Lithofacies and lithostratigraphic correlation potential of the Rapitan iron formation, Snake River area (NTS 106F), Yukon

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ABSTRACT

The Neoproterozoic Rapitan iron formation in the Mackenzie Mountains of Yukon and Northwest Territories is one of the largest iron deposits in North America. The Rapitan Group can be traced along strike for several hundred kilometres, but the thickest and most extensive part of this unit is located on the border between Northwest Territories and Yukon in NTS 106F. Several stratigraphic sections in the areas of Discovery and Iron creeks were measured as part of a larger effort to understand basin architecture and marine redox history during deposition of the Rapitan Group, with special emphasis on attributes of the thick interval of iron formation. The iron formation contains diverse textures including a wide variety of jasper nodules and beds. Due to the variable presence of these diverse textures, long-distance correlation of iron formation correlation is challenging. Minor copper mineralization of probable post-depositional origin was found in local float at Discovery Creek and *in situ* at Iron Creek.

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INTRODUCTION

The Rapitan iron formation of the Mackenzie and Wernecke Mountains (Northwest Territories (NWT) and Yukon) is the archetype of Neoproterozoic 'Rapitan-type' iron formations, and was deposited in a dynamic early rift setting. Although this iron formation has been a major component in models for the surficial and oceanic evolution of the Precambrian Earth, and despite several excellent studies in the 1980s and early 1990s, it remains relatively poorly understood. This paper reports on one component of a larger study attempt to resolve the stratigraphy, geochemistry, and basin architecture of the Rapitan iron formation in NWT and Yukon, in an effort to explain its role in the geochemical evolution of Earth's surface environments and the tectonic history of the northern Canadian Cordillera.

One of the more controversial questions about the Rapitan Group relates to the disputed temporal relationships among the major lithostratigraphic units exposed in different areas along its more than 200 hundred kilometres of strike length. Although several regional correlation schemes have been proposed, no true consensus has emerged regarding the temporal relationships among the depositional units in the two main Rapitan basins (Snake River and Redstone-Keele-Mountain Rivers). The ability to correlate at a broad regional scale (hundreds of kilometres), as well as at a comparatively local scale (kilometres to tens of kilometres) is highly desirable, because it would enable predictions about the possible presence and composition of Rapitan strata in the subsurface, permit the tracing of mineralized units (iron, and to a lesser extent, copper-rich layers), and identify marker beds that can provide the basis for interpretations regarding basin evolution. This paper provides detailed descriptions of stratigraphic sections of this iron formation in Yukon, assesses the potential for local-scale correlation within the Snake River basin, offers a preliminary solution to long-standing problems in regional stratigraphic correlation of the Rapitan Group, and discusses the implications of minor copper occurrences in the area.

PREVIOUS WORK

The Neoproterozoic Rapitan iron formation in the Snake River area, Yukon, was the subject of extensive work in past decades. Iron formation was first identified in the Snake River area during the Klondike gold rush (Keele, 1906). Associated diamictite was first interpreted as glaciogenic by Ziegler (1959). Extensive exploration for iron ore at the Crest deposit was undertaken in the 1960s, and up to 18.6 billion tonnes of iron reserves were estimated, including 5.6 billion tonnes at 47.2% iron along Iron Creek in Yukon (Stuart, 1963). Extensive research into the stratigraphy and sedimentology of the Rapitan Group was conducted through the 1970s, and focused on assessing basin architecture and glacial sedimentology (*e.g.*, Eisbacher, 1976, 1978, 1981a,b; Young, 1976); this research resulted in designation of the Mount Berg, Sayunei, and Shezal formations (Green and Godwin, 1963; Upitis, 1966; Eisbacher, 1981a). Further study of the stratigraphy, geochemistry, and depositional setting followed, leading to the suggestion that hydrothermal and glacial processes combined to form the iron deposit (Yeo, 1981, 1984, 1986). This was complemented by an intensive geochemical study of drill core archived from earlier exploration (Klein and Beukes, 1993). The latter authors produced an elegant depositional model for the iron formation, in which a low-oxygen, subglacial water mass became enriched in ferrous iron (Fe^{2+}) and was subsequently oxidized upon glacial retreat and reventilation of the ocean. At the time, this was a plausible depositional model in the context of the early iterations of the "snowball" Earth model (*e.g.*, Kirschvink, 1992), but since then new developments in the understanding of basin analysis, redox geochemistry (*e.g.*, Tribovillard *et al.*, 2006), and Proterozoic oceanic chemistry (*e.g.*, Lyons *et al.*, 2009) have necessitated a renewed stratigraphic and geochemical examination of the Rapitan iron formation.

The Crest deposit of the Rapitan iron formation straddles the border between Yukon and NWT in NTS map sheet 106F, with the bulk of the thick iron formation in the vicinity of Iron Creek, a tributary of the Snake River. Another thick exposure of the iron formation is present along the Cranswick River, and thinner exposures are present between these main localities, such as along Discovery Creek. This paper presents selected stratigraphic sections measured along Discovery Creek and Iron Creek (Fig. 1).

RAPITAN IRON FORMATION STRATIGRAPHY

DISCOVERY CREEK

Stratigraphic section Discovery Creek 2 (DC-2 on Fig. 1) was measured near the headwaters of Discovery Creek, Yukon. This section includes the entire exposure of the Rapitan Group at this location, with a measured thickness of ~430 m. Here, the Rapitan Group overlies carbonate

