WATER CONTENT IN MELT INCLUSIONS AND APATITES IN LOW-TITANIUM LUNAR MARE BASALT, 15555. A. Basu Sarbadhikari, K. K. Marhas, Sameer, J. N. Goswami, Physical Research Laboratory, Ahmedabad – 380009, India, (amitbs@prl.res.in).

Introduction: The presence of water and other volatiles in lunar pyroclastic glasses, apatites and olivine-hosted melt inclusions has been established and the inferred water concentrations in their lunar mantle source(s) vary over a wide range [1-5]. The water content in olivine-hosted melt inclusions showed a range of 615–1410 ppm leading to an estimation of 79–409 ppm water concentrations in their lunar mantle source [5]. Water content in lunar apatite ranges from a few hundred to several thousand ppm [2-4].

We have studied volatile content in late-crystallizing apatite grains and the early entrapped melt inclusions in magnesian olivine present in the lunar sample 15555, a low-Ti olivine normative mare basalt with a crystallization age of 3.3 Ga. Initial results for apatites have been presented earlier [7]. The high-Mg bulk composition of 15555 may be considered to be representative of a parent-magma in the low-Ti mare basalt suite. Model calculations and experimental studies show limited accumulation of olivine and Fe–Mg equilibrium between olivine, orthopyroxene and the whole-rock suggests that 15555 preserves a closed-system melt composition at 8.5 kbar pressure [8]. This makes 15555 an ideal sample to constrain the volatile abundance in the low-Ti mare basalt source.

Melt Inclusions in 15555, 199: Several melt-inclusions are observed in this section within the host olivine and pyroxene phenocrysts. We have analyzed two melt-inclusions trapped in early crystallizing magnesian olivine (Fo_{65-58}) to retrieve the parent melt composition of 15555. Melt-inclusions in the core olivine range up to 50-100 µm along the longest dimension (see Fig.1) with tabular to elongated shape and have pyroxene, plagioclase and a silica-rich phase as major constituents. Modal abundances (area%) of pyroxene, plagioclase and silica in the two melt-inclusions analyzed in this study are 48:39:13 and 65:34:1, respectively. Apatites present in this sample are euhedral to subhedral, and range in size from 10 to 40 µm. Ilmenite, tridymite Fe-olivine and Fe-pyroxene occur as associated mineral phases with apatite (Fig.1).

Analytical Methods: We have used the nano-SIMS-50 at PRL to analyze $^{16}OH^-$, $^{18}O^-$, $^{19}F^-$, $^{28}Si^-$ and $^{31}P^-$ ions in multi-collection mode. A Cs^+ primary beam of ~40pA was used to raster an area of 2×2 micron with 128×128 pixels. Analyses were carried out at a mass resolution of around 7000, sufficient to separate ^{16}OH from ^{17}O. Pre-sputtering was done for suitable time to avoid contribution from surface contamination. The nano-SIMS analyses chamber vacuum was monitored and was ~4×10^{-10} torr ensuring negligible hydride contribution. $^{16}OH/^{18}O$ value for ilmenite present in the analyzed section was used for background correction and was found to be nearly constant (~ 0.007) on all the days of analyses. Durango apatite was used as standard to calculate the water content both in the lunar apatites as well in melt inclusions analyzed in this study.

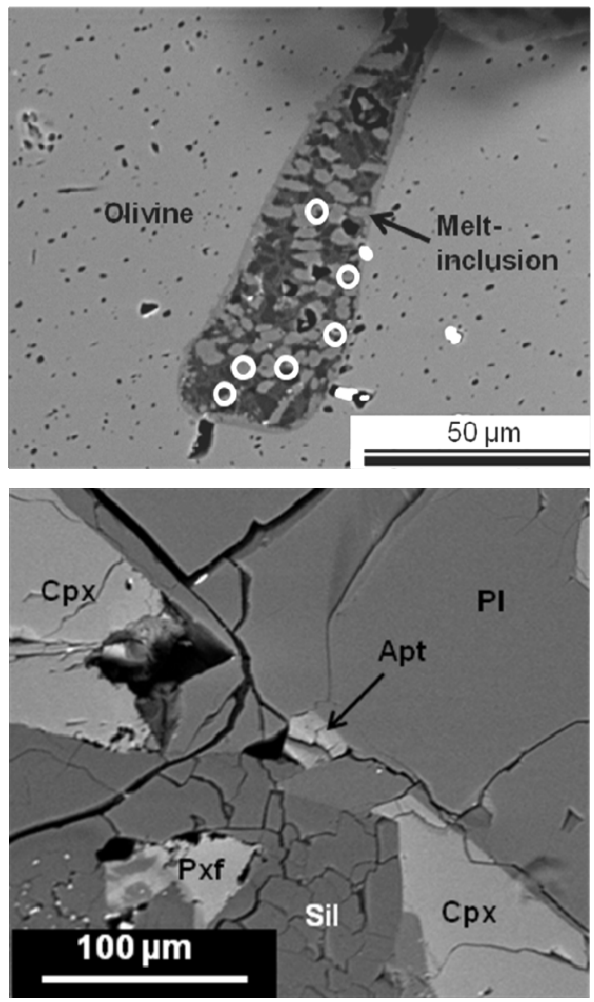

Fig. 1. Olivine hosted Melt Inclusion and Apatite from mare basalt 15555 analyzed in this study. Analyzed spot in the melt inclusion are marked.

Results: The weighted average of H_2O content considering all the raster areas of the two studied melt-inclusions are ~ 60 and ~290 ppm, respectively, based on a value of 900 ppm for Durango apatite. After post-entrapment crystallization correction (30%), the calculated water content for the most water-rich melt-inclusions is ~200 ppm. Our earlier [7] and present study indicate that the apatite grains have H_2O content, varying from ~2000 to 6000 ppm. If we assume that the apatite fractionated from the residual melt at 99% level the parent melt of 15555 had 80-240 ppm H_2O that may be considered as the minimum value of water content. This value is close to that inferred for melt inclusion and support the possibility that 15555 has undergone close-system crystallization [8].

References: [1] Saal, A.E. *et al.* (2008) *Nature* **454**, 192-196; [2] Boyce, J.W. *et al.* (2010) *Nature* **466**, 466-469; [3] McCubbin, F.M. *et al.* (2010) *PNAS* **107**, 11223-11228; [4] Greenwood, J.P. *et al.* (2011) *Nature Geoscience* **4**, 79-82; [5] Hauri, E.H. et al. (2011) *Science* **333**, 213-215; [6] Elkins-Tanton, L.T. & Grove, T.L. (2011) *EPSL* **307**, 173-179; [7] Basu Sarbadhikari, A. *et al.* (2012) Annual Meteoritical Society Meeting **75**, #5252; [8] Walker, D. et al. (1977) *LPSC* **8**, 1521-1547.