The distribution of TiO_2 and Ti-bearing minerals on the surface of the Moon

B. Jolliff (1), M. Robinson (2), S. Brylow (3), E. Eliason (4), H. Hiesinger (5), M. Malin (3), A. McEwen (4), P. Thomas (6), E. Turtle (4)

(1) Washington University, USA , (2) Northwestern University, USA, (3) Malin Space Science Systems, USA , (4) University of Arizona, USA, (5) Brown University, USA , (6) Cornell University, USA; (blj@wustl.edu / Fax: 314-935-7361 / Phone: 314-935-5622)

The concentration and mineralogy of Ti in lunar rocks and soils are known from studies of the Apollo and Luna samples and lunar meteorites. Concentrations of TiO_2 reach 10 wt% in high-Ti mare regolith, 12 wt% in high-Ti mare basalts, and 17 wt% in some volcanic glasses. The mineralogy of Ti is dominated by the oxide mineral ilmenite, but also includes the oxides armalcolite, ulvöspinel, and rutile. Titanium occurs as a minor element in pyroxene and it occurs in volcanic and impact glasses, including agglutinates. Titanium is an important element in terms of the petrogenesis of the mare basalts. Ilmenite is important as a potential resource because of its ability to concentrate solar-wind gases and because of its potential as a feedstock for oxygen production and a source of Ti metal.

The distribution of Ti on the Moon's surface is known globally to first order from reflectance spectra obtained from Earth-based telescopes, Galileo and Clementine spacecraft, and from neutron and gamma-ray spectra obtained by Lunar Prospector (LP). However, considerable uncertainty remains in the accuracy of TiO_2 estimates. Concentrations of TiO_2 derived from Clementine UV-VIS data ($\sim$100 m/pixel) were calibrated to landing-site soil compositions and found to correlate well, except for the Apollo 11 and the Luna 16 and 24 sites. These are among mare locations for which the Clementine-derived TiO_2 differs significantly from LP-derived TiO_2. Moreover, LP gamma-ray TiO_2 concentrations differ from those estimated from analysis of the neutron-spectrometer data, and the LP data have a very large footprint, i.e., 60x60 km for Ti. Thus a requirement for future missions is to more accurately determine TiO_2 concentrations at a scale better than one km and to define deposits that are rich in Ti (and specifically ilmenite).

The Lunar Reconnaissance Orbiter (LRO) mission includes a wide-angle camera (WAC) as part of the LRO Camera (LROC) system (Robinson et al., these proceedings). The WAC will be used to conduct systematic multispectral imaging over the entire globe in the ultraviolet to visible range, with band passes at $\sim$315, 360, 415, 560, 600, 640, and 680 nm. LROC will acquire global visible observations at 100 m/pixel and UV observations at 400 m/pixel. The LROC global color images will mesh well with Clementine images, which have 100-200 m/pixel resolution at 415, 750, 900, 950, and 1000 nm band passes. Ilmenite has very low reflectance and a broad absorption feature centered at 500 nm. The WAC band passes will have high signal-to-noise and are well suited to define this feature. The WAC multispectral data will distinguish ilmenite-rich regolith from that dominated by low-Ti, ilmenite-poor basalt. The new data will significantly improve the capability to map TiO2-rich soils and thus to help locate and define the extents and concentrations of H- and He-rich deposits, which have been identified as high priority for resource assessment.