

PS Complete 3-D Reconstruction of an Early Paleozoic Fore-Reef Succession in Yukon, Canada*

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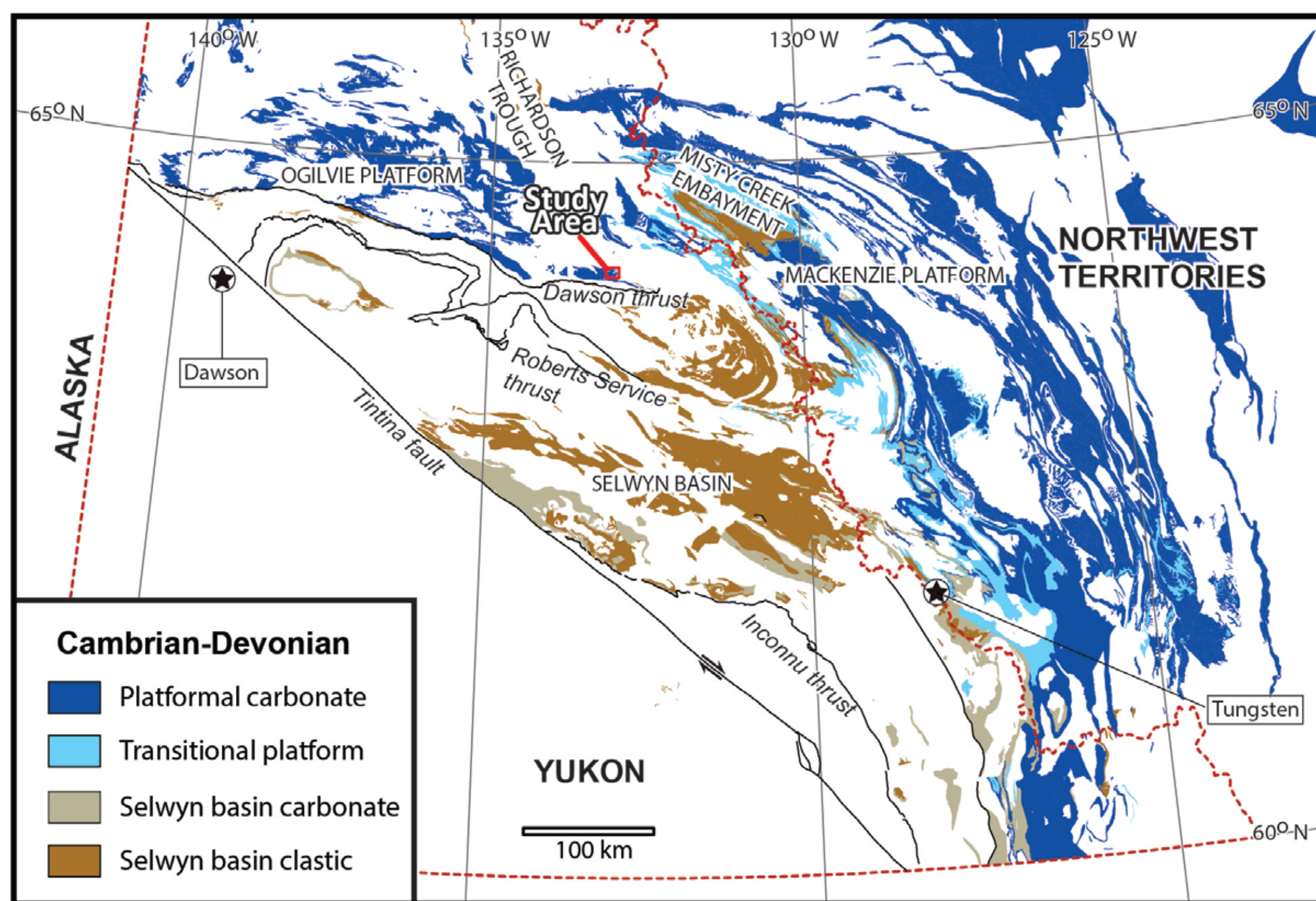
Abstract

