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Sapphirine in the Sittampundi Complex, India: A discussion

JANARDHANAN and Leake (1974) have described a plagioclase-rich rock from the Sittampundi Complex that has the assemblage: plagioclase + gedrite + colourless clinoamphibole + phlogopite + sillimanite + chrome-spinel + corundum + sapphirine. We have inadvertently synthesized sapphirine[1] as a product of incongruent melting of plagioclase during experimental studies of deformation of an anorthosite (plagioclase composition An 78–80, with a trace of chlorite) using talc as the confining medium, and feel this may have some bearing on the genesis of the rock described by Janardhan and Leake.

The experiments were carried out in a solid-medium deformation apparatus of the type described by Griggs (1967). A cylindrical sample of anorthosite 19 mm in length and 6 mm in diameter was surrounded by a 2 mm thick sleeve of talc within a thin graphite tube furnace. The furnace was enclosed in a 7 mm thick talc jacket through which the confining pressure was applied. In these experiments the temperature is at a maximum in the centre of the sample and decreases towards both ends due to conductive losses through the alumina end pieces. During uniaxial deformation at 850 °C and 10 kb confining pressure, the talc sleeve dehydrated yielding a vapour phase that must have been rich in Mg and Si. Plagioclase in the maximum-temperature region adjacent to the dehydrated talc melted incongruently to sapphirine + liquid due

to interaction with the vapour. The reaction is analogous to that described by Boettcher (1970), who found that anorthite melts incongruently to corundum+liquid at P_{H_2O} in the range 9 to 14 kb. We have obtained this reaction also in an experiment at approximately 8 kb and 825 °C maximum temperature, where there was no inner talc sleeve about the sample. Instead, the anorthosite was directly in contact with the furnace, and vapour derived from dehydration of the outer talc jacket diffused through the furnace, resulting in a small amount of incongruent melting to corundum+liquid. Possibly the activity of Mg^{2+} ($a_{Mg^{2+}}$) in the vapour phase reacting with the plagioclase was less than in the experiment in which talc and plagioclase were in contact, and this could account for the formation of corundum rather than sapphirine.

Our results are no substitute for detailed equilibrium studies, but they suggest in a qualitative way that sapphirine may be formed by incongruent melting of plagioclase at high P_{H_2O}, with a high $a_{Mg^{2+}}$ in the vapour phase. At lower $a_{Mg^{2+}}$, corundum is formed. Since sapphirine and corundum in the Sittampundi sample are almost always related to plagioclase (corundum is specifically described as sometimes occurring in thin strips along plagioclase grain boundaries), this seems an attractive model for the generation of these minerals in this instance. We therefore suggest that the rock described by Janardhanan and Leake is the residuum after a small amount of partial melting under conditions of high water-pressure. Local development of corundum rather than sapphirine might reflect initial variations in $a_{Mg^{2+}}$ in the vapour phase, in which case sapphirine would tend to occur in the vicinity of other Mg-bearing minerals.

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[1] Sapphirine was identified by microprobe analysis.

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