Advanced Aspects Of Groundwater Flow And 3D Geologic Models In The Oil Shale Basins, Jordan

Professor Omar Al Ayed[1], Paul G. Quinn[2]

1. Department of Chemical Engineering, Al-Balqa Applied University, Marka 11134, Amman Jordan
2. Ambet, 3124 S. Parker Road, A2-131, Aurora, CO, 80014

Abstract

Oil-shale deposits have been identified in the Jordan Basins. Geophysical and Geological Investigations have been conducted on the Oil Shale basins. The availability, natural dynamics and interaction between surface water and groundwater resources are understood and will be important to understanding integrated hydrologic impacts from development of oil shale resources on the Oil Shale Basins. Development will require groundwater to access and process oil shale deposits. The removal of this water and subsequent disposal of it will likely impact both groundwater and surface water. Understanding these impacts requires detailed knowledge of both the surface hydrology and subsurface hydrogeology of the basin system and their interaction. Natural ground water recharge within the basin aquifer is derived from precipitation whereas ground-water discharge is to either ephemeral or, perennial streams. The geohydrologic units considered in these models in geologic Formations that are unconfined and confined units. These deposits directly influence flows between surface water and groundwater. Hydraulic conductivity of the basin aquifer is related to lithology and the degree of fracturing. This presentation discusses development of conceptual models of the El Lajjun and Sultani basins and an initial computer model of the Attarat basin, and inputs necessary to construct a fully integrated surface water-groundwater hydrologic model of existing conditions of the Oil Shale Basins: El Lajjun, Sultani, and Attarat.

Introduction

Jordan has resources of oil and gas and no commercial deposits of coal. However, there are about 26 known deposits of oil shale, some of which are large and relatively high-grade (Jaber and others, 1997; Hamarneh, 1998, p. 2). The eight most important of these are the Juref ed Darawish, Sultani, Wadi Maghar, El Lajjun, Attarat Umm Ghudran, Khan ez Zabib, Siwaga, and Wadi Thamad deposits. These eight deposits are located in west central Jordan within 20 to 75 km east of the Dead Sea.

The Jordanian oil-shale deposits are marinites of Late Cretaceous (Maastrichtian) to early Tertiary age. A number of deposits are in grabens and some may prove to be parts of larger deposits, such as the Wadi Maghar deposit that is now considered to be the southern extension of the Attarat Umm Ghudran deposit. The deposits are at shallow depths, in essentially horizontal beds. As much as 90 percent of the oil shale is amenable to open-pit mining (Hamarneh, 1998, p. 5). The overburden consists of unconsolidated gravel and silt containing some stringers of marlstone and limestone and, in some areas, basalt. Overall, the oil shales

thicken northward toward the Yarmouk deposit near the northern border of Jordan and may prove to be an exceptionally large deposit—underlying several hundred square kilometers and reaching 400 m in thickness.

The oil shales in central Jordan are in the marine Chalk-Marl unit, which is underlain by phosphatic limestone and chert of the Phosphorite unit. The oil shales are typically brown, gray, or black and weather to a distinctive light bluish-gray. The moisture content of the oil shale is low (2 to 5.5 weight percent). Calcite, quartz, kaolinite, and apatite make up the major mineral components of the El Lajjun oil shale, along with small amounts of dolomite, feldspar, pyrite, illite, goethite, and gypsum.

GIS and Groundwater Modeling

GIS 3D models assist with establishing a conceptual hydrogeological model of the groundwater system. Knowledge of the local hydrogeological background from previous work was the starting point of this presentation. The GIS models shown in this presentation are as follows:

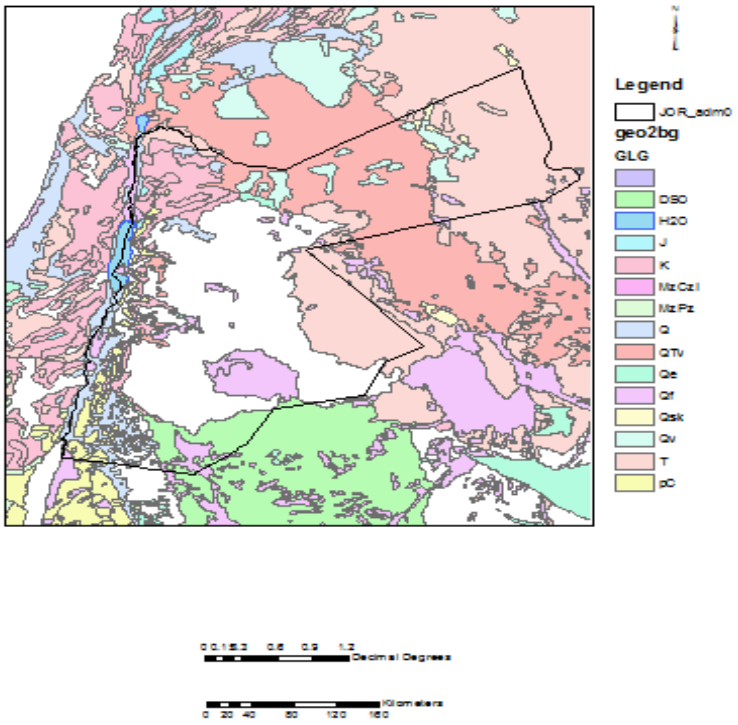


Fig. 1. Surface Geology Map Jordan

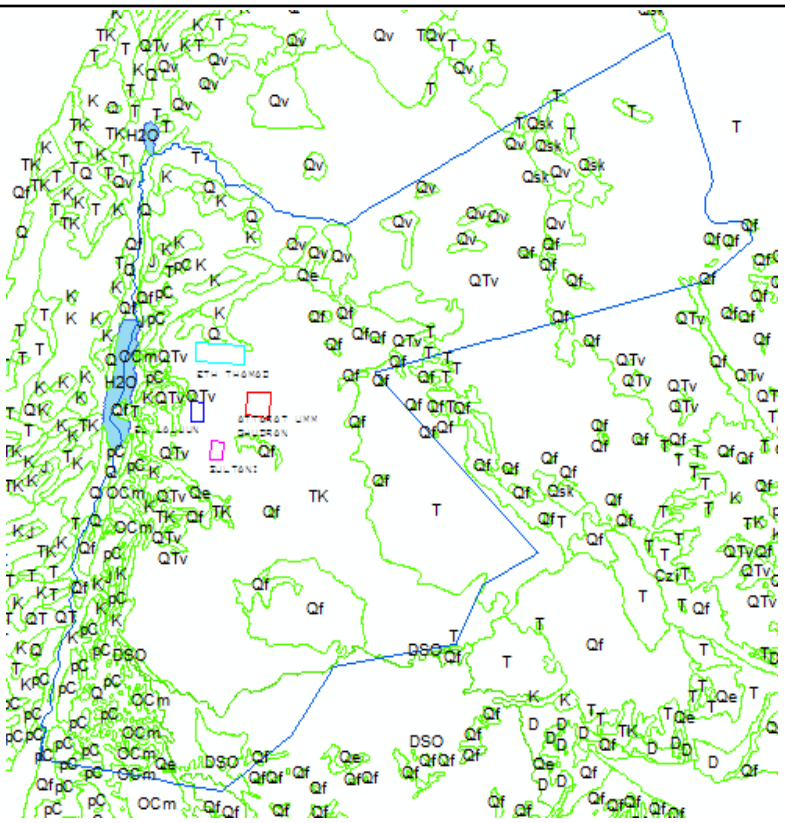


Fig. 2. Annotated Surface Geology illustrating the Oil Shale Deposits

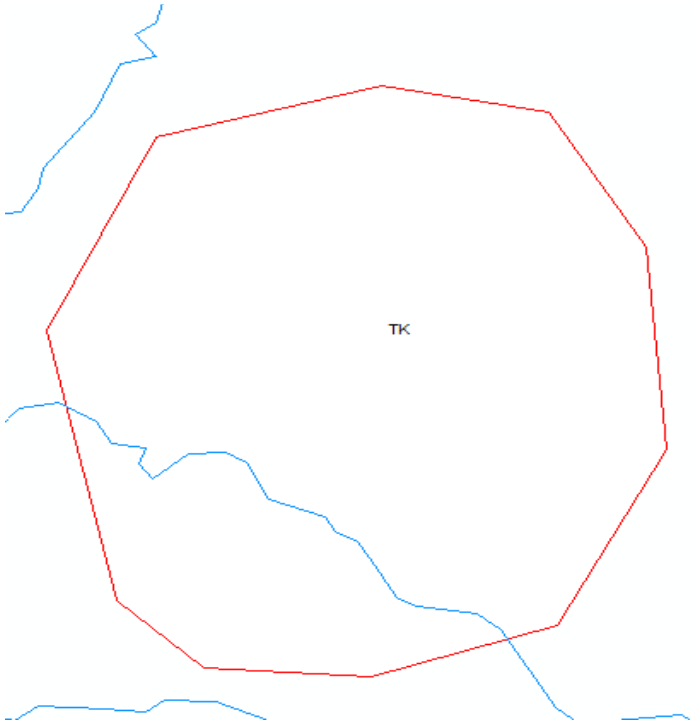
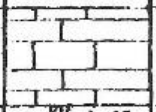
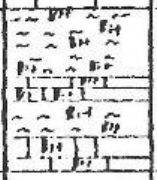
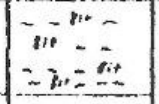
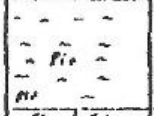
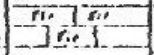
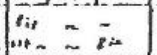
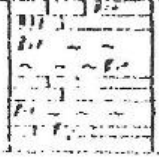
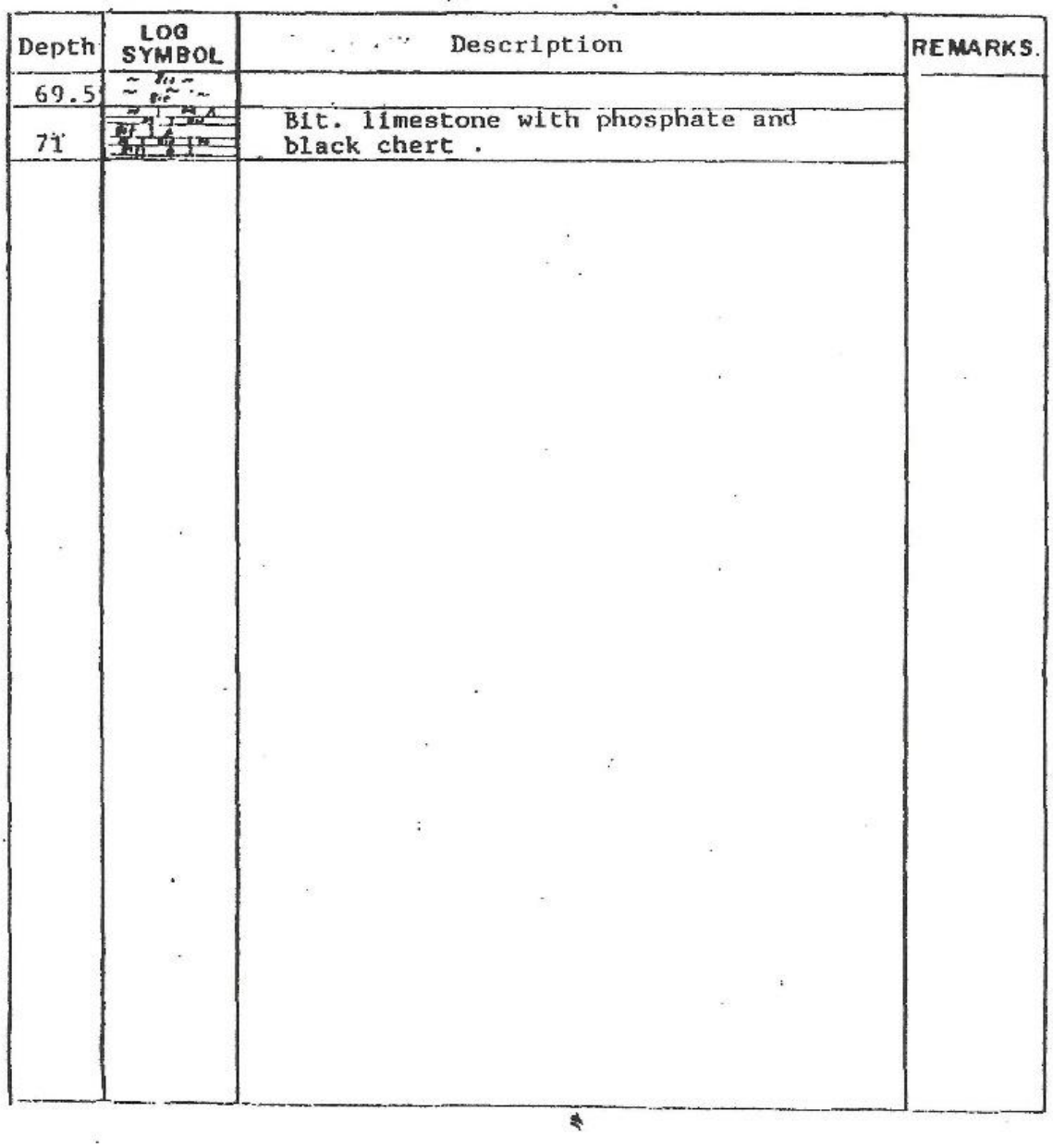


