DIVERSITY OF FLOAT ROCKS AT BRESSAY ON VERA RUBIN RIDGE, GALE CRATER, MARS.
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Introduction: Located on the northwestern flank of Mt. Sharp in Gale crater, the VERA Rubin ridge (VRR) is a ~200 m wide, ~6.5 km long northeast-southwest trending topographic feature. The VRR is comprised of mudstone and fine sandstone facies interpreted as lacustrine deposits [1]. The Mars Science Laboratory Curiosity rover encountered a few spatially-confined pebble and cobble rock accumulations on the VRR. Bressay is one such accumulation of rocks.

Here we report on the results of a multi-stop campaign at Bressay, where remote sensing and contact science data were collected. During sols 2013-2023, Bressay clasts were observed with Curiosity instruments including the color cameras Mastcam and MAHLI, and the monochrome cameras Navcam and RMI (ChemCam’s Remote Micro Imager). Complementing prior reports on the chemical composition of Bressay rocks [e.g., 2, 3], we characterize image observations of cobbles at Bressay (Fig. 1) and draw comparisons to rocks examined earlier in the mission.

Observations of Bressay Float Rocks: The term “float” is used here to describe loose clasts superimposed on a surface, some distance from their source. Bressay is a quasi-elliptical (<200 m²) grouping of heterolithic float rocks. In rover images, the distribution of rocks appear to be approximately orthogonal to the long-axis of VRR and aligned along the modern slope. The largest stones are concentrated in an area <3 m², with clast dimensions 15-25 cm across that stand 10-20 cm in relief. Most rocks are dark-toned, in contrast to the red and tan colors typical of the bedrock on the VRR [1].

Float rock types present at Bressay are very diverse (Fig. 1). Igneous rocks are identified in roughly 1/4 of the cobbles. Ledmore is a candidate basalt with anorthoclase feldspar phenocrysts. A striking light-toned rock, Askival, is interpreted as a plagioclase mafic cumulate that has been silicified and hydrated [2, 3].

Sedimentary rocks are common at Bressay. Examples include a polymict conglomerate, Hopeman, as well as several sandstone cobbles with a range of grain-size (fine to coarse sand) and lamination style (massive, cross-beded and finely-laminated). In the cross-bedded Roussay cobble, very coarse sand is resolvable in MAHLI images. Two unnamed pebbley sandstones appear similar to the Waterfowl target located at a nearby rock accumulation site. In addition, Sanquhar is a silica-rich, finely laminated cobble that could be a siliceous mudstone or chert.

Porphyritic Rocks at Bressay. Bressay is also a noteworthy locale because there are two examples of a distinctive porphyritic texture. First, a subangular cobble, Quinag, has thin (<1 mm wide, up to 7 mm long) rectangular crystals evident in the RMI images. These blades are harder to recognize in the Mastcam images owing to sun glinting on the surface.

The second example is in the unsorted Hopeman conglomerate, which has resolvable grains from coarse sand to very coarse gravel in a clast-supported framework (Fig. 2). One of the larger, subangular clasts has light grey bladed phenocrysts in a dark grey fine-grained matrix (Fig. 2B). Crystal dimensions in this clast are 0.5-1 mm wide and up to 50 mm long, similar to euhedral plagioclase phenocrysts.

Discussion: The Bressay float rocks are distinct not only from the VRR bedrock, but also from typical float rocks at Gale crater. Bressay is located on the upper VRR, near the contact between two stratigraphic members of the Murray formation (Pettegrove Point and Jura) [1]. However, most Bressay rock attributes are dissimilar to the sedimentary facies identified at the VRR [1], indicating these rocks are not locally derived and were transported to this location. A reasonable interpretation is that the Bressay float rocks are unconsolidated deposits superimposed on an erosional surface that exposes the Murray formation.

The origin of the localized Bressay-like deposits remains enigmatic. Any proposed process to emplace Bressay-like deposits must account for the disparate formation environments represented in the cobbles. These include both intrusive (Askival) and extrusive (Ledmore) igneous settings. In addition, there is a wide range of sedimentary depositional environments: both energetic flows and low energy settings, as well as aeolian environments comparable to those recorded in the Stimson formation [4] (Roussay). This criteria disfavors a crater ejecta interpretation because (1) the impactor excavates the target lithology and is unlikely to result in varied heterolithic deposits, and (2) such ejecta tends to be dispersed, not concentrated. Other mass transport processes, such as debris flow or landslides, are possible, although the small area covered is puzzling.
Porphyritic Rocks at Gale Crater. The porphyritic clasts at Bressay have attributes consistent with other porphyritic rocks rarely observed along Curiosity’s route, spanning an elevation range of 350 m, and a linear distance of 8.8 km (Fig. 3). Rocks with a porphyritic texture are commonly float rocks, but also are clasts (up to 10 cm in size) in polymict conglomerates (e.g., Harrison [5-7], Mount Powell [8], boulder at Bimbe). This feldspar-rich rock type is interpreted as an igneous extrusive or shallow intrusive rock [5-7].

This porphyritic rock type is uniquely observed at Gale crater and has not been recognized at other landed locations [5, 9-10]. Given the apparent uniqueness of the porphyritic rock type, it is conceivable they have a common source region. Earlier studies proposed that these felsic rocks on the Bradbury Rise were distal Peace Vallis alluvial fan deposits [6, 7]. With the Bressay examples of porphyritic rocks at a significantly higher elevation and closer in proximity to Mt. Sharp than the Peace Vallis fan, it is possible that a source region for porphyritic rocks could be to the south (from the central peak and/or Mt. Sharp) rather than the northwest. This hypothesis predicts the presence of porphyritic clasts adjacent to, within, or superimposed on the Greenheugh pediment. Furthermore, if all or most of these porphyritic rocks have the same provenance, their distribution may further support the idea that draping strata at one point overlaid the current surface and extended from Vera Rubin ridge to Pahrump Hills and possibly to Bradbury Landing.

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