How thick is the oceanic crust?

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As we prepare for very deep drilling of the ocean crust, an important question remaining from the Mohole Project in the early 1960's is, how thick is the ocean crust and what, petrologically, does the seismic Moho represent? Although it is now widely believed that the Moho represents the transition from gabbros to peridotites, the possibility that it represents a boundary between cracked, serpentinized peridotite and fresh, massive peridotite Hess [1962] cannot be ruled out. In fact, the discovery by ODP of both large and small exposures of gabbro and serpentinite on the seafloor (e.g., Cannat [1996]) provides a reminder that the distribution of basalts is not uniform and that the question that Hess posed nearly four decades ago is still with us.

To help answer this question, we first ask how much gabbro should there be at various places in the ocean basins to account for the compositions of the basalts found at the surface? We use data from numerous ODP drill sites to calibrate a simple model of the origin of ocean crust essentially consisting of frozen liquids (basalts plus dikes) and crystals separated from those liquids (gabbro adcumulates; see Natland and Dick abstracts, this volume). This simple model is consistent with numerous independent lines of evidence, including the findings of ODP Leg 147 at Hess Deep, where a virtually continuous and nearly complete section of ocean crust was studies by the offset drilling method [*Natland and Dick,* 1996]. In addition, it is consistent with the chemistry of volcanic rocks and gabbros from other ODP drill holes with good seismic data on layer thicknesses [*Mutter and Mutter,* 1993]. This model suggests that the gabbro fraction of the ocean crust should be proportional to the extent of differentiation of the basalts: where basalts are highly differentiated, as at Hess Deep, gabbro cumulates should be thick, and where basalts are primitive, gabbro cumulates should be thin. Based on basalt compositions, all sufficiently sampled portions of the East Pacific Rise consistently fall short (by ~2 km) of the extent of differentiation required to give requisite thicknesses of seismic layer 3 as gabbro cumulates. Indeed, Hess Deep has one of the smallest misfits. Applying this model to the extensively sampled Mid-Atlantic Ridge gives even larger misfits (2-4 km) between estimated magmatic and seismic crustal thicknesses, even over the Azores platform.

From this model, we conclude that petrologic models of ocean crust presently overestimate the total melt production. At Hole 504B, the deepest ODP penetration into ocean crust, this model favors the notion (see Salisbury et al., [1993] and Collins et al., [1989]) that the mid-crustal region of high velocity gradient and the low-velocity region above the seismic Moho there, represent a sequence from troctolites to serpentinized peridotites. If this is correct, the petrologic base of the crust at hole 504B may be only 0.5-1 km below the bottom of the hole. We do not have to drill all the way to seismic Moho to test Hess's hypothesis.

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