Evaporitic sulfate concretions, Moodies Group (~3.2 Ga, Barberton Greenstone Belt, South Africa)

SAMI NABHAN[1], CHRISTOPH HEUBECK[1] AND MARTIN HOMANN[1]

[1] Freie University Berlin, Institute of Geological Sciences, Malteserstr. 74-100, 12249 Berlin (sami.nabhan@fu-berlin.de; christoph.heubeck@fu-berlin.de; martin.homann@fu-berlin.de)

Quartz-rich sandstones of fluvial to supratidal facies in the Archean Moodies Group (~3223 Ma, Barberton Greenstone Belt, South Africa) include several regionally traceable beds with common to abundant nodular concretions of chert and megaquartz pseudomorphs after gypsum and barite. Electron microprobe analyses show remnants (<20 μm) of these minerals within the concretions but not in the host rock. Petrographic thin sections show characteristic mottled extinction of poikilotopic gypsum cement, now silicified.

Concretions reach up to 8 cm in diameter, are stratiform and commonly associated with aqueously reworked fine-grained tuffaceous sediment of rhyodacitic composition. Detailed geological mapping indicates a braided fluvio-deltaic setting, transitional to sandy supratidal flats which were colonized by microbial mats and occasionally underwent desiccation; the setting is clearly nonmarine. Gypsum pseudomorphs commonly grew inward into concentric hollow or fluid-filled cavities, suggesting mantling followed by dissolution of an unknown precursor mineral, but also grew displacively outward. Nodule growth apparently took place under early diagenetic conditions in unconsolidated sediment in the vadose zone dominated by frequent capillary rise of groundwater brine under mildly evaporative conditions. Partially reworked rhyodacitic tuffs may have delivered alkali cations such as Ca, Na, Ba, and K while carbonates were supplied by atmospheric silicate weathering of mafic to ultramafic volcanic rocks. The provenance of sulphate ions is unknown but may have included microbial and/or abiotic disproportionation of volcanic S or SO2.

Nodular concretions of the Moodies Group may represent the oldest terrigenous evaporites known to date. Their chemical and isotopic composition constrains the occurrence of sulfate in the atmo- and hydrosphere of the Early Earth, its interaction with the emerging biosphere, Archean weathering, possibly local climatic conditions, and vadose-zone hydrodynamics of the world's oldest well-preserved siliciclastic shoreline system.

Petrosomatic Evolution of Montviel Alkaline System and Rare Earth Carbonatites, Abitibi, Canada

O. NADEAU*, R. STEVENSON AND M. JÉBRAK

*(correspondence: nadeau.olivier@uqam.ca) Geotop, Université du Québec à Montréal, Québec, Canada

Montviel is a Paleoproterozoic alkaline complex intruding the Archean TTG and volcanic rocks of the Northern Abitibi Zone, Quebec, Canada. It consists of a series of ultramafic to carbonatitic peralkaline bodies. According to field relations, intrusions of peridotites and pyroxenites were followed by melteigeites / ijolites / urtites, syenites, sodic granite, and comagmatic silicocarbonatites, calciocarbonatites and ferrocarbonatites [1]. The magmatic evolution appears to have ended with a major explosive event which formed carbonatite-bearing polygenic breccia. The carbonatites and the breccia are hosts of one of the largest rare earth element (REE) and niobium mineral deposits being developed in Canada [2]. Detailed petrographic work indicates primary mineralization was partly magmatic, hosted in carbocernaite (REE carbonate) and partly carbothermal, recrystallizing carbocernaite to cebaite and kukharenkoite (REE fluorocarbonates). A second carbothermal event enriched specific parts of the system in heavy rare earths, crystallizing ewaldite (heavy REE carbonate) and heavy REE-enriched qaqarssukite (a fluorocarbonate). A third metasomatic event preferentially remobilized the light REE, further enriching the heavy REE in the areas that were first enriched. Preliminary analyses suggest that the flurorocarbonic stages were followed by an aqueous, hydrothermal stage. The final explosion stage of mineralization preferentially remobilized the light REE enriching the breccia in heavy REE. Trace element concentrations and 143Nd/144Nd ratios are used to investigate the petrogenesis of the system, trace the source(s) of the rare earths and study their behavior in this complex magmatic-carbothermal system.

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