AMORPHOUS SILICA DEPOSITS SUGGEST AEOLIAN AND PERIGLACIAL CONDITIONS IN ERIDANIA BASIN, MARS. E. B. Hughes[1], J. Wray[1] and S. Karunatillake[2], [1]Earth and Atmospheric Sciences Department, Georgia Institute of Technology, Atlanta, GA 30332, [2]Department of Geology and Geophysics, Louisiana State University, Baton Rouge, LA 70803

Introduction: Amorphous silica is formed in environments that have interacted with water; therefore, its distribution, geologic context and geochemical properties are useful for constraining regional water activity. On Mars, this can be particularly useful when applied to regions that may have undergone fluvial or lacustrine alteration. Here we consider amorphous silica in Eridania Basin. Eridania is purported to have once been home to an ice-covered lake, and may have hosted a hydrothermal system heated by the decay of radiogenic heat-producing elements (HPEs) for many hundreds of Ma during the Noachian [1,2].

Given the longevity of this putative hydrothermal system, alteration minerals, potentially including amorphous silica, should be relatively regionally widespread. In this work, we examine hyperspectral data from the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) to determine 1) the extent of amorphous silica in the Eridania region and 2) the regional context, geology, and stratigraphy of the deposits identified.

Dataset: We rely on MTRDR hyperspectral data from the Eridania region (c.o. https://pds-geosciences.wustl.edu/missions/mro/crism.htm). We have, at the date of abstract submission, investigated ~50 CRISM stamps for the presence of amorphous silica. As of this time, amorphous silica has clearly been identified in two CRISM stamps.

One stamp (frt0000caf3) is located in a crater to the northwest of Ariadnes Colles. Here amorphous silica is clearly identifiable both within the crater and outside of it, with deposits additionally exposed along the crater wall. Most of the silica appears to be fine-grained material in topographic lows, indicating aeolian redistribution. The deposit may have been exhumed by or after impact; given that the crater is inside a larger impact crater, these deposits may indicate short-lived hydrothermalism induced by the earlier impact event (as is posited by [2]). Based solely on the local geomorphology and stratigraphy, a lake setting is not unequivocally supported.

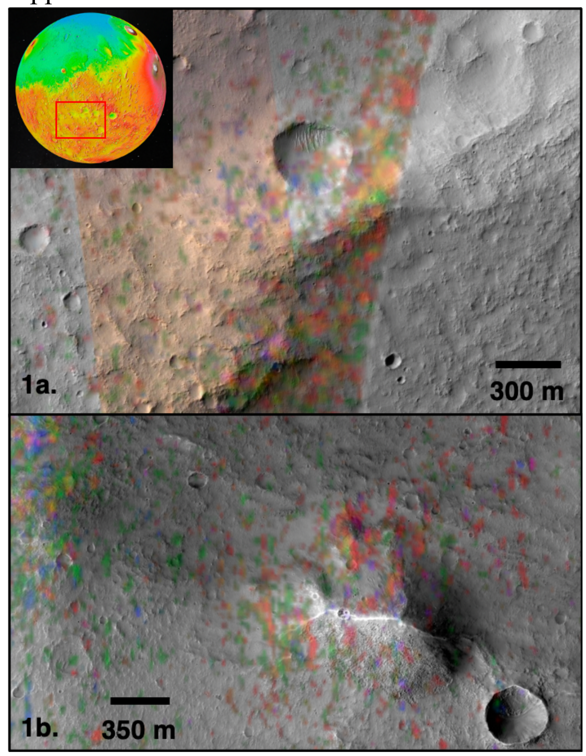

Fig. 1 *Mapped band parameters: MIN2250 (Red), BD2250 (Green) and BD1900R2 (Blue) for CRISM stamp frt00005b98 overlying HiRISE images PSP_003768_1430 (bottom) and ESP_072181_1430 (top). Mars map c.o. NASA/USGS/ESA/DLR/FU Berlin (G. Neukum).*

The second locality is on a topographic high between the two basins Atlantis Chaos and Simois Colles (Fig. 1). Amorphous silica is present throughout this CRISM stamp (frt00005b98), with deposits appearing mainly on the local high-standing sloped surfaces, indicating they may be indurated (bedrock?) materials rather than aeolian. However, some deposits may be periglacial, influenced by recent (i.e., Amazonian-aged) sublimation, based on the saw-toothed textures identifiable in Fig. 1b.

Analysis: The position, concavity, and band depth ratios of amorphous silica VNIR absorptions can be used to interpret relative crystallinity and hydration. The crater locality (caf3) shows a 1.95 µm band minimum whereas the intercrater locality (5b98) shows a 1.91 µm band minimum. Broadly speaking this may indicate that the crater deposit has more hydrogen-bonded water molecules while the intercrater deposit may have more free molecular water [3]. Caf3 has a band minimum at 2.24 µm (hydrogen-bonded silanols), while 5b98 has a band minimum at 2.22 µm (free silanols) [3]. These differences seem to indicate that Caf3 is more consistent with crystalline, hydrated silica, and 5b98 is perhaps more consistent with amorphous opaline silica.

