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STABILITY AND STRUCTURAL RELATIONS OF (Mg, Fe) METASILICATES

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The polymorphism of $MgSiO_3$ and $MgSiO_3-FeSiO_3$ solid solutions, which are widespread in nature, has been the subject of numerous investigations which have obtained very contradictory results as to the number of modifications, their fields of stability and their structures (fig. 1).

As we now know, these diverse findings can be explained mainly on two facts, namely the use of starting materials of different origin and chemical composition, and the difficulties in identifying the polymorphs on the basis of their similar X-ray powder patterns.

Following HARALDSEN (1930) we shall interpret as protoenstatite the phase which is formed when talc is calcined, particularly the technical product which contains excess silica and some iron. To find out the stability relations it seemed necessary to use pure $MgSiO_3$, a compound which can be synthesized from the respective oxides MgO and SiO_2 in a ratio one to one.

On heating, the primary products are olivine and cristobalite, which transform slowly to the metasilicate at temperatures between 1450 and 1550 °C. It is necessary to grind the material several times. Subsequent annealing at about 1000 °C will give pure $MgSiO_3$ in which olivine or cristobalite can no longer be detected by X-ray or optical methods. The material synthesized in this way is monoclinic and corresponds both optically and in its X-ray pattern to clinoenstatite (MORIMOTO, *et al.*, 1960). On heating, clinoenstatite can be transformed to protoenstatite at 1260 ± 10 °C, and the protoenstatite remains unchanged up to the point of incongruent melting at 1555 °C. The powder patterns within this region are identical with those of protoenstatite formed from talc. Thus it is clear that the term protoenstatite is correct for the high-temperature modification of $MgSiO_3$.

Protoenstatite, formed from pure $MgSiO_3$ at tem-

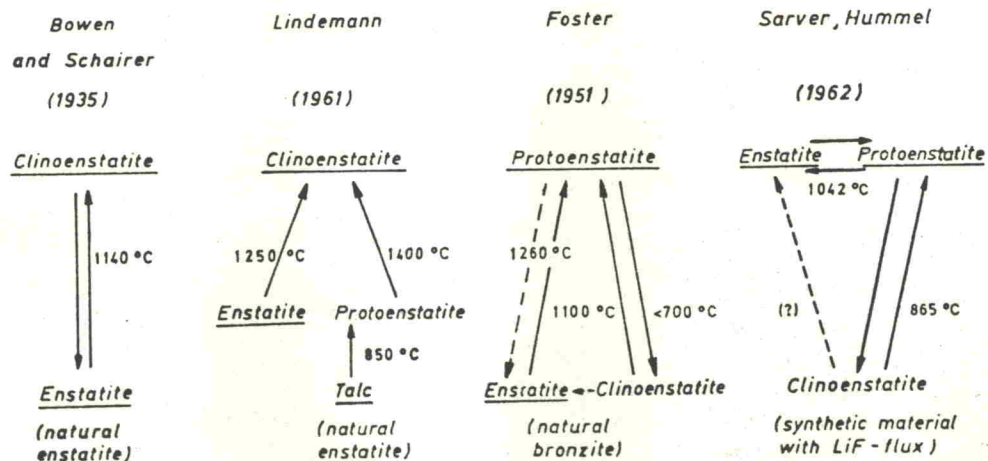


Fig. 1. Polymorphism of $MgSiO_3$ according to BOWEN and SCHAIRER (1935), LINDEMANN (1960), FOSTER (1951) and SARVER and HUMMEL (1962). Modifications regarded as stable are underlined. The starting materials are given in parentheses.