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2019

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Permanent link: https://doi.org/10.4095/314660

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Recommended citation
Meek, R., Ielpi, A., and Rainbird, R.H., 2019. Sedimentology and stratigraphy of the Mesoproterozoic Husky Creek Formation, lower Coppermine River region, Nunavut; Geological Survey of Canada, Open File 8559, 28 p. https://doi.org/10.4095/314660

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Sedimentology and stratigraphy of the Mesoproterozoic Husky Creek Formation, lower Coppermine River region, Nunavut

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Introduction

This open file presents results from the "Coppermine River Transect" campaign, which consisted of field activities conducted in July and August 2017 in western Nunavut as part of the second phase of the Geo-mapping for Energy and Minerals (GEM-2) program. Research activities related to this report were led by the Geological Survey of Canada (Ottawa, Central Canada Division), in collaboration with Laurentian University of Sudbury (Ontario). This report provides a first detailed sedimentologic and stratigraphic description and interpretation of the Mesoproterozoic Husky Creek Formation in the Coppermine Homocline, which is best exposed along the Coppermine River and its tributaries to southwest of Kugluktuk, Nunavut.

Geologic Background

Proterozoic Stratigraphy

The Proterozoic stratigraphic record of northwestern Canada can be separated into three unconformity-bounded sedimentary successions named, from oldest to youngest, A-B-C (Young et al., 1979) (**Figure 1**). The erosional unconformity between sequences A and B is considered to reflect a tectonic disturbance accompanying amalgamation of Rodinia (1100-1050 Ma) while the Sequence B-C boundary signals the beginning of rifting and magmatism associated with Rodinia's breakup at approximately 720 Ma (Rainbird et al., 1996, 2017). Sequences A and B are preserved in the northern Cordillera and in a series of inliers located along the northern Canadian mainland and Arctic islands (**Figure 1**). Sequence C is only preserved in the northern Cordillera (Young et al., 1979; Rainbird et al., 1994, 1996). The Husky Creek Formation is in the uppermost stratigraphic unit of Sequence A in the Coppermine Homocline, being unconformably overlain by marine sandstones of the Rae Group (**Figure 2**).

The Coppermine Homocline

The Coppermine Homocline is located in western Nunavut and includes strata of the Hornby Bay, Dismal Lakes and Coppermine River groups (**Figure 3**). The term "homocline" is here used purely for consistency with previous literature, as there is in fact evidence for gentle folding in the exposed strata. The Coppermine River Group comprises basalt flows of the Copper Creek Formation and overlying red sandstone and siltstone of the Husky Creek Formation (Barager and Donaldson, 1973; Campbell, 1983; Hildebrand and Barager, 1991; Skulski et al., 2018). Basalt flows of the Copper Creek Formation are an important component of the Mackenzie Large Igneous Province (Kerans, 1983, Barager and Donaldson, 1991; LeCheminant and Heaman, 1989; Skulski et al., 2018), which also includes the Muskox intrusion and the nearly pancontinental Mackenzie dyke swarm (red lines in **Figure 3**) (Kerans, 1983; LeCheminant and Heaman, 1989; Hildebrand and Barager, 1991). Basalts of the Copper Creek Formation form an approximately 2.5 km-thick, stepped plateau across the Coppermine Homocline (**Figure 3**). Two periods of deformation (an earlier easterly trending folding associated to southerly vergent thrusting; and a later, northerly trending folding) occurred after the deposition of the Husky Creek Formation, but prior to the deposition of strata belonging to the Rae Group (Shaler Supergroup, Sequence B; **Figures 2 and 3**) (Hildebrand and Barager, 1991).

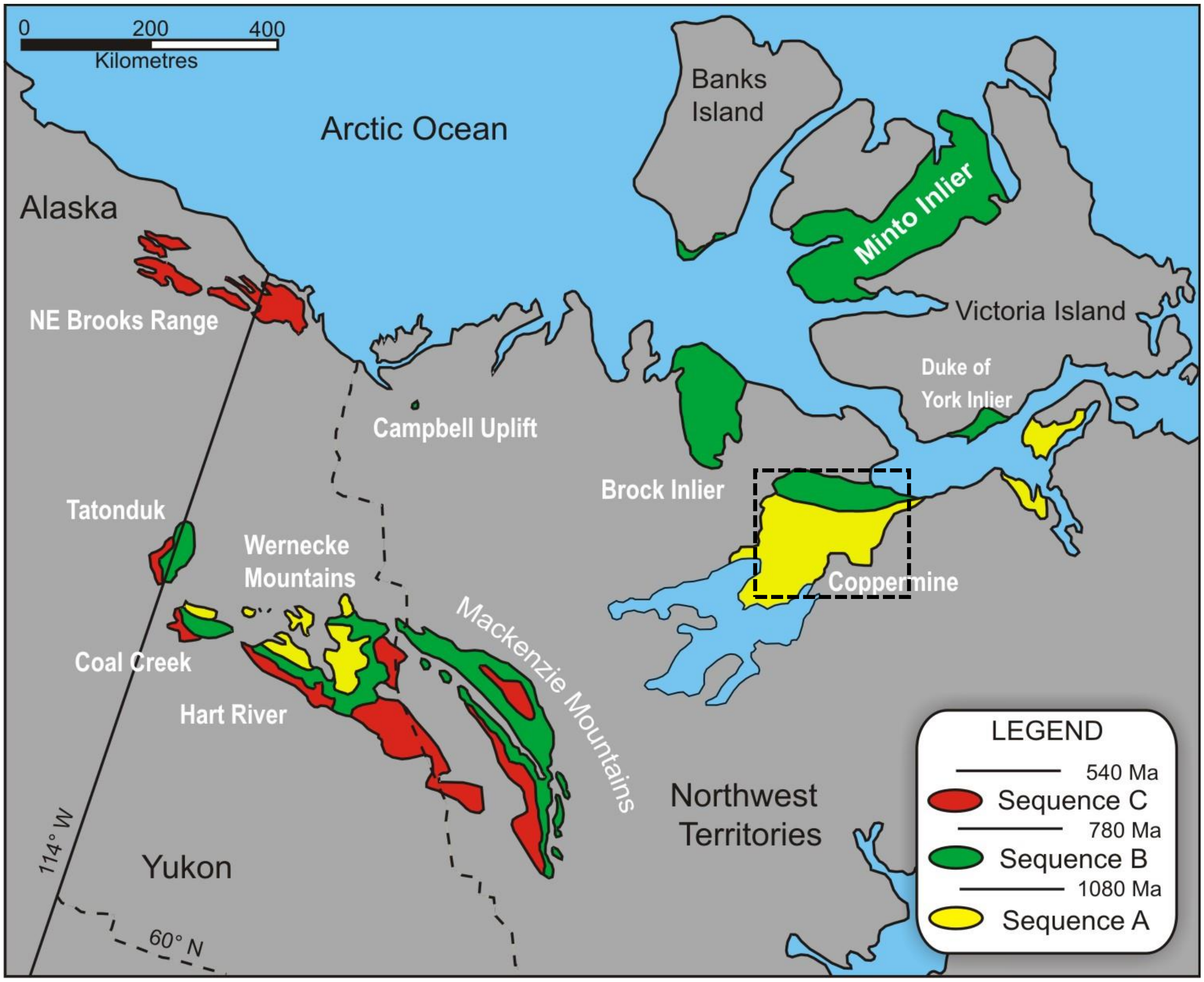

Figure 1: Location of study area in western Nunavut (black box) with extent of sequence A stratigraphy highlighted in yellow (after Young et al., 1979).

