207	4.860	0.166	15.125	0.210	3.730	7.101	0.251	28.765	9.008	110.122	36.917	151.801	38.895	435.830	41.911	5722.769	1.276	44.551	171.699
09LP093 L 31	163.602	11.765	553.949	498258.559	0.973		6.481	0.080	1.846	4.174	0.486	16.128	5.202	60.435	21.745	86.847	22.123	252.429	26.262	5537.390	0.605	12.318	52.270
09LP093 L 59	137.711	10.060	456.046	484809.777	0.309	0.013	9.720	0.278	3.341	4.177	1.426	14.122	4.478	48.811	15.750	69.858	18.016	219.764	24.659	5553.019	0.234	78.324	101.647
09LP093 L 60	116.871	15.918	312.493	481269.682	0.931	0.041	14.662	0.260	4.845	6.128	1.321	17.572	4.423	41.628	12.194	42.391	9.593	98.168	10.139	6575.665	0.386	75.759	70.181
09LP093 L 94	186.987	17.840	774.666	584396.949	0.538	0.037	4.710	0.346	5.916	9.705	2.219	37.245	9.975	102.730	31.437	120.686	28.427	286.518	33.270	6989.810	0.290	24.808	44.615
09LP093 L 61	230.376	3.383	1856.465	478748.916	2.595	0.161	23.419	0.679	11.379	18.599	6.159	71.189	19.756	211.492	67.825	263.535	67.791	770.682	80.596	5571.774	0.656	414.368	456.724
09LP093 L 63	133.213	10.522	654.827	503355.937	0.670	0.052	7.115	0.113	2.266	5.009	1.157	23.874	7.394	77.952	25.150	96.510	25.332	254.201	27.204	7173.755	0.345	31.806	64.734
09LP093 L 76	175.344	2.876	1395.989	608333.897	8.864		27.974	0.189	4.048	10.032	0.129	44.747	13.521	160.101	55.442	222.242	50.729	494.804	58.710	8585.054	2.202	169.676	205.596
09LP093 L 54	166.703	4.657	1035.893	456263.441	1.224	0.059	5.731	0.139	2.024	6.615	1.082	26.333	8.679	103.674	38.134	159.890	43.938	519.188	50.937	6432.756	0.470	70.661	230.614
09LP093 L 42	154.120	5.444	279.318	455936.205	0.975		8.929	0.031	0.204	0.341	0.178	4.980	1.895	26.454	10.173	46.556	14.561	179.289	21.086	8008.550	0.577	22.928	127.151
09LP093 L 96	166.989	10.848	409.987	569784.043	1.279		26.409	0.144	2.092	4.764	1.142	15.343	4.165	45.834	14.870	58.921	16.021	173.128	20.390	8198.181	0.791	102.967	189.748
09LP093 L 22	202.102	9.498	609.034	538296.988	0.922	0.027	11.600	0.044	1.187	3.275	0.855	11.646	3.683	47.886	19.950	99.636	30.850	412.670	54.354	6748.650	0.512	36.409	165.430
09LP093 L 52	~~285.545~~	~~9.373~~	~~690.778~~	~~463171.408~~	~~1.103~~	~~0.321~~	~~14.052~~	~~0.441~~	~~3.414~~	~~4.108~~	~~1.767~~	~~14.651~~	~~6.008~~	~~63.930~~	~~22.733~~	~~109.640~~	~~34.405~~	~~492.712~~	~~56.983~~	~~5296.406~~	~~0.533~~	~~121.205~~	~~365.793~~
09LP093 L 13	224.616	5.496	1065.949	571696.797	2.966	0.021	20.592	0.021	2.033	3.665	0.386	25.478	9.404	108.780	39.990	163.733	42.527	453.885	54.812	10135.280	1.913	211.196	300.127
09LP093 L 91	169.018	10.206	627.707	618781.475	2.696	0.047	11.947	0.001	0.449	2.332	0.155	12.936	4.697	61.429	22.806	104.123	26.559	278.697	36.168	10244.899	1.826	79.956	192.453
09LP093 L 51	74.595	3.911	116.671	452788.205	0.465		5.118	0.002	0.742	0.927	0.474	4.612	1.473	13.572	4.771	17.601	4.914	59.133	6.138	6501.389	0.098	12.854	70.125
09LP093 L 47	170.245	17.964	335.585	456886.822	1.464	0.160	5.316	0.147	2.063	4.285	0.343	13.904	3.806	43.370	13.421	50.489	12.853	142.544	14.542	5330.633	0.557	18.942	43.742
09LP093 L 24	197.484	10.612	613.634	520875.697	4.093		26.199	0.039	1.169	3.646	0.401	16.497	5.161	66.314	22.193	95.446	24.775	280.645	31.492	8085.180	1.757	76.522	146.287
09LP093 L 34	181.500	4.439	1215.059	487806.664	1.027	0.081	12.747	0.491	7.496	13.002	2.840	44.884	13.615	148.828	49.281	183.036	45.947	477.737	47.628	5890.112	0.458	78.531	109.075
09LP093 L 78	190.548	4.330	1207.907	638006.968	1.681		5.242	0.119	2.659	3.480	1.915	20.883	6.646	95.525	40.361	204.704	62.267	755.465	118.300	8841.225	0.408	15.814	157.252
09LP093 L 67	96.797	18.373	533.000	531291.912	0.861	0.014	33.446	0.198	4.242	5.999	2.084	22.881	6.519	60.024	19.068	72.751	18.216	185.133	20.914	5882.694	0.425	59.774	101.698
09LP093 L 110	163.086	10.910	299.125	472184.126	1.365		28.934	0.020	1.534	3.057	0.780	10.346	2.964	34.032	10.304	42.411	12.182	134.403	13.916	6644.558	0.523	116.502	199.560

Table B7b, *continued.* Detrital zircon trace element analyses from sample **09LP093** in unit OSs - Isotope Geology Laboratory, Boise State University

Analysis	Concentrations (ppm)																						
	P	Ti	Y	Zr	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	Th	U
09LP093 L 105	~~189.481~~	~~229.132~~	~~461.608~~	~~438508.847~~	~~6.507~~	~~0.410~~	~~42.116~~	~~0.140~~	~~1.688~~	~~2.791~~	~~0.399~~	~~11.138~~	~~3.859~~	~~47.309~~	~~16.311~~	~~72.188~~	~~19.124~~	~~216.732~~	~~26.425~~	~~6386.267~~	~~1.157~~	~~56.112~~	~~63.923~~
09LP093 L 69	247.519	5.880	855.192	546804.619	4.950		27.210	0.037	1.069	2.543	0.153	13.069	6.177	78.792	31.622	144.100	41.924	480.260	57.565	9161.294	2.701	114.726	386.652
09LP093 L 66	161.925	12.730	416.942	518004.748	0.480	0.009	19.219	0.061	1.687	4.524	0.958	15.994	4.901	47.153	16.384	65.225	17.044	192.976	21.530	5642.358	0.342	26.675	66.954
09LP093 L 70	246.266	14.204	490.623	563364.176	1.129		12.738	0.044	0.847	3.450	0.548	11.570	4.271	47.964	17.471	74.450	20.258	231.108	27.629	10109.815	0.966	47.981	134.482
09LP093 L 25	157.480	16.399	429.121	524950.197	1.015	0.089	15.957	0.085	1.466	4.047	0.668	14.987	4.519	49.898	16.552	61.700	15.731	157.712	16.681	8223.625	0.411	93.022	185.157
09LP093 L 99	165.681	5.126	1100.424	559721.883	1.031		37.166	0.148	2.342	8.102	2.036	35.043	11.333	127.989	43.240	170.435	42.818	444.682	50.417	8219.180	0.451	122.080	98.350
09LP093 L 82	252.489	14.356	777.920	656903.875	1.468		13.703	0.197	2.466	4.564	0.789	23.054	7.758	80.573	27.219	114.151	27.164	260.974	37.603	11578.959	0.722	198.461	274.308
09LP093 L 45	138.918	12.583	306.281	474532.426	2.239		21.142	0.026	0.963	2.064	0.323	8.325	2.899	33.690	11.939	52.564	14.046	160.883	16.139	7878.596	1.402	69.118	97.884
09LP093 L 49	180.447	12.034	420.361	445406.997	1.011		3.931	0.029	0.590	1.521	0.253	10.993	3.745	45.951	16.726	65.138	17.641	201.061	21.545	7552.218	0.692	42.953	128.537
09LP093 L 11	127.491	6.681	514.930	590625.428	0.548		3.316	0.054	0.787	1.358	0.522	10.642	3.934	47.774	17.643	82.926	22.987	259.298	31.859	8519.860	0.396	45.058	171.263
09LP093 L 41	248.584	9.723	670.560	454503.176	4.108		6.126	0.053	1.407	2.530	0.253	15.978	5.969	75.264	25.915	106.658	27.933	312.534	31.949	7207.975	2.443	87.683	253.848
09LP093 L 108	204.475	15.388	917.782	514821.013	0.970	0.004	4.837	0.083	2.214	4.689	0.527	27.198	9.101	105.629	35.981	135.397	32.629	343.101	33.366	7561.764	0.437	80.550	173.802
09LP093 L 44	173.479	13.434	632.713	455776.061	1.017		17.743	0.035	1.242	4.593	1.060	20.444	6.221	70.706	23.254	87.700	22.273	248.863	25.110	6896.722	0.478	72.569	124.741
09LP093 L 37	~~458.133~~	~~2771.253~~	~~1003.505~~	~~428063.717~~	~~15.171~~	~~7.824~~	~~36.233~~	~~2.307~~	~~14.357~~	~~11.673~~	~~2.105~~	~~34.086~~	~~10.019~~	~~115.452~~	~~39.514~~	~~154.285~~	~~40.034~~	~~434.198~~	~~46.592~~	~~5413.354~~	~~1.355~~	~~171.220~~	~~140.078~~
09LP093 L 92	227.033	7.130	1320.545	610458.815	5.993	0.012	61.666	0.092	1.706	5.782	1.465	24.151	9.501	123.675	48.311	217.973	61.533	672.569	85.787	9219.842	1.836	95.927	151.058
09LP093 L 6	~~797.545~~	~~39.324~~	~~3320.349~~	~~652469.680~~	~~7.688~~	~~9.236~~	~~61.729~~	~~7.794~~	~~48.839~~	~~30.591~~	~~8.030~~	~~84.470~~	~~28.194~~	~~327.088~~	~~114.362~~	~~470.439~~	~~112.452~~	~~1098.148~~	~~140.195~~	~~13100.247~~	~~3.402~~	~~184.514~~	~~295.018~~

Notes:
Yellow highlighted rows are samples that intersected inclusions.
Trace element concentrations in ppm, calculated using mean count rate method.
Backgrounds were monitored during sweeps 10 to 27. Sample counts were integrated from sweeps 36 to 69.
Ablation used a laser spot size of 25 microns, and a laser firing repitition rate of 10 Hz.

Table B7c. Detrital zircon calculated ratios and values from sample **09LP093** in unit **OSs** - Isotope Geology Laboratory, Boise State University

Analysis	CI chondrite normalizing values from Sun and McDonough (1989)													
	0.237	0.612	0.095	0.467	0.153	0.058	0.206	0.037	0.254	0.057	0.166	0.026	0.17	0.025
	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
09LP093 L 29	0.082	14.643	3.262	8.069	67.367	35.441	276.301	565.690	1023.867	1688.166	2419.512	4087.041	6616.509	4730.942
09LP093 L 73		14.395	0.327	1.465	7.789	3.013	44.476	86.063	188.241	334.330	540.195	991.519	1795.235	1467.212
09LP093 L 57	0.074	13.552	2.341	11.809	74.797	31.972	258.268	454.939	746.849	1099.271	1422.014	2239.048	3561.487	2258.804
09LP093 L 1	0.268	9.794	0.538	2.409	13.222	3.219	67.293	139.304	256.318	430.894	705.563	1145.521	1775.542	1718.835
09LP093 L 81	~~6.059~~	~~52.281~~	~~5.231~~	~~12.491~~	~~47.591~~	~~33.813~~	~~136.475~~	~~210.126~~	~~366.330~~	~~575.513~~	~~788.732~~	~~1193.613~~	~~1680.551~~	~~1636.512~~
09LP093 L 28	0.226	7.847	0.745	1.783	13.706	9.206	55.133	112.326	210.631	366.427	557.920	1049.559	1773.459	1486.312
09LP093 L 2	0.120	72.927	6.980	25.253	127.052	93.689	329.118	553.496	809.765	1107.192	1473.997	2208.737	3070.251	2738.164
09LP093 L 97	0.028	27.717	1.126	3.283	25.268	26.860	69.114	100.258	159.144	229.591	295.523	468.067	767.262	588.145
09LP093 L 55	0.429	36.595	0.207	1.375	7.338	5.306	22.382	41.165	61.061	90.053	130.617	243.147	453.970	328.025
09LP093 L 12	0.468	29.440	1.422	4.258	21.064	6.410	76.906	150.593	263.454	432.128	688.539	1182.967	1970.396	1705.076
09LP093 L 95	0.014	28.710	0.569	1.958	15.695	2.568	65.594	110.058	194.506	336.521	448.473	729.805	1139.398	873.285
09LP093 L 53	0.003	14.158	0.101	0.995	15.223	3.279	68.753	136.195	246.760	399.883	565.401	1004.864	1669.897	1081.740
09LP093 L 17		37.478	0.767	3.433	16.010	16.027	56.338	85.696	122.589	191.074	246.554	447.362	725.933	556.689
09LP093 L 90	0.287	20.357	1.584	8.086	50.912	37.278	194.869	335.129	594.786	942.830	1326.167	2054.546	3163.369	2759.251
09LP093 L 72	0.028	78.174	1.118	5.397	39.184	10.849	136.677	250.162	418.300	655.727	905.465	1448.060	2314.926	1708.119
09LP093 L 46	0.383	23.840	0.287	2.089	24.732	2.436	88.350	187.118	345.563	556.353	765.275	1240.597	2073.162	1372.181
09LP093 L 104	0.014	13.180	0.545	3.037	22.976	5.419	66.239	117.474	180.354	286.480	423.832	705.401	1148.111	895.547
09LP093 L 35	0.256	9.109	0.424	0.686	9.717	2.598	46.071	82.612	132.413	193.227	257.161	454.019	785.863	528.430
09LP093 L 10	0.031	74.517	0.317	3.097	14.986	14.749	46.306	66.226	96.978	127.391	180.325	345.967	594.829	471.314
09LP093 L 50	0.441	13.000	0.817	3.924	21.022	3.535	67.164	122.498	208.896	299.908	426.035	781.021	1280.692	886.887
09LP093 L 85		18.932	0.020	0.089	6.393	0.421	36.584	86.805	155.108	280.743	444.191	735.238	1135.800	1130.253
09LP093 L 30	0.001	13.613	0.027	1.830	11.431	4.346	39.707	67.251	109.921	158.250	224.373	375.820	617.915	443.345
09LP093 L 4	0.108	13.348	4.299	19.509	91.117	35.787	275.853	415.086	641.797	917.757	1176.728	1649.694	2253.951	2071.263
09LP093 L 71	0.021	28.565	0.831	5.344	47.535	10.531	134.412	209.476	367.781	542.118	767.763	1245.961	2069.788	1508.452
09LP093 L 43	0.591	19.087	3.618	12.670	53.659	17.995	107.791	193.629	314.419	492.272	641.384	1012.883	1835.434	1176.106
09LP093 L 8	0.066	32.286	5.430	19.643	88.506	41.527	275.511	419.497	690.228	1036.608	1479.725	2273.701	3430.527	3082.099
09LP093 L 27	0.017	10.852	0.662	3.092	22.926	6.136	65.390	120.046	188.034	291.031	402.836	657.444	1074.651	778.015
09LP093 L 68	~~162.620~~	~~152.667~~	~~121.252~~	~~129.089~~	~~121.788~~	~~42.336~~	~~222.025~~	~~306.155~~	~~487.368~~	~~766.671~~	~~1043.075~~	~~1687.258~~	~~2864.610~~	~~2067.099~~
09LP093 L 109	0.883	19.161	0.818	1.735	8.056	8.150	23.494	41.290	86.695	137.891	233.844	423.565	828.084	682.754
09LP093 L 65	0.019	24.541	0.745	2.502	20.804	8.830	66.179	128.780	206.400	350.689	512.959	934.662	1675.070	1268.106
09LP093 L 74	0.001	8.400	0.037	0.671	11.636	6.737	36.644	90.749	156.506	280.250	416.943	752.631	1296.041	1122.474
09LP093 L 33	0.002	9.345	0.064	0.548	11.201	3.337	62.961	125.635	228.837	370.891	553.360	940.042	1597.715	1107.447
09LP093 L 5	0.026	31.902	1.036	3.538	32.377	13.005	83.116	140.028	236.385	372.886	544.703	900.155	1351.378	1302.223
09LP093 L 79	0.041	7.179	1.655	3.870	45.451	4.405	176.009	282.987	387.510	539.547	633.662	872.206	1135.809	898.440
09LP093 L 102	0.019	32.455	0.762	5.237	56.614	9.978	181.540	320.426	528.419	788.205	1013.468	1575.381	2411.462	1668.419
09LP093 L 36	0.014	16.497	0.540	3.984	21.322	17.246	78.984	114.535	193.127	261.401	365.351	620.263	1115.159	831.835
09LP093 L 58	0.162	34.123	3.614	14.963	84.483	38.420	227.537	374.374	597.693	854.874	1134.442	1785.794	2852.462	1848.095
09LP093 L 86	~~0.108~~	~~8.883~~	~~0.991~~	~~6.244~~	~~51.233~~	~~31.371~~	~~218.854~~	~~374.176~~	~~735.849~~	~~1283.055~~	~~1957.783~~	~~3196.224~~	~~5142.965~~	~~5193.318~~
09LP093 L 98	0.074	1.861	0.272	3.750	39.305	0.794	175.928	393.228	706.474	1146.357	1710.479	2898.186	4394.105	3148.752
09LP093 L 7	0.049	35.914	0.178	3.498	15.367	5.089	48.467	92.945	167.976	281.131	421.317	716.604	1054.559	1053.184
09LP093 L 84	0.008	9.496	0.321	4.152	27.593	4.111	73.772	119.896	181.786	273.059	351.935	560.417	750.580	663.770
09LP093 L 64	0.034	4.733	0.092	0.090	1.922	2.693	15.078	44.373	122.768	274.995	581.488	1402.173	3228.913	3055.564

Ti-in-zircon T (°C)	Ce/Ce*	Eu/Eu*	(Sm/Nd) cn	(Lu/Nd) cn	Lu/Hf	Nb/Ta	Nb/U	Th/U	Th/Y	Y/Hf
771	8.76	0.21	8.35	586.33	0.02	1.97	0.01	0.93	0.06	0.38
724		0.12	5.32	1001.28	0.00	0.85	0.00	0.47	0.27	0.06
696	11.22	0.19	6.33	191.28	0.01	2.20	0.02	0.65	0.05	0.25
679	24.30	0.08	5.49	713.41	0.00	2.17	0.02	0.50	0.08	0.07
~~1227~~	~~9.26~~	~~0.37~~	~~3.81~~	~~131.01~~	~~0.00~~	~~2.55~~	~~0.07~~	~~1.76~~	~~0.08~~	~~0.09~~
729	16.18	0.27	7.68	833.39	0.00	2.09	0.01	0.40	0.12	0.08
632	20.54	0.41	5.03	108.43	0.01	2.37	0.01	1.61	0.15	0.20
765	48.03	0.57	7.70	179.17	0.00	1.19	0.00	0.63	0.44	0.04
734	115.03	0.36	5.34	238.54	0.00	1.66	0.01	0.42	0.31	0.02
745	31.16	0.13	4.95	400.40	0.00	1.39	0.01	1.04	0.31	0.07
718	98.40	0.06	8.01	445.90	0.00	2.48	0.02	1.89	0.17	0.04
748	273.21	0.08	15.31	1087.66	0.00	1.08	0.01	0.59	0.08	0.09
800		0.44	4.66	162.16	0.00	1.90	0.01	1.04	0.51	0.03
768	21.77	0.30	6.30	341.24	0.01	2.08	0.02	0.90	0.05	0.15
768	136.48	0.12	7.26	316.47	0.00	2.30	0.02	2.04	0.28	0.10
743	71.13	0.04	11.84	656.95	0.00	2.19	0.02	0.88	0.23	0.10
816	47.22	0.12	7.57	294.92	0.00	1.73	0.02	0.55	0.09	0.06
866	26.78	0.09	14.17	770.62	0.00	1.58	0.00	0.58	0.28	0.04
776	427.69	0.48	4.84	152.20	0.00	1.97	0.00	0.94	1.08	0.03
720	20.67	0.08	5.36	225.99	0.00	1.28	0.01	0.52	0.20	0.06
686		0.02	71.75	12685.85	0.00	1.02	0.01	0.51	0.24	0.03
742	976.30	0.17	6.25	242.27	0.00	2.03	0.01	0.68	0.19	0.03
847	6.06	0.20	4.67	106.17	0.01	1.97	0.01	0.95	0.07	0.14
766	67.06	0.12	8.89	282.25	0.00	1.27	0.01	0.51	0.21	0.10
885	9.07	0.22	4.24	92.82	0.00	1.50	0.01	0.60	0.11	0.11
791	11.75	0.23	4.51	156.90	0.01	1.74	0.01	1.18	0.15	0.19
792	32.00	0.14	7.41	251.58	0.00	2.37	0.04	0.58	0.07	0.06
~~771~~	~~1.08~~	~~0.25~~	~~0.94~~	~~16.01~~	~~0.01~~	~~2.09~~	~~0.01~~	~~0.65~~	~~0.14~~	~~0.16~~
748	22.53	0.52	4.64	393.48	0.00	1.54	0.00	0.37	0.25	0.03
680	64.25	0.20	8.32	506.93	0.00	1.49	0.01	0.55	0.13	0.07
753	442.60	0.28	17.34	1672.96	0.00	1.32	0.00	0.37	0.10	0.04
843	285.84	0.09	20.45	2021.78	0.00	1.71	0.02	0.42	0.09	0.08
815	60.06	0.23	9.15	368.11	0.00	1.72	0.01	0.78	0.20	0.06
786	8.47	0.04	11.74	232.13	0.00	2.12	0.01	0.62	0.16	0.06
644	83.11	0.08	10.81	318.60	0.00	2.22	0.01	1.25	0.25	0.13
667	59.55	0.34	5.35	208.77	0.00	1.73	0.02	0.42	0.15	0.05
818	18.07	0.25	5.65	123.51	0.01	1.58	0.01	0.94	0.13	0.18
~~872~~	~~16.17~~	~~0.23~~	~~8.21~~	~~831.76~~	~~0.01~~	~~2.29~~	~~0.01~~	~~0.56~~	~~0.08~~	~~0.17~~
759	10.76	0.01	10.48	839.65	0.01	1.26	0.00	0.27	0.06	0.16
841	316.19	0.16	4.39	301.12	0.00	1.64	0.02	0.96	0.24	0.04
893	57.66	0.08	6.65	159.87	0.00	1.73	0.01	1.02	0.22	0.03
623	75.27	0.32	21.25	33779.80	0.01	1.21	0.02	0.06	0.04	0.06

Table B7c, *continued*. Detrital zircon calculated ratios and values from sample **09LP093** in unit **OSs** - Isotope Geology Laboratory, Boise State University

