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高温高圧下における周期振動実験による地震波減衰測定
Seismic attenuation measurement by cyclic loading under high pressure and temperature

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The estimation of the mantle structure using seismic tomography method has been advanced by understanding of the detailed velocity structure of the Earth interior . On the other hand , Brillouin scattering in the DAC at very high pressure, X-rays inelastic scattering, sound velocity measurement of ultrasonic range in the large press is also improved. These developments can be expected this time as a further declaration of a picture of a more detailed Earth interior. However, as compared to the frequency band of MHz to GHz region, the frequency range of the seismic waves propagating through the earth interior is much lower. We should noted that it is greatly affected by the attenuation of seismic waves. Because the materials are not in a perfectly elastic body, energy loss inside the materials occurs in the wave propagation because of presence of grain boundaries, dislocations, and defects. Thus, seismic attenuation occurs as a function of frequency.

The attenuation of seismic waves (the determination of the Q-1) of mantle material under high pressure has not been reported until recently mostly because it is an experimental quantification is very difficult . Temperature effects and particle size effects were reported for the first time systematically for olivine aggregates at high temperature under low pressure. However, for this system the upper limit of the generated pressure is low because it is a torsion test performed in the gas pressure. So the study of pressure -dependent and high-pressure mineral is difficult . The other group using the D-DIA type press having two differential ram measured $Q^{-}1$ combining an in-situ observation and radiation uniaxial periodic vibration test. This system expands a possibility of experimental determination of Q^{-1} at much higher pressure. In Japan, the DIA type press was installed at SPring8 (D-DIA). Recently we started the measurement of Q^{-1} under high pressure using in situ image acquisition of the high time and spacial resolution at short period of oscillation cycle.

In this paper, some experimental developments for measuring seismic attenuation at high pressure and results of cyclic loading tests are introduced. Time resolved images of the sample and reference material obtained by a synchrotron X-ray radiography provide their strain as a function of time during cyclic loading. Attenuation is determined as the tangent of the angle of phase lag between the strain of the sample and the strain of the reference material. A newly installed short period sinusoidal cyclic loading oil pressure system enable us to determine minimal strain of the sample in a wide frequency range from 2 to 0.01 hertz on olivine aggregates at 1 GPa and up to 1673 K. The detectable minimum strain is around 5×10^{-5}. Several test experiments exhibited resolvable Q^{-1} (10^{-2}) above 1273 K. The results are generally consistent with previously reported data.

キーワード: 減衰, 高圧, 振動, Q 値, 剛性率
Keywords: seismic attenuation, high pressure, oscillation, Q value, shear modulus