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Hypothesis

For endogenous KREEP basalts, the KREEP signature was inherited from the source.

Introduction

KREEP basalts [1] are distinguished from the more common mare basalts by containing higher incompatible trace element (ITE) concentrations and a lower Ca/Al ratio. The KREEP chemical signature, detected at each sample return site, is not found in its pure form, uriKREEP (the last liquid fraction of Lunar Magma Ocean) [2-4]. KREEP basalts are the most 'pure' form of KREEP in the lunar sample collection, but how they acquired the KREEP signature is uncertain.

Methods

Optical Microscopy.
- Photomicrographs taken using 4x objective.
- Photomosaic assembled using Photoshop.

- JEOL and Cameca SX50.
- Conditions: 15 kv, 25 nA, 1 µm to 3 µm spot size.

Laser Ablation Inductively Coupled Plasma Mass Spectrometry
Thermo Finnegan Element 2 with at UP 213 Laser
- Conditions: 55 µm Spot, 5 Hz, fluence 6-7 J/cm², one minute background, one minute sample

Pyroxene Partition coefficient calculations for equilibrium liquids using the method of [5] and [6].

Results

- Pyroxene compositions range from Opx through Mg-rich Pigeonite to Augite and Fe-rich Pigeonite (Fig. 3).
- Pyroxene cores are typically Opx with increasing Ca and Fe towards the rim (Pigeonite with rare Augite).
- Ti/Al ratios: Opx: cores ≤ 1.4, rimward/small ≤ 1.2; Mg-Pigeonite/Augite: between 1.4 and 1.2; Fe-Pigeonite/Augite: ≈ 1.2.
- See red line in Fig. 4 for core to rim variation in Ti/Al.

Discussion

- Three groups of REE profiles: LREE-enriched (> KREEP), LREE-enriched (= KREEP), and LREE-depleted. (Fig. 5b, see Fig. 3 for composition).
- Different cycles of pyroxene growth recorded came from liquids possessing different REE compositions (Fig. 2).
- Magna-Mixing: incapable of reproducing the observed REE variations.
- LREE-depleted source undergoing varying degrees of partial melting generated the observed equilibrium liquid compositions.

Conclusions

- Zonations in pyroxene from KREEP basalt 14160,214 are consistent with varying degrees of partial melting of a single LREE-depleted source.
- Endogenous KREEP basalt 14160,214 is unique amongst endogenous KREEP basalts in that it may be derived from a LREE-depleted source region.
- Detailed examination of the unique pyroxene zonations in 14160,214 allow the complete petrogenetic cycle for this sample to be documented.

References


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