Application of Formation Water Geochemistry-A New Approach to Understand the Evolution of Kuwait Petroleum System

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Formation water chemistry provides an additional tool for constraining fluid flow in the subsurface at both the basin and reservoir scales. Analysis of formation waters from the Kuwait petroleum system suggests the existence of three unique formation water chemistries, and the presence of a fourth type of formation water that occurs throughout sedimentary successions but is characteristic of Mesozoic and Early Paleozoic horizons. Formation waters from the lowest stratigraphic horizons are of a Cl-Ca type, and indicate waters at chemical equilibrium in a hydrodynamically static water-body. Formation water chemistries occurring slightly higher in the succession are often transitional in terms of their formation water type between Cl-Mg and Cl-Ca types. However, there are Upper Mesozoic formation waters with anomalously high salinities, which from a geological perspective represent magnesium rich dolomitizing fluids. Where present these fluids are at chemical disequilibrium for their depth. The most probable sources for saline fluids are the stratigraphicaly lower Najmah and Gotnia formations. The occurrence of highly saline Upper Mesozoic formation waters at higher levels can be linked to the presence of faults active during the Zagros Orogeny, and locations where hydraulic connectivity between upper and lower horizons can be proven. The shallowest formation water chemistry type can be termed SO42—Na and has a low chloride concentration. Formation water type can be linked to basin scale process of profound importance to petroleum exploration and production. Formation water chemistry in the Kuwait petroleum system can be tied to diagenetic processes within key reservoir intervals and basin scale fluid movements - including major episodes of petroleum charging. Formation water chemistry is also pertinent to reservoir development where it can be used to fingerprint produced fluids and constrain their origin. These observations and conclusions have been established after evaluating a large database of 415 individual formation water analysis reports from 100 and 126 deep oil and shallow water wells in Kuwait. Chemical and physical properties vary geographically and starigraphically throughout Kuwait and this variation can be rationalized with respect to current knowledge and basin models; e.g. the presence of physical barriers and periods of tectonic activity.