Carbonate reefs provide an excellent paleontological record of marine biodiversity and can also contain significant hydrocarbon accumulations. In particular, fore-reef and reef margin successions preserve the sedimentary record of environmental change in reef systems and also host many prolific hydrocarbon reservoirs. However, there are few exposures of reef margin depositional systems which provide appropriate outcrop analogues to subsurface equivalents containing hydrocarbon accumulations. A remarkable exposure of the Cambrian-Devonian Bouvette Formation at Nadaleen Mountain in Yukon, Canada was discovered in 2017, and reconnaissance observations suggested a fore-reef succession was preserved at the margin of the Ogilvie Platform. In August 2018, we measured 24 closely spaced stratigraphic sections of the Bouvette Formation along depositional dip and strike and carefully mapped the region to test the hypothesis that the exposure at Nadaleen Mountain represents a fore-reef depositional system. To aid in mapping and visualization of the depositional system, an Unmanned Aerial Vehicle (UAV) was employed to collect imagery and create a high-resolution digital elevation model (DEM) of the entire Bouvette Formation exposure. Approximately 100 strike and dips were measured with accompanying GPS points, so that in combination with the UAV imagery and DEM, a 3-D depositional model can be constructed. The measured stratigraphic sections and UAV imagery revealed several important stratigraphic features at Nadaleen Mountain. Notably, two 5-30 m thick stacked clinoformal wedges of fossiliferous packstone composed of crinoid and reef fossil debris thicken to the NW in the study area. A third more massive unit ~15-100 m thick composed entirely of reef debris and topped by domal tabulate and rugose coral reef buildups also thickens to the NW in a clinoformal geometry. Sedimentary facies and unit geometries observed suggest the Bouvette Formation at Nadaleen Mountain comprises a fore-reef depositional environment and records significant environmental change along the margin of the Ogilvie Platform in the early Paleozoic. The study will allow for a complete 3-D reconstruction of a fore-reef depositional system that can be used in reservoir modeling of analogous petroleum systems. Furthermore, these data will also provide an exceptional record of early Paleozoic sequence stratigraphy, carbonate sedimentology, reef ecology, and carbonate geochemistry.

