SERPENTINITE WEATHERING AND IMPLICATIONS FOR MARS.

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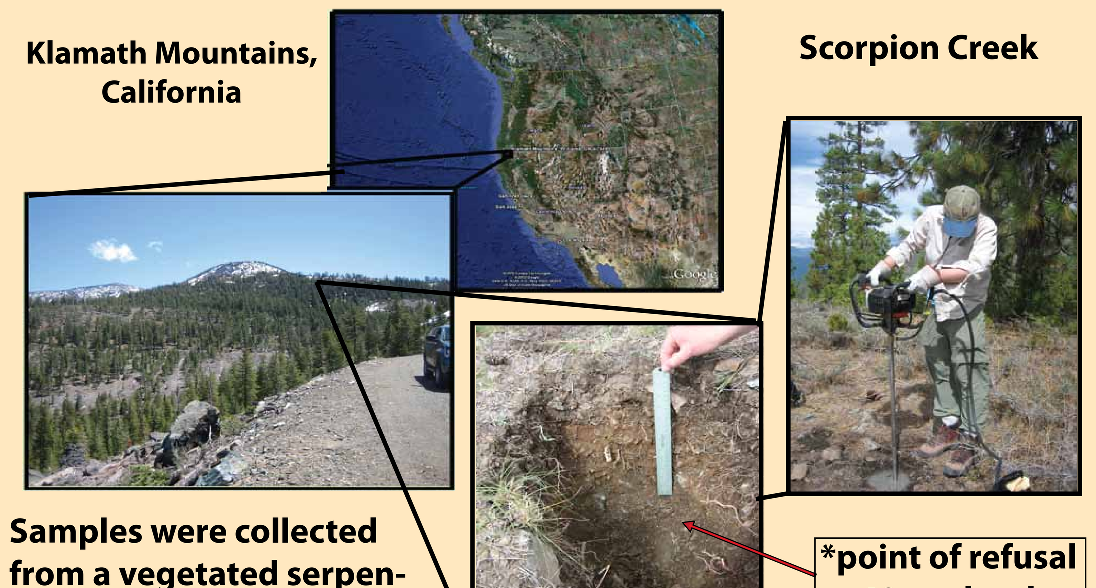
I. INTRODUCTION

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 ultra-mafic minerals , and may produce important biosignatures.

II. FIELD AREA & SAMPLE COLLECTION



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

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

III. METHODS

1 Sample collection

2 Bulk Density

3 SEM/EDS
Scanning Electron Microscopy/ Energy Dispersive spectroscopy

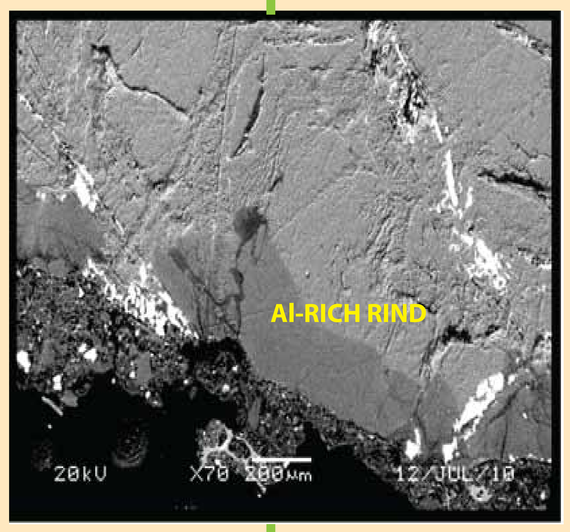
4 XRD
X-ray Diffraction

5 XRF
X-ray Fluorescence

6 BARTS™
Biological Activity Reaction Tests

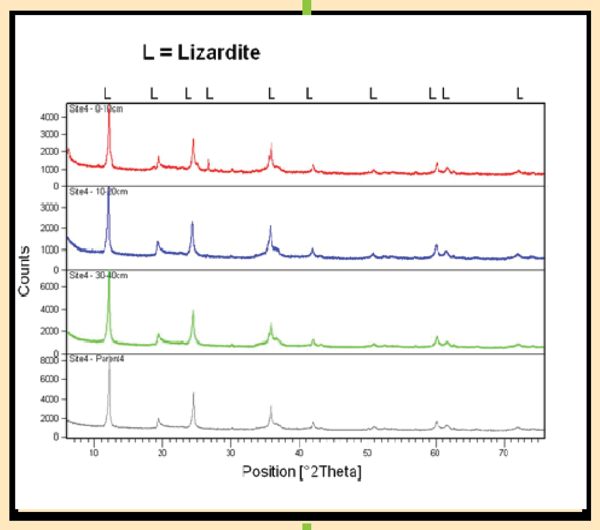
IV. RESULTS

SEM/EDS



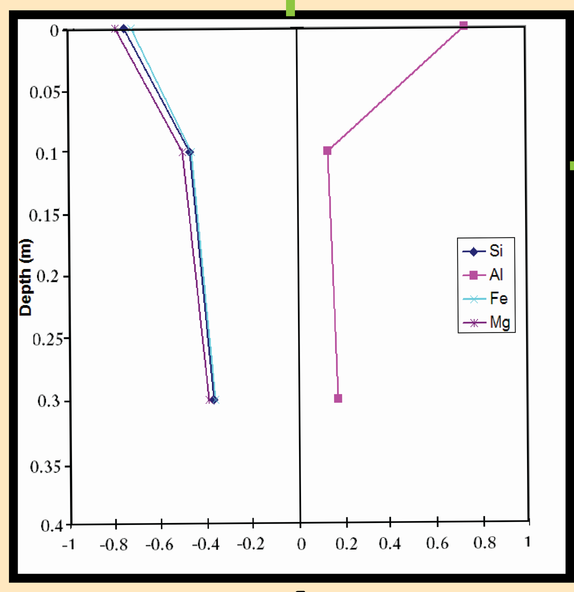
SEM images of polished weathered rock suggest the formation of AL-bearing secondary minerals on the surface.

