Precambrian Research 181 (2010) 167–186

Contents lists available at ScienceDirect

Precambrian Research

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

Early Paleoproterozoic supracrustal assemblages of the Rae domain, Nunavut, Canada: Intracratonic basin development during supercontinent break-up and assembly

R.H. Rainbird*, W.J. Davis, S.J. Pehrsson, N. Wodicka, N. Rayner, T. Skulski

Geological Survey of Canada, 601 Booth St., Ottawa, ON, Canada K1A 0E8

ARTICLE INFO

Article history:
Received 21 December 2009
Received in revised form 19 May 2010
Accepted 2 June 2010

Keywords:
Detrital zircon geochronology
Paleoproterozoic
Intracratonic basin
Stratigraphic correlation
Supercontinent
Churchill Province

ABSTRACT

The basal Paleoproterozoic supracrustal succession of the Churchill Province in northern Canada comprises sedimentary basins overlying the Archean Rae and Hearne domains. The Rae domain supracrustal succession (e.g. Amer, Ketyet River, Chantrey and Montresor groups) comprises four lithotectonic assemblages which include, in ascending stratigraphic position: (1) shallow marine-fluvial quartzarenite with mainly Neoarchean detrital zircons of local provenance; (2) shallow marine quartzarenite with mainly local provenance that locally includes carbonates ± mafic volcanic flows; (3) abrupt but conformable transition to basinal dark shales and overlying platformal carbonates that pass upward into siltstones and sandstones that record gradual emergence of the platform. Sandstones within this assemblage display a substantially different detrital zircon provenance signature dominated by early Paleoproterozoic zircons, with grains as young as 1.95 Ga; (4) unconformably to conformably overlying immature marine sandstones, including turbidites, with a significant component of 2.0–1.9 Ga detritus probably derived from a combination of local and distal sources. The thickness and relative compositional maturity of the basal lithotectonic assemblage 1 records a protracted period of enhanced weathering on a slowly subsiding but stable supercontinent (e.g. *Kenorland*). This was followed by mafic volcanism and marine transgression, consistent with partial rifting of the Rae domain and crustal extension attending supercontinent break-up (lithotectonic assemblage 2). Strata of lithotectonic assemblage 3 record basin flooding and deepening followed by platformal sedimentation along the margins of extended continental blocks. Assemblage 4 is interpreted to represent deposition in foreland basins during early amalgamation of Laurentia (part of *Nuna*) at ca. 1.9 Ga. The stratigraphy and detrital zircon geochronology of the Hurwitz Group, which overlies the Hearne domain, is broadly similar to the supracrustal sequence of the Rae domain, but differs through the presence of basal diamictites and lack of 2.5 Ga detritus, a major local source in the Rae. Our data suggest that the Rae and Hearne domains were assembled together by max. 1.91 Ga (i.e. max. age of deposition of the uppermost Hurwitz and Amer groups). The Paleoproterozoic stratigraphic assemblage framework for the Churchill Province compares well with that of other cratons derived from break-up of *Kenorland* and ultimately amalgamated in *Nuna*. Examples from Laurentia include supracrustal rocks that overlie the southern margin of the Superior Province (Southern Province, e.g. Huron Supergroup, Animikie Group, Marquette Range Supergroup, Whitewater Group and Mistassini-Otish Group). The Paleoproterozoic assemblages of the Southern and Churchill provinces exhibit first-order stratigraphic similarities that indicate a shared history of stable continental sedimentation followed by rifting, basin opening and basin closure.

