Note on sapphirine and sillimanite + orthopyroxene from Panrimalai, Madurai District, Tamil Nadu

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Sapphirine and the association of sillimanite with orthopyroxene are of special interest to petrologists, for they are indicative of metamorphism at relatively high temperatures and pressures and low water fugacities in the granulite facies. Rocks containing sapphirine or sillimanite + orthopyroxene are found at a number of localities throughout the charnockitic region of South India. In a recent paper and note (Grew, 1982, 1983), I reviewed the petrogenesis of these minerals from 22 localities in South India and concluded they formed mostly at temperatures near 800°C, lithostatic pressures of 6 to 8 kbar, and water pressures significantly less than lithostatic pressures.

A report of sapphirine from Panrimalai, a locality not included in my review, recently came to my attention. McKie (1963, p. 640) mentions a 'sapphirine-sillimanite-cordierite rock, Panrimali [sic], Madura, India' a specimen of which is housed in the University of Cambridge Mineralogy Musem (No. 78125). In April, 1983, when I had the opportunity to visit the University of Cambridge, Drs. S. O. Agrell and G. A. Chinner kindly provided me with a chip of the Panrimalai specimen from the Mineralogy Museum, and later, Dr. B. P. Radhakrishna sent me the exact location for Panrimalai.

The purpose of the present note is to communicate this new information on the Panrimalai specimen. To my knowledge, this specimen is only the third rock from Tamil Nadu to contain sillimanite and orthopyroxene. The other two Tamil Nadu localities are Madras and the North Arcot district. The first, which was discovered by S. K. Sen, has been described in detail (see Grew, 1982), and the second is mentioned in an abstract (Anantha Iyer *et al* 1976). Consequently the Panrimalai specimen is of special interest in understanding the petrogenesis of the sillimanite-orthopyroxene association in South India.

Panrimalai (102°1'30"N, 77°45'30"E) is located on the eastern slopes of the Palni Hills, about 20 km north-northeast of Ganguvarpatti, where sapphirine was found by Muthuswamy (1949). Dr. A. P. Subramanian, who donated the sapphirine

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EXPLANATION OF FIGURES

Fig. 1. Orthopyroxene (Op) embayed and cut by sprays of biotite that appear to be of a younger generation than nearby coarser biotite (Bt). Feldspars (Fs) associated with biotite include plagioclase and K-feldspar. Plane polarized light. Length of bar is 0.5 mm.

Fig. 2. A bundle of prismatic sillimanite (Si) surrounded and embayed by sapphirine (Sa – dark laths) – cordierite symplectite and cordierite (Cd – featureless) which isolates the bundles from orthopyroxene (Op) and biotite. Plane polarized light. Length of bar is 0.5 mm.

Fig. 3. Sillimanite (Si) bundle and prisms (single cleavage) and orthopyroxene (Op) separated by cordierite (Cd) with rare sapphirine. K-feldspar (Kf) is separated from cordierite by a rim of plagioclase; both feldspars are present in cordierite at lower right (Cd+Fs). Length of bar is 1 mm.

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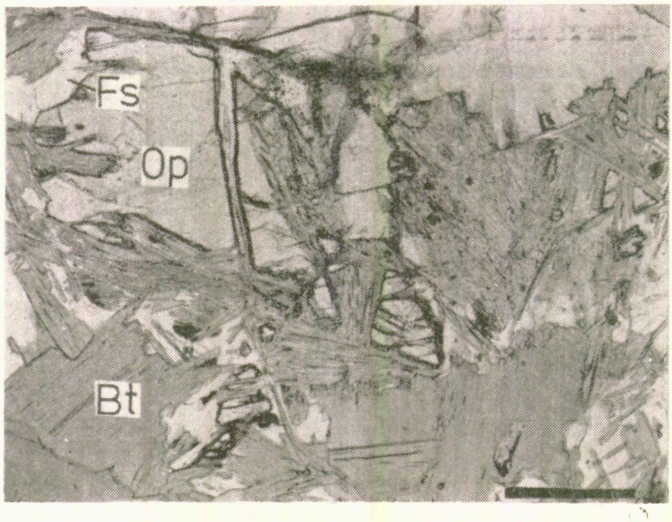

Fig. 1.

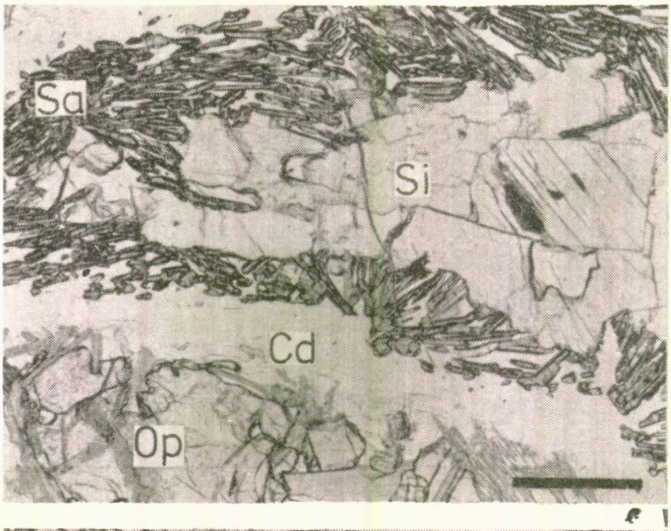

Fig. 2.