Analysis	CI chondrite normalizing values from Sun and McDonough (1989)													
	0.237	0.612	0.095	0.467	0.153	0.058	0.206	0.037	0.254	0.057	0.166	0.026	0.17	0.025
	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
09LP093 L 93	0.022	36.256	0.889	4.572	25.250	4.272	73.423	124.252	201.425	303.841	398.886	630.677	969.576	698.766
09LP093 L 103	0.709	82.012	0.993	3.632	25.159	13.113	88.049	155.006	247.404	391.969	578.394	1029.592	1693.594	1276.742
09LP093 L 107	0.023	5.806	0.911	2.801	20.266	0.688	67.088	129.938	209.901	319.043	426.780	693.880	1153.978	856.554
09LP093 L 48	0.015	13.274	0.598	1.834	12.251	1.780	38.075	57.295	94.356	140.625	187.391	325.428	515.363	326.299
09LP093 L 100	0.056	26.699	2.235	9.074	59.587	31.835	146.356	234.538	354.694	522.278	720.725	1153.037	1851.967	1412.259
09LP093 L 18	~~55.301~~	~~81.896~~	~~58.853~~	~~96.690~~	~~199.272~~	~~61.248~~	~~332.755~~	~~460.139~~	~~586.976~~	~~733.647~~	~~849.820~~	~~1201.479~~	~~1751.986~~	~~1185.018~~
09LP093 L 106	0.155	10.684	0.927	2.080	15.224	5.887	64.282	107.070	175.045	278.045	408.974	711.662	1238.649	965.282
09LP093 L 88	0.544	18.841	2.590	9.547	47.016	9.068	134.132	201.589	309.026	421.586	524.828	761.126	999.196	861.210
09LP093 L 20	0.012	21.704	0.470	1.783	13.126	9.898	52.883	97.715	188.278	272.459	381.908	674.404	1141.662	839.932
09LP093 L 15	0.185	53.245	0.640	3.224	19.678	7.110	60.464	97.984	165.087	265.761	370.378	612.615	989.856	780.943
09LP093 L 62	0.003	9.435	0.139	4.634	28.928	6.660	106.421	168.977	274.293	378.442	491.970	806.865	1297.957	876.913
09LP093 L 40		7.606	0.294	1.317	10.588	8.433	50.894	99.461	190.981	327.154	480.399	911.144	1731.048	1200.666
09LP093 L 16	0.151	14.518	6.036	24.197	108.257	15.606	264.411	393.825	576.467	810.297	1000.686	1589.570	2293.782	1628.665
09LP093 L 75		30.692	0.289	1.292	3.919	1.584	17.491	26.195	41.700	72.713	105.111	204.698	400.339	424.882
09LP093 L 21	0.017	19.602	0.679	4.875	40.894	31.886	97.204	148.804	219.487	326.831	455.043	803.402	1441.534	1152.230
09LP093 L 101	~~2.686~~	~~62.881~~	~~1.923~~	~~5.302~~	~~26.938~~	~~18.376~~	~~103.507~~	~~198.532~~	~~335.853~~	~~531.782~~	~~799.796~~	~~1380.753~~	~~2265.936~~	~~1750.712~~
09LP093 L 80	0.014	31.187	0.549	3.651	18.486	13.098	62.070	110.754	160.710	237.587	330.666	517.394	800.105	743.573
09LP093 L 3	0.437	28.258	11.382	36.788	117.723	49.636	360.671	566.017	887.545	1328.615	1730.151	2472.121	3284.638	3119.474
09LP093 L 87	0.156	15.429	2.729	6.282	36.531	8.012	111.582	191.112	300.731	471.440	676.152	1081.557	1512.493	1407.078
09LP093 L 26	0.007	20.833	0.269	0.753	3.698	6.383	16.460	30.077	56.399	88.203	139.562	267.639	531.099	427.260
09LP093 L 38	0.449	28.639	4.591	15.217	82.048	106.044	228.007	326.834	477.697	642.088	815.908	1286.502	2097.385	1399.357
09LP093 L 83	0.028	50.783	1.118	2.181	21.543	19.082	72.383	107.943	169.522	275.586	386.821	641.489	1006.034	986.410
09LP093 L 56	0.700	24.714	2.216	7.988	46.412	4.321	139.978	240.843	433.553	652.238	917.225	1525.293	2563.706	1650.023
09LP093 L 31	0.021	10.590	0.842	3.953	27.281	8.384	78.484	139.095	237.932	384.187	524.754	867.587	1484.878	1033.925
09LP093 L 59	0.053	15.882	2.931	7.154	27.303	24.587	68.721	119.731	192.171	278.271	422.102	706.506	1292.731	970.845
09LP093 L 60	0.175	23.957	2.735	10.374	40.055	22.777	85.508	118.253	163.888	215.447	256.142	376.207	577.456	399.176
09LP093 L 94	0.155	7.695	3.644	12.667	63.429	38.254	181.239	266.719	404.447	555.420	729.219	1114.774	1685.397	1309.849
09LP093 L 61	0.679	38.267	7.148	24.365	121.561	106.187	346.417	528.243	832.644	1198.330	1592.354	2658.464	4533.424	3173.071
09LP093 L 63	0.219	11.626	1.190	4.852	32.742	19.955	116.173	197.706	306.898	444.354	583.142	993.399	1495.298	1071.039
09LP093 L 76	0.050	45.710	1.994	8.668	65.571	2.216	217.745	361.536	630.319	979.537	1342.849	1989.381	2910.615	2311.414
09LP093 L 54	0.248	9.364	1.463	4.335	43.238	18.662	128.140	232.051	408.167	673.747	966.101	1723.050	3054.045	2005.378
09LP093 L 42	0.008	14.591	0.326	0.437	2.232	3.075	24.232	50.665	104.150	179.735	281.308	571.008	1054.640	830.160
09LP093 L 96	0.038	43.151	1.513	4.480	31.134	19.695	74.660	111.361	180.450	262.725	356.015	628.285	1018.398	802.762
09LP093 L 22	0.115	18.954	0.464	2.541	21.403	14.739	56.670	98.474	188.529	352.466	602.028	1209.821	2427.471	2139.926
09LP093 L 52	~~1.356~~	~~22.961~~	~~4.645~~	~~7.311~~	~~26.851~~	~~30.463~~	~~71.294~~	~~160.641~~	~~251.694~~	~~401.636~~	~~662.476~~	~~1349.212~~	~~2898.305~~	~~2243.422~~
09LP093 L 13	0.088	33.647	0.223	4.353	23.952	6.648	123.979	251.451	428.267	706.541	989.320	1667.710	2669.914	2157.945
09LP093 L 91	0.197	19.522	0.007	0.961	15.244	2.667	62.947	125.600	241.848	402.927	629.145	1041.512	1639.397	1423.927
09LP093 L 51	0.001	8.363	0.023	1.588	6.058	8.168	22.444	39.382	53.432	84.301	106.353	192.699	347.839	241.634
09LP093 L 47	0.677	8.687	1.550	4.417	28.006	5.911	67.659	101.755	170.750	237.122	305.067	504.044	838.495	572.517
09LP093 L 24	0.010	42.808	0.413	2.504	23.830	6.906	80.276	137.991	261.078	392.111	576.714	971.560	1650.851	1239.839
09LP093 L 34	0.343	20.828	5.168	16.051	84.983	48.970	218.414	364.038	585.936	870.686	1105.959	1801.829	2810.216	1875.131
09LP093 L 78	0.031	8.565	1.250	5.693	22.742	33.018	101.620	177.710	376.084	713.091	1236.883	2441.861	4443.911	4657.468

Ti-in-zircon T (°C)
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Ce/Ce*	Eu/Eu*	(Sm/Nd) cn	(Lu/Nd) cn	Lu/Hf	Nb/Ta	Nb/U	Th/U	Th/Y	Y/Hf
79.59	0.09	5.52	152.84	0.00	1.81	0.01	0.62	0.46	0.04
96.37	0.23	6.93	351.50	0.00	2.63	0.05	0.83	0.13	0.08
12.43	0.02	7.23	305.76	0.00	2.01	0.01	0.45	0.18	0.06
43.32	0.07	6.68	177.90	0.00	1.71	0.02	0.40	0.35	0.02
23.31	0.31	6.57	155.64	0.00	1.44	0.00	0.39	0.08	0.09
~~1.43~~	~~0.23~~	~~2.06~~	~~12.26~~	~~0.00~~	~~2.00~~	~~0.01~~	~~1.79~~	~~0.16~~	~~0.11~~
19.76	0.15	7.32	464.11	0.00	1.73	0.01	0.31	0.09	0.06
12.02	0.10	4.92	90.20	0.00	1.91	0.04	1.08	0.17	0.05
90.09	0.30	7.36	471.14	0.00	1.75	0.01	0.65	0.32	0.04
129.07	0.18	6.10	242.25	0.00	1.38	0.01	0.83	0.49	0.04
132.52	0.10	6.24	189.25	0.00	3.05	0.10	1.00	0.09	0.08
	0.27	8.04	911.81	0.00	0.92	0.00	0.32	0.12	0.06
4.69	0.08	4.47	67.31	0.01	2.51	0.02	0.66	0.06	0.17
	0.15	3.03	328.79	0.00	4.33	0.00	0.36	1.09	0.01
56.36	0.46	8.39	236.37	0.00	1.68	0.00	0.42	0.06	0.07
~~27.29~~	~~0.28~~	~~5.08~~	~~330.22~~	~~0.01~~	~~1.95~~	~~0.02~~	~~0.45~~	~~0.08~~	~~0.10~~
110.79	0.33	5.06	203.67	0.00	2.62	0.01	0.60	0.18	0.04
4.78	0.21	3.20	84.80	0.01	1.14	0.01	1.16	0.05	0.24
10.70	0.11	5.82	224.00	0.00	1.43	0.00	0.45	0.14	0.08
151.09	0.63	4.91	567.50	0.00	1.61	0.01	0.29	0.29	0.02
11.37	0.68	5.39	91.96	0.01	4.85	0.02	0.59	0.06	0.18
88.66	0.41	9.88	452.21	0.00	2.17	0.01	0.47	0.17	0.04
16.95	0.05	5.81	206.56	0.01	3.81	0.03	0.26	0.05	0.17
24.55	0.16	6.90	261.57	0.00	1.61	0.02	0.24	0.02	0.10
10.64	0.51	3.82	135.70	0.00	1.32	0.00	0.77	0.17	0.08
16.47	0.36	3.86	38.48	0.00	2.41	0.01	1.08	0.24	0.05
4.05	0.31	5.01	103.40	0.00	1.85	0.01	0.56	0.03	0.11
9.78	0.45	4.99	130.23	0.01	3.96	0.01	0.91	0.22	0.33
16.51	0.27	6.75	220.76	0.00	1.94	0.01	0.49	0.05	0.09
44.73	0.02	7.57	266.67	0.01	4.03	0.04	0.83	0.12	0.16
10.95	0.22	9.98	462.65	0.01	2.60	0.01	0.31	0.07	0.16
87.26	0.23	5.11	1901.67	0.00	1.69	0.01	0.18	0.08	0.03
55.66	0.37	6.95	179.18	0.00	1.62	0.01	0.54	0.25	0.05
65.49	0.38	8.42	842.03	0.01	1.80	0.01	0.22	0.06	0.09
~~7.65~~	~~0.62~~	~~3.67~~	~~306.86~~	~~0.01~~	~~2.07~~	~~0.00~~	~~0.33~~	~~0.18~~	~~0.13~~
216.81	0.09	5.50	495.76	0.01	1.55	0.01	0.70	0.20	0.11
191.61	0.07	15.87	1482.12	0.00	1.48	0.01	0.42	0.13	0.06
702.83	0.57	3.81	152.16	0.00	4.75	0.01	0.18	0.11	0.02
7.80	0.12	6.34	129.62	0.00	2.63	0.03	0.43	0.06	0.06
202.12	0.13	9.52	495.23	0.00	2.33	0.03	0.52	0.12	0.08
7.56	0.32	5.29	116.83	0.01	2.25	0.01	0.72	0.06	0.21
13.37	0.53	3.99	818.12	0.01	4.12	0.01	0.10	0.01	0.14

Table B7c, *continued*. Detrital zircon calculated ratios and values from sample **09LP093** in unit **OSs** - Isotope Geology Laboratory, Boise State University

Analysis	CI chondrite normalizing values from Sun and McDonough (1989)													
	0.237	0.612	0.095	0.467	0.153	0.058	0.206	0.037	0.254	0.057	0.166	0.026	0.17	0.025
	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
09LP093 L 67	0.059	54.651	2.086	9.085	39.211	35.934	111.343	174.303	236.316	336.890	439.585	714.371	1089.017	823.397
09LP093 L 110	0.005	47.278	0.209	3.284	19.977	13.454	50.345	79.255	133.983	182.052	256.262	477.745	790.607	547.870
09LP093 L 105	~~1.730~~	~~68.817~~	~~1.471~~	~~3.614~~	~~18.241~~	~~6.876~~	~~54.201~~	~~103.186~~	~~186.256~~	~~288.177~~	~~436.184~~	~~749.974~~	~~1274.895~~	~~1040.372~~
09LP093 L 69	0.010	44.461	0.387	2.290	16.619	2.645	63.598	165.166	310.204	558.699	870.693	1644.074	2825.059	2266.355
09LP093 L 66	0.039	31.403	0.638	3.612	29.570	16.511	77.830	131.050	185.640	289.465	394.109	668.411	1135.151	847.641
09LP093 L 70	0.011	20.814	0.459	1.815	22.548	9.454	56.300	114.199	188.835	308.681	449.847	794.430	1359.461	1087.774
09LP093 L 25	0.374	26.073	0.892	3.139	26.449	11.517	72.928	120.825	196.447	292.446	372.807	616.884	927.720	656.735
09LP093 L 99	0.039	60.728	1.561	5.014	52.953	35.105	170.524	303.011	503.894	763.960	1029.817	1679.131	2615.776	1984.904
09LP093 L 82	0.052	22.390	2.073	5.279	29.827	13.599	112.185	207.432	317.217	480.898	689.736	1065.260	1535.140	1480.415
09LP093 L 45	0.007	34.546	0.269	2.063	13.489	5.571	40.509	77.522	132.639	210.930	317.610	550.833	946.372	635.390
09LP093 L 49	0.008	6.424	0.302	1.264	9.940	4.363	53.492	100.127	180.910	295.511	393.585	691.795	1182.709	848.218
09LP093 L 11	0.014	5.419	0.571	1.684	8.878	9.001	51.784	105.194	188.088	311.708	501.063	901.434	1525.282	1254.275
09LP093 L 41	0.014	10.010	0.562	3.012	16.533	4.355	77.752	159.610	296.315	457.869	644.462	1095.420	1838.438	1257.826
09LP093 L 108	0.017	7.904	0.875	4.742	30.644	9.091	132.352	243.335	415.861	635.701	818.111	1279.557	2018.243	1313.635
09LP093 L 44	0.009	28.992	0.368	2.660	30.021	18.277	99.486	166.339	278.372	410.849	529.907	873.452	1463.901	988.583
09LP093 L 37	~~33.013~~	~~59.204~~	~~24.280~~	~~30.742~~	~~76.291~~	~~36.297~~	~~165.867~~	~~267.885~~	~~454.537~~	~~698.119~~	~~932.234~~	~~1569.972~~	~~2554.108~~	~~1834.320~~
09LP093 L 92	0.052	100.761	0.968	3.653	37.790	25.255	117.523	254.035	486.908	853.553	1317.059	2413.048	3956.286	3377.433
09LP093 L 6	~~38.970~~	~~100.865~~	~~82.038~~	~~104.581~~	~~199.938~~	~~138.455~~	~~411.047~~	~~753.843~~	~~1287.748~~	~~2020.529~~	~~2842.530~~	~~4409.888~~	~~6459.695~~	~~5519.507~~

Ti-in-zircon T (°C)	Ce/Ce*	Eu/Eu*	(Sm/Nd) cn	(Lu/Nd) cn	Lu/Hf	Nb/Ta	Nb/U	Th/U	Th/Y	Y/Hf
863	50.96	0.48	4.32	90.64	0.00	2.03	0.01	0.59	0.11	0.09
805	442.28	0.38	6.08	166.82	0.00	2.61	0.01	0.58	0.39	0.05
~~1261~~	~~43.00~~	~~0.19~~	~~5.05~~	~~287.84~~	~~0.00~~	~~5.63~~	~~0.10~~	~~0.88~~	~~0.12~~	~~0.07~~
744	224.04	0.07	7.26	989.71	0.01	1.83	0.01	0.30	0.13	0.09
822	92.74	0.31	8.19	234.68	0.00	1.41	0.01	0.40	0.06	0.07
834	88.55	0.24	12.42	599.41	0.00	1.17	0.01	0.36	0.10	0.05
850	41.18	0.23	8.43	209.23	0.00	2.47	0.01	0.50	0.22	0.05
731	75.93	0.31	10.56	395.84	0.01	2.29	0.01	1.24	0.11	0.13
835	21.08	0.19	5.65	280.41	0.00	2.03	0.01	0.72	0.26	0.07
821	250.97	0.21	6.54	308.02	0.00	1.60	0.02	0.71	0.23	0.04
816	41.48	0.14	7.86	670.83	0.00	1.46	0.01	0.33	0.10	0.06
756	18.52	0.30	5.27	744.73	0.00	1.38	0.00	0.26	0.09	0.06
793	34.77	0.09	5.49	417.55	0.00	1.68	0.02	0.35	0.13	0.09
843	17.72	0.11	6.46	277.04	0.00	2.22	0.01	0.46	0.09	0.12
828	153.59	0.28	11.28	371.60	0.00	2.13	0.01	0.58	0.11	0.09
~~2072~~	~~2.07~~	~~0.30~~	~~2.48~~	~~59.67~~	~~0.01~~	~~11.20~~	~~0.11~~	~~1.22~~	~~0.17~~	~~0.19~~
762	197.49	0.33	10.34	924.48	0.01	3.26	0.04	0.64	0.07	0.14
~~960~~	~~1.67~~	~~0.45~~	~~1.91~~	~~52.78~~	~~0.01~~	~~2.26~~	~~0.03~~	~~0.63~~	~~0.06~~	~~0.25~~

Notes:

Activity (SiO_2) = 1; activity (TiO_2) = 0.6.
Yellow highlighted rows are samples that intersected inclusions.
Trace element concentrations in ppm, calculated using mean count rate method.
Backgrounds were monitored between sweeps 10 to 27. Sample counts were integrated from sweeps 36 to 69.
Ablation used a laser spot size of 25 microns, and a laser firing repitition rate of 10 Hz.

Table B8a. Detrital zircon U-Pb geochronologic analyses from sample **09LP090** in Mattson Formation (MM) - Isotope Geology Laboratory, Boise State University

Analysis	U (ppm)	Th (ppm)	Pb* (ppm)	Th/U	Corrected isotope ratios												Apparent ages (Ma)						% disc.
					$^{206}Pb^*/^{207}Pb^*$	±2σ (%)	$^{207}Pb^*/^{235}U^*$	±2σ (%)	$^{206}Pb^*/^{238}U$	±2σ (%)	error corr.	$^{238}U/^{206}Pb^*$	±2σ (%)	$^{207}Pb^*/^{206}Pb^*$	±2σ (%)	error corr.	$^{207}Pb^*/^{206}Pb^*$	±2σ (Ma)	$^{207}Pb^*/^{235}U$	±2σ (Ma)	$^{206}Pb^*/^{238}U^*$	±2σ (Ma)	
09LP090 L 115	112.93	226.81	125.43	2.01	3.731	1.749	22.485	5.469	0.608	5.182	0.947	1.644	5.182	0.268	1.749	-0.0	**3294**	**27**	3205	53	3064	126	7
09LP090 L 132	103.28	44.78	86.13	0.43	4.449	2.828	18.724	7.080	0.604	6.490	0.917	1.655	6.490	0.225	2.828	0	**3015**	**45**	3028	68	3047	158	-1
09LP090 L 129	681.46	23.10	502.83	0.03	4.465	1.801	18.447	5.552	0.597	5.252	0.946	1.674	5.252	0.224	1.801	0	**3010**	**29**	3013	53	3019	127	-0
09LP090 L 195	51.47	25.89	39.72	0.50	4.931	2.427	15.683	5.359	0.561	4.778	0.892	1.783	4.778	0.203	2.427	0.0	**2849**	**40**	2858	51	2870	111	-1
09LP090 L 216	779.52	16.87	506.70	0.02	5.133	2.401	14.527	5.166	0.541	4.573	0.885	1.849	4.573	0.195	2.401	-0.0	**2783**	**39**	2785	49	2787	103	-0
09LP090 L 156	32.34	35.27	27.83	1.09	5.159	4.253	14.696	8.518	0.550	7.380	0.866	1.818	7.380	0.194	4.253	-0.0	**2775**	**70**	2796	81	2825	169	-2
09LP090 L 184	50.42	52.36	39.93	1.04	5.249	2.758	13.709	6.491	0.522	5.876	0.905	1.916	5.876	0.190	2.758	0.0	**2746**	**45**	2730	61	2707	130	1
09LP090 L 176	296.08	156.71	198.42	0.53	5.258	1.383	13.250	5.448	0.505	5.270	0.967	1.979	5.270	0.190	1.383	-0.0	**2744**	**23**	2698	51	2636	114	4
09LP090 L 170	148.07	48.86	95.78	0.33	5.283	1.416	13.270	5.416	0.508	5.228	0.965	1.967	5.228	0.189	1.416	-0.0	**2736**	**23**	2699	51	2650	114	3
09LP090 L 153	187.22	109.67	123.33	0.59	5.287	2.410	12.277	8.265	0.471	7.906	0.957	2.124	7.906	0.189	2.410	0	**2735**	**40**	2626	78	2487	163	9
09LP090 L 148	552.44	162.90	372.42	0.29	5.355	2.063	13.437	5.565	0.522	5.168	0.929	1.916	5.168	0.187	2.063	-0.0	**2714**	**34**	2711	53	2707	114	0
09LP090 L 166	33.12	30.32	23.73	0.92	5.680	3.296	12.110	7.957	0.499	7.242	0.910	2.005	7.242	0.176	3.296	-0.0	**2616**	**55**	2613	75	2609	155	0
09LP090 L 133	30.68	20.93	22.49	0.68	5.872	4.128	12.133	7.356	0.517	6.088	0.828	1.935	6.088	0.170	4.128	0.0	**2561**	**69**	2615	69	2685	134	-5
09LP090 L 145	63.27	40.84	46.21	0.65	6.199	3.174	11.878	11.083	0.534	10.619	0.958	1.872	10.619	0.161	3.174	0	**2469**	**54**	2595	104	2758	238	-12
09LP090 L 147	599.85	241.98	231.00	0.40	8.186	2.585	5.129	5.969	0.305	5.380	0.901	3.284	5.380	0.122	2.585	0	**1988**	**46**	1841	51	1714	81	14
09LP090 L 130	287.37	106.59	126.32	0.37	8.209	2.861	5.886	6.323	0.350	5.639	0.892	2.854	5.639	0.122	2.861	0.0	**1983**	**51**	1959	55	1937	94	2
09LP090 L 178	811.27	206.71	331.79	0.25	8.401	1.919	5.610	5.473	0.342	5.125	0.937	2.926	5.125	0.119	1.919	0	**1942**	**34**	1918	47	1895	84	2
09LP090 L 192	227.42	26.83	90.34	0.12	8.423	2.546	5.608	6.004	0.343	5.437	0.906	2.919	5.437	0.119	2.546	0	**1937**	**46**	1917	52	1899	89	2
09LP090 L 131	423.40	145.42	168.29	0.34	8.522	2.036	5.181	5.797	0.320	5.428	0.936	3.123	5.428	0.117	2.036	-0.0	**1916**	**37**	1850	49	1791	85	7
09LP090 L 140	133.97	30.64	57.21	0.23	8.593	2.689	5.724	6.801	0.357	6.247	0.919	2.803	6.247	0.116	2.689	0	**1901**	**48**	1935	59	1967	106	-3
09LP090 L 146	124.43	74.54	57.52	0.60	8.634	3.260	5.559	7.603	0.348	6.869	0.903	2.873	6.869	0.116	3.260	-0.0	**1893**	**59**	1910	65	1926	114	-2
09LP090 L 155	47.46	90.96	28.10	1.92	8.939	4.284	5.037	7.175	0.327	5.755	0.802	3.062	5.755	0.112	4.284	0.0	**1830**	**78**	1826	61	1822	91	0
09LP090 L 188	165.33	40.77	67.92	0.25	9.093	3.329	5.220	6.134	0.344	5.152	0.840	2.905	5.152	0.110	3.329	0	**1799**	**61**	1856	52	1907	85	-6
09LP090 L 144	107.46	61.64	44.80	0.57	9.130	2.405	4.745	7.373	0.314	6.969	0.945	3.183	6.969	0.110	2.405	-0.0	**1792**	**44**	1775	62	1761	107	2
09LP090 L 201	410.63	137.54	159.31	0.33	9.143	1.779	4.746	4.891	0.315	4.557	0.932	3.177	4.557	0.109	1.779	0.0	**1789**	**32**	1775	41	1764	70	1
09LP090 L 111	113.75	64.21	45.97	0.56	9.144	2.695	4.804	5.563	0.319	4.867	0.875	3.139	4.867	0.109	2.695	-0.0	**1789**	**49**	1786	47	1783	76	0
09LP090 L 123	428.24	149.88	163.90	0.35	9.146	1.743	4.696	5.174	0.312	4.871	0.942	3.210	4.871	0.109	1.743	-0.0	**1788**	**32**	1767	43	1748	75	2
09LP090 L 185	241.74	82.37	99.33	0.34	9.151	2.383	5.090	5.643	0.338	5.115	0.906	2.960	5.115	0.109	2.383	0	**1787**	**43**	1834	48	1876	83	-5
09LP090 L 114	137.56	55.84	51.22	0.41	9.219	1.649	4.544	5.415	0.304	5.158	0.953	3.292	5.158	0.108	1.649	-0.0	**1774**	**30**	1739	45	1710	77	4
09LP090 L 165	250.67	114.65	99.35	0.46	9.225	2.084	4.755	5.395	0.318	4.976	0.922	3.144	4.976	0.108	2.084	-0.0	**1773**	**38**	1777	45	1780	77	-0
09LP090 L 211	416.97	92.00	155.75	0.22	9.231	1.826	4.696	4.986	0.314	4.639	0.931	3.181	4.639	0.108	1.826	-0.0	**1772**	**33**	1766	42	1762	72	1
09LP090 L 143	125.35	44.08	47.80	0.35	9.308	3.077	4.549	7.184	0.307	6.491	0.904	3.257	6.491	0.107	3.077	-0.0	**1756**	**56**	1740	60	1726	98	2
09LP090 L 181	36.35	23.66	14.67	0.65	9.315	5.311	4.506	7.885	0.304	5.828	0.739	3.285	5.828	0.107	5.311	0	**1755**	**97**	1732	66	1713	88	2
09LP090 L 137	465.77	135.37	183.54	0.29	9.340	2.337	4.779	6.415	0.324	5.974	0.931	3.089	5.974	0.107	2.337	-0.0	**1750**	**43**	1781	54	1808	94	-3
09LP090 L 212	34.32	5.78	12.92	0.17	9.358	4.453	4.748	7.031	0.322	5.441	0.774	3.103	5.441	0.107	4.453	-0.0	**1747**	**82**	1776	59	1801	85	-3
09LP090 L 202	39.63	14.98	15.08	0.38	9.361	3.157	4.488	6.102	0.305	5.222	0.856	3.282	5.222	0.107	3.157	0	**1746**	**58**	1729	51	1714	79	2
09LP090 L 112	161.32	43.93	60.32	0.27	9.424	2.150	4.621	4.779	0.316	4.268	0.893	3.166	4.268	0.106	2.150	0	**1734**	**39**	1753	40	1770	66	-2
09LP090 L 198	52.12	44.62	21.82	0.86	9.775	4.255	4.189	7.048	0.297	5.618	0.797	3.367	5.618	0.102	4.255	-0.0	**1666**	**79**	1672	58	1676	83	-1
09LP090 L 219	1106.44	124.74	377.18	0.11	9.781	2.661	4.217	6.704	0.299	6.153	0.918	3.343	6.153	0.102	2.661	0.0	**1665**	**49**	1677	55	1687	91	-1
09LP090 L 190	221.05	53.54	73.51	0.24	9.784	2.678	3.917	6.046	0.278	5.420	0.897	3.597	5.420	0.102	2.678	-0.0	**1665**	**50**	1617	49	1581	76	5
09LP090 L 116	68.45	78.43	28.83	1.15	9.808	3.249	4.018	6.767	0.286	5.936	0.877	3.499	5.936	0.102	3.249	0	**1660**	**60**	1638	55	1621	85	2

