

17th Annual CORDILLERAN TECTONICS WORKSHOP - FINAL PROGRAM

University of Calgary - 1991

Friday, February 22

7:00 p.m. Registration, social and set-up of Saturday posters in ES 149

Saturday, February 23

Morning Program - Coast Belt and Terrane Accretion

- 8:30 Late Registration
- 8:45 Introductory remarks
- 9:00 Murray Journeay (GSC-Vancouver) - Crustal Structure of the Southern Coast Belt; a Two-Sided Contractional Orogen
- 9:15 Peter S. Mustard (GSC-Vancouver) - Upper Cretaceous-Tertiary Georgia Basin: Forearc or Foreland?
- 9:30 James W.H. Monger (GSC-Vancouver) - Evolution of Southwestern Coast Belt and Adjacent Insular Belt
- 9:45 Discussion
- 10:00 Posters and coffee
- 11:00 Michael Covey, E.A. Schmidtke, D.W. Klepacki, & S.R. May (Esso & Exxon) - Phanerozoic Tectonic Reconstructions of the Northern Cordillera
- 11:15 Richard L. Brown (Carleton) - The Orogenic Float of the Southern Canadian Cordillera
- 11:30 E. H. Brown and R.F. Burmester (Western Washington University) - Metamorphic Evidence for Tilt of the Spuzzum Pluton
- 11:45 Discussion
- 12:00 Lunch

Afternoon Program - Terrane links and the Omineca Belt

- 1:00 Posters
- 2:00 Craig Hart (UBC) & M.G. Mihalynuk (B.C. Geol. Surv. Branch) - Doubts about Terrane Composition (or What do you call Stikinia)?
- 2:15 Lisel Currie (Carleton) - Geology and timing constraints for deformation of the Tagish Lake area
- 2:30 Guowei Zhang (McGill) - Structure of the Takla Group East of the Finlay-Ingenika Fault, McConnell Area, North-central B.C.
- 2:45 Discussion

- 3:00 Posters and coffee
- 3:45 Filippo Ferri (B.C. Geol. Surv. Branch) - The Wolverine Fault Zone: Eocene Extensional Tectonism?
- 4:00 Heather E. Plint (Univ. of Alberta) - Eocene Tectonics in the Horseranch Range, Northern Omineca Belt, British Columbia
- 4:15 James J. Vogl and P.S. Simony (Univ. of Calgary) - The Tail of the Nelson Batholith: Structure and Emplacement
- 4:30 Jon M. Einarsen (Univ. of Calgary) - Structural Geology of the Terrane Accretion Boundary, Pend d'Oreille area, southern Kootenay Arc
- 4:45 Discussion
- 5:00 Posters
- 6:00 Removal of Saturday posters, set-up of Sunday posters

Saturday Posters

- D.A. Archibald (Queen's) - ⁴⁰Ar/³⁹Ar evidence for Permian and Triassic igneous and metamorphic events, Bridge River Area
- James L. Crowley (Carleton) - Displacement along the Standfast Creek fault zone, southern British Columbia
- Jon M. Einarsen (Univ. of Calgary) - Structural Geology of the Terrane Accretion Boundary, Pend d'Oreille area, southern Kootenay Arc
- P. Erdmer (Univ. of Alberta) - Eclogite in the Anvil allochthon, St. Cyr klippe, Yukon
- Filippo Ferri (B.C. Geol. Surv. Branch) - Three years of mapping in the Manson Creek Area; New Insights, New Problems
- George M. Green (Carleton) - Detailed sedimentology of the Bowser Lake Group, northern Bowser Basin, British Columbia
- Thomas Heah (UBC) - Shames River mylonite zone: Late Cretaceous northeast directed shear zone on the east margin of Central Gneiss Complex, Terrace, British Columbia
- Brad Johnson (Carleton) - Distribution and Kinematics of Early Extensional Shearing in the Shuswap Highland, B.C.
- Stephen T. Johnston (Shell Canada Ltd.) - Early Jurassic Amphibolite Grade Metamorphism of the Nisling Assemblage in the Aishihik Lake Map-area
- Randy Parrish (GSC-Ottawa) - A Model of Middle Eocene Extension and Strike-Slip Faulting for the Canadian Cordillera and Pacific Northwest
- Rob Scammell (Queen's) - Structure of the Kootenay Terrane between Scrip Nappe and Monashee Terrane, southern Omineca Belt, British Columbia

⁴⁰Ar/³⁹Ar EVIDENCE FOR PERMIAN AND TRIASSIC IGNEOUS AND METAMORPHIC EVENTS, BRIDGE RIVER AREA (POSTER)

D.A. Archibald (Queen's University)

⁴⁰Ar/³⁹Ar step-heating of amphibole from the diorite in the Bralorne mine and the Goldbridge quarry and, from a massive to weakly lineated, coarsely brecciated amphibolite knocker in the northwestern part of the serpentinite mélange in the Shulaps complex reveals that the samples contain variable amounts of initial argon however, ages in the 260 to 280 Ma range are recovered. These ages are consistent with the U-Pb zircon date of Leitch et al. (1991) for the Bralorne diorite. These results suggest that the rocks in these areas cooled through the argon closure temperature of amphibole (ca. 500°C) in Early Permian time. The dates corroborate the correlation of the two mafic/ultramafic complexes suggested by Wright et al. (1982) and provide the first direct evidence for the age of the sea-floor crust preserved in the Shulaps complex.

Blueschist-facies rocks occur in narrow fault-bounded panels in the intervening Bridge River complex near Eldorado mountain (Barver, 1989). Step-heating of white mica that defines the schistosity in these rocks yields a range of dates but the results so far suggest that this tectonothermal event occurred in Middle Triassic or earlier time.

DYNAMIC CASTING AND GROWTH FAULTING OF DAWSON CREEK GRABEN COMPLEX: Carboniferous-Permian, Western Canada Basin.

J. E. BARCLAY, 1. GSC, 2. U. of Calgary; F.F. KRAUSE, 2.; R.I. CAMPBELL, Calamity Resources; J. UTTING, 1. (all of Calgary, Alberta).

The Dawson Creek Graben Complex ("DCGC") was an aulacogen that developed inboard of the Paleozoic western North America craton margin and persisted for 100 Ma during the Carboniferous and Early Permian. The DCGC formed by localised subsidence within the larger Peace River Embayment, a broad depocentre on the NW flank of the "stable" cratonic platform. The DCGC comprised many km-scale horst/graben blocks that were filled syntectonically.

Five casting stages characterize DCGC tectonic evolution: 1. Initial subsidence in western areas during Banff fm. deposition (Tournaisian), 2. Subsidence in eastern areas, and continued western subsidence, formed a large central graben during Rundle Gp. deposition (Tournaisian-Viséan), 3. Increased subsidence along with satellite graben development and intense growth-type block-faulting during Golata and Kiskatinaw formation deposition (Viséan), 4. Slowed subsidence caused graben filling and graben decay during Taylor flat fm. deposition (Viséan-Serpukhovian) and, 5. Widespread but decreased subsidence and development of new depocentres during Belloy fm. deposition (Early Permian). This stage recorded graben cessation and imposition of a new tectonic regime.

The structural mechanism that created the DCGC trough on the apparently stable platform is unknown. We can say that the DCGC was an extensional basin with possible strike-slip-related compression and rotation, and that DCGC was dominated by tectonic rather than eustatic controls. Although DCGC is filled by craton-sourced sediments, a western structural driving force controlling graben development is suggested by several observations: subsidence began in the west, persisted longest in the west, subsidence migrated from west to east, and the DCGC is bordered by western highlands ("Siukana uplift"). The subsidence created a west-plunging trough that widened westward and closed eastward. A proto-Cordilleran "Antler-like" orogeny may have provided the graben's structural driving force.

METAMORPHIC EVIDENCE FOR TILT OF THE SPUZZUM PLUTON

E.H. Brown and R.F. Burmester, Department of Geology, Western Washington University, Bellingham, WA 98225.

To address the question of tilt vs translation as the mechanism responsible for discordance between the paleomagnetic directions of Cretaceous plutons in the B.C. Coast Plutonic Complex and the North American reference direction, metamorphic pressures around the margin of the Spuzzum pluton have been determined. Pressures are derived based on microprobe analyses of exchange equilibria in the assemblage garnet-biotite-plagioclase-aluminum silicate-quartz. Samples studied come from the contact aureole at eight localities ringing the pluton and surrounding the area of Irving and others' (1985) paleomagnetic study. The studied samples are coarse-grained and exhibit textural features indicative of equilibrium crystallization following emplacement of the Spuzzum pluton. Three dimensional least-squares regression analysis restoring paleodepths to present-day positions shows good fit to a plane which has been tilted 33° down to the southwest about a horizontal axis trending 332°. Southwest tilt of the pluton since metamorphism to its present orientation accounts for the paleomagnetic discordance and thus provides a viable alternative to the concept of northward translation of the Spuzzum pluton from Mexican latitudes.

THE OROGENIC FLOAT OF THE SOUTHERN CANADIAN CORDILLERA

Richard L. Brown, Dept. Earth Sciences, Carleton University

The concept of orogenic float as first proposed by Laubscher in 1977 has recently been applied to the North American Cordillera by Oldow et al. (1989). Lithoprobe transects of the southern Canadian Cordillera confirm this hypothesis, and its acceptance requires radical revision of tectonic models of the region. The Rocky Mountains form the eastern margin of the float, and its underlying decollement extends westward to the paleo-plate boundary beneath Cache Creek terrane. Accreted terranes are thin slices within the float that have been stripped from their lithospheric roots. Strike slip faults such as the Yalakom-Fraser River system terminate at the basal decollement. Strain due to oblique subduction is partitioned in the float and distributed in the lower crust and upper mantle. Gravitationally induced tectonic denudation may be accommodated in the float without regional strain below the decollement.

