On the Equilibrium of the Radioactive Elements in the Hydrosphere. IV. On the Ratio of Thorium X to Radium in the Hydrosphere.

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Introduction.

In the previous paper[1], the occurrence of thorium X in the mineral waters of Masutomi was reported by the authors. The ratio of thorium X to radium expressed in Curie unit was considerably large in the case of Masutomi. The highest value of this ratio was 10.3 of the spring B7. This ratio was larger than 1 in many springs in Masutomi, and it was considerably larger than the value obtained by Kurbatov in three springs of Gelesnovdsk (0.02 to 0.58). Is this ratio also large in other radioactive springs of Japan or not? The authors have intended to determine the ratio of thorium X to radium in the mineral springs of Ikeda and in the hot springs of Misasa.

I. Determination of Thorium X and Radium.

Radium and thorium X were co-precipitated together with barium sulphate from 1 to 3 litres of the mineral water, and the radioactivity of the powdered precipitate was measured with the Lauritsen-electroscope. The radioactivity diminishes slowly for several days, according to the presence of thorium X. The radioactivity becomes constant after about thirty days and this radioactivity is due to radium. The thorium X content ($C\ ThX$) and the radium content ($C\ Ra$) were obtained from the equations

$$CRa = I_e K_{Ra} \tag{1}$$

and

$$CThX = \frac{I_t - I_e(Ra)_t}{(ThX)_t} \times K_{ThX} \tag{2}$$

where, I_t = observed radioactivity at time t,

I_e = observed radioactivity at $t = 30$ days,

$(Ra)_t$ = the factor of the radioactivity of radium to calculate the radioactivity at each time,

$(ThX)_t$ = the degree of the disintegration of thorium X in time t,

K_{ThX} and K_{Ra} = sensitivity of the instrument for thorium X or radium, and their values were as follows:

(1) K. Kuroda and Y. Yokoyama, this Bulletin, 21 (1948), 52.

$$K_{Ra} = 83 \times 10^{-12} \text{ g per div. per min.} \quad (3)$$

and

$$K_{ThX} = 75 \times 10^{-12} \text{ Curie per div. per min.} \quad (4)$$

II. Results.

The results obtained are shown in Table 1 and Table 2. The thorium X contents are shown in two units, their relation being as follows.

$$\text{g Th/l} = 1.11 \times 10^{-7} \text{ Curie/l.} \quad (5)$$

Table 1. The Thorium X and Radium Content of the Hot Springs of Misasa. (May 5, 1948).

	Name	Temp. °C	Rn 10^{-10}C/1	I_t	I_e	Ra 10^{-12}g/1	ThX 10^{-12}C/1	10^{-5}gTh/1
(1)	Okayama Univ.	61	40	0.31	0.14	12	23	21
(2)	Misasa Hotel	58	18	0.36	0.22	18	26	23
(3)	Ohasi-Soto-Yu	49	38	1.03	0.14	12	80	72
(4)	Matubara	61	70	0.34	0.23	19	25	23
(5)	Tennen-Gankutu	43	260	0.28	0.10	8	21	19
(6)	Tabakoya	38	560	0.30	0.04	3	24	22
(7)	Yamadaku	55	900	0.03	0.03	3	2	2
(8)	Hanaya	59	650	0.03	0.03	3	2	2
(9)	Akasakiya	42	180	0.02	0.05	4	0.5	0.5

Table 2. The Thorium X and the Radium Content of the Mineral Springs of Ikeda.

Name	Temp. °C	Rn 10^{-10}C/1	I_t	I_e	Ra 10^{-12}g/1	ThX 10^{-12}C/1	10^{-5}gTh/1
No.1	15	480	1.35	0.50	41	108	97
No.2	16.5	380	1.24	0.53	44	98	88
No.3	16	770	1.37	0.50	42	111	100
No.4	13	6100	0.18	0.29	24	9	8
No.5	12.5	8500	0.06	0.07	6	4	4
Oku-no-yu	22	(20)	0.64	0.25	21	50	45

Table 1 and Table 2 show that the ratio of thorium X to radium is also large in the mineral springs of Ikeda and the hot springs of Misasa. The highest value was 8.0 in the spring water of Akasakiya in Misasa. The following rules were found in Ikeda and in Misasa, namely: (1) the higher the water temperature and the larger the amount of flow, the larger is the ratio of ThX/Ra, and (2) the larger the radium content and the smaller the radon content, the larger is the thorium X content. These tendencies are quite similar to those obtained in Masutomi, but they are not so clear compared with the case of Masutomi. It is probably because the springs issue from the bottom of the bath, and we sometimes used stagnant waters. The ratio of thorium X to radium in these mineral springs are summarized in Table 3 and Table 4.

Table 3. The ThX/Ra Ratio in 25 springs of Masutomi.

ThX/Ra	<1	1–2	2–4	4–6	>6
Number of springs	7	4	5	5	2

Table 4. The ThX/Ra Ratio in 15 Springs of Misasa and Ikeda.

ThX/Ra	<1	1–2	2–4	4-6	>6
Number of springs in					
Misasa	3	3	1	0	2
Ikeda	2	0	4	0	0

Summary.

The thorium X and radium contents of mineral springs of Ikeda and the hot springs of Misasa were estimated. The ratio of thorium X to radium in these springs was considerably larger than that obtained by Kurbatov in Gelesnovdsk. The relation between the ratio of thorium X and radium, and water temperature, radium content, radon content, etc., was quite similar to that found in Masutomi.

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