A type of Mantle-derived hydrothermal dolomite in a Permian Rift Basin

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Subaqueous volcanic-hydrothermal field is a complex hybrid geological system, where sediments originated from underground, terrestrial, and biotic sources are mixed. Here we propose a possible primary origin of dolomite in a interpreted sediment-hosted geothermal system in a lacustrine environment, where hydrothermal, volcanic, and biotic domains interact. The dolomite occurs in middle-Permian Lucaogou Fm., Santanghu Basin, NW China, which was an intracontinental rift basin and contains a lot of hydrothermal-volcanic build-ups from seismic sections. The fm. is main laminated dolostones interbedding with tuffaceous shales. The dolostones are composed of dolomite (77% on average) and pyroclastics (quartz, alkaline feldspars, and analcimes). Dolomite crystals are commonly less than 3 μm in size, mainly anhedral to subhedral with a low degree of stoichiometry. The pyroclastics are angular, shard-like, bedding parallel, and show normal grading in dolomite-dominated laminae, indicating a volcanic origin during deposition and precipitation. Unique nanoscale filamentary minerals and build-up structures were observed at intercrystalline pores of dolomite and laminae of dolostones in some samples, respectively. And $\delta^{13}C$ (5.2‰ to 9.9‰, 6.9‰ on average) of dolomite suggests the formation of dolomites was affected by the generation of bacterial participating methane. $\delta^{18}O$ (-1‰ to -17.4‰, -7.5‰ on average) values of dolostones composed of subhedral dolomite are more negative than those of anhedral ones, which indicate recrystallization by hydrothermal activities. The whole rock strontium isotope values (0.70462 to 0.70525, 0.70501 on average) and δ Mg (-0.89 to -0.24, -0.52 on average) values indicate that the sedimentary fluids may be derived from mantle. The dolostone is a rare type of microbially-influenced dolostone related to hydrothermal and volcanic activities. Repetitive volcanic-hydrothermal activities raised the temperature unevenly on the lake floor, which broke the threshold dynamic barrier temperature (~50℃). Hydrothermal fluids which reacted with mantle-originated magma and wall rocks provided abundant Mg. Thermophilic microbes near the hydrothermal vents multiplied rapidly, generating a favorable chemical condition for dolomite precipitation. This work shows a mixed geothermal system related to subaqueous volcanism in an ancient lake sedimentation.