Benha University
Faculty of Science
Geology Department

Post graduated Exam
Petroleum and hydrogeology
Branch Geology Department
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Advanced Petroleum Geology (1) (G604)
Time allowed: 3hrs

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<u>Model Answer</u>

1-Net to gross and net pay

A reservoir commonly contains a mixture of nonreservoir lithologies (rocks) such as mudstone or evaporite minerals interbedded with the reservoir lithology, commonly sandstone or limestone. The ratio of the porous and permeable interval to the nonporous and/or nonpermeable interval is called the "net to gross." Net pay is the portion of the net reservoir containing petroleum and from which petroleum will flow.

2- Maturation of source rocks: kerogen to oil to gas

Kerogen is composed of large hydrocarbon molecules that are stable at low temperatures, but will break down into smaller molecules of liquid and gaseous hydrocarbon compounds with progressive exposure to higher temperatures. In addition, nonhydrocarbon gases such as $C0_2$ and H_20 are produced, and a nonreactive residue remains. The transformation to smaller and lighter compounds is controlled by the reaction kinetics; that is, the strength of the bonds between the atoms and thus the energy required to break those bonds. Many studies have shown that the most important control is temperature.

3-Migration and trap formation.

The timing of trap formation relative to that of petroleum generation and migration is critical. Clearly, if it is to be viable, the trap has to form at the same time or earlier than petroleum migration. In simple rift basins and passive margin basins, calculation of both the timing of trap formation and that of petroleum migration may be relatively straightforward.

There are now a reasonable number of commercially available computer software packages which allow calculation of the structural and thermal histories of a basin, given input of some well data, seismic configurations, and source rock characteristics. Similar calculations for foreland and transpressional basins are likely to be much less precise, because such compressional systems commonly involve the destruction or severe modification of early-formed structures. This may lead to multiple phases of petroleum remigration. The destruction process may include that of the source rock.

4-Tertiary migration.

Tertiary migration includes leakage, seepage, dissipation, and alteration of petroleum as it reaches the Earth's surface. Insofar as they might be useful as direct petroleum indicators in a poorly understood basin. To recap, the products of seepage may be gas chimneys in the shallow sediment, gas hydrate layers and mounds, cemented pock marks and mud volcanoes, effects on vegetation and olive oil, and gas seepage at the surface. For more information on these products, the reader should refer to Chapter 3. Here, we examine briefly the tertiary migration processes. The physical processes that drive tertiary migration are the same as those that operate during secondary migration. Buoyancy drives the petroleum to the surface. This may be helped or hindered by overpressure gradients or hydrodynamics. Perhaps the only major difference that can be used to separate tertiary migration from secondary migration is the rate of petroleum supply. Trap failure, through capillary leakage, hydraulic fracture, or tectonism, supplies petroleum into a new carrier system much more rapidly than does a maturing source rock. The direction of tertiary migration can be vertical, horizontal, or some combination of both.

5-Fractured reservoir.

Open fractures contribute in a variety of ways to both the viability and performance of reservoirs. A fracture system may contain all of the pore volume for the reservoir as well as controlling the permeability, or provide permeability for a porous but otherwise low-permeability reservoir. Finally, open fractures can enhance the permeability of an already permeable reservoir. Conversely, closed fractures and faults with clay smear or nonreservoir-to-reservoir juxtaposition will increase the compartmentalization in a reservoir. In the following discussion, we concentrate our efforts on reservoirs where open fractures either constitute the reservoir porosity or provide permeability to an otherwise unproducible reservoir.

6-Water saturation.

A petroleum-bearing reservoir always contains some water.The quantity of water is commonly expressed as a fraction or percentage of the pore space. There are, of course, comparable terms for oil and gas.

7-Reservoir lithologies .

Sandstone and limestone (including dolomite) are the most common reservoir lithologies. Sandstones dominate as important reservoirs in the USA (including Alaska), South America, Europe, Russian Asia, North Africa, and Australia. Limestones form the dominant reservoirs in the Middle East. They are also important in the Far East, western Canada, and some of the former Soviet states. Sandstones, limestones, and dolomites of any age can make fine reservoirs. However, most of the best reservoirs in the world are relatively young. Commercial petroleum fields are more common in Cenozoic and Mesozoic sediments than in Paleozoic reservoirs

8-Gas to oil ratio.

The gas that is exsolved when oil is raised from the trap to the surface is produced alongside the oil. The proportion of gas and oil in the produced fluid at stock tank is known as the gas to oil ratio (or "GOR").

9-*Origin of petroleum from living organisms*

The chemical composition of organic matter is diverse because the organisms from which it is derived are complex. The principal biological components of living organisms are proteins, carbohydrates, lipids, and lignin. Animal tissue and enzymes are partly composed of proteins, built from amino acids. Carbohydrates are also found in animal tissue, being a principal source of energy for living organisms. Lipids are fatty organic compounds, insoluble in water, and found in most abundance in algae, pollen, and spores. Lipids are rich in hydrogen, and hence yield high volumes of hydrocarbon molecules on maturation (Section 3. 7 .4). The lipid group contains a special group of compounds called isoprenoids, which are found in chlorophyll and include pristane and phytane. These molecules are preserved during petroleum formation.

Their abundance and composition in petroleum can be indicative of the depositional environment in which the organic matter accumulated. Under normal conditions, organic matter is very dilute in sediments. In global average terms, claystones and shales (excluding oceanic sediments) contain only 0.99 wt% (weight percent) of organic carbon, compared with 0.33wt% in carbonate rocks and 0.28 wt% in average sandstones (Hunt 1979). In comparison, most source rocks contain in excess of 1.0 wt% of organic carbon, rich source rocks contain >5.0wt%, and the value can reach as high as 20wt%.

With best wishes

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