# THE EFFICIENCY OF FLUVIAL TRAP SITES TO CONCENTRATE KIMBERLITIC MINERALS: AN EXPERIMENTAL SAMPLING PROGRAMME

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The selection of optimum river-bed trap sites for heavy minerals associated with kimberlites, lamproites or other potential diamond host rocks is based largely on theoretical predictions about fluvial processes, combined with cumulative prospecting experience spanning several decades. There is relatively little published information on heavy-mineral distribution within the fluvial environment, and a particular paucity of data relating specifically to diamond-indicator minerals. This paper discusses a small-scale experiment carried out to test the validity of traditional stream-gravel sampling methods used for diamond prospecting.

A sampling location was selected in the Kimberley Region of Western Australia (Fig. 1). Apart from the highly diamondiferous Argyle lamproite (AK1), this Region hosts a large range of other lamproites, some also diamondiferous, as well as a few, mainly barren, kimberlites. A comprehensive network of rivers, active on a seasonal basis, cuts the central craton and its flanking mobile zones, generally providing excellent conditions for stream-sampling operations. Within this environment there were a number of constraints on the selection of the location for the experiment. It was essential to choose a river site where gravels would yield a sufficient quantity of kimberlitic indicator minerals to permit a viable statistical study of their distribution. Moreover, it was important to conduct the experiment within a restricted length of river to minimize bias in results caused by variations in the creek load and distance from the kimberlitic source(s). The test locality had also to include a variety of stream-bed environments to provide a suitable range of trap sites. The location chosen on the Wilson River (16°49'S, 127°50'E) embraces the abovementioned criteria. Previous sampling during regional exploration had indicated moderate quantities of picroilmenite and traces of pyrope-garnet in the gravels at this point. The Devils Elbow kimberlite dykes of the East Kimberley Kimberlite Province lie around 15 kilometres upstream.

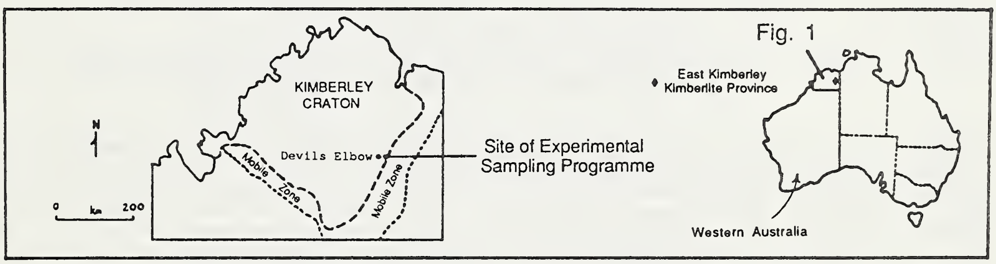


**Fig. 1** Sampling Location: Kimberley Region, Western Australia

Twelve samples were collected from sites up to 200 metres apart, but generally much closer. Each site was classified in the field into one of five categories, from "good" through to "poor", based on a set of standard river-bed conditions for assessing the quality of a diamond prospecting sample (Fig. 2). All samples initially had the same volume (equivalent to 10.8 ± 0.2 litres) and consisted of the minus 4 millimetre fraction screened on site. Sample weights, and volumes in the later processing stages, of the heavy-mineral fractions were recorded during the successive steps of laboratory processing in order to monitor relative weights and increasing sample densities during heavy-mineral concentration to achieve final densities exceeding 2.95. Table 1a shows, for each sample, the initial field-assessed trap-site ratings, and the results for each stage of laboratory processing, listed in sample-number sequence. Final ratings, based on the number of picroilmenite grains present in each sample, are also shown. Studies of final heavy-mineral concentrates provided counts of kimberlitic indicator-mineral grains and percentage estimates of phases occurring in the accompanying detrital suite.

