Colour in charnockites

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Summary. Microprobe analysis of leached and unleached varieties of a charnockitic rock from Madras supports the contention of Howie (1964) that the characteristic dark greenish colour of such rocks is contained mainly in fine (chloritic?) veinlets cutting the feldspar and quartz, though a certain amount appears to be contained in exsolved sodium feldspar. Leaching of the darkish colour of the charnockitic rock has not affected the crystallographic state of the potassium feldspar.

THE nature of the characteristic dark greenish-brown hand specimen colour of charnockites has recently been discussed by Howie (1964, 1967). He has shown that the colour is due to iron and that this can be leached out by hydrochloric acid. The colour, according to Howie (1967), is contained in 'thin pale greenish or brownish yellow veins and stringers throughout the rock'. Howie expressed the opinion (1964) that a cut charnockite surface darkens on exposure due to increased oxidation of the iron (hydrated iron oxide) in the veins and stringers, and commented in this connection that observations on specimens from working quarries in charnockites would be of interest.

The writer recently had the opportunity to collect a specimen (No. 20122)[1] of 'charnockite' from a working quarry in the type charnockite area near Madras, India. The exposed surface from which the specimen was taken is a quarried surface yet it had been leached quite white to a depth of 2 or 3 cm within a period of presumably a few years.

This development of a white 'skin' on weathered, naturally eroded charnockite surfaces has been seen not uncommonly elsewhere (e.g. Norway, Ceylon) by the writer; it would appear to be the result of leaching of iron during weathering in a manner analogous to that

[1] Specimen number is from the collection in the Department of Geology, University of Adelaide, South Australia.

effected by Howie with hydrochloric acid in the laboratory; it can be regarded as the usual effect of weathering of charnockite, at least in areas of relatively abundant rainfall, rather than a darkening of the natural colour due to oxidation of the iron, as suggested by Howie.

The white-coloured selvage to No. 20122 is quite compact, and a thin slice of it can be cut as easily as can be a slice of the dark-coloured 'charnockite'. A visual estimate of the mineral assemblage of the 'charnockite' and its white selvage (two separate thin sections) gives:

	Quartz	*Plagioclase*	*Perthite*	*Opaques*	*Biotite*
Dark 'charnockite'	50 %	24 % (An_{25})	24 %	1 %	1 %
White selvage	50	10 (An_{26-27})	37	1	1

The two varieties can be regarded as mineralogically similar and in fact cannot be distinguished in thin section except perhaps for a lightening in colour of the veins in the leached rock.

Support for the postulate that the darkish charnockitic colour is due to iron, is contained in the above described veins and stringers, and is lost by leaching from the veins and stringers, is provided by the results of a JEOL electron probe examination of feldspars in the 'charnockite' and its white selvage (see figs. 1 and 2). The potassium feldspar and its sodium-rich inclusions were identified with the aid of electron and X-ray scanning images. Calcium was used to locate the sodic feldspar because sodium could not be detected with the operating spectrometer crystal. Point analyses for iron were made of the potassium and sodium feldspars as well as of the veins and stringers. A pure iron standard was used and corrections for mass absorption effects were carried out for all the determined values. Results of the probe analysis are:

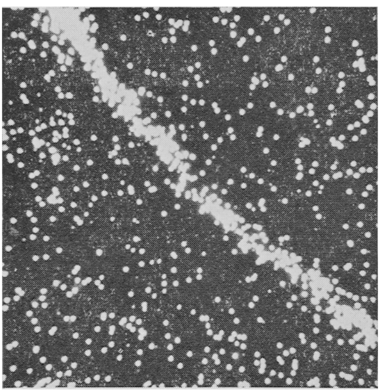
		Exsolved Na *feldspar*	*Host* K *feldspar*	*Vein*
Dark 'charnockite'	Fe	$0{\cdot}121 \pm 0{\cdot}07$ % (15)	$0{\cdot}016 \pm 0{\cdot}011$ % (13)	$1{\cdot}18 \pm 0{\cdot}39$ (9)
White selvage		$0{\cdot}015 \pm 0{\cdot}015$ (13)	$0{\cdot}007 \pm 0{\cdot}007$ (15)	$0{\cdot}29 \pm 0{\cdot}11$ (8)

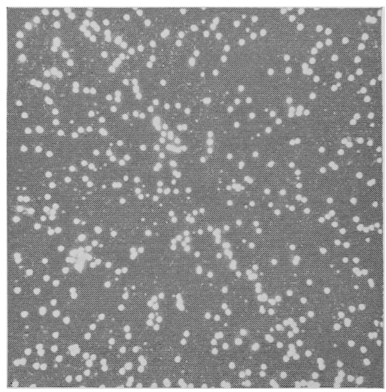
The figures in parentheses are the numbers of measurements.

Two additional points of interest shown by the above figures are: that the exsolved sodium feldspar contains appreciably more iron than does the potassium feldspar host, indicating, presumably, that iron is preferentially exsolved from the alkali feldspar along with sodium during subsolvus crystallization; and that significant iron is lost during leaching *from the sodium feldspar* as well as from the iron-rich veins.

There appears to be no significant difference between the iron content of the calcic plagioclase in the 'charnockite' (0·01–0·02 %) and that in the white selvage (0·01–0·05 %).

In an attempt to throw some light on the identity of the relatively iron-rich veins and stringers, qualitative probes of the vein material were made for other elements. The results are: Ca, Mg, K absent; Al, Si (in addition Fe) present in significant amounts. It is noteworthy that





FIGS. 1 and 2. Fig. 1 (left): Electron probe image, using iron radiation, of chloritic (?) veins in potassium feldspar of 'charnockite'. Fig. 2 (right): Electron-probe image, using iron radiation of chloritic (?) veins in potassium feldspar of white selvage.

Orliac, quoted by Howie (1967), artificially leached from Malagachitic charnockites not only iron but also appreciable alumina, plus water. Howie suggests that the vein material might be goethite or lepidocrocite (FeO.OH), but the above-quoted data, plus upper second order interference colours, variable extinction angle, and fibrous appearance, quoted by Howie, are more indicative of a chlorite.

That the feldspars themselves do not appear to have been affected crystallographically by the leaching process is indicated by optic axial angle and obliquity determinations on potassium feldspar in both the 'charnockite' and the white selvage. Grains showing no cross-hatching from the 'charnockite' gave 2V 59, 60, 61, 60, 60, 55°, and from the white selvage 63, 60, 60, 64°; grains showing cross-hatching gave 76 and 73° ('charnockite') and 80, 67, 76, 74° (selvage). Separated and powdered feldspar from both the 'charnockite' and the white selvage gave single 130 and 131 peaks, indicating disorder.

Commenting on the earlier noted preference of iron for exsolved plagioclase rather than for potassium feldspar, this is surprising in view of the presumed greater acceptance of iron in the potassium feldspar lattice compared with that of plagioclase. For the same reason it is perhaps strange that small amounts of iron are exsolved at all (assuming that the iron-rich veins are the result of exsolution) from potassium feldspar. Also noteworthy is the observation that iron is removed during weathering from the chloritic (?) veins and apparently also from perthite itself, without any obvious modification of the potassium feldspar or of the rock as a whole.

References

Howie (R. A.), 1964. Science progress, vol. 52, p. 628 [M.A. **17**-337].
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