THE BUSHMANLAND KIMBERLITES

by

A.K. Cornelissen* and W.J. Verwoerd**

*19 Josling Street, Upington, South Africa
**University of Stellenbosch, South Africa

The Bushmanland plateau is situated south of the Orange River and approximately 100 km inland, adjoining a highly dissected portion of the Western Escarpment of South Africa. Kimberlite was first reported from this area by Reuning (1931) who sought to establish the source of the coastal diamonds at the mouth of the Buffels River (Kleinsee). He claimed the discovery of a kimberlite dyke and seven pipes, including a diamondiferous one on the farm Burtonsputs. Subsequently Du Toit (1939) stated that a small diamond had been found in a pipe on the boundary between the farms Gamoep and Koppies-kraal. On chemical grounds he considered this occurrence to be intermediate between kimberlite and melilite basalt.

Between 1928 and 1961 the Namaqualand-Bushmanland area was closed to diamond prospecting with the result that it remained one of the least known kimberlite provinces in South Africa. An intensive prospecting campaign followed during the years 1961 - 1966. At least 151 pipe-like features were drilled to depths ranging from 20m to 279m and kimberlitic material was encountered in 77 of them. It is the purpose of this paper to present some of the geological information that were brought to light. Grateful acknowledgement is due to the three mining companies concerned (De Beers, Rand Mines and the O'okiep Copper Company) for access to plans, logs and reports which were formerly considered as confidential.

Distribution: Some 270 pipe-like bodies are known to occur in an area of approximately 8 400 sq. km from the vicinity of Platbakkies in the south to Aggeneys in the north. Without any doubt many more remain to be discovered. Only about two-thirds of this area was held under option and properly prospected. In the dissected country the pipes generally show up on aerial photographs as hills or circular depressions among gneiss outcrops but towards the east they are covered by calcrete which reaches a thickness of 1 - 2m on the pipes. Magnetometer traverses proved useful in locating some pipes and in delineating their boundaries. An aeromagnetic map by the Geological Survey shows hundreds of small circular anomalies but these could not be correlated successfully with individual pipes. It seems likely that the Bushmanland Province consists of several clusters in which pipes are more closely spaced; outliers which may or may not belong here are found as far afield as Bitterfontein and Pofadder.

The regional structure of the gneisses appears to have exerted no influence on the emplacement of the pipes but prominent vertical joints trending N15°W, N60°W and N55°E are responsible for the alignment of some of them. Joint directions can only be established in the dissected area west of the plateau. Attention is also drawn to the fact that several other manifestations of volcanic activity of the type usually associated with cratonic upwarps are located along a zone parallel to the west coast of the continent: trachyte, carbonatite and olivine-melilitite near Sutherland, carbonate-rich diatremes in the Great Karasberge, phonolite in the Klinghardt Mountains, kimberlitic rocks near Gibeon, carbonatitic diatremes around Brukkaros and plugs of trachyte and phonolite between Windhoek and Rehoboth. The warping probably preceded the separation of Africa and South America during the Cretaceous.

Description: The pipes fall in three categories: (a) Melilite and melilite-nepheline basalts (olivine melilititte) that are clearly distinguishable from the others. They form conspicuous brown rubble-strewn hills. The rocks are perfectly fresh. They were first described by Rogers (1911) and genetically linked with kimberlite by Taljaard (1937) and are at present being studied by Mr. A. Moore in the Department of Geochemistry, University of Cape Town.

(b) Sediment and breccia-filled diatremes. This description applies to the majority of occurrences. They range from 50m to 500m in diameter and are occupied by shale, sandstone, grit, arkose and conglomerate showing graded bedding. The sediments are often disturbed by great blocks of country rock that collapsed into the crater. The latter may be adjoined by a volcanic neck (as on Riembreek and Kap-Kap), consisting wholly of angular blocks of gneiss measuring up to several metres across and testifying to repeated explosive eruptions. More tranquil crater-filling conditions and a temperate climate are reflected elsewhere by deposits of carbonaceous shale, dysodile and mudstone with calcareous intercalations. These contain fossil frogs and dicotyledonous leaf impressions (Haughton 1931, Rennie 1931, Kirchheimer 1934). Drilling has proved that such sediments extend down to depths of 250m (Koppieskraal no. 5) and more than 266m (Hoendernesvlei). In many cases e.g. Burtonsputs, Gamoep no. 1 and Koppieskraal no. 5 the shales were found to have intercalations of blue-green tuffaceous kimberlite towards the base (cf. chemical analysis by Reuning, 1934) and eventually to overlie solid blue-ground resembling kimberlite breccia. The prospecting programme thus strengthened the opinion that the diatremes and sediment-filled depressions are surface expressions of deep-seated pipes with kimberlitic affinities.

A peculiar feature of the sediment-filled pipes is the presence of late-stage silicification around their margins:

ferruginous opal, veins of opaque white silicified kaolin and sometimes manganese oxide encrustations afford excellent indications of the proximity of a pipe. In a semi-arid area such as this the pipes are of considerable importance as aquifers.

