similar to those of Paakkila, with the exception that anthophyllite has clearly replaced enstatite. Relict enstatite is still present, penetrated by needles of anthophyllite; in addition, olivine-bearing serpentine, talc, and chlorite have been observed (Aurola, 1954).

The anthophyllite asbestos deposits at Paakkila were first leased in 1907 but not worked to any degree until 1918, when they were taken over by Suomen Mineraali Oy and operated continuously until production stopped for economic reasons in 1975. Paakkila produced in total 350,000 tonnes of asbestos, of which 230,000 tonnes was exported (Huuskonen *et al.*, 1980). The asbestos mine and mill at Maljasalmi was operated contemporaneously by the same company, but the ore was inferior to that from Paakkila.

MINOR GEOLOGICAL OCCURRENCES OF AMPHIBOLE ASBESTOS

Anthophyllite asbestos

Small deposits of anthophyllite asbestos have been worked in many localities, but none approached the Paakkila output of 350,000 tonnes. In the United States anthophyllite has been mined in a number of localities, particularly in Georgia, North Carolina, Idaho, Maryland, and Massachusetts. Some of the more active mines were the Sall Mountain and Calhoun mines, Sall Mountain, Georgia; the Hollywood mine, Habersham County, Georgia; the Kamiah mine, Idaho County, Idaho; the Bok Asbestos mine and Alberton mine, Baltimore County, Maryland; and the Pelham quarry, Hampshire County, Massachusetts. The mode of occurrence of anthophyllite asbestos in these localities is very similar to that in Paakkila and Maljasalmi, East Finland. Typically these anthophyllite deposits are found in metamorphosed ultramafic bodies, generally serpentinized and amphibolized dunites and harzburgites caught up as inclusions within the country rock schists and gneisses. In localities within the Appalachian Orgenic belt, metamorphism is regional and repeated; in Kamiah, Idaho, much of the metamorphism was accomplished by the intrusion of the Idaho batholith. Granitic intrusions are noted in some localities and may have contributed to the metamorphism, particularly in regard to supply of heat, SiO_2, and H_2O.

The Kamiah deposit (Anderson, 1931) is particularly interesting in its similarity to the Finnish deposits. Here also the ultramafic lenses (dunites and harzburgites) are included within mica schists and gneisses. Anthophyllite clearly replaced olivine and enstatite, for needles grew into the relict grains. In addition, anthophyllite replaces antigorite, the antigorite having previously replaced olivine. Talc is a minor constituent in the Kamiah deposit but replaces anthophyllite, antigorite, and olivine. The various assemblages observed at Kamiah, Paakkila, and Maljasalmi can be explained with the phase diagrams suggested by Hemley *et al.* (1977), three of which are shown in Figure 6.

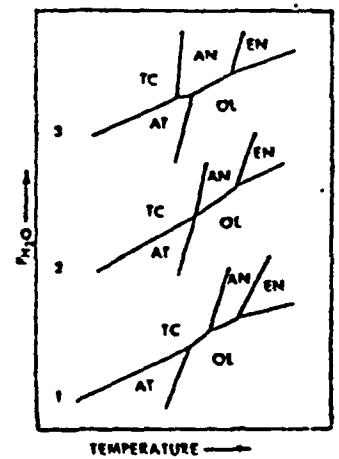

Figure 6. Proposed phase relations in the system MgO-SiO_2-H_2O (Hemley *et al.*, 1977). EN = enstatite, AN = anthophyllite, AT = antigorite (serpentine), OL = olivine, TC = talc. Suggested reactions which could occur at lower or higher P_{H_2O} (1, 2, or 3) are: EN + AN (M,K), OL + AN (P,K), OL + AT (P,K), AT + TC (K), AN + TC (P,K). Reaction at lower P_{H_2O} only: OL + TC (P,K). Reaction at higher P_{H_2O} only: AT + AN (K). M = Maljasalmi, Finland; P = Paakkila, Finland; K = Kamiah, Idaho.

Tremolite asbestos

Although there are numerous references to tremolite asbestos in the literature, relatively little of this fiber entered the world market. Probably the most famous reference to tremolite asbestos is to that from the Italian Alps, reportedly the asbestos of the Romans. Inquiry into this, however, leads one to believe that most of the asbestos fiber from the Alps was chrysotile, not tremolite.[3] Fibrous tremolite has not been reported in the recent and extensive literature on metamorphosed ultramafic rocks from north Italy, whereas chrysotile is often mentioned. Also, in a letter to Oliver Bowles, asbestos commodity specialist, U.S. Bureau of Mines (Bowles, 1937, p. 6), the chief mineral inspector in Rome stated in part: