Seismic images of multiple magma sills beneath the East Pacific Rise

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Abstract

Along fast and intermediate spreading centers, thin and narrow axial magma lenses (AMLs) are detected beneath much of the ridge axis, and the notion that the AML is the primary melt reservoir for dike intrusions and volcanic eruptions that build the upper crust is commonly accepted. However the role of the AML in construction of the lower crust is still actively debated. Some models based on geochemistry and structural observations from ophiolites suggest that formation of the lower crustal gabbro section takes place in situ, from multiple small magma sills, with the AML being the shallowest of these. Here, we present new observations from multichannel seismic data collected in 2008 along the East Pacific Rise (EPR) for seismic reflectors below the AML or sub-axial magma lens (SAML). The most prominent SAML events are found between latitudes 9°20’ and 9°56’N, where they appear as moderately bright, discontinuous reflectors, at ~ 50 to 300 ms (~ 200-600 m) below the

AML. From an analysis of the characteristics of these events, we rule out possible “artifact” origins for the SAML including, seafloor side scattering, out-of-plane imaging of the AML or other crustal horizons, internal multiples, and the presence of a P-to-S converted phase (PAMLS). We interpret these deep melt lenses to have a low crystalline component (i.e. they are mostly molten). Disruptions in the SAML reflector, represented by relatively abrupt steps in two-way travel time are collocated with small-scale discontinuities in the AML and further support the notion of crustal accretion through small magmatic units. In addition, within the area of documented volcanic eruptions in 1991-1992 and 2005-2006, two prominent gaps centered at 9°46’ and 9°50.5’ N in the SAML reflectors are identified. We hypothesize that magma from these deeper lenses have also contributed to the eruption, implying hydraulic connectivity between the AML and SAMLs during eruption events. We suggest that the SAMLs play an important role in eruption triggering and processes of magma lens replenishment and magma fractionation beneath this fast spreading ridge.

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