New Data on the Cenozoic Epithermal Uranium Concentrations at Nopal deposit, Mexico

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Epithermal uranium deposits of the Sierra Peña Blanca are classic examples of volcanic-hosted deposits and have been used as natural analogues for radionuclide migration in volcanic settings. We present a new genetic model that incorporates both geochemical and tectonic features of these deposits, including one of the few documented cases of a geochemical signature of biogenic reducing conditions favoring uranium mineralization in an epithermal deposit. Four tectono-magmatic faulting events affected the volcanic pile. Uranium occurrences are associated with breccia zones at the intersection of fault systems. Periodic reactivation of these structures associated with Basin and Range and Rio Grande tectonic events resulted in the mobilization of U and other elements by meteoric fluids heated by geothermal activity. Focused along breccia zones, these fluids precipitated under reducing conditions several generations of pyrite and uraninite together with kaolinite. Oxygen isotopic data indicate a low formation temperature of uraninite, 45–55°C for the uraninite from the ore body and ~20°C for late uraninite hosted by the underlying conglomerate. There is geochemical evidence for biological activity being at the origin of these reducing conditions, as shown by low δ34S values (~ -24.5 ‰) in pyrites and the presence of low δ13C (~ -24 ‰) values in microbial patches intimately associated with uraninite. These data show that tectonic activity coupled with microbial activity can play a major role in the formation of epithermal uranium deposits in unusual near surface environments.

(U)SANS analysis of experimental dissolution and formation of quartz overgrowths in St. Peter Sandstone

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Introduction

The microstructure and evolution of porosity in time and space play a critical role in many geologic processes, including migration and retention of water, gas and hydrocarbons, the evolution of hydrothermal systems, weathering, diagenesis and metamorphism, as well as technological processes such as CO_2 sequestration, shale gas and secondary oil recovery. The size, distribution and connectivity of these confined geometries collectively dictate how fluids migrate into and through these micro- and nanoenvironments, wet and react with mineral surfaces. To interpret the time-temperature-pressure history of a geological system the physical and chemical "fingerprints" of this evolution in the rock should be interrogated from the nanoscale to the macroscale.

Description

We have performed a series of experiments to understand the effects of quartz overgrowths on nanometer to centimeter scale pore structures of sandstones. Blocks from two samples of St. Peter Sandstone with different initial porosities (5.8 and 18.3 %) were reacted from 3 days to 7.5 months at 100 and 200°C in aqueous solutions supersaturated with respect to quartz by reaction with amorphous silica. Porosity in the resultant samples was analyzed using small and ultrasmall angle neutron scattering and SEM/BSE-based image processing techniques.

Results and Conclusion

Significant changes were observed in the multiscale pore structures. By 3 days the overgrowths in the low-porosity sample dissolved away. The reason for this is uncertain, but the overgrowths can be clearly distinguished from the cores in the BSE images. At longer times the larger pores are observed to fill with needle-like precipitates. As with the unreacted sandstones, porosity is a step function of size. Grain boundaries are typically fractal, but no evidence of mass fractal or fuzzy interface behavior was observed [cf.1] suggesting a structural difference between chemical and clastic sediments. After the initial loss of the overgrowths image scale porosity (> ~ 1 μm) decreases with time, while submicron porosity (typically ~25 % of the total) is relatively constant or slightly decreasing, and the fraction of small pores increases.

[1] Anovitz et al. (2009) Geochimica et Cosmochimica Acta 73, 7303

Research sponsored by the Division of Chemical Sciences, Geosciences, and Biosciences, Office of Basic Energy Sciences, U.S. Department of Energy.