Personal Reminiscences

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My first intimate contact with X-ray crystallography took place in 1927. Fifteen years had then passed since von Laue's discovery of X-ray diffraction, but the new discipline had not developed much at this stage, largely because of the First World War. Although the methods were beginning to permit the analysis of structures of medium complexity, the number of fairly simple compounds not yet investigated was still very large. Great fields could, therefore, be opened for study as was also pointed out to me by Arne Westgren. He had just obtained the chair in General and Inorganic Chemistry at the University of Stockholm, and asked me if I was willing to work for the 'filosofie doktor' degree in X-ray crystallography. I had earlier done research in other branches of chemistry, and I have a vivid memory of Westgren describing the thrills of X-ray work, where 'one nearly has the feeling of touching the atoms.'

Westgren had by then collaborated for some years with Gösta Phragmén, at this time connected with the Institute of Metal Research in Stockholm. Westgren's great imaginative power, skill in numerical calculations and the speed and easiness with which he worked was complemented very neatly by Phragmén's critical attitude, thorough knowledge of thermodynamics and great experience in workshop problems and instrument construction. Their cooperation at this time was very important for the early development of X-ray crystallography in Sweden. Although Phragmén was later on mostly occupied with other problems, especially as head of the Institute of Metal Research, his death in 1944 at the age of 46 meant a very great loss to X-ray crystallography.

In about 1927 Westgren and Phragmén were investigating alloy systems exclusively. The success with which they solved fundamental structural problems in this field was to a large extent the product of their great experience in physical metallurgy, their sound methods of

preparation, and in particular the excellent powder cameras constructed by Phragmén. These cameras were of the Seemann-Bohlin focussing type, but following an analysis of the focusing conditions Phragmén had succeeded in obtaining a resolution which for many years could not be attained by any other camera. This put the Stockholm laboratory in a very favourable position at a time when most equilibrium diagrams had to be revised by means of phase analysis with powder photographs and when a great many structures were determined by powder methods. In single-crystal work, Laue photographs still played an important role for crystal adjustment and symmetry determination. For the subsequent structure analysis, however, they had already been superseded by oscillation and rotation photographs.

In these surroundings I started to investigate the binary systems of iron with the elements of the fifth group. Here I came at once in contact with metallic phases formed between transition elements and non-metals, a group of compounds to which I was later to devote much time. My thesis was ready in 1929, and when it was to be discussed in public the Faculty chose Professor Gregori Aminoff as its opponent. In this way I got to know Aminoff more closely and had many connections with him in the years that followed. Aminoff was a very modest man of retiring disposition. This, together with the non-educational character of his institution, tended to isolate him from the wider circles of Swedish science. Moreover he had very few pupils. In crystallography he was much aided by his deep sense for spatial relationships which was probably connected with his artistic gifts. Before 1913 he practised several years as an artist and had studied arts in France and Italy.

After having obtained my degree in 1929 I was appointed lecturer in General and Inorganic Chemistry at the University of Stockholm. From a scientific point of view the following seven years in Westgren's institute were the best of my life. They were filled with work on many interesting problems, the intercourse with Westgren, Phragmén and our fellow-workers was stimulating, the equipment was fairly adequate and administrative work, which was later to be a heavy burden, was practically non-existent.

During these years I continued the studies of metallic phases between transition metals and non-metals, started work on solid interstitial solutions with the structures of iron sulphide and selenide, tungsten bronzes and spinels, and took up the investigation of molybdenum and tungsten oxides. Satisfactory diffraction data for the

latter oxides could only be obtained following the construction of a Weissenberg camera, the first of its kind in Scandinavia. Since during this period I was also connected with the Institute of Metal Research, it was my duty to do some research in physical metallurgy. In this field, X-ray diffraction studies bearing on the formation and decomposition of martensite as well as on nitride hardening were carried out. To this was added work of a more incidental character, e.g. structure determinations of dithionates.

In order to obtain experience in the preparation of metallic hydrides I spent a couple of months in 1930 in Professor A. Sievert's laboratory in Jena. I also saw various German institutes where X-ray diffraction was practised. My visit to V. M. Goldschmidt in Göttingen had the consequence that some months later Goldschmidt invited me to join his staff. In view of what happened in Germany a few years later I am glad that I had to refuse his kind invitation.

At the end of 1936 I was appointed professor in General and Inorganic Chemistry at the University of Uppsala. Research in inorganic chemistry had not been carried out there for more than twenty years, so it had to be organized from zero level including the training of a scientific staff. This made work very slow at the beginning, and effective research could not be started before 1940. Since then, however, the volume of research has increased at a fairly rapid rate. This has been possible above all through the cooperation of a number of enthusiastic and clever collaborators.