BEHAVIOR OF A SNOW COVER AFTER CRACK FORMATION ON MOUNTAIN SLOPE

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ABSTRACT

Observations were made of the movement of a snow cover along a ground surface on a mountain slope after formation of a crack were observed. By these observations,behaviors of snow cover after crack formation, gliding distance,gliding speed and the process of the occurrence of a full depth avalanches were obtained. The results indicate that increase in gliding speed to a fairly large value during 30 minutes give rise to a full depth avalanche.

INTRODUCTION

A large compressive bump-shaped undulation caused by the movement appearing on the slope under a portion of the crack and a failure of the undulation immediately gave rise to a full depth avalanche as shown in Fig.1. On the other hand ,it was observed that sometimes making several large undulations,the snow cover moved downwards on the slope without failures of the undulations and without any avalanches as shown in Fig.2. Studying of behavior of the snow cover after formation of a crack on a slope provides an important clue to the prediction of a full depth avalanche

METHOD

Measurements were made of snow glide after formation of a crack showing on high frequency of a slope covered with bamboo bushes and avalanches beginning midwinter,every year,in the northern Hokkaido,Japan. An aparatus for mesuring a snow glide was set in a crack as shown in Fig.3. Movement of the snow cover was transferred to the value of electric resistance measured by the potentiometer with the axis attached with a pulley 12 cm in diameter capable of rotating ten times,around which a thread was wound on, the end of thread having been fixed in a gliding snow. The electric resistance was recorded every ten minutes on a data recorder.

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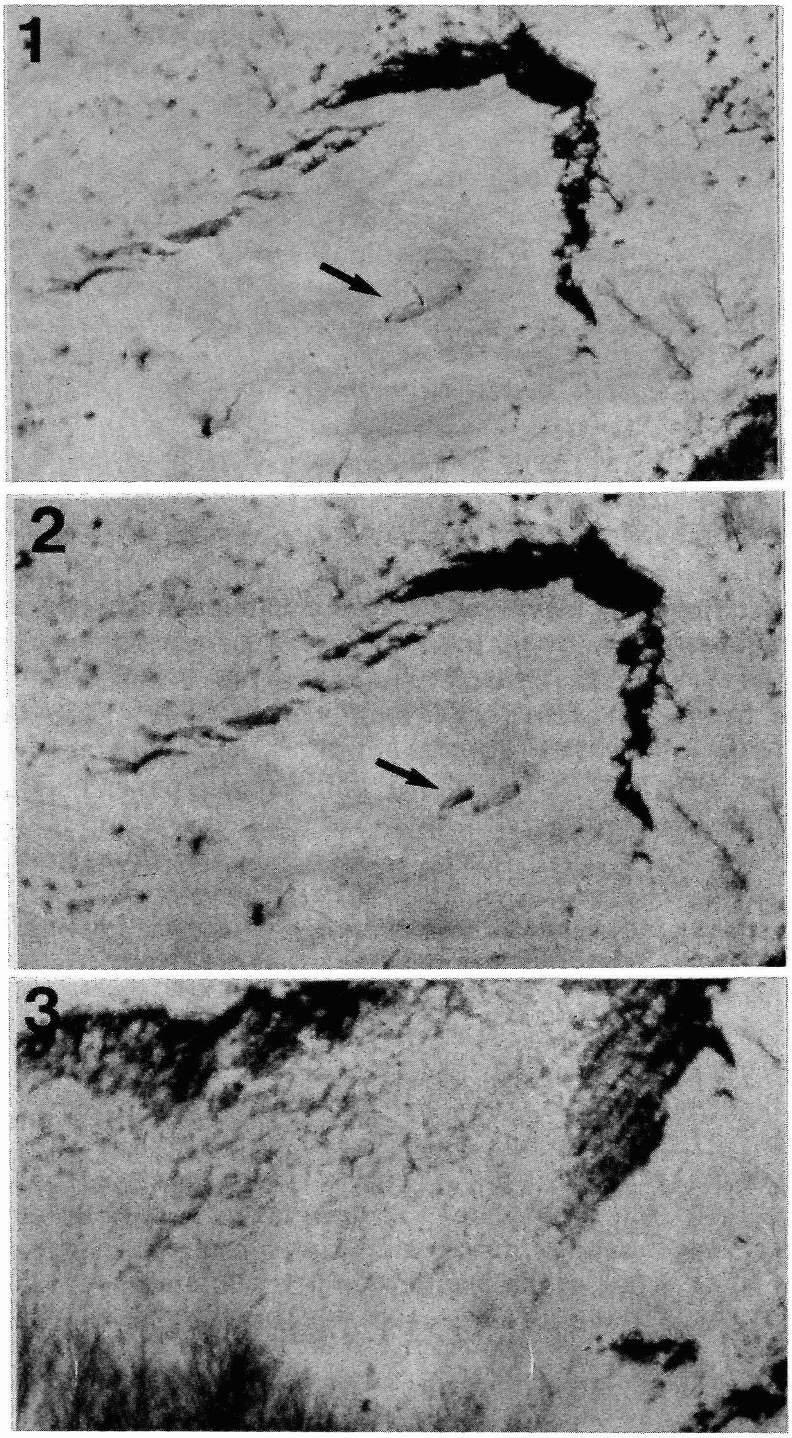