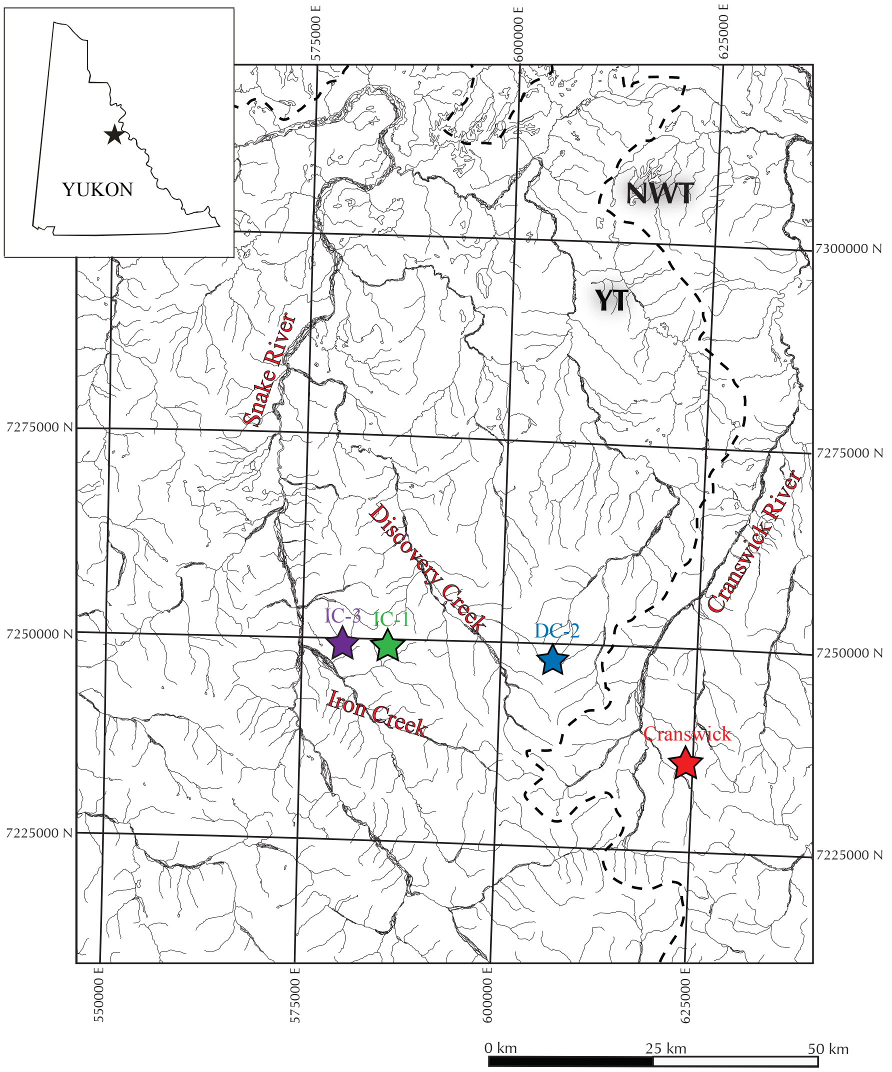

Figure 1. *Locations of measured sections in NTS 106F (NAD 83, Zone 8). Section DC-2 is marked in blue, IC-1 in green, and IC-3 in purple. A location on the Cranswick River, NWT (mentioned in text) is marked in red. Major rivers and creeks in the area are also labeled.*

rocks of the Little Dal Group and is unconformably overlain by the Cambro-Ordovician Franklin Mountain Formation. This is the thickest exposure of the Rapitan Group in the Discovery Creek area; other sections to the northwest record pronounced thinning down to zero thickness over about 10 km.

The lowermost 340 m of the section are siliciclastic rocks that have been interpreted to be glaciogenic in origin (Fig.2; Eisbacher, 1978; Yeo 1981). The dominant rock types in this section are dark red to purple, clast-poor to clast-rich intermediate diamictites (classification scheme of Moncrieff, 1989) (Fig. 3a), with a broad spectrum of clast sizes (pebble to boulder) and weathering characteristics. Previous authors (*e.g.*, Yeo, 1981) have interpreted the entirety of the Rapitan Group in the Snake River to belong to the Shezal Formation, based on the sedimentological character and weathering patterns of the diamictites in the region. Diamictites of the Shezal Formation are typically massive, clast-poor to clast-rich, intermediate pebble to boulder diamictites with characteristic fissile to platy weathering that has been referred to by the informal descriptive term "scaly" weathering, and is common in diamictites of the Discovery Creek area. The diamictites of this section are locally interbedded with matrix-supported and rare framework-supported conglomerate (Fig. 3b) and siltstone units, although in terms of overall character, each of these may be extremely clast-rich and clast-poor end-members of the diamictite spectrum, in that the clasts and/or matrix are nearly identical in all reported lithologies. The presence of dropstones in some of the siltstone units indicates that such rocks may be a variety of clast-poor diamictite, but at a minimum demonstrates their glacial association.

Iron formation is present at three distinct levels in the uppermost 67 m of the Discovery Creek section, representing about 16.5 m of this interval. The two lower iron formation units are thin (0.1 to 1 m thick). They are characterized by dark grey to blue, massive hematite bands with bright red-orange to wine-red jasper (Fig. 3c). Jasper layers are both bedded and nodular; adjacent jasper layers are commonly distinguished only by colour. The nodular jasper is typically lenticular and predominantly bright red, and often are transitional between nodular and bedded facies (Fig. 3d). The lenticular shape, coupled with the deformation of hematite beds around the nodules, suggests that the nodules are early diagenetic, pre-compactional features that developed in the upper metre or so of the sedimentary column. The two lower iron formation units form resistantly weathering prominences.

