



## XIII. On radioactivity of mineral springs

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XIII. *On Radioactivity of Mineral Springs.* By G. A. BLANC,  
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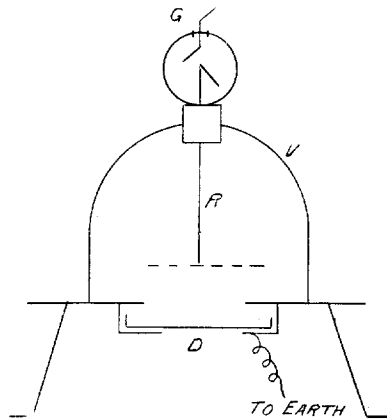
THE researches made by Sella, J. J. Thomson, Himstedt, and other physicists have shown that ordinary tap-water generally contains a radioactive gas or emanation that can be easily obtained by boiling the water or by drawing air through it.

Mineral waters, and the deposits which they form, have hitherto generally shown considerable activity, the subject having been studied by Elster and Geitel, Strutt, Lord Blythwood and Allen, Curie and Laborde, and others.

I shall give here the results of an investigation concerning the radioactive properties of the materials deposited by a certain number of mineral and thermal waters belonging to the Alpine region, which I have had the opportunity of examining during the summer.

To measure the activity of the various sediments I adopted the apparatus shown in fig. 1, which has been used by Sella in similar researches. It consists of a glass vessel

Fig. 1.



V with an opening at the top through which a metal rod R is fixed by means of a sulphur insulator. To the lower end of this rod a wire-gauze disk can be fixed horizontally, while the upper part carries an aluminium leaf and is covered by an electroscope case. The vessel stands on a metallic plate provided with an opening in its centre, under which a dish D may be placed containing the substance to be tested. The charge is given to the apparatus by a movable contact C of the usual type.

\* Communicated by Lord Kelvin.

In this case the deviations of the aluminium leaf were read by means of a microscope containing a micrometer eyepiece, the measurements being made by observing the time taken by the aluminium leaf to fall from a determined scale-division to another; this method has the advantage of insuring a constant sensibility of the apparatus throughout all the observations.

The readings were reduced to the potential fall in volts per hour, the effects due to the natural ionization of the air of the room and to the imperfections of insulation being each time subtracted.

Ten grams of each material, reduced into a fine powder and uniformly spread on the dish, so as to form a very thin layer, were successively tested in the apparatus, with the results that follow (see Table, p. 150).

The effect due to an equal weight of uranium nitrate is given as a term of comparison.

As one can see, the activity of the different sediments deposited by the waters diminishes greatly with the increasing distance between the spring and the spot at which they are formed. A similar observation had already been made by Elster and Geitel with the deposits of Baden.

I have noted a curious fact in connexion with this at the so-called "Source d'Alun" of Aix-les Bains; the waters there show at their surface a viscous substance, partly organic, called "Barégine," which has a considerably greater activity than any other material that I could collect in this particular spring. The theory of the origin of this substance, as given by naturalists, states that it is formed at the spot where the waters emerge from the soil.

I had noted that by keeping some of the sediments for a certain time in the testing-vessel the conductivity of the air inside steadily increased until it reached a maximum. This being evidently due to the formation of a radioactive emanation, I undertook to determine its rate of decay.

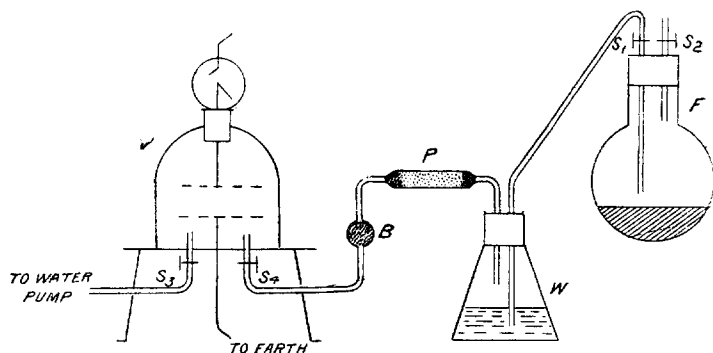
The apparatus which I used for this purpose is represented in fig. 2 (p. 151).

A certain amount of the sediment to be tested was introduced into a flask F and left there for some days, the flask being heated from time to time. Then the two stopcocks  $S_1$  and  $S_2$  were opened and air was drawn by means of a water-pump from F through a wash-bottle W containing sulphuric acid, a tube P containing phosphoric pentoxide, and a bulb B tightly packed with glass-wool, into the testing-vessel V, after which the stopcocks  $S_3$  and  $S_4$  were carefully closed.

