

A contribution to the detection of the aerosols containing sulphate particles

By F. ANÝŽ, *Czechoslovak Academy of Sciences, Institute of the Physics of the Atmosphere, Prague 4, Boční II, Czechoslovakia*

(Manuscript received August 28, 1965)

ABSTRACT

The aim of the paper is to refer to the influence of water vapour after the sampling at the detection of sulphate particles. Gelatine layers with barium chloride, cellophane and collodion layers were tested. Gelatine layers were prepared by using the diffusion method. After cooling to -80° and heating to $+180^{\circ}$ they did not lose the capacity to enter into reaction with sulphate particles. The exposure of the layers to the influence of the air saturated with water vapour is recommended.

In recent years the boundary for taking samples for chemical analysis moved high above the tropopause (cf. References). Sampling of atmospheric aerosols always appeared to be a supplement to the main program of rocket sounding and in the case of an unsuccessful analysis it is not possible to undertake the expensive measurement again. For that reason we consider it expedient to pay due attention to basic methods of taking and processing of aerosol samples.

1. Diffusion method of the preparation of layers

We carried out experiments by using Liesegang layers with the aim to detect individual sulphate particles. The layers prepared in the usual way by coating the slides with gelatine solution, to which barium chloride was added, contain even before the fall of sulphate particles certain unhomogenities in the form of bubbles or irregular particles. This background interferes in evaluating the samples. We tried the diffusion saturation of the layer with barium chloride. Dry gelatine layer smeared on a glass slide was dipped in a 10 % solution of BaCl_2 for one hour. It was dried after a short washing off, which prevents the building of irregular precipitates on the surface of the layer. We filtered the solutions immediately before use and the gelatine layer was prepared of photo-

graphic plates. The plates were fixed in 20 % solution of sodium thiosulphate and washed 10 times at least in distilled water in order to remove the salt residues. We compared the number of imperfections on the area of a picture before the preparation of the layer and afterwards. The average values obtained of 10 measurements of materials type A, B, C have been published in Table 1. The material B proved to be best. For comparison, also the number of imperfections in a layer prepared in a normal way, has been given.

TABLE 1

| Layer | Number of microscopic particles before soaking in the solution of BaCl_2 . Area 0.137 mm^2 | Number of microscopic particles after soaking in the solution of BaCl_2 . Area 0.137 mm^2 |
|--|---|--|
| A. Agfa Mikro-Platten | 18 | 21 |
| B. Orwo Diapositiv-Platte DU 2 | 14 | 15 |
| C. Agfa Lippmann-Platten | 11 | 19 |
| Normal layer prepared by coating with gelatine solution containing BaCl_2 | — | 51 |