PALEOZOIC (?) AND MESOZOIC TECTONIC EVOLUTION OF THE WESTERN SELKIRK MOUNTAINS, B.C.: AN EVALUATION OF THE "MULTIPLE SUTURE" HYPOTHESIS AND MODES OF CRUSTAL THICKENING (POSTER)

Maurice Colpron (Queen's University)

Relations between part of Kootenay terrane and North America have become the focus of a controversial interpretation. Smith and Gehrels (*in review*) propose that most of Lardeau Group stratigraphy was inverted and juxtaposed over Early Paleozoic miogeoclinal rocks during a mid-Paleozoic (Antler?) orogenic event. However, much has yet to be learned about the internal stratigraphy of the Lardeau Group and its relationship to regional structural evolution.

Exposure of Lardeau Group rocks at the northern end of the Illecillewaet synclinorium will be the focus of field work during the summer of 1991. In addition to investigation of the stratigraphic and structural relations between rocks of the Lardeau Group and those of the Hanill Group and Badshot Formation, the proposed study will document the evolution of a zone of structural divergence marking the suture between Intermontane "superterrane" and North America, along the southwest flank of the Selkirk fan structure. The steep southeasterly plunge of the synclinorium in that region and the presence of, apparently pre-folding, Middle Jurassic (?) plutons should provide critical information about the style and timing of tectonic thickening within the Omineca crystalline belt.

Phanerozoic Tectonic Reconstructions of the Northern Cordillera

M. C. Covey (Esso Resources Canada Ltd., Calgary, AB)
E. A. Schmidtke (Exxon, U. S. A., Houston, TX)
D. W. Klepucki (Esso Resources Canada Ltd., Calgary, AB)
S. R. May (Exxon Production Research Co., Houston, TX)

We have attempted to combine all available kinematic and geologic data to produce a geometrically and internally consistent plate tectonic model which describes the formation and subsequent relative motion of terranes along the Cordilleran margin from the Devonian to present. Using an Evans and Sutherland graphics computer, with software developed at Exxon Production Research Company, a plate motion animation (movie) depicting Cordilleran terrane motion and interaction has been generated. This type of modeling depicts the entire northern Cordillera as an integrated system, whose internal geometry is controlled by the interaction of major plates in the Pacific basin with each other and with North America. Key tectonic events in the Cordillera are temporally linked to changes in absolute motion (as obtained from the apparent polar wander path), and to changes in the relative motion of oceanic plates in the Pacific Basin. We have found that with the exception of the Peninsular-Alexander-Wrangellia (PAW) terrane complex, the evolution of the northern Cordillera is best explained by a model which holds most elements close to the North American margin. Episodic rifting and sea-floor spreading in the Devonian through Permian separated Stikine basement from North America and produced the Cache Creek and Slide Mountain basins. These basins were subsequently closed by convergence with North America in Permian through Middle Jurassic time. The PAW terrane complex originated at low latitudes in an intra-oceanic setting and collided with the Cordillera in Middle Jurassic time. Major left-lateral transtensional shear between the PAW terrane complex and the rest of the Cordillera is consistent with absolute North American plate motion during the Late Jurassic and Early Cretaceous. We believe that this explains the formation and subsequent collapse of the Gravina-Nutzotin and associated Jura-Cretaceous flysch basins. Eocene extension and strike slip faulting in the Cordillera are kinematically balanced in our model.

DISPLACEMENT ALONG THE STANDFAST CREEK FAULT ZONE, SOUTHERN BRITISH COLUMBIA (POSTER)

James L. Crowley (Carleton University)

The Standfast Creek fault zone (SCFZ) forms the upper boundary of the Clachnacudainn slice of the Selkirk allochthon. The fault zone is up to a kilometre wide and includes both penetrative ductile deformation and superimposed discrete brittle faulting. Ductile strain predates emplacement of the mid-Cretaceous Albert stock, but the age of discrete brittle faulting is unconstrained. Kinematic indicators within the fault zone point to a complex displacement history with evidence of both hanging-wall-to-the-west and hanging-wall-to-the-east sense of shear. Brittle normal faulting has occurred on moderate easterly dipping shears; the magnitude of displacement on these brittle shears is unknown but thought to be on the order of kilometres or less. Major displacement on the ductile SCFZ is not required by the data but cannot be ruled out.

Lisel Currie (Carleton University)

In the Tagish Lake area the Nisling Terrane comprises the Mount Lawson, Boundary Ranges, and Florence Range metamorphic suites, and the Bighorn Creek orthogneiss, Wann River gneiss and Hale Mountain granodiorite. Fieldwork during the summer of 1990 showed that the structurally lowest lithologic units of the Nisling Terrane exposed in the Tagish Lake area include the Late Devonian to Early Mississippian Bighorn Creek orthogneiss, the Mount Lawson gneiss, and the Mount Lawson metamorphic suite. They lie structurally below the Boundary Ranges metamorphic suite.

Metamorphic rocks of the Nisling Terrane in the Tagish Lake area were ductilely deformed between Early Jurassic and Early Cretaceous, based on deformation of Early Jurassic Hale Mountain granodiorite, which is intruded by undeformed Early Cretaceous granite. This deformation may be correlative with deformation that affected rocks within the Coast Plutonic Complex to the south and Nisling Terrane rocks in Yukon, to the north. Fabrics associated with this deformation are concordant with the Wann River Shear Zone (WRSZ) and Hoboe Glacier Shear Zone and are truncated by the Willison Creek Shear Zone, Chicken Creek Fault, Wann River Fault and Llewellyn Fault. Consequently, some movement on these faults must have occurred after Early Jurassic time.

Eclogite in the Anvil allochthon, St Cyr klippe, Yukon

P. Erdmer
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Eclogite in Yukon is a minor but characteristic component of the allochthonous Yukon-Tanana terrane, a complex tectonostratigraphic assemblage which is juxtaposed against more than 1000 km of the former continental margin in the Cordillera. It is associated mainly with metasedimentary rocks interpreted to be subducted Paleozoic trench or continental margin strata (Nisutlin allochthon), and with minor interleaved ophiolitic rocks. It occurs both at the leading edge of accreted terrane in the Teslin suture zone and in klippen above autochthonous North American miogeoclinal strata east of the Tintina fault.

Two newly discovered occurrences show that it also occurs in a klippe in the Cassiar terrane, that is, above rocks of North American affinity to the west of Tintina fault. It is associated there with metaophiolitic rocks of the Anvil allochthon, which gives rise to both similarities and differences in petrology from other Yukon eclogite. Its occurrence in this structural setting provides independent evidence that the Teslin suture zone is the root zone of the exotic nappes in the Cassiar terrane, and establishes that large parts of the Anvil allochthon were subducted and metamorphosed under high P-T conditions.

The poster describes the eclogite occurrences, provides quantitative P-T data, and discusses the implications for regional tectonic evolution.

STRUCTURAL GEOLOGY OF THE TERRANE ACCRETION BOUNDARY, PEND D'OREILLE AREA, SOUTHERN KOOTENAY ARC.

Einarsen, Jon M., Dept Geology and Geophysics, The University of Calgary, Calgary AB T2N 1N4

In the southern Kootenay Arc a newly discovered structure, the Tillicum Creek fault, separates mildly deformed Lower Jurassic island arc assemblages (Rosslund Group) of the Quesnel terrane and a probable upper Paleozoic marginal basin assemblage (Cs unit) from poly-deformed lower Paleozoic North American miogeoclinal rocks. The Tillicum Creek fault is either intruded by or carries sheared ultramafic pods, truncates phase 1 structures in the Lower Cambrian Laib formation, and is a fundamental structure along which oceanic assemblages and miogeoclinal rocks are juxtaposed. The Cs unit is in the same structural position as the Milford-Kaslo-Slocan package, and the Midge Creek fault east of the tail of the Nelson Batholith may be equivalent to the Tillicum Creek fault.

The structure of the lower Paleozoic rocks is dominated by the Salmo River neutral fold, a large phase 1 reclined fold with a south-dipping axial plane and south plunging L₁ linear elements. In contrast to exposures to the north, linear elements in the Pend D' Oreille area plunge steeply (20°-40°). The fold is cored by the Quartzite Range formation (Hamill Group) and is probably related to the suite of phase 1 nappes in the central and northern Kootenay Arc. Refolded folds, folded S₁ and locally developed S₂ indicate that the lower Paleozoic rocks have undergone two phases of deformation but S₁ cleavage and greenschist facies M₁ mineral assemblages are commonly preserved. Phase 2 deformation is essentially parallel to phase 1 and is mild by comparison to the central and northern Kootenay Arc. The Salmo River neutral fold is truncated by thrust faults associated with phase 2 deformation.

Along the Pend D' Oreille river the pre-108 Ma Waneta fault is an east-west trending south-dipping phase 2 structure that postdates collision. Although poorly exposed, the Waneta fault appears to truncate the Tillicum Creek fault. Scarce kinematic indicators show hangingwall down to the south but sedimentary rocks of the Rosslund Group in the footwall are overturned, suggesting that the fault is overturned.

THE SKEENA FOLD BELT (POSTER)
Carol Evenchick (GSC-Vancouver)

The Skeena Fold Belt is a regional fold and thrust belt which spans most of the width of the northern Intermontane Belt and exhibits shortening comparable with that in the Rocky Mountain Fold and Thrust Belt. The Skeena Fold Belt has many features of thin-skinned fold and thrust belts, such as thrust faults which sole into a detachment, a wide variety of structural styles which depend on rock type, a foreland basin which was cannibalized by continued deformation, a frontal triangle zone, and a hinterland of metamorphic and plutonic rocks (Coast Plutonic Complex). The Skeena Fold Belt thus is comparable with the Rocky Mountain Fold and Thrust Belt, but rather than deforming a continental terrace wedge, it developed in a terrane (Stikinia) which had accreted to North America in the Early Mesozoic, and in Jurassic and Cretaceous clastic successions (Bowser Lake and Sustut groups) which overlie Stikinia.

Structural and stratigraphic relationships show that the earliest deformation occurred between Oxfordian and Albian time, and the last folds developed in latest Cretaceous or early Tertiary time. As much as 160 km of northeastward shortening in the Skeena Fold Belt was broadly contemporaneous with crustal thickening in the Coast Plutonic Complex and Omineca Belt, with dextral strike-slip faulting east of the Skeena Fold Belt, and with shortening in the Rocky Mountain Fold and Thrust Belt.

Charles Ferguson (University of Calgary)

The Late Proterozoic Kaza and Cariboo groups of the Cariboo Mountains comprise a tripartite shallowing-upward sequence of deep-marine turbidites (Kaza Group and lower Isaac Fm), slope deposits (middle and upper Isaac Fm), and a carbonate siliciclastic platform (Cunningham and Yankee Belle fms).

Kaza Group sandstones are overlain by and interfinger with the northeast with base-of-slope sandstones and pelites of the Isaac Fm. Middle and upper Isaac Fm consists of southwest-directed argillaceous slump deposits and carbonate-clast olistostromes that are overlain by platform carbonates and siliciclastics of the Cunningham and Yankee Belle fms. The slope-platform transition zone, which contains Ediacaran fossils, appears to step down-section to the northeast, implying westward progradation of the platform. The platform sequence thins from 2 km to less than 1 km to the east where it is punctuated by at least two karstic unconformities. The unconformities become less obvious and the percentage of carbonate in the platform increases (30 to 70%) to the west. The platform is unconformably overlain by fluvial quartzites and bioturbated marginal marine quartzite-pelite units of the Lower Cambrian Yanks Peak Fm.

The 5-6 km thick sequence appears to be a southwest-facing passive margin, and is important because it predates the early Cambrian rift event (expressed in this area by the sub Yanks Peak unconformity) which lead to development of the more widely recognized lower Paleozoic cordilleran miogeocline.

THE WOLVERINE FAULT ZONE: EOCENE EXTENSIONAL TECTONISM?
Filippo Ferri (B.C. Geological Survey Branch)

The Wolverine complex of central British Columbia is one of several metamorphic core complexes located in the Omineca Belt. In the Germansen Landing/Manson Creek area, middle to upper amphibolite grade rocks of the complex are juxtaposed against greenschist grade rocks of the Slide Mountain Terrane and upper Ingenika Group along the Wolverine fault zone. The Wolverine fault zone has been traced for over 100 km and contains both ductile and brittle components. The ductile element is a moderately dipping layer parallel shear zone located within metasedimentary rocks of the complex. This ductile zone can be up to several kilometres thick and overprints annealed metamorphic textures within this part of the complex. Mineral lineations within this zone plunge moderately south to southwest. High angle brittle faults appear to cut the ductile shear zone in several localities and may be the high level expression of the shear zone. Presently no kinematic indicators have been obtained from the fault zone.

Isotopic studies by the GSB and others have consistently yielded Early Tertiary ages (K/Ar and U/Pb) for the high grade metamorphic rocks and associated intrusive rocks of the complex. A recent sampling transect across the northern portion of the Wolverine fault zone indicates Middle Jurassic metamorphism within the hanging wall. Metamorphic cooling ages from near the fault suggests uplift was initiated along this structure during the Late Cretaceous. However, the predominance of Early Tertiary ages from the complex as a whole, indicate that rapid cooling and the bulk of the uplift occurred during this later time.

STRUCTURAL INTERPRETATION OF THE SELWYN RANGE FAULT, WESTERN MAIN RANGES, B.C.

Stephen Grasby (McGill University)

In the southern Selwyn Range, on the west limb of the Fraser River Antiform, shear zone fabrics of the Selwyn Range Fault are well exposed and show progressive development of strain over a 100m fault zone (occurring just below the Old Fort Point Formation of the middle Miette Group). Previously this fault was interpreted to be a D₂ structure that was folded by the D₃ Fraser River Antiform. Such a correlation would require this shear zone to continue over, and occur on, the east limb of the Fraser River Antiform, below the lowest exposed grit units of the middle Miette. No strain zones were observed on relatively well exposed ridges, at three localities, along the east limb of the Fraser River Antiform.

Alternatively, the Selwyn Range Fault could be interpreted as a D₂ structure localised on the west limb of the Fraser River Antiform. This interpretation, creates difficulties in drawing cross sections, because it would require the Selwyn Range Fault to produce a stratigraphic omission, cutting out the lower half of the middle Miette Group.

Dextral and Compressional Motion Along the Chatter Creek Fault (POSTER)

Stephen Grasby and Eric Mountjoy (McGill University)

The Chatter Creek Fault was examined in two areas west of Mallard Peak, immediately northwest of the Whirlpool River. Two phases of deformation occur in this region; an early phase responsible for low angle thrusting (D₁), and a second phase that folded these structures, producing major upright folds (D₂). The McGillivray Fault crops out east of, and is cut by, the Chatter Creek Fault. The McGillivray Fault dips 20° to 30° southwest and may represent a minor splay from a D₂ thrust.

Slickensides and minor folds in the Chatter Creek Fault zone, west of Mallard Peak, indicate two distinct stages of motion: 1) compressional NE vergent, and 2) dextral. The relative timing of these two stages of motion is uncertain. The Chatter Creek Fault is likely a D₂ or later structure. A fold train trending 20-35° more westerly than regional D₂ folds may be related to dextral motion along the Chatter Creek Fault.

DETAILED SEDIMENTOLOGY OF THE BOWSER LAKE GROUP, NORTHERN BOWSER
BASIN, BRITISH COLUMBIA (POSTER)
George M. Green (Carleton University)

In the northern part of the Bowser Basin (Spatsizi map area), the Middle to Upper Jurassic Bowser Lake Group comprises coastal, fan delta, shelf, prodelta-slope, and submarine canyon/gully assemblages. A shale/siltstone facies within the prodelta-slope assemblage contains a sandstone subfacies which is inferred to represent overbank deposits of submarine fan channels. Coalesced, offstacked conglomerates of the submarine canyon/gully assemblage may represent major supply routes from a source to the north. In the shelf assemblage, repetitive coarsening-up cycles containing fossiliferous beds represent a persistent shallow marine shelf. Bedform geometries and internal fabrics in rusty conglomerates suggest coalesced fan deltas or gravel bars on braid deltas. Association with carbonaceous shales is compatible with a barrier bar-lagoonal setting. Paleocurrent data from ripple cross-stratification and clast imbrication indicate south-southwesterly sediment transport. Megascopic point counts of conglomerates indicate no significant lateral or vertical changes in clast compositions.

DOUBTS ABOUT TERRANE COMPOSITION (or WHAT DO YOU CALL STIKINIA?),
HART, Craig J.R., Dept. of Geological Sciences, University of British
Columbia, and MIHALYNUK, M.G. BC Geological Survey Branch.

Terrane nomenclature has been in a state of flux since the terrane concept was first introduced. Stikinia, is an accreted terrane in the Canadian Cordillera whose characteristics vary considerably between its northern and central portions. Traditionally Stikinia has been defined as having a basement of Devonian to Permian shelf carbonates and mafic to felsic volcanic rocks (Stikine Assemblage-SA) unconformably overlain by Triassic and lower Jurassic arc volcanics (Lewes River, Stuhini and Hazelton Gps.) and arc-derived clastics (Laberge and Spatsizi Gps. a.k.a Whitehorse Trough). This package is intruded by comagmatic Mesozoic plutons which are also considered to be part of the terrane. The Mesozoic and Paleozoic packages are observed to have distinctly different deformational histories.

In Yukon and northernmost B.C., Paleozoic SA rocks are absent and Stikinia is represented by the Triassic arc volcanics, their plutonic roots and the Whitehorse Trough clastic sediments. The Trough rocks however, are known to lie in stratigraphic contact on the adjacent Cache Creek (and possibly Nisling) Terrane(s), and thus form an overlap assemblage. This precludes their use as a terrane defining unit.

The Triassic arcs obviously formed upon the SA, but where this basement is absent, they overlie rocks of the Cache Creek Terrane. Furthermore, if the coeval plutonic arc is deemed to be comagmatic with the Triassic volcanics, then the Lewes River arc was built upon the pericratonic Nisling Terrane basement adjacent to Cache Creek rocks. Therefore the Lewes River/Stuhini arc formed a magmatic link between the SA, the Nisling and Cache Creek Terranes during Late Triassic time. Thus the Triassic rocks cannot be used to define Stikinia.