Table B8a, *continued*. Detrital zircon U-Pb geochronologic analyses from sample **09LP090** in Mattson Formation (Mm) - Isotope Geology Laboratory, Boise State University

Analysis	U (ppm)	Th (ppm)	Pb^* (ppm)	Th/U	Corrected isotope ratios												Apparent ages (Ma)						% disc.
					$\frac{^{206}Pb^*}{^{207}Pb^*}$	±2σ (%)	$\frac{^{207}Pb^*}{^{235}U^*}$	±2σ (%)	$\frac{^{206}Pb^*}{^{238}U}$	±2σ (%)	error corr.	$\frac{^{238}U}{^{206}Pb^*}$	±2σ (%)	$\frac{^{207}Pb^*}{^{206}Pb^*}$	±2σ (%)	error corr.	$\frac{^{207}Pb^*}{^{206}Pb^*}$	±2σ (Ma)	$\frac{^{207}Pb^*}{^{235}U}$	±2σ (Ma)	$\frac{^{206}Pb^*}{^{238}U^*}$	±2σ (Ma)	
09LP090 L 149	159.50	34.90	50.51	0.22	9.861	2.605	3.739	6.100	0.267	5.516	0.904	3.740	5.516	0.101	2.605	0	**1650**	**48**	1580	49	1527	75	7
09LP090 L 206	320.33	110.29	115.49	0.34	9.907	1.975	4.103	5.943	0.295	5.605	0.943	3.392	5.605	0.101	1.975	0	**1641**	**37**	1655	49	1665	82	-1
09LP090 L 204	172.13	59.44	63.79	0.35	9.997	2.555	4.165	5.375	0.302	4.728	0.880	3.312	4.728	0.100	2.555	-0.0	**1625**	**48**	1667	44	1701	71	-5
09LP090 L 168	68.05	27.14	22.56	0.40	10.086	3.117	3.734	6.339	0.273	5.520	0.871	3.661	5.520	0.099	3.117	0.0	**1608**	**58**	1579	51	1557	76	3
09LP090 L 180	122.64	85.26	46.05	0.70	10.106	2.512	3.905	6.476	0.286	5.968	0.922	3.494	5.968	0.099	2.512	-0.0	**1604**	**47**	1615	52	1623	86	-1
09LP090 L 154	20.80	11.90	8.02	0.57	10.141	5.854	4.017	8.862	0.295	6.654	0.751	3.385	6.654	0.099	5.854	-0.0	**1598**	**109**	1638	72	1669	98	-4
09LP090 L 113	199.11	19.09	49.60	0.10	10.281	2.252	2.957	5.112	0.221	4.590	0.898	4.535	4.590	0.097	2.252	0.0	**1572**	**42**	1397	39	1285	53	18
09LP090 L 205	369.47	151.85	130.70	0.41	10.380	2.112	3.767	5.671	0.284	5.263	0.928	3.526	5.263	0.096	2.112	0	**1554**	**40**	1586	45	1609	75	-4
09LP090 L 141	144.30	51.70	49.43	0.36	10.541	3.130	3.635	6.955	0.278	6.211	0.893	3.599	6.211	0.095	3.130	0.0	**1525**	**59**	1557	55	1581	87	-4
09LP090 L 191	22.97	24.88	8.09	1.08	10.626	5.943	3.021	7.699	0.233	4.894	0.636	4.295	4.894	0.094	5.943	-0.0	**1510**	**112**	1413	59	1349	60	11
09LP090 L 150	265.57	103.84	88.64	0.39	10.797	3.338	3.437	6.822	0.269	5.950	0.872	3.716	5.950	0.093	3.338	0	**1480**	**63**	1513	54	1536	81	-4
09LP090 L 135	187.08	46.72	57.38	0.25	10.886	2.914	3.257	6.046	0.257	5.298	0.876	3.889	5.298	0.092	2.914	0	**1465**	**55**	1471	47	1475	70	-1
09LP090 L 117	111.00	48.61	33.23	0.44	11.074	2.830	3.012	5.559	0.242	4.785	0.861	4.133	4.785	0.090	2.830	0.0	**1432**	**54**	1411	42	1397	60	2
09LP090 L 217	73.65	41.29	23.12	0.56	11.108	3.164	3.029	6.608	0.244	5.801	0.878	4.098	5.801	0.090	3.164	0	**1426**	**60**	1415	50	1407	73	1
09LP090 L 164	147.16	158.84	42.25	1.08	11.174	4.520	2.430	6.632	0.197	4.853	0.732	5.078	4.853	0.089	4.520	-0.0	**1415**	**86**	1252	48	1159	51	18
09LP090 L 187	216.03	85.01	65.05	0.39	11.394	2.262	2.978	6.458	0.246	6.049	0.937	4.064	6.049	0.088	2.262	0	**1377**	**43**	1402	49	1418	77	-3
09LP090 L 214	68.70	31.17	21.28	0.45	11.549	4.001	2.939	6.413	0.246	5.012	0.781	4.062	5.012	0.087	4.001	-0.0	**1351**	**77**	1392	49	1419	64	-5
09LP090 L 163	720.64	159.52	184.19	0.22	11.583	2.125	2.627	5.371	0.221	4.933	0.918	4.532	4.933	0.086	2.125	0.0	**1346**	**41**	1308	40	1285	57	4
09LP090 L 199	50.77	24.40	14.77	0.48	11.650	4.489	2.719	6.903	0.230	5.243	0.760	4.352	5.243	0.086	4.489	0	**1334**	**87**	1334	51	1333	63	0
09LP090 L 138	833.72	32.13	208.70	0.04	11.755	2.846	2.670	8.568	0.228	8.081	0.943	4.393	8.081	0.085	2.846	-0.0	**1317**	**55**	1320	63	1322	97	-0
09LP090 L 121	101.45	72.22	28.06	0.71	11.817	3.673	2.425	6.371	0.208	5.206	0.817	4.811	5.206	0.085	3.673	-0.0	**1307**	**71**	1250	46	1217	58	7
09LP090 L 197	17.45	13.30	4.90	0.76	11.871	5.200	2.378	8.843	0.205	7.153	0.809	4.884	7.153	0.084	5.200	0.0	**1298**	**101**	1236	63	1201	78	7
09LP090 L 157	38.62	13.69	9.23	0.35	12.198	4.763	2.217	7.591	0.196	5.912	0.779	5.098	5.912	0.082	4.763	0.0	**1245**	**93**	1186	53	1155	62	7
09LP090 L 142	224.10	79.66	59.11	0.36	12.238	2.463	2.439	6.483	0.216	5.997	0.925	4.619	5.997	0.082	2.463	0	**1239**	**48**	1254	47	1263	69	-2
09LP090 L 215	207.89	120.45	53.20	0.58	12.341	2.642	2.192	5.610	0.196	4.949	0.882	5.097	4.949	0.081	2.642	0.0	**1222**	**52**	1178	39	1155	52	6
09LP090 L 173	51.83	25.88	11.27	0.50	12.555	5.542	1.969	8.179	0.179	6.015	0.735	5.577	6.015	0.080	5.542	-0.0	**1188**	**109**	1105	55	1063	59	11
09LP090 L 208	221.67	105.72	51.63	0.48	12.591	2.453	2.026	5.968	0.185	5.441	0.912	5.406	5.441	0.079	2.453	-0.0	**1183**	**48**	1124	41	1094	55	7
09LP090 L 179	538.70	294.32	136.54	0.55	12.602	1.877	2.223	5.768	0.203	5.454	0.946	4.922	5.454	0.079	1.877	0	**1181**	**37**	1188	40	1192	59	-1
09LP090 L 159	655.68	92.75	144.30	0.14	12.638	2.031	2.118	5.491	0.194	5.101	0.929	5.151	5.101	0.079	2.031	-0.0	**1175**	**40**	1155	38	1144	53	3
09LP090 L 119	123.03	41.86	29.59	0.34	12.705	3.236	2.184	6.553	0.201	5.698	0.870	4.970	5.698	0.079	3.236	-0.0	**1165**	**64**	1176	46	1182	62	-1
09LP090 L 207	152.62	71.21	38.18	0.47	12.724	2.668	2.173	6.875	0.201	6.336	0.922	4.987	6.336	0.079	2.668	0.0	**1162**	**53**	1172	48	1178	68	-1
09LP090 L 200	85.43	29.50	20.53	0.35	12.734	4.039	2.151	6.388	0.199	4.949	0.775	5.034	4.949	0.079	4.039	-0.0	**1160**	**80**	1165	44	1168	53	-1
09LP090 L 193	186.81	47.46	44.94	0.25	12.774	3.104	2.207	6.225	0.205	5.396	0.867	4.890	5.396	0.078	3.104	-0.0	**1154**	**62**	1183	43	1199	59	-4
09LP090 L 126	120.17	59.04	29.49	0.49	12.837	2.726	2.102	6.552	0.196	5.958	0.909	5.110	5.958	0.078	2.726	-0.0	**1144**	**54**	1149	45	1152	63	-1
09LP090 L 162	45.14	29.92	9.61	0.66	13.064	6.698	1.740	8.948	0.165	5.933	0.663	6.066	5.933	0.077	6.698	0	**1109**	**134**	1023	58	984	54	11
09LP090 L 183	150.08	67.52	34.92	0.45	13.068	3.926	2.010	6.970	0.190	5.759	0.826	5.250	5.759	0.077	3.926	-0.0	**1109**	**78**	1119	47	1124	59	-1
09LP090 L 172	299.81	45.88	62.03	0.15	13.101	2.830	1.950	6.056	0.185	5.355	0.884	5.399	5.355	0.076	2.830	-0.0	**1104**	**57**	1098	41	1096	54	1
09LP090 L 189	67.84	40.70	18.14	0.60	13.113	4.236	2.158	8.273	0.205	7.106	0.859	4.873	7.106	0.076	4.236	0	**1102**	**85**	1168	57	1203	78	-9
09LP090 L 177	1138.64	437.49	234.55	0.38	13.198	1.768	1.811	5.136	0.173	4.822	0.939	5.769	4.822	0.076	1.768	0	**1089**	**35**	1049	34	1031	46	5
09LP090 L 125	156.41	55.70	34.19	0.36	13.226	3.309	1.893	6.386	0.182	5.462	0.855	5.506	5.462	0.076	3.309	0.0	**1085**	**66**	1079	42	1076	54	1
09LP090 L 220	438.14	211.60	98.85	0.48	13.238	2.925	1.888	6.809	0.181	6.149	0.903	5.517	6.149	0.076	2.925	0.0	**1083**	**59**	1077	45	1074	61	1
09LP090 L 209	35.69	18.40	8.58	0.52	13.307	6.622	1.951	8.688	0.188	5.625	0.647	5.311	5.625	0.075	6.622	0	**1072**	**133**	1099	58	1112	57	-4

Table B8a, *continued*. Detrital zircon U-Pb geochronologic analyses from sample **09LP090** in Mattson Formation (Mm) - Isotope Geology Laboratory, Boise State University

Analysis	U (ppm)	Th (ppm)	Pb^* (ppm)	Th/U	Corrected isotope ratios												Apparent ages (Ma)						% disc.
					$\frac{^{206}Pb^*}{^{207}Pb^*}$	±2σ (%)	$\frac{^{207}Pb^*}{^{235}U^*}$	±2σ (%)	$\frac{^{206}Pb^*}{^{238}U}$	±2σ (%)	error corr.	$\frac{^{238}U}{^{206}Pb^*}$	±2σ (%)	$\frac{^{207}Pb^*}{^{206}Pb^*}$	±2σ (%)	error corr.	$\frac{^{207}Pb^*}{^{206}Pb^*}$	±2σ (Ma)	$\frac{^{207}Pb^*}{^{235}U}$	±2σ (Ma)	$\frac{^{206}Pb^*}{^{238}U^*}$	±2σ (Ma)	
09LP090 L 120	73.81	135.55	20.62	1.84	13.309	4.622	1.689	7.628	0.163	6.069	0.796	6.135	6.069	0.075	4.622	0.0	**1072**	**93**	1004	49	973	55	9
09LP090 L 174	309.63	241.77	71.51	0.78	13.354	2.079	1.861	6.024	0.180	5.653	0.939	5.549	5.653	0.075	2.079	0.0	**1065**	**42**	1067	40	1068	56	-0
09LP090 L 213	170.25	110.88	44.06	0.65	13.359	2.902	2.033	5.926	0.197	5.166	0.872	5.076	5.166	0.075	2.902	0	**1065**	**58**	1127	40	1159	55	-9
09LP090 L 127	210.83	132.65	45.20	0.63	13.502	2.956	1.677	6.579	0.164	5.877	0.893	6.090	5.877	0.074	2.956	0.0	**1043**	**60**	1000	42	980	53	6
09LP090 L 151	42.55	40.92	9.52	0.96	13.530	5.020	1.553	8.072	0.152	6.322	0.783	6.561	6.322	0.074	5.020	-0.0	**1039**	**101**	952	50	915	54	12
09LP090 L 175	310.05	37.28	55.03	0.12	13.568	3.501	1.631	8.618	0.161	7.875	0.914	6.230	7.875	0.074	3.501	0	**1033**	**71**	982	54	960	70	7
09LP090 L 203	200.39	4.79	40.19	0.02	13.581	3.318	1.882	6.652	0.185	5.765	0.867	5.395	5.765	0.074	3.318	0.0	**1031**	**67**	1075	44	1096	58	-6
09LP090 L 218	103.67	37.66	23.26	0.36	13.636	4.297	1.877	6.501	0.186	4.878	0.750	5.388	4.878	0.073	4.297	0	**1023**	**87**	1073	43	1098	49	-7
09LP090 L 139	107.97	30.46	22.97	0.28	13.649	3.853	1.811	7.829	0.179	6.815	0.871	5.577	6.815	0.073	3.853	0	**1021**	**78**	1050	51	1063	67	-4
09LP090 L 210	202.32	119.72	46.56	0.59	13.724	2.813	1.781	5.730	0.177	4.992	0.871	5.643	4.992	0.073	2.813	0	**1010**	**57**	1038	37	1052	48	-4
09LP090 L 167	62.11	58.76	15.46	0.95	13.813	5.309	1.829	8.228	0.183	6.286	0.764	5.459	6.286	0.072	5.309	-0.0	**997**	**108**	1056	54	1084	63	-9
09LP090 L 118	364.57	140.84	73.09	0.39	13.882	1.834	1.646	5.332	0.166	5.006	0.939	6.035	5.006	0.072	1.834	0.0	**987**	**37**	988	34	988	46	-0
09LP090 L 194	284.30	165.19	59.29	0.58	13.920	2.765	1.600	5.668	0.162	4.948	0.873	6.191	4.948	0.072	2.765	0	**981**	**56**	970	35	965	44	2
09LP090 L 182	117.21	112.68	27.00	0.96	14.038	3.844	1.623	7.518	0.165	6.461	0.859	6.052	6.461	0.071	3.844	0	**964**	**78**	979	47	986	59	-2
09LP090 L 134	140.54	40.04	28.69	0.28	14.144	3.366	1.674	6.003	0.172	4.970	0.828	5.824	4.970	0.071	3.366	0	**949**	**69**	999	38	1021	47	-8
09LP090 L 171	290.88	151.95	51.23	0.52	14.207	2.611	1.419	6.946	0.146	6.437	0.927	6.841	6.437	0.070	2.611	0.0	**940**	**54**	897	41	879	53	6
09LP090 L 186	152.86	1.42	26.50	0.01	14.589	3.859	1.529	6.702	0.162	5.480	0.818	6.181	5.480	0.069	3.859	0	**885**	**80**	942	41	967	49	-9
09LP090 L 152	143.78	12.97	17.13	0.09	14.684	3.410	0.979	6.117	0.104	5.078	0.830	9.586	5.078	0.068	3.410	-0.0	872	71	693	31	**640**	**31**	27
09LP090 L 161	171.01	37.46	19.59	0.22	15.446	4.887	0.864	7.096	0.097	5.145	0.725	10.328	5.145	0.065	4.887	0	766	103	632	33	**596**	**29**	22
09LP090 L 158	32.45	12.49	2.82	0.38	19.417	11.970	0.515	14.434	0.073	8.067	0.559	13.783	8.067	0.052	11.970	-0.0	263	275	422	50	**452**	**35**	-71
09LP090 L 196	191.20	170.39	19.16	0.89	18.347	4.569	0.536	6.781	0.071	5.010	0.739	14.022	5.010	0.055	4.569	0	392	103	436	24	**444**	**22**	-13
09LP090 L 124	649.56	879.87	68.91	1.35	18.068	2.890	0.525	5.852	0.069	5.088	0.870	14.537	5.088	0.055	2.890	0	426	64	428	20	**429**	**21**	-1
09LP090 L 122	360.74	76.67	27.96	0.21	17.408	3.526	0.543	6.312	0.069	5.235	0.829	14.592	5.235	0.057	3.526	-0.0	509	78	440	23	**427**	**22**	16
09LP090 L 128	279.43	175.33	24.62	0.63	17.457	4.577	0.538	7.352	0.068	5.753	0.783	14.693	5.753	0.057	4.577	0	502	101	437	26	**424**	**24**	16

Notes:

Yellow highlighted rows are samples that intersected inclusions.
Isotope ratios and ages are NOT corrected for initial common Pb.
Isotope ratio and apparent age errors include systematic calibration errors of 4.82108305642064% ($^{208}Pb/^{232}Th$), 0.431914068815385% ($^{207}Pb/^{206}Pb$), 1.64420908282226% ($^{206}Pb/^{238}U$) (all 1-sigma).
Sweep-by-sweep downhole fractionation of U/Pb ratios NOT corrected via Si/Zr fractionation factor.
Backgrounds were monitored during sweeps 10 to 27. Sample counts were integrated from sweeps 36 to 69.
Ablation used a laser spot size of 25 microns, and a laser firing repitition rate of 10 Hz.

Table B8b. Detrital zircon trace element analyses from sample **09LP090** in Mattson Formation (MM) - Isotope Geology Laboratory, Boise State University

