

Magnetic parameters of soils developed on different geologic backgrounds, Central Portugal

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Three different types of soils were studied using the environmental magnetism method in the Coimbra region, Central Portugal. Mass specific magnetic susceptibility and isothermal remanent magnetization imparted at 1 tesla (IRM_{IT}) were determined in order to characterize and map the topsoils in an area of 200 km². The soils studied are Fluvisols, Cambisols and Leptosols, according to FAO classification. Fluvisols are formed on the alluvial plain of Mondego River (Holocene age). Leptosols and Cambisols are formed on metamorphic rocks of Proterozoic age and red sandstones of Upper Triassic age. Magnetic susceptibility was measured on 48 surface soil samples. This parameter ranges between 0.10 and 1.04 ($10^{-6} m^3 kg^{-1}$) in Fluvisols, between 0.09 and 4.06 ($10^{-6} m^3 kg^{-1}$) in Cambisols and between 0.35 and 6.20 ($10^{-6} m^3 kg^{-1}$) in Leptosols. The IRM_{IT} measured on 32 samples of Cambisols and Leptosols. IRM_{IT} values ranges between 0.60 and 107.40 ($10^{-3} Am^2 kg^{-1}$) in Cambisols and between 4.10 and 49.04 ($10^{-3} Am^2 kg^{-1}$) in Leptosols. The results revealed that the magnetic parameters are higher in soils formed on metamorphic rocks than on sandstones. In this case study the differences obtained are mainly due to the lithological and pedological influences and the role of the geological background is clear. The anthropogenic Fe-particles contribution is only obvious near roads and rivers. Topsoil magnetic parameters can be useful as a proxy to anthropogenic pollution particles and an auxiliary tool for geologic and soil mapping.

Assessing cementation in the El Capitan Reef Complex and Lincolnshire Limestone using ¹³C-¹⁸O bond abundances in carbonates

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The Permian El Capitan and Jurassic Lincolnshire limestones have been intensely studied for their stratigraphy, depositional setting and paleoecology. Nevertheless, the diagenetic development of these two units remains controversial, particularly with regard to diagenetic carbonate formation. Calcite cement phases have previously been characterized via $\delta^{18}O$ and $\delta^{13}C$ in order to determine precipitation temperatures and carbon sources, however, these results have lead to conflicting hypotheses.

Here, we present clumped isotope data (values corresponding to the relative abundance of the ¹³C-¹⁸O bond in carbonates) from cements of the El Capitan and Lincolnshire limestones in an attempt to more robustly characterize precipitation temperatures and directly calculate fluid $\delta^{18}O$ values, a previously elusive measurement. Intriguingly, the resultant data display a fairly tight positive correlation between these two parameters ($R^2 \sim 0.7$ for both units). In El Capitan calcites, cements with elevated fluid $\delta^{18}O$ closer to seawater values (from $\sim -2\%$ VSMOW) exhibit higher precipitation temperatures (up to 70°C) than those with isotopic compositions more like meteoric fluids (down to $\sim -10\%$ and 28°C). The Lincolnshire Limestone calcites formed in fluids with $\delta^{18}O$ values and temperatures ranging from $\sim -3\%$ and 50°C to $\sim -6.5\%$ and 32°C, respectively.

These results suggest a tight coupling between pore water evolution and cement precipitation temperature, a somewhat intuitive finding. However, the trajectory of the combined fluid $\delta^{18}O$ and temperature trend is intriguing and potentially transformative in our understanding of the cementation of carbonate rock units. In both units, progressive cementation follows a trend toward increasingly meteoric-like fluids potentially suggesting precipitation in mixed-zone settings rather than a strictly marine environment. The nature of cementation, its bearing on the reported geochemical signatures and the implications for standing hypotheses will be discussed further.