Schlumberger

LOG INTERPRETATION

Volume I–Principles

1972 EDITION

DOCUMENT

the SP deflection (measured from the shale line) is the *difference* between the contributions of the mud cake and shale electrokinetic effects. In practice the net electrokinetic contribution to the SP deflection is usually small, and it is normally regarded as negligible. This is particularly true if the formation water is rather saline (resistivity less than 0.1 ohm-m) and the differential pressure has a normal value (Refs. 6, 10, 11).

It is possible for electrokinetic effects to become more important in cases of unusually large pressure differentials (e.g., depleted-pressure formations or very heavy muds). In these cases the mud cake and shale electrokinetic effects may not cancel each other.

Important electrokinetic effects may be seen in very low-permeability formations (less than 5 md), in which an appreciable part of the pressure differential is applied across the formation itself. If, as is sometimes the case, permeability is so low that no mud cake is formed, *all* of the pressure differential is applied to the formation. If the formation water is brackish, the mud is resistive, and the formation is clean and has some porosity, the low-permeability electrokinetic effect may be quite large (Fig. 9 of Ref. 8), sometimes exceeding −200 mv. Of course, the SP deflection from such low-permeability zones cannot be used to obtain a reliable value of R_w, nor is the large SP deflection indicative that the zone will produce any fluid.

These effects are difficult to detect, and infrequent, but conditions favoring their existence should alert us to the possibility of large E_k values.

SP vs PERMEABILITY AND POROSITY

The movement of ions, which causes the SP phenomenon, is possible only in formations having a certain minimum permeability (a small fraction of a millidarcy is sufficient). But there is no direct relationship between the value of permeability and the magnitude of the SP deflection, nor does the SP deflection have any direct relation to the porosity.

STATIC SP

Fig. 2-2 shows, schematically, the SP current lines. The SP current directions shown correspond to the usual case where the salinity of the formation water is greater than that of the mud filtrate. Thus the potential observed opposite the permeable bed is negative with respect to the potential opposite the shale. This negative SP variation corresponds to an SP curve deflection toward the left.

If the salinity of the mud filtrate is greater than that of the formation water, the SP currents will flow in the opposite direction. In that case the SP deflection of the permeable bed will be positive (that is, to the right). Positive SP deflections are usually observed for fresh-water-bearing formations.

As shown on Fig. 2-2, the SP currents flow through four different media: the borehole, the invaded zone, the non-invaded part of the permeable formation, and the surrounding shales. In each medium the potential along a line of current flow drops in proportion to the resistance encountered; the total potential drop along a line of current flow is equal to the total emf.

The deflections on the SP curve are a measurement of the potential drops in the borehole due to the SP currents. These potential drops represent only a fraction of the total emf's because there are also potential drops in the formations. If the SP currents could be prevented from flowing, for example by means of insulating plugs as schematically indicated on the upper part of Fig. 2-2, the potential differences observed in the mud would be equal to the total emf. The SP curve which would be recorded in such idealized conditions is called the "Static SP Diagram". The *Static SP,* or SSP, is the SP deflection opposite a thick clean formation. The deflection is measured from the shale base line.

The SSP may be used to obtain R_w; this is discussed in Chapter I-13.

SHAPE OF THE SP CURVE

The slope of the SP curve at any level is proportional to the intensity of the SP currents in the mud at that level. As

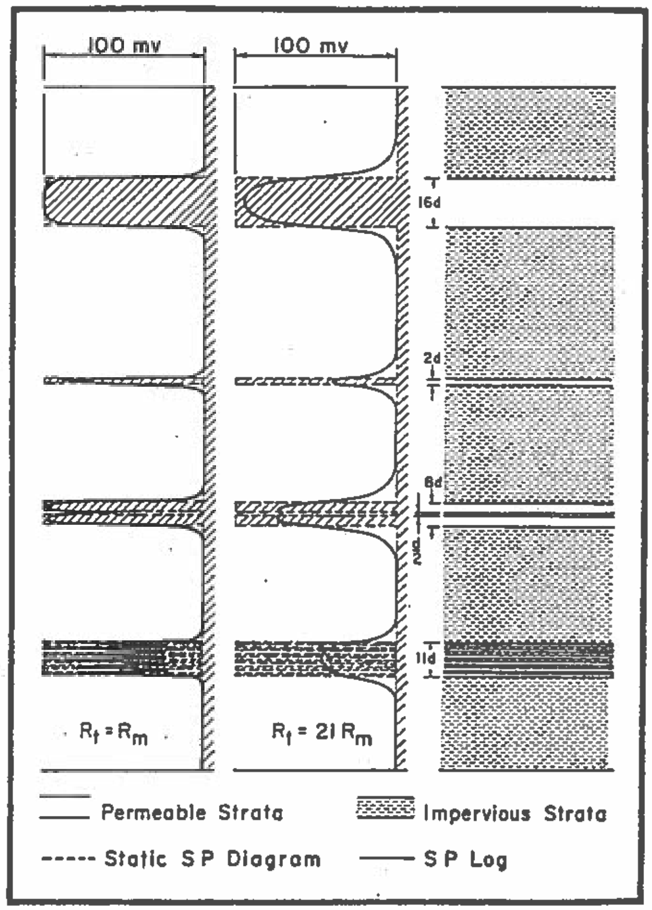


Fig. 2-3 — SP curve in beds of different thickness for $R_t = R_m$ (left) and $R_t = 21 R_m$ (center).

