

## ***In situ* immobilization of radionuclide and metallic contaminants in deep vadose zone environments via reactant microfoams**

DAWN M. WELLMAN<sup>1,2</sup>, LIRONG ZHONG<sup>2</sup>,  
SHAS V. MATTIGOD<sup>2</sup>, JIM SZECSODY<sup>2</sup>  
AND FRED ZHANG<sup>2</sup>

<sup>1</sup>U.S. Department of Energy, Office of Environmental Management, Germantown, MD

<sup>2</sup>Pacific Northwest National Laboratory, 902 Battelle Blvd, PO Box 999, MS K3-62, Richland, WA 99352

Metal and radionuclide environmental contamination, at sites in which the capacity of the natural system to attenuate the contaminants is exceeded, is a critical issue plaguing water supplies globally. Within the United States, the most significant inventory is the results of legacy contamination within the Department of Energy complex. Long-lived radionuclides, <sup>99</sup>Tc and U (VI), and highly toxic metals, Cr (VI), are of particular concern.

Arid waste sites throughout the western United States, afford oxic, circum-neutral to alkaline geochemical conditions which maintain these contaminants as oxidized, highly mobile anions capable of migrating relatively unretarded through the subsurface. Moreover, the majority of the contaminant mass resides within deep vadose zone environments which present hydrogeologic challenges limiting access and remediation options.

Heterogeneous deep vadose zone environments contain preferential flow paths. Generally, vertical migration of infiltrating remedial solutions is observed through high permeability zones and low permeability strata that are the dominant source of legacy contaminants are bypassed. Moreover, the wetting front of a water-based delivery can readily mobilize contaminants and potentially enhance transport to underlying aquifers prior to stabilization.

In contrast, shear-thinning fluids (e.g. surfactants) can be used to lower the surface tension of liquids and create stable foams. The flow of foam through a vadose zone environment can be directed by pressure gradient rather than gravity. Moreover, the use of foam as a delivery mechanism limits the volume of water (< 3% vol.) required for remedy delivery and emplacement, thus mitigating contaminant mobilization. We will present bench- and intermediate-scale laboratory results discussing the fundamental hydrogeochemical properties controlling the efficacy of utilizing RCMs for *in situ* stabilization of uranium, technetium, and chromium.

## **New insights into the development of early clay grain coats**

JOANN E. WELTON<sup>1</sup> AND GRANT Y. YIP<sup>1,2</sup>

<sup>1</sup>ExxonMobil Upstream Research Company, P.O. Box 2189, Houston, TX 77252-2198  
(joann.welton@exxonmobil.com)

<sup>2</sup>Currently, ExxonMobil Production Company, 800 Bell St., Houston, TX 77002 (grant.y.yip@exxonmobil.com)

Clay grain coats have long been recognized as one of the key controls on the preservation of deep reservoir quality [1, 2, 3, 4]. However, most grain coat studies have emphasized high temperature cement growth, providing few insights into the initial processes responsible for early coat development.

A fundamental question is, how and why does clay adhere to grain surfaces? The purpose of this research was to evaluate the primary controls on the development and distribution of early grain coats in a modern fluvial system. The Brazos River in Texas was selected for this study. It is a very clay-rich river, ranking 6<sup>th</sup> in terms of mean annual suspended sediment discharge (11mt/yr) in North America. It is a predominantly a meandering river system which extends approximately 850 miles through central Texas, crossing a diverse climate zone ranging from semi-arid to subtropical.

The primary controls investigated include the impact of bedrock geology, fluvial style, climate, texture, pedogenesis, and the role of biological organisms in the development of clay and carbonate grain coats. Results confirmed that climate, texture, soil processes, and biological activity (e.g. microbial to land snails), do indeed play a critical role in the development of effective grain coats. Recognition criteria for identification of early grain coat processes in ancient sandstones will be discussed.

- [1] Pittman & Lumsden (1968) *J. Sed. Pet.* **38**, 668–670.  
[2] Pittman, Larese & Heald (1992) *SEPM Spec. Pub.* **47**, 241–255. [3] Ehrenberg (1993) *AAPG* **77**, pp. 1260–1286.  
[4] Worden & Morad (2003) *Int. Assoc. Sedimentol. Spec. Publ.* **34**, 3–41.