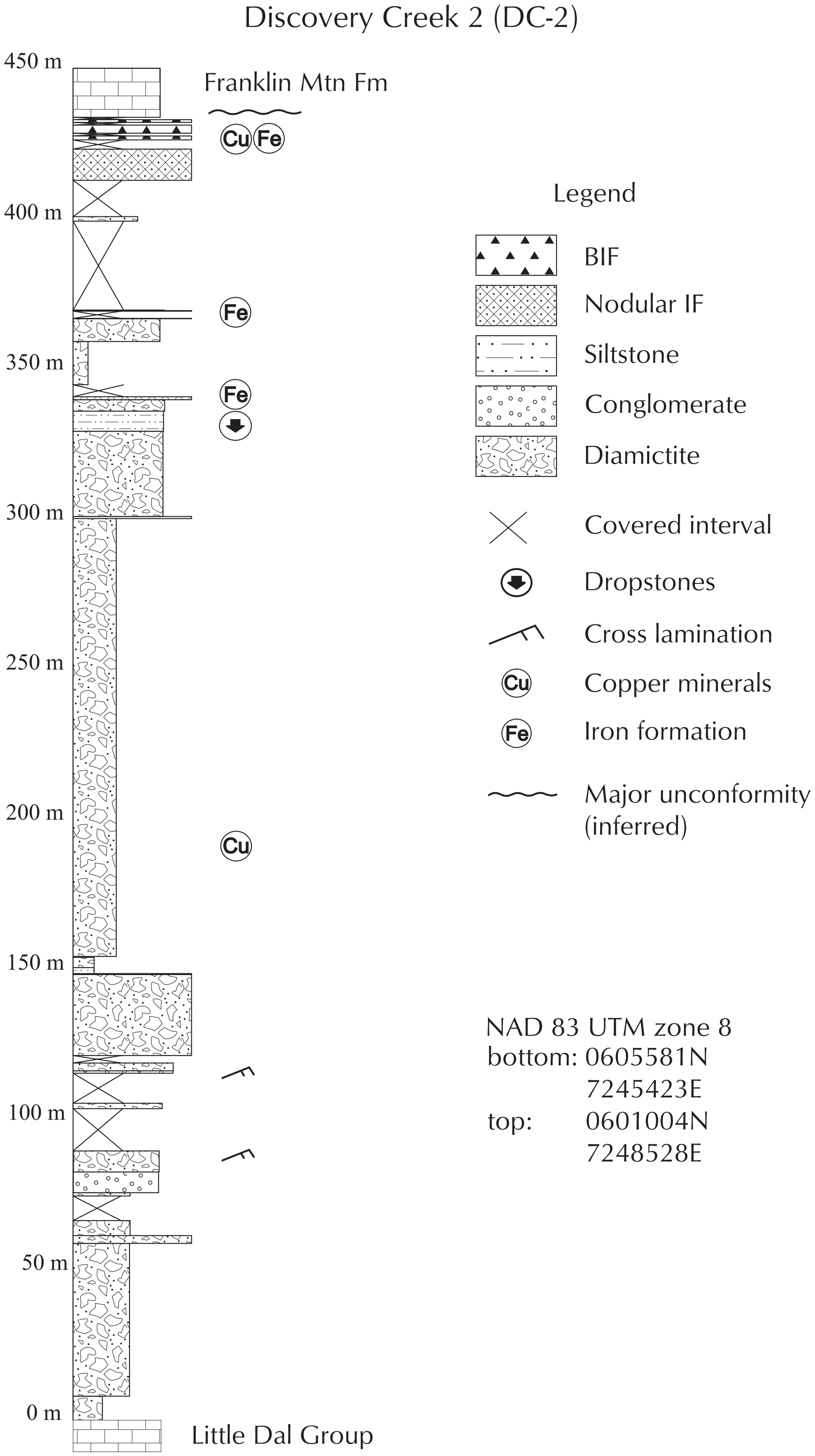

Figure 2. *Stratigraphic column of Discovery Creek 2 section (DC-2). Box widths depict the relative weathering profile of natural exposures. Iron formation units are marked by circled Fe due to the very thin exposure of this lithofacies relative to the thickness of the measured section. Copper showings are marked with a circled Cu. Base of measured section is at the contact between the underlying Little Dal Group A and the base of the Rapitan Group. Above the top of the section are unmeasured carbonate rocks of the Franklin Mountain Formation.*

As much as 15.3 m of the upper iron formation is exposed in a 20.2 m-thick unit. Unlike the lower (thinner) iron formation units, the upper unit has a greater range of textures and colours. Jasper beds are bright red-orange to wine-red, with shades of orange that are not present in lower units. Nodule shape in this unit is also more varied: subspherical nodules indicate minimal compaction, whereas lenticular and ellipsoidal nodules indicate considerable bedding-parallel flattening. The more spherical nodules do not crosscut bedding in the hematite, and so are probably of very early diagenetic origin and formed pre-compaction, much like the more flattened (lensoidal) nodules. There is no apparent relationship between stratigraphic position and the degree of nodule compaction, and so the cause for variation in nodule shape remains unknown. Contacts between jasper and hematite beds are commonly planar, although irregular contacts are also present. This iron-formation-bearing interval forms the uppermost exposure of the Rapitan Group in the Discovery Creek area and is overlain by a 1 m thick covered interval below the first exposure of the overlying Franklin Mountain Formation.

The most unusual finding in this field study was the discovery of two occurrences of copper mineralization in the Rapitan Group section at Discovery Creek. Copper has not been previously reported in the Rapitan Group in

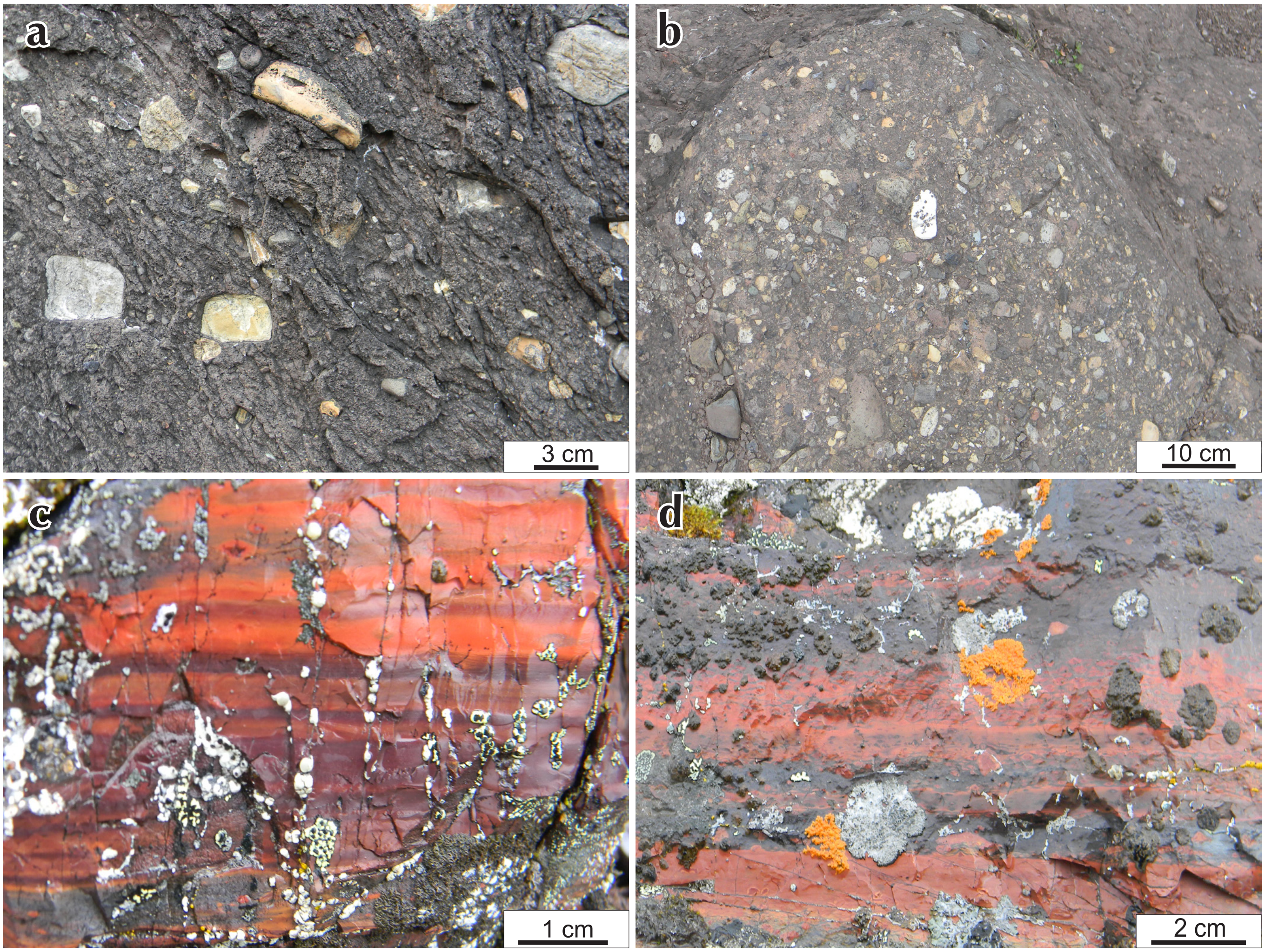

Figure 3. *Photographs of typical lithofacies from section DC-2.* ***(a)*** *Pebble-bearing clast-poor intermediate diamictite dominates the lower part of the section (located at 89.7 m).* ***(b)*** *Pebble conglomerate, the framework-supported end-member of the range of siliciclastic material (siltstone to conglomerate) present in this section (located at 145 m).* ***(c)*** *Bedded iron formation exhibiting interbedded jasper of different colours (located at 350 m). This style of bedding was suggested to be of diagenetic origin by Klein and Beukes (1993).* ***(d)*** *Iron formation with both bedded and nodular types. Some jasper bands appear to be transitional between nodules and beds, a common texture throughout the region (located at 349 m).*