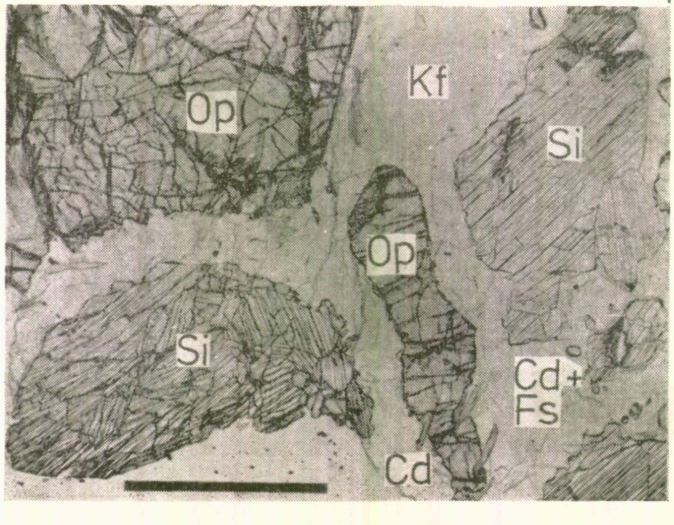

Fig. 3.

rock to the University of Cambridge collection, carried out fieldwork during the 1952-53 season in the Panrimalai area and probably collected the sample at this time.

The Panrimalai specimen is a foliated inequigranular medium grained (0.1 to 6 mm) rock consisting of biotite, orthopyroxene, sillimanite, sapphirine, cordierite and feldspar; traces of zircon, rutile, and secondary micas are also present. Lenticular foliae of biotite, orthopyroxene and feldspar (subordinate) alternate with foliae of sillimanite, cordierite and sapphirine; the foliae are generally several mm thick. Orthopyroxene, in grains up to 6 mm long, is pleochroic from pale brown to nearly colorless and is locally embayed by sprays of biotite (Fig. 1). K-feldspar is commonly perthitic and plagioclase is in places myrmekitic. Sillimanite prisms (0.2 to 1 mm across) form bundles that are isolated from the biotite-orthopyroxene foliae by cordierite-sapphirine symplectite and granular cordierite (Fig. 2). In places, sapphirine is almost absent and sillimanite and orthopyroxene are separated by only 0.2 mm of cordierite (Fig. 3). Pale blue sapphirine in plates mostly 0.1 – 0.5 mm long and 0.01-0.05 mm thick is found only in the symplectite adjacent to sillimanite (Fig. 2). Biotite also occurs as scattered flakes in the sillimanite bundles, so that biotite and sillimanite are in contact, but K-feldspar was not found in contact with either sillimanite or sapphirine. Orthopyroxene and feldspar show only minor alteration and cordierite is almost entirely fresh.

The Panrimalai specimen appears to be unique among Indian sapphirine-bearing rocks in that sapphirine-cordierite symplectite has formed around sillimanite, isolating it from orthopyroxene. In other Indian rocks containing sapphirine, sillimanite and orthopyroxene, some sapphirine grains have overgrowths of sillimanite, and sillimanite and orthopyroxene are locally in contact (Nanda and Natarajan, 1977; Grew, 1982). Sapphirine-cordierite symplectites are reported from Ganguvarpatti and Anakapalle (Andhra Pradesh) (Muthuswamy, 1949; Nanda and Natarajan, 1977; Grew, 1982) and in the Kiranur area (Ackermand *et al* 1981). In the former two localities, the symplectite commonly occurs around garnet and probably formed from reactions involving garnet, while at Kiranur the symplectite formed from reaction between sillimanite and gedrite. Sapphirine-cordierite symplectite from Ellammankovilpatti (Grew, 1982) may also have formed from gedrite + sillimanite, but no gedrite was found in the Ellammankovilpatti sapphirine bearing rocks. In sapphirine bearing rocks from outside of India, a textural relation similar to the Panrimalai rock is well illustrated in a sapphirine granulite from Val Codera in the Italian Alps (Schreyer, 1970, Fig. 15).

Textural relations in the Panrimalai rock between sillimanite (Sil), orthopyroxene (Opx), cordierite (Crd), sapphirine (Sap), biotite (Bt) and K-feldspar (Kfs) can be interpreted to result from the following reaction: Opx + Sil + Kfs = Sap + Crd + Bt (second generation), which is the same as that proposed by Schreyer (1970) for the Val Codera rock, except that K_2O is involved. According to the petrogenetic grid presented earlier (Grew, 1982, Fig. 14), the reaction Opx + Sil = Sap + Crd can only occur at pressures above and temperatures below those suggested for Ganguvarpatti (roughly 5 kbar, 800°C), where cordierite and spinel occur together. Metamorphic conditions may have differed between the two localities, which are 20 km apart. An alternative interpretation is that the rocks at both localities record a range of metamorphic pressures and temperatures. The spinel-sapphirine-orthopyroxene-cordierite symplectites at Ganguvarpatti, such as that illustrated in Grew (1982, Fig. 3), may have developed from garnet at the time sapphirine-cordierite

symplectite developed from sillimanite and orthopyroxene at Panrimalai. Schreyer (1970) suggested that the Val Codera sapphirine-cordierite symplectite developed as a result of decreasing metamorphic pressure and Ackermand *et al* (1981) proposed an isothermic drop in pressure for the development of cordierite-sapphirine symplectite from gedrite and sillimanite A drop in metamorphic pressure at nearly constant temperature could also explain the reaction of garnet to form symplectite at Ganguvarpatti Consequently the assemblages at Ganguvarpatti and Panrimalai may be recording a range of piessure-temperature conditions to which the rocks from both areas were subjected during a single metamorphic cycle

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