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OBSERVATIONS OF ROCK FABRIC CONTROLS ON THE ELECTRICAL PROPERTIES OF SANDSTONES

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ABSTRACT

We report electrical properties measurements on 323 sandstone samples with minimal amounts of predominantly authigenic clays. All measurements were made at Chevron during the past 15 years using net effective reservoir pressure and room temperature. Almost all of the samples are fairly well consolidated. The most common clay is kaolinite with lesser amounts of illite, chlorite, glauconite, and traces of smectite. Our objectives in this paper are to document the ranges of the cementation (**m**) and saturation (**n**) exponents in our data and to relate the values of **m** and **n** to rock fabric.

We "clay corrected" the measured values of resistivity index (**RI**) and formation factor (**F**) using the Waxman-Smits equations (1968) and the B value from Juhasz (1981) to obtain **F***, **RI***, **m*** and **n***, the clay corrected cementation and saturation exponents. These clay corrections are typically less than 0.05 to **m** and 0.1 to **n**. Henceforth, we shall refer only to the "clay corrected" or geometric parameters: **F***, **RI***, **m*** and **n***.

For the distribution of **m***, 95% of the values are between 1.7 and 2.1 with a sharp peak between 1.8-1.9. Consistent with prior observations (e.g. Wyllie and Gregory, 1953), the relatively small variation in **m*** appears to be controlled by grain shape and cementation.

The values of **n*** are broadly distributed between 0.6 and 2.6. The large variation in **n*** appears to be related to cementation, pressure solution, and depositional environment (e.g. laminations).

Samples without visible laminations, as identified from thin-section photographs, have **n*** values ranging from 1.0 to 2.6. Such samples with low values of **n*** tend to have an appreciable fraction of their pore volumes consisting of well-connected, hairline pores. Because of their high capillarity, these pores remain brine saturated high in the hydrocarbon column and act to preserve conductivity as brine is drained from the rock.

Finely-laminated, aeolian sandstones tend to have low saturation exponents, i.e., $0.6 \leq n^* \leq 1.4$. Their **n*** values are strongly correlated to the inverse of the minimum brine saturation attained during desaturation. Such low values of **n*** are consistent with a simple model which accounts for systematic variations in capillary pressure and brine saturation in laminated samples.

The value of **n*** in our dataset is fairly well correlated with porosity. This correlation is useful for establishing bounds on **n***.