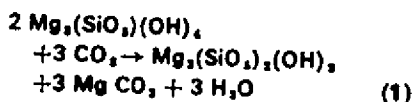


secondary, metamorphic type of mineral.

Most mineral rocks, eg igneous rocks, are definite chemical combinations which commonly are stable only in definite conditions. If those minerals are subjected to radically new conditions they will tend to change into new chemical combinations, stable under the new conditions. The main factors responsible for metamorphic alterations are: temperature, pressure, circulating liquid solutions and gases and time. Under the influence of these factors, the parent rocks gradually acquire new, distinctive chemical, physical as well as crystallographical characteristics. The latter often take shape of banding or foliation, partly by mechanical elongation and flattening of mineral particles already present, partly through growth of new mineral crystals with an orientation imposed by stresses. The finest of the secondary formations of that type are called schists, and this is where talc belongs together with other minerals exhibiting similar characteristics, eg micas, foliated gypsum, etc.

The immediate corollary of the aforesaid is that the chemical and physical properties of a metamorphic mineral like talc will be determined by the type of parent rock, metamorphic parameters involved, and the degree of alterations.

Turner and Verhoogen (11) studied possible mechanisms of formation of talc. One of the postulated reactions was simple addition of CO₂ to serpentinite rock, viz:



but by varying temperatures and various cation bearing solutions to simulate hydrothermal metamorphism, they managed to obtain simultaneously a number of intermediate compounds, a state of affairs confirmed by the actual field studies of similar geological systems.

It must be noted in the above example that while MgCO₃ is a by-product of the reaction, and will appear as an impurity, the intermediate compounds remain in a kind of a state of dynamic equilibrium with talc, consistent with the degree of progress, towards the completion of the reaction (1), and that, for practical purposes, such a system will appear homogeneous.

Pask and Warner(4) using the previously reported research on the MgO—SiO₂—H₂O system by Bowen and Tuttle(5) as a starting point, studied phase relationship of that system, in the presence of excess water, varying only one parameter, ie temperature, and found at certain temperature intervals a definite equilibrium co-existence of various related compounds. Those variations, ascribed by the authors to the occur-

rence in the system of solid solutions, both ionic and molecular, have been suggested as a possible explanation for wide differences in composition observed even in 'purified' samples of talc of various origins.

Another factor, necessary for understanding the nature of talc, especially in the context of the investigated problem of its asbestos content, is the realisation that both of them are members of the same family of silicate minerals of widespread occurrence and dissemination, enormous in numbers, and spectrum of varieties as well as close relationships.

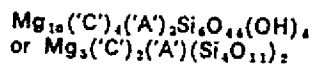
However, all those silicate minerals, occurring in nature have similar atomic structure. The 'building bricks' of that structure are SiO₄ tetrahedral units which polymerize easily to form (depending on the manner of linking) single or double chains, rings, sheets and three-dimensional anionic framework. The negative charge of the anionic framework, comprising silicon, oxygen, and frequently also aluminium atoms (as aluminium is also capable of forming analogous AlO₄ units) as well as hydroxyl ions, is balanced by combining with various cations which are interspersed throughout the lattice in appropriate sites according to their valency and co-ordination(12). A reference to fig 1 will make apparent the modular character of such structures.

It is obvious that in such a system a whole spectrum of changes can be produced, by varying the 'cementing' cations, associating, dissociating or intermixing modules (ie chains, single or double the whole 'sheets', and the layers) thus virtually transmuting one mineral into another, through a variety of intermediate stages.

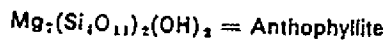
An example taken from Warren's work (13) will best illustrate the idea.

In fig 2 the modules of talc layer (cf fig 1) are easily recognisable. They are, however, expanded, being linked by means of double chains—as indicated by the existence of (Si₂O₁₁)₂ grouping, thus creating voids at 'A' and 'C' which can be filled by varying cations.

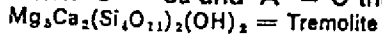
The formula for unit of the above structure will thus be:



Now, when 'C' = Mg⁺⁺ and 'A' = O, the formula will become:



When 'C' = Ca and 'A' = O then



Finally, when 'C' = Ca⁺⁺ or Mg⁺⁺, some Si⁺⁺⁺⁺ is substituted by Al⁺⁺⁺ and 'A' = Na or K then the general formula for amphibole will result.

The relationship of the above listed minerals with talc, and the feasibility of their partial or total transformation into the latter are quite apparent. This fact has been confirmed experimentally by Bowen and Tuttle(5) as well as by the actual field studies.

The important fact to note is that tremolite, the singled out amphibole in the above example, is a member of the asbestos minerals group.

ASBESTOS

A word of Greek origin, asbestos means unquenched, and is a generic name for a number of minerals that have in common (apart from their fire-proofing properties) a crystalline fibrous structure, allowing them to be spun or felted. Mineralogically they

Fig 2 Schematic diagram of Amphibolic crystalline structure

