

Mercury and other toxic metals in organic-rich mudstone (oil shale) from the Green River Formation, eastern Uinta Basin, Utah, USA

ALEXANDER ANI AND DAVID KEIGHLEY

*Department of Earth Sciences, University of New Brunswick, Fredericton, New Brunswick E3B 5C3
Canada <aani@unb.ca>*

The Green River Formation (GRF) of the Uinta Basin contains the world's largest oil shale resource, concentrated in 8 organic-rich mudstone (ORM) intervals (up-section from R1 to R8) that were deposited in a stratified, alkaline, lacustrine environment. Ongoing studies relate to several beds of oil shale sampled from both core and outcrop in the lower R8 zone, ~60 to 130 m above the base of the regional R7 marker unit (Mahogany Oil Shale Zone). Analyses indicate enrichment of lanthanides, actinides, and toxic heavy metals occurring in phosphate-rich intervals of ORM. Additionally, in one phosphatic ORM bed, sulfide mineralization outside of a mat-like organic structure is predominantly FeS_2 , with limited occurrence of other phases e.g., ZnS and HgS. The FeS_2 shows evidence of post-depositional, pre-compaction diagenetic growth, with highly localized fabric disruptions and cross-cutting relationships with ORM laminae. Heavy and toxic-metals, including Tl, W, and Po, are found associated with [1.70 μm] euhedral HgS enclosed alongside dolomite within blocky carbonate-fluorapatite (CFA) cement inside the preserved organic structure. Organic geochemical analyses of isoprenoid/n-alkane ratios vary between phosphatic and non-phosphatic intervals in the upper GRF, and maturity indices such as CPI indicate differences in the respective organic matter populations. Some contribution to the differences in trace-element geochemistry might be ascribed to variations in the nature and type of preserved organic matter. As HgS is observed only within CFA inside the mat structure, its formation and/or preservation are likely related to the phosphatization process. Polonium is only observed only in HgS, which suggests that the sequestration of toxic metals is linked to biogeochemical processes. Local [paleo]pore-water chemistry is not precisely understood but might have played a role in the differences observed in the long-chain alkane profiles of analyzed samples. Organic matter may have interacted with local pore-water to alter microbial organic matter, helping to sequester toxic metals, and establish conditions favourable to the precipitation of less common sulfide phases.