Synergistic effects of biocatalysis and mineral photocatalysis

ANHUAI LU AND YAN LI

School of Earth and Space Sciences, Peking University, Beijing 100871, P.R. China (ahlu@pku.edu.cn)

Geophotocatalysis of natural semiconducting minerals play key roles in driving redox reactions on earth surface. Whether it is related to microbial metabolism remains unknown. This study focused on revealing the potential interactions among light, microbes and minerals by studying the relationship between bacterial metabolism and semiconducting mineral photocatalysis. To achieve this goal, a photoelectrochemical approach was employed by using a microbial fuel cell (MFC)-based equipment. To distinguish from traditional MFC, the novel system is named as light fuel cell (LFC), which is specifically used for investigating the biophotochemical reactions participated by microorganisms and semiconducting minerals. When using O_2 as the cathodic electron acceptor, the volumetric power density of a LFC with a microbial anode and a visible light-irradiated rutile-cathode was 12.1 W/m^3, 1.6 times higher than that obtained in the dark (7.5 W/m^3). Electrochemical impedance spectroscopy (EIS) data indicated that the cathodic polarization resistance of the LFC in light was 196 Ω, while that operated in the dark was 2820 Ω. These results manifested the synergistic effect of biocatalysis and semiconductor photocatalysis significantly improved the electron transfer efficiency. Further experiments showed a broad range of pollutants (e.g. hexavalent chromium, azo dyes, landfill leachate) were effectively treated in this system. The finding that microorganisms can donate electrons to photoexcited semiconducting minerals not only indicated a new aspect of microbe-mineral interactive pathway, but also predicted a new environmental remediation strategy. Based on our study, we believe the exploration of LFC will help in discovery of natural solar-driven biogeochemical process and development of interdisciplinary techniques in environmental remediation.

Two contrasting ore-bearing granites: Sn-bearing Qitianling granite and W-bearing Xintianling granite, Hunan province, China

JIANJUN LU, RONGQING ZHANG AND RUCHEN WANG

State Key Laboratory for Mineral Deposits Research, School of Earth Sciences and Engineering, Nanjing University, Nanjing, 210093, China (lujj@nju.edu.cn)

The Xintianling skarn type scheelite deposit is located to the northern of the Qitianling composite pluton associated with Furong tin deposit and was considered genetically to be relative to the Qitianling granite pluton. The authors had carried out in detail investigations to the age, Hf isotope and geochemical features of the Qitianling granite and the granite spatially associated with the Xintianling tungsten deposit.

The Qitianling composite pluton is mainly composed of hornblende biotite monzogranite with an age of 160~163 Ma, biotite monzogranite with an age of 153~157 Ma and fine-grained granite with an age of 146~150 Ma. These granitic rocks have higher contents of TiO_2, MgO, FeOt, HFSE (Zr+Nb+Y+Ce), total REE and LREE and higher ratio values of 10000×(Ga/Al), Th/U and LREE/HREE. They have an average values of 0.53 wt%, 0.62 wt%, 3.31 wt%, 491.48 ppm, 335.92 ppm, 305.59 ppm, 3.13, 3.51 and 10.87, respectively. The average values of A/CNK and zircon saturation temperature are 0.96 and 818 °C respectively. The ε_{Hf} (t) values of the zircons in the Qitianling granite vary from -8.1 to -3.7. These geochemical features indicate that the Qitianling granite belongs to A_2-type granite.

The granite relating to Xintianling skarn type scheelite deposit (named as Xintianling granite) consists mainly of fine to medium grained biotite granite with an age of 165 Ma and fine-grained biotite granite with an age of 154.5 Ma. The Xintianling granite has lower contents of TiO_2, MgO, FeOt, HFSE (Zr+Nb+Y+Ce), total REE and LREE and lower ratio values of 10000×(Ga/Al), Th/U and LREE/HREE. They have an average values of 0.18 wt%, 0.21 wt%, 1.15 wt%, 164.25 ppm, 87.65 ppm, 75.40 ppm, 2.43, 1.57 and 5.90, respectively. The average values of A/CNK and zircon saturation temperature are 1.03 and 734 °C respectively. The ε_{Hf} (t) values of the zircons vary from -12.7 to -6.1. The Xintianling granite belongs to S-type granite.

The geochemical characters discussed above demonstrate that the W-bearing Xintianling granite is genetically entirely different from the Sn-bearing Qitianling granite.

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