



DISCOVERY OF KIMBERLITE PIPES IN THE FORREST RIVER AREA, KIMBERLEY REGION, WESTERN AUSTRALIA

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INTRODUCTION

During the period 1990–1994, Stockdale Prospecting Limited, in Joint Venture with BHP Minerals, undertook extensive diamond exploration within the Forrest River Aboriginal Reserve in the North Kimberley Region, Western Australia (Figure 1). The primary exploration techniques used were aeromagnetic surveys and heavy mineral sampling. Seventeen kimberlite occurrences were identified within the project area. Most are small, dyke-like bodies, however two pipes Pteropus 02 and Seppelt 01 are sizeable with the latter being significantly diamondiferous and of continuing economic interest. This paper presents an overview of the exploration programme which led to the discovery of these pipes and their geochemical and geophysical signature.

REGIONAL GEOLOGY

The North Kimberley Region lies wholly within the Kimberley Basin. The Kimberley Basin comprises a series of near flat lying sedimentary and basaltic units accumulated at approximately 1800 Ma on stable continental crust. The units that outcrop within the exploration area are, from youngest to oldest, the Pentecost Sandstone, Elgee Siltstone and Warton Sandstone. The Carson Volcanics underlies the Warton Sandstone, though it does not outcrop within the project area. The basement age of the Kimberley Basin is unknown, though Archaean has been inferred.

PREVIOUS EXPLORATION

Diamond exploration commenced in the Northern Kimberley with heavy mineral stream sediment sampling by TANKS/CRAE in 1972. Between that time and 1987 CRA Exploration, Stockdale Prospecting, and most extensively BHP Minerals explored the area using heavy mineral sampling, photogeology, aeromagnetism and radiometrics. During this period six major occurrences comprising two pipes (Skerring and Pteropus 01) and four dykes were located.

DISCOVERY OF THE SEPELTT 01 & PTEROPUS 02 PIPES

The Seppelt 01 kimberlite was discovered after heavy mineral stream samples were collected over the whole project area. Large numbers of spinels and diamonds were recovered in drainage samples downstream

of the now known location of the kimberlite pipe, the best result returned 31 diamonds, weighing 1.05 carats and abundant spinels. A geological investigation of the drainage around the likely cut off sample located kimberlite float, and subsequently an outcropping dyke. When the data from a detailed airborne magnetic survey flown over the area became available, a magnetic anomaly in the vicinity of the dyke was evident (Figure 2). This was subsequently drilled and identified as a kimberlite pipe. The Pteropus 02 kimberlite was discovered after heavy mineral stream sampling returned large numbers of kimberlitic spinels in a sample immediately upstream of kimberlite Pteropus 01. The airborne survey identified a magnetic anomaly immediately upstream of this sample site (Figure 5). Drilling confirmed the source of the anomaly as kimberlite.

Seppelt 01

Geology

Seppelt 01 intrudes Pentecost Sandstone. The kimberlite forms two lobes, both of which have a complex geometry. Figure 3 shows the northern lobe. Interpretation of this geometry was made more difficult by the kimberlite's extreme weathering. The first 30 metres of kimberlite have been weathered to kaolinite. Below this more readily recognised hypabyssal kimberlite is encountered. The kimberlite grades from the centre of the body out, having a core of pure kimberlite, which grades into kimberlitic breccia and then into country rock. Kimberlitic breccia is more prevalent in the highest parts of the pipe, suggesting the addition of collapsed country rock material.

Heavy minerals

Seppelt 01 contains large numbers of chrome spinel, rare garnets located only at depth, and no ilmenites. Chemistries of the garnets are shown in Figure 4.

Geophysics

Magnetics—The airborne and ground magnetic data show a clear positive dipolar anomaly associated with each of the two lobes of the