Fig.1 Failure of an undulation and a full-depth avalanche.
1.The arrow shows an undulation.
2.Failure of an undulation.
3.An avalanche started several seconds after the failure.

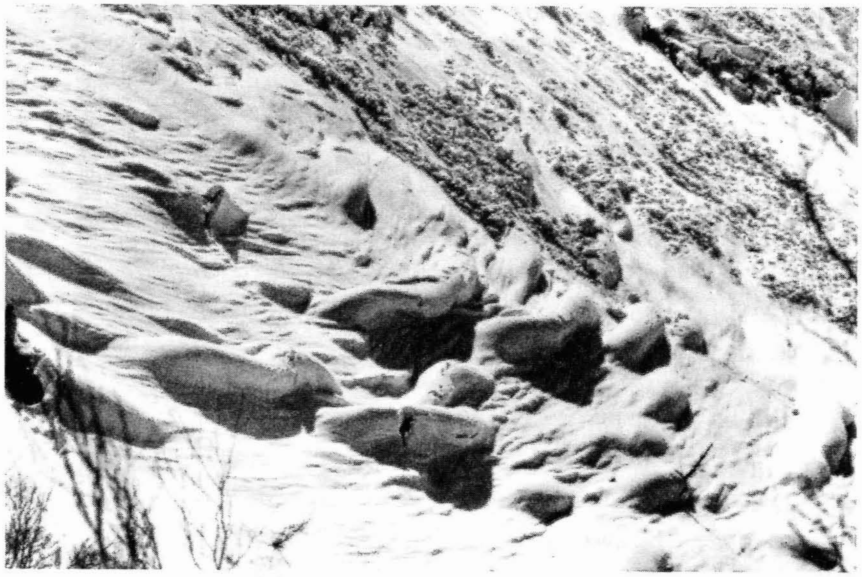

Fig.2 A gliding snow cover with large undulations not resulting in an avalanche.

