Source rock geochemistry and sedimentary environments of the Oligocene mud-rich deposits of the Huty Formation (Prešov JT-10 borehole, Eastern Slovakia)

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Provenance and sedimentary environments of the Huty Formation have been inferred by using major and trace element geochemistry and foraminiferal and nannoplankton study. The Prešov section is formed by homogenous dark calcareous mudstones (50–34 m), which higher up pass to weakly calcareous claystones, laminated claystones, and fish shales.

The claystones of the Huty Formation are markedly depleted in Ba, Nb, Sr, and Tb relative to upper continental crust. Further, the rocks exhibit light rare earth element (REE) enrichment (La_N/Yb_N = 8.48–10.00), flat heavy REE, and significantly negative Eu anomalies (Eu/Eu* = 0.62–0.70) in chondrite-normalized REE patterns, similar to post-Archean average Australian shale (Taylor & McLennan 1985). Low Zr concentrations as well as various discriminant plots (for instance Th/Sc–Zr/Sc and Al_2O_3–TiO_2–Zr) indicate unimportant mineral sorting or recycling of these shales. The bulk chemistry and selected trace elements preserve the signatures of an intermediate igneous and quartzose sedimentary provenance, and thus suggest an immature continental margin magmatic arc to passive continental margin tectonic setting of the source areas for the Huty Formation shales. The Chemical Index of Alteration (CIA) (Nesbitt & Young 1982) values obtained from the shales studied range from 72 to 94 and suggest that the degree of weathering at the source areas was intensive. Such strong chemical weathering indicates a warm and wet paleoclimate.

Foraminiferal microfauna comprises of the large planktonic species in the lower part of the formation (*Globoturborotalita ouachitaensis*, *G. gnaucki*, *Globigerina praebulloides*, *G. officinalis*, "*Dentoglobigerina*" *venezuelana*, and *Paragloborotalia opima*). These cool-water foraminiferal species are associated with the planktonic pteropods, i.e. cold-adapted epiplanktonic molluscs indicating an influence of cold-water masses (Báldi 1984). Pteropoda-rich sediments of the Prešov section provide a correlative horizon with the Pteropoda beds of the Paratethys (Tard clays – Báldi 1984, Majkop Group – Popov et al. 2008). Diatoms also indicate a cool-water productivity and eutrophic conditions.

The most important foraminiferal bioevent is recorded by the appearance of *Globigerinoides primordius* in the upper part of the Prešov section (12.8 m).

This species with supplementary apertures occurred in the Late Oligocene (Zone O6), and is constrained as an ecological response of warming waters (Jenkins 1973).

Calcareous nannofossils from the lower part of the Prešov section (36.4 to 49.5 m) indicate the Early/Late Oligocene age (Zone NP23 and NP24), based on the species *Reticulofenestra lockeri*, *Isthmolithus lockeri*, and *Reticulofenestra ornata* (Martini 1971, Perch-Nielsen 1985). The upper part of the Prešov section between 10.5 to 36.4 m belongs to the Late Oligocene, based on the species *Cyclicargolithus abisectus* and *Helicosphaera recta* (Zone NP24). Calcareous nannofossils indicate a change of paleoenvironmental conditions in the interval of 36.4 m by decreasing of eutrophic and cold-water species from the lower part of the section, and by increasing of warm-water species towards to the higher part of the section.

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