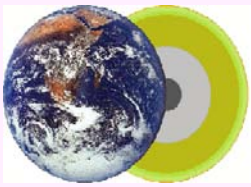
Geodynamics Seminar

第317回ジオダイナミクスセミナー

Synthesis and elastic wave velocities of polycrystalline pyrope $Mg_3Al_2Si_3O_{12}$ garnet up to 20 GPa and 1700 K

Yongtao Zou (Ph.D. student, Ehime University)

主催：愛媛大学地球深部ダイナミクス研究センター
日時：2/10（金）午後 4時30分～
場所：総合研究棟 4F 会議室



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Abstract

Silicate garnets are one of the most abundant constituent minerals of the upper mantle and mantle transition zone, comprising about 40% by volume for pyrolite composition. Pyrope garnet with a composition of Mg_3Al_2 $(SiO_4)_3$ is one of the most significant magnesium end-member of garnets group. Elastic properties of pyrope garnet for both single crystal and synthetic polycrystalline samples have been measured by many scientists with different techniques, including ultrasonic interferometry, Brillouin scattering and static compression methods. To the best of our knowledge, to data, we find that very few studies have been performed to measure the elasticity as well as the sound velocities of pyrope garnet *in situ* at simultaneous high-pressure and high-temperature. Earlier experimental study on the elasticity for polycrystalline Mg_3Al_2 $(SiO_4)_3$ pyrope garnet has been carried out by Chen et al. using ultrasonic interferometry techniques in multi-anvil apparatus to 10 GPa at room temperature. Gwanmesia et al had studied the high-temperature elastic properties of synthetic polycrystalline $Mg_3Al_2(SiO_4)_3$ garnet to 1000K and 0.3 GPa by using a gas-medium apparatus. Moreover, high-temperature elasticity of single crystal pyrope garnet has been investigated to 800 ºC at room pressure by Brillouin scattering.

However, to date, direct measurements of the elasticity and sound velocities for $Mg_3Al_2(SiO_4)_3$ pyrope garnet based on *in situ* high *P-T* experiments have been still limited. Previous studies were carried out either at high temperature and ambient pressure, or at high pressure at room temperature. The recent simultaneous high-pressure and high-temperature study on the elasticity of polycrystalline $Mg_3Al_2(SiO_4)_3$ garnet were carried out to 9 GPa and 1000 ºC by using ultrasonic measurement techniques, but this experimental data also do not cover the *P-T* conditions up to the mantle transition zone. In addition, the previous studies on the elasticity, especially for their pressure and temperature dependences are not well constrained. It is thus of great geophysical importance to carry out further studies for $Mg_3Al_2(SiO_4)_3$ garnet at elevated pressures and temperatures.

In this study, we report elastic properties and sound velocities for synthetic polycrystalline pyrope $Mg_3Al_2(SiO_4)_3$ garnet up to 20 GPa and 1700 K, equivalent to the middle part of the mantle transition zone, by using ultrasonic interferometry combined with energy-dispersive synchrotron X-ray diffraction in a cubic-anvil DIA-type apparatus. Both compressional (*Vp*) and shear wave (*Vs*) velocities as well as the adiabatic bulk (*Ks*) and shear (*G*) moduli exhibit monotonic increase with increasing pressure, and decrease with increasing temperature, respectively. A two-dimensional (*P-T*) linear fitting for the present data yields the following parameters: K_{S0} = 170.0 (2) GPa, $\partial Ks/\partial P$ = 4.51(2), $\partial Ks/\partial T$ = -0.0170(1) GPa/K, G_0 = 93.2(1) GPa, $\partial G/\partial P$ = 1.51(2), and $\partial G/\partial T$ = -0.0107(1) GPa/K, which is in good agreement with the earlier results by Brillouin scattering and/or ultrasonic measurements at relatively low *P-T* conditions. In addition, we have observed a quasi-linear pressure and temperature dependences in both *Vp* and *Vs*, which is in contrast to the non-linear behaviors in *Vp* and *Vs* of majorite garnet with pyrolite composition, in particular for *Vs*.

詳細は当センターホームページ: http://www.ehime-u.ac.jp/~grc/をご覧ください
問い合わせ先：桑山 靖弘（TEL:089-927-8408,e-mail:kuwayama@sci.ehime-u.ac.jp）