Geophysical Research Abstracts, Vol. 9, 04146, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-04146

Geology and Geophysics of the Bermuda Volcanic Edifice and Bermuda Rise: Synthesis and Current Research

P.R. Vogt (1), W.Y. Jung (2), M.C. Williamson (3) and S. Blasco (3)

(1) Marine Science Institute, University of California at Santa Barbara, CA, USA (ptr_vogt@yahoo.com)

(2) Code 7420, Naval Research Laboratory, Washington, DC 20375-5320, USA (jung@qur.nrl.navy.mil)

(3) Geological Survey of Canada, Bedford Institute of Oceanography, P.O. Box 1006, Dartmouth, NS, Canada B2Y4A2 (mwilliam@nrcan.gc.ca, sblasco@nrcan.gc.ca)

Deep-sea drilling of ocean floor during DSDP Leg 43 and on Bermuda itself, together with geophysical data (anomalies in basement depth, geoid and possibly heat flow) and modeling, suggest that volcanism and uplift forming the Bermuda Rise and four volcanoes began during the early to middle part of the Midde Eocene (47-40 Ma). Some authors also attribute 65 Ma igneous activity in Mississippi and 115 Ma activity in Kansas to a "Bermuda hotspot" or plume fixed in the mantle below a moving North America plate. However, such a hotspot/plume would have had tomanifest itself episodically, turning off for up to 25 million years at a time, and/or be heavily influenced by lithospheric structure. Moreover, Cretaceous igneous activity in Texas and Eocene intrusions in Virginia then require separate mantle "blobs".

Bathymetric and magnetic data show the elongation of both the Bermuda volcanoes and Rise along crustal isochrons, and the Bermuda Rise is located mostly within a belt of rougher, thinner crust and seismically "slower" upper mantle—implying possible retention of gabbroic melts at the ancient MAR axis and suggesting the involvement of mantle lithosphere. The Bermuda Rise is also seismically more active than the surrounding crust, possibly reflecting weaker upper mantle. These observations are consistent with numerical models, constrained by available geophysical data, which attribute the Bermuda Rise to some combination of lithospheric re-heating and dy-

namic uplift. While the relative contributions of these processes remain unknown, three features of the Bermuda Rise and volcanic edifices clearly distinguish them from archetype seamount chains such as Hawaii: 1) the Bermuda edifices and Rise are elongated at right angles to the direction of plate motion; 2) there has been little or no subsidence of the Rise and volcanic edifice since its formation—in fact, it appears that Rise uplift continued from the late Middle Eocene into the Miocene; and 3) the small volume of magma, estimated from the size of the volcanic edifices, is inconsistent with the effects of a long-lived mantle plume. However, geochemical studies of over 1000 units of lava flows and intrusive rocks recovered from the Dalhousie University Deep Drill 1972 indicate the presence of a wide compositional gap between shield-building tholeiitic lava flows and strongly undersaturated melilite nephelinites intruded as dykes, similar to what is observed on some “hotspot”-generated seamounts and islands, e.g. Hawaii.

We infer that the Bermuda Rise and other Atlantic mid-plate rises are supported by anomalous asthenosphere, upwelling or not, that penetrates the thermal boundary layer and travels with the overlying North America plate. New CO_2 laser ^{40}Ar-^{39}Ar age data for lava flows and intrusive units recovered from the 1972 borehole provide a test of this hypothesis. We speculate that the “Bermuda event” is linked to a global plate kinematic reorganization, triggered by the closing of the Tethys and the associated gravitational collapse into the lower mantle of subducted slabs which had been temporarily stagnant near the 660 km mantle discontinuity. The widespread onset of sinking slabs required simultaneous upwelling for mass balance. The global plate reorganization was accompanied by increased stress in some plate interiors, favoring magma ascent along pre-existing fractures. This model implies that the Bermuda event and concomitant igneous activity in e.g., Virginia, West Antarctica, and Africa were among such upwellings, but structurally influenced by the lithosphere.

Future geophysical surveys and drilling of a transect of boreholes across and along the Bermuda Rise— elucidating turbidite offlap during rise formation— might discriminate between a widely distributed mantle source and a narrow plume whose head (or melt root) spreads out radially over time, generating an upward and outward expanding swell.