

On the Growth of Ice Crystals in the Air

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Ice Crystals in the Air are grouped into three fundamental forms, as follows.

- a) hexagonal twin-prism,
- b) hexagonal prism,
- c) hexagonal plate.

Each crystal grows into a skeleton-shaped form, and the hexagonal plate especially shows a beautiful variety observed under the optical microscope. Some examples of these crystals are shown in Figs. 1 and 2.

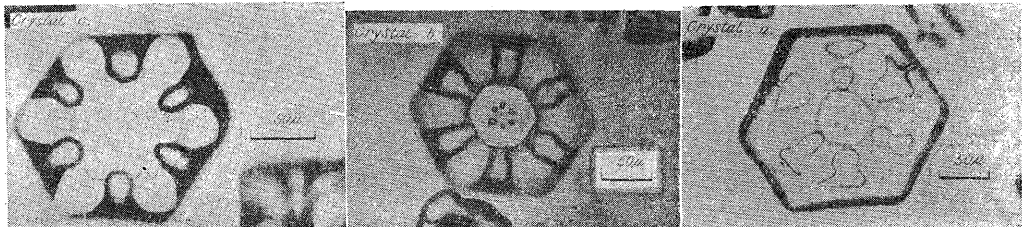


Fig. 1 Hexagonal plate type Ice Crystals in the Air

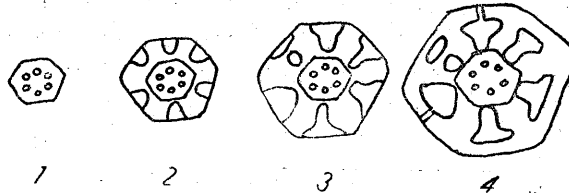


Fig. 2 The growth of
Crystal a.

1. Incipient stage,
2. 2nd stage,
3. 3rd stage,
4. 4th stage.

Crystal a :

Six small bubbles (diameter about 5.5μ) are enclosed in the central part of the crystal in symmetric position. The writer considers the central part which can be definitely distinguished from the surrounding region to be the incipient stage of the Ice Crystals in the Air. From this stage the crystal can grow up step by step as shown in the following various examples.

Table 1

Stage	Diameter	Thickness	Volume(ca.)
incipient	58μ	58μ	$1.0 \times 10^{-7} \text{ cm}^3$
2nd	140μ	40μ	$3.4 \times 10^{-6} \text{ cm}^3$
3rd	180μ	20μ	$2.8 \times 10^{-6} \text{ cm}^3$
4th	220μ	20μ	$4.1 \times 10^{-6} \text{ cm}^3$

In Table 1, the diameter, the thickness and the size at each stage of growth are shown. From this table, it can be understood that the thickness and the vol-

umes of each stage can be correlated. It is to be noted that the mutual relations between the skeletal growth of the crystal and the surface energy of the minute ice and the content of water vapour in the atmosphere are of great importance.

There are two fine tubes which connect the large bubbles and the outer free air (The tube diameter is about 6μ). It is probable that the fine tubes are formed in order to keep a balance of air pressure between the interior and the exterior of the crystal. This pressure difference must occur during the winter in the lower layer of the atmosphere, for there are frequent inversions of air temperature from about 200 m to 600 m in height.

Crystal b :

The incipient stage of this crystal also consists of hexagonal plates of ice and contains six bubbles in symmetric position. The magnitude of diameter and the thickness at each of the stages are shown in the following table.

Table 2

Stage	Diameter	Thickness
incipient	60μ	60μ
2nd	110μ	25μ
3rd	170μ	30μ




Crystal c :

It seems that in the incipient stage this crystal is very small but a perfect one. And both the second and third stages are distinctly skeleton-shaped crystals.

The Incipient Crystal

It has been reported that the incipient stage of snow crystals is usually a perfect one with a diameter of about 10μ . As mentioned above the incipient stage of the Ice Crystals in the Air also consists of a perfect or nearly perfect hexagonal crystal. And the crystal forms in the incipient stage are arranged in three groups as indicated in the following table.

Table 3

Class	Variety	Diameter	Perfectness
1) hexagonal skeleton shaped twin-prism		$60\sim 70\mu$	nearly perfect
2) hexagonal thick plate		$60\sim 70\mu$	nearly perfect
3) hexagonal plate		$100\sim 110\mu$	perfect

It is to be noted that the size of the incipient stage of the Ice Crystals in the Air is far larger than that of the snow-crystal. The writer can offer no satisfactory explanation for this difference of size. But since the lower atmosphere where the Ice Crystals in the Air are observed is in a very stable and cold condition, it is quite conceivable that they are greater than snow-crystals in the incipient stage.

The Ice Crystals in the Air are grouped roughly into three types as indicated above. The crystals which belong to b) and c) are in 2~4 stages. But it seems that the hexagonal twin-prism type crystals are almost exclusively incipient ones. This leads to the consideration that the Ice Crystals in the Air belonging to the hexagonal twin-prism type group are formed in the lower layer of the atmosphere, and the other types of crystals are formed in a layer higher than that. Since the air temperature in cold winter is usually in the condition of inversion, the hexagonal twin-prism type crystal is a natural consequence.