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11. Radon Concentration in Underground Waters from the Landslide Zone in Narao District, Shinshu Shinmachi, Nagano Prefecture.

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1. Introduction

The outbreak of spontaneous landslide is thought to be closely related to an unusual change in water systems under the ground. Certain chemical species in underground waters have been investigated with respect to their possible bearings on such a change. It is, however, not very clear what kind of a constituent is the best parameter.

The large-scale landslide which occurred along the eastern flank of the Chausu-yama, about 10 km south of Nagano City, provided one of the typical fields for studying chemical species of changing water systems (Yokozawa, 1972). Chemical analyses were made on the underground waters (springs, well waters, etc.) from both the moving zone and its surrounding area, in order to see the possible differences in chemical composition between the two groups of water. The results on two anions, SO_4^{2-} and Cl^- are reproduced in Fig. 1. It is seen from Fig. 1 that higher values of SO_4^{2-} concentration are observed in the waters from the sliding zone whereas higher values of Cl^- are found in the waters from the outside. The source of the "excess" SO_4^{2-} found in the sliding zone is possibly country rocks occurring in the area which are known to be relatively rich in iron sulfide minerals. A sudden increase in SO_4^{2-} concentration was observed in some well waters immediately

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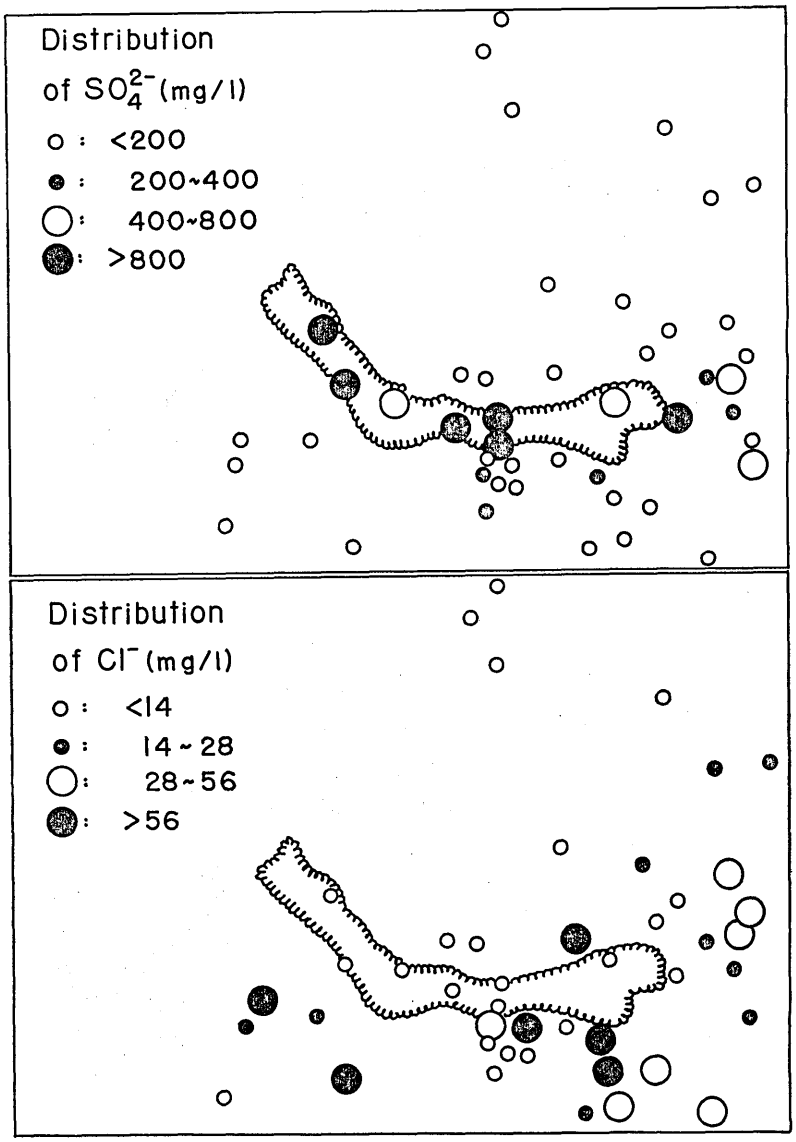

