INTERVIEW OF KAZUO SAITO
(International Christian University)

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Kazuo Saito was born in Tokyo, Japan, on July 26th 1923. He was educated at the University of Tokyo, where he received the degree of bachelor (1945) and doctor (1952). After spending two years at University College, London on a Ramsay Memorial Fellowship, he returned to Japan where he joined the Institute for Nuclear Studies in 1956 and became Professor of Coordination Chemistry in Tohoku University, Sendai in 1963. He was engaged in the establishment of the Coordination Chemistry Laboratories at the Inter-university Institute for Molecular Science in Okazaki, and took charge of the laboratories from 1984 to 1987. He then joined the International Christian University as Graduate School Professor.

His work is mostly related to the stereochemistry and reaction kinetics of coordination compounds, and the results have been presented in many monograph reviews and also as invited lectures at international meetings. He has served many years in IUPAC and has contributed to the improvement of mutual understanding among chemists.

A.N. You were born in 1923 in Tokyo, and spent your school days there. How did you get interested in chemistry?

I was born in July, one month earlier than expected, and my family was anxious about the premature birth. The hospital in which I was born, however, was destroyed by an earthquake and burnt on September 1st. Nobody survived. Had I been born as expected, I would not have existed. A Chinese proverb says Happiness and unhappiness are like entangled strings. I do believe that this is very true.

From my youth I was interested in nature. Few members of my family were interested in natural science or technology. My primary school master showed us many interesting experiments. The teacher in charge of my class in the middle school was a biologist, and taught us to "Study nature, not books". He showed us how to collect micro-organisms at a moat near the school and to observe them under a microscope. We learned how to study nature before learning the structure of nature systematically.

However, my interest shifted gradually to chemistry. The change of one material into another seemed mysterious to me, and I made up my mind to choose a "science

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course" in high school. The educational system was different before the war. High schools were very privileged and the curriculum was similar to that of a Liberal Arts College. There were many lectures on classics and foreign languages. We enjoyed school life and our field of vision became very wide.

A.N. Your university days were during the Second World War. Did this have a big influence on you?

Yes, very much. Our high school session was shortened by six months. In the university laboratories, imported chemicals such as potassium salts were not available, and there were not many research associates and post-graduate students in the Department. Particularly in 1945, Tokyo was bombed several times. The third year course students joined research groups under the supervision of professors to do project work for their bachelor's thesis, but we had to work hard to help the evacuation of laboratories to the countryside.

A.N. You joined the Inorganic Chemistry Laboratory supervised by Prof. Kenjiro Kimura. What was the research?

I was interested in the diversity of inorganic compounds. The Inorganic Chemistry Laboratory at the University of Tokyo was long chaired by Prof. Yuji Shibata, who had worked with Prof. A. Werner in ETH. After he moved to Nagoya University to open the new Faculty of Science in 1941, the Chair passed to Prof. Kimura. He had worked with Prof. Hevesy in Copenhagen, and was collaborating with Dr. Yoshio Nishina, Institute of Physical and Chemical Research (Riken) to detect radioisotopes formed by nuclear reactions, including fission of uranium. However, when I joined the group, a search of natural resources, particularly for the rarer elements was undertaken. The first work I participated in was to find germanium in the flue dust of metal refineries. (The use of germanium for transistors was unknown in 1945 in Japan.)

A.N. Did you continue such studies after the war?

Not really. University laboratories returned to Tokyo after the war, but there were few places in industry where a pure chemist could work. I remained in the Department of Chemistry as a Research Associate until 1953. Professor Kimura helped the juniors to get ahead and gave us the opportunity to do whatever research we wanted. However, the infrastructure and the research funding were very poor. Towards the 1950s, the research circumstances became slightly better, but far from satisfactory for pursuing original studies in the forefront of chemistry. Most inorganic chemistry laboratories in Japan were in a classic state except for some, such as Prof. Tsuchida's in Osaka University. The future of inorganic chemistry itself did not look

prosperous. We later found that the "renaissance of inorganic chemistry" had already begun in the USA and Europe.

A.N. Then you went to London in 1953. How were you planning to study coordination chemistry in those days?

In our school days, coordination chemistry lectures were given by Prof. Satoshi Inoue, a part-time lecturer from Gakushuin High School, who had studied in Bonn under Prof. Pfeiffer. His lectures were very stimulating, but sometimes given during air-raid alarms.

The Peace Treaty was signed in 1952 and some exchange systems which had been suspended during the war were restored. The Ramsay Memorial Fellowship was one of them. The Japanese Government joined the Trust initially as a sustaining member in 1919. In 1953, applications were accepted and I was very fortunate to get a chance to go to UK. (The fellowship is still active and ca. 30 young chemists have spent two years' post-doctoral fellowship in UK.) The Trust sent me to University College London (UCL). This opportunity had an immeasurable influence upon me.

