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TRACE ELEMENT PARTITIONING BETWEEN MINERALS OF THE ALPE ARAMI GARNET PERIDOTITE, SWITZERLAND

Jens Paquin, Rainer Altherr and **Thomas Ludwig**

Mineralogisches Institut, Universität Heidelberg, Im Neuenheimer Feld 236, D-69120 Heidelberg, Germany.

ABSTRACT

The internal zones of orogenic belts often bear (ultra)high-pressure peridotites. The P-T paths recorded by their mineral assemblages can give valuable information on orogenic processes. Apart from phase diagrams, the internal chemical structure of individual mineral grains and the partitioning of elements between different mineral phases are the main tools to constrain the P-T evolution of peridotitic rocks. We present the first results of a combined electron microprobe and ion microprobe study on the abundances of major and trace elements in minerals of the garnet peridotite from the classical Alpe Arami locality (Switzerland).

Previous studies on the Alpe Arami peridotite have not documented the existence of pronounced chemical zoning of mineral grains (Fig. 1). Furthermore, textural relationships as well as major element compositions indicate the presence of two clinopyroxene (cpx) generations. Type-I cpx (cpx I) forms large porphyroclasts and inclusions in garnet (grt); type-II cpx (cpx II) is the ordinary matrix cpx. Compared with cpx I, cpx II is characterized by lower Al_2O_3 (1.9 vs 3.0 wt %) and Na_2O (1.0 vs 2.0 wt %), but higher CaO (22.0 vs 21.3 wt %). In grt grains Mg, Ca and X_{Mg} decrease and Fe and Mn increase from core to rim. Cr shows a more complex, W-shaped zoning pattern (Fig. 1), whereby Cr abundances first decrease from core to rim, but then abruptly increase in the outermost rims (250 µm). Orthopyroxene (opx) exhibits strong zonation, with Al and Cr increasing from core to rim, followed by a decrease only in the outermost rims (100 µm). In cpx, Al, Cr and Na decrease but Mg and Ca increase from core to rim. With respect to Al, Cr and Ca, core compositions in grt and cpx are constant. Stepscan ion microprobe analyses were performed along the same profiles investigated by electron microprobe. Grt shows decreasing abundances of Sc and Ni from core to rim; only a narrow zone of constant composition is displayed in the core. In opx, trace element zoning is only shown by Ni and V. Ni decreases only in the outermost rims while V behaves like Al. In cpx, Sc increases and V decreases (like Al) in the outermost portion of rims.

