

Noble gases composition of palaeo Archaean atmosphere and mantle

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Several models of the noble gas evolution of the Archaean atmosphere-mantle exist [1, 2, 3], with implications on our understanding of the development of the early Earth and the appearance of life.

Pristine drill core samples (Pilbara Drilling Project) from the 3.525 Ga chert-barite of the Dresser Formation (North Pole, Western Australia) allowed fresh samples preserving primary fluid inclusions unaffected by surface weathering to be directly analysed using synchrotron and mass spectrometer methods. The Dresser formation has been interpreted as a shallow basin strongly affected by hydrothermalism practically during formation of the basin and prior to early diagenesis [4, 5]. This chronology permitted primary fluids from different origins (marine, hydrothermal) to be trapped within the volcano-sedimentary sequence.

Two studies, one of intrapillow quartz pods overlying chert-barite deposits [6], and the other of the same formation but 100 m deeper, have been carried out. Synchrotron X-ray microfluorescence shows the presence of three fluid endmembers (in different proportions) in fluid inclusions in quartz. Two of them, enriched in Ba and/or Fe, are likely to originate from the hydrothermalism while the third, metal-depleted, fluid is the North Pole seawater endmember. Primary fluid inclusions from the bottom of the Dresser formation are dominated by hydrothermal fluids, which allow us to constrain the noble gases hydrothermal signature.

Inclusion-trapped fluids were analysed by mass spectrometry (using a Helix Multicollector) following extraction of the fluids by in vacuo crushing. Neon isotopes, ³⁶Ar and ⁴⁰Ar, ⁸⁴Kr, ¹²⁹Xe, ¹³²Xe and ¹³⁶Xe were measured in fluid inclusions and in the host matrix. The results show mixing between two fluids, confirming previous studies. The Seawater pole reveals the composition of the palaeo atmosphere thus it is possible to determine the composition of palaeo archaean mantle within the signature of hydrothermal fluid.

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Constraining groundwater residence times in a fractured aquifer using noble gas isotopes

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In fractured rock aquifers, groundwater ages obtained with environmental tracers usually do not represent the hydraulic age of the water. Solutes in the water have diffusive access to the micro pores of the rock matrix and are therefore retarded compared to the water flux in the fractures. In a system of parallel fissures, the ratio between the apparent tracer age and the water age depends on the extend of diffusive penetration between the fractures and the matrix. Visa versa is the penetration depth in transient conditions a function of the groundwater residence time in the fractures (Maloszewski and Zuber, 1994). This intrinsic dilemma for groundwater dating can only be reduced by the use of multiple tracers with different decay constants and input histories. In the present study ⁸⁵Kr (T_{1/2}: 10.76 yr, ³⁹Ar (T_{1/2}: 269 yr) and ¹⁴C (T_{1/2}: 5730 years) were used in order to constrain the groundwater residence times in a fractured aquifer in the Clare Valley Australia (Love *et al.*, 1999). In the atmosphere ³⁹Ar is mainly produced by cosmic ray induced ⁴⁰Ar(n,2n)³⁹Ar reactions. In this study the subsurface secular equilibrium ³⁹Ar activity due to the ³⁹K(n,p)³⁹Ar reaction exceeds the atmospheric value of 1.8 mBq/L Argon (Loosli, 1983) by a factor of two. The subsurface ingrowth rate can, however, be interpreted in terms of groundwater residence time. The obtained time scales support findings from indicators of past recharge conditions. (Love and Herczeg, 2001).

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