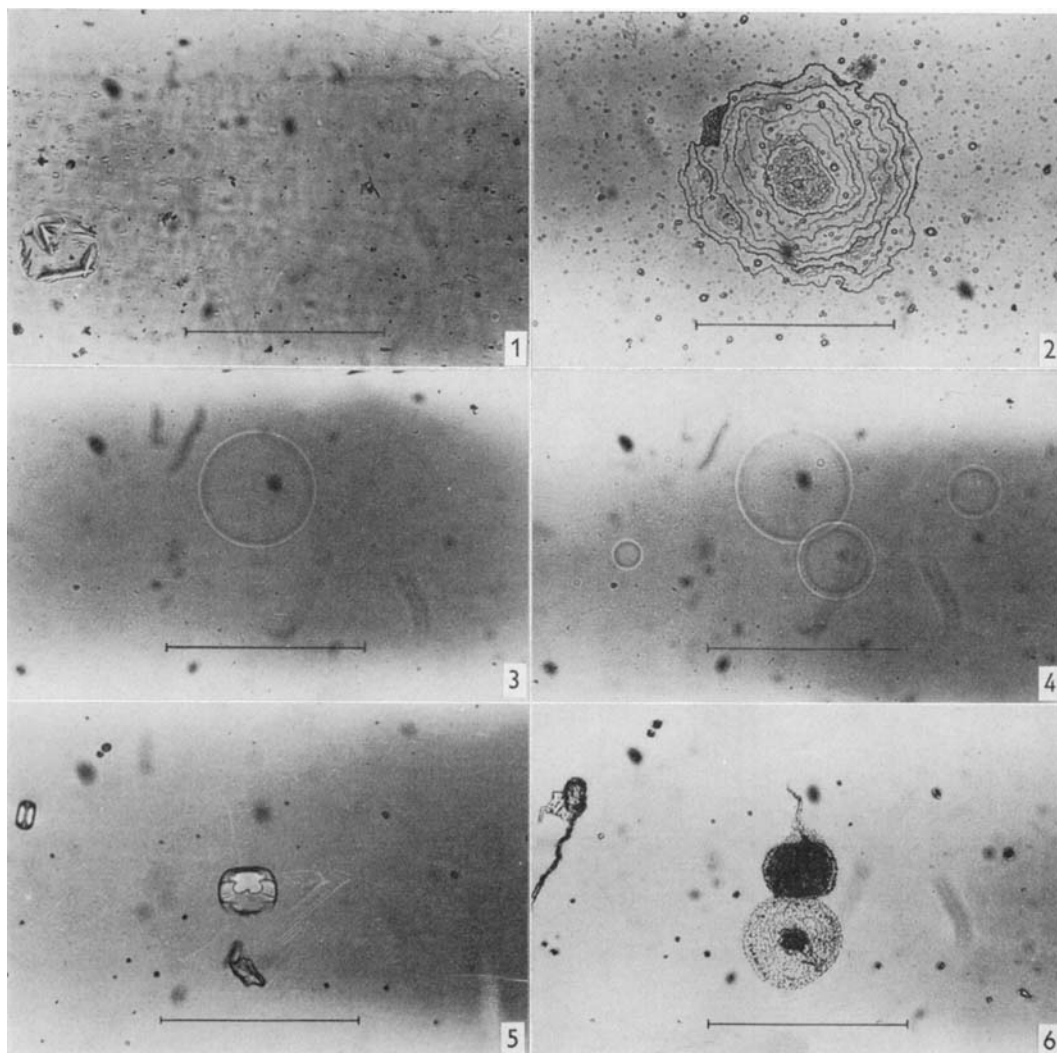


FIG. 1. Traces of potassium sulphate particles on cellophane soaked with BaCl_2 .

FIG. 2. Trace of a potassium sulphate particle on a collodion film.

FIG. 3. Trace of a water droplet on a gelatine layer.

FIG. 4. Droplet traces of 10% sulphuric acid on a gelatine layer.

FIG. 5. Aerosol of potassium sulphate on a gelatine layer.

FIG. 6. Influence of 1000 min. exposure in the air saturated with water vapour. The same area as in Fig. 5.

2. Cellophane layers

Cellophane was prepared by submerging it in a 10% solution of BaCl_2 for 16 hours. After this washing it was lightly turbid with a whitish colouring. We were not successful in removing this effect even by preceding repeated washing

the cellophane in distilled water for 24 hours. The traces are very slight, even the structure of the cellophane proved to be disturbing. For this reason these experiments were not continued (Fig. 1). The segment on the pictures indicates the length of 100μ .