this area, but it is associated with the underlying Coates Lake Group in NWT (*e.g.*, Jefferson and Ruelle, 1987). Both copper occurrences at DC-2 are in float, but are interpreted to be approximately *in situ* due to the knife-edge geometry of the ridge on which they were found, which would prevent samples that had been transported more than a few metres from remaining on the ridge crest. The lower copper occurrence is in a diamictite unit at 209.3 m, although its exact original stratigraphic position is uncertain. The occurrence consists of malachite-stained pebbles that have weathered out completely from the host rock. The upper occurrence is in a boulder of iron formation associated with the upper iron formation interval and consists of an ~2 cm diameter piece of malachite-coated chalcopyrite within an ~5 cm diameter vug in the iron formation.

IRON CREEK

The entire thickness of the Rapitan iron formation is not exposed in any one location in the Iron Creek area owing to abundant vegetation, colluvial cover, and the pervasive coating of the rocks by a modern calcite and gypsum leachate. Four stratigraphic sections were measured in order to generate a composite section covering the entire thickness of the unit. Two of these sections, covering the majority of the thickness of the iron formation, are described below.

Iron Creek 1 (IC-1)

Iron Creek section 1 (IC-1) covers the greatest thickness of the Rapitan iron formation in the area (Fig. 1). Although several intervals are covered, including the base of the iron formation, this is the only section that spans the entire thickness of the Rapitan iron formation and includes both underlying and overlying strata (Fig. 4). The lowest part of section IC-1 is in a thick package of massive, matrix-supported cobble to boulder diamictite, which is underlain by a covered interval of unknown thickness. This diamictite is dark red to purple, with clasts consisting predominantly of limestone and dolostone (Fig. 5a). The lower part of the unit is well indurated and cliff-forming, but higher units are increasingly recessive. The exposed thickness of the unit is 36.5 m, although it may be thicker because it is overlain by a 29 m-thick covered interval, above which is the lowermost exposure of iron formation.

Unlike the section at Discovery Creek, the majority of the rest of the section consists of iron formation, capped by interbedded diamictite and siltstone, whereas Discovery Creek was predominantly diamictite. Iron formation at this location includes a wide variety of colours and textures. Bedded jasper-hematite units are thinly to thickly laminated (Fig. 5b). Colours are similar to those at Discovery Creek, with the addition of thin bands of pink jasper. Jasper is predominantly nodular (2 mm to 5 cm in diameter). The nodules are common in both hematite, and to a lesser degree, jasper bands, and locally form the bulk of the host jasper band. The largest nodules commonly are cored by a variety of materials including carbonate clasts and hematite particles (Fig. 5c,d), which results in more complicated nodule shapes that range from tabular to spheroidal to irregular. Some irregular nodules contain multiple nuclei and are interpreted to have resulted from intergrowth of two or more nodules. Some irregular nodules exhibit continuous growth zones around a single nucleus, suggesting irregular, uneven growth patterns. In a layer at 158 m, nodules consist of white chert in a jasper band; this is the only known example of white nodules in the Rapitan Group (Fig. 5e), although tan chert nodules have been reported from the vicinity of Cranswick River, NWT (Baldwin *et al.* 2012 *in press*; their Figure 4f). Bedded jasper exhibits a wide range of characteristics. Layer thicknesses vary from 1 mm to several centimetres (thick laminated to thin bedded). Faint micro-laminae are locally evident in some of the thicker jasper beds. Contorted bedding, load structures, and wavy bedding are all common. In rare cases, hematite nodules are present in the thickest jasper bands, mimicking the relationship of the jasper nodules that are so common in the hematite beds.

The iron formation at section IC-1 is interbedded with intervals of siltstone and diamictite. Siltstone intervals are typically less than 1 m thick, whereas diamictite units are up to 5 m thick. These siliciclastic units are most common between 75 and ~100 m, but they may make up a significant proportion of the recessively weathering, covered intervals of the section (diamictite exposures are commonly immediately overlain by covered or vegetated intervals). At the top of the iron formation, two thin units of granular iron formation (GIF) are present (Fig. 5f). Previously referred to as ‘iron formation arenite’ by Klein and Beukes (1993), granular iron formation consists of sand-sized particles of chert and hematite that are typically pelloidal or oolitic (Clout and Simonson, 2005). This type of iron formation is common in late Palaeoproterozoic ‘Superior-type’ iron formations, such as the Gunflint (Lake Superior region) or Sokomon (Labrador Trough) iron formations. Granular iron formation is considered to indicate iron formation deposition above storm wave-base, where shoaling can occur, allowing the

