Fundamentals of Reservoir Rock Properties

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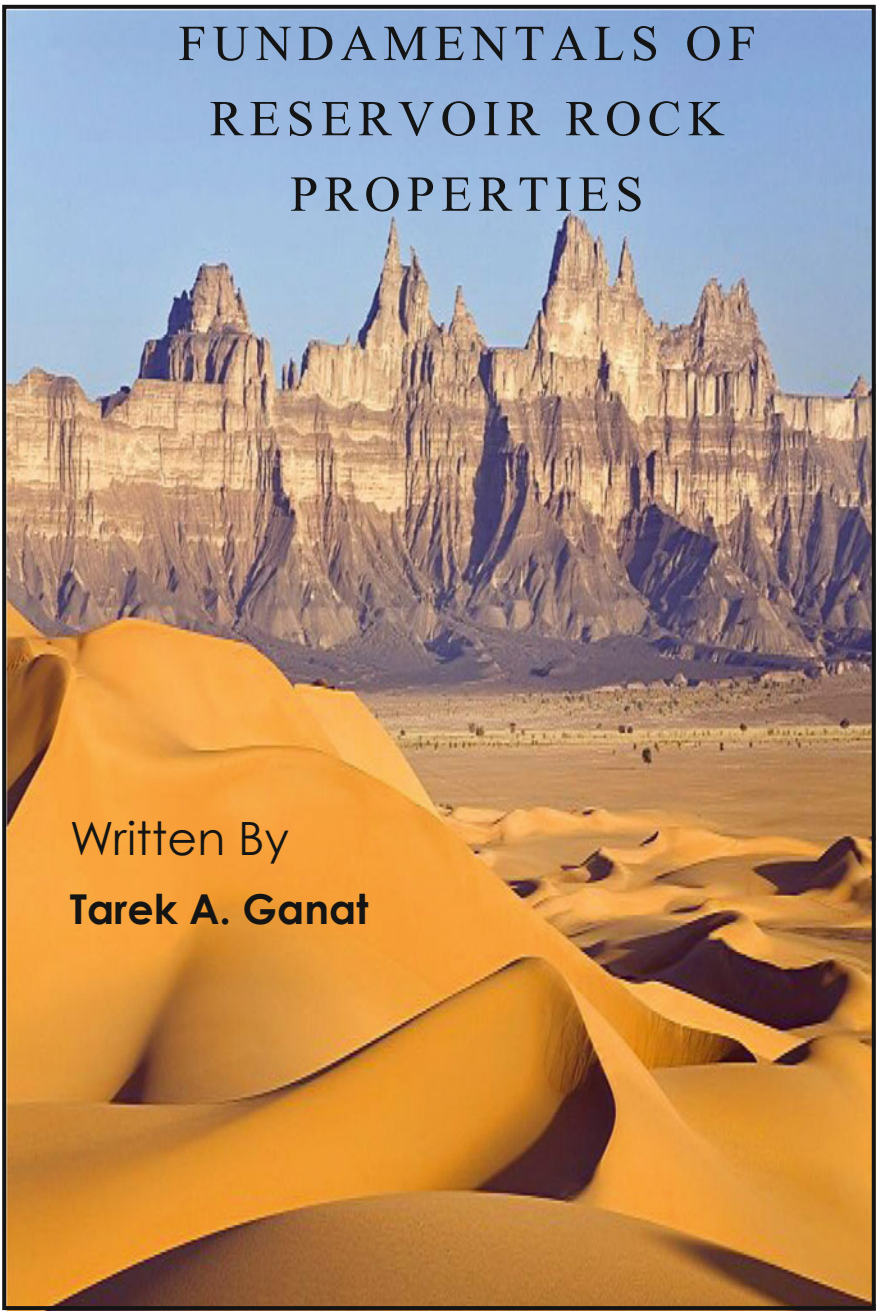

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Introduction

In general, naturally occurring rocks are saturated with fluids, water, oil, or gas (Amyx et al. 1960). Any formation rock can produce oil, gas, and water which are considered as reservoir rock. A reservoir rock is a rock has an adequate permeability and porosity to permit fluids flow, to accumulate and to extract in viable volumes (Daniel and Lapedes 1978).

