Hydrated mineral stratigraphy in Ius Chasma, Valles Marineris. L.H. Roach[1], J.F. Mustard[1], S.L. Murchie[2], J.L. Bishop[3], B.L. Ehlmann[1], R.E. Milliken[4], K. Lichtenberg[5], M. Parente[3], and the CRISM Science Team. [1]Dept. of Geological Sciences, Box 1846, Brown University, Providence, RI 02912, Leah_Roach@brown.edu, [2]Johns Hopkins/APL, Laurel, MD 20723, [3]SETI Institute/NASA-ARC, Mountain View, CA 94043, [4]JPL, Pasadena, CA 91106, [5]Dept. Earth Planetary Sciences, Washington University, St. Louis, MO 63031.

Introduction: Ius Chasma is a linear trough in western Valles Marineris, formed by horst and graben structures and mass wasting [e.g. 1-6]. Sulfates and other hydrated minerals are found in thin floor deposits, which differs from the thick sulfate-bearing Interior Layered Deposits (ILDs) found in the basinal chasmata, like Capri and Melas. Kieserite ($MgSO_4 \cdot H_2O$), a polyhydrated sulfate (PHS), hydrated silica, Fe/Mg phyllosilicate, and a hydrated silicate (possibly consistent with an acid-leached phyllosilicate) are found in light-toned units within Ius Chasma. The close association of phyllosilicate, sulfate, and hydrated silica are ideal to assess relationships among aqueous processes in the canyon system. Furthermore, this tests the hypothesis that global regimes of alkaline then acidic groundwater chemistry affected crustal alteration [e.g. 7].

Using high-resolution data from MRO, we identify morphologic units with CTX and HiRISE imagery and their aqueous mineralogy from spectra in targeted CRISM observations. From these observations we define stratigraphic and superposition relationships. We find mineralogic evidence for alkaline and acidic alteration, and while the relative timing of all alteration events is uncertain, we suggest that regional groundwater chemistry was more complex than previously thought.

Geologic setting: The region consists of a megabrecciated basement [11] overlain in the Late Noachian by sequences of horizontally layered lava flows at least 8 km thick [4, 12, 13]. Ius Chasma clearly shows the strong tectonic control that opened Valles Marineris in the preferred orientations of its sapping channels and faults [3]. The central ridge, Geryon Montes, is interpreted as a horst between the two graben of north and south Ius [1]. Ius Chasma may have been separated from Melas Chasma during its earliest stage [1]. The water debouched in large outflows channels at the eastern end of Valles Marineris did not leave fluvial features in Ius Chasma, either because the bulk of the water was sourced eastward of Ius, or because later deposition and landslides obscured those features.

Datasets: CRISM, a visible-near infrared hyperspectral imager on Mars Reconnaissance Orbiter (MRO), has 544 wavelengths from 0.362-3.92 µm and takes targeted observations at up to 18m/pixel [8]. The MRO HiRISE camera is capable of acquiring co-aligned imagery with CRISM and can resolve details down to ~30 cm/pixel [9]. The MRO CTX (Context) camera is also co-aligned and acquires imagery at ~6 m/pixel [10].

Spectral Results: Hydrated sulfates have an absorption near 2.4 µm due to H_2O and OH combinations and sulfate bending overtones [14]. Kieserite is identified by characteristic vibrational absorption features at 1.6 and 2.1

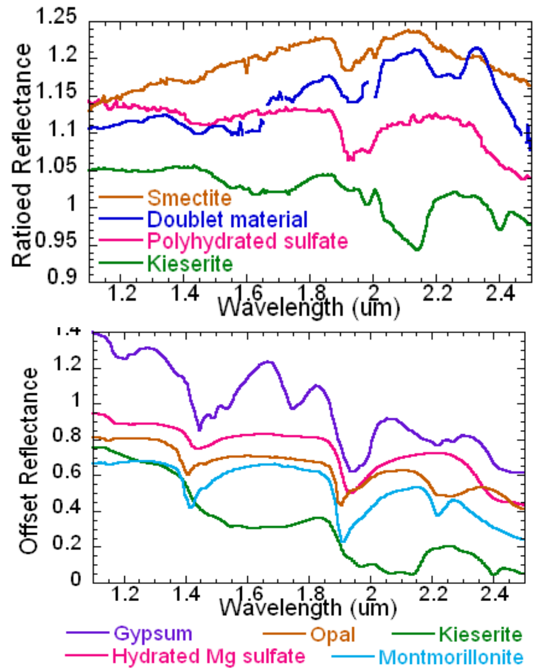

Fig 1. CRISM spectra of hydrated mineralogy detected in Ius Chasma, with closest library spectral matches.

