TRANSMISSION ELECTRON MICROSCOPE STUDY OF ILLITE/SMECTITE, GCO/DOE #1 PLEASANT BAYOU GEOPRESSURED GEOTHERMAL TEST WELL, BRAZORIA COUNTY, TEXAS

R.L. Freed[1] and D.R. Peacor[2]

ABSTRACT

Six shale samples, two from core and four from hand-picked cuttings, were examined by transmission electron microscopy (TEM) techniques to study the effects of burial metamorphism on mixed-phase illite/smectite (I/S). TEM lattice fringe images from shallower samples show mixed-phase I/S layers in sub-parallel orientations relative to each other, commonly with branching and interfingering relationships. Electron diffraction patterns of these shallower samples show very diffuse basal reflections, prominent turbostratic structure, pronounced streaking along z*, and multiple z* orientations in the same diffraction pattern. All of these features indicate a poorly defined interstratification of the mixed-phase I/S: the diffuse basal reflections are probably due to the presence of only a few layers in a diffraction position; the turbostratic structure is due to misalignment of individual layers relative to each other; the z* streaking is due to stacking disorders of the layers in a direction perpendicular to the layers; and the multiple z* orientations are due to rotational disorder of the layers about an axis parallel to the layers.

TEM lattice fringe images from deeper samples show mixed-phase I/S layers arranged in a more parallel fashion, with less branching and interfingering. Electron diffraction patterns for these deeper samples show well defined basal reflections, and both turbostratic structure and z* streaking are less pronounced. These relationships indicate a more regular interstratification for deeper layers: a large number of layers are in diffraction position; the misalignment of individual layers is less evident; and the stacking disorder perpendicular to the layers is less pronounced.

X-ray powder diffractograms have been interpreted to indicate ordering of illite and smectite layers within the mixed-phase I/S. This order is first observed below the "soft" geopressure boundary (0.465 psi/ft; 10.5 k Pa/m) and is prominent below the "hard" geopressure boundary (0.7 psi/ft; 15.8 k Pa/m). However, neither the TEM lattice fringe images nor the electron diffraction patterns show ordering of illite and smectite layers within mixed-phase I/S.

---

[1]Trinity University, San Antonio, Texas.
[2]University of Michigan, Ann Arbor, Michigan.