Fig. 3. Attarat Umm Ghudran Deposit Geology With River Network

Depth	LOG SYMBOL	Description	REMARKS
1.0		Top soil yellowish .	
5.0		Chalky marl with chalky limestone , white and chert , brown to black .	
10		Marl , dirty white to reddish , medium to fine grained .	
18		Clayey marl , reddish to greyish fine to medium grained .	
21		Clayey marl , grey to reddish , fine with some chert brownish .	
33		Clayey marl , reddish to yellowish , fine .	
		Limestone , white to dirty white , hard .	

Depth	LOG SYMBOL	Description	REMARKS
38		Limestone , white to dirty white , hard .	
42.5		Alternating of bit limestone with Bit marl , grey to light grey .	
46.5		Bit marl , grey to Brownish .	
48.5		Alternating of Bit. limestone , with Bit. marl grey to light grey .	
55.2			
58		Bit . marl light grey .	
		Bit . marl grey .	
61.8		Light grey slightly bit. limestone .	
61.5		Bit. marl grey to light grey .	
		Alternating of bit. limestone with Bit. marl	



Depth	LOG SYMBOL	Description	REMARKS.
69.5			
71		Bit. limestone with phosphate and black chert .	

Fig. 4abc. Stratigraphic Section Borehole Log for Attarat Umm Gudran Deposit

Fig. 5. Sultani Deposit Geology With River Network

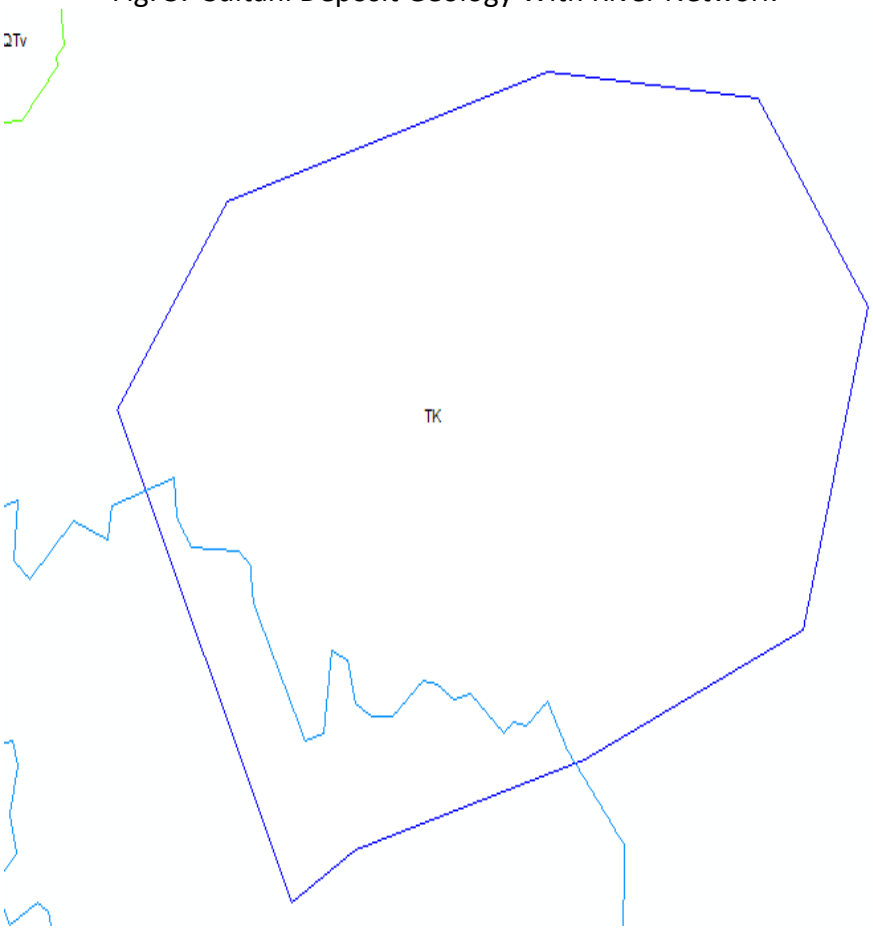


Fig. 6. El Lajjun Deposit Geology With River Network

Computer Modeling of the Attarat Umm Gudran Deposit

A Conceptual Model was constructed for this deposit with the following layers:

LAYER 1: TOP SOIL, YELLOWISH

LAYER 2: CHALKY MARL

LAYER 3: MARL

LAYER 4: CLAYEY MARL

LAYER 5: LIMESTONE

LAYER 6: BIT MARL

LAYER 7: BIT LIMESTONE

Fig. 7. The Locations of cross-sections was constructed in the Attarat Umm Gudran Deposit:

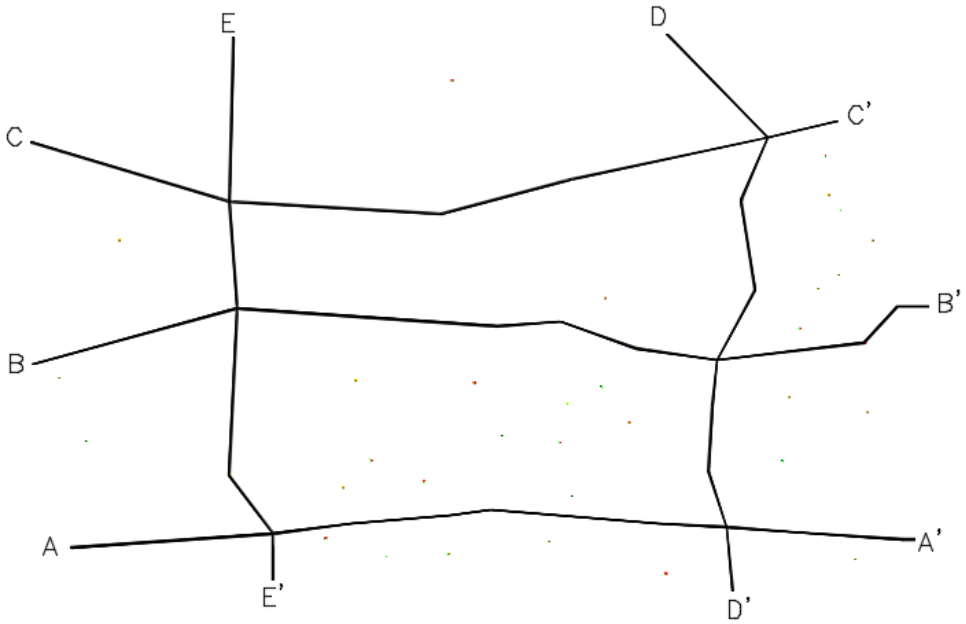


Fig. 8. Contour Map of Ground Surface in the Attarat Umm Gudran Deposit:

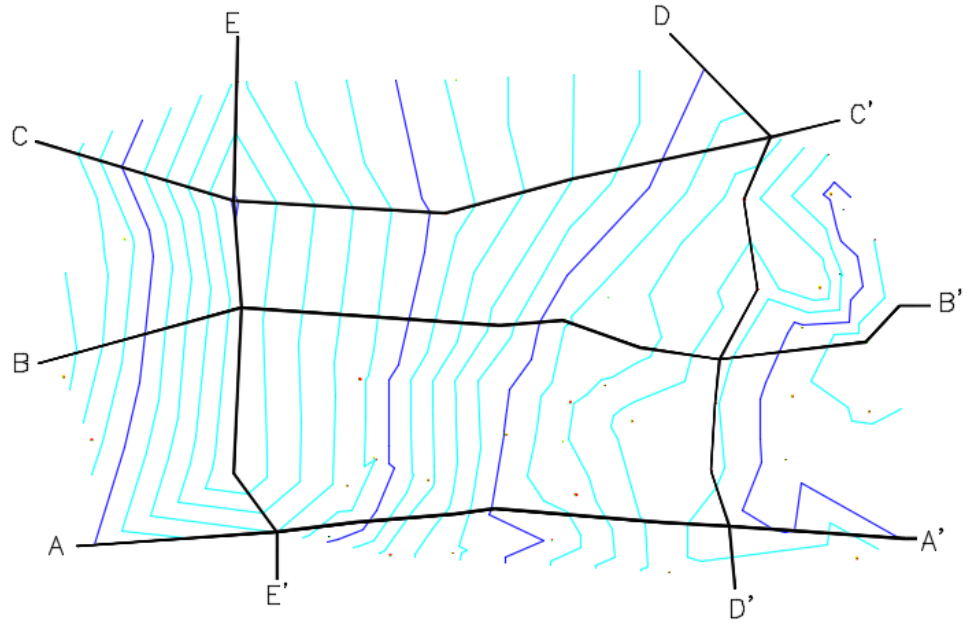


Fig. 9. Contour Map of top of Oil Shale Layer in the Attarat Umm Gudran Deposit:

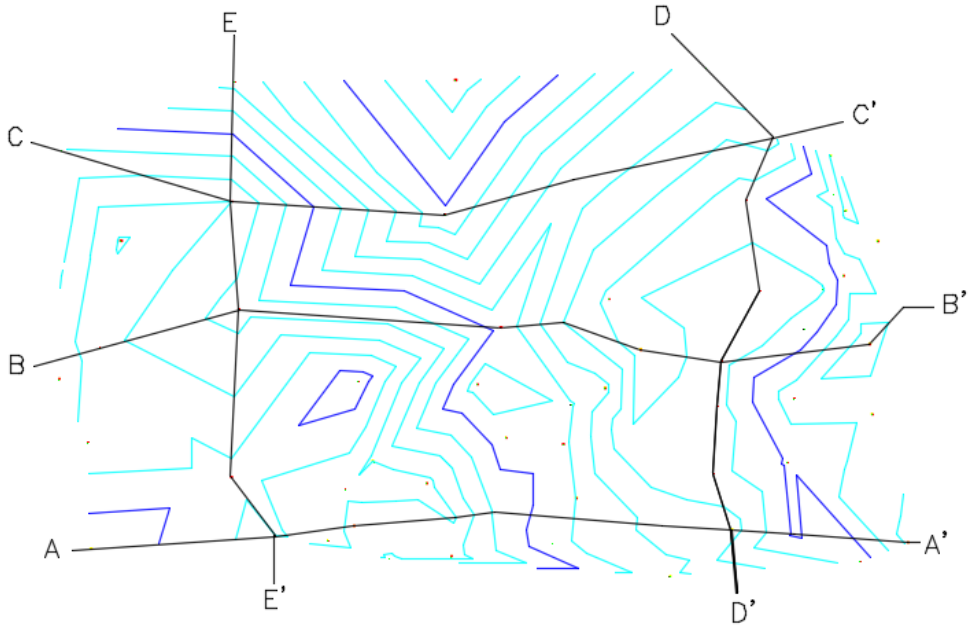


Fig. 10. Contour Map of bottom surface of Oil Shale Layer in the Attarat Umm Gudran Deposit:

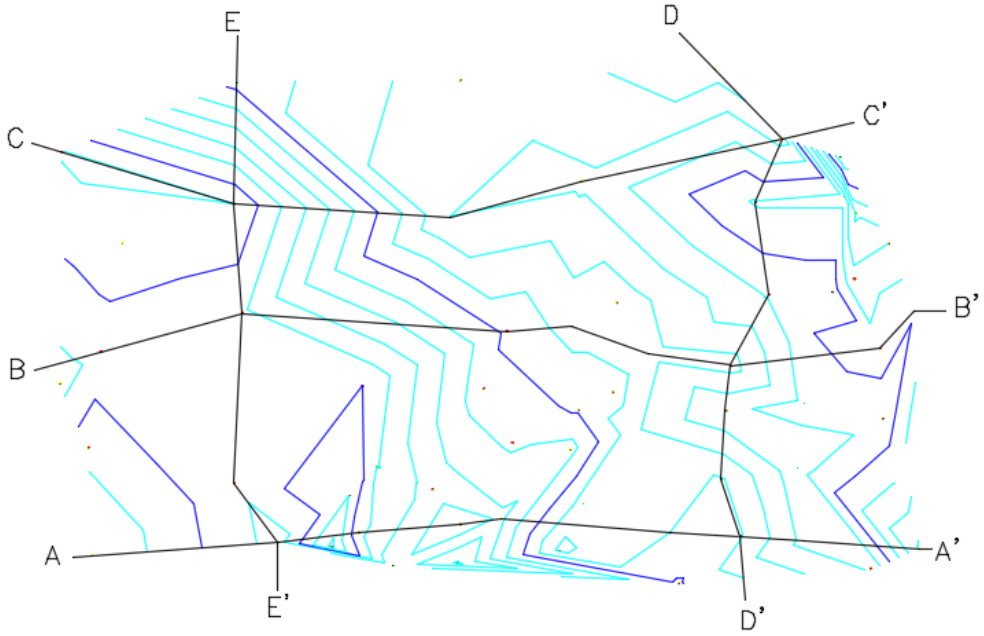
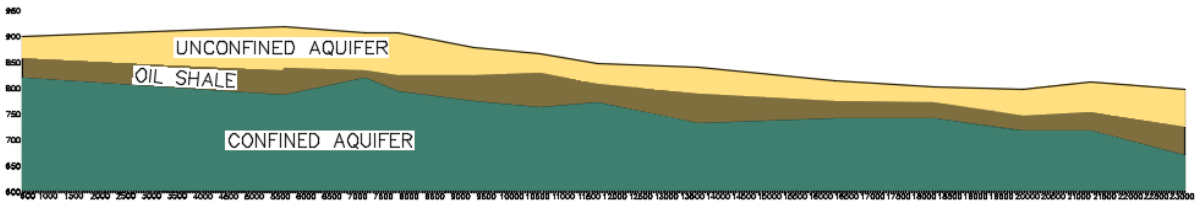
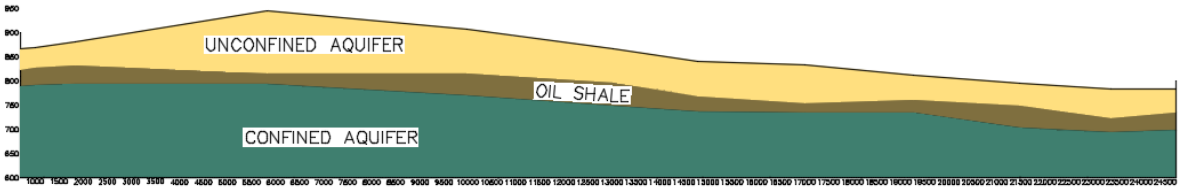


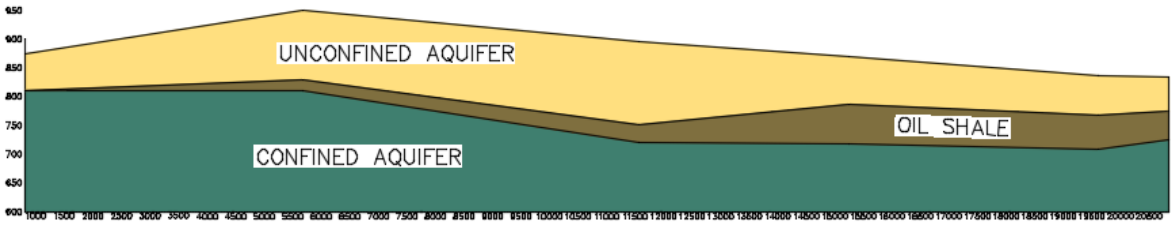
Figure 11abcde. Cross-sections were constructed in the Attarat Umm Gudran Deposit and are shown here in metric (m) units:



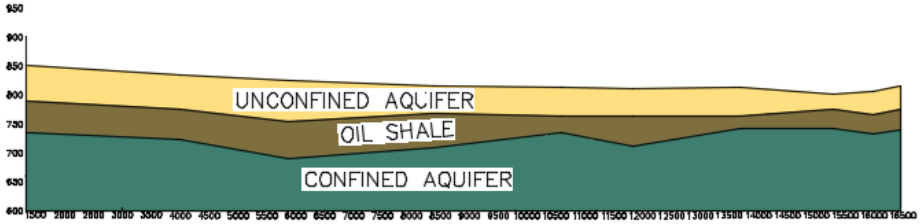
CROSS SECTION AA'



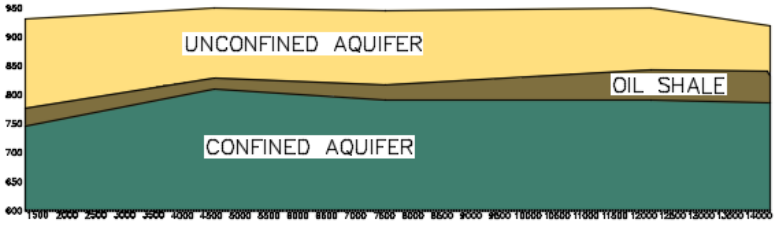
CROSS SECTION BB'



CROSS SECTION CC'

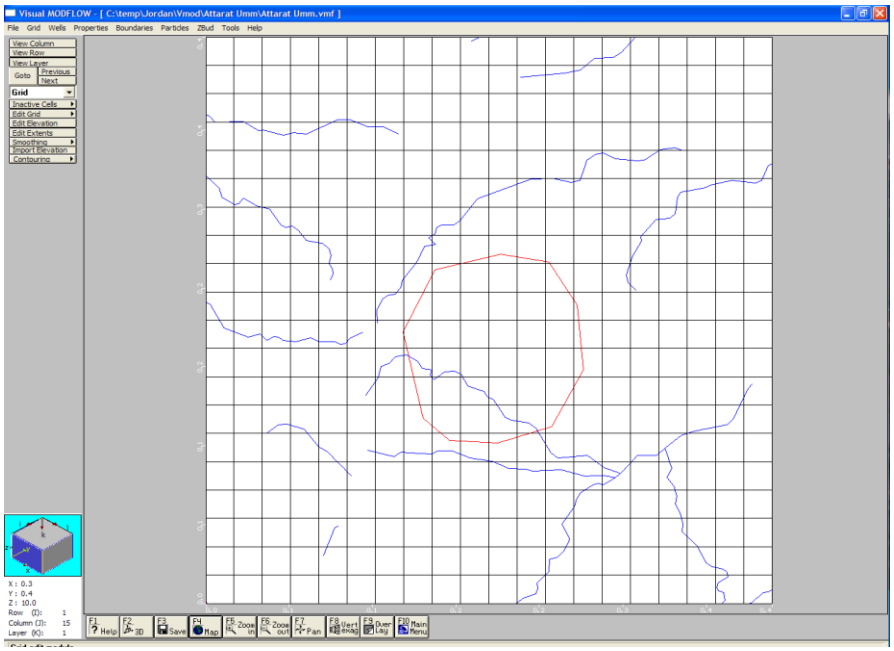


CROSS SECTION DD'



CROSS SECTION EE'

Fig. 12. The Initial Computer Model is depicted in this initial modeling view of the Attarat Umm Gudran Deposit:



Conclusions: The aspects of modeling the Oil Shale basins have been presented in this paper and presentation with the partial data available for the Lajjun and Sultani basins, and full data available for the Attarat basin. The GIS models have shown the spatial aspects of the Lajjun, Sultani, and Attarat basins (Figs. 1,2,3,5,6). Locations of Cross-sections and the cross-sections were generated for the Attarat Umm Gudran Deposit and presented in this presentation and paper (Figs. 7-11abcde). The initial Groundwater model was generated for the Attarat Umm Gudran Deposit (Fig. 12). Future modeling will be completed with more data.

References Cited

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