SHAMES RIVER MYLONITE ZONE: LATE CRETACEOUS NORTHEAST DIRECTED
SHEAR ZONE ON EAST MARGIN OF CENTRAL GNEISS COMPLEX, TERRACE,
BRITISH COLUMBIA (POSTER)
Thomas Heah (University of British Columbia)

The eastern margin of the Central Gneiss Complex (CGC) west of Terrace is a 6-8 km thick, northeast-directed mylonitic zone (informally termed Shames River mylonite zone, SRMZ). Along Shames River, upper amphibolite facies metamorphic rocks of the CGC are in steep, brittle fault contact with greenschist facies supracrustal strata of Stikinia. U-Pb (zircon) and K-Ar (hornblende and biotite) dating of pre- to late syn-kinematic granitoid rocks constrains ductile movement to between 69-51 Ma. Al(total) in hornblende barometry on pre- and syn-kinematic granodiorites in CGC show an upward decrease in crystallization pressure from the SRMZ. Metamorphic conditions also decrease abruptly eastward across Shames River. Thermobarometry indicates initial, rapid, isothermal depressurization between Late Cretaceous and Early Tertiary, followed by rapid, near isobaric cooling to surface conditions. The rapid uplift, abrupt eastward drop in metamorphic grade, normal metamorphic sequence, association with abundant I- and minor S-type plutonism, and onset at the latter stages of Cordillera-wide, Late Cretaceous crustal thickening, indicate that ductile movement was accommodated by crustal collapse.

STRUCTURAL STUDIES IN THE PINCHER CREEK AREA, ALBERTA (POSTER)
Stephen N. Hiebert (University of Calgary)

A 150 square kilometre area of the Foothills belt in the Pincher Creek - Beaver Mines region was mapped at 1:20,000 scale during the summer of 1990. Regionally, west-dipping beds are cut by thrusts that repeat cretaceous stratigraphy at surface. Emphasis was placed on a series of structures, originally mapped as vertical transverse faults, occurring southwest of the town of Pincher Creek. Field data suggests these structures may be interpreted as several duplexes dipping obliquely to the regional dominant trend of the thrust sheet which hosts the structures. A local interpretation of the triangle zone at the leading edge of the Foothills belt is given. Preliminary interpretation suggests that triangle zone development in this region may be less advanced and not as internally deformed as it has found to be along strike further north.

The Bouguer gravity field of the Canadian cordillera is dominated by the large low associated with crustal thickening. Isolated minor highs are evident on the eastern flank of this low, on the DNAG gravity map of North America. The Rocky Mountain frontal thrusts follow an approximate small circle centred about 122°W, 49°N, and all the highs are at approximately the same angular distance from this pole. The mean Bouguer gravity varies systematically with radial distance from 122°W, 49°N, and the highs appear as a 3 mgal bump on the eastern flank of the large low. The bump is interpreted to reflect the flexural bulge underneath the Rocky Mountain foreland. Forward modelling of the gravity field using an elastic model for the Rocky Mountain lithosphere allows an independent estimate of the flexural rigidity in this region.

DISTRIBUTION AND KINEMATICS OF EARLY TERTIARY EXTENSIONAL
SHEARING IN THE SHUSWAP HIGHLAND, B.C. (POSTER)

Brad Johnson, Earth Sciences, Carleton University
The Okanagan fault system is traceable from Omak Lake in northern Washington along the Okanagan, north Shuswap, and Eagle River valleys in southern B.C. to the Anstey Arm of Shuswap Lake. Along this length, hangingwall rocks of low metamorphic grade that are not significantly affected by ductile Eocene strain have been dropped down to the west relative to a ductilely sheared footwall of granitoid rocks and migmatites. 40 km west of Shuswap Lake, greenschist-facies rocks and the mid-Cretaceous Baldy granite are faulted down to the west against tectonized amphibolite-facies metamorphic rocks and two-mica leucogranite by a splay of the Okanagan fault system that controls the linear morphology of northern Adams Lake and that probably connects with the North Thompson River normal fault. Extension is transferred between Shuswap and Adams lakes by partitioning of strain into multiple brittle and ductile-brittle faults, each with little displacement, and into seemingly homogeneous upper-plate-westward ductile strain that is most evident in the leucogranite. This *en echelon* geometry of major "detachment" segments contrasts with a previous contention that the sillimanite isograd coincides with a continuous low-angle normal fault that bounds the Shuswap metamorphic complex at least as far north as Adams Lake.

EARLY JURASSIC, AMPHIBOLITE GRADE METAMORPHISM OF THE NISLING
ASSEMBLAGE IN THE AISHHIK LAKE MAP-AREA, SW YUKON. (POSTER)

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The Early Paleozoic (?) Nisling Assemblage near Aishihik Lake, SW Yukon, was metamorphosed to amphibolite facies during the intrusion of the Aishihik Batholith in the Early Jurassic. Two isograds, including: (1) ST + MUSC + QTZ = GAR + BI + KY + H₂O; and (2) KY = SIL, cross the study area. The isograds parallel the margin of, and define an increase in metamorphic grade towards, the Aishihik Batholith. Garnet - biotite geothermometry places the ST-out isograd at about 600°C and the KY = SIL isograd at about 650°C. Pressure is limited to a minimum of 7 kb by geobarometry (Ghent et al., 1979).
Andalusite mantles both ST and KY and post-dates peak metamorphism. Post-metamorphic Early to Middle Jurassic, shallow level plutons of pink quartz monzonite, characterized by the presence of miarolitic cavities, intrude the Nisling assemblage. These relationships suggest rapid post-metamorphic unroofing of the Nisling assemblage.
The Nisling assemblage appears to have bobbed rapidly down and up in the Early to Middle Jurassic. Although metamorphism is directly related to the intrusion of the Aishihik Batholith, the depths of burial (25 km) suggest tectonic loading of the area, probably due to collision with another terrane. The Early to Middle Jurassic Laberge Group, a sequence of coarse cobble conglomerates and alluvial sediments preserved within the Whitehorse Trough, may provide a record of the rapid unroofing of the Nisling Assemblage.

CRUSTAL STRUCTURE OF THE SOUTHERN COAST BELT; A TWO-SIDED
CONTRACTIONAL OROGEN
Murray Journeay (GSC-Vancouver)

The Lillooet River Fault System (LRFS) is the leading edge of a Late Cretaceous contractional belt that extends northward along the inboard margin of the Insular Superterrane. It separates supracrustal arc sequences and related plutonic suites of the Western Coast Belt (WCB) from an overlying stack of disrupted island arc and ophiolite terranes that comprise the high-grade crystalline core of the Central Coast Belt-Northwest Cascade System (CCB-NCS). Structural studies and U-Pb zircon dating of the LRFS indicate a two-stage history of crustal imbrication; thin-skinned folding and thrusting along the inboard margin of the WCB (~96-94 Ma), followed by out-of-sequence thrusting and westward telescoping of the high-grade crystalline core (~94-90 Ma). The Bralorne-Kwoick Creek Fault System (BKFS) marks the eastern margin of the CCB-NCS, and roots eastward beneath imbricated Bridge River and Methow Terranes of the Eastern Coast Belt (ECB). Structures within the BKFS record a long-lived history of west-vergent thrusting, the most recent of which appears to have outlasted displacement along the LRFS.

Both of these west-vergent fault systems are interpreted to have formed in response to frontal accretion and eastward underplating of the Insular Superterrane. They are imaged seismically as east-dipping reflection zones, and can be traced from the surface down to mid-crustal levels (3-4 seconds TWT), where they are truncated by a system of west-dipping discontinuities. These discontinuities merge with sub-horizontal Moho reflections beneath the Insular Superterrane to the west, and are interpreted to be the root zone for east-vergent thrust systems that feed eastward into the Intermontane and Omineca Belts. The kinematic linkage between east- and west-vergent thrust systems in the Coast Belt is uncertain, but can be explained either by tectonic wedging or by vergence reversal.

DEFORMATION IN THE FOOTWALL OF THE LEWIS THRUST FAULT, NORTH KOOTENAY PASS REENTRANT, ALBERTA

Teresa Kerber (Queen's University)

A series of enigmatic structures beneath the Lewis thrust fault have been studied by detailed mapping in the North Kootenay Pass reentrant where the orientation of the Cordilleran fold and thrust belt changes from NW-SE (south of the pass) to N-S (north of the pass). These include tightly folded Crowsnest and Alberta Group units nested between structural panels of overturned Kootenay and Blaimore strata. The overturned panels conform to the shape of the Lewis thrust fault, changing strike by almost 90° beneath the North Kootenay Pass Monocline - a northwest trending fold at Crowsnest Pass which marks the change in position of the Lewis thrust fault from a detachment zone in the Middle Purcell Supergroup (SE-side) to a detachment zone near the base of the Paleozoic succession (NW-side).

Delamination within the Fernie Group because of tectonic wedging of Upper Paleozoic units, and subsequent shear beneath the Lewis thrust fault has produced a deformed "Triangle Zone" in the footwall of the Lewis thrust fault along the northwest flank of the Clark Range Sallient of the Lewis thrust sheet.

The existence of the Clark Range Sallient, the development of the Lewis thrust sheet and the structures in its footwall at North Kootenay Pass may reflect the configuration of the basin in which the Purcell Supergroup was deposited.

BALANCED CROSS SECTIONS THROUGH THE OUTER FOOTHILLS IN THE COALSPUR AREA, ALBERTA

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Upper Cretaceous and Tertiary strata are known from outcrop in the study area, while older rocks were encountered in oil and gas wells. The major structures of the area are, from north to south the Pedley Thrust and Coalspur Triangle Zone (formerly called Coalspur Anticline), Entrance Syncline, Mercoal Thrust, Brazeau Flats, Brazeau Thrust, Brazeau Syncline and Cadomin Syncline. The economic coal seams of the Coalspur Formation are present in the area in three parallel bands in the Entrance Syncline and Coalspur Triangle Zone. In the Entrance Syncline, the Coalspur coals are buried at various depths (up to 1 km) and may form exploration targets for coal-bed methane.

