"MASSIF' ANORTHOSITES IN ALHA81005: POSSIBLE ORIGIN FROM A DIAPIR?

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Introduction: Ferroan anorthosite is a dominant rock type in the lunar highland crust. Currently it is thought that the crust was formed by the crystallization and flotation of plagioclase from a global magma ocean [1,2]. This hypothesis of the lunar crust formation was made based on numerous analyses of Apollo and Luna lunar samples of ferroan anorthosites. Nevertheless these samples are now known to be unusual in several respects (e.g., KREEP components). Therefore it is not surprising that the actual generation mechanisms of crystallization and flotation of plagioclase in the global magma ocean hypothesis is still under debate [3-6]. At issue is whether anorthosite forms a global layer, or occurs as discrete intrusive bodies (like terrestrial massif anorthosites, [7]). We have investigated anorthosites in lunar highlands meteorite ALHA81005 and found that they span the widest range in Mg# in any lunar sample. Based on these results we can relate them to formation hypotheses without significant contributions from the LMO.

Results and Implication: The anorthosites in ALHA81005 (<1.5mm across) are mainly "pure", i.e. >98vol% plagioclase [5]. Plagioclases in ALHA81005 are calcic, An_{94-97}; mafic minerals (olivine & pyroxene) in the anorthosites continuously range from highly magnesian (Mg# = 86), to hyper-ferroan (Mg# = 39). This is the widest reported range of compositions for anorthositic materials in any lunar sample. Ferroan anorthosite compositions typical of LMO models, Mg# of 50-70, are present but are not more abundant than any other composition range.

The result of pure anorthosites in AHLA81005 is important because recently [5] reported large exposed outcrops of pure anorthosite on the Moon that have so far not been reported in lunar samples. The generation of pure anorthosite requires very efficient separation of plagioclase from coexisting melt [6].

The range of anorthosite compositions fits poorly into standard models of lunar petrogenesis. The range of Mg# is extraordinary; it spans the previously described gap in the Mg#-An plot, separating rocks of the ferroan anorthosite suite from those of the magnesian plutonic suite. The magnesian anorthosites are not consistent with formation in a LMO, because their parent magmas would not have been dense enough to float anorthite. The range of Mg#s is similar to that in some terrestrial massif anorthosites [7], as are the low abundances of mafics [6]. This suggests a similar mode of formation – as diapiric masses, partially molten and rich in plagioclase [3,6,8]. The anorthosites of ALHA 81005 could represent such diapirs without significant contributions from LMO anorthosites or magnesian-suite layered plutons.

References: [1] Wood et al., 1970. *Science* 167, pp.602 – 604. [2] Taylor 1982. *Lunar and Planetary Institute, 1982*, pp.481. [3] Warren P.H. 1990. *American Mineralogist* 75, 46-58. [4] Longhi, 2003. Journal of Geophysical Research 108, p.5083. [5] Ohtake et al 2009. *Nature*, 461, pp.236-241. [6] Korotev et al., 2010. *41st Lunar and Planetary Science Conference* p.1440. [7] Ashwal L.D. 1993. Anorthosites. *Springer*, 422 p. [8] Bédard J. H. (2001). *Contributions to Mineralogy and Petrology* 141:747–771.