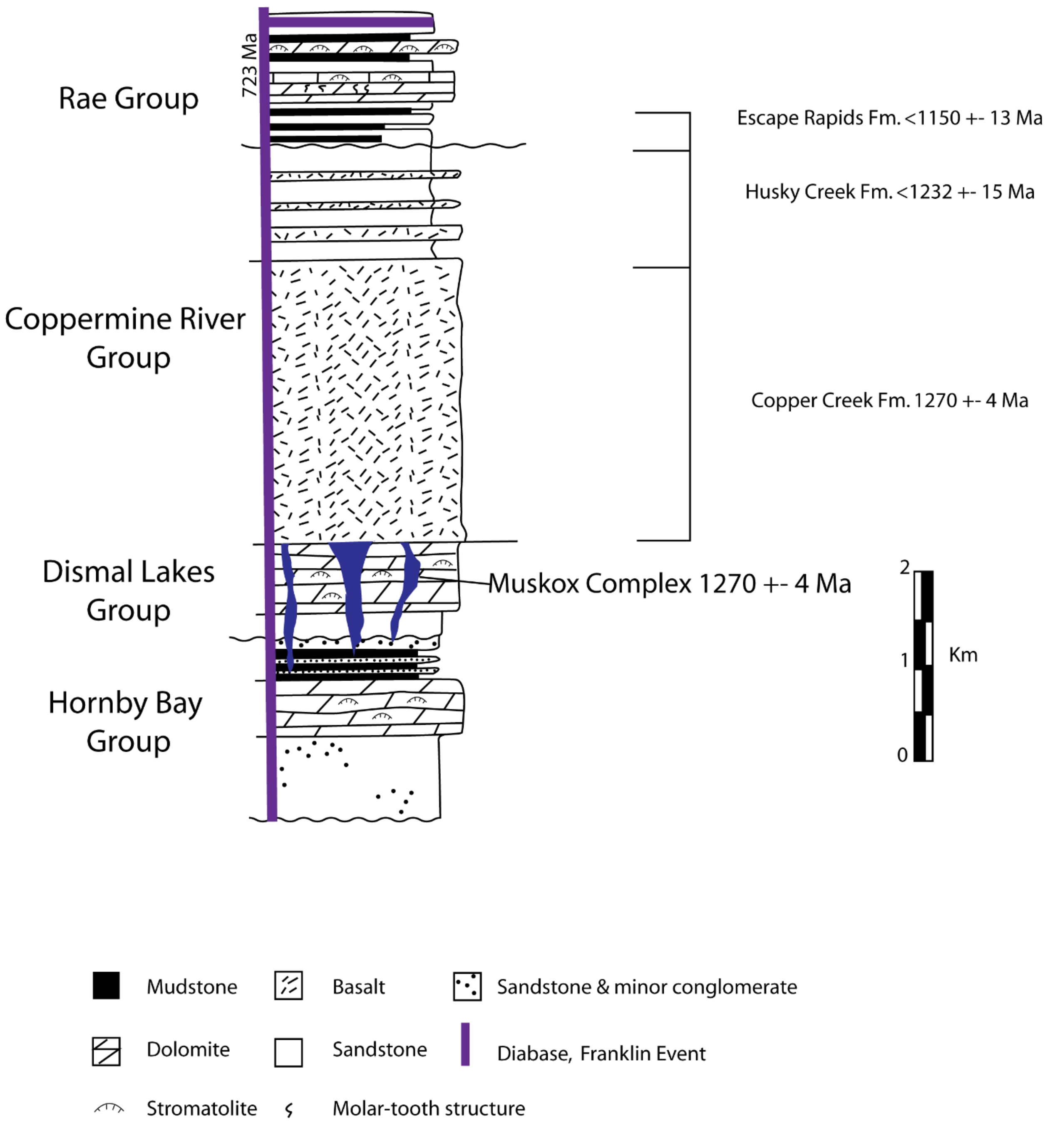

Figure 2: Generalized stratigraphy of the Coppermine Homocline. Modified from Young et al., 1979 with ages from Rayner and Rainbird, 2013 and Lecheminant and Heaman, 1989

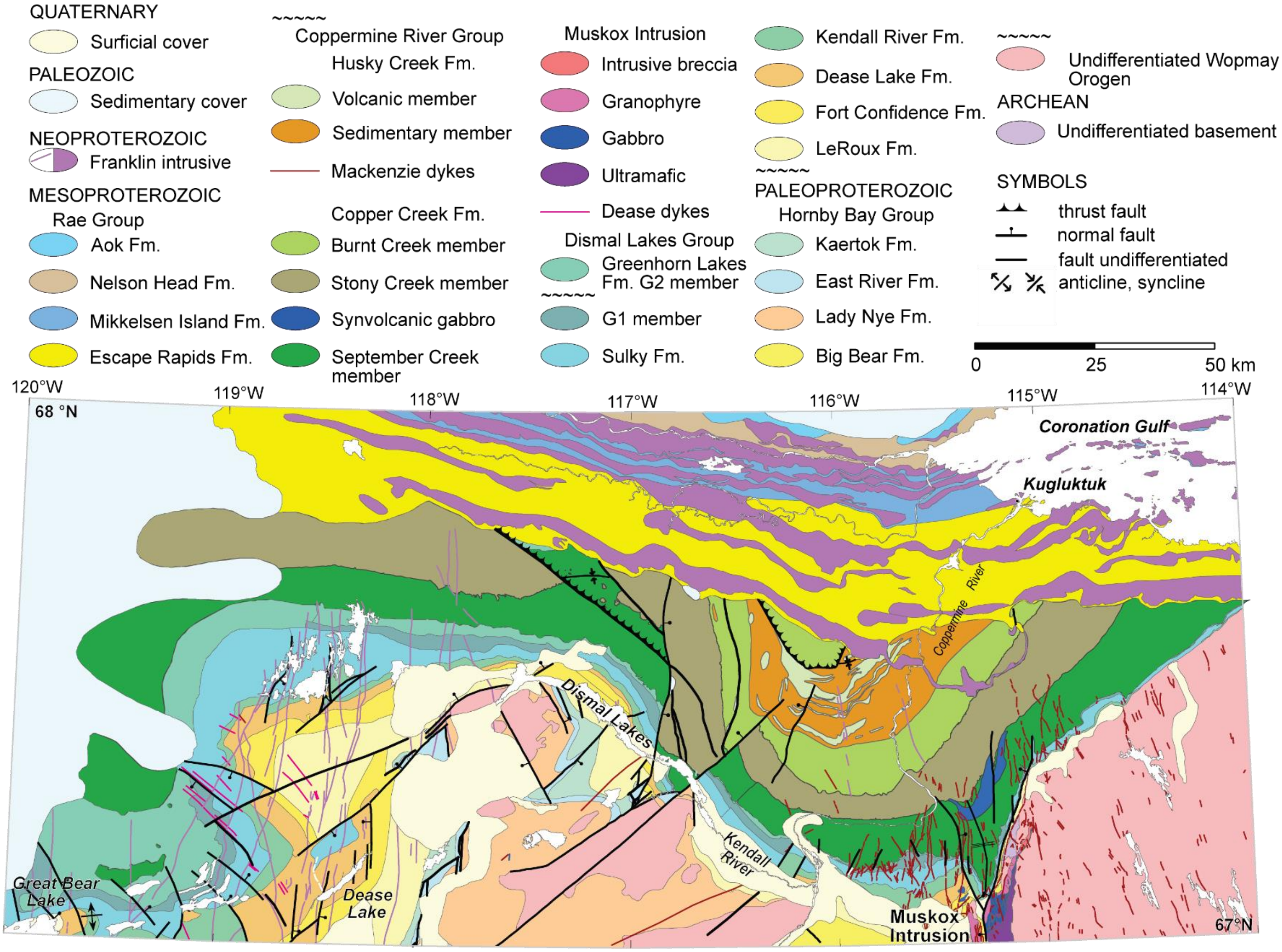

Figure 3: **Regional geology of the Coppermine Homocline (from Skulski et al. 2018).**

Previous Work

The Husky Creek Formation was originally described by Barager and Donaldson (1973), with the type section recognized along the Coppermine River. These authors noted that the basalts of the Coppermine River Group are partially contemporaneous with the sandstones of the Husky Creek Formation. Due to their compositional immaturity, the sandstones weather recessively, with exposures being limited to canyon sections along the Coppermine River, its tributaries, and areas where interbedded basaltic flows have protected the erosion of sandstone (Barager and Donaldson, 1973; Campbell, 1983). Further work by Campbell (1983) included the collection of paleocurrent data from three locations along the Coppermine River. These data pointed to polymodal sediment dispersal, yet with overall southwestward transport (see below). These aspects were interpreted to represent accumulation of the Husky Creek Formation in a southwest-trending valley, predominantly filled with volcaniclastic detritus and potentially associated pyroclastic material. U-Pb detrital zircon geochronology of a sample from near the top of the Husky Creek Formation produced a maximum age of deposition of 1232 ±15 Ma (Rayner and Rainbird, 2013).

Stratigraphy

General description

The Husky Creek Formation has a thickness of approximately 1900 m at the type section, a figure calculated from bedding orientation measurements plotted in a GIS environment from strata exposed along the Coppermine River. The formation thickness slightly westward of the river transect (**Figure 3**). A summary of the formation's stratigraphy is reported in **Figure 4**, and photographs from outcrops and thin sections are reported in **Figures 5–8**. The Husky Creek Formation consists largely of red lithic arenite, siltstone, and local oligomictic conglomerate layers intercalated with basalt flows (**Figure 4)**. The framework of the sedimentary rocks that comprise the Husky Creek Formation consists of lithic fragments, altered plagioclase, and quartz with interstitial carbonate and Fe-oxide cement (**Figure 6f**). Intraformational mud clasts abound throughout the entire formation. Heavy mineral bands defined by dark laminae and predominantly composed of hematite and ilmenite are common (**Figure 8a**). The Husky Creek Formation overlies flood basalts of the Copper Creek Formation, which is interpreted to be the extrusive component of the Mackenzie Large Igneous Event (Ernst et al., 1995). The sharp but conformable contact between sandstones of the Husky Creek Formation and the underlying lava flows of the Copper Creek Formation is undulatory at the outcrop scale, with swales 30-50 cm deep, spaced approximately10 m apart **(Figure 5a)**. The uppermost basalt of the Copper Creek Formation is heavily vesiculated, with evidence for magma-sediment mingling (peperite texture) indicating that the Husky Creek Formation was water-saturated and unlithified during eruption of the lava flow (cf. Busby-Spera and White, 1987). This indicates that there was no significant time gap between deposition of the lava and the sandstone. Similar mingling features were observed between the interbedded basalts and lithic-rich sandstones within the Husky Creek Formation, with basalt flows being heavily vesiculated near the contact peperite **(Figure 5b)**. The Husky Creek Formation is unconformably overlain by grey-green, shallow marine sandstone and siltstone of the Escape Rapids Formation **(**Rae Group; **Figure 5c)**.

