SEDIMENTARY INCLUSIONS AND INTERNAL SALT STRATIGRAPHY WITHIN ALLOCHTHONOUS SALT SHEETS, OFFSHORE GULF OF MEXICO

DWIGHT "CLINT" MOORE
Anadarko Petroleum Corporation
17001 Northchase Drive
Houston, Texas 77060

HOLLY HARRISON
FRANK C. SNYDER
Phillips Petroleum Company
6330 West Loop South
Bellaire, Texas 77401

Salt massifs have been encountered in subsurface drilling and mining under many circumstances and in many parts of the world. Salt structures have been formed from primary layers of autochthonous beds of evaporite deposits, and mobilized into pillows, rollers, walls, stocks, diapirs, and allochthonous sheets (Jackson and Talbot 1991). Until recently, these features have been significant barriers to deeper hydrocarbon exploration in the offshore Northwestern Gulf of Mexico Basin of the United States (Moore and Brooks 1995). These allochthonous sheets in the Gulf of Mexico have now been completely penetrated in over 30 wells and encountered at the bottom of over 100 additional wellbores during the nearly 50 year drilling history of the basin.

In several of the wells that drilled both the top and base of a salt sheet, significant thicknesses of early-mid Tertiary aged sediments have been encountered within the sheet. Specifically, from both proprietary and commercially available biostratigraphic reports, a broad range of Eocene, Oligocene, and some mixed-Miocene assemblages were encountered in discrete zones within these salt sheets. Data from high resolution Formation MicroImaging (FMS/FMI) logs and rotary sidewall cores in several wellbores demonstrates unique characteristics of the sedimentary inclusion intervals. Convolved and limited internal stratigraphy within the allochthonous sheets has similarities to "anomalous zones" in salt stocks of the coastal Louisiana Five Island Salt Dome province.

Kupfer (1990) describes a classification of anomalous zones derived from salt mine observations and offers descriptive and genetic classifications for zones from these coastal salt domes. Regrettably, offshore well penetrations are widely dispersed, with distances between wells in the tens of miles, instead of tens of feet. The 8-10 inch wellbore diameters are clearly not as extensive as salt mine cavern cuts. The wells drilled at Mahogany (Ship Shoal 349/359) and Mesquite (Vermilion 349), located on separate allochthonous salt sheets over 90 miles apart, encountered sedimentary inclusions within their sheets. In the Mahogany subsalt discovery area several wellbores have now penetrated an extensive, regional salt sheet. The second and third wellbores offset the initial wellbore within 1500' and 3000' laterally. These wells reveal discontinuous characteristics similar to the coastal salt "anomalous zones." Clastic sediments, older faunal foraminiferal tests (broken and whole), and occurrences of liquid oil have been observed, and are similar to Kupfer's descriptions in his direct subsurface observations of salt mine faces.

Many individual zones ranging from a few inches to over four feet in thickness, are observed in all three of the Mahogany wellbores. These intervals are discontinuous between wellbores and the lower 1000' of salt has a greater occurrence of these "anomalous zones." This has been attributed (Harrison and Patton 1995) as a product of a basal shear mechanism that has entrained sedimentary inclusions in the lower portion of salt sheets where salt and sediment have been redistributed along shear zones. Zones of thin (1-12") sedimentary inclusions occur less frequently throughout the upper 2000' of this 3000+' thick salt sheet and suggest a more complex genetic origin. Kupfer chose not to offer any genetic origin within the context of his report, while documenting similar zones and beds in detail.

A much thicker salt sedimentary inclusion occurred as an 88' thick bedded zone of clastic sediment nearly 800' above the base of a 2400' thick salt sheet in the Mesquite well in Vermilion 349. This zone was also thoroughly sampled by sidewall cores, and thin section and x-ray diffraction analysis performed on the recovered core material. This zone appeared brecciated, composed of calcareous shales containing abundant fossils, siltstones, and kaolinitic, illitic, and chloritic clays, as well as halite as intergranular cement. Quartz was the predominant framework grain, with some samples also containing small amounts of pyrite, plagioclase feldspar, and calcite cement filling some fractures.

The majority of the clastic sediment found within the salt can be described as "compacted" inclusions which were entrained within the salt sheets during preceding salt structure coalescence and tectonism. The consistent occurrence of these Late Eocene-Oligocene sedimentary inclusions suggests an earlier major episode of salt sheet development in the Northern Gulf of Mexico. Based on the age of internal sediments within these salt sheets, and the much younger ages of sediment above and below these salt sheets, an evolutionary development of salt remobilization and emplacement can be inferred. Only through continued, detailed wellbore logging and sampling efforts will we better understand the evolutionary role that these beds played in salt sheet development.

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