XRD



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

XRF



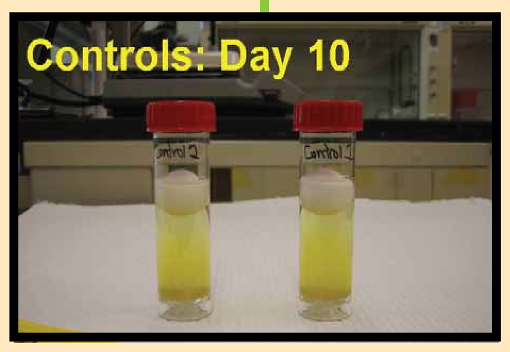
$$\tau_{i,j} = \frac{C_{j,w}\,C_{i,p}}{C_{j,p}\,C_{i,w}} - 1$$

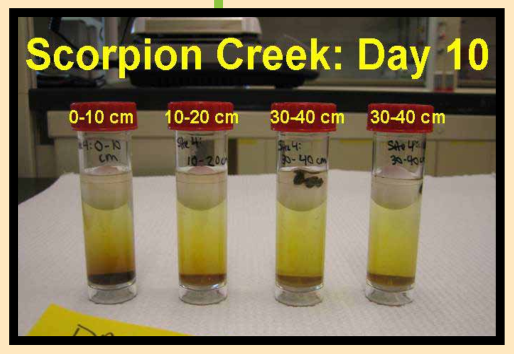
- $\tau_{i,j}$ normalized concentration of the immobile or mobile element
- $C_{j,w}$ concentration of the mobile element in weathered material
- $C_{j,p}$ concentration of the mobile element in parent material
- $C_{i,p}$ concentration of immobile element in parent material
- $C_{i,w}$ concentration of immobile element in weathered material

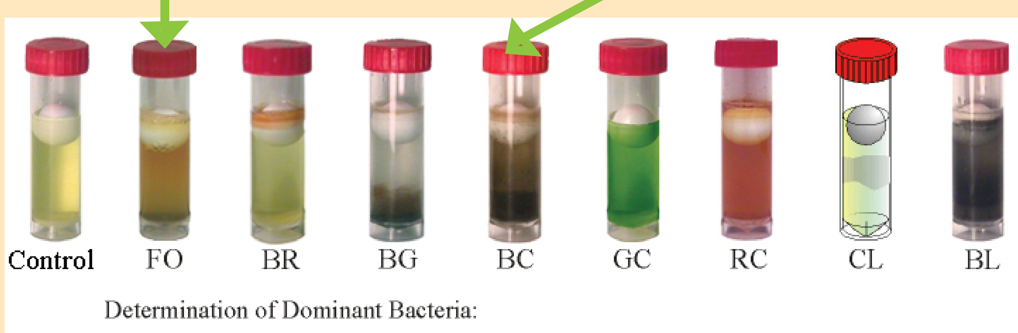
When:
$\tau = 0$, normalized concentration is equal to parent rock.
$\tau < 0$, normalized concentration is depleted relative to parent rock.
$\tau > 0$, normalized concentration is enriched relative to parent rock.

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

BARTS



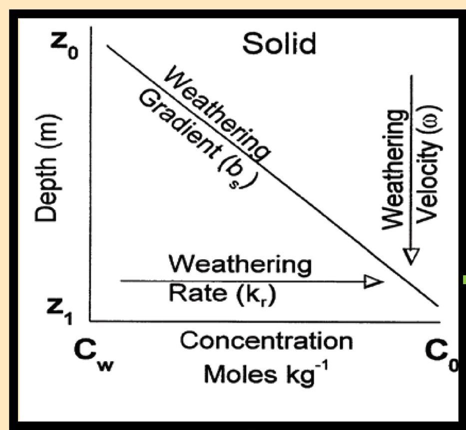




Determination of Dominant Bacteria:
FOAM(FO) around ball- Anaerobic Bacteria.
BROWN RINGS(BR), GEL(BG), and/or CLOUDS(BC) - IRB.
Solution GREEN-CLOUDY(GC) - Pseudomonads.
Solution RED-CLOUDY(RC) - Enteric Bacteria.
Solution CLOUDY(CL) - Heterotrophic Bacteria.
Solution BLACK(BL) - Pseudomonads and Enterics.

V. DISCUSSION

Calculation of Serpentinite Dissolution Rate



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

$$R_s = 1000\,\frac{\rho_w}{S\beta}\left(\frac{\omega}{b_s}\right)$$

- R_s surface-area normalized weathering rate
- ρ_w density of the weathered material
- S reactive surface-area
- β stochiometric coefficient
- ω weathering advance rate
- b_s weathering gradient

VI. CONCLUSIONS

- Natural weathering rate of Scorpion Creek: 2.42 x 10^{-16} mol/m^{2}s
*To our knowledge this is the first field weathering rate of lizardite.
- Lizardite appears to be altering to smectite.
- Chemical weathering appears to be occurring below the point of refusal.
- At first BARTS™ 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.

VII. ACKNOWLEDGEMENTS

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