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# High $P_{H_2O}$ and hornblende in the Sittampundi Complex, India

WE are grateful for Yardley and Blacic's contribution and we agree with their deduction. The suggestion that the corundum and sapphirine are formed by incongruent melting of the plagioclase under high $P_{H_2O}$ is entirely supported by the textures of the rock, and is not inconsistent with Chappel and White's (1970) deduction of 7 to 8 kb at 850 °C for the conditions of formation of the garnetiferous granulite, though presumably the latter figure is for drier conditions. It is also relevant to the as yet unresolved problem of the initial origin of the hornblende in this meta-anorthositic complex. Was it crystallized as a primary igneous hornblende under high $P_{H_2O}$ and then recrystallized metamorphically to give the perfect triple junction texture with the plagioclase, or was it formed from igneous pyroxene (and possibly olivine) by metamorphic recrystallization under conditions of high $P_{H_2O}$? Windley *et al.* (1973) believed the hornblende in the rather similar Fiskenaesset bytownite–anorthite meta-anorthosite to be of primary igneous crystallization but this we have not been able to ascertain at Sittampundi.

Mr. A. Kemp has analysed a typical hornblende from a Sittampundi layered rock (JS 156) from near the sapphirine locality that is composed of about 51 % $An_{81}$ bytownite and 49 % hornblende with a little opaque ore, the plagioclase being almost identical in composition to that used by Yardley and Blacic. The analysis is $SiO_2$ 46·30, $Al_2O_3$ 13·05, $TiO_2$ 0·34, $Fe_2O_3$ 1·42, FeO 9·85, MgO 14·65, CaO 9·45, $Na_2O$ 1·54, $K_2O$ 0·07, MnO 0·17, $H_2O$+2·91, total 99·75. This gives Si 6·56, $Al^{iv}$ 1·44, $Al^{vi}$ 0·74, Ti 0·03, $Fe^{3+}$ 0·15, $Fe^{2+}$ 1·17, Mn 0·02, Mg 3·09, Ca 1·43, Na 0·43, K 0·01, OH 2·75, O 21·25 calculated to 24(O, OH) with $\Sigma Z$ 8·00, $\Sigma Y$ 5·20, $\Sigma X$ 1·87, mg 0·70, corresponding to a subcalcic magnesio-hornblende (Leake, 1968). The significant aspects are the high contents of water and $Al^{vi}$, consistent with crystallization under a high $P_{H_2O}$. The composition strongly suggests a metamorphic crystallization, being hardly consistent with magmatic conditions (Leake, 1971).

The high $Al^{vi}$ is in agreement with the previously published amphibole analyses from the complex (Subramaniam, 1956) that are also rich in $Al^{vi}$, the gedrite with 17·64 % $Al_2O_3$ being exceedingly rich in Al with values of Si 6·32, $Al^{iv}$ 1·68, $Al^{vi}$ 1·20, comparable to gedrites coexisting with kyanite. The calcic composition of the plagioclase in this intrusion, combined with the instability of calcic plagioclase under high-pressure conditions, as pointed out by Yardley and Blacic, explains the existence of the aluminous amphiboles, sillimanite, corundum, and sapphirine but does not solve the problem of whether or not there was primary igneous hornblende.

It is important to appreciate that if the metamorphism was in the range of 8 to 10 kb $P_{H_2O}$ at about 800 °C then an overburden of 25 to 35 km will be required and the implication is that the rocks had not been previously involved in metamorphism or else they would have been previously dehydrated and this would not promote a high $P_{H_2O}$. If the Sittampundi complex is Archaean in emplacement and part of an early anorthositic episode as seen in Greenland, the Limpopo orogenic belt of Africa, Malagasy, and elsewhere (Windley, 1973) then it becomes important to date the age of the metamorphism as it will enable the time by which the crust in this part of India had assumed a minimum thickness of about 30 km to be estimated.

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# Intergrowth of prehnite and biotite

INTERGROWTHS of prehnite and biotite, or of prehnite and chlorite, occur in the metagabbro of the Tantalite Valley Complex, SW. Africa (Moore, 1973, 1975).

The metagabbro consists essentially of *c.* 56 % plagioclase, An 75–50, 39 % amphibole, and smaller amounts of biotite, quartz, opaque minerals, sphene, chlorite, epidote, and saussurite after plagioclase, in an original igneous texture that is equigranular and coarsely ophitic. The metagabbro intruded a zone of deformed gneisses, producing a contact metamorphic aureole, and was completely altered to metagabbro by hydration metamorphism before being intruded by gabbronorite that has almost