Comparing onshore and offshore volumes of large igneous provinces associated with passive continental margins

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The rifting of continents can lead to the initiation of seafloor spreading and the formation of passive margins. Magma-rich passive margins, which are defined as being underlain by enormous volumes of igneous rocks, are often associated with large igneous provinces (LIPs). However, the relationship between the igneous units found along these magma-rich passive margins, rifting processes, and LIPs is poorly understood.

We have developed the VOLMIR (VOLcanic passive Margin Igneous Rocks) dataset to investigate these relationships. VOLMIR is based on seismic reflection profiles in which the volumes and geometries of both shallow seaward dipping reflector (SDR) and deeper high velocity lower crustal (HVLC) units can be measured. We find a relatively consistent ratio of SDR to HVLC volumes, with SDR volumes about one third that of HVLC. This consistency suggests that the units are related during formation and may be used to provide insight into how such units form during continental rifting and breakup. Presumably, as magmas rise and erupt to the surface to form SDRs, the remaining high-density residuum or cumulate becomes the HVLC. The volumes of SDR units are moderately positively correlated with distance from the Euler pole, and weakly negatively correlated with distance from the nearest hotspot, suggesting that lithospheric processes play more of a role in late-stage continental rifting and breakup than hotspot/mantle plume processes.

The Mid- and South Atlantic Ocean breakups, and the resulting offshore volcanic passive margins, are temporally and spatially associated with the Central Atlantic Magmatic Province (CAMP) and Paraná-Etendeka LIP. Using VOLMIR, we estimate the amount of igneous material in the offshore volcanic passive and compare it to estimates for the adjacent on-land LIPs. The results indicate that a significant volume of volcanics exist in the offshore passive margins, increasing the inferred amount of volcanic output associated with the LIPs. Further studies will provide insight into the relationship between offshore passive margins and on-land LIPs, and perhaps provide further understanding on the role of magmatism in rifting processes.