Reference Cited

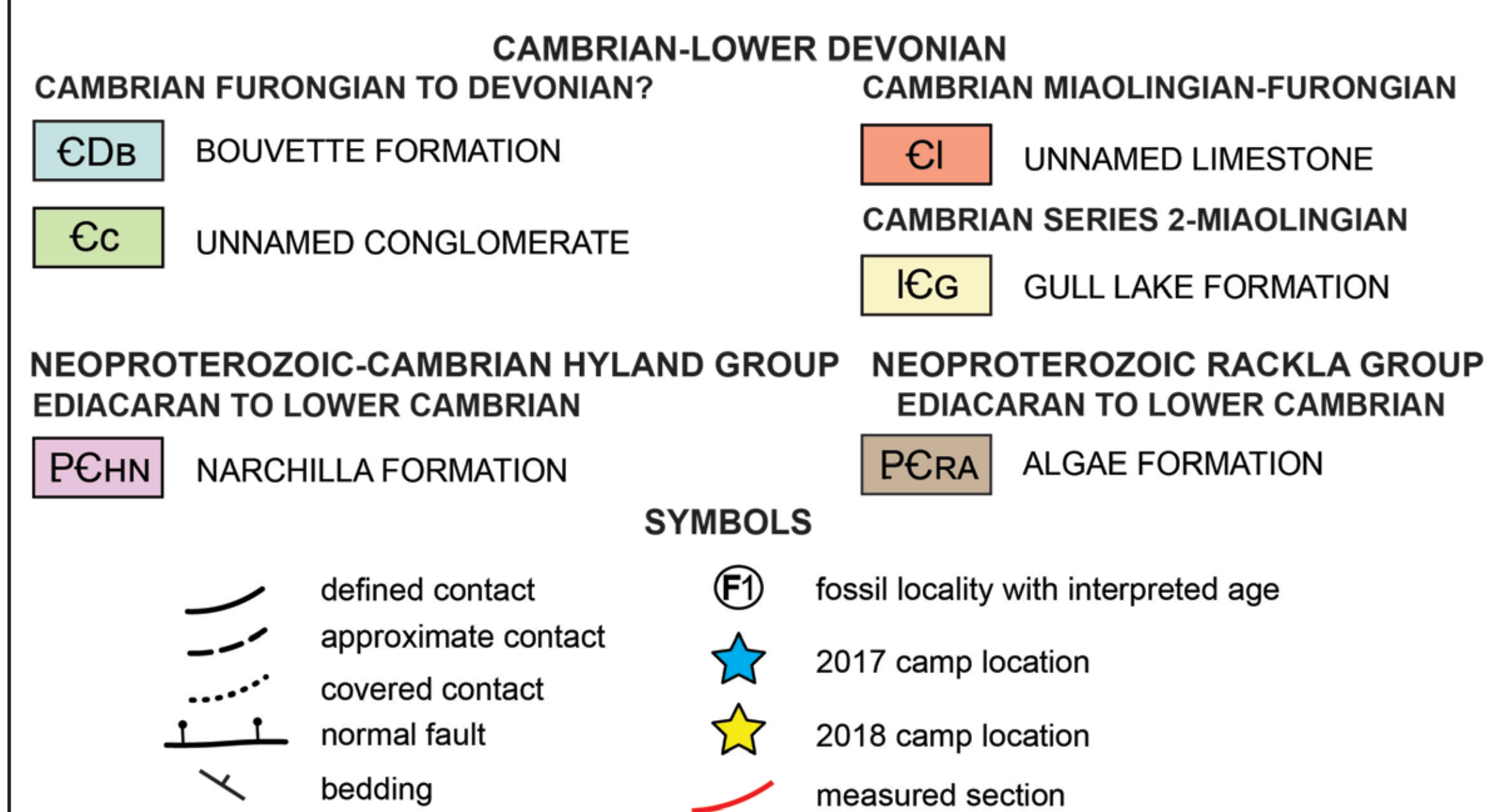
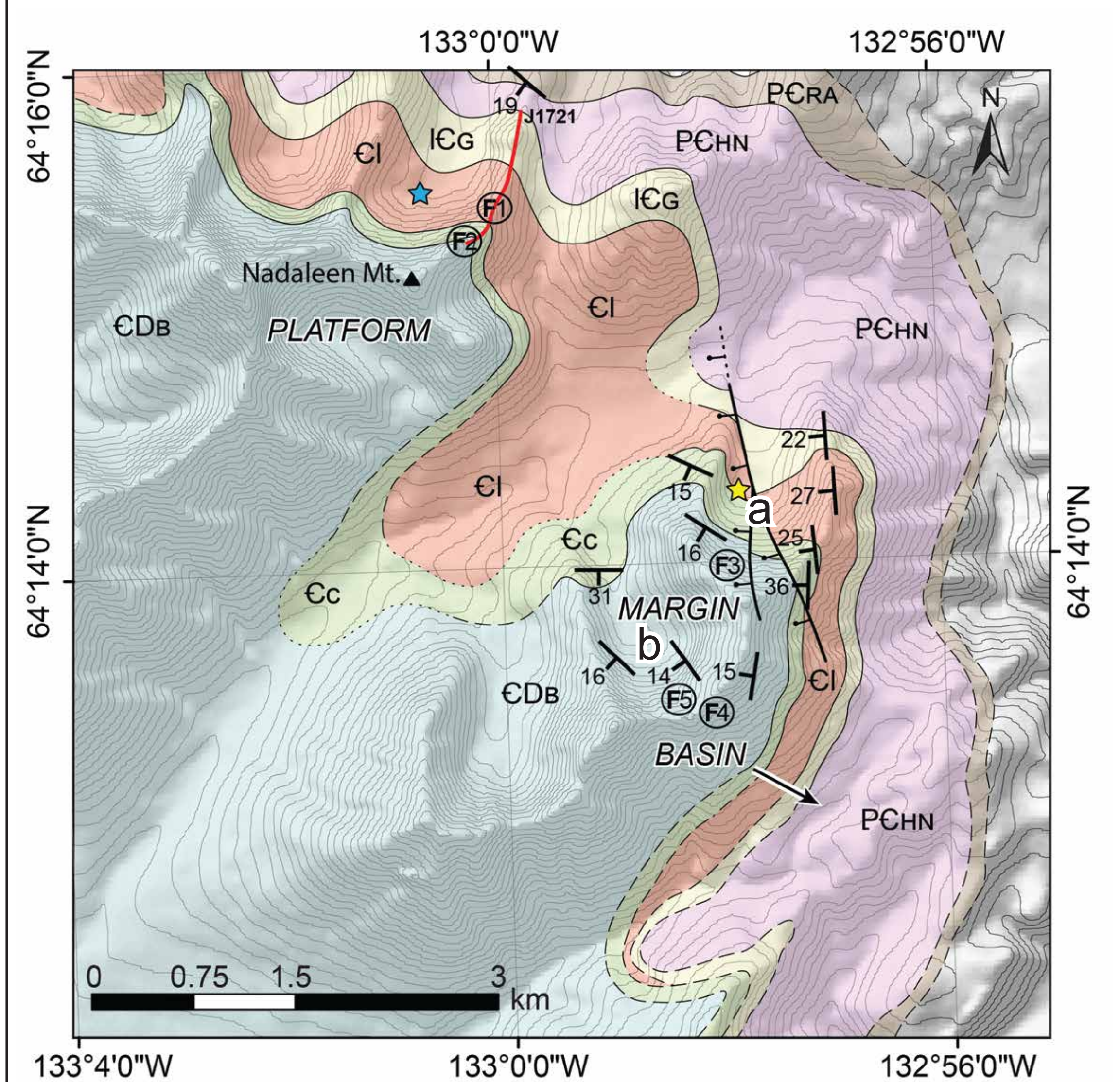
Busch, J.F., Strauss, J.V., Saylor, M.H., Allen, T.J., Faehrich, K. and Taylor, J.F., 2019, Preliminary observations of the Bouvette Formation at Nadaleen Mountain, Yukon (NTS 106C/2, 3): in Yukon Exploration and Geology 2018, K.E. MacFarlane (ed.), Yukon Geological Survey, p. 19–42.

