Residual Oil Zones: From Science to Commercial Exploitation

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The first basin-wide study of Residual Oil Zones (ROZ's) in the upper Guadalupian carbonates of the Permian Basin, supported by the Research Partnership to Secure Energy for America (RPSEA), has been initiated. Production from ROZ's and anecdotal evidence from exploration wells, coupled with the theory/model of the development of ROZ's, has led to the belief that there are potentially billions of barrels of additional producible tertiary reserves in the Permian Basin and elsewhere. ROZ's have historically been interpreted as being long Transition Zones. Although the upper portions of TZ's/ROZ's have long been assumed to contribute to production in some fields, until recently, their potential as a CO_2 recovery target was not exploited.

ROZ's appear to be common in Leonardian and Guadalupian carbonates on the Central Basin Platform and Northwest Shelf. Exploitation of thick ROZ's associated with many of the major San Andres fields has begun with CO_2 projects underway at Wasson, Seminole, Vacuum, Means, Goldsmith, and Hanford Fields, with others planned. Development wells scheduled to test deeper horizons, have drilled through zones with good shows in samples, porosity and oil saturation in core, and where the zones are expected to be oil productive based on log calculations. Although these wells have a poor record of success, the tantalizing results suggest that there are wells with tertiary recovery potential in ROZ's.

The anecdotal evidence from a growing number of exploration wells documents examples of what can be interpreted as ROZ's. Often, the wells were plugged and considered unsuccessful as there was no associated primary production to develop. From discussions with a number of explorationists and review and reinterpretation of research articles on Permian Basin fields, a set of common ROZ characteristics is developing: The presence of sulfur crystals in the carbonates; at least in the near source region, enhanced porosity developed as the result of meteoric dissolution of sulfates; sample shows of oil and/or gas and cores with 20-40 percent oil saturation; sulfur water produced on DST's or attempted production tests; log calculations that suggest producible hydrocarbons; tilted oil/water contacts in fields; multiple stages of dolomitization, at least one of which is associated with the lateral flushing; tight updip facies with poor production associated with porous downdip facies that are swept.

The tectonically associated lateral flushing, responsible for the development of the Residual Oil Zones, occurred beginning ~60 Ma, during the Laramide Orogeny, and continuing through the Basin and Range uplift. The recharge areas and entry points for the meteoric water were the large uplifted areas between the Rio Grande Rift and the easternmost outcrops of Leonardian and Guadalupian carbonates in the Guadalupe and Sacramento Mountains. The large sulfur deposits in northern Pecos County are believed to represent flushing-pathway evidence on the Central Basin Platform for the flushed oil and waters. Modeling of the system that created "Mother Natures Waterflood" will be completed as part of this study.