Fig. 1. Distribution of SO_4^{2-} and Cl^- concentrations in and around the sliding zone (enclosed area), Chausu-yama—Nakao-yama district, Nagano Prefecture (after YOKOZAWA, 1972).

after the slide started. The concentration of SO_4^{2-} appears to have a close relation to the mechanism of the slide. On the other hand, the concentration of Cl^- can be interpreted to be largely controlled by every sorts of waters from the human lives in the area. Data obtained for chemical species such as are habitually used in human lives may be

generally attended with difficulties in interpretation. It is essential to use chemical species which are commonly present in natural waters but not affected by any local supply. One of the species fulfilling these requirements is radon. The half-life of ^{222}Rn, 3.8d, is, better still, short enough to follow any time-to-time fluctuation of water composition which might be connected with the phenomenon concerned.

As a large-scale landslide is of rare occurrence, it is of prime importance on such an occasion to obtain substantial information from the field for a relatively short period of time. This report presents results of an exploratory observation made from this point of view.

2. Landslide in Narao district

On October 8, 1976 a landslide (ca. 16 ha) started in Narao district, 25km southwest of Nagano City. The area faces the Sai River and is adjacent to Yanagikubo where a landslide had occurred in 1847. The relevant part of these areas is shown in Fig. 2. The movement goes toward the southwest down a small valley. The average velocity was about 40cm a day in the beginning, and was diminished to 4cm a day up to the end of December, 1976.

There are several outlets of spring waters in and around the sliding zone. In addition, a number of horizontal borings which functioned as drainpipes of underground waters from the moving zone have been

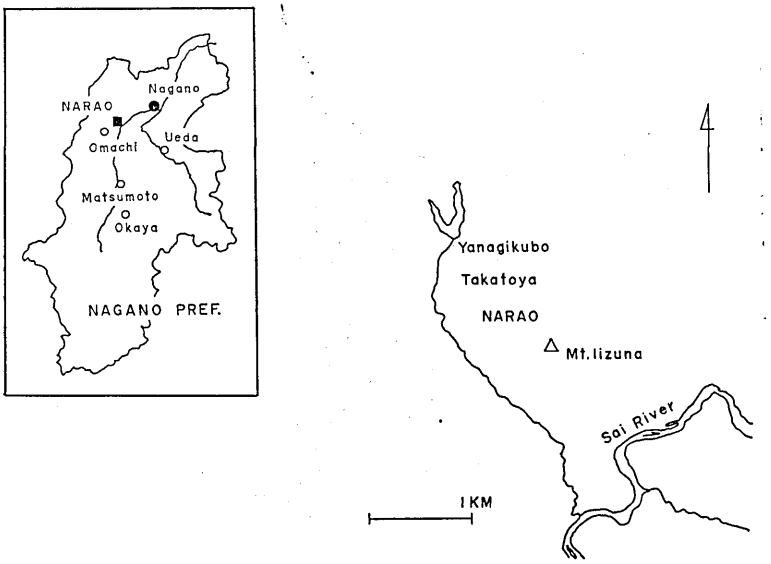

Fig. 2. Map showing the locality of landslide zone, Narao district.

Table 1. Radon concentration in underground waters from the landslide zone in Narao district, Shinshu Shinmachi, Nagano Prefecture.

	Sampling point	Oct. 11	Oct. 24	Oct. 28	Oct. 30	Nov. 4	Nov. 7	Nov. 14	Nov. 17	Nov. 19	Nov. 20	Nov. 28	Dec. 8	Dec. 19	Dec. 26
Sliding zone	A	1.7	broken down												
	B	2.1	broken down												
	C	1.8	broken down												
	D		1.4	1.0	1.0	1.2	0.7		1.3						1.0
	E		3.8	3.1	2.7	4.2	3.1	3.2	2.3	2.0	2.8	1.6	2.0	1.1	1.6
	F		2.3	1.9	1.5	1.5	1.4	broken down							
	G					2.6	2.8		2.4	2.7	2.2	2.2	2.4	1.7	2.8
	P						2.6								
	Q								2.5		2.4	2.4	2.4	broken down	
	R											0.6	1.7	1.3	
	S												0.5	1.2	
Surrounding area	H			0.6	0.4		<0.3		0.4						
	I			0.6	0.5	broken down									
	L		0.7	broken down											
	J			<0.3		<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
	K			0.8			1.2		0.9	0.8	0.6	0.6	0.7	0.6	0.6

made by the prefectural authorities to brake the movement. Some of the outlets of this type in the moving zone were broken down as indicated in Table 1 in the course of the slide movement, and new ones were further set up to continue releasing water.

