Geothermometry of oxidized Zn-Pb ores: Oxygen isotope systematics and a new femtosecond laser technique on monophase fluid inclusions

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We studied the $^{18}O/^{16}O$ systematics of carbonate minerals from supergene oxidized Zn-Pb deposits and from submarine alteration of ancient slags to constrain oxygen isotope fractionation factors for smithsonite, cerussite, and phosgenite. The temperature dependence of oxygen isotope fractionation between Pb and Zn carbonate minerals and water below 100°C can be expressed as

$$1000 \ln\alpha_{\text{cerussite-water}} = 2.29\,(10^6/T[K]^2) - 3.56$$
$$1000 \ln \alpha_{\text{smithsonite-water}} = 3.10\,(10^6/T[K]^2) - 3.50$$
$$1000 \ln \alpha_{\text{phosgenite-water}} = 2.55\,(10^6/T[K]^2) - 3.50$$

Average formation temperatures of the studied supergene deposits (SW Sardinia, E Belgium, Broken Hill district, Australia, and others) are calculated to be 20 ± 5°C using the estimated isotope compositions of local paleometeoric waters.

We also applied a new technique using a femtosecond laser to nucleate the vapor bubble in monophase fluid inclusions. Homogenization temperatures of inclusions in cerussite and hemimorphite from the same deposits range from +6.1 to +25.5°C and confirm our stable isotope results.

New fluid inclusion and oxygen isotope data from willemite-bearing oxidized Pb-Zn ores from E Belgium and S Portugal, however, suggest that certain mineralization stages in these districts were formed by distinct low-temperature (<50°C) hydrothermal systems involving saline fluids.

Thus, oxygen isotope and fluid inclusion data for base metal carbonate minerals can be used to distinguish ores produced by weathering from very-low-temperature hydrothermal ores. They may also provide valuable paleoclimatic information.

Organic geochemical assessment of the onset of an Oceanic Anoxic Event

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A geochemical study was conducted on cored Posidonia Shale sections and underlying sediments derived from two wells located in the southern North Sea offshore the Netherlands. Samples were subjected to a variety of analytical techniques including CS analysis, Rock Eval pyrolysis, GC-MS and carbon and sulphur isotope analysis. It is well established that the Posidonia Shale (Early Toarcian) is marked by the deposition of organic-rich shales throughout Europe as a result of an Oceanic Anoxic Event (OAE). Our data provides evidence that establishment of these anoxic conditions is a gradual process from sediment anoxic conditions into true anoxia within the Posidonia Shale. This is indicated by the depth profile of most of the measured parameters. The values of sulphur content, TOC, hydrogen index, Ts/Tm ratio and pristane/phytane ratio gradually increase in the underlying sediments with decreasing depth towards the Posidonia Shale. Within the Posidonia Shale the values of those parameters remain constant.

The carbon isotope data show a negative excursion within the Posidonia, in agreement with earlier reports. This indicates that OAE might have been a global event. Our research focuses, among others, on the question whether this proto OAE development can be recognised throughout the basin.

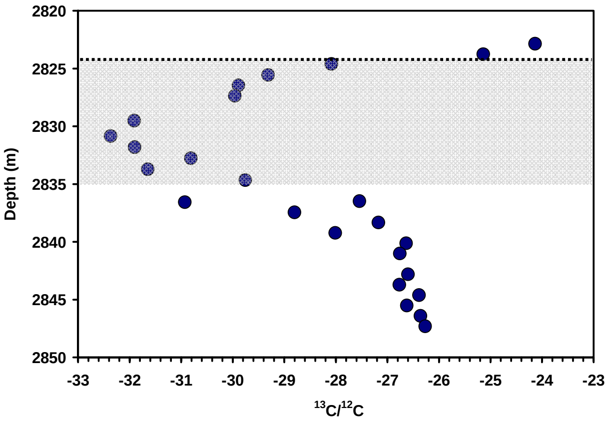

Figure 1: Illustration of the carbon isotope excursion (approximately 7 ‰) in the Posidonia Shale(shaded region)