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LOCATION AND REGIONAL GEOLOGY

The Argyle alluvial diamond deposits are associated with the AK1 pipe, a lamproite diatreme of 50 hectares surface area located in the Halls Creek Mobile Zone 120km south of the town of Kununurra in the Kimberley region of Western Australia.

The pipe forms a 200m deep valley in the northerly dipping Proterozoic sediments of the Matsu Range. Smoke Creek and Gap Creek, a tributary of Limestone Creek, originate in the range and flow across the surrounding plains into Lake Argyle 35km distant (fig. 1). Diamonds derived by erosion of the pipe are found in both drainages. Coarse diamondiferous scree deposits cover the surface of the pipe.

DISCOVERY

In August 1979 diamonds were recovered from 40kg-sized gravel samples taken in Smoke Creek as part of a regional drainage sampling programme carried out by the Ashton Joint Venture. Follow-up work led to the recognition of the Smoke Creek alluvial deposits and the AK1 diatreme one month later (Atkinson et al, 1984). The Limestone Creek deposit was identified in 1981 after further sampling.

ALLUVIAL GEOLOGY

Smoke Creek

The economic Upper Smoke Creek deposit occurs directly to the north of the pipe and comprises coarse, poorly sorted, massively bedded modern floodplain deposits situated upstream of a gap in the hills formed of the Devonian Ragged Range Conglomerate, and underlain by Cambrian Antrim Plateau Volcanics.

Downstream of the gorge are located the lower grade Lower Smoke Creek deposits where three deposit types are recognised; modern floodplain deposits, Pliocene low terrace gravels and a high level lateritised terrace of Miocene age. The floodplain gravels, up to 4m in thickness, form a broad, sinuous and partly braided tract. The low terrace gravels occur as terrace remnants 4m above the floodplain and exhibit incipient lateritisation. A 2m thick lateritised and lightly cemented gravel comprises the high terrace which occurs 8m above the floodplain and forms the high ground flanking Smoke Creek.

Limestone Creek

Directly to the east of the pipe are situated the Limestone Creek deposits where modern floodplain, low terrace and lag gravels occur derived from the partial erosion of a lateritised and partly duricrusted Pliocene age piedmont fan. The deposits range to 3.5m in thickness and blanket the undulating granitic rocks of the Lower Proterozoic Lamboo Complex (fig. 2). The fan splays south east from the foot of Matsu Range and may be subdivided into proximal facies with coarse, angular and poorly sorted detrital sediments, and distal facies with subrounded clasts, reasonable sorting and interdigitiation of gravel with sand lenses (Meakins, 1983). With increasing distance from source the fan deposits grade into coarse channel fill gravels which occur as remnant terraces along the creek.

The alluvial deposits have little or no overburden near source with increasing sand and silt overburden in the lower reaches of the creeks.

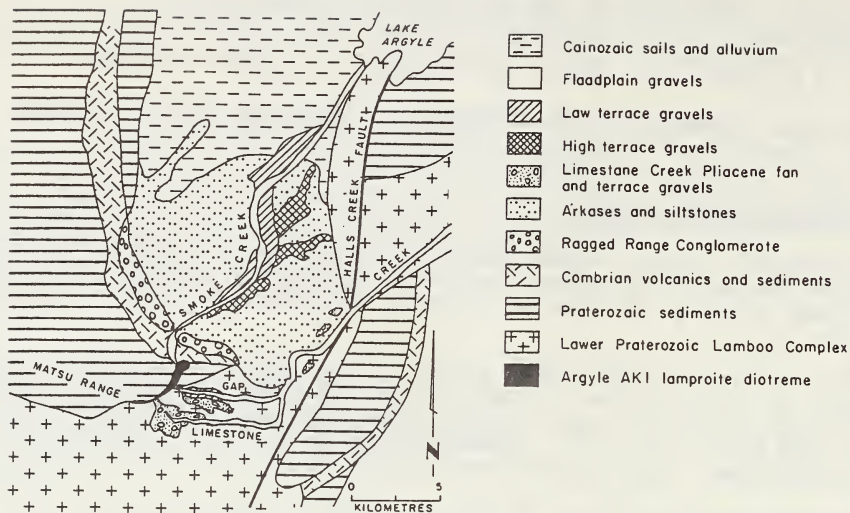


Fig. 1. Argyle diamond deposits, geology and geographic distribution

Age determination of the deposits is based on the geomorphological relationships of the terraces, supported by Mössbauer spectroscopic investigations of the relative degree of development of crystallinity, and hence of age, shown by iron-oxide pisolites and ferruginous cement in the gravels.