3. Radon concentration in underground waters from Narao district

Radon is extracted to 25 m*l* of toluene from 200 m*l* of sample water with about 80% recovery. The extracted radon is determined by means of a liquid scintillation spectrometer (Packard 3315). The procedure is described in detail in a previous report (SATO and SATO. 1976).

The sampling was successively made from each of the water outlets indicated in Fig. 3 mostly at intervals of 2 to 7 days. The radon concentrations thus obtained are given in Table 1. Fig. 3 illustrates an

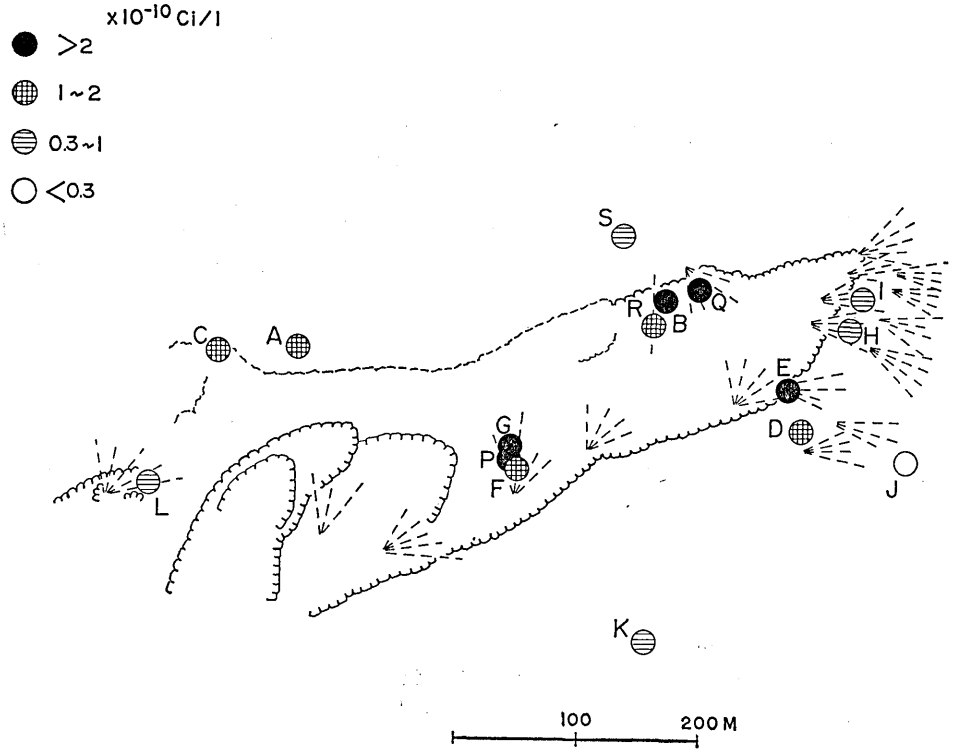

Fig. 3. Distribution of radon concentration in underground waters in and around the sliding zone (semi-closed area), Narao district, Nagano Prefecture. Gradations are based on the data compiled for about two months. Dashed lines indicate locations of horizontal borings.

