A NOTE ON NATIVE COPPER OCCURRENCES IN KAROO BASALTS OF THE ETENDEKA FORMATION

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Native copper occurs in some of the Tafelberg basalts of the Etendeka Formation which have been described in detail by Erlank *et al.* (1984). The copper was first recognised during mineral separation work on four samples where it occurs as a few irregular grains in the non-magnetic fraction of the crushed basalt, in some cases adhering to feldspar and pyroxene. Electron microprobe analysis has confirmed that the material is pure Cu with no significant concentration of other elements. It is highly unlikely that the copper is a contaminant from a previously processed sample which was introduced into the basalt during sample preparation because the basalts in which it has been identified were processed at different times.

Sulphur concentrations by XRF (this work). The bulk Cu data from Erlank (1984) microfiche, except * Milner (pers. comm., 1987). Mean and standard deviation for Tafelberg basalt and quartz latite from Duncan *et al.* (1984).

Note: the mineral separates in which copper was recognised were taken from the jaw-crushed material from which the powder was obtained for analysis.

Table 1 shows that in the four basalts in which native copper has been identified, the bulk Cu is consistent with that for the Tafelberg basalts as a whole given in table 6 of Duncan *et al.* (1984). Whilst the copper is of no economic importance in these basalts, it does have important petrogenetic implications. Copper is well known to be associated with altered basalts (e.g. Dana, 1903 p. 20) where it is considered to be hydrothermal in origin. In basalt melts any excess Cu present, which does not become incorporated in the crystallizing silicate and oxide phases, should crystallize as a sulphide since some sulphur will normally be present unless the sulphur fugacity is extremely low. Table 1 shows there to be a wide range in sulphur contents in the four copperbearing basalts. This is not likely to reflect the original sulphur contents of the basalt magmas since degassing of sulphur as SO_2 must have occurred as well as possible loss or addition of sulphur during alteration of

TABLE 1: Copper content and location of samples containing native copper

Sample	Cu (ppm)	S (ppm)	Location	
KLS 46	95	13	20°52'S	13°33'W
KLS 53	81	154	20°14'	13°50'
KLS 58	76	84	20°46'	13°37'
Sm13*	57	5	20°18'	14°09'

Basalt (av). 99 (S.D. 49; n=39)
Quartz latite (av.) 42 (S.D. 25; n=19)

the basalts.

It is almost certain, therefore, that the native copper in the Tafelberg Basalts is secondary in origin and as such can be considered as minor hydrothermal mineralization. Sample SM13 (Table 1) contains small veinlets of quartz about 1 mm wide which, in places, pervade the groundmass of the surrounding basalt. In addition SM13 contains isolated amygdales of quartz and zeolite. It is suggested that the veins, and possibly the amygdaloidal material as well, host the native copper. The four samples in Table 1 are from widely spaced localities in some cases up to 50 km apart, hence the copper 'mineralization' is fairly widespread in the southern Etendeka. Although the copper is considered to be hydrothermal in origin, it should be stressed that there is no field evidence to suggest that a major hydrothermal system operated in this area (A.R. Duncan, pers. comm., 1987)

Another feature of the Tafelberg basalts which shows that they were affected by fluid activity is their oxygen isotopic composition. A feature of the Tafelberg basalts is their high whole rock ($\delta^{18}O$ values (usually >7.5 5‰; sometimes as high as 11 ‰0). In some basalts the clinopyroxene phenocryst (δ^8O is up to 5‰ lower than the whole rock values (Harris, unpublished data). This disequilibrium is interpreted as being due to replacement of groundmass material by silica and zeolite, having high ($\delta^{18}O$, while the pyroxene remained relatively unaffected by the fluid circulation. The oxygen isotope geochemistry of the Tafelberg basalts is Further complicated by the strong probability that crustal contamination (Erlank *et al.*, 1984) has been an additional source of heavy oxygen. Crustal contamination alone cannot, however, account for the oxygen isotope disequilibrium observed in these rocks.

It is suggested that deposition of native copper was related to the fluid activity responsible for the oxygen isotope disequilibrium. The cause of this relatively small scale hydrothermal activity and source of the fluids is open to speculation. The native copper is unlikely to have been deposited by late stage fluids associated with the basalts themselves because, if this is the case, native copper should be common in basalts in general. It is possible that the extrusion of quartz latite caused the hydrothermal activity, but they are unlikely to have been the source of the fluids as Milner (1986) considers them to have been dry melts. Alternatively, it is possible that the copper deposition was due to small-scale hydrothermal activity peripheral to one of the post-Karoo intrusives such as Brandberg, but it is also possible that

an additional, unexposed, intrusive complex lies underneath the southern Etendeka.

Native copper has not been found in the Etendeka quartz latites which in general, have lower bulk Cu contents than the Tafelberg basalts (Table 1).

The complex post-magmatic history of the Etendeka volcanics is at present poorly understood. It is hoped that the oxygen isotope investigations currently in progress at U.C.T. will shed Further light on this problem.

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