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Mn-BEARING GRANDITE FROM GARNET SKARN IN THE ORDOVICIAN ROCKS (ZAWIERCIE, SOUTHERN POLAND)

INTRODUCTION

The granodiorite intrusion at Zawiercie (north-west of Kraków) is thrusted over unmetamorphosed Silurian sedimentary rocks and has chilled margins at contacts with Cambrian and Ordovician rocks. (Unrug et al. 1999). Thermal and metasomatic alterations genetically connected with the granodiorite intrusion and its fluids are marked by the formation of skarns in adjacent carbonate rocks. One of such garnet skarn bodies was drilled in the borehole RK-5 at depths from 1221 to 1225m. The results of detailed investigations of Mn-grandite occurring in this skarn are presented in this paper.

GRANDITE SKARN

A skarn body, composed of layers and lenses, several cm thick, occurs within the coarse-crystalline marble. The protolith of the marble were Ordovician (Llanvirnian) limestones. In a hand specimen, this skarn is pale-brown to brown-greenish in colour, in contrast to white and beige wallrock marble.

Prograde pale-brown to brown garnets are the main component of this skarn. They are often strongly cracked and show various grades of preservation. In some cases they undergo complete or partial alteration into calcite and green chlorite. Garnets belong to the andradite-grossular series. Andradite garnets ($And_{98}Sp_2$) are isotropic in most of the cases. However they sometimes show zonal anisotropy at rims. In such cases the composition of garnets changes from $And_{98}Sp_2$ in the core to $And_{49}Gro_{42}Sp_9$ in the rim. In some samples intermediate grandites of ($Gro_{80\text{-}37}$ $And_{58\text{-}15}Sp_{27\text{-}4}$) composition were found.

Clinozoisite occurs in calcite veinlets. Quartz, filling the spaces between garnet aggregates, contains needle-shaped amphibole of tremolite-actinolite series. Moreover, small amount of green chloritized phlogopite was observed. Subordinate titanite and apatite were detected. Sulphide minerals associated with garnet skarn are mainly pyrite, chalcopyrite and sphalerite. Other ore minerals, in decreasing order of abundance are hematite, galena and molybdenite.

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Mn-BEARING GRANDITE

The Mn-bearing grandites were recognised at the depth interval from 1223 to 1225m. Anhedral, subhedral and euhedral pale-brown garnet crystals are up to 0,8mm in size. In euhedral crystals, the rhomb-dodecahedron {110} habit is most common.

In thin sections these grandites show marked anisotropy. Twinning and zoning are visible in them. The cores of the crystals are composed of 4 or 6 triangular sectors with vertices meeting at the centre of the crystal. At the rims oscillatory zoning was observed.

EDS analyses revealed that crystals of the grandites studied are characterised by compositional variation. It is manifested by an increase in Fe content (andradite member) toward the rim of crystals. In contrast to the rim the cores of garnet crystals show sectoral twinning and are enriched in Al. Within this sectoral part significant variations in Fe content were not observed, whereas a distinct increase in Mn (spessartine member) content and decrease in Al content (grossular member) was noted (Fig.1a).

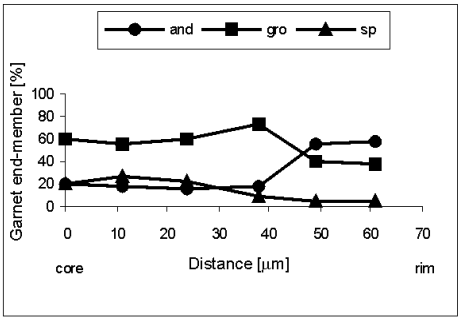

Fig. 1a

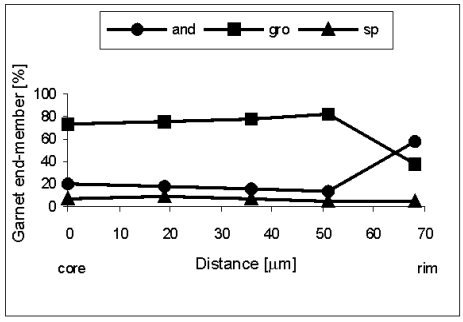

Fig. 1b

Fig.1. Chemical variability of a zoned euhedral grandite in marginal part of garnet aggregates (1a) and in subhedral crystal occurring in central part of the aggregates (1b). The chemical composition of garnets was examined using an energy dispersive spectrometer (EDS) Voyager 3100 (NORAN) equipped with scanning electron microscopy (JEOL 5410)

These significant compositional changes were found in euhedral grandites crystallized on the margin of garnet aggregates. On the other hand, anhedral and subhedral crystals occurring in the central parts of the aggregates have less variable composition and show lower Mn content (Fig.1b, Table 1).

Table 1. Chemical compositions of grandite crystals (depth 1225 m) occurring in:

	marginal parts of the garnet aggregates	central parts of the garnet aggregates
cores	$Gro_{78-59}And_{32-15}Sp_{26-8}$	$Gro_{83-74}And_{19-13}Sp_{8-4}$
rims	$And_{60-56}Gro_{40-36}Sp_{4}$	$And_{58-41}Gro_{55-38}Sp_{5-4}$

FINAL REMARKS

This is the first finding of the garnets showing such a high Mn-content (up to 10 wt% MnO) in the Zawiercie region. Garnet skarns in the Ordovician marble were also drilled in other boreholes (RK-1, RK-6). Although in the skarns andradite was the most dominant mineral, small amount of grandite were also found there. The content of MnO in both types of garnet from these skarns did not exceed 1 wt% (Koszowska 1982, Rudawska 1992).

The garnet skarn in the Ordovician marble in Zawiercie was formed at some distance from granodiorite body, due to the activity of fluids genetically connected with this intrusion.

Grossular-rich garnet may be the product of interaction of host rock with H_2O-rich fluids. In the majority of the crystals the sectoral twinning and distinctive oscillatory zoning, typical of hydrothermal skarn garnets, are observed. This indicates multiple pulses of hydrothermal fluids. In general, rims are more andraditic than cores, which is characteristic of normal zoning.

The crystallization conditions of the grandite studied were characterized by a fluctuation of chemical composition (Fe, Mn, Al concentrations). Lower temperature solutions penetrating this skarn body are responsible for retrogressive transformations of prograde skarn minerals (i.e. chloritization of garnets).

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