THE ALLUVIAL DIAMONDS OF THE WESTERN TRANSVAAL, SOUTH AFRICA

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Alluvial diamonds are distributed over an extensive area of the western and south-western Transvaal (Fig. 1). Within the region, three major fields are developed : (i) the Lichtenburg-Bakerville Field, developed on the dolomite plain in the north; (ii) the Ventersdorp-Klerksdorp-Potchefstroom Field to the northeast; and (iii) the Christiana-Schweizer-Reneke-Wolmaransstad Field in the southwest. Scattered between and around these fields, as far as Mafikeng, are numerous small and sporadic patches of diamondiferous gravels. The diamond-bearing gravels appear to be confined to the Vaal-Harts interfluve, the dolomite plain, and the present channels of the Vaal River and its right-bank tributaries, between Potchefstroom and Christiana. The total area embraced is of the order of 25 000 sq. km, having a southwest-northeast length of 300 km, and a maximum width of 170 km. Between 1904 and 1984, a total of 14,4 million carats were recovered from the gravels, valued at R141,6 million (Table I). The average realized value of the diamonds was thus R9,83 per carat. For comparison, the Big Hole of the Kimberley pipe yielded, after 44 years of mining, 14,5 million carats, valued at R100,0 million, and averaging R6,90 per carat. On surface, this pipe measured 490 x 450 m, and covered an area of 0,15 sq. km (15,4 ha). Mining terminated at a depth of 1098 m, after 25,4 million metric tonnes of kimberlite had been excavated.

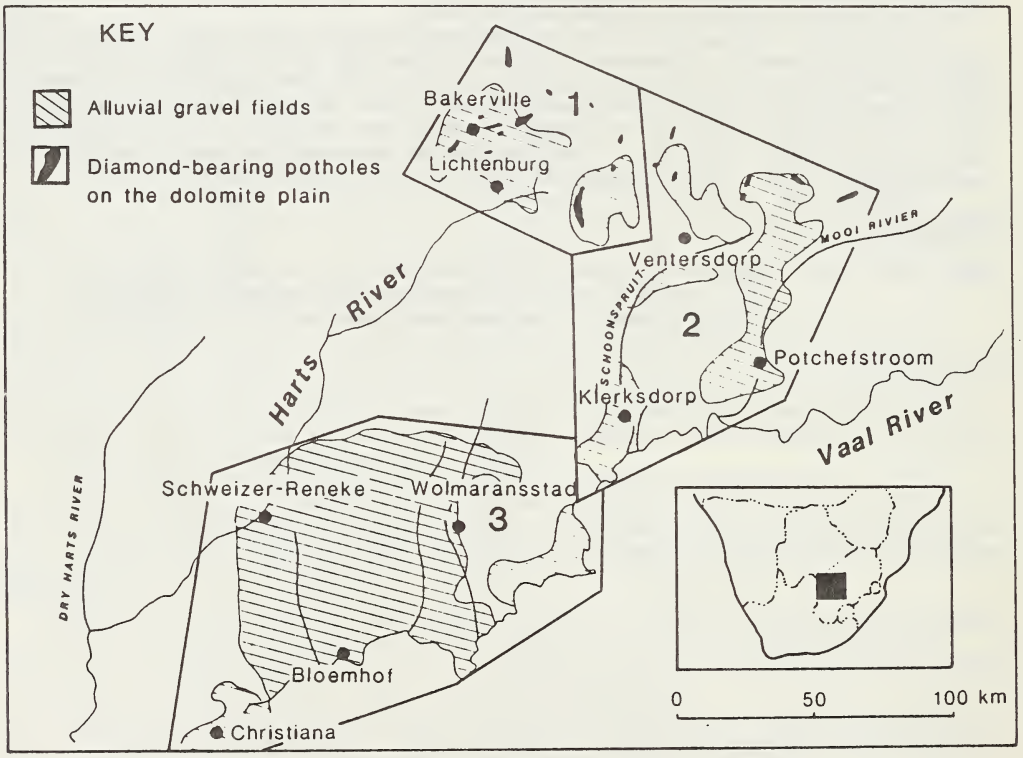

Figure 1 : Locality of the diamond-bearing alluvial gravels of the Western Transvaal, showing the Northern (Bakerville-Lichtenburg) Field (1), the Eastern (Ventersdorp-Potchefstroom-Klerksdorp) Field (2), and the Southern (Christiana-Schweizer-Reneke-Wolmaransstad) Field (3).

TABLE I
ALLUVIAL DIAMOND PRODUCTION (1904-1984)

FIELD	TOTAL PRODUCTION (CARATS)	TOTAL VALUE (RANDS)	AVE. VALUE (R/CARAT)
Lichtenburg-Bakerville (Northern Field)	9 766 224,21	52 185 860	5,34
Christiana-Bloemhof-Wolmaransstad (Southern Field)	1 961 747,74	66 614 577	33,96
Ventersdorp-Klerksdorp-Potchefstroom (Eastern Field) and scattered occurrences	2 674 080,66	22 835 527	8,54
TOTAL	14 402 052,61	141 635 864	9,83

