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Sequence stratigraphy of the Portrait Lake Formation, Howards Pass, Yukon, Canada

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Introduction

The Selwyn basin region is a deep-water depocenter that contains numerous Pb-Zn±Ag sediment-hosted ore deposits that are observed in the Paleozoic strata across the region. Mudstone-dominated successions host stratiform examples of syn-depositional mineralization that form economic deposits within the region. A previous study by Schultz et al. (2026) aimed to geochemically characterize the expression of sequence stratigraphic surfaces and systems tracts in order to explain patterns of mineralization in the region and to create a framework for future mineral exploration.

This study aims to correlate along depositional strike within the Selwyn basin region to explain the distribution and extent of sequences that accumulated in the Late Devonian. Additionally, geochemical data collected in the region may help explain why mineralization is prevalent in the Portrait Lake Formation in the Macmillan Pass District but occurs at a lower interval in the Howards Pass District.

In the Howards Pass District, the Portrait Lake Formation lacks stratiform mineralization despite hosting a significant deposit at Macmillan Pass, only 75 km to the northwest. The distribution of mineralization reflects the 3D variability in systems tracts and facies. Because sequence stratigraphic boundaries in mudstone-dominated settings are typically gradational, geochemical tools are required for regional identification. At Howards Pass, XRF and organic carbon isotope data from drill core were used to define sequence boundaries and systems tracts. Previous work at Macmillan Pass identified equivalent surfaces and significant Pb-Zn±Ag mineralization within the same formation, indicating that the geochemical composition of the mudstone may be a controlling factor in mineralization.

The objective of this study is to correlate these surfaces along depositional strike from Macmillan Pass toward Howards Pass to determine whether lower-frequency sequence stratigraphic expressions are regionally mappable and to better explain mineralization patterns within mudstone-dominated intervals.

Selwyn basin

The Cambrian to Devonian rocks at Macmillan Pass and Howards Pass were deposited in Selwyn basin, which was a depocenter along the northwestern margin of Laurentia (Gordey and Anderson, 1993). The Devonian strata belong to the Earn Group, which is subdivided in this region into the Portrait Lake and Prevost formations (Fig. 1).

At Macmillan Pass, intermittent periods of extension are marked in the area by normal faults that were reactivated during the later stages of deposition of the Portrait Lake Formation and during the deposition of the Prevost Formation. The reactivation led to significant compartmentalization

and rapid lateral variability of sedimentary units (e.g., thick conglomerates adjacent to thick mudstone successions) and complicated the correlation of genetically related strata in the basin.

Similar patterns of intermittent fault reactivation are recognized in the Portrait Lake Formation at Howards Pass, however, the unit is sedimentologically distinct from its expression at Macmillan Pass. At Howards Pass, deposition primarily occurred through hemipelagic sedimentation or at the most distal extent of turbidite systems. Conglomerates and sand-rich intervals are not intersected until the uppermost members of the formation and are commonly absent in cored intervals, being observed mainly in regional outcrops.

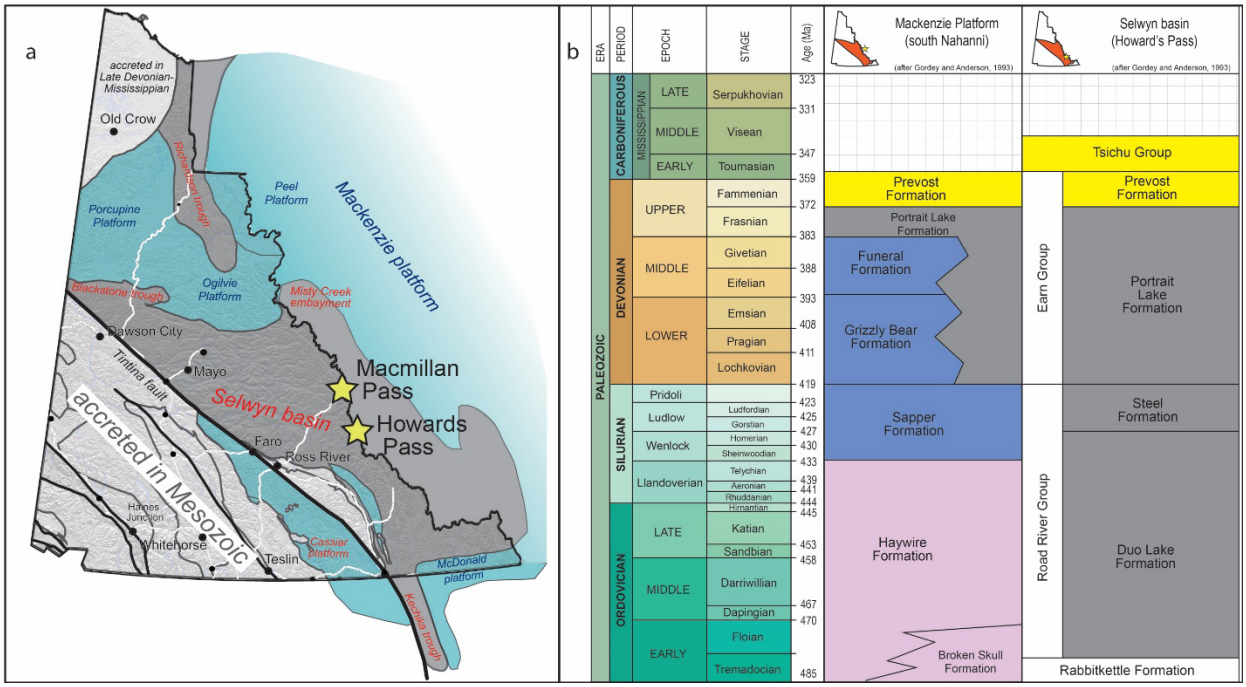


Figure 1: a) Location of Macmillan Pass and Howards Pass in the Selwyn basin region (Schultz et al., 2026 modified from Nelson et al., 2013). b) Table of formations for Howards Pass (Schultz et al., 2026 modified from Gordey and Anderson, 1993 and Cecile, 2000).

