geoconvention
Virtual Event
September 21-23
2020
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Diagenetic sequestration of trace and toxic elements in phosphatic oil shale precursor, from the Green River Formation, Uinta Basin, Utah.

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Summary

The Green River Formation (GRF) of the Uinta Basin, Utah, USA, contains some of the world's richest oil shale, deposited in the ancient Lake Uinta, and concentrated in 8 organic-rich mudstone (ORM) intervals (up-section from R1 to R8). The R7 or Mahogany Oil Shale Zone (MOSZ) acts a regional datum, marking the start of the informal "upper GRF", and the transition from a period of maximum lake expansion during the Eocene. Several beds of phosphatic oil shale occur above the MOSZ, which have been sampled from both core and outcrop. The relationship between trace-element enrichment and organic matter (OM) in phosphatic intervals of ORM is being examined using thin section and scanning electron microscopy (SEM-EDS), laser-ablation inductively-coupled-plasma mass-spectrometry (LA-ICP-MS), X-ray fluorescence (XRF), and gas-chromatography mass-spectrometry (GC-MS). Results indicate REE accumulation within carbonate fluorapatite (CFA) in the phosphatic oil shale, and isolation of toxic metals by blocky CFA in non-phosphatic oil shale. Traditional biomarker based indices such as the odd/even carbon preference (OEP/CPI) are of limited use in the investigation of these unconventional petroleum resources. However, differences in mineralogy and individual biomarker compounds provide insights into the cause and effects of variations in OM accumulation during deposition of the phosphatic oil shale. A microbial biomarker signature in the *n*-alkane fraction of the phosphatic oil shale is observed in GC-MS. Enrichment patterns of lanthanides, actinides, and toxic heavy metals can be related to the nature and type of OM that accumulated in Lake Uinta, which in turn reflects changes in the lake environment (Fig. 1).

Acknowledgements

Technical and analytical expertise at UNB was provided by Stephen Delahunty, Ancel Murphy and Calvin Nash (sample preparation), Suporn Boonsue and Steven Cogswell (SEM), Brandon Boucher and Chris McFarlane (XRF, LA-ICP-MS).

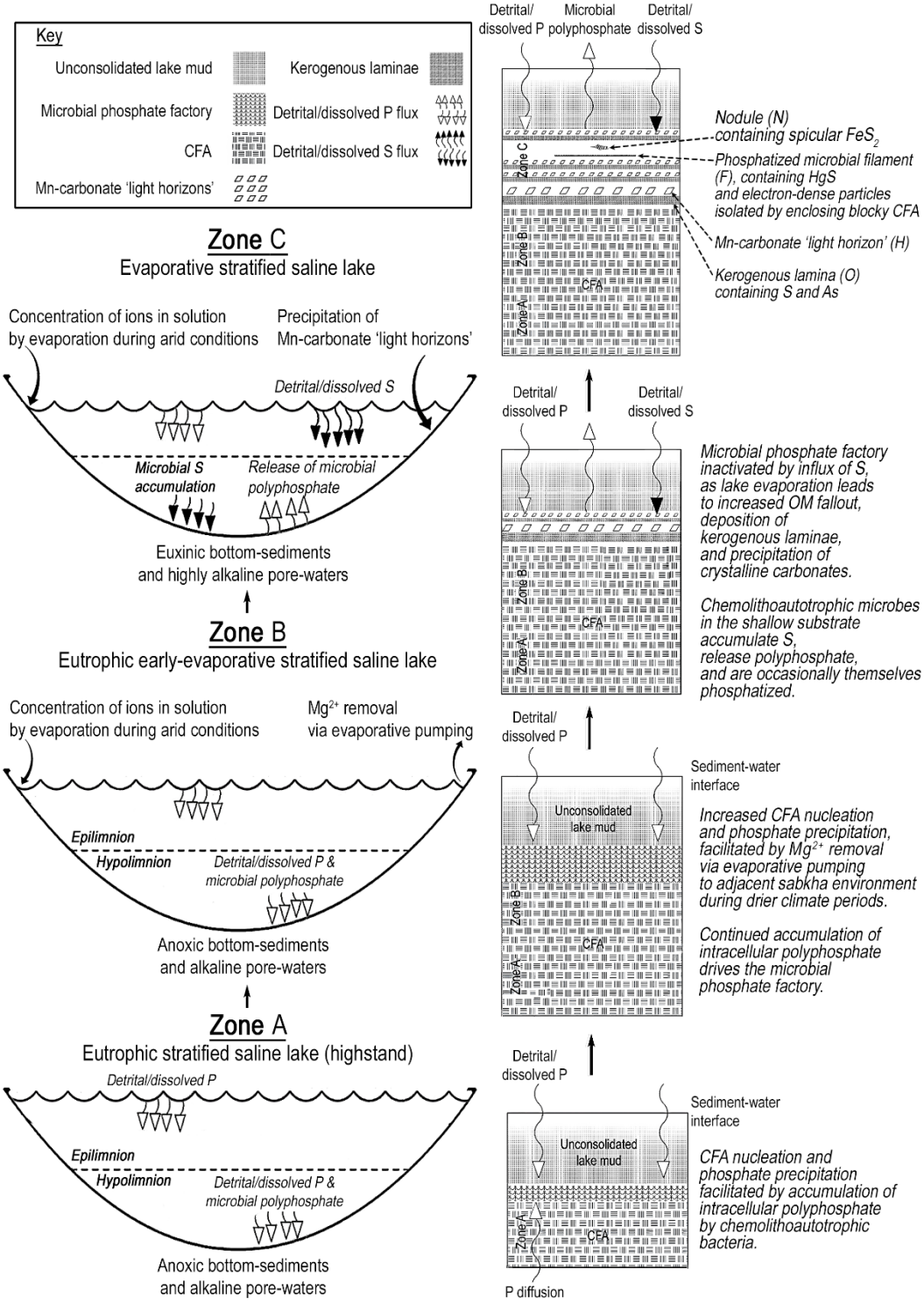

Figure 1: Effects of climatic controls on the lake-bottom and pore-water chemistry of Lake Uinta. The microbial community beneath the hypolimnion was sensitive to changes in lake level, facilitating the precipitation of phosphatic oil shale as evaporation concentrates ions in solution.