Analysis	Concentrations (ppm)																						
	P	Ti	Y	Zr	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	Th	U
09LP090 L 115	~~254.724~~	~~11.840~~	~~1609.351~~	~~617608.894~~	~~2.565~~	~~0.063~~	~~57.920~~	~~0.523~~	~~8.983~~	~~14.908~~	~~2.496~~	~~53.095~~	~~16.798~~	~~168.071~~	~~58.323~~	~~230.297~~	~~57.597~~	~~547.519~~	~~70.776~~	~~9346.028~~	~~1.159~~	~~226.813~~	~~112.933~~
09LP090 L 132	177.678	6.942	571.869	476754.214	0.587		5.675		1.024	2.183	0.603	11.843	4.124	56.585	21.425	92.198	25.797	306.478	32.223	6145.835	0.650	44.776	103.276
09LP090 L 129	87.816	3.490	335.129	491726.847	0.846		1.966		0.510	1.251	0.439	5.958	2.101	28.500	10.407	54.143	15.774	220.251	28.296	8390.308	1.953	23.099	681.463
09LP090 L 195	198.465	3.913	1097.893	464471.589	1.341	0.027	3.327	0.037	1.555	4.271	0.947	24.148	8.835	112.791	40.869	173.474	46.794	531.206	51.030	5366.421	0.792	25.886	51.473
09LP090 L 216	72.082	8.092	109.808	480099.594	0.452	0.050	1.109	0.024	0.265	0.287	0.100	1.429	0.695	9.718	3.763	17.237	5.971	87.001	11.127	8765.050	1.506	16.868	779.524
09LP090 L 156	~~170.462~~	~~17.429~~	~~343.674~~	~~470964.373~~	~~1.679~~	~~1.270~~	~~34.163~~	~~0.289~~	~~2.092~~	~~2.063~~	~~0.716~~	~~11.444~~	~~3.242~~	~~38.967~~	~~12.338~~	~~51.803~~	~~13.837~~	~~160.269~~	~~15.783~~	~~5857.068~~	~~0.615~~	~~35.270~~	~~32.343~~
09LP090 L 184	171.880	10.040	386.157	521427.344	1.103	0.065	12.998	0.095	1.217	2.260	0.821	11.527	3.453	39.906	14.458	55.625	14.859	171.022	18.140	7563.415	0.547	52.359	50.425
09LP090 L 176	135.336	3.098	556.373	609741.573	2.228		6.249	0.010	0.921	1.585	0.479	13.591	4.580	55.000	20.307	84.199	21.400	217.614	27.744	12338.040	1.480	156.711	296.076
09LP090 L 170	110.608	3.928	232.002	665684.574	0.956		6.639			0.568	0.078	4.242	1.560	22.228	8.121	36.872	9.378	107.243	16.095	13037.609	0.722	48.859	148.069
09LP090 L 153	254.038	7.311	597.656	478544.201	3.378	0.076	38.989	0.065	1.514	3.164	0.993	14.589	5.939	65.483	22.246	90.108	25.433	304.138	29.464	7145.747	2.090	109.674	187.220
09LP090 L 148	352.720	5.752	868.071	474874.915	2.744		11.550	0.082	1.863	5.208	0.292	21.882	8.036	94.484	32.398	128.090	32.801	357.144	36.665	7897.674	2.557	162.901	552.440
09LP090 L 166	175.070	8.251	389.410	602354.495	0.369		14.982	0.047	0.625	3.015	0.578	10.722	3.501	41.869	15.118	58.695	15.559	172.245	20.721	7215.312	0.278	30.319	33.123
09LP090 L 133	~~440.729~~	~~14.210~~	~~535.895~~	~~467540.998~~	~~1.514~~	~~3.517~~	~~14.670~~	~~1.041~~	~~6.177~~	~~4.446~~	~~0.661~~	~~15.044~~	~~4.741~~	~~59.481~~	~~19.745~~	~~79.236~~	~~21.760~~	~~235.432~~	~~24.171~~	~~6507.687~~	~~0.538~~	~~20.927~~	~~30.676~~
09LP090 L 145	~~241.281~~	~~37.116~~	~~404.953~~	~~487816.223~~	~~2.209~~	~~0.201~~	~~15.431~~	~~0.034~~	~~0.990~~	~~2.057~~	~~0.523~~	~~8.876~~	~~3.676~~	~~40.789~~	~~14.201~~	~~58.369~~	~~16.329~~	~~191.283~~	~~19.812~~	~~7692.900~~	~~1.100~~	~~40.844~~	~~63.270~~
09LP090 L 147	~~527.213~~	~~15.079~~	~~1501.464~~	~~482540.953~~	~~9.869~~	~~0.179~~	~~56.481~~	~~0.381~~	~~4.852~~	~~8.741~~	~~2.750~~	~~40.128~~	~~12.360~~	~~144.076~~	~~55.373~~	~~242.561~~	~~71.805~~	~~845.397~~	~~95.533~~	~~6016.937~~	~~2.923~~	~~241.979~~	~~599.848~~
09LP090 L 130	809.839	11.162	543.828	495810.644	1.159	8.786	26.490	2.131	10.859	5.409	0.979	14.526	5.133	56.618	19.288	88.941	23.961	290.903	31.478	6738.188	0.518	106.590	287.370
09LP090 L 178	~~414.880~~	~~10.430~~	~~913.127~~	~~551003.687~~	~~9.273~~	~~0.351~~	~~15.377~~	~~0.770~~	~~6.375~~	~~12.819~~	~~3.157~~	~~41.177~~	~~8.208~~	~~88.992~~	~~31.718~~	~~130.203~~	~~38.328~~	~~431.548~~	~~56.310~~	~~10848.672~~	~~5.013~~	~~206.707~~	~~811.266~~
09LP090 L 192	83.884	2.746	182.482	479860.219	0.462		1.563		0.273	0.494	0.046	1.926	1.003	13.960	6.218	28.120	9.688	133.783	16.475	8290.647	0.565	26.827	227.420
09LP090 L 131	90.863	3.291	173.439	481410.714	0.474	0.060	0.940		0.081	0.420	0.295	2.979	1.305	17.213	6.181	28.353	8.024	105.700	13.164	3646.307	0.518	145.416	423.404
09LP090 L 140	716.835	12.564	1197.933	472849.816	0.293		0.919	0.042	0.950	3.623	0.074	25.691	8.869	122.655	44.866	190.693	50.887	571.121	53.267	8108.413	0.288	30.643	133.969
09LP090 L 146	232.914	4.828	653.273	485926.877	3.138	0.020	18.567	0.067	1.998	5.420	0.268	20.966	7.221	77.967	26.014	100.111	25.324	272.677	27.127	7815.673	1.690	74.536	124.435
09LP090 L 155	160.527	5.602	457.106	489449.073	2.188	0.032	36.799	0.216	3.472	6.741	1.705	22.925	5.771	57.623	17.157	60.131	16.262	172.284	16.446	6411.315	0.734	90.956	47.461
09LP090 L 188	97.891	3.618	241.553	490920.074	0.787	0.021	7.317		0.275	0.469	0.150	4.139	1.660	19.211	8.026	40.051	11.737	153.057	19.066	6804.537	0.560	40.767	165.328
09LP090 L 144	88.881	2.325	194.176	459738.138	1.354		8.207		0.513	0.697	0.192	3.670	1.473	20.265	6.690	30.160	8.427	105.185	11.693	7729.331	1.081	61.642	107.464
09LP090 L 201	143.934	2.480	530.770	467119.646	1.921		10.964	0.004	0.754	2.770	1.070	13.338	4.661	54.997	19.623	80.410	22.600	276.283	29.153	7361.287	1.574	137.543	410.627
09LP090 L 111	229.447	17.511	767.871	654203.468	1.149	0.006	9.860	0.060	1.104	3.668	0.355	18.557	5.912	74.248	27.521	118.879	29.305	291.088	42.936	9166.048	0.509	64.206	113.753
09LP090 L 123	380.369	6.916	1095.789	537548.274	2.046	0.080	8.590	0.074	1.745	4.907	0.017	24.353	9.371	116.751	38.106	170.064	43.538	474.019	51.080	9877.087	1.649	149.879	428.245
09LP090 L 185	180.638	10.074	493.442	511087.201	1.891		16.688	0.035	0.736	2.428	0.358	10.245	3.714	46.139	18.028	77.512	22.356	272.584	29.856	8273.461	0.953	82.369	241.744
09LP090 L 114	248.558	22.924	779.503	634659.765	1.491	0.010	5.345	0.117	3.177	4.294	0.380	24.732	6.671	79.243	28.099	117.077	28.152	278.783	35.617	9054.814	0.626	55.844	137.562
09LP090 L 165	196.533	10.061	609.043	581741.014	1.932	0.008	25.092	0.017	1.064	2.702	0.436	14.165	4.665	60.109	22.262	92.771	26.410	303.003	38.170	9653.792	1.070	114.652	250.669
09LP090 L 211	159.996	8.159	464.998	464644.211	2.805		12.790	0.006	0.727	1.588	0.059	9.250	3.661	46.894	17.130	75.563	20.601	251.621	24.620	7706.481	1.689	92.000	416.966
09LP090 L 143	194.822	12.320	458.874	460351.882	1.399		8.030	0.034	1.116	2.350	0.373	10.875	4.140	49.663	17.052	73.424	19.638	245.136	24.421	6334.747	0.767	44.082	125.355
09LP090 L 181	151.130	17.577	550.098	528355.146	1.818		5.272	0.184	3.762	5.125	0.790	20.017	5.826	69.151	20.901	79.062	19.553	209.655	21.309	6977.054	0.746	23.664	36.354
09LP090 L 137	175.525	5.591	512.274	448260.903	4.475	0.552	27.574	0.222	1.610	1.888	0.203	9.593	3.525	47.859	18.172	83.907	25.970	332.965	36.379	6972.874	1.996	135.365	465.772
09LP090 L 212	106.088	13.450	149.023	481921.544	0.390		2.170	0.069	0.483	0.858		3.172	1.026	14.416	5.921	23.965	6.324	79.952	8.165	5413.178	0.196	5.779	34.325
09LP090 L 202	150.974	16.285	274.567	482887.713	0.654	0.043	3.386		0.301	1.273	0.115	8.109	2.375	28.696	9.896	43.039	11.199	132.711	13.464	5903.452	0.269	14.976	39.629
09LP090 L 112	154.296	4.984	577.252	663021.456	0.637		3.101	0.026	0.660	1.840	0.224	11.985	4.310	53.314	20.405	90.808	22.621	222.590	34.090	10523.052	0.434	43.926	161.319
09LP090 L 198	259.386	18.129	606.131	474496.197	2.309	0.010	36.087	0.151	3.898	5.216	0.870	20.053	6.380	70.850	23.204	96.813	25.631	296.385	28.821	5571.853	0.733	44.618	52.123
09LP090 L 219	2197.080	4.968	5260.945	479625.949	80.564		34.898	0.057	1.181	7.689	0.249	50.743	29.513	485.090	194.464	988.349	319.868	4041.065	427.755	11141.601	45.583	124.739	1106.445
09LP090 L 190	208.413	3.251	802.679	462457.390	15.617		11.434	0.063	0.344	2.134	0.115	15.575	5.896	81.274	30.586	128.232	35.889	411.259	40.132	7986.423	6.628	53.541	221.045
09LP090 L 116	266.180	11.928	914.597	581286.370	1.602	0.033	23.549	0.130	2.546	4.656	0.823	22.770	7.387	90.775	32.425	143.956	37.934	417.878	53.468	8395.702	0.948	78.432	68.452
09LP090 L 149	148.779	10.650	387.053	476916.652	3.067		5.616	0.017	0.465	1.554	0.055	7.426	3.167	37.236	14.554	62.146	16.537	190.956	19.102	6984.224	1.498	34.897	159.499
09LP090 L 206	174.301	10.110	461.211	477171.187	1.150	0.010	11.989	0.005	0.828	2.251	0.398	10.282	4.042	45.400	16.269	70.151	20.290	237.141	25.024	7676.818	0.593	110.290	320.334

Table B8b, *continued.* Detrital zircon trace element analyses from sample **09LP090** in Mattson Formation (MM) - Isotope Geology Laboratory, Boise State University

Analysis	Concentrations (ppm)																						
	P	Ti	Y	Zr	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	Th	U
09LP090 L 204	528.133	7.732	922.434	468903.557	3.312		13.260	0.017	0.729	2.284	0.255	13.738	5.707	85.666	34.554	167.407	47.783	596.930	61.311	8106.203	2.112	59.439	172.129
09LP090 L 168	188.669	17.593	450.810	620323.843	1.980		3.436	0.020	0.593	2.006	0.090	11.202	3.619	46.403	15.660	72.614	18.267	192.373	24.252	9379.602	1.055	27.142	68.049
09LP090 L 180	255.208	11.323	837.018	573696.912	2.056	0.199	23.753	0.037	1.453	2.452	0.815	17.532	5.990	76.311	29.085	133.132	35.976	391.580	46.871	9095.748	1.145	85.260	122.639
09LP090 L 154	257.572	8.342	560.656	489118.750	2.960	0.031	43.076	0.005	0.643	2.175	0.823	9.174	4.206	53.955	21.123	95.964	28.805	364.682	39.148	6082.798	1.130	11.895	20.797
09LP090 L 113	895.655	9.990	1986.873	662527.633	2.429	0.008	4.494		0.315	2.233	0.278	19.123	9.441	148.374	69.386	376.656	120.925	1434.686	217.964	13887.532	2.113	19.086	199.106
09LP090 L 205	~~1123.826~~	~~9.151~~	~~500.445~~	~~475605.589~~	~~3.073~~	~~39.593~~	~~106.990~~	~~11.530~~	~~48.545~~	~~10.978~~	~~0.372~~	~~15.735~~	~~4.439~~	~~52.120~~	~~17.832~~	~~78.710~~	~~22.531~~	~~273.118~~	~~28.008~~	~~7908.489~~	~~2.194~~	~~151.845~~	~~369.466~~
09LP090 L 141	200.738	10.268	674.713	482187.301	2.760		6.895	0.037	1.045	3.620	0.263	16.361	6.106	73.599	27.158	110.555	28.161	311.893	30.007	7058.561	1.407	51.702	144.296
09LP090 L 191	~~143.064~~	~~22.528~~	~~474.746~~	~~452315.432~~	~~1.348~~	~~0.408~~	~~3.303~~	~~0.078~~	~~1.418~~	~~3.159~~	~~0.172~~	~~13.369~~	~~4.555~~	~~55.113~~	~~18.020~~	~~70.492~~	~~17.614~~	~~185.832~~	~~18.423~~	~~6175.698~~	~~0.526~~	~~24.876~~	~~22.968~~
09LP090 L 150	236.649	6.849	1093.736	481601.175	2.882		5.341	0.082	2.352	4.410	0.739	24.358	8.625	107.753	40.615	174.416	46.123	543.490	54.806	5459.240	1.012	103.844	265.572
09LP090 L 135	293.991	17.877	642.204	451138.207	1.280		5.049	0.066	1.274	2.847	0.144	12.849	5.097	66.618	23.593	98.172	26.634	297.297	27.703	7729.013	0.551	46.723	187.078
09LP090 L 117	111.676	5.512	375.808	584198.753	0.198		5.334		0.495	1.017	0.530	7.267	2.234	29.513	12.336	59.322	18.740	242.098	34.085	8338.362	0.362	48.606	111.003
09LP090 L 217	219.677	19.634	1069.089	486329.387	0.369		4.469	0.219	4.555	6.951	2.844	33.075	10.503	122.323	42.804	168.399	43.359	482.014	46.609	5466.825	0.256	41.290	73.646
09LP090 L 164	~~6141.921~~	~~11.719~~	~~2931.327~~	~~535508.689~~	~~18.155~~	~~1323.084~~	~~3019.068~~	~~440.652~~	~~2360.965~~	~~574.978~~	~~13.853~~	~~552.801~~	~~87.160~~	~~570.911~~	~~131.284~~	~~396.264~~	~~78.880~~	~~680.133~~	~~66.861~~	~~6952.589~~	~~6.193~~	~~158.845~~	~~147.157~~
09LP090 L 187	201.734	4.655	763.691	503455.592	4.008		13.978	0.080	0.450	2.079	0.185	16.189	5.583	78.954	29.213	122.374	33.314	388.821	39.700	8049.241	2.298	85.015	216.027
09LP090 L 214	247.674	12.280	589.352	459778.040	0.750		10.666		0.929	2.272	0.767	13.270	4.297	59.702	21.385	93.581	26.045	313.975	32.436	6368.125	0.604	31.168	68.703
09LP090 L 163	153.735	5.369	995.905	532683.682	12.600	0.010	11.078		0.699	1.700	0.065	13.927	6.034	88.775	35.082	167.142	46.598	526.450	53.993	11175.684	7.342	159.520	720.640
09LP090 L 199	161.457	13.956	357.954	477711.865	2.746		4.562	0.000	0.523	1.927	0.117	8.830	3.379	37.209	13.384	56.878	15.900	170.384	17.620	6315.014	0.998	24.403	50.765
09LP090 L 138	448.631	3.553	777.092	444917.720	1.865	0.012	0.770		0.314	1.757	0.055	12.676	6.734	84.580	28.278	110.855	28.506	320.978	32.368	7913.208	1.469	32.131	833.715
09LP090 L 121	210.443	3.671	787.262	565379.213	7.112	0.030	10.968	0.062	1.294	3.815	0.201	18.953	6.532	80.484	28.832	125.950	33.482	361.658	39.069	8291.767	3.371	72.221	101.450
09LP090 L 197	165.165	10.104	228.836	462897.574	1.105	0.096	12.726	0.029	1.227	2.470	0.521	8.340	2.438	24.696	7.432	31.082	8.517	101.423	10.500	6760.563	0.388	13.298	17.445
09LP090 L 157	215.540	20.632	514.778	474185.888	2.140	0.033	2.725	0.073	1.254	2.374	0.265	13.595	5.244	59.891	20.581	77.303	20.248	221.214	22.067	6630.760	0.928	13.694	38.616
09LP090 L 142	339.312	8.069	745.111	467312.866	3.184	0.133	6.786	0.067	0.956	2.319	0.020	16.471	6.329	79.182	29.104	119.208	33.512	379.512	34.883	7250.629	1.698	79.656	224.104
09LP090 L 215	417.616	6.276	2100.245	460842.005	23.636	0.279	9.873	0.595	9.607	15.516	0.583	70.496	22.506	260.456	86.664	328.333	76.324	786.139	70.531	5741.171	7.494	120.452	207.891
09LP090 L 173	169.133	10.896	504.452	679587.664	4.404	0.033	10.050	0.018	0.548	2.117	0.321	12.212	4.103	51.709	19.017	80.210	19.315	194.956	28.207	11651.824	2.633	25.876	51.831
09LP090 L 208	280.235	7.331	825.699	469750.963	15.904	0.325	14.183	0.202	1.809	3.810	0.504	18.693	7.085	89.010	31.849	134.210	35.416	415.008	39.456	7406.105	6.535	105.724	221.668
09LP090 L 179	348.179	3.375	1439.586	575101.347	17.501	0.050	24.571	0.036	2.172	5.543	0.185	30.129	11.255	149.033	53.804	229.156	61.563	657.869	75.304	9753.223	8.050	294.322	538.696
09LP090 L 159	1046.058	7.357	2167.379	513347.872	1.055	0.014	1.216	0.029	1.220	4.770	0.151	33.833	15.450	212.391	84.090	358.497	92.828	992.199	98.830	9978.868	1.063	92.755	655.676
09LP090 L 119	216.212	2.902	1185.949	573162.737	41.933		11.328		0.454	3.381	0.258	21.691	9.302	128.932	46.203	188.993	46.440	479.583	48.262	10543.353	15.851	41.862	123.035
09LP090 L 207	265.672	11.518	771.990	472467.105	3.364	0.106	10.632	0.159	2.407	4.392	0.731	20.927	7.106	87.055	30.660	118.235	31.520	341.783	31.679	7149.529	1.139	71.209	152.623
09LP090 L 200	86.563	2.010	669.413	471184.642	2.792		10.636		1.056	3.137	0.205	15.544	6.525	74.710	26.219	105.524	26.448	288.300	25.366	7192.439	1.508	29.499	85.426
09LP090 L 193	185.808	8.359	549.243	464268.809	2.866	3.068	11.556	0.842	5.056	4.236	0.065	15.079	4.876	59.586	21.348	86.998	22.176	263.547	24.236	6938.075	1.723	47.461	186.815
09LP090 L 126	277.327	22.394	1049.876	528949.822	2.166	0.126	7.782	0.159	2.904	6.841	0.569	29.233	9.986	124.853	40.744	158.942	38.796	413.544	42.712	7803.458	1.051	59.040	120.172
09LP090 L 162	230.789	23.473	896.931	537870.908	2.737	0.065	17.204	0.092	3.880	6.943	1.144	33.999	10.311	114.004	35.554	129.911	29.976	309.136	32.360	7731.606	1.017	29.923	45.141
09LP090 L 183	102.034	5.807	1746.965	521689.601	6.089		9.379	0.300	6.850	13.412	0.174	58.157	20.173	221.033	71.764	265.580	58.705	556.487	51.905	7112.968	2.656	67.524	150.076
09LP090 L 172	234.601	6.389	477.309	666866.815	0.315	0.016	1.995	0.015	0.387	1.947	0.258	18.824	6.182	59.261	16.756	58.017	13.394	115.257	15.782	16362.101	0.624	45.882	299.806
09LP090 L 189	187.378	34.923	475.166	458759.219	0.884		9.308	0.111	1.208	2.635	0.711	12.546	4.306	47.393	17.114	75.043	19.926	241.535	23.751	5449.357	0.470	40.702	67.838
09LP090 L 177	353.208	10.757	2522.543	587180.573	152.832	0.070	17.935	0.115	1.731	4.650	0.659	31.209	15.472	216.212	89.325	414.065	116.387	1231.418	147.630	14663.005	59.623	437.489	1138.639
09LP090 L 125	147.125	6.594	930.796	530270.086	8.246		13.302	0.095	2.073	5.475	0.089	25.319	9.726	107.983	35.798	141.073	34.875	355.494	35.825	7736.125	3.067	55.700	156.406
09LP090 L 220	161.339	8.984	533.121	502328.679	3.191		10.148	0.110	2.362	4.948	0.284	20.872	5.297	59.907	19.935	75.272	18.582	193.752	19.636	7422.961	1.650	211.602	438.141
09LP090 L 209	207.199	17.773	364.693	481875.830	2.991	0.037	6.091	0.022	0.494	1.279	0.125	8.668	2.913	36.713	13.804	58.316	16.112	190.368	19.471	6286.796	1.334	18.400	35.692
09LP090 L 120	251.018	36.637	687.226	572913.699	2.996	0.004	65.230	0.490	8.177	10.472	2.036	34.590	8.957	88.629	27.176	96.709	23.504	235.866	25.893	7451.155	1.125	135.550	73.813
09LP090 L 174	329.525	19.930	2284.079	665067.107	2.580		19.458	0.519	9.054	12.107	2.829	53.550	18.514	222.719	82.888	349.084	84.708	818.272	113.865	10425.193	2.202	241.772	309.628
09LP090 L 213	281.019	8.164	823.646	470265.652	16.948		16.414	0.083	1.082	3.325	0.099	17.384	6.857	87.663	32.881	137.385	38.336	423.221	40.407	7666.345	7.187	110.876	170.254

Table B8b, *continued.* Detrital zircon trace element analyses from sample **09LP090** in Mattson Formation (MM) - Isotope Geology Laboratory, Boise State University

Analysis	Concentrations (ppm)																						
	P	Ti	Y	Zr	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	Th	U
09LP090 L 127	~~195.639~~	~~20.152~~	~~610.418~~	~~499648.906~~	~~6.990~~		~~51.392~~	~~0.161~~	~~1.536~~	~~3.905~~	~~0.521~~	~~13.686~~	~~5.295~~	~~62.526~~	~~22.912~~	~~94.778~~	~~27.611~~	~~305.478~~	~~33.435~~	~~8349.793~~	~~3.758~~	~~132.652~~	~~210.829~~
09LP090 L 151	376.028	26.406	1275.043	486514.853	1.305		4.514	0.157	3.781	8.658	0.432	41.071	13.663	152.583	47.772	183.586	44.627	459.335	43.819	6995.448	0.625	40.921	42.551
09LP090 L 175	~~670.592~~	~~6.511~~	~~1841.566~~	~~637863.652~~	~~0.768~~		~~0.946~~	~~0.029~~	~~0.942~~	~~2.358~~	~~0.016~~	~~20.039~~	~~10.847~~	~~160.546~~	~~65.484~~	~~301.359~~	~~75.994~~	~~784.462~~	~~97.478~~	~~12095.783~~	~~0.654~~	~~37.281~~	~~310.052~~
09LP090 L 203	68.800	0.574	112.126	480282.265	4.880	0.232	3.141	0.045	0.169	0.398	0.003	1.987	0.901	16.808	7.161	33.578	9.656	132.204	13.298	9194.006	4.048	4.792	200.389
09LP090 L 218	198.493	9.409	384.145	484917.948	4.749	0.035	32.018	0.053	0.873	1.533	0.380	9.130	2.900	37.406	13.593	59.731	17.726	207.968	21.917	7806.998	3.010	37.664	103.670
09LP090 L 139	183.809	6.259	357.371	470577.236	3.351		9.986	0.053	0.478	1.339	0.055	7.017	2.234	31.767	13.143	57.959	17.056	211.717	21.675	6971.615	1.998	30.457	107.973
09LP090 L 210	205.938	15.390	426.221	476593.051	3.070		28.526	0.009	0.783	1.846	0.422	10.561	3.675	47.021	16.401	68.213	20.622	257.525	25.899	7275.279	1.888	119.724	202.322
09LP090 L 167	252.694	16.902	597.430	598693.499	3.281	0.039	14.011	0.049	1.380	2.890	0.271	15.636	5.481	67.293	23.190	95.281	24.381	238.790	27.882	10032.079	1.356	58.764	62.105
09LP090 L 118	208.804	5.707	1149.029	559561.551	17.419	0.127	14.963	0.056	1.836	5.467	0.318	30.182	10.789	125.318	45.480	182.578	44.961	452.096	48.159	10800.591	7.287	140.839	364.568
09LP090 L 194	428.684	8.674	1158.848	460746.093	2.878		9.407	0.095	1.871	4.335	0.100	28.597	10.473	129.163	46.019	179.303	45.571	486.059	42.924	8249.393	1.795	165.191	284.296
09LP090 L 182	77.964	4.426	408.894	533036.331	6.603	0.325	38.069	0.037	0.666	0.929	0.201	4.914	2.020	26.736	11.521	64.813	21.957	326.540	44.669	9865.051	2.063	112.678	117.205
09LP090 L 134	134.209	9.307	453.517	484405.114	1.749	0.008	7.880	0.000	0.496	1.556	0.116	9.397	3.457	46.012	16.567	69.307	20.266	220.395	22.805	7985.909	1.062	40.040	140.538
09LP090 L 171	277.664	4.751	1136.368	661337.071	4.315	0.014	10.820		0.858	2.604	0.048	20.751	8.660	106.772	41.223	177.675	42.382	405.755	54.497	13691.798	3.188	151.947	290.878
09LP090 L 186	54.039	2.178	174.211	507661.011	0.147		0.136				0.130	1.035	0.766	12.305	5.514	30.314	10.174	150.106	20.729	7167.442	0.009	1.420	152.858
09LP090 L 152	104.815	2.325	273.266	459278.457	1.292		0.769		0.133	0.958	0.109	4.672	1.717	26.592	9.817	42.372	11.731	134.863	12.764	8239.922	1.334	12.969	143.777
09LP090 L 161	339.770	7.421	555.248	532673.691	4.184	0.056	7.176	0.080	1.257	2.858	0.489	11.367	3.745	54.097	21.330	94.999	30.802	401.225	46.062	9180.418	2.178	37.457	171.006
09LP090 L 158	100.184	11.013	185.018	512747.242	0.150	0.046	4.638	0.040	0.270	0.672	0.239	3.422	1.527	19.440	6.745	28.959	8.104	98.131	10.782	6816.566	0.179	12.489	32.452
09LP090 L 196	206.258	16.796	892.552	458192.682	0.652	0.104	5.072	0.254	4.502	5.341	1.705	22.753	8.086	93.565	32.632	133.655	37.556	426.727	43.080	4987.787	0.731	170.391	191.196
09LP090 L 124	512.282	16.532	2760.061	539355.602	2.465	0.010	29.315	0.718	10.944	20.094	9.164	90.376	28.329	313.117	104.333	421.316	108.488	1172.904	131.061	6642.730	0.890	879.868	649.564
09LP090 L 122	792.533	5.157	1899.751	557197.217	2.318	0.026	2.661	0.097	2.067	6.226	0.189	37.881	15.448	196.062	70.984	299.376	75.314	803.514	84.556	10027.353	2.220	76.669	360.745
09LP090 L 128	160.839	17.804	1047.819	515442.476	0.611	0.014	8.873	0.410	6.348	9.705	0.947	36.731	10.858	115.815	39.422	161.935	42.382	423.473	43.250	7064.838	0.468	175.326	279.427

Notes:

Yellow highlighted rows are samples that intersected inclusions.
Trace element concentrations in ppm, calculated using mean count rate method.
Backgrounds were monitored during sweeps 10 to 27. Sample counts were integrated from sweeps 36 to 69.
Ablation used a laser spot size of 25 microns, and a laser firing repitition rate of 10 Hz.

