ART. XXIV.—*On the Radio-activity of certain Soils.*

By J. H. HOWELL, B.A., B.Sc.

[*Read before the Philosophical Institute of Canterbury, 3rd October, 1906.*]

As is well known, radio-active substances are in many cases found present in the water of mineral springs and in the deposits formed by them; and it has been suggested, since the radio-active products are powerful germicides, that the therapeutic properties of such springs may be due to their presence. In some cases experiments have seemed to show that this is at any rate a partial explanation. An examination of the mineral waters of New Zealand would therefore be interesting; and with that end in view small quantities of the deposits from a number of the Te Aroha springs were collected. Subsequently, in order to get comparative data, the radio-active properties of the light volcanic soil of Mount Eden, Auckland, of the heavy subsoil of the same district, and also of Parnell clay, were investigated.

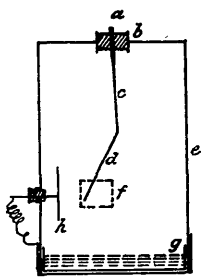

Fig. 1.

a, Small brass screw; *b*, plug of sulphur; *c*, thin copper wire, *d*, gold leaf of about 1 mm. in width observed by a microscope with micrometer eye-piece and 1 in. objective; *e*, brass cylindrical electroscope, 2 in. in diameter; *f*, glass window; *g*, copper cap containing deposit; *h*, earthed copper plate

The radio-activity of the Te Aroha deposits was at first tested in a simple electroscope of the following type:—

The electroscope was charged by touching the head of the screw with an insulated sewing-needle which had been charged by a replenisher, and the rates of leak were determined by a large number of observations taken alternately with and without the deposit. Although the results seemed on the whole to indicate the presence of radio-active substances, the irregularities were too great to allow any definite conclusions to be drawn. It was therefore decided to modify the apparatus so as to diminish as far as possible any leak over the insulation and also to allow the use of a much larger quantity of the deposit.

The apparatus used in the remaining experiments was as follows:—

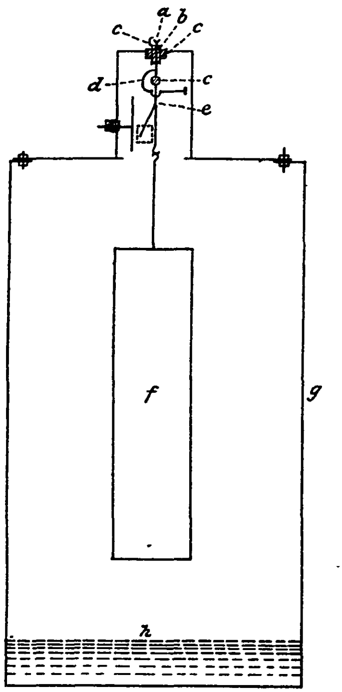

Fig. 2.

a, Brass rod with mercury cup; *b*, brass guard-tube with connecting wire; *c*, sulphur; *d*, iron-wire spring; *e*, brass ribbon; *f*, copper-gauze cylinder; *g*, tin can, 14 in by 7 in.; *h*, deposit.

The brass rod and guard-cylinder were first charged as before, while the wire from the guard-tube was dipped into the mercury, and the rod and cylinder were made to share their charge with the insulated lower system by momentarily making connection by attracting the steel spring with a magnet. The guard-cylinder was then disconnected. In all experiments the charge given was such that the initial divergence of the leaves was practically the same.

The Te Aroha deposit that had given most promise of radio-activity in the preliminary experiments was that from No. 1 Spring, and through the kindness of Dr. Kenny a good supply of this was obtained. All leaks are expressed in micrometer divisions per ten minutes. The leak through the air due to the influence of the can alone was tested on three successive days, the leaks being as follows:—

First Day.—4·2, 4·7, 4·5, 4·0, 4·5: average, 4·25.

Second Day.—3·7, 4·2, 3·7, 3·7, 4·2: average, 3·9.

Third Day.—4·8, 5·0, 4·8, 4·8, 4·8: average, 4·85.

On the third day, after the above experiments had been carried out, the Te Aroha deposit was placed in the instrument and the following leaks were observed: 11·5, 11·0, 10·3, 10·3, 9·8, 8·7, 9·7, 9·0: average, 10·0. Leak due to deposit only, 10 − 4·85 = 5·15/ten minutes.