The Pedley Thrust appears to have at least 1 km of southwest directed displacement. This fault defines the Coalspur Triangle Zone. The Mercoal Thrust may have about 2 km of southwest directed displacement and defines a triangle zone that probably formed before the Coalspur Triangle Zone. The Brazeau Thrust shows at least 3 km of northeast directed movements and places Blackstone shales on top of the Brazeau Formation. The Brazeau Syncline has an overturned southwest limb and is a tight fold.

Three cross sections through the area were obtained by the TRIPOD Structural Geological Information System. After balancing the sections, section BB' shows 27 percent shortening and section CC' 35 percent.

STRUCTURAL ENIGMAS IN THE EAST FLANK OF THE TRIANGLE ZONE

Don Lawton, D.A. Spratt, & R.T. Slotboom (Univ. of Calgary)

High quality reflection seismic data from the eastern limit of the Rocky Mountain thrust and fold belt west of Calgary has delineated some unusual and enigmatic structural relationships between deformed and undeformed rocks within the Triangle Zone. The eastern flank of the Triangle Zone was created by the emplacement of a wedge of sedimentary rocks into the foreland succession, resulting in uplift of sequences above the roof thrust (upper detachment). Within the study area, the amount of uplift increases monotonically to the west. The roof thrust is west-verging and appears to be bedding-plane parallel, with the dip of the fault plane decreasing steadily to the east. However, the sole thrust (lower detachment) of the allochthonous wedge is considerably more complex and is folded and faulted by younger faults. The enigma is that the deformation associated with these faults (duplexes and 'pop-up' structures) appears to terminate within the wedge and does not disturb the upper detachment. Examples from several seismic lines will be used to illustrate the structural relationships.

STRUCTURE AND STRATIGRAPHY OF THE WESTERN MAIN RANGES BETWEEN THE SULLIVAN AND WOOD RIVERS (POSTER)

Henry Lickorish (University of Calgary)

Beneath the prominent quartzite marker of the McNaughton Formation there is a distinctive sequence of quartzite-feldspathic crossbedded sandstones and conglomerates. This sequence is generally thicker on the east, up to 1 km, but thin, 0-100m, on the west. This facies distribution may suggest filling of fault controlled basins possibly related to Late Proterozoic rifting.

A carbonate marker unit found elsewhere in Windermere stratigraphy in the middle of the thick grit sequence has been located in the core of the PCA providing control on the stratigraphic position of the Miette grits exposed in the study area. They belong to the upper division of the middle Miette. Although no upper Miette has been documented in the Sullivan River area, up to 500m of this unit is preserved near the Wood River, and possibly 100m near Tsar Creek suggesting that at the Sullivan River there is probably no more than 200m of middle Miette missing beneath the sub-Cambrian unconformity.

The deformation of the strata overlying the Gog Group above a detachment at the base of the Middle Cambrian rocks is an important structural element of the western PCA. This detachment is not evident in the eastern carbonate facies, and motion on it must be lost near the facies change. Activation of a lower detachment produced an early deformation in the Miette Group at a deep structural level. Structures associated with this deformation are not seen everywhere, and are particularly absent immediately beneath the competent Gog Group, which is itself never affected. The growth of the large scale structures which constitute the PCA must be associated with the activation of a yet lower detachment, well below sea level in the study area. The whole structure was later cut by the out-of-sequence Charley Creek Thrust.

THE ROLE OF THE UPPER DETACHMENT SURFACE IN BALANCED CROSS-SECTIONS - TURNER VALLEY, ALBERTA

MacKay, P.A., Spratt, D.A., Dept. of Geology and Geophysics, University of Calgary, Calgary, Ab. T2N 1N4

The foreland fold and thrust belt of western Canada is bounded by a lower detachment surface and an upper detachment surface. In fold and thrust belts, detachment surfaces typically occur in conjugate pairs similar to conjugate shear planes in a triaxial test. The lower detachment surface is recognized as the lowermost thrust that carries the entire deformed section within its hangingwall. The upper detachment surface is recognized as a series of observations that appear contradictory with regular foothills style deformation. Failure to recognize the upper detachment surface will lead to errors in construction of the cross-section and improper assumptions within the balanced section.

The upper detachment surface is a structural domain boundary which separates foreland verging rocks within the footwall from hinterland verging rocks within the hangingwall. This surface is compressive, dips to the foreland and places younger strata over older strata. The upper detachment surface is a brittle failure plane made up of flats and ramps that cuts both down-section and up-section in the direction of hangingwall transport.

Typical foothill's thrust faults, thicken and repeat the stratigraphic section, however the upper detachment surface cuts and thins the stratigraphic section. Faults associated with the upper detachment surface are progressively older with depth with the youngest fault developed nearest to surface. As deformation advances the upper detachment surface is abandoned and a new detachment surface develops to the foreland. These abandoned surfaces are given the name "relic upper detachment" to signify their geometric relationship within the deformed belt.

Along the banks of the Highwood and Sheep Rivers in the vicinity of Turner Valley, these relationships are observed in outcrop. Seismic data confirms the interpretation of the Turner Valley structure as a triangle zone or leading edge duplex with involvement of the upper detachment surface within the structure.

THE TRIANGLE ZONE - TURNER VALLEY, ALBERTA (POSTER)

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The Turner Valley structure is a triangle zone located at the leading edge of the foreland fold and thrust belt of the Canadian Cordillera. Detailed surface mapping, good quality seismic data and abundant well control demonstrate that the structure is a complexly faulted duplex within undeformed autochthonous strata of the plains. The upper and lower detachment surfaces, which are common to the entire deformed belt, bound the upper and lower surfaces of this duplex.

A significant hangingwall lateral ramp exists within one of the larger thrust blocks of the duplex. This ramp cuts upsection to the south from Paleozoic strata in the north to Mesozoic strata in the south. The effects of this ramp is to increase the size and displacement of the duplex to the north. As the deformed wedge increases in size to the north, the upper detachment surface is folded, uplifted, eroded and eventually abandoned.

Restored, balanced cross-sections indicate that up to 50% shortening has occurred within the wedge. Much of the shortening has occurred along extensive flats within the Exshaw and Fernie Formations.

DEXTRAL-OBLIQUE CRUSTAL THICKENING AND COLLAPSE IN PROTEROZOIC BASEMENT ROCKS OF THE MALTON COMPLEX, SOUTHERN OMINACA BELT, BRITISH COLUMBIA

Michael R. McDonough (GSC-Calgary)

The Malton Range lies near the outer limit of the internal zone of the Columbian orogen, forming the northern limit of the Monashee Mountains. It is underlain by Early Proterozoic crystalline basement of the Malton Complex, and by infolds of Late Proterozoic Windermere cover rocks.

The crystalline basement of the Malton Complex is deformed into thin ductile thrust sheets separated by discrete shear zones that display ductile mylonite fabrics and outcrop-scale northeast-directed thrust imbrication. Associated with mylonite fabrics are prominent orogen-parallel stretching lineations, indicating that the thrusts on the outer limit of the internal zone have a significant non-ideal component to their displacement history. Kinematic indicators in outcrop indicate that the non-ideal component of the thrust motion is dextral.

The thickened thrust stack was extended by normal faulting, probably in the Eocene. Brittle faults within and parallel to the Southern Rocky Mountain Trench display fibre data of chlorite-quartz intergrowths that indicate dextral oblique extension.

EVOLUTION OF SOUTHWESTERN COAST BELT AND ADJACENT INSULAR BELT

J.W.H. Monger, Geological Survey of Canada, 100, West Pender St., Vancouver V6B 1R8, B.C.

Southwestern Coast Belt (west of Harrison Lake) consists largely of Middle Jurassic to mid-Cretaceous granitic rocks, with fault slices and pendants of Triassic through Lower Cretaceous strata, whereas Insular Belt to the west comprises mainly mid-Paleozoic to Middle Jurassic Wrangellian strata, and lesser Early Jurassic plutons. Late Triassic(?) and Early Jurassic Wrangellian strata occur in southwesternmost Coast Belt, Late Jurassic and Early Cretaceous magmatic rocks are restricted to southwestern Coast Belt, and Coast and Insular belts are overlapped by Late Cretaceous and Tertiary Georgia Basin clastics. The region was affected by: (1) post-185, pre-155 Ma contraction in SW Coast Belt; (2) Late Jurassic(?) - Early Cretaceous (synplutonic) extension in SW Coast Belt; (3) early Late Cretaceous (93 Ma) contraction (whose metamorphic/structural culmination is in SE Coast Belt); (4) early(?) Tertiary contraction in E Vancouver Island; (5) late Tertiary northeast-trending extension and (?) lateral translation; (6) late Tertiary to Recent differential uplift of Coast Belt and (?) western Vancouver Island, creating Georgia Depression. Speculatively, older Georgia Basin strata are foreland basin deposits related to (3) but largely isolated from their sources by (6), and younger strata are possibly rift basin deposits related to (5) that may result from Juan de Fuca Plate indentation.

GEOLOGY OF FOOTWALL OF THE BLACKMAN THRUST AND FACIES VARIATIONS IN MIDDLE MIETTE GROUP, SOUTHERN SELWYN RANGE, B.C. (POSTER)

Eric Mountjoy and Stephen Grasby (McGill University)

Near Blackman Creek, repetition of the distinctive Old Fort Point Formation, between the Selwyn Range and Hugh Allan thrusts, indicates the presence of two additional thrust faults in the footwall of the Blackman Thrust. Correlation of stratigraphy across this area, using the Old Fort Point Formation as a datum, shows that the middle Miette Group "shales-out" from east to west across the southwest part of the Fraser River Antiform. The top of the middle Miette also "shales-out" west of the Chatter Creek Fault near Athabasca and Canoe passes.

