Altered volcanic ashes in Paleocene/Eocene Eureka Sound Group sediments (Ellesmere Island, Arctic Canada) – new stratigraphic tie-points?

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Abstract

The mainly clastic Eureka Sound Group sediments on southern Ellesmere Island (Stenkul Fiord/Split Lake area) bear only few fossils, which allow the identification of particular stratigraphic stages. Recently, we found altered volcanic ash layers that could provide novel stratigraphic marker horizons in the coal–bearing estuarine and fluvial-deltaic sediments spanning the Paleocene/Eocene boundary.

Two volcanic ash horizons, which are centimeter-thick and laterally traceable, were identified in fine-grained estuarine/coal swamp sediments of the Paleocene Mount Lawson Formation of the Eureka Sound Group north of Split Lake (fission track age ca. 60 Ma according to Grist & Zentilli 2005). The beige-brown layers are preserved as smectite-bentonites. A more whitish and several centimeter-thick layer was recovered from within a coal seam of the Late Paleocene to Early Eocene Margaret Formation south of Stenkul Fiord. The layer crops out just below the first occurrence of Eocene palynomorphs (Kalkreuth et al. 1996). It consists principally of the rare hydrated aluminium phosphate minerals Sr-crandallite or goyazite that are characteristic alteration products of volcanic ashes, which fell into coal swamps (e.g., Reinink-Smith 1990). Despite the diagenetic alteration, distinctive volcanic ash structures like columnar fragments, glass shards, and bubble-rich shards are preserved as pseudomorphs (identified by SEM).

XRF and ICPMS analyses of all three samples were done in order to obtain the geochemical fingerprints of the original lava. The chondrite-normalized REE patterns of the smectite-bentonite samples are comparable to those of alkaline volcanics. They fit well to the patterns of alkaline intercalations of the West-Greenland tholeiitic rift-related complex (Disko Island, absolute age 60 Ma, Larsen et al. 2003b) as well as to the patterns of bentonite layers in the Paleocene Basilika Formation on Spitsbergen. The REE pattern of the phosphate-rich sample is similar to the REE patterns of the Mo-clay volcanic ashes in Denmark (Larsen et al. 2003a), which have their origin in the strong volcanic activity on East-Greenland around 55 Ma (i.e., approximately at the Paleocene-Eocene boundary) during the opening of the North Atlantic.

All samples yielded only a small quantity of zircon. Most of the zircon consists of rounded detrital grains yielding a wide variety of ages by LA-ICPMS that are representative of the Laurentian craton. A few euhedral grains were also found and these proved to be about 55 Ma in age but precision is limited by common Pb bias. The youngest grains identified by LA-ICPMS

were re-mounted and analyzed using SHRIMP. Three anhedral grains proved to be zirconolite that could not be dated in the absence of a standard, while several of the tiny zircon grains were lost during mounting. Only 1 zircon from each sample could be relatively precisely dated. These were analyzed 2-4 times after which degradation of the gold coating began to noticeably bias Pb/U ratios. Results from the two lower (Paleocene) units give 53.9 +/- 3.1 Ma and 59.5 +/- 1.0 Ma while the higher unit gives 52.6 +/- 1.9 Ma. The latter result from the Margaret Formation is in the range of the 55.28 Ma age of the +19 ash discussed recently by Westerhold et al. (2009), while the most precise age from the Mount Lawson Formation agrees with fission-track results. However, more data are required to confirm these results and clearly resolve the volcanic events.

The identified ash layers might prove to be good stratigraphic tie-points providing the framework for onshore investigations of the Paleocene-Eocene Thermal Maximum global warming event as the Eureka Sound Group sediments contain numerous coal seams. Further thin ash layers have already been identified in adjacent outcrops of Mount Lawson Formation sediments.

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