**Introduction:** Mare Moscoviense is an enigma in many ways. Located within some of the thickest crust (80 km [1]) and at ~4 km above the mean lunar radius [2], these basalts were able to overcome buoyancy forces that have been proposed to impede the eruption of far side basalts [3]. In contrast, South Pole-Aitken basin exists in an area of the thinnest crust and 4-6 km below the mean lunar radius; thus, it should by all accounts be flooded and overflowing with basalt, yet the area of basalt in Mare Moscoviense, 35,000 km², is larger than any individual deposit within South Pole-Aitken. In addition, volcanism in Moscoviense occurred over a protracted period of time (potentially from Nectarian to upper Imbrian), in at least three different volcanic eruptive events. Compositionally, soils derived from these different flows exhibit a wide variation in titanium compositions, from low-Ti, ~1 wt.%, to high-Ti, 6-8 wt%. A similar range in TiO₂ compositions is reported for basalt ponds within the Australe and South Pole-Aitken basins. We also report for this first time the presence of high-Mg orthopyroxene (opx) bearing basalt within Moscoviense. Together these data points suggest that the far side maria represent a compositionally heterogeneous mantle, able to partially melt over a prolong period of time, and that the rise of magma through the farside crust was minimally suppressed.

**Data:** Clementine collected 11-band multispectral data (415, 750, 900, 950, 1000, 1100, 1250, 1500, 2000, 2620, and 2792 nm) at 100-200 meter per pixel spatial resolution for most of the lunar surface [4]. The Clementine data presented here are from the digital image model processed by the USGS with calibrations of [5-7]. From these data color ratio, FeO and TiO₂ composition maps, and optical maturity index maps were yielded. Calculations of optical maturity (OMAT) are used to target optically immature craters that exhibit the best spectral contrast and signal-to-noise.

**Observations:** Five different volcanic units are identified on the basis of their spectral properties and composition: high-Ti basalts, low-Ti basalts, ancient mare basalt that exhibits the presence of high-Mg opx, cryptomare, and pyroclastic materials.

The youngest unit in the basin is the high-Ti unit. The surface of this deposit exhibits 5-8 wt% TiO₂ and 17-20 wt% FeO (Fig 1). Individual fresh craters, which represent compositions less contaminated by impact mixing by highland materials show higher FeO (20-21 wt.%) and TiO₂ (8-10 wt%) contents (mare basalts within the Apollo basin and Australe basin exhibit similar TiO₂ compositions but are less areally extensive).

The next youngest unit is the low-Ti deposit. The average surface composition is 11-15 wt.% FeO and 1-3 wt.% TiO₂. A combination of the age the thinness of the deposit have resulted in greater contamination by highlands and underlying lower iron ancient basalt. This low-Ti unit was designated as a possible candidate for a high-Al surface exposure on the basis of its composition (FeO, TiO₂, and Th) and age [8]. Numerous small craters display high iron (17-19 wt%) ejecta deposits suggesting a highly contaminated surface regolith layer but not a high-Al basalt exposure (Fig 1). The low-Ti unit is overlain by the high-Ti unit as evidenced by the excavation of low-Ti, high-Fe materials by craters in the 1-2 km diameter size range superposed on the high-Ti unit. From this we estimate of the high-Ti unit thickness is 150 m. A thickness of 500m is estimated for the low-Ti unit, as the smallest crater to excavate low-Fe material from beneath this basalt unit is ~5km.

The oldest unit exposed in Moscoviense is the ancient mare basalt. Lunar Orbiter IV images of the basin show that this unit is more heavily cratered than the previous two units. This unit exhibits low FeO (8-13 wt.%) and low TiO₂ (<1 wt%) compositions. This ancient mare unit is similar in composition and
morphological appearance to volcanic materials on the
basin floor of Smythii [9]. We examine Clementine spectra of ancient basalt and find evidence for opx as a major phase (i.e., the ferrous-silicate 1-μm absorption is centered on 0.9 μm rather than 0.95 μm). We are working towards ruling out the contamination of typical clinopyroxene bearing basalt by the surrounding or underlying noritic anorthosite highlands. Early evidence supports the presence of inherent opx in these ancient basalts. We acquire spectra of immature craters within the ancient basalt unit, FeO values of the crater material are iron rich compared to their surroundings, and we cannot produce spectra similar to those we observe using end member components of fresh clinopyroxene basalt and different highland and mare end members. The shape of the spectra of the opx bearing basalts is reminiscent to high-Mg opx phases observed in the data of Lucey et al. (this conference). Thus, it is possible that the noritic Mg-rich material we observe is a surface exposure of Mg-suite rocks. In addition, basalts with spectra indicative of opx are also found in Mare Australe [10].

Lunar Prospector gamma-ray data [11] at half-degree (15 km) resolution show that the Th content for all three basalt exposures is ~1 ppm. This is not significantly higher than average Th values of the farside highlands 0.5 ppm Th [12]. Remote sensing data for mare basalts of the Procellarum KREEP terrane consistently yield Th values >3 ppm and up to 10 ppm in areas. Th values for Mare Moscovyiene more closely match those of other partially filled basins of the nearside (e.g., Nectaris, Smythii, Marginis, Orientale, Crismis, Facunditsis).

Outside Mare Moscovyiene to the northwest between the inner (220 km diameter [13]) and outer (420 km diameter [13]) rings of the basin exists a light to moderate albedo plains unit. Spectra of fresh crater materials within this region show that while the overall albedo of the unit is similar to highlands, there is a flattening of the continuum between 750 and 1000 nm and a small absorption centered 950 nm. These craters also show elevated iron contents, 6-10 wt.%, relative to typical highlands material in the surrounding region [14]. These cryptomare deposits attest to the expanded length of time volcanism occurred in the Moscovyiene region.

A Global Perspective: The dichotomy in global mare distribution is less likely the result of differences crustal dimensions but related magma ocean dynamics. The dregs of the magma ocean were concentrated on the nearside of the Moon in what is now the Procellarum KREEP terrain [15], not the global layer typically envisioned. The last products of the magma ocean would include ilmenite-rich cumulates followed by urKREEP. These dense rocks could sink, interacting with the underlying mantle, fertilizing the mantle with radiogenic materials (K, U, & Th) suitable for the production of mare basalts. Concurrent to this down welling of dense material, low-density Mg-rich rocks formed by accumulation of olivine would rise. The rising rocks could melt as they encountered lower pressure, and form magmas. The greater concentration of K, U, Th, and ilmenite on the nearside of the Moon would be more efficient at producing melt through this complex system interplay involving both final dregs of the magma ocean and the mantle of the Moon. Thus a less convective mantle, lower amounts of urKREEP and ilmenite cumulates resulted in a lower volume of partial melting of the farside mantle and less mare basalt production.


LPSC XXXVII, 2006 abstract #2454