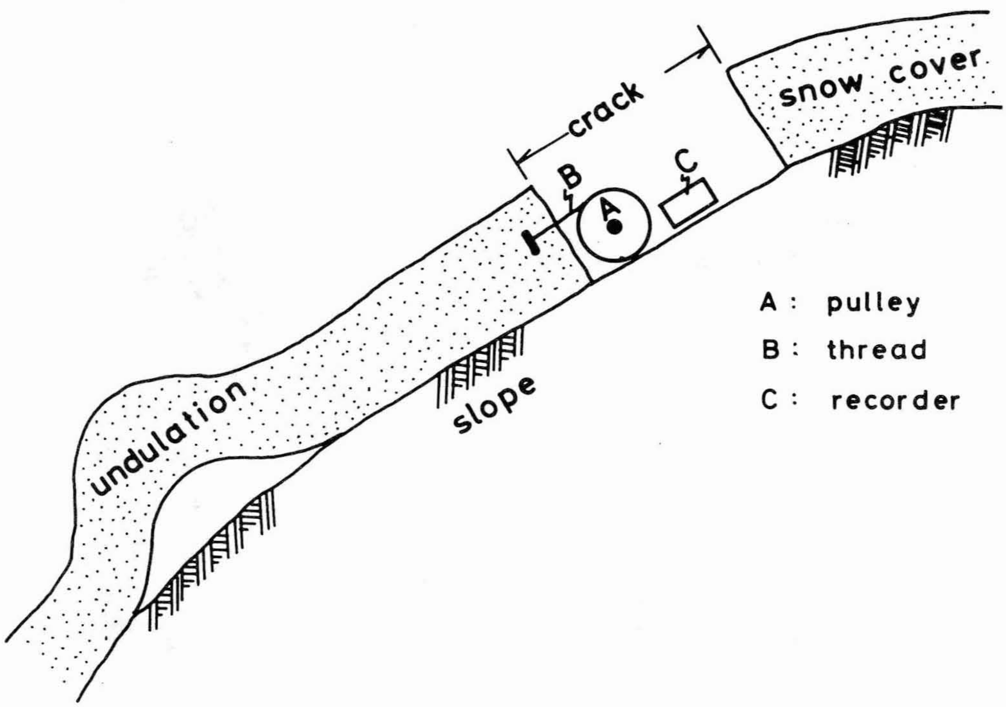

Fig.3 Method of snow glide measurement in a crack.

RESULT

Nine series of recording were obtained during the two winters,1986-87 and 1987-88. In these observations full depth avalanche generated at only one crack with a small amount of glide movement but at other cases glide motion stopped without anavalanche despite a large value of glide distance

Shown in Fig.4 and 5 are, respectively, the frequency of occurrence of gliding speed measured at an interval of one hour cm/hr,against the speed larger than 1 cm/hr, and the frequency of the same against the time at which the snow started gliding at the speed larger than 4 cm/hr. The two figures show that the frequency of gliding speed rapidly decreases with increasing speed and the number of occurrence of gliding speed larger than 4 cm/hr occurred fairly frequently between noon and 10 p.m..

Cumulative gliding distance from the start of measurement with time is shown in Fig.6 (series No.5), where it attained more than 7 meters making several large compressive undulations without an avalanche and finally the movement stopped. On the other hand, an avalanche occurred at the cumulative distance of 0.6 meters,as shown in Fig.7(series No.6). The total gliding distance from the occurrence of the crack reached about 10 meters at No.5 and 2 meters at No.6,respectively.From the analysis of gliding speed calculated at one hour interval ,the speed is smaller in the case of an avalanche shown in Fig.6 than in other cases without avalanches as in Fig.7. We can conclude from the results that the glide distance and glide speed at one hour interval dose not immediate connection with avalanche occurrences.

Comparing of glide speed every ten minutes between avalanched and not avalanched cases some typical differences can bee recognized. Increase in gliding speed to a fairly large value is continued during 30 minutes as 6.8, 9.1 and 14.8 cm/hr every ten minutes; and the avalanche occurred during the following 10 minutes. Table 1 shows the gliding speed every ten minutes larger than 6.0 cm/hr and the gliding speed which increased by 2 cm/hr after 20 minutes and also shows the speed after 30 minutes if it increases more than previous values. Among the 33 cases in Table 1, only three cases continued to increase the speed during the period of 30 minutes as marked **. An avalanche occurred practically at No.6 marked ** in the three cases.It is considered there were also high posibilities of avalanche occurrence in other twoo cases marked **.

