CHARACTERISATION OF FLOAT ROCKS AT IRESON HILL, GALE CRATER. D. L. Bowden[1], (dlb28@le.ac.uk), J. C. Bridges[1], S. P. Schwenzer[2], R. C. Wiens[3], O. Gasnault[4], L. Thompson[5], P. Gasda[3] and C. Bedford[6,7,8]. [1]School of Physics and Astronomy, University of Leicester, UK [2]*AstrobiologyOU*, The Open University, UK, [3]Los Alamos National Laboratory, Los Alamos, NM, US. [4]IRAP-OMP, CNRS-UPS, Toulouse, France. [5]Planetary and Space Science Centre, University of New Brunswick, Canada. [6]Lunar and Planetary Institute USRA, TX, USA. [7]Johnson Space Center, TX, USA. [8]The Open University, UK.

Introduction: Float rocks discovered by surface missions on Mars have given unique insights into the sedimentary, diagenetic and igneous processes that have operated throughout the planet's history. In addition, Gale sedimentary rocks, both float and in situ, record a combination of source compositions and diagenetic overprints [1,2]. We examine a group of float rocks that were identified by the Mars Science Laboratory mission's Curiosity rover at the Ireson Hill site, circa. sol 1600 using ChemCam LIBS, APXS and images from the MastCam, Mars Hand Lens Imager (MAHLI) and ChemCam Remote Micro-Imager (RMI) cameras. Geochemical data provided by the APXS and ChemCam instruments allow us to compare the compositions of these rocks to known rock types from Gale crater, as well as elsewhere on Mars. Ireson Hill is a 15 m long butte in the Murray formation with a dark capping unit with chemical and stratigraphic consistency with the Stimson formation [3]. A total of 6 float rocks have been studied on the butte.

Float Rock Textures: One float rock, Perry (Fig. 1) is clearly clastic sedimentary in origin. Other Ireson Hill samples have well defined Dreikanter morphologies e.g. Passagassawakeag, which hints at a harder, crystalline mineralogy (Fig. 2).

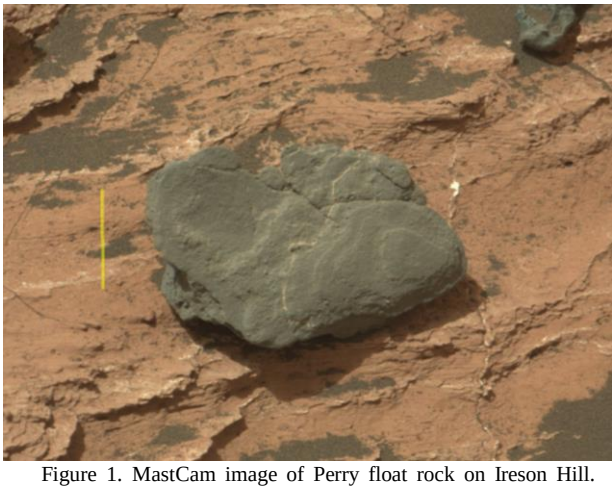

Figure 1. MastCam image of Perry float rock on Ireson Hill. Scale bar = 3cm. The rock shows sedimentary grains across its surface, as well as a thin bedding structure visible on the lower right-hand segment of the rock. This likely a fragment of the Stimson capping unit.

High resolution images of the Pogy float rock (Fig. 3) reveal an unusual texture with two visually distinct phases. A lighter toned phase makes up approximately 60% of Pogy's texture, and the darker toned phase approximately 20%, with the remainder being interstitial material without distinct grains. Both phases are anhedral, with grain sizes typically ranging from 1-1.5 mm. The texture appears largely crystalline. It appears notably dissimilar to the normal Stimson *in situ* and float (e.g. Perry, Fig. 1) rocks. Diagenetic processes may have cemented a more massive horizon in the Stimson capping unit, although the compositions (see below) do not suggest a high state of hydration. In other parts of the Stimson unit in Gale, silica-rich fluids have exploited fractures [4] but that is not seen at Ireson Hill. A possible alternative explanation is that Pogy is an igneous, plutonic rock, with an uncertain emplacement process at Ireson Hill.

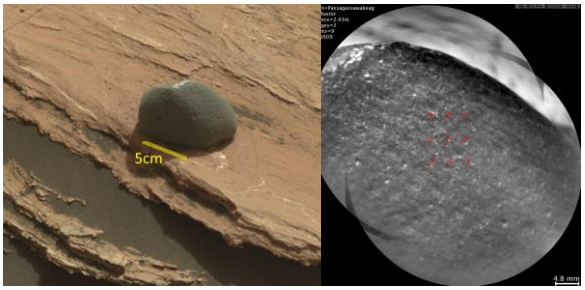

Figure 2. Ireson Hill float rock Passagassawakeag. This a dreikanter, suggesting that the sample may be a hard, crystalline rock. However, definitive textural origins are not evident. MCAM on left and ChemCam RMI on right, showing a 3x3 LIBS raster.

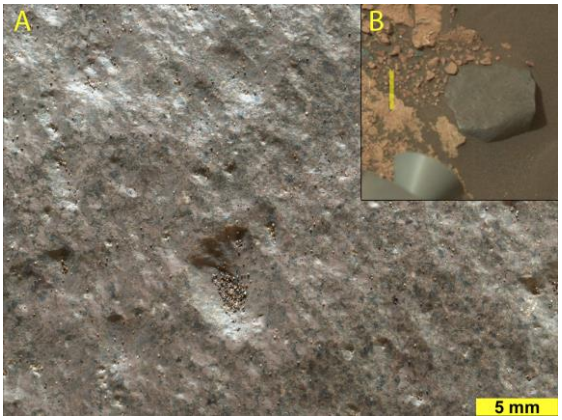

Figure 3. A) MAHLI image showing Pogy's crystalline texture B) MastCam image of Pogy. Scale bar = 4cm.

