Interpretation of Data from Electrical Resistivity Geophysical Surveys

In connexion with the note by J. M. Hough on work by himself and Prof. L. S. Palmer of University College, Hull[1], I should like to direct attention to a method I described briefly in 1934, and which I have been practising since that date[2].

It will be noticed that I use the ratio ρ_a/ρ_1 for application to standard curves, of which I have sets in many forms. In all cases I obtain solutions by superposition of field curves on transparent paper, having long ago calculated sufficient values for complete sets of curves.

In the solution of multilayer problems I have used proportional compasses and thereby obtain four or five similar curves for superposition on standard curves, from which the 'scale', that is, the effective value of ρ_1, is obtained. I am grateful for the suggestion of using logarithmic plots, which are similar in shape and result merely in a shift of the axes according to 'scale'.

Finally, I would like to suggest to Prof. Palmer and Mr. Hough that a day in the field using my method will convince them of the advantages of my lay-out, in which a is fixed and α varied. A small handbook is now in the press giving details of the method and standard curves for the use of Survey officers.

Incidentally, there is a printer's error in the formula in my paper[2] at the foot of p. 276, owing to my not being able to check the proofs; it should read:

$$\frac{\rho_a}{\rho_1} = 1 + 2f(f+1) \sum_{n=1}^{n=\infty} k^n \left[\frac{1}{(f^2 + 4\lambda^2 n^2)^{1/2}} - \frac{1}{((f+1)^2 + 4\lambda^2 n^2)^{1/2}}\right]$$

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[1] *Nature*, **161**, 812 (1948).

[2] *Mining Mag.* (Nov. 1934).

The comparison of field curves with sets of standard curves, as suggested by Mr. W. G. G. Cooper, is one method of interpreting results. This method requires a large number of standard curves even for the two-layer case, as there are two variables, namely, the depth of the surface layer and the ratio of the resistivities of the two layers. The number of standard curves is reduced to a single set when logarithmic curves are used, as suggested by Whitehead and Radley[1] and in my original letter[2]. Mr. Cooper agrees with me that for multi-layer curves the use of logarithmic curves is a definite advantage.

Mr. Cooper's method for field-work has obvious advantages over our method in needing a smaller operating team. When α is small, the potential difference between the potential electrodes is small, and this may cause the method to be insensitive for these readings. Although the usual electrode-layout is that due to Wenner, there are many other possibilities, and we hope to make an investigation into some of these in the near future. We expect that the most suitable electrode arrangement will depend upon the particular geological structure to be investigated.

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[1] Whitehead, S., and Radley, W. G., *Proc. Phys. Soc.*, **47**, 589 (1935).

[2] Hough, J. M., *Nature*, **161**, 812 (1948).

Blinking

In recent discussions on blinking[1], it has been taken for granted that, in a physical experiment, an object cannot be kept under continuous observation. The difficulty, however, is easily overcome. It is easy to acquire the habit of blinking the eyes alternately and, provided the period is made slightly shorter than that associated with normal blinking, no discomfort results.

I have used this technique in the laboratory for more than twenty years, and have always assumed that it was generally known; but this, apparently, is not the case.

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[1] Lawson, R. W., *Nature*, **161**, 154 (1948); **162**, 531 (1948).

Dr. Clark's interesting and novel method of avoiding the interruption of vision due to blinking assumes that blinking is suppressed when the subject 'winks' periodically with alternate eyes. After repeated trials, I doubt whether this assumption is justified. Moreover, few people are aware of their normal rate of blinking.

Almost the whole of the lid movement during blinking is performed by the upper lid, and the two lids meet roughly at the level of the base of the iris. The period of blackout during blinking is made up of two parts: the time taken by the upper lid to traverse in both directions the lower iris, and the time during which the lids are in contact. In general, the vision is 'mobile' during the whole of the blink, and for a short time afterwards (Lawson, *l.c.*). Both blackout and mobile vision become serious only at relatively high rates of blinking.

In 'winking', on the other hand, the lid movement is shared about equally by the upper and lower lids, and contact is established in general over the pupil. The period of blackout for each eye is consequently restricted to the time of contact of the lids, and is thus shorter than the blackout due to blinking. The vision of the winking eye is, however, mobile during the whole of the wink, owing to the development of a mobile diplopia caused apparently by refraction in the superficial corneal fluid as the lids approach each other. The existence of this diplopia in binocular vision during winking can readily be demonstrated by holding the wink, when two images are clearly visible. For myself it amounts to about 1° in the field of vision, the direction of displacement varying from subject to subject. On the other hand, the mobile vision due to eyeball rotation associated with blinking amounts to only $\frac{1}{2}$° in the field of vision (*l.c.*).

Thus, although the effect of blackout is largely eliminated by the process of 'winking' alternately in binocular vision, mobile vision is enhanced and becomes much more disturbing. The 'cure' seems to be worse than the 'disease', and I am not clear how it can be applied to observations through a 'monocular' microscope.

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