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# The Geochemical Evolution of Hawaiian Magmatism Since the Mesozoic: Evidence from Lavas from the Emperor Seamounts

**Marcel Regelous** (regelous@mpch-mainz.mpg.de)[1], **Albrecht W. Hofmann**, **Wafa Abouchami** & **Stephen J. G. Galer**

[1] Max-Planck-Institut für Chemie, Postfach 3060, 55020 Mainz, Germany

The Emperor Seamount Chain (ESC) in the northern Pacific Ocean was created during the passage of the Pacific Plate over the Hawaiian mantle plume, between about 85 and 43 Ma ago. We measured major and trace element concentrations, and Sr, Nd and Pb isotope compositions of 50 samples from 9 different seamounts along the entire length of the ESC. The samples include tholeiitic (shield stage) and alkalic (post-shield and post-erosional) lavas. Sr and Pb isotope measurements were carried out on leached samples.

There are systematic changes in incompatible trace element chemistry, and in Sr, Nd and Pb isotope composition with age along the ESC. Tholeiitic lavas from the younger end of the ESC (62 - 43 Ma) have incompatible trace element patterns similar to those of tholeiites from the Hawaiian Islands (younger than 5 Ma). However, measured $^{87}Sr/^{86}Sr$ of the Emperor tholeiites (0.70324 - 0.70340) extend to lower values than are found in young tholeiites from the Hawaiian Islands and the Hawaiian Seamount Chain (Lanphere et al., 1980; Basu and Faggart, 1996). Tholeiitic lavas from Detroit Seamount (about 81 Ma) have very different trace element and isotope compositions to all other Hawaiian-Emperor lavas (Keller et al., 1994). The concentrations of highly incompatible trace elements such as Th are about 7 times lower in the Detroit tholeiites compared to tholeiites from the Hawaiian Islands. Chondrite-normalised La/Yb (0.76 - 0.81), and measured $^{87}Sr/^{86}Sr$ (0.70264 - 0.70276) are similar to Pacific mid-ocean ridge lavas. Unlike young Hawaiian lavas, Detroit tholeiites have initial $^{143}Nd/^{144}Nd$ values (0.51303 - 0.51305) which are higher than those of more alkalic lavas from the same seamount (0.51297 - 0.51299). On the other hand, $^{207}Pb/^{204}Pb$ ratios (15.43 - 15.46, measured using a triple spike) are similar to young Hawaiian lavas (15.42 - 15.50), and lower than most EPR MORB (15.47 - 15.58). Tholeiites from Meiji Seamount (about 85 Ma), at the far northern end of the ESC, are not as depleted as the Detroit lavas. However, measured $^{87}Sr/^{86}Sr$ (0.70299 - 0.70333), and $(La/Yb)_{CN}$ ratios (2.00 - 2.16) are significantly lower than those of tholeiites from the Hawaiian Islands, and from Emperor Seamounts younger than 62 Ma.

One possible explanation for the unusual compositions of the oldest Emperor Seamount lavas is that the composition of the mantle material being brought up in the Hawaiian plume has changed with time. Alternatively, variations in the thickness of the underlying lithosphere, or distance to a spreading center (Lanphere et al., 1980) influenced the compositions of Hawaiian-Emperor lavas. The age of the underlying oceanic crust, at the time each seamount was constructed, decreases northwards along the ESC, and the oldest Emperor Seamounts may have been formed on relatively young, thin lithosphere close to a spreading center. The ESC lavas cannot be modelled as melts of mixtures of Pacific MORB mantle and Hawaiian mantle, and this, together with the age progression along the ESC, appears to rule out plume-ridge interaction as an explanation for the depleted compositions of Detroit and Meiji lavas. Lithospheric thickness, which is a function of age, may control the extent of decompression melting of the underlying mantle (Haase, 1996). Beneath relatively old, thick lithosphere, melting is less extensive, and the compositions of the melts formed are dominated by enriched, easily-melted mantle material (Phipps Morgan, 1999). Lavas from seamounts built upon younger, thinner lithosphere are more depleted because they were formed by larger degrees of melting, with a greater contribution from incompatible element-depleted, refractory mantle material. However, this model cannot easily account for the very low concentrations of highly incompatible elements in the Detroit lavas.