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DISCUSSION

On: "Role of borehole geophysics in defining the physical characteristics of the Raft River geothermal reservoir, Idaho" by W. S. Keys and J. K. Sullivan (GEOPHYSICS, June 1979, p. 1116–1141).

There is an error in equation (6) on p. 1140 of Keys and Sullivan; the equation should read:

$$R_{wc} = R_t/F = \frac{R_t \phi^m}{a}.$$

However, Table 4, p. 1140 of the same paper appears to have been computed using the correct form of the equation, as given above.

Furthermore, the caption of the right-hand curve of Figure 12 should, I believe, read "Porosity-percent" rather than "Porosity-pulses per second."

The authors assume $a = 1$ and $m = 2.0$ and calculate apparent water resistivities which do not favorably compare with measured values. On the basis of these assumptions and computed values of R_w, this method seems to have been discarded; however, a number of factors should be considered before the technique is dismissed.

(1) Ideally, formation factor-porosity plots of sample data from the same rock types yield the appropriate a and m values for that rock type.

(2) The samples listed in Table 4 (p. 1140) represent three different rock types, based on the sections shown in Figure 2 (p. 1118); it is reasonable to expect to find different sets of values of a and m for each different rock type. In this case, one sample represents a quartzite, two samples represent the Salt Lake formation, and three samples are from sedimentary rocks much farther up the hole.

(3) Using an $m = 2.0$ and an $a = 1.0$ made it nearly impossible to compute a reasonable value of R_w, because these values of m and a do not fit any of the rock types described. It is probable that values of $a < 1.0$ and $m > 2.0$ would be more applicable in the rock types described.

(4) The authors mentioned the possibility that differences may exist in the factors influencing responses of porosity and resistivity devices, and this is correct; in addition, it is important to realize that none of the resistivity curves run in these holes will yield near-true resistivities unless corrections for borehole, bed thickness, and other effects are carried out. Apparently, these corrections were not performed.

I consider this paper one of the better ones to be published to date on formation evaluation in geothermal boreholes, and the authors deserve congratulations for the thorough manner in which they have treated this tough data.

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Reply by author to H. B. Evans

Evans is correct about the error in the equation on p. 1140 and the caption on Figure 12. With all of the review we had, it's hard to understand how such errors creep through. For publication in errata, the equation should be

$$R_{wc} = R_t/F = \frac{R_t \phi^m}{a}$$

and the right-hand curve in Figure 12 should be labeled "porosity-percent" rather then "porosity-pulses per second."

Evans' comments about the formation factor porosity relationship are valid, but I think it is more than just a question of the values of a and m used. As pointed out in the report, most of the permeability (and an unknown part of the porosity) in all of the rocks at Raft River is secondary, present as both fractures and solution openings. The validity of the relationships between R_0, R_w, F, and ϕ is questionable in such rocks. A second problem is pointed out on p. 1125; porosities obtained from logs at Raft River are not dependable, and some of the values in Table 4 are from logs. I do not know if J. Sullivan used departure curves for correcting resistivity values, but I doubt that he did, and therefore, R_t should not have been used. I think the conclusion is still correct that some empirical data are needed to establish the validity of the method. Obviously, we had very few good data, and the last short section of the paper was more of an afterthought than a well substantiated part of the study.

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DISCUSSION

On: "Complex seismic trace analysis" by M. T. Taner, F. Koehler, and R. E. Sheriff (GEOPHYSICS, June 1979, p. 1041–1063).

In Appendix B, the authors derive an analytical expression for the conjugate component of a Ricker wavelet and state that the different attributes of a wavelet with a peak frequency of 25 Hz are listed in Table 1 of their paper. The quadrature component of a Ricker wavelet should be read as:

$$f^*(t) = (2/\pi)^{1/2} \int_0^\infty \omega^2 e^{-\omega^2/2} \sin \omega t \, d\omega$$
$$= 2(2/\pi)^{1/2} e^{-t^2/2} \left[t - \frac{\widehat{(2m-3)}}{(2m+1)!} t^{2m+1} \right], \quad (1)$$

where $\widehat{(2m-3)} = 1$ for $m = 1$ and $1.3 \ldots\ldots, (2m-3)$ for $m \geq 2$.

The expression in parentheses in equation (1) is series expression of $_1F_1(-1/2;\ 3/2;\ t^2/2)$, where $_1F_1(a;b;z)$ is the confluent hypergeometric function. Equation (1) converges for any finite t, since b in $_1F_1(a;b;z)$ in this case is neither zero nor negative. However, we have seen that the rate of convergence of equation (1) is slow. Consequently as t increases, more and more terms of the sequence in $_1F_1(a;b;z)$ are to be taken into account to achieve the desired accuracy. In fact, equation (1) is not useful for practical computations. In the main part of the paper (p. 1043), the authors have given the time-domain and also the frequency-domain representations for calculation of the quadrature component.

We have designed Hilbert operators of various lengths in the time domain starting from 19 to 43 samples for calculating the quadrature component of a 25-Hz Ricker wavelet, and the results for 19, 27, 39, and 43 samples are given here in Table 1. The same quadrature components have been calculated using a frequency-domain approach also, and the results are shown in column 3 of the table. A comparison with Table 1 of the authors reveals that in order to obtain their results, we should use a time-domain operator of minimum 43 points. No simple analytical relation exists to find out this optimum length in time domain. The frequency-domain approach in such a case can be exploited profitably. This can be appreciated from the fact that the Hilbert operator $1/\pi t$ approaches zero asymptotically, and even at large operator lengths, the coefficients although small, maintain finite values. Thus, it is obvious that selection of an optimum time-domain