

GENIUS OF THE PERIODIC TABLE

"Isn't it the work of a genius!" exclaimed Academician V.I. Spitsyn, USSR, a member of the Scientific Advisory Committee when talking to an Agency audience in January. His listeners shared his enthusiasm. Academician Spitsyn was referring to the first formulation a hundred years ago by Professor Dmitry I. Mendeleev of the Periodic Law of Elements.

In conditions of enormous difficulty, considering the lack of data on atomic weights of elements, Mendeleev created in less than two years work at St. Petersburg University, a system of chemical elements that is, in general, still being used. His law became a powerful instrument for further development of chemistry and physics. He was able immediately to correct the atomic weight numbers of some elements, including uranium, whose atomic weight he found to be double that given at the time. Two years later Mendeleev went so far as to give a detailed description of physical or chemical properties of some elements which were as yet undiscovered. Time gave striking proof of his predictions and his periodic law.

Mendeleev published his conclusions in the first place by sending, early in March 1869, a leaflet to many Russian and foreign scientists. It gave his system of elements based on their atomic weights and chemical resemblance.

On the 18th March that year his paper on the subject was read at the meeting of the Russian Chemical Society, and two months later the Society's Journal published his article entitled "The correlation between properties of elements and their atomic weight". In the article Mendeleev's first formulation of the Periodic Law was: "Elements arranged in accordance with their atomic weights display a marked periodicity of properties". Later he gave it with even greater precision as: "Properties of elements as well as forms and properties of their compounds are in a periodic dependence on the atomic weights of the elements".

Although previous attempts had been made to classify elements in groups and tables, this was the first elucidation of the general relationship between the properties of all known chemical elements. The outstanding importance for the philosophy of science lay primarily in the fact that it disclosed the existence of an interrelation among all chemical elements, their physical and chemical properties. The groups and series of the system could now be used as a firm basis from which to identify families of related elements.

Among elements predicted by Mendeleev and afterwards discovered were those now known as gallium, scandium, germanium, radium, actinium, polonium (all found during his lifetime), technetium, rhenium, francium and protectinium.

The Periodic law extended to compounds of elements, melting points of elements and metal chlorides, the structure of spectra, and magnetic properties. Mendeleev continued to work on it for close on forty years, his last variant of the Table being prepared shortly before his death in 1907.

After reviewing the great pioneer's work, Academician Spitsyn dealt with its effect on studies of the structure of matter. It played an important part in elucidating the phenomena of radioactivity, transmutation of elements by decay and led to the discovery of isotopes. As theories of atomic structure were developed they served to give further validity to Mendeleev's law. Steadily the blank positions in his table were filled in as new elements were found, until in 1947 the finding of promethium completed the list between hydrogen and uranium. Formerly it was considered that there could be no more, but in fact twelve "transuranic" elements have to date been isolated through using powerful modern accelerators. Element 101 was named mendelevium in recognition of the man whose system for predicting properties of undiscovered elements had provided the key to the discoveries.

For producing the transuranic elements in quantity the usual procedure starts with irradiating uranium, enriched uranium or plutonium in a reactor. For some of them, however, underground nuclear explosions are a method, though the problem then exists of isolating elements or their isotopes from a great mass of molten rock. Scales of production vary considerably. Annual world manufacture of plutonium amounts to many tons; other figures are tens of kilogrammes of neptunium, tens or hundreds of grammes of curium, milligrammes of berkelium and californium, microgrammes of einsteinium and fermium, and only trace amounts of mendelevium, the unnamed element 102 and laurencium.

In dealing with aspects of continuing research and discoveries the speaker emphasized that much of it is based on, or alternatively provides further exemplification of, the Mendeleev law.