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論 文 要 旨

THESIS SUMMARY

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学籍番号： Student ID Number	11D04050	指導教員（主）： Academic Advisor(main)	廣瀬　敬
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

This thesis is consisted with 5 chapters and 2 appendixes.

In chapter 1, the necessity of elastic measurements of the Earth's constituent materials at high pressure condition to understand chemical structure of the Earth's deep interior, and experimental methods for the measurements of them at high pressure condition are described. Then, the advantage and principle of Brillouin scattering method, and its application to diamond anvil cell for high pressure measurements are explained. Moreover, the structure, signatures of seismic anomalies at the lowermost mantle, the importance of understanding them, convincing hypothesizes of those anomalies are explained. At last, the fact that conclusive evidences for those hypothesizes are the absent because of the lacking of elastic properties of constituent materials at high pressure are described.

In chapter 2, sound velocity of $CaSiO_3$ perovskite up to 133 GPa at room temperature is obtained by Brillouin scattering method. Present X-ray diffraction pattern shows the crystal structure of present $CaSiO_3$ perovskite is tetragonal at all the pressure points. Signals by shear mode of $CaSiO_3$ perovskite are clearly obtained. Its shear velocity is significantly slower than both previous theoretical predictions for cubic phase and other constituent minerals of the lower mantle. Although the signals of shear mode are clearly obtained, compressional velocity is not obtained directly, because these signals would be masked by the huge signals by shear mode of diamond anvils, therefore, compressional velocity is deduced by both present shear modulus and experimental compression result obtained previously. Based on present experimental results, sound velocities of pyrolytic mantle and harzburgitic rock at the lowermost mantle condition are calculated. This calculation result shows the faster shear velocity and slower bulk sound velocity anomaly beneath circum-Pacific region can be explained by subducted harzburgitic rock.

In chapter 3, shear velocity of $(Mg,Fe)SiO_3$ glass is measured up to 113 GPa. Some of previous melting experiments showed that the iron concentration ratio between melt and coexisting solid phase drastically changes at around 76 GPa, and possibility of density crossover between silicate melt and coexisting solid phase caused by the rapidly increasing of iron concentration to melt. It is conceivable that the cause of rapidly increasing of iron concentration is spin crossover of iron among silicate melt, however, its existence is still under discussion. Pressure derivative of shear velocity of present glass shows anomaly at 60 GPa. This anomaly is very similar to that of ferropericlase. The velocity anomaly in ferropericlase is caused by spin crossover. Therefore, the observed anomaly in present glass would be also as a result of spin crossover. On the other hand, silicate glasses are good analogue to corresponding silicate melts, thereby, iron among silicate melt is also prospected to spin crossover.

In chapter 4, both shear and compressional velocities of $(Mg,Fe)SiO_3$ glass are measured up to 53 GPa. Present shear and compressional velocities, and Poisson's ratio show very similar behavior to those of silica and $MgSiO_3$ glasses. It indicates that iron among silicate glasses would not affect to the structure of silicate glasses dominantly in present pressure range. Based on measured velocities, bulk sound velocity and elastic moduli of present glass at high pressure are estimated. Additionally, minimum density profile at high pressure condition is estimated.

In chapter 5. all the results and conclusions are summarized, and required studies for understanding seismic anomalies at the lower mantle are discussed. There are some guided studies based on this thesis. Firstly, sound velocity measurements for $CaSiO_3$ perovskite at high pressure-temperature condition are needed, in order to understand more accurate elastic behavior of $CaSiO_3$ perovskite at the lower mantle. To measure, employing laser heated or externally heated diamond anvil cell is considered as a suitable method. Secondly, to identify subducted mid-ocean-ridge basalt at the lowermost mantle, sound velocity

measurements of α-PbO_2-type SiO_2 phase are necessary because only this material has no experimental researches of the experimental sound velocity measurements among the constituent minerals of subducted mid-ocean-ridge-basalt to the lowermost mantle. However, this material is stable phase above 100 GPa, therefore, *in-situ* synthesis with CO_2 laser heating would be quite difficult because of the thinner thermal insulator in sample chamber than that at lower pressure. To avoid this problem, employing other starting material or synthesis with other laser such as YAG-laser or fiber laser is considered. Thirdly, determination of phase relation of other candidate chemical heterogeneities such as continental crust and anorthite at high pressure condition is necessary, because the knowledge of phase relation of those rocks at the lower mantle condition is quite limited. At last, decreasing the signal by shear mode of diamond anvils is needed, because compressional velocity is hidden by the huge signals of shear mode of diamond anvils. Directional measurement of compressional velocity is also important for not only interpretation of seismic structure but also construction of absolute pressure scale. Backscattering geometry measurement has potential to overcome this problem.