Dolomitization and H_2S buildups related to $MgSO_4$-rich seawater, Upper Permian, NE Sichuan, China

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Massive dolomites occur mainly in the Upper Permian reef and bank deposits, NE Sichuan, China, and host giant volumes of sour gas resources, despite the absence of gypsum or anhydrite within the formation. This study examined the dolomitization regime and chemical evolution of the dolomitizing fluids during progressive burial, and evaluated the possible role of dolomitization as an alternative sulphate source for H_2S production. We found that dolomitization occurred pervasively during early burial prior to chemical compaction and was initiated by penesaline seawater. The reflux of the condensed seawater developed in back-reef and inter-reef lagoons during sea-level fall into reef-flat facies, which may have served as a Mg supply and explain well the dolomite distribution pattern.

During the dolomitization, moderate condensation and migration of seawater, combining with release of carbonate-associated sulphate (CAS), have multiplied the SO_4^{2-} concentration of pore waters, without anhydrite precipitation, from 2.21 g/L of the origin $MgSO_4$ seawater to 5.2 g/L~10.7g/L, as determined in the fluid inclusion water of the post-bitumen calcite. These accumulated sulphates had promoted subsequent thermochemical sulphate reduction (TSR) and have been almost consumed up (78%~99%) to produce the high concentrations of H_2S (mostly 3.3%~7.3%) in the gas reservoirs. Distinct sea-level fluctuation in Eurasian Tethys, $MgSO_4$ (aragonite) seawater and restricted carbonate lagoon seem to be favourable for the occurrence of dolomitization-driven TSR. Despite evaporite-carbonate units are undoubtedly favourite sites for H_2S buildups [1], the deep-buried pure dolomite horizons that meet certain criteria are perfectly capable of hosting sour gas, which deserves special attention during deep petroleum exploitation.

[1] Machel, H.G., 2001. Bacterial and thermochemical sulphate reduction in diagenetic settings old and new insights. Sediment. Geol. 140, 143-175.