VARIATIONS IN SERPENTINE ALONG THE HC-VC SUTURE ZONE OF SRI LANKA: AN ANALOGUE FOR STUDYING MARTIAN SERPENTINITES.

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Introduction: Serpentine, $(Fe,Mg)_6Si_4O_{10}(OH)_8$ is considered a mineral interface between the solid Earth, the hydrosphere and the biosphere. Its formation is closely associated with hydrothermal alteration of ultramafic minerals that takes place over a wide range of temperatures (400-800°C), but are only slightly dependent on pressure [1]. Environments on Earth known to produce serpentinites are (1) ophiolites, (2) convergent margins, (3) divergent margins, and (4) greenstone belts. Serpentine textures, properties and alterations preserved at the macro and micro scale then correspond to the P-T conditions and the environment of serpentinization. Specific properties of the serpentines (i.e. density, fracture infill) indicate specific formation conditions and environments. Ancient serpentinites from Sri Lanka in general, and their derived soils in particular [2] have been suggested as analogs to Mars [3]. Accordingly, our aims consist of (1) establishing variations in macro textures along the HC-VC contact, and (2) mapping the geologic variations of an exposed outcrop. That work serves the overall goal of using Sri Lanka's serpentine formations to advance the utility of island serpentines as a reference for future Mars analog field work.

Significance: The process of serpentinization occurs in the presence of H_2O and CO_2 fluids. This results in the production of significant quantities of hydrogen, CH_4 [3], and lesser quantities of long-chain hydrocarbons [1]. This is of immediate interest for the global research community given the episodic CH_4 plumes and S-bearing organic molecules identified by the Curiosity rover at Gale Crater [4], especially since it establishes redox and chemical gradients that Earth-analog biology can exploit. For example, serpentinization is closely linked to providing an energy source for anaerobic microorganisms [5].

Geologic Setting: The island of Sri Lanka is unique given distinctness dating back to Gondwana and even the fragmentation of Rodinia [4]. With minimal geologic overprinting since its migration with India, Sri Lanka offers an unprecedented window into ancient Earth going back at least ~600 Ma, making it an optimal Earthly analogue to study ancient Martian serpentines. The suture zone along the Highland Complex (HC) and the Vijayan complex (VC) is identified by serpentine outcrops mineralized between the two units (Fig. 1).

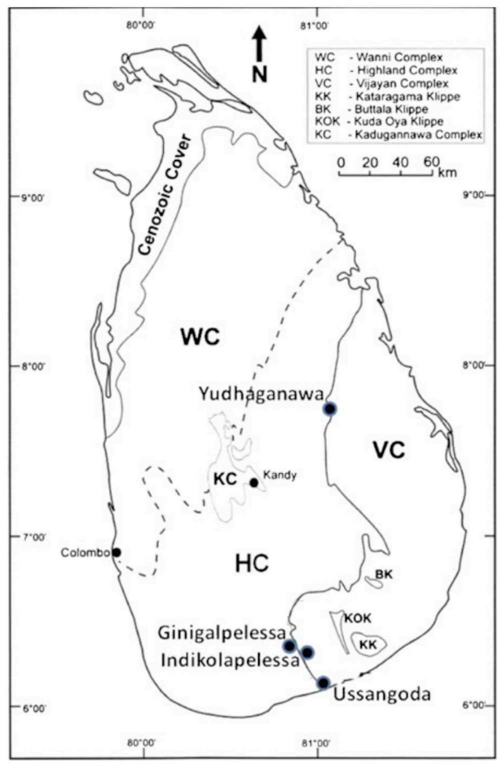

Fig. 1. A geological map of Sri Lanka showing the HC-VC contact. Known serpentine sites are marked by dots along the zone. (Vithanage et al., 2014)

By examining and describing serpentine variations across the HC-VC suture zone more closely, the nature of their emplacement and specific environments can be characterized at a level of detail sufficient to inform comparable processes on

Mars, as well as the potential for challenges that future human explorers may face when using Martian soil as an in situ resource for crops. Furthermore, ongoing field work would help advance existing soil simulants for Mars.

