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 brizzard 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 caes of the brizzard 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 measurments 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 1 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 aquired 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
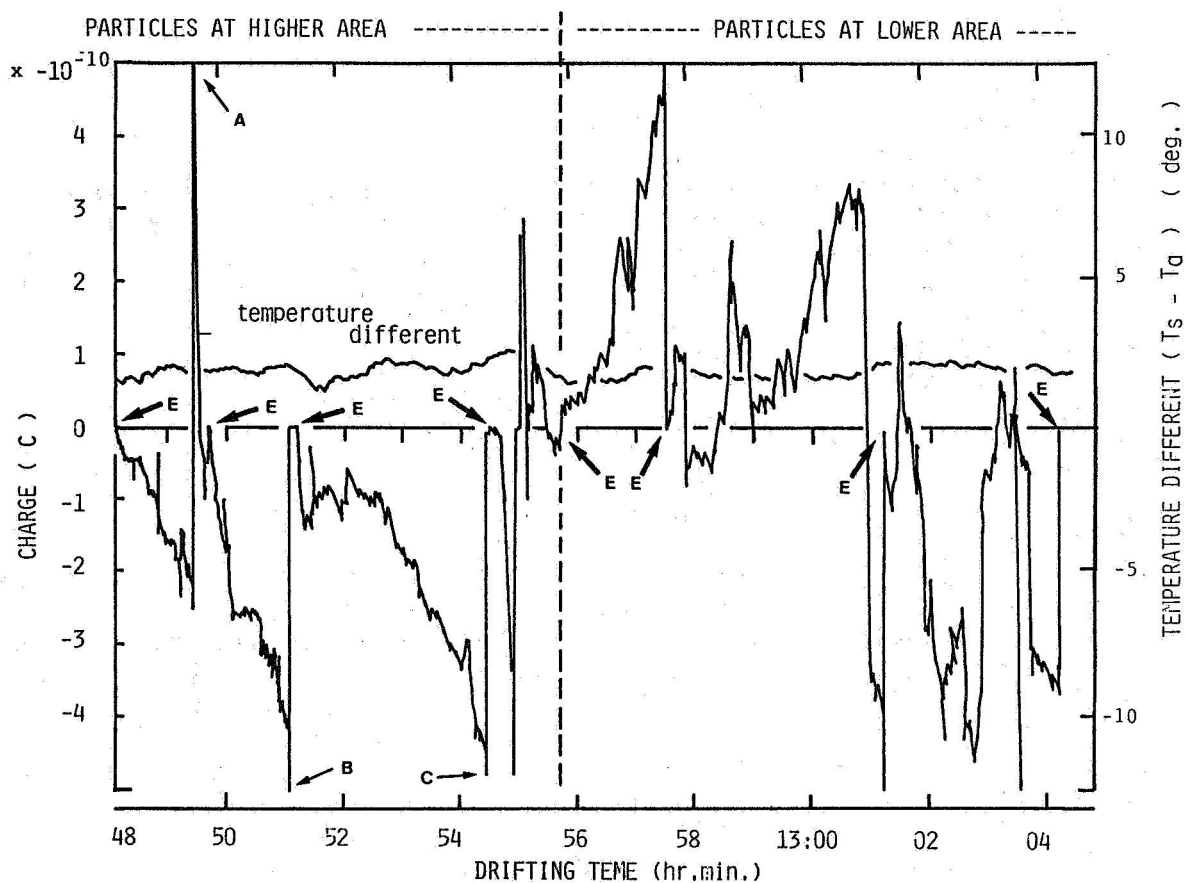
Fig.1. Charge against drifting time. Higher area:12h 48min to 12h 55min. Lower area:12h 55min 30sec to 13h 4min 10sec. Arrows A, B and C show the points where the stored charge is over the regions measured possibly using the electrometer, then, it was earthed as shown by arrow E.