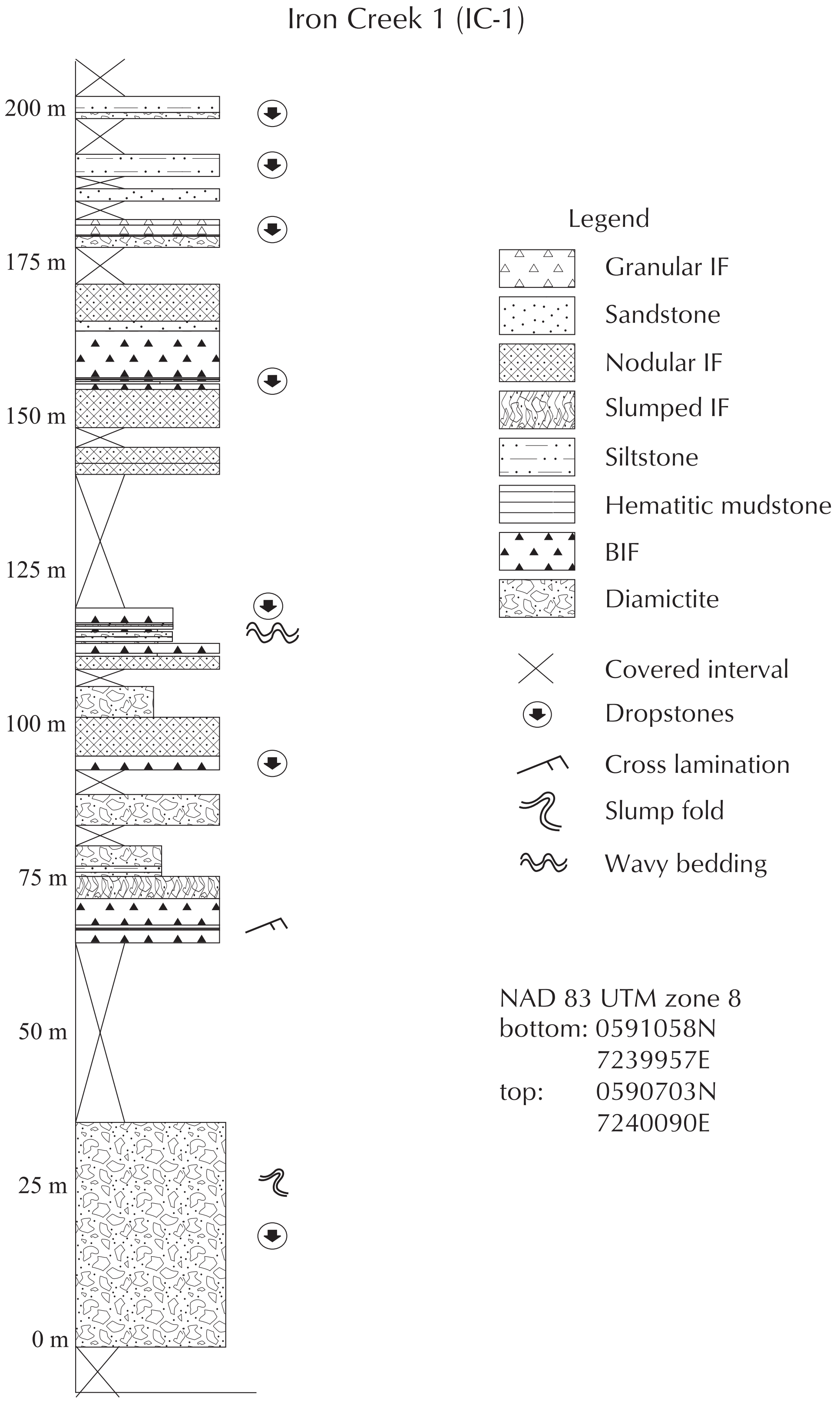

Figure 4. *Stratigraphic column of Iron Creek 1 section (IC-1). Box widths depict the relative weathering profile of natural exposures, but variations in weathering profile within a given unit are not illustrated. The section base is the lowest exposed stratigraphic level of Rapitan group at this location, and the top of the section is not the top of the Rapitan Group, exposure is very poor above the top of the measured section.*

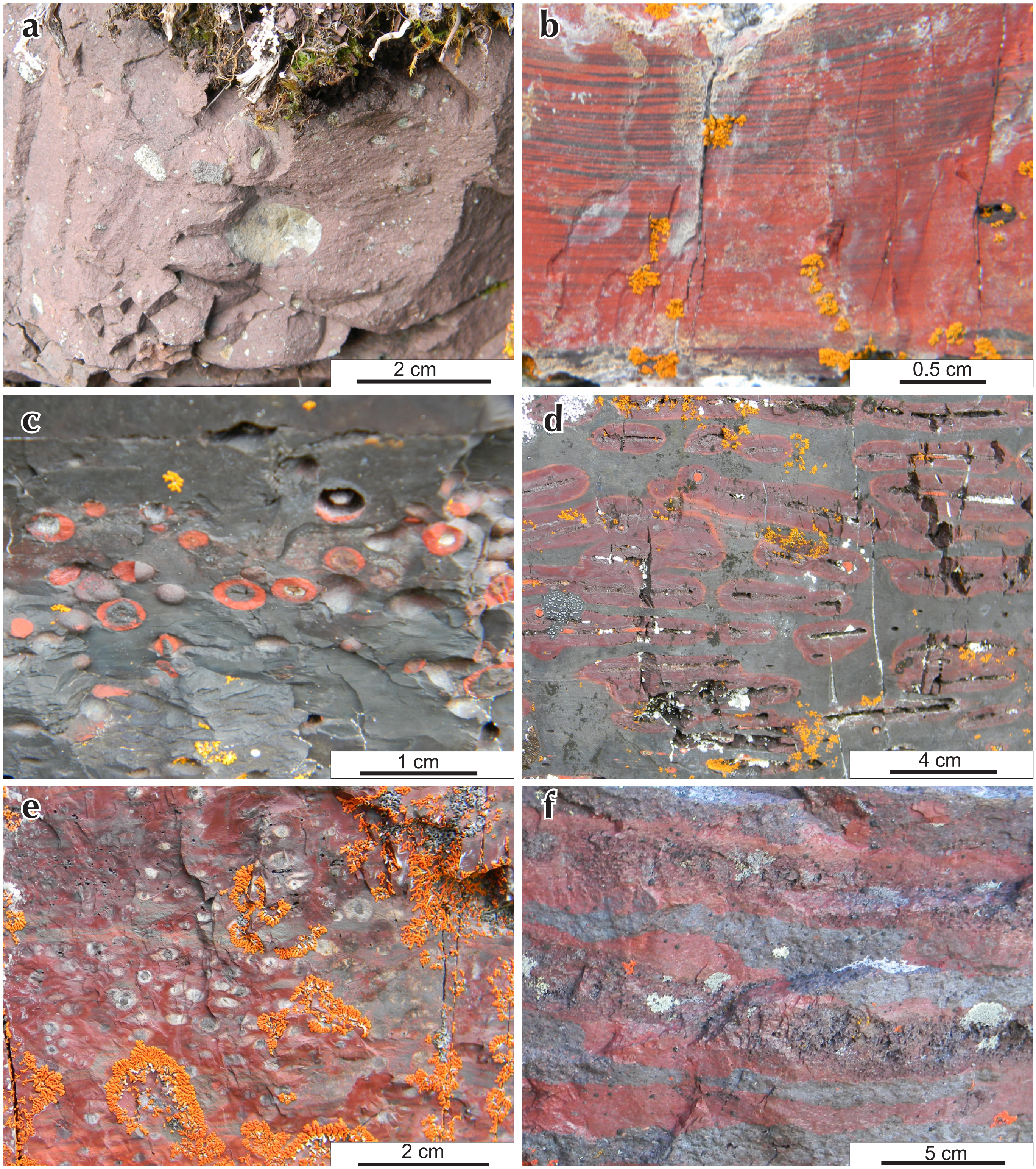

Figure 5. *Photographs of typical and unusual lithofacies from section IC-1.* ***(a)*** *Non-stratified clast-poor intermediate diamictite from below the iron formation, at ~0 m.* ***(b)*** *Thinly bedded jasper and hematite iron formation (located at 68 m).* ***(c)*** *Compound hematite-jasper nodules (located at 96 m).* ***(d)*** *Oblate jasper nodules, with tabular hematite-jasper cores that may represent rip-up clasts of bedded iron formation (located at 105 m).* ***(e)*** *White chert nodules are present only in this thin unit at ~158 m (located at 158 m).* ***(f)*** *Granular iron formation (GIF), consisting of coarse sand-sized grains of jasper and hematite (located at 184 m).*

chemogenic material to form granules. The granular iron formation in section IC-1 is overlain by a thick succession of interbedded pebble to cobble-bearing diamictite and maroon siltstone, the lower 17.4 m of which was measured. The presence of the GIF in direct contact with the transition to clastic sediment suggests that in this area, iron formation deposition was terminated by a loss of accommodation space, which initially caused shoaling of the iron formation in shallow water, but soon led to an influx of clastic sediment.

