Evolved Igneous Materials in Gale crater, Mars

Conference or Workshop Item

EVOLVED IGNEOUS MATERIALS IN GALE CRATER, MARS

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Initial Igneous Discoveries: The NASA Curiosity Rover has been exploring Gale crater since August 2012 and climbing its central 5 km tall sedimentary mound, Aeolis Mons. Up to martian solar day (Sol) ~800 the rover traversed the flat plain in the base of the crater, Aeolis Palus, interpreted as alluvial fan debris and fluvial deltaic deposits [1]. During this time, Curiosity encountered a large number of identifiable igneous float rocks and clasts in conglomerate outcrops [2]. The lack of extensive open-system weathering in the sedimentary units in the first 800 sols [3] means that protolith igneous compositions can be identified in them as well [e.g., 4]. Although Mars has been thought of as a primarily basaltic planet based on orbital observations [5], the Curiosity rover has shown that a wide range of evolved igneous materials are present on Mars, including compositions from basalts to trachybasalts [2, 4, 6–9], and silica oversaturated rocks [10, 11]. Potentially, these materials are samples of the Southern Highlands and were transported from the crater rim by mass wasting and fluvial action [12].

Methods: The mast-mounted ChemCam instrument collects elemental data for ~300 µm sized spots up to 7 m from the target and captures context images for each target using its remote micro imager [14–18]. The arm-mounted APXS [19] is the other main elemental analysis instrument, and has a larger footprint (1.5–2 cm). MAHLI, the arm-mounted hand lens, [20] and Mastcam, the mast-mounted stereo imager [21], both provide target context imaging.

Recent Igneous Sample Discoveries: A new type of likely igneous material was identified in float rocks at Ireson Hill (sol 1608). Pogy has an mm-grain size granular texture suggesting a plutonic origin. APXS shows Pogy to have 42 wt% SiO_2, and very low in K_2O, Ni, Zn compared to other Gale rocks, but high in CaO. ChemCam also sees high CaO, and very low K_2O in the Passagassawakeag and Wassataquoik float rock targets. These are unique Gale compositions (Fig. 1) with some similarities to shergottites (though with relatively high Na_2O) than the subalkaline igneous float rocks identified previously [6].

Discussion: Observations show that Gale igneous materials include subalkaline tholeiitic basalts with low Mg# [7] compared to Gusev compositions [2, 22], and about half of the float rocks are felsic [2]. Some evolved Gale igneous materials show possible similarities with the NWA 7034 polymict breccia that contains clasts of evolved igneous compositions [23, 24]. The felsic compositions may suggest they are derived from fractional crystallization of multiple source magmas, possibly implying some heterogeneity of the martian mantle [9]. Alternatively [6, 7], argue that such compositions can be derived through anhydrous, low P fractional crystallization of an Adirondack-type melt. The wide range of igneous components in Gale crater suggests that the Southern Highlands may be much more diverse in their igneous contents than has been previously understood.

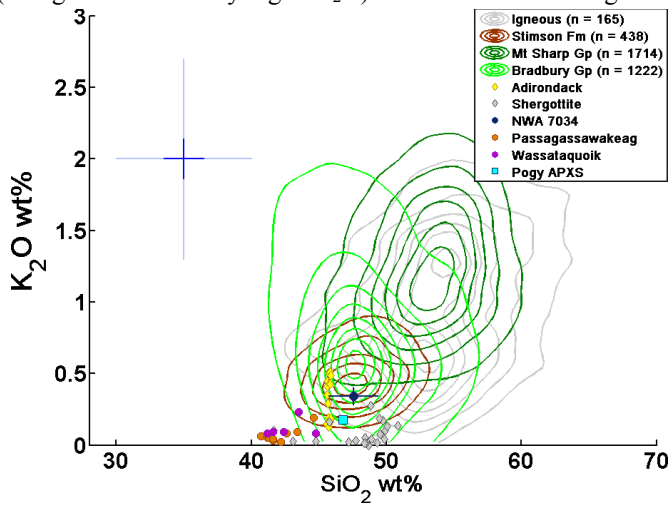

Fig. 1. Density contour plots for Gale stratigraphic unit ChemCam data, igneous float rocks, shergottites, and NWA 7034 martian meteorite [6, 7, 24].

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