Early diagenetic controls affecting the inorganic composition of oil shale from the upper Green River Formation (Mahogany Oil Shale Zone — Uinta Formation boundary), Uinta Basin, Utah

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In the Uinta Basin of eastern Utah, the base of the Mahogany Oil Shale Zone (MOSZ) up to the base of the sandstone-bearing Uinta Formation consists almost entirely of variably shaly, variably organic rich (oil shale) to dolomitic to very finely arenaceous and tuffaceous, variably grey to olive to brown to black mudstone. Informally assigned to the upper Green River Formation (GRF), this mudstone succession increases in thickness from east to west due to the interfingering of the Uinta Formation. Numerous samples from oil-shale beds in three outcrop sections of the upper GRF have been analyzed by X-ray Diffraction, Inductively Coupled Plasma Spectrometry and Scanning Electron Microscopy. To date, work has concentrated on phosphorus anomalies (up to ~10 wt % P, from ICP data) identified in some of the beds. In particular, a sample from an oil shale ~128 m above the base of the MOSZ in Buck Canyon indicates that the P is concentrated toward the top of the 25 cm-thick bed, and XRD has identified Ca-fluorapatite (CFA) comprising ~15-20 % of the rock abundance. SEM analysis of this P-enriched oil shale further indicates that the CFA (or its precursor gel) formed as it fossilized and preserved algal remains (possibly Pediastrum sp.). No pyrite is associated with this oil shale, but the mineral is recorded (~1-2 %) in the one oil shale sample analyzed to date that is not P-enriched. The fossilization of well-preserved plant matter fits with models that indicate CFA is a very early diagenetic phase, forming in the top few centimeters of the substrate. Most models also promote the idea that phosphorites tend to form as oxic bottom-waters become dysoxic: crusts of Fe-oxyhydroxides with adsorbed P are reduced, liberating P so that pore waters are supersaturated with the element. The presence of oxic bottom-water conditions does not seem tenable for the preservation of what is now a 25cm-thick oil shale, nor should an oxic layer be a necessary pre-requisite for P saturation of pore waters.