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

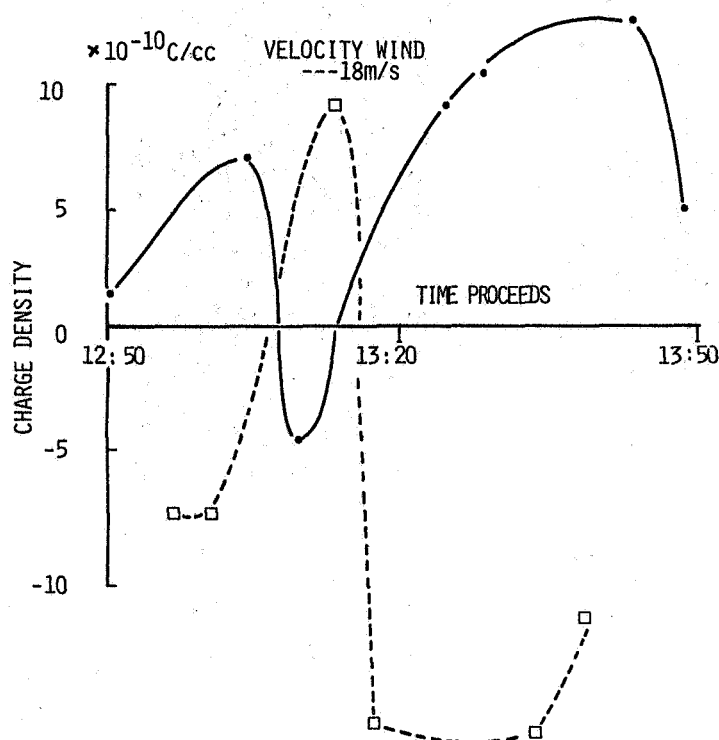drifting particles is below that of the snow field. On the basis of the temperature gradi-

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 regard-
ness of the height above snow
field. However fig. 3 does not
show its tendency. The wind ve-
locity 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 pre-
cipitated 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 inter-
val. It shows that the snow par-
ticles 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 fall-
ing in the parallel electric
field of D.C. and A.C. Fig. 5
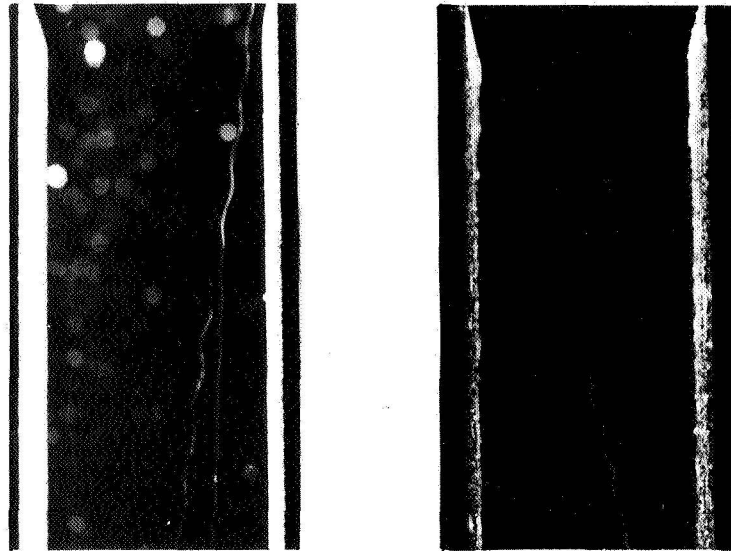shows that the charge on par-

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
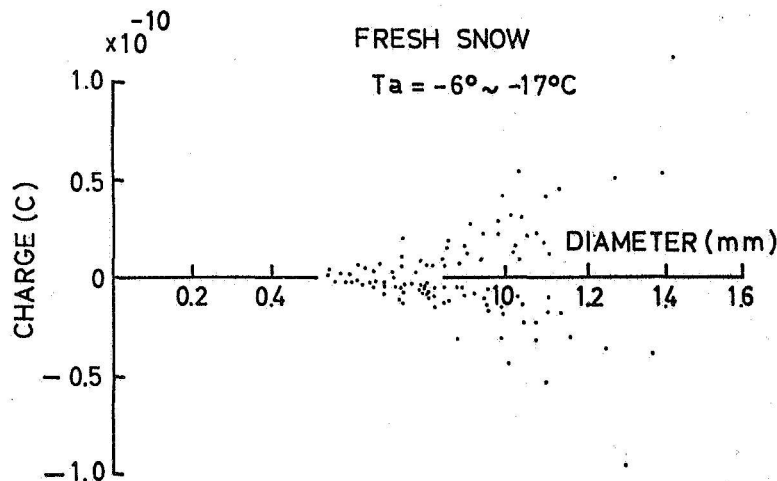blowing off the fresh snow with compressed air.

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

ticles against their diameters distributed uniformely with in the range smaller than $\pm 10^{-10}$ C. The size of the particle which was fixed on slide glass by the replica method are shown by green diameter. The charge on the the particle was uniformly distributed in the positive and negative range.

