FALCONBRIDGE DISCOVERY OF THE GOPE (Go25) (GHAGHOO)
KIMBERLITE, CENTRAL KALAHARI, BOTSWANA

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INTRODUCTION
The Gope (Go25) kimberlite was discovered by Falconbridge Explorations Limited (Botswana) (FELB) in 1981, following a helicopter-supported sampling programme within Reconnaissance Permits RP8/79 and RP1/80, covering approximately 78,500 km², centred on the Central Kalahari area of Botswana (Fig. 1). The majority of this area is covered by sands of the Kalahari Group, with thicknesses up to 100m. Unfortunately, most original company files, including mineral distribution maps and mineral analyses were not available to the author. This paper draws on the excellent summary of the discovery of the Gope (Go-25) kimberlite by Lee et al. (2009), together with the author’s personal recollections.

EXPLORATION RATIONALE AND FIELD PROGRAMME
The reconnaissance sampling area was selected as a target for investigation as it was considered to cover a major portion of the Kaapvaal Craton which had not previously been sampled for kimberlites. The reconnaissance sampling programme was carried out on a grid of approximately 13km x 13km, using photo-mosaics based on 1955 RAF photography, with a scale of 1:125,000, for navigation.

The sample spacing was exceptionally coarse relative to modern kimberlite reconnaissance grids, which are typically 1km x 1km. This coarse grid interval was in part dictated by financial constraints, with the total cost of fieldwork and sample analysis estimated at approximately P80 000 at the time of the sampling was
carried out in 1980. Nevertheless, an important rationale in selecting this sample spacing was the observation that known kimberlites in the Orapa, Kokong and Tsabong fields occurred within areas with a diameter of roughly 40 km. The extent of the Jwaneng cluster was slightly smaller (~20 km diameter). It was envisaged that the planned sample density would result in a block of 2-3 x 2-3 (4–9) samples over sub-Kalahari fields similar in extent to the Kalahari kimberlite clusters known in Botswana at the time. The object was therefore to identify a lead-in to virgin kimberlite fields.

Where possible, sample locations were centred on topographic features such as pans and fossil drainage lines to facilitate their relocation during subsequent follow-up. At each site, semi-continuous surface deflation scoop samples were collected along 1 km long N-S lines, commencing beyond the pan depression. This strategy was aimed at minimising possible sample bias related to pans and relict sand dunes. Total initial sample weight was approximately 20kg (unscreened), which is probably far lower than most modern reconnaissance samples.

Samples were screened in the field to recover the coarse (+425 μm) sand fraction, with the finer fraction retained for possible later analysis. The coarse sand fraction was treated at the Falconbridge exploration dense liquid facility in Gaborone to recover the heavy mineral fraction. In order to minimise the risk of contamination, this facility followed strict protocols to ensure that only exploration samples were processed (i.e. no kimberlite samples were ever treated at this facility). Concentrates were logged microscopically by John Lee (then Chief Geologist) and Andy Moore (project field geologist), to recover any possible kimberlitic indicator minerals (KIMs). In order to extract maximum information from the samples, the numbers of all non-kimberlitic heavy minerals were also recorded.

RESULTS

Discovery of the Gope (Go-25) kimberlite

The sampling programme resulted in the recovery of a number of discrete groupings of kimberlite indicator minerals (KIMs), most of which were ilmenites (Fig. 3). Four +425 μm picro-ilmenites and a pyrope garnet were recovered within a broad area in the southeast of the reconnaissance block (Fig. 3), surrounding the position where the Gope kimberlite was subsequently discovered. Further KIMs were recovered in the south of the reconnaissance block, and a group of relatively MgO-poor (<8.0 % MgO) ilmenites, mostly with Cr2O3-poor compositions, were recovered in the extreme west of the reconnaissance area. In addition, a scatter of highly rounded pyrope garnets (not included in Fig. 3) was recovered in the extreme north of the area sampled.
The finer (250-425μm) sand fraction from areas of anomalous KIM recoveries was then treated, and further micro-ilmenites were recovered. These were then grouped into discrete populations in terms of their chemistry and distribution (Fig. 4). Despite the limited numbers of grains recovered, it is clear from Fig. 4 that there are systematic differences in the ilmenite compositional fields for different areas within the reconnaissance block. This was interpreted by Chris Jennings to provide strong evidence for the presence of a number of discrete kimberlite fields. The Cr-rich and relatively high-Mg characteristics of ilmenites (one +425 μm ilmenite and three additional +250 μm grains) within the area designated Go-1 (Fig. 3 & 4) was considered to be particularly encouraging. To the author’s knowledge, this was the first widely known successful application of ilmenite fingerprinting to kimberlite exploration.

Application was made for prospecting licences over areas with anomalous kimberlite indicator mineral (KIM) concentrations in the south of the Central Kalahari reconnaissance sampling ground, including a block of 4 licences (approximately 4000 km²) covering the soil anomalies designated Go-1 and Go-2 (Fig. 3). Aeromagnetic surveys, with a 500m line spacing, were then flown over these licences. At this time, prior to the advent of GPS systems, this required prior acquisition of aerial photographs for planning of flight paths and visual navigation during flying of the aeromagnetic survey.

Falconbridge’s Gope aeromagnetic dataset proved to be very noisy, reflecting the sub-Kalahari Karoo basalt bedrock. It was screened by Dr. Chris Jennings, who selected a prominent bulls-eye magnetic feature designated Go-25, and a number of further magnetic targets for further investigation. Instructions were given for immediate ground magnetic follow-up of the top three targets which were identified. Within a week of receiving this instruction, Andy Moore, Richard Fynn and the late Dave Adey had located the approximate position of the Go-25 anomaly on the ground, using a chopper for access, and carried out a paced ground magnetic survey (200m line spacing and 25m sample interval) to pinpoint the magnetic target. Richard Fynn then established a 70 km cross-country bush track from the nearest village to the Go-25 target, using aerial photographs to identify landmarks, often only clumps of bushes. This undertaking required remarkable navigational skills, which may perhaps not be readily appreciated by those accustomed to the support of the Global Positioning System (GPS).

A jumper drill was immediately mobilized to drill the Go-25 magnetic target. However, at a depth of about 80m beneath the Kalahari cover, fresh homogeneous Karoo basalt was intersected. It was considered possible that this could represent a large xenolith, and the decision was taken to extend the hole by a further 10m. This revealed that the initially homogeneous basalt capping showed a transition to intense calcite veining with depth, prior to intersecting compact kimberlite. The initial borehole had apparently been sited over a portion of the pipe which had not quite blown the basalt cap!
Further detailed follow-up in Area Go-1 (Fig. 3) resulted in the discovery of four additional smaller diamondiferous kimberlites.

Gem Diamonds subsequently acquired the Gope Kimberlite, which was renamed Ghagoo (the San name for Acacia luederitzii – a common tree in the central Kalahari), and commenced an underground mining operation in 2014. The company reported a grade of 27.6 cpht at an average value of $157/ct for the 6-month period ending 30 June, 2017. However, in February, 2017 the decision was taken to suspend mining operations because of a drop in the average price of stones recovered.

Results of additional follow-up of KIM anomalies within the Central Kalahari reconnaissance block

Three prominent aeromagnetic targets in the Kikao licences were drilled, and proved to be small kimberlites. Ultimately a total of 6 small pipes were discovered associated with the Ki-Ku anomaly, forming two sub-clusters. Unfortunately all of these kimberlites proved to be sub-economic.