Table B8c. Detrital zircon calculated ratios and values from sample **09LP090** in Mattson Formation (MM) - Isotope Geology Laboratory, Boise State University

Analysis	CI chondrite normalizing values from Sun and McDonough (1989)													
	0.237	0.612	0.095	0.467	0.153	0.058	0.206	0.037	0.254	0.057	0.166	0.026	0.170	0.025
	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
09LP090 L 115	~~0.266~~	~~94.641~~	~~5.500~~	~~19.235~~	~~97.440~~	~~43.034~~	~~258.372~~	~~449.136~~	~~661.699~~	~~1030.435~~	~~1391.521~~	~~2258.699~~	~~3220.699~~	~~2786.451~~
09LP090 L 132		9.273	0.490	2.193	14.267	10.401	57.633	110.259	222.777	378.535	557.086	1011.638	1802.811	1268.635
09LP090 L 129		3.212	0.244	1.091	8.179	7.570	28.991	56.181	112.206	183.871	327.148	618.572	1295.596	1114.005
09LP090 L 195	0.112	5.437	0.390	3.330	27.917	16.326	117.508	236.242	444.058	722.070	1048.180	1835.047	3124.742	2009.049
09LP090 L 216	0.209	1.812	0.248	0.568	1.873	1.731	6.952	18.577	38.259	66.481	104.150	234.169	511.769	438.078
09LP090 L 156	~~5.358~~	~~55.822~~	~~3.044~~	~~4.479~~	~~13.483~~	~~12.347~~	~~55.686~~	~~86.680~~	~~153.413~~	~~217.990~~	~~313.006~~	~~542.644~~	~~942.761~~	~~621.362~~
09LP090 L 184	0.274	21.238	1.002	2.606	14.771	14.155	56.091	92.319	157.112	255.443	336.105	582.715	1006.014	714.155
09LP090 L 176	0.003	10.210	0.104	1.972	10.363	8.258	66.138	122.450	216.537	358.778	508.752	839.231	1280.082	1092.286
09LP090 L 170		10.848		0.380	3.715	1.341	20.644	41.700	87.512	143.477	222.790	367.760	630.839	633.654
09LP090 L 153	0.320	63.708	0.681	3.242	20.681	17.117	70.994	158.801	257.805	393.037	544.462	997.355	1789.045	1160.012
09LP090 L 148	0.022	18.873	0.861	3.990	34.037	5.028	106.483	214.857	371.986	572.403	773.955	1286.302	2100.847	1443.497
09LP090 L 166	0.012	24.481	0.492	1.338	19.707	9.960	52.175	93.606	164.840	267.099	354.654	610.160	1013.206	815.773
09LP090 L 133	~~14.840~~	~~23.971~~	~~10.958~~	~~13.228~~	~~29.057~~	~~11.394~~	~~73.208~~	~~126.774~~	~~234.176~~	~~348.853~~	~~478.767~~	~~853.327~~	~~1384.897~~	~~951.615~~
09LP090 L 145	~~0.849~~	~~25.214~~	~~0.358~~	~~2.121~~	~~13.443~~	~~9.021~~	~~43.193~~	~~98.286~~	~~160.586~~	~~250.907~~	~~352.680~~	~~640.339~~	~~1125.193~~	~~779.996~~
09LP090 L 147	~~0.754~~	~~92.289~~	~~4.011~~	~~10.389~~	~~57.131~~	~~47.418~~	~~195.270~~	~~330.483~~	~~567.229~~	~~978.319~~	~~1465.624~~	~~2815.890~~	~~4972.923~~	~~3761.132~~
09LP090 L 130	37.073	43.284	22.435	23.253	35.353	16.878	70.688	137.243	222.907	340.772	537.407	939.649	1711.195	1239.297
09LP090 L 178	~~1.481~~	~~25.125~~	~~8.101~~	~~13.651~~	~~83.781~~	~~54.437~~	~~200.375~~	~~219.458~~	~~350.363~~	~~560.387~~	~~786.727~~	~~1503.054~~	~~2538.518~~	~~2216.924~~
09LP090 L 192		2.554	0.130	0.584	3.229	0.794	9.373	26.825	54.962	109.854	169.911	379.935	786.957	648.632
09LP090 L 131	0.253	1.537	0.039	0.174	2.746	5.088	14.497	34.885	67.770	109.204	171.315	314.683	621.766	518.264
09LP090 L 140	0.011	1.502	0.437	2.034	23.679	1.275	125.016	237.137	482.893	792.680	1152.225	1995.562	3359.533	2097.136
09LP090 L 146	0.084	30.338	0.704	4.279	35.424	4.619	102.026	193.082	306.958	459.617	604.899	993.095	1603.982	1067.976
09LP090 L 155	0.134	60.129	2.275	7.434	44.057	29.388	111.557	154.307	226.864	303.123	363.331	637.710	1013.434	647.474
09LP090 L 188	0.088	11.955	0.131	0.588	3.064	2.579	20.141	44.380	75.635	141.810	242.000	460.256	900.333	750.638
09LP090 L 144		13.410	0.245	1.098	4.553	3.311	17.858	39.383	79.782	118.206	182.236	330.468	618.732	460.355
09LP090 L 201	0.001	17.914	0.040	1.614	18.107	18.441	64.903	124.625	216.524	346.705	485.861	886.264	1625.193	1147.747
09LP090 L 111	0.024	16.111	0.636	2.365	23.976	6.122	90.302	158.085	292.313	486.237	718.303	1149.207	1712.283	1690.384
09LP090 L 123	0.339	14.036	0.782	3.736	32.070	0.299	118.508	250.550	459.651	673.259	1027.575	1707.365	2788.350	2011.007
09LP090 L 185	0.009	27.268	0.369	1.576	15.870	6.176	49.855	99.296	181.650	318.516	468.352	876.708	1603.438	1175.424
09LP090 L 114	0.044	8.734	1.237	6.802	28.062	6.547	120.352	178.365	311.979	496.446	707.415	1103.983	1639.901	1402.241
09LP090 L 165	0.034	41.000	0.177	2.278	17.658	7.521	68.929	124.735	236.649	393.330	560.551	1035.683	1782.369	1502.773
09LP090 L 211	0.002	20.899	0.063	1.557	10.377	1.013	45.015	97.895	184.622	302.645	456.576	807.868	1480.125	969.287
09LP090 L 143	0.009	13.121	0.362	2.390	15.358	6.429	52.920	110.693	195.524	301.272	443.649	770.124	1441.976	961.447
09LP090 L 181	0.048	8.615	1.932	8.056	33.497	13.622	97.408	155.771	272.248	369.283	477.717	766.769	1233.265	838.933
09LP090 L 137	2.328	45.055	2.338	3.448	12.341	3.502	46.683	94.261	188.420	321.056	506.991	1018.432	1958.619	1432.252
09LP090 L 212	0.018	3.546	0.728	1.034	5.611		15.436	27.431	56.756	104.614	144.803	248.006	470.308	321.472
09LP090 L 202	0.183	5.533	0.144	0.644	8.322	1.986	39.459	63.510	112.974	174.845	260.052	439.180	780.652	530.077
09LP090 L 112	0.007	5.066	0.273	1.414	12.027	3.859	58.320	115.236	209.899	360.518	548.688	887.103	1309.353	1342.107
09LP090 L 198	0.042	58.966	1.586	8.346	34.092	15.005	97.580	170.597	278.937	409.970	584.970	1005.119	1743.443	1134.687
09LP090 L 219	0.015	57.022	0.602	2.530	50.252	4.299	246.924	789.111	1909.803	3435.764	5971.894	12543.846	23770.969	16840.743
09LP090 L 190	0.017	18.682	0.659	0.737	13.947	1.974	75.793	157.638	319.976	540.396	774.816	1407.400	2419.172	1580.010
09LP090 L 116	0.137	38.479	1.369	5.453	30.431	14.190	110.801	197.526	357.384	572.878	869.824	1487.609	2458.105	2105.029
09LP090 L 149	0.004	9.176	0.177	0.997	10.155	0.948	36.136	84.680	146.600	257.145	375.503	648.521	1123.272	752.064

Ti-in-zircon T (°C)
~~814~~
760
697
707
775
~~857~~
797
687
708
765
742
777
~~834~~
~~952~~
~~840~~
808
~~801~~
677
692
820
726
739
700
664
669
858
759
797
890
797
776
818
858
739
828
849
729
862
728
691
815
803

Ce/Ce*	Eu/Eu*	(Sm/Nd) cn	(Lu/Nd) cn	Lu/Hf	Nb/Ta	Nb/U	Th/U	Th/Y	Y/Hf
~~32.83~~	~~0.24~~	~~5.07~~	~~144.86~~	~~0.01~~	~~2.21~~	~~0.02~~	~~2.01~~	~~0.14~~	~~0.17~~
	0.29	6.51	578.50	0.01	0.90	0.01	0.43	0.08	0.09
	0.41	7.50	1021.01	0.00	0.43	0.00	0.03	0.07	0.04
21.62	0.22	8.38	603.34	0.01	1.69	0.03	0.50	0.02	0.20
7.94	0.39	3.30	771.13	0.00	0.30	0.00	0.02	0.15	0.01
~~13.29~~	~~0.36~~	~~3.01~~	~~138.72~~	~~0.00~~	~~2.73~~	~~0.05~~	~~1.09~~	~~0.10~~	~~0.06~~
33.27	0.40	5.67	274.07	0.00	2.02	0.02	1.04	0.14	0.05
192.45	0.22	5.25	553.76	0.00	1.51	0.01	0.53	0.28	0.05
	0.11	9.77	1665.84	0.00	1.32	0.01	0.33	0.21	0.02
127.25	0.37	6.38	357.86	0.00	1.62	0.02	0.59	0.18	0.08
42.77	0.07	8.53	361.81	0.00	1.07	0.00	0.29	0.19	0.11
97.05	0.28	14.73	609.58	0.00	1.33	0.01	0.92	0.08	0.05
~~1.86~~	~~0.22~~	~~2.20~~	~~71.94~~	~~0.00~~	~~2.81~~	~~0.05~~	~~0.68~~	~~0.04~~	~~0.08~~
~~41.79~~	~~0.32~~	~~6.34~~	~~367.79~~	~~0.00~~	~~2.01~~	~~0.03~~	~~0.65~~	~~0.10~~	~~0.05~~
~~38.74~~	~~0.38~~	~~5.50~~	~~362.04~~	~~0.02~~	~~3.38~~	~~0.02~~	~~0.40~~	~~0.16~~	~~0.25~~
1.45	0.32	1.52	53.30	0.00	2.24	0.00	0.37	0.20	0.08
~~5.24~~	~~0.38~~	~~6.14~~	~~162.40~~	~~0.01~~	~~1.85~~	~~0.01~~	~~0.25~~	~~0.23~~	~~0.08~~
	0.13	5.53	1111.22	0.00	0.82	0.00	0.12	0.15	0.02
10.54	0.59	15.79	2979.83	0.00	0.92	0.00	0.34	0.84	0.05
6.70	0.02	11.64	1031.12	0.01	1.02	0.00	0.23	0.03	0.15
77.02	0.07	8.28	249.57	0.00	1.86	0.03	0.60	0.11	0.08
49.92	0.38	5.93	87.09	0.00	2.98	0.05	1.92	0.20	0.07
108.76	0.22	5.21	1276.94	0.00	1.41	0.00	0.25	0.17	0.04
	0.30	4.14	419.08	0.00	1.25	0.01	0.57	0.32	0.03
868.01	0.44	11.22	710.92	0.00	1.22	0.00	0.33	0.26	0.07
48.85	0.11	10.14	714.80	0.00	2.26	0.01	0.56	0.08	0.08
25.03	0.00	8.58	538.32	0.01	1.24	0.00	0.35	0.14	0.11
144.26	0.19	10.07	745.96	0.00	1.98	0.01	0.34	0.17	0.06
13.64	0.09	4.13	206.15	0.00	2.38	0.01	0.41	0.07	0.09
387.80	0.17	7.75	659.69	0.00	1.80	0.01	0.46	0.19	0.06
647.42	0.04	6.66	622.47	0.00	1.66	0.01	0.22	0.20	0.06
70.70	0.19	6.43	402.36	0.00	1.82	0.01	0.35	0.10	0.07
8.70	0.21	4.16	104.14	0.00	2.44	0.05	0.65	0.04	0.08
19.31	0.12	3.58	415.36	0.01	2.24	0.01	0.29	0.26	0.07
9.51	#VALUE	5.43	310.95	0.00	1.99	0.01	0.17	0.04	0.03
33.81	0.08	12.93	823.67	0.00	2.43	0.02	0.38	0.05	0.05
36.15	0.11	8.51	949.10	0.00	1.47	0.00	0.27	0.08	0.05
72.46	0.23	4.08	135.95	0.01	3.15	0.04	0.86	0.07	0.11
184.76	0.03	19.87	6657.61	0.04	1.77	0.07	0.11	0.02	0.47
55.28	0.04	18.93	2144.45	0.01	2.36	0.07	0.24	0.07	0.10
51.10	0.20	5.58	386.06	0.01	1.69	0.02	1.15	0.09	0.11
101.36	0.04	10.19	754.56	0.00	2.05	0.02	0.22	0.09	0.06

Table B8c, *continued*. Detrital zircon calculated ratios and values from sample **09LP090** in Mattson Formation (MM) - Isotope Geology Laboratory, Boise State University

Analysis	CI chondrite normalizing values from Sun and McDonough (1989)													
	0.237	0.612	0.095	0.467	0.153	0.058	0.206	0.037	0.254	0.057	0.166	0.026	0.170	0.025
	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
09LP090 L 206	0.042	19.589	0.050	1.772	14.714	6.868	50.033	108.070	178.742	287.437	423.874	795.701	1394.947	985.212
09LP090 L 204	0.004	21.666	0.176	1.562	14.928	4.398	66.853	152.596	337.267	610.490	1011.523	1873.857	3511.351	2413.804
09LP090 L 168	0.005	5.614	0.206	1.270	13.109	1.559	54.510	96.778	182.687	276.686	438.757	716.344	1131.605	954.818
09LP090 L 180	0.840	38.812	0.386	3.112	16.026	14.048	85.313	160.170	300.437	513.862	804.424	1410.831	2303.411	1845.328
09LP090 L 154	0.131	70.386	0.056	1.377	14.217	14.194	44.642	112.460	212.423	373.199	579.845	1129.593	2145.188	1541.248
09LP090 L 113	0.035	7.343	0.151	0.675	14.593	4.799	93.054	252.446	584.149	1225.894	2275.869	4742.146	8439.330	8581.257
09LP090 L 205	~~167.060~~	~~174.820~~	~~121.365~~	~~103.950~~	~~71.750~~	~~6.413~~	~~76.568~~	~~118.683~~	~~205.199~~	~~315.048~~	~~475.592~~	~~883.578~~	~~1606.574~~	~~1102.659~~
09LP090 L 141	0.010	11.266	0.387	2.238	23.659	4.533	79.615	163.261	289.758	479.831	668.006	1104.338	1834.664	1181.396
09LP090 L 191	~~1.724~~	~~5.396~~	~~0.820~~	~~3.036~~	~~20.646~~	~~2.973~~	~~65.056~~	~~121.798~~	~~216.979~~	~~318.382~~	~~425.934~~	~~690.755~~	~~1093.132~~	~~725.328~~
09LP090 L 150	0.022	8.727	0.858	5.037	28.825	12.750	118.531	230.627	424.223	717.576	1053.873	1808.743	3196.997	2157.705
09LP090 L 135	0.017	8.251	0.695	2.728	18.609	2.489	62.525	136.283	262.276	416.836	593.184	1044.463	1748.803	1090.658
09LP090 L 117		8.715	0.237	1.061	6.650	9.142	35.362	59.727	116.194	217.944	358.442	734.883	1424.106	1341.926
09LP090 L 217	0.058	7.303	2.307	9.755	45.433	49.029	160.950	280.835	481.586	756.263	1017.515	1700.369	2835.375	1834.991
09LP090 L 164	~~5582.635~~	~~4933.118~~	~~4638.446~~	~~5055.600~~	~~3758.023~~	~~238.845~~	~~2690.029~~	~~2330.485~~	~~2247.683~~	~~2319.514~~	~~2394.347~~	~~3093.346~~	~~4000.781~~	~~2632.322~~
09LP090 L 187	0.021	22.840	0.840	0.963	13.588	3.183	78.779	149.284	310.843	516.123	739.417	1306.422	2287.182	1562.976
09LP090 L 214		17.428	0.445	1.989	14.852	13.225	64.573	114.886	235.046	377.835	565.447	1021.382	1846.910	1276.994
09LP090 L 163	0.042	18.102	0.334	1.497	11.112	1.123	67.772	161.346	349.507	619.829	1009.924	1827.372	3096.764	2125.690
09LP090 L 199	0.000	7.454	0.004	1.120	12.592	2.009	42.967	90.359	146.494	236.463	343.674	623.520	1002.256	693.687
09LP090 L 138	0.049	1.259	0.150	0.672	11.483	0.943	61.683	180.040	332.993	499.606	669.817	1117.901	1888.104	1274.319
09LP090 L 121	0.127	17.922	0.650	2.770	24.937	3.462	92.227	174.641	316.867	509.400	761.030	1313.004	2127.403	1538.145
09LP090 L 197	0.403	20.795	0.309	2.628	16.145	8.975	40.583	65.199	97.230	131.310	187.804	333.987	596.608	413.387
09LP090 L 157	0.140	4.453	0.764	2.686	15.518	4.574	66.157	140.206	235.793	363.619	467.085	794.036	1301.262	868.787
09LP090 L 142	0.562	11.088	0.702	2.047	15.159	0.337	80.149	169.232	311.741	514.199	720.290	1314.191	2232.422	1373.327
09LP090 L 215	1.176	16.133	6.267	20.572	101.409	10.043	343.048	601.772	1025.419	1531.174	1983.884	2993.109	4624.346	2776.822
09LP090 L 173	0.141	16.421	0.191	1.174	13.837	5.536	59.425	109.696	203.580	335.995	484.652	757.438	1146.801	1110.511
09LP090 L 208	1.370	23.175	2.127	3.874	24.901	8.686	90.962	189.438	350.433	562.699	810.935	1388.852	2441.225	1553.370
09LP090 L 179	0.209	40.148	0.379	4.651	36.232	3.191	146.614	300.924	586.745	950.605	1384.627	2414.247	3869.819	2964.706
09LP090 L 159	0.059	1.987	0.307	2.613	31.173	2.607	164.635	413.094	836.187	1485.691	2166.147	3640.325	5836.463	3890.951
09LP090 L 119		18.509	0.217	0.973	22.097	4.454	105.554	248.725	507.606	816.311	1141.949	1821.162	2821.078	1900.088
09LP090 L 207	0.448	17.372	1.670	5.155	28.705	12.611	101.835	189.992	342.735	541.700	714.411	1236.062	2010.487	1247.187
09LP090 L 200		17.378	0.505	2.261	20.503	3.543	75.641	174.468	294.135	463.235	637.606	1037.181	1695.884	998.673
09LP090 L 193	12.945	18.883	8.861	10.826	27.686	1.120	73.375	130.364	234.590	377.166	525.670	869.655	1550.276	954.155
09LP090 L 126	0.530	12.716	1.675	6.219	44.710	9.802	142.252	267.012	491.547	719.867	960.374	1521.416	2432.612	1681.571
09LP090 L 162	0.276	28.110	0.969	8.308	45.377	19.723	165.444	275.683	448.836	628.168	784.959	1175.544	1818.446	1274.005
09LP090 L 183	0.079	15.325	3.159	14.668	87.663	2.994	283.003	539.380	870.210	1267.909	1604.714	2302.138	3273.455	2043.491
09LP090 L 172	0.066	3.259	0.155	0.830	12.724	4.446	91.601	165.285	233.312	296.045	350.553	525.268	677.983	621.320
09LP090 L 189	0.029	15.209	1.171	2.586	17.223	12.256	61.050	115.137	186.587	302.366	453.430	781.403	1420.792	935.095
09LP090 L 177	0.297	29.305	1.209	3.707	30.395	11.356	151.870	413.681	851.227	1578.185	2501.904	4564.180	7243.638	5812.220
09LP090 L 125	0.025	21.736	0.995	4.438	35.786	1.529	123.209	260.057	425.129	632.472	852.404	1367.631	2091.138	1410.426
09LP090 L 220	0.029	16.582	1.154	5.057	32.339	4.897	101.567	141.634	235.852	352.213	454.814	728.694	1139.715	773.074
09LP090 L 209	0.155	9.952	0.233	1.057	8.361	2.147	42.182	77.891	144.539	243.893	352.365	631.844	1119.809	766.557
09LP090 L 120	0.017	106.584	5.161	17.510	68.445	35.106	168.322	239.487	348.934	480.134	584.347	921.726	1387.448	1019.427

Ti-in-zircon T (°C)	Ce/Ce*	Eu/Eu*	(Sm/Nd) cn	(Lu/Nd) cn	Lu/Hf	Nb/Ta	Nb/U	Th/U	Th/Y	Y/Hf
797	422.69	0.21	8.30	555.84	0.00	1.94	0.00	0.34	0.24	0.06
770	240.09	0.11	9.56	1545.27	0.01	1.57	0.02	0.35	0.06	0.11
858	53.18	0.05	10.32	751.73	0.00	1.88	0.03	0.40	0.06	0.05
809	63.30	0.28	5.15	592.96	0.01	1.80	0.02	0.70	0.10	0.09
778	753.82	0.48	10.32	1118.95	0.01	2.62	0.14	0.57	0.02	0.09
796	79.12	0.09	21.63	12720.88	0.02	1.15	0.01	0.10	0.01	0.14
~~787~~	~~1.21~~	~~0.09~~	~~0.69~~	~~10.61~~	~~0.00~~	~~1.40~~	~~0.01~~	~~0.41~~	~~0.30~~	~~0.06~~
799	56.78	0.09	10.57	527.90	0.00	1.96	0.02	0.36	0.08	0.10
~~887~~	~~4.24~~	~~0.07~~	~~6.80~~	~~238.89~~	~~0.00~~	~~2.56~~	~~0.06~~	~~1.08~~	~~0.05~~	~~0.08~~
758	19.84	0.17	5.72	428.35	0.01	2.85	0.01	0.39	0.09	0.20
860	23.17	0.06	6.82	399.78	0.00	2.32	0.01	0.25	0.07	0.08
738		0.44	6.27	1264.94	0.00	0.55	0.00	0.44	0.13	0.05
871	6.18	0.48	4.66	188.12	0.01	1.44	0.01	0.56	0.04	0.20
~~813~~	~~0.97~~	~~0.07~~	~~0.74~~	~~0.52~~	~~0.01~~	~~2.93~~	~~0.12~~	~~1.08~~	~~0.05~~	~~0.42~~
723	53.04	0.07	14.10	1622.46	0.00	1.74	0.02	0.39	0.11	0.09
818		0.33	7.47	641.93	0.01	1.24	0.01	0.45	0.05	0.09
736	96.06	0.03	7.42	1420.20	0.00	1.72	0.02	0.22	0.16	0.09
832	3443.79	0.07	11.24	619.45	0.00	2.75	0.05	0.48	0.07	0.06
699	12.65	0.03	17.10	1897.12	0.00	1.27	0.00	0.04	0.04	0.10
702	46.11	0.06	9.00	555.32	0.00	2.11	0.07	0.71	0.09	0.09
797	58.38	0.32	6.14	157.29	0.00	2.85	0.06	0.76	0.06	0.03
877	9.85	0.11	5.78	323.45	0.00	2.30	0.06	0.35	0.03	0.08
774	17.54	0.01	7.41	670.95	0.00	1.88	0.01	0.36	0.11	0.10
750	4.34	0.05	4.93	134.98	0.01	3.15	0.11	0.58	0.06	0.37
805	99.04	0.15	11.79	946.24	0.00	1.67	0.08	0.50	0.05	0.04
765	13.25	0.15	6.43	401.01	0.01	2.43	0.07	0.48	0.13	0.11
695	136.57	0.03	7.79	637.38	0.01	2.17	0.03	0.55	0.20	0.15
765	10.86	0.03	11.93	1489.33	0.01	0.99	0.00	0.14	0.04	0.22
682		0.07	22.72	1953.80	0.00	2.65	0.34	0.34	0.04	0.11
811	16.41	0.19	5.57	241.95	0.00	2.95	0.02	0.47	0.09	0.11
653		0.07	9.07	441.62	0.00	1.85	0.03	0.35	0.04	0.09
778	1.73	0.02	2.56	88.14	0.00	1.66	0.02	0.25	0.09	0.08
887	11.53	0.10	7.19	270.39	0.01	2.06	0.02	0.49	0.06	0.13
892	45.18	0.19	5.46	153.35	0.00	2.69	0.06	0.66	0.03	0.12
743	9.47	0.02	5.98	139.31	0.01	2.29	0.04	0.45	0.04	0.25
752	29.58	0.09	15.34	748.89	0.00	0.50	0.00	0.15	0.10	0.03
943	25.34	0.31	6.66	361.59	0.00	1.88	0.01	0.60	0.09	0.09
804	38.90	0.12	8.20	1568.10	0.01	2.56	0.13	0.38	0.17	0.17
755	42.62	0.02	8.06	317.78	0.00	2.69	0.05	0.36	0.06	0.12
785	28.03	0.07	6.39	152.86	0.00	1.93	0.01	0.48	0.40	0.07
859	51.37	0.08	7.91	725.25	0.00	2.24	0.08	0.52	0.05	0.06
950	41.17	0.30	3.91	58.22	0.00	2.66	0.04	1.84	0.20	0.09