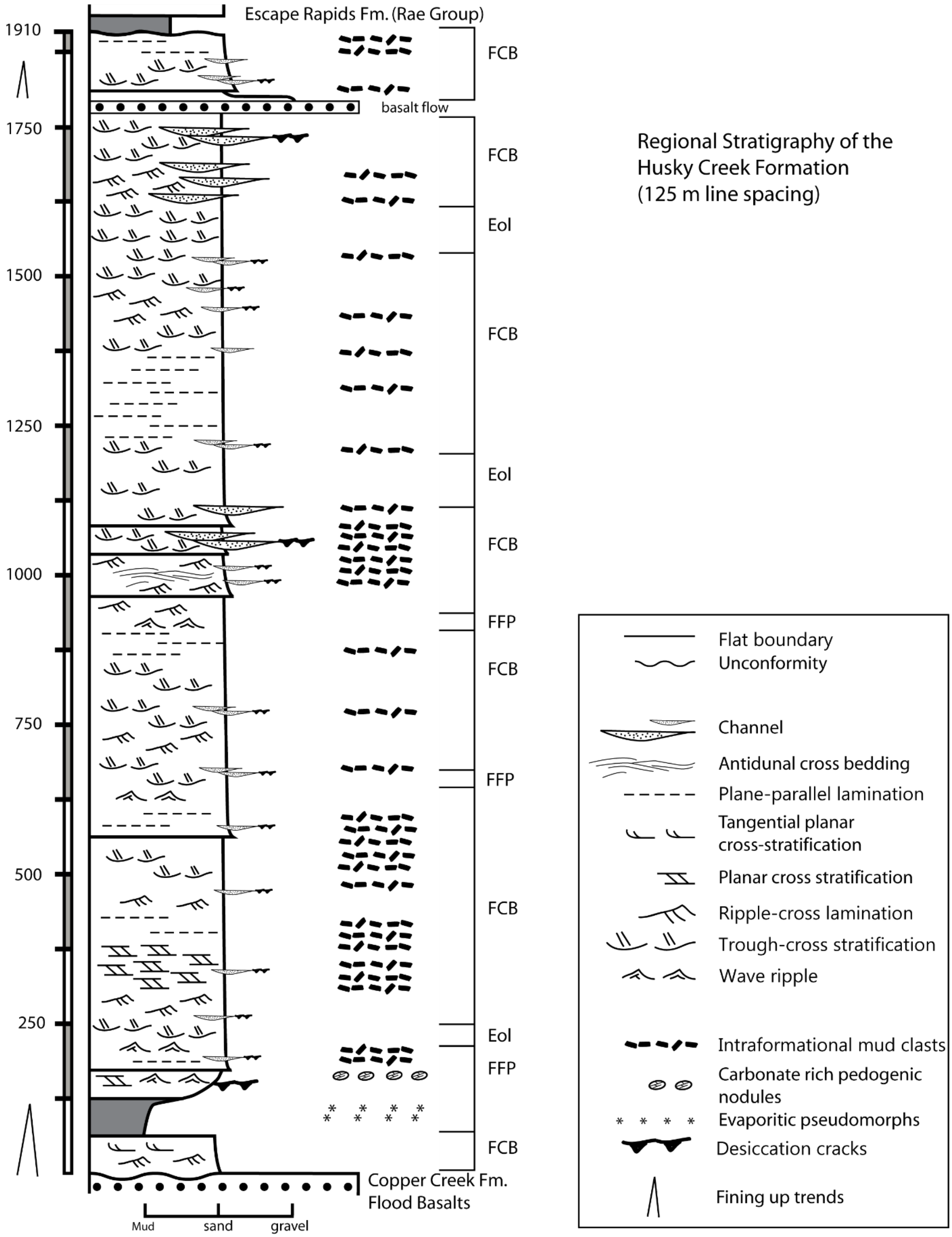

Figure 4: Generalized stratigraphic column of the Husky Creek Fm. through transect of exposed strata along the Coppermine River.

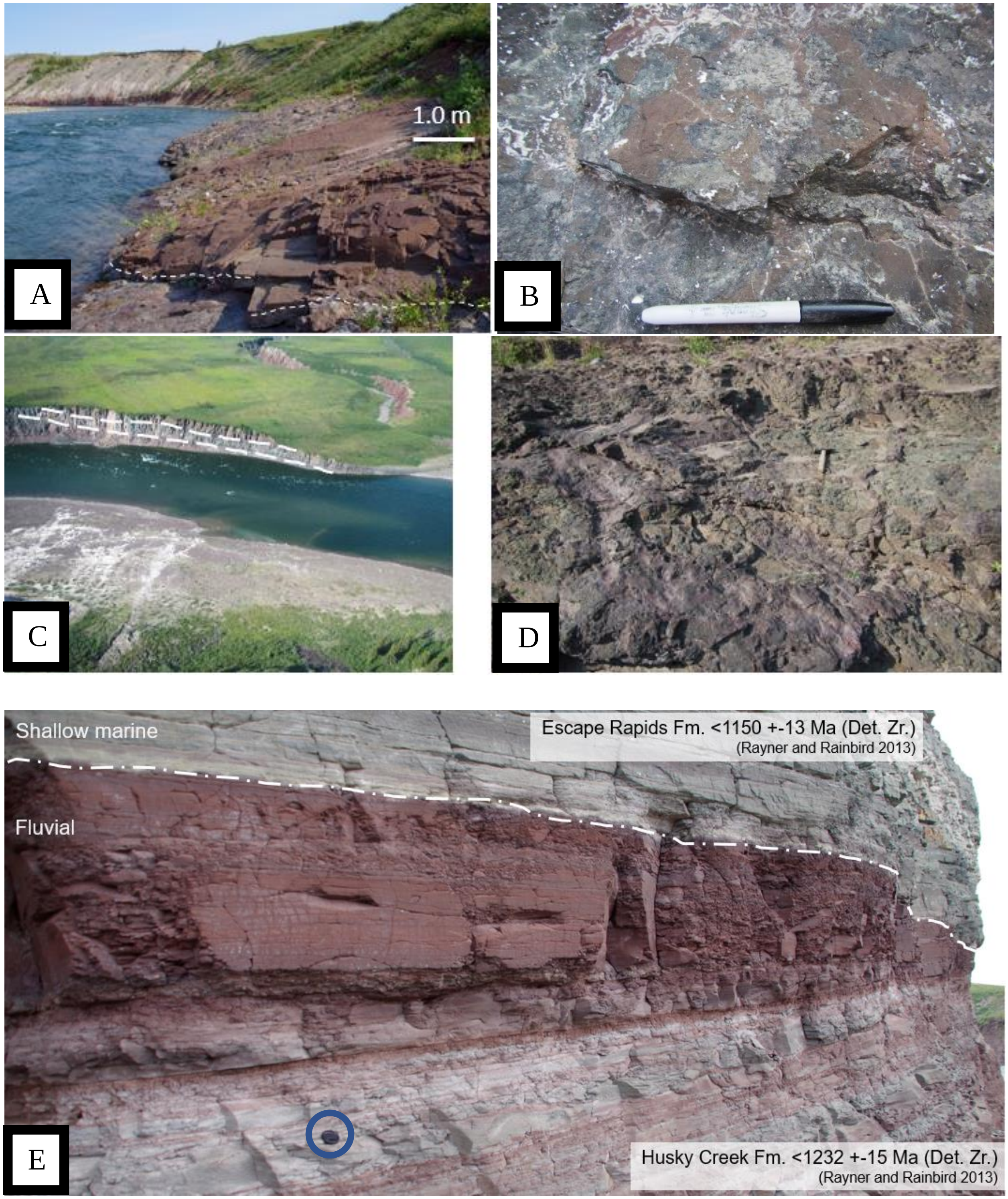

Figure 5. A) Contact between red lithic arenite of the Husky Creek Formation and underlying basaltic lava flows of the Copper Creek Formation. Also reported is a close-up of the contact between basalt/peperite and overlying red sandstone B) Note mingling of red sand and darker lava at contact between the Husky Creek Formation and the Copper

Creek Formation. C) Dashed lines represent the extent of a basalt flow in upper Husky Creek Formation. Field of view is roughly 250 m. D) Close-up showing the globular peperites at the contact between basalt (green) and sandstone (red) in the upper Husky Creek Formation. E) Unconformable contact between grey-green shallow marine sandstones of the Escape Rapids Formation and the underlying sandstone of the Husky Creek Formation (lens cap, encircled for scale, is roughly 7 cm in diameter).

Facies descriptions

Fourteen facies were identified and are representative of three depositional settings: fluvial channel-belt, fluvial floodplain, and eolian. The facies were recognized in three detailed (5 cm resolution) stratigraphic columns totalling 180 m (see **Appendix A**). The stratigraphic sections, together with bedding orientation data plotted in GIS environment, were used to construct the generalized stratigraphic column for the entire Husky Creek Formation (**Figure 4**).

Planar-bedded sandstone (facies 1)

Description. This facies is composed of poorly to moderately sorted, fine- to medium-grained (locally coarse-grained) lithic wacke to lithic arenite. Beds display plane-parallel lamination and in planview primary current lineation was recognized **(Figure 6a, b**). Bedding is tabular and generally between 0.1–1.0 m and up to 2.3 m thick. Mud-rich intraclasts are common in these beds and are locally imbricated. This facies commonly separates cross-bedded units. Polygonal fracturing defined by positive relief on bedforms is locally observed.

Interpretation. Plane beds occur during upper-flow-regime waterflows and, accordingly, this facies is interpreted be represent the aggradation of upper-flow-regime traction carpets either: along channel bottoms during flood conditions; or along shallowly submerged bar tops during waning-flood stages (Cant and Walker, 1975). The presence of intraformational mud-rich clasts indicate rip-up and entrainment of mud-rich units during phases of fluvial incision (e.g., Ielpi and Ghinassi, 2016).

Planar cross-bedded sandstone (facies 2)

Description. This facies is composed of medium-grained lithic wacke and lithic arenite that exhibits cross stratification (**Figure 6d**). This facies is subordinate relative to the trough cross-bedded facies (see below). Foresets are planar with angular relationship with bottomsets. Beds are tabular and 0.2-5.6 m thick. Mud-rich intraclasts are present in thinner beds.

Interpretation. This facies is interpreted to represent accretion and reworking of straight, long-crested dunes during lower- to near-transitional flow regime waterflows, or the accretion of small bar slipfaces (e.g. Todd and Went, 1991; Collinson et al., 2006) within fluvial channels.

Trough cross-bedded sandstone (facies 3)

Description. Trough cross-bedding is the most abundant facies in the Husky Creek Formation. Beds are 0.2-5.5 m thick along measured sections. This facies consists of tabular beds of medium-grained lithic wacke-lithic arenite with intersecting trough forms (**Figure 6e**). Mud-rich intraclasts are also common, particularly at the bases of these beds (**Figure 6f**).

