# Resolving environmental signatures from a paleovalley sedimentary sequence from arid northwest Australia

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Sediments from paleolakes can retain invaluable archives of past environmental conditions. However, deciphering a depositional signal from digenetic processes can be challenging in arid environments owing to extremely variable rainfall and saline groundwaters, which result in aggressive chemical conditions that often limit the preservation of traditionally used proxies. We investigated the development of hydroclimatic proxies based on sediment geochemistry from the Fortescue Marsh, in the arid Pilbara region of northwest Australia. The Marsh lies in a paleovalley that acts as a terminal basin for the upper part of the Fortescue River and consists of a $\sim$1000 km2 contiguous floodplain with freshwater pools episodically inundated during intense rainfall events. The paleovalley is bound by mountain ranges that contain some of the most Fe-ore rich and ancient deposits on Earth, which we expected to confer unique geochemical characteristics to the sediments. We used a sonic rig to retrieve a 25 m core from one of the deepest sedimentary sections of the Fortescue Marsh (86 m to bedrock). We combined $\delta^{34}$S and $\delta^{18}$O stable isotopes analyses with scanning $\mu$XRF and reflectance spectroscopy to quantitatively map the elemental and mineralogical composition of the sedimentary sequence and to identify underlying mechanisms relating to paleoclimate. We found that Fe, Ca and Sr were the most abundant elements identified by $\mu$XRF. Typically, layers of up to 1 m that were almost exclusively Fe-dominated alternated with layers of 0.3-2.4 m thickness dominated by Ca and/or Sr, with at least five intervals with distinct peaks in Sr. As expected, the hyperspectral characterization confirmed that Fe oxides were most abundant during the Fe-rich intervals. While clay minerals including kaolinite and montmorillonite were also indicated from the spectral data, this assessment is contradicted by the low relative abundance of Al and Si. Peaks in Sr don't appear to reflect carbonates nor Sr sulfates, thus further analyses are required to confirm their origin. Hyperspectral mapping and strong correlation between S and Ca confirmed that the intervals with high Ca corresponded to gypsum ($CaSO_4$). We suggest that this gypsum is an authigenic sulfate mineral that formed within the top-most sediment due to groundwater fluctuation. Water chemistry measurements taken down the profile show that the conditions are close to saturation of gypsum throughout, and it is likely that such high concentration of crystals would form during prolonged "dry" periods following very "wet" periods. Under this scenario, current conditions are "dry" but there have been significant "wet" periods during which detrital materials, such as Fe, Rb and other low abundance metals here, have accumulated in the system via transport from the catchment. $\delta^{34}$S and $\delta^{18}$O analyses will help confirm the origins of formation of the crystals. Overall, our findings demonstrate that wetting and drying cycles and de-dolomitization processes are the main mechanisms influencing local geochemistry. Establishment of geochronology for this profile is currently underway. We are also examining other proxies including $\delta^{87}$Sr and particle size. Collectively, a multi-proxy and process-based approach will be used to characterize long-term hydroclimatic change in northwest Australia.