Characterization and distribution of the Sarir Sandstone Reservoir in the Chadar Field, Concession 126, Sirte Basin, North Libya.

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ABSTRACT

Introduction

The study concentrates on characterization and distribution of the Sarir Sandstone reservoir in the Chadar Field. It includes wireline logs analysis integrated with core analysis and analyzed well test data from four wells drilled in the Chadar Field; three wells explored by Mobil Oil Libya in May 1966 and one well by Sirte Oil Company for production, manufacturing of oil & gas in November 2014.The Chadar Field is part of Concession 126; it is located in eastern part of the Sirte Basin in the north central of Libya. The area of study is located in the westward of Messlah High between the south of Ajdabiya Trough and north of Sarir Trough (figure 1). The Chadar Field was first discovered in 1968 and A1-126 well was tested gas condensate flowed to surface from the Sarir Sandstone. The Sarir Sandstone Formation of Upper Jurassic to Lower Cretaceous represents the main hydrocarbon potential reservoir in the Chadar Field. The Sarir Sandstone is distributed widely in the subsurface of the study area and it is composed of a thick sandstone unit interbedded with shale.

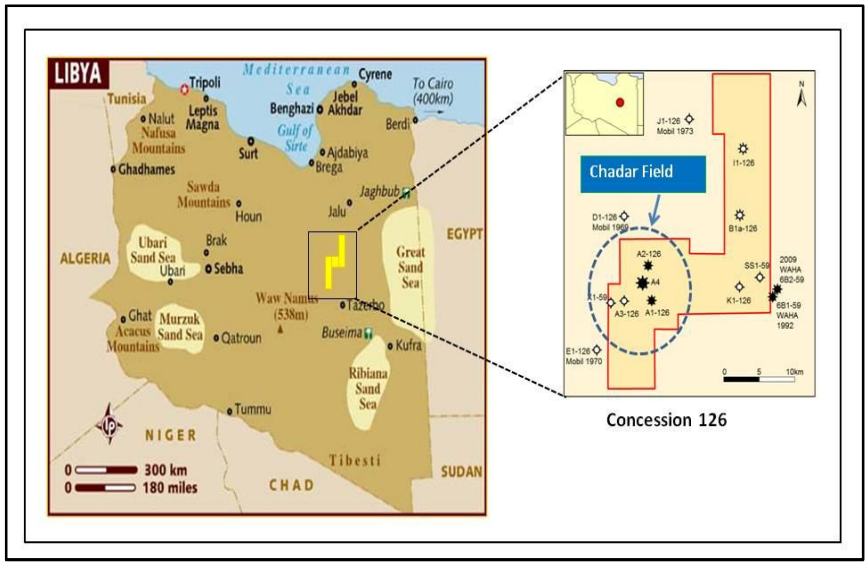


Figure 1 : Location of the study area, Concession 126.

Evaluation, analysis and interpretation were carried out utilizing all Chadar Field data to build up a good understanding of the characterization and distribution of the Sarir Sandstone reservoir. The reservoir property was defined and addressed; like porosity, permeability, and hydrocarbon saturation. Also, 3D seismic data was interpreted to define the main structural pattern and reserves calculation.

Methodology

3D seismic, cores, wire line logs data and petroleum engineer data (reports) were used in this project. The petrophysical analysis workflow ware achieved into the Sarir Sandstone reservoir and identified the reservoir parameters like shale volume, effective porosity, and fluid saturation. The permeability synthetic logs were generated in A1-126, A2-126 and A3-126 wells from porosity and permeability relationships based on the available core data. The reservoir permeability values were obtained from analyzed well data reports such as; drill stem test (DST), production tests, modular formation dynamics tester (MDT) and combinable magnetic resonance tool (CMR) , as well as from core data. Petrographic evaluation of thin sections was established in A4-126 well into the Sarir Sandstone reservoir interval to identify and quantify the primary composition as well as cementation and porosity types. 3D seismic data of the Chadar Field was loaded into workstation to pick the horizon of the Sarir Sandstone over the study area, generated time structure map and then generated depth structure map. Isochore maps were generated for Sarir Sandstone interval based on well tops. The structure cross section and stratigrphic cross section were generated to display the reservoir thickness distribution in the area of study. The reservoir properties models were building to show the distribution of reservoir porosity and permeability in area of study.

