VOLCANIC FEATURES OF THE CENTRAL ATLANTIC OCEAN: TECTONIC AND MAGMATIC MODELS

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Similar to other ocean basins, the central Atlantic Ocean (roughly latitude 10° to 50° N) contains more than a hundred volcanic seamounts grouped in chains, clusters, and individual features. Although the Atlantic Ocean crust has been forming continuously from the Early Jurassic to the present with tholeiitic rift basalts, most of the seamounts were created during the Middle to Late Cretaceous as alkaline basaltic volcanoes, with some continuing activity into recent times.

Basaltic melts from the lithosphere-mantle boundary evolved with Pangaean rifting in the Early Jurassic, progressing from an early magma enriched by continental and older subduction-slab components, into a relatively depleted ocean mantle melt. Sources from wide-ranging homogeneous upper-mantle layers are indicated by intermediate-Ti basalts of the Central Atlantic Magmatic Province, which are all near 200 Ma in age. Dikes of CAMP magmas form distinct, overlapping suites, and sub-parallel swarms that are related to the geometry of Pangaean rifts, and they are not co-magmatic dikes radiating around a common geographic center. Basaltic magmas flowed obliquely within the dikes as they followed propagating fractures for hundreds of km, but the magmas are not interconnected between suites and swarms. There is no evidence for uplift over a “plume center”, and there is no “tail trail” of Jurassic hotspot volcanoes or ocean ridge that proceeds away from any plume center.

In the Cretaceous after 125 Ma, geometrically discrete, chemically undepleted sections of the deeper mantle produced pulses of alkaline magmas to feed numerous widely-separated volcanoes, in both the continents and the oceans. These magmatic events started when entire plates experienced major tectonic shifts in the Cretaceous, related to a change in plate motions as mantle convection and lithospheric rifting moved northward and southward into the Laurasia and Gondwana super-continents. Sub-lithospheric alkaline magmas collected during this event and moved rapidly to the surface along extensional fracture zones and fracture intersections, in the oceans as well as in adjacent continents within the same plates.

The geographic patterns, compositions, and styles of igneous activity of the seamounts contrast greatly with ocean crust magmatism at the mid-ocean ridge. A deep mantle plume cannot be responsible for both the initiation of Early Jurassic sea-floor spreading and the younger alkaline seamounts. All of the magmas are derived from the upper mantle and can be related to mantle convection, depth of melting, lithospheric structures and stress patterns, and plate tectonism.