Implications of the new hypothesis on the apparent discrepancy between field – lab feldspar dissolution rates on modeling reactive transport in the critical zone

CHEN ZHU[1]*, PENG LU[1] AND JIWCHAR GANOR[2]

[1]Indiana University, Bloomington, IN 47408
[2]Ben-Gurion University of the Negev, Israel

Recently, we have proposed and tested a new hypothesis that appears to resolve part of the apparent discrepancy between lab – field feldspar dissolution rates [1, 2, 3]. The slow secondary mineral precipitation results in a quasi-steady state, at which dissolution proceeds at rates that are orders of magnitude slower than the rates measured at far-from-equilibrium. The quasi-steady state is determined by the relative rate constants, and the function of Gibbs free energy in the rate laws. Therefore, slow clay precipitation effectively reduce feldspar dissolution rates by orders of magnitude, in a fashion consistent with lab rates at conditions far from equilibrium, the control of dissolution rates by the Gibbs free energy of the reaction, and many field observations.

To explore the potential effects of fluid flow rates on the coupling of reactions, we extrapolate a batch system to open systems and simulated 1D reactive mass transport for oligoclase dissolution and kaolinite precipitation in a homogeneous porous media. Different steady states were achieved at different locations along the 1D domain. The time-space distribution and saturation indices (SI) at the steady states were a function of flow rates for a given kinetic model. Regardless of the differences in SI, the ratio between oligoclase dissolution rates and kaolinite precipitation rates remained 1.626, as in the batch system case. Therefore, our simulation results demonstrated coupling among dissolution, precipitation, and flow rates.

[1] Zhu, C. 2009. Geochemical Modeling of Reaction Paths & Geochemical Reaction Networks. In, Oelkers, E. H. & Schott, J. (eds) *Thermodynamics & kinetics of water-rock interaction*. **70**, 533–569, Mineralogical Society of America. [2] Fu *et al.* (2009) *Chemical Geology*, **91**(3) 955–964. [3] Zhu, C. & Lu, P. (2009) *Geochimica et Cosmochimica Acta*. **73**, 3171–3120. doi, 10.1016/j.gca.2009.03.015.

Geochemistry of the Early Tertiary salt lake in the Dongying Depression, Bohai Bay Basin of Eastern China

G.Y. ZHU AND S.C. ZHANG

Research Institute of Petroleum Exploration and Development, PetroChina, Beijing, China (zhuguangyou@Petrochina.com.cn)

A sequence of evaporite and dark-colored mudstones, stratigraphilly belonging to middle-upper part of the fourth Member of the Shahejie Formation (Es_4), Lower Tertiary, is more than 1000m in thickness deposited in central area of the Dongying Depression, Bohai Bay Basin. In the sequence, the thickness of anhydrites is about 200m, while that of argillaceous rocks being 800m. Some scholars thought that depositional environment of evaporite was not favorable to source rocks, so they seldom paid enough attention to evaluating their hydrocarbon generation potential [1]. Having investigated the evaporite sedimentation, the authors believe that lacustrine evaporites are not only deposited with source rock, but also deposited with purely itself.

Geochemical evidence and sedimentary system showed that the saline lacustrine was in an under-filling situation during the geological period of mid-upper Es_4, and a deep-water salt lake was formed. In the salt lake, the salinity of surface water was different from that of bottom water, which resulted in a delamination of the lake water for a long time. As vertical circulation of the lake water being limited, the bottom lake water was in an absolutely stagnant state and appeared in anoxic environment, which prohibited the activity of benthos and led to the preservation of deposited organic matter as much as possible. This environment and sedimentation can be described by geochemical characteristics of dark-grey mudstone and shale interbedded with layered evaporite. In conclusion, super-saline lacustrine water is beneficial not only to accumulation and preservation of organic matter, but also to superior source rocks, such as those developed in the mid-upper Es_4 Formation of the Dongying Depression. A great deal of oil and gas has been generated the source rocks. Meanwhile, it is noticeable that anhydrites are developed in the Es_4 in the Dongying Depression and are buried below 3500m with subsurface temperature over 120°C; H_2S is also generated due to the thermochemical sulfate reduction (TSR).

[1] Zhu G Y, *et al.*(2004) *Acta Geologica Sinica*, **78** (6)1275-1288