

A black shale facies in the upper Werfen Formation: Indication of an anoxic event during the rifting of the Meliata Ocean?

Mario Krieger, Franz Neubauer, Gertrude Friedl

University of Salzburg, Department of Geography and Geology, Salzburg, Austria; e-mail: mario.krieger@stud.sbg.ac.at

Within the Austroalpine and Southalpine domains of Eastern Alps and Carpathians, the Lower Triassic Werfen Formation with mostly reddish/purple siltstones and fine-grained siliciclastic sandstones in the lower part and detrital carbonates in the upper part represent a key formation often representing the first marine unit in the transition from Permian terrestrial to Triassic marine depositional environments. Within the Northern Calcareous Alps (NCA), three subformations are known from base to top: the Werfen Quartzite, the Werfen siltstones/fine-grained sandstones with rare bivalves and ammonites, and the Werfen Limestone. Within the NCA, we investigated a section exposing reddish-brownish siltstone, dark Werfen Limestone overlain by dark-colored bedded Anisian dolomites (Gutenstein Fm.). The section is located to the east of the Werfen type area, where also the stratiform Sulzau-Werfen iron mineralization is known just above the Werfen Formation.

Within the studied Werfen Limestone section, three microfacies types can be distinguished. All three types turn out to be sparitic, fine sandy limestones often transitioning into more siliciclastic, argillaceous marls or blackish slates always comprising some carbonate components. Secondary alteration include pressure solution, recrystallization (inhibited by graphitic material) and a conodont color alteration index of six indicating a metamorphic temperature significantly higher than 300 °C. Microfacies type 1 is characterized by grey, sandy, sometimes graded limestones and rare fossil remains. Microfacies type 2 is a transitional type between types 1 and 3, appears distinctively darker than type 1 and shows a mid to dark grey or even blackish color. The matrix mainly consists of silt-sized grains and phyllosilicates. Thin layers of fine sand with graded bedding are intercalated. On bedding planes, crinoids, detrital mica, pyrite and graphitic material can be identified. Microfacies type 3 usually comprises patterns of thin sandstone layers with graded bedding alternating with much thicker blackish layers of phyllosilicates. Sandstone layers resemble distal tempestites. High amounts of detrital white mica, the graphitic nature and the graded bedding suggest a deep depositional environment. Tests on conodonts revealed dominant single cone conodont elements, and some ramiform and rare platform elements; single cone elements remain an exception during Early Triassic. EDX investigations revealed the presence of sulfides like pyrite, chalcopyrite, and sphalerite, of sulfates like alunite, jarosite and celestine(?), and of carbonates like ankerite/siderite.

We interpret the depositional environment as in part anoxic with sulfides in deep basin overlain by stratified water column, from which Fe-carbonates were deposited. We interpret the formation of basins with an anoxic facies as driven by crustal extension, where potentially metal-bearing hydrothermal fluids were expelled on basin-confining faults similar as it was recently demonstrated for the western Southern Alps.