Table 1 shows that 67% of the time of the occurrence of 33 caseswas during eight hours from noon to 8 p.m.20 and 6% from 10 p.m. to 6 a.m.. The result shows that glide motion is activated by high air temperature and sunshine with some time-lag and avalanche activity grows up when a fairly large glide speed continues to increasing during the time of 30 minutes.

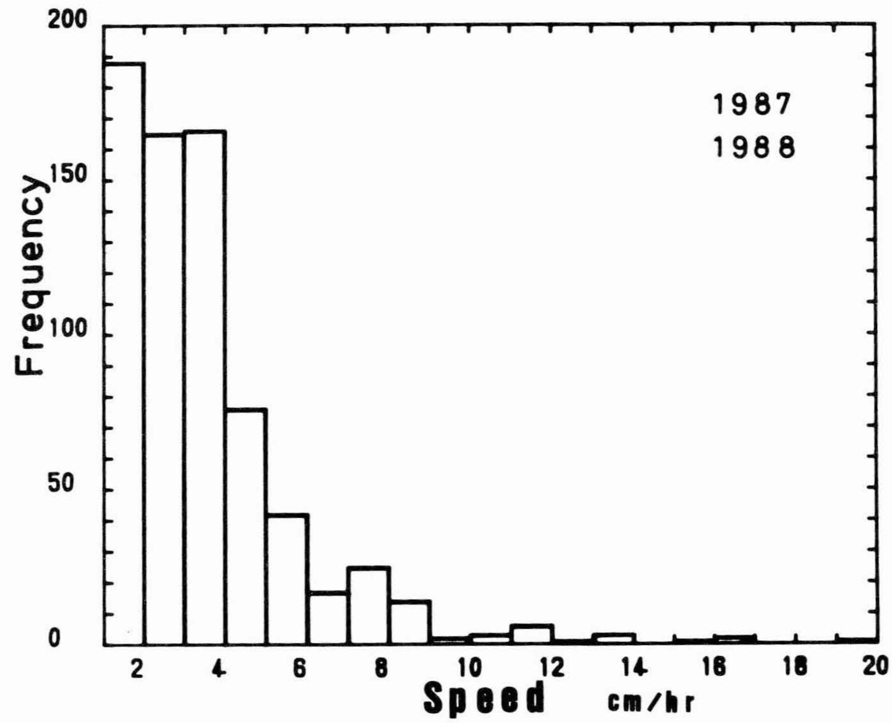

Fig.4 Frequency of gliding speed measured at an interval of one hour.

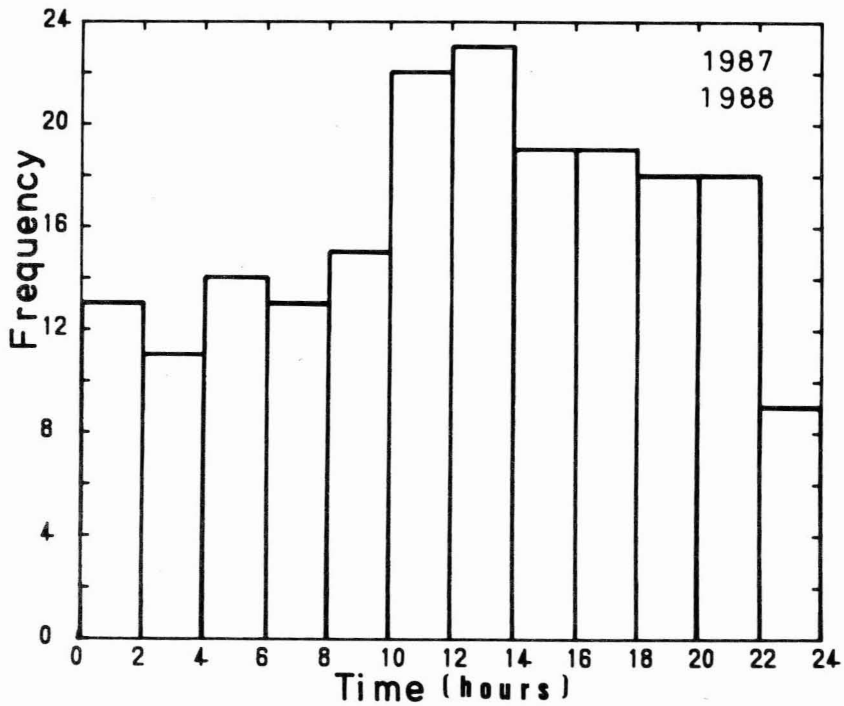

Fig.5 Appeared time of a gliding speed larger than 4 cm/hr.

