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Cadmium anomalies in Jurassic carbonates in western and southern Europe: towards the causes and mechanisms

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Cadmium concentrations of up to 21.4 mg/kg were discovered in oolitic carbonates of Bajocian and Oxfordian/Kimmeridgian age, in the Swiss and French Jura (Prudente, 1999; Benitez-Vasquez, 1999; Veuve, 2000; Dubois et al., 2002; Rambeau, 2006). These values exceed the mean Cd value in marine carbonates of 0.03 mg/kg (Gong et al., 1977; Tuchschmid, 1995). These elevated cadmium contents in the rock substratum lead to cadmium enrichments in associated soils, which reach values of up to 10.4 mg/kg. These concentrations largely exceed the official guideline values in Switzerland (0.8 mg/kg) and France (2 mg/kg).

In contrast to the carbonates measured in basinal areas for the same periods (Rambeau 2006, our study), the distribution of cadmium is quite heterogeneous in the shallow-water carbonates of the Swiss and French Jura. Cadmium enrichment is controlled by the permeability of the different formations of Jurassic carbonates and is often associated with the presence of late diagenetic sphalerite crystals and microcrystals, which were likely formed during the Eocene-Oligocene phase of tectonic and hydrothermal activity in this region. We propose a genetic link between the presence of sphalerite and cadmium and the incorporation of cadmium into the Jurassic rocks during this period of tectonic and hydrothermal activity. As such the cadmium contents in Jurassic carbonates of the Swiss and French Jura have no significance with regards to the interpretation of the depositional setting and paleoceanographic conditions during the formation of these shallow-water carbonates as was proposed before (Veuve, 2000;

Rambeau, 2006).

Cadmium enrichments in coeval sections of the basinal, pelagic Tethys realm, however, appear to have a paleoceanographic background. The general increase of Cd contents in hemipelagic sections of central Italy (Terminiletto) and southern Spain (Carcabuey) for the Bajocian stage coincides with a positive shift in the $\delta^{13}C_{carb}$ isotope curve established by Bartolini et al. (1996) and O'Dogherty et al. (2006). For the section of middle Oxfordian to Kimmeridgian age in the Vocontian basin (SE France) a positive shift in cadmium contents in sediments of middle to late Oxfordian age may be correlated with the positive shift in the hemipelagic section of Terminiletto situated in central Italy, which was studied by Rambeau (2006). Unfortunately, the temporal framework of the last section is not precise enough. At the same time there is no evident correlation with the isotopic curves of $\delta^{13}C$ for the Oxfordian stage (Bartolini et al., 1996).

The obtained data should be interpreted with care for all investigated sections because of the presence of isolated cadmium peaks which may be associated with the circulation of continental hydrothermal fluids and may perturb the primary cadmium signal.

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