LUNAR SPINEL-RICH ROCKS BY REACTION BETWEEN PICRITIC MAGMA AND ANORTHOSITIC CRUST, AND IMPLICATIONS FOR M^3 OBSERVATIONS.

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Introduction: The lunar crust contains some of the most important and accessible clues to the history of the Moon's chemical evolution [e.g., 1-3]. The M^3 near-infrared mapping spectrometer on the Chandrayaan-1 spacecraft [4-6], recently detected a new rock type on the rim of the Moscoviense basin – rock rich in $(Mg,Fe)Al_2O_4$ spinel, with less than 5% mafic silicate minerals (olivine and pyroxene). No such material had been described from lunar rocks. Here, we describe a rock fragment rich in Mg-Al spinel from lunar meteorite ALHA 81005. The fragment is not identical to the M^3 rock (it contains ~20% olivine + pyroxene) but is similar enough to be relevant.

Sample: Antarctic meteorite Allan Hills (ALH) A81005, is a polymict, anorthositic regolith breccia from the lunar highlands [7-9]. It is composed of anorthosites, granulites, isolated mineral fragments, impactites, impact glasses, and mare basalts set in an glassy, agglutinitic matrix [10]. Thin section ALHA 81005,9 contains a single rock fragment, 350 x 150 µm, with ~30 vol% $(Mg,Fe)Al_2O_4$ spinel – enough that an outcrop of it would be easily detected by M^3. The rest of this clast is ~15% olivine, ~6% low-Ca pyroxene, and 49% plagioclase. The fragment is so fine-grained (30-50 µm) that it reasonably could represent a larger rock body; it is not spinel-rich merely by chance.

Discussion and Implications: The clast is so rich in spinel that it could not have formed by melting a peridotitic mantle or a basaltic lunar crust. The clast's small grain size and its apparent disequilibrium between spinel and pyroxene suggest rapid crystallization at low pressure. A likely origin for its bulk composition is assimilation of anorthosite by a picritic magma. This model explains the petrographic and chemical features of our clast, and is consistent with the regional setting of the spinel-rich regions identified by M^3. The spinel-rich area near Moscoviense is associated with two other unusual spectral signatures – rock rich in olivine, and rock rich in orthopyroxene (the "OOS" association [5]). A picritic intrusion into the anorthositic crust, as suggested here, could produce such rocks as cumulate dunite and pyroxenite, in addition to its spinel-rich cumulates. All of these rocks, igneous and metasomatic, could have been brought to the Moon's surface in the impact that produced the Moscoviense basin. Other spinel-bearing rocks of such a picritic intrusion, like the rock fragment described here, may not be detectable by M^3 because of their high abundance of mafic minerals. The strength of the NIR spinel signature is masked significantly if the rock contains more than 5% mafic minerals [4]. Thus spinel-rich rocks might be common in the lunar crust but not yet detectable. However, with the advent of high spectral and high spatial resolution instruments, there is every expectation that similar exposures of materials might be found across the entire surface of the Moon [5].

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