Trace element distribution in Palaeozoic Black Shales: Kupferschiefer (Germany) and Exshaw Formation (Canada)

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Introduction

Sediments of the Lower Rhine Basin and black shales of the Canadian Exshaw Formation were investigated for their major and minor element composition in order to gain information on palaeoseawater composition. A comparison of the minor element distribution-patterns of Palaeozoic, Mesozoic and more recent black shales may provide new information on the environment of deposition.

Kupferschiefer of the Lower Rhine Basin

The Permian Kupferschiefer is a typical bituminous marl. Core Niederwald 1 of the Lower Rhine Basin comprises the underlying Carboniferous (S1), the Kupferschiefer (T1) and the overlying Zechstein limestone (Ca1) (Fig. 1).

The elements V, Mo, Re, Cd, Sb (also Ni, U and As; not shown) occur in high concentrations typical of black shales (syngenetic mineralisation).

In the top of the Kupferschiefer the Re/Mo-ratio increases significantly. This is likely to be caused by less intense reducing conditions during sedimentation (Crusius et al., 1996).

Furthermore Pb, Zn, Cu and Ba (not shown) and less distinct Ag, As, Cd, Co, Ni, Sb and Tl

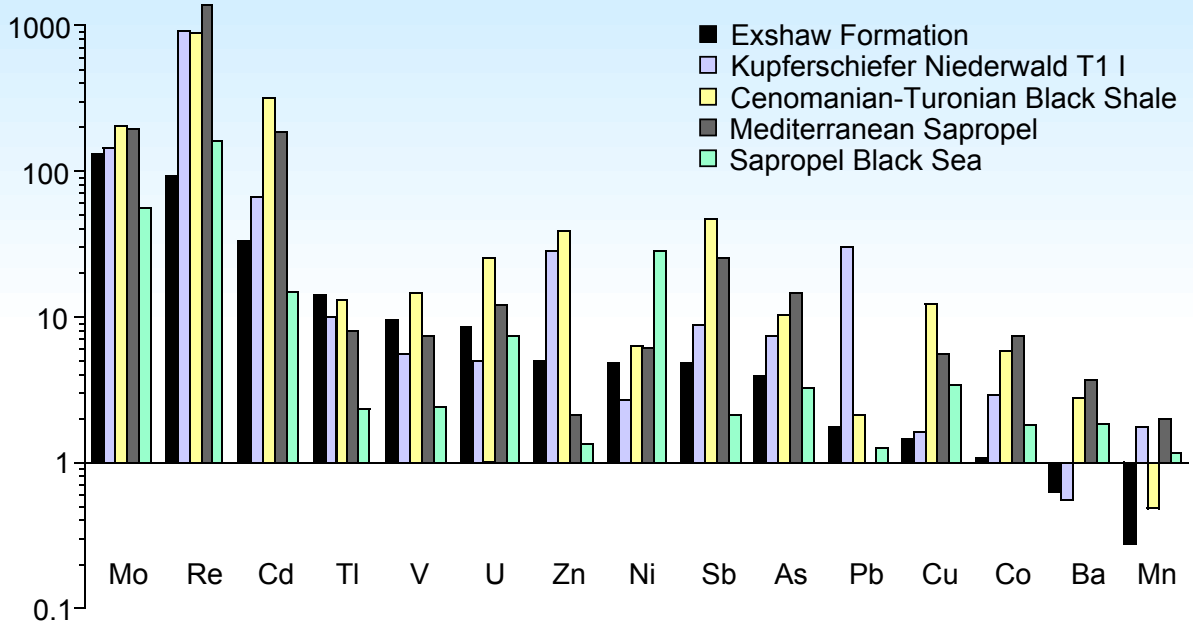
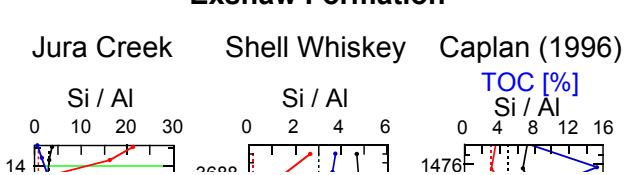


Fig. 2: Enrichment factor versus average shale of minor elements in the Exshaw Black Shale, Kupferschiefer and other selected anoxic sediments.

Exshaw Formation

The black shale of the Exshaw Formation (Famennian/Tournaisian) represents a marine, transgressive euxinic sediment (Richards and Higgins, 1988). Probably the laminated sediment has been deposited in an



are enriched in discrete layers within or below the T1 (epigenetic mineralisation). Generally secondary leaching processes in the underlying Carboniferous are responsible for the epigenetic mineralisation (Vaughan et al., 1989).

