Aqueous Alteration of the Askival Feldspathic Cumulate Sample in Gale Crater

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Introduction: The Askival sample is a geochemically and texturally unique sample investigated by the Curiosity rover in Gale crater. Located at the Bressay site and analyzed between mission sols 2015 to 2021, Askival has a feldspathic cumulate texture, but presents geochemical evidence of aqueous alteration beyond initial crystallization and accumulation. An earlier target, Bindi, provides an important comparative sample as it also appears to be a feldspathic cumulate but lacks the alteration present in Askival.

Methods: Geochemical analysis of Askival and Bindi was performed using the Chemistry and Camera (ChemCam) instrument on the MSL *Curiosity* rover [1]. ChemCam is a laser induced breakdown spectrometer (LIBS) instrument that performs geochemical remote sensing on targets up to 7 m away from the rover. LIBS analyses occur by creating an energized plasma at a micron-scale point on the target rock, allowing for sampling of different phases within coarse-grained targets such as Askival. Supporting imagery from the ChemCam remote micro-imager (RMI) allows these chemical analyses to be correlated with visual identification of different phases.

Further geochemical analysis of Askival using the Alpha-Particle X-Ray Spectrometer (APXS) [2] and images from the Mars Hand Lens Imager (MAHLI) [3] provide complementary datasets.

Results & Analysis: Texturally, Askival has strong resemblance to feldspar cumulate samples, with roughly 65% of the sample consisting of light-toned, subhedral crystals with some examples of elongation. This phase is separated and, in some cases, enclosed by a fine-grained darker matrix, which comprises approximately 30% of the sample. The remaining texture is comprised of a fibrous grey/brown phase that occurs only in a couple of visible areas of the sample, as well as a secondary light-toned phase observed as small veins occupying interstitial areas.

Geochemically, the primary light-toned phase has a range of compositions which form a linear trend away from stoichiometric feldspar composition. The most prominent chemical divergence is an enrichment in silica, with some of the sampled LIBS points containing >80% SiO_2. This enrichment correlates with a detected increase in H, and a decrease in alkali elements and enrichment in Mg. This is consistent with the production of a leached layer and precipitation of secondary Mg-phyllosilicates under low temperature acidic conditions [4]. Other rocks located at Bressay do not show similar alteration, and are not of the same cumulate origin, indicating either a diversity of sources within a single locality or that Bressay has a collection of samples that have undergone different transportation pathways.

The secondary phase presents a diverse mafic composition, indicating multiple mineral endmembers contributing to the phase that are not visibly distinguished in the RMI imagery. Normative calculations support a composition made of Fe/Mg silicates including pyroxenes and amphibole, supporting a model of formation under an upper crustal setting.

References:

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