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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% SiO₂, and very low in K₂O, Ni, Zn compared to other Gale rocks, but high in CaO. ChemCam also sees high CaO, and very low K₂O in the Passagassawakeag and Wassataquoik float rock targets. These are unique Gale compositions (Fig. 1) with some similarities to shergottites (though with relatively high Na₂O) 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.

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