

## Geochemistry of micas associated with tantalum mineralization in the Tanco pegmatite, Canada

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Tantalum is a high-tech metal which is mainly mined from rare-element pegmatites. Although the mineralogy of tantalum is well constrained, very little is known about the mineralizing processes, and in particular the role of fluids in the formation of Ta ore. In many Ta deposits, the high-grade Ta ore is associated with late micaceous alteration of central pegmatite zones. Such metasomatism was commonly interpreted as hydrothermal (i.e., due to aqueous pegmatitic fluids). However, the recent discovery of melt inclusions with extremely high concentrations of volatiles (H<sub>2</sub>O, B, F, etc...) has provided an alternate explanation. Such melts could be at the origin of the metasomatic alteration commonly encountered in granitic pegmatites.

In the Tanco pegmatite, one of the world's major tantalum deposits, micas are common accessory phases that are intimately associated with the successive stages of Ta mineralization, from the wall zone to the central zone where micaceous replacement is pervasive. The different generations of micas, both primary and secondary, associated with Ta oxides, were analyzed by electron microprobe and LA-ICP-MS in order to investigate the magmatic-metasomatic transition in the Tanco pegmatite. Their chemical composition trends permit to determine whether they crystallized from a melt or an aqueous fluid.

The primary micas range from dioctahedral muscovite to trioctahedral lepidolite and show high Li-F as well as Ta (100 to 250 ppm) contents. On the other hand, replacement micas consist of end member muscovite with high B and low Li-F and Ta (around 40 ppm) contents. The B-rich and Na-Li-Ta-poor compositions of replacement micas compared to primary micas suggest that they crystallized from a B-rich aqueous fluid. This fluid would have coexisted with a late Li-rich, Ta-saturated melt, which is consistent with an immiscibility model as advocated by Veksler and Thomas (2002).

### Reference

Veksler I.V. and Thomas R., (2002), *Contrib. Mineral. Petrol.* **143**, 673-683.

## Aluminum diffusion and Al-vacancy association in MgO

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Periclase, with end-member formula MgO, is the second most abundant mineral in Earth's lower mantle and may play a significant role in chemical exchange across the core-mantle boundary. Aluminum and other trivalent cations diffuse very rapidly through periclase, orders of magnitude faster than divalent cations such as Mg. This is opposite to what is observed in most silicate minerals, where highly charged cations are generally among the slowest diffusing species. The culprit appears to be a highly mobile defect associate consisting of a cation vacancy electrostatically bound to a trivalent cation [1]. Lidiard [2] developed the theory for divalent cation diffusion in alkali halide crystals, and we extend it to describe the functional dependence of trivalent cation diffusivity on concentration in alkaline earth oxides. The theory is applied to Al diffusion profiles in MgO obtained from experiments over a wide range of pressures and temperatures (1 atm to 25 GPa and 1577 to 2273 K). A family of synthetic diffusion profiles was calculated numerically, for various combinations of Al-vacancy pair diffusivity and binding energy, and the best fit for each experimental profile was determined by chi-square minimization. The binding energy for all but one experiment is in the range 0.45-0.62 eV, slightly lower than theoretical values [3] of 0.65-0.71 eV, and shows no clear dependence on temperature or pressure. The activation energy for Al-vacancy pair diffusion is 2.1 eV, and the activation volume is 2.9 cm<sup>3</sup>/mol.

### References

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