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Graphic Representation of the Properties of the Elements

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GRAPHIC REPRESENTATION OF THE PROPERTIES OF THE ELEMENTS.

BY T. PROCTOR HALL.

In Mendeleeff's classification the elements are arranged in order on a plane surface, so as to increase along one axis in atomic weight, and along the other axis in valence. The properties of an element can then, to some extent, be inferred from its relation to the others on the diagram. Some of the relations are found to be better expressed when the surface is made cylindrical.

Lothar Meyer shows the same properties in a slightly different way by placing the elements along one axis at distances indicated by their atomic weights, and along the other by their atomic volumes. All the known elements then take their places on a series of wave-like curves, and similar elements have similar positions on the curves. Each curve represents one of Mendeleeff's periods.

It has been suggested that since in the C. G. S. system there are three and only three arbitrary units, namely, mass, length and time; a curve might be drawn with reference to three coördinates corresponding to the three fundamental units, and that the positions of the elements on such a curve ought to be a complete expression of their properties. But if we take only two arbitrary units, say mass and length, all others may, as is well known, be derived from them. In gravitation, force is related directly to mass and inversely to length. Acceleration varies as force, and the unit of time may be easily defined in terms of acceleration and length. But it does not follow that the properties of the elements can be well expressed by a two-fold diagram. Elements and atoms are solids and exist in three-fold space. The constant relation of mass to gravitational force makes it highly probable that all the atoms are composed of the same basal matter, and that their differences arise from differences in atomic structure, and in the quantity of the fundamental matter included in each. The properties of an element are then dependent upon the distribution of matter in three-fold space in its atoms, and are functions of the three space coördinates. The properties cannot, therefore, be completely expressed by a one-fold or a two-fold diagram. A three-fold diagram on such a plan implies a far fuller knowledge of the atoms than we can hope to gain for a long time, and for the present we must be content with approximations.

Mendeleeff's diagram is based on two units—atomic weight, which is proportional to mass; and valence, which is a rough indication of the distribution of the matter of an atom in space. Lothar Meyer takes for the units in his diagram atomic weight and atomic volume. The latter is a different measure of the distribution of the matter of an atom in space. If to either of these diagrams be added a third coördinate indicative in a different manner of some essential feature of the distribution of the matter of an atom in space, the curve in space thus found will be a still closer approximate to the true and complete three-fold diagram. The third coördinate must represent some property which is constant under known conditions for all elements. Valence is too variable. The atomic weight is the only known property of atoms which is strictly constant. Atomic volume, considered as the inverse of the density of the solid element, is slightly variable. If the density could be taken at absolute zero we should have the volume under more uniform conditions. Wherever the coefficient of expansion of an element is known, its volume at absolute zero may be approximately calculated. I have done this in the case of a few elements, and find that its general result is to smooth out the irregularities on Meyer's curve. If, instead of atomic volume, the cube root of the volume is taken, so as to make the coördinate refer to atomic diameter, the curve shows a much more even distribution of atoms than it shows when drawn in the ordinary way.

For a third coördinate the force of attraction between atoms of the same kind seems to be the best property we can find at present. In solids this force is represented by tenacity; in liquids it is proportioned to surface tension, and in gases it is proportional to the heat energy required to move the atoms so far apart that they can no longer cohere, that is to say, to the critical temperature of gas.

The critical temperature can be calculated from measurements of surface tension, leaving only two series of data which may be correlated by the method of comparison, since both the tenacity of the solid and the surface tension in the liquid state can be found for some elements.

Unfortunately I have not been able to collect sufficient data to draw the curve even approximately, but an inspection of the elements on Meyer's curve shows that the curve in space will approximate a spiral, of which Meyer's curve is a projection. For example: The volatile element flourine and the metal magnesium will stand near the top and bottom of the curve respectively, and in general the elements on the rising branch will be high, and those on the falling branch of Meyer's curve low, with respect to the third co-ordinate. Melting points, boiling points, hardness, and other related properties of the elements are likely to be much more clearly represented on this curve than they are by either Meyer's or Mendeleeff's system.

CERTAIN MINERALS OF WEBSTER COUNTY, IOWA.

BY ARTHUR C. SPENCER.

Within the limits of Webster county are found a number of interesting minerals. The following notes are descriptive of a few of them.

Quartz. In the vicinity of Fort Dodge the sandy deposits overlying the gypsum are full of rough calcareous concretions of irregular shape. These formations are never hollow like geodes, but like them consist largely of quartz crystals. Calcite showing little or no crystalline character surrounds and incloses perfect crystals of doubly terminated quartz. These small crystals rarely exceed 3 mm. in length. They show only the simple forms of the unit prism and the unit rhombohedron. Its intimate association with calcite indicates that the quartz was without doubt deposited by circulating carbonate or alkaline waters.

Pyrite. Though of very frequent occurrence throughout the coal measures of Webster county no good crystals have