Study Area



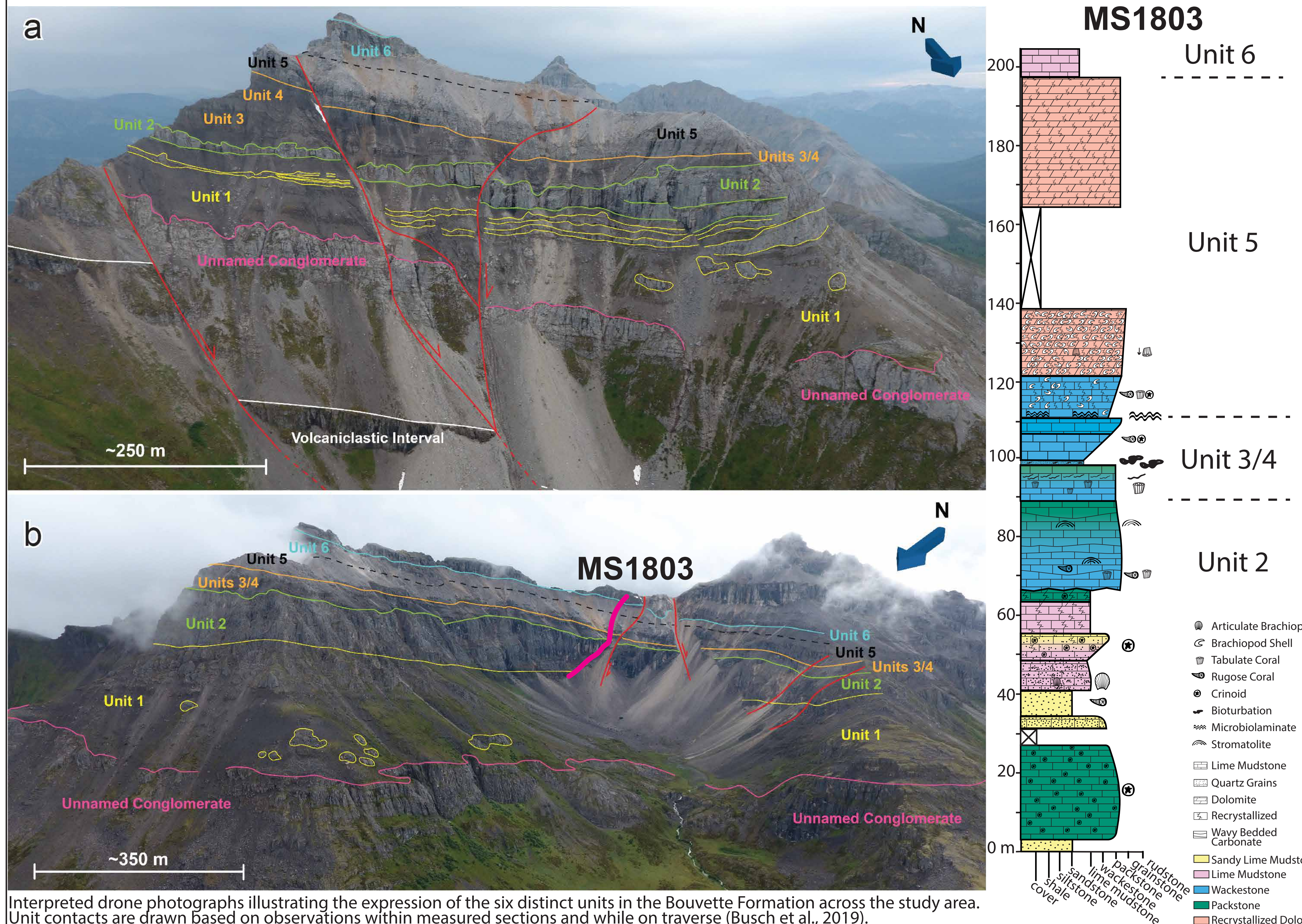
Simplified geological map of Proterozoic and Paleozoic strata in the northern Canadian Cordillera after Moynihan et al. (2019). The study area lies north of the Dawson fault, within the Rackla Belt of the Wernecke Mountains (Busch et al., 2019).