Result and Dissection

The Sarir Sandstone is widely distributed in the subsurface of the Chadar Field and it's composed of continental siliciclastics deposit interbedded with shale. The Sarir Sandstone was deposited during the Late Jurassic to Early Cretaceous time. The Chadar structure is a two way dip closure dipping toward the northwest and bounded by two normal faults from south and east. There are two directions dominating the fault system in the area of study, the E-W direction and the NW-SE direction. These faults are respectively related to the opening of the Atlantic Ocean and the Tethys Ocean (Figure 2). Main plate tectonic events were the opening of the central Atlantic between Africa and North America and the opening of the central Tethyan Basin during the middle Jurassic to Early Cretaceous time (Hallett, 2002). During this period of time, the tectonic evolution of the Sirte Basin was exposed to different phases of uplift and subsidence.

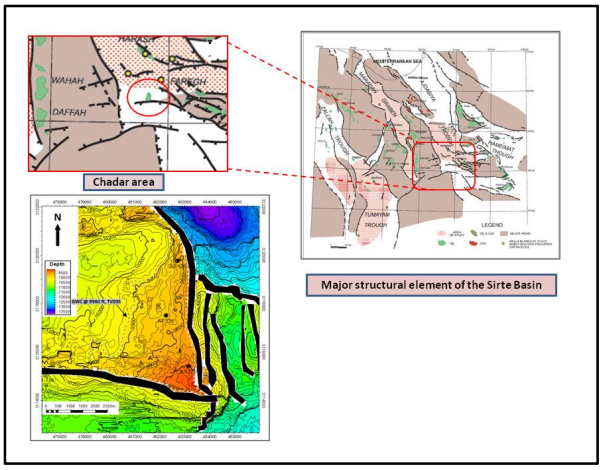


Figure 2: Showing the major structure element map of the Sirte Basin, the depth structure map shows two main faults directions in the Chadar Field, the first in E-W direction and the second main fault direction is NW-SE; this fault is younger than the E-W fault system and is consistent with the regional tectonic development of the Sirte Basin (Modified after Rusk, 2000).

Four wells were drilled within the Chadar Field, three wells have been tested hydrocarbon bearing in the Sarir Sandstone reservoir (A1-126, A2-126 and A4-126) and one well A3-126 was tested salt water because the well was drilled below the water contact at the edge of the closure. The comparison between the different methods in computing the reservoir porosity and permeability, such as core plugs measurements, evaluation of wireline logs and well test analyzed data shows a good matching and agreement in the final results of estimating the reservoir properties in the Chadar Field (figure 3).

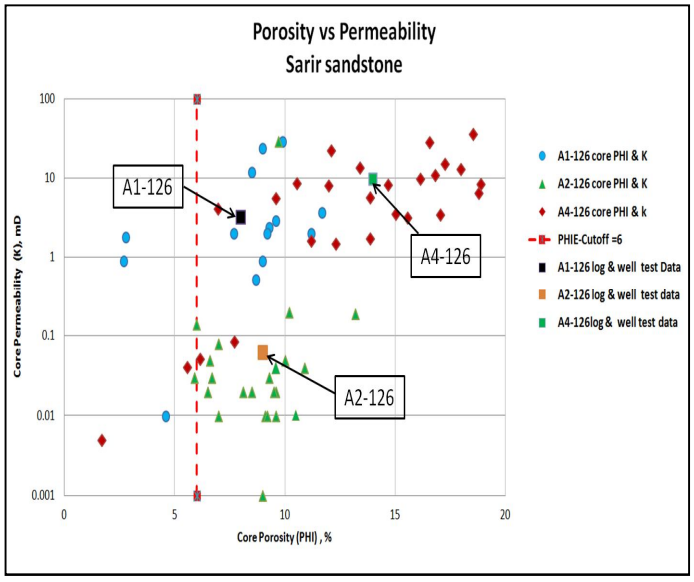


Figure 2: Core porosity-permeability vs. porosity-permeability obtained from logs and well test data shows a good matching of final result of computing the reservoir properties from different methods in the Chadar Field.

