

IMPACTS OF WATER-ROCK INTERACTIONS ON SMECTITES, CHLORITES, AND MIXED-LAYER CLAY MINERALS AND IMPLICATIONS FOR INTERPRETING PAST AQUEOUS CONDITIONS IN JEZERO CRATER, MARS. A. W. Provow¹, E. M. Hausrath¹, T.S. Peretyazhko², and C. Adcock¹, ¹Department of Geoscience, University of Nevada, Las Vegas, Las Vegas, NV, USA (provow@unlv.nevada.edu), ²NASA Johnson Space Center, Houston, TX, USA.

Introduction: The presence of authigenic minerals, like phyllosilicates, on the surface of Mars is an important indication that fluid-rock interaction occurred at some time in the past. Their formation requires the influence of fluids on solid rock material at certain conditions. Therefore, understanding the behavior and kinetic properties of these minerals is essential to making inferences about paleoenvironmental conditions.

This research targets minerals that are relevant to Jezero crater, the landing site of the Mars 2020 rover [3]. This locality is an impact crater in the Nili Fossae region of Mars and, based on geomorphological evidence, this crater is thought to have been an open paleolake with at least two contributing watersheds [4]. These watersheds produced two fan-like deposits that are interpreted as deltas [5]. Smectite, chlorite, and mixed layer phyllosilicates have been identified via CRISM VNIR data in and around these watersheds and on the deltas themselves [6]. This observation indicates that in some places, like the delta surface, these minerals are likely detrital rather than formed *in-situ* [5]. As such, alteration of these detrital phases has the potential to help elucidate aqueous processes at Jezero crater.

Mixed-layer phyllosilicates, like corrensite, present a unique opportunity to study products of secondary alteration due to their structure of 1:1 alternating layers of chlorite and smectite [2]. Evidence of past fluid-rock interaction may be preserved in these alternating layers, but little work has examined the impact of aqueous interactions on these phases.

Here, we report our results to date on ongoing experiments to determine the effects of aqueous alteration on smectite, corrensite, and chlorite phases. We present preliminary data for dissolution and alteration experiments on poorly crystalline synthetic nontronite ($\text{Na}_{0.3}\text{Fe}_2((\text{Si},\text{Al})_4\text{O}_{10})(\text{OH})_2 \cdot n\text{H}_2\text{O}$), as well as the well-crystalline nontronite standard, NAu-1 [7].

Methods: NAu-1 was purchased from the Clay Mineral Society and the synthetic nontronite was prepared after methods described in [8]. Batch reactors are being used in ongoing experiments to measure the dissolution rate of each mineral.

In each case, approximately 0.10 g of powdered mineral sample is weighed and placed into a 250 mL acid-washed LDPE or HDPE bottle. 200 mL of 0.01 M NaCl solution, adjusted to a pH of 2, 3, 4 or 5 with high purity HCl, is then added, and the mixture allowed to

react for the duration of the experiment in a temperature controlled shaker bath at 25 ± 0.1 °C. Each experiment is conducted in duplicate and with a solution-only blank. Each batch is sampled periodically by removing 10 ml of fluid sample twice daily within the first week, with two long-term samples taken to determine steady conditions. At the time of each sample extraction, 2 mL of the sample is tested for pH. The remaining 8 mL is filtered through a 0.20 μm filter and acidified to 3% v/v with high purity HCl before analysis for Si by atomic absorption spectrometry (AA). The release of Si has been shown to be the rate-limiting step in the dissolution of phyllosilicate minerals [9]. Thus, measuring the concentration of Si in the reaction fluids over time allows us to calculate an apparent dissolution rate constant. To correct for the change in volume due to sample extraction, we used the following equation from [10]:

$$m_{(t)} = m_{(t-1)} + (c_{(t)} - c_{(t-1)})V_{(t-1)} \quad (1)$$

where $m_{(t)}$ is moles of Si at time t, $m_{(t-1)}$ is moles of Si released at time t-1, $c_{(t)}$ and $c_{(t-1)}$ are the concentrations of Si in moles/L at time t and t-1, and $V_{(t-1)}$ is the volume (L) of solution at t-1. The apparent dissolution rate constant (k_{diss}) is then calculated after [10] and [11]:

$$-m_{ss} \ln\left(1 - \frac{m}{m_{ss}}\right) = Ak_{diss}t + C \quad (2)$$

where m is moles of Si released at each sampling point, calculated using Equation 1; m_{ss} is the moles of Si released at steady state, calculated by taking the average of two long-term points; A is the surface area; k_{diss} is the apparent dissolution rate constant in $\text{mol}/\text{m}^2\text{s}$; t is the time in seconds; and C is the constant of integration.