Interpretation. Trough cross bedding is interpreted to be a result of accretion of three-dimensional dunes in lower flow regime waterflow, and is the typical result of perennial discharge in relatively deep fluvial channels (Harms et al., 1975; Collinson et al., 2006).

Antidunal-bedded sandstone (facies 4)
Description. This facies is composed of thin beds of medium- to coarse-grained lithic arenite, < 30 cm thick and displaying sigmoidal cross-bedding and small-scale (~5 cm in relief) undulatory bedding. Beds scour underlying strata. Mud-rich intraclasts are also common.
Interpretation. This facies is interpreted to represent accretion and reworking of plane and antidunal beds in transitional (sigmoidal cross bedding) to upper flow regime (undulatory bedding) conditions within the fluvial channel-belt (Fielding, 2006).

Soft-sediment deformed sandstone (facies 5)
Description. This facies is composed of poorly to moderately sorted, fine- to medium-grained lithic arenite that displays extensive internal deformation. Internal deformation occurs in both plane beds and cross bedded units.
Interpretation. This facies is interpreted to represent gravitational destabilization that affected a water-saturated and unconsolidated sediment soon after deposition, leading to fluidization and upward water escape (Collinson et al., 2006). Fluidization may be caused by either seismicity or flow-induced sediment shearing (Owen and Santos, 2014).

Ripple cross- laminated sandstone (facies 6)
Description. This facies is composed of fine- to medium-grained lithic wacke and lithic arenite with unidirectional ripple forms (**Figure 6b**). Ripple cross stratified layers (including laminae and beds) are < 5 cm thick, forming tabular cosets up to 10 m thick. Mud-rich intraclasts are also present in places. Symmetrical ripples are observed in discrete <5 cm thick beds.
Interpretation. This facies is interpreted to represent deposition and reworking in ripple-bed, lower flow regime conditions within fluvial channels (Jopling and Walker, 1968). Symmetrical ripple forms relate to oscillatory flow from wave agitation in shallow water (Clifton, 2006), potentially within a floodplain pond.

Massive sandstone (facies 7)
Description. This facies is rarely observed and consists of structureless fine- to medium-grained lithic wacke- lithic arenite. Beds are thin, <10 cm thick and tabular. This facies also contains layers rich in mud intraclasts.
Interpretation. The presence of massive sandstone units is indicative of depositional freezing of laminar, high-density flows, potentially triggered by a flooding event (Reading and Collinson, 1996) within the fluvial channel-belt. Alternatively, pedogenesis processes may have obscured primary hydrodynamic structures in a floodplain environment or a shallow channel bed subject to seasonal sub-aerial exposure (e.g. Marconato et al., 2014; Ielpi et al., 2016).

Mud-rich sandstone with polygonal fractures (facies 8)
Description. This facies is composed of tabular beds of lithic-rich siltstone and fine-grained lithic wacke and arenite, which displays a faint planar lamination disrupted by polygonal fractures

(**Figure 7c**). Individual fractures are recessive on outcrops and are defined by subtle grain-size variation. This facies is represented by beds <10 cm thick and seldom occurs throughout the Husky Creek Formation, although it was best observed in the lower 250 m of the stratigraphy. *Interpretation.* The facies represents the deposition of fine-grained sand and silt by low-strength, shallow waterflows, likely in a channel-proximal overbank environment (cf. Fralick and Zaniewski, 2012). The polygonal fractures that intersect the planar lamination indicates the later development of incipient desiccation structures, in response to repeated expansion and contraction due to wetting and drying of cohesive material (Reading and Collinson 1996; Marconato et al., 2014). The facies, therefore, indicates periodic sub-aerial exposures, and possibly incipient pedogenesis (Collinson et al., 2006).

Nodule-rich sandstone (facies 9)

Description. This facies is composed of tabular beds of medium-grained, poorly sorted, massive lithic arenite containing spherical to oblate, reddish brown, 1-5 cm nodules composed of calcite and lithic fragments (**Figure 7a**). This facies is limited to the lower Husky Creek Formation, specifically along a zone overlying thick mudstone-siltstone deposits (Figure 4).
Interpretation. This facies is interpreted to represent pedogenesis on exposed banks of river channels, or nearby floodplain tracts, upon recessing water levels. The presence of nodules potentially indicates a semi-arid environment where evapotranspiration is equal to, or greater than, precipitation with alkaline pore water both percolating down from surface to a near surface layer and being drawn up by capillary action (Collinson et al., 2006).

Sandstone with adhesion warts (facies 10)

Description. This facies consists of fine- to medium-grained lithic arenite with irregular warts, 5-10 mm across and with about 1 mm of relief, superimposed on the stratification planes of underlying sedimentary structures. Beds are generally <5 cm thick. This facies is also characterized by an absence of intraclasts.
Interpretation. The presence of adhesion warts superimposed on other sedimentary structures indicates that sediment was wind-blown onto older deposits while they were still damp, or in response to daily fluctuations in atmospheric humidity (Olsen et al. 1989). Owing to their irregular shape, adhesion warts are typically related to frequently changing wind directions (Collinson et al., 2006).

Large-scale trough cross-bedded sandstone (facies 11)

Description. This facies is composed of fine- to medium-grained, moderately sorted, lithic arenite with tabular to wedge-shaped beds of intersecting trough forms (**Figure 8d)**. Pin-stripe lamination (described in higher detail below) is present in bottomsets (**Figure 8b, c**). Beds are 0.3–1.2 m thick along logged sections (Appendix A, B). Additionally, this facies is characterized by an absence of intraclasts and slightly higher compositional and textural maturity in comparison to other sandstone facies.
Interpretation. This facies is interpreted to represent the migration of eolian dunes and associated scour pits (Mountney and Thompson, 2002). Grains are still texturally and chemically immature, suggesting that sediment was likely re-worked from fluvial deposits in a short timespan.

Pin-stripe-laminated sandstone (Facies 12)

Description. This facies is composed of fine- to medium-grained, lithic arenite that displays pin-stripe lamination (**Figure 8a,c**) defined by well-developed grain-size segregation (Fryberger and Schenk, 1988). Laminae are moderately well sorted and commonly inversely graded. Such sandstones have slightly higher compositional maturity in comparison to other sandstone facies. Beds are tabular, generally 10 cm thick and laterally discontinuous. Additionally, these beds are closely associated or interbedded with facies 11. This facies is also characterized by an absence of intraclasts.

Interpretation. This facies is interpreted to represent accretion and migration of subcritically climbing wind ripples (Hunter, 1977; Fryberger and Shenk, 1988; Collinson et al., 2006). As grains are still texturally and chemically immature, sediment was likely re-worked from fluvial deposits in a relatively short time span.

Massive mudstone and siltstone (facies 13)

Description. Massive, lithic-rich mudstone and siltstone form a ca. 60 m-thick bedset in the lower 125 m of the Husky Creek Formation's stratigraphy (**Figure 4**). In the lower portion of this bedset, bladed calcite rosettes, 0.25–2.00 cm wide, have been observed (**Figures 4, 6**).

Interpretation. This facies originated after deposition of fine-grained fractions in a floodplain tract located far away from active channels, likely due to fallout of suspended load fed by diluted and low-energy overbank flows (Miall, 2010). The floodplain was also likely subject to evaporative concentration of solutes (Potter et al., 2005; Collinson et al., 2006), as indicated by the occurrence of the bladed rosettes. The latter are interpreted as pseudomorphs after an evaporitic mineral, possibly aragonite, suggesting arid to temperate conditions where evaporation exceeds discharge (Potter et al., 2005).

Crudely bedded conglomerate (facies 14)

Description. Oligomictic, matrix-supported conglomerate with 1-40 cm angular to sub-angular clasts of mudstone, siltstone, and basalt, typifies this facies. Only crude tabular bedding is locally observed, forming beds roughly 30–50 cm thick. Clasts are angular to sub-angular, and generally fine upward throughout a bed. This facies was only observed in one location, where it directly overlies an intra-formational basalt flow. The bedset is approximately 10 m thick.

Interpretation. The facies is interpreted to represent deposition by highly concentrated and matrix-rich flows that were capable of entraining coarse detritus from locally eroded basalt (Collinson et al., 2006). The matrix-supported and yet fining-upward character of these beds suggests that flows might have experienced a transition from plastic to viscous rheology over short transport distance (Benvenuti, 2003).

Facies Associations

Fluvial Channel-Belt Facies Association

This facies association describes the majority of strata exposed along the Coppermine River transect, comprising facies 1, 2, 3, 4, 5, 6, 7 and 14. Sandstones in this facies association are immature, pointing to a proximal sediment source with limited reworking and transport. Overall, the abundance of unidirectional cross-strata and the pervasive early diagenetic reddening supports deposition by sustained flow in a continental, oxidizing, environment – most likely a set of channel belts. Perennial discharge is indicated by the abundance of trough-cross and planar-cross beds (Facies 2 and 3), which accumulated and were reworked in deeper portions of fluvial channels (Cant and Walker, 2975; Todd and Went, 1991; Collinson et al., 2006). Ripple cross-lamination (Facies 6) indicates deposition in low-energy environments by weaker stream flows (Jopling and Walker, 1968). Rare massive sandstone units suggest that large flooding events seldom lead to flow-induced soft-sediment deformation. Plane-laminated sandstones (Facies 1) alternating with thin siltstone to fine sandstone beds with desiccation cracks separate large-scale cross-bedded units (Facies 2 and 3) are interpreted to represent subaerial exposure after episodes of channel avulsion. The thickest stacks of cross-bedded sandstone observed on outcrop suggest that the larger channels in the Husky Creek fluvial systems may have reached ~6 m depth, a feature that is possibly consistent with channels a few hundred meters wide (Ielpi et al., 2017). The lack of extensive three-dimensional exposures where channel-bar complexes could be observed in their entirety hampers any interpretation of fluvial planform. Furthermore, although this facies association is dominated by cross-bedded units that typically occur in perennial discharge regimes, they are commonly separated by upper-flow regime bedforms, typically plane beds. The co-occurrence of upper and lower flow regime bedforms may be interpreted as a transition from a perennial discharge regime conducive to the formation of thick cross-bedded units (facies 2 and 3) (Long, 2011) to more ephemeral discharge regimes which produced planar laminated sandstone units (facies 1) during high-discharge stages (Long, 2011), or to supra-elevated portions of channel belts (i.e. bar tops) where shallower water favoured the establishment of supercritical flow conditions.

