Intra-plate magmatism of the Al Haruj Volcanic Field, Libya

SARAH NIXON*, JOHN MACLENNAN AND NICKY WHITE

Department of Earth Sciences, University of Cambridge, Cambridge, CB2 3EQ, UK
(*correspondence: sn340@cam.ac.uk)

The Al Haruj volcanic field covers a 45,000 km^2 area in central Libya. The volcanic field is comprised of a sequence of 6 volcanic phases and a series of lava shields and scoria cones. The volcanic phases were distinguished using ASTER images and field observations. The age of the Al Haruj has been estimated to range from 5.27-0.1 Ma. New ^3He exposure dates on the youngest lava flow extend this age range, revealing recent activity with an age of 2.31±0.81 ka (1σ, n=5). Initial phases of volcanism 1-3, consist of both alkali and tholeiitic basalts which were erupted in close spatial proximity. The younger phases 4-6 can be attributed to better preserved continuous lava flows and show a more consistent geochemical signature evolving from transitional to sub-alkaline lavas.

The alkali basalts are incompatible trace element enriched and isotopically depleted relative to the tholeiitic samples. Fractional crystallisation occurred at depths of 25-39 km and temperatures between 1215-1360°C. 0-4% combined assimilation and fractional crystallisation introduced a heterogeneous crustal component to the mantle melts. Differentiation processes cannot account for all compositional variability. REE inversion modelling predicts generation of alkali and tholeiitic basalts can be accounted for by melting of a predominately anhydrous mixed mantle source in an upper mantle plume with a mantle Tp of ~1460-1480°C. The maximum melt fractions are 18.9 and 13.5%, extracted at depths of 70 and 74 km for tholeiitic and alkali basalts, respectively.

Across North Africa volcanism is predominately of alkaline affinity. The lithospheric thickness influences the melt fraction; small degree (0.5-2.2%), incompatible element enriched melts, are found beneath regions of thicker lithosphere at Hoggar and Air Massifs. These melts are also isotopically depleted. At the Jebel Marra and Tibesti volcanic provinces, values of Vs are lower and predicted melts fractions are larger (4.4-8.2%) and melts are enriched isotopically. The larger melt fractions estimated for the Al Haruj lavas and the abundance of tholeiitic basalts in comparison to other North African volcanic fields is attributed to a higher Tp in addition to the occurrence of thinner lithosphere (<80 km). North African Cenozoic volcanic provinces can be explained by diapiric upwellings or hot fingers originating in the upper mantle. Isotopic enrichment of larger melt fractions may represent a greater proportion of a lithospheric or plume component in the source.

Pb-Sr-Nd systematics of the early Mauna Kea Shield Phase and insight into the Pacific deep mantle

INÊS GARCIA NOBRE SILVA*, DOMINIQUE WEIS AND JAMES S. SCOATES

PCIGR, EOS, University of British Columbia, Canada
(*correspondence: inobre@eos.ubc.ca)

High-precision Pb, Sr and Nd isotopic compositions of 40 basalts from the bottom 408 metres of core recovered during the final phase of the Hawai'i Scientific Drilling Project (HSDP2-B and -C) reveal compositional continuity of the >650 ka stratigraphic record of Mauna Kea volcano, with the majority of the basalts plotting along the 'Kea-mid8' array [1]. Compared to the previous ~3099 m of drill core, the upper 210 m (3098.2 to 3308.2 m) of samples from this drilling phase show very restricted isotopic variations (e.g. 5x and 3x smaller variation for $^{206}Pb/^{204}Pb$ and $^{86}Sr/^{87}Sr$, respectively). This indicates sampling of a more homogeneous source domain during the time interval represented by the eruption of these basalts. In contrast, samples from the deeper 170 metres show the largest range of $^{206}Pb/^{204}Pb$ (18.304–18.693) and $^{208}Pb/^{204}Pb$ (37.923–38.270). These older lavas extend the isotopic record of Mauna Kea both to significantly more radiogenic values, similar to the isotopic compositions shown by 'ancestral' Kilauea lavas [2], and to significantly less radiogenic values, similar to those observed in Mauna Kea and Kohala post-shield lavas [3]. Based on their older ages (> 650 kyr) and compositional characteristics, these basalts likely erupted in the very early shield phase of Mauna Kea, rather than representing part of the output of Kohala or another unknown volcano [4]. Similar to Mauna Loa [5], the earlier stages (older lavas) of Mauna Kea volcanism are isotopically more variable than subsequent stages. Overall, the isotopic heterogeneity in Mauna Kea shield lavas can be explained by mixing variable proportions of four isotopically distinct components intrinsic to the Hawaiian mantle plume: the more radiogenic 'Kea' component, a high $^{208}Pb^*/^{206}Pb^*$ (producing low-SiO_2 basalts) component similar to Loihi, and two components with less radiogenic Pb isotopic compositions. Besides being a common, long-lived component in the Hawaiian plume, 'Kea' has isotopic similarities to the common mantle component 'C'. The fact that it is positioned at the convergence between other Pacific Ocean island basalt groups suggests that 'Kea' is a common composition in the deep mantle beneath the Pacific Ocean basin.

[1] Eisele *et al.* (2003) *G³* **4**, 1–32. [2] Kimura *et al.* (2006) *JVGR* **151**, 51–72. [3] Holcomb *et al.* (2000) *Geology*, **28**, 547–550. [4] Blichert-Toft & Albarède (2009) *EPSL* **282**, 190–200. [5] D. Weis (in preparation)