Poster

A combination of X-ray and electron crystallographic methods for understanding the origin of sector-zoning birefringent garnets with almandine-grossular composition

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Garnet-supergroup phases are among the most widespread minerals in the Earth, growing in rocks with composition from ultra-mafic to felsic (e.g. mantle peridotites, metamorphic rocks and granulites) and occurring as detrital minerals in sediments. Their broad *P*-*T* stability field (*T* up to 2000 °C and *P* ~25 GPa) allows garnet crystallization from the Crust to the deep Mantle, at depths up to ~660 km [1, 2]. Garnet is considered the archetypal cubic mineral, crystallizing in the cubic *Ia*-3*d* space group and appearing optically isotropic under cross-polarized light. However, occurrences of garnets showing optical birefringence are reported [3, 4, 5]. These "uncommon" samples are generally characterized by specific chemistry, i.e. "hydrogrossular", $Ca_3Al_2(SiO_4)_{3-x}(H_4O_4)_x$, and "grandite", a solid solution between grossular and andradite, $Ca_3(Al,Fe^{3+})_2(SiO_4)_3$. In these cases, the optical anisotropy is explained as a consequence of symmetry reduction due to cation ordering, lattice strain or presence of hydroxyl groups.

Recent findings of sector-zoning birefringent garnets with almandine-grossular composition, $(Fe^{2+},Ca)_3Al_2(SiO_4)_3$, in blueschist- and greenschist-facies metamorphosed rocks from several worldwide localities (e.g. Farinole, Cazadero, Jenner and eastern Italian Alps) have suggested that optically anisotropic, not-cubic garnets could be more common as hitherto assumed (Fig. 1). Cesare *et al.* [6] proposed that garnets could initially grow tetragonal in low-*T* (<450 °C) geological contexts, with possible consequences on the role of garnet as investigative-process mineral in these environments. However, the cause of birefringence in these samples is not clear and a more detailed investigation is required.

Here, we present a series of crystallographic studies on sector-zoning birefringent and non-hydrous garnets, using polychromatic polarization microscopy, lab and synchrotron X-ray diffraction, transmission electron microscopy and 3D electron diffraction [7]. Data were collected on low-*T* garnets in metamorphosed rocks from Cazadero (California, USA) and Farinole (Corsica, France). Our preliminary data suggest the birefringence is due to a reduction of symmetry from cubic to tetragonal systems connected with twinning or exsolution.

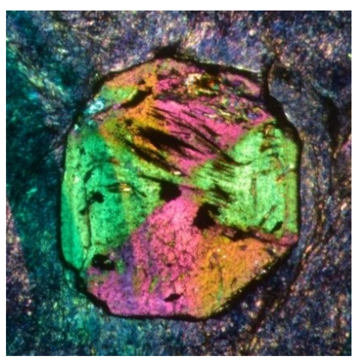

Figure 1. Typical sector-zoning birefringent garnet in polychromatic polarization microscopy. The whole grain is about 1.5 mm.

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