Geologic Map



Preliminary geological map of NTS 106C/2, 3 (scale 1:40 000) based on our field observations and modifications from Colpron (2012a) and Colpron et al. (2013). Elevation contour interval is 20 m. Modified from Busch et al. (2019).

Interpreted Drone Imagery and a Representative Measured Section



Interpreted drone photographs illustrating the expression of the six distinct units in the Bouvette Formation across the study area. Unit contacts are drawn based on observations within measured sections and while on traverse (Busch et al., 2019).

Study Motivation

The Cambrian–Devonian Bouvette Formation outcrops over large parts of central Yukon, Canada. Despite its broad lateral and temporal extent, relatively little is known about its precise age range, facies distribution, and depositional history. At Nadaleen Mountain in east-central Yukon, the Bouvette Formation is remarkably well exposed and provides new insight into the transition between the southeastern Ogilvie platform and northern Selwyn basin. Here, we present preliminary data collected from this region during 2017 and 2018, including measured stratigraphic sections, biostratigraphic data, and detailed imagery acquired from Unmanned Aerial Vehicles (UAVs), in order to test the hypothesis that the Bouvette Formation locally preserves a platform margin reef and forereef succession.

Data Collection

- In 2017, several reconnaissance stratigraphic sections were measured at Nadaleen Mountain and sampled for fossil material
- In 2018, we measured 27 stratigraphic sections of the Neoproterozoic-Paleozoic units south of Nadaleen Mountain
- Macrofossils material was collected within measured sections along with coarse-resolution carbonate samples for C-isotope measurements
- Fossiliferous intervals within each unit were collected for conodont biostratigraphy
- UAV imagery was collected at high-resolution for the entire exposure of the Bouvette Formation within the study area

Preliminary Results

- The Bouvette Formation unconformably overlies previously undescribed coarse-grained volcanoclastic and carbonate rocks that record the establishment of the Ogilvie platform in the terminal Cambrian
- These possible rift-related strata are overlain by distinct forereef to upper slope facies
- Spectacular exposures of reef-margin facies include fossiliferous lime packstones/wackestones in clinoformal wedge geometries rich in coral, echinoderm, mollusc, arthropod, and brachiopod debris
- Preliminary biostratigraphic data provide Late Ordovician to Early Silurian age constraints on the Bouvette Formation