Diamond Size Distributions

Each geologically homogeneous economic deposit type has its characteristic lognormal size distribution and price per carat. Mean stone sizes range from 0.08 carats per stone (ct/st) to 0.24 ct/st. The high level terrace and lag gravels contain the larger diamond populations. The alluvial diamonds have larger mean stone sizes and higher value compared to diamonds from the pipe. Quality is also better due to elimination of the weaker and more fractured pipe diamonds during alluvial transportation.

DIAMOND DISTRIBUTION

Spatial Variations

In contrast to many of the classic African alluvial diamond deposits, the economic Argyle alluvials are only marginally removed from, and poorly enriched in relation to the primary source. This is a reflection of the steep gradient in the source area, the abrupt change in creek gradient at the surrounding plains, and the semi-arid environment with sporadic but intense rainfall.

Their high grades are derived from the high grade of the AK1 pipe which averages 5 carats per tonne (ct/t) grade at surface.

The Upper Smoke Creek gravels average 4.6 ct/t with a mean stone size of 0.08 ct/st. Grades decrease laterally from the creek channel (5-10 ct/t) to the edge of the floodplain (1-2 ct/t). With increasing distance from source there is a steady decrease in grade due to dilution and a decrease in diamond size. At 20km from the pipe grades in the floodplain gravels are reduced to 0.05 ct/t and mean stone size to 0.05 ct/st.

Vertical Variations

In all deposit types diamonds occur throughout the gravel profile but with a

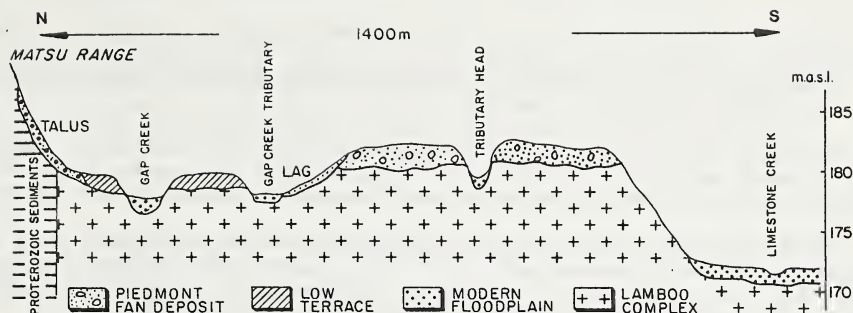


Fig. 2. Schematic cross-section of Limestone Creek deposit 1.5 km downstream of AK1 pipe.

distinct increase in number and size towards the base. In Lower Smoke Creek floodplain gravels directly below the gap, grade increases from 0.97 ct/t in the upper gravel layers to 1.80 ct/t in the basal 1m of gravel resting on bedrock. Similarly average stone size and stone density (stones per tonne [st/t]) increase from 0.08 ct/st to 0.12 ct/st, and from 12 st/t to 15 st/t respectively. This vertical sorting of diamonds is related to the clast size of the gravels which generally increases with depth.

INDICATOR MINERALS

In the alluvials the normal suite of kimberlitic indicator minerals; picroilmenite, pyrope garnet and chrome diopside, is absent, reflecting the mineralogy of the primary AK1 lamproite.

The location of these rich diamond deposits in a mobile zone and the absence of typical indicator minerals have important implications for regional diamond exploration.

THE DIAMONDS

The diamonds are predominantly of industrial quality with a 10% gem content and have an average price of US\$9 per carat. Production from the Argyle alluvials since the start of alluvial mining in January 1983 to December 1985 totalled 17 million carats, 11% of world natural diamond production.

ACKNOWLEDGEMENTS

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