2010 Annual Sheriff Lecture – Student Abstracts

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Major Element Geochemistry of Peridotites from Santa Elena Ophiolite Complex, NW Costa Rica, and Their Tectonic Implications

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The Santa Elena Ophiolite Complex (SEOC) is located on the west coast of northern Costa Rica near the Nicaraguan border. It consists primarily of preserved oceanic crustal rocks and underlying upper mantle thrust onto an accretionary complex. The petrogenesis and tectonic origin of this complex have widely been interpreted to be either a preserved mantle portion of the Caribbean Large Igneous Province (CLIP) as it drifted between North and South America from the Galapagos hotpot into the present-day Caribbean Ocean around 80 Ma, or as the mantle section of the nearby Nicoya complex. Previous structural work suggests that SEOC is a supra-subduction complex, not related to the CLIP or Nicoya (Denyer and Gazel, 2009). Our preliminary results agree. Mantle peridotites collected from the Santa Elena Ophiolite Complex consist primarily of spinel Iherzolite (61 %) with minor amounts of harzburgite and dunite (22 % and 16 % respectively). Spinel Cr# [molar Cr / (Cr+Al)*100] is widely accepted as constraining mantle partial melting and lithospheric melt stagnation (Dick and Bullen, 1984; Dick, 1989). Cr# of spinels within Santa Elena lherzolites fall between 12 and 35, suggesting an extent of 3 % to 13 % partial melting. Cr# of harzburgites range from 35 to 39, suggesting 13 % to 14 % partial melting. This range of partial melting suggests only modest depletion of this exposed portion of the ancient uppermost mantle. TiO_2 concentrations of the lherzolite and harzburgite range from 0.004% to 0.128%, with the exception of one sample, SE10 - 17 (0.258%), and fall within the normal melting trend for mantle peridotites. The presence of dunite indicates that melt flow and associated melt-rock reaction with the surrounding peridotite took place within this portion of the mantle. A Cr# of 84.5 from one of these dunite samples indicates that significant melt rock reaction with refractory melts took place. Such results are rarely found in mid-ocean ridge abyssal peridotite settings and are currently found primarily in forearc tectonic settings (Ishii et al.,

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1992). However, the overall "normal" TiO_2 concentrations in all but one spinel peridotite require, if melt flow did occur, that the melt be nearly depleted in titanium. The relatively low Cr#'s and TiO_2 concentrations of spinel in these peridotites that suggest low degrees of partial melting along with the paleo presence of melt flow and melt-rock reaction by low titanium melts, such as boninites. This situation points toward a young fore-arc model for the tectonic origin of this ophiolite body rather than a preserved mantle portion of the CLIP. Additionally, two lines of evidence suggest SEOC was emplaced prior to the collision of the CLIP with North and South America. The SEOC is 1) capped by a Campanian (83.5 - 70.6 Ma) rudist limestone and 2) lies uncomformably atop Cenomanian (93.6 - 99.6 Ma) radiolarite beds. This suggests that the mantle portion of the SEOC was emplaced and exposed at the Caribbean ocean floor prior to the Late Cretaceous (Campanian), but no earlier than the Cenomanian. This combined tectonic and geochemical evidence suggests SEOC may be a portion of the proto-arc that existed between the Americas in the Cretaceous prior to assault by the CLIP. ■