Dating deposition and petroleum migration from the same samples using the Re/Os geochronometer

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Both a deposition and migration age are recorded by separate Rhenium-Osmium (Re-Os) isochrons obtained from different phases within the same interval in the Mesoproterozoic Velkerri Formation. A depositional age of 1427±42Ma obtained from digestion of the organic matter and sulphide fraction with inverse aqua regia conforms with other independent geochronometric ages obtained for the interval. A second isochron obtained on the co-exsisting fraction of bitumen by a CrO_3-H_2SO_4 acid solution identified an age of 382±81Ma and is interpreted to record the timing of migration. The more radiogenic (^{187}Os) initial value of this fraction is consistent with remobilization of Os from depositional (Meosporterozoic aged) organic matter during homogenization in migration pathways that restarted the Re/os geochronometer.

Electron imaging using FEG-SEM in backscatter mode and Nanomin mineral mapping of the samples before and after acid treatments was used to identify which phases were yielding Re and Os. Samples before acid treatment were comprised of in-situ organic matter and later stage micro fracture filling bitumen. Nanomin sub-micron mineral mapping of the remains of the samples following acid treatment shows only quartz, feldspars and titanium oxides left following inverse aqua regia treatment. Likely resistant organic matter, clay minerals, and other silicates remained after treatment by CrO_3-H_2SO_4 acid. Later stage euhedral pyrite aligned as stringers within bitumen veins evident before acid treatment was absent after both types of acid digestion.

These findings suggest that with detailed study of petrographic textures, specific isotopically closed phases can be individually dated and tied to geological events such as, sediment provenance, deposition, or diagenesis. The results also identiy a pervasive hydrocarbon migration event in a black shale considered to be an economic unconventional target. The Devonoian-Carboniferous age corresponds to the Alice Springs Orogeny in central Australia, and consitutes a much younger timing of generation than the 1 Ga generation age commonly used for hydrocarbon system modeling for this interval.