Name of the Spring.	Nature of Water.	Temp. C°.	Nature of Substance Tested.	Potential fall in volts per hour.
Echaillon (Maurienne) .....	Saline.	34°	Deposit from serbatory, coloured red by iron.	312.0
" " .....	"	"	Deposit from well, yellow in colour.	122.9
Salins-Moutiers, Grande Source.....	"	35°	Reddish sediment from the spring.	128.8
" " " .....	"	"	Red sediment from canal-walls.	72.0
Salins-Moutiers, Petite Source .....	"	37°	Brown-red sediment from canal-walls.	56.0
Aix-les-Bains, Source d'Alun .....	Sulphurous-Sodic.	46°	Barégine.	19.4
" " " .....	"	"	Hard grey sediment from canal-walls.	11.2
Aix-les-Bains, Source de Soufre .....	"	45°	Greyish mud from the spring.	4.9
Allevard (Isère) .....	Sulphureous.	16°	Grey sediment, very rich in sulphur.	4.0
Challes (near Chambéry) .....	"	10°	Grey mud " "	3.3
La Boisse (Chambéry).....	Ferruginous.	"	Deposit coloured red by iron.	2.6
La Bauche (Ain) .....	"	12°	Mud coloured red by iron.	0.7
			Uranium nitrate.	5752.0

By examining in this way some of the most active materials, I could see that each produced a certain amount of emanation, the activity of which decayed with time at rates not very dissimilar from that of radium emanation.

Fig. 2.



The sediment of the Source d'Alun of Aix-les-Bains produced considerable effects, the conductivity in the testing-vessel rising to several hundred times the normal value. After the introduction of the emanation into the testing-vessel the conductivity increased steadily until it reached a maximum, and then began to decay according to an exponential law, falling to half its value in 3.2 days.

The activity of the emanation obtained from this sediment has, as one can see, a rate of decay somewhat more rapid than should be expected for radium emanation, but the result is in close agreement with the one obtained by Ebert and Ewers with emanation contained in air removed from the soil\*. It also differs only slightly from the value given by Adams for the rate of decay of emanation obtained from Cambridge tap-water†.

But a fact that struck me in the course of these measurements was that some of the most active deposits, as for instance those of Salins-Moutiers, when tested in the manner which I have now described, seemed to produce a very small amount of emanation as compared with the large amount obtained from other sediments which appeared to be much less active when examined by the method described in the first part of this note.

\* *Phys. Zeit.* iv. p. 162 (1902).

† *Phil. Mag.* Nov. 1903.

It seemed to me therefore evident that the greatest part of the activity shown by a certain number of sediments must be due to the presence of a radioactive substance without any emanating power, or maybe whose emanation lost its activity very rapidly with time. This hypothesis could also explain how the waters of Salins-Moutiers, when examined by Curie and Laborde, had proved to contain very little emanation\*, while the sediments were among the most active which I had found.

To settle this I proceeded in the following way:—Having left for a few minutes some 50 grams of sediment from the Grande Source of Salins-Moutiers in the dish of the apparatus shown in fig. 1, I managed to slide rapidly a metal screen over the dish, so as to close the opening under the vessel and remove the air inside it from the direct action of the sediment. (I had previously ascertained that the metal plate used as a screen was sufficient to cut away any direct radiation from the active substance.) In this way I was able to see that the conductivity of the air in the testing-vessel did not drop instantly when the screen was introduced, but that it gradually decayed with time.

By noting the rate at which the aluminium leaf fell I was able to determine with sufficient approximation the law according to which the emanation lost its activity. Repeated measures showed that the conductivity is reduced to half its value in about one minute.

Similar results were obtained by examining in the same manner the various sediments of the "Petite Source" of Salins-Moutiers and of the Echaillon spring.

