Pressure dependence of He diffusion and fission-track annealing kinetics in apatite?: Experimental results

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A number of preliminary experiments have been undertaken to test results reported by Wendt et al. (2002), concerning the dependancy of pressure on fission track annealing in apatite, and which implied a similar dependancy for He difusion in apatite.

He diffusion results

No pressure dependency of He diffusion coefficient outside of analytical error was observed at the two temperatures studied. For example, at 302°C we obtained ln(D/a2) values of -16.24, -16.05, and -16.27 (0.25) at 1000, 500, and 20 bars, respectively. From these data, we conclude that He diffusion in Durango apatite is not pressure sensitive over the pressure range relevant for thermochronometry.

Fission-track annealing results

In comparison to the experiments of Wendt et al. (2002), our P-T conditions are rather limited. However, no significant pressure effect was observed at the two temperatures studied. For example, at 302°C we obtained mean track length values of 9.94±0.12 µm, 10.20±0.10 µm, and 9.79±0.12 µm (±1σ) at 1000, 500, and 20 bars, respectively (similar results from Donelick & O'Sullivan). Futher work is underway to attempt to directly reproduce the 168 hour experiments of Wendt et al. for Durango apatite up to 1000 bars pressure.

References

Wendt, A.S., Vidal, O. and Chadderton, L.T. (2002), *Earth and Planetary Science Letters*, 201, 593-607.

bars/°C/hours	ln D/a^2 (mean)	Donelick TL±1σ (µm)	O'Sullivan TL±1σ (µm)
Reference		14.41±0.09	14.59±0.08
1/250/24	-18.86	12.98±0.09	13.33±0.10
500/250/24	-19.06	13.26±0.09	13.97±0.12
500/250/24	-18.33	13.38±0.08	13.92±0.09
985/250/24	-18.63	13.06±0.09	13.74±0.09
20/302/25.75	-16.27	9.79±0.12	10.13±0.12
500/302/25.5	-16.05	10.20±0.10	10.40±0.11
1000/302/24	-16.24	9.94±0.12	10.03±0.13

Sulphate-bearing carbonatites of West Transbaikalia

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Carbonatites of West Transbaikalia are accosiated with forming of intraplate rift zone (MZ_3). Age of carbonatites and their comagmatic alkalic silicate rocks is 118-127 Ma. The main feature of carbonatites is a high content of sulphate sulfur (to 4-8 wt. %). Comagmatic schonkinites and syenites contain up to 1.5 wt. % of SO_3. Inclusions of sulphate phases (anhydrite, highbarium celestine) in aegirine-diopside and titanite indicate the enrichment of parental silicate melt with sulphate-ion. That is also confirmed by interstitial segregations and schlierens of calcite, apatite, amphibole with sulphate minerals.

Participation of sulphate sulphur is noted from magmatic to hydrothermal stage. Barite-celestine, celestine and anhydrite formed in silicate rocks and carbonatites during magmatic stage. Furthermore, sulphates are widely distributed in primary saline inclusions of bastnaesite formed at magmatic stage. Sulphates of Na, K, Ca, Sr are determined among daugther phases in primary saline inclusions of minerals from carbonatites, they are similar to composition of aphthitalite, arcanite, thenardite and non-diagnostic salts complicated composition.

Sulphate specialization of alkaline-basic carbonatitic complex is also emphasized by a high concentration of sulphur in apatite and monazite. Content of SO_3 in apatite is 1.8 wt. % in carbonatites, 0.7 wt.% in schonkinites, 1.3 wt. % in alkalic syenites and 0.9 wt. % in alkaline metasomatites. Apatite which forms acicular crystals in zircon and presents with magnetite and phlogopite primary stage crystallization of carbonatite melt contains up to 1.2 wt. % of SO_3.

Isotopic composition of sulphate sulphur testifies to its endogenous sources. Average composition of $\delta^{34}S$ is about 9.9‰ for 4 occurrences, and one of them has value of 3.2-6.4‰.

The feature of carbonatites in West Transbaikalia is also participation of non-silicate compounds of alkalies in their forming. Composition of primary saline inclusions in minerals shows a predominance of Na and K sulphates. Leaching of non-diagnosed phases which could be sulphates and\or carbonates of alkalies, or their double salt stimulated an appearance of cavernosity in carbonatites. That is fixed by the presence of secondary jarosite in a number of cavities, and subterranean waters is high enriched with sodium sulphate (berkeyite).

High concentration of sulphate-ion is an evidence of oxidizing conditions of carbonatites forming at West Transbaikalia. It is also confirmed by a presence of goethite, haematite and magnetite in rocks, and a content of Fe_2O_3 in mica from carbonatites riches values typical for tetraferribiotites.

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