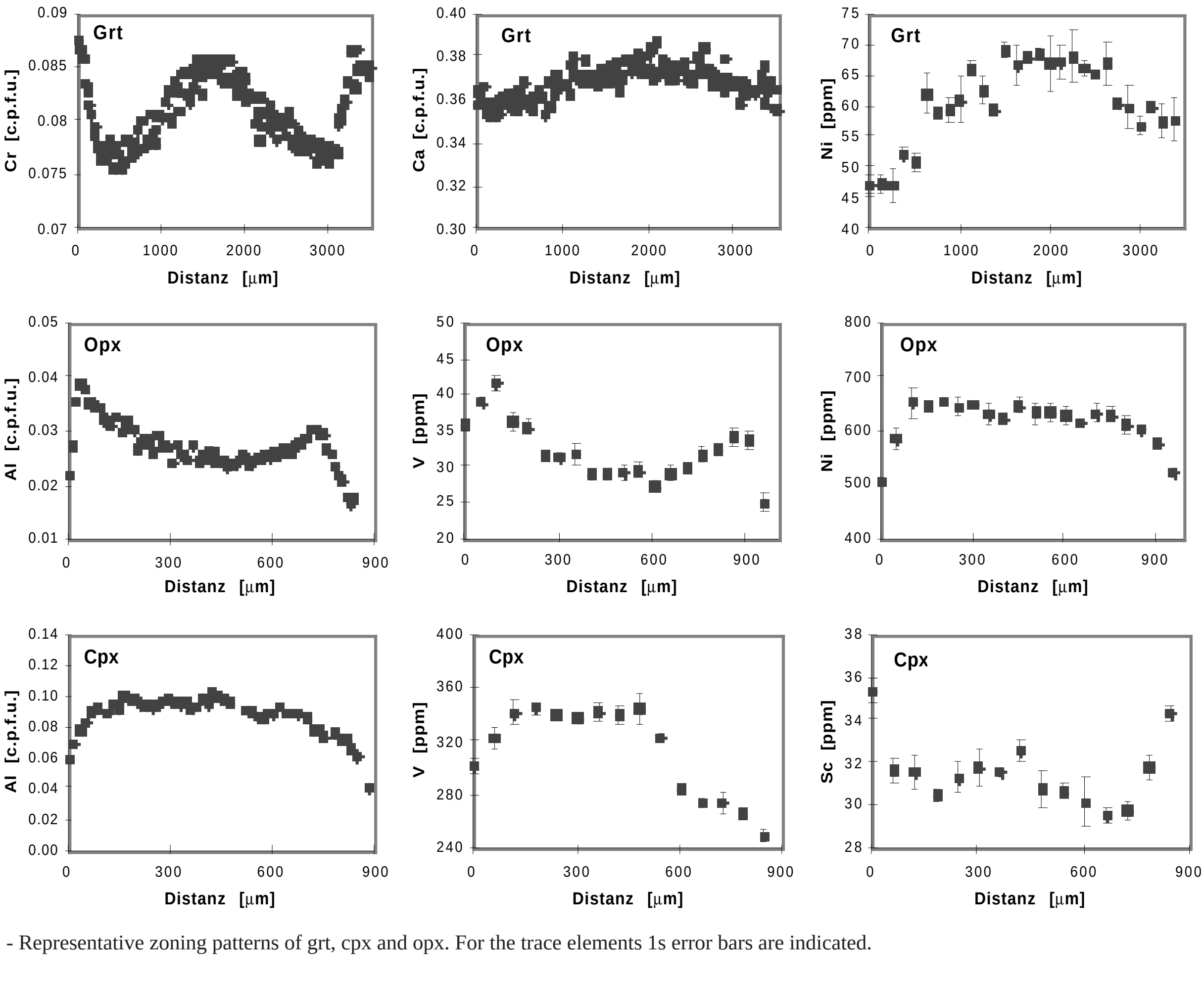

Fig. 1 - Representative zoning patterns of grt, cpx and opx. For the trace elements 1s error bars are indicated.

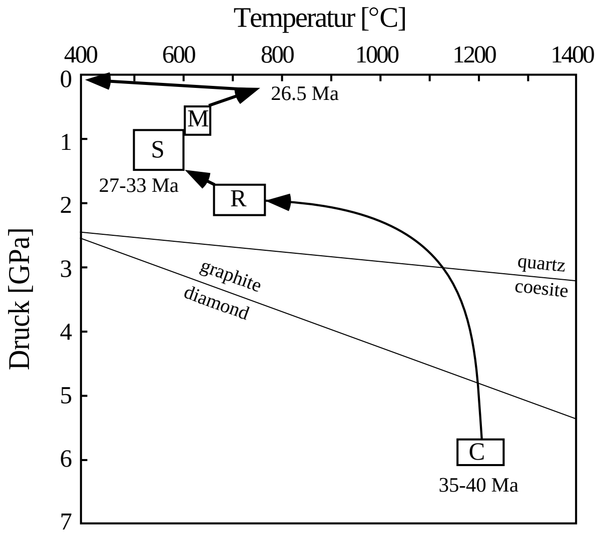

Fig. 2 - P-T path for the Alpe Arami garnet peridotite, modified after Brenker & Brey (1997). For geochronological ages see also Brenker and Brey (1997) and references therein.

Geothermobarometric calculations on mineral core compositions (chemical plateaus) yield temperatures and pressures of 1150 ± 50°C and 5.9 ± 0.2 GPa derived from the combination of the grt-olivine (ol) Fe-Mg exchange thermometer (O' Neill and Wood, 1979) with the Al-in-opx barometer (Brey and Köhler, 1990). Applying the Ni-in-grt thermometer (Ryan et al., 1996) yields similar temperatures. Our P-T values are slightly higher than previous estimates (Brenker and Brey, 1997). Lower temperatures of 1050 ± 50°C were obtained using a thermometer based on Ni-Mg partitioning between ol and opx (Podvin, 1988). The two-pyroxene thermometer of Brey and Köhler (1990) involving cpx II yields even lower temperatures of 850 ± 50°C (see also Brenker and Brey 1997. Using cpx I, the obtained temperatures are only slightly higher (870 ± 50°C because both cpx generations have nearly similar Ca contents.

While the abundances of Li in grt (0.2 to 0.3 ppm), opx (0.2 to 0.4 ppm), cpx I (1 to 3 ppm) and ol (1.0-1.5 pmm) are normal and reflect equilibrium partitioning (Seitz and Woodland, 1999), those of cpx II grains are abnormally high (6 to 16 ppm) indicating disequilibrium with the other phases and suggesting a secondary (metasomatic) nature of cpx II.

Considering the zonation patterns and assuming that transition element diffusion is mainly controlled by temperature, we suggest that the first stage of decompression was nearly isothermal (Fig. 2) and slow enough for an increase of Al in opx. Subsequent cooling was a more rapid process because only the outermost opx rims were affected by a decrease of Al. This is supported by the decrease of Ni in opx and of Sc in grt observed in the outermost rims of grains.

REFERENCES

Brenker F.B. and Brey G.P., 1997. Reconstruction of the exhumation path of the Alpe Arami garnet-peridotite body from depths exceeding 160 km. J. Metam. Geol., 15: 581-592.

O'Neill H. and Wood B.J., 1979. An experimental study of Fe-Mg-patitioning between garnet and olivine and ist calibration as a geothermometer. Contrib. Mineral. Petrol., 70: 59-70.

Brey G. and Köhler T., 1990. Geothermobarometry in four-phase lherzolites II. New thermobarometers, and practical assessment of existing thermobarometers. J. Petrol., 31: 1353-1378.

Ryan G.R. and Griffin W.L., 1996. Garnet geotherms: Pressure-temperature data from Cr-pyrope garnet xenocrysts in volcanic rocks. J. Geophys. Res., 101: 5611-5625.

Podvin P., 1988. Ni-Mg partitioning between synthetic olivines and orthopyroxenes: Application to geothermometry. Amer. Mineral., 73: 274-280.

Seitz H.M. and Woodland A.B., 1999. The distribution of Lithium in peridotitic and pyroxenitic mantle lithologies - an indicator of magmatic and metasomatic processes. Chem. Geol., submitted.