氏　　　名	森　下　知　晃
生 年 月 日	
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学位授与の題目	Evolution of the Horoman Peridotite Complex and its implications for the origin of heterogeneous mantle（幌満かんらん岩体の形成史－不均質マントルの成因－）
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学位論文要旨

ABSTRACT

The most important feature in the Horoman Peridotite Complex is a symmetrical layered structure characterized by an arrangement of cumulus peridotite in the middle of a series of residual peridotites with increasing melt component outward.

There are several types of mafic rocks. One of them, Type II mafic rock restrictedly occurs in the cumulus peridotite in the center of the symmetric layered structure. The chemical and field relationships between Type II rocks and cumulus peridotites suggest that the former was crystallized from the melts responsible for the formation of the latter cumulates and residual peridotites.

An inferred P-T history of the Type II mafic rocks is as follows; Type II rocks were initially formed as cumulates at low-pressure conditions, then they had been metamorphosed at high P-T conditions during compression due to subduction or convection within the mantle, and finally they were formed from garnet pyroxenite on ascent.

The most important factor controlling the repetition of symmetrical layered structure in the Horoman complex is not the melting process but deformation processes, because the Type II mafic rocks have a complex P-T history after they were formed as a member of the layered structure. The symmetrical layered structure will be efficiently caused by stretching and folding of a stratified lithological unit, not depending on the melting mode.

These direct petrologic investigations will give us profound understanding of the processes of the recycling of the oceanic lithosphere in the mantle.

Ascending mantle materials almost inevitable cross their solidus and experience partial melting due to a pressure decrease on ascent if an initial temperature is sufficiently high. It has been recently considered that the melting of a heterogeneous mantle consisting of peridotite and mafic (or pyroxenite/eclogite) rocks will cause compositional diversity as well as voluminous character of some magmas. Many orogenic lherzolite massifs show conspicuous heterogeneous features characterized by layered structures consisting of peridotite matrix with mafic (or pyroxenite/eclogite) layers. We need to know how and when the inhomogeneous mantle materials has been produced.

The Horoman Peridotite Complex, Hokkaido, northern Japan, has two specific features; one is the presence of symplectite, and the other is a symmetric layered structure characterized by an arrangement of cumulus peridotite and mafic rock in the middle of a series of residual peridotite with increasing melt component outward. The symmetrical layered structure repeats several times with intervals of several meters to a few hundred meters in the complex (Niida, 1984; Takahashi, 1992).

Symplectite-bearing rocks in the Horoman complex are divided into three types based on the petrography. The first, and the most abundant, is in a kind of mantle restite, clinopyroxene-rich spinel lherzolite and plagioclase lherzolite. The second is in cumulus peridotites. The third is in pyroxenites which occur as thin layers in the mantle restite. Textural and chemical characteristics (both major and trace elements) of symplectites are almost common to them in spite of the differences in their occurrences. Mineral assemblages and chemical compositions of the symplectites suggest that they were generally formed by the decompression reaction between pyrope-rich garnet and olivine. Chemical compositions and constituent minerals of the symplectites systematically change from the lower part to the upper part within the complex. This would be explained by the difference in the P-T trajectory, which is higher in temperature in the latter than in the former as suggested by Ozawa & Takahashi (1995). The presence of symplectite in cumulus peridotite and pyroxenite suggests the presence of primary garnet as a cumulus phase equilibrated at about 2 GPa or more.

