Orthopyroxene in primitive Layered Gabbros from Hess Deep (EPR) drilled by IODP

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At the Hess Deep Rift in the equatorial Pacific at the East Pacific Rise (EPR), IODP (International Ocean Discovery Program) Expedition 345 drilled, for the first time in the history of IODP, coherent cores of the deeper part of the lower, plutonic crust from a fast-spreading ridge. The drilled cores show spectacular modal and/or grain size layering present in >50% of the recovered core, validating for the first time the use of the ophiolite model for interpreting EPR crust. Typical rocks recovered are primitive (Mg# 75-89) olivine gabbros and troctolites. A significant first-order observation from this expedition is that orthopyroxene was found as an abundant cumulus phase in many of the layered primitive gabbroic rocks. This was unexpected, since experiments on the liquid line of descent of MORB show that orthopyroxene always crystallizes late in the sequence of MORB-type systems, in a regime where the melt fraction is low, implying interstitial crystallization. Recovered rocks at Site U1415, however, show orthopyroxene as a prismatic phase in primitive gabbroic rocks and even as monomineralic bands in some primitive gabbronorites.

The Mg#'s of ortho- and clinopyroxenes from 18 primitive gabbroic rocks from Hess Deep vary within a narrow range between 82-90 (clinopyroxene) and 80-86 (orthopyroxene). A good correlation between the Mg#'s of orthopyroxene and clinopyroxene implies a common evolution by co-crystallization/fractionation. Half of all analyses of orthopyroxene show Cr_2O_3 contents ≤ 0.1 wt%, indicating that these orthopyroxenes do not correspond to relics which survived from a melt in equilibrium with mantle. First results on trace element analysis of ortho-, clinopyroxene, and plagioclase in one primitive olivine gabbro drilled by Expedition 345 and in one more evolved gabbronorite from the top of the plutonic section of Hess Deep drilled by ODP Leg 147 reveal chondrite-normalized REE patterns which are very similar for the corresponding minerals. The patterns of the gabbronorite phases are always slightly enriched, compared to those of the primitive gabbro from the base of the crust, implying an origin by fractional crystallization from the same parental melt.