Long-distance transport of North Gondwana Cambro-Ordovician sandstones: Evidence from detrital zircon Hf isotopic composition

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A voluminous Early Paleozoic sequence of quartz-rich sandstones was deposited in northern Gondwana following its assembly during the Neoproterozoic-Cambrian Pan-African Orogeny. Field evidence for the sense of transport indicate that sediments were carried from Gondwana hinterland towards the supercontinent margins in the North (present coordinates). Derivation from Pan-African terranes is evident from the ubiquity of detrital zircons with Neoproterozoic U-Pb ages, but the exact provenance of these siliciclastic deposits remains unclear. Herein we present new Hf isotopic data from U-Pb dated detrital zircons of the Cambro-Ordovician sandstone that top the juvenile Neoproterozoic basement of the Arabian-Nubian Shield in Israel and Jordan. Remarkably, the detrital zircon Hf isotopic signal stands in marked contrast with Nd and Hf isotopic signature of the underlying basement. A preponderance (61%) of the Neoproterozoic-aged detrital zircons from the Cambro-Ordovician sandstones in Israel and Jordan yielded negative $\varepsilon_{Hf(t)}$ values incompatible with a juvenile source. Therefore, rather than from the adjacent Arabian-Nubian Shield, most of the detrital zircons were derived from distant terrane(s), comprising pre-Neoproterozoic crust reworked during Pan-African orogeny. Because our sampling sites are situated at the northern tip of the Arabian-Nubian Shield, sand must have been transported several thousand kilometers before deposition. This finding also implies that the Arabian-Nubian Shield and other Pan-African orogens of NE Africa were completely warned down by the onset of Cambro-Ordovician deposition and that vast areas in the northern part of Gondwana were then low-lying such as to allow transfer of sand across the continent.

Macroscopic anhydrite interacted with Pb-doped solutions

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Pb is a toxic metal that affects the vital functions of living organisms. A previous study showed that Pb sorption by gypsum is an effective uptake mechanism [1]. Here the ability of anhydrite to uptake Pb from aqueous solutions is evaluated and its effectiveness as Pb-remover compared with that of gypsum. Experiments were performed by placing 2g of crushed pure anhydrite in 100 mL of Pb-bearing aqueous solutions (ranged from 10 to 1000 mg/L) and, after specific reaction periods (1 minute to 5 weeks), analyzing the aqueous solution and examining the solids formed on the surface of the anhydrite crystals. DRX data revealed that anglesite formed on anhydrite after short interaction periods (Figure 1). ICP-OES analyses showed that when the initial Pb concentration, [Pb]ini, was ≥ 50 ppm, it decreased very rapidly to reach a constant value (≈ 5 ppm) after about six hours. The evolution of the solution composition is consistent with a coupling between anhydrite dissolution and anglesite precipitation. Our results indicate that anhydrite and gypsum surfaces have similar ability to remove Pb from aqueous solutions.

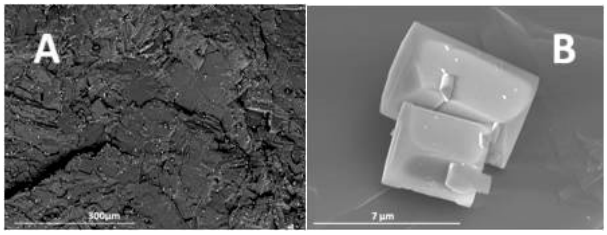

Figure 1: SEM images of anhydrite surface after interaction with a Pb-bearing aqueous solution ($[Pb]_{ini}$ =100ppm). (A) BSE image showing the distribution of anglesite crystals (bright spots) formed on anhydrite surface after 5 minutes interaction. (B) After a 24 hours interaction period of anglesite reach sizes in the range 3 to 10 microns.

[1] J.M. Astilleros *et al*. (2010) *Applied Geochemistry* **25**(7), pp. 1008–1016.