Latham [4] reported the charge per one crystal was $- 4 \times 10^{-14}$ C , which is close to the value of the maximun 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

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 obseration is shown in Fig. 6 and 7. Fig. 6 shows the asta obtained in daytime, fig. 7 is data after sundown. The wind veloci- ties 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-
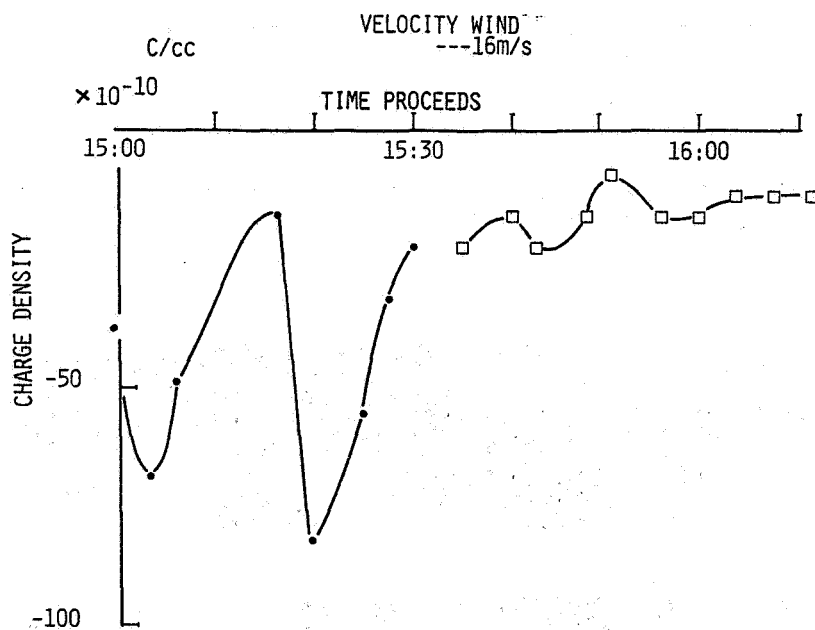

Fig. 6. Charge densities on particle collected in blizzard without snowfall in daytime.

ard to leeward and simultanelusly 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
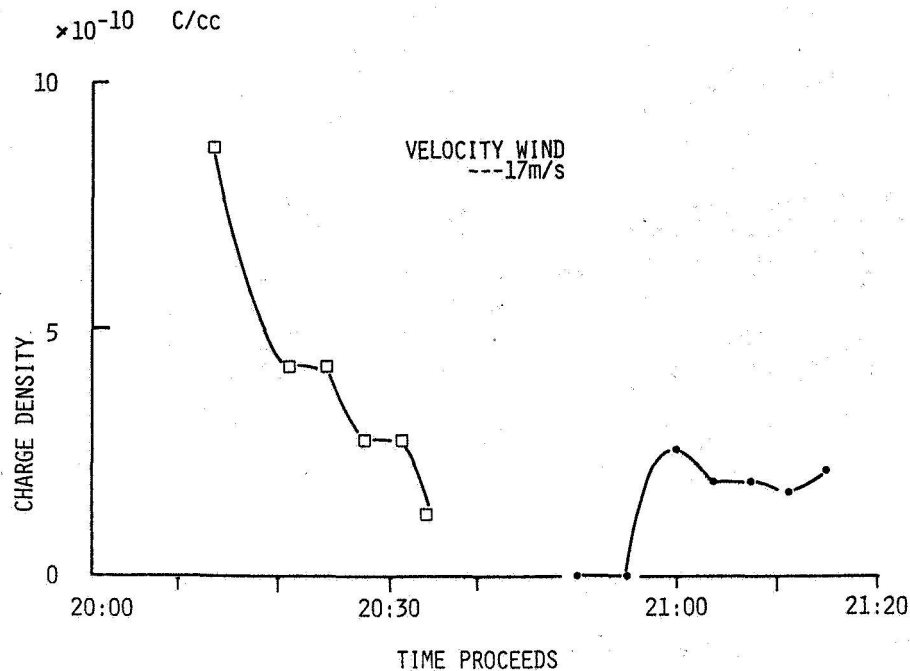
Fig. 7. Charge densities on particle collected in blizzard without snowfall after sundown.
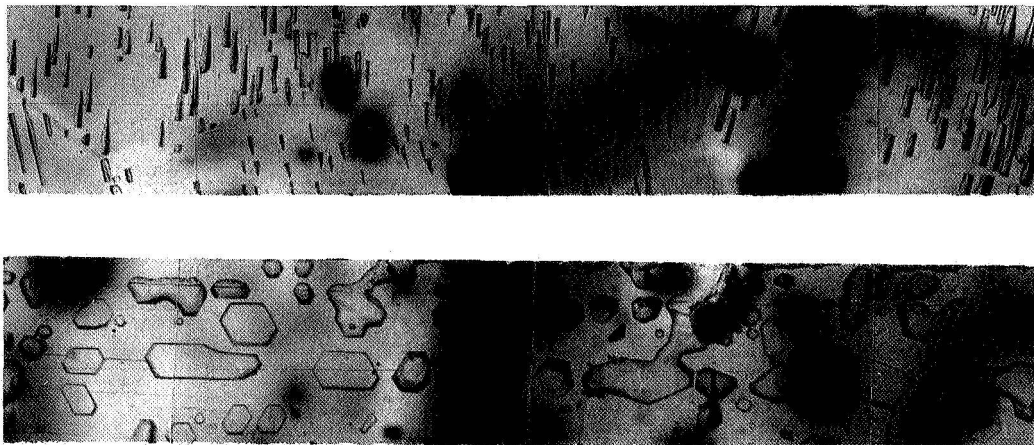
Fig. 8. Crystal orientation of hardened snow field determined by pits. The upper photo. is surface of hardened snow field oriented nearly with prism plane, collected at windward. The lower photo. shows its surface with nearly basal plane, collected at leeward.

