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Petrological characteristics of Opx-bearing primitive gabbros from the East Pacific Rise and the Oman ophiolite

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The Mid Oceanic Ridge Basalt is the tectonic window, which provides the geochemical and petrological character of the lower oceanic crust and the process associated with the melt-rock interaction and crystallization. The Hess Deep rift is located in the vicinity of the Galapagos triple junction between the fast spreading East Pacific Rise and the Cocos-Nazca Ridge. Lower crust of Hess Deep is exposed along the southern slope of the intrarift ridge between 4675 and 4800 m depth and was sampled during IODP Expedition 345. Primitive troctolites and olivine-rich gabbros are the dominant recovered lithologies and shipboard data showed a high Mg# whole rock chemistry in concordance with their primitive nature. In a MOR system, olivine is a typical primitive mineral and orthoyroxene (Opx) usually appear late in the crystallisation 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 Hess Deep gabbros and may be 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 ODP/IODP Hole 1256D, in the upper Hess Deep crustal section (ODP Hole 894G), and in the crustal section of the Oman ophiolite (Kahwad and Maqsad massifs) where, in particular, Opx-bearing troctolites coexist with clinopyroxene oikocrysts and Opx-bearing troctolites and amphibole-bearing primitive olivine gabbros.

Three types of Opx textures may be distinguished in Opx-bearing olivine gabbros and troctolites: (1) recrystallised corona around olivine, (2) exsolution within clinopyroxene and (3) large prismatic or poikilitic grains. Prismatic or poikilitic Opx are present at all level of the gabbroic crust, while exsolutions and corona were observed only in the lower crust. The mineral chemical compositions vary more with the structural level than with the lithological type and (Opx-bearing) olivine gabbros from Holes 894G, 1256D and from the upper crust of the Oman ophiolite show more differentiated characteristics than the same lithology in the Site 1415 and in the Oman lower crust. Pyroxenes in all samples from the lower crust show a relatively narrow range of Mg# (from 84 to 86% for Opx and 86 to 89% for Cpx) with large variation of minor elements (Ti, Al, Cr) suggesting a strong influence of melt-rock reaction during their formation. On the other hand, the upper crust samples show a large variation in their ferro-magnesian Mg# (72-87% for Cpx and 70-85% for Opx) together with a relatively weak scatter in minor elements. Poikilitic Opx are more differentiated and associated with lower Fo-olivine. Magmatic crystallisation were then the dominant event in the upper crust, so that Opx is likely to be directly crystallised from magma. In contrast, in the lower crust, magmatic processes were dominated by melt-rock reaction, and the chemical composition and habitus of Opx show that they have been probably formed by reaction between previously abundant olivine and melt.

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