**DO HIGH TI ABUNDANCES IN LUNAR BASALTS LEAD TO SILICA-ENRICHMENT? YES AND NO.**

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**Introduction:** Lunar mafic breccia Northwest Africa 773 (NWA 773) consists mostly of co-magmatic lithic clasts that can be linked together by progressive variations in Fe# (FeO/[FeO+MgO]) and Ti# (Ti/[Ti+Cr]) of pyroxenes [1-3]. Free igneous silica occurs only in ferroan clasts (pyroxene Fe#>0.8), indicating FeO-enrichment prior to $SiO_2$-enrichment, similar to the terrestrial tholeiitic trend. In contrast, quartz monzodiorite (QMD) clasts from Apollo sample 15405 have igneous silica coexisting with magnesian pyroxene (0.5<Fe#<0.7; in addition to our analyses, see [4]), similar to the terrestrial calc-alkaline trend. The NWA 773 clasts have low ilmenite abundances, consistent with a very low-Ti (VLT) parent liquid [2], whereas the QMD contains up to 7 mode % ilmenite, indicating a more Ti-rich origin. In this study, we compare observations from these samples with MELTS models [5] and Apollo era experiments [6,7] to evaluate Ti-concentrations among other controls on fractionation of lunar basaltic rocks

**MELTS Models and Review of Experiments:** MELTS [5] was used to model fractional crystallization of high-Ti, low-Ti and VLT mare basalts at 1 bar pressure and $f(O_2)$ buffered by Fe-FeO. This oxygen fugacity might be too high, but almost all model Fe is ferrous iron, as we expect for lunar basalts. In the models, Ti-oxide crystallizes early for the high-Ti basalts, leading to some early $SiO_2$-enrichment of fractionated liquids, consistent with experiments [6]. According to MELTS modeling, $SiO_2$-enrichment of Ti-rich liquid continues with progressive fractional crystallization. In contrast, low-Ti and VLT basaltic liquids do not show steady $SiO_2$-enrichment until latest stages of crystallization. However, all of the mare basalts showed fractionation to extreme Fe# values prior to crystallization of silica (i.e., all produce a tholeiite-like trend; none result in a rock like the QMD).

*Crystallization of KREEP basalt.* MELTS modeling of Apollo 15 KREEP basalt [4] shows a more calc-alkaline-like trend (greater enrichment in $SiO_2$ and alkalis at moderate Fe#) consistent with experiments [7]. Furthermore, the experiments show that silicate liquid immiscibility results in alkali-silica-rich and Fe-Mg-rich liquids. Variable mixing of these endmembers could produce a calc-alkaline-like trend and the QMD [8].

High-Ti concentrations can cause silica-enrichment in mare basalts due to fractionation of Fe-Ti-oxides. However, this effect does not lead to alkali-silica-rich rocks with moderate Fe#. Lunar granitic rocks, like Apollo 15 QMD, require another mechanism for their origin. This might include KREEP-like parental liquids and silicate liquid immiscibility.

**References:** [1] Fagan T.J. et al. 2003. *Meteoritics & Planetary Science* 38: 529-554. [2] Jolliff B.L. et al. 2003. *Geoch. Cosmochim. Acta* 67: 4857-4879. [3] Fagan T.J. et al. 2010. *NIPR Antarctic Meteorites* 23: 9-10. [4] Ryder G. 1976. *Earth Planet. Sci. Lett.* 29: 255-268. [5] Ghiorso M.S. and Sack R.O. 1995. *Contr. Mineral. Petrol.* 119: 197-212. [6] Kesson S.E. 1976. *Proc. Lunar Sci. Conf.* 6: 921-944. [7] Rutherford M.J. et al. 1976. *Proc. Lunar Sci. Conf.* 7: 1723-1740. [8] Taylor G.J. et al. 1980. In *Proceedings of the Conference on the Lunar Highlands Crust*: 339-352.