

THE CAUSE OF THE VARIATION OF THE EMANATION CONTENT OF SPRING WATER.

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Last year at the annual meeting of this Society I presented a paper on "Radioactivity of Spring Water" in which I called attention to the fact that there was a variation of the radioactivity from time to time. During nine months of the past year I have measured the emanation content of two springs once every week. In a short time I discovered that there was a connection between the radioactivity and the flow of the springs. The flow of one of the springs was measured every week during six months.

The springs are about 1.3 miles apart. One issues out of coarse gravel the other issues from a crevice in the solid rock. Both springs are known as never failing springs, however the flow of both are affected by the rain fall. They both vary in the same manner but not to the same degree. The variation of the Ill. Cent. spring, the one measured, is much more than the Hottle spring. The method of measuring the flow was by means of a horizontal weir, the depth being measured and computed according to the usual formula.

The radioactivity was measured by means of the Schmidt shaking method and an emanation electroscope. The electroscope was standardized by means of an emanation standard secured from the Bureau of Standards. The Schmidt shaking method can be carried out at the spring. The accuracy of the method when the measurements are made at the spring in 15 to 30 minutes is about 5 per cent. The observations for the nine months are shown in the table I. The date of observation, the temperature, the flow in gallons per day, and the emanation content of the water is given for each spring.

It will be noted that the radioactivity of the Hottle spring is higher and more constant than the Ill. Cent. spring. In the same manner the flow of the Hottle spring is more constant than the Ill. Cent. spring but it is not always greater than the Ill. Cent. It will be noted that the fluctuations of the radioactivity are in the same general manner for both springs.

This is better shown by means of curves Figure II. The full lines are for the radioactivity the dotted line is for the flow. The curves have a general

¹Indiana Academy of Science Proceedings, 1914.

fall towards low values and then a rather sudden rise. An increase in flow is accompanied by an increase in radioactivity.

The increase of flow follows the melting of a heavy snow or a heavy rain. Thus the radioactivity of the spring depends upon the rain fall. The radioactivity of rain water is very small compared to the values obtained at the springs. It can not be due to the radioactivity of rain water.

The above results, together with the fact that "wet weather" springs are very radioactive and that one on the campus of Indiana University measured 1920×10^{-12} a short time after a heavy rain fall, lead to the conclusion that the variation of the emanation content of Indiana springs is due to the rain water percolating through the soil and dissolving and carrying down with it some of the emanation which is continually moving upwards from the interior of the earth to the surface. During dry weather when the flow of the water is not rapid a large per cent of the emanation which was dissolved in the water is transformed into radium A, B, C, and D before the water issues from the ground.

This conclusion is in accord with the observations of Wright & Smith (Phys. Rev. Vol. 5, p. 459, 1915) in which they find that the amount of emanation which issues from the soil is decreased as much as 50 per cent at times after heavy rains.

To recapitulate, the variation of the emanation content of spring water is due to the rain water dissolving emanation as it percolates through the soil.

Department of Physics, Indiana University, December 1, 1915.

TABLE 1.

Variation of the Emanation Content of Certain Springs near Bloomington Indiana. (Flow given in gallons per day.)

DATE.	HOTTELE SPRING.			ILLINOIS CENTRAL SPRING.		
	Temp C. °	Flow.	Curies per Liter.	Temp. C. °	Flow.	Curies per Liter.
1914,						
Sept. 24.	13		650×10^{-12}			445×10^{-12}
Oct. 16.	13		695	12.8		166
Oct. 23.	13.3		700	13		120
Oct. 30.	13	10000	665	12.7	130000	20
Nov. 6.	13		650	12.6		40

DATE.	HOTLE SPRING.			ILLINOIS CENTRAL SPRING.		
	Temp. C.	Flow.	Curies per Liter.	Temp. C.	Flow.	Curies per Liter.
Nov. 13.....	13		705	13		20
Nov. 20.....	13		520	13		20
Nov. 26.....	13		550	13		30
Dec. 3.....	13		535	13		60
Dec. 11.....	13		510	13		20
Dec. 18.....			450	13		00
Dec. 26.....	13		445	12.8	5000	00
1915.						
Jan. 1.....		20000	560		32000	40
Jan. 7.....	12.6		1020	12	136000	340
Jan. 14.....	13		770	13	39500	272
Jan. 21.....	13		680	12.8	40000	100
Jan. 18.....	12		610	12	32000	20
Feb. 4.....	12	62000	850	12	250000	750
Feb. 11.....	12		875	12.6	123000	166
Feb. 18.....	11.8		915	12	100000	350
Feb. 25.....	11.3		890	12	75000	170
Mar. 5.....	11.5		1010	12	100000	143
Mar. 11.....	11.5		900	12	85000	220
Mar. 18.....	11.3		920	12	62500	160
Mar. 25.....	11.3		800	12	40000	90
April 1.....	11		670	12	30000	45
April 8.....	11.3		690	12	30000	30
April 15.....			830	12	28000	60
April 22.....	12		890	12	30000	6
April 28.....			750	12.2	25000	410
May 7.....	11.4		1110	12	410000	365
May 13.....	11.9		825	12.4	60000	365
May 21.....	11		1050	12.3	42000	25
May 27.....	12		1340	12	500000	750
June 3.....	11.6		1420	12	400000	820
June 10.....	11.8		1120	12	76000	355
June 25.....	12		1280	12.5	30000	715