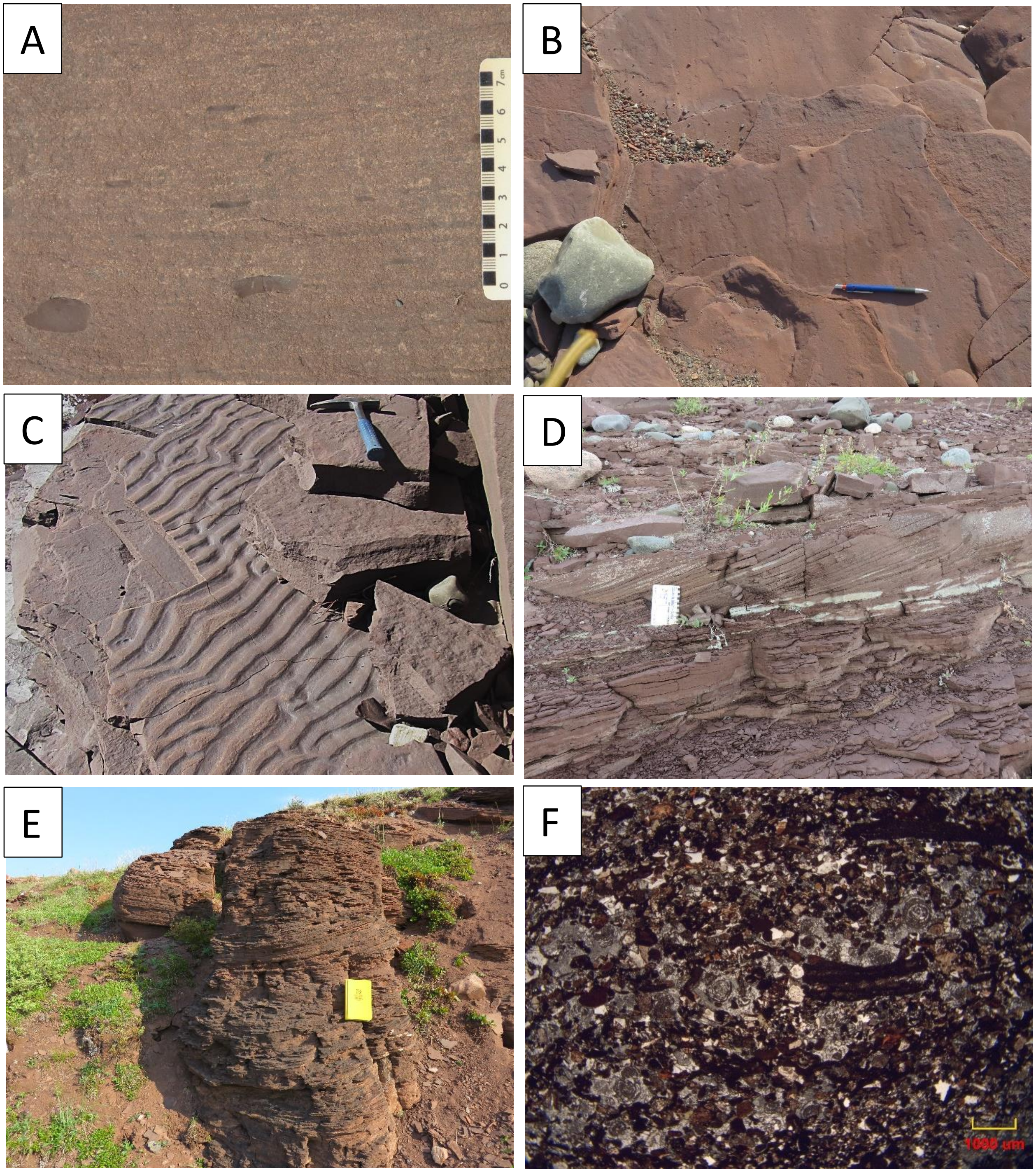

Figure 6. Fluvial deposits. A) Plane-parallel lamination with mud-rich intraclasts. B) Plan view of bedding surface exhibiting primary current lineation. C) 2D, asymmetrical ripples. D) Planar-cross stratified beds. E) Trough-cross stratified beds. F) Photomicrograph of fluvial sandstones with a framework composed of elongate, mud-rich intraclasts, quartz, and altered volcanic rock fragments and feldspar grains. Minor mud matrix, with Fe-oxide and calcite cement. Magnification: 1.25x, plane-polarized light.

Fluvial-floodplain facies association

Facies 6, 7, 8, 9, and 13 comprise the fluvial-floodplain facies association. These facies share compositional and textural similarities to the fluvial channel-belt facies association, although the detritus is generally finer grained, indicating lower flow strength at time of deposition. A roughly 60 m thick massive mudstone-siltstone unit with evaporitic pseudomorphs is a prominent feature of the lower Husky Creek Formation (facies 14), in addition to subordinate massive sandstone beds that contain pedogenic nodules along specific horizons (facies 9) (**Figure 7b**). Additionally, thin beds of weathered sandstone and mudstone with desiccation cracks and polygonal fracturing were observed throughout the formation (Facies 8). These facies are bounded by large-scale cross-bedded units associated with the fluvial channel-belt (facies 2 and 3). This association is interpreted to represent a floodplain adjacent to a channel-belt that was subject to periodic flooding and drying as well as pedogenesis along channel banks (e.g. Marconato et al., 2014; Ielpi et al., 2018). Units in this facies association were deposited after abandonment of fluvial channels or in ephemeral floodplain lakes (Potter et al., 2005), a depositional motif that can be linked to the occurrence of stacked cross-bedded units separated by thin floodplain deposits. Eolian deposits (see below) are found in juxtaposition with this facies association, suggesting that eolian dune fields were proximal to the fluvial floodplains.

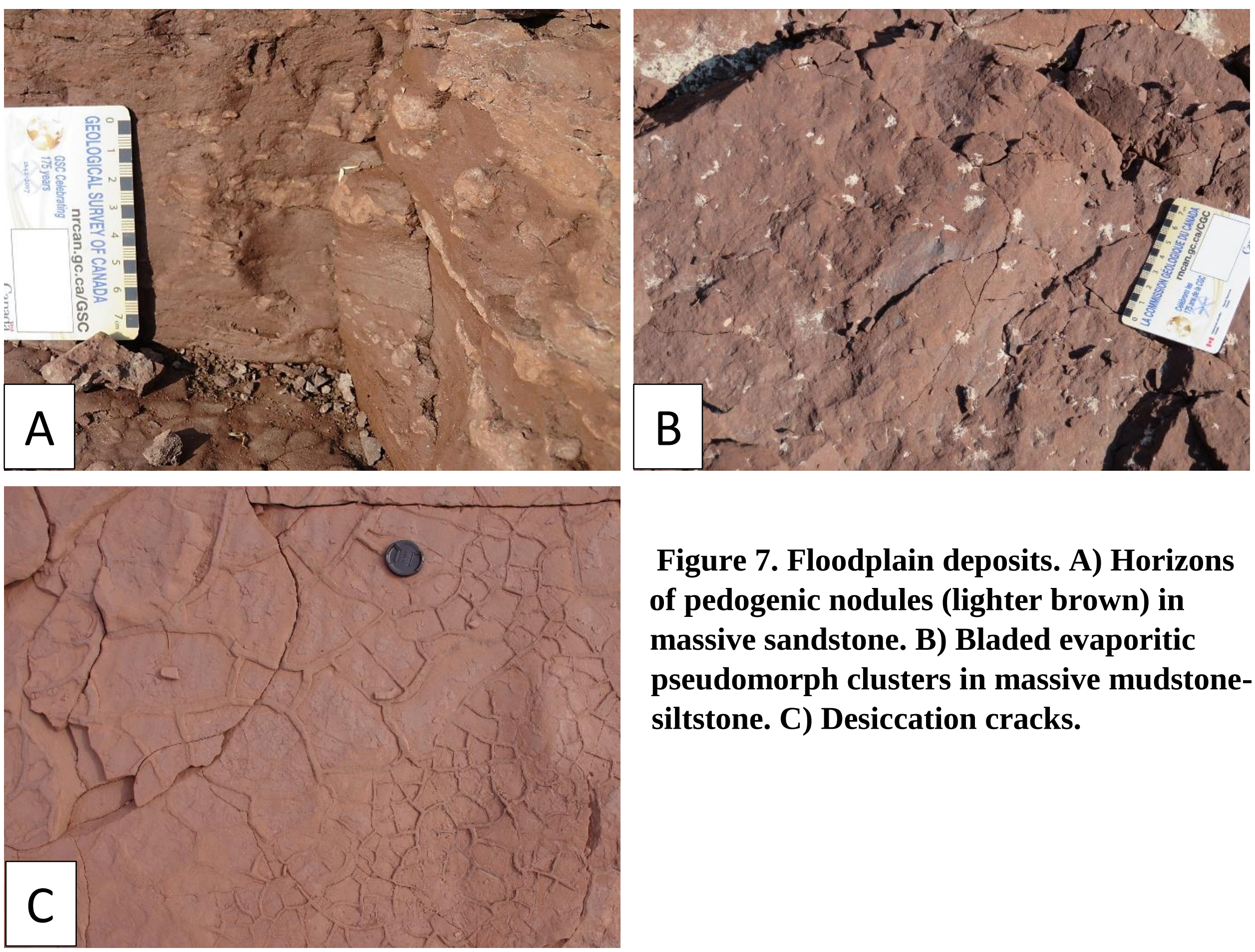

Figure 7. Floodplain deposits. A) Horizons of pedogenic nodules (lighter brown) in massive sandstone. B) Bladed evaporitic pseudomorph clusters in massive mudstone-siltstone. C) Desiccation cracks.

