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Principal component analysis around the Transitional and Sandy Dolomite boundary in the Velebit Mt. (Croatia)

Analiza glavnih komponenti na granici prijelaznog i pjeskovitog dolomita na Velebitu (Hrvatska)

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Late Permian and Early Triassic deposits in the Velebit Mt. are represented by two informal lithostratigraphic units, Transitional Dolomite (TD) and Sandy Dolomite (SD) (SALOPEK, 1948). Due to the lack of the Triassic index fossils above the erosional contact between TD and SD, this lithologic change used to be considered as the Permian-Triassic Boundary (PTB), until the recent findings of Permian fossils in the lower part of the Sandy Dolomite unit (FIO et al., submitted).

Transitional Dolomite is represented by well-bedded light-grey to grey early- and late-diagenetic dolomites, relatively rich in fossils, containing up to 6.70% of calcite and 0.09–7.61% of insoluble residue. Sandy Dolomite comprises thin-bedded dolomites, often with recrystallized grains and scarce fossil findings, with up to 1.88% of calcite, and up to 29.56% of insoluble residue, mostly terrigenous siliciclastic material. The lowermost part of the Sandy Dolomite is characterized by complete lack of fossils, numerous ooids and angular siliciclastic grains, above the clear erosional boundary between Transitional and Sandy dolomites (Fig. 1).

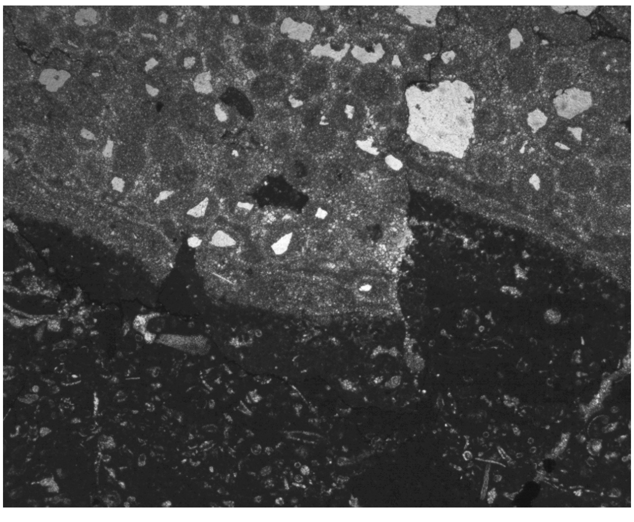

Figure 1. Erosional boundary between Transitional and Sandy Dolomite. Width of the photomicrograph is 5 mm.

Slika 1. Erozijska granica između prijelaznog i pjeskovitog dolomita. ŠIrina fotografije je 5 mm.

The Principal component analysis (PCA) was used to identify patterns of positive and negative covariation for Transitional and Sandy Dolomite samples, such as those expected between Al and trace elements included in clay matrices, or relations between Mg and Ca and siliciclastic minerals (Fig. 2). Al, Si, K and Ti in the TD and SD datasets show high scores on the first principal component, indicating strong positive covariation. Elements with high coefficient of determination (R^2) that correlate to Al_2O_3 content are those which tend to stay bound with clays during weathering and erosion, and therefore can be related to the terrigenous source area.

Ca, Mg, S and Sr are generally more closely related within the Transitional Dolomite and may be connected to relatively abundant fossil content in these deposits. Transitional Dolomite is characterized by the positive Ca–Mg correlation (R^2 = 0.59) and low variability in Ca/Mg ratio (1.48–1.50), indicating consistency in carbonate stechiometry. Sandy Dolomite with more variable Ca/Mg ratio (1.39–1.52) and low negative Ca–Mg correlation (R^2 = –0.25) indicate more diverse carbonate mineralization. The increase in Mg content and its variability in Sandy Dolomite can be explained by sediment dolomitization and diagenesis. Correlations between Ca and S content in both units are positive (R^2 = 0.46 in TD and 0.30 in SD). Mg and S are uncorrelated in the TD (R^2 = 0.01), but show negative correlation in the

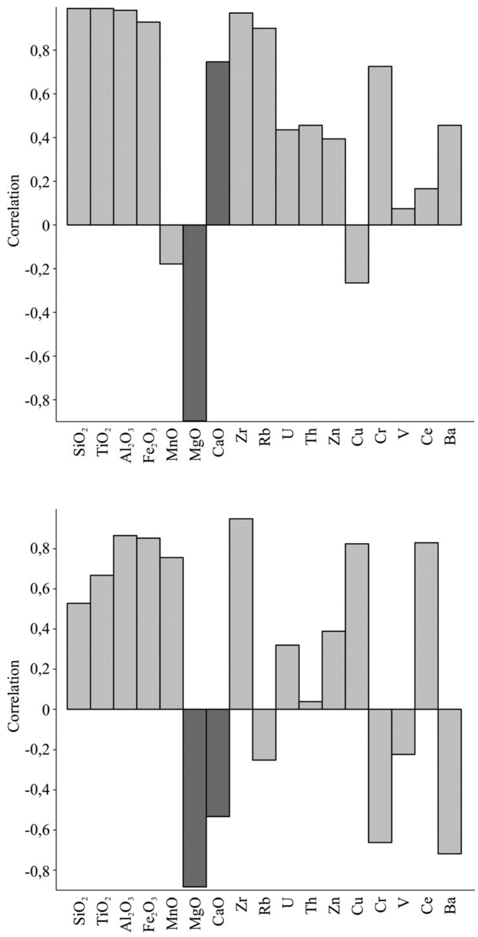

Figure 2. The Principal component analysis (PCA) for Transitional and Sandy Dolomite samples. More than 43% of the total data variance for the Transitional Dolomite (A) and more than 51% of variance for Sandy Dolomite (B) is explained by the first principal component. Dark-grey columns represent MgO and CaO.

Slika 2. Analiza glavnih komponenti za uzorke prijelaznog I pjeskovitog dolomita. Više od 43% varijance podataka za prijelazni dolomit (A) i više od 51% varijance za pjeskoviti dolomit (B) je objašnjeno prvom PCA komponentom. Tamno sivi stupci predstavljaju MgO I CaO.

SD unit ($R^2 = -0.48$), suggesting that Mg source is not related to organic matter. This is consistent with the lack of the Mg-calcite skeletal remains in the lowermost part of the SD unit.

The abrupt lithologic change between TD and SD is marked by the enrichment in lithophile (Si, Al, K, Rb, Zr, Th, V, Y), siderophile (Fe, Co, Ni) and chalcophile (Cu, Zn, As) elements, enrichment in rare earth elements and negative Cerium anomaly, showing simultaneously a strong decrease in the CaO, MgO, S and Sr content.

The PCA analyses and coefficients of determination gave us possibility to derive the most useful elemental data to define lithologic change. The decrease in Ca–Mg correlation and sulphur content in the Sandy Dolomite after the lithologic boundary, high correlation of elements attributive to clays and siliciclastic material (quartz, zircon, feldspars), sudden disappearance of fossils and occurrence of ooids may be explained as a consequence of the Late Permian regression, and the sediment reworking and import by the transgression onset.

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