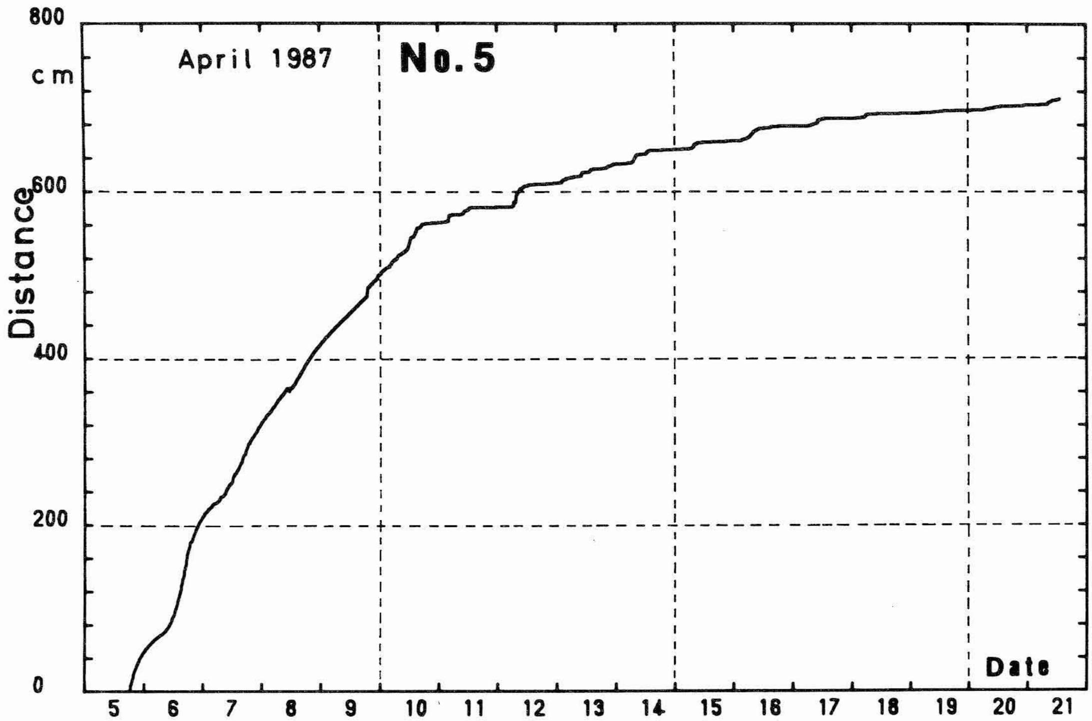

Fig.6 Cumulative gliding distance with time (not avalanched).