Eolian Facies association

This facies association consists of facies 10, 11 and 12; these facies are more compositionally and texturally mature than the fluvial associations described above. Irregular adhesion surfaces (Facies 10) superimposed on fluvial bedforms as well as thin, spatially limited pinstripe laminated beds (Facies 12) bounded by fluvial bedforms are representative of eolian re-working of fluvial derived sediment and deposition after channel abandonment. Overall, this interpretation is corroborated by the occurrence of pin-stripe lamination, a distinctive feature of eolian deposits (Hunter, 1977; Fryberger and Schenk, 1988). Large scale sets of well sorted, pinstripe laminated trough cross-bedded sandstone (Facies 11) underlain by pin-stripe laminated plane parallel beds (Facies 12) are interpreted to represent eolian deposition in dune fields (Ielpi et al., 2016). The framework sediment remains angular to sub-angular and is compositionally immature (**Figure 8a**) indicating that reworking by eolian processes was relatively limited and the eolian facies are generally bounded by fluvial deposits, suggesting that the dune fields were proximal to the floodplain and channel belt elements.

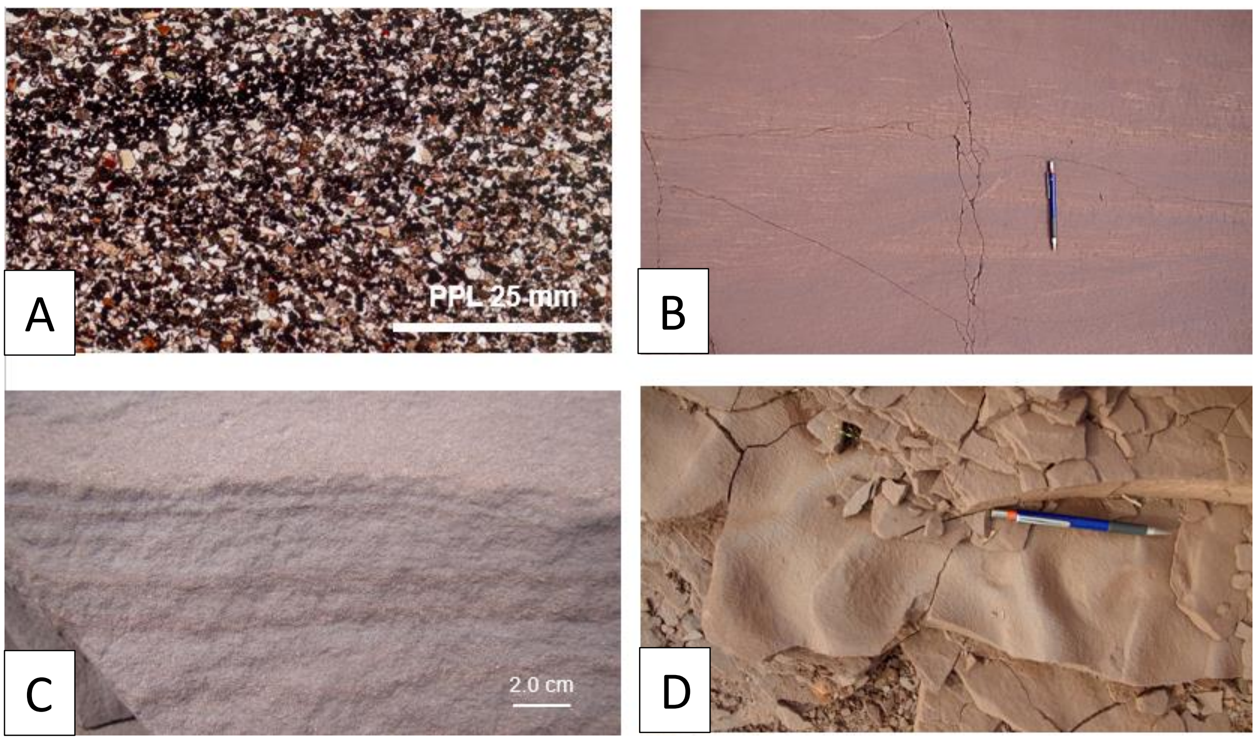

Figure 8. Eolian deposits. A) Thin section scan (plane polarized light) of pinstriped, planar laminated eolian lithic arenite. Note the absence of mud intraclasts, and better sorting in comparison to the fluvial sandstones in Figure 6h. B) Pinstripe laminated cross beds. C) Pin-stripe -laminated lithic arenite at the base of larger eolian dunes. D) Adhesion warts on asymmetrical 3D ripples. E) Large-scale, trough cross stratified sandstone representing eolian dunes that developed of the margins of abandoned channels.

Stratigraphic Variations

Grain size is relatively homogenous throughout the Husky Creek Formation (**Figure 4**); that being said, a first-order coarsening upward trend can be observed throughout the formation and is shown by the presence of a mudstone near the base, sandstones mid-section and occasional gravel beds near the top of the formation (**Figure 4**). Furthermore, two smaller-scale fining-upwards trends are observed: 1) along the lowest 125 m of the formation's stratigraphy, where medium-grained sandstones are overlain by a 60 m-thick mudstone-siltstone; and 2) along the top 200 m of the formation's stratigraphy, where a volcaniclastic conglomerate passes upward into medium-grained sandstone (**Figure 4**). Local variations in grain size are observed where medium grained sandstone associated with the fluvial channel-belt are overlain by finer grained floodplain associated sandstone.

Paleoflow analysis

A total of 265 paleoflow measurements were collected from 10 stations; 9 from outcrops along the Coppermine River and one located roughly in the center of the outcrop belt (Figure 9). Estimation of paleocurrent direction was based on the azimuth of foreset dip direction in planar- and trough-cross bedded and ripple-cross laminated sandstone. The paleoflow patterns throughout the Husky Creek Formation have high dispersion with a general indicated transport to the WNW. Individual paleoflow stations exhibit unimodal distribution varying from WSW to WNW, while other paleoflow clusters are polymodal. The cumulative results thus suggest overall sediment sourcing from the ESE. This result is significant in that the source area projected from paleoflow data roughly corresponds to the Muskox Intrusion, a possible source for the medium- to coarse-grained mafic clasts present in the Husky Creek Formation. Notably, these paleoflow results differ from Campbell (1983) (**Figure 9**), potentially as a result of sample bias, and a higher number of bedforms measured in this study. This aspect could also indicate that sediment accumulated in a WNW trending valley as opposed to the SW trending valley proposed by Campbell (1983). In agreement with both interpretations, the polymodal nature of some paleoflow measurements is postulated to reflect fluvial transport from valley flanks (Campbell, 1983). Limited eolian paleoflow measurements yield a bimodal distribution, indicating prevailing winds from the SE and N (**Figure 9**).

