The myth of a highly heterogeneous Hf-Nd Eoarchean mantle and large early crustal volumes

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One of the most fundamental and long-standing problems in Earth Sciences is the question of continental growth. Despite decades of work on this problem there is still no consensus on when the continents formed, what were the mechanisms of their formation, and how they have evolved through time. Resolution between the competing models requires insight into the earliest Earth, but the window into this critical time period is far from clear.

One reason for this uncertainty is the lack of old rocks in the geologic record. Crust older than 3.5 Ga constitutes less than 2% globally and the crust that remains is often a complicated mixture of components with different ages and isotopic compositions. Without an accurate integration of age and isotopic composition, analysis of these complicated rocks can yield meaningless information about Earth evolution.

Our solution is to integrate age and Hf isotope data from zircons of the Earth's oldest rocks. We do this using the laser ablation "split stream" technique whereby the aerosol from the zircon laser ablation is split to two mass spectrometers: one to determine U-Pb ages and the other to determine its corresponding Hf isotopic compositions. In this way we can unambiguously determine age and Hf isotopic composition on the same zircon volume.

Using this approach we find that the isotopic record for rocks older than 3.5 Ga is much less variable than has been recently claimed. Two features stand out from these data. First, there are very few samples with ε_{Hf} values significantly above zero prior to 3.5 Ga, indicating the lack of a widespread depleted mantle before 3.5 Ga. Second, while there are negative ε_{Hf} values for some ancient zircons, consistent with recycling of early-formed crust, the lack of a complementary depleted mantle reservoir from 4.4 to 3.5 Ga indicates that the volume of this early enriched (not necessarily continental) crust was modest. We conclude that widespread continental crust formation did not begin in earnest until ca. 3.5 Ga. This is consistent with both the preserved crystalline rock record and the ages of detrital zircons in the sedimentary record.

Hydrogeochemical study of the multi-aquifer system of the Sibari Plain (Calabria, Southern Italy)

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The groundwaters hosted in the Sibari Plain multi-aquifer system are heavily exploited through a large number of wells drilled for agriculture. Similar to many other coastal areas, this excessive groundwater extraction has led to intrusion of seawater. To understand the extension of this phenomenon and adopt suitable actions, a multidisciplinary approach was applied in this investigation, which is carried out in the framework of a PON project: "*Study for the environmental protection and the mitigation of anthropogenic pollution in the coastal environment of selected areas of Calabria*".

Hydrostratigraphic correlations, water level measurements, field determinations (electrical conductivity, temperature, pH) and laboratory chemical and isotopic analyses were carried out for 100 selected wells. In particular, high conductivity values, even >4 mS/cm, and high chloride contents, up to 1,200 mg/l, were measured in several groundwater samples (Figure 1). Interpretation of geochemical data is complicated by both the dissolution of Miocene evaporite deposits, which generates aqueous solutions with characteristics similar to those dictated by seawater ingression, and the occurrence of other processes, such as bacterial sulfate reduction and ion exchange [1, 2].

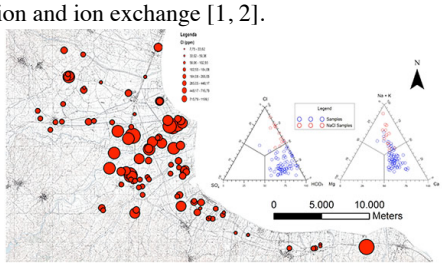

Figure 1. Map of Cl^- concentrations in the wells of the study area and triangular diagrams of major anions and cations.

[1] Apollaro *et al*. (2012) *Geochemical Journal*, **46** (2), 117-129.[2] Vespasiano *et al*. (2012) In *Rendiconti Online Società Geologica Italiana* **21** (2) , pp. 841-842

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