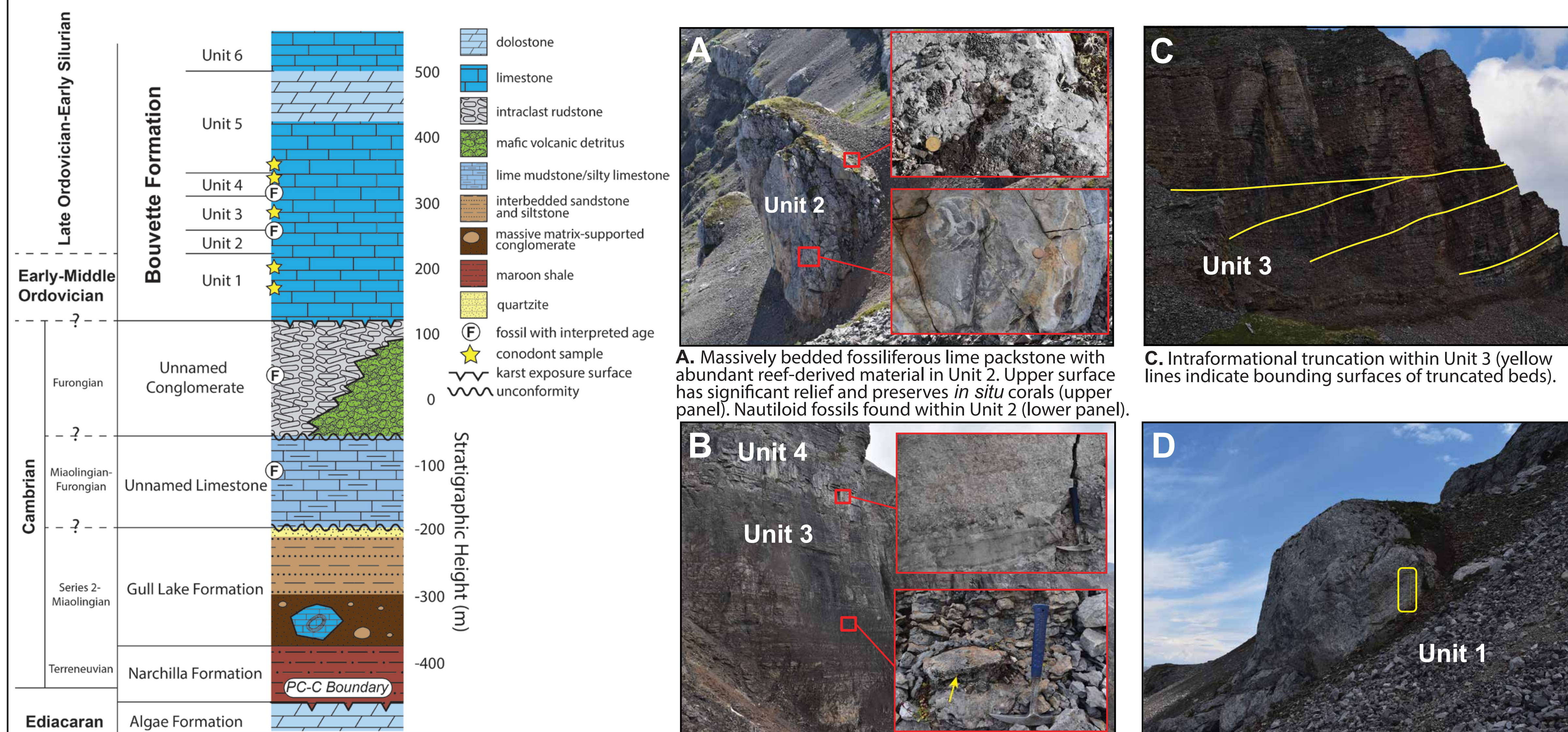
Future Work

- Additional geological mapping of the study area
- Measured sections of the strata that overly Unit 6
- Collection of additional fossil material and high-resolution carbonate samples for C-isotopes in the previously measured units 1-5
- Further collection of UAV imagery to aid in the construction of a complete 3-D model of the depositional system

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Generalized Stratigraphy and Field Photographs



Schematic stratigraphic column of Neoproterozoic-Paleozoic strata in the Nadaleen Mountain study area. Modified from Busch et al. (2019).

A. Massively bedded fossiliferous lime packstone with abundant reef-derived material in Unit 2. Upper surface has significant relief and preserves *in situ* corals (upper panel). Nautiloid fossils found within Unit 2 (lower panel).

B. Thin wavy bedded fossiliferous lime wackestone/packstone with abundant *in situ* corals of Unit 3 (lower panel) and thickly bedded brachiopod packstone and grainstone of Unit 4 (upper panel).

C. Intraformational truncation within Unit 3 (yellow lines indicate bounding surfaces of truncated beds).

D. Isolated block in Unit 1 composed of recrystallized lime packstone surrounded and overlain by fossiliferous lime wackestone (m stick circled for scale).

Schematic stratigraphic column of Neoproterozoic-Paleozoic strata in the Nadaleen Mountain study area. Modified from Busch et al. (2019).