Table B8c, *continued*. Detrital zircon calculated ratios and values from sample **09LP090** in Mattson Formation (MM) - Isotope Geology Laboratory, Boise State University

Analysis	CI chondrite normalizing values from Sun and McDonough (1989)													
	0.237	0.612	0.095	0.467	0.153	0.058	0.206	0.037	0.254	0.057	0.166	0.026	0.170	0.025
	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
09LP090 L 174	0.137	31.795	5.465	19.388	79.133	48.774	260.586	495.024	876.848	1464.452	2109.270	3321.875	4813.367	4482.874
09LP090 L 213	0.022	26.821	0.877	2.317	21.735	1.710	84.591	183.331	345.130	580.938	830.122	1503.360	2489.536	1590.819
09LP090 L 127	~~0.043~~	~~83.974~~	~~1.697~~	~~3.289~~	~~25.525~~	~~8.986~~	~~66.598~~	~~141.571~~	~~246.165~~	~~404.803~~	~~572.677~~	~~1082.771~~	~~1796.930~~	~~1316.323~~
09LP090 L 151	0.041	7.376	1.648	8.097	56.586	7.443	199.857	365.313	600.720	844.022	1109.280	1750.060	2701.968	1725.157
09LP090 L 175	~~0.008~~	~~1.546~~	~~0.310~~	~~2.018~~	~~15.409~~	~~0.283~~	~~97.513~~	~~290.023~~	~~632.072~~	~~1156.960~~	~~1820.897~~	~~2980.157~~	~~4614.484~~	~~3837.726~~
09LP090 L 203	0.981	5.133	0.474	0.363	2.599	0.046	9.671	24.086	66.173	126.512	202.890	378.683	777.669	523.533
09LP090 L 218	0.147	52.317	0.558	1.870	10.019	6.551	44.429	77.552	147.266	240.157	360.911	695.137	1223.341	862.862
09LP090 L 139	0.014	16.316	0.562	1.024	8.754	0.941	34.144	59.743	125.067	232.203	350.203	668.853	1245.392	853.330
09LP090 L 210	0.002	46.612	0.090	1.677	12.067	7.278	51.392	98.270	185.123	289.772	412.164	808.689	1514.854	1019.630
09LP090 L 167	0.165	22.894	0.520	2.955	18.887	4.678	76.089	146.550	264.932	409.721	575.714	956.134	1404.648	1097.709
09LP090 L 118	0.538	24.450	0.586	3.932	35.735	5.481	146.872	288.475	493.377	803.542	1103.190	1763.187	2659.390	1896.037
09LP090 L 194	0.025	15.371	1.005	4.006	28.335	1.725	139.158	280.024	508.518	813.048	1083.400	1787.083	2859.172	1689.910
09LP090 L 182	1.370	62.203	0.388	1.426	6.072	3.468	23.913	53.997	105.260	203.553	391.618	861.066	1920.824	1758.621
09LP090 L 134	0.033	12.877	0.005	1.062	10.171	1.998	45.727	92.440	181.151	292.701	418.773	794.727	1296.444	897.820
09LP090 L 171	0.061	17.680	0.411	1.838	17.023	0.834	100.979	231.556	420.361	728.314	1073.562	1662.058	2386.794	2145.543
09LP090 L 186		0.222				2.241	5.035	20.485	48.445	97.419	183.168	398.984	882.978	816.086
09LP090 L 152		1.257	0.064	0.285	6.262	1.885	22.736	45.898	104.691	173.439	256.025	460.028	793.309	502.537
09LP090 L 161	0.236	11.726	0.844	2.692	18.680	8.438	55.315	100.133	212.979	376.852	574.012	1207.939	2360.149	1813.462
09LP090 L 158	0.192	7.579	0.416	0.578	4.394	4.117	16.650	40.825	76.534	119.164	174.976	317.796	577.241	424.491
09LP090 L 196	0.441	8.287	2.672	9.640	34.907	29.397	110.719	216.204	368.365	576.534	807.583	1472.769	2510.161	1696.073
09LP090 L 124	0.042	47.901	7.554	23.434	131.334	157.999	439.788	757.448	1232.743	1843.344	2545.713	4254.441	6899.436	5159.866
09LP090 L 122	0.110	4.349	1.024	4.426	40.693	3.254	184.336	413.035	771.899	1254.139	1808.916	2953.479	4726.552	3328.970
09LP090 L 128	0.057	14.499	4.316	13.593	63.430	16.334	178.739	290.327	455.965	696.499	978.457	1662.022	2491.017	1702.762

Ti-in-zircon T (°C)
873
776
~~874~~
907
~~754~~
565
790
750
843
853
741
782
718
789
724
659
664
766
806
853
851
732
859

Ce/Ce*	Eu/Eu*	(Sm/Nd) cn	(Lu/Nd) cn	Lu/Hf	Nb/Ta	Nb/U	Th/U	Th/Y	Y/Hf
11.35	0.29	4.08	231.22	0.01	1.17	0.01	0.78	0.11	0.22
59.65	0.03	9.38	686.57	0.01	2.36	0.10	0.65	0.13	0.11
~~96.56~~	~~0.20~~	~~7.76~~	~~400.19~~	~~0.00~~	~~1.86~~	~~0.03~~	~~0.63~~	~~0.22~~	~~0.07~~
8.73	0.06	6.99	213.06	0.01	2.09	0.03	0.96	0.03	0.18
~~9.74~~	~~0.01~~	~~7.64~~	~~1901.64~~	~~0.01~~	~~1.17~~	~~0.00~~	~~0.12~~	~~0.02~~	~~0.15~~
7.05	0.01	7.17	1443.99	0.00	1.21	0.02	0.02	0.04	0.01
148.27	0.24	5.36	461.51	0.00	1.58	0.05	0.36	0.10	0.05
56.63	0.04	8.54	832.95	0.00	1.68	0.03	0.28	0.09	0.05
1007.94	0.23	7.19	607.90	0.00	1.63	0.02	0.59	0.28	0.06
66.84	0.10	6.39	371.50	0.00	2.42	0.05	0.95	0.10	0.06
43.52	0.06	9.09	482.22	0.00	2.39	0.05	0.39	0.12	0.11
29.85	0.02	7.07	421.87	0.01	1.60	0.01	0.58	0.14	0.14
70.77	0.23	4.26	1233.64	0.00	3.20	0.06	0.96	0.28	0.04
676.02	0.07	9.58	845.65	0.00	1.65	0.01	0.28	0.09	0.06
74.97	0.01	9.26	1167.32	0.00	1.35	0.01	0.52	0.13	0.08
				0.00	16.47	0.00	0.01	0.01	0.02
	0.13	22.00	1765.47	0.00	0.97	0.01	0.09	0.05	0.03
21.70	0.23	6.94	673.71	0.01	1.92	0.02	0.22	0.07	0.06
24.90	0.39	7.60	733.94	0.00	0.84	0.00	0.38	0.07	0.03
5.33	0.40	3.62	175.95	0.01	0.89	0.00	0.89	0.19	0.18
12.61	0.55	5.60	220.19	0.02	2.77	0.00	1.35	0.32	0.42
7.67	0.03	9.19	752.12	0.01	1.04	0.01	0.21	0.04	0.19
6.63	0.13	4.67	125.27	0.01	1.31	0.00	0.63	0.17	0.15

Notes:

Activity (SiO_2) = 1; activity (TiO_2) = 0.6.
Yellow highlighted rows are samples that intersected inclusions.
Trace element concentrations in ppm, calculated using mean count rate method.
Backgrounds were monitored between sweeps 10 to 27. Sample counts were integrated from sweeps 36 to 69.
Ablation used a laser spot size of 25 microns, and a laser firing repitition rate of 10 Hz.

APPENDIX C - WHOLE ROCK GEOCHEMISTRY

Table C1. Analyses for volcanic rocks in the undivided Vampire-Narchilla unit. All coordinates are NAD83 datum, zone 9. (See analytical notes at the end of the table.)

Sample		**07LP044A**	**07LP044B**	**07LP055**
Station		**07LP044**	**07LP044**	**07LP055**
Rock		**flow**	**flow**	**diabase**
Unit		**PЄVN-v**	**PЄVN-v**	**PЄVN-v**
UTM E		**594608**	**594608**	**594412**
UTM N		**6706355**	**6706355**	**6714284**
SiO_2 (%)	FUS XRF	47.14	46.93	44.27
Al_2O_3 (%)	FUS XRF	16.90	16.62	16.79
FeO (%)	TITR	NA	NA	NA
Fe_2O_3 (%)	DIFF	NA	NA	NA
Fe_2O_3* (%)	FUS XRF	10.61	10.50	12.50
MnO (%)	FUS XRF	0.204	0.213	0.253
MgO (%)	FUS XRF	2.63	2.61	3.71
CaO (%)	FUS XRF	5.93	6.36	8.57
Na_2O (%)	FUS XRF	4.86	4.84	3.68
K_2O (%)	FUS XRF	2.18	2.18	2.20
TiO_2 (%)	FUS XRF	2.07	2.06	2.74
P_2O_5 (%)	FUS XRF	1.25	1.23	1.91
L.O.I. (%)		5.81	6.11	3.00
Total (%)		**99.58**	**99.65**	**99.62**
Au (ppb)	INAA	NA	NA	NA
As (ppm)	INAA	NA	NA	NA
Br (ppm)	INAA	NA	NA	NA
Cr (ppm)	INAA	NA	NA	NA
Ir (ppm)	INAA	NA	NA	NA
Sc (ppm)	INAA	1.164	1.304	1.395
Se (ppm)	INAA	NA	NA	NA
Sb (ppm)	INAA	NA	NA	NA
Sc (ppm)	FUS ICP	NA	NA	NA
Be (ppm)	FUS ICP	NA	NA	NA
V (ppm)	FUS ICP-MS	56	97	56
Cr (ppm)	FUS ICP-MS	-20	-20	-20
Co (ppm)	FUS ICP-MS	13	12	18
Ni (ppm)	FUS ICP-MS	-20	-20	-20
Cu (ppm)	FUS ICP-MS	-10	-10	20
Zn (ppm)	FUS ICP-MS	90	80	170
Ga (ppm)	FUS ICP-MS	21	20	19
Ge (ppm)	FUS ICP-MS	1.6	1.4	1.5
As (ppm)	FUS ICP-MS	-5	-5	11
Rb (ppm)	FUS ICP-MS	43	41	34
Sr (ppm)	FUS ICP-MS	296	307	2320
Y (ppm)	FUS ICP-MS	46.6	46.9	44.5
Zr (ppm)	FUS ICP-MS	103	73	24

Sample		**09TOA006**
Station		**09TOA006**
Rock		**diabase**
Unit		**PЄVN-v**
UTM E		**594385**
UTM N		**6714232**
SiO_2 (%)	FUS ICP	45.61
Al_2O_3 (%)	FUS ICP	16.25
FeO (%)	TITR	7.10
Fe_2O_3 (%)	DIFF	4.06
Fe_2O_3* (%)	FUS ICP	11.95
MnO (%)	FUS ICP	0.222
MgO (%)	FUS ICP	3.53
CaO (%)	FUS ICP	7.43
Na_2O (%)	FUS ICP	3.5
K_2O (%)	FUS ICP	2.71
TiO_2 (%)	FUS ICP	2.816
P_2O_5 (%)	FUS ICP	1.94
L.O.I. (%)		2.31
Total (%)		**97.48**
Au (ppb)	INAA	-2
As (ppm)	INAA	-0.5
Br (ppm)	INAA	-0.5
Cr (ppm)	INAA	-5
Ir (ppm)	INAA	-5
Sc (ppm)	INAA	7.0
Se (ppm)	INAA	-3
Sb (ppm)	INAA	0.3
Sc (ppm)	FUS ICP	8
Be (ppm)	FUS ICP	2
V (ppm)	FUS ICP	115
Cr (ppm)	FUS ICP-MS	-20
Co (ppm)	FUS ICP-MS	17
Ni (ppm)	FUS ICP-MS	-20
Cu (ppm)	FUS ICP-MS	-10
Zn (ppm)	FUS ICP-MS	110
Ga (ppm)	FUS ICP-MS	18
Ge (ppm)	FUS ICP-MS	1.6
As (ppm)	FUS ICP-MS	-5
Rb (ppm)	FUS ICP-MS	41
Sr (ppm)	FUS ICP	2106
Y (ppm)	FUS ICP-MS	43.1
Zr (ppm)	FUS ICP-MS	401

Table C1, *continued*. Analyses for volcanic rocks in the undivided Vampire-Narchilla unit. All coordinates are NAD83 datum, zone 9. (See analytical notes at the end of the table.)

Sample		07LP044A	07LP044B	07LP055
Station		07LP044	07LP044	07LP055
Nb (ppm)	FUS ICP-MS	113	111	80
Mo (ppm)	FUS ICP-MS	-2	-2	3
Ag (ppm)	FUS ICP-MS	-0.5	-0.5	-0.5
In (ppm)	FUS ICP-MS	-0.1	-0.1	-0.1
Sn (ppm)	FUS ICP-MS	7	2	2
Sb (ppm)	FUS ICP-MS	3.1	1.2	-0.2
Cs (ppm)	FUS ICP-MS	1.0	0.8	1.0
Ba (ppm)	FUS ICP-MS	828	826	974
La (ppm)	FUS ICP-MS	105	102	88.1
Ce (ppm)	FUS ICP-MS	211	206	187
Pr (ppm)	FUS ICP-MS	27.1	26.9	25.3
Nd (ppm)	FUS ICP-MS	93.7	91.9	90.8
Sm (ppm)	FUS ICP-MS	15.80	15.60	15.90
Eu (ppm)	FUS ICP-MS	4.82	4.81	5.16
Gd (ppm)	FUS ICP-MS	13.10	12.90	13.50
Tb (ppm)	FUS ICP-MS	1.83	1.80	1.86
Dy (ppm)	FUS ICP-MS	9.20	9.17	8.96
Ho (ppm)	FUS ICP-MS	1.65	1.63	1.61
Er (ppm)	FUS ICP-MS	4.51	4.48	4.25
Tm (ppm)	FUS ICP-MS	0.616	0.613	0.575
Yb (ppm)	FUS ICP-MS	3.82	3.74	3.37
Lu (ppm)	FUS ICP-MS	0.552	0.530	0.480
Hf (ppm)	FUS ICP-MS	2.8	1.9	0.6
Ta (ppm)	FUS ICP-MS	8.60	8.51	5.99
W (ppm)	FUS ICP-MS	1.1	1.0	1.1
Tl (ppm)	FUS ICP-MS	0.12	0.12	0.14
Pb (ppm)	FUS ICP-MS	-5	-5	6
Bi (ppm)	FUS ICP-MS	0.2	0.1	0.2
Th (ppm)	FUS ICP-MS	12.30	12.00	10.00
U (ppm)	FUS ICP-MS	2.76	2.73	4.10

Sample		09TOA006
Station		09TOA006
Nb (ppm)	FUS ICP-MS	115
Mo (ppm)	FUS ICP-MS	-2
Ag (ppm)	FUS ICP-MS	1.1
In (ppm)	FUS ICP-MS	-0.1
Sn (ppm)	FUS ICP-MS	2
Sb (ppm)	FUS ICP-MS	0.5
Cs (ppm)	FUS ICP-MS	1.0
Ba (ppm)	FUS ICP	1095
La (ppm)	FUS ICP-MS	94.7
Ce (ppm)	FUS ICP-MS	209
Pr (ppm)	FUS ICP-MS	25.0
Nd (ppm)	FUS ICP-MS	101
Sm (ppm)	FUS ICP-MS	17.8
Eu (ppm)	FUS ICP-MS	4.98
Gd (ppm)	FUS ICP-MS	13.8
Tb (ppm)	FUS ICP-MS	1.56
Dy (ppm)	FUS ICP-MS	9.22
Ho (ppm)	FUS ICP-MS	1.64
Er (ppm)	FUS ICP-MS	4.31
Tm (ppm)	FUS ICP-MS	0.557
Yb (ppm)	FUS ICP-MS	3.39
Lu (ppm)	FUS ICP-MS	0.514
Hf (ppm)	FUS ICP-MS	7.8
Ta (ppm)	FUS ICP-MS	7.93
W (ppm)	FUS ICP-MS	0.7
Tl (ppm)	FUS ICP-MS	0.06
Pb (ppm)	FUS ICP-MS	5
Bi (ppm)	FUS ICP-MS	-0.1
Th (ppm)	FUS ICP-MS	7.73
U (ppm)	FUS ICP-MS	1.76

* Total iron reported as Fe_2O_3.

Notes:

Samples were analyzed at Activation Laboratories Ltd., Ancaster, Ontario, Canada.
Major oxides and most minor elements were determined by X-Ray Fluorescence (XRF) on a fusion sample containing a lithium metaborate/tetraborate flux, in 2007.
Those determined by Inductively Coupled Plasma (ICP) were performed in 2009, also on a fusion sample.
FeO was determined by titration.
Au, As, Br, Cr, Ir, Sc, Se, Sb were determined by Instrumental Neutron Activation Analysis (INAA).
Trace elements and REE were analyzed by ICP-Mass Spectrometry (MS) or ICP on a fusion sample.
An elemental abundance below the detection limit is shown as a negative value.
NA = not analyzed

Table C2a. Analyses of dikes and volcanic rocks within the Toobally and Crow formations (2003). All coordinates are NAD83 datum, zone 9. (See analytical notes at the end of the table.)

Sample		**03LP003**	**03LP004**	**03LP010**	**03LP017**	**03LP021**	**03LP023**	**03LP028**	**03LP028%**	**03LP029**
Station		**03LP003**	**03LP004**	**03LP010**	**03LP017**	**03LP021**	**03LP023**	**03LP028**	**03LP028**	**03LP029**
Rock		**altered dyke/ sill**	**dyke/sill**	**altered dyke/ sill**	**altered dyke/ sill**	**dyke/sill**	**altered breccia**	**lapilli tuff**	**lapilli tuff**	**lapilli tuff**
Unit		**Þt**	**Þt**	**Þt**	**Þt**	**Þt**	**€Oc-v**	**€Oc-v**	**€Oc-v**	**€Oc-v**
UTM E		**649 516**	**649 441**	**649 320**	**650 123**	**647 628**	**647 538**	**647 053**	**647 053**	**646 909**
UTM N		**6 698 177**	**6 698 146**	**6 694 834**	**6 698 395**	**6 697 581**	**6 697 584**	**6 697 555**	**6 697 555**	**6 697 722**
SiO_2 (%)	FUS ICP	31.79	45.35	34.74	52.62	42.08	36.67	47.45		51.12
Al_2O_3 (%)	FUS ICP	13.45	15.26	14.98	14.85	14.68	10.18	14.62		12.90
$Fe_2O_3^*$ (%)	FUS ICP	11.55	11.24	10.61	10.59	15.01	15.90	11.39		10.11
MnO (%)	FUS ICP	0.183	0.184	0.125	0.045	0.176	0.230	0.162		0.209
MgO (%)	FUS ICP	8.04	7.57	3.72	2.26	4.65	4.66	8.55		8.55
CaO (%)	FUS ICP	8.57	8.72	12.15	1.95	8.23	7.99	6.21		6.54
Na_2O (%)	FUS ICP	1.62	2.41	2.91	0.16	2.88	0.12	3.87		3.10
K_2O (%)	FUS ICP	2.00	2.07	1.45	2.71	0.47	1.43	0.63		0.76
TiO_2 (%)	FUS ICP	1.438	1.672	2.067	2.753	3.369	2.461	1.596		1.824
P_2O_5 (%)	FUS ICP	0.31	0.32	0.20	0.34	0.37	0.43	0.18		0.25
L.O.I. (%)		19.68	4.31	15.64	10.88	6.92	18.56	4.35		3.34
Total (%)		**98.63**	**99.11**	**98.59**	**99.16**	**98.84**	**98.63**	**99.01**		**98.70**
Ba (ppm)	FUS ICP	389	814	268	260	337	92	326		295
Sr (ppm)	FUS ICP	198	257	526	52	698	76	380		732
Y (ppm)	FUS ICP	21	27	21	22	24	27	16		18
Sc (ppm)	FUS ICP	31	34	30	32	20	16	31		29
Zr (ppm)	FUS ICP	83	95	97	201	177	159	105		122
Be (ppm)	FUS ICP	2	1	1	2	2	1	1		1
V (ppm)	FUS ICP	226	258	249	272	270	178	193		156
V (ppm)	FUS ICP-MS	211	247	237	249	257	162	178	181	143
Cr (ppm)	FUS ICP-MS	314	271	528	254	-20	-20	279	291	250
Co (ppm)	FUS ICP-MS	39	38	52	69	47	26	45	45	34
Ni (ppm)	FUS ICP-MS	100	80	198	103	52	25	130	136	69
Cu (ppm)	FUS ICP-MS	-10	51	317	635	28	13	60	69	-10
Zn (ppm)	FUS ICP-MS	62	91	80	67	125	42	83	112	122
Ga (ppm)	FUS ICP-MS	14	16	18	17	20	14	15	15	15
Ge (ppm)	FUS ICP-MS	2	2	2	3	2	2	1	2	2
As (ppm)	FUS ICP-MS	-5	12	115	60	-5	21	-5	-5	-5
Rb (ppm)	FUS ICP-MS	50	27	54	69	14	36	10	10	13
Sr (ppm)	FUS ICP-MS	196	249	503	51	735	75	378	387	746
Y (ppm)	FUS ICP-MS	20	23	18	23	26	24	17	17	20
Zr (ppm)	FUS ICP-MS	87	105	110	210	200	172	110	112	133
Nb (ppm)	FUS ICP-MS	35	38	23	48	38	29	27	27	28
Mo (ppm)	FUS ICP-MS	3	>100	>100	2	2	>100	-2	-2	-2
Ag (ppm)	FUS ICP-MS	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
In (ppm)	FUS ICP-MS	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Sn (ppm)	FUS ICP-MS	-1	-1	1	2	2	1	1	2	1
Sb (ppm)	FUS ICP-MS	-0.5	-0.5	-0.5	1.5	0.7	1.9	-0.5	0.7	-0.5
Cs (ppm)	FUS ICP-MS	7.8	3.3	3.1	4.1	2.2	1.4	0.8	0.8	-0.5
Ba (ppm)	FUS ICP-MS	396	828	275	264	362	95	336	340	313

Table C2a, *continued*. Analyses of dikes and volcanic rocks within the Toobally and Crow formations (2003). All coordinates are NAD83 datum, zone 9. (See analytical notes at the end of the table.)

Sample		03LP003	03LP004	03LP010	03LP017	03LP021	03LP023	03LP028	03LP028%	03LP029
Station		03LP003	03LP004	03LP010	03LP017	03LP021	03LP023	03LP028	03LP028	03LP029
La (ppm)	FUS ICP-MS	29.9	31.4	15.7	23.6	34.1	21.6	14.9	15.6	25.3
Ce (ppm)	FUS ICP-MS	59.9	62.5	33.8	49.8	73.2	46.3	32.8	34.3	50.4
Pr (ppm)	FUS ICP-MS	6.53	6.86	4.12	5.58	8.19	5.45	3.92	4.02	5.64
Nd (ppm)	FUS ICP-MS	27.9	28.8	19.5	24.5	35.6	24.6	18.0	18.1	25.3
Sm (ppm)	FUS ICP-MS	5	5.6	4.4	4.9	6.8	6.0	3.9	3.9	5.0
Eu (ppm)	FUS ICP-MS	1.88	2.10	1.29	1.53	2.83	2.15	1.73	1.71	2.17
Gd (ppm)	FUS ICP-MS	5	5.8	4.6	5.4	6.8	6.5	4.3	4.2	5.3
Tb (ppm)	FUS ICP-MS	0.8	0.9	0.7	0.9	1.1	1.0	0.7	0.7	0.8
Dy (ppm)	FUS ICP-MS	4.1	4.7	3.8	5.0	5.5	5.0	3.6	3.6	4.3
Ho (ppm)	FUS ICP-MS	0.8	0.9	0.7	0.9	1.0	0.9	0.7	0.7	0.8
Er (ppm)	FUS ICP-MS	2.3	2.7	2.0	2.7	2.9	2.7	1.9	1.9	2.1
Tm (ppm)	FUS ICP-MS	0.32	0.36	0.27	0.39	0.38	0.36	0.26	0.26	0.28
Yb (ppm)	FUS ICP-MS	1.8	2.1	1.5	2.2	2.3	2.2	1.5	1.5	1.7
Lu (ppm)	FUS ICP-MS	0.3	0.32	0.23	0.33	0.34	0.33	0.23	0.23	0.25
Hf (ppm)	FUS ICP-MS	2.3	2.7	3.2	5.5	5.1	4.4	2.9	2.9	3.5
Ta (ppm)	FUS ICP-MS	1.9	2.2	1.3	3.2	2.3	1.8	1.7	1.5	1.6
W (ppm)	FUS ICP-MS	1	-1	-1	2	-1	-1	-1	-1	-1
Tl (ppm)	FUS ICP-MS	0.2	0.2	0.2	0.3	-0.1	0.3	-0.1	-0.1	-0.1
Pb (ppm)	FUS ICP-MS	-5	10	18	-5	7	14	-5	10	9
Bi (ppm)	FUS ICP-MS	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4
Th (ppm)	FUS ICP-MS	2.6	3.1	1.6	5.2	4.0	3.6	1.6	1.6	2.4
U (ppm)	FUS ICP-MS	0.7	0.8	0.4	1.4	0.9	0.8	0.4	0.4	0.6

* Total iron reported as Fe_2O_3.
% Replicate analysis.

