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Flood and Shield Basalts from Ethiopia: Magmas from the African Superswell

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The Ethiopian plateau is made up of several distinct volcanic centres of different ages and magmatic affinities. In the NE, a thick sequence of 30 Ma flood basalts is overlain by the 30 Ma Simien shield volcano. The flood basalts and most of this shield volcano, except for a thin veneer of alkali basalt, are tholeiitic. In the centre of the province, a far thinner sequence of flood basalt is overlain by the 22 Ma Choke and Guguftu shield volcanoes. Like the underlying flood basalts, these shields are composed of alkaline lavas. A third type of magma, which also erupted at 30 Ma, is more magnesian, alkaline and strongly enriched in incompatible trace elements. Eruption of this magma was confined to the NE of the province, a region where the lava flows are steeply tilted as a result of deformation contemporaneous with their emplacement. Younger shields (e.g. Mt Guna, 10·7 Ma) are composed of Si-undersaturated lavas. The three main types of magma have very different major and trace element characteristics ranging from compositions low in incompatible elements in the tholeiites [e.g. 10 ppm La at 7 wt % MgO (=La_7), La/Yb = 4·2], moderate in the alkali basalts (La_7 = 24, La/Yb = 9·2), and very high in the magnesian alkaline magmas (La_7 = 43, La/Yb = 17). Although their Nd and Sr isotope compositions are similar, Pb isotopic compositions vary considerably; $^{206}Pb/^{204}Pb$ varies in the range of ~17·9–18·6 in the tholeiites and ~19·0–19·6 in the 22 Ma shields. A conventional model of melting in a mantle plume, or series of plumes, cannot explain the synchronous eruption of incompatible-element-poor tholeiites and incompatible-element-rich alkali lavas, the large range of Pb isotope compositions and the broad transition from tholeiitic to alkali magmatism during a period of continental rifting. The lithospheric mantle played only a passive role in the volcanism and does not represent a major source of magma. The mantle source of the Ethiopian volcanism can be compared with the broad region of mantle upwelling in the South Pacific that gave rise to the volcanic islands of French Polynesia. Melting in large hotter-than-average parts of the Ethiopian superswell produced the flood basalts; melting in small compositionally distinct regions produced the magmas that fed the shield volcanoes.

KEY WORDS: *Ethiopia; flood basalts; shield volcanism; superswell*

INTRODUCTION

According to Hofmann *et al.* (1997), most of the Ethiopian flood basalts erupted 30 Myr ago, during

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