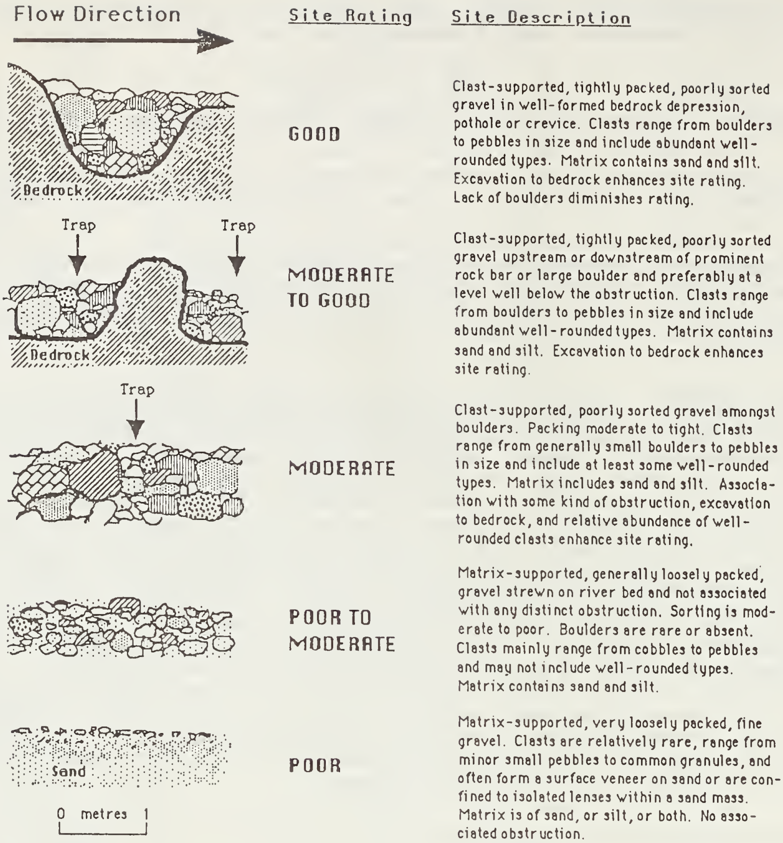


**Fig. 2** Broad Field Classification of Heavy-Mineral Trap Sites. Diagrams are of River-Bed Cross Sections Parallel to Main Water Flow Direction.

Table 1b contains a brief description of each trap site, with samples listed in sequence of declining initial trap-site ratings. Their corresponding amended ratings, based on picroilmenite grain counts, are also shown. Although there are some interesting exceptions, the results show that field site-ratings based on conventional concepts are reasonably accurate. There is strong evidence to show that the commonly adopted traditional practice of sampling the deepest part of the main, active flow-channel is of prime importance. A common belief when collecting uniform-size diamond prospecting samples is that relatively heavy ones, assuming all wet or all dry conditions, signify the best traps. The results in Table 1c, listed according to diminishing final site ratings, demonstrate this concept to be very misleading. In this experiment, the initially least dense samples generally became the most dense after heavy-mineral concentration, and tend to correlate with the more effective trap sites. Where poor sampling conditions prevail, choice is often restricted to a sample site located by a midstream obstacle, such as a rock bar or tree trunk, and a trap amongst loose, extremely fine gravel (less than 1 cm diameter) strewn on the river-bed surface with no nearby obstruction. The results suggest that the former is more likely to trap kimberlitic minerals, even if the site has no obvious gravel. A study of the distribution of heavy minerals in different grain size-fractions provides further insight into the most favourable conditons for trapping kimberlitic species.

In summary, mineralogical information derived from a set of experimental, diamond-prospecting samples, combined with detailed descriptions, including observations of sorting and packing, of their river-bed locations provide a basis for reviewing trap-site selection for kimberlitic indicator minerals.

## Table 1a Laboratory Processing Results

| SN | Field | A | IW | B | ID | C | WT | D | W2 | E | WF | F | TB | G | FD | H | NP | I | Final |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | GOOD | 2 | 23.8 | 9 | 2.2 | 9 | 7.5 | 3 | 4.0 | 2 | 1.7 | 4 | 74.2 | 11 | 3.7 | 5 | 25 | 4 | MODERATE TO OOOD |
| 2 | MODERATE TO GOOO | 3 | 22.0 | 11 | 2.0 | 11 | 6.3 | 8 | 4.0 | 2 | 2.0 | 2 | 229.4 | 3 | 3.9 | 2 | 43 | 3 | MODERATE TO GOOD |
| 3 | MOOERATE TO GOOD | 5 | 19.7 | 12 | 1.8 | 12 | 3.3 | 12 | 1.6 | 12 | 0.9 | 6 | 155.0 | 4 | 4.1 | 1 | 47 | 2 | MODERATE TO GOOD |
| 4 | GOOD | 1 | 27.0 | 7 | 2.5 | 7 | 5.1 | 8 | 1.7 | 8 | 0.8 | 7 | 95.6 | 7 | 3.8 | 4 | 59 | 1 | GOOD |
| 5 | MODERATE | 6 | 23.3 | 10 | 2.2 | 9 | 6.9 | 4 | 3.5 | 5 | 1.7 | 4 | 95.5 | 8 | 3.2 | 11 | 4 | 6 | POOR TO MOOERATE |
| 6 | POOR TO MODERATE | 8 | 30.4 | 5 | 2.8 | 3 | 4.3 | 9 | 1.7 | 8 | 0.7 | 8 | 81.2 | 10 | 3.6 | 7 | 4 | 8 | POOR TO MODERATE |
| 7 | POOR | 11 | 30.0 | 6 | 2.8 | 3 | 8.4 | 2 | 6 5 | 1 | 3.9 | 1 | 112.4 | 6 | 3.1 | 12 | 0 | 12 | POOR |
| 8 | POOR | 10 | 31.9 | 1 | 2.9 | 1 | 4.2 | 10 | 1.7 | 8 | 0.7 | 8 | 89.7 | 9 | 3.4 | 10 | 2 | 10 | POOR |
| 9 | POOR TO MODERATE | 9 | 30.6 | 4 | 2.8 | 3 | 6.1 | 7 | 4.0 | 2 | 1.3 | 5 | 279.9 | 2 | 3.5 | 8 | 4 | 6 | POOR TO MODERATE |
| 10 | MODERATE TO GOOO | 4 | 31.0 | 2 | 2.9 | 1 | 3.9 | 11 | 1.7 | 8 | 0.8 | 7 | 115.3 | 5 | 3.9 | 2 | 3 | 9 | POOR TO MODERATE |
| 11 | MODERATE | 7 | 24.7 | 8 | 2.3 | 8 | 6.4 | 5 | 2.7 | 7 | 1.9 | 3 | 351.7 | 1 | 3.5 | 8 | 18 | 5 | MODERATE |
| 12 | POOR | 12 | 30.8 | 3 | 2.8 | 3 | 8.8 | 1 | 3.5 | 5 | 0.8 | 7 | 72.8 | 12 | 3.7 | 5 | 1 | 11 | POOR |

