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Evidence of large-scale subsidence caused by interstratal karstification of evaporites in the Interior Homocline of Central Saudi Arabia

Memesh, A. (1), Dini, S.M. (1), Gutiérrez, F. (2) and Wallace, C.A. (3)

1. Saudi Geological Survey, Kingdom of Saudi Arabia, (2) Earth Sciences Department, University of Zaragoza, Spain, (3) Wallace Consulting LLC, Colorado 80465, USA (fgutier@unizar.es)

The Interior Homocline of Central Saudi Arabia constitutes an arcuate belt of gently dipping Phanerozoic sedimentary rocks lying unconformably on the eastern flank of the Proterozoic Arabian Shield. This succession includes a Late Jurassic cyclic sequence composed four limestone units, each overlain by Ca-sulfate units. The porous carbonate units constitute prolific oil reservoirs. The total thickness of this sequence is 326 m in the Abu Jifan Oil Field, located about 110 km ENE of Ar Riyad. The upper evaporitic unit, 132 m thick in the Abu Jifan area, is called the Hit Formation. The underlying carbonate and Ca-sulfate units of the cyclic sequence are designated as the Arab Formation. Arab-A Member corresponds to the carbonate unit directly below the Hit Formation and Arab-B, -C and -D members are the underlying carbonate and Ca-sulfate cycles, in descending order. Cumulative thickness of the anhydrite units in the Hit and Arab formations reach 234 m in the Abu Jifan Oil Field. The Arab Formation is underlain by limestone of the Jubailah Formation and the Hit Formation is overlain by limestone of the Sulaiy and Yamanah formations. Above, there is a Cretaceous and Tertiary succession more than 1 km thick.

Interstratal dissolution of these evaporitic units has caused the sagging and collapse of the overlying formations along a band more than 550 km long from the north of Ar Riyad to the south of As Sulayyil. Most of the population and economic activity of the area is concentrated in this sinkhole-prone topographically low subsidence area

where groundwater is available at shallow depth. In fact, as indicates Vaslet et al. (1991), Ar Riyad, the capital of the Kingdom, lies on a dissolution-induced subsidence depression. In these subsidence areas the structure and the topography are primarily governed by dissolution-induced gravitational deformation.

Between latitudes 24˚ 00' N and 23˚ 00' N (Hawtat Bani Tamim quadrangle, sheet 23I), the Phanerozoic sequence has a NNE-SSW strike and is tilted about 1º to the ESE. Here, dissolution-induced subsidence has affected a band up to 31 km wide along the homocline. The west margin of the subsidence belt is defined by the outcrops of the limestone unit of the Arab-D Member. The eastern margin of the subsidence area can be traced along a sinuous escarpment in which the Sulaiy Formation commonly shows a west-facing monoclinal flexure. This scarp, up to 50 m in local relief, roughly reflects the eastward extent reached by the down-dip migration of the dissolution front. Evidence of interstratal karstification and subsidence in the subsidence area include: (1) Lack of significant anhydrite and gypsum outcrops. (2) Chaotic ductile and brittle deformation (folds, faults, interstratal and transtratal collapse breccias) in the supra-evaporitic units. (3) Outcrops of Neogene alluvial and lacustrine sediments (Sha'al and Rufa formations) restricted to the subsidence area. (4) N-S trending internally drained subsidence depressions up 55 km long and 13 km wide (khabras). (5) Blocks of Yamamah Formation foundered some hundred meters in the bottom of the subsidence depressions. (6) Extensive tracts of basin and dome structure and topography with poorly developed drainage attributed to differential karstication of the evaporites and the consequent passive bending (sagging) of the overlying strata. (7) Caprock collapse sinkholes several tens of meters across and up to about 50 m deep commonly associated with the monoclinal structure that defines the eastern margin of the subsidence area. (8) Ca-sulfate rich groundwater in the underlying karst aquifers.