Schlumberger®

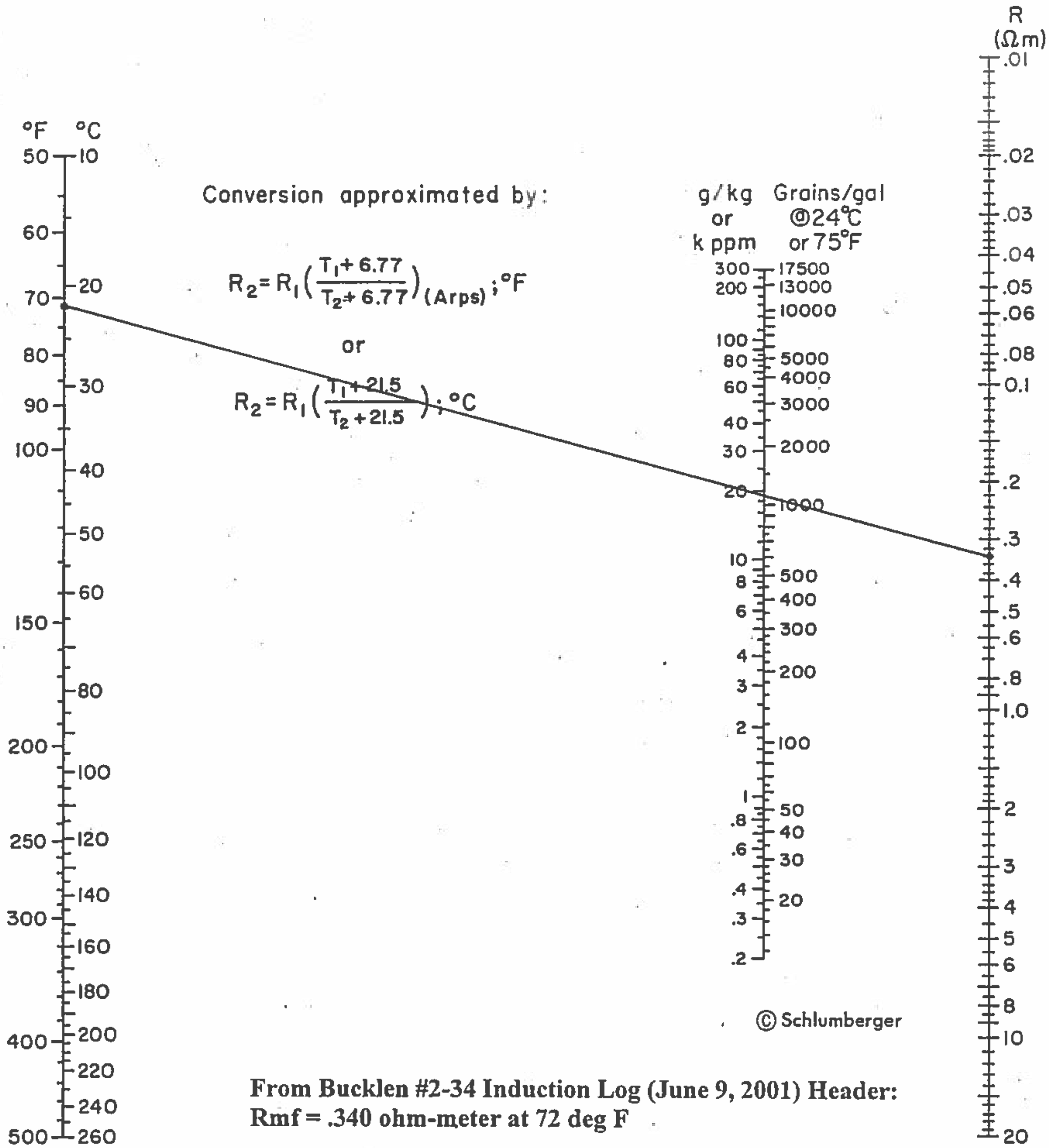
Log Interpretation Charts

English — Metric
1979 EDITION

Schlumberger

RESISTIVITY NOMOGRAPH FOR NaCl SOLUTIONS

Rmf
Rm
Rw



Conversion approximated by:

$$R_2 = R_1\left(\frac{T_1 + 6.77}{T_2 + 6.77}\right)_{(Arps)};\ °F$$

or

$$R_2 = R_1\left(\frac{T_1 + 21.5}{T_2 + 21.5}\right);\ °C$$

From Bucklen #2-34 Induction Log (June 9, 2001) Header:
Rmf = .340 ohm-meter at 72 deg F

Using this information and the Schlumberger Gen-9 Chart:
The Mud Filtrate has 19,000 ppm NaCl

If the SP Curve deflects to the right (positive SP deflection) of the shale base line it is an indication that the water in the formation is fresher than the mud filtrate, i.e. less than 19,000 ppm NaCl for the Cheyenne formation in the Bucklen #2-34 well

Gen-9