Low-frequency dielectric spectroscopy measurements on sulfate-reducing bacteria cell suspensions

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Recent biogeophysics research demonstrates the sensitivity of electrical measurements to microbial growth and microbial induced alterations to geologic material. However, the inherent dielectric properties of microbes themselves and how they might directly contribute to the electrical responses observed during bioremediation processes are poorly understood.

To improve the understanding of electrical signals from microbial-mineral transformations in porous media, we studied the low frequency dielectric properties of sulfate-reducing bacteria (*Desulfovibrio vulgaris*) in cellular suspensions. We have acquired precise dielectric dispersion curves of *D. vulgaris* cell suspensions over the frequency range 0.1 Hz to 1M Hz using two-electrode dielectric spectroscopy. We adopted a simple and robust strategy to measure, analyze and remove electrode polarization impedance arising from the interface between electrodes and ionic solutions at low frequencies (< 1000 Hz). This polarization removal technique has been tested on water saturated silica beads. We show that the broadband dielectric response of *D. vulgaris* cell suspensions can be reliably determined using this approach, with the increase of cell concentration being proportional to the increase in dielectric permittivity at low frequencies (alpha regime). The measurements were modeled assuming a dilute suspension of polarizable particles embedded in a non-polarizing medium, with the polarization attributed to the surface charge on the cell walls. Our results suggest quantitative prediction of pore- and nano (cell wall) scale microbe-mineral transformations may be possible from electrical data, and provide insights into the likely contribution of the cells themselves to electrical signals observed during biomineralization processes.

Geochemical signature of felsic porphyries in the western Tianshan Mountains, Xinjiang, NW China

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A porphyry-type Cu (Mo, Zn, Au) polymetallic ore belt extends in an E-W direction for >200 km along the late Paleozoic Kokirqin arc in the western Tianshan Mountains of China, part of the Central Asian Orogenic Belt (CAOB). Petrologic, mineralogical and geochemical study for the Lalisigao'er Mo-Cu, 3571 Cu and Lamasu Cu-Zn deposits, indicated that the ore-forming porphyries are predominantly intermediate-felsic and belong to calc-alkaline and transitional series. They are characterized by similar major element compositions to those associated with giant porphyry copper deposits in the CAOB. They exhibit enrichment of large ion lithophile elements and depletion of high field strength elements and heavy rare earth element coupled with slightly negative Eu-anomalies. These rocks also show high $(^{87}Sr/^{86}Sr)_t$ (0.70722-0.71028) and low ε_{Nd} (t) values (-3.71-++0.17), coupled with depletion of Ba relative to Th and elevated Th/Ce, Nb/Y and Th/Yb ratios, suggesting that the porphyry magma originated largely from partial melting of a subducted oceanic slab, mixed with minor melts produced by partial melting of mantle wedge components and involvement also of lower continental crust. New LA-ICPMS zircon U-Pb dating indicates that the ore-forming porphyries of the Lailisigao'er and 3571 deposits formed at ca. 346-354 Ma. In combination with extensive field investigations, we infer that the porphyries of two of the deposits, the Lailisigao'er and 3571, appear to be co-magmatic and the area beneath the 3571 deposit should be considered as a potential target for prospecting the porphyry Mo deposit.

Compared with the geochronological and geochemical datas of other ore-forming porphyries in the Chinese Tianshan, the emplacement of the ore-forming porphyries occurred mainly in the late Paleozoic, and can be divided into two groups: ca. 390-340 Ma and ca. 300-250 Ma.These three deposits belong to the first metallogenic group in the Chinese Tianshan, which formed from the Middle Devonian to the early Carboniferous in a continental arc environment related to a subducted oceanic slab, which are distinguishable from a second group that formed in the Permian during a late collisional stage, in which regional collisional compression changed to extension.