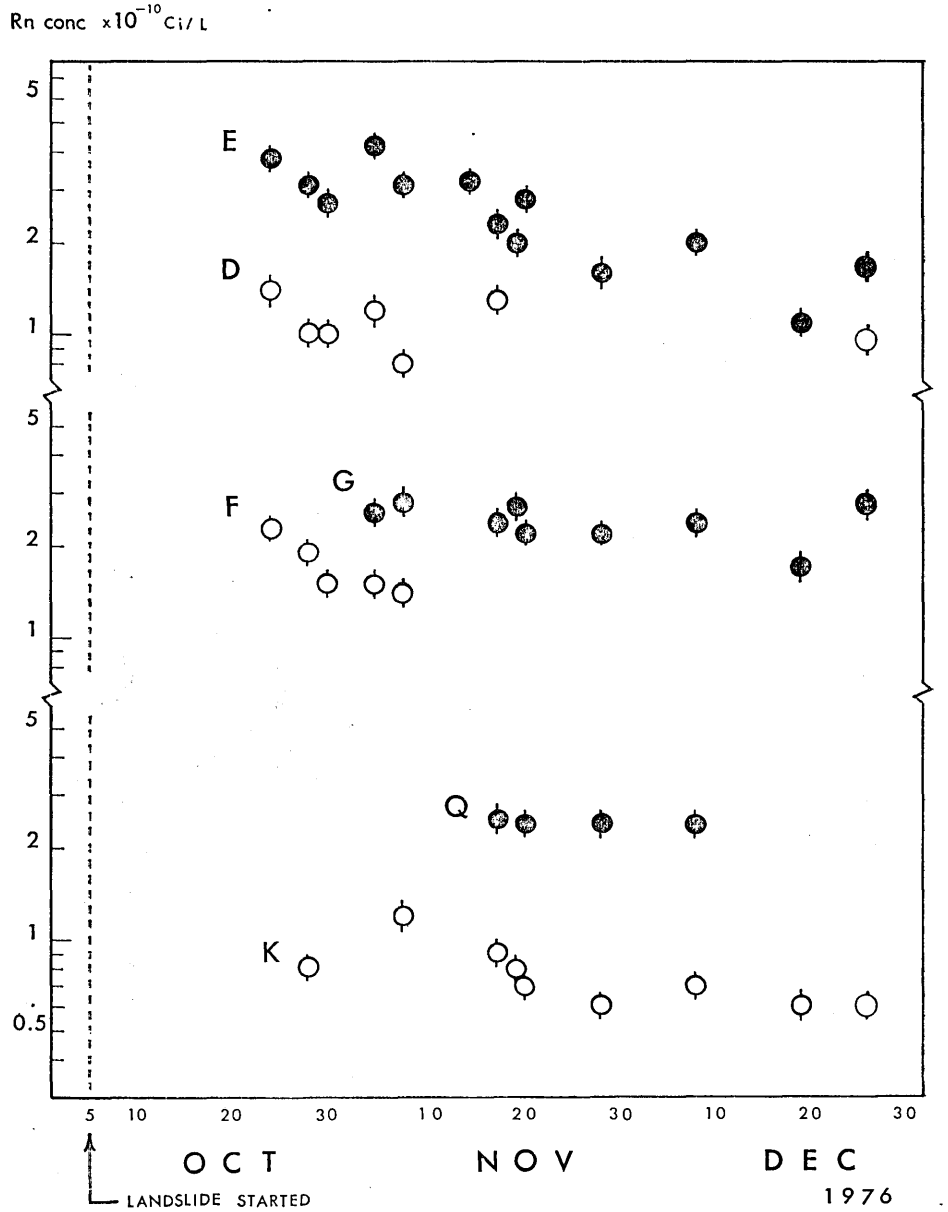

Fig. 4. Variation of radon concentration in underground waters from Narao district for the period of about two months. Open or solid circles are used for convenience in distinguishing between different water outlets.

outline of their distribution over the field. The data in Table 1 indicate that the radon concentration is generally variable to a certain extent, but does not exceed 5×10^{-10}Ci/l. As far as the data available

to date are concerned, it may be pointed out that the radon concentration in waters from the moving zone is slightly but consistently higher than in the surrounding area, though both groups of data are at any rate not beyond the limits of those known in the ordinary natural underground waters.

Fig. 4 shows variations of radon concentration observed for some of the outlets over a period of about two months. It appears that the radon concentrations of all these outlets show a trend of gradual decrease with small rises and falls.

Acknowledgment—The measurement was carried out at the Radioisotope Centre, University of Tokyo.

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11. 長野県上水内郡信州新町奈良尾地区の地辷り地帯の湧水中のラドン濃度

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1976年10月8日に長野県上水内郡信州新町奈良尾地区に大規模な地辷りが発生し，1976年12月現在もなお辷り続けている．この地帯の湧水中のラドン濃度の測定を地辷り発生以来連続して行った結果，湧水中のラドン濃度は普通の地下水と同程度ではあるが，地辷り地帯からの湧水は，その周辺地帯からの湧水に比べてわずかに高いことが認められた．大きな経時変化は見られていない．

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