Sulfur tracks diagenetic processes in Permian San Andres Formation

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The Middle Permian San Andres Formation of West Texas is comprised of intercalated dolomite, limestone and siltstone rocks. It is characterized by a complex diagenetic history including paleokarst development, anhydrite cementation and carbonate replacement. However, the combined sulfur and oxygen isotope data of sulfur from different mineral phases (sulfates, sulfides, and native sulfur) provide the option for more thorough diagenetic reconstruction of the system, providing constraint on the observed heterogeneity.

The analyzed limestones are characterized by $\delta^{34}S$ values in both carbonate associated sulfate (CAS) and water soluble sulfate (WSS) that rather resemble the Middle Permian seawater sulfate. In contrast to that, the dolomitic layers reflect post-depositional carbonate recrystallization with microbial sulfate reduction as revealed by the enriched $\delta^{34}S$ values of both CAS and WSS. The present data show that limestones represent a more reliable archive for seawater sulfate isotope data than dolomites which tend to reflect signals stemming from early diagenetic processes rather than open marine signatures.

In the intercalated siltstone parts, the depleted $\delta^{34}S$ and $\delta^{18}O$ isotope values of the WSS reflect pyrite oxidation likely caused by groundwater influence. The CAS values of the less prominent carbonate phases within the siliciclastic layers are also influenced by lighter sulfur isotope values. This indicates that the carbonate phases in the siliciclastics were formed during the later course of diagenetic processes, a observation not exclusively evidenced by the respective $\delta^{13}C$ data.

Overall, these data provide a framework that reflects the various depositional and diagenetic processes that formed and modified the San Andres formation, demonstrating the applicability of analyzing the isotopes of three sulfur phases. Our results demonstrate that sulfur analysis can be useful addition to other parameters indicating the degree of diagenetic overprint.