Calculate a More Accurate Water Saturation by Visually Estimating "m"

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Water saturation calculations derived from wireline log responses have historically assumed "m" = 2 when "m" (the cementation exponent) is unknown. This practice can lead to erroneously high values for water saturation, and possibly by-passed pay, since there are many instances where "m" is less than 2.

The Archie "m" can be measured in the laboratory, but this is an expensive ($300-$500 per sample) and time-consuming process. Also, rotary core plugs are required for the analysis. Measurement cannot be obtained with cuttings or sidewall core samples. A quicker and less expensive alternative (and the only alternative if rotary core plugs are unavailable) is to estimate "m" by comparing your samples to rocks with known "m" values. Rather than assuming "m" = 2, a more accurate estimate can be made to more accurately calculate water saturation.

Visual evaluation of cuttings, sidewall core, and/or whole core using a binocular microscope at 20X to 50X magnification will allow you to describe the many features of a rock which affect Archie "m". Once these features have been described, an accurate estimate of "m" can be made.

Pattern recognition skills are useful for visually estimating Archie "m" since it is based on the familiarization of rock comparators which have measured "m" values. The comparators referred to here can be the ones supplied to members of the Shell Rock Catalog, or similar ones which companies make for their private use. Once a frame of reference has been established for rocks with measured "m", estimates can be made for rocks with unknown "m". An accurate visual estimate of Archie "m" ultimately requires practice and patience. The best way to acquire this skill is through the use of rock comparators.

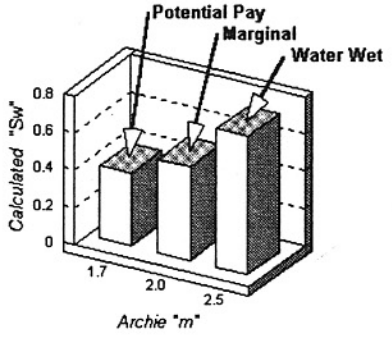
The cementation exponent "m" is related to the pore geometry of the rock; therefore, it is extremely important that you view a dry, freshly broken surface for this examination.

The effects on "m" can be said to be associated with the concept of order versus disorder. That is, the more orderly the pore geometry of a rock, the lower the value of "m"; conversely, the more disorderly the pore geometry, the higher the "m" value.

The cementation exponent can vary from 1.2 to 2.2 for sandstones, and can be as high as 3.1 for carbonates. The following is a list of factors which can influence "m" (if the porosity remains unchanged), along with the reasons for their impact on "m":

1. An increase in grain sorting decreases "m" since the pore geometry becomes more orderly.
2. An increase in cement increases "m" because the pore geometry becomes more disorderly.
3. An increase in compaction increases "m" because pore throats are cut off, thus isolating pores.
4. An increase in "patchy" cement increases "m" due to the breaks in net electrical continuity.
5. A decrease in grain size increases "m" because the surface area to grain volume increases.
6. Bimodality increases "m" because the pore geometry becomes more disorderly.
7. An increase in the amount of interconnected vugs increases "m" because the pore geometry becomes more disorderly.
8. An increase in the amount of clay increases "m" because the surface area to grain volume increases. Some clay types will have more of an effect than others because of the variation in cation exchange capacities (CEC). The greater the CEC, the greater the conductivity, the lesser the effect on "m". The commonly encountered clay minerals in order of increasing CEC and decreasing effect on the value of "m" are: kaolinite with CEC of 3 to 15, chlorite and illite with CEC of 10 to 40, and smectite with CEC of 80 to 150.
9. For carbonates, "m" is affected by particle size, interparticle porosity, and vuggy porosity (isolated and interconnected).

ASSUMING "m" = 2 CAN LEAD TO POOR COMPLETION DECISIONS



This graph shows how varying the value of "m" affects calculated water saturation when all else remains constant. A more accurate "m" is quickly and inexpensively estimated from visual rock analysis. This greatly increases your chances for success.

All of these contributing factors are visible features of the rock and can be used to visually estimate Archie "m". Cuttings are a readily available source from which an accurate and inexpensive estimate of "m" can be made. The more accurate the "m", the more accurate the water saturation calculation, which ultimately leads to a reduced danger of by-passing pay.

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