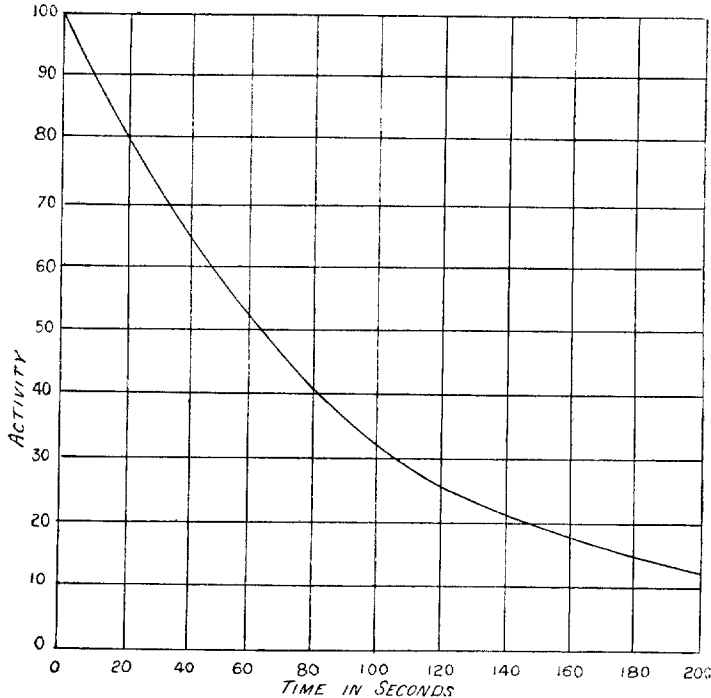
The results obtained with the sediments of Echaillon are shown graphically in fig. 3. These results seemed to point to the conclusion that a great part of the activity shown by the materials now mentioned was due to the presence of a radioactive constituent similar to, if not identical with, thorium.

I thought therefore that it would be interesting to see whether an inactive body could be made temporarily radioactive by exposing it to the emanation, and in this case verify whether the rate of decay of the excited activity was the same as in the case of thorium. After keeping for a couple of hours a disk of tinfoil in a glass vessel containing a certain amount of sediment from any one of the three springs mentioned above, it showed a notable activity. Considerably stronger

\* *Comptes Rendus*, cxxxviii. p. 1150.

effects were obtained by keeping the tinfoil disk charged at a potential of about  $-600$  volts, by means of a Zamboni pile. The activity decayed with time, falling to half its value in

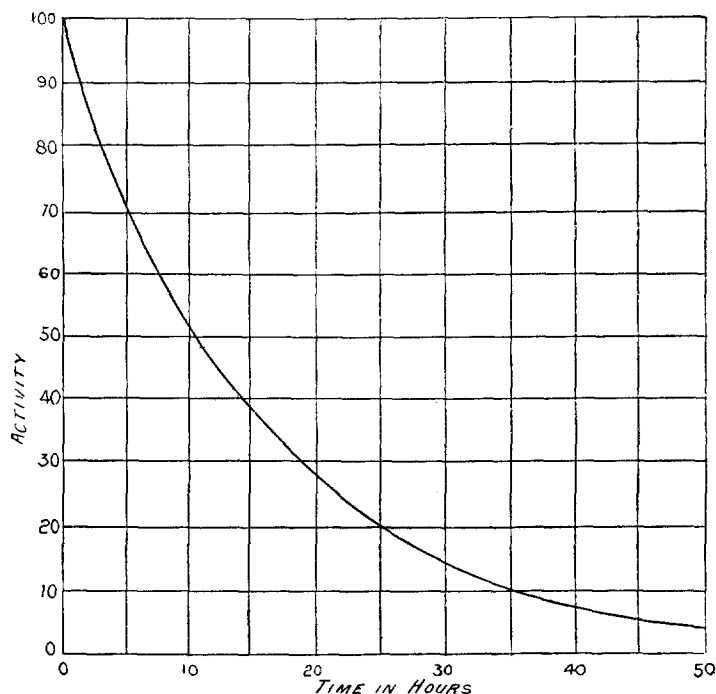
Fig. 3.



about eleven hours. The resulting curve is shown in fig. 4 (p. 154). The close agreement that exists between these measurements and the values obtained by other observers for thorium, seems to establish clearly the existence of this metal in the sediments of a certain number of thermal springs.

I could detect no similar effects with the other deposits, which, as I have mentioned above, give rise to an emanation that loses half of its activity in 3.2 days. The excited activity obtained from this emanation decayed at a rate very like the one of radium-excited activity, *i.e.* falling to half its value in about half-an-hour.

Fig. 4.

**CONCLUSION.**

The results given above show that besides the activity and emanation probably due to traces of radium which several physicists have observed in the sediments of a great number of mineral and thermal springs, some deposits contain a radioactive constituent, in all probability thorium, the emanation of which loses half of its activity in about one minute, and is capable of producing excited activity that decays with time, falling to half its value in about eleven hours.

I may add that attempts are now being made with the object of separating by chemical means the radioactive constituents and of determining as exactly as possible the amount of each present in the different sediments.

In conclusion I desire to express my heartiest thanks to Lord Kelvin, who was good enough to take some interest in the present research, and did me the honour of witnessing some of my experiments.