THE ORIGIN OF THE KOOLAU COMPONENT: EVIDENCE AGAINST THE INVOLVEMENT OF RECYCLED PELAGIC SEDIMENTS

V.J.M. Salters (NHMFL and FSU Geological Sciences) and J. Blichert-Toft (ENS, Lyon, France)

Introduction

Of the Hawaiian volcanoes the Koolua volcano shows the largest range in chemical composition [1-4]. Lavas from the Koolau volcano form the most "enriched" end of the chemical composition spectrum of Hawaiian volcanics. This "enriched" end is characterized by low $^{143}Nd/^{144}Nd$, low $^{176}Hf/^{177}Hf$, low $^{206}Pb/^{204}Pb$, high $^{207}Pb/^{204}Pb$ for given $^{206}Pb/^{204}Pb$ and higher SiO_2-content. It has been argued that materials that have once been at the surface of the Earth now are part of the deep seated plume. Previously the isotope characteristics have been interpreted as being caused by the influence of pelagic sediments [5]. The high SiO_2-and FeO- content of the Koolau basalts are thought to be related to a source with a relatively large pyroxenite component [3]. It has also been argued on the basis of high Sr-content that a gabbroic component is involved [6]. To further determine the source of the Koolau lavas as well as to determine which period of the Koolau eruptive history shows the distinctive chemical signatures a previous rotary drilled water well was cored and analyzed.

Results and Discussion

We determined the Nd and Hf isotopic composition in the drill core. In combination with the Pb-isotopic composition and the trace element data produced by other research groups on these samples, it has become clear that the enriched signature is only present in a small part of the eruptive history of the Koolau volcano. The important trace element signatures for the enriched endmember of the Koolau component is high Sr/Nd, low Ce/Pb ands chondritic La/Nb ratios. The end member also shows only moderate LREE enrichment $Ce/Yb)_N=2$. Although the Koolau volcanics show a relatively shallow slope on a Nd-Hf isotope correlation diagram (indicative of ancient pelagic sediment involvement) the samples with the lowest Hf-isotopic composition also show lowest $^{206}Pb/^{204}Pb$ and lowest $^{207}Pb/^{204}Pb$. The combined Hf-Pb isotope variations are therefore inconsistent with pelagic sediment involvement. This conclusion is supported by the lack of a significant Nb depletion and only moderate LREE enrichment.

With respect to the presence of a pyroxenite component for the enriched Koolau endmember it needs to be noted that the pyroxenite xenoliths that are brought up by the Honolulu Volcanic Series have far more depleted Hf and Nd isotopic compositions than the Koolau endmember (see report in this issue by Bizimis et al). As these pyroxenite xenoliths show textural evidence of having been in the majorite stability field (pressures in excess of 5GPa) [7] there is no doubt that these pyroxenites are part of the plume. However, these pyroxenites are responsible for the enriched isotope characteristics.

Conclusions

Hawaii's most enriched volcanic products do not contain an unaltered ancient pelagic sediment component. In addition, the stark isotopic contrast between the enriched Koolau end member and the pyroxenites makes a pyroxenitic origin for the enriched component unlikely. This supports the earlier conclusions by Stracke et al [8] based on the combined Hf-Nd-Th isotope variations of all Hawaiian lavas.

References

1 M.F. Roden, et al, Earth Plan Sci Lett 69, 141-158, 1984.
2 M.F. Roden, et al, Geochimica et Cosmochimica Acta 58(5), 1431-1440, 1994.
3 E. Hauri, Nature 382, 415-419, 1996.
4 C.-Y. Chen and F.A. Frey, Nature 203, 785-789, 1983.
5 J. Blichert-Toft, et al. Science 285, 879-882, 1999.
6 A.V. Sobolev, et al. , Nature 404, 986-989, 2000.
7 S. Keshav and G. Sen, Geophysical Research Letters 28(18), 3509-3512, 2001.
8 A. Stracke, et al, Geochemistry, Geophysics, Geosystems, G^3 1(1), 1999.