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# Surface mapping of the Milh Karwah salt diapir to better understand the subsurface petroleum system in the Sab'atayn Basin, onshore Yemen

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In the central part of the Sab'atayn Basin of Yemen hydrocarbons were generated from pre-salt Upper Jurassic source rocks during the Cenozoic and the salt provides the ultimate super seal for the pre-salt and intra-salt traps. Therefore the proper understanding of salt tectonics is critical for ongoing hydrocarbon exploration efforts in the Sab'atayn Basin.

Based on numerous well penetrations, the presence of non-evaporitic lithologic units such as neritic carbonates and black shales within the Sab'atayn Formation is the function of the depositional environment within the rift basin. Coarse clastics are common along the basin margin whereas massive halite and neritic carbonates are more frequently drilled in the basin center. Non-evaporitic lithologies within the Sab'atayn Formation are quite common and are quite important for the prolific Alif oil play in Yemen.

The internal lithologic and structural complexity within the Sab'atayn Formation was studied by analyzing a few outcropping salt diapirs east of the Habban Field area. The Milh Kharwah diapir was studied by recently acquired high-resolution satellite images (16 band VIS-NVIR and SWIR World-View 3 imagery) integrated by field sampling of the various lithologies within the salt diapir. The Sab'atayn Formation was found here to be a "dirty salt" as it has not only halite, anhydrite and gypsum, but various stringers of bituminous marls and other non-evaporitic lithologies. Based on the lithologic composition of the 10 surface spot samples and their spectral signal in the infra-red satellite data sets, a very detailed geologic map of the diapir was compiled. This evaluation was done in lieau of the time-consuming and logistically challenging surface geologic mapping in this conflict-stricken region. The geometry of intra-salt curtain folds seen on the new geological map, with subvertical fold axes and stringers, is very characteristic for the stems of diapirs suggesting significant post-kinematic exhumation and erosion in the area.

Since evolving salt diapirs can modify significantly the thermal regime around them, the thermal anomalies then can modify the maturation of source rocks nearby. Salt diapirs reaching the surface dissipate heat more efficiently and thus keep deeper regions of the basin relatively colder and potentially within the oil window for a longer time. The cooling effect is maximized when the top of the salt diapir remains at or very close to the surface for a significant period of time. Recent apatite fission-track analysis using core samples from nearby wells provided an Eocene age interval for the subaerial exposure of the Milh Kharwah salt diapir constraining our basin modelling study. Moreover, the quantitative lithologic description of the "salt" integrating the surface samples with high-resolution satellite images further refined our modelling results.