THE KOOTENAY - NORTH AMERICA TERRANE BOUNDARY IN THE CARIBOO MOUNTAINS: THE PLEASANT VALLEY THRUST REVISITED

Donald Murphy (GSC-Vancouver)

A cryptic, km-scale, folded, premetamorphic shear zone separating North American crystalline basement and Windermere Supergroup cover from upper clastic, semipelitic-amphibolite, lower pelite, and lower grit units of Kootenay Terrane was observed during the last two summers' mapping in the Premier Range of the southern Cariboo Mountains. The shear zone was identified on the basis of observed or inferred footwall stratigraphic cutoffs, incongruent hangingwall and footwall structural geometries, discontinuous reversal of stratigraphic facing directions, and the observation of a zone consisting of several hundred meters to over a kilometre of isoclinally folded pelitic schist and quartzofeldspathic psammite (proportions vary). Outcrop- to large cliff-scale folds with a sheath-like shape (approximate NW-SE trending sheath axis) occur throughout the zone. A pronounced NW-SE trending clast elongation lineation occurs throughout the region (hangingwall, footwall, and shear zone) but may be a younger feature associated with the syn-metamorphic Early Cretaceous tight, 1:250 000-scale, NE-overturned folds which deform the shear zone. Hangingwall and footwall folds verge to the southwest suggesting a southwestwardly directed component of displacement and also a Middle Jurassic age for the shear zone. The shear zone cuts upsection to the southwest in both hangingwall and footwall from where observed in the Premier Range and may be traced to near where the Pleasant Valley Thrust has been mapped in Wells Gray Provincial Park. Including data from the Quesnel Highlands, a thrust trajectory can be defined cutting downsection from Late Paleozoic and Mesozoic rocks at shallow structural levels in the west to Early Proterozoic crystalline basement rocks at deep structural levels in the east.

CANOE RIVER (83D): A NEW 1:250000 GEOLOGICAL COMPILATION (POSTER)

Donald Murphy (GSC-Vancouver)

Canoe River map area (83D) lies in eastern British Columbia and western Alberta between 52°N and 53°N. The map area straddles the southern Rocky Mountain Trench (SRMT) near the town of Valemount, B.C. and includes parts of the southern Cariboo Mountains, northern Monashee Mountains, and the Park and Selwyn Ranges of the western Rocky Mountains.

Canoe River map area comprises parts of the Rocky Mountain fold and thrust and Omineca belts of the Canadian Cordillera. In this area, the boundary between the two belts has traditionally been placed in the SRMT; however, the occurrence in the Bearfoot thrust sheet east of the SRMT of Early Proterozoic orthogneissic basement and para-autochthonous metasedimentary rocks with structural histories similar to Omineca Belt rocks warrants relocation of part of the boundary to the Bearfoot fault. The SRMT at this latitude is occupied by faults with down-to-the-west normal dip-slip and possibly early minor dextral strike-slip.

The Rocky Mountain fold and thrust belt in Canoe River map area is composed primarily of faulted, folded, and weakly metamorphosed strata ranging in age from Late Proterozoic to Triassic (Miette Group of the Windermere Supergroup; Gog Group; Snake Indian, Eldon, Pika, Arctomys, Lynx, Survey Peak formations; Falholme Group; Sassenach, Falliser, and Banff formations; and Rundle and Spray River groups. Originally deposited at or near the western margin of North America, these strata were shortened intermittently during the late Jurassic to Paleocene interval by displacement on an imbricate and interlocking array of mainly NE-vergent thrust faults. The structurally highest thrusts in the western Main Ranges are synmetamorphic and may correlate with Early Cretaceous synmetamorphic NE-vergent folds and thrust of the Omineca Belt.

The Omineca Belt at this latitude consists primarily of multiply deformed and variably metamorphosed rocks of the Late Proterozoic Windermere Supergroup (Kaza and Cariboo groups in Cariboo Mountains and equivalent lower grit and pelite units of Monashee and Selkirk mountains), Kootenay Terrane (lower grit and pelite, semipelitic-amphibolite, middle marble, and upper clastic units of Monashee, Cariboo, and Selkirk mountains) and Proterozoic gneiss considered to be basement to the North American continental margin sequence, including Kootenay Terrane (Malton, Yellowjacket, Bulldog, Hugh Allan, Mt. Blackman, and Gold Creek gneisses). The basement/cover contact is conformable in the Cariboo Mountains, but is the locus of shear zones in the northern Monashee and Rocky mountains. Regardless of the nature of the basement/cover contact, the overlying stratigraphy can be correlated between ranges, suggesting that shearing is concentrated along a basal unconformity. Neither the age nor magnitude of displacement along the contact are known.

In addition to the Early Cretaceous NE-vergent synmetamorphic phase of deformation shared with rocks of the Rocky Mountain belt, rocks of the Omineca Belt also exhibit older polyphase deformation, metamorphism, and plutonism and younger extensional faulting. The early history includes Middle Jurassic SW-vergent folding, thrusting, regional metamorphism, and plutonism associated with the juxtaposition of Kootenay Terrane and Gold Creek Gneiss, Windermere Supergroup and younger rocks along the Pleasant Valley Thrust, Late Cretaceous, early Late Triassic and Devonian-Mississippian plutonism, and pre-Middle Jurassic NE-vergent deformation. Extension leading to unroofing and exposure of deep crustal levels occurred during the Eocene, accommodated by structures such as the North Thompson-Albreda fault, late normal faults in the SRMT, and an array of oblique dextral-normal faults in the western Cariboo Mountains and Quesnel Highlands.

Juxtaposition of the rocks of Rocky Mountain and Omineca belts probably occurred during the Early Cretaceous by displacement on NE-vergent thrusts. The detailed geometry of that deformation at deep structural levels in both belts is controversial and the focus of current research.

Upper Cretaceous-Tertiary Georgia Basin: Forearc or Foreland?

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Georgia Basin comprises the late Cretaceous Nanaimo Group of Georgia Strait, plus Tertiary rocks in the Fraser Delta area and N.W. Washington. Nanaimo Group sedimentation has generally been interpreted as occurring in a forearc basin and Tertiary sedimentation in a strike-slip basin.

The Nanaimo Group can also be interpreted as the deposits of a foreland basin, with most material derived from the Coast Belt to the east and N.W. Cascades to the southeast and shed onto a foreland of Mesozoic-Paleozoic Wrangellia terrane and the western Coast Belt. Late Cretaceous southwest-vergent thrusting has recently been documented in the Coast Belt east of the Georgia Basin. Current radiometric constraints on the thrusting are 96-92 Ma, older than the oldest known Nanaimo Group rocks (about 91-88 Ma). However many thrusts are not precisely constrained. The closeness of the known age of the thrusting and initial Nanaimo Group deposition suggests thrusting influenced initial basin formation.

Paleocurrent and provenance trends within the Nanaimo Group support this interpretation. Except for lowest units of Nanaimo Group, most paleocurrents indicate derivation from the Coast Mountains to the east or N.W. Cascade system to the south. Although lowest units have local provenance, most of the Nanaimo Group contains detritus derived predominantly from thrust belts to the east or south.

Recent recognition of a southwest-vergent thrust belt of probable late Paleocene age in the southern Nanaimo Group (England, 1990) suggests reinterpretation of early Tertiary basin tectonic models. Compressional features in the late Paleocene-Eocene Chukanut Formation of N.W. Washington parallel the trend of the thrust belt and may be coeval to the thrusting. Seismic and gravity data from the Fraser lowlands show northeast and northwest trending structures, including southwest-vergent thrust faults which cut lower strata. Age constraints on the seismic stratigraphy are poor, but the main compressional event may be Paleocene-Eocene age, suggesting thrusting also influenced initial Tertiary basin formation.

A MODEL OF MIDDLE EOCENE EXTENSION AND STRIKE-SLIP FAULTING FOR THE CANADIAN CORDILLERA AND PACIFIC NORTHWEST (Poster)

Parrish, R. R., Geol. Survey of Canada, 601 Booth Street, Ottawa, Ont. K1A 0E8, and Coleman, Meg E., Dept. Earth Sci., Carleton University, Ottawa, Ont., K1S 5B6 (now travelling the world).

East of the Coast Mountains, the main dextral strike-slip faults of the Cordillera are the Tintina-Northern Rocky Mountain Trench, Yalakom, Fraser River faults, and the Lewis and Clark zone. Aggregate Eocene displacement on these may exceed 200 km of northward translation of the Coast Mountains crustal block. The main period of crustal extension in southern B.C. and the U.S. north of the Snake River Plain, as well as the Challis magmatic event, occurred during the Middle Eocene. Contraction in the Rocky Mountains and Omineca Belt had ceased by this time. The Fraser fault is entirely younger than 46 Ma, and postdates the main period of extension.

Like Price (1979), we suggest a relationship between strike-slip faulting and extension in the Cordillera, with several modifications. We propose that the Lewis and Clark and Yalakom fault zones were part of the same fault system which translated the Coast Mountains block northward; this fault zone has zero displacement at each end. South of Lewis and Clark zone, the Idaho batholith was pulled away from the craton, creating an extended zone in its wake; this may have included some of the area presently covered by Columbia River basalts. North of the termination of the Yalakom fault in west-central B.C., the Coast and Intermontane zones formed one crustal block which moved north by strike-slip faulting on the Tintina-NRMT fault system and by pulling away from the craton to form a wide heterogeneous zone of crustal extension in southern B.C. and northern Washington. Middle Eocene volcanism broadly coincides with the areas of complex intraplate extensional deformation.

This model provides an explanation for the peculiar termination of both the Lewis and Clark and Yalakom faults; it also suggests that plate motions had a strong bearing on the distinctive Middle Eocene tectonics of the northern Cordillera.

