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Iron sources and cycling during diagenetic transformations of southern Israel phosphorites

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The Late Cretaceous phosphates in Israel are part of a vast phosphorite deposition belt that spread from Turkey to Morocco during the Cretaceous to Eocene periods. The prevailing westerly wind direction in the Tethys during the Late Cretaceous caused an extensive high productivity upwelling regime that persisted from Santonian to Maastrichtian age (85-65 Ma), while the most intense upwelling occurred during Middle-Late Campanian during phosphorite deposition.

Israeli phosphate deposits are characterized by two phosphorite facies: pristine with low phosphorous content deposited under high productivity, high sedimentation rates, and low energy conditions and reworked with high phosphorous content originated from pristine phosphates during high-energy episodes with low sedimentation rates, resulting in lateral transport and bioturbation.

Iron speciation in Israeli phosphorites, which are formed at different sedimentation settings, were studied to characterize and better understand factors controlling distribution of iron phases in phosphate rocks. Pristine phosphorites were associated with substantially higher total iron (Fe_T) and highly reactive iron (Fe_{HR}) contents compared to reworked phosphates. Conversely, Fe_{HR}/Fe_T values are higher in reworked phosphates. The iron paleoredox proxies values, which are diagnostic for ferruginous water columns (high Fe_{HR}/Fe_T and low Fe_{pyrite}/Fe_{HR}), were detected in the studied pristine phosphorites. Physical transport of Fe_{HR}-rich particles to the sediments like aeolian dust input probably lead to a false ferruginous signal in pristine layers. Ferruginous signals with higher Fe_{HR}/Fe_T values in the reworked phosphorites were probably caused by preferential removal of poorly reactive Fe-rich smectites during reworking that also decreased Fe_T that produced a signal, which can be falsely interpreted as a presence of an anoxic water column. Thus, the differences in iron speciation in pristine and reworked phosphorites should not be used as a redox condition indicator without taking into account physical depositional processes.

Interestingly, total organic carbon (TOC) was highly correlated with Fe_{HR} content in all phosphorite sections with TOC greater than 1%. We suggest that the oxygenation level of the surface sediments controls both parameters. High concentrations of oxygen at the sediment-water interface resulted in a decrease in TOC and Fe_{pyrite} content.