ON CHARGING OF SNOW PARTICLES IN BLIZZARD

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ABSTRACT

We investigated the causes of the charge polarity on blizzard consisted of the fractured snow crystals and the ice particles. As a result, the charging phenomena showed the characteristics on blizzard as follows:

i) In the case of the blizzard with snowfall the fractured snow particles drifting at near the surface of snow field (Lower area: Height 0.3 m) had positive charge, while those drifting at higher area (Height 2 m) from the surface of snow field had negative charge. However during the series of blizzard two kinds of particles positively and negatively charged were collected in equal amounts in Faraday Cage. It may be considered that a snow crystal with electrically neutral properties were separated into two kinds of snow flakes charged positively and negatively by destroying of snow crystal.

ii) In the case of the blizzard consisted of irregularly formal ice drops generated by pealing off the hardened snow field, the charge polarity on irregularly formal ice drops salting over the snow field was particularly controlled by the crystallographic characteristics on the surface of the snow field hardened by the powerful wind pressure.
INTRODUCTION

Magono et al. [2] has reported that the charge polarity of particles was dependent on the vertical distance from snow fields according to measurements of the electrostatic potential gradient in blizzard without snowfall at Mt. Teine (Height: 1023 m). Latham et al. [3] explained the charging phenomena in blizzard with the temperature gradient effect which was presented in Latham and Mason [1]. Latham [4] also investigated the vertical electric field strength near snow cornice on Bridger Ridge (Height: 2590 m), and suggested that the appropriated condition to the development of cornice is due to the electrostatic force being generated between the snow field and the charged snow particles under the comparatively low velocities of drifting snow particles. Shio et al. [5,6], and Shio [7,8] pointed out shortcoming of the temperature gradient effect in relation to the frictional phenomena, and suggested that the polarity on frictional electrification, is concerned with the different characteristics on crystallization, and the hardness effect of specimen.

In this paper, in order to observe the relation between the crystallographic properties on snow field and the electrostatic phenomena in blizzard the measurements of the charging on snow particles were carried out with Faraday Cage and Wells and Gerke's Horizontal Field Method [9]. While, snow particles were collected by Replica Method, in the most windy season we carried out the measurements at Sugatami area of Mt. Asahidake (Height: 1970 m), in the lowest temperature season being colder than -30°C at Tomamu area.

RESULTS AND DISCUSSION

During those observations the charging tendency may be divided into two groups, namely whether the snowfall was or not in blizzard.

BLIZZARD WITH SNOWFALL

An example of this condition is shown in Fig. 1. Estimates have been made of the charging on particles drifting in the higher area in the blizzard during from 12 h 48 min to 12 h 55 min, while in the lower area during from 12 h 56 min to 13 h 04 min. The charging curve became repeatedly to be beyond the value which could be measured by using the static potential electrometer as shown by the arrows E, and then, Faraday Cage was earthed. At 12 h 49 min and 12 h 55 min, the charging curve suddenly changed from negative sign to positive sign, while at 13 h 01 min the reversal tendency on comparing the result as above appeared. Fig. 2 shows an example of the trajectory of particles moving unnaturally into the Faraday Cage at 12 h 49 min and 12 h 55 min. At those times the electrometer shows the inversion on sign of charge. It is estimated that those particles had acquired a strong positive charge and were absorbed into Faraday Cage by pulling of the strong electrostatic forces induced by the negative charge accumulated in the Faraday Cage. Fig. 3 shows the charge densities against the measuring periods. Since the ambient temperature being -19°C is always about -2°C colder.
Fig. 1. Charge against drifting time. Higher area: 12h 48min to 12h 55min. Lower area: 12h 55min 30sec to 13h 4min 10sec. Arrows A, B, and C show the points where the stored charge is over the regions measured possibly using the electrometer, then, it was earthed as shown by arrow E.

Fig. 2. Trajectory of particles moving unnaturally into Faraday Cage. than at the point of about 0.1 m above the snow field, same temperatures of the drifting particles is below that of the snow field. On the basis of the temperature gradi-
Fig. 3. Charge densities against drifting time. Open squares: Charging at higher area. Solid circles: Charging at lower area.

ent the particles should always be positively charged regardless of the height above snow field. However fig. 3 does not show its tendency. The wind velocity was 18 m/s at 10 m above the snow field and 2 m/s at 0.3 m. After measuring of charge the volume of the particles precipitated in Faraday Cage was accurately measured by melting of it. The charged densities show the accumulated charge vs. the particles precipitated in Faraday Cage during 8 min interval. It shows that the snow particles have negative charge at higher area and positive charge in the lower area. The sign of charge densities was dependent upon the vertical distances from snow field except in the period between 13 h 01 min to 13 h 15 min when the charging curve was changed with the change of wind direction.

