Two new super-reduced phases from Luobusa chromitite: jianmuite, $ZrTi^{4+}Ti^{3+}_5Al_3O_{16}$, and a Ti^{3+}-rich calcium amphibole, $\square Ca_2(Mg_2Ti^{3+}_3)(Si_5Al_3)O_{22}(OH)_2$

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Corundum from the Cr-11 chromitite orebody in the Luobusa ophiolite near Kangjinla (Tibet, China) [1] contain a great variety of ultra-reduced inclusions (URIs, i.e. phases without oxygen, e.g. phosphides, silicides, nitride) and super-reduced inclusions (SRIs, i.e. phases with oxygen, but also with metals in an unusual, reduced state, e.g. Ti^{3+}). Given the micrometric to sub-micrometric size of these inclusions, their chemical and structural characterization is only possible by using advanced analytical protocols that involve a focused ion beam (FIB) and transmission electron microscope (TEM). In particular, three-dimensional electron diffraction (3DED) [2] combined with programs for the dynamical refinement (i.e., structural refinement that takes into account dynamical scattering) [3] constitute powerful tools to solve the structure of crystal phases that are too small for conventional single-crystal X-ray diffraction methods. In this work, we present two new phases found as SRIs in a FIB lamella from a corundum grain extracted from the Cr-11 orebody.

Jianmuite, ideally $ZrTi^{4+}Ti^{3+}_5Al_3O_{16}$ [4], is a Zr-Ti-Al-oxide similar in chemistry and paragenesis to carmeltazite, $ZrAl_2Ti^{3+}_4O_{11}$ [5], but with a space group *I*-4, a = 10.3675(10) Å, c = 9.8125(10) Å. Remarkably, this mineral was also found among refractory phases in the matrix of the Allende meteorite, a CV3 carbonaceous chondrite. In the same lamella, we also found another potential new mineral, with a structure consistent with the amphibole supergroup [6], but a novel composition with the ideal formula $\square Ca_2(Mg_2Ti^{3+}_3)(Si_5Al_3)O_{22}(OH)_2$. The charge arrangement is unique as is Ti^{3+} being the dominant trivalent C cation (through the hypothetical homovalent substitution $^{C}Al^{3+} = {}^{C}Ti^{3+}$), so a new rootname and the prefix “titano-“ (never used so far in the amphibole supergroup) are needed. The occurrence of Ti^{3+} in terrestrial minerals is petrologically significant as it constrains the redox conditions under which the Ti^{3+}-bearing minerals crystallized.

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