INTRODUCTION & CONTEXT

* Rare Earth Elements (REE) and Ti are incorporated in zircons during crystallisation and are routinely used to track the chemistry of their parent rocks and temperature of crystallisation.
* Significant information about the Hadean Earth is based exclusively on trace element data measured in detrital zircon, including REE, Ti-in-zircon concentration (and temperature) and oxygen fugacity (calculated from Ce content and T).
* These results depict a cool Early Earth, covered by oceans and dominated by modern tectonics, with a granitic continental crust [e.g. 1-5].
* Controversy has arisen when studies have shown that REE in zircons may not be completely reliable to identify the chemistry of their parent magma [6,7], hence casting doubt on the cool Early Earth model and the possibility of a modern-like continental crust.

WHAT IS THIS STUDY ABOUT?

* REE and Ti in lunar zircons have received little attention compared to terrestrial grains, although the history of lunar zircons is simpler (no metamorphism on the Moon) and they are therefore better candidates to evaluate the usefulness of REE as petrogenetic indicators.
* We present new REE and Ti concentrations as well as oxygen fugacity (fO₂) on lunar zircons, some of which are enclosed within lithic clasts, so that the parental rock can be identified.

METHODS

* REE and Ti were analysed by SIMS (Secondary Ion Mass Spectrometry) on the Cameca 1280 at the NordSIM facility in the Museum of Natural Sciences of Stockholm and on the SHRIMP at the John deLaeter Centre of Curtin University, Perth.
* Temperatures were calculated using the thermometer described by [8] and oxygen fugacities using the empirical formula determined by [9].

RESULTS

* A lot of variability is observed in light REE measured within a single zircon grain (e.g. 14303-49-1 above, in red).
* There is no consistency in the REE spectra of zircons located within the same granitic clast (e.g. in 14303, 49).

DISCUSSION

REE concentrations measured within single grains and across different grains within the same lithic clasts vary to a larger degree than what is expected for a mineral crystallised from a single batch of magma.

REE in zircon may not constitute reliable petrogenetic indicators, as was already pointing out by [6,7].

Variations in Ti concentrations, that translate to variations in T of crystallisation of the zircon, cannot always be correlated to specific physical features of the grains, like micro-cracks or impact features.

The distribution of Ti in zircon may be influenced by other, more elusive, parameters such as pressure and TiO₂ activity controlled by the coeval crystallisation of Ti-rich phases. Although the lunar mantle is characterised by reduced conditions [11] and fO₂ calculated from Ce anomalies in lunar zircons support this result, it is still possible to produce strong positive Ce anomalies in some zircons (Fig. 2) that are consistent with oxidising conditions.

These anomalies probably reflect very local (sub-mm scale) variations in the melt during crystallisation and cannot be extrapolated to regional conditions within the lunar mantle.

REFERENCES


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