CORRESPONDENCE

Hornfels in the Land's End aureole

SIR – Chinner & Fox (Geol. Mag. **111** (5), 1974, 397–408) lead one to believe that a lime-rich hornfels is absent from the 'cordierite-anthophyllite' rocks of the Land's End aureole around Kenidjack. They apparently dismiss Ca as having played a rôle in the formation of this suite of rocks by saying 'The metasomatic conclusion was also reached by Floyd (1965) in recording similar rocks from the other portions of the aureole; here, however, the presence of lime-rich hornfels was emphasized, and the rôle of complementary redistribution of elements stressed.' This refers to the hornfels developed at Tater-du on the southern side of the Land's End aureole.

A very similar lime-rich hornfels in fact does occur near Kenidjack. In the summer of 1971 I studied this area, whilst at Aberdeen University, and in addition to the mineral assemblages Chinner & Fox describe, I collected from a lime-rich hornfels near the base of the cliff below the Botallock Mines at The Crowns (G.R. 362336). The rock here consists of a grossular-rich garnet-vesuvianite-diopside-axinite assemblage. The area occupied by this hornfels extends for about 30 m laterally and about 5 m vertically. Similar repositories of a lime-rich hornfels are found at Tater-du. Veins of garnet up to 25 cm in width occur at The Crowns; Floyd similarly records these at Tater-du. In fact the only difference between the hornfels in the two areas seems to be the occurrence of vesuvianite at The Crowns.

The occurrence of this lime-rich assemblage in close proximity to a hornfels which is distinctly Ca-deficient can surely only lead one to the conclusion that there has been a metasomatic migration and eventual concentration of Ca ions. This loss of Ca would help to explain the formation of the Ca-deficient cordierite-antophyllite hornfels. It would thus seem that a model for the formation of the rocks of the Kenidjack area which differs from the metasomatic model of Floyd (1965) is unnecessary.

With this information I hope that Chinner & Fox need no longer worry about having to be on guard against their 'excessive enthusiasm in the prospective overthrow of an established hypothesis'.

References

Chinner, G. A. & Fox, J. S. 1974. The origin of cordierite-anthophyllite rocks in the Land's End aureole. *Geol. Mag.* **111** (5), 397–408.

Floyd, P. A. 1965. Metasomatic hornfelses of the Land's End aureole at Tater-du, Cornwall. *J. Petrology* **6**, 223–45.

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SIR – We did not wish to suggest that lime-hornfels are absent from the Kenidjack area; their existence has indeed been documented for over 60 years (Reid & Flett, 1907, p. 39). However, such hornfels, with their axinite content and textures suggesting derivation from hornblende hornfels (Floyd, 1975), seemed so likely to be associated with the fluorine and boron-rich skarns which characteristically accompany Hercynian granite intrusion in Cornwall and Devon, that we did not consider them to be relevant to our argument. The point which we clearly did not emphasize sufficiently, now documented in more detail by Dr Floyd, is that at least two periods of metasomatism are likely to have affected the Devonian greenstones of south-western England. One, pre-dating granite intrusion, was degradative – showing some resemblance to modern

ocean-floor metamorphism it probably involved large- or small-scale metasomatic redistribution of material, producing *inter alia* chlorite-quartz or clay-mineral aggregates with possibly some complementary lime-rich rocks. Another, to which the boron- and fluorine-skarns belong, seems to be a direct associate of granite intrusion. To establish a relationship between lime-skarn and granite is not, however, to prove the origin of contiguous lime-poor rocks by a complementary process, even though analyses of the two types can be juggled to the approximate composition of greenstone.

Of the several types of evidence (Floyd, 1975; Chinner & Fox, 1974) which suggest that the chemical composition of cordierite-anthophyllite hornfels is largely unrelated to granite intrusion, the most striking single fact is surely the presence of peraluminous clots on the scale of several hundred micron dimension. Alumina, as the hydrates diaspore or gibbsite, is chemically compatible with chlorite and with possible precursor clay minerals such as montmorillonites (cf. Velde, 1973). Within the hornblende hornfels facies of the granite aureole, however, alumina is incompatible with the gedrite-cordierite association; the production of aluminous inhomogeneity at the hornfels stage is thus unlikely. This argument is regrettably confused by the fact that the alumina hydrates dehydrate to corundum at temperatures (2 kb, 400 °C; see Haas, 1972) far below those (2 kb, *ca.* 600 °C; P. D. Fleming & J. J. Fawcett, pers. comm.) at which quartz and chlorites of a range of Fe:Mg ratio react to give cordierite and anthophyllite-bearing assemblages. Diaspore thus could not have been stable in the hornfelses and must be regarded as a relict, persisting metastably, perhaps due to difficulty in nucleating corundum (cf. Floyd, 1971, p. 341). None the less, the formation of peraluminous compositions from basic igneous rocks, though poorly understood, is far more familiar a feature of low-temperature alteration than of granite-associated skarn formation.

Confusion of the effects of several superimposed but unrelated metasomatic episodes has no doubt happened often enough in Petrology – the simplest hypothesis is the most preferable, and only after more detailed consideration may Occam's Razor be recognized as a blunt instrument. Our paper of course dealt purely with timing and had nothing to say on the metasomatic mechanisms involved. The precise unravelling of Cornish metamorphic history promises to be an intricate process; not only must the complexities touched on by Dr Floyd be considered, but also such possible puzzles as the remobilization, during subsequent granite-associated tin/tungsten mineralization, of original low-temperature copper/zinc ores.

References additional to those above

Floyd, P. A. 1971. Temperature distribution in the Land's End granite aureole. *Proc. Ussher Soc.* **2**, 335–51.

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