The GIF lithofacies at the top of IC-1 is also present near the tops of several other measured stratigraphic sections in the Iron Creek area, specifically IC-2 and IC-4, but is not exposed in section IC-3 (described below), probably due to colluvial and vegetation cover. The GIF is overlain by an unmeasured thickness of interbedded purple siltstone and diamictite, with a minimum thickness of 40 m, based on other sections measured in the area (IC-2).

Iron Creek 3 (IC-3)

Iron Creek section 3 (IC-3) was selected because the contact of the iron formation with underlying diamictite is exposed, even though exposure of the iron formation itself is limited (Figs. 1 and 6). The base of the lowermost iron formation lies conformably on the underlying red pebble and cobble-bearing diamictite that is common in the area, which has been attributed to the Shezal Formation despite its sharp differences in both colour and texture from classic Shezal Formation to the southeast in NWT (Eisbacher, 1981a). The diamictite here is roughly 100 m thick but was not measured. The lowermost iron formation unit is 5.4 m thick, and includes alternating layers of bedded iron formation (Fig. 7a), nodular iron formation, and a thin interval of what is referred to here as ‘hematitic mudstone’. The latter lithofacies is a thinly bedded, very fine grained hematitic mudstone lacking jasper and was referred to as ‘massive hematite’ in other publications (*e.g.*, Klein and Beukes, 1993). The top unit of this basal iron formation contains minor copper mineralization: a vug containing copper minerals oxidized to malachite (Fig. 7b). This mineralization is significant because unlike other copper occurrences in the area (*e.g.*, the upper mineralization at DC-2), it was documented in outcrop.

The basal iron formation at IC-3 is overlain by ~7 m of recessively weathering diamictite that is texturally identical to the underlying siliciclastic rocks except for its weathering profile. This is succeeded by a 14 m covered interval. This covered interval is overlain by 83 m of iron formation with less than 50% exposure in the upper 50 m. The iron formation is in places interbedded with siliciclastic rocks, including sandstone, siltstone, conglomerate and diamictite. Iron formation that is under or overlain by these clastic intervals, particularly diamictite, commonly shows evidence of slumping and reworking marked by intense folding and convolution of jasper beds. In section IC-3, the unit is dominated by nodular iron formation, with a smaller proportion of bedded iron formation. Nodule and jasper bands exhibit a similar range of colour and morphology to beds in section IC-1. Jasper nodules are lenticular to highly spheroidal (Fig. 7c). Rare hematite nodules in jasper bands are a textural reversal from the norm but have been documented at Cranswick River, NWT (Figs. 1 and 7d). The section was terminated at this point due to very poor exposure above the top of the measured iron formation, as well as an apparent shift towards siltstone and diamictite based on the scattered boulders present.

Despite their similarity and relatively close proximity (~6 km apart), correlation of individual iron formation units between sections IC-1 and IC-3 using jasper textures does not appear to be possible. This problem is compounded by the absence from section IC-3 of any obvious marker units documented in other sections, such as the GIF unit; the absence of the GIF unit is interpreted to be a function of incomplete exposure at the top of the section. This limitation notwithstanding, it appears that a high degree of lateral variability existed at the time of deposition, a feature that has also been documented by the author in sections measured in the NWT.

DISCUSSION

CORRELATION

Long-distance correlation between different regions where the Rapitan iron formation is exposed in NTS sheet 106F appears to be impossible. Although ostensibly coeval iron formation in other regions of the world commonly include laterally persistent marker beds, no such layers have been documented in the Rapitan iron formation. Although the iron formation overall is a geographically extensive unit deposited during a single, limited time interval in the Snake River area, its internal stratigraphy and relationships with subjacent and suprajacent strata demonstrate considerable local variability, making more detailed correlation difficult. The absence of the upper diamictite at Discovery Creek may simply be a result of erosion, as indicated by the rapid pinch-out of the Rapitan Group to the northwest. This erosion makes it impossible to determine whether or how

