Magmatic Inclusions in Minerals Address Major Challenges in Earth Sciences

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The information on the contents of volatile and other highly mobile elements and their isotopes in the mantle and crustal magmas is crucial in addressing such major challenges in Earth science as (1) evolution of mantle-crust system over the time; (2) onset of plate tectonics on the Earth; (3) the source and contents of H_2O in the Earth mantle. However, this information is only partially available from fresh submarine glasses mostly of Cenozoic age and is almost completely missing for Precambrian Earth. Fortunately, such information is preserved within inclusions of melt in phenocrysts partly protected by host minerals from the mass exchange with an external system. Such inclusions can preserve original contents of H_2O and D/H ratios before major degassing events, trace elements including Pb and Sr concentrations and their isotopes unaffected by later magma mixing, contamination and postmagmatic alteration.

In this presentation, we will summarize some published and new data on melt inclusions in minerals which provide constraints in resolving major challenges in the Earth Sciences. In particular, using data for melt inclusions in olivines we will show the presence of significant excess of H_2O and Cl and depletion of Pb in the deep mantle sources of komatiites of ages of up to 3.3.Ga. These data suggest global recycling of crust to the deep mantle starting at least since 3.3 Ga and provide evidence for the source and contents of H_2O in the mantle transition zone. We will remind crucial role of melt inclusions study in understanding of H_2O recycling in subduction zones, obtaining of ages and composition of recycled crust in the sources of mantle plumes, and in the deciphering of dynamics of melt separation under mid-oceanic ridges. All these achievements rely mostly on the study of magmatic inclusions in minerals despite well-known potential problems of this approach: the possible partial exchange between melt inclusions and external system by rapidly diffusive elements (e.g. D, H and major elements of host mineral) and possibly unrepresentative sampling. If time will permit, we will show that these problems in most cases could be well recognized and successfully resolved.