Global patterns of dust deposition deduced from dissolved Al in the surface ocean

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High resolution dissolved aluminium data (Al) from surface waters obtained during the CLIVAR repeat hydrography program is being used to create a global map of dust deposition to the surface of the oceans. The results so far show generally good agreement with the existing GESAMP predictions of oceanic deposition that were based on land based aerosol sampling. In some regions though we see evidence of surface water dust input that is not represented in current atmospheric deposition models, notably the southern Indian and Pacific oceans, downwind of Australia. Additionally, in the NW Pacific the models appear to be overestimating dust deposition. High resolution depth profiles along the CLIVAR cruise tracks show preferential imprinting of the sub-tropical mode waters formed in the western parts of the Pacific and Atlantic Ocean. These sub-surface signals result from the subduction of surface water labeled with Al by dust deposition in the mode water formation regions. Thus the Al signal may be a potential paleo proxy of the mode water formation process. The GEOTRACES sampling program which will incorporate multiple trace element and isotope sampling across geochemical gradients, will help identify new geochemical tracers of processes such as atmospheric deposition. These new tracers will constrain our understanding of both contemporary geochemical processes in the ocean as well as forming the basis of new paleo proxies of physical and biological processes.

Composition of low-degree hydrous melts of fertile spinel- or garnet-bearing lherzolite

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We have experimentally determined the composition of low degree hydrous mantle melts in equilibrium with spinel and garnet-lherzolite mineralogy around 1050-1100 °C at 1.0 and 2.0 GPa. The maximum amount of water that can be stored in upper mantle lherzolite is about 0.5 wt% [1]. This water is mostly stored in amphibole and will be released by amphibole breakdown (between 1050 and 1100 °C in fertile mantle compositions; [2]) inducing partial melting of the mantle. Amphibole breakdown thus marks the lowest possible temperature where melting occurs in the absence of a free fluid phase.

Experimental melts produced by amphibole breakdown are in equilibrium with olivine, orthopyroxene, clinopyroxene, and either spinel (1.0 GPa) or garnet (2.0 GPa). Comparison with subsolidus experiments allows calculating amphibole breakdown reactions:

1 amph + 0.2 opx = 0.2 ol + 0.4 cpx + 0.01 sp + 0.4 melt
amph + opx = ol + cpx + gt + melt (preliminary)

in the spinel and garnet stability fields, respectively.

Melt compositions are very similar to the compositions of low-degree melts of dry lherzolites (e.g. [3]). However, similar melt compositions (in terms of Si, Al, Mg contents) are obtained at much higher degrees of melting, resulting in lower incompatible element (e.g. Na and K) concentrations, and thus less pronounced silica-undersaturation.

Although silica-rich, experimentally produced melts are compositionaly far from typical high-Mg andesites, being much less magnesian at a given silica content, and too rich in alkalies. This strongly suggest that high-Mg andesites cannot be produced by fluid-absent melting of fertile (or even worse, metasomatized) mantle. Instead, generation of mantle derived high-Mg andesites requires high-water content (water-saturation = flux melting process), and high degrees of melting of a depleted mantle source (harzburgite).

[1] Schmidt & Poli (1998) *EPSL* **163,** 361-379. [2] Niida & Green (1999) *Contrib. Mineral. Petrol.* **135,** 28-40. [3] Hirschmann *et al.* (1998) *Geochim. Cosmochim. Acta* **62,** 883-902.