Neoproterozoic glaciations in the Windermere Supergroup, Canada

A.-C. PIERSON-WICKMANN, T.K. KYSER, N. JAMES AND G. NARBONNE

Department of Geological Sciences and Geological Engineering, Queen's University, Kingston, ON K7L 2N6, Canada (wickmann@geol.queensu.ca, kyser@geol.queensu.ca, james@geol.queensu.ca, narbonne@geol.queensu.ca)

The Windermere Supergroup in NW Canada is a succession of shallow shelf to continental-slope deposits in which two major Neoproterozoic glaciations occurred, the Rapitan and the Ice Brook glacial deposits, which correlate with the Australian Sturtian and Marinoan glacial deposits. The Rapitan cap carbonates at the top of the Rapitan glacial deposits are a thin, finely laminated, dark grey, organic-rich limestone unit that records slightly negative carbonate $\delta^{13}C$ values. Above these cap limestones, a rise of sea level led to deposition of the deeper water shales and limestones of the Twitya Formation, which are further overlain by limestones of the Keele Formation as water depth again shallowed before the Ice Brook glaciation. The carbonate $\delta^{13}C$ values shift dramatically from near +1‰ in the Twitya Formation to anomalously ^{13}C-enriched values up to +10‰ in the Keele Formation (Kaufman et al., 1997), which is similar to the trend observed in equivalent units globally. However, differences between $\delta^{13}C$ values of coexisting organic and carbonate carbon are not constant throughout this interval.

Geochemical and sedimentological aspects of the carbonate samples indicate variable diagenesis of the limestones, with better preservation of the Rapitan cap carbonates compared to the Ice Brook cap carbonates (James et al., 2001). Diagenetic effects can be removed to reveal the original geochemical characteristics of the carbonates. Low Sr isotopic ratios measured in the Rapitan cap carbonates, Keele and Sheepbed formations do not vary greatly, contrary to the expected increase in Sr isotopic ratios that should follow extensive continental glaciation. Negative Ce anomalies in the Rapitan cap carbonates, as well as the Twitya and Keele carbonates and oolitic carbonates in the Keele Formation. are consistent with oxic seawater throughout this interval, in contrast to what is reported from other studies (Jiedong et al., 1999; Shields et al., in press). Two seawater proxies (REE, Sr) with different residence time in the oceans suggest that chemical changes in the ocean between the two Neoproterozoic glaciations sampled by the Windemere sections were minimal.

References

James et al. (2001), *Can. J. Earth Sci.*, 38, 1229-1262.

Jiedong et al. (1999) *Precamb. Res.*, 93, 215-233.

Kaufman et al. (1997), *Proc. Natl. Acad. Sci. USA*, 94, 6600–6605.

Shields et al. (2002), *Earth Planet. Sci. Lett.*, in press.

Long-term drainage network stability and uplift of the Ethiopian plateau deduced from (U-Th)/He thermochronometry

RAPHAËL PIK , BERNARD MARTY, JEAN CARIGNAN

CRPG, BP 20, 54501 Vandoeuvre-Lès-Nancy Cedex, rpik@crpg.cnrs-nancy.fr

The Afar plume-related volcanic province is dissected by a system of three rifts which contribute to separate Arabia from Africa. These rifts are connected in the Afar depression where they are surrounded by the Ethiopian and Yemeni highlands. This present day typical morphology is generally presented as the evolution trough time of the margins by volcano-tectonic rifting processes: piling up of lava flows and additional uplift of basement symmetrical to the rift zone. Plume-driven models are the traditional explanation for the formation of such volcanic rifted margins with significant surface uplift occurring prior to flood volcanism and break-up extension. However, the precise timing of margins and plateau uplift is not precisely known and is frequently debated. Was this typical margin landscape achieved progressively ? By the sum of episodic uplift interspersed between prolonged stable intervals ? Or, was it mainly achieved since the flood basalts eruption (30 Ma ago) prior to significant extension ?

To address this question we carried out a geomorphological and thermochronological study of the main Ethiopian plateau. (U-Th)/He age (apatite and titanite) have been measured on samples collected in the Blue Nile canyon which drains half of the plateau surface and on a latteral smaller river catchment. The sensitivity of this very low-temperature thermochronometer to river incision has already been tested by House et al., (1998) in valleys from Sierra Nevada. In the case of the Ethiopian plateau, the flood basalt pile (500 to 1500 m) emplaced 30 Ma ago buried rapidly (1-2 Ma) the pre-rift surface. As a consequence, shallow already cooled samples were brutally transferred deepest in the temperature range of He partial retention zone (He-PRZ) and started to be partially reset. The importance of partial resetting will depend on the time spent in the He-PRZ. In river catchment we estimated the duration of partial resetting by comparing our apparent He age profiles with calculated simulations (details in Ehlers et al., 2001) based on precise geological data.

Results suggest that the Blue Nile river started incision of its main canyon as early as 25 Ma ago. Laterally youngest He-ages in the smallest catchment of the Anger river are compatible with a more recent (10-12 Ma) initiation of significant denudation. The extent and morphology of these river catchment are governed on the plateau by volcanic and tectonic divides. The long-term stability of these networks and divides have implications which suggest that most of the present day uplift of the plateau was achieved between 30 and 25 Ma significantly before the beginning of extension in Afar (20 Ma ago). We could then envisage that the main tectonic scarp results from the fall in base level of Afar depression after the rupture of an already elevated region.