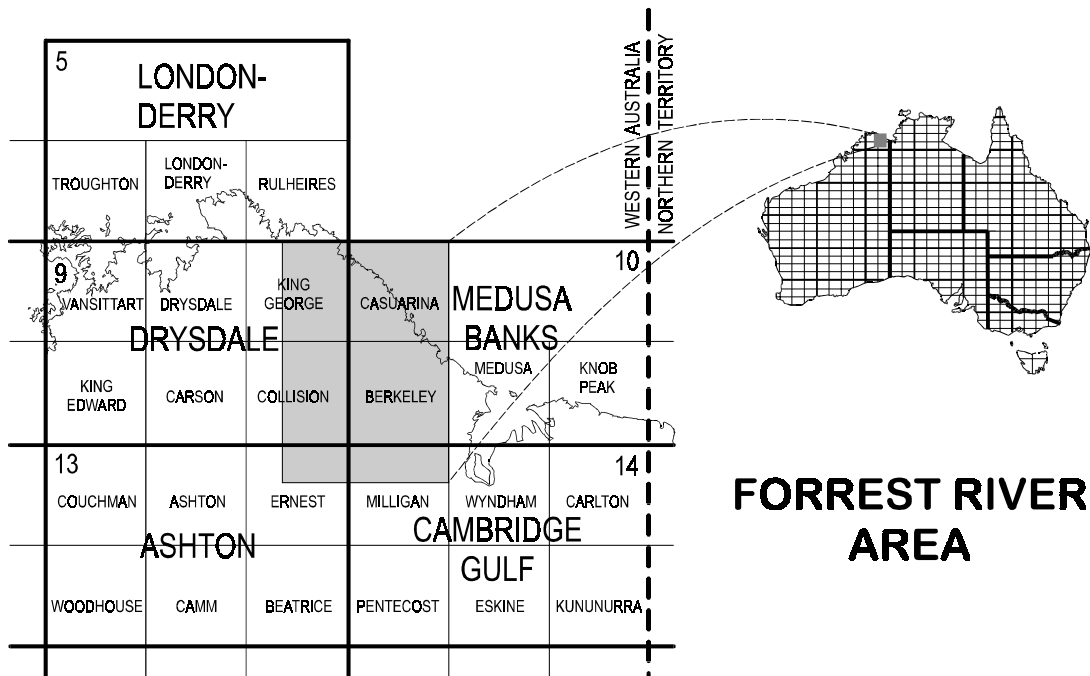


Figure 1: Location of the Forrest River area.

pipe. The measured magnetic susceptibility indicates that the body is strongly magnetic compared with many other kimberlites, i.e., 0.040 SI units, however the observed magnetic anomaly is greatly reduced by a strong reversely magnetised remanent component, determined by measurements on drill core.

Gravity— Gravity data show residual Bouguer gravity lows over both lobes of the kimberlite, with a maximum amplitude of 0.5 mGal. This is considered typical of kimberlites in this environment and is attributed to weathering of the upper part of the pipe.

Electromagnetics— The Dighem helicopter EM system was flown over Seppelt 01. The EM response is interpreted as a weak conductor associated with the top, weathered portion of the pipe. SIROTEM Mk III and Geonics EM-34 time-domain electromagnetic data were acquired over the body. The clearer response is from the latter.

Pteropus 02

Geology

Pteropus 02 intrudes Warton Sandstone, exposed in a valley in the core of an anticline. The kimberlite is made up of hypabyssal kimberlite that grades from pure kimberlite, into kimberlitic breccia, then country rock permeated with kimberlite stringers. A plan of the body is shown in Figure 6. Unlike Seppelt 01 it has not undergone extreme weathering.

Heavy minerals

Pteropus 02 contains chrome spinel, garnets, rare ilmenites, and clinopyroxene. Chemistries of the garnets are shown in Figure 7.

Geophysics

Magnetics—The airborne and ground magnetic data over the Pteropus 02 body shows a clear anomaly associated with the pipe.

Gravity— A residual low of 1.6mGal is associated with the pipe. A smaller low, 0.6 mGal in amplitude is coincident with the Pteropus 01 breccia, which is not resolvable from the magnetic data. It can be seen that the gravity response of the Pteropus 02 pipe infers a larger body than would be interpreted from the magnetic data. It is interpreted that the magnetic response is derived from the magnetic, hypabyssal core of the intrusion, while the gravity response has a significant contribution from brecciated country rock surrounding the central core. The form of the gravity map is somewhat disturbed by the presence of a steep slope to the west of Pteropus 01.

