The effect of 1,10-phenanthroline on the oxidative dissolution of iron monosulfide (FeS)

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The effect of 1,10-phenanthroline (a Fe^{2+} ligand) on the oxidative dissolution of synthetic iron monosulfide (FeS) was tested by using electrochemical methods. The experiments were performed in air-saturated HCl solutions with the concentration of 1,10-phenanthroline in range 0-1 mM, at pH 5 and 25ºC. The corrosion current densities (i_{corr}), corrosion potentials (E_{corr}) and values of the components of equivalent circuit that fits the Electrochemical Impedance Spectroscopy (EIS) data were determined.

i_{corr} values are quasi-constant when the concentration of 1,10-phenanthroline varies between 0 and 0.5 mM. When the concentration of 10-phenanthroline exceeds the value of 0.5 mM, i_{corr} increases from 30.7 μA cm^{-2} up to 38 μA cm^{-2}. E_{corr} increases from -393 mV up to -338 mV when the concentration of 1,10-phenanthroline increases from 0 to 0.5 mM. At higher concentrations of ligand, E_{corr} decreases down to -355 mV. The values of the components of equivalent circuit that fits EIS data were found to be in agreement with the variation of i_{corr} and E_{corr}.

Our conclusion is that the oxidative dissolution of FeS in the presence of 1,10-phenanthroline is the result of two processes with opposite effect: 1) the inhibiting adsorption of 1,10-phenanthroline on the FeS surface and 2) the promoting effect of 1,10-phenanthroline on the breakage of Fe-S bond.

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Earth’s building blocks: The “Core Spyglass”

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The details of Earth’s accretion, and the nature of Earth’s building blocks in particular, are still poorly understood. One way to constrain accretionary processes is to understand the major differentiation event that took place during accretion: core formation. Earth’s core formed during accretion as a result of melting, phase-separation, and segregation of accretionary building blocks (meteorites, planetesimals, protoplanets). Extensive melting lead to the formation of a Magma Ocean, and the bulk compositions of the core and mantle depend on it evolution (pressure, temperature, composition) during accretion. The entire process left a compositional imprint on both reservoirs: in the silicate Earth, in terms of siderophile trace-element concentrations (a record that is observed in present-day mantle rocks); and on the core, in terms of major element composition and light elements dissolved in the metal (a record that is observed by seismology through the core density-deficit).

Constraining accretionary processes by looking at the core has been studied for almost ten years. Based on partitioning of slightly siderophile elements, the current paradigm is that Earth must have formed under very reducing conditions, followed by a complex oxidation mechanism to reach the present-day redox state. In the light of new partitioning data under extreme conditions, we will show here that Earth can form at a constant redox state (the present-day value), or even form in relatively oxidized conditions (that of carbonaceous or ordinary chondrites). This paradigm shift is strengthened by the fact that oxidizing conditions favour oxygen solubility in the core, which is a requirement both for the inner-core density jump and outer core density deficit.

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