µm. PHS is identified by absorptions near 1.4 and 1.9 µm due to H_2O [14, 15]. Fe/Mg phyllosilicates have a metal-OH absorption near 2.3 µm, with the exact minimum varying by cation [16]. Hydrated silica has a wide Si-OH vibration near 2.2 µm [17].

From the CRISM data we identify kieserite, a polyhydrated sulfate of unknown cation, hydrated silica, Fe/Mg phyllosilicate, and a hydrated silicate mineral (Fig 1). The mineralogic signatures are in distinct geomorphic units with little evidence of mixing.

Stratigraphic Results: The geologic map produced from CRISM mineral detections and CTX and HiRISE contact mapping (Fig 2) reveals evaporitic sulfates within a closed basin (Fig 3), Fe/Mg smectites unconformably overlain by a hydrated silicate that could be an acid-leaching phyllosilicate (Fig 4), and hydrated silica from the plains transported by sapping channels (Figs 3 and 4).

Conclusions: The detailed stratigraphy of the distinct units define different periods of varying aqueous processes, with unclear relative timing. (1) Mono- and polyhydrated sulfates within a closed evaporite basin indicating an acidic brine. (2) Fluvial or aeolian sedimentary layers of Fe/Mg phyllosilicate eroded and unconformably overlain by a hydrated silicate. The hydrated silicate is interpreted to be in situ acidic alteration of the Fe/Mg phyllosilicate. This sequence indicates an alkaline or neutral chemistry followed by more acidic groundwater. (3) Acidic alteration of volcanic layers on plains to hydrated silica.

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References: [1] Peulvast J.-P. and Ph.L. Masson (1993) *Earth, Moon Planets 61*, 191–217. [2] Blasius, K.R., et al. (1977) *JGR 82*(28), 4067-4091. [3] Kochel, R.C. and J.F. Piper (1986), *JGR 91*, E175-E192. [4] Lucchitta, B.K., et al. (1992), in *Mars*, pp. 453-492, UArizona Press, Tucson. [5] Carr, M.K. (1974) *JGR 79*, 3943-3949. [6] Schultz, R.A. (1998) *Planet. Space Sci. 46* (6/7), 827-834. [7] Bibring, J.-P. et al. (2006) *Science 312*, 400-404. [8] Murchie, S.L., et al. (2007) *JGR 112*, E05S03. [9] McEwen, A.S. et al. (2007) *JGR 112,* E05S02. [10] Malin et al. (2007) *JGR 112,* E05S04. [11] Tanaka, K.L. and M.P. Golombek (1989), *Proc. Lunar Planet. Sci. Conf. XIX*, 383-396. [12] Tanaka, K.L., et al. (1992), in *Mars*, pp345-382, UArizona Press, Tucson. [13] McEwen, A.S., et al. (1999), *Nature 397*, 584-586. [14] Cloutis, E.A. et al. (2006) *Icarus 184*, 121-157. [15] Hunt, G.R., J. Salisbury and C. Lenhoff (1971) *Modern Geology 3*, 1-14. [16] Frost, R.L., et al. (2002) *Spectrochim. Acta A Mol. Biomol. Spectrosc. 58*, 1657-1668. [17] Langer and Florke (1974).

Fig 3 (below). Evaporite basin with kieserite (orange) and polyhydrated sulfate (light green). Hydrated silica deposit (blue) transported from sapping channel. Landslides and other fill (gray) beneath the sulfates sit atop the graben.

