ABSTRACT

The pollution of air, soil and water by heavy metals through anthropogenic activities is an object of numerous environmental studies since long times. A number of natural processes, such as volcanic activity, hydrothermal fluid circulation and weathering of metal-rich deposits may lead to an additional and potentially important input and accumulation of heavy metals in the environment. In the Swiss and French Jura Mountains, anomalous high cadmium (Cd) concentrations (up to 16 ppm) in certain soils are related to the presence of underlying Cd-enriched (up to 21 ppm) carbonate rocks of Middle to Late Jurassic age. The aim of this study is to understand the processes controlling Cd incorporation into carbonate rocks of Middle and Late Jurassic age and to reconstruct the sedimentary and environmental conditions, which have led to Cd enrichments in these sedimentary rocks.

Cd concentrations in studied hemipelagic sections in France vary between 0.1 and 0.5 ppm (mean 0.15 ppm). Trace-element behavior and high Mn concentrations suggest that sediment accumulation occurred in a well-oxygenated environment. Increases in Cd contents in the bulk-rock carbonate sediments may be related to increases in surface-water productivity under oxic conditions and important remineralization of organic matter within the water column. In platform settings preserved in the Swiss Jura Mountains, no correlation is observed between Cd contents and evolution of environmental conditions. Cd concentrations in these platform sections are often below the detection limit, with isolated peaks of up to 21 ppm. These important Cd enrichments are associated with peaks in Zn concentrations and are present in carbonate rocks independently of facies and age. The high Cd contents in these shallow-water carbonate rocks are partly related to the presence of disseminated, Cd-rich (up to 1.8%), sphalerite (ZnS) mineralization. The basement rocks are considered to be the source of metals for sulfide mineralization in the overlying Jurassic strata, as the sphalerite Pb isotope pattern is comparable to that of granite rocks from the nearby southern Black Forest crystalline massif. The Rb-Sr ages of sphalerite samples indicate that a main phase of sphalerite formation occurred near the boundary between the late Middle and early Late Jurassic, at around 162 Ma, as a result of enhanced tectonic and hydrothermal activity in Europe, related to the opening of the Central Atlantic and to the tectonic/thermal subsidence during spreading of the Alpine Tethys. I therefore propose to use unusually high Cd concentrations in carbonates as a tracer of tectonic activity in the Jura Mountains area, especially in the case when important enrichments in Zn co-occur. Paleoproductivity reconstructions based on records of authigenic Cd may be compromised not only by post-depositional redistribution, but also by incorporation of additional Cd from hydrothermal solutions circulating in the rock.

The circulation of metal-rich hydrothermal fluids through the sediment sequence, in addition to specific environmental conditions during sedimentation, contributes to the incorporation of Cd into the carbonate rocks. However, only hydrothermal activity has led to the unusually high concentrations of Cd in carbonate rocks of Bajocian-Oxfordian age, through the formation of sphalerite mineralization.

Keywords: *Cadmium, Bajocian, Oxfordian, redox-sensitive trace elements, sphalerite, Jura Mountains, Vocontian Basin.*