# Reconsidering the origin of lunar Highlands lithologies: Insights from plagioclase

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Long-standing problems in understanding the origin of lunar Highlands lithologies revolve around plagioclase. These include the presence of both ferroan anorthosites (with intermediate Mg') and Mg-suite rocktypes with high Mg' that contain similar highly anorthitic plagioclase and the observation that in the latter lithologies, plagioclase evolves in the normal way but, in the ferroan anorthosites, the An content of plagioclase is nearly invariant. Furthermore, recent age redeterminations of some anorthosites [1] suggest that Mg-suite rocktypes may not have formed by *post*-magma ocean processes and reopen the need for a model that explains the origin of both rocktypes.

The differences in plagioclase evolution and yet its compositional similarity in these lithology types could be explained by the presence of an azeotrope in the projected plagioclase system at depth and its absence at low pressure, as seen in the simple plagioclase system [2]. In this case, plagioclase could form at depth earlier and from a more sodic lunar magma ocean than currently accepted, and be even bytownitic in composition. As long as the LMO composition lay in projection to the An side of the azeotrope, this plagioclase would evolve to higher An content with dropping Mg'. At shallower levels, the same composition would start with anorthitic plagioclase at higher Mg', but plagioclase would become more albitic with dropping temperature and Mg'.

In order for this model to be viable, the azeotrope must occur at lower pressure than in the simple system, but not extend completely to low pressure. Dynamic cooling experiments were conducted to investigate the effect of olivine melt components on anorthite destabilization by spinel formation at low pressure. These experiments definitively indicated that although spinel is stable at low pressure, there is no azeotrope at 1 bar, and open up the possibility of a significantly more sodic and feldspathic LMO.

[1] Borg *et al* (2011) *Nature* **477**, 70–72. [2] Lindsley (1968) *Mem. 18 NY State Mus. Sci. Serv.*, 39-46.