Geophysical Research Abstracts,
Vol. 11, EGU2009-319, 2009
EGU General Assembly 2009

What is the cementation exponent? A new differential interpretation

P.W.J. Glover

Université Laval, Département de géologie et de génie géologique, Québec, Canada (paglover@ggl.ulaval.ca, +1 (418) 656 7339)

Between 1950 and 2002 the total volume of reserves discovered has run to over 1500 Bbbl. for oil and 7.5 Tcf. for gas. Over half of these resources has already been produced, and has driven the global economy for the last fifty years. *All* of the assessments of the volume of hydrocarbon reserves were made using Archie‘s relationships (1942). It would be difficult, therefore, to overestimate the impact of either the petrophysical techniques or Archie‘s relationships on the worldwide economy. Archie‘s laws link the electrical resistivity of a rock to its porosity, to the resistivity of the water that saturates its pores, and to the fractional saturation of the pore space with the water, and are used to calculate the hydrocarbon saturation of the reservoir rock from which the reserves are then calculated. Archie’s laws contain two exponents, m and n, which Archie called the cementation exponent and the saturation exponent, respectively. The conductivity of the hydrocarbon saturated rock is highly sensitive to changes in either exponent. However, despite the importance of the cementation exponent, few petrophysicists, commercial or academic, are able to describe its real physical meaning. The purpose of this contribution is to investigate the elusive physical meaning of the cementation exponent. We review the traditional interpretation of the cementation exponent and consider the extension of Archie’s first law to two conducting phases. Consequently, we develop a new differential interpretation of the cementation exponent that is based on a new definition for the connectedness of the conducting phases in a porous medium. In this interpretation the connectedness of a porous medium is defined as the availability of pathways for transport, where the connectedness is the inverse of the formation resistivity factor, $G = \sigma_o/\sigma_w = 1/F$(and may also be called the conductivity formation factor). Porosity is defined as the fractional amount of pore space in the usual manner. Connectivity is defined as the measure of how the pore space is arranged, is given by $\chi = \phi^{m-1}$, and depends upon the porosity and the cementation exponent m. The connectedness is then given by $G = \phi\chi$, and depends upon the amount of pore space (porosity) and the arrangement of the pore space (connectivity). The rate of change of connectedness with porosity $dG/d\phi = m\chi$ depends upon the connectivity χ and the cementation exponent m. Hence, the cementation exponent can be interpreted differentially as the rate of change of the connectedness with porosity and connectivity, $m = d^2G/d\chi d\phi$.