P-T EVOLUTION OF PALAEOZOIC GARNET PERIDOTITES FROM THE SAXONIAN ERZGEBIRGE AND THE ÅHEIM REGION, W NORWAY.

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Occurrences of relatively fresh ultrabasic rocks as lenses in quartzofeldspathic country rocks are known from many places in the world. It seems to be typical that the surrounding country rocks show high-pressure signature and that the ultrabasic lenses are accompanied by lenses of eclogites and other high-pressure rocks. Examples are the Dabie Mountains in Central China (e.g. Maruyama et al., 1994) and several areas in the Palaeozoic Urals-Mongolian fold system (Sobolev et al., 1986) with the noteworthy Kokchetav Massif where diamondiferous quartzofeldspathic country rocks occur (Sobolev and Shatsky, 1990). Furthermore, there are several places in the Norwegian Caledonides and Mid-European Variscides (Medaris and Carswell, 1990), where our case study areas are situated. In order to understand the geodynamic processes leading to the above situation, our aim was to decipher the P-T evolution of garnet peridotites more precisely than previously attempted.

Petrographic and analytical studies were initiated on samples of various ultramafic rocks from the crystalline complex of the Erzgebirge, Germany, and from a little portion of the Western Gneiss Region, Norway, situated close to the village of Åheim north of the Nordfjord. From every case study area, we selected one sample that was thoroughly investigated with the electron microprobe. Besides a large amount of full analyses, many obtained along profile lines and from mineral inclusions, we produced distribution maps of major cations for the relevant mineral phases by scanning (see Massonne, 1992a). In particular, the latter method provided good information about the changing compositions of garnet as well as ortho- and clinopyroxene during the P-T evolution.

The sample from the Saxonian Erzgebirge is from an ultramafic body being a few hundred meters in length. It occurs 3 km SW of the village of Seiffen. The equigranular rock sample contains considerable amounts of fresh garnet, orthopyroxene, clinopyroxene and amphibole. The major constituent olivine is moderately serpentinized. Cr-spinel occurs as accessory phase. The sample from our second case study area in Norway is from the Raudkleivane ultrabasic body. The sample locality is situated less than 1 km ENE of the little village of Halse. The peridotite contains large garnets with kelyphitic rims. In addition, large grains of olivine, orthopyroxene and minor clinopyroxene occur. Originally, the rock was probably equigranular, but due to a penetrative deformation the major part of the rock now consists of a finer grained matrix mainly composed of fresh olivine.

In both samples, olivine is hardly chemically zoned with about 90 mol% forsterite component. However, pyrope rich garnets show significant zonation patterns. In case of the Erzgebirge, a clear decrease of the grossular component accompanied by an increase of the Cr concentration from core to rim occurs. At the outermost rim, an inverse zonation can be observed. By contrast, garnet from the Norwegian sample is fairly homogeneous, but a zonation is, nevertheless, discernible by increasing Fe concentrations from core to rim. Orthopyroxene shows an increase of Al from core to rim in the Saxonian sample, but a decrease of Al in the other sample. Na concentrations decrease towards the rim of clinopyroxene in both samples. However, considering the calculated Al concentration for the tetrahedral site, it shows an increase for the Saxonian sample and a slight decrease for the other sample from core to rim. This is identical to the change of Al concentrations in orthopyroxene.

Geothermobarometry was applied thereafter to derive P-T paths. Mineral equilibria were calculated using the Ge0-Calc software package of Brown et al. (1988). We only considered almandine, grossular and pyrope components in garnet, forsterite and fayalite components in olivine, enstatite, ferrosilite and Al_2O_3 components in orthopyroxene and diopside, hedenbergite and $CaAl_2SiO_6$ components in clinopyroxene. Thermodynamic data for these components were taken from Berman (1988). A few of these data were slightly modified by Massonne (1992a). In the corresponding paper, complex solid solution models were also presented for garnet and clinopyroxene. Similarly complex solid solution models were derived for orthopyroxene and olivine considering various literature data. Data for the Al_2O_3 component in orthopyroxene were taken from Massonne (1992b).

Several equilibria could be calculated for distinct equilibration stages. For example, we selected mineral core compositions to determine therearcompesistage. We were able to obtain a P-T range for a particular event, because various invariant points resulted from the thermodynamic calculations. However, we took into account that, for example, pressures obtained from the Al content in the tetrahedral site of orthopyroxene are more reliable than those from Al in this site of clinopyroxene. The reason for that is the less precise calculation method for Al in the tetrahedral site of clinopyroxene, for example, due to much higher concentrations of jadeite and acmite component in this mineral.

Finally, two different P-T paths resulted. In the case of the Åheim region, we deduced a pressure increase from about 30 to 36 kbar accompanied by a temperature increase of about 100°C to 1050°C. This event was followed by a pressure decrease to 32 kbar with a simultaneous cooling to 900°C. For the garnet peridotite of the Saxonian Erzgebirge, a pressure decrease from about 40 kbar to 25 kbar accompanied by slight cooling can be deduced. At the final stage, temperatures somewhat below 1000°C were reached. Cr-spinel formed at that stage leading to a clear Cr decrease towards the outermost rims of garnet.

The P-T paths derived will certainly help to understand the mantle flow and other geodynamic processes during subduction and final continent-continent collision. Because of the lack of good tectonic models, any interpretation of the P-T paths would be highly speculative. However, at least with respect to the Palaeozoic situation of the crystalline complex of the Erzgebirge, the results for the Saxonian garnet peridotite provide evidence against an "in situ" model favoured by many geoscientists for areas mentioned here at the very beginning. On the contrary, they rather support the view of Massonne (1994). Because of the different P-T evolution of quartzofeldspathic country rocks, eclogite and peridotite lenses, the latter rocks were tectonically emplaced into the metaacidites, probably at the base of thickened continental crust.

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