The mafic rocks in the Horoman complex have been divided into several types. One of these mafic layers, Type II mafic rock restrictedly occurs in the cumulus peridotite which is located in the middle of residual peridotite with the symmetric layered structure. Some textural characteristics of the Type II mafic rocks are similar to those of the symplectite-bearing pyroxenites in the cumulus peridotite. It is highly possible that the Type II mafic rocks have the same origin as symplectite-bearing pyroxenites, that is the subsolidus breakdown product of garnet-bearing pyroxenites formed at high-pressure conditions to the gabbroic rock at lower-pressure conditions. On the other hand, it is considered that the Type II mafic rocks were formed at lower pressure conditions based on their geochemical signatures (Shiotani & Niida, 1997; Takazawa et al., in press). A kind of Type II mafic layer with coarse-grained corundum was found as a boulder. Textural relationships among minerals of this rock show that corundum was not stable in the Type II mafic rocks at the latest P-T conditions and require that they had experienced heating and/or decompression. The presence of corundum in the Type II mafic rock suggests a possibility that it also ascended as a mantle diapir after it had been metamorphosed under high P-T conditions. A possible P-T history for the Type II mafic layer is as follows: (1) A protolith of the Type II was formed as a cumulate at lower pressure conditions. On the basis of the chemical and field relationships between the Type II and cumulus peridotite, Type II was crystallized from the melts responsible for the formation of the cumulus peridotite. (2) The protolith of Type II rocks had been metamorphosed to garnet-bearing pyroxenite at high P-T conditions during compression due to subduction or convection within the mantle. (3) The complex ascended from the garnet stability field to the plagioclase peridotite stability filed as a diapir. The Type II rocks were formed from garnet-bearing pyroxenite through symplectite-bearing rock due to breakdown of garnet and corundum at low pressures.

A complex P-T trajectory of the Type II mafic rocks after they were formed as a member of the layered structure. This means that the most important factor controlling the repetition of the symmetrical layered structure in the Horoman complex is not the melting process but deformation processes. In my conclusion, the melting process have only an important role in formation of a stratified lithological unit composed of cumulate rock, residual peridotite and primitive peridotite. It is possible that the stratified lithological unit was formed as oceanic lithosphere under a mid-oceanic ridge environment. Lithological features are, however, not exactly consistent with those of the known oceanic lithosphere, although geochemical signature of the peridotite and Type II mafic rocks are consistent with a MORB source mantle peridotite (Yoshikawa & Nakamura, in press) and MORB-like magma (Takazawa et al., in press), respectively. A question where the melting and melt extraction occurred to form the cumulate rocks at the first stage of the Horoman complex is not yet clear.

The Ronda peridotite massif, southern Spain, one of the most famous peridotite massifs in the world, also has similar aluminous garnet pyroxenites (granulite) which contain sapphirine and corundum. An inferred evolutionary history of the aluminous mafic layer in the Ronda massif is almost similar to that for the Type II mafic layer in the Horoman complex. This indicates that the orogenic peridotite massifs are generally composed of peridotite and recycled oceanic crustal rocks.

学位論文審査結果の要旨

森下知晃君の提出論文について，1月28日の第1回審査委員会に引き続き，2月3日に公開発表会，第2回審査委員会を開き以下の結論を得た。

本論文は北海道日高帯最南端に露出する有名な幌満かんらん岩の形成史を，主としてマフィック岩やかんらん岩の産状，鉱物組み合わせ，組織，化学組成などの各種の情報を総合して論じたものである。特筆すべきはこれらの岩石中に新たに，かつて高圧下にあったことを示唆する特徴をいくつか見いだしたこと，そしてそれを海洋地殻のリサイクルおよびマントルの様々なスケールの不均質性の成因といった極めてスケールの大きな話しに発展させたことであろう。この見通しを，同様な性質を持つと思われていたスペインのロンダかんらん岩体でも実証したことも目立った成果の一つである。幌満岩体やロンダ岩体はその露出の良さ，新鮮さから，有力な岩石学・地球化学者により最近詳細に研究されている。そこへ切り込んだ森下君の活躍は目を見張るものがあった。森下君といえばその精力的な野外調査が印象的であるが，博士論文ではそれに加えて，室内での微妙で繊細な作業・解析にもその能力をいかんなく発揮した。その確かなものの見方と，何よりも強い意志に裏打ちされた調査能力は特に高く評価されてよい。また，研究成果の公表や学外での議論などにも積極的であり，研究者としての将来性を高く感じさせる。これらを合わせ考えると，森下知晃君の論文は博士(理学)の学位を与えるのに十分値するものである。