writer found that copper-oxide (Cu_2O, presumably) shows the effect quite unmistakably.

Without going into details here as to the mode of production of copper-oxide cells or bridges, it may be stated that copper-oxide has a much lower specific resistance than either selenium or stibnite and is much the more transparent toward red light (layers having a thickness of more than 1 mm. are still slightly translucent). The fundamental facts which have been established for this new light-sensitive substance are:

1. The conduction is electronic and not electrolytic.

2. The increase in conductivity, occasioned by light, is distinctly different from that produced by a heating effect.

3. The conductivity increases with the applied voltage, *i. e.,* Ohm's law is not obeyed (voltage effect).

4. The region of increased conductivity spreads slightly to portions of the material not illuminated (transmitted effect).

5. The region of highest sensibility lies in the ultra-violet near $\lambda = 2800$ A. U.

6. Cooling in liquid air increases the percentage change in conductivity and displaces the sensibility maximum in the red toward shorter wave-lengths.

7. The relation between the radiant energy absorbed (E) and the resultant change in conductivity (C) is very approximately of the form $C = KE^\beta$ where K is a constant and β lies near 0.5.

While the percentage change in conductivity upon illumination is much less than that of selenium and stibnite, the comparatively high conductivity of copper-oxide makes the absolute increase quite large. The best cell which the writer has thus far constructed has a resistance of 15,200 ohms at 17° C. for 1 volt. The change in conductivity occasioned by the light from a 40-watt tungsten lamp at 20 cm. is about 15 per cent. The area exposed to radiation is about 12 mm.[2] If this cell be connected to a 2-volt cell and a galvanometer (forming part of a simple potentiometer) a sensitive device for detecting radiant energy is produced. Exposing the cell to daylight in a moderately lighted room throws the galvanometer spot of light violently off the scale. Monochromatic radiations which are quite too feeble to affect a sensitive radio-micrometer, bring about large deflections when allowed to fall on the copper-oxide cell. If the cell be connected to a telephone receiver and battery and if an intermittent light beam of definite frequency be allowed to fall on the cell, a clear, musical note is heard.

The preceding discussion is to be looked upon as being of a preliminary nature. A systematic search for light-sensibility is being undertaken and a complete account of the work will appear later.

A. H. Pfund

Johns Hopkins University,
November, 1915

RADIOACTIVITY OF UNDERGROUND WATERS IN PROVIDENCE AND THE VICINITY

Some idea of the distribution of radium salts near the surface of the earth may be obtained from a study of the relative amounts of radium emanation dissolved in underground waters. Within the last ten years a number of the better known springs and wells in America, Europe and Japan have been examined for emanation content. Some of the activities obtained have been tabulated by Schlunt and Moore[1] also by Dole.[2]

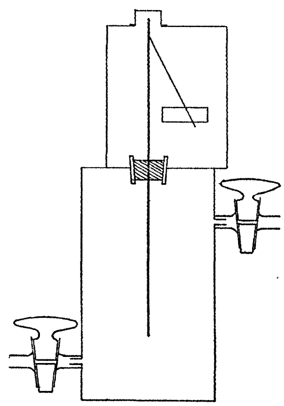

Fig. 1.

[1] U. S. Geological Survey Bulletin 395, 1909.

[2] U. S. Geological Survey, "Mineral Resources of the U. S., 1913," Part II., pp. 393–440.

The most active source thus far recorded was found in mine water at Joachimsthal, Bohemia, and contained per liter an amount of emanation equivalent to that in equilibrium with 700×10^{-10} gram radium.

Fig. 1 shows the type of electroscope used in the present experiments. The gold leaf was mounted on a brass rod passing through a sulphur plug into the ionization chamber. The leaf was used at a fairly high sensibility. Since it was not convenient to use a guard ring, the natural leak of the instrument was large, varying from .25 to .40 divisions per minute on different days. No suitable constant source of potential was available and the leaf was charged with an ebonite rod by removing the metal cap at the top. The ionization chamber was gas tight and was of approximately 725 c.c. capacity.

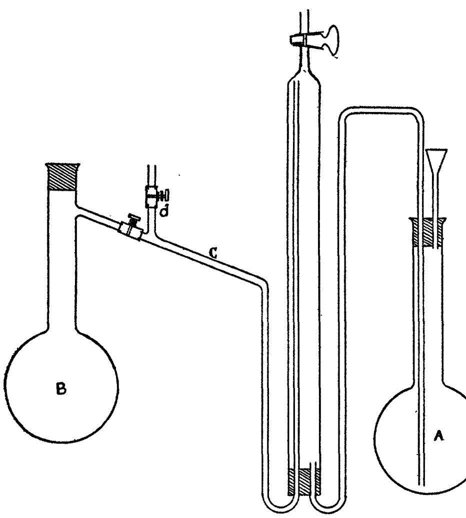

FIG. 2.

Samples of water to be tested were collected in suitable boiling flasks at different localities. The contained emanation was removed by boiling and allowed to cool. The ionization chamber was then partially exhausted, and the mixture of air and emanation allowed to flow slowly into it through a drying tube of calcium chloride with end plugs of cotton wool. The rate of motion of the gold leaf in divisions per minute after three hours was used in comparing the activities of different samples. All readings were corrected for the natural leak of the instrument and for the decay of the emanation itself during the time elapsing between collection and examination. After three hours the emanation was pumped off by means of a foot bellows through a long pipe into the open air far outside the laboratory. The ionization then decayed with the half value period of active deposit.

