

Soil microbial species selection and activity influenced by semiconducting minerals

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Semiconducting minerals are a unique class that could absorb photons with energy equivalents to or higher than the bandgap to form negatively charged photoelectrons and positively charged photoholes in the conduction band (CB) and valence band (VB), respectively. There is a wide distribution of semiconducting minerals in natural soils, mainly including Fe and Mn oxides [e.g., hematite (Fe₂O₃), goethite (FeOOH), pyrolusite (MnO₂)]. The redox potential of their CB electrons ranges from -1.01 V to 0.28 V (vs. NHE). Natural microbes have evolved various strategies to acquire electron energy for maintaining metabolism. We predicted photoelectrons in the CB of semiconducting minerals is a natural solid phase electron source for microbes and make influences on microbial metabolism. We designed experiments in an electrochemical equipment to simulate the energy of CB electrons by setting the redox potential of electrodes similar to the CB potential of goethite. A natural soil microbial community was inoculated and the microbial community structure were analyzed by *16S ribosomal RNA* gene. The results indicated the soil microbial community at day 0 was diverse, and some species like *Chitinophaga*, *Pseudomonas*, *Alcaligenes* and *Pedobacter* became enriched by day 5. By day 10, the *Alcaligenes* species constituted greater than 70% of the total bacterial population, in marked contrast to < 8% in the control with no applied electrode potential. Then, the growth of a pure *Alcaligenes* strain under three different electrode potential (-0.15 V, -0.06 V and +0.06V) was observed and its denitrification efficiency of nitrate was measured. Both were found to be closely related to the electrode potential. The quantity of the biofilm coated on the electrode and the nitrate reduction efficiency reached the highest at -0.15 V among three electrode potentials. In contrast, no biofilm formation or no reduction of nitrate were observed in the open circuit control. Therefore, photoelectrons probably led to the enrichment and selection of certain microbes such as *Alcaligenes* and also influenced its denitrification activity.

A contrastive study of organic matter influences on the smectite illitization in Dongying Sag, China

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Many factors such as temperature, pressure and time etc. can affect the smectite illitization in mudstone. Whereas the organic matter which owns important relationship with clay minerals has been easily ignored. For this point, samples respectively representing water-rock interaction system and water-rock-organic interaction system were selected here to make a contrastive study on the influences of organic matter during the smectite illitization in mudstone.

11 red mudstone (RM, 1000m-5300m) and 23 dark mudstone (DM, 2200m-3500m) samples from Dongying Sag were studied with X-ray Diffraction and pyrolytic analysis. Results show that RM had about 0.01-0.14%TOC (0.07% in average) while the latter had 0.17-6.75%TOC (2.16% in average). Obvious smectite illitization differences were also indicated. (1) Above 3100m: Illite proportion of RM (37-60%) was higher than that of DM (31-48%). Mixed-layered illite/smectite of RM was mainly R0, R1 patterns and that of DM was R0 pattern. Illite Crystallinity of RM (Kübler index, 0.40-0.76) was usually higher than that of DM (0.44-0.69). (2) Beneath 3100m: Illite proportion of RM (9-65%) turned significantly lower than that of DM (52-100%). Mixed-layered illite/smectite of RM turned to be mostly R3 pattern, while the DM being R1, R3 pattern. Simultaneously, the RM Illite Crystallinity (Kübler index, 0.61-0.69) got lower than that of DM (0.69-0.90). In short, the three mentioned parameters significantly inverted at the depth of 3100m. Considering their discrepancy in TOC content, it is thought that organic matter not only influenced the smectite illitization but also made this differently above/beneath 3100m. This could stimulate further study of smectite illitization especially under water-rock-organic matter interaction system.

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