

GEOCHEMICAL RESEARCH IN THE ANTARCTIC, PAST AND FUTURE

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Abstract: Since the IGY, geochemical investigations around Syowa Station and in the McMurdo Sound area have been conducted by Japanese geochemists in the fields of limnology, mineralogy, atmospheric chemistry and environmental science. The investigations have essentially aimed at clarifying the chemical characteristics of saline lakes, and at knowing the distribution and sources of evaporites around the lakes.

This paper briefly reports the results of the investigations up to the present, and also proposes some future programs for the next 5 years.

1. Geochemical Researches since the IGY

Since the beginning of the Japanese Antarctic Research Expedition, many geochemists in this country have taken interest in the geochemical researches in an uncontaminated region where human beings have not stepped in, and they organized a Committee for Antarctic Geochemical Research. The committee was headed by Dr. Y. MIYAKE, and the members have been carrying out projects both at Syowa Station and in the McMurdo Sound area.

At an earlier stage, the chemical properties of snow and ice, puddle and lake waters, minerals, evaporites and marine sediments were investigated. Those samples were collected aboard the observation ship SÔYA during her cruise and around Syowa Station. Twenty-three papers altogether were presented at the first geochemical symposium held in 1963 under the auspices of the Science Council of Japan (1963). The symposium stimulated many young researchers to study further the geochemistry in the Antarctic.

Moreover, oceanographic observations during the cruise to and from the Antarctic have been conducted on board on a routine basis every year since the first expedition up to present, and the results in chemical oceanography have contributed considerably to clarify the mechanism of water mass movement and the distribution of nutrient matters in the Antarctic Ocean.

In 1973, a project of environmental science was started in concert with biological and medical sections, and the environmental monitoring for pollutants such as carbon dioxide, nitrogen oxides and heavy metals around the station has been carried out by a wintering geochemist between 1971 and 1975. The results were presented

at the Symposium on Geochemistry in the Antarctic Research (1976) and the First Symposium on the Antarctic Environmental Science (1977) which were held in 1976 under the auspices of the National Institute of Polar Research.

The extensive limnological studies around Syowa Station began in the 1966–67 summer season when the first helicopter support was applied to the field survey, which led to the discoveries of saline ponds and lakes in the Skarvsnes and Langhovde areas of Syowa oasis. Since that time the origin and evolution of saline waters in the coastal area have become attractive subjects for study by the groups from many universities. They studied chemical components and stable isotopes in lake waters and the surrounding samples, together with the geomorphological evidence.

On the other hand, a group of Japanese geochemists began limnological and mineralogical research works in the Dry Valleys area of South Victoria Land, with the support from the National Science Foundation, USA and Antarctic Division, New Zealand since the 1963–64 summer season. And we concentrated our efforts on clarifying the chemical characteristics of saline lakes and also on knowing the distribution and sources of evaporites around the lakes. This activity led to the discovery of a new mineral, antarcticite.

In the course of examination of the results of the 1965–66 summer season, N. YAMAGATA and the author got an idea that further advances in the Dry Valleys study would necessarily require a study of the unconsolidated materials at lake sites by means of direct shallow drilling. We became convinced that this was the only way to reveal and reconstruct the early history and mechanism of the formation of these lakes and salt deposits. Finally this idea developed into an international program called the Dry Valley Drilling Project (DVDP) during the 1971–76 summer season.

Initially, the plan was to explore the physical, chemical and biological features of the subsurface materials in the arid and enigmatic ice-free valleys which have been studied continuously since the IGY. As it has evolved, the project has been expanded to explore the valleys, the Ross Island volcanics, and the McMurdo Sound marine sediments. This tripartite project was organized by the scientists from the United States, New Zealand and Japan, and the final DVDP seminar was held in Tokyo in June 1978. The history of Japanese geochemical activities until now was summarized in *Chikyu Kagaku (Geochemistry)* by WATANUKI (1975).

2. Future Program

Great advances have been made in earth sciences including geochemistry during the last two decades. From a viewpoint of geochemistry in Antarctica is important, because of its remoteness from many sources of contamination. Nevertheless, many fundamental questions in this field remain still unsolved.

In these days, all the earth scientists are aware of the indispensability of applying chemical techniques to the study of geology, glaciology, meteorology and also

geophysics, *e. g.*, the age determination of ice and rock, measurement of snow accumulation, and paleoclimatology by using stable isotope ratio, etc.

At this stage, the author calls for special attention to the following future program in resuming the research works so far conducted.

2.1. *Detailed studies on the distribution of chemical species to obtain the background information of the globe*

The UNEP (United Nations Environmental Programmes) and SCOPE (Special Committee on Problems of the Environment/ICSU) are undertaking a project of monitoring the globe in order to detect any influences of human activities. The baseline determinations in the polar regions can never be excluded for the completeness of this project. More detailed survey on the distribution of chemical species studied so far should be made around Syowa Station.

2.2. *Carbon dioxide observation*

Observations of carbon dioxide in the atmosphere at Amundsen-Scott South Pole Station, Mauna Loa in Hawaii and in the upper troposphere of the Northern Hemisphere have been made for almost 20 years, but there are few analyses of it in high latitudes.

We have given special attention to the general problem of the world budget of CO₂, and studies on gas composition in Antarctic ice (MATSUO and MIYAKE, 1966), CO₂ in the surface water and the atmosphere (MIYAKE and SUGIMURA, 1969), and continuous observation of CO₂ in the atmosphere at Syowa Station (MURAYAMA, 1977) have been conducted. Our knowledge of the dynamics of CO₂ in the atmosphere and ocean is still limited, and further studies should be made on atmosphere-sea interaction phenomena and also a routine observation of CO₂ in the atmosphere at Syowa Station in the future.

2.3. *Comparative geochemical studies of oases*

Japanese geochemists have studied comprehensively Antarctic saline waters in Syowa and McMurdo oases. With the results obtained during these 15 years, we still hope to survey other ice-free areas, especially around Ablation Point in Alexander Island near the Antarctic Peninsula. Further, the comparison between the Arctic and Antarctic is desired, *e. g.*, the surveillance of Peary Land in Greenland.

These studies will help to gain knowledge of the formative processes of saline waters under frigid conditions and will provide a clue to the early history, especially the Quaternary, through the mechanisms of precipitation, for example.

2.4. *Joint programs with other fields*

The following studies are considered to get fruitful results in concert with other neighboring fields of earth sciences.

- 1) Chemistry of volcanic activities in West Antarctica.
- 2) Shallow drilling in the Transantarctic Mountains.
- 3) Comprehensive studies on the marine sediments in Lützow-Holm Bay.

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