Underground Water Provinces, Districts and Sub-Districts

TOLMAN[1] shows, in his work on underground water, that over a large area there are water provinces; and Bond[2], in South Africa, after a geochemical survey, has grouped the underground waters of South Africa into five main types. In any of these areas local anomalies are found, so that it is necessary to divide the waters into districts (say, areas of 100 square miles or so) and sub-districts and portions of smaller area. It has been found that electrical resistivity measurements are primarily dependent upon the rock formations over which the work is carried out, and as water is a mineral and when in bulk constitutes a rock formation, its chemical nature and hence its resistivity are most important.

I have found in working over diabase–shale–quartzite horizons that the underground water depends upon the formation, and after checking many boreholes can, in many doubtful cases (outcrops being absent and boreholes without records), say whether the borehole is situated in diabase, shale, granite, quartzite or dolomite from a determination of the resistivity of the water. As this is very easily determined, it is a great help where outcrops are absent.

The following data are given to show the order of the values obtained in various areas:

Formation	Resistivity of water at 20–21° C.	Locality
Black Reef quartzites	3500	Zebediela
Karroo basalt	780	,,
Diabase (dolerite to syenite)	2000–4000	Western Transvaal
Quartzite	25,000–80,000	,, ,,
Granite	6000–7000	North of Johannesburg
Dolomite	3360	West ,, ,,
Amygdaloidal andesite	3200–7800	South ,, ,,
Dwyka tillite	1400–1550	Douglas District
Amygdaloidal andesite	1000	,, ,,
Syenite	1800–4300	Rustenburg
Karroo shales and sandstones (Ecca)	10,000–15,000	East of Johannesburg
Table Mountain sandstone	7730	Artesian: Uitenhage †
,, ,,	2270	Artesian: Amanzi Estate †
,, ,,	1240	Artesian: Coega Kop †
,, ,,	1300	Artesian: Zwartkops †
Cretaceous clays and sandstones*	128–150	Port Elizabeth area
Karroo rocks	330–1700	Odendaalsrust, O.F.S.
Artesian borehole in Karroo rocks	126–160	,, ,,

* These cover the Sundays River artesian basin. See also Heiland (ref. 3).
† Port Elizabeth district.

At Zebediela, the basalt covers the Black Reef quartzites, and electrical resistivity traverses at 100-ft. electrode separation showed scarcely any change from quartzite to basalt. This was apparently due to the large quantities of pure water in the quartzite and the small quantities of saline waters in the basalt equalizing the apparent resistivity values.

Enslin[4] has recently shown that different formations can have a lateral effect on the depth probe values. I have confirmed this independently, and, in fact, now use the effect to delimit the sub-outcrop at, say, 100-ft. depth by setting out the traverses so that the sub-outcrop is intersected at a very small angle. Drilling has proved the correctness of this, and in addition I have carried out the same procedure over well-defined outcrops.

After correlating about sixty depth probes over boreholes of which there were fairly accurate records showing the formations intersected and the positions of water struck, I have found that, except in the case of caves in the dolomite or in interbedded shales and quartzites (caves are very common in such sedimentary rhythms), water cannot be detected in the small fissures and porous layers at rock contacts that characterize South African underground water resources. Very often the water occurs at rock contacts, and these can be easily and accurately inferred from inflexions in the depth probes.

As South Africa is a comparatively highly mineralized country, it is interesting to note that electrical resistivity work has not been successful in locating copper ores[5] or lead ores[6]. Recently, I carried out researches over tin ores which have highly mineralized lodes (tourmaline, hæmatite present in abundance) and found that the lodes could not be detected. This is indeed fortunate, as water is South Africa's most important mineral to-day and in few, if any, circumstances can the resistivity work be affected by mineral deposits, except perhaps manganese and iron.

I am indebted to members of my staff for assistance in the field, and in particular to Messrs. H. G. Trevelyan and J. D. Moore.

V. L. BOSAZZA

Petrologgia, 39 Barkly Road, Parktown,
Johannesburg. March 2.

[1] Tolman, C. F., "Underground Water", chapter 17.
[2] Bond, G. F., Mem. 41, Union of S. Africa Geological Survey.
[3] Heiland, C. A., "Geophysical Exploration", 638.
[4] Enslin, J. F., *Trans. Geol. Soc. S. Africa* (in the press).
[5] A recent company report on the Messina area.
[6] Geological Survey Mem. 39, 70, 109.

Relation of the Alpha Rhythm of the Brain to Psychomotor Phenomena

SIMULTANEOUS recordings were made of the alpha rhythm and eye opening in response to an auditory stimulus, using a standard electroencephalograph apparatus. By plotting the number of responses against the phase of the alpha rhythm, a curve was obtained which showed a variation of more than 2 to 1 in the number of responses in different parts of the cycle. The exact distribution of the responses was examined by means of an electronic timing device, which registered a point in the alpha cycle by a signal of short duration, and the eye opening by a similar signal. The time interval between the signals was then measured by recording the charge gained by a condenser. The measurements confirmed that the probability of a response was not randomly distributed in time, but showed peaks and troughs recurring at approximately 10 per second and in accurate phase relations with the alpha rhythm. Similar results were obtained for other voluntary movements.

The observations indicate that voluntary muscular movements are influenced by the electrical rhythms of the brain. The probability of the occurrence of a motor discharge depends on the phase of the alpha rhythm and in certain subjects is greater during a phase of positive potential than during a negative potential on the occipital cortex.

G. O. KIBBLER
J. L. BOREHAM
D. RICHTER

Neuropsychiatric Research Centre,
Whitchurch Hospital, Cardiff.
March 28.