Water delivery from the outer planetary system: The role of dynamical instabilities

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Water abounds in the outer regions of planetary systems. Indeed, comets, which are the leftover building blocks of the giant planets, are roughly 40% water by mass. Thus, these regions can furnish a significant amount of water to terrestrial planets provided a dynamical mechanism exists that can transport enough material inward.

In recent years it has become recognized that planetary systems can become dynamically unstable, leading to a violent redistribution of the planetary orbits. Indeed, we see evidence of such instabilities in some of the extra-solar planetary systems thus far discovered (Rasio & Ford 1996). These events, which can occur quite late in the history of a planetary system, can liberate a large amount of water rich objects and deliver them to the inner planetary system where they can strike the terrestrial planets.

Such an event may have occurred in our own Solar System. Many of the large basins on the Moon formed ~700Myr after the beginning of the Solar System – much too late for the impactors to be the leftovers of terrestrial planet formation (Bottke *et al*. 2007). The model that has been the most successful at reproducing the characteristics of these basins is one where the orbits of Uranus and Neptune became unstable, sending a large amount of icy material into the inner Solar System (Gomes *et al*. 2005). Such an event would have contibuted roughly 5% of Earth oceans. Also, it would have contributed enough icy material to Mars to explain its putative early massive atmosphere (Levison *et al*. 2001).

More details on this talk can be found at www.boulder.swri.edu/~hal/talks.html

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Volatiles and Boron isotopes analysis in olivine-hosted melt inclusions from Vulcano (Italy) and Pichincha (Ecuador) lavas

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We have analysed in-situ major and trace elements (electron probe, LMV, Clermont Ferrand, France), as well as volatiles and boron isotopic compositions (ion probe, 1280 WHOI, MA, USA) in olivine-hosted primitive melt inclusions (MI) in basic lavas of two volcanoes from two different subduction settings:

1- The Ecuadorian subduction zone is controlled by the subduction of the Nazca plate beneath South America. The collision of the Carnegie aseismic ridge disturbs the subduction, flattens the slab (small dip from 20 to 30°) and controls the surface expression of active volcanism. Slab melt takes part in the formation of these lavas and some adakite occurrences have been described.

2- The Aeolian arc lavas are thought to represent typical examples of island-arc calc-alkaline magmatism. The tectonic setting of the Tyrrhenian Sea is dominated by the convergence between the European and African plates. The Aeolian arc is related to the subduction of the oceanic Ionian plate beneath the Tyrrhenian Sea (strong dip around 50 and 60°), actually in eastward migration.

Primary MI are at equilibrium with their host minerals, so they preserve information on the composition of intermediate steps in the formation of magmas. In particular, MI in the early-formed olivine phenocrysts have been proposed to be pristine samples of mantle-derived melts that were trapped prior to mixing at shallower levels. Moreover, unlike lavas, MI keep their primitive volatile content.

The MI from these two different settings are CaO-rich and nepheline-normative. These compositions have been interpreted as the result of melting of a lower crust clinopyroxene-rich lithology (Schiano *et al*., 2000)

$\delta^{11}B$ in MI range from –5.0±1.0‰ to +3.0±1.0‰ for Vulcano, and from –18.8±1.0‰ to +9.5±1.0‰ for Pichincha) which suggest heterogeneous sources for the two volcanoes. MI from Vulcano are enriched in H_2O and Cl, and those from Pichincha are enriched in CO_2, F and S (Vulcano: 0.95 to 3.50% H_2O, 80 to 170 ppm CO_2, 805 to 910 ppm F, 3000 to 3500 ppm Cl and 2000 to 2400 ppm S; Pichincha: 0.1 to 1.5 % H_2O, 130 to 800 ppm $C0_2$, 100 to 400 ppm F, 200 to 700 ppm Cl, 500 to 2500 ppm S; relative errors are equal to or less than 5%). We will discuss the results in terms of source variation and input from the slab.

Reference

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