Precambrian Research 232 (2013) 209–225

Contents lists available at SciVerse ScienceDirect

Precambrian Research

journal homepage: www.elsevier.com/locate/precamres

Sequence stratigraphy, provenance, C and O isotopic composition, and correlation of the late Paleoproterozoic–early Mesoproterozoic upper Hornby Bay and lower Dismal Lakes groups, NWT and Nunavut

Katherine Hahn [a,*], Robert Rainbird [b], Brian Cousens [a]

[a] Carleton University, Department of Earth Sciences, 2125 Herzberg Building, 1125 Colonel By Drive, Ottawa, Ontario, Canada K1S 5B6
[b] Department of Earth Science, Laurentian University, 935 Ramsey Lake Road, Sudbury ON, Canada P3E 2C6

ARTICLE INFO

Article history:
Received 2 May 2011
Received in revised form 14 May 2012
Accepted 5 June 2012
Available online 13 June 2012

Keywords:
Sequence stratigraphy
Paleoproterozoic
Intracontinental basins
Chemostratigraphy
Stratigraphic correlation
Sedimentary provenance

ABSTRACT

Late Paleoproterozoic basins of Canada's north, including the Thelon, Athabasca, and Hornby Bay basins, can be broadly correlated based on similarities in age, sequence stratigraphy, paleocurrents, and detrital zircon provenance, but their detailed evolution is poorly understood and their age and lateral equivalencies are poorly constrained. This study contributes to the understanding of sedimentary basins during a critical interval of time, representing the latest stages of amalgamation of the supercontinent Laurentia/Nuna, through a detailed study of the Hornby Bay Basin. The Hornby Bay Basin strata have been divided into four unconformity-bounded subsequences, A1, A2, A3, A4, that belong to the first of three unconformity-bounded post-Hudsonian Proterozoic stratigraphic packages in northwestern Canada. Subsequences A2 (>1600 Ma) and A3 (<1600–1270 Ma) of the Hornby Bay Basin were intersected during diamond drilling for uranium exploration. Sequence stratigraphic interpretations reveal that the subsequence A2–A3 boundary lies below the LeRoux Formation, which forms the base of the Dismal Lakes Group, a critical relationship that was previously disputed. Stratigraphic patterns in the late stages of development of the Hornby Bay Basin are considered to have been largely controlled by the Paleoproterozoic Forward Orogeny (~1600 Ma), rather than by global eustasy.

Analysis of Sm–Nd isotopes on mudrocks yielded isotopic compositions in the range −8.2 to −2.3 (ε_{Nd}(1600 Ma)) in subsequence A2 and −9.8 to −5.0 (ε_{Nd}(1400 Ma)) in subsequence A3. An ε_{Nd} versus time graph illustrates two distinct groupings that plot within known isotopic evolution fields of the Taltson-Thelon Tectonic Zone, and the Great Bear Magmatic Zone. Sediment provenance was strongly influenced by the Paleoproterozoic Forward Orogeny, but there are no significant changes in sedimentary provenance across the A2–A3 sequence boundary. Stable isotope analyses of C and O in the dolomitic East River Formation of subsequence A2 reveal a relatively monotonous signal with an average of −0.5‰ δ^{13}C and −8.76‰ δ^{18}O, which is consistent with global values of other late Paleoproterozoic carbonate successions. Enriched Mn values and depleted Sr values, however, suggest that the East River carbonate rocks experienced some degree of meteoric alteration; it is unknown how much this alteration affected stable isotope compositions.

Based on similarities in sedimentary provenance, age, and sequence stratigraphy, subsequence A2 of the Hornby Bay Group is correlated with the Wernecke Supergroup (Yukon). The latter is interpreted to represent the deep-water distal equivalent of the upper Hornby Bay Group in a westward-deepening basin. Deposition of subsequence A2 is recorded across North America and is mirrored by deep-water sedimentation along the eastern margin of the North Australian craton. The tectonic evolution of subsequence A2 in Laurentia is therefore remarkably similar to that of the North Australian craton up to ~1600 Ma, the age of the Forward Orogeny, and this has implications for interpretation of the latest stages of accretion of the supercontinent Nuna.

1. Introduction

Late Paleoproterozoic basins of Canada's north, including the Thelon, Athabasca, and Hornby Bay basins, all hosting uranium deposits, can be broadly correlated based on similarities in age, sequence stratigraphy, paleocurrents and detrital zircon

* Corresponding author at: 407 Laura Ave – Apt. 2, Sudbury, ON, Canada P3E 3S2. Tel.: +1 613 889 5985.
E-mail addresses: khahn85@gmail.com (K. Hahn), rrainbir@nrcan.gc.ca (R. Rainbird), bcousens@earthsci.carleton.ca (B. Cousens).

