K132-P002 **Room: Poster Session Hall** **Time: May 17**

Factors governing the upper crustal structures of fast-spreading mid-ocean ridges — insights from ODP Hole 1256D

Susumu Umino[1]

[1] Earth Sci., Kanazawa Univ.

Structures of the upper oceanic crust formed at intermediate-fast spreading rates are characterized by the lava carapace overlying the sheeted dike complex, which extruded and intruded at the ridge axes. Ratios of the thickness of the extrusive to intrusive rocks (Re/i) are higher for faster-spread crust and well inversely correlated with the depth to the Axial Magma Chamber (AMC). Because the AMC depth is determined by the heat balance between hydrothermal circulation and magmatic supply [Hooft et al., 1997], Re/i mainly depends on magmatic supply rate. This paper discusses how the high Re/i = 2.4 formed at the superfast-spread crust drilled at ODP Hole 1256D.

An Ultrasonic Borehole Imager and a Formation MicroScanner measurements conducted in Hole 1256D have shown that the upper 450-m thick extrusive rocks flowed onto the subhorizontal ridge flank and the intermediate 125-m thick pillow lava deposited on the ridge slope, while the lower 239-m thick massive flows were emplaced on the ridge crest [Tominaga et al., 2008]. Thus, more than two third of the extrusive rocks was emplaced off axis. Logging-based lithodensity data and the whole rock compositions show that Site 1256 crust has denser extrusive rocks and sheeted dikes than magmas in the AMC and lacks the Level of Neutral Buoyancy [Umino et al., 2008]. Any dike intrusion will reach the surface and extrude onto the seafloor. Because the ridge crest is so flat and lacks any axial troughs, extruded lava will flow downslope and form a thick off-axial lava pile. The upper crust extends by dike intrusions near the spreading axis, while strain accumulated in the off-axial lava pile is released by faulting.

Development of tectonic features in the fast-spreading East Pacific rise suggests that strain of the upper crust induced by plate spreading concentrates within a 10 km wide zone over the ridge axis. Assuming a 10-km wide volcanotectonic zone on the paleoridge of Site 1256, differential stress accumulates to 3-5 MPa in 2-4 yr at a spreading rate of 22 cm/a, which equals to yield strength of the AMC roof. The amount of strain attains to 22 cm/a X 2-4 yr = 0.5-0.8 m, which equals to or thicker than the average sheeted dike thickness.

Assuming a triangular cross section of the AMC with a height of 100-200 m and a base of 1 km, excess pressure of magma due to buoyancy at the AMC roof is 0.13-0.25 MPa (density contrast between magma and the upper crust = 128 kg/m^3). Therefore, a dike intrusion is triggered by the increase in differential stress within the upper crust by plate spreading. The strain accumulated in the upper crust is released by a 0.5-0.8 m thick dike intrusion. Neglecting along-axis magma flowage, the AMC volume per unit length of the ridge axis is 50-100 km^3/m. As the AMC depth is 350 m for the Site 1256 paleoridge, the volume of a 0.5-0.8 m thick dike attains to 0.2-0.6 vol% of the AMC volume. If the average extrusive to intrusive volume for a single intrusion-extrusion event is Re/i = 2.4, the volume of extruding magma is only 0.4-1.3 vol% of that of the AMC. Thus, the AMC volume, hence the excess pressure will not change during an intrusion-extrusion event.

Magma head at the top of 550-m tall dike from the base of a 200-m thick AMC has an excess pressure of 0.7 MPa. If this excess pressure balances with the elastic stress of the upper crust, the open crack at the surface will be 0.2 m wide. Assuming a Poiselli flow of upwelling magma with a viscosity of 300 Pas (estimated from the glass compositions of quenched lava using MELTS) through the crack, velocity of magma is 6 cm/s. In order to from a 0.5-m thick dike and Re/i of 2.4 at the end of an eruption, the eruption must terminate in 7 hr. Magma upwelling through a crack is stagnated due to cooling in less than 0.5 da at a host rock temperature of 100 degC [Bruce and Huppert, 1991]. This is consistent with the above estimate.