## Table 1c Sample Density Comparisons

| SN | Final | I | IW | B | ID | C | FD | H |
|---|---|---|---|---|---|---|---|---|
| 4 | GOOD | 1 | 27.0 | 7 | 2.5 | 7 | 3.8 | 4 |
| 3 | MODERATE TO GOOD | 2 | 19.7 | 12 | 1.8 | 12 | 4.1 | 1 |
| 2 | MODERATE TO GOOD | 3 | 22.0 | 11 | 2.0 | 11 | 3.9 | 2 |
| 1 | MODERATE TO GOOD | 4 | 23.8 | 9 | 2.2 | 9 | 3.7 | 5 |
| 11 | MODERATE | 5 | 24.7 | 8 | 2.3 | 8 | 3.5 | 8 |
| 5 | POOR TO MODERATE | 6 | 23.3 | 10 | 2.2 | 9 | 3.2 | 11 |
| 9 | POOR TO MODERATE | 8 | 30.6 | 4 | 2.8 | 3 | 3.5 | 8 |
| 6 | POOR TO MODERATE | 8 | 30.4 | 5 | 2.8 | 3 | 3.6 | 7 |
| 10 | POOR TO MOOERATE | 9 | 31.0 | 2 | 2.9 | 1 | 3.9 | 2 |
| 8 | POOR | 10 | 31.9 | 1 | 2.9 | 1 | 3.4 | 10 |
| 12 | POOR | 11 | 30.8 | 3 | 2.8 | 3 | 3.7 | 5 |
| 7 | POOR | 12 | 30.0 | 6 | 2.8 | 3 | 3.1 | 12 |

## Table 1b Sample Trap-Site Ratings and Descriptions

| SN | Field | A | Description | % BP | X | NP | I | Final |
|---|---|---|---|---|---|---|---|---|
| 4 | Good | 1 | Very tightly packed, poorly sorted gravel amongst large local granitic boulders near rock outcrop. Site at deepest point in main channel. Bedrock reached during excavation and sample material removed to this depth. Sample sites Nos 1-3 a few metres away. | 85 | 1 | 59 | 1 | Good |
| 1 | Good | 2 | Tightly packed, poorly sorted gravel amongst local granitic boulders and bedrock. Deep point in main channel. Fairly high mud content at base probably reflects bedrock weathering. Bedrock reached and sample material removed to this depth. Sample sites Nos 2-4 a few metres away. | 85 | 1 | 25 | 4 | Moderate to Good |
| 2 | Moderate to Good | 3 | Similar to sample No.1, but site amongst boulders only (no bedrock). Bedrock not reached during excavation. Sample sites Nos 1, 3 and 4 a few metres away. | 85 | 1 | 43 | 3 | Moderate to Good |
| 10 | Moderate to Good | 4 | Good wedge-shaped trap on downstream side of small rock bar. Loose sand only on top but, below this, poorly sorted, fairly tightly packed gravel. Fairly low point in main channel but not as low as site for No. 4. Bedrock reached and sample excavated to this depth. | 75 | 5 | 3 | 9 | Poor to Moderate |
| 3 | Moderate to Good | 5 | Same type of site as No. 2 but at deeper point in main channel. Tree roots also present. Bedrock not reached during excavation but suspected close due to relative position and excavation depth of nearby sample site No.1, and increase of clay towards bottom of hole. | 85 | 1 | 47 | 2 | Moderate to Good |
| 5 | Moderate | 6 | Site near the northern bank approaching or in flood-level zone at much higher level than site Nos 1-4. Rather loosely packed, poorly sorted gravel of pebbles and cobbles up to 10 cm diameter in good wedge-shaped bedrock trap. Sample hole very deep, but bedrock not reached. | 65 | 6 | 4 | 6 | Poor to Moderate |
| 11 | Moderate | 7 | Similar to site No. 9 but material more tightly packed, amongst a few boulders. Site at a fairly low point in main channel. Packing in trap became tighter with depth of sample hole. Bedrock not reached during excavation. | 60 | 7 | 18 | 5 | Moderate |
| 6 | Poor to Moderate | 8 | Site a few metres away from that of No. 5 at same height near or at flood level. A small saucer-shaped bedrock trap with very loosely packed pebbley gravel, clasts up to 3 cm diameter, mainly 1 cm or less. Sample hole closely approached, but did not reach, bedrock. | 50 | 8 | 4 | 6 | Poor to Moderate |
| 9 | Poor to Moderate | 9 | Site on downstream side of bouldery area consisting of large local granitic boulders and bedrock. No distinct trap at site. Sample consisted of essentially matrix-supported gravel with very loosely packed pebbles up to 6 cm diameter, mainly 2-3 cm. Bedrock not reached during excavation. | 45 | 9 | 4 | 6 | Poor to Moderate |
| 8 | Poor | 10 | Similar to site No. 7 but gravel coarser, up to 1 cm diameter. Sampled material consisted of a thin surface scrape of fine, matrix-supported gravel overlying sand in a mini-channel. Gravel not present in sand below about 1 cm from surface. Bedrock not reached during excavation. | 8 | 10 | 2 | 10 | Poor |
| 7 | Poor | 11 | No trap. Sampled material consisted of a thin surface scrape of fine, matrix-supported gravel (granules up to 3mm diameter) overlying sand near prominent bend in river. Site fairly low in main channel. Sand contains some granules to 3 cm depth. Bedrock not reached during excavation. | 5 | 11 | 0 | 12 | Poor |
| 12 | Poor | 12 | Small, wedge-shaped bedrock trapon downstream side and at base of steep outcrop. Material at site almost entirely sand with rare granules, chiefly granitic (derived locally). Possibly material would become coarser below surface sand. Bedrock not reached during excavation. | 1 | 12 | 1 | 11 | Poor |

## Abbreviations

| | |
|---|---|
| SN | **Sample number** |
| Field | Field trap-site ratings (initial ratings) based on standard assessment criteria |
| A | Index for Field: Best initial rating (1) to worst (12) |
| IW | Initial dry sample weight (kg) |
| B | Index for IW: Initially heaviest sample (1) to lightest (12) |
| ID | Initial density (based on standard initial sample volume of 10.8 litres) |
| C | Index for ID: Initially most dense (1) to least dense (12) |
| WT | Weight (kg) of heavy-mineral (HM) fraction after Wilfley Tabling |
| D | Index for WT: Heaviest after Wilfley Tabling (1) to lightest (12) |
| W2 | Weight (kg) of minus 2 mm HM fraction after Wilfley Tabling |
| E | Index for W2: Heaviest of the minus 2 mm HM fractions (1) to lightest (12) |
| WF | Weight (kg) of 2 - 0.4 mm HM fraction after Wilfley Tabling: Fraction used for subsequent studies. |
| F | Index for WF: Heaviest of the 2 - 0.4 mm HM fractions (1) to lightest (12) |
| TB | Weight (g) of - 2 mm HM fraction ("sinks") after immersion in tetra-bromoethane (TBE): TBE density = 2.95. |
| G | Index for TB: Heaviest of the HM TBE "sinks" fractions (1) to lightest (12) |
| FD | Final density, of the HM TBE "sinks" fraction. |
| H | Index for FD: Most dense of the "sinks" fractions (1) to least dense (12) |
| NP | Number of picroilmenite grains recovered from 2 - 0.4 mm HM TBE "sinks" fraction: This determines the revised trap-site ratings ("Final"). |
| I | Index for NP: Greatest number of picroilmenite grains (1) to smallest (12) |
| Final | Revised trap-site ratings based on number of picroilmenite grains in 2 - 0.4 mm HM TBE "sinks" fraction. |
| % BP | In situ field estimate of percentage of gravel (including boulders) to sand in trap-site. |
| X | Index for % BP: Highest percentage of gravel (1) to lowest (12) |