Study area and methods

At Howards Pass, three cores were logged and sampled in July and August 2025. Cores were selected based on vintage (2005–2010 drilling programs), length, and the intersection with the lower and upper boundaries of the Portrait Lake Formation. Hole DON-142 was drilled from the upper members of the Portrait Lake Formation into the mineralized rocks of the underlying Road River Group. Additional core is available outside of what was logged for the current study. The cores from holes XYC-208 and XYC-241 form a composite section from the Steel Formation into the upper informal members of the Portrait Lake Formation. These two holes are less than 800 m away from each other, were of newer vintage, and had overlapping strata preserved in them, which is why they were selected for creating the composite section.

Samples were taken at a 2 m interval through all the core for an XRF study. The sampling interval was chosen to compare results between Macmillan Pass and Howards Pass (Fraser et al., 2021; Schultz et al., 2026). Samples from DON-142 were also run for an organic carbon isotope ($\delta^{13}C$) study to determine if there are significant deviations in isotope signatures that may be able to be tracked along depositional strike to Macmillan Pass.

Discussion

The geochemical data used in this study builds upon the proxies that were used by Fraser et al. (2021) and Schultz et al. (2026) for the Macmillan Pass region. Geochemical proxies were calculated for terrigenous input (TIP), carbonate content and enrichment factors of redox-sensitive elements. These proxies were used to mark the position of sequence stratigraphic horizons and to typify systems tracts. Total organic carbon (TOC) values were provided as part of the $\delta^{13}C$ results, allowing for the increase and decrease of these values to be tied to systems tracts deposition as well.

Maximum flooding surface (MFS)

The maximum flooding surface marks the boundary between underlying TST deposits and overlying regressive strata. It is characterized by the lowest TIP values, minimum carbonate content, and a gradual increase in TOC above the surface. Above this horizon, TIP, carbonate content, and TOC generally increase. The MFS may also correspond to low spectral gamma-ray values and, at higher frequencies, displays similar geochemical patterns.

Maximum regressive surface (MRS)

The maximum regressive surface separates underlying regressive deposits from overlying TST strata. It is defined by abrupt decreases in TIP values and carbonate content, along with declining TOC above the surface. Below this boundary, TIP and carbonate values are typically high. The surface commonly occurs within fining-upward successions.

Transgressive systems tract (TST)

The TST is characterized by overall decreasing trends in TIP values, carbonate content, and TOC. TIP values average ~10%, while carbonate concentrations are typically ~2% MgO and ~5% CaO. These trends indicate a general reduction in terrigenous input to the depositional system during transgression.

Regressive systems tracts

This study does not differentiate regression in relation to fluctuations in relative sea level. Mudstones accumulated across the highstand, falling-stage and lowstand systems tracts. Collectively, regressive systems tracts show increasing trends in TIP values, carbonate content, and TOC. Deposits formed during regression also display low or declining enrichment of molybdenum (Mo) and vanadium (V), suggesting variable redox conditions persisted during deposition.

Patterns of mineralization

Systems tracts have unique sedimentological and geochemical characteristics that are diagnostic to their identification. Mineralization is predominantly found in mudstone-dominated intervals of Paleozoic strata throughout Selwyn basin. However, not every region forms the same patterns

and textures of mineralization. This suggests that the geochemistry of mudstone intervals may act as a control on the formation of mineralization. By comparing the geochemistry of the mudstones in the Portrait Lake Formation at Macmillan Pass and Howards Pass, it may be possible to highlight mudstone characteristics that would be favourable to host syn-depositional mineralization based on the following models:

1. Mineralization that forms through the replacement of barite by sphalerite and galena.
2. Dense bottom water brines precipitating in topographic low and forming laminae and beds of mineralization.

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References

Cecile, M.P. 2000. Geology of the northeastern Niddery Lake map area, east-central Yukon and adjacent Northwest Territories. Geological Survey of Canada, Bulletin 553, 120 p.

Fraser, T.A., Milton, J. and Gouwy, S.A. 2021. New geochemistry from old drill holes at the Tom property, Macmillan Pass, Yukon. In: Yukon Exploration and Geology 2020, K.E. MacFarlane (ed.), Yukon Geological Survey, p. 19 – 46.

Gordey, S.P. and Anderson, R.G. 1993. Evolution of the northern Cordilleran miogeocline, Nahanni map area (105I), Yukon and Northwest Territories. Geological Survey of Canada, Memoir 428, 214 p.

Schultz, S.K., Catuneanu, O. and Gordon, J.B., 2026. Preliminary analysis of the sequence stratigraphy and geochemistry of the Portrait Lake Formation at Macmillan Pass, Yukon, Canada. In: Yukon Exploration and Geology 2025, A. Stuart, L.H. Weston and S.K. Schultz (eds.), Yukon Geological Survey, Government of Yukon, p. 167–190, plus digital appendix.