Sulfate mineral assemblages from Mars-analog environments II: Indicators of specific environmental conditions

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Interpretations of high-resolution, specific environmental conditions can be made from the study of sulfate minerals. Gypsum, anhydrite, jarosite, and alunite from six modern and ancient Mars-analog deposits are used as examples here. Gypsum grows quickly in acid saline surface waters, trapping primary fluid inclusions (Fig. 1), which can be analyzed for water temperature, water salinity, and water composition during time of gypsum growth. Likewise, displacive gypsum grown very early from acid saline groundwaters can contain fluid inclusions that can be tested for groundwater temperature, salinity, and composition. Gypsum, anhydrite, jarosite, and alunite grow rapidly enough from waters that they also easily trap solids, including other minerals, such as other sulfates, hematite, and halite, as well as biological remains, such as pollen, wood, algae, bacteria, Archea, and insects. Observations and analyses of sulfate minerals on the microscopic scale can lead to specific interpretations about past water salinities, past water compositions, past water temperatures, and past life in the terrestrial and extraterrestrial rock record.

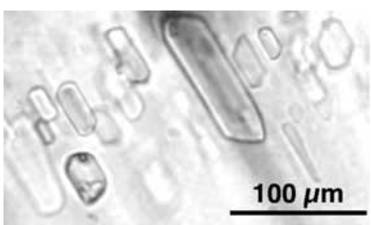

Figure 1: Primary fluid inclusions in gypsum from an acid saline lake in Western Australia.

In situ dating of metamorphic zircon, Kapuskasing structural zone: Crustal refinement of a Late Archean LIP

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The Kapuskasing structural zone (KSZ) represents the high-grade lower crustal equivalent of the Late Archean Abitibi granite-greenstone subprovince, Superior Province. The Abitibi Subprovince is the upper crust of a larger tectonic entity, the Abitibi-Opatica terrane (AOT) that also includes the Opatica gneiss domain. We propose that the AOT represents a modified Large Igneous Province. This formed partly on juvenile oceanic crust but it also overlapped a pre-3000 Ma continental margin. The AOT was later tectonically accreted to older crustal blocks, ca. 2.7 Ga. The tectono-magmatic history of the AOT is based on compiled geochronological, geochemical and structural data, and on interpretations of LITHOPROBE seismic-reflection profiles.

We used *in situ* LA-ICP-MS to obtain U/Pb zircon dates from the KSZ directly in polished sections. Zircon was dated from three samples; a Cpx-Hbl-Grt granulite and two Grt metatonalites. Zircon grains are anhedral to subhedral, and BSE and CL images reveal that they are unzoned or weakly zoned. Zircon REE patterns show HREE depletion, suggesting equilibration with prograde metamorphic garnet and hence a predominantly metamorphic origin of zircon. The U/Pb dates include an older group (3190 Ma to 2800 Ma) corresponding to zircons inherited from the overlapped continental margin. Younger groups of dates record metamorphic pulses in the lower crust that are associated with known magmatic events in the upper crust. Thus we are able to date thermal pulses in the lower crust. The data help refine the 3-layer crust model, driven by two separate processes. First, chemical stratification of the crust via periods of crustal melting that produced TTG and second, magmatic additions to the crust by melting of the wedge and subducting slab.