***IN SITU* CHEMICAL ANALYSES OF ARCHEAN ROCKS: TERRESTRIAL ANALOG FOR PLANETARY FIELD STUDIES.** A. E. Davatzes[1] and C. Monshizadegan[1], [1] Department of Earth and Environmental Science, Temple University (1901 N. 13th St. Philadelphia, PA 19122; alix@temple.edu).

Introduction: Rocks from the base of the Fig Tree Group in the Sheba Mine section of the Barberton greenstone belt (BGB), in South Africa represent biological and chemical sediments deposited locally in low-energy deep water following volcanism at about 3.24 Ga. Evidence of low-energy conditions include a lack of current deposits and the presence of massive beds, beds that are finely graded, and crinkly laminations that appear biological.

Studies of these sediments, particularly studies with *in situ* geochemical techniques, are critical for providing terrestrial constraints for planetary exploration. The rocks in the BGB are an ideal candidate because they contain a range of carbonaceous particles including possible microbial mats and are some of the oldest sediments on Earth. This study tests the use of portable microanalytical tools on a section of cored rock in comparison to petrographic analyses.

Samples: A 4.5-meter section of core from the Sheba Mine was logged for lithology, structural and post-depositional features, such as veins and dissolution seams. Petrographic thin sections were analyzed and geochemical analyses were performed using the ThermoScientific Niton® XRF Analyzer, a portable tool intended for analysis in the field. Ongoing laser Raman analyses are being performed, using the RockHound™, also intended for field analysis.

Lithology: The section of core analyzed contains 8 major lithologic units based on petrographic observations: (1) dark finely laminated chert, (2) translucent chert, (3) black chert, (4) black and white banded chert, (5) dark granular chert, (6) grey-green granular chert, (7) sediments with rounded and flattened grains, and (8) microcrystalline translucent chert with patchy dark chert regions.

Most of the lithologic units contain carbonaceous material. Walsh and Lowe [1] define different types of carbonaceous material, including: (1) Simple grains, which are the most common type and range in size from 5 to 750 μm. This type tends to have irregular margins. (2) Lobate composite grains, which range from 100 to 1000 μm. Some examples have isolated flecks of sericite, and are commonly seen in microbial mat layers. (3) Wisps of carbonaceous material that are 10 to 50 μm thick and 50 to 1000 μm long. (4) Cloudy diffuse carbonaceous matter, which appears as irregular patches and are not resolvable as individual grains. This type of carbonaceous material is interpreted to be fine detrital or degraded carbonaceous matter. All of these four types are present in one or more of the different units in this section.

The finely laminated dark chert is composed of crinkly laminations that appear mat-like. The laminations are thin and laterally continuous. Only some small simple carbonaceous grains are incorporated into these laminations. The geometry of the crinkly laminated chert is consistent with formation as microbial mats. Previous studies of similar sedimentary structures and associated carbonaceous materials from the BGB have suggested they formed as mats in shallow water [1, 2], although such carbonaceous matter has been documented in all settings, including both current-active platform settings and below-wave-base basins [3]. The lack of any large clasts, ripped-up material, or other bedforms in most of the carbonaceous units suggests deposition was not shallow and not subjected to current or wave activity. Furthermore, Fig Tree sediments in the northern portion of the BGB, where this core was obtained, have been identified as deep-water deposits [4].

The translucent chert is composed entirely of pure microcrystalline chert and lack carbonaceous material. Occasionally pyrite is dispersed through the bed, particularly in veins and stylolites. The black chert is composed of very fine carbonaceous material, mostly simple irregularly shaped carbonaceous grains and wisps. The black and white banded chert sections are composed of interbedded layers of translucent chert and either mat-like crinkly laminated chert or pure black chert. The granular dark chert layers are composed of simple carbonaceous grains as well as some larger complex carbonaceous grains and other detrital material. It is coarser-grained than the pure back chert layers, with grains as large as 0.5 mm and some larger clasts. The grey-green chert is composed of intergrown quartz and sericite with wisps of carbonaceous material. The clastic sediment is rare and only seen in two of the beds. It contains spherical or oval-shaped particles that are deposited with carbonaceous material and other detritus that was subsequently flattened. Pre-flattening size estimates of the spherical grains are approximately 0.75mm in diameter. The patchy dark chert contains regions of cloudy carbonaceous material and simple carbonaceous grains in otherwise pure microcrystalline quartz. Calcite and siderite are also present, particularly in some portions of translucent chert and in the granular dark chert units. A stratigraphic section (Figure 1) of the core shows the distribution of these lithologies.

XRF results: The XRF analyses (Figure 1) successfully identified 1 potential impact layer near the 100cm mark with high Cr and Ni abundances, consistent with the presence of flattened spherical grains found petrographically. Elevation in Cr abundance from approximately 175-230cm in height is consistent with an increase in the presence of clastic komatiitic particles in the petrographic thin sections. A high Zr peak near the 400cm mark suggests an influx of felsic material, and this spike corresponds to the section of grey-green granular chert. Other felsic volcanic tuffs throughout the BGB have the same characteristic pale green color and granular texture. Five peaks of Fe and S correlate, consistent with petrographic observations of pyrite within veins.

The XRF is limited in that it cannot measure the lightest elements (below Z=16) and therefore cannot measure Si, Al, C, or P, which are all critical in looking at chemical and possibly biological sediments. This therefore necessitates the use of other tools, such as the laser Raman.