(c) A few bodies (some of them dyke-like rather than pipe-like) are known where weathered kimberlitic rock are exposed at the surface. The best-known occurrence is the one (Gamoep no. 1) referred to by Du Toit (1939) where an offshoot from the sediment-filled pipe consists of "hardebank." It contains nodules of an earlier kimberlite(?) in which chrome-diopside appears to be concentrated. No undoubted eclogite or peridotite inclusions have been found. The only known occurrence with a large amount of biotite in a weathered serpentinous groundmass is the one on the boundary between Papkuilsfontein and Couragiefontein. A heavy residue from a similar decomposed kimberlite(?) on Kap-Kap yielded ilmenite but no garnet.

Age: The Bushmanland pipes cannot be dated too closely yet. The fossil evidence from the crater deposits indicate an Upper Cretaceous or Eocene age. Detailed investigation of fossils collected during the prospecting activities are still in progress.

Composition and Mineralogy: The results of the prospecting were not only disappointing, but it actually failed to yield a single diamond from any of these pipes, despite the fact that several thousand loads were treated in washing plants. Consequently some doubt has arisen about the validity of their identification as kimberlites and the older reports have come to be regarded with skepticism.

Unfortunately most bore-hole samples have been destroyed and complete analyses of Bushmanland kimberlites are not available. Partial analyses for SiO_2, Al_2O_3, FeO and MgO have been carried out on 512 samples and these results led one of us (A.K.C.) to the conclusion that only a few pipes (e.g. Gamoep no. 1, Klein Katvlei no. 1, Koppieskraal no. 18, Vermeulens Rust no. 1) contain classical kimberlite; the rest are deficient in magnesia.

In thin section the kimberlitic rocks present the usual intensely altered appearance. The following minerals were identified in heavy concentrates from the bore-holes: ilmenite (ubiquitous), garnet (purple, red and brown), chrome-diopside, enstatite (En_{80-85}), zircon, biotite, pyrite, magnetite and barite. Olivine and perovskite are sometimes present, undoubtedly derived from melilite basalt. In addition to pyrope with n=1,74 - 1,76 and a_o=11,55A, more almandite-rich garnets (from gneiss?) were also found. The ilmenite shows a variable composition and variable magnetic properties.

Picroilmenite with 10,20% MgO and 57,00% TiO_2 was recovered from Banke no. 3 but several other analysed samples contain less than 6% MgO and are low in titania. Indications are that strongly magnetic ilmenite or titaniferous magnetite is associated with the "low-magnesia kimberlites" and that chrome-diopside is absent from them. The real affinities of this rock type appears to be problematic. Hydrothermally altered melilite-bearing rocks may have been confused with kimberlite. However, the presence of typical "indicator minerals" in at least some of the pipes would seem to confirm the existence of true kimberlite in this province.

Conclusion: The Bushmanland pipes attracted the attention of geologists mainly for three reasons:

(a) They were considered to be the most likely source of the alluvial diamonds along the lower and upper reaches of the Buffels River to the west and the Koa River valley to the east (eg. on Galputs and Bosluispan). This problem has not been solved. In Tanzania over 200 kimberlite occurrences were found during a R4 million prospecting campaign, yet nearly all of them are barren and the Mwadui mine remains the only one of economic importance. (Edwards and Howkins 1966). Thus there is still a possibility that a diamondiferous pipe may be discovered in Bushmanland. The two provinces have many features in common.

(b) The former existence of craters 250m deep and their subsequent filling by lacustrine sediments represent aspects of the emplacement of kimberlite that are unknown elsewhere in South Africa. Does this imply a difference in erosion level, age or eruptive mechanism?

(c) The age-old question whether kimberlite and melilite basalt are genetically related may possibly be answered here. It has been claimed that both rock types are found together in the pipes on Tauseb and Klein Katvlei and that the kimberlite pipe on Kamiebees contains inclusions of melilite basalt. Geological relationships are not sufficiently clear to confirm this.

From the above it should be clear that a detailed study of the Bushmanland pipes promises to elucidate many intriguing problems of kimberlite geology.

References

1. Du Toit, A.L. 1939. The Geology of South Africa. 2nd.Ed.
2. Edwards, C.B. and J.B.Howkins 1966.Econ.Geol. 61,537-554.
3. Haughton,S.H. 1931. Trans.roy.Soc.S.Afr. 19, 233-249.
4. Kirchheimer,F. 1934. Trans.roy.Soc.S.Afr. 21, 41-50.
5. Rennie,J.V.L. 1931. Trans.roy.Soc.S.Afr. 19, 251-253.
6. Reuning, E. 1931. Trans.roy.Soc.S.Afr. 19, 215-232.
7. Reuning, E. 1934. Trans.roy.Soc.S.Afr. 21, 33-39.
8. Rogers, A.W. 1911. Ann.Rep.Geol.Comm. Cape of Good Hope, 16, 7-84.
9. Taljaard, M.S. 1937. Trans.geol.Soc.S.Afr. 39, 291-316.