The type of porosity was identified by petrography evaluation of thin sections, which were selected from sidewall core at different interval in the top of the reservoir section in A4-126 well. The investigation of thin section shows that; intergranular porosity is the dominant pore system type in the Sarir Sandstone reservoir and secondary porosity is mainly formed by leaching of the unstable rock fragments and feldspars. The pores in the Sarir Sandstone reservoir are destructive by some processes such as; the cementation by siderite and dolomite, compaction of rock fragments and kaolinite matrix, these processes controlled the reservoir porosity and caused in disconnect between the pores, subsequently the reservoir has low or poor permeability.

The porosity model (figure 4) shows a sinuous linear NE-SW trend of higher effective porosity distribution, which is interpreted as a fluvial system controlled facies distribution. The facies distribution, in turn controls the porosity and permeability distribution in the Chadar area. Thin section observations corroborate this facies assemblage of fluvial system. It can be seen that there is a good agreement between the porosity model and permeability model derived from wireline logs.

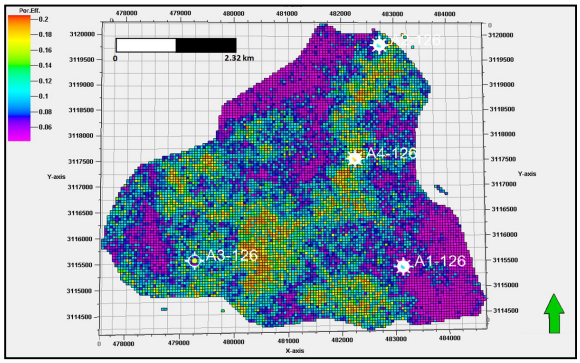


Figure 4: The effective porosity model shows a sinuous NE-SW trend of high effective porosity population

Conclusion

The Sarir Sandstone Formation was deposited during late Jurassic to early Cretaceous time. It is composed of sandstone (continental siliciclastics) interbedded with shale and represents the principal hydrocarbon potential in the Chadar Field. The Sarir Sandstone is penetrated in all the wells in the Chadar Field with varying thickness reaching upto 1000 ft. The thickness of the Sarir Sandstone increases towards the top of closure where the A1-126 and A4-126 wells were drilled and decreases toward the edge where the A2 and A3 were drilled at the edges of the structure. The Chadar structure is a two way dip closure dipping toward the northwest and bounded by two normal faults from south (E-W direction) and east (NW-SE direction).These faults are related to the opening of the Atlantic Ocean and the Tethys Ocean during the middle Jurassic to early Cretaceous time, respectively. Core data, wireline logs interpretation and well test data were used to compute the reservoir porosity and permeability in order to reduce the uncertainty values. The final results are matching from the different methods and support each other to address the reservoir properties in the study area. The reservoir has a poor to fair porosity ranges from 8 to 14 % and it has a tight to poor reservoir permeability ranges from 0.04 to 9.7 mD. The Sarir Sandstone reservoir has primary type porosity; intergranular porosity is the dominant pore system type. The pores are partially destructed due to the rock cementation such as; siderite and dolomite, compaction of rock fragments and kaolinite matrix caused in plug the pore throats and subsequently decreases the reservoir permeability. Reservoir property models were built to display the porosity and permeability distribution in the Chadar Field. It's recommended to cut cores from the top to the bottom of the Sarir Sandstone in any new appraisal well for more detail study to build environmental model. As well as hydraulic fracturing technique is required into the reservoir interval in order to enhancement from the permeability and productivity of the reservoir.

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Keyword: Chadar Field, Sarir Sandstone Formation, Characterization, Distribution, Messlah High, property models.