Melt transport and evolution in the shallow mantle beneath the East Pacific Rise: preliminary results from ODP site 895

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ODP Leg 147 drilled 30–94 m long mantle sections at 3 locations 250 metres apart on the intrarift high at Hess Deep where the amagmatic tip of the westward propagating Cocos Nazca Rift breaks into old EPR lower crust and mantle. The stratigraphy of these holes consists of depleted harzburgite tectonite, with protogranular to porphyroclastic texture, cut by dunite. The dunites in many cases successively enclose: troctolite, olivine gabbro, gabbro and magnesian gabbronorite apparently representing compound dykes and melt transport out of the shallow mantle. The sequence is most often partial, with harzburgite typically enclosing only dunite. 145 units were drilled from a few cm to many metres thick. The dunites are believed to have formed by a combination of wall-rock reaction and cumulus olivine precipitation from migrating melt immediately beneath the Moho (*Scientific Party,* 1993). Troctolites range from dunite impregnated by plagioclase crystallized from migrating melt, to cumulates crystallized in the conduits. Olivine gabbros and gabbros in turn, are complex cumulate dykes, axisymetric to the dunites representing sidewall crystallization within the conduits. Site 895 stratigraphy varies laterally: with mostly harzburgite at Holes 895A-D, mostly dunite and gabbroic rocks at Hole 895E; and only harzburgite at Hole 895F. This variation is similar to podiform dunites in ophiolites, suggesting that Site 895 bracketed a local conduit for focused melt flow through the mantle beneath the EPR.

Contacts between harzburgites, dunites and gabbros in the intact Hole 895E section are planar and subvertical when rotated back to their paleoposition, essentially identical to contacts measured in the Hole 894G high level gabbros drilled 9 km to the west on the same tectonic block (*Scientific Party,* 1993). The latter are parallel to the East Pacific Rise when reoriented using down hole logs and paleomagnetic declinations. This indicates that the orientation of the tabular dunites was controlled by the same stress field as that controlling emplacement of the gabbros. The large number of the dunites and their vertical orientation then indicates periodic cracking during melt transport in a finite lithosphere beneath the crust at the EPR causing local focusing of melt flow and the formation of dunite along the walls of the conduit - in effect the mantle melt transport analog to sheeted dyke emplacement in the crust.

The harzburgite tectonites are very depleted, with an average mode of 82.9 vol.% Ol, 15.3% OPX, 1.1% CPX and 0.8% SP, with Fo_{ave} = 90.8 nearly identical to the most depleted SW Indian Ridge peridotites associated with the Bouvet and Marion hotspots (ave. abyssal peridotite has 74.8% OL 20.6 OPX, 3.6 CPX and 0.5 SP). Chemically, however, the Hess Deep harzburgites have 50% less alumina, and lower absolute concentrations of *REE* particularly the heavy rare earths. This would be consistent with the average EPR having either undergone higher degrees of melting due to a higher initial potential temperature than MAR or SWIR mantle, ignoring the possible effects of formation of the dunites on the shallow mantle section, or having a more depleted initial composition. Harzburgite chromian spinel ($Cr*100/(Cr+Al) = 54.0 \pm 2.2$) and the average wollastonite content of CPX indicate that the peridotite was saturated with respect to diopside and melting was limited by the CPX-out melting boundary as at other ridges.

The dunites are slightly more iron-rich than the harzburgites with $Fo_{90.3-89.4}$ while the troctolites and gabbroic segregations are even more iron rich $Fo_{89.6-85.9}$. In contrast plagioclase has a large bimodal range of $An_{98.9-93.9}$ and $An_{88.5-74.7}$, with the more calcic plagioclase found only in the olivine gabbro segregations. *REE* in the segregations of La/Sm and La/Yb expected for equilibrium with the more primitive MORB's dredged from the EPR to the west. The *REE* patterns of the more evolved segregations contain significant negative Eu anomalies and are identical to those of clinopyroxene in the high level Hole 894G gabbros, though they contain far more magnesian olivine and diopside and calcic plagioclase due to buffering by the mantle wall rocks during fractionation of late trapped melt in and around the conduits. Thus, the magmas passing through the shallow mantle conduits appear to have been fully aggregated MORB, rather than fractional melts. The large range in *REE* element absolute concentrations and anorthite content of plagioclase, however, indicate that substantial in-situ fractional crystallization of the melts did occur locally, though the limited range of forsterite contents indicates that the enclosing mantle wall rocks played an important role in buffering melt composition. This, indicates that the composition of MORB passing through the shallow mantle was not constrained by simple phase relations to equilibrium with the mantle assemblage Ol + 2PX + SP, and that melt-rock reaction must have played a significant role in the chemical evolution of MORB beneath the EPR.

We believe that the high anorthite gabbroic segregations represent extensive late melt-rock reaction or melt stagnation in the mantle conduits. Latter reopening of the conduits by intrusion of fresh magma, then, would incorporate the high Mg-diopside and anorthite as xenocrysts. This could explain the presence of such phenocrysts in many erupted MORB's without invoking high pressure melt segregation or fractionation, as has sometimes been suggested.