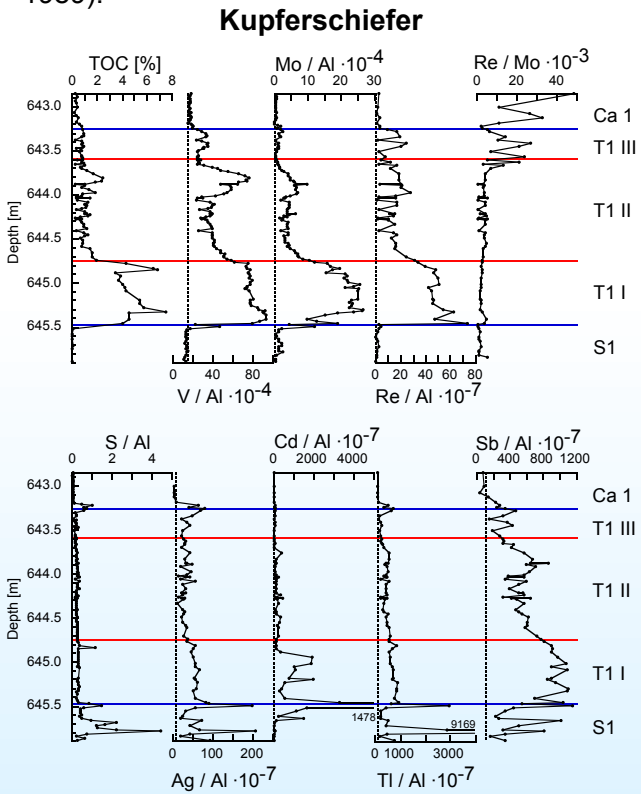


Fig. 1: Selected minor elements representing the syngenetic mineralisation (upper fig.) and the epigentic mineralisation (lower fig.) of the Kupferschiefer.

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epicontinental upwelling area below storm-wave basis (Parrish, 1982). Volcanic activity as a possible source for different components has to be considered. The TOC-rich parts exhibit strong enrichments in the minor elements Mo, Re, Cd, Tl, V and U. The average Re/Mo-ratio of $0.4 \cdot 10^{-3}$ is low with respect to seawater and confirms the existence of an euxinic depositional environment (Fig. 3).

Conclusions

A comparison of Palaeozoic black shales with Mediterranean sapropels, Cretaceous black shales and recent anoxic sediments (Fig. 2) shows comparable enrichments of certain minor elements (Mo, Re, Cd, Tl, V, U, As). On the other hand for some elements (Zn, Ni, Sb, Pb, Cu, Co, Ba, Mn) a stronger concentration variability is detectable. The availability of dissolved and suspended material and secondary processes seem to be very important. A more profound understanding of the geochemical behaviour of minor elements during early diagenesis is necessary for gaining information on palaeoseawater composition.

Literature

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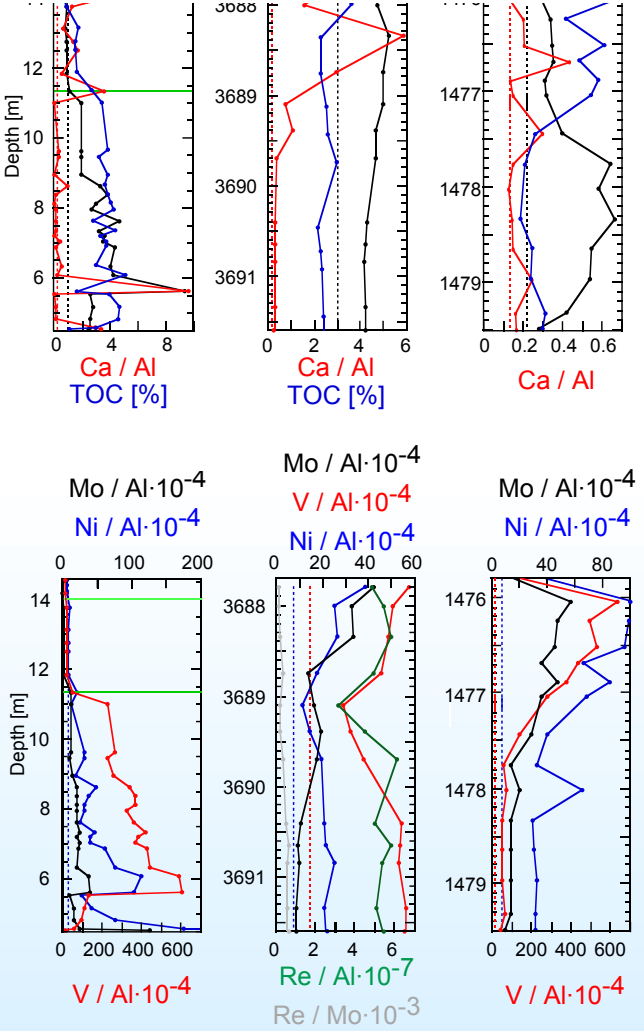

Fig. 3: Three different locations of Exshaw Black Shales: The enrichent of minor elements depends on the distribution of major components like organic material, carbonate and siliciclastics (dooted line: average shale).