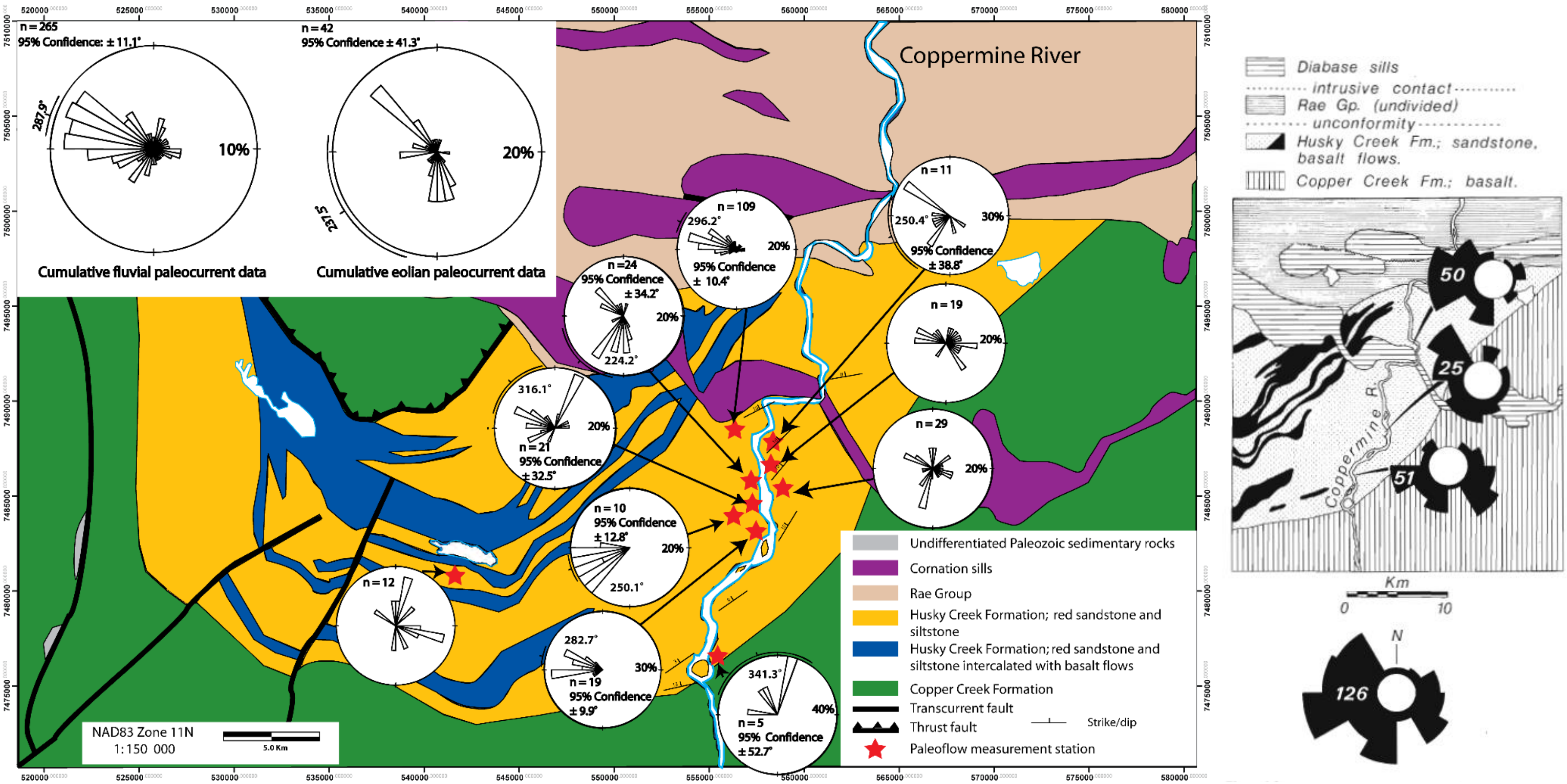

Figure 9. (Left) Map of the Husky Creek Formation (modified from Hildebrand 2011) with cumulative fluvial and eolian paleoflow displayed in the top left and fluvial paleoflow results throughout the formation. (Right) Paleocurrent results from Campbell 1983.

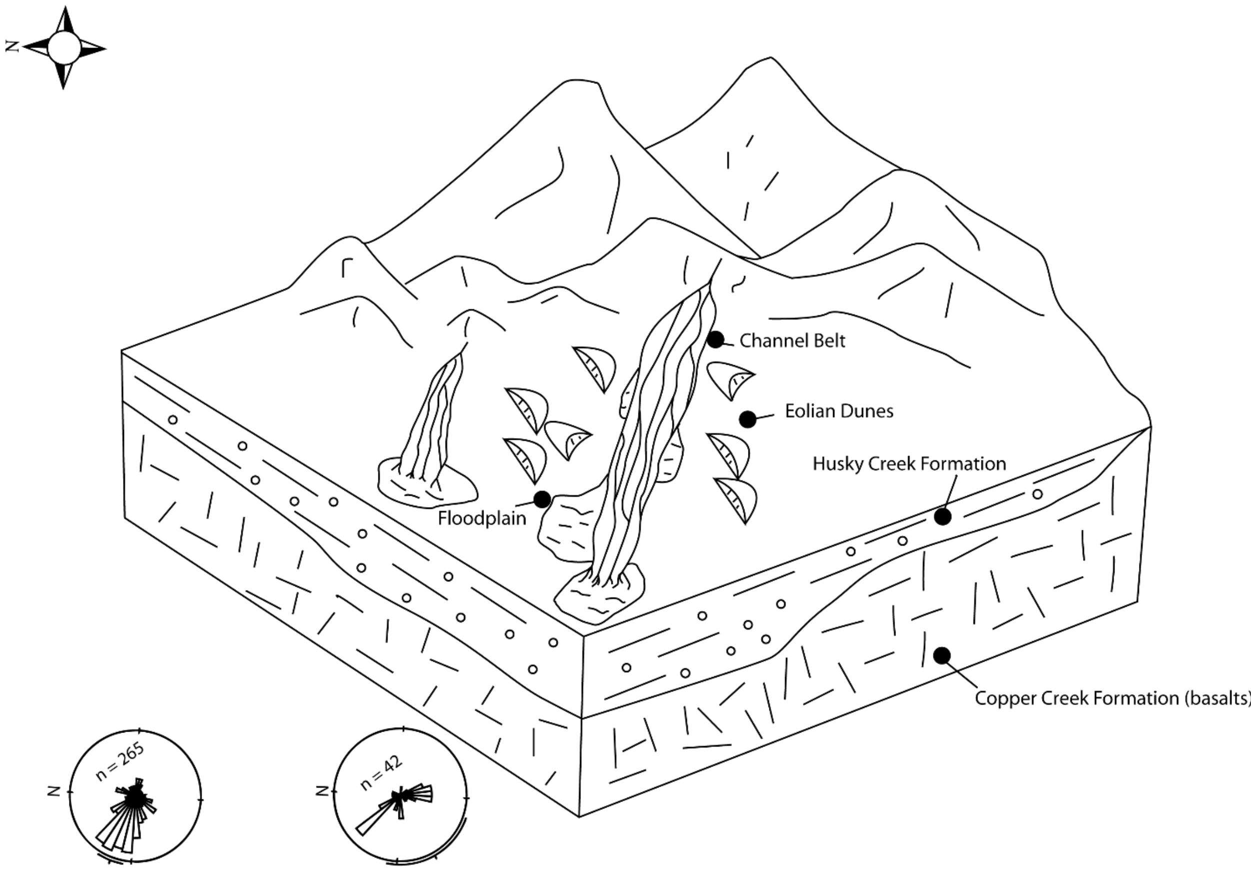

Figure 10: Depositional model inferred for the Husky Creek Formation displaying the close association of channel belt, floodplain, and eolian elements. **No scale is implied.**

Depositional Style

Overall, facies and paleoflow analysis indicates that the Husky Creek Formation is the record of a river system deposited within an incised valley with eolian and floodplain deposits (**Figure 10**). This inference is supported by the lensoidal aspect of the formation's outcrop belt, and the dominance of unidirectional sedimentary structures, predominantly of fluvial origin, trending towards the WNW. The cumulative paleoflow trend indicates provenance from the interior of the Proterozoic Laurentian landmass. Little is known at this stage about the mechanisms responsible for subsidence generation in the area; loading from the extensive Copper Creek Formation flood basalts and Husky Creek Formation basalt flows, as well as local faulting, may have contributed to basin subsidence and expansion of drainage watersheds. Despite a first-order coarsening upwards grain-size trend is observed throughout the formation's stratigraphy, the grain size is overall homogeneous (**Figure 4**), a feature that may be related to a state of near-equilibrium between subsidence, aggradation and sediment supply (Lebeau and Ielpi, 2017). That being said, the local occurrence of fine-grained units represents the establishment of mature floodplain tracts located far away from active channels, whereas coarser volcaniclastic sediment found in association with basalt may indicate the generation of local topography in response to magma extrusion. Floodplain bedsets in the Husky Creek Formation are important indicators of the local hydrologic budget at the time of deposition. Specifically, the presence of evaporitic pseudomorphs and pedogenic nodules indicate a setting where evaporation exceeds recharge for a significant portion of the year. The observations above, coupled with the presence of adhesion structures and desiccation cracks also suggests an arid to temperate paleoclimate (Ielpi et al., 2018). These observations suggest that the Husky Creek Formation might have been deposited in an endorheic basin, i.e. an inland sink.

Conclusions

The Husky Creek Formation, a sandstone-dominated succession forming the topmost portion of the Coppermine Homocline, western Nunavut, represents a sedimentation event that closely followed the emplacement of a thick succession of lava flows represented by the Copper Creek Formation, which is in turn part of the extensive Mackenzie Large Igneous Province. Deposition in sub-aerial settings is indicated by sandstone reddening, although this could have also occurred during early diagenesis through interaction of oxidized groundwater with iron bearing minerals. The Husky Creek Formation displays abundant unidirectional flow structures, which suggest that the bulk of the formation was deposited in a terrestrial environment that includes fluvial channel-belts, floodplains, and eolian dunes (**Figure 10**). Occurrence of both lower- and upper-flow-regime sedimentary structures points to the alternation between phases of perennial and seasonal discharge, and frequent channel avulsion is indicated by the pervasive occurrence of intraformational mud-rich clasts. Futhermore, the occurrence of desiccation cracks, pedogenic nodules, adhesion surfaces, and pin-stripe lamination of eolian origin reinforce the interpretation of deposition in a sub-aerial environment, and specifically an endorheic setting where evaporation exceed hydrologic recharge for part of the year. The abundance of lithic fragments with angular to sub-angular grains, with low sphericity and moderate sorting suggests a proximal sediment source with limited transport, reworking, or chemical weathering (Allen 1982). The lensoidal aspect of the outcrop belt, and the overall trend of paleoflow indicators support the interpretation of the Husky Creek Formation being deposited in a WNW-trending incised valley. In conclusion, the field observations collected in this study help refine the paleogeographic and paleoclimate setting of northwestern Laurentia (present coordinates) in the late Mesoproterozoic. Forthcoming studies on the Husky Creek Formation will focus on its provenance, which will be resolved with detrital zircon U-Pb geochronology.

Acknowledgements

RM received a financial bursary from the Research Affiliate Program of Natural Resources Canada, and by a Discovery Grant from the Natural Sciences and Engineering Research Council of Canada to AI. Logistical support was provided by the Geo-mapping for Energy and Mineral Program of NRCan and by the Agouron Institute (agi.org). We thank Bill Davis for his critical review of the paper.

