5.1.28

Temporal changes of Cape Verde mantle sources: The Evolution of Santo Antão

P.M. HOLM[1], J.R. WILSON[2], B.P. CHRISTENSEN[1],
L. HANSEN[2], S.L. HANSEN[1], K.M. HEIN[1],
A.K. MORTENSEN[2], R. PEDERSEN[2], S. PLESNER[2] AND
M. K. RUNGE[1]

[1] Geological Institute, University of Copenhagen
[2] Department of Earth Sciences, Aarhus University
(paulmh@geol.ku.dk; jrw@geo.au.dk)

A study on the scale of one island in the archipelago reveals several systematic and significant changes of the mantle source compositions. The 7.5 - 0.1 Ma old volcanics of the northwesternmost Cape Verde Island of Santo Antão show a change from early incompatible element enriched basanite-phonolite series to more enriched nephelinite/melilite nephelinite-phonolite series volcanics all of HIMU OIB type. Mantle melts with around 12 wt.% MgO olivine Fo88 - 91 were derived by 1- 4 % melting of silicate melt enriched sources.

Isotopically the Old Volcanics (> 2 Ma) group can be largely explained by mixing of two components both with relatively radiogenic Sr and unradiogenic Nd of which one is a young HIMU-type source () 8/4 . 0 and) 7/4 . -5). The period 2 - 0.7 Ma saw two component mixing of two other enc members of which one is a young HIMU source with less radiogenic Sr and more radiogenic Nd and) 8/4 . 38 and) 7/4 . -5, which isotopically is similar to the carbonatite end member of carbonatites from the neighbouring island of Sãão Vicente and the sourthern island Santiago. The latetest devolopment shows stronger source enrichment, the most silica undersaturated magmas and an old HIMU-type component () 7/4 > 2). Santo Antão volcanics have no EM1-type enrichment that characterise the southern Cape Verde Island. We argue that the main components of Santo Antão volcanism are plume derived and display a vertical variation in plume composition. The inter island variation of the Cape Verdes may reflect lateral variation of plume composition or, for the southern islands, lithosphere derived components

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Heterogeneity and geochemical reservoirs in the mantle

R.J. O'CONNELL[1], J.B. KELLOGG[2] AND S.B. JACOBSEN[1]

[1] Dept. Earth & Planetary Sciences, Harvard University, Cambridge MA 02138
(oconnell@geophysics.harvard.edu)
[2] Dept. Earth & Space Sciences, UCLA, Los Angeles, CA 90095

Recent models of the isotopic evolution of Nd-Sm and Rb-Sr [1] and U,Th-Pb [2] in the mantle have indicated the essential role of the development of heterogeneity in the mantle during differentiation, crustal growth and recycling. In the models, mantle heterogeneities result from the residues of oceanic and continental crust formation, and from recyling of crustal material. These evolve isotopically with time according to their composition, and their length scales are reduced owing to deformation in the mantle; this process is paramaterized in terms of a characteristic time of the order of hundreds of My. The scale of recycled crustal components becomes smaller than a km after a few characteristic times and hence their compositions are likely to be well averaged during melting beneath ridges. Residues of crustal formation are initially larger than recycled heterogeneities, and may survive as blobs larger than ~20 km for 1 Gy, and create distinct signatures in ridge basalts.

The controls on the evolution of heterogenieties is thus an important question in understanding oceanic basalt compositions and heterogeneity. Viscosity is a primary control. High viscosity dehydrated oceanic lithosphere would thus be more likely to maintain a larger length scale than hydrated material. Higher viscosity regions beneath the asthenosphere would deform more slowly, and heterogeneities there would maintain larger length scales. Plumes from beneath the asthenosphere may show more heterogeneity owing to the larger size of heterogeneities in their source region.

The strain rate in the upper mantle is high because of plate motions and a toroidal flow field. Consequently, in the upper mantle heterogeneities should evolve to smaller sizes faster than when in the lower mantle. The migration of ridges and trenches at ~2 cm/yr causes the uppermost mantle to be sampled by melting with a time scale of ~500My. The corresponding time scale for the whole mantle to be sampled by ridges is 10 times longer. The upper mantle should thus have smaller heterogenities and be more highly processed by ridge melting than the deeper mantle., which may have larger heterogeneities as well as a different mix of original, depleted and recycled material.

References

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