NASCENT JAROSITE MINERALIZATION OF SULPHUR SPRINGS, ST. LUCIA, W.I.: IMPLICATIONS FOR MERIDIANI JAROSITE FORMATION. J. P. Greenwood[1], M. S. Gilmore[1], R. E. Blake[2], A. M. Martini[3], M. Gomes[1], S. Tracy[3], M. D. Dyar[4], J. A. Gilmore[5], and J. Varekamp[1], [1]Dept. of Earth & Environmental Sciences, Wesleyan University, Middletown, CT 06459, [2]Dept. of Geology & Geophysics, Kline Geology Laboratory, Yale University, New Haven, CT 06520, [3]Dept. of Geology, Amherst College, Amherst, MA 01002, [4]Dept. of Astronomy, Mount Holyoke College, South Hadley, MA 01075, [5]Brooklyn, NY (jgreenwood@wesleyan.edu).

Introduction: We have been studying the current emanations of Qualibou caldera in the Lesser Antilles island of St. Lucia, W.I. since 2000 [1,2]. In June 2005, we observed a new occurrence of jarosite mineralization, less than 1 year old. A bubbling mudpot that appeared to be weakly active in November 2004 (Fig. 1a) was observed to have become extinct and had acquired a thin rind of jarosite on its surface in June 2005 (Fig. 1b). We have begun to undertake a comprehensive study using a wide range of techniques (XRD, XRF, SEM/EDS, EPMA, VIS/NIR, Mössbauer, SIRMS, ICP-MS) to understand this nascent jarosite mineralization and the similarities and differences to other areas of jarosite mineralization at this site [2]. We then use jarosite mineralization at St. Lucia as a basis for comparison to the Meridiani Planum [3].

Fig. 1. (a) Top photo, Near-extinct mudpot in Nov. 2004. (b) Bottom photo, Same mudpot in June 2005, with jarosite rind (brownish-yellow coating) on roof of mudpot.

Previous work: Our previous surveys [2] in the Qualibou caldera have identified two main areas of jarosite mineralization:

1) Jarosite Mt.: A large area on the edge of the active fumarole zone where a former ash flow has now been highly altered to a highly silicized 'mush' and there is almost a complete lack of primary igneous minerals. The outcrop is generally water-saturated and there are many areas of steam emanation throughout the outcrop. A hot spring pool is located above the outcrop and could be the source of fluids, but other seeps within the outcrop cannot be ruled out. Jarosite typically occurs as rinds on surfaces (with an algal biomat directly beneath the jarosite layer), or as large sheets of jarosite, which form in veins that permeate the outcrop. We interpret these as former aerial and subaerial evaporation surfaces. Gypsum, goethite, kaolinite are common accessory phases in the outcrop. At the top of the outcrop, large gypsum spires are forming, also consistent with evaporation.

VIS/NIR spectra, XRD and SEM-EDS analysis also show that jarosite is found closely associated with alunite. SEM images show jarosite to be very fne grained (<1 micron) and often found as a rim on larger alunite crystals (though some alunite grains seem to show an internal jarosite rim, suggesting multiple episodes of jarosite deposition). The fine-grained nature of jarosite, its hydrous nature, and its common intergrowths with silica, have made quantitative analysis of jarosite composition very challenging, but eprobe chemistry suggests that jarosite compositions at this outcrop are variable and all contain a significant hydronium component. An alunite core at Jarosite Mtn. gives a best estimate of $K_{0.45}Na_{0.36}(H_3O^+)_{0.19}(Al_{0.99}Fe_{0.01})_3(SO_4)_2(OH)_6$. A jarosite rind in different sample gives $K_{0.42}Na_{0.03}(H_3O^+)_{0.55}Fe_3(SO_4)_2(OH)_6$.

2) Yellow-Brick Road (YBR): The jarosite mineralization here consists of mud cobbles with jarosite rinds on their topmost surface. The cobbles are less altered than at Jarosite Mtn., and contain rare pyrite, highly altered feldspar, and pyroxene in addition to highly silicized mud. The cobbles adjoin an ephemeral stream that drains from an acidic bubbling pool (pH 2.3). Our interpretation is that the

acidic pool occasionally overflows and jarosite is precipitated as the water evaporates. The waters may start out jarosite-saturated, or become so with lowering of pH during evapo-precipitation. SEM-EDS shows the jarosite rinds to be finely intergrown with silica, and often occurs as rims on alunite (Fig. 2). A best estimate of the jarosite composition of jarosite rinds on a mud cobble is $K_{0.80}Na_{0.02}(H_3O^+)_{0.18}(Al_{0.13}Fe_{0.87})_3(SO_4)_2(OH)_6$.

