Calibration of regional groundwater flow models – working toward a better understanding of site-specific systems: He insights

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Estimation of groundwater ages over extended periods of time requires the use of numerical approaches that will lead to the establishment of groundwater flow models representative of the real system. The difficulty with this approach is the lack of unique solutions resulting in a number of possible groundwater flow scenarios for specific sites. Through a set of groundwater simulations conducted in the Carrizo aquifer and surrounding formations in Texas, four very different calibrated groundwater flow scenarios are presented. It is shown that a variation of hydraulic conductivity values up to two orders of magnitude in different areas in the Carrizo aquifer and overlying confining layer lead to very similar calculated hydraulic heads with a maximum deviation of 3.3% among all calculated values. Each calibrated water flow model leads to groundwater flow system scenarios concerning recharge rates, velocity fields and computed water ages that are not unreasonable for the area. In the absence of additional constraints it is not possible to validate or invalidate one groundwater flow scenario over another. In contrast, when all calibrated scenarios were tested with a ^{4}He transport conceptual model based on direct measurements and reasonable assumptions, all groundwater flow scenarios except one failed to reproduce a coherent ^{4}He transport behaviour and concentration distribution in the system. It is clear that without the additional constraints provided by ^{4}He, it would not be possible to discern which model most closely replicated natural conditions. Thus, the use of an independent tracer such as ^{4}He contributes to an increased confidence in groundwater flow model results by strongly reducing the number of solutions available. Advective water ages were estimated for the entire system. By establishing a direct relationship between these water ages and NGTs (Noble gas Temperatures) it is our goal to illustrate how, in the future, one expects to achieve the most accurate paleoclimatic reconstruction.

Implications of Gas Washing of Oil in the Offshore Louisiana Gulf of Mexico Basin

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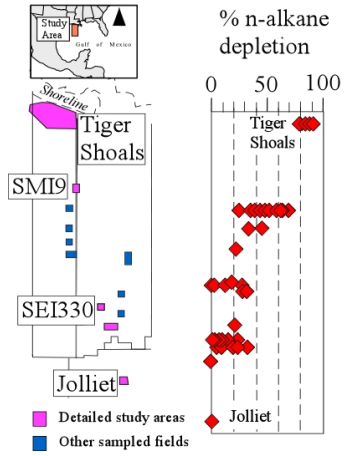
Analysis of 138 un-biodegraded oils in a 100 x 200 km area of the offshore Louisiana Gulf of Mexico Basin shows a remarkable pattern of n-alkane depletion. Depletion is calculated assuming that unaltered oils have a log-linear abundance of n-alkanes (Kissen, 1987). The depletion is the difference between the measured composition of the oils and the composition determined by linearly extrapolating the log n-alkane abundance at high to low carbon number.



The alteration is best explained as the consequence of the "washing" of oil in migration pathways by late-generated dry gas. Substantial amounts of gas are required (over 100 moles of gas per mole of oil for 90 wt% removal). However, straight-forward basin and maturation modelling indicates that the requisite gas is available provided the hydrocarbon system operates in a flow-through fashion with very little retention outside of the source strata (e.g. hydrocarbons fill <~0.05% of the pore volume there). If this is the case, both the intensity of washing and its changes from north to south are expected, ~99% of the oil and 72% of the gas that has been generated has been expelled to the ocean, and the present model gas-oil ratio of venting hydrocarbons (~70 at Tiger Shoals and ~1 at Jolliet) accounts for the changes in depletion. Structural constraints and the lack of biodegradation requires that the reservoirs at Tiger Shoals, SMI9, SEI330 and Jolliet filled recently or very recently (5.5 to 0.01 Ma). Filling in the required timeframe can be accomplished if hydrocarbons are drawn from square areas 32, 14, 56 and 20 km on a side, respectively. Aspects of the modelling address the breakdown of oil to methane, but our discussion will largely focus on the gas washing process and its implications.