ALLUVIAL DIAMONDS IN SOUTH AFRICA*

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EXTENDED ABSTRACT

History

The first recorded alluvial diamond finds were in India, as early as 2000 BC. It was not until 1477, when Archduke Maximillian of Austria gàve a diamond ring to Mary of Brugundy, that the tradition of diamond engagement rings was born. India remained the world's only known diamond producer for over two millennia.

The first diamond finds in South Africa were on the banks of the Orange River where a yellow stone identified as a 21.25 ct diamond, (later to become known as the Eureka) was discovered in 1867. In March 1869, a magnificent 83.5 ct diamond which became known as The Star of South Africa was found. This alluvial diamond was to trigger the first diamond-rush in the country. In 1870, it is estimated that more than 5000 diggers were actively prospecting for alluvial diamonds with early efforts concentrated on the Vaal River near Barkly West.

Occurrence

The bulk of South Africa's alluvial diamond deposits extend in a belt from Lichtenburg and Swartruggens in the west and north to the Mooi river area in the east and south through Ventersdorp, Bloemhof, Wolmeranstad and the Scheweizer Reynecke area to Barclay West and Douglas in the south west. In almost all cases the Vaal and in part the Orange rivers form the southern limit of alluvial diamonds. Scattered occurrences are found in the NW Cape area associated with palaeo river channels, as well as along the Orange River in the Richtersveld area. Coastal and marine diamonds occur along the west coast from the Olifants river in the south to beyond Alexander Bay and into Namibia in the north. Shallow marine diamonds are also now of considerable importance.

Alluvial diamond deposits were rapidly discovered and have been exploited from numerous localities within the Vaal and Orange River systems, as well Koa River. Buffels, Spoeg, Horees, Groen and Olifants River which enter the Atlantic Ocean along the west coast. The Limpopo River is currently being tested for alluvials.

Deposits of the Lower Vaal and Middle Orange Rivers

Alluvial deposits of the Lower Vaal and Middle Orange Rivers are developed on a lava bedrock of the Ventersdorp Supergroup, and deposits occur where the Vaal, Orange and Riet Rivers flow off the younger Karoo Cover and on to the hard basement along the Vaal River from Windsorton in the north to Schmidtsdritt in the south. On the Orange River they occur between Hopetown in the south and Douglas in the north.

Two main types of alluvial diamondiferous sequences have been targeted by alluvial miners namely higher lying Deflation gravels, (also called Rooikoppie gravels), and Basal gravels.

Rooikoppie gravels have undergone one or more (and often several) phases of weathering and alteration (mainly chemical alteration) with the attendant 'deflation' and removal or destruction of the less robust rock and matrix components. They often have a high grade (carats per hundred tonnes) and the diamonds are also distributed more evenly throughout the deposit compared to Basal gravel.

Basal gravels have undergone limited or no chemical alteration and most of the original clasts and matrix have been preserved. The Basal gravels have been subdivided into many sequences by many authors mainly based on their elevation, composition and age. Remnants of diamondiferous gravel deposits occur on terraces at several different elevations along the lower Vaal and middle Orange Rivers. The general trend is the higher the terrace above the sea level, the higher the grade of the deposit.

The majority of the mining activities were concentrated around major nick points in the Vaal River, where a significant lowering of the bedrock elevation occurs beyond the point where the river has cut a narrow channel into mainly Ventersdorp Lava bedrock.

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On the lower lying, typically softer bedrock, classic gravels splays have formed due to a reduction in the flow velocity of the river as it opens up when it exits a gorge The abundance of coarse material that gets dumped, the associated turbulence and velocity gradients set up and the remaining relatively high energy of the river system forms the ideal setting for the concentration and sorting of heavy minerals, including diamonds

Further to the main controls of gravel distribution and diamond concentration local controls include the presence of dykes and structural features, bedrock geology control (e g the presence of underlying Karoo Dwyka diamictite with large boulders protruding from a softer matrix), as well as faults and joints These local controls create 'rich-spots' and higher grades in deposits that may otherwise be extensive and of low average grade

Lower Orange River Deposits

The lower Orange River deposits are of Miocene to Pleistocene age on the basis of mainly mammalian fossils They have been mined since 1966, and have a high proportion of gem quality diamonds (96 98%) and a large average stone size of 0 8 and 1 3 ct

The best diamond grades are obtained on the higher older terraces Three terraces are distinguished

1 Higher terrace - situated at ±40 m above the present river bed
2 Middle terrace - between 20 and 40 m
3 Lower terrace - less than 20 m above

At the Baken-Sanddrif operation a 5 m thick diamondiferous basal gravel is being mined after the removal of up to 27 5 m of overburden

West Coast Onshore Deposits

The richest deposits and those with the biggest stones are located close to the mouth of the major rivers The size of diamonds recovered decreases away from these river mouths as a result of littorial drift with diamond distribution spreading predominantly northwards The best diamond concentrations are found close to, or on the bedrock, particularly where the bedrock is irregular and dissected with potholes and gullies which represent favourable traps for the diamonds transported by the littoral drift