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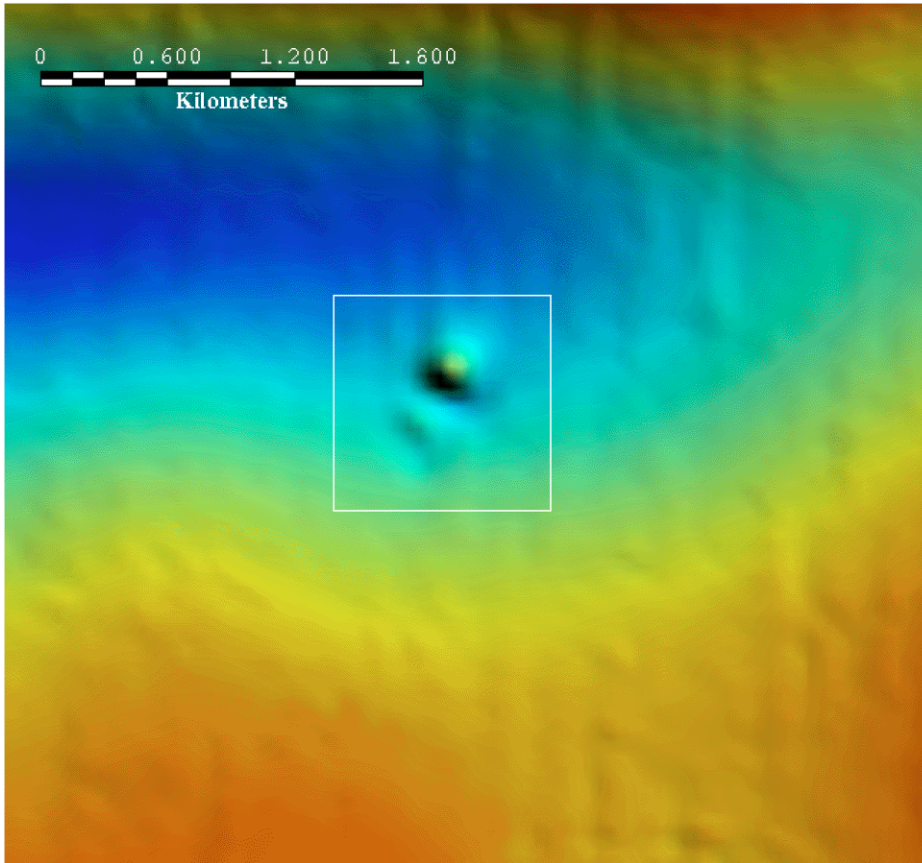


Figure 2: Airborne magnetic data over the Seppelt 01 kimberlite. Line spacing 100 m, sensor height 60 m.

Geological Plan of Seppelt 01 Kimberlite Pipe

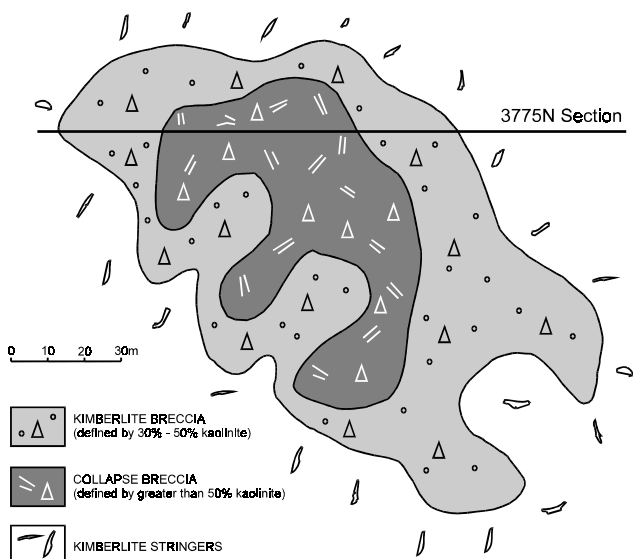


Figure 3: Geological plan of Seppelt 01 kimberlite pipe.

