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学　位　論　文　内　容　の　要　旨
Abstract of Doctoral Dissertation

博士の専攻分野の名称　博士（理 学）　　氏　名　シャヤンタニ　チャテルジ
Degree requested　Doctor of Science　　Sayantani Chatterjee

学　位　論　文　題　名
Title of Doctoral Dissertation

Petrological and geochemical characteristics of gabbros drilled at IODP site 1415: Evidence for an enriched mantle source beneath the East Pacific Rise

(IODP 地点 1415 で掘削されたはんれい岩の岩石学的および地球化学的特徴：

東太平洋海嶺下の肥沃なマントルソースの証拠)

IODP Expedition 345 aimed to drill lower crust gabbros at Hess deep rift (East Pacific Rise, 2°14'N-101°30'W), which is located near the junction between EPR and the Cocos, Nazca and Ridge. Lower crust oceanic gabbros were sampled on a about 200 m wide bench located on the intrarift southern slope between 4675 and 4850 m below sea level, and total of 11 holes (1415A to P) were drilled, among which two reached a depth over 110 m below seafloor (Holes 1415J and 1415P; see IODP Expedition 345 Scientific Report, 2013). Primitive troctolites and olivine-rich gabbros were the main lithologies recovered from these two holes. Shipboard data showed a whole rock chemistry with a high Mg# in concordance with their primitive nature. In a MOR system, olivine is a typical primitive mineral and orthoyroxene (Opx) usually appear late in the crystallization sequence, when the magma already reached a significant degree of differentiation. In spite Opx is not expected in any primitive lithology, this mineral is commonly present in Hole 1415P gabbros and associated with olivine. This curious association of cumulate Opx with olivine and other primitive minerals was also observed at a lower extent in some gabbros from IODP Hole 1256D, in the upper Hess Deep crustal section (ODP Hole 894G)

We studied about 70 samples from Holes J and P, and 15 samples from the upper crust (ODP Hole 894G and rubbles from IODP site 1415) for their petrography and mineral chemistry. All samples are olivine gabbros and show an overall cumulate texture with ophitic to subophitic domain consisting of large clinopyroxenes enclosing plagioclase and olivine chadacrysts. Olivine is subhedral to sub-rounded and plagioclase appear as subhedral laths. Beside the main constituent phases in Olivine gabbros, a relatively high content of orthopyroxenes may be observed (≥ 5%). Three types of Opx textures may be distinguished in Opx-bearing olivine gabbros (1) recrystallized corona around olivine, (2) exsolution within clinopyroxene and (3) large prismatic or poikilitic grains. The third type is the most common and overall texture points to a crystallization order starting with olivine and plagioclase, and finishing with clinopyroxene and then orthopyroxene.

In the upper crust, samples are less rich in olivine and mineral chemistry points to relatively differentiated characteristics compatible with a formation by fractional crystallization from a magma a MORB melt having undergone a certain degree of differentiation. In the lower crust, mineral chemistry show systematically primitive characteristics with high olivine forsterite content, clinopyroxene and orthopyroxene Mg# for all samples. Hole J gabbros show a clear evolution from the bottom to the top, with decreasing Mg# and increasing minor and trace elements contents in mafic minerals. Processes dominated by fractional crystallization can explain the genesis of the Hole 1415J gabbroic column. On the other hand, the narrow down hole variation ranges for Mg# in Opx (84-86%), Cpx (86-92%) and olivine (85-90%) in Hole 1415P, together with a a large scatter in minor and trace elements (Ti, Al, Cr, Ni, Mn, Yb, Cs, Zr, etc.), in Cpx and Opx suggests that, at a global scale, the gabbro column were only affected by a moderate degree of differentiation and melt/rock reaction leading to Mg/Fe ratio buffering played a major role in the formation process. However the relatively low Mg# (below 88%) values show that the reactant was rich in relatively differentiated mafic minerals with a general Mg# lower than in mantle rocks. Chemical zoning observed in the ophitic clinopyroxenes show that the crystallization process might be locally dominated by small-scale differentiation.

Calculated compositions for liquids in equilibrium with Cpx and plagioclase, using both minor and trace elements are consistently between the EPR MORB and the Galapagos basalts chemical domains. In contrast, the melt in equilibrium with Opx in Hole P plot out of the MORB and OIB domain and is significantly richer in Ti. Mg# calculations on all the ferro-magnesian minerals show that Opx and olivine are in equilibrium while Cpx has a higher Mg# than the calculated Cpx in equilibrium with Opx These demonstrate that a two phases magmatic process occurred, in association with the melting of a enriched mantle source (similar to that producing enriched basalts at the Galapagos hotspot) to generate EPR lower gabbros: 1) Crystallization of a Mg/Fe ration buffered mush. The melt in this mush originated from an enriched mantle source, melts injected in the mush got buffered by a probable melt-rock reaction process occurring in the underlying troctolites. A certain degree of differentiation may occur in the mantle and troctolites, leading to stronger enrichment but the buffering event erased any chemical evidence of differentiation. The appearances of Opx at an early stage in the crystallization sequence suggest a Si-rich source compatible with pyroxenite melting. 2) Local differentiation leading to the crystallization of zoned Cpx in concurrence with Opx precipitation.

MORB melts crystallizing in Hole 1415J are expelled out from the lower crust to the melt lens located at the top of the gabbro section. Enriched melts crystallizing in Hole 1415P are not observed in the basalts formed at the top of the section, this show that some melts produced in the mantle were not extracted from the basaltic mush to the melt lens. They entirely crystallized in the lower crust and are not expressed at the surface. Our study showed the limitation of the basaltic glasses method, sued up to now in order to calculate a general MORB or enriched mantle source.