EXPERIMENTAL AND PETROLOGIC STUDIES OF SCHREIBERSITE CORROSION
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Introduction: Schreibersite, (Fe,Ni)₃P, is a common meteoritic mineral. Phosphorus in schreibersite is reduced relative to orthophosphate, PO₄³⁻, the stable oxidation state on the surface of the Earth. Consequently, P in schreibersite is oxidized by water and atmospheric O₂. The only known mineral associated with the oxidation of schreibersite is cassidyite, Ca₂(Ni,Mg)(PO₄)₂•2H₂O, a poorly studied mineral associated with the Wolf Creek meteorite [1]. Since nearly all P on the surface of the Earth is orthophosphate, schreibersite corrosion products may serve as an indicator of extraterrestrial impacts.

Samples and Methods: Schreibersite corrosion was studied by a series of experiments in which ~1g of a synthetic iron phosphide (Fe₃P) powder or ~7 g samples of the Seymchan or Canyon Diablo meteorites were oxidized in water at 25°C for 1 day to 1 month. Oxidation took place both under air and under an inert Ar atmosphere to elucidate the effects of O₂. The aqueous corrosion products were analyzed by ³¹P NMR, EPR, and MS techniques [2,3].

NWA 4194 is a weathered enstatite meteorite with 20μm-200μm grains of schreibersite surrounded by P-rich rust. A section of NWA 4194 was analyzed by EMPA (Sx50), with a focus on P chemistry in the rust.

Results and Discussion: Schreibersite corrodes to phosphite (HPO₃²⁻), orthophosphate (HPO₄²⁻), hypophosphate (HP₂O₆³⁻), and pyrophosphate (HP₂O₇⁴⁻) in aqueous solution. The oxidation state of P in these compounds ranges from 3⁺ to 5⁺, and their formation proceeds by a free radical pathway [3].

Schreibersite in NWA 4194 is surrounded by a hydrous Fe, Ni, Ca, P-rich oxide. The oxide is highly heterogeneous, and is enriched in P relative to Fe and Ni. Ca was introduced from the terrestrial environment during weathering. The O:P ratio is ~ 3:1 (R² = 0.883), which may indicate that the P is reduced relative to orthophosphate.

These heterogeneous phases are incompletely characterized, but may represent a new group of reduced P minerals. If so, these minerals would demonstrate the formation of reduced P oxides on Earth. Since reduced P compounds are derived almost exclusively from extraterrestrial sources and crustal P is uniformly orthophosphate, detection of phosphite or hypophosphate in soil or rock samples may serve as an indicator of ancient meteoritic impacts or meteoritic flux.

Finally, schreibersite was a highly reactive source of P on the early Earth and may have primed the environment with reduced P compounds, which react with organics to form phosphorylated compounds, enabling the origin of life. Several species of bacteria can use reduced P as their sole P source [4], which may be an ancient genetic indicator of the environment of the early Earth.