The Cause of Carbon Isotope Minimum Events on Glacial Terminations

HOWARD J. SPERO[1] AND DAVID W .LEA[2]

[1]Department of Geology, University of California Davis, California, USA (spero@geology.ucdavis.edu)
[2]Department of Geological Sciences, University of California Santa Barbara, California, USA (lea@geol.ucsb.edu)

A persistent feature of planktic foraminifera carbon isotopic records from the Indo-Pacific, Subantarctic and South Atlantic are $\delta^{13}C$ minima at the beginning of deglaciations. We use the $\delta^{13}C$ record of a thermocline dwelling foraminifera, *Neogloboquadrina dutertrei*, and Mg/Ca based surface temperature estimates from a surface dwelling species, *Globigerinoides ruber*, in eastern equatorial Pacific core TR163-19 (2°15.5'N, 90°57.1'W, 2348 m water depth) to demonstrate that the initiation of Southern Ocean warming and the last $\delta^{13}C$ minimum event (^{14}C age of 16,630 ± 50 ybp (70 cm), equivalent to 19.8 ± 0.3 calendar ky) occur simultaneously (within the age resolution of the core). Timing agreement between the marine $\delta^{13}C$ event and an atmospheric $\delta^{13}C$ minimum in Taylor Dome ice core, Antarctica, suggest the $\delta^{13}C$ minima events initiate with the end-glacial termination of surface water stratification and renewed Circumpolar Deep Water upwelling and advection of low $\delta^{13}C$ waters to the convergence zone at the Subantarctic front. Based on age agreement between the absolute $\delta^{13}C$ minimum in *N. dutertrei* (^{14}C age of 13,250 ± 40 (53 cm), equivalent to 15.9 ± 0.2 calendar ky) and the low to high $\delta^{13}C$ shift from previously published benthic foraminifera data in deep South Atlantic cores, we propose that the event end, as defined by a sign change towards positive values, was due to the arrival of North Atlantic Deep Water at the polar front.

Highway to Hell: geochemical consequences of channelized melt transport

MARC SPIEGELMAN[1] AND PETER B KELEMEN[2]

[1] Dept. of Earth and Environmental Sciences, LDEO, Columbia University, Palisades, NY 10964, USA, (mspieg@ldeo.columbia.edu),
[2] Woods Hole Oceanographic Institution, Woods Hole, MA, 02543 USA, (peterk@whoi.edu)

The transport of melts from their source regions to the surface is a fundamental process affecting the composition and spatial variability of lavas, residues and melt inclusions. An outstanding question remains, however, as to the diagnostic, observable consequences of melt transport. While it might be expected that melt transport leads to a reduction in chemical variability due to enhanced mixing, both field evidence and recent calculations suggest that melt transport processes can preserve large chemical variations on small length scales and may actually enhance variability through the development of a channelized melt transport network.

We review observations of chemical variability in lavas and melt inclusions from mid-ocean ridges and show that these systems display large trace-element concentration variability with little obvious spatial correlation on all scales from 1000 km of ridge down to the hand-sample scale measured in melt inclusions. While some of this variability is due to source variations, we suggest that a large component could be the consequence of magma transport in channelized systems. We also review field evidence from ophiolites that suggests that "replacive dunites" are a likely candidate for such channels.

To explore these problems, we present numerical models that calculate the physics and chemical consequences of channel formation by reactive magma transport. We show that channelized flow can produce orders of magnitude variation in the concentrations of highly incompatible elements, even for idealized systems with a homogeneous source, constant bulk partition coefficients and equilibrium transport. Most importantly, the full range of variability is found in each channel due to advection of highly depleted melts from the inter-channel regions into the edges of the channels. As these channels may be spaced on scales of 1-100 m in the mantle, this mechanism allows highly variable melts to be delivered to the Moho on very small length scales and provides an explanation for the extreme variability seen in melt inclusions. We show that the chemical variation produced in the models is consistent with a range of observations. Time permitting, we discuss new models that include the effects of depth-dependent partition coefficients and consequences for U-series disequilibrium.