Fourth Day.—The deposit being left in the meanwhile, the following leaks were observed: 9·7, 10·2, 11·0, 10·7: average, 10·4. On removing the deposit and wiping out the can, the leak due to the influence of the can only was found to be 2 in ten minutes, which gives as leak due to deposit only 8·4 per ten minutes. The surface of the can had meanwhile become covered by an amalgam with mercury, and it is interesting to note the falling-off in the leak due to the can alone.

Fifth Day.—Can only 1·5. Deposit replaced, 8·0, 7·3, 8·2, 10·0: average, 8·4. Effect due to deposit only, 6·9, which is less than the effect of the previous day but greater than the initial effect.

VOLCANIC SOILS.

A. *Light Volcanic Soil.*—For purposes of comparison similar experiments were done with some of the light volcanic surface soil common in the Mount Eden district of Auckland, an approximately equal volume being taken.

The leaks per ten minutes obtained over a period of four hours were 12·0, 12·7, 17·7, 22·0, or an average of 15·9, while those due to can alone were 2·2, 1·8, or an average of 2·0.

The Te Aroha deposit was placed in the can on the same day, when the leaks were 10·0, 9·7, while on the following day the leaks due to the Te Aroha deposit were 9·0, 9·2, and to the can alone 1·8.

The experiments indicate that the light volcanic soil contains substances of greater radio-activity than the Te Aroha deposit, though the explanation of the rapid rise in the rate of leak is not obvious.

B. *Volcanic Subsoil.*—Beyond the boundary of the light volcanic district, what is locally known as "heavy volcanic soil" is found, and about 10 in. below the surface the volcanic ash forms a very hard "pan," which is attacked better with the pickaxe than with the spade. Some of this subsoil from a depth of about 15 in. was taken, the leak due to the can alone having just previously been found to be 1·5 per ten minutes. The following were the leaks due to the subsoil: 40·8, 38·0, 40·0, 40·8, 40·0, 36·0, 49·3, 37·8, 35·7, 37·2, 45·0, 45·0, 36·7, 40·0, 41·7, the average of fifteen readings being 40·3.

On the morning of the second day, the subsoil being left undisturbed overnight, the following leaks were observed: 52·5, 52·3, 45·5, 51·7, 56·7, 46·7, the average being 50·9. Later on in the same day the leaks were 57·2, 57·2, 58·2, 55·0, 55·0, 60·0, or an average of 57·1.

On the third day, the subsoil still being in the can, the leaks were 52·2, 53·8, 58·7, 50·8, 56·7, or an average of 54·4.

On the fourth day, in the morning the soil was taken out and the can well cleaned; the leaks with can only were now 9·5, 8·7, or an average of 9·1. At night the leak due to can only was 2·8.

C. *Parnell Clay.*—The effect of Parnell clay, a surface soil formed by the weathering of volcanic rock, was next observed, a measured quantity of about one-third the previous quantities being taken. The leaks obtained on the first day were 8·8, 9·8, 7·7: average, 8·8. Second day, 7·7, 7·7, 8·7: average, 8·0. Third day, 9·3, 11·0: average, 10·1. Fourth day, 7·7, 7·7.

An equal quantity of volcanic subsoil was then taken, when the leaks observed were 29·5, 28·7, 35·0, 37·0, or an average of 32·5. As an average of fifteen readings with about three times the quantity of soil was 40·3, the rate of leak would not be appreciably affected by small variations in the quantities taken, and it is therefore sufficient for purposes of comparison if approximately equal amounts are tested. On the fifth day the subsoil gave 30·0, 32·3, 34·7—average, 32·3; and on the following day 32·3, 33·3, 31·7, 29·5—average, 31·7. The subsoil was then left in the can for sixteen days, at the end of which the leaks obtained were 46·0, 46·5, showing an increase of 50 per cent.

No further experiments could be carried out at the time, but it is hoped shortly to continue and extend them in order to determine the nature of the radio-active substances. In future experiments the apparatus will be modified in several respects in order to try to get rid of the irregularities which have so far occurred; and by conducting the experiments over a longer period with the same material more accurate information will be gained as to the rate of growth and decay of the induced radio-activity

The results so far obtained indicate the presence of radio-active substances in small quantities in the deposit from No. 1 Spring, Te Aroha, and in larger quantities in both surface soils, while the hard volcanic subsoil is about six times as active. The difference between the surface soil and the subsoil is what would be expected if radium were present, for the heavy emanation gas produced by the disintegration of this element would more or less be imprisoned in the subsoil, and the subsequent soil-products, themselves radio-active, formed by the subsequent disintegration would accumulate there. On the other hand, in the case of the loose surface soil, the emanation would for the most part escape and the further products be lost.