Notes:

Samples were analyzed at Activation Laboratories Ltd., Ancaster, Ontario, Canada.
Samples were crushed and then pulverized in a ceramic mill.
Major and minor elements were determined by Inductively Coupled Plasma (ICP) on a fusion sample.
Trace elements and REE were analyzed by ICP-Mass Spectrometry (MS) on a fusion sample.
An elemental abundance below the detection limit is shown as a negative value.
Upper detection limits are indicated with > upper limit.
NA = not analyzed

Table C2b(i). Analyses of dikes and volcanic rocks within the Crow Formation (2004-2005). All coordinates are NAD83 datum, zone 9. (See analytical notes at the end of the table.)

Sample		**05LP005-1**	**05LP008**	**04LP017**	**04LP018-1**	**04LP018-2**	**04LP052-1**	**04LP052-2**	**04LP052-3**	**04LP067(1)**
Station		**05LP005**	**05LP008**	**04LP017**	**04LP018**	**04LP018**	**04LP052**	**04LP052**	**04LP052**	**04LP067**
Rock		**flow**	**flow**	**volcani-clastic**	**flow**	**flow**	**flow**	**flow**	**flow**	**flow**
Unit		€Oc-v	€Oc-v	€Oc-v	€Oc-v	€Oc-v	€Oc-v	€Oc-v	€Oc-v	€Oc-v
UTM E		**653 170**	**650 376**	**647 676**	**647 392**	**647 392**	**648 485**	**648 485**	**648 485**	**647 299**
UTM N		**6 702 526**	**6 698 707**	**6 689 077**	**6 688 779**	**6 688 779**	**6 701 937**	**6 701 937**	**6 701 937**	**6 688 532**
SiO_2 (%)	FUS XRF	47.37	27.87	41.18	47.94	54.73	48.08	43.57	47.46	47.38
Al_2O_3 (%)	FUS XRF	18.8	11.97	13.72	11.53	10.51	14.64	17.51	15.89	15.21
Cr_2O_3 (%)	FUS XRF	0.03	0.06	-0.01	-0.01	0.18	0.05	0.06	0.10	-0.01
$Fe_2O_3^*$ (%)	FUS XRF	12.13	12.22	10.03	9.91	11.96	11.73	10.30	10.89	12.34
MnO (%)	FUS XRF	0.156	0.213	0.167	0.168	0.024	0.182	0.233	0.186	0.193
MgO (%)	FUS XRF	6.65	7.44	4.34	4.90	13.81	7.58	11.91	10.03	4.32
CaO (%)	FUS XRF	0.91	16.04	8.68	7.52	0.43	4.80	5.23	3.00	4.44
Na_2O (%)	FUS XRF	4.96	1.91	0.10	2.55	0.03	4.26	2.76	3.45	4.63
K_2O (%)	FUS XRF	0.34	0.08	3.67	0.91	0.02	1.62	1.39	2.86	0.57
TiO_2 (%)	FUS XRF	2.56	2.1	3.60	2.23	1.15	1.33	1.50	1.37	2.85
P_2O_5 (%)	FUS XRF	0.28	0.27	1.12	0.50	0.11	0.44	0.48	0.44	0.62
L.O.I. (%)		5.75	19.39	13.90	11.93	7.30	5.62	5.37	4.17	7.77
Total (%)		**99.94**	**99.56**	**100.50**	**100.08**	**100.25**	**100.33**	**100.32**	**99.85**	**100.31**
Sc (ppm)	INAA	33.4	34.8	10.9	12.8	18.0	16.7	20.2	17.6	15.4
V (ppm)	FUS ICP-MS	257	235	190	133	138	109	140	122	149
Cr (ppm)	FUS ICP-MS	180	310	29	-20	1,140	299	374	338	-20
Co (ppm)	FUS ICP-MS	14	33	23	46	73	33	42	41	41
Ni (ppm)	FUS ICP-MS	50	140	-20	113	449	162	199	188	-20
Cu (ppm)	FUS ICP-MS	50	60	12	33	-10	-10	-10	12	24
Zn (ppm)	FUS ICP-MS	90	150	42	-30	64	61	116	101	39
Ga (ppm)	FUS ICP-MS	21	15	21	14	12	16	22	19	16
Ge (ppm)	FUS ICP-MS	1.5	1.3	1.7	1.0	1.4	1.0	2.0	1.4	1.1
As (ppm)	FUS ICP-MS	-5	-5	-5	-5	-5	-5	-5	-5	-5
Rb (ppm)	FUS ICP-MS	8	2	116	19	-1	15	21	37	10
Sr (ppm)	FUS ICP-MS	254	180	422	73	25	175	647	259	52
Y (ppm)	FUS ICP-MS	21.3	19	38.4	20.4	10.0	23.6	30.1	27.1	21.9
Zr (ppm)	FUS ICP-MS	135	113	413	156	54	179	202	210	167
Nb (ppm)	FUS ICP-MS	22.5	17.7	137	32.4	11.9	86.7	99.1	106	34.1
Mo (ppm)	FUS ICP-MS	-2	-2	-2	-2	-2	-2	-2	-2	-2
Ag (ppm)	FUS ICP-MS	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
In (ppm)	FUS ICP-MS	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Sn (ppm)	FUS ICP-MS	-1	-1	1	-1	-1	-1	-1	3	-1
Sb (ppm)	FUS ICP-MS	0.7	1	-0.2	-0.2	-0.2	-0.2	-0.2	0.2	-0.2
Cs (ppm)	FUS ICP-MS	1.4	0.1	3.2	1.5	0.1	0.2	0.5	0.5	0.7
Ba (ppm)	FUS ICP-MS	151	23	673	128	5	415	765	946	50
La (ppm)	FUS ICP-MS	20	6.28	159	12.3	5.66	49.8	64.4	66.2	23.4
Ce (ppm)	FUS ICP-MS	48.7	16.4	294	26.9	12.5	98.7	121	123	51.7
Pr (ppm)	FUS ICP-MS	6.21	2.35	32.0	3.31	1.46	9.97	12.4	12.3	6.23
Nd (ppm)	FUS ICP-MS	25.9	11.3	117	16.6	6.26	36.7	44.9	42.8	26.8
Sm (ppm)	FUS ICP-MS	5.62	3.31	18.8	5.46	1.46	6.55	8.02	7.34	7.29

Table C2b(i), *continued*. Analyses of dikes and volcanic rocks within the Crow Formation (2004-2005). All coordinates are NAD83 datum, zone 9. (See analytical notes at the end of the table.)

Sample		05LP005-1	05LP008	04LP017	04LP018-1	04LP018-2	04LP052-1	04LP052-2	04LP052-3	04LP067(1)
Station		05LP005	05LP008	04LP017	04LP018	04LP018	04LP052	04LP052	04LP052	04LP067
Eu (ppm)	FUS ICP-MS	2.44	1.46	5.61	2.10	0.484	2.24	3.24	2.61	2.83
Gd (ppm)	FUS ICP-MS	5.71	4	14.2	5.86	1.77	5.67	6.67	6.02	7.53
Tb (ppm)	FUS ICP-MS	0.88	0.69	1.91	0.88	0.34	0.91	1.05	0.98	1.12
Dy (ppm)	FUS ICP-MS	4.67	4.09	9.00	4.51	2.12	5.00	5.84	5.44	5.43
Ho (ppm)	FUS ICP-MS	0.86	0.72	1.45	0.77	0.41	0.94	1.09	0.99	0.89
Er (ppm)	FUS ICP-MS	2.32	1.83	3.73	2.07	1.08	2.73	3.04	2.79	2.30
Tm (ppm)	FUS ICP-MS	0.306	0.244	0.497	0.283	0.142	0.383	0.423	0.391	0.294
Yb (ppm)	FUS ICP-MS	1.77	1.37	2.92	1.67	0.81	2.27	2.62	2.48	1.72
Lu (ppm)	FUS ICP-MS	0.234	0.171	0.401	0.237	0.110	0.329	0.376	0.360	0.233
Hf (ppm)	FUS ICP-MS	3.5	2.9	9.5	3.8	1.5	4.1	4.3	4.4	4.4
Ta (ppm)	FUS ICP-MS	1.62	1.26	8.77	1.75	0.59	4.68	4.88	5.23	2.22
W (ppm)	FUS ICP-MS	-0.5	-0.5	1.7	0.9	-0.5	-0.5	-0.5	0.6	4.2
Tl (ppm)	FUS ICP-MS	0.1	0.05	0.82	0.17	-0.05	0.21	0.18	0.30	0.09
Pb (ppm)	FUS ICP-MS	-5	-5	10	-5	-5	6	9	9	-5
Bi (ppm)	FUS ICP-MS	-0.1	-0.1	2.7	1.4	0.9	1.5	2.1	1.5	0.6
Th (ppm)	FUS ICP-MS	1.96	1.68	14.8	2.04	0.88	6.89	7.32	7.67	2.56
U (ppm)	FUS ICP-MS	0.53	0.39	4.67	0.63	0.24	1.82	1.84	2.50	0.74

Table C2b(ii). Analyses of dikes and volcanic rocks within the Crow Formation (2004-2005). All coordinates are NAD83 datum, zone 9. (See analytical notes at the end of the table.)

Sample		**04LP067(2)**	**05LP037**	**05LP060**	**05LP064**	**05LP047**	**05LP047A**	**04LP030**	**04LP058**	**04LP062**
Station		**04LP067**	**05LP037**	**05LP060**	**05LP064**	**05LP047**	**05LP047**	**04LP030**	**04LP058**	**04LP062**
Rock		**flow**	**flow**	**flow?**	**flow**	**dyke/sill?**	**dyke/sill?**	**volcani-clastic**	**flow**	**flow**
Unit		ЄOc-v	ЄOc-v	ЄOc-v	ЄOc-v	ЄOc-v	ЄOc-v	ЄOc-v	ЄOc-v	ЄOc-v
UTM E		**647 299**	**646 474**	**648 589**	**648 671**	**643 488**	**643 488**	**640 489**	**638 839**	**639 536**
UTM N		**6 688 532**	**6 698 311**	**6 701 885**	**6 703 655**	**6 698 498**	**6 698 498**	**6 698 856**	**6 706 551**	**6 708 455**
SiO_2 (%)	FUS XRF	47.35	45.47	40.32	43.22	46.59	46.20	48.40	49.69	46.67
Al_2O_3 (%)	FUS XRF	15.16	14.66	12.84	13.76	16.70	16.68	14.07	15.89	14.26
Cr_2O_3 (%)	FUS XRF	-0.01	0.05	0.10	0.07	0.01	0.05	0.04	0.01	-0.01
Fe_2O_3* (%)	FUS XRF	12.38	11.29	13.63	14.21	11.33	11.40	11.54	10.83	14.61
MnO (%)	FUS XRF	0.193	0.118	0.132	0.216	0.158	0.163	0.166	0.138	0.136
MgO (%)	FUS XRF	4.28	9.38	8.85	11.59	5.15	5.18	7.64	6.14	5.02
CaO (%)	FUS XRF	4.43	5.04	8.34	5.74	10.67	10.66	8.78	4.41	6.28
Na_2O (%)	FUS XRF	4.66	4.14	0.69	2.89	2.33	2.47	1.87	4.69	4.61
K_2O (%)	FUS XRF	0.57	0.39	2.55	0.84	1.40	1.30	2.28	2.14	1.40
TiO_2 (%)	FUS XRF	2.84	1.75	1.73	1.78	2.26	2.22	2.42	2.86	3.91
P_2O_5 (%)	FUS XRF	0.61	0.42	0.32	0.44	0.33	0.33	0.32	0.44	0.65
L.O.I. (%)		7.77	7.21	10.03	4.53	2.14	2.52	2.83	3.15	2.19
Total (%)		**100.23**	**99.92**	**99.53**	**99.29**	**99.07**	**99.17**	**100.36**	**100.39**	**99.73**
Sc (ppm)	INAA		20.4	28.2	27.9	29.0	29.2	27.9	26.8	29.5
V (ppm)	FUS ICP-MS		116	164	163	209	222	255	247	314
Cr (ppm)	FUS ICP-MS		270	440	380	70	80	238	57	-20
Co (ppm)	FUS ICP-MS		33	37	47	31	31	42	40	34
Ni (ppm)	FUS ICP-MS		140	230	190	30	30	125	35	-20
Cu (ppm)	FUS ICP-MS		-10	-10	-10	50	50	74	68	13
Zn (ppm)	FUS ICP-MS		70	70	90	60	70	86	110	83
Ga (ppm)	FUS ICP-MS		16	15	14	18	18	19	20	20
Ge (ppm)	FUS ICP-MS		1.2	1.1	1.2	1.3	1.3	1.5	0.9	1.5
As (ppm)	FUS ICP-MS		-5	-5	-5	6	-5	-5	-5	-5
Rb (ppm)	FUS ICP-MS		8	64	12	27	25	35	23	15
Sr (ppm)	FUS ICP-MS		91	81	291	385	395	241	70	245
Y (ppm)	FUS ICP-MS		23.9	19.5	22.2	22.7	22.3	26.1	25.9	31.1
Zr (ppm)	FUS ICP-MS		145	101	120	180	177	176	245	186
Nb (ppm)	FUS ICP-MS		43.5	25.4	34.9	28.0	27.4	31.2	45.1	39.0
Mo (ppm)	FUS ICP-MS		-2	-2	-2	-2	-2	-2	2	-2
Ag (ppm)	FUS ICP-MS		-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
In (ppm)	FUS ICP-MS		-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Sn (ppm)	FUS ICP-MS		-1	-1	-1	-1	-1	-1	-1	-1
Sb (ppm)	FUS ICP-MS		1.1	0.9	0.9	0.9	0.8	-0.2	-0.2	-0.2
Cs (ppm)	FUS ICP-MS		0.2	2.1	0.7	0.3	0.2	0.4	0.3	0.4
Ba (ppm)	FUS ICP-MS		40	168	371	249	227	288	147	193
La (ppm)	FUS ICP-MS		29.7	19.5	28.8	24.4	23.7	25.9	24.1	33.0
Ce (ppm)	FUS ICP-MS		60.4	42.8	60.6	56.7	52.9	56.7	57.4	75.7
Pr (ppm)	FUS ICP-MS		7.11	5.50	7.26	7.13	6.63	6.72	7.01	9.09
Nd (ppm)	FUS ICP-MS		28.0	22.4	28.7	28.3	26.7	28.0	28.0	38.6
Sm (ppm)	FUS ICP-MS		5.74	4.79	5.71	6.05	5.74	6.38	5.88	8.36

Table C2b(ii), *continued.* Analyses of dikes and volcanic rocks within the Crow Formation (2004-2005). All coordinates are NAD83 datum, zone 9. (See analytical notes at the end of the table.)

Sample		04LP067(2)	05LP037	05LP060	05LP064	05LP047	05LP047A	04LP030	04LP058	04LP062
Station		04LP067	05LP037	05LP060	05LP064	05LP047	05LP047	04LP030	04LP058	04LP062
Eu (ppm)	FUS ICP-MS		2.04	1.69	1.90	2.08	2.01	2.10	1.53	3.00
Gd (ppm)	FUS ICP-MS		5.61	4.72	5.50	5.56	5.39	6.15	5.54	8.44
Tb (ppm)	FUS ICP-MS		0.85	0.71	0.78	0.86	0.82	1.00	0.92	1.32
Dy (ppm)	FUS ICP-MS		4.73	3.91	4.37	4.71	4.68	5.51	5.19	6.88
Ho (ppm)	FUS ICP-MS		0.90	0.72	0.84	0.89	0.89	1.02	1.02	1.25
Er (ppm)	FUS ICP-MS		2.50	2.07	2.42	2.33	2.45	2.84	2.94	3.34
Tm (ppm)	FUS ICP-MS		0.349	0.280	0.333	0.328	0.336	0.383	0.418	0.453
Yb (ppm)	FUS ICP-MS		2.11	1.59	1.96	2.00	1.97	2.23	2.56	2.69
Lu (ppm)	FUS ICP-MS		0.299	0.223	0.287	0.294	0.270	0.314	0.367	0.358
Hf (ppm)	FUS ICP-MS		3.3	2.6	2.8	4.5	4.3	4.7	6.2	5.2
Ta (ppm)	FUS ICP-MS		2.47	1.51	2.18	1.96	1.91	1.87	2.57	2.46
W (ppm)	FUS ICP-MS		-0.5	-0.5	-0.5	-0.5	1.2	-0.5	1.1	1.1
Tl (ppm)	FUS ICP-MS		-0.05	0.20	0.06	0.09	0.09	0.18	0.10	0.10
Pb (ppm)	FUS ICP-MS		6	7	-5	-5	-5	-5	-5	6
Bi (ppm)	FUS ICP-MS		-0.1	-0.1	-0.1	-0.1	-0.1	0.6	0.5	1.0
Th (ppm)	FUS ICP-MS		4.79	2.52	3.47	3.36	2.95	2.52	4.44	2.89
U (ppm)	FUS ICP-MS		1.14	0.48	0.67	0.80	0.72	0.62	0.80	0.72

* Total iron reported as Fe_2O_3.

Notes:

Samples were analyzed at Activation Laboratories Ltd., Ancaster, Ontario, Canada.
Samples were crushed and then pulverized in a ceramic mill. Major oxides and most minor elements were determined by X-Ray Fluorescence (XRF) on a fusion sample. Sc was analyzed using Instrumental Neutron Activation Analysis (INAA). Trace elements and REE were analyzed by ICP-Mass Spectrometry (MS) at research detection limits on a fusion sample containing a lithium metaborate/tetraborate flux. An elemental abundance below the detection limit is shown as a negative value. NA = not analyzed

Table C2c. Analyses of volcanic rocks within the Crow Formation (2009-2010). All coordinates are NAD83 datum, zone 9. (See analytical notes at the end of the table.)

Sample		**09TOA141E**	**09TOA149**	**09LP082-1**	**09LP083-2**	**10TOA024**
Station		**09TOA141**	**09TOA149**	**09LP082**	**09LP083**	**10TOA024**
Rock		**flow**	**flow**	**flow**	**tuff**	**flow**
Unit		**ЄOc-v**	**ЄOc-v**	**ЄOc-v**	**ЄOc-v**	**ЄOc-v**
UTM E		**633 677**	**640 254**	**632 218**	**633 122**	**637 550**
UTM N		**6 715 218**	**6 718 980**	**6 762 262**	**6 761 980**	**6 718 719**
SiO_2 (%)	FUS ICP	60.26	45.03	42.37	46.04	69.39
Al_2O_3 (%)	FUS ICP	16.06	13.38	17.08	20.31	12.85
FeO (%)	TITR	1.31	5.43	6.35	3.90	1.11
Fe_2O_3 (%)	DIFF	6.79	5.34	3.20	3.25	2.72
Fe_2O_3* (%)	FUS ICP	8.25	11.37	10.26	7.58	3.95
MnO (%)	FUS ICP	0.015	0.164	0.084	0.139	0.050
MgO (%)	FUS ICP	1.81	5.33	6.84	6.06	3.16
CaO (%)	FUS ICP	0.13	8.49	6.58	4.16	0.50
Na_2O (%)	FUS ICP	0.58	4.29	3.09	3.19	0.65
K_2O (%)	FUS ICP	7.68	0.19	2.43	3.79	4.48
TiO_2 (%)	FUS ICP	0.589	2.609	2.03	1.56	0.44
P_2O_5 (%)	FUS ICP	0.08	0.33	0.30	0.21	0.34
L.O.I. (%)		2.99	8.26	8.60	6.41	2.75
Total (%)		**98.43**	**99.45**	**99.69**	**99.45**	**98.54**
Au (ppb)	INAA	-2	-2	-2	-2	NA
As (ppm)	INAA	-0.5	-0.5	-0.5	4.1	NA
Br (ppm)	INAA	-0.5	-0.5	-0.5	-0.5	NA
Cr (ppm)	INAA	-5	43	221	56	NA
Ir (ppm)	INAA	-5	-5	-5	-5	NA
Sc (ppm)	INAA	22.6	29.0	28.9	20.4	NA
Se (ppm)	INAA	-3	-3	-3	-3	NA
Sb (ppm)	INAA	0.3	-0.2	0.2	0.5	NA
Sc (ppm)	FUS ICP	24	33	32	22	9
Be (ppm)	FUS ICP	4	1	1	1.0	3
V (ppm)	FUS ICP	84	338	285	208	44
Cr (ppm)	FUS ICP-MS	-20	50	210	50	-20
Co (ppm)	FUS ICP-MS	4	34	37	28	15
Ni (ppm)	FUS ICP-MS	-20	40	70	30	-20
Cu (ppm)	FUS ICP-MS	-10	110	-10	30	-10
Zn (ppm)	FUS ICP-MS	40	150	100	120	50
Ga (ppm)	FUS ICP-MS	27	17	18	18	24
Ge (ppm)	FUS ICP-MS	1.9	2.0	1.1	0.9	2.0
As (ppm)	FUS ICP-MS	-5	-5	-5	5	-5
Rb (ppm)	FUS ICP-MS	143	3	37	67	126
Sr (ppm)	FUS ICP	21	133	108	102	15
Y (ppm)	FUS ICP-MS	51.7	26.2	20.8	14.9	51.4
Zr (ppm)	FUS ICP-MS	817	190	144	111	143

Table C2c, *continued*. Analyses of volcanic rocks within the Crow Formation (2009-2010). All coordinates are NAD83 datum, zone 9. (See analytical notes at the end of the table.)

Sample		09TOA141E	09TOA149	09LP082-1	09LP083-2	10TOA024
Station		09TOA141	09TOA149	09LP082	09LP083	10TOA024
Nb (ppm)	FUS ICP-MS	108	36.2	26	23.4	51.9
Mo (ppm)	FUS ICP-MS	-2	-2	-2	-2	-2
Ag (ppm)	FUS ICP-MS	2.4	0.5	-0.5	-0.5	-0.5
In (ppm)	FUS ICP-MS	-0.1	-0.1	-0.1	-0.1	-0.1
Sn (ppm)	FUS ICP-MS	6	2	1	-1	9
Sb (ppm)	FUS ICP-MS	-0.2	-0.2	-0.2	0.3	-0.2
Cs (ppm)	FUS ICP-MS	3.6	0.3	5.0	2.1	2.5
Ba (ppm)	FUS ICP	628	43	204	288	289
La (ppm)	FUS ICP-MS	91.5	23.3	19.0	15.7	41.0
Ce (ppm)	FUS ICP-MS	195	53.1	42	34.5	88.1
Pr (ppm)	FUS ICP-MS	21.10	6.57	5.14	4.16	10.1
Nd (ppm)	FUS ICP-MS	77.9	28.0	22	17.1	38.4
Sm (ppm)	FUS ICP-MS	13.6	6.53	5.0	3.76	9.40
Eu (ppm)	FUS ICP-MS	3.26	2.08	1.44	1.33	1.140
Gd (ppm)	FUS ICP-MS	10.5	6.19	4.88	3.53	9.79
Tb (ppm)	FUS ICP-MS	1.70	0.96	0.78	0.56	1.68
Dy (ppm)	FUS ICP-MS	9.81	5.32	4.32	3.06	9.93
Ho (ppm)	FUS ICP-MS	1.98	0.96	0.77	0.58	1.91
Er (ppm)	FUS ICP-MS	5.74	2.57	2.11	1.56	5.43
Tm (ppm)	FUS ICP-MS	0.877	0.352	0.302	0.226	0.813
Yb (ppm)	FUS ICP-MS	6.07	2.19	1.85	1.39	5.25
Lu (ppm)	FUS ICP-MS	1.02	0.331	0.275	0.200	0.820
Hf (ppm)	FUS ICP-MS	17.0	4.2	3.2	2.5	4.3
Ta (ppm)	FUS ICP-MS	7.47	2.72	1.91	1.69	4.49
W (ppm)	FUS ICP-MS	-0.5	-0.5	-0.5	-0.5	-0.5
Tl (ppm)	FUS ICP-MS	0.18	-0.05	-0.05	0.09	0.32
Pb (ppm)	FUS ICP-MS	6	20	-5	7	-5
Bi (ppm)	FUS ICP-MS	-0.1	-0.1	-0.1	-0.1	-0.1
Th (ppm)	FUS ICP-MS	21.0	2.89	2.6	2.28	20.40
U (ppm)	FUS ICP-MS	2.75	0.74	0.66	0.48	4.57

* Total iron reported as Fe_2O_3.