Following the signing of a joint venture agreement with de Beers in 1982, Falconbridge, conducted very detailed follow up over the KIM anomalies designated E and F (Fig. 3). This follow-up included an initial low-level aeromagnetic survey with a 500m line spacing, coupled with loam surface sampling on increasingly more detailed grids. The latter work recovered large numbers of kimberlitic ilmenites and very subordinate garnets. Follow-up drilling failed to identify any kimberlites, but indicated that the highest KIM counts appeared to be associated with basal Kalahari gravels. It was concluded that the surface KIM anomaly, now generally referred to as the Dutlwe Anomaly, was secondary, transported from a distal source. Chemical fingerprints of the Dutlwe ilmenites suggested that a majority could be matched with kimberlites in the Jwaneng field to the southeast. However, the source of a subordinate proportion of the ilmenites has not yet been satisfactorily resolved. Nevertheless, subsequent detailed follow-up of the Dutlwe anomaly by a series of other companies also failed to locate any associated kimberlites.

Falconbridge considered that the low MgO and Cr2O3 compositions of the ilmenites associated with Anomaly I, in the west of the reconnaissance sampling block, was not sufficiently encouraging to warrant further follow up. Subsequent work in this area by De Beers found a group of small uneconomic kimberlites (the Okwa cluster), to the south of the headwaters of the Okwa palaeo-drainage. It was also decided not to follow up the diffuse scatter of pyrope garnets in the extreme north of the reconnaissance sampling block, as the absence of associated ilmenites and high degree of rounding of the garnets suggested that they represented a secondary (distal) KIM concentration. A recent assessment of this anomaly (Moore, 2013) supports this interpretation.

IMPLICATIONS FOR KALAHARI KIMBERLITE PROSPECTING PROGRAMMES

Programme design

The Central Kalahari Reconnaissance sampling programme, covering an extensive area (78 500 km2) on a very broad (13km x 13km) sampling grid was completed within 6 months at the cost of about P80 000 (1980 value). Nevertheless this remarkably audacious undertaking was an outstanding technical success, which resulted in the discovery of the Gope, Kikao and Khutse kimberlite fields, and also the major ilmenite-dominated Dutlwe heavy mineral anomaly (anomalous areas E and F, Fig. 3). It also provided the lead-in to the eventual discovery of the Okwa kimberlite field. While this success was in part a reward for leading the field in breaking new ground, it also vindicated a carefully designed exploration concept.

Work by Petra Diamonds has recently discovered an isolated diamond-bearing kimberlite, designated KX36 to the south of the Gope pipe, in the extreme southeast of the area covered by Central Kalahari reconnaissance sampling. The economic potential of KX36 is at present being investigated by Petra Diamonds. The failure by Falconbridge to locate this pipe could possibly be considered to represent a technical failure of the Falconbridge reconnaissance programme. Nevertheless, KX36 is an isolated small (3 ha) pipe, associated with a very subtle, restricted garnet-dominated soil anomaly. Prior to discovery by Petra, KX36 was overlooked during the course of detailed work by a number of companies which carried out exploration programmes in the ground covering the pipe. The discovery of the KX36 kimberlite should therefore rather be regarded as a reflection of the tenacity and technical expertise of the Petra Diamonds diamond exploration team, led by Jim Davidson.

The extreme paucity of ilmenites in KX36 (Lobatlamang et al., 2018) raises the possibility that it might be either a Group II kimberlite (originally recognized by Smith, 1983), or comparable to the ilmenite-poor Group I kimberlites which were discovered in the south of Zimbabwe in the mid- to late- 1990’s. Thus, both in the absence of associated kimberlites, and the paucity of ilmenite, KX36 deviates from the model which formed
the basis of the Falconbridge Central Kalahari reconnaissance sampling programme. The lesson for kimberlite prospectors is to expect the unexpected. This is encapsulated by the wry observation by the late Barry Dawson at the 1st International Kimberlite Conference in 1973 - that the only consistent feature of kimberlites was their variability.

Contamination issues

A critical factor in the successful Falconbridge Central Kalahari sampling programme was use of separate facilities for treating kimberlite and exploration samples. This strict attention to avoiding contamination, ably managed by Carol Spark, the company mineralogist, together with Angelina Yalala, provided considerable confidence that the four widely spaced high Mg/Cr ilmenites recovered in the vicinity of the Gope kimberlite were indeed anomalous, and warranted top priority follow-up.

Implications for sampling strategy

Fig. 5 illustrates the variation in the proportion of the coarse (>425 μm) sand fraction in samples collected within RP 1/80. This shows a remarkably systematic pattern of variation, with the northeast, south and west of the reconnaissance block characterized by relatively high proportions (> 5%) of the coarse sand fraction, surrounding a broad NW-SE swath with low proportions (< 2%) of this sand fraction, (Fig. 5). Areas of coarser sand are associated with higher numbers of tourmalines – the most common non-kimberlitic heavy mineral phase recovered in the coarse sand fraction (Fig. 6). There is a particularly low proportions (<0.5 – 1%) of the > 425 μm sand fraction in the vicinity of the Gope pipe, equating to only 100–200g of the coarse fraction from the original 20 kg sample. Numbers of tourmalines recovered in this area are also relatively low (Fig. 6).

Follow-up sampling in the Gope area showed that very large initial samples (200 kg) were required in order to define localized concentrations of KIMs in the surface Kalahari sand over a sub-Kalahari kimberlite. This is undoubtedly a reflection of the low proportions of the coarse sand fraction in this area. The message is that in designing a sampling programme, the Kalahari sand grainsize characteristics are important in deciding on the initial sample size.
The cover sand which constitutes the Kalahari Formation is often referred to as an aeolian deposit because of the presence of relict surface dune forms. However, the pattern of grainsize variation (Fig. 5) and distribution of tourmalines (Fig. 6) seems incompatible with an aeolian deposition, dominated by the prevailing easterly to north-easterly wind. The thickness of the Kalahari Formation decreases to the northeast of the Central Kalahari reconnaissance block, with minimal cover over the Orapa AK-1 kimberlite, and also towards the Bakalahari Schwelle in the south, where basement outcrops sporadically. Coarser grainsize and increasing numbers of tourmalines thus indicate proximity to the margins of the Kalahari Basin. Moore and Dingle (1999) argue that these patterns are consistent with a fluvio-lacustrine depositional model within a Kalahari sub-basin, as originally envisaged by du Toit (1927) and subsequently by Du Plessis and Le Roux (1995). Areas of coarser sand and higher numbers of non-kimberlitic heavy minerals, closer to the basin margins, were interpreted to reflect lags, resulting from winnowing and transport of the finer sediment fraction, which was deposited as the broad northwest – southeast trending swathe in the distal portion of the basin (Fig. 5). Relict surface dune forms are interpreted to represent later Aeolian reworking of the Kalahari surface sand, probably during arid Pleistocene climatic episodes.
CONCLUSIONS

A highly audacious exploration programme, carried out over the previously unsampled remote area of the Central Kalahari, resulted in the discovery of several virgin kimberlite fields. This success was underpinned by the innovative approach of the senior management of FELB (Chris Jennings, John Lee, Roger Billington and John Blaine), and the meticulous attention to avoid contamination issues at the company heavy mineral recovery facility, managed by Carol Spark and Angelina Yalala.

ACKNOWLEDGEMENTS

The editor (A. Proyer) and reviewer (Z. Bagai) are thanked for their constructive comments. Working with the highly motivated and innovative Falconbridge exploration team was one of the great privileges of my professional career. The Falconbridge senior management (Chris Jennings, John Lee, John Blaine and Roger Billington) must take a bow for conceiving and designing the audacious Central Kalahari reconnaissance programme. The success of the programme was in no small measure dependant on the meticulous maintenance of a clean heavy mineral exploration and mineralogical laboratory by Carol Spark and Angelina Yalala and their team of mineral pickers. Shawn Nthlaile collected half of every sample, and the Republic Air pilots (Fig. 7) provided highly reliable professional support, and (mostly) indulged the author’s habit of cluttering the aircraft with Kalahari vegetation specimens. John Jeffes is in particular remembered for his tale of discussing the concept of “mana” (“tomorrow”) with a Shetland farmer. When asked whether there was an equivalent word in Gaelic, the Shetlander commented sagely (with a broad Scottish accent): “Nae laddie. I cannae think of a single word in Gaelic which expresses such urgency.”

REFERENCES