A diagram of the apparatus used for boiling out the emanation which is but a slight modification of that described by Makower and Geiger[3] is shown in Fig. 2. The burette was filled with water previously boiled in the flask *A*. The water under investigation in flask *B* was boiled from ten to fifteen minutes. Emanation still remaining in the connecting tube *c* after the burette had been emptied was carried over into it by air let in through the side tube *d*. 920 c.c. of water was collected for each test.

Standardization of the Readings of the Electroscope

In order to standardize the readings of the electroscope 10 c.c. of a standard solution containing 1.57×10^{-5} mg. radium was diluted to 250 c.c., and 60 c.c. of this solution boiled thoroughly and allowed to grow emanation for 31 days. This emanation, the equivalent to that in equilibrium with 3.77×10^{-9} gram radium, was introduced into the electroscope. The ionization after three hours was 57.11 divisions per minute.

The results obtained from a number of sources are given in the following table:

Column 5 in the above table records the amounts of radium emanation found in the different sources. These values are comparatively large. The maximum activity found in spring water by Shrader[4] near Williamstown, Mass., was 2.12×10^{-10} gram radium. The most active sources found during this investigation were in Arlington, R. I. Both the springs examined flowed out of Fenner's Ledge. This contains deposits of graphite mixed with a low-grade soft coal. The geological

[3] "Practical Measurements in Radioactivity," Longmans, 1912, p. 114.

[4] *Physical Review*, May, 1914, pp. 339–345.

Source	Locality	Approx. Cap. Liters per Min.	Corrected Div. per Min. per Liter.	Equivalent in Radium 10^{10} Gram	Remarks.
Spring	Arlington, R.I.	10	87.78	57.93	Graphite mine.
Spring	Arlington, R. I.	6	70.80	46.71	Nr. car barn.
Spring	Nr. Wilbur Ave.	3	17.74	11.70	On Woonsocket car line.
Spring	Girard's Hatchery	30	16.98	11.19	Mineral Spring Ave.
Spring	Quinsnicket Park	5	15.65	10.33	Called Cool Spring.
Spring	Girard's office	.....	5.85	3.86	150-gal. tank.
Well	Nr. Bristol, R.I.	.. ..	4.21	2.78	60 ft. deep.
Spring	Smithfield Ave.	1	3.39	2.24	Nr. reservoir.
Spring	Johnson, R. I.	.....	3.34	2.20	Ochee.
Spring	E. Providence	2	1.78	1.18	On Lion Farm.
Well	College pump	.....	1.10	.73	On Campus.
Well	In heating plant	.....	1.03	.68	On Campus (unused).
Tap water	Eng. Lab.	.....	.05	.03	From city reservoir.

formation is such that the water comes in all probability from a considerable depth. Graphite is now being mined near the surface. Several samples of this graphite were powdered and tested qualitatively in an α ray electroscope. Only slight traces of radioactive content could be found.

I am indebted to Professor B. B. Boltwood, of Yale University, for the standard solution used in calibrating the electroscope.

BROWN UNIVERSITY, P. B. PERKINS
June 14, 1915

SOCIETIES AND ACADEMIES

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

AT the 489th meeting of the society, held October 19, 1915, Dr. D. S. Lamb read a paper on "The Medicine and Surgery of the Ancient Peruvians." They used Peruvian bark for fevers. It is doubted whether syphilis, leprosy and tuberculosis occurred among them, although some infer that skin tuberculosis caused the mutilations represented on their pottery. Three skin diseases peculiar to the ancient Peruvians were the *mirunta*, the *verrugas* and the *uta*. Smallpox, measles, scarlet fever and yellow fever were introduced by the whites. Goiter prevailed; also the *tabardillo*. The heads of their infants were deformed. They let blood and treated dislocations, wounds and fractures, and trephined the skull. Dr. E. L. Morgan and others who discussed the paper agreed with the speaker in thinking that trephining had probably begun with the idea of getting rid of the evil spirit but was continued for its observed curative value. The idea of ridding the patient of an evil spirit was common to all primitive peoples. In the Iroquois language, said Mr. J. N. B Hewitt, the expression used in case of sickness is, "It is biting me." Dr. C. L. G. Anderson held that the megalithic people who preceded the Incas also knew much about medicinal herbs. They made infusions, powders and ointments of them. Sulphur, salty earths and hot springs were used as cures of rheumatism and skin diseases. Sarsaparilla, coca and quina were local drugs used.

DANIEL FOLKMAR,
Secretary

NEW ORLEANS ACADEMY OF SCIENCES

THE regular meeting of the academy was held in Tulane University on Tuesday, October 18. Dr. Gustave Mann presided. The paper of the evening was by Professor O. M. Rosenwall on "Some Methods of Offense and Defense among Insects."

The paper outlined the orders of insects which were to be touched upon and the specific insects which were to be referred to. As far as possible, insects found in the state of Louisiana were used as examples.

Among all the methods mentioned, those which were "active in defense," made up the material for the greater part of the paper, and these were mainly the "repugnatorial glands." This means of defense was possessed by some species of nearly all the important orders, and mainly in Coleoptera, Hemiptera and Orthoptera.

In many of the insects the appendages are adapted as means of defense, *e. g.*, mandibles and front-legs. At this point, the "praying mantis" was discussed, being one of the common insects of this region.

Then followed the use of "stings" in connection with "poison-glands," and the following subjects were discussed briefly: "Poisonous Saliva," "The Repellant Fluid of Several Species of Coleoptera," "Phosphorescence" and "Protective Attitudes"; the paper closing with "The Means of Defense among Insect Larvæ."

An interesting discussion among members took place after the reading of the paper, and examples of the insects discussed were on exhibition. The academy then adjourned.

R. S. COCKS,
Secretary