0301-9268/$ – see front matter © 2012 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.precamres.2012.06.001

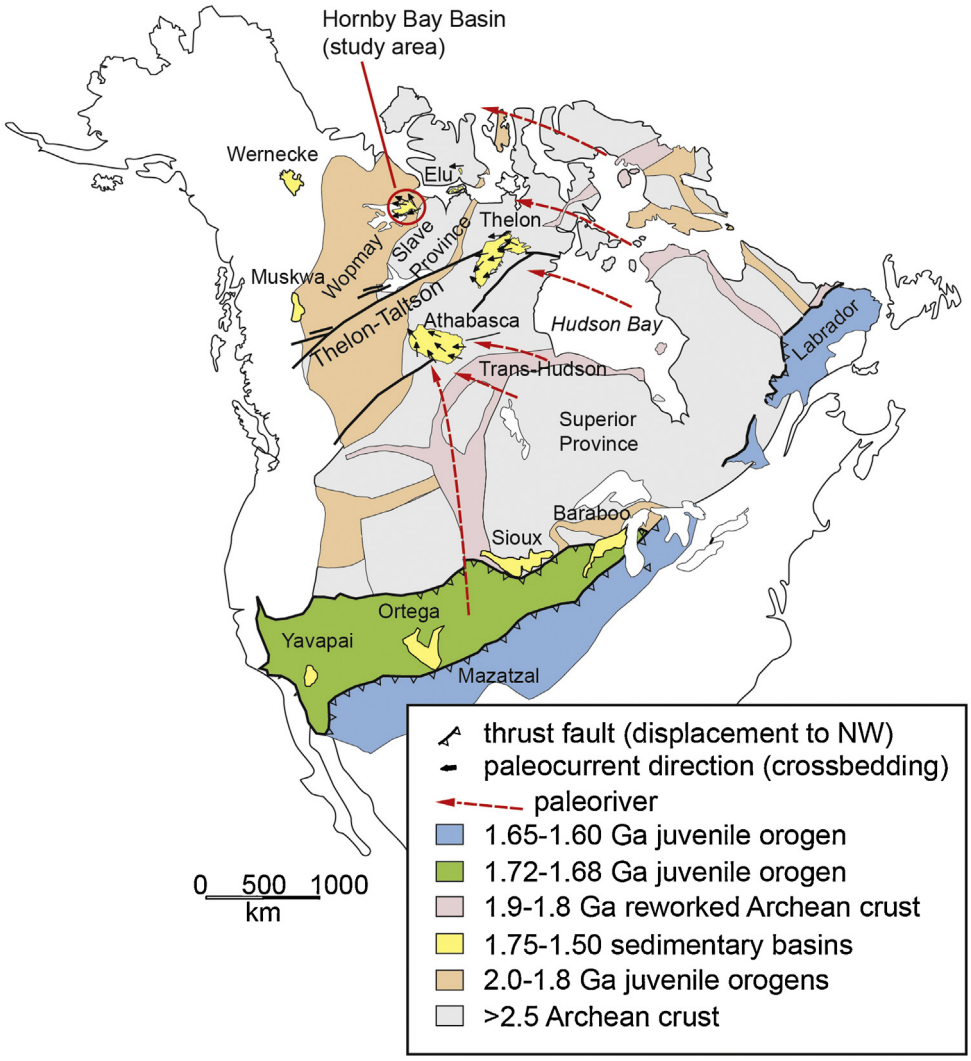

Fig. 1. Generalized geological map of North America illustrating the extent of Laurentia, Paleoproterozoic sedimentary basins, and dominantly west-directed paleocurrents. Modified from Rainbird and Young (2009).

provenance (Fig. 1). This paper derives a sequence stratigraphic framework and sedimentary provenance and carbonate isotopic profiles for the late Paleoproterozoic to early Mesoproterozoic Hornby Bay Basin in order to test hypotheses regarding regional correlation, specifically addressing correlation with the Wernecke Supergroup to the west. The Hornby Bay Basin is located along the Nunavut-Northwest Territories border north of Great Bear Lake (Figs. 1 and 2). Detailed mapping by Ross and Kerans (1989) provided the stratigraphic and sedimentologic framework that forms the basis for this study, which is focused on the upper Hornby Bay Group and the lower Dismal Lakes Group.

Fraser et al. (1970) and Young et al. (1979) suggested that the generally fine-grained Wernecke Supergroup of the Wernecke Mountains, Yukon, may represent the distal, deep-marine equivalent of shallow-marine to terrestrial Hornby Bay strata. This relationship was further investigated and refined by MacLean and Cook (2004) through the interpretation of seismic data from the interior plains region of northwestern Canada. The results of MacLean and Cook (2004) supported the original hypothesis of Young et al. (1979) but subdivided strata into four subsequences (A1, A2, A3, and A4), specifically linking subsequence A1 in the Hornby Bay Group to the Wernecke Supergroup of the northern Cordillera (Fig. 1). Although exact ages of the Wernecke Supergoup and Hornby Bay Group are poorly constrained, recent detrital zircon geochronology indicates that the Wernecke Supergroup may be 100 m.y. younger than previously thought, suggesting that a more detailed examination of this correlation is required. The subsequences of the Hornby Bay Basin can be broadly correlated with those of other intracontinental basins in Laurentia, such as the Thelon, Athabasca and Elu. Understanding the sedimentary history of these basins is critical to our understanding of Laurentia and its position within the supercontinent Nuna.

The current study centers around the Mountain Lake uranium deposit, which is located approximately 15 km southwest of the southern arm of Dismal Lakes, Nunavut (Fig. 2). Results are based on observations and samples from exploratory rock cores drilled by Triex Minerals Corp. during the 2007 and 2008 field seasons. The sequence stratigraphic framework established for the Hornby Bay Basin by MacLean and Cook (2004) was used, with some modifications, as a basis for regional correlation and age comparison with other Proterozoic basins in Canada. U–Pb dating of detrital zircons from sandstones of the Hornby Bay Group was recently completed (Rainbird et al., 2009a) and used in conjunction with Sm–Nd analysis of mudrocks to evaluate sediment provenance. In addition, carbon and oxygen isotopes were measured on carbonate units within each basin in order to further constrain correlations.