

## HRTEM STUDY OF TAAFFEITE CRYSTALS FROM MOGOK (MYANMAR)

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Taaffeite ( $\text{BeMg}_3\text{Al}_8\text{O}_{16}$ ) and musgravite ( $\text{BeMg}_2\text{Al}_6\text{O}_{12}$ ) are members of the rare group of Al-Mg-Be oxide minerals occurring in high-grade metamorphic rocks and their alluvial deposits (SCHMETZER *et al.*, 2005). In most cases taaffeite group of minerals are linked to metamorphic processes. In Mogok (Myanmar), taaffeite crystals are associated with euhedral spinel crystals ( $\text{MgAl}_2\text{O}_4$ ) in the Mogok marble belt that developed in metamorphic processes along the contact of more or less dolomitic limestones with granitic intrusives, which served as a source of beryllium. Taaffeite group minerals are also found near Stubenberg in Styria (Austria), where they formed as a replacement product of spinel in veins within polymetamorphic dolomitic marbles (BERNHARD *et al.*, 2008). Here, the origin of beryllium could be Be-rich fluids from granites or pegmatites generated during the contact metamorphism or by mobilization of Be by the fluids formed during the metamorphic processes.

Taaffeite-group minerals comprise basic structural elements that are found in spinel ( $\text{MgAl}_2\text{O}_4$ ) and chrysoberyl ( $\text{BeAl}_2\text{O}_4$ ). Spinel (*s.g.*  $Fd\bar{3}m$ ) has *ccp* arrangement of the oxygen sublattice along the  $\langle 111 \rangle$  directions. In these directions, the structure is composed of alternating kagome (Al) and mixed (Mg and Al) layers, where the  $\text{Al}^{3+}$  ions occupy the octahedral and  $\text{Mg}^{2+}$  ions the tetrahedral sites (SICKAFUS *et al.*, 1999). On the other hand, chrysoberyl ( $\text{BeAl}_2\text{O}_4$ ) has a slightly distorted *hcp* stacking of the oxygen sublattice along the  $[0001]$  direction (*s.g.*  $Pbnm$ ) with  $\text{Al}^{3+}$  and  $\text{Be}^{2+}$  ions located in the corresponding octahedral or tetrahedral interstices (TABATA *et al.*, 1974). A recent study of  $(111)$  twins of spinel (DANEU *et al.*, 2007) revealed that the stacking across the twin boundary is hexagonal (*hcp*) and  $\text{Mg}^{2+}$  near the boundary tetrahedral sites are locally replaced by  $\text{Be}^{2+}$ . This indicates that  $\text{Be}^{2+}$  in fact causes the hexagonal stacking fault in an otherwise perfect cubic structure. Local structure of  $(111)$  twin boundaries in spinel is closely related to chrysoberyl and taaffeite-group of polysomatic minerals and can be understood as an initial stage of taaffeite-type phase transformation. In this view we can under-

stand the alternation of *ccp* and *hcp* sequences at the unit-cell level in these structurally correlated systems.

In the present work, the atomic structure of taaffeite crystals from Mogok was studied by X-ray powder diffraction (XRD), electron diffraction (ED) and high-resolution transmission electron microscopy (HRTEM). XRD analysis confirmed that the sample in fact corresponds to taaffeite ( $\text{BeMg}_3\text{Al}_8\text{O}_{16}$ ). Two slightly different structural models for this compound were reported (MOOR *et al.*, 1981; NUBER & SCHMETZER, 1983). In both models, the stacking sequence of the oxygen sublattice (ABCABA...) along the crystallographic *c*-axis is identical, they differ only in the occupancy of the interstitial sites within mixed layers. In Moor's model, all  $\text{Al}^{3+}$  ions lie in octahedral positions and all  $\text{Mg}^{2+}$  ions in tetrahedral positions, whereas in the Nuber's model, the positions of  $\text{Al}^{3+}$  and  $\text{Mg}^{2+}$  ions within the mixed layers are switched. At the present state of investigations, we can not confirm the validity of either model from HRTEM images.

### References

- BERNHARD, F., HAUZENBERGER, C. & WALTER, F. (2008): Canadian Mineralogist, 46: 1195–1205.
- DANEU, N., REČNIK, A., YAMAZAKI, T. & DOLENEC, T. (2007): Physics and Chemistry of Minerals, 34: 223–247.
- MOOR, R., OBERHOLZER, W.F. & GÜBELIN, E. (1981): Schweizerische Mineralogische und Petrographische Mitteilungen, 61: 13–21.
- NUBER, B. & SCHMETZER, K. (1983): Neues Jahrbuch für Mineralogie – Abhandlungen, 146: 393–402.
- SCHMETZER, K., KIEFERT, L., BERNHARDT, H.J. & BURFORD, M. (2005): Neues Jahrbuch für Mineralogie – Abhandlungen, 181: 265–270.
- SICKAFUS, K.E., WILLIS, J.M. & GRIMES, N.W. (1999): Journal of the American Ceramic Society, 82: 3279–3292.
- TABATA, H., ISHII, E. & OKUDA, H. (1974): Journal of Crystal Growth, 24–25: 656–660.

See the figure on the following page.

