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GARNETS FROM LOWER SILESIA RODINGITES: CONSTRAINTS FROM THEIR CHEMISTRY

Abstract: Chemical composition of garnet form rodingites (Sudetic ophiolite) is diversified; major varieties are grossular- and andradite-rich. Early clinozoisitic rodingites contain grossular-rich and frequently Mn-bearing garnets; the Mn enrichment probably resulted due to its mobility during serpentinization close to ocean hydrothermal system. Andradite-rich garnets from late vesuvianite rodingites were formed during metamorphic event above subduction zone.

Keywords: garnet, rodingite, Sudetic ophiolite

INTRODUCTION

Rodingite is Ca-rich, SiO_2-undersaturated rock, that forms as a by-product of Ca-metasomatism related to serpentinization. Rodingitic rocks consist of numerous Ca-silicates. The rodingite are usually formed by metasomatism of mafic rock, although rodingites formed at the expense of various felsic and siliceous sedimentary rocks were also found. Both initial serpentinization of the peridotite and concomitant rodingitization of lithic inclusions usually occur in oceanic environment (e.g., Honnorez, Kirst 1975, Hékinian et al. 1993, Früh-Green et al. 1996). However, serpentinization and rodingitization can be also results of other stages of ophiolite evolution (e.g., Schulte, Sindern 2002, Li et al. 2004).

Numerous rodingitic inclusions occur within serpentinite massifs representing mantle tectonites of tectonically dismembered Sudetic ophiolite (Majerowicz 1984, Dubińska 1995, 1997, Gunia 1996). The purpose of this study is to present new data on the chemical variability of the garnets from the Sudetic ophiolite rodingites.

RESULTS AND DISCUSSION

Mineral assemblages of Sudetic ophiolite rodingites (Tab. 1) were recognized on the basis of detailed petrographic examination combined with X-ray powder diffraction study and electron microprobe determinations.

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Samples containing grossular (*grs*) garnets as the sole Ca-silicate phase do not contain relict minerals; they are composed of single *grs* garnet either of birefrigent garnet cemented by CT-opal (Fig. 1A). *Grs* garnets from clinozoisite (*czo*) variety of rodingites (Jordanów-Gogołów serpentinite massif, JGSM) occur commonly as atolls with crushed epidote inside and coarse grained epidote outside or atoll-like buckle with chlorite inside (Fig. 1B), small inclusion of birefrigent euhedral garnet in coarse-grained epidote are numerous. Vesuvianite variety of rodingites commonly embraces minute late andradite (*adr*) rich garnets adjacent to crushed vesuvianite (Fig. 1C) and *adr* garnet paths within deformed chlorite zones (Fig. 1D). Vesuvianite group of rodingites can contain small freckles of *grs* garnets enclosed within large vesuvianite crystals (Dubińska, Gunia 1997).

Table 1. The mineralogy of Lower Silesia rodingites.

Rodingite variety (parent rock)	Mineralogy
czo rodingite (plagiogranite)*	**major:** *czo*, *grs*-rich garnet, chlorite, diopside (newly formed); **minor:** albite (relict), K-feldspar (frequently Ba-bearing), prehnite, apatite; **accessory:** titanite, anorthite, wairakite, zircon
vesuvianite rodingite (boninite affinity rock)**	**major:** vesuvianite, *grs*-rich garnet, **minor:** *adr*-rich garnet, epidote, cpx with (100) partings (relict), phlogopite
grossular rodingite (unknown parent rock)*	**major:** *grs*-rich garnet, ±CT-opal
clintonite rodingite (boninite affinity rock)***	**major:** epidote, *grs*-rich garnet, clintonite, spinel, aluminous diopside (relict and newly formed), **minor:** monoclinic amphibole

*JGSM, **JGSM and Braszowice-Brzeźnica serpentinite massifs, *** Szklary massif (SM); the parent rock was determined on the basis of relict minerals and geochemical characteristics (see for details Dubińska 1995, 1997).

Chemical composition of the garnets (Fig. 2) is generally related to its position in the rodingites. The composition of the garnets is bimodal. Al-rich variety represents the earliest generation of the rodingitic garnets. *Grs*-rich garnets from clintonite rodingites (Szklary massif) can embrace up to 10.7 % FeO (total iron as FeO) although garnets from the Szklary rodingites can be Fe-free. The *adr*-rich garnets occur in JGSM vesuvianite rodingites containing relic clinopyroxene and they are younger than Al-rich variety. Diversified chemistry of *grs*-*adr* garnets is probably related to different oxygen fugacity (fO_2) during garnet crystallization. *Grs* garnets seemingly formed in the presence of Ca^{2+}-bearing and low fO_2 fluids accompanying serpentinization, while *adr* garnets can be products of a dehydration reaction during progressive metamorphism of the serpentinite. Diversification of chemistry of garnets from Szklary massif is probably related to local variations of fO_2 in fluids generating metamorphism of rodingites from Szklary (ca. 300ºC according to Dubińska et al. 1991). Uvarovitic garnets (15-16 % of Cr_2O_3, Fig. 2) surround