Compositions: Results for Pogy are presented SO_3-free with a corresponding amount of CaO removed in order to account for excess $CaSO_4$ present on Martian rock surfaces. Results were then recalculated to 100% total weight. Pogy's APXS geochemical composition (Fig. 4) differs from the Stimson-like cap rock composition seen in Perry due to its lower Na_2O, K_2O, MgO, Ni, Zn, and Cl, as well as elevated CaO [4]. Pogy does show similarity in SiO_2, Na_2O, K_2O, CaO, Al_2O_3 & TiO_2 to the Adirondack-class basalt compositions predominant at the Gusev crater MER mission site, with some difference seen in MgO and FeO(T), resulting in a reduced Mg#. However, we note that this similarity does not in itself establish an igneous origin for Pogy as martian sedimentary rocks can also record igneous source compositions [1,2].

Previous work has hypothesized that the more evolved basaltic and trachybasaltic compositions identified to date in Gale crater – both as discrete igneous float rocks, conglomerate clasts, and also as source components inferred from the compositions of the bulk rocks – may have evolved from a parental magma with composition similar to that of the Gusev basalts [5], but direct observations of such a rock type are absent at Gale crater [6].

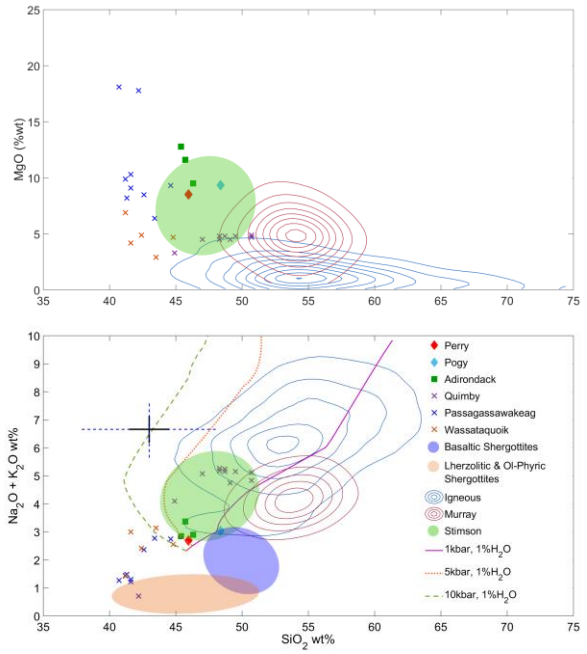

Figure 4. Total Alkali vs Silica composition plot. Contours and Stimson field show bulk ChemCam compositional data [2,4]. Error bars show ChemCam precision (solid) and accuracy (dashed) Adirondack class compositions from [7]. Pogy and Perry data from APXS, other data from ChemCam taken on Ireson Hill float rocks (crosses). Passagassawakeag compositions are similar to those of Pogy. TAS diagram includes MELTS [8] modelled liquid lines of descent. The models are consistent with low pressure, shallow crustal crystal fraction from an Adirondack-type, and low H_2O primary melt.

CIPW normative mineral calculations indicate that Pogy's source is silica-saturated, although this mineralogy does not clearly relate to images of Pogy's texture.

We use MELTS [8], Fig. 4, to investigate possible magmatic evolution pathways for Pogy. This is relevant both if Pogy has a direct igneous, plutonic origin, but also if we assume that as an alternative hypothesis it is diagenetically recrystallised sediment that has largely preserved an approximation of the rock's source compositions.

Pogy-like compositions can be generated by fractionation of magmatic compositions previously derived as parental to Adirondack-class basalts [9], with approximately 13% of the original mass removed through olivine crystal fractionation. The exact conditions of magmatic evolution differ somewhat from the Gusev basalt pathways in order to account for the lower Mg# of Pogy's composition compared to the Adirondack composition.

Conclusions: Float rocks investigated at the Ireson Hill butte show a variety of textures and compositions, some of which are similar to the Stimson formation textures, suggesting that they are fragments of sedimentary cap rock material. However, other float rocks e.g. Passagassawakeag and Pogy appear to be more crystalline than normal Stimson material. They may have originated through diagenetic recrystallization, or as an alternative hypothesis, Pogy may be igneous in origin. Comparing to known Gale compositions and rocks, suggests that the Pogy composition represents low pressure, low H_2O, fractionation in a shallow crustal setting. This has been preserved either directly as an igneous rock or as a dominant source component in some Gale sedimentary units.

References: [1] Siebach, K.L., et al., Journal of Geophysical Research: Planets, 2017. 122(2): p. 295-328. [2] Bedford, C.C., et al.,. Geochimica et Cosmochimica Acta, 2019. 246: p. 234-266. [3] J. M. Comellas, H.E.N., et al. LPSC. [4] Bedford, C.C., et al., Icarus, in press. [5] Edwards, P.H., et al.,. Meteoritics & Planetary Science, 2017. 52(11): p. 2931-2410. [6] Cousin, A., et al. Icarus, 2017. 288: p. 265-283. [7] McSween, H.Y., et al.,. Science, 2004. 305: p. 842-845. [8] Ghiorso, M.S. et al. Eos, Transactions American Geophysical Union, 1994. 75(49): p. 571-576. [9] Filiberto, J. and R. Dasgupta, Earth and Planetary Science Letters, 2011. 304(3): p. 527-537.