

The Application of Transport-Reaction Modeling in Understanding Marine Sediments Geochemistry

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Abstract

Transport-reaction models have been widely applied to advance our knowledge in the geochemistry of marine sediments for couple decades. It is a powerful tool to quantify fluxes and rates, interpret geochemistry profiles, and/or infer temporal evolution. I will present three case studies that demonstrate how transport-reaction models can be used to decipher the enigmatic geochemistry profiles and provide interpretations based on fundamental chemical and physical laws.

Biogeochemistry in cold seep environments

Interactions among several biogeochemical reactions around the sulfate-methane-transition-zone in marine sediments complicate the interpretation of how methane budget should be balanced. A model that considers balances of, stoichiometry, fluxes, and isotopes of carbon was developed and applied on chimney and non-chimney sites in Ulleung Basin, East Sea. Our model results reveal delicate feedbacks among reactions that were not previously elaborated.

Barite geochemistry and paleo-methane flux

Authigenic barite, whose saturation depends on the concentration of pore water sulfate, has great potential to quantify ancient flux of methane. Extensive signs of post-depositional and methane-related diagenesis were observed at one of the non-seeping sites at Hydrate Ridge, offshore Oregon. Our model, which simulates the sedimentary barium record, reveals the highly-fluctuated history in methane strength at the location that is currently quiescent.

Silica diagenesis in Nankai Trough

Small amount of amorphous silica cement, which was originated from volcanic ash alteration, has been shown to dramatically alter the physical properties of incoming sediments to the Nankai Trough. We quantify the ash alteration rate by simulating pore water Sr isotopic profiles and investigate the reaction network with the constraints from key pore water and solid species. We conclude that sedimentary thermal history and the formation of clinoptilolite are the keys controlling the extension of the silica cement.