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The Relationship of Subsurface Reservoir Properties and Hydrocarbon Seeps in the Green Canyon Area, Northern Gulf of Mexico

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Numerous Gulf of Mexico sea surface oil slicks can be identified on satellite images; additionally sea floor hydrocarbon seeps are well documented through studies of chemosynthetic communities, seafloor features such as pock marks and mud mounds, and the presence of gas hydrates. Initial reviews of satellite images indicate that certain areas with recurring surface slicks are associated with known subsurface hydrocarbon production. However some areas with established production have no sea surface hydrocarbon slicks and several areas with sea surface slicks have no subsurface production. The relationship of sea surface slicks to underlying seafloor seeps is influenced by several geologic characteristics and these characteristics may determine which seeps develop into surface slicks. One of the geologic factors that contribute to the development of a sea surface slick is the character of the hydrocarbon in the subsurface. In the Green Canyon Area of the Gulf of Mexico 205 sea surface slicks have been identified on satellite images and 54 of these slicks are in areas of proven subsurface production. The Minerals Management Service (MMS) has made publicly available reservoir properties for 750 reservoirs in the Green Canyon area and 100 of these reservoirs are beneath sea surface slick sites. This paper will discuss the relationships of the seep site reservoir properties and contrast these with those of the reservoirs that do not have associated sea surface slicks. Specific reservoir characteristics to be considered include reservoir depth, API gravity, primary trap, reservoir age, reserve size, drive mechanism, porosity, water saturation, permeability, pressure, gas-oil ratio, gas specific gravity and initial temperature. An improved understanding of factors influencing Gulf of Mexico subsurface reservoirs and surface slick relationships will contribute to a more accurate assessment of source and pathway relationships for hydrocarbon transport.

The API oil Gravity Versus Depth analysis for the 750 reservoirs is presented in Figure 1 and the calculated best fit line indicates an abnormal relationship of decreasing reservoir oil gravity with depth. The expected result is for reservoir oils to increase 1^{O} API for every 200 to 400 feet of increasing burial (Hunt, 1996). This relationship is evaluated in more detail for the 100 seep site reservoirs in Figure 2, and the decreasing oil gravity with depth is also indicted for this subset; however when the depth to the underlying salt is considered the reservoir depth and API relationship can be explained. The reservoirs in areas where the top of salt is 2 milliseconds or less on seismic are presented in Figure 3. These are areas where diapirs or shallow salt structures are present and indicate conduits available for transport from the deep subsurface for the hydrocarbon. These rapid transport conduits have provided higher API gravity oil that has been trapped in shallower reservoirs than is expected. In contrast Figure 4 presents reservoirs in areas where the salt is not present or is below 4 milliseconds and these areas represent mini-basins or salt withdrawal areas where sediment deposition has occurred. These areas have the expected relationship of increasing API gravity with depth and this analysis indicates the conduit for the creation of the surface slick has yet to be determined.

Figure 1. API versus Depth relationship for 750 reservoirs in the Green Canyon area. Black line is best fit relationship for the data.

