# SILICATES

The silicates comprise the largest chemical group among minerals. They show a wide range in composition which is frequently very complex in character. Recently, however, X-ray investigation has revealed important fundamental facts concerning their atomic structure and thrown much light upon the intricate problem of their composition. It is now established that the fundamental structural unit of all silicates has a tetrahedral shape with four oxygen atoms surrounding each atom of silicon. But these $SiO_4$ groups may be linked together in various ways to form indefinitely extended series. In the orthosilicates these $SiO_4$ groups occur independently with relations to the other elements present, as in an ordinary salt, such as a sulphate, a carbonate, etc. In other types of silicates, however, the $SiO_4$ groups are linked together by having one or more atoms of oxygen shared in common by neighboring groups. If two adjacent silicate groups have one atom of oxygen in common, individual groups with such formulas as $Si_2O_7$, $Si_3O_9$, $Si_4O_{12}$, $Si_6O_{18}$ may occur. Further, the $SiO_4$ groups may form chains in which two oxygen atoms of two adjacent groups are held in common. Single chains of this type with a composition corresponding to $SiO_3$ occur in pyroxene. In amphibole two such chains are linked together, giving a composition represented by $Si_4O_{11}$. Such chains may be further linked together to form a silicon-oxygen sheet, thought to be characteristic of the micas, with a composition of $Si_2O_5$. Again the linking of the silicon-oxygen chains may take place so as to give rise to a three-dimensional network. Such a grouping is characteristic of the different forms of silica (quartz, tridymite, etc.), and by supposing a partial replacement of silicon by aluminum an extended acid network may be obtained into which basic atoms can be introduced. This latter structure is supposed to be characteristic of the zeolites, where metallic atoms may be artificially substituted for each other and the water content varied without disturbing the fundamental structure. In these various silicon-oxygen structures, metallic atoms are placed in such ways as to bind the whole structure together. It has been shown that where isomorphous replacement takes place the number of oxygen atoms (including F and OH) remains constant for each unit cell of the structure. Variations in composition may involve the substitution of Si by Al, of Al, Mg, and Fe by each other, of Na by Ca, etc. A general statement by Bragg* is "that a silicate should be regarded as a structure having a constant number of oxygen atoms in the unit, with a constant number of places for metal and silicon which can be filled by these elements in varying proportions consistent with a balance between valencies."

It can be seen that this view of the structure of the silicates largely does away with the customary assumption of the existence of distinctive silicate acid radicals and alters greatly the usual method of the classification of the silicates. Such a study of the silicates is, however, only

just begun, and the time has not yet arrived when a fundamental reclassification can be attempted. Therefore, in this edition, the usual chemical classification of the silicates has been kept, but short statements concerning the new facts of structure and relations between species have been introduced in their appropriate places.

The silicates are in part strictly anhydrous, in part hydrous, as the zeolites and the amorphous clays, etc. Furthermore, a large number of the silicates yield more or less water upon ignition, and in many cases it is known that they are, therefore, to be regarded as basic (or acid) silicates. The line, however, between the strictly anhydrous and hydrous silicates cannot be sharply drawn, since with many species which yield water upon ignition the part played by the elements forming the water is as yet uncertain. Furthermore, in the cases of several groups, the strict arrangement must be deviated from, since the relation of the species is best exhibited by introducing the related hydrous species immediately after the others.

* The substance of these paragraphs has been condensed from an article entitled, The Structure of Silicates, by W. L. Bragg, Zs. Kr., 74, 237, 1930.

Copied from - Dana, E. S. and W. E. Ford, A textbook of mineralogy. John Wiley, N. Y. 4th ed. 1932.