A.N. You spent two years from 1953 to 1955 there. I understand Prof. C.K. Ingold was in charge of the Chemistry Department. How was Prof. Nyholm?

Professor Ingold was a very active leader. The leader of the inorganic chemistry group was Prof. Henry Terrey. He was a good old man, and very good at descriptive inorganic chemistry. I learned from him that an inorganic chemist should have sufficient knowledge about all kinds of inorganic compounds. He suggested that I should work on the EDTA complexes of gallium, indium and thallium, and he opened my eyes on the coordination chemistry of main group elements. He died in 1954, and Prof. Ronald Nyholm came back from the University of New South Wales to take the chair in 1955. So I spent only a short period with Terrey.

A.N. UCL was one of the most active research centres in those days. How impressive was the activity?

I was fortunate to experience the renaissance of inorganic chemistry in Europe. Distinguished visitors gave many stimulating lectures in UCL, e.g. Dr. Orgel's ligand field theory, Prof. Bijhout's absolute configuration of tartaric acid, Dr. Pauson's ferrocene and Dr. Martin's gas chromatography. There were symposia on modern topics, e.g. the Swain–Scott equation on nucleophilic substitution, and bioinorganic chemistry organized by young Dr. Bob Williams.

The most impressive one was the first Symposium on the Reaction Mechanisms of Inorganic Compounds organized by Prof. Ingold and Dr. Joe Chatt in January 1954 in the Chemical Society. The discussion was on a topic which I had never

thought of or even heard of in Japan. I found that the mechanistic studies of organic acid–base reactions performed in UCL were closely related to those of ligand substitution reactions of coordination compounds. This profoundly influenced my research thereafter.

A.N. When you came back to Japan, you joined the Institute for Nuclear Studies (INS) affiliated with the University of Tokyo. What kind of work were you expecting?

In 1954, the Japanese Government started new plans for improving research circumstances, including the establishment of Inter-university Research Institutes with excellent research facilities. Academic staff of all universities were entitled to use these facilities. INS was one of the first. It was affiliated with the University of Tokyo, but was rather independent of the senate. Committees consisting of representatives from many universities were responsible for the administration.

Prof. Kimura suggested that I should join this institute as Associate Professor. With little experience in nuclear studies, I was rather reluctant, but the Director General, Prof. Kikuchi, clearly said that INS needed a pure chemist who was good at chemistry. I was expected to help physicists and also to carry out good original research in the field I chose. However, all of the academic staff of INS had a moral obligation to leave the institute after eight years.

His guiding words deeply touched my heart, and I made up my mind to join INS in April 1956. I had been really disgusted at the poor research facilities in Japanese universities, and was pleased to work in a rich institute, although its aims were slightly outside of my current field of interest.

A.N. What was the nature of your work there?

The institute had just been born. I had to do everything from scratch, including construction of the building. One of my duties was the separation of radioisotopes produced at INS. Another task was related to the observation of "air showers" of cosmic rays, e.g. preparation of scintillators. I carried out such work by myself with young chemists coming to INS to learn the technique.

INS was a good place for using short-lived and neutron deficient radioisotopes, and I performed kinetic studies of isotopic exchange of coordination compounds with labelled central metal ions. Isotopic exchange kinetics is a good measure for elucidating the lability of a chemical species, but the experiment is very laborious. The apparatus for measuring radioactivity was excellent there. Later (in Sendai) I exploited the measuring technique of low-energy radiation and studied the exchange kinetics of various metal ions with acetylacetonate[^{14}C] as a common ligand. I found many interesting results as to the lability and reaction mechanism of metal complexes.

A.N. Then you moved to Sendai. How were the days at INS for you, generally speaking?

The time limit of service in INS came soon. Fortunately, the Government started to expand national universities in the 1960s, and new chairs were founded. I got some offers, and accepted an invitation from Tohoku University in Sendai to take a new chair of coordination chemistry, the first coordination chemistry chair in Japan.

It may seem to be a detour to have worked at INS, but I do not think so. First of all, I worked amidst physicists and realized the identity of chemistry, particularly of inorganic chemistry. Chemical approach to nuclear phenomena seemed to play only a subordinate role. Secondly, I felt strongly the necessity for inter-university cooperation. I was confident that inorganic chemistry should have an inter-university research institute; with this motivation, I later put a great effort towards the establishment of an inter-university organization in coordination chemistry.

A.N. How did you organize your laboratory in Sendai?

