The Geochemistry of Hawaiian Plume Dynamics.

M. JULL[1] AND N. RIBE[2]

[1]Woods Hole Oceanographic Institution, Woods Hole, MA, USA, jull@whoi.edu.
[2]Institut de Physique du Globe, Paris, France, ribe@ipgp.jussieu.fr

Magmas erupted along the Hawaiian Island chain provide a detailed source of information about the dynamics and structure of a mantle plume. High resolution major, trace, and isotopic studies of these magmas (e.g., Frey and Rhodes, 1993; Kurz et al., 1996; Sims et al., 1999), in addition to their volume and eruption rate, provide constraints on the degree and rate of melting, the geometry of the melt zone, and the nature and extent of melt extraction in the underlying mantle. Previous coupled geodynamic-geochemical studies (Watson and McKenzie, 1991; Richardson and McKenzie, 1994), did not take into account the asymmetry of the plume caused by the motion of the overlying Pacific plate, or the effect of temperature dependent viscosity on mantle flow. Consequently, these studies could not, for example, use the variability in magma production rate and chemistry from the leading edge of the plume at Loihi, the main stage volcanics at Mouna Loa, and the late stage "rejuvenated" volcanics at Haleakala to constrain the plume dynamics. Any model for the large scale dynamics of the Hawaiian plume must be able to account for the observed variation in melt production and chemistry along the island chain.

Numerical models that include interaction between the mantle plume and the overlying plate (e.g., Ribe and Christensen, 1994; Ribe and Christensen, 1999) have provided an explanation for the variability in magma production rates along the island chain, but there has been no attempt to incorporate calculations of melt chemistry into these models. In order to determine the sensitivity of plume dynamics calculations to constraints from geochemical observations at the surface, we have developed a coupled geodynamic-geochemical model of the Hawaiian plume that builds on the variable viscosity, multi-grid code of Albers (2000). This model takes into account the effect of motion of the overlying Pacific plate, temperature-dependent viscosity, depletion buoyancy, and viscous shear heating, and also allows local grid refinements in the model domain. Preliminary results show that the late stage melting event is sensitive to boundary conditions of the model domain. We will present calculated rare earth element concentrations and uranium series disequilibria [(^{226}Ra/^{230}Th) and (^{230}Th/^{238}U)] from our plume model and thus produce a "map" of the magma chemistry on the overlying plate as a function of position with regard to the underlying plume. These results will be compared to the chemistry of basalts from along the island chain, and recent data from the Hawaiian Scientific Drilling Project. If time permits, we will incorporate chemical tracers from a heterogeneous mantle source into our calculations.

Decadal-Centennial scale climate variations in the Arabian Sea during the Early Holocene

JUNG, S.[1], G. DAVIES[1], G. GANSSEN[1], D. KROON

[1]Institute of Earth Sciences, Free University Amsterdam, De Boelelaan 1085, 1081 HV Amsterdam, The Netherlands, Tel.: 020-4447424, Fax: 020-6462457, e-mail: jung@geo.vu.nl

The monsoonal system in the Arabian Sea area is highly sensitive to seasonal variations in solar insolation and is the subject of this study. Here we show that during the Early Holocene rapid δ^{18}O-change of the surface dwelling foraminifer *G. bulloides* of up to ~0.6 ‰ in Core 905 translates into temperature variations in the Arabian Sea of roughly 2-3°C during summer. Within the resolution of the AMS^{14}C-dating, these inferred temperature changes occur in phase with precipitation induced δ^{18}O-variations recorded in the Hoti Cave in Oman [Neff *et al*, 2001] which are controlled by the monsoonal system. From this relationship we conclude that solar insolation affected the monsoonal system on a regional scale.

In addition we present stable O-isotope data from the benthic foraminifera *C. kullenbergi*. These data record an overall δ—_-reduction by 0.5 ‰ between 10 and ~6.5 kyr BP superimposed upon short-term δ—_-variations at a decadal-centennial time scale. We conclude from modelling experiments that the short-term δ—_-variations between 10 and ~6.5 kyr BP most likely document changes in the evaporation-precipitation balance in the central Red Sea. Changes in water temperature and salinity cause the outflowing Red Sea Water to settle roughly 800 m deeper than today. In summary our results show that the Early Holocene climate in the Arabian Sea was much more variable than previously believed down to a decadal resolution.

References

Neff, U. et al. Strong coherence between solar variability and the monsoon in Oman between 9 and 6 kyr ago. *Nature* **411**, 290-293 (2001).