学位論文要旨

Seismic velocity structure of oceanic lithosphere based on elastic wave velocity measurements of core samples collected from the Oman ophiolite
（オマーンオフィオライト掘削試料の弾性波速度測定に基づく海洋リソスフェアの地震波速度構造）

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Seismic velocity structure below seafloor is important for understanding the architecture of oceanic lithosphere. Recently, core samples were collected from each lithology in the Oman ophiolite. Elastic wave velocity of these cores drilled from ophiolite interpreted as fragments of ancient oceanic lithosphere are important for understanding seismic velocity structures. However, elastic wave velocity shows the pressure dependence due to the closure of pores. To understand the velocity structure of oceanic lithosphere, it is necessary to measure elastic wave velocity under pressure conditions corresponding to depth. In this study, I conducted the following experiments to investigate the effects of pore and mineral assemblage on elastic wave velocity of core samples drilled from Oman ophiolite, and velocity structure of the ophiolite stratigraphy was constructed. Based on these velocity structure, the architecture and the distribution of water in oceanic lithosphere were discussed.

【Effect of cracks and mineral assemblage in elastic wave velocity of mafic rocks】

Seismic velocity of oceanic crust increases with depth. The velocity gradient in the lower oceanic crust is caused by the effect of crack closure and mineral assemblage, and both need to be comprehensively considered. In this experiments, elastic wave velocity of core samples corresponding to the lower oceanic crust was measured at high confining pressure under dry and wet conditions, and crack density was calculated applied to theoretical model. In addition, the effect of mineral assemblage on velocity was evaluated based on modal composition determined by microstructural observation. Elastic wave velocities of diabase and gabbro were measured. High pressure experiments were conducted using Intra-vessel deformation and fluid flow apparatus. Two loading cycles up to 200 MPa of confining pressure were required per specimen to measure the velocity under successively dry and wet conditions. Elastic wave velocity increased with confining pressure, suggesting closing cracks.

Crack density calculated from experimental results shows a change of approximately 0.02 under pressure condition in lower oceanic crust. Velocities calculated from mode agree with the experimental results measured under high pressure and tend to be higher in the lower part of oceanic crust. This is related to the contents of amphibole, suggesting that the influence of hydrothermal alteration extends to the lower oceanic crust. Velocity structure that considers both mineral assemblage and the effect of crack closure is inferred from these results, and it is clarified that velocity gradient depends on crack aspect ratio. This is useful for considering the distribution of water in the oceanic crust.

【Pressure dependence of anisotropy of elastic wave velocity in ultramafic rocks】

A systematic anisotropy has been observed in elastic wave velocities measured under atmospheric pressure for samples drilled from mantle section. Since the anisotropy of elastic wave velocity is caused by the preferred orientation of crystals or cracks, this anisotropy may reflect mantle flow or a differential stress field in the brittle regime, respectively. However, measurements at atmospheric pressure have not identified the dominant factor. In this experiment, pressure dependence of the anisotropy of elastic wave velocity of core samples drilled from mantle section was examined. To measure the anisotropy under high pressure, I improved the experimental apparatus and succeeded in measuring elastic wave velocity of four components. Elastic wave velocity increased slightly with pressure, showing the effect of closing cracks. However, anisotropy was unchanged with increasing confining pressure. Therefore, anisotropy is caused by the preferred orientation of crystals. Core samples of mantle section show a markedly low velocity in only one direction, suggesting that the *c* axis of lizardite is oriented in this direction. Such structure is likely to be formed by a topotactic serpentinization and reflects that the anisotropy by mantle flow.

【Velocity structure of the Oman ophiolite stratigraphy and oceanic lithosphere】

Based on the experimental results, I constructed the velocity structure of the ophiolite stratigraphy, which is consistent with data of samples collected from the outcrop of the Oman ophiolite. This indicates that local core samples represent geology of the Oman ophiolite. Seismic velocity structure of oceanic crust of the Pacific plate agrees with velocity calculated from mode of experimental samples, suggesting that the Pacific plate is dry condition. On the other hand, seismic velocity at outer-rise region offshore the Japan Trench decreases due to fracturing and hydration of oceanic lithosphere. From velocity reduction of oceanic lithosphere, porosity in oceanic crust is estimated to be 4%, and serpentinization in uppermost mantle is estimated up to 46%.