The formation of dolomite at the Fortescue Marsh, northwest Australia

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Terrestrial carbonates are widespread in the semi-arid Pilbara region of northwest Australia, including at the Fortescue Marsh, a nationally significant ephemeral wetland. We investigate the geochemistry and stable isotope composition of carbonates and groundwater from the Fortescue Marsh to determine the mode of carbonate formation and provide information on the environmental and hydrochemical conditions occurring at the time of precipitation. The carbonates belong to two distinct groups based on $\delta^{18}O$, depth and mineral composition. The $\delta^{18}O$ of carbonates increase with depth. Below 380 m asl (>25 m bgl) carbonates are almost pure dolomite with more positive $\delta^{18}O$ values (-4.5 to 0.16 ‰) compared to samples at higher elevations (-7.7 to -6 ‰) comprised of both calcite-rich and dolomite-rich carbonates. Groundwater isotopic composition revealed mixing between fresh flood water ($\delta^{18}O$ = -8.0±0.9 ‰) with highly saline, deep groundwater (-6 to +2.3 ‰). Modelled $\delta^{18}O$ values of the water from which the shallow carbonates precipitated (-5.3 to -2.7 ‰) and the distribution of the carbonates, which are concentrated around alluvial fans, are consistent with groundwater calcrete formation within the mixing zone of fresh and saline groundwater. We propose that infiltration of relatively fresh, carbonate-rich surface water and alluvium groundwater, increases the Mg and Ca concentration and alkalinity within the marsh, triggering the precipitation of carbonates. However, the presence of almost pure dolomite layers at depth may be indicative of a different mode of formation as the occurrence of terrestrial dolomite has largely been associated with saline ephemeral lakes where dolomite may have formed by primary precipitation or dolomitization of calcite. The higher $\delta^{18}O$ of pure dolomite indicates a more evaporated source water and may indicate lacustrine deposition under a different hydrological regime with a relatively higher water table.