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An integrative biostratigraphic, chemostratigraphic, and sequence stratigraphic perspective of the Ordovician–Silurian boundary on Anticosti Island (Canada)

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Anticosti Island, Canada, has long been recognized as an exceptional Ordovician–Silurian boundary succession with the potential to serve as one of the best records of climatic, oceanographic, and biological events associated with the Late Ordovician mass extinction. However, differing interpretations as to the position of the Hirnantian Stage within the stratigraphic succession due to the paucity of diagnostic graptolites, the apparent absence of a typical *Hirnantia* fauna within the Upper Ordovician Ellis Bay Formation, and lateral facies variability among outcrops has hindered the study of the Ordovician–Silurian boundary on the island, particularly in the eastern half of the outcrop belt. Definitively identifying the stratigraphic position of the Hirnantian Stage within the succession is therefore critical for understanding this classic Ordovician–Silurian boundary section, as well as for the integration of data from Anticosti into our global understanding of the Late Ordovician mass extinction.

Here, we take an integrative approach to studying the Ellis Bay and lowermost Becscie formations, combining new paleobiological, geochemical, radiometric, and sequence stratigraphic constraints from ongoing fieldwork with existing biostratigraphic, geochemical, and palynological studies in the context of newly measured stratigraphic sections. These formations record six depositional sequences bounded by regionally traceable but subtle unconformities, often mantled by thin siliciclastic veneers reworked into transgressive lag facies. Many of these unconformities have gone unrecognized despite more than a century of work at certain localities. Furthermore, despite previous controversy, multiple lines of evidence favor a Hirnantian age for the entire Ellis Bay and lowermost Becscie formations, including newly recognized occurrences of *Hirnantia* and *Hindella* in the lower Ellis Bay Formation, a two-phased positive carbon isotope excursion, with the second phase reaching ~6‰ in the Laframboise Member of the Ellis Bay Formation, and a U-Pb TIMS age of 443.61 ± 0.52 Ma from zircons in a bentonite from the mid-Ellis Bay Formation. While graptolite and conodont biostratigraphy support this age model, determination based on chitinozoan biozonation is more equivocal but may be controlled by facies preferences. Conodont, brachiopod, and chemostratigraphic data additionally suggest that the Hirnantian Stage may extend slightly into the lower Becscie Formation on the western end of Anticosti and well into the lower Becscie Formation in the eastern part of Anticosti.

Our reappraisal of a classic Ordovician–Silurian boundary section has important implications for understanding the sequence of climatic, environmental, and biological events throughout the Late Ordovician mass extinction. Given that the Ellis Bay and lowermost Becscie formations are indeed Hirnantian in age (encompassing ~2 My), these formations record six fourth-order depositional sequences of approximately ~333 ky. Furthermore, comparison of the Hirnantian of Anticosti to coeval exposures suggests that other regions may be incomplete at the level of the fourth-order cycles that occur in the Ellis Bay Formation. Resulting uncertainties in correlations based on unconformities and interpretations of stratigraphic architecture may therefore greatly complicate global correlation of Hirnantian records. Further study of this issue is critical, as stratigraphic architecture is expected to be an overarching control on the expression of oceanographic, climatic, and biotic events at a regional scale, complicating the interpretation of the pattern and drivers of the Late Ordovician mass extinction.

ABSTRACT

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