

## Reaction textures of allanite in metagranitoids: A sub-micrometer insight in REE-mobility

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Various reaction textures of accessory allanite in an orthogneiss from the Tauern Window (Austria), which experienced metamorphism (max. 500-550°C, 1.0 GPa; Selverstone 1993), and extensive metasomatism have been investigated by high-resolution BSE images (JEOL Hyperprobe JXA-8500 F, field-emission cathode).

Euhedral to anhedral ( $\varnothing$  150 - 500  $\mu\text{m}$ ), partly zoned allanite crystals have corona-type textures with polycrystalline (REE+Y)-poor epidote/clinozoisite rims (type 1). Variable deformation stages resulted in regularly to sigmoid or irregularly shaped rims of 20 - 200  $\mu\text{m}$  thickness. Anhedral titanite crystals (15  $\mu\text{m}$ ) mark the core-rim boundary along the epidote/clinozoisite site of the paragenesis. Micropores within allanite (type 2), partly filled with Th- or REE-silicates, are part of the core-rim zonation (relatively REE+Y+Th-rich to -poor) or scattered over allanite. Th-silicates on grain boundaries of newly formed (REE+Y)-poor epidote/clinozoisite (polycrystalline epidote/ clinozoisite rim of allanite) indicate decomposition and reprecipitation of that phase. Patchy aggregates of allanite and REE-poor epidote with intermediate compositions, changing in an irregular pattern on the  $\mu\text{m}$  and sub- $\mu\text{m}$  scale, are the dominant feature in the intensely deformed orthogneiss (type 3). In addition to these well-known textures up to 1  $\mu\text{m}$  wide mineral-filled channels within elongate textures (max. 80  $\mu\text{m}$ ) in an allanite of type (3) were found (type 4). The zoned channels pass perpendicular through the internal textures, which are orientated parallel and perpendicular to the long axis of the allanite and connect (REE+Y+Th)-poor with relatively (REE+Y+Th)-enriched parts of the unzoned crystals.

In a preliminary interpretation texture (1) was formed in late- to postmagmatic stage in the protolith, textures (2, 3, 4) indicate a simultaneous fluid-assisted decomposition of allanite and growth of (REE+Y)-poor epidote/clinozoisite in an open system during metamorphism. The Th-silicate on grain boundaries within the epidote/clinozoisite rims of allanite and sub-micrometer wide channels within allanite possibly indicate multistage grain boundary diffusion and a gradually changing composition of the fluid phase during the breakdown process.

### References

Selverstone J. (1993), *Schweiz. Mineral. Petrograph. Mitt.* **73**, 229-239.

## The bulk chemical composition of the upper Martian crust

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There is strong evidence that the Martian surface has been extensively chemically homogenized over time due to broad-scale impact gardening, an apparent lack of plate tectonic fractionation and evolution, long-term global eolian processes, and periodic fluvial transport. Despite wide geographic separation, soil chemistry from landing site analyses (MER, Pathfinder, and Viking) are remarkably similar with most variation attributed to the addition of some local rock components - strongly implying that the unconsolidated fraction of the Martian surface has been reasonably well-homogenized. Gamma-Ray Spectrometer (GRS) elemental abundance maps agree well with surface analyses and, with some notable exceptions, global GRS elemental abundance maps reveal less broad-scale chemical variation compared to the terrestrial or lunar surfaces.

Therefore, it has been suggested that the chemical composition of averaged Martian soil analyses reflect the bulk chemical composition of the Martian surface from which they are derived - much in the same way terrestrial sedimentary chemistry can be used as a proxy for the bulk terrestrial upper crust. Weathering, sedimentary transport, and deposition naturally sample a wide array of source rocks with the resultant chemistry being an efficient mixture of source terrains.

With carefully screened MER APXS data, we develop an estimate of major and trace element crustal chemistry based upon MER soil averages. GRS global chemical averages for certain elements are used to corroborate compositions calculated from the soil data and in some cases GRS global averages for a particular element are assumed to represent the bulk upper crust. Where applicable, SNC chemistry and canonical cosmochemical relationships are also incorporated into the bulk determination.