

## Na-bearing majoritic garnets in the system $\text{Mg}_3\text{Al}_2\text{Si}_5\text{O}_{12}$ – $\text{Na}_2\text{MgSi}_5\text{O}_{12}$ at 11–20 GPa: Solid solutions and structural peculiarities

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The phase with composition  $\text{Na}_2\text{MgSi}_5\text{O}_{12}$  (Na-majorite), end-member of sodium-rich majoritic garnet [1], was synthesized and garnet/pyroxene *PT* phase boundary was determined in multi-anvil experiments at 11–20 GPa and 1500–2100 °C. Na-majorite was obtained at 16 GPa and 1500°C; its stability spreads to the high-temperature region with pressure (1900 °C at 17 GPa and 2100 °C at 19.5 GPa) [2]. Single-crystal study of Na-majorite provided evidence for its tetragonal symmetry, space group *I4<sub>1</sub>/acd*, and cell parameters  $a = 11.3966(6)$ ,  $c = 11.3369(5)$  Å and  $V = 1472.5(1)$  Å<sup>3</sup> [3]. Experiments at 18 GPa and 1600 °C on the pyrope ( $\text{Mg}_3\text{Al}_2\text{Si}_3\text{O}_{12}$ )–Na-majorite join allowed us to study mixing peculiarities for sodium-rich majoritic garnet. The study demonstrated that the transition from cubic to tetragonal symmetry is observed for the starting composition with ~80 mol %  $\text{Na}_2\text{MgSi}_5\text{O}_{12}$ , which is consistent with the similar change of the structure in the pyrope–majorite ( $\text{Mg}_4\text{Si}_4\text{O}_{12}$ ) system [4]. Significant Na-majorite solubility in pyrope, as well as findings of natural garnets with high Na concentrations (>1 wt %  $\text{Na}_2\text{O}$ ) allow us to consider Na-bearing majoritic garnet as a phase accumulating sodium in the deep upper mantle and transition zone. Successful synthesis of the Na-majorite end-member and study of its structure are of key importance for obtaining of thermodynamic constants for this phase, which together with the computer modeling will allow us to suggest the new version of thermobarometer for mineral assemblages containing Na-bearing majoritic garnet.

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[1] Bobrov *et al.* (2008) *CMP* **156**, 243-257. [2] Dymshits *et al.* (2010) *Doklady Earth Sci.* **434**, 1263-1266. [3] Bindi *et al.* (2011) *Am. Mineral.* **96**, 447-450. [4] Parise *et al.* (1996) *Geophys. Res. Lett.* **23**, 3799-3802.

## Application of the Linkam TS1400 X-Y heating stage to melt inclusion studies

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One of the major limitations in studying melt inclusions in natural samples has been the lack of availability of easy-to-use microscope-mounted heating stages that allow the user to heat the inclusion while it is being observed and to quench the sample rapidly to maintain a homogeneous glass and to avoid reequilibration during cooling.

The recently introduced Linkam TS 1400 X-Y stage has been tested and found to produce satisfactory results for many types of melt inclusions. Several experiments have been performed on recrystallized melt inclusions (MI) contained in olivine and sanidine phenocrysts from eruptions at Campi Flegrei, Italy, and in clinopyroxene from the Sarno eruption at Monte Somma-Vesuvius Italy. During the heating experiment, a constant flow of argon gas was introduced into the sample chamber at a flow rate of  $0.5 \pm 5\%$  liter/min. During heating the temperature is easily controlled and the heating rate can be adjusted during the heating experiment. In all cases, it was possible to homogenize the MI and, importantly, to quench the melt to a glass after homogenization. In one experiment, the sample was heated to 1340°C. At that temperature, the field of view became a darkish-red and it was difficult to observe the behavior of the MI. At lower temperatures the optics were excellent. The quality of the optics during heating appears to be dependent on the sample characteristics, with samples containing matrix glass being most problematic.

In most of the experiments, the MI were homogenized completely (crystals + bubbles) and remained homogeneous during quenching to room temperature to produce a glass. In one case, the MI was heated to 1340°C and the solids all melted but the bubble did not dissolve back into the melt. When the MI was quenched, the single bubble remained in the MI and grew larger during cooling. The bubble in this MI may represent a trapped vapor bubble (i.e., the MI trapped a volatile-saturated melt plus a vapor bubble) and thus the bubble should not be expected to dissolve back into melt.