

The "Golden Zone" Temperature Distribution of Petroleum Examined for Reservoirs of the Arabian Platform and the Zagros Foldbelt

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Abstract

The estimated ultimate recovery (EUR = sum of past production plus present proven reserves) of world-wide oil, gas, and gas-condensate has been found to correlate with present reservoir temperature, based on a global database of 1175 well characterized reservoirs from 954 oil and gas fields (representing roughly 50% of the Earth's petroleum). For these 954 fields, most (74%) of the total EUR occurs in reservoirs at temperatures of 60-120 \pm 2°C, corresponding with the isotherm-bounded depth interval in petroliferous basins termed the "Golden Zone" (GZ). Relative proportions vary greatly between different regions, but overall there is a gradual decrease into the 20% of total EUR <58°C and an abrupt decrease into the 6% of total EUR >122°C. These observations are entirely empirical and have important significance for evaluating the risk of exploration targets. The causes of the GZ limits are theoretical and open to discussion. The low-temperature limit may reflect a combination of poor effectiveness of shale seals <58°C, extensive up-dip lateral migration, and biodegradation. The high-temperature limit is attributed to seal failure and remigration of petroleum, caused by increasing fluid pressure as porosity in the strata enclosing petroleum reservoirs is lost by quartz cementation, the rate of which increases exponentially >122°C. This pressure drive also affects quartz-free carbonate reservoirs because of porosity loss by quartz cementation in surrounding/underlying siliciclastic sediments. The temperature distribution of oil and gas in the Middle East was examined separately for two main tectonic provinces: the Arabian Platform, where reservoirs of Permian and mainly Jurassic to Cretaceous age were gradually buried to their present near-maximum depth, and the Zagros Foldbelt, where reservoirs of mainly Cretaceous to Neogene age experienced widely varying degrees of uplift following maximum burial in late Miocene to Pliocene time. Arabian Platform EUR is dominated by the supergiant Ghawar oilfield (102°C) and the South Pars / North gasfield (106°C), but even without these anomalously large reservoirs, 95% of total EUR is within the GZ, and only 3% is reservoirized at higher temperatures. It is difficult to explain this sharp drop-off in EUR >122°C as the result of seal failure, however, because almost all Arabian Platform reservoirs have near-hydrostatic fluid pressure. This is therefore a topic in need of future research. In the Zagros province, where many reservoirs have been cooled by late uplift, only 52% of total EUR is within the GZ. The 46% of Zagros EUR <58°C is dominated by the supergiant Kirkuk oilfield (40°C), which was uplifted to shallow depth in Pliocene time.