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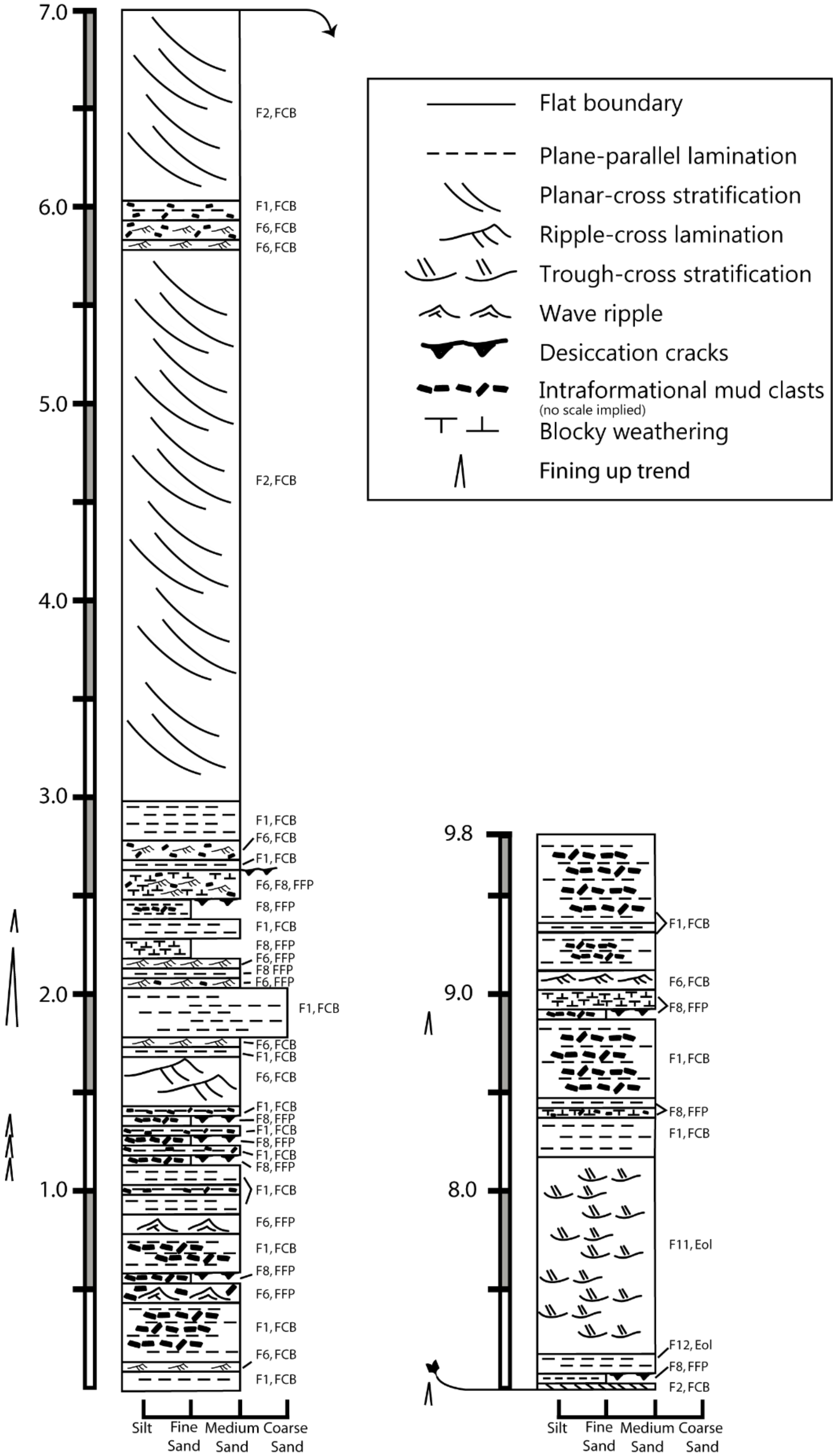
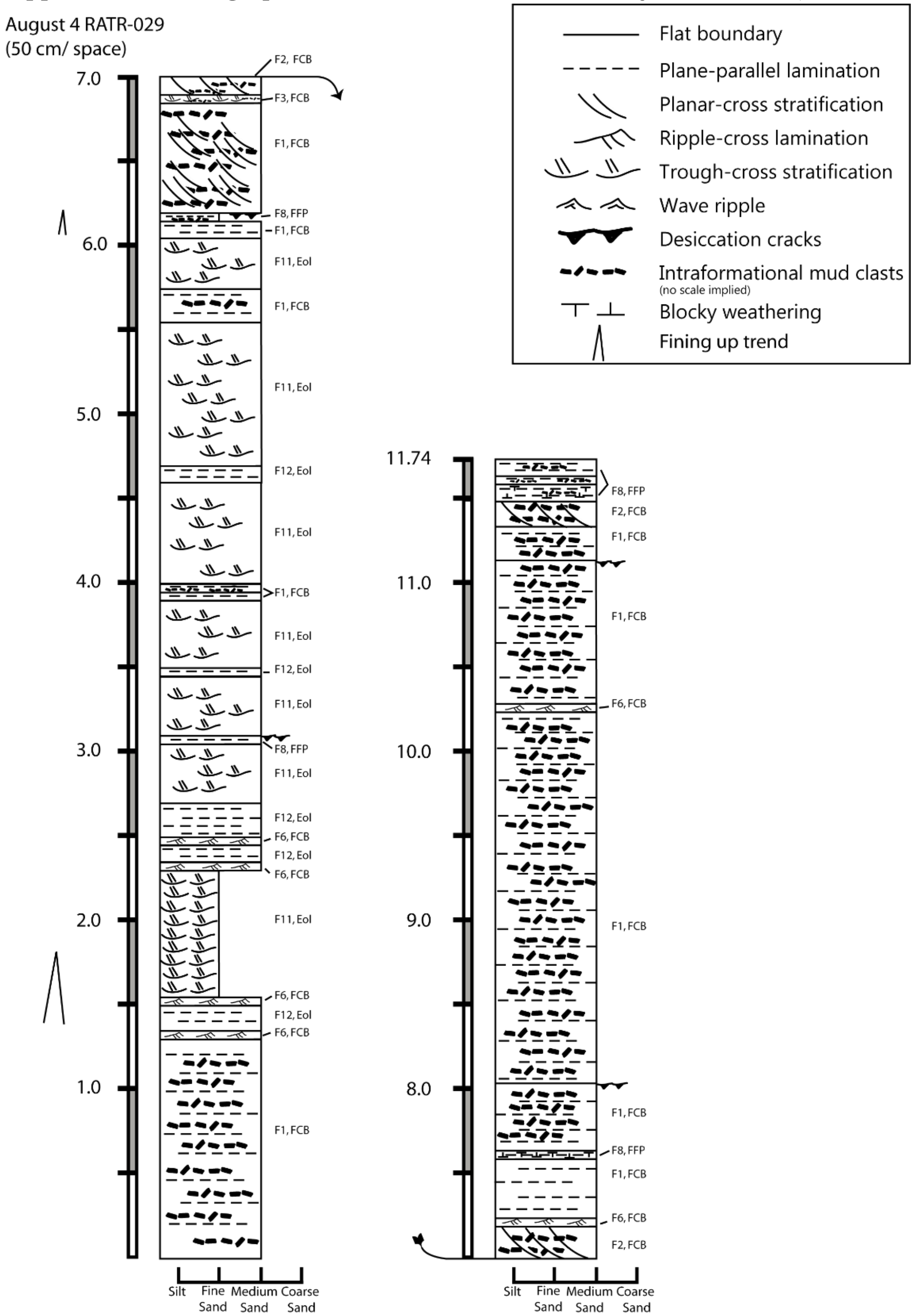
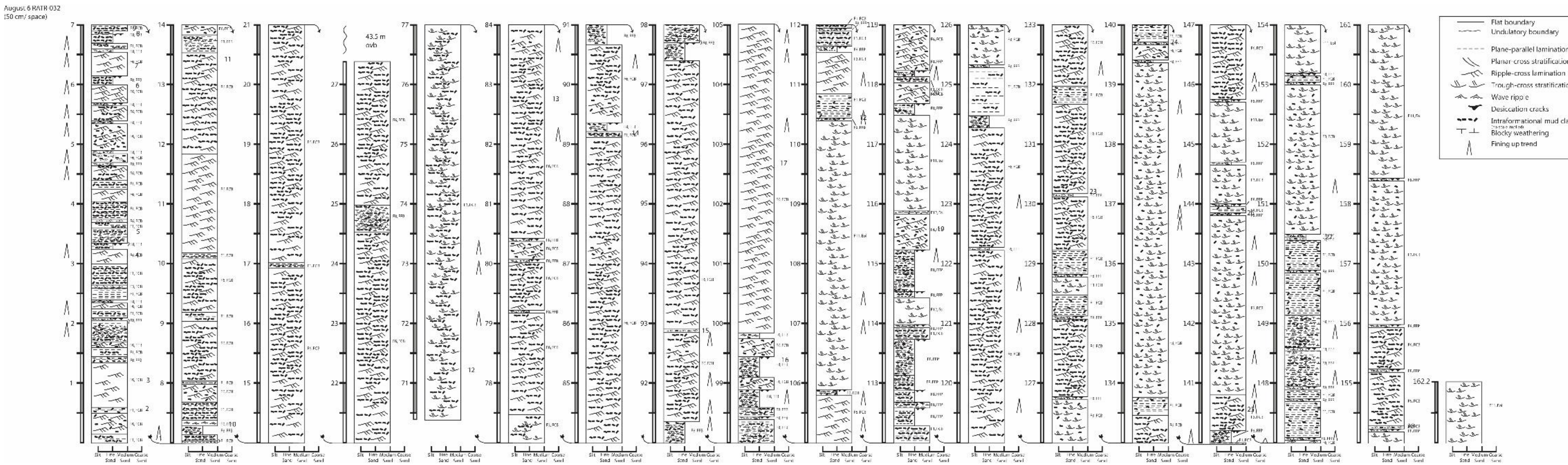
Appendixes

Appendix A: Stratigraphic column of the middle Husky Creek Formation (17-RATR-028).



Appendix B: Stratigraphic column of the middle Husky Creek Fm. (17-RATR-029).





Appendix C: Stratigraphic column of the upper Husky Creek Fm. (17-RATR-032)