Geochemical records of anthropogenic change: lake sediments and peat bogs

J.G. FARMER

School of GeoSciences, University of Edinburgh, Scotland, UK (J.G.Farmer@ed.ac.uk)

Radiometrically dated cores of sediments from freshwater lakes and of peat from ombrotrophic bogs have been used to reconstruct the history of heavy element deposition arising from humankind's activities over the past few thousand years. The historical records so obtained for lead, by far the most studied element, are probably the most convincing, with confidence augmented by the corroborative use of source-related stable lead isotope variations and by correspondence with independently derived records, for example from ice cores and archival herbarium mosses. Yet the bottom sediments of freshwater lakes and the living/decaying vegetation and peat of ombrotrophic bogs are dynamic systems with potential for perturbation of historical pollution records through remobilization and redistribution of elements as a consequence of inter-related physical, chemical and biological processes. The natural diagenetic enrichment of arsenic, in association with redox-sensitive iron, sometimes observed in the solid and solution phases of near-surface layers of lake sediments, and the vegetative recycling of nutrient manganese in peat bog surface plants are but two examples. Site-specific conditions, as well as element-specific processes, can be important in the case of both lakes and peat bogs and comparative studies of the two systems, where geographically possible and appropriate, may be additionally revealing. The authenticity of historical records in lake sediments and peat bogs depends also upon the accuracy of radiometric dating techniques, such as those based upon naturally occurring ^{210}Pb, nuclear fallout ^{137}Cs and ^{241}Am, and 'bomb' and cosmogenic ^{14}C, each with its own strength and weaknesses, and the current need for routine application of additional methods (e.g. ^{32}Si) with half-life (~140 y) intermediate between those of ^{210}Pb (22.3 y) and ^{14}C (5730 y).

Dynamics and internal structure of a mantle plume conduit

C.G. FARNETANI [1] AND A.W. HOFMANN[2]

[1]Institut de Physique du Globe de Paris, France (cinzia@ipgp.jussieu.fr)
[2]Max-Planck-Institut für Chemie, Postfach 3060, Mainz, Germany (hofmann@mpch-mainz.mpg.de)

Plumes are often thought of as thermal structures, the key parameter being their excess temperature with respect to the surrounding mantle, while the associated velocity field is frequently neglected. However, in order to understand the structure of a plume conduit and the internal distribution of geochemical heterogeneities we change perspective and focus on velocities and strain rates. Like the hands of an invisible sculptor, velocity gradients constantly modify the shape of heterogeneities rising in the plume conduit.

Numerical simulations of a vigorous thermal plume provide a high resolution velocity field that is used to advect deep-seated passive heterogeneities. Our first objective is to investigate the relation between initial length-scales of heterogeneities across D" and the length- and time-scale of geochemical variations induced in the plume conduit. We also explore dynamical differences between the central and peripheral part of the plume conduit, and calculate the strain rate ε_{rz}, the buoyancy flux and the elongation as a function of radial distance from the plume axis. Our results clearly show that most of the plume buoyancy flux occurs in highly sheared parts of the conduit.

We then concentrate on a 'Hawaiian' plume sheared by a fast moving oceanic plate. Our fully three-dimensional numerical model allows us to study the flow trajectories inside a sheared plume conduit and the deformations undergone by passive heterogeneities. Although our approach is simplistic, we consider the lifetime of a volcano carried by the plate over different parts of the plume conduit and we investigate the relation between heterogeneous structures in the mantle and the spatio-temporal geochemical variability registered by the volcano.