Normally, hydrocarbons exist in sandstones, carbonate, and shales formations and also are present in metamorphic and igneous rocks (basement rock). The principal reservoir rocks are sandstone and carbonate formations. Typically, the physical properties and the composition of the sandstone and carbonate reservoir rocks are varying (Cecil 1949). Therefore, known the physical properties of reservoir rocks, reservoir engineers can estimate the hydrocarbon reserve and identified the ultimate reservoir recovery and determine the best effective production that is economically viable under the existing condition.

The scale of investigation used in reservoir studies is microscopic (geological thin section), macroscopic (wireline log, core plug), megascopic (reservoir modelling grid cell), and gigascopic (well test). In this section, the focus will be on microscopic and megascopic scales to characterise the reservoir. By studying a core sample of any reservoir rock under telescopic equipments, to determine the reservoir rock and the reservoir textures either solid or brittle. The reservoir pore space is generally known as voidage space (pores media), where the fluids can either move in and fill in the apertures or pass throughout the void space if the pores are connected. From the shape and size of the connected apertures in a reservoir, the estimation of the ability of the reservoir rock to store and transfer the fluids can be evaluated. Hence, the reservoir rock physical properties are very reliant on the composition and the rock texture.

The following are the main important characteristics of oil reservoir properties that control the overall reservoir performance and production potential:

1. The reservoir rock porosity, permeability, and compressibility;
2. The capillary pressure, phase saturation, relative permeability, wettability properties;
3. The net to gross of reservoir hydrocarbons and fluid mixture composition.

The objective of this book is to understand the fundamentals and the definitions of the petrophysical properties and their laboratory measurements. The main purpose of reservoir description is to make 3D images' petrophysical properties of the reservoir rocks.

Reservoir Rocks

The reservoir rock is permeable rock formation capable of retaining the hydrocarbon reserves. It consists of one or more subsurface lithological units of either sedimentary or carbonate origin. Reservoir rocks are described by good permeability and porosity and confined by sealed layers that trap the hydrocarbons. A reservoir cross section is depicted in Fig. 1. Hydrocarbon is produced from underground permeable rock formations throughout production wells optimally drilled around the reservoir area.

Usually, reservoir rocks contain pores media and the fraction of pores in the total rock volume is known as effective porosity. The pores need to be interconnecting and permit the hydrocarbons to flow everywhere. The lack of impediment in the reservoir enhances the permeability which is the ability of the fluid to transfer within the pore space of the reservoir rock.

The geological trap is rocks that confine hydrocarbons in the subsurface. Above the trap, there is an impermeable rock layer that prevents the hydrocarbons from migrating to the shallower layers or to the surface. Below the reservoir rock, there is a plane surface that splits it from the underlying fluid, usually briny water. A reservoir rock may contain liquid, gas, or both, and the vertical occurrence of

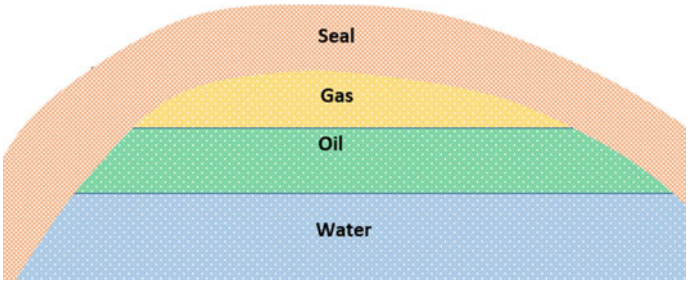

Fig. 1 Cross-sectional view of a simple reservoir oil and gas accumulation in an anticline trap

fluids in the structure is governed by the gravitational separation. If the three phases exist in the reservoir rock, then the reservoir fluids are stacked on the top of each other, due to the difference in densities, gas on top, oil in the middle, and water on the bottom.

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