Notes:

Samples were analyzed at Activation Laboratories Ltd., Ancaster, Ontario, Canada.
Samples were crushed and then pulverized in a mild steel mill.
Major elemental oxides and most minor elements were determined by Inductively Coupled Plasma (ICP) on a fusion sample.
FeO was determined by titration.
Au, As, Br, Cr, Ir, Sc, Se and Sb were determined by Instrumental Neutron Activation Analysis (INAA).
Trace elements and REE were analyzed by ICP-Mass Spectrometry (MS) at research detection limits on a fusion sample containing a lithium metaborate/tetraborate flux.
An elemental abundance below the detection limit is shown as a negative value.
NA = not analyzed

Table C3. Analyses for volcanic rocks of the Rabbitkettle Formation. All coordinates are NAD83 datum, zone 9. (See analytical notes at the end of the table.)

Sample		J96-10 155.7m	J96-11 36.8m	07LP032
Station		drill hole	drill hole	07LP032
Rock		flow/sill?	flow/sill?	flow
Unit		ЄOR-v	ЄOR-v	ЄOR-v
Easting		590 910	590 870	591 303
Northing		6 698 779	6 699 220	6 698 365
SiO_2 (%)	FUS XRF	44.31	43.44	43.97
Al_2O_3 (%)	FUS XRF	14.43	14.58	14.49
FeO (%)	TITR	NA	NA	NA
Fe_2O_3 (%)	DIFF	NA	NA	NA
Fe_2O_3* (%)	FUS XRF	13.26	13.15	12.92
MnO (%)	FUS XRF	0.193	0.199	0.185
MgO (%)	FUS XRF	8.80	8.18	8.30
CaO (%)	FUS XRF	8.07	8.84	8.85
Na_2O (%)	FUS XRF	2.54	2.35	2.68
K_2O (%)	FUS XRF	0.92	1.83	0.64
TiO_2 (%)	FUS XRF	2.88	2.90	2.92
P_2O_5 (%)	FUS XRF	0.53	0.52	0.52
Cr_2O_3 (%)	FUS XRF	0.02	0.02	0.02
L.O.I. (%)		4.46	3.31	4.25
Total (%)		**100.41**	**99.32**	**99.75**
Au (ppb)	INAA	NA	NA	NA
As (ppm)	INAA	NA	NA	NA
Br (ppm)	INAA	NA	NA	NA
Cr (ppm)	INAA	NA	NA	NA
Ir (ppm)	INAA	NA	NA	NA
Sc (ppm)	INAA	26.5	26.7	26.8
Se (ppm)	INAA	NA	NA	NA
Sb (ppm)	INAA	NA	NA	NA
Sc (ppm)	FUS ICP	NA	NA	NA
Be (ppm)	FUS ICP	NA	NA	NA
V (ppm)	FUS ICP-MS	254	261	264
Cr (ppm)	FUS ICP-MS	280	280	270
Co (ppm)	FUS ICP-MS	48	48	47
Ni (ppm)	FUS ICP-MS	140	140	140
Cu (ppm)	FUS ICP-MS	70	70	50
Zn (ppm)	FUS ICP-MS	140	110	140
Ga (ppm)	FUS ICP-MS	20	19	20
Ge (ppm)	FUS ICP-MS	1.6	1.4	1.4
As (ppm)	FUS ICP-MS	-5	-5	-5

Sample		09LP003-3	09LP049-2	09RAS050D	09TOA161	09TOA165	09RAS168B extra
Station		09LP003-3	09LP049	09RAS050	09TOA161	09TOA165	09RAS168
Rock		altered flow	flow	sill	flow	flow	flow
Unit		ЄOR-v	ЄOR-v	ЄOR-v	ЄOR-v	ЄOR-v	ЄOR-v
Easting		582 955	569 574	572 762	613 430	612 912	609 000
Northing		6 709 689	6 722 949	6 749 796	6 753 492	6 739 782	6 727 200
SiO_2 (%)	FUS ICP	55.99	48.36	48.34	49.10	45.84	43.62
Al_2O_3 (%)	FUS ICP	16.82	16.04	12.67	12.58	15.26	14.39
FeO (%)	TITR	4.51	6.19	6.59	8.10	6.41	9.40
Fe_2O_3 (%))	DIFF	0.81	4.25	5.70	0.76	3.61	2.10
Fe_2O_3* (%)	FUS ICP	5.82	11.13	13.02	9.76	10.73	12.55
MnO (%)	FUS ICP	0.098	0.156	0.176	0.154	0.133	0.158
MgO (%)	FUS ICP	6.29	5.75	5.56	8.91	6.76	9.50
CaO (%)	FUS ICP	2.47	8.49	5.07	7.24	9.40	8.94
Na_2O (%)	FUS ICP	4.92	2.93	3.53	3.93	2.00	1.96
K_2O (%)	FUS ICP	1.19	0.87	0.11	1.04	3.16	1.62
TiO_2 (%)	FUS ICP	0.669	2.326	3.254	1.129	3.076	2.292
P_2O_5 (%)	FUS ICP	0.15	0.66	0.41	0.17	0.58	0.34
Cr_2O_3 (%)	FUS ICP	NA	NA	NA	NA	NA	NA
L.O.I. (%)		5.08	2.79	7.90	4.45	3.12	4.17
Total (%)		**99.49**	**99.51**	**100.10**	**98.47**	**100.10**	**99.55**
Au (ppb)	INAA	-2	-2	-2	-2	-2	-2
As (ppm)	INAA	4.2	-0.5	11.8	-0.5	-0.5	2.2
Br (ppm)	INAA	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Cr (ppm)	INAA	107	107	42	337	346	491
Ir (ppm)	INAA	-5	-5	-5	-5	-5	-5
Sc (ppm)	INAA	16.1	24.6	28.2	20.1	27.4	31.6
Se (ppm)	INAA	-3	-3	-3	-3	-3	-3
Sb (ppm)	INAA	-0.2	-0.2	0.8	0.5	0.2	0.5
Sc (ppm)	FUS ICP	19	28	31	22	31	36
Be (ppm)	FUS ICP	2	2	1	-1	-1	-1
V (ppm)	FUS ICP	148	247	426	179	312	305
Cr (ppm)	FUS ICP-MS	120	110	40	350	320	470
Co (ppm)	FUS ICP-MS	17	32	46	45	41	54
Ni (ppm)	FUS ICP-MS	50	-20	-20	240	130	240
Cu (ppm)	FUS ICP-MS	30	10	60	50	30	70
Zn (ppm)	FUS ICP-MS	50	110	130	90	60	90
Ga (ppm)	FUS ICP-MS	16	18	19	15	16	21
Ge (ppm)	FUS ICP-MS	1.8	1.6	2.1	1.4	1.5	1.5
As (ppm)	FUS ICP-MS	8	-5	13	-5	-5	-5

Table C3, *continued*. Analyses for volcanic rocks of the Rabbitkettle Formation. All coordinates are NAD83 datum, zone 9. (See analytical notes at the end of the table.)

Sample		J96-10 155.7m	J96-11 36.8m	07LP032
Station		drill hole	drill hole	07LP032
Rb (ppm)	FUS ICP-MS	20	32	9
Sr (ppm)	FUS ICP-MS	615	827	855
Y (ppm)	FUS ICP-MS	30.6	30.7	30.6
Zr (ppm)	FUS ICP-MS	272	271	271
Nb (ppm)	FUS ICP-MS	55.9	56.2	56.9
Mo (ppm)	FUS ICP-MS	2	-2	-2
Ag (ppm)	FUS ICP-MS	0.9	0.6	< 0.5
In (ppm)	FUS ICP-MS	-0.1	-0.1	-0.1
Sn (ppm)	FUS ICP-MS	2	2	3
Sb (ppm)	FUS ICP-MS	3.9	-0.2	-0.2
Cs (ppm)	FUS ICP-MS	2.3	1.7	1.0
Ba (ppm)	FUS ICP-MS	982	1080	1130
La (ppm)	FUS ICP-MS	47.8	46.6	45.3
Ce (ppm)	FUS ICP-MS	95.5	93.6	92.4
Pr (ppm)	FUS ICP-MS	11.9	11.8	12.1
Nd (ppm)	FUS ICP-MS	43.7	42.4	42.6
Sm (ppm)	FUS ICP-MS	8.65	8.26	8.39
Eu (ppm)	FUS ICP-MS	2.66	2.68	2.52
Gd (ppm)	FUS ICP-MS	7.64	7.65	7.68
Tb (ppm)	FUS ICP-MS	1.19	1.16	1.17
Dy (ppm)	FUS ICP-MS	6.09	5.93	6.01
Ho (ppm)	FUS ICP-MS	1.10	1.09	1.06
Er (ppm)	FUS ICP-MS	3.05	2.96	2.93
Tm (ppm)	FUS ICP-MS	0.413	0.400	0.399
Yb (ppm)	FUS ICP-MS	2.46	2.46	2.46
Lu (ppm)	FUS ICP-MS	0.381	0.365	0.362
Hf (ppm)	FUS ICP-MS	6.3	6.3	6.3
Ta (ppm)	FUS ICP-MS	4.35	4.27	4.29
W (ppm)	FUS ICP-MS	0.8	0.7	0.8
Tl (ppm)	FUS ICP-MS	0.12	0.08	0.06
Pb (ppm)	FUS ICP-MS	5	-5	7

Sample		09LP003-3	09LP049-2	09RAS050D	09TOA161	09TOA165	09RAS168B extra
Station		09LP003-3	09LP049	09RAS050	09TOA161	09TOA165	09RAS168
Rb (ppm)	FUS ICP-MS	30	15	<1	13	47	17
Sr (ppm)	FUS ICP	177	531	436	267	772	367
Y (ppm)	FUS ICP-MS	18.0	38.8	32.1	16.3	21.3	23.5
Zr (ppm)	FUS ICP-MS	131	252	222	101	147	192
Nb (ppm)	FUS ICP-MS	9.9	21.1	43.6	14.3	37.0	44.8
Mo (ppm)	FUS ICP-MS	-2	-2	-2	-2	-2	-2
Ag (ppm)	FUS ICP-MS	-0.5	0.7	0.6	-0.5	-0.5	0.6
In (ppm)	FUS ICP-MS	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Sn (ppm)	FUS ICP-MS	1	2	2	-1	1	1
Sb (ppm)	FUS ICP-MS	-0.2	-0.2	0.9	-0.2	-0.2	0.4
Cs (ppm)	FUS ICP-MS	1.7	1.8	1.7	2.9	2.9	1.7
Ba (ppm)	FUS ICP	650	551	435	601	2951	1597
La (ppm)	FUS ICP-MS	27.7	32.0	28.1	52.6	32.2	30.7
Ce (ppm)	FUS ICP-MS	54.7	74.5	62.9	90.0	74.9	64.6
Pr (ppm)	FUS ICP-MS	5.92	9.36	7.77	9.05	9.17	7.55
Nd (ppm)	FUS ICP-MS	22.4	39.2	33.2	31.3	38.0	31.0
Sm (ppm)	FUS ICP-MS	4.23	8.65	7.61	4.48	7.76	6.53
Eu (ppm)	FUS ICP-MS	0.810	2.30	2.27	1.41	2.21	1.82
Gd (ppm)	FUS ICP-MS	3.49	7.97	7.23	4.04	6.69	6.12
Tb (ppm)	FUS ICP-MS	0.55	1.29	1.11	0.60	0.91	0.91
Dy (ppm)	FUS ICP-MS	3.22	7.40	6.21	3.26	4.68	4.91
Ho (ppm)	FUS ICP-MS	0.65	1.41	1.14	0.62	0.84	0.90
Er (ppm)	FUS ICP-MS	1.93	4.00	3.26	1.70	2.14	2.40
Tm (ppm)	FUS ICP-MS	0.289	0.596	0.460	0.246	0.278	0.333
Yb (ppm)	FUS ICP-MS	1.95	3.85	2.87	1.50	1.63	2.02
Lu (ppm)	FUS ICP-MS	0.319	0.613	0.422	0.231	0.238	0.296
Hf (ppm)	FUS ICP-MS	3.0	4.9	4.9	2.1	3.3	4.3
Ta (ppm)	FUS ICP-MS	0.82	1.35	3.18	0.63	2.79	3.18
W (ppm)	FUS ICP-MS	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Tl (ppm)	FUS ICP-MS	0.09	-0.05	-0.05	-0.05	0.10	-0.05
Pb (ppm)	FUS ICP-MS	28	6	-5	6	-5	-5

Table C3, *continued*. Analyses for volcanic rocks of the Rabbitkettle Formation. All coordinates are NAD83 datum, zone 9. (See analytical notes at the end of the table.)

Sample		J96-10 155.7m	J96-11 36.8m	07LP032
Station		drill hole	drill hole	07LP032
Bi (ppm)	FUS ICP-MS	0.1	-0.1	0.2
Th (ppm)	FUS ICP-MS	7.29	6.83	6.99
U (ppm)	FUS ICP-MS	1.87	1.67	1.68

Sample		09LP003-3	09LP049-2	09RAS050D	09TOA161	09TOA165	09RAS168B extra
Station		09LP003-3	09LP049	09RAS050	09TOA161	09TOA165	09RAS168
Bi (ppm)	FUS ICP-MS	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Th (ppm)	FUS ICP-MS	8.15	3.36	4.30	2.82	6.81	4.08
U (ppm)	FUS ICP-MS	1.98	0.7	1.04	0.85	0.66	1.04

* Total iron reported as Fe_2O_3.

Notes:

Samples were analyzed at Activation Laboratories Ltd., Ancaster, Ontario, Canada.
Samples were crushed and then pulverized in a mild steel mill.
Major oxides and most minor elements were determined by X-Ray Fluorescence (XRF) on a fusion sample containing a lithium metaborate/tetraborate flux, in 2007.
Those determined by Inductively Coupled Plasma (ICP) were performed in 2009, also on a fusion sample.
FeO was determined by titration.
Au, As, Br, Cr, Ir, Sc, Se, Sb were determined by Instrumental Neutron Activation Analysis (INAA).
Trace elements and REE were analyzed by ICP-Mass Spectrometry (MS) or ICP on a fusion sample.
An elemental abundance below the detection limit is shown as a negative value.
NA = not analyzed

Table C4. Analyses of volcanic rocks within the Sunblood Formation. All coordinates are NAD83 datum, zone 9.

Sample		**09LP072**	**09MBKL01**
Station		**09LP072**	**09MBKL001**
Rock		**flow**	**flow**
Unit		**OSu-v**	**OSu-v**
UTM E		**621 003**	**626 074**
UTM N		**6 684 592**	**6 705 020**
SiO_2 (%)	FUS ICP	48.73	48.28
Al_2O_3 (%)	FUS ICP	14.98	15.07
FeO (%)	TITR	5.80	10.20
Fe_2O_3 (%)	DIFF	2.11	0.73
Fe_2O_3* (%)	FUS ICP	8.56	12.07
MnO (%)	FUS ICP	0.066	0.097
MgO (%)	FUS ICP	8.15	8.94
CaO (%)	FUS ICP	4.73	4.29
Na_2O (%)	FUS ICP	0.71	2.44
K_2O (%)	FUS ICP	5.2	2.1
TiO_2 (%)	FUS ICP	1.608	2.407
P_2O_5 (%)	FUS ICP	0.27	0.28
L.O.I. (%)		7.20	2.09
Total (%)		**100.20**	**98.05**
Au (ppb)	INAA	-2	-2
As (ppm)	INAA	1.6	-0.5
Br (ppm)	INAA	-0.5	-0.5
Cr (ppm)	INAA	348	69
Ir (ppm)	INAA	-5	-5
Sc (ppm)	INAA	23.6	32.5
Se (ppm)	INAA	-3	-3
Sb (ppm)	INAA	-0.2	-0.2
Sc (ppm)	FUS ICP	25	35
Be (ppm)	FUS ICP	-1	1
V (ppm)	FUS ICP	226	307
Cr (ppm)	FUS ICP-MS	310	70
Co (ppm)	FUS ICP-MS	55	42
Ni (ppm)	FUS ICP-MS	160	40
Cu (ppm)	FUS ICP-MS	100	70
Zn (ppm)	FUS ICP-MS	60	90
Ga (ppm)	FUS ICP-MS	17	19
Ge (ppm)	FUS ICP-MS	0.8	1.2
As (ppm)	FUS ICP-MS	-5	-5
Rb (ppm)	FUS ICP-MS	40	32
Sr (ppm)	FUS ICP	123	197
Y (ppm)	FUS ICP-MS	20.2	23.6
Zr (ppm)	FUS ICP-MS	130	190
Nb (ppm)	FUS ICP-MS	29.9	34.6
Mo (ppm)	FUS ICP-MS	-2	-2
Ag (ppm)	FUS ICP-MS	-0.5	0.6
In (ppm)	FUS ICP-MS	-0.1	-0.1
Sn (ppm)	FUS ICP-MS	1	2
Sb (ppm)	FUS ICP-MS	-0.2	-0.2
Cs (ppm)	FUS ICP-MS	3.2	4.2
Ba (ppm)	FUS ICP	517	875
La (ppm)	FUS ICP-MS	18.0	18.6
Ce (ppm)	FUS ICP-MS	38.9	46.2
Pr (ppm)	FUS ICP-MS	4.68	5.98
Nd (ppm)	FUS ICP-MS	19.4	26.5
Sm (ppm)	FUS ICP-MS	4.68	6.26
Eu (ppm)	FUS ICP-MS	0.996	1.74
Gd (ppm)	FUS ICP-MS	4.55	5.75
Tb (ppm)	FUS ICP-MS	0.74	0.88
Dy (ppm)	FUS ICP-MS	4.26	4.92
Ho (ppm)	FUS ICP-MS	0.81	0.90
Er (ppm)	FUS ICP-MS	2.20	2.41
Tm (ppm)	FUS ICP-MS	0.318	0.317
Yb (ppm)	FUS ICP-MS	1.96	2.01
Lu (ppm)	FUS ICP-MS	0.304	0.298
Hf (ppm)	FUS ICP-MS	3.1	4.2
Ta (ppm)	FUS ICP-MS	2.06	2.60
W (ppm)	FUS ICP-MS	0.9	-0.5
Tl (ppm)	FUS ICP-MS	0.49	0.21
Pb (ppm)	FUS ICP-MS	-5	-5
Bi (ppm)	FUS ICP-MS	-0.1	-0.1
Th (ppm)	FUS ICP-MS	5.0	3.55
U (ppm)	FUS ICP-MS	0.95	0.90

continued...

* Total iron reported as Fe_2O_3.

Notes:

Samples were analyzed at Activation Laboratories Ltd., Ancaster, Ontario, Canada.
Samples were crushed and then pulverized in a mild steel mill.
Major oxides and most minor elements were determined by X-Ray Fluorescence (XRF) on a fusion sample containing a lithium metaborate/tetraborate flux, in 2007.
Those determined by Inductively Coupled Plasma (ICP) were performed in 2009, also on a fusion sample.
FeO was determined by titration.
Au, As, Br, Cr, Ir, Sc, Se, Sb were determined by Instrumental Neutron Activation Analysis (INAA).
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An elemental abundance below the detection limit is shown as a negative value.
NA = not analyzed

APPENDIX D - ROCK-EVAL ANALYSES

Measured parameters for Rock-Eval-6

Parameter	Units	Mode	Description
S1	Mg HC/g rock	Pyrolysis	Free hydrocarbons
S2	Mg HC/g rock	Pyrolysis	Oil generation potential
Tpeak	°C	Pyrolysis	Temperature for S2 maximum release
S3	mgCO_2/g rock	Pyrolysis	CO_2 from organic source
S3CO	mgCO/g rock	Pyrolysis	CO from organic source
S4CO_2	mgCO_2/g rock	Oxidation	CO_2 from organic source
S4CO	mgCO/g rock	Oxidation	CO from organic source
S5	mgCO_2/g rock	Oxidation	CO_2 from mineral source
S5CO	mgCO/g rock	Oxidation	CO from mineral source

Calculated parameters from Rock-Eval-6

Parameter	Unit	Formula	Name
Tmax	°C	Calculated from TpS2-	Tmax
PI		S1/(S1+S2)	Production Index
PC	Wt %	Calculated from S1, S2, S3, S3CO, S3'CO	Pyrolysable organic carbon
RC CO	Wt %	Calculated from S4CO	Residual organic carbon (CO)
RC CO_2	Wt %	Calculated from S4CO_2	Residual organic carbon (CO_2)
RC	Wt %	RC CO + RC CO_2	Residual organic carbon
TOC	Wt %	PC + RC	Total organic carbon
HI	Mg HC/g TOC	S2*100/TOC	Hydrogen Index
OI	Mg CO_2/g TOC	S3*100/TOC	Oxygen Index
OI CO	Mg CO/g TOC	S3CO*100/TOC	Oxygen Index CO
MinC	Wt %	pyroMinC + oxiMinC	Mineral Carbon

Table D1. Rock-Eval-6 analyses for samples collected from Coal River area (NTS 95D).

Sample	UTM E (m)	UTM N (m)	UTM Zone	Rock Type	Unit	Qty (mg)	S1 (mg HC/g rock)	S2 (mg HC/g rock)	PI	S3	Tmax (°C)	Tpeak (°C)	S3CO (mg CO/g rock)	PC (wt %)	TOC (wt %)	RC (wt %)	HI (mg HC/g TOC)	OICO (mg CO/g TOC)	OI	MinC (wt %)	S4CO	S4CO_2	RCCO (wt %)	RCCO_2 (wt %)
9107					**standard**	70.7	0.73	12.13	0.06	0.51	441	478	0.21	1.10	5.10	4.00	238	4	10	4.3	18.6	117.3	0.800	3.20
09CYA010-1	579 525	6 708 840	9N	black silty shale	SDRR	70.3	0.02	0.06	0.22	1.04	610	647	0.05	0.04	1.77	1.73	3	3	59	6.0	7.9	51.0	0.340	1.39
09LP039-2	579 916	6 716 388	9N	black silty shale	SDRR	70.4	0.00	0.00	0.70	0.18	296	333	0.00	0.00	0.18	0.18	0	0	100	0.0	0.9	5.3	0.040	0.14
09LP074-1	623 195	6 684 500	9N	black silty shale	SDRR	70.0	0.00	0.00	0.18	0.42	480	517	0.02	0.01	0.28	0.27	0	7	150	11.9	0.6	9.2	0.020	0.25
09LP058-1	559 154	6 658 253	9N	limestone	SDRR contaminated	70.5	0.01	0.10	0.08	0.52	389	426	0.13	0.03	1.08	1.05	9	12	48	0.1	4.0	32.1	0.170	0.88
9107					**standard**	70.9	0.67	11.78	0.05	0.49	441	478	0.24	1.07	5.07	4.00	232	5	10	4.3	18.3	117.9	0.780	3.22
09LP062-1	617 826	6 683 313	9N	silty shale	SDRR	70.5	0.01	0.01	0.32	0.32	485	522	0.02	0.01	0.27	0.26	4	7	119	13.0	0.8	8.4	0.030	0.23
09RAS106-1	647 762	6 668 800	9N	black silty shale	DMBR	70.8	0.01	0.06	0.13	1.64	516	553	0.26	0.07	3.69	3.62	2	7	44	0.2	12.7	112.5	0.550	3.07
09LP093-2	658 912	6 734 865	9N	black silty shale	SMRB	70.7	0.01	0.01	0.34	1.22	503	540	0.19	0.05	2.27	2.22	0	8	54	0.1	6.3	71.6	0.270	1.95
09LP077-1	657 060	6 712 865	9N	mudstone	SMRB	50.2	0.01	0.02	0.20	1.99	500	537	0.31	0.08	7.36	7.28	0	4	27	0.2	31.3	217.8	1.340	5.94
9107					**standard**	70.6	0.72	12.11	0.06	0.50	442	479	0.19	1.10	5.02	3.92	241	4	10	4.4	18.3	115.0	0.780	3.14
10TOA035	559 765	6 660 180	9N	black silty shale	SDRR	70.0	0.01	0.02	0.44	2.48	412	451	0.67	0.12	3.49	3.37	1	19	71	0.4	12.3	104.1	0.530	2.84
9107					**standard**	70.7	0.63	11.89	0.05	0.47	441	480	0.16	1.07	5.04	3.97	236	3	9	4.4	18.4	116.6	0.790	3.18