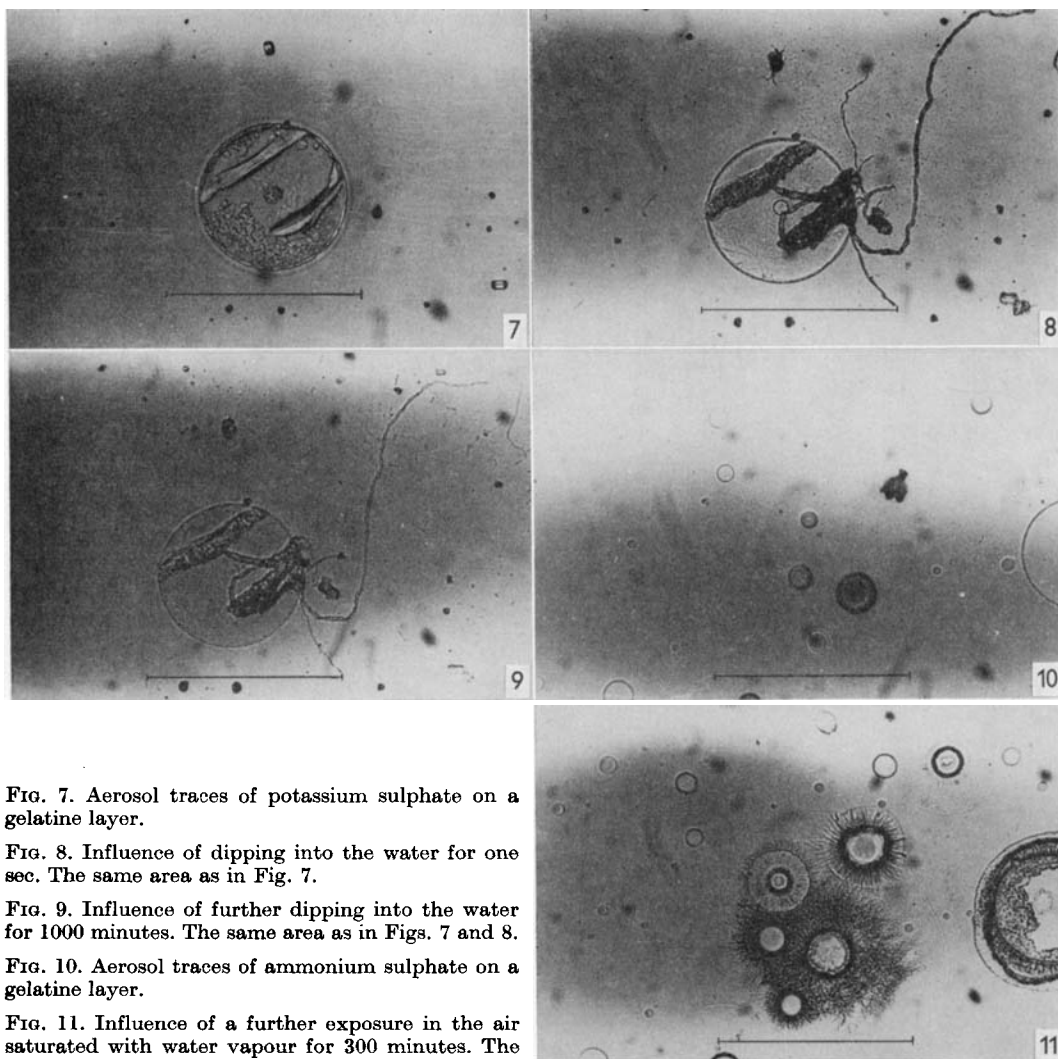


FIG. 7. Aerosol traces of potassium sulphate on a gelatine layer.

FIG. 8. Influence of dipping into the water for one sec. The same area as in Fig. 7.

FIG. 9. Influence of further dipping into the water for 1000 minutes. The same area as in Figs. 7 and 8.

FIG. 10. Aerosol traces of ammonium sulphate on a gelatine layer.

FIG. 11. Influence of a further exposure in the air saturated with water vapour for 300 minutes. The same area as in Fig. 10.

3. Collodion layers

By spreading several droplets of 2 % solution of collodion in butylacetate a thin film on the surface of water was prepared. Experiments with the preparation of this film by soaking it into the solution of BaCl_2 , showed that the layer does not enter into reaction with sulphate particles. Therefore, the following processing method was suggested: The film removed from the water was exposed to the action of the spray of 10 % potassium sulphate droplets and then it was carefully carried over on the surface of 10 % BaCl_2 . In this case the reaction can be

realized only after the penetration of the solution through the collodion film to the sulphate particle. This diffusion advances very slowly. In Fig. 2 we see the trace of the particles of potassium sulphate, induced after a 48-hour action. The procedure is slow and, besides, in the course of the treatment many films are being destroyed. In most cases the film will be damaged while spreading it on the surface of the reagent solution and while repeatedly carrying it over into the bath of distilled water. For the time being, it is not possible to consider applying this method for usual cases, even if

the traces are very clear and the individual Liesegang rings separated and characteristically frilled.