I invited excellent collaborators. Dr. Jun Fujita came from Prof. Tsuchida's laboratory in Osaka to become Associate Professor and made an immeasurable contribution, particularly in the studies of structural stereochemistry by introducing optically active ligands and circular dichroism measurements. We had also able young research associates and graduate students from various universities and they have done excellent work. However, the facilities of the new laboratory were at first poor, and very often we had to borrow apparatus from other laboratories and departments. Fortunately, we got research grants rather often from the Ministry of Education, Science and Culture, and the research conditions gradually improved.

We tried to take advantage of the heterogeneous structure of the group. At the same time, I avoided concentrating their energy in particular projects, but urged them to pursue their own interests in harmony with the research group. Our work was extended to various fields, including the comparison of lability and reaction mechanism of substitution reactions of various metal ions on the basis of isotopic exchange studies, the pressure effect on ligand substitution and outer-sphere redox reactions, optical activity of asymmetrically coordinated olefins, characteristics of stereochemistry and electron transfer reactions of early transition elements, and synthesis and properties of bi- and multinuclear complexes of the transition elements. I owe much credit to my co-workers and also to many coordination chemists both from Japan and abroad with whom I came into contact at Sendai and at international meetings. I was very lucky in obtaining many opportunities to present the results of our research activities in monographic form in periodicals such as *Coordination Chemistry Reviews, Journal of Organometallic Chemistry, Pure and Applied Chemistry, Polyhedron* and also as invited lectures in International Conference on Coordination Chemistry, IUPAC Congress and Mendeleev Congress.

A.N. While you were at Sendai, you devoted a lot of energy to the establishment of inter-university organization on coordination chemistry. How did you manage that?

One of the important activities of the Japan Science Council (JSC), the representative organization of research workers in all fields of pure and applied studies, is to recommend policy on the future planning of fundamental research to the Government. Professor Kazuo Yamasaki and other senior coordination chemists strived for, and succeeded in obtaining, the recommendation to establish the Institute of Coordination Chemistry (ICC) in 1971. However, there had been too many recommendations, and early implementation was extremely difficult.

There was an implicit understanding among chemists in Japan that the Institute for Molecular Science (IMS) should be established first among other inter-university institutes of chemical science. I joined the Preparatory Committee of IMS to help its establishment. It was founded in Okazaki in 1975, and soon thereafter I joined the Council. IMS was expected to help the establishment of sister institutes of chemistry.

Despite the endeavour, ICC has not yet been established. However, a few coordination chemistry research laboratories were founded and affiliated with IMS in 1984. I was urged to move from Sendai to take care of the laboratories for three years. Many research chemists, including physical chemists at IMS, have given us helping hands, for which coordination chemists should be very grateful. Professor Hitoshi Ohtaki succeeded me and the laboratories are developing favourably.

A.N. You have been also very active in the International Union of Pure and Applied Chemistry (IUPAC).

First, I attended a few meetings of the Commission on Nomenclature of Inorganic Chemistry (CNIC) as a national representative. You kindly followed me in such an activity for years. In 1977, Prof. Norman Greenwood at Leeds, then President Elect of the Inorganic Chemistry Division, asked me to join the Division Committee as Secretary. Recklessly I accepted his invitation and served as Secretary, Vice-President and President of the Inorganic Chemistry Division for ten years and also joined the Chemical Research Applied to World Needs Committee (CHEMRAWN) until 1991. The work was difficult for me, because I had to do everything in English. However, I benefitted greatly from meeting eminent pure and applied chemists all over the world. These experiences gave me an understanding as to the importance and also the difficulty of international cooperation.

A.N. They say that human civilization is approaching a turning point. How do you see the future of chemical science, especially of inorganic and coordination chemistry?

That is a very difficult question. There is a great deal of discussion as to the merit and demerit of chemical science. The good points must, of course, be developed.

For overcoming the deficiencies, however, man has also to rely on chemistry. In the 21st century, cooperation among developed and developing countries should become more important, not only in solving world wide problems such as environmental problems, but also for the advancement of the frontiers of chemical research. The population of eminent young persons has already reached a maximum in the developed nations. However, there are many nations in which talented young persons are waiting to be discovered.

As for inorganic chemistry, I am afraid it is now believed to be too systematic or too clear. Some popular text books are responsible for this sort of misunderstanding. They say little about, for example, solid state compounds or non-stoichiometry. There is a wide gap between the understanding of molecular compounds and solid state properties. Pure chemists tend to think that the study of solid state compounds is in the area of applied chemistry. This is unfortunate. You have recently been advocating that inorganic chemistry should be "all-element chemistry", and I very much agree with you. We have to understand inorganic substances more inclusively. In order to couple the studies of molecular compounds and solid state compounds of all the elements, coordination chemistry is really a very important mediator. I am sure that coordination chemistry will play a leading role in the circus of pure and applied chemistry.