The Gravel Deposits

On the dolomite plain the diamondiferous gravels occur both in potholes and terraces in what appears to be palaeo-river courses (du Toit, 1951). Here, the gravels are dominated by cherty and dolomitic angular detritus, similar to that found on the present-day surrounding deflation surfaces. The diamonds, however, are associated with the rubefied, colluvially-reworked portions of the gravels that contain abundant proportions of mullberry-wash (small manganiferous concretions). In the southern and eastern alluvial fields, the gravels are found on Palaeozoic terraces, on terraces associated with the Tertiary Vaal drainage system, and in and along the present stream channels. The oldest gravels, occurring on exhumed pre-Karoo terraces, represent remnants of original fluvial gravels of a high-competence river (the ancestral-Vaal) and of predominantly colluvial gravels veneered across generally planar segments of the Palaeozoic surface, indicative of a long period of continuing erosion (Helgren, 1979). The younger gravel deposits are confined almost exclusively to the terraces and channels associated with the Quaternary Vaal-Harts drainage lines. These gravels are often highly calcretized, once again indicating extended periods of subaerial exposure. An analysis of the pebbles has indicated that the gravels have been derived from both local and extrabasinal sources (Helgren, 1979) :

(a) material derived from extrabasinal sources includes striated clasts of Waterberg and Transvaal material obviously derived from the northern Transvaal, pebbles from eastern Botswana (found only in the London Run between Schweizer-Reneke and Bloemhof), and fine bedload identical to that found in all rivers which drain the high Lesotho plateaux;

(b) locally, material has been derived from the Karoo rocks (shales and dolerite), from the Ventersdorp lavas, from the reworking of the older gravel deposits, and from the detritus on the dolomite plain; furthermore the nearby Dwyka tillite and dropstone beds have been eroded to produce the extraneously derived, striated Waterberg and Transvaal pebbles mentioned above.

Apart from the small amounts of material emanating from eastern Botswana and the fine bedload originating on the Lesotho highlands, all the other clasts have been eroded from local material. This is also obvious from the sub-angular nature of many of the gravel clasts.

The Diamonds

The Lichtenburg-Bakerville Field, between 1926 and 1984, yielded 9,7 million carats (68 per cent of the alluvial diamonds of the western Transvaal), with an average value of only R5,34 per carat. In contrast, the Southern Field has contributed 14 per cent of the diamonds, but, with an average value of R33,96 per carat, has realized over R66,6 million. This difference may be attributed to the differing nature of the processes responsible for the concentration of the gravels in the two fields and to an abundance of pure, snowy-white brilliant stones and blue-white cleavages found in the Southern Field

(Wagner, 1914). A review of the literature concerning the diamonds themselves indicates that the majority of these are of unknown origin. Some of the diamonds, however, are traceable : the pale green diamonds found only in the Schoonspruit are derived from the Witwatersrand uraniferous conglomerates of the Klerksdorp Goldfield (Wagner, 1914); those diamonds that show distinct signs of glacial attrition were initially transported from the northern Transvaal by the Dwyka glaciers and were subsequently eroded from the tillite deposits (Harger, 1909); and some of the diamonds have been reported as having similar characteristics to those found in the pipes of the Orange Free State (Wagner, 1914).

Discussion

Earlier theories (Stratten, 1979) have hypothesized that the gravels and the associated diamonds were derived from kimberlite intrusions in eastern Botswana and the northwestern and northern Transvaal. However, it has been shown that almost all the gravel is of local origin, and the implication is that the diamonds are as well. Further, studies of erosion surfaces in the area indicate that the Cretaceous landscape was lowered by relatively-humid fluvial processes (accompanied by extensive laterite development), followed by semi-arid deflation and calcretization of the subsequently formed mid-Tertiary erosion surfaces. Under such circumstances the dominant surface processes would lower the surface vertically, allowing any gravels to accrue as lag accumulation. Structural studies in progress (D.A. Pretorius, pers. comm., 1986) show that the exposed basement granite between Lichtenburg and Wolmaransstad is the result of a structural culmination. On the northeastwards extension of the upwarp axis occur the diamondiferous kimberlites of Swartruggens and the Pilanesberg and, on the south-westward extension, the fissures and pipes of Barkly West and Kimberley. It is suggested that other diamond-bearing kimberlites were emplaced along the upwarp between Swartruggens and Barkly West (along the Vaal-Harts interfluve) and the accentuated uplift of the structural culmination in this area led to the complete erosion of these bodies. The extended period of erosion that followed allowed for the development of the lateritic horizons and the destruction of the pyrope garnets and other kimberlitic indicator minerals that are obviously lacking in the gravel deposits and soil profiles today. Later reactivation of the structural culmination resulted in the reworking of the older gravel deposits into the Pliocene-to-Recent stream channels adjacent to the palaeotopographic high, and in the depression of the lateratized surface both to the north (Kalahari basin) and to the south (western Orange Free State) of it.

Morphotectonic analysis of the mid-Tertiary landscape in the Orange Free State indicates that it was drained by a large, east-west flowing river, situated to the north of Kimberley. The gravels of this river have been downwarped, along with its associated erosion surface, and are buried beneath cultivated farmlands. It is suggested that the gravels of this river were derived from the same deflation surface as gave rise to the diamondiferous deposits of the western Transvaal and, therefore, should contain the same basal, diamond-bearing, older gravel units.

The new model that is thus proposed for the development of the alluvial diamondiferous gravels of the western Transvaal suggests that the source of the diamonds was kimberlite intruded into the area now underlain by the gravels and that the optimum concentration of the alluvial diamonds is a product of maximum tectonic uplift and the consequent erosion of *in situ* diamondiferous kimberlites.

References

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