SIGNIFICANCE OF KOMATIITE: THERMAL EMISSION SPECTROSCOPY OF KOMATIITE FOR REMOTE SENSING OF PLANETARY SURFACES; David P. Reyes, Department of Geology, Arizona State University, Tempe, AZ 85287-1404.

Basalts of komatiitic composition are of great importance for studying the Earth's mantle, and will also be important for Mars if they exist there [1]. Terrestrial komatiite is an ultramafic extrusive characterized by compositional and textural layering within individual flow units, and by high MgO content. [2] The Thermal Emission Spectrometer (TES) is one of six instruments which is flying to Mars aboard the Mars Observer spacecraft, which will arrive at Mars in August of 1993. The TES instrument will observe the surface of Mars in emission in the mid-infrared wavelength region where silicate rocks, such as komatiite, may easily be detected.

The existence of komatiite is particularly important for deciphering the early history of the Earth's mantle. The prevalence of komatiite almost entirely in the Archean indicates fundamental differences between ancient and modern mantle conditions. The high magnesium content of komatiitic lavas imply high degrees of partial melting of their mantle source regions, generation at great depths, and a mantle which had a significantly higher temperature gradient than at present. Beyond the academic, komatiite is intimately associated with nickel ore deposits in many parts of Canada, Zimbabwe, and Western Australia.

In order to remotely detect komatiite in the mid-infrared it's fundamental spectral properties must be understood. To accomplish this, a suite of komatiitic lavas were subjected to extensive analysis including whole rock analysis, optical petrography, electron microprobe, and spectral analysis. Samples, include peridotitic, pyroxenitic, and basaltic komatiite, were collected from "Dundonald Beach", Dundonald Township and "Pyke Hill", Munro Township, Ontario, Canada. Several samples of more common basalts, including andesitic basalt, alkali basalt, and tholeiitic basalt, were collected for comparison.

Preliminary examination of the data shows that komatiite spectra can easily be distinguished from other less mafic basalt types because of komatiite's unique ultramafic mineralogy [3]. This relationship is shown in Figure 1. Peridotitic komatiite examined consists mostly of magnesium olivine within a groundmass of augite. Pyroxenitic komatiite examined are dominated by augite, with minor magnesium olivine, and plagioiclas. Basaltic komatiite consists of augite, plagioclase, and few or no olivines. The tholeiitic basalt contains abundant plagioclase and pyroxene, with less olivine. The decreasing content of mafic minerals from peridotitic komatiite to tholeiitic basalt is shown in the spectra by a shift in the location of the deepest absorption feature to greater wavenumber (shorter wavelength) with decreasing mafic content and increasing silica content. Also, the number of mineral endmembers may increase, and the difference in amounts of endmembers becomes less, as the mafic content declines. This is evident in the decreasing contrast of spectra from peridotitic komatiite to tholeiite as more endmembers are added and the percentages of mineral endmembers come closer together. The majority of background research and data collection has been completed, and now only rigorous interpretation remains.

This work will be of important as a reference for remote sensing of komatiite for the Earth and Mars. For the Earth, mapping of komatiite from airborne or orbital mid-infrared sensors will help discover new potential areas of komatiite associated nickel ore deposits, and help plan efficient use of existing deposits. Additionally, remote mapping may help constrain the physical volcanology of terrestrial komatiites which is poorly understood. For Mars, detection of komatiite by the TES instrument will be important for studying the evolution of the Martian mantle and would have important implications for comparison to the development of the Earth and other terrestrial planets.
References

Figure 1 - Komatiite and Basalt Spectra