Distribution of metabolically active microbial communities in CO_2-rich marine sediments

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In the Okinawa Trough back-arc hydrothermal system, the surface sediments sometimes pool large amounts of CO_2 transported via the hydrothermal circulation [1]. The high CO_2 concentration consequently lowers pH in the sdiment porewater, which affects population, diversity, and metabolic functioning of benthic microbes [2].

During the SO196 expedition in 2008, we visited the Yonaguni Knoll IV hydrothermal field in the Okinawa Trough and observed liquid CO_2 emissions and high CO_2 concentration areas by the ROV QUEST. We measured *in situ* pH using microsensors, indicating notably low pH in the CO_2-rich sediments. The abundance of microbial cells in the sediments was evaluated by a recently developed fluorescent microscope image analysis using SYBR Green I stain [3], revealed that the cell numbers were significantly decreased by the high CO_2 concentration and low pH.

To understand the diversity richness and composition of metabolically active microbial communities in those habitats, we extracted RNA and studied the reverse-transcribed 16S rRNA fragments using pyrosequencer. Preliminary results showed that the metabolically active microbial communities indigenously inhabit sediments above the liquid CO_2 (i.e., no liquid CO_2) with relatively low diversity richness, suggesting that the liquid CO_2-bearing sediments (by very high concentration of CO_2 and/or very low pH) are too extreme to host diverse microbial life. The active microbial communities found in some distance to the liquid CO_2 include populations which are closely related to ANME-archaea and sulfate-reducing bacteria, indicating that the potential for anaerobic oxidation of methane is present at the Yonaguni Knoll seeps but repressed in the CO_2-rich, acidic sediments.

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Helium isotope variation influenced by radioactive elements decay

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Xushen gas field occurs mostly at volcanic rocks with natural gas reserves exceeding $1000\times10^8 m^3$, which is located in Xujiaweizi fault depression of Songliao Basin, NE China. Dai *et al.* [1] verified this gas field, espesically Xushen1 block which is dominated by alkane gases, is abiogenic. Jenden *et al.* [2] stantisticed that the R/Ra (R represents $^3He/^4He$ of gas samples, and Ra is $^3He/^4He$ of air) value is less than 0.1 in most commercial gas fields in the world, and it indicating the existance of mantle helium when this value is higher than 0.1. Xushen gas field contains more mantle helium than the regular reservoirs of sandstones or carbonate rocks for its unconventional origin. R/Ra values are 1.1±0.2 in Xushen1 block, and the natural gas constituents of Xushen1 block are more homogeneous basically.

It is a very long term geological history after reservoirs formed although it is one of the most slight and slow course that producing ^3He and ^4He by radioactive elements decay of Li, B, U, and Th in rocks. The average content of U and Th are 4.42ppm and 15.77ppm respectively stanticsticed from 650 volcanic rocks of 48 wells, and these two element concentrations are higher than that of sedimentary rocks in upper and deeper strata. It will be a significant influence on helium isotope.

Helium isotope composition is a good indicator for estimating the abiogenic contribution in this reservoir. One gram volcanic rocks of the reservoirs (Yingcheng formation, lower Cretaceous) in Xujiaweizi fault depression produce ^4He $5.1\times10^{-12}cm^3$ every year; ^3He production can be negligible [3]. The original $^3He/^4He$ was 3.51×10^{-6} and R/Ra was 2.51 when taking no account of diffusion, R/Ra value become 43.8% of the original, indicating obvious nucleogenic ^4He accumulation. The proportion of mantle helium decreased from the original 29.9% to 10.75% at present, just be a slight higher than 1/3 of the original. This result indicates more abiogenic volatile contribution for Xushen gas field.

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