EOCENE TECTONICS IN THE HORSECRANCH RANGE, NORTHERN OMINECA BELT, BRITISH COLUMBIA

Heather E. Flint (University of Alberta)

The Horsecranch Range, north-central B.C. is underlain by a high-grade schist complex (including staurolite and sillimanite pelitic, psammitic, and metacarbonate schist, and orthogneiss), granitic, dioritic, and gabbroic rocks, and low-grade chloritic phyllite, quartzite, and non-metamorphosed carbonate rocks. Low and high-grade rocks are juxtaposed along a NW-striking, moderately to steeply SW-dipping, mylonite zone along the western side of the range. Regional metamorphism (650 °C, 6-8 kb) outlasted isoclinal, syn-metamorphic folding of S₁ about NNW-trending hinges and development of axial planar S₂. Monazite and zircon U-Pb crystallization ages (113 ± 0.4 Ma) for syn- to post-S₂ granitic rocks constrain regional metamorphic peak to mid-Cretaceous or younger. Gentle to tight, post-metamorphic folding of S₂ about NW-trending hinges was followed by moderate temperature (ca. 300-350 °C) mylonitization along the western side of the range. Kinematic indicators in mylonite reflect widespread top (upper member of shear couple)-down-to-the-northwest and local dextral strike-slip displacement. Zircon and monazite U-Pb crystallization ages in granitic mylonite, ⁴⁰Ar-³⁹Ar cooling ages for hornblende, muscovite, and biotite from schist, granite, and mylonite, and fission track data for apatite from granitic orthogneiss and mylonite record Eocene mylonitization and rapid cooling in the schist complex from ca. 500 °C to ≤ 50 °C in ≤ 7 Ma. Comparison with simple shear models indicates that mylonite may have developed in a Riedel (dextral strike-slip) shear zone associated with the regional dextral strike-slip Kechika fault. Late Cretaceous to Early Tertiary migration of regional compressive stress from N to NE caused Eocene NW-directed extension obliquely down-dip in this zone and gentle NE-trending arching, uplift, and rapid cooling of the schist complex. North-striking(?) brittle faults bounding the range may have developed contemporaneously as strike-slip faults.

THOUGHTS ON THE ROLE OF STRIKE-SLIP FAULTS IN THE DEVELOPMENT OF THE NORTHEASTERNMOST CORDILLERAN THRUST BELT, BEAUFORT SEA REGION

Kevin Root, Shell Canada Limited, Calgary, Alberta

During the late Paleocene - middle Eocene, the Beaufort Fold and Thrust Belt was bounded on the southeast by a zone of right-lateral strike-slip faults that apparently is the northern extension of the Rapid Fault Array. Subsequently, the strike-slip zone ceased most activity and the thrust belt migrated along strike, to the southeast, and was bounded by the Donna River right-lateral strike-slip fault. The presence of northeast-striking right lateral faults, east-striking left-lateral antithetic strike-slip faults, and possible rotations about vertical axes, within the thrust belt suggests it formed within a broad zone of right-lateral shear.

AN EXAMPLE OF FOLD MECHANISMS AND GEOMETRY FOR THE JURA-CRETACEOUS BLAIRMORE AND KOOTENAY GROUPS SOUTHEASTERN ROCKY MOUNTAINS (Poster)

Deborah A. Sanderson (Petrel-Robertson, Calgary)

Fold styles for the Mesozoic sequence in the southeastern Rocky Mountains are well illustrated in the Highwood-Elbow area. Steep exposures over a distance of more than ten kilometres along strike have provided information that was not readily available based on surface exposure alone in the Jurassic-Cretaceous clastic sequence.

Study of geometries using fold profiles, dip isogons, fold axis trend and plunge, radius of curvature and thickness of the Blairmore and Kootenay Groups have been used to illustrate the changes of a major fold along its hinge, at different stratigraphic and structural levels. Fold mechanisms can be deduced from smaller scale folds associated with the megascopic fold. These include flexural slip and flexural flow along boundaries of contrasting ductility, and within more ductile units respectively. Overall geometries resemble 'modified' parallel folds with converging and diverging dip isogons. The limitations of the concentric fold geometry are examined in light of the fold termination along strike.

Structure of the Kootenay Terrane between Scrip Nappe and Monashee Terrane, southern Omineca Belt, British Columbia (Poster)

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In the hanging wall of the Monashee Decollement, and south of Scrip Nappe, the Kootenay Terrane is characterized by polydeformed, sillimanite-grade, sedimentary and igneous rocks, plus extensive leucogranite intrusions. Stratified rocks are correlated with rocks to the north which are inferred to be part of the Upper Proterozoic Horsethief Creek Group. A strong regional foliation is defined by co-planar compositional layering, schistosity, gneissic and migmatitic layering. This foliation records four phases of folding. The first-order macroscopic structure is an overall upright gentle synform which deforms the upright limb of a reclined F_1 syncline inferred to underlie Scrip Nappe. The hinge zone of Scrip Nappe may crop out in the study area, south of its previously inferred position. The macroscopic structure is complicated by extensive emplacement of four suites of leucogranite, plus F_2 and local F_3 folding. An east-west trending sillimanite-grade mineral elongation lineation is coaxial with mesoscopic F_1 and F_2 folds. Mesoscopic post-metamorphic F_3 and F_4 folds are rare. The Monashee Decollement is marked by a zone of high strain >1000 m thick in which spectacular shear sense indicators indicate east-vergent overthrusting of the Kootenay Terrane. The Monashee Decollement truncates F_2 folds in both its foot and hanging walls. Within the hanging wall of the Monashee Decollement, high-grade mylonitic fabrics record horizontal shortening and possible coeval thinning of the Kootenay Terrane. Low-grade unannealed mylonitic fabrics define discrete shear zones which record down-to-the-west normal motion and horizontal extension of the Kootenay Terrane. In progress U-Pb geochronologic studies will provide age constraints on the ages of granite intrusion, deformation and metamorphism. Preliminary results of these geochronologic studies will be presented.

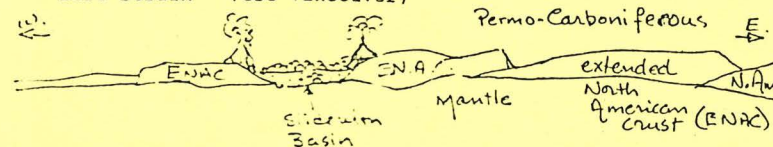
THE TRIANGLE ZONE IN THE JUMPINGPOUND-WILDCAT AREA (POSTER)
Robin T. Slotboom (University of Calgary)

Good quality seismic data, borehole data, surface geologic data, and gravity data from the Jumpingpound-Wildcat area, west of Calgary, have been analysed in an attempt to image the triangle zone in this area. The data reveal a structure that contains elements that both challenge and support the current ideas of this enigmatic feature. In the study area, structures that are typical of the triangle zone eg. thrust faulting, folding, and tectonic wedging can be seen. However, the interpretation of the data shows features such as antithetic faulting, a fault far ahead of the main culmination, the lack of a simple foreland branch point joining upper and lower detachments, and wedging and duplexing at several stratigraphic levels and scales, that are surprising in light of the current models.

In this presentation focus will be given to seismic data from the study area: what observations can be made from them, and what significance those observations have. Some general observations about the efficacy of various geophysical techniques to unravel triangle-zone structures will also be made.

A PERMO-CARBONIFEROUS RIFT IN MY THINKING (ABOUT THE PINE PASS MAP AREA)

Bert Struik (GSC-Vancouver)



Pine Pass map area may contain the eastern edge of a Permo-Carboniferous Slide Mountain rift basin, as represented by fragmental basalt and diorite deposited on Devonian? Egan Group, and early Paleozoic Road River Gp and Fran Gp. These rocks are presently juxtaposed by the McLeod Lake Fault against Rocky Mountains palaeo-stratigraphy.

THE TAIL OF THE NELSON BATHOLITE STRUCTURE AND EMPLACEMENT

VOGL, J.J., and SIMONY, P.S., Geology Department, University of Calgary, Calgary, AB, T2N 1N4

The Mid-Jurassic Nelson Batholith in southeastern British Columbia consists of a main northern mass with 1500 km² outcrop area and a southward narrowing, 25 km long "tail". On the east the "tail" intrudes North American Cambrian strata while the rest of the Batholith intrudes Mesozoic rocks of the accreted Quesnel Terrane. It is therefore a "striching" pluton. The "tail" is composed of three sub-vertical porphyritic granodiorite and tonalite sheets parallel to its margins and concordant with the regional structural grain.

Similar pluton "tails" have been interpreted as the deeper portion of the tadpole-shaped diapirs exposed in oblique crustal sections. Similar metamorphic pressures and stratigraphic level along the length of the body and layer-parallel injection on the west margin of the "tail" suggest that a similar origin is unlikely.

Two fabrics within the "tail" are recognized. A foliation (S_1) parallel to the country rock layering both within the "tail" and at the margins is defined by undeformed feldspars and biotites and may be magmatic in origin. A regional scale mylonitic foliation (S_2) is sub-vertical, strikes NNE and shows a consistent dextral shear sense. S_2 cuts S_1 where S_1 strikes NNW and may rotate S_1 into parallelism with S_2 or enhance S_1 with grain scale shear bands where S_1 is parallel to S_2 . Recrystallization of feldspars and the stability of hornblende indicate a relatively high temperature for the deformation (country rocks are greenschist facies). This suggests that deformation may have occurred soon after emplacement thus providing an age constraint for dextral shear in this area.

