C-isotope evidence for pCO_2 and volcanic forcing during the early Aptian OAE 1a – The Cau section (SE Spain)

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The Early Aptian Oceanic Anoxic Event (OAE1a) represents a major perturbation in the global carbon cycle and is linked to environmental, biotic and sedimentary changes. The isotopic signature of OAEs consists of a positive $\delta^{13}C$ excursion, interpreted as the result of massive deposition of organic matter and subsequent ^{12}C drawdown.

Most investigations consider that high atmospheric CO_2 concentrations related to volcanic outgassing [1] played a main role during OAE1a, but only few studies estimate pCO_2 during this time interval [2]. Here we test the use of the offset between the $\delta^{13}C_{carb}$ and $\delta^{13}C_{org}$ as a qualitative proxy for pCO_2 ($\Delta^{13}C$, [3]), which has been proved useful for the OAE2 [4].

We explore the temporal variations in pCO_2 from an expanded section of the OAE1a (Cau section, Spain). The high resolution study combining C-isotope stratigraphy and biostratigraphy, has led to a precise correlation with other well known sections from the Tehys domain.

Our results suggest that pCO_2 increased during the prelude of OAE1a. Intriguingly, it mantained stable high concentrations during most of the positive isotope excursion, despite a putative OM burial event, then droped in a relatively short time at the end of OAE 1a. This episode of high pCO_2 was punctuated by several short-lived cooling episodes [5], but high temperatures were rapidly recovered. This is consitent with a mantained volcanic forcing, demonstrated by Os isotope data [1, 6]. This study has proven the value of the $\Delta^{13}C$ as a pCO_2 proxy, and confirmed the link between volcanic outgassing and organic matter deposition in balancing the global climate change during OAE1a.

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Advances in Our Understanding of the Noble Gas Thermometer in Groundwater - New Applications

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Noble gases are conservative tracers and their concentrations in recharge areas of groundwater systems are a function of temperature, pressure, and excess air. Consequently, noble gas temperatures (NGTs) are regarded as robust indicators of past climate. Until recently, however, limited attention had been placed on processes taking place in the unsaturated zone and at the water table/soil air interface capable of impacting NGTs. In recent years, we highlighted the potential impact of O_2 depletion without corresponding CO_2 build-up in the unsaturated zone on noble gas partial pressures, leading to a bias to low NGTs. A recent study in Michigan showed, however, that recharge conditions can be significantly modified by large precipitation events such as Hurricane Ike and bring O_2 depleted soil air back to standard conditions.

Atmospheric noble gases were also measured in high-altitude springs in the Galapagos Islands. These revealed the presence of a unknown pattern with atmospheric He excesses and Ne, Kr, and Xe depletion together with relative Ar enrichment. A rainwater noble gas study was subsequently carried out in Michigan and revealed the presence of two patterns both with He excesses. The first one, associated with low pressure systems, presence of fog and light rainfall, displays a pattern remarkably similar to that previously identified in the Galapagos Islands. The second one, associated with the passage of frontal systems, displays a mass-dependent depletion pattern with respect to surface conditions. Precipitation is characterized by thunderstorms, heavy rainfall, and high cloud ceiling heights. This rainwater study suggests that noble gases dissolved in rainwater and in shallow aquifer systems where infiltration is rapid can be used to trace weather patterns.

DOI: 10.1180/minmag.2013.077.5.3