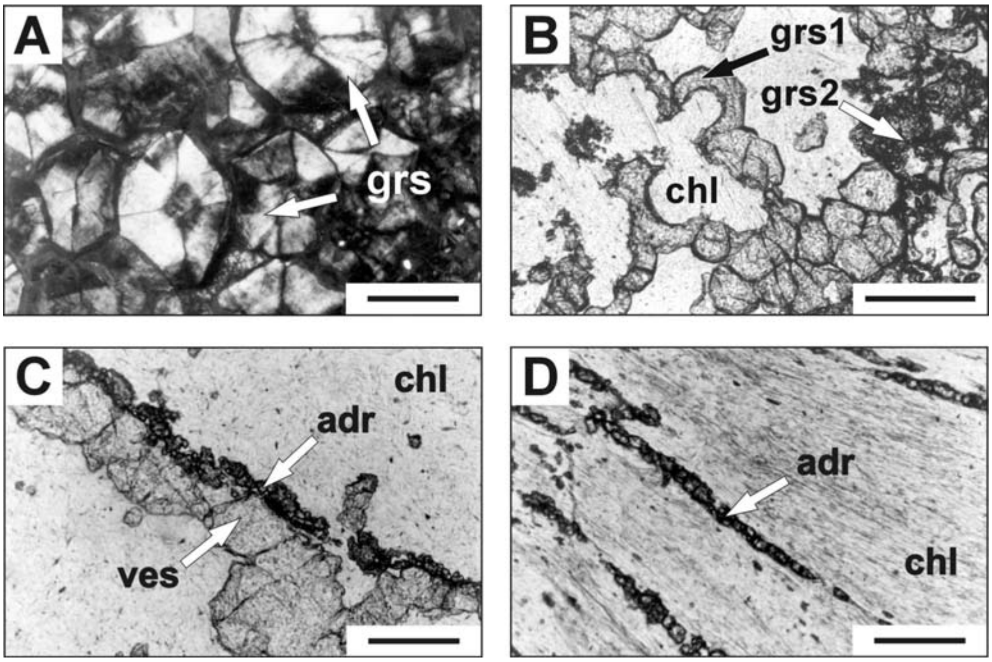

Fig. 1. Microphotographs of garnets from JGSM rodingites; A. birefrigent (hydro?) *grs* garnet (grs) cemented by CT-opal, crossed polars; B. euhedral small grains (bottom), atoll-like (grs1) buckles, and fine-grained crushed (grs2) *grs* garnets, plane light; C. tectonized fragment of vesuvianite rodingite containing crushed vesuvianite (ves) and late *adr*-rich garnet (adr) within chlorite (chl) matrix;, plane light: D. fine-grained path of *adr*-rich garnet (adr) inside zone of deformed chlorite, plane light.

Cr-spinel grains in serpentinite clasts tectonically incorporated into rodingite (Dubińska 1995).

Grs garnets from *czo* rodingites from JGSM are frequently Mn-enriched (up to 5.95 % MnO). The Mn enrichment usually involves all garnets regardless their location in the rodingite, albeit scarce *czo* rodingite samples contain Mn-free or both Mn-enriched and Mn-free unzoned *grs* garnets. *Grs* garnet is major Mn carrier in the studied *czo* rodingites; Mn content in its other possible carriers is negligible, e.g, *czo* typically contain below 0.2 % MnO. Whole rock chemical analyses of the *czo* rodingites also reveal a high of Mn concentration (MnO>1.5 %, Dubińska et al. 2004), whereas MnO content in the adjacent serpentinite is below 0.1% (unpublished data).

The *czo* rodingites represent the earliest rodingite variety (Li et al. 2004), therefore chemical composition of the garnets reflects high Mn content in hydrothermal fluids (270-300°C according to Dubińska et al. 2004) related to the serpentinization. Occurrence of Mn-rich garnets combined with occurrence of Ba-rich feldspars and manganese and phosphorus enrichment of the *czo* rodingites (Dubińska 1995, Dubińska et al. 2004) are typical indicators of ocean hydrothermal system. Chemical variability of the garnets from the Sudetic ophiolite rodingites record geotectonic evolution of the serpentinites starting from early serpentinization close to oceanic ridge recorded by Mn-bearing garnets from *czo* rodingites to late metamorphic events including deformation above subduction zone documented by *adr* garnets in vesuvianite rodingites of boninite affinity.

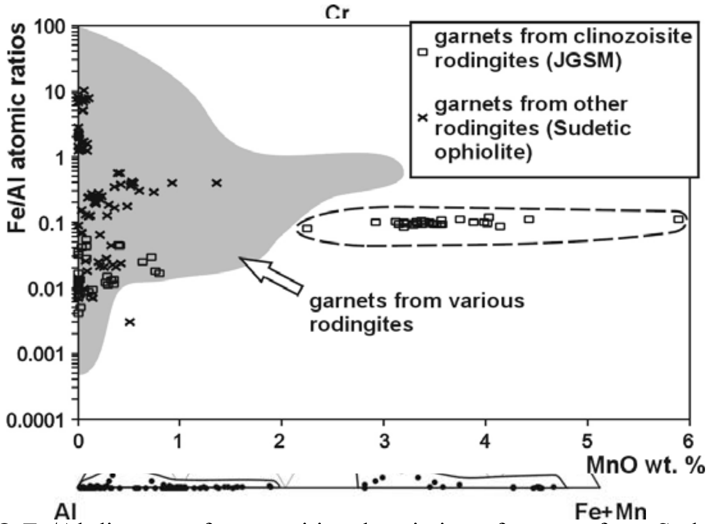

Fig. 3. MnO-Fe/Al diagram of compositional variation of garnets from Sudetic ophiolite rodingites; shaded area represents chemical composition of various rodingitic garnets (dataset available on request).

grants.

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