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Growth Marks of titanian-andradite crystals from Colli Albani (Italy)

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The study of relationships among structural defects, chemical zonings, morphology and crystal growth of minerals plays a basic role within minero- petrogenetic field. Actually, the growth defects –lattice defects and chemical zonings- represent a record -growth marks- of growth environment evolution (Graziani et al., 1990). With the aim to determine distinctive features characterizing minerals grown directly from high temperature solution in an open system (volcanic chamber), growth defects and chemical zonings of Ti-rich andradite (melanite) crystals from Colli Albani were investigated by means of Electron Probe Microanalysis, X-ray Topography and Transmission Electron Microscopy. The studied samples, cut in (110) and (001) slices, showed a number of primary melt inclusions chiefly multiphase and, in addition, an unusual color zoning consisting with a darker color of the {211} growth sectors with the respect to {110}. Chemical analyses proved that this zoning is due to small but meaningful enrichment of TiO_2 and decrease of Al_2O_3 content on the {211} growth sectors. Moreover, a concentric zoning, consisting chiefly of TiO_2 and SiO_2 concentration variations, was also recorded crossing successive growth stages, and was associated to physio-chemical evolution of growth environment. The analysis of the growth defects - growth bands, sector boundaries and bundles of dislocations parallel to the growth directions- allowed to reconstruct the morphological evolution vs. time of samples showing that from their origin the crystals were faceted with faster {211}and lower {110} faces. Furthermore, most of the examined dislocations were nucleated from inclusions and were characterized by a strong edge component. The faceted morphology of these garnets and the characterization of only edge dislocations suggest a layer spreading growth mechanism by two dimensional nucleation. In literature it is well known that minerals from the hydrothermal and metasomatic environments (low supersaturation) grew by spiral growth mechanism (Sun and Baronnet, 1989; Jamtveit and Andersen, 1992; Milke, 2004; Agrosì et al., 2006); conversely, minerals grown under cooling from high magmatic temperatures, at high supersaturation, grew by fast continuous growth with the growing faces generally rough (Sunagawa, 2005). Consequently, the growth mechanism by two dimensional nucleation and the afore-mentioned growth defects can be considered distinctive growth marks of genetic environment of Ti-rich andradites from Colli Albani because they characterize and distinguish our samples from those grown in different environments and permit to hypothesize that they grew during a deep crystallization of a silicatic melt under slow cooling.

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