Serpentinite Weathering and Implications for Mars

V. Tu, J. Baumeister, R. Metcalf, A. Olsen, E. Hausrath

I. Introduction

In the search for life on Mars, near-surface soil environments may be important habitats for life accessible to future missions. Serpentinite rocks have been documented on Mars, as well as other clay minerals including smectite and kaolinites. Previous studies of soils formed on serpentinites on Earth have documented the formation of extensive clays. Serpentinites are additionally of interest as habitats for life such as methanogens. Here we examine weathering of serpentinites from bedrock to soil surface, as a potential route for the formation of clay minerals on Mars from abundant ultramafic minerals. We additionally test for the presence of Fe-oxidizing bacteria in weathered serpentinite rocks. Fe-oxidizing bacteria have been previously demonstrated to affect dissolution rates of ultramafic minerals. We additionally tested for the formation of clay minerals on Mars from abundant ultramafic minerals. From bedrock to soil surface, as a potential route for the formation of clay minerals on Mars from abundant ultramafic minerals, and may produce important biosignatures.

II. Field Area & Sample Collection

Klamath Mountains, California

Samples were collected in a vegetated serpentinite soil at 41°05'08" N, 122°39'54" W from a depth of 0 to 40 cm.

Scorpion Creek

Samples of rock were collected from road cuts beneath profile and core samples were additionally collected.

III. Methods

1. Sample collection
2. Bulk Density
3. SEM/EDS Scanning Electron Microscopy/ Energy Dispersive spectroscopy
4. XRD X-ray Diffraction
5. XRF X-ray Fluorescence
6. BARTSTM Biological Activity Reaction Tests

IV. Results

SEM images of polished weathered rock suggest the formation of AL-bearing secondary minerals on the surface.

XRD Preliminary results suggest the presence of lizardite in parent material and smectites, and Fe oxides in weathered soils.

XRF Bulk chemistry of the soils were normalized to parent material with the immobile element to calculate the dimensionless mass transfer coefficient (T(Fe)).

BARTs

Control: Day 10
Scorpion Creek: Day 10

VI. Discussion

Calculation of Serpentinite Dissolution Rate

\[ R_w = \frac{1000 b_{\text{ss}}}{\beta b_w} \]

\[ R_w \] surface-area normalized weathering rate
\[ \beta \] density of the weathered material
\[ S \] reactive surface-area
\[ \beta \] stoichiometric coefficient
\[ b_w \] weathering advance rate
\[ b_{\text{ss}} \] weathering gradient

Rates have been calculated from the weathering velocity and the weathering gradient using the method of (White, 2002).

VII. Conclusions

1. Natural weathering rate of Scorpion Creek: 2.42 x 10^{-16} mol/m²/s
2. To our knowledge this is the first field weathering rate of lizardite.
3. Lizardite appears to be altering to smectite.
4. Chemical weathering appears to be occurring below the point of refusal.
5. At first BARTSTM did not yield any apparent signs of growth however, samples we monitored for a total of 136 days and growth of Fe-oxidizing bacteria may now be present.

VIII. References

We would like to thank NSF EPSCoR for funding and Dr. R. Metcalf, J. Cornell, R. Johnson, and Dr. S. Mulcahy, C. Adcock, Dr. Z. Yu, and the UNLV Geoscience department for their assistance.