# Obvious problems in lunar petrogenesis and new perspectives

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Since the first manned landing on the Moon with returned lunar samples 46 years ago, a vast database has been accumulated with many ideas published on lunar petrogenesis, yet important problems recognized in early days remain under-addressed. We discuss that contrary to the prevalent view, the available data do not show the presence of a strong positive Eu anomaly (Eu/Eu* >1) in the lunar highland crust, but a weak negative one (Eu/Eu* <1) if any. This observation weakens the plagioclase flotation hypothesis, hence also weakens the prevailing lunar magma ocean (LMO) hypothesis. Recent success in the determination of abundant water in lunar glasses and minerals confirms the early prediction that the Moon may have been a water-rich planet and may still be so in its interior, which disfavours the dry Moon hypothesis, further weakens the LMO hypothesis. Volatilization (into the vacuum-like lunar "atmosphere") of lunar magmatism during its early histories could have facilitated plagioclase crystallization and feldspathic crustal formation. The role and effect of plagioclase crystallization is best manifested by the correlation ($R^2$ = 0.983 for $N$ = 21) of Eu/Eu* (0.24 – 1.10) with Sr/Sr* (0.10 – 1.12) defined by lunar samples. Although the anorthositic lunar highlands are expected to have large positive Eu (Eu/Eu* > 1; ~ 1.99) and Sr (Sr/Sr* > 1; ~ 2.56) anomalies, yet their absence inferred from the global remote sensing data is best explained by the widespread KREEP-like materials (volumetrically insignificant but highly enriched in incompatible elements) with very strong negative Eu and Sr anomalies. The KREEP-like materials may be produced through enrichment equivalent to processes in advancing, periodically replenished, periodically tapped, and continuously fractionated magma chambers. Compared with Earth's magmatic rocks, lunar rocks are depleted in moderately volatile elements like P, Na, K, Rb, Cs etc., probably associated with volatilization during the early histories of the lunar magmatism. Further work is needed towards an improved understanding of the origin and evolution of the Moon and its magmatism [1] [2].

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[1] O'Hara, M.J., Niu, Y.L., 2015. *GSA Special Paper* 514 (in press)