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Behaviour of the REE in experimentally induced hydrothermal alterations of chevkinite-(Ce) – differences between nature and experiment

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The behaviour of rare earth elements (REEs) during the hydrothermal transformation processes of alkaline rocks is one of the important topics in recent scientific research. A better and deeper understanding of these processes is of profound importance for understanding the mechanisms of rock formation and the origin of some ore deposits, especially REEs.

Chevkinite-(Ce) – rare earth and titanium silicate was chosen as the subject of experiments. They were conducted using a standard cold-sealed autoclave in a high-pressure hydrothermal line, using mineral assemblages typical of alkaline rocks and hydrothermal fluids of various compositions. The temperatures varied from 500 to 600°C, and the pressures from 200 to 400 MPa. The duration of the experiments was from 21 to 63 days.

The experiments resulted in a wide range of mineral phases. The main REE-containing phases synthesized were fluorbritholite-(Ce), monazite-(Ce) and epidote supergroup minerals; other mineral phases with significant LREE content (gagarinite-(Ce), titanite) have also been synthesized.

Experimental results are generally consistent with paragenesis formed in natural environments, where hydrothermal alteration of chevkinite (Ce) was observed. However, there were some exceptions. The most puzzling were:

-the absence of allanite (Ce) in most experiments, the mineral most often formed by hydrothermal alteration of chevkinite (Ce) in nature,

-the overrepresentation of britholite-(Ce), which is known from only two places in the world, giving the experimental results an unprecedented character in this matter.

(Ferri)allanite was eventually formed when fluids had high Ca/Na ratios (rich in $Ca(OH)_2$ and CaF_2), while fluorite crystallized from fluids with low Ca/Na ratios; the relative scarcity of phase in natural chevkinite transformation systems seems to indicate that such fluids are not common in nature.

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