1. Introduction

Sequence stratigraphic studies in concert with U–Pb dating offer a powerful tool for correlation and for evaluating the tectonic development of sedimentary basins. Such studies have helped to further our understanding of the temporal and evolutionary relationships among Earth's oldest thick, mature, cratonic sedimentary successions and are critical to our understanding of the tectonic evolution, reworking and potential paleogeographic correlation of the underlying Archean crustal domains. For example, a connection between the Churchill Province (Rae and Hearne domains), Superior Province and the Wyoming craton was proposed over 30 years ago, based on lithostratigraphic correlation of what was considered to be an extensive succession of Paleoproterozoic glacial diamic-

* Corresponding author at: Geological Survey of Canada, 601 Booth St., Ottawa, ON, Canada K1A 0E8. Tel.: +1 613 9432212; fax: +1 613 9435318.
E-mail addresses: rrainbir@nrcan.gc.ca, rob.rainbird@nrcan-rncan.gc (R.H. Rainbird).

0301-9268/$ – see front matter.
doi:10.1016/j.precamres.2010.06.005

tites and overlying thick aluminous quartzarenites (Young, 1973). The regional continuity of this succession was used as evidence for the existence of a late Archean supercontinent (*Kenorland*) (Aspler and Chiarenzelli, 1998; Williams et al., 1991). The characteristics of the supracrustal succession on the Rae domain are not well described making comparisons with better documented successions on other cratons difficult. In this paper we attempt to correlate stratigraphic and geochronological information for several geographically separated belts and outliers of basal Paleoproterozoic strata from across the north-central Rae domain and interpret their common stratigraphic and provenance attributes in terms of the tectonic evolution of this region. Ultimately we compare data from the Rae supracrustal succession with similar data from possibly correlative successions to make inferences about tectonic reconstructions.

2. Regional geology

Supracrustal rocks of early-mid Paleoproterozoic age are preserved as erosional remnants of mainly northeast-trending basement-cover infolds across the Rae and Hearne domains of the Churchill Province in northern Canada (Fig. 1, Aspler et al., 2001; Bell, 1970; Eade and Chandler, 1974; Jackson and Taylor, 1972; Lord, 1953; Wright, 1967). These supracrustal rocks predate the much better preserved supracrustal rocks of the Dubawnt Supergroup deposited after 1830 Ma (e.g. Rainbird and Davis, 2007; Rainbird et al., 2003). The Churchill Province is predominantly composed of Meso- to Neoarchean rocks that were variably reworked during initial assembly of Laurentia at 2.0–1.75 Ga (Hoffman, 1988). On the mainland, the region is divided into the Rae and Hearne domains by the Snowbird tectonic zone, a major intracrustal geophysical lineament that records Neoarchean and Paleoproterozoic histories (e.g. Berman et al., 2007; Gibb and Thomas, 1976; Hanmer et al., 1995; Martel et al., 2008). The western boundary of the Churchill Province is the Taltson–Thelon orogen, a major plutonometamorphic belt that developed during collision of the Slave craton and Buffalo Head terrane with the Rae domain at 2.0–1.9 Ga (e.g. Henderson et al., 1990; Hoffman, 1989; McDonough et al., 2000; McNicoll et al., 2000). To the east and southeast lie the internides of the Trans-Hudson orogen (Reindeer zone), which represents the orogenic suture formed by the collision between the Churchill, Sask and Superior cratons at 1.84–1.79 Ga (e.g. Bickford et al., 1990; Corrigan et al., 2009; Lewry and Collerson, 1990).

The basal Paleoproterozoic supracrustal belts are dominated by siliciclastic sedimentary rocks, mainly sandstones, with intercalated mafic volcanic rocks being common near the base and platformal carbonates present in the middle part of the succession. To date, only the relatively low metamorphic grade supracrustal belts of the north-central part of the Rae domain have been well studied, and hence are the subject of this paper (Amer and Ketyet River groups; Fig. 1). Also described are some smaller supracrustal outliers to the north, including the Montresor and Chantrey groups (Frisch, 2000) and the Folster Lake Formation (Frisch, 1982) (Fig. 1). Potential correlations with more distant supracrustal sequences of the greater Rae domain are considered in Section 3.