Results and Discussion: Initial results indicate that the poorly crystalline synthetic nontronite dissolves approximately 5 times more rapidly than the natural NAu-1 at pH 2 (Figure 1), and 20 times faster than natural nontronite at pH 5. These results suggest that poorly crystalline materials, similar to what may be present on Mars, would dissolve more rapidly than well-crystalline clay mineral standards often used for comparison. Past evidence of water-rock interactions may therefore be better preserved in such poorly-crystalline materials. In addition, the preliminary dissolution rates at pH 2 and pH 5 for the synthetic nontronite and natural nontronite suggest that the dissolution of well crystalline nontronite is more dependent on pH than poorly crystalline synthetic nontronite. This is similar to previous results that found that dissolution of X-ray amorphous

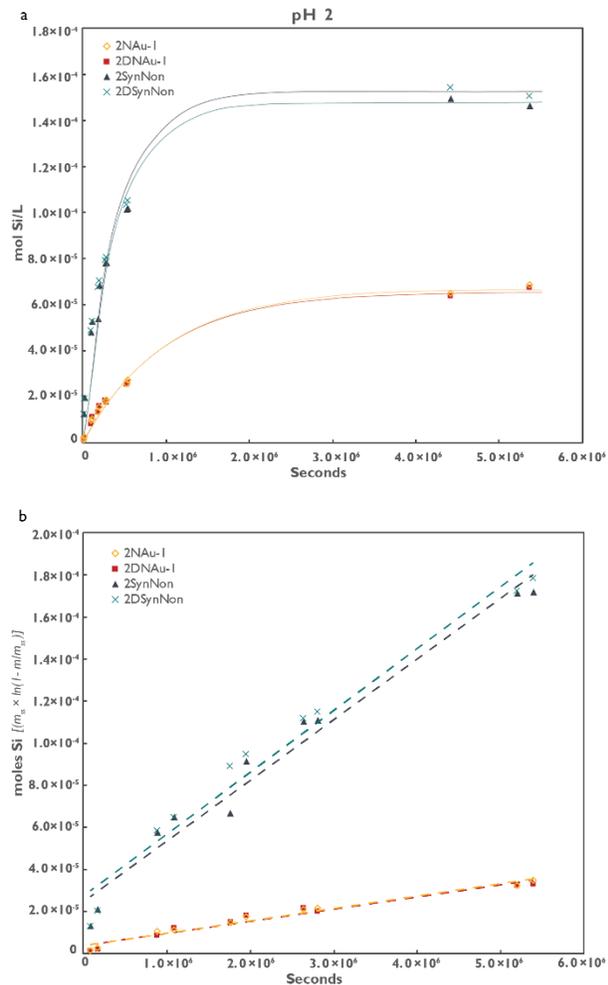


Figure 1. Release of Si (mol/L) versus time for synthetic and natural nontronite (NAu-1) dissolution experiments at pH 2. (a) Concentrations are corrected for volume loss using equation (1). Expected concentration lines are constructed using the calculated k_{diss} in equation (2) and manipulated concentrations shown in (b). (b) Concentrations are corrected for volume loss and manipulated using equations (1) and (2) after [10] and [11].

phases allophane, Fe-containing allophane, and hisingerite have very low dependences on pH [12; 13]. The dissolution rates of the synthetic and natural nontronite measured here are also faster than has been previously found for nontronite using column flow reactors [14], which is common for batch reactors.

In our ongoing work, we will perform the same dissolution experiments on the chlorite end-member as well as mixed layer phyllosilicates, to better interpret the minerals present in Jezero crater. Future work will also involve examining reacted and unreacted materials with scanning electron microscopy (SEM) and transmission electron microscopy (TEM). This work will therefore yield important information for interpreting past fluid-rock interactions in Jezero crater, Mars.

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