Methods: Serpentine rock samples were taken from the four locations along the suture zone marked in figure 1. Samples were taken directly from serpentine outcrops and float rock. Samples were then described based on observable characteristics such as: weathered surface colors, fresh surface colors, rock density, grain type, alterations, inclusions and rock strength.

Results: Chemical variations at the micro scale are outwardly expressed as changes in observable rock properties. Samples are described based on their weathered (W) and fresh (F) rock surface surfaces. Location names are as given in figure 1.

1. *Ussangoda:* (W): light green/orange, low-moderate density, somewhat well consolidated, pits on surface (1-5mm). (F): light green, crystalline, chromite pods (suspected chromite) present sporadically about the matrix (0.5-1.5 mm), organized and lineated quartz veins are also present (0.5-3 mm thick).
2. *Indikolapelessa:* (W): light green, low-moderate density, porous, not well consolidated, quartz veins present (1-5mm). (F): dark green, crystalline, small pores (0.5-1mm) present sporadically throughout the matrix, chromite present (0.5-1 mm).

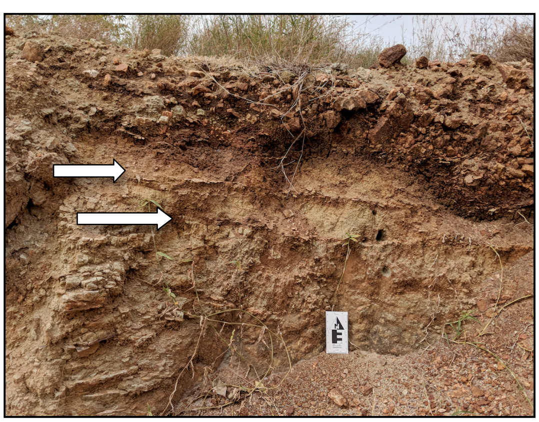

Figure 2. A weathered outcrop at Indikolapelessa displaying quartz veins (white arrows) cutting across the serpentine outcrop.

3. *Ginigalpelessa:* (W) Earthy green, low-moderate density. (F) light green with white clay in matrix. Pores sparsely present (0.5-1mm). Chromite pods present both moderately organized and sporadically throughout the matrix (0.5-2 mm). Small yellow minerals (>0.5 mm) also present.
4. *Yudhaganawa:* (W) dark green/dark orange, low density. (F) light green, crystalline, chromite pods (0.5-2mm) present both highly organized and sporadically about the matrix. Chert veins present (0.5-3 mm thick)

Implications: Variations in chromite pod organization, sample density and fracture properties suggest sites 1-4 may not have experienced alteration at consistent P-T conditions. Variations in sample characteristics may also represent differences in protolith material prior to serpentinization. More organized chromite pods may correspond to deeper tectonic fabrics in the transition zone [6], suggesting the highest P-T condition of alterations identified in the field, as observed at sites 3 and 4. Serpentines from sites 1 and 2 display lower density compared to sites 3 and 4, indicating they are not as thoroughly serpentinized [1]. Additionally, we observed extensive fracturing and quartz filled veins at sites 1 and 2 (Fig. 2). A lack of calcite veins/calcite replacement in all samples suggests this suture zone is not likely ophiolite in origin [1]. Alternatively, these fracture characteristics correspond to low angle detachment faults associated with spreading ridges [1]. Our ongoing work analyzing the samples for bulk chemistry (XRF; ICP-MS) and mineralogy (XRD) will help us determine the correspondence between the rocks and soils as analogs for Mars.

References: [1] Iyer, K. (2007) *Mechanisms of Serpentinization and some Geochemical Effects* [2] Kumarathilaka, P., Oze, C., & Vithanage, M. (2016). Perchlorate mobilization of metals in serpentine soils. *Applied Geochemistry*, *74*, 203–209. [3] Ehlmann B. et al., (2010) GRL, 37, L06201. [4] Kröner, A. et al., 2013, AES 22:279–300. [5] Oze, C., Sharma, M. (2005) GRL 32. [6] Mosier D. et al., (2012) SIR 2012-5176.