3. Sedimentology and lithostratigraphy

3.1. Amer group

The Amer Group outcrops in a northeast-trending fold-thrust belt that underlies the late Paleoproterozoic Thelon Basin and overlies mainly Neoarchean granitic and lesser supracrustal rocks of the Woodburn Lake Group (e.g. Patterson, 1986, Fig. 2). It records initial terrestrial (mainly fluvial) sedimentation followed by marine or lacustrine reworking with development of a thick succession of ultra-mature sandstone (Ayagaq Lake Formation). In the southeast part of the belt, the quartzarenite contains a discontinuous, up to 50-m-thick, carbonate unit originally mapped as part of the Aluminium River Formation but now considered to be part of the Ayagaq Lake Formation (Rainbird et al., in press; see below and Figs. 2 and 3). The carbonate unit is overlain and intercalated (tectonically interleaved?) with tectonized mafic volcanic rocks referred to as the Five-Mile Lake formation. The volcanic rocks are covered by another thick section of quartzarenite. The basin then subsided rapidly as recorded by abruptly overlying carbonaceous shale and fine sandstone of the Resort Lake formation, which pass gradationally upward into shallower water deposits of massive cherty carbonate of the Aluminium River formation. The succeeding Three Lakes Formation, composed of siltstone and mudstone, Oora Lake Formation, composed of quartzarenite and interbedded carbonate and Showing Lake formation, composed of rhythmically interbedded feldspathic sandstone and mudstone are interpreted as an upward-shallowing sequence and are probably, in part, facies equivalents recording a regional regressive depositional episode (Fig. 3). The uppermost unit, the Itza Lake Formation, is typified by crossbedded sub-arkosic sandstone of interpreted marine origin. The base of the formation is marked by a coarse conglomerate, interpreted as a submarine fan deposit, and some thin units of shallow marine stromatolitic dolostone. The conglomerate contains large rounded clasts derived from the Ayagaq Lake Formation. These clasts suggest local tectonic uplift during deposition of the Itza Lake Formation. In some areas the contact between the Itza Lake and Showing Lake formations is gradational. Paleocurrents from ripples in the Itza Lake Formation have a strong northeasterly trend, suggesting that the shoreline of the basin trended northwest–southeast, a disposition approximately normal to that inferred for the lower part of the succession (Rainbird et al., in press). The facies and paleocurrents from the Itza Lake Formation probably indicate major changes in basin configuration related to significant tectonic readjustment.

3.2. Ketyet River group

The Ketyet River group (informal) is a thick succession of siliciclastic sedimentary and lesser mafic volcanic-intrusive rocks that extends for 200 km in the central Rae domain, north of Baker Lake (Figs. 1 and 2). Schau et al. (1982) subdivided it into a northern association characterized by volcaniclastic rocks, volcanogenic sedimentary rocks and siliceous carbonate, now dated at 2.74–2.71 Ga (Davis and Zaleski, 1998; Sherlock et al., 2004; Zaleski et al., 2000) and a southern association characterized by quartzarenite (quartzite), polymict conglomerate, carbonaceous mudstone (pelitic schist) and impure carbonate (Fig. 4). Based on geochemistry (Sandeman, 2007), U–Pb detrital zircon ages (this paper) and stratigraphy we propose that the southern association correlates with the Amer Group to the north and the Penrhyn and Piling groups to the northeast (Figs. 1 and 5, see also Pehrsson et al., 2002). The northern association is now considered part of the Archean Woodburn Lake group. The stratigraphy of the Ketyet River group is similar to the Amer Group, comprising a lower succession of quartzarenite and feldspathic arenite with mafic flows, local iron formation and shale, a middle succession of sulphidic–graphitic pelite–semipelite with impure carbonate, and an upper succession of greywacke–pelite (Fig. 4). The lower succession of the group is further subdivided into a basal quartz–sericite schist–quartzarenite package and a disconformably overlying more impure arenite package with mafic volcanic flows. The basal sericitic schist is >5-m thick and is highly tectonized at its unconformable contact with Neoarchean rocks. The schist thins locally and is associated with oligo- to polymictic conglomerate characterized by quartzarenite,