

Contrasting microbial communities and geochemical patterns reflect different styles of methane oxidation and methanogenesis in terrestrial mud volcanoes

PEI-LING WANG¹, LI-HUNG LIN², TING-WEN CHENG², YUNG-HSIN CHANG², WEN-JING LAI¹, JING-YI TSENG¹, WEN-YU TSAI² AND CHIH-HSIEN SUN³

¹Institute of Oceanography, National Taiwan University

²Department of Geosciences, National Taiwan University

³Exploration and Development Research Institute, CPC Corporation Taiwan

Hydrocarbon seeps and mud volcanoes are ubiquitous in marine and terrestrial environments where gaseous fluids with unconsolidated sediments ascend along fractures tapping into potential gas or petroleum reservoirs in deep subsurface. Although extensive geochemical and microbiological studies have been conducted on marine settings, terrestrial counterparts remain poorly constrained.

This study combined molecular screening of 16S rRNA and functional genes, and geochemical analyses of porewater, sediment and gas collected from mud volcanoes distributed in eastern and southwestern Taiwan to determine how microbial communities respond to various methane fluxes and geological contexts. Our findings indicated that mud volcano systems in both regions were characterized by stratified geochemical characteristics and community assemblages resembling or contrasting those in marine settings in several aspects. In particular, anaerobic methanotrophy was linked to different electron accepting processes (sulfate versus iron reduction) in different regions, suggesting various affinities of functional expression on the presence of specific minerals. The proliferation of anaerobic methanotrophy is apparently decoupled from the supply of deeply-sourced methane but strongly dependent on the in-situ methanogenesis controlled by the fermentative production of specific methanogenic precursors. Microbial communities compartmentalized into different depth intervals collectively enable less than 40% of methane inventory emitted to atmosphere. Contrasting patterns of metabolic and geochemical stratification reflect microbial communities thriving on inherited minerals and geochemical disequilibria induced by the interaction between the upward transport of gaseous, reducing, diluted fluids and the downward infiltration of oxidizing, solute-enriched fluids subjected to surface evaporation.

Potential-pH diagram for the V-Cl-H₂O system at high chlorine concentration

R. L. WANG¹, Y. ZENG^{1,2*} AND S. H. ZHANG¹

¹Department of Geochemistry, Chengdu University of Technology, Chengdu, 610059 China;

²Mineral Resources Chemistry Key Laboratory of Sichuan Higher Education Institutions, Chengdu 610059, China (*correspondence: zengyster@gmail.com)

Vanadium, widely distributed in the nature, is essential to human and closely related to human health. While the total amount of vanadium in human body gathers to a certain degree, it shows middle-high toxicity. The toxicity of vanadium depends on its species and valence, which are mainly due to pH value, potentials, the total concentration of vanadium, and the kinds of coexistent ions in the solution. Moreover, the toxicity of vanadium increases with increasing oxidation state.

Under natural environmental conditions in soil and water, vanadium dominantly exists in either +4 or +5 oxidation state as aquatic species of vanadyl(VO₃²⁻) or vanadate(VO₄³⁻), respectively. Under weak reducing conditions, vanadyl(V^{IV}) species is stable, while in oxidizing conditions, vanadate(V^V) is stable across almost the entire pH range. VO₃²⁻ and VO₄³⁻ can coexist depending on the redox potential and pH value of the solution and concentration.

In this paper, the potential and pH value of the V-Cl-H₂O system at C_{T(Cl)} = 1.0 mol·L⁻¹ are determined by using a concentration comparison method. Based on the measured data, the preliminary predominance diagrams were constructed. A Comparison between the predominance diagrams for the V-Cl-H₂O system with C_{T(Cl)} = 1.0 mol·L⁻¹ at different vanadium concentrations (C_{T(V)} = 1.0×10⁻³ mol·L⁻¹ and C_{T(V)} = 1.0×10⁻⁵ mol·L⁻¹) [1],[2] has been done. It is shown that the location and size of the advantage regional of vanadium ion VO₂⁺, H₂VO₄⁻, VO₄³⁻ are similar. Under the conditions with pH 0.00-5.68, and Eh 0.5-0.9 V, the area of VO₂⁺ advantage region is decreased at C_{T(V)} = 1.0×10⁻⁵ mol·L⁻¹. At Eh value of 0.0-0.5 V, the HV₂O₅⁻ advantage region is replaced by VO⁺ with pH 3.68-14.00.

The authors acknowledge the support of the Program for New Century Excellent Talents in University (NCET-08-0900)

[1] Zeng, Y.; Ma, M. R. (2009) *Acta Phys.-Chim.Sin.*, , **25**: 955. [2] Wu, J.M.; Zeng, Y. (2007) *Acta Phys.-Chim.Sin.*, , **23**: 1141.