4. Gelatine layers with barium chloride in reaction with aerosols of various sulphate salts

For the investigation of the high atmosphere it is not possible, for the time being, to devise other layers. Therefore we were occupied with a thorough study of gelatine layers. Besides the experiments having the aim to lower the background by a diffusion preparation of the layers, attention was paid to the reaction with various sulphate compounds. The introductory experiments were made with a spray of distilled water. As we see from Fig. 3, the traces of water droplets are not clear and barely perceptible. They cannot disturb the estimation, nor can they be taken for particles SO_4^{--} . The traces after droplets of 10 % sulphuric acid are clearer to some extent (see Fig. 4), but still they do not remind us of typical sulphate traces. Their character is different and they have no nucleus. The last figure illustrates not only the trace of sulphuric acid droplets, but also the original trace of a water droplet shown separately in Fig. 3. The traces of droplets of 10 % solution of potassium sulphate are to be seen in Fig. 5. The preparation was then for 1000 minutes exposed to the influence of the air saturated with water vapour. After this treatment further traces appeared (see Fig. 6). This gelatine layer was, prior to taking samples, exposed for two hours to the influence of the temperature $+180^\circ\text{C}$; however, it did not lose the capacity to enter into reaction with particles SO_4^{--} . Similarly, a 20-hour exposure of the layer at -80°C did not disturb the following reaction with sulphates. Fig. 7 illustrates this layer with created traces of particles of 10 % solution of potassium sulphate. The exposure

in the atmosphere saturated with water vapours changed the appearance of the traces only very slightly. The soaking under the surface of the water for one second caused the appearance of filaments, which can be seen in Fig. 8. Clearly it is a product of a chemical reaction: the traces are resistant, even after a 1000 minutes soaking in distilled water (see Fig. 9). Apparently, owing to this prolonged soaking the gelatine layer begins to be separated from the substrate.

Similar experiments were made with ammonium sulphate. In Fig. 10 we can see the traces of the aerosol of 10 % ammonium sulphate. After 300 minutes of exposure in the medium saturated with water vapour the same traces changed markedly (see Fig. 11).

Conclusion

1. By using the diffusion method it is possible to prepare layers having standard qualities and small quantities of ingredients.
2. Cellophane soaked with barium chloride shows very faint traces of sulphate particles, which are practically of no use.
3. In a thin collodion film very marked Liesegang rings with an irregular contour can be produced. It is very difficult to apply this method experimentally and, therefore, it is not applicable for standard measurements.
4. Gelatine layers enter into reaction with sulphate particles even after preliminary exposure to the temperature of -80°C and $+180^\circ\text{C}$, *i.e.* at boundary temperatures of the studied regions of the high atmosphere.
5. For the sake of the lowering of the background and of the better development of Liesegang rings we recommend to expose the layers, after having taken the samples, to the influence of the air saturated with water vapour. In this way the background of the not reacting salt particles will be suppressed and the characteristic reaction will be realized more markedly.

REFERENCES

- HEMENWAY, C. L., SOBERMAN, R. K., and WITT, G., 1964, Sampling of noctilucent cloud particles, *Tellus*, **16**, pp. 84-88.
- JUNGE, CH. E., CHAGNON, C. E., and MANSON, J. E., 1961, Stratospheric aerosols, *J. of Meteorology*, **18**, pp. 81-108.
- WITT, G., HEMENWAY, C. L., and SOBERMAN, R. K., 1964, Collection and analysis of particles from the mesopause, Space research IV. Proceedings of the Fourth International Space Science Symposium, Warsaw, June 3-12, 1963.

К ВОПРОСУ ОБ ОБНАРУЖЕНИИ АЭРОЗОЛЕЙ, СОДЕРЖАЩИХ ЧАСТИЦЫ
СУЛЬФАТА

Цель статьи — выяснить влияние водяного пара на пробы для обнаружения частиц сульфата. Были испытаны пленки желатина с хлоридом бария, целлофановые и коллодиевые пленки. Желатиновые пленки были приготовлены с помощью метода диффузии.

После охлаждения до -80° и нагревания до $+180^{\circ}$ они не теряют способности вступать в реакцию с частицами сульфата. Пленки рекомендуется подвергать влиянию воздуха, насыщенного водяным паром.