Laser Raman: Preliminary analyses using the RockHound™ laser Raman analyzer have successfully identified the primary peaks characteristic of disordered carbon at 1310 cm^{-1} and 1600 cm^{-1}. A representative example from one of the black chert samples containing irregular shaped grains and wisps is shown in Figure 2. In previous studies, biogenic and abiogenic carbon appears to display the same signal, and differences in Raman spectra are more useful for geothermometry [5]. However, here we look at different morphologies of carbonaceous matter that have reached the same diagenetic temperatures to determine if there is a useful marker that can be used.

References: [1] Walsh M. and Lowe D.R. (1999) *GSA Sp. Paper* 329, [2] Tice M. M. and Lowe D. R. (2004) *Nature* 431, 549-552 [3] Lowe, D.R. (1999) *GSA Sp. Paper* 329, 83-114 [4] Lowe D.R. and Byerly, G.R. (1999) *GSA Sp. Paper* 329, 287-312 [5] Marshall C.P. et al (2010) *Astrobiology*, 10, 229-243.

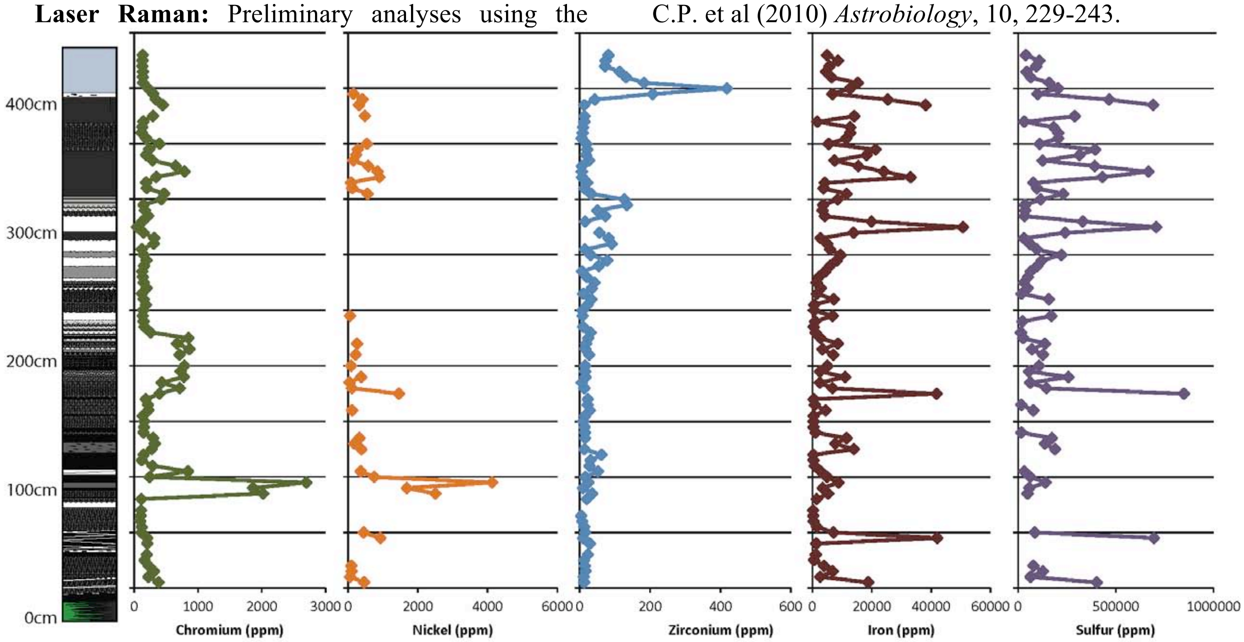

Figure 1: Stratigraphic section from the base of the Fig Tree containing chemical and possible biological sediments along with XRF results for selected elements.

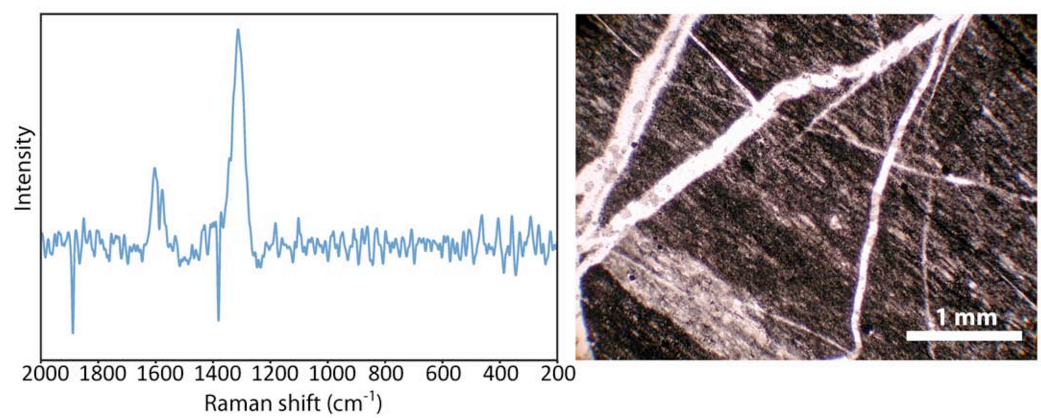

Figure 2: Example of a Raman spectrum from a black carbonaceous chert layer at approximately 150cm above the base of the section.