Deposits include the following

1 The Alexander Bay area, between the mouth of the Orange river and Port Nolloth,
2 The Buffels Marine Complex (including Kleinzee), situated on raised beaches north of the Buffels River mouth,
3 The Koingnaas and Hondeklipbaai areas,
4 The Olifants River area

West Coast Offshore Deposits

The recognition of wave-cut platforms and ancient strand lines below modern sea level, with bedrock features similar to those developed onshore, led to the emergence of the west coast offshore diamond industry

The geological history of these deposits is complex and involves the interaction of fluvial, marine and (at least in Namibia) aeolian systems They are the product of repeated reworkings of material derived from the hinterland during a series of marine regressions, and transgressions over the continental shelf The footwall consisting of Precambrian schist, phylite and gneiss is ideal for the formation of classic diamond trap sites such as gulleys, potholes, cliffs and caves In contrast, the footwall on the middle shelf consists of Cretaceous and Paleogene sediments This reduces the development of trap sites

Lichtenburg Alluvial Deposits

The diamondiferous gravels of the Lichtenburg and Ventersdorp Districts are underlain by a peneplain of Chuniespoort Group dolomites, with the preservation of the diamondiferous sediments being controlled principally by karstification of the dolomites Many sinkholes developed close to the contact between these two major formations, particularly along faults, fractures and intrusive dykes Subterranean cave systems, which eventually collapsed to form sinkholes and gorges typical of a karst terrain also formed These have subsequently been filled by gravel, sand and clay

The large infilled sinkholes and gorges are referred to as 'potholes' and 'runs' respectively As dissolution of the surrounding dolomites continued, the siliciclastic sediments infilling the potholes and gorges formed mounds or chains of higher ground The majority of diamonds were recovered from potholes, some of which were exceedingly rich such as Cowper's Pothole which yielded in excess of 2 3 million ct Theories of genesis range from a classic alluvial terrace model, modified by karstification to local derivation for the diamonds on the basis of clast assemblages and diamond quantity and quality

Conclusions

South Africa has for 136 years mined high quality alluvial diamonds from deposits found along the Vaal and Orange Rivers A unique set of circumstances have created an alluvial diamond mining sector unmatched elsewhere in the world However due to statutory, fiscal and other changes in South Africa, globalization, expectations, and the depletion of previously 'easy to mine' alluvial deposits, this industry is experiencing changes which will inevitably lead to a range of new challenges

The future of the industry depends on improving skills and expertise, improved understanding of geological models, improved technology, and close co-operation between all the role players Access to new resources, transparent and quicker turnaround in the processing, issuing and renewal of prospecting and mining permit applications, and the creation of and access to an alluvial diamond mining databank is needed to ensure the survival of this industry

ORIGIN AND EVOLUTION OF THE WEST COAST OF INDIA*

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EXTENDED ABSTRACT

Origin of the coasts is closely linked to the origin of Ocean-Continent margins Two distinct types of margins — Atlantic and Pacific, were first recognized by E Suess in 1883 The Atlantic type of margins have their major structural elements abutting the coast, where as in the case of Pacific type of margins, there is parallelism between the coastline and the mega structures on the land In the plate tectonics parlance, the Atlantic and the Pacific types are Passive and Active margins respectively Three sub-categories are recognized in both Passive and Active ocean margins The development of an ocean-continent margin begins with doming of the (super) continent, followed by volcanism, rifting and drifting The death of the margin takes place through subduction and collision There is normally a transition zone between the oceanic and continental crusts along the passive margins The continental crust becomes thin due to stretching, rotational faulting and partial melting Because of these, the continental crust imperceptibly merges with the oceanic crust Thus, locating the boundary between the continental and oceanic crusts becomes difficult

The present configuration of India primarily is the result of tectonic processes The first among them is the breakup Gondwanaland The immediate neighbours prior to breakup were Antarctica and Madagascar Rifting between India and Antarctica and drifting began around 120 Ma ago This marks the birth of the East Coast of India (ECI) In comparison to ECI, the history of the West Coast of India (WCI) is more eventful and hence more complicated The oldest marine magnetic anomaly in the Arabian Sea is M 22 (~150 Ma), which represents the separation of Africa from Madagascar and India The oldest anomaly between India and Madagascar is A34 (120 to 80Ma) Based on other evidences available from the WCI (St Mary's island rhyodacites) and the east coast of Madagascar (Marion hotspot volcanics), it can be stated that doming occurred around 93 Ma ago and rifting began around 88 Ma ago This also marks the origin of the WCI and the *Sahyadris* (Western Ghats) The northern parts of the WCI and the Sahyadris experienced basaltic magmatism of exceptional scale around 67 Ma ago This igneous activity is related to the Reunion hotspot As the west facing scarp was already in place before the volcanic event, the lava