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STRATIGRAPHY, FLUID FLOW PATTERNS AND RESERVOIR COMPARTMENTALIZATION AROUND GULF COAST SALT DOMES

Objective: Vital economic interest in petroleum resources has long been the driving force behind the studies on the stratigraphy, source and flow pattern of fluids around the salt domes in the US Gulf Coast. This proposed research is a continuation of an ongoing integrated research on tying the source, flow pattern and compartmentalization of fluids around a number of Gulf Coast salt domes with the local stratigraphy, a part of which has been published in Banga *et al.* (2002). High resolution geochemical data of the fluids (brines and oil) collected from the Cenozoic horizons around the Vinton salt dome (**VSD**) in Louisiana will be tied with the well log data, biostratigraphic data, and 3D seismic data, under a geographic information systems (GIS) environment, to evaluate the source and flow pattern of fluids and most importantly reservoir compartmentalization. Also the geochemical attributes of the VSD fluids will be compared with that of three other capped salt domes (South Liberty, High Island, and Spindletop) coming from Eocene to Miocene horizons in the southeastern Texas Gulf Coast. In brief, an integrated study of major, minor, trace element, and stable isotope geochemistry of fluids, in conjunction with structural-stratigraphical constraints will be used to evaluate the source, migration pattern, and compartmentalization of the fluids in the vicinity of these Gulf Coast salt domes.

The research has the following objectives: (i) to generate stratigraphic cross-sections around the **VSD**; (ii) to evaluate the influence of geology, structure, cap rock, and the salt body on the fluid flow pattern in the Vinton oil field; (iii) to compare the chemistry and flow pattern of formation water and oil around the **VSD** with that of the South Liberty, High Island, and Spindletop salt domes; and most importantly (iv) to evaluate the extent to which reservoir compartmentalization can be identified with the help of fluid chemistry and 3 D seismic data, in a more comprehensive fashion than has been done in the South Liberty oil field using limited 2D seismic data; please see Banga *et al.*, 2002.

Previous Work: Galloway *et al.* (1983) have discussed in detail the stratigraphy of the US Gulf Coast. Hanor and Sassen (1990), in their work on the Louisiana Gulf coast, report that aqueous fluid flow directions in most of the deep geopressured sediments are nearly vertically up and that fluids in the hydropressured zones have been emplaced by vertical migration from deeper and older geopressured source rocks. Many workers (including Ranganathan and Hanor, 1989; Capuano, 1994) have reported dynamic, large-scale fluid-flow system of dissolution and mass-transport and elevated pore water salinity has facilitated by fault systems in the vicinity of the piercement salt domes from the Gulf of Mexico basin. Galloway (1984) also has discussed the influence of faults and microfractures acting as conduits for fluid flow in the geopressured sediments of the Gulf Coast. Dissolution of cap rock and salt body, and mixing between meteoric water and geopressured fluids (from deeper source) along the flank of the South Liberty salt dome in Texas have been described by Banga *et al.* (2002) on the basis of the brine chemistry, structure and 2D seismic data. We [Banga *et al.* (2002)] also have pointed at possible reservoir compartmentalization around the South Liberty salt dome, Texas, on the basis of brine chemistry, biostratigraphic data and limited 2D seismic data. A comparison on the isotopic characters of aqueous fluids collected from the Texas and Louisiana Gulf Coast is given in Banga (2003).

Methodology: The study involves several different steps including: (a) collection of oil-field fluid samples (oil and water) and fresh water samples from wellheads; (b) chemical analysis of the brines for major anions and cations; (c) analysis of the brines for stable isotopes of oxygen ($\delta^{18}O$) and hydrogen (δD); (d) geochemical characterization of these brines with the help of elemental and isotopic tracer chemistry, geochemical modeling, and chemical cross-plots; (e) high resolution whole oil gas chromatography, and saturated and aromatic biomarker gas chromatography of some selected samples; (f) stable isotopes of whole oil, saturates and aromatic components of some selected samples; (g) spatial analyses of the geochemical data through GIS software; (h) stratigraphic work and fault identification in the local horizons on the bases of well-logs, biostratigraphic data, and 3D seismic data from around the **VSD**; (i) interpreting geochemical and geophysical data to formulate comprehensive fluid flow pattern; and (j) comparing the **VSD** fluid flow pattern with the South Liberty, High Island and Spindletop fluids. The broad divisions in the methodology follow.

(a) Chemical Work: Brine samples will be analyzed for: (a) basic field parameters; (b) analyses of 19 cations and anions using inductively coupled plasma spectroscopic (**ICP**) and ion chromatographic (**IC**) instruments; and (c) stable isotope of hydrogen (δ**D**) and oxygen (δ^{18}**O**) using mass spectrometers. Oil samples will be analyzed for high-resolution whole oil gas chromatography, biomarker gas chromatography mass spectrometry, and stable isotope mass spectrometry.

(b) Stratigraphic Work: The stratigraphic framework of the sediments surrounding the **VSD** will be examined, using A2D Smartraster™ images and well logs, and biostratigraphic data. Geoplus™ Petra interpretation software will be used for building cross-sections around the salt domes. In addition, a number of cores will be studied to evaluate the depositional set-up around the **VSD**.

(c) Seismic Work: 3-D seismic data of the **VSD** oil field available in the University Of Houston Department Of Geosciences (obtained through Output Exploration LLC., or OPEX) will be used for better visualization of the **VSD** flanks and wells and fault identification. Interpreted seismic data will be used to detect reservoir fault blocks, and finally, fluid chemistry of samples from individual fault blocks will be used to determine reservoir compartmentalization or connectivity.

(d) Spatial Analyses: Well production data from these four oil fields (obtained from PI/Dwights PLUS dataset) and geochemical data will be plotted using ArcView GIS software, for the purpose of better visualization of spatial variation of production and chemistry around the fields. The spatial analyses will also be used to make location maps, base maps for stratigraphic studies and base maps for spatial plots of brine chemistry. Other culture data (digital orthoquad images or DOQ images, counties, roads, rail-roads, rivers, cities, etc.) will be downloaded from various sources of the public domain database.

Key References:

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