Nascent Jarosite at Gabriels Crater (GC): Thin layers of jarosite have precipitated or evaporated on the roof of this extinct mudpot. This occurrence appears very similar to Yellow-Brick Road jarosite, both at the macro-, and micro-scale although YBR jarosite rinds are thicker (~20 µm) than the new jarosite rinds at GC (~5 µm). (Fig. 2 and 3). Mineralogically, both rinds appear very similar. The jarosite rinds are finely intergrown with silica-rich layers and small alunite grains appear ubiquitous. Mössbauer parameters of this new jarosite closely resemble those of a synthetic jarosite with a composition of $K_{0.70}Na_{0.01}(H_3O^+)_{0.29}Fe_3(SO_4)_2(OH)_6$ [4]. This is similar to the electron microprobe determination of jarosite at YBR (above), suggesting there are compositional similarities among these jarosite occurrences.

Jarosite in St. Lucia and Meridiani Planum and Missing Alunite on Mars:

In each of the three jarosite occurrences, jarosite appears to be forming as the result of evaporation of jarosite-saturated waters on surfaces and within subsurface veins. The ubiquity of alunite with jarosite suggests that pH is varying in the system perhaps as a function of meteoric water input.

Alunite commonly forms with jarosite in St. Lucia and most terrestrial occurrences. Where is the alunite on Mars? Alunite generally precipitates at higher pH than jarosite. Though the MER instruments are not optimized for alunite identification, the anti-correlation of Al and S in Meridiani S-rich rocks suggests alunite is at most a minor phase. Conditions which would lead to jarosite w/o alunite would be the intrinsically higher Fe/Al of Mars and/or that pH was never high enough in Meridiani fluids for alunite precipitation.

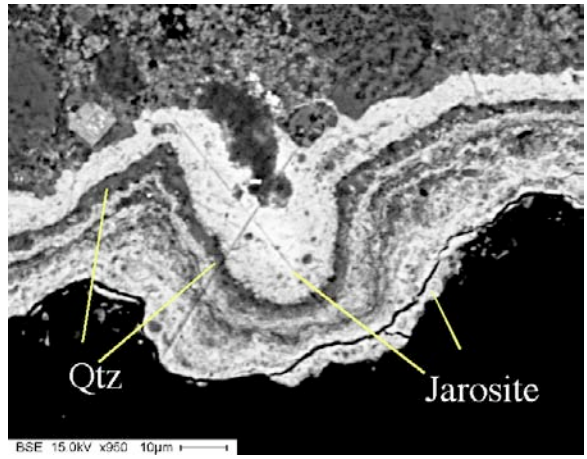
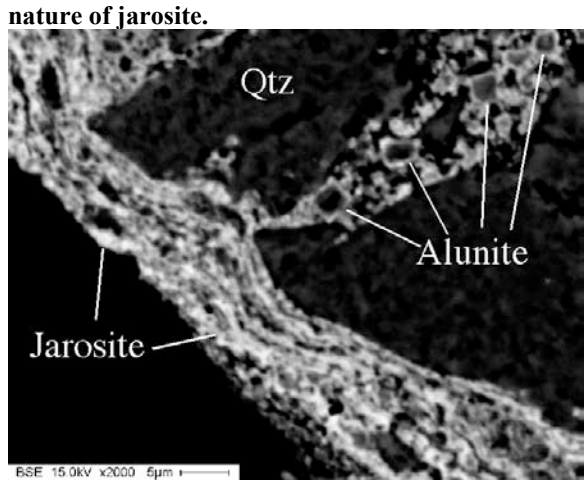


Fig. 2: BSE image of Yellow-brick road jarosite rim on topmost surface of cobbles.

Fig. 3: New Jarosite: Fine rim of jarosite on topmost surface of extinct mudpot. Note layered nature of jarosite.



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