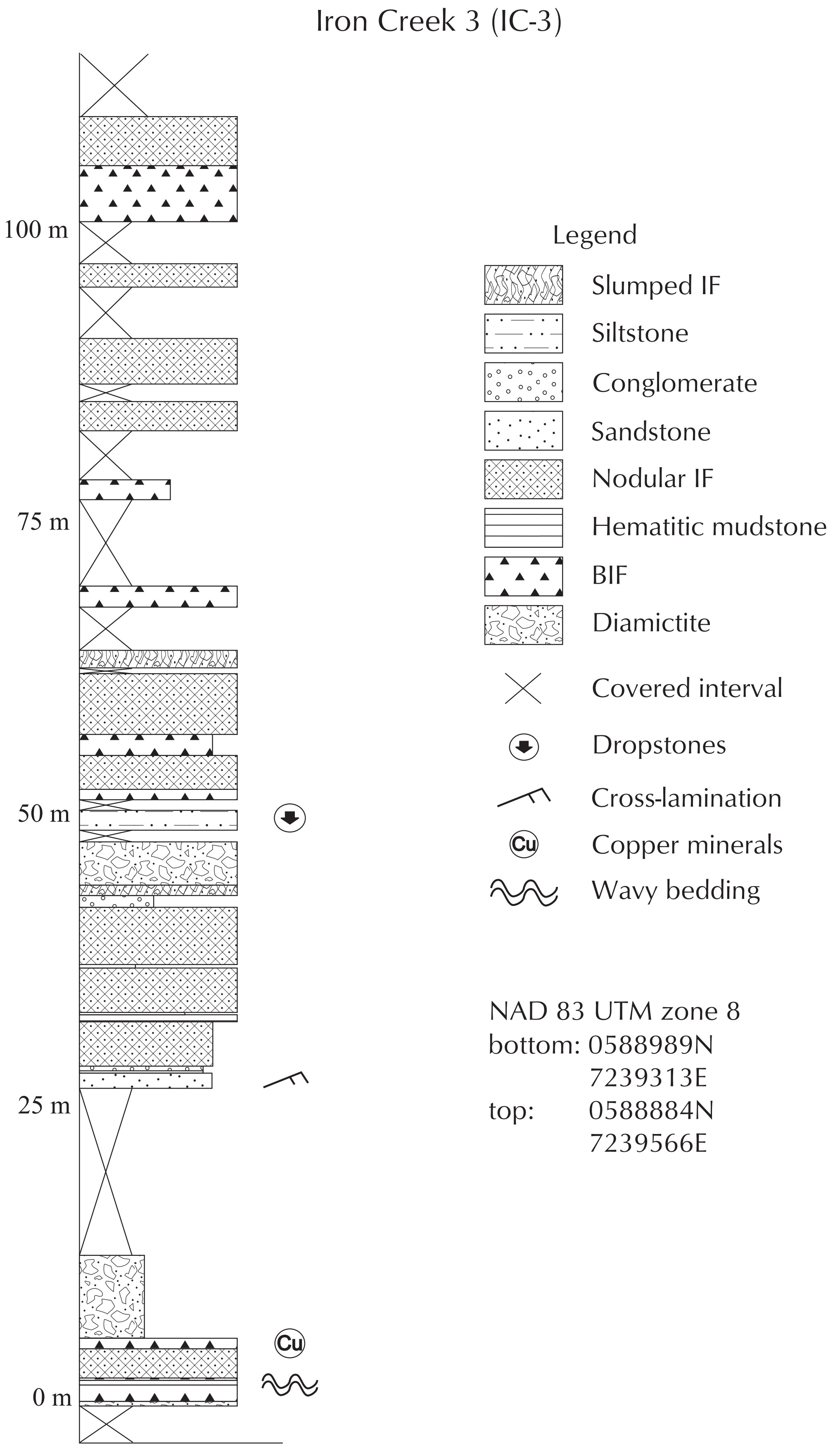

Figure 6. *Stratigraphic column of Iron Creek section 3 (IC-3). Box widths depict the relative weathering profile of natural exposures.*

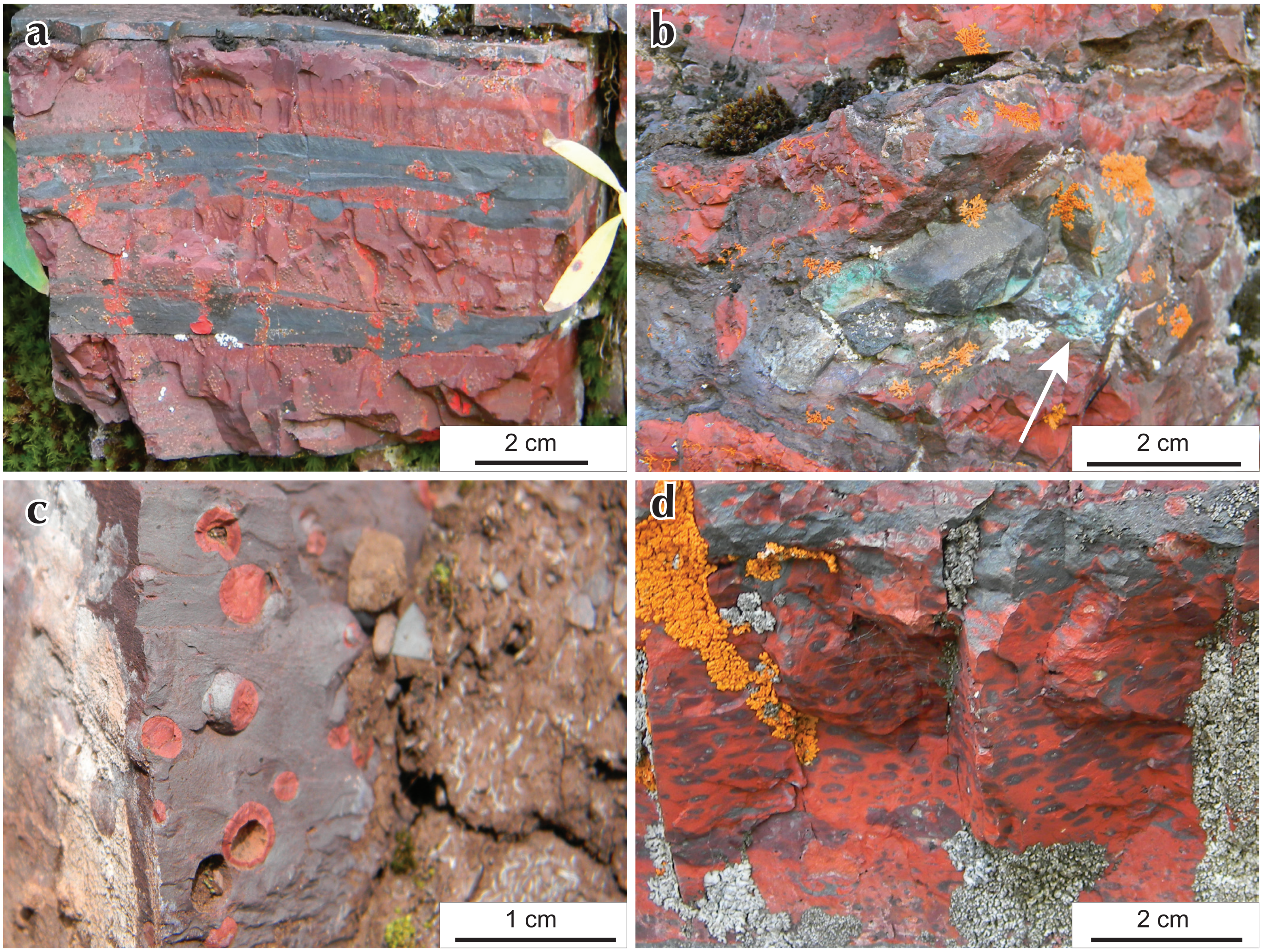

Figure 7. *Photographs of typical lithofacies from section IC-3.* ***(a)*** *Interbedded jasper and hematite from just above the basal iron formation at ~5 m.* ***(b)*** *Copper mineralization within the iron formation at 7 m characterized by malachite (arrow).* ***(c)*** *Highly spheroidal nodules at 35 m.* ***(d)*** *Hematite nodules in jasper (the reverse of the normal nodule-host rock compositional relationship) at 72 m.*

much of the upper Windermere Supergroup (e.g., Hay Creek Group and the informal 'upper group'; Yeo *et al.*, 1978; Aitken, 1989) was originally deposited in this area prior to erosion.

It is possible that different thicknesses of exposed iron formation at Discovery Creek and Iron Creek are in part a primary feature. Based on the sections measured at Iron Creek and data reported at Cranswick River, NWT (Baldwin *et al.*, *in press*) lateral facies variation is common in the Rapitan Group. For example, 30 m of iron formation pinches out to no more than 3 m over a strike-length of less than one kilometre along the Cranswick River. This suggests that small-scale facies variations or differences in paleobathymetry may have existed in the Snake River basin, complicating stratigraphic correlation across large distances. At a very local scale, this phenomenon is expressed most obviously as lateral discontinuity of distinctive individual units in the iron formation. At a larger scale, the phenomenon is expressed as localized to regional variations in the sedimentological character of associated clastic rocks, which show considerable variability in the relative proportions of sand, mud, and coarse clasts (pebbles, cobbles, and boulders) at apparently similar stratigraphic levels over very short distances (<1 km). Apparent variations in the iron content (and therefore colour) of the same clastic rocks are also visible over relatively short distances. Such variability in glacioclastic rocks is not uncommon, because local topography, glaciology, hydrodynamics, and sediment sources can profoundly influence their sedimentological character. This does not, however, imply that deposition of the iron formation at Discovery Creek, Iron Creek, and Cranswick River was asynchronous, but merely that the textural details of each area's strata may be too different to permit definitive correlations. As discussed in the previous section, this difficulty in correlation is exacerbated by the lack of any truly distinctive marker horizons across all measured sections in the region (*e.g.*, GIF, a distinctive conglomerate bed, or an easily identifiable, texturally distinct nodule layer). Each of these features has enabled correlation within geographically limited areas, but none has extended across all three localities (Discovery Creek, Iron Creek, Cranswick River) nor conclusively across any two.

