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Interpretation of geochemical indices vs. overlapping pedogenesis and diagenesis processes in relatively immature paleosols from the Upper Silesian Coal Basin – Poland

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Micromorphological and geochemical studies of Paleozoic soils are an important tool for the interpretation of paleoclimate and paleoenvironments. Particularly, estimating the chemical weathering indices and elements ratios contributes to the reconstruction of the palaeoenvironmental conditions and allow to reflect climate changes in the past. Moreover, paleosols should allow to determine the stage of advancement of the pedogenesis after sediment deposition in time.

In the present work, the investigation was performed on 33 paleosols samples from the Mudstone Series of Pennsylvanian age. The content of main (Al, Ca, K, Mg, Na), trace (e.g. Ba, Cu, Sr, Mo) and rare earth elements (La, Y, Th) was determined by inductively coupled plasma atomic emission spectrometry (ICP-OES) and inductively coupled plasma mass spectrometry (ICP-MS). Mineralogical data were obtained by the powder X-ray diffraction analysis (XRD), optical and scanning electron microscope (SEM) observations.

Mineralogy and micromorphology of the paleosols suggest their formation on sedimentologically active valley systems which were frequently flooded. Climate during the Pennsylvanian age (Westphalian A and B) in the Central Europe was characterized by warm/hot and humid conditions, which is perfectly reflected by the CIA and PIA values as well as trace element ratios (Sr/Cu, Rb/Sr) obtained in our analysis. Commonly used proxies, such as CIA, CIW, PIA, CALMAG, Base Loss, and Clayeyness suggest intense chemical weathering of samples, but they should be interpreted with great caution due to the complex mineralogical composition. The analyzed material contained phases coming from different sources such as: detrital phases coming from the parent material (e.q. quartz, feldspars, micas), pedogenic (e.g. siderite, kaolinite?, illite-smectite?), and also diagenetic phases (e.g. pyrite, galena). Moreover the frequent ‘rejuvenation’ of the paleosols by deposition of the fresh sediment prevented the development of deep, matured, and well-differentiated paleosols in the Mudstone Series.

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