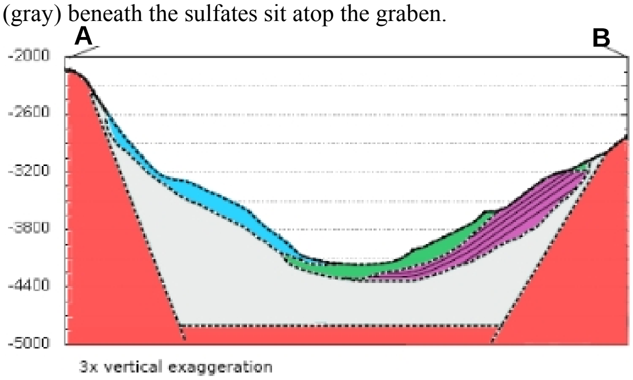
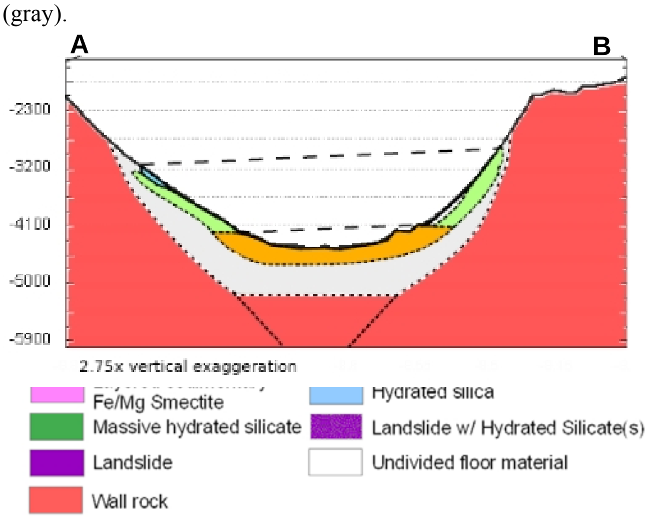


Fig 4 (below). Sedimentary Fe/Mg smectite (pink) unconformably overlain by hydrated silicate (green). Hydrated silica deposit (blue) at base of sapping channel. Landslides and other fill (gray).



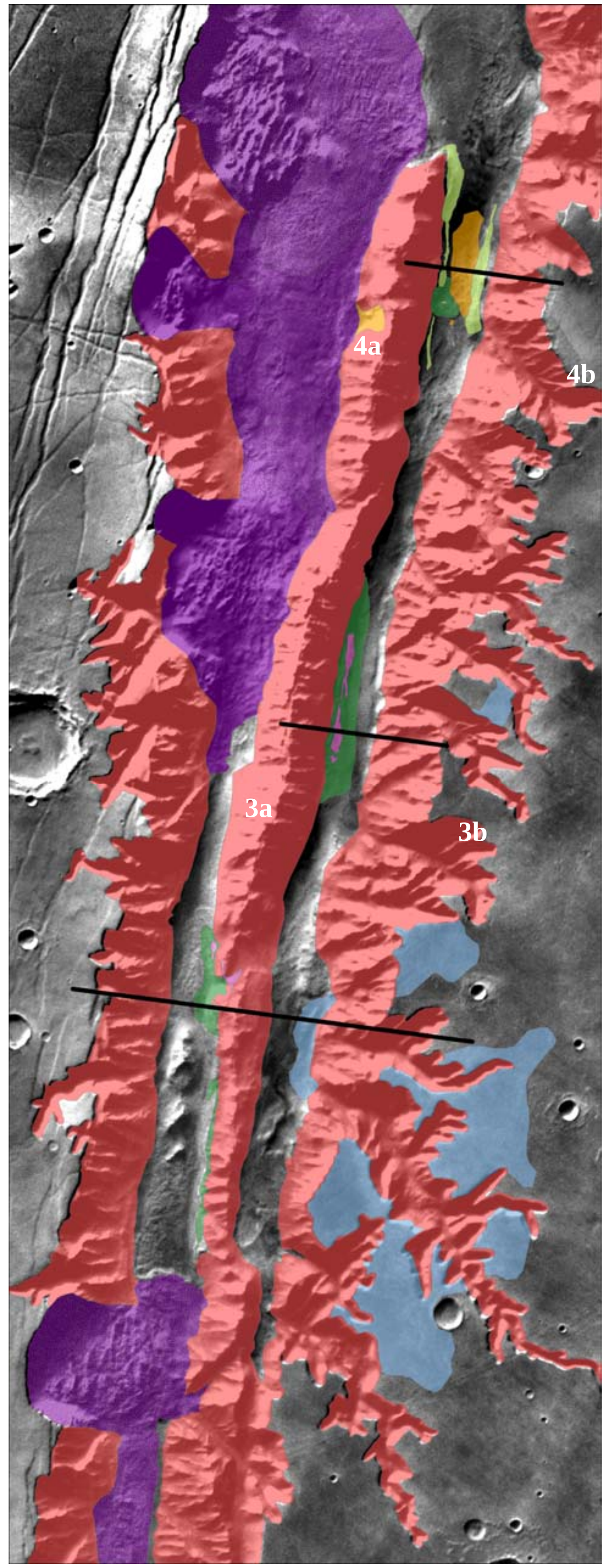


Fig 2 (above). Geologic map of Ius Chasma. North to left. Legend below. Location of cross-sections shown in Fig 3 and 4 are labelled. Cross-sections are drawn with south to the left.