The difficulty in local to regional correlation is best interpreted as a symptom of the dynamic tectonic environment in which the Rapitan Group was deposited. The preponderance of evidence suggests that the Rapitan Group was deposited in a relatively young rift basin (Yeo, 1981), probably related to the rifting of Rodinia (Young, 1992), with ample evidence for active tectonic subsidence during deposition (Helmstaedt *et al.*, 1979). An active rift graben system would have provided considerable paleobathymetric variability, featuring bathymetric highs or 'sills', as well as highly compartmentalized sub-basins. Consequently, in addition to the larger regional Rapitan sub-basins (Snake River basin and Redstone-Keele-Mountain River basin), each of these sub-basins would have been internally subdivided and would therefore have possessed extensive sedimentological and stratigraphic variation over short distances, as is recorded in both the clastic and hydrogenous (iron formation) records. This has already been shown to be a major control on the overall distribution and thickness of iron formation across the Mackenzie Mountains (Baldwin *et al.*, 2011), and may have provided considerable local control on the stratigraphy of iron formation in any given locality. Consequently, only the top and base of the iron formation are liable to have consistent correlation of stratigraphic horizons, both sedimentologically and temporally, and even these probably varied geographically.

COPPER MINERALIZATION

Although copper mineralization has been described in the Rapitan Group southeast of the present study area (*e.g.*, Nite and June showings; Helmstaedt *et al.*, 1979, 1981; Aitken *et al.*, 1981), it has not previously been reported in the Snake River area. Copper occurrences in the present study area consist of copper-rich minerals (malachite, chalcopyrite) lining vugs in iron formation at Discovery and Iron creeks, and malachite-stained pebbles weathered out of a diamictite at Discovery Creek. Both types of occurrence could have origins as copper-rich carbonate dropstones which eroded from the diamictite (leaving behind copper-rich pebbles) and weathered out of the iron formation (leaving behind vugs with a copper-rich "crust"). The source the dropstones is uncertain, as not enough is presently known about ice movement to link them to the Redstone River Formation. Several mechanisms for copper paragenesis have been previously presented, including the remobilization of copper from the Coates Lake Group, which underlies the Rapitan Group in the Redstone-Keele-Mountain River area or through the resedimentation of carbonate and siltstone clasts of similar origin (Helmstaedt *et al.*, 1979). Neither of these explanations is especially plausible for the minor copper mineralization reported here from the Snake River area, because the Coates Lake Group is not present in this area.. The minor copper mineralization of the Snake River area probably had an authigenic, post-depositional origin similar to that found to the southeast, but the copper source and fluid conduits were undoubtedly distinct. This relates back to the overall basin architecture, in which the Snake River area formed as a separate sub-basin from areas to the southeast. Consequently, it is probable that the fluids responsible for precipitating copper minerals did not pass through the same source rocks as those responsible for the Coates Lake deposit, nor its related deposits (*e.g.*, Nite, June) hosted in the adjacent Rapitan Group.

COMPARISON WITH PREVIOUS WORK

Several previous authors have made significant efforts to resolve the controversial stratigraphy of the Rapitan Group in the Snake River area. Yeo (1981, 1984), measured numerous stratigraphic sections in the region in an effort to resolve both the map distribution and stratigraphy of the entire Rapitan Group, whereas Klein and Beukes (1993) reported details of diamond drill core logs for drillholes from both the Iron Creek and Cranswick River (NWT) areas. Comparing the stratigraphy and sedimentology of the sections documented in this paper measured with those provided in earlier publications is difficult. The details of original stratigraphic sections from some studies that favoured generalized stratigraphic composites remain unavailable (*e.g.,* Yeo, 1981), which inhibits the direct comparison of the originally observed stratigraphy and sedimentology to other work, such as the detailed work on core by Klein and Beukes (1993). The present paper describes many of the iron formation units as hybrids of bedded iron formation and nodular iron formation, which is distinct from the practice in both previous studies, which leaned toward identification of lithofacies as either one end-member or the other, resulting in fewer and less-variable units in the iron formation, and complicated efforts to compare the stratigraphy. The best study available for direct comparison was conducted using archived drill core, with a minimal field component (Klein and Beukes, 1993). Although this core-based study had the advantage of fresh, unweathered surfaces, it lacked the small-scale lateral spatial data available in detailed field studies that is necessary to characterize the well-developed lateral variability that is expressed on a scale of metres to hundreds of metres throughout the region, despite well-reported core thicknesses and approximate drill collar locations. As a consequence of stratigraphic simplification, the core-based study inferred direct correlations between the Iron Creek area and the Cranswick River area in NWT (Klein and Beukes, 1993). The proposed correlations were based exclusively on the composition and vertical distribution of siliciclastic intervals in the iron formation, which were used as regional marker units. The present study shows that such units are probably not meaningful markers, based on major differences in sediment colour and matrix composition, among other features. Based on the observations reported here and by Baldwin *et al.* (*in press*), most sedimentary units within and associated with the iron formation are not laterally traceable due to dramatic lateral facies changes related to the tectonically influenced paleobathymetric variability of the rift basin at the time of deposition. Previous authors may have been in error in attempting to correlate across the basin based on anything more detailed than the (probable) time-marker horizons of the top and bottom of the iron formation.

FUTURE WORK

Future work on the Rapitan iron formation will focus on the geochemistry of the measured sections and the possible use of chemostratigraphy for regional correlation. A pilot study on samples from Cranswick River (NWT) is currently in press (Baldwin *et al.*, *in press*). Work to date has focused on developing a working model for basin configuration and characterizing the redox stratification of the Snake River basin, using rare earth elements and redox-sensitive metals such as molybdenum and uranium, and on implications for the depositional processes and iron source for the Rapitan iron formation. The principles established in the pilot study will be applied to samples collected elsewhere in the Rapitan iron formation, including the exposures in Yukon. It is possible that the chemostratigraphy of Mo and U may help resolve the sedimentological limitations on long-distance correlation, because water-mass chemistry may have been significantly less susceptible to lateral variability than physical sedimentology. Alternatively, each sub-basin may have been influenced by a chemically distinct water mass. If this approach fails to permit high-quality chemostratigraphic correlation, it will probably demonstrate instead that basin morphology was characterized by chemically and sedimentologically distinct sub-basins. Ongoing detrital U-Pb zircon studies on samples from across the belt may help provide further insight into time correlations and basin architecture.

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