

Siderite Formation in a Marine Methane Seep Environment, the TY Mud Volcano, Offshore SW Taiwan

YI-TING TSENG¹, SAULWOOD LIN^{1,*}, I-CHIH HSIEH¹,
KAI-LI LIEN¹

¹ Institute of Oceanography, National Taiwan University,
Taiwan; tiffanytseng@ntu.edu.tw;

*: corresponding author: swlin@ntu.edu.tw

Siderite, iron carbonate, usually found in the freshwater environment, whereas pyrite become predominant in marine setting. In this study, we report siderite formation at an active mud volcano in a marine setting with mud flow and associated large amounts of gas and fluid vents in taking the environment into a condition where very limited pyrite could be found and yet a condition favor siderite formation. The study Tsanyao Mud volcano located at the upper slope of the accretionary wedge offshore Southwestern Taiwan at a water depth of about 600 meters. Dome shape mud volcano cone grow to a height of about 224 m, with a slope angle reaching about 13 degrees in less than 1 kilometer. Multibeam bathymetry mapping, coring and measurements of pore water sulphate, chloride, magnesium, sodium, potassium, and iron as well as sediments stable carbon isotopic signature, pyrite-S concentration, XRD and SEM siderite analyses.

Two modes of siderite have been identified in the mud volcano sediments, spherical and rhombohedral siderite. Rhombohedral siderite appeared throughout the whole core. Spherical siderite appeared at the SMTZ (sulphate methane transition zone). Sizes of rhombohedral siderite are much smaller (~3 μm) at the top of the core near sediment/water interface and larger size at depth. Stable carbon isotopic value of siderite is about - 8 per mil, while bulk sediment carbonate with spherical siderite is about - 12.5 per mil.

Contrary to most methane seeps, mud volcano sediment favor siderite formation. Lower concentrations of chloride, a result of clay mineral dehydration at depth, and upward advection of mud limited methane oxidation and sulphate reduction occurred only at the top of the mud volcano sediments. The AOM reaction near the top provided additional carbon with negative isotopic value favor spherical siderite overgrowth or transformation near the SMTZ in mud volcano sediments. Pyrite, on the other hand, was limited with very low concentration existed in mud volcano sediments.