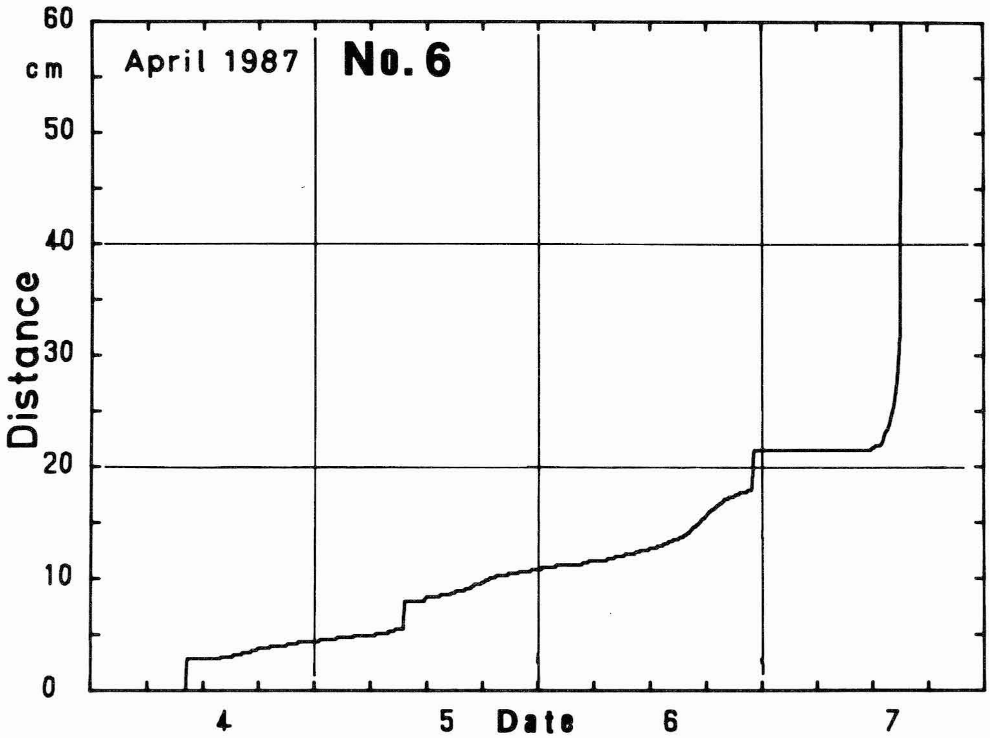

Fig.7 Cumulative gliding distance with time (avalanched).

Table 1. Acceleration of gliding speed measured at an interval of ten Minutes.

Ser. No.	Start of obsv.	Date	Time *	Gliding speed after 10 min.	20 min.	30 min.
1	4/15	4/15	13:03	11.4	18.2	
2	4/6	4/9	7:37	8.0	10.3	
4	4/4	4/5	17:38	16.0	18.3	
			18:28	13.7	16.0	
			19:48	10.3	12.5	
			20:58	8.0	10.3	
		4/6	11:38	6.8	14.8	17.1* *
		4/10	13:08	6.8	9.1	
		4/11	2:08	10.3	32.0	
5	4/4	4/5	18:15	9.1	13.7	
		4/6	11:25	8.0	16.0	
			14:55	13.7	17.1	
			16:15	12.5	18.2	
			17:05	13.7	40.0	
			17:55	10.3	12.5	
			18:25	11.4	18.2	
		4/7	10:25	8.0	14.8	
			12:05	19.4	21.7	
			15:55	8.0	20.5	
		4/10	12:05	8.0	17.1	
6	4/4	4/7	14:31	6.8	9.1	14.8* *
8	3/17	3/19	15:49	6.8	9.1	
		3/21	9:09	6.8	9.1	
9	3/17	3/18	9:38	6.8	10.3	
			23:08	6.8	58.1	
		3/19	8:38	6.8	14.8	
			12:28	6.8	9.1	
			13:28	10.3	12.5	
			14:38	6.8	9.1	11.4* *
			16:18	6.8	11.4	
			17:38	10.3	14.8	
			19:28	10.3	21.7	
			21:58	6.8	9.1	

* Time at which the speed was larger than 6 cm/hr ten minutes later and 8 cm/hr 20 minutes later.
* * Those speeds which were larger than the speeds 20 minutes later.

REFERENCE

Eizi Akitaya,1980, "Observations of ground avalanches with a video tape recorder",J.Glaciology,Vol.26,No.94,pp.493-49.

Yasoichi Endo,1983, "Glide processes of snow cover as a release mechanism of an avalanche on a slope covered with bamboo bushes",Contr.Low Temp.Sci,.A.32,pp.39-68.