2004 AAPG ANNUAL CONVENTION
April 18 – 21, 2004
Dallas, Texas

GEOCHEMICAL EXPLORATION FOR OIL AND GAS

GEOCHEMICAL INDICATIONS OF FRACTURED CARBONATE RESERVOIRS IN NEW YORK FROM ASTER DATA

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Fractured carbonate fields (e.g., Trenton-Black River Glodes Corners Road field, NY and Stony Point and Albion-Scipio fields, MI) are an end member of a continuum with Mississippi Valley type (MVT) lead-zinc deposits at the other extreme. Both the oil fields and MVT deposits involve: 1) the movement of large volumes of low temperature fluids (70ºC < T < 200ºC) and 2) fractured carbonate rocks that have undergone significant dissolution, dolomitization, and mineralization. Porosity and permeability are confined to solution enhanced fracture systems and dolomitized wall rock immediately adjacent to the fracture system. (Interestingly enough, the temperature range is also the range associated with the generation and expulsion of hydrocarbons from source rocks). Once the dissolution and dolomitization (which produces a 14% reduction in rock volume and concomitant increase in porosity) occur and the hydrocarbons wet the fracture surface, it is unlikely that later mineralization or changes in stress regime will close the fractures and destroy porosity and permeability.

Digitally enhanced ASTER data (14 spectral bands from the visible to thermal infrared) reveal a large number of fractures. In the Bass Island trend, many of these fractures match known and postulated faults and fracture intensity domains mapped by University of Buffalo geologists. A soil gas survey by the University of Buffalo crossed several of these spectrally defined ASTER fractures and FIDs. The survey showed that soil gas values (C_1 - C_2) are elevated in the satellite mapped fracture systems and FIDs.

In the Glodes Corners Road field area, field work confirmed a direct correlation between fractures mapped in the imagery and the location and orientation of fractures in the field. Small oil and gas seeps occurred along some of the fractures. Fall field work showed that specific vegetation types, growing in the fracture zones, cause the spectral signature seen in the summer imagery. The response of vegetation to hydrocarbon in the soil is strongly location-specific and depends on climate, drainage, soil type, and available vegetation communities, to list a few. Because hydrocarbon microseepage occurs for long periods of time relative to the life span of vegetation, the hydrocarbons do not actually produce vegetation “stress” in the usual sense. Rather, the presence of hydrocarbons produces structural changes in the vegetation community, such as changes in species, plant distribution, crown density, leaf structure, apparent vigor (dwarfs or giants). These changes in the vegetation community, over an actively seeping area, in turn produce subtle changes in the spectral reflectivity of the area.

In the Glodes Corners Road field area, the fall colors of the leaves revealed that the tree communities within the fracture zones marked by spectral anomalies were very different from the tree communities outside the fracture zones. Oak hard wood forests constitute the majority of the forests in the area. Within the fracture zones mapped on the ASTER data, maples, green ash, poplars, and basswood with their bright fall colors are common. This difference in color and tree species is obvious in the fall when the leaves have turned, but the ASTER imagery was acquired in the summertime when tree color and species differentiation were not as obvious to the unaided eye. The difference in forest types extended beyond the creek bottoms and drainage features that marked many of the fracture zones and was not solely related to differences in soil moisture. Apparently the ASTER data were detecting subtle differences in the spectral characteristics of the different forests.

In the Geosat Report, Barry Rock noted the same type of anomalous vegetation associated with the Lost River gas field in West Virginia. Tree species within the fracture zones have mycorrhizal fungi internal to the roots whereas adjacent tree species have these fungi in external root nodes. Trees with internal root fungi are more tolerant to gas in the soil than trees with external root fungi.

These results suggest ASTER data are an effective tool to guide the exploration for fractured reservoirs in New York, and by analogy elsewhere.