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Distribution of rare earth elements in lunar zircon

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Abstract

An investigation of rare earth elements (REE) in 15 zircon grains from lunar breccia sample 14321, combined with published analyses, has allowed lunar zircon grains to be separated into four distinctive types. Type-1 zircon is characterized by the relative depletion of light REE (LREE) resulting in a steep chondrite-normalized pattern. Type-2 zircon shows relative enrichment in the LREE compared to type-1 grains. Type-3 zircon also shows relatively high concentrations of LREE as well as a relative depletion in the heavy REE (HREE), which results in a relatively flat chondrite-normalized pattern. Type-4 zircon grains are characterized by the steepest chondrite-normalized REE pattern, with the lowest LREE and the highest HREE as well as by a distinctive positive Ce anomaly. Multiple analyses of REE in a complex impact modified zircon from breccia sample 73235 suggest a possibility that the very light REE from La to Nd were mobilized during impact. However, the main differences between the identified zircon types appear to be primary and reflect the original crystallization environment of zircon grains. These differences are not linked to major changes associated with the different suites of plutonic rocks, such as Mg- and alkali-suites, and quartz monzodiorites (QMD), but instead reflect small-scale variations in residual pockets of melt where zircon grains crystallized. For example, the presence of plagioclase in the immediate vicinity of zircon was responsible for the type-1 zircon REE pattern, whereas type-2 zircon was formed in the presence of pyroxene. The only exception is type-4 zircon, which was probably associated with some felsite and "granite" samples representing very late differentiates of lunar mafic magmas.

Keywords: Moon, zircon, REE, lunar breccias