snow field surface with similar crystallographic orientaion was

centered on a specific area. 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 fiels by compresser 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 orintation of 0° to 30° against the C-axis acquired positive charge, the particle with an angle of 60° to 90° against the C-axis acquired negative charge at ambient temperature below -7° C. At temperature above -7^OC both groups of particle were always electrified positively.
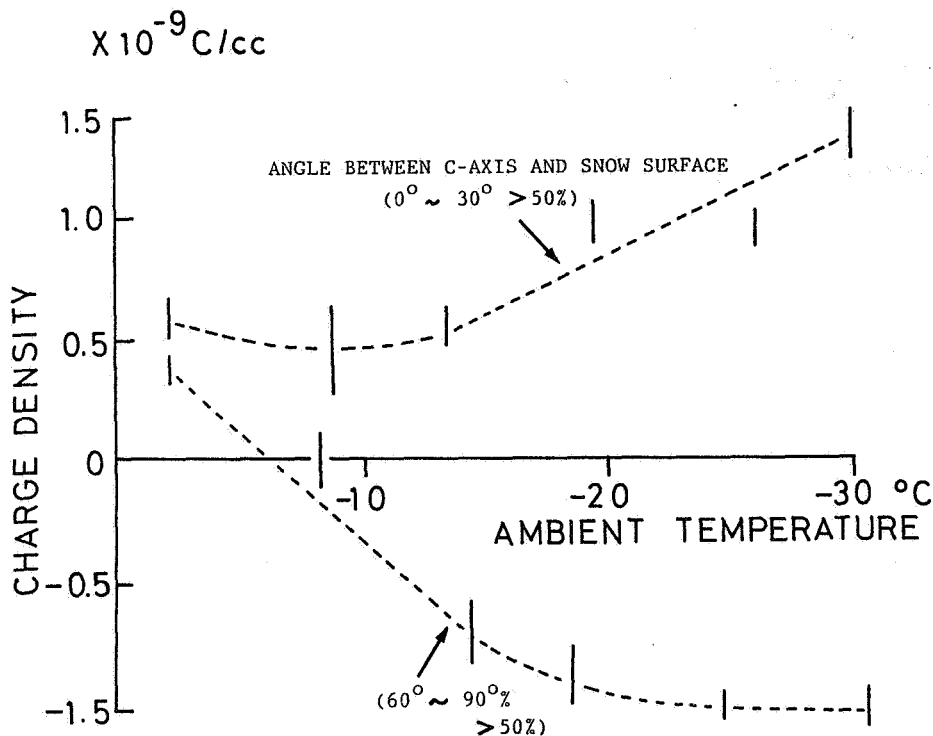

Fig. 9. In room experiment, by compresser the charge on ice particle made by peeling of the hardened snow field against anisotropy of surface of snow field.

CONCLUDING REMARKS

The result may be summarized as follows:
i) In the case of blizzard with fresh snow the charging phenomena of fractrued 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 -7^OC 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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