Elastic wave velocities of polycrystalline $Mg_3Al_2Si_3O_{12}$-pyrope garnet to 24 GPa and 1300K

J. Chantel[1], G. Manthilake[12], D. Frost[3], C. Beyer[3], Z. Jing[4] and Y. Wang[4]

[1] Universite Blaise Pascal, Laboratoire Magmas et Volcans, Clermont-Ferrand, France
[2] CNRS, UMR 6524, LMV, Clermont-Ferrand, France
[3] Bayerisches Geoinstitut, University Bayreuth, Germany
[4] University of Chicago, Chicago, IL, USA

The most accurate method to investigate the mineralogy and chemistry of the mantle at depths greater than 150 km is through the analysis of compressional (*P*) and shear (*S*), seismic waves and comparison with the same velocities calculated for expected mineral assemblages. Regional variations in seismic wave velocities could originate from either chemical or thermal heterogeneities and experimental measurements of wave velocities of candidate phases at high pressures and temperatures are required to differentiate between these causes. In the transition zone, rocks formed from subducted basaltic crust are rich in garnet and its mineral proportion and chemistry differs from typical ultramafic mineral phases, which are dominated by olivine polymorphs wadsleyite and ringwoodite. Although the sound velocities of olivine polymorphs at relevant pressures have been well documented, those of garnet have not been investigated in its stability field.

We have successfully measured the acoustic wave velocities for synthetic polycrystalline pyrope garnet ($Mg_3Al_2Si_3O_{12}$) were to 24 GPa and temperatures up to 1300K by ultrasonic interferometry combined with energy-dispersive synchrotron X-ray diffraction in a 1000-ton press and a T-25 multi-anvil module (13ID-D, APS). Specimen lengths at high pressures (*P*) and temperatures (*T*) are directly measured by X-ray radiography methods, while elastic wave travel times and X-ray diffraction data were collected. Two dimensional (*P-T*) linear fittings of the present data yields the following parameters: K_{S0} = 168.5 (2) GPa, $\delta K_S/\ \delta P$ = 4.49 (2), $\delta K_S/\ \delta T$ = -19.9 MPa/K, G_0 = 88.5 GPa, $\delta G/\ \delta P$ = 1.59 (1) and $\delta G/\ \delta T$ = -8.9 MPa/K which is consistent with earlier results at lower pressures except for a significantly lower G_0 and $\delta G/\ \delta T$. Compressional (V_P) and shear (V_S) wave velocities as well as the adiabatic bulk (K_S) and shear (*G*) moduli exhibit monotonic increase with increasing pressure and decrease with increasing temperature, respectively. The observed linear pressure and temperature dependence in both V_P and V_S is in contrast to the non-linear behavior of V_P and V_S for majorite garnet with the pyrolite composition, in particular for V_S.

Stability of polycyclic aromatic hydrocarbons at upper mantle conditions

A.D. Chanyshev[12]*, K.D. Litasov[1,2], A. Shatskiy[12] Y. Furukawa[3] and E. Ohtani[3]

[1]Sobolev Institute of Geology and Mineralogy, Novosibirsk, 630090, Russia
(*correspondence: chanyshev_90@mail.ru)
[2]Novosibirsk State University, Novosibirsk, 630090, Russia
[3]Tohoku University, Sendai, 980-8578, Japan

The origin of deep-seated hydrocarbons was widely discussed in relation to the study of C-O-H fluid. The estimation of fO_2 conditions in the deep mantle indicate that it can be in equilibrium with reduced fluids and fO_2 in mantle rocks can be fluctuated near that for the iron-wustite buffer at the depth below 300 km [1]. The calculations of fluid compositions at these conditions in the C-O-H system indicate the dominant CH_4-H_2O mixture, with subordinate H_2, and heavier hydrocarbons [1]. However, some theoretical calculations predict that heavy hydrocarbons, such as alkanes, alkenes, polycyclic aromatic hydrocarbons (PAH), can become stable in the mantle fluids at 300-600 km and deeper [2].

Here we determined stability and chemical reactivity of PAHs at upper mantle pressures. PAHs were selected according to abundance in natural samples [3] and meteorites. The starting materials were from naphthalene to coronene. The decomposition parameters were detected by *in situ* X-ray diffraction and laboratory multianvil experiments. In the pressure range of 6-9 GPa selected PAHs become unstable at temperatures of 873-1023 K. After experiments we analyzed products using matrix-assisted laser desorption/ionization method (MALDI). As a result, the formation of polymers of starting materials at 7 GPa and 773-873 K was determined. The polymers have atomic masses up to 5000 Da.

The P-T parameters for the PAHs stability field do not correspond to the upper mantle conditions; indicating that PAHs in diamonds and other mantle minerals [3] would have secondary origin. Indeed, data for PAHs stability is important for near-surface geodynamics of small and large planetary bodies as PAHs are widely observed in the Universe [4]. The work is supported by RFBR No 12-05-00841.

[1] Frost & McCammon (2008) *Annu. Rev. Earth Planet. Sci.* **36**, 389-420. [2] Zubkov (2001) *Geochemistry* **39**, 131-154. [3] Kulakova *et al.* (1982) *Doklady Earth Sciences* **267**, 1458-1461. [4] Ehrenfreund & Cami (2010) *Cold Spring Harb Perspect Biol.* **2**, doi: 10.1101/cshperspect.a002097.

www.minersoc.org
DOI: 10.1180/minmag.2013.077.5.3