TECTONIC SIGNIFICANCE OF STRATIGRAPHIC AND STRUCTURAL CONTRASTS BETWEEN THE KOOTENAY ARC AND THE PURCELL ANTICLINORIUM IN THE VICINITY OF GLACIER AND HAMILL CREEKS, B.C. (POSTER)

Marian J. Warren (Queen's University)

Tight, upright folds in Horsethief Creek, Hamill, Badshot, and Lardeau strata in the upper reaches of Hamill and Glacier Creeks include elongate, semiconcordant granitic plutons (J.E. Reesor, 1973, GSC Memoir 369), which should provide constraints on pressure, temperature, and timing of the deformation. These structures mark a transition from the northeast-verging, lower greenschist facies thrust and fold structures of the eastern Purcell anticlinorium, to the southwest-verging, refolded, upper greenschist to amphibolite facies nappes of the Kootenay arc (J.T. Fyles, 1964, B.C. Department of Mines and Petroleum Resources, Bulletin 49). This structural link, the focus of field studies to begin in 1991, provides an opportunity to assess the nature and tectonic significance of these contrasting structural and metamorphic domains.

A profound stratigraphic contrast occurs between the eastern Purcell anticlinorium and the Kootenay arc. The Hamill-Badshot-Lardeau succession, which is >2 km thick in the structural transition zone and the Kootenay arc, is missing 10-20 km to the east, beneath the Mt. Forster thrust fault, where upper Devonian strata rest unconformably on the Horsethief Creek Group (K.G. Root, 1985, GSC Paper 85-1A). The structures responsible for this contrast, and the nature of their influence on compressional deformation, will be a second main focus of the project.

STRUCTURE OF THE TAKLA GROUP EAST OF THE FINLAY-INGENIKA FAULT, MCCONNELL AREA, NORTH CENTRAL B.C.

Guowei Zhang (McGill University)

Structure of the Takla Group in the study area is characterized predominantly by steeply dipping or vertical, dextral strike-slip faults trending NW, NNW and NNE, and sinistral strike-slip faults trending ENE, as well as two large-scale folds with axes trending NW and NNW, respectively. The folds and faults are thought to have formed in association with dextral transcurrent motion on the Finlay-Ingenika fault. They cut the Takla Group volcanic and volcanoclastic rocks into fault-bounded, weakly deformed blocks. As displacement on the Finlay-Ingenika fault progressed, deformation was confined to the previously formed faults while the weakly deformed, discrete upper crustal blocks were rotated clockwise in response to the large-scale, dextral faulting. Statistics of regionally distributed cleavage indicate that the amount of rotation was not identical over the study area but greater close to, and smaller away from, the Finlay-Ingenika fault.

Sunday, February 24Program - North American Crust and the Cordilleran Foreland Belts

- 9:00 Michael R. McDonough (GSC-Calgary) - Dextral-oblique Crustal Thickening and Collapse in Proterozoic Basement Rocks of the Malton Complex, southern Omineca Belt, B.C.
- 9:15 Donald Murphy (GSC-Vancouver) - The Kootenay - North America terrane boundary in the Cariboo Mountains, B.C.: the Pleasant Valley thrust revisited
- 9:30 Charles A. Ferguson (Univ. of Calgary) - Latest Proterozoic slope and platform in the Omineca belt, southeast British Columbia
- 9:45 Discussion
- 10:00 Posters and coffee
- 11:00 Stephen Grasby (McGill) - Structural Interpretation of the Selwyn Range Fault, Western Main Ranges, B.C.
- 11:15 Bert Struik (GSC-Vancouver) - A Permian-Carboniferous rift in my thinking (about Pine Pass map area)
- 11:30 Jim Barclay, F.F. Krause, R.I. Campbell, & J. Utting (Univ. of Calgary & GSC) - Dynamic Casting and Growth Faulting of Dawson Creek Graben Complex: Carboniferous-Permian, Western Canada Basin
- 11:45 Discussion
- 12:00 Lunch
- 1:00 Posters
- 2:00 Kevin Root (Shell Canada Ltd.) - Thoughts on the Role of Strike-Slip Faults in the Development of the northeasternmost Cordilleran Thrust Belt, Beaufort Sea Region
- 2:15 Teresa Kerber (Queen's) - Deformation in the Footwall of the Lewis Thrust Fault, Northern Kootenay Pass Reentrant, Alberta
- 2:30 Discussion
- 2:45 Posters and coffee
- 3:30 Andrew Hynes (McGill) - Gravity and Flexure in the Canadian Cordillera
- 3:45 Don Lawton, D.A. Spratt, and R.T. Slotboom (Univ. of Calgary) - Structural Enigmas in the East Flank of the Triangle Zone
- 4:00 Paul A. MacKay and D.A. Spratt (Univ. of Calgary) - The Role of the Upper Detachment Surface in Balanced Cross-sections - Turner Valley, Alberta
- 4:15 Discussion
- 4:30 Concluding remarks and plans for next year
- 4:45-5:30 Posters

Sunday Posters

- Maurice Colpron (Queen's) - Paleozoic(?) and Mesozoic Tectonic Evolution of the western Selkirk Mountains, B.C.: An Evaluation of the "Multiple Suture" Hypothesis and Modes of Crustal Thickening
- Carol Evenchick (GSC-Vancouver) - The Skeena Fold Belt
- Stephen Grasby and Eric Mountjoy (McGill) - Dextral and Compressional Motion Along the Chatter Creek Fault
- Stephen N. Hiebert (Univ. of Calgary) - Structural Studies in the Pincher Creek Area, Alberta
- Willem Langenberg (Alberta Research Council) - Balanced Cross Sections Through the Outer Foothills in the Coalspur Area, Alberta
- Henry Lickorish (Univ. of Calgary) - Structure and Stratigraphy of the Western Main Ranges between the Sullivan and Wood Rivers
- Paul A. MacKay and Deborah A. Spratt (Univ. of Calgary) - The Triangle Zone - Turner Valley, Alberta
- Eric Mountjoy and Stephen Grasby (McGill) - Geology of the Footwall of the Blackman Thrust and Facies Variations in the Middle Miette Group, Southern Selwyn Range, B.C.
- Donald C. Murphy (GSC-Vancouver) - Canoe River (83D): a new 1:250 000 geologic compilation
- Deborah Sanderson (Petrel-Robertson) - An Example of Fold Mechanisms and Geometry for the Jura-Cretaceous Blairmore and Kootenay Groups, southeastern Rocky Mountains
- Robin T. Slotboom (Univ. of Calgary) - The Triangle Zone in the Jumpingpound-Wildcat Area
- Marian J. Warren (Queen's) - Tectonic Significance of Stratigraphic and Structural Contrasts Between the Kootenay Arc and the Purcell Anticlinorium in the Vicinity of Glacier and Hamill Creeks, B.C.

Note: 1) Dick Brown suggests episodic extension in Selkirk from Mid. J. to Eocene. (??)

2) L. Lawley: both Eup-W and E-down in ductile fabric of SFCF

ABSTRACTS ARE ARRANGED ALPHABETICALLY BY FIRST AUTHOR'S SURNAME

1991 CORDILLERAN TECTONICS WORKSHOP - UNIVERSITY OF CALGARY

LIST OF REGISTRANTS

University of Alberta

Philippe Erdmer
Barbara Henderson
Heather E. Plint
Robert Stevens

University of British Columbia

Richard Armstrong
Richard Friedman
Craig Hart
Thomas Heah
J. Brian Mahoney

University of Calgary

Jon Einarsen
Charles Ferguson
Edward D. Ghent
Tim Grover
Stephen Hiebert
Fed Krause
Don Lawton
Henry Lickorish
Paul MacKay
Philip S. Simony
Robin Slotboom
Greg Soule
Deborah A. Spratt
Sabrina Trupia
Jim Vogl

Carleton University

Richard L. Brown
Sharon Carr
James L. Crowley
Lisel Currie
George M. Green
Brad Johnson

Queen's University

Doug Archibald
Dugald Carmichael
Maurice Colpron
John Dixon
Teresa Kerber
Rob Scammell
Marian Warren
Alastair Welbon

McGill University

Stephen Grasby
Andrew Hynes
Eric Mountjoy
Guowei Zhang

University of New Brunswick

Paul Williams

University of Victoria/PGC

Michael Wingate

Western Washington University

Ned Brown

Alberta Geological Survey /ARC

Willem Langenberg

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Kim Bellefontaine
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Michael McDonough
Kirk Osadetz
Gerry Ross

GSC - Ottawa

Randy Parrish

GSC - Vancouver

Carol Evenchick
Murray Journeay
Jim Monger
Peter Mustard
Bert Struik

Grant Abbott

INAC (Yukon)

Brad Burton

Norcen

Mark Cooper

BP

Michael Covey

Esso

David Halwas

Esso

Bill Howard

Stephen Johnston

Shell

David Klepacki

Esso

→ Thomas Kubli

Mobil (Ph.D. U.of C. ~ 1989)

Ed Lisle

Amoco

Jeff Nazarchuk

Robert Pratt

Jeff Reid

BP

Kenneth Richards

Chevron

Kevin Root

Shell

Deborah Sanderson

Petrel-Robertson

Roy Shegelski

Esso

Sunday, February 24

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Best Struik = paper in Technical
about Miss. or Devonian rift
and origin of slide rth. - - -

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Thomas Kurbli → Ph.D. thesis (?) U. of C.
east of Beaver Riv. F.2. ~ 1989

Geotop studies (mostly Rb/Sr) at U.B.C.
by Dick Armstrong + others

Fang → 167 Mz (R. Parrish + Dick Brown)
not deformed out F₁ F₂ structures

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R. Brown = open file for Davnie Ck. area.
↳ Cairnes Mappe