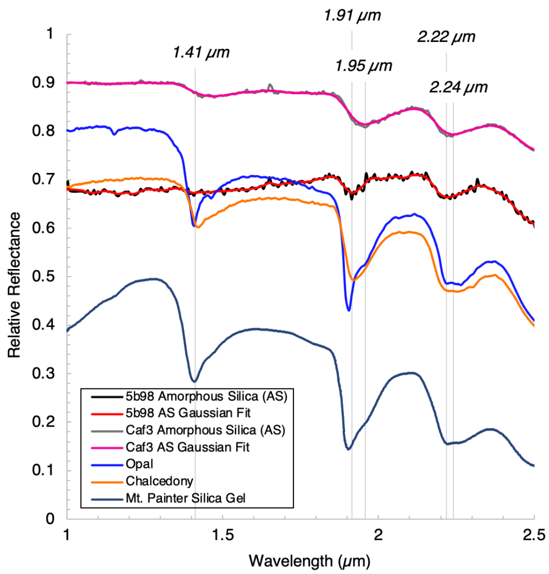

Fig. 2 *Amorphous silica spectra from the two Eridania localities and from Mt. Painter, Flinders Ranges, South Australia.*

Sun and Milliken [4] devised a system of distinguishing locality (bedrock versus aeolian deposit), which correlates well to amorphous opal vs. more crystalline/hydrated opal, respectively, which we apply here (Fig. 3). Plotting results with data from [4], we see that the intercrater deposit (5b98) plots within the boundaries of both aeolian/periglacial and bedrock silica from elsewhere on Mars. Spectra from the crater deposit (caf3) plot more clearly towards the aeolian deposit side, consistent with this being relatively crystalline aeolian material. This deposit therefore may not be an indicator of hydrothermal activity, whether due to impact-generated heat or a long-lived radiogenically heated hydrothermal system.

We additionally compare our CRISM data from Mars to spectra obtained of "silica gel" samples from the Mt. Painter Inlier System in the Flinders Ranges of South Australia (Fig. 2, 3). This silica gel was deposited in a long-lived hydrothermal system, and may represent late-stage formation, but curiously has not altered significantly from its amorphous form over the (likely) many Ma since deposition. As such it is considered a possible analogue for martian hydrothermal silica [1]. Its absorption features do not clearly match either of our localities on Mars (Fig. 2), both of which may have more crystalline ordering than the Mt. Painter sample.

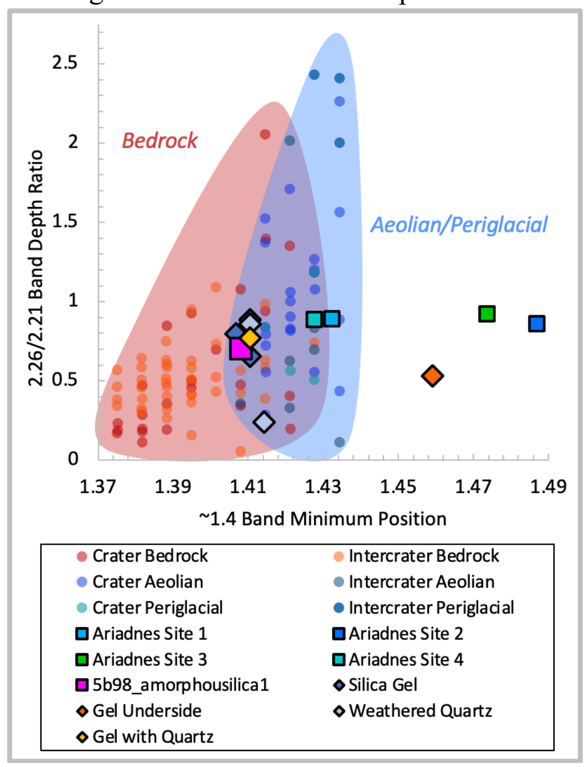

Fig. 3 *Data from the Ariadnes amorphous silica detection (caf3, crater unit) and the intercrater detection (5b98) with data from [4], and "silica gel" samples from Mt. Painter, Australia.*

Conclusions: Our findings indicate aeolian and periglacial origins for these deposits. Coupled with the lack of silica detections in other regional CRISM images, this work does not support long-lived hydrothermalism for this region.

References: [1] Ojha et al. (2021), *Nature Comm.*, 12(1754). [2] Michalski et al. (2017), *Nature Comm.*, 8(15978). [3] Pineau et al. (2020), *Icarus,* 347(113706) [4] Sun and Milliken (2018), *GRL*, 45(10,221-10,228).