Since Yoshida [10] and Magono et al [2] reported the relation between the charging ice particles and their size, in order to examine how the charge polarity depends on the size of snow flakes we investigated the correlation frequency of the sign of charge on snow flakes against those size using Wells and Gerke's method. The results are shown in Fig. 4 and Fig. 5. Fig. 4 shows a trajectory of a charged particles falling in the parallel electric field of D.C. and A.C. Fig. 5 shows that the charge on par-
Fig. 4. Trajectory of the moving particles with positive charge in electrostatic field with A.C and D.C. electric power. The destroyed particle was made by blowing off the fresh snow with compressed air.

Latham [4] reported the charge per one crystal was $-4 \times 10^{-14}$ C, which is close to the value of the maximum charge deduced by Latham et al. [3]. On comparing the result as above, its result shows greater quantity of the charge per one crystal. We could not confirmed the

Fig. 5 Charge of the destroyed particle against its size.

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strong relation between the charge polarity and the size of the particle made by destroying of the fresh snow. However, the charge polarity on the drifting particle in brizzard was a function of distance from the surface of snow field.

BLIZZARDS WITH IRREGULAR ICE DROPS GENERATED BY PEELING OF THE HARDENED SURFACE OF SNOW FIELDS

An example of observation is shown in Fig. 6 and 7. Fig. 6 shows the asta obtained in daytime, fig. 7 is data after sundown. The wind velocities were 16 to 17 m/s at 10 m, and 5 to 6 m/s at 0.3 m above the surface of snow field. In the daytime the particle always aquired negative charge regardless of height from the surface of snow field. However, after sundown the direction of wind was suddenly changed from wind-

![Fig. 6. Charge densities on particle collected in blizzard without snowfall in daytime.](image)

ard to leeward and simultanelus-ly the charge was changed from negative to positive regardless of height from the surface of snow field.

In order to investigate the relation between the inversion of sign of charge and the change of direction of wind, we observed about the crystallographic characteristics of ice plate made of snow lumps collected from the various snow field at the windward areas and at the leeward area under polarimicroscope. The result is shown in Fig.8. It appears that the hardened
Fig. 7. Charge densities on particle collected in blizzard without snowfall after sundown.

Fig. 8. Crystal orientation of hardened snow field determined by pits. The upper photo. is surface of hardened snow field oriented nearly with prism plane, collected at windward. The lower photo. shows its surface with nearly basal plane, collected at leeward. Snow field surface with similar centered on a specific area. Crystallographic orientation was In order to determine
between the charge polarity on ice particle generated by peeling of the hardened snow field and the anisotropy of the peeled surface of snow field, the charge on ice particle peeled from the snow lump collected at the hardened snow fields by compressor was measured using Faraday Cage. The result is shown in Fig. 9. As the result, the ice particle peeled from the surface with an angle crystallographic orientation of $0^\circ$ to $30^\circ$ against the C-axis acquired positive charge, the particle with an angle of $60^\circ$ to $90^\circ$ against the C-axis acquired negative charge at ambient temperature below $-70^\circ$ C. At temperature above $-70^\circ$ C both groups of particle were always electrified positively.

Fig. 9. In room experiment, by compressor the charge on ice particle made by peeling of the hardened snow field against anisotropy of surface of snow field.

CONCLUDING REMARKS

The result may be summarized as follows:

i) In the case of blizzard with fresh snow the charging phenomena of fractured snow flak were dependent on the destruction effect of fresh snow crystal.

Whether the snow flake were generated by collision with each other or by friction of fresh snow crystal on the surface of snow field.

ii) In the case of blizzard without fresh snow at ambient temperature below $-70^\circ$ C the
charge polarity was dependent on the anisotropy of the hardened surface of snow field. At temperature above -7°C the fractured irregular shapeless flake was positively charged regardless of the anisotropy of surface of snow field.

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