Magma system processes constrained by mineral-scale isotope variations

JON DAVIDSON[1], FRANK TEPLEY III[2], JOHN HORA[3] AND KURT KNESEL[4]

[1]Dept of Geological Sciences, U. of Durham, South Rd., Durham, DH1 3LE, UK, j.p.davidson@durham.ac.uk
[2]Dept. of Geology, U. of Illinois, 1301 Green St.,, Urbana, IL 61801, USA, tepley@uiuc.edu
[3]Dept. of Earth & Space Sciences, UCLA, Los Angeles, CA 90095, USA, jhora@ess.ucla.edu
[4]Dept. of Earth Sci., U. of Queensland, St Lucia, Brisbane, Qld 4072, Australia, kknesel@earth.uq.edu.au

The cogenetic relationship between volcanic phenocrysts and the matrix or glass in which they are hosted has recently been increasingly called into question. Long-standing petrographic observations indicative of disequilibrium are now supported by crystal isotope stratigraphy studies in which the isotopic ratios of crystal cores are shown to differ from both crystal rims and bulk rock. Variations in initial ratio among crystal phases are arguably the most convincing evidence for open system evolution during crustal differentiation. In such cases, which are apparently common, the bulk rock isotope characteristics clearly do not faithfully reflect those of a mantle source.

Plagioclase crystals from Chaos Crags (Lassen, CA) and El Chichon (Mexico) and K-feldspar crystals from Taylor Creek (NM) have high $^{87}Sr/^{86}Sr$ cores and low $^{87}Sr/^{86}Sr$ rims, underscoring the general importance of recharge in magmatic systems. Implicit in such an interpretation is the fact that the resident magma is already contaminated. Growth from a progressively more contaminated magma may be reflected in plagioclase crystals from Ngauruhoe volcano (New Zealand), for which rim $^{87}Sr/^{86}Sr$ are commonly higher than those of the cores. In all cases however, the crystals do not unequivocally record the compositions of primitive (uncontaminated) magmas involved in the system.

The slow diffusion rates of Sr in feldspar, even at magmatic temperatures, may allow magmatic differentiation pathways to be recovered from plutonic systems also. Core-rim variations in feldspars from the Rum intrusion (Scotland) are consistent with growth from a primitive magma undergoing contamination, followed by cooling that was sufficiently rapid to prevent isotopic equilibration over distances of ~1mm. An improved understanding of diffusion rates for Sr, Nd and Pb in igneous mineral phases might allow crystal isotope stratigraphy to be used as a general tool to determine residence times and cooling rates. A corollary of the common occurrence of variable $^{87}Sr/^{86}Sr_i$ among mineral phases in volcanic and plutonic systems is that the precision and accuracy of Rb/Sr isochrons for ancient igneous rocks might be compromised.

Abrupt climate change in N-Africa: the asynchronous termination of the African Humid Period

G. R. DAVIES*, JUNG, S. J. A., *, G. M. GANSSEN*

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

NE-Africa and Arabia are foci for early prehistoric civilisations and these regions are controlled by the Asian and African monsoon that are among the most fragile parts of Earth's climate. General links between climate and human prehistoric evolution have been proposed but there are few climate data from these regions with a decadal/centennial time resolution. Consequently it is difficult to unambiguously relate human socio-cultural evolution to climate change. Based on the Sr-Nd-isotope records of the lithic sediment fraction from sediment Core 905 (~1600 m water depth, NW Arabian Sea off Somalia) we established that there is no provenance change in aeolian dust supply. Marked variation in Sr-isotope ratios are used to deduce in detail the Holocene weathering history of NE Africa. We show that the Early Holocene (10-6 ka) was generally more humid than today (African humid period - AHP) but that there were three centennial scale arid-humid oscillations each punctuated by even shorter events. A dramatic change towards dryer conditions between 6 and 3.8 ka BP marks the end of the AHP and dry conditions prevail over the last 3.8 ka. Comparison of the weathering data from the Arabian Sea with sediments off NW Africa (deMenocal *et al*, 2000) and continental records (e.g. Lamb *et al.*, 2000) demonstrates that the AHP termination occurred ~1500 years later in NE- than in NW-Africa. We propose that the asynchronous termination of the AHP may result from a "continent-constellation"-effect that is stronger in NE-Africa and facilitates a longer northward shift of the major rainfall belts. The detailed climate record from Core 905 provides a reference frame to which human socio-cultural evolution in Africa can now be compared and may improve the understanding of prehistoric human development in NE Africa.

References

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