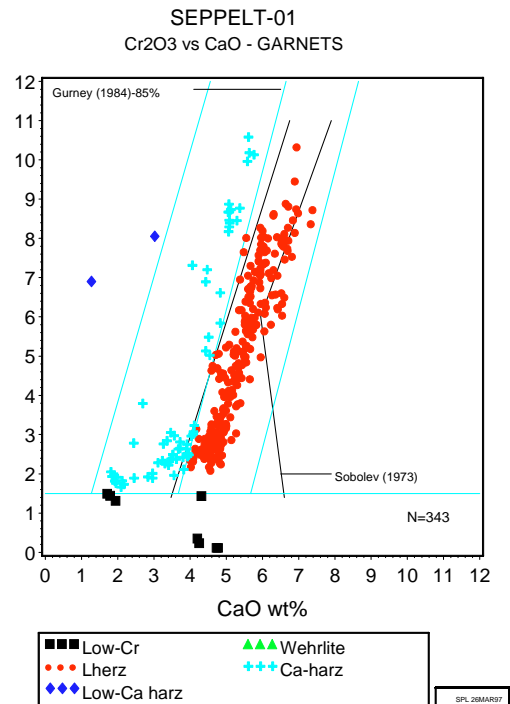


Figure 4: Garnet mineral chemistry—Seppelt 01. Cr_2O_3 vs CaO

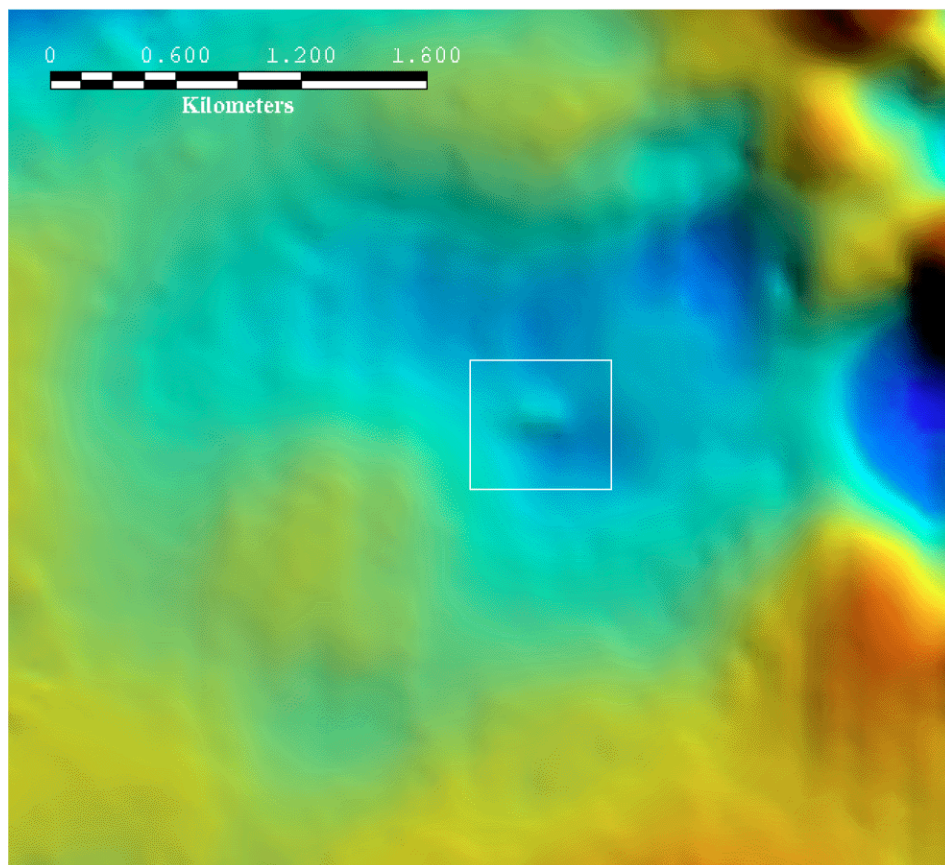


Figure 5: Airborne magnetic data over the Pteropus 02 kimberlite. Line spacing is 100 m, sensor height 60 m.

Geological Plan of Pteropus 02 Kimberlite

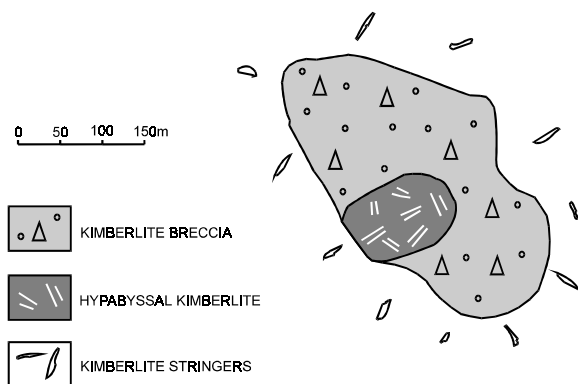


Figure 6: Geological plan of Pteropus 02 kimberlite pipe.

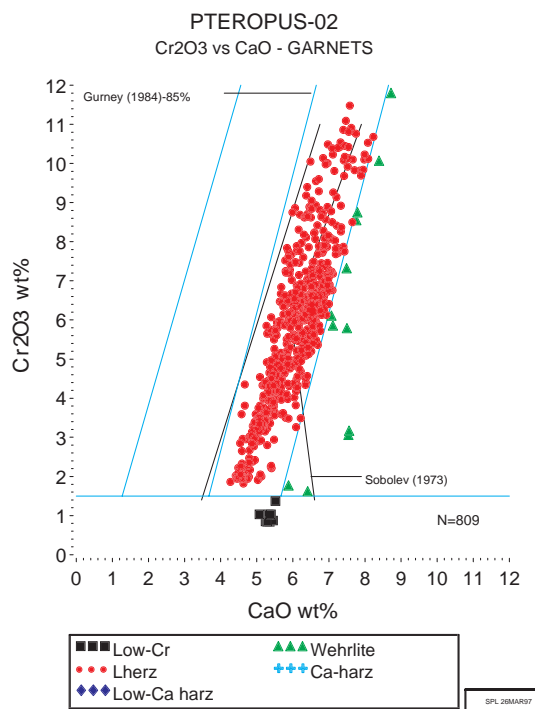


Figure 7: Garnet Mineral Chemistry—Pteropus 02. Cr_2O_3 vs CaO .