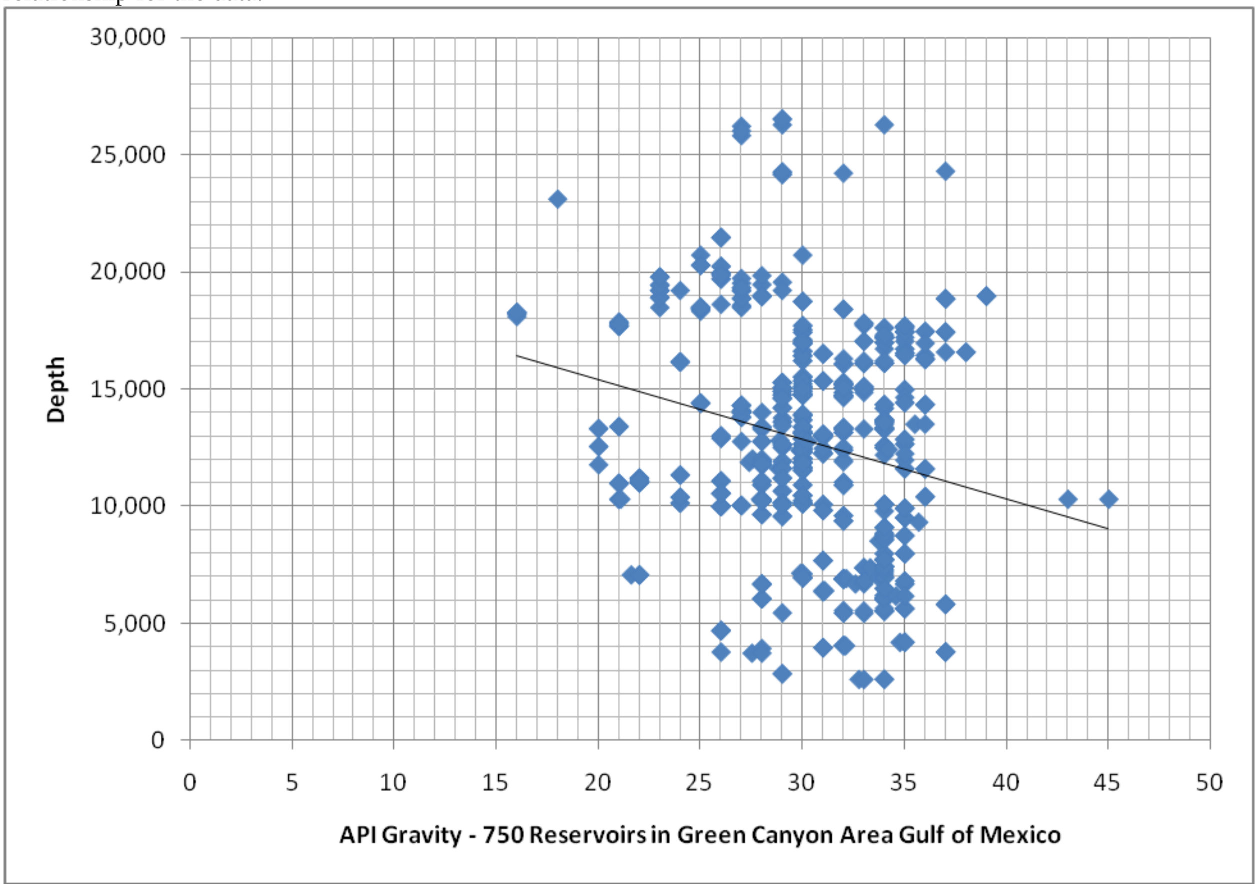


Figure 2. API versus Depth relationship for 100 reservoirs under sea surface slick sites in the Green Canyon area. Black line is best fit relationship for the data.

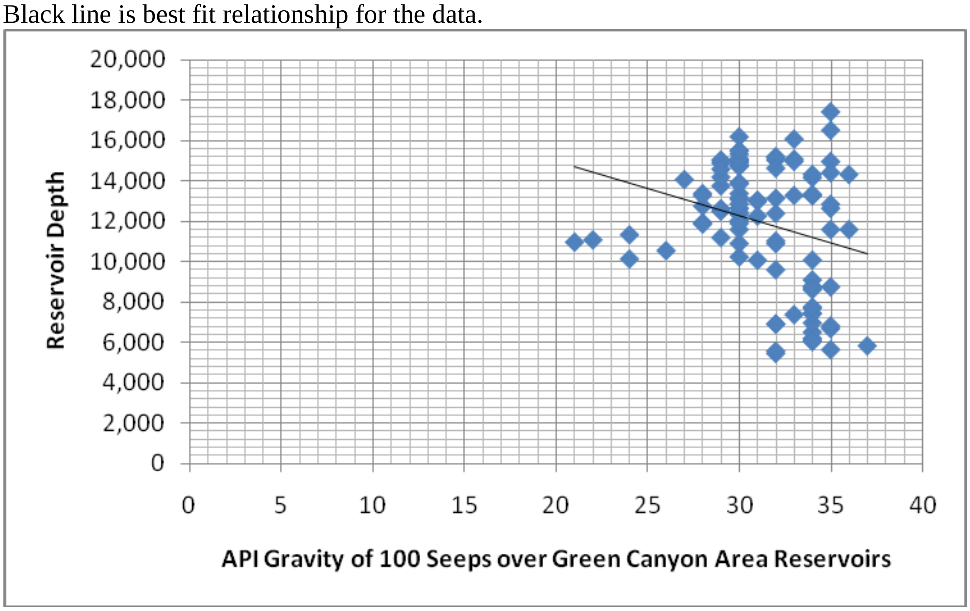


Figure 3. API versus Depth relationship for reservoirs under sea surface slick sites in areas with depth to salt less than 2 milliseconds on seismic. Black line is best fit relationship for the data.

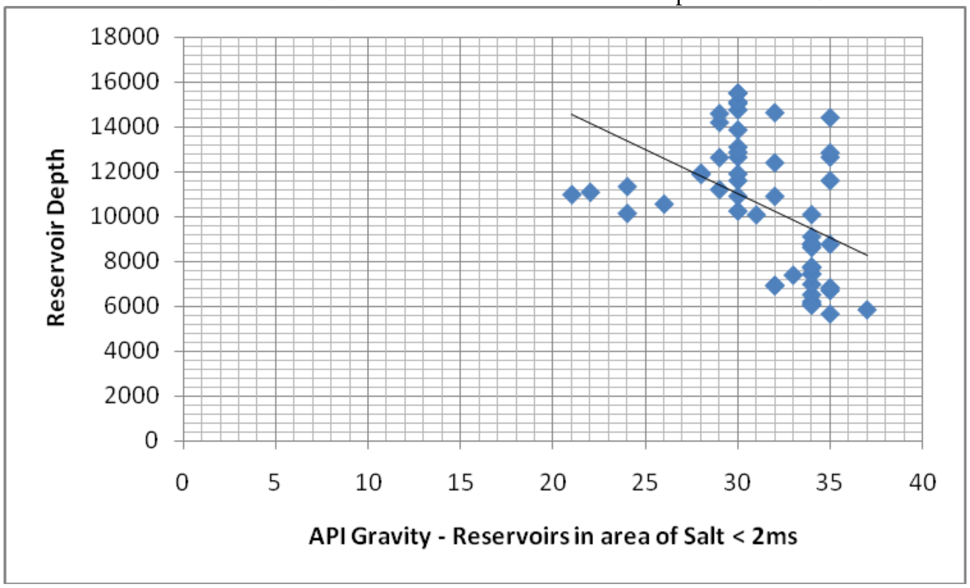
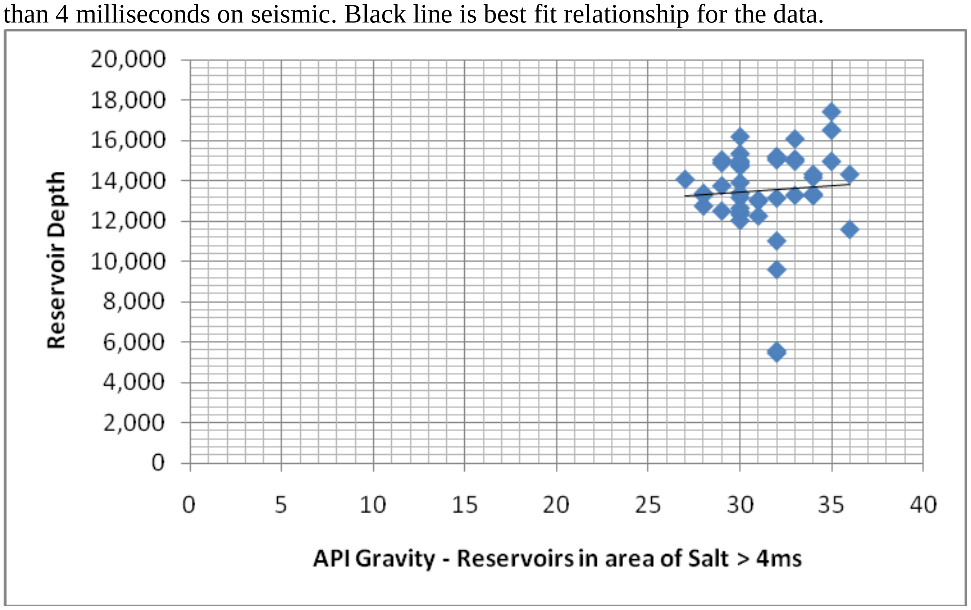


Figure 4. API versus Depth relationship for reservoirs under sea surface slick sites in areas with depth to salt greater than 4 milliseconds on seismic. Black line is best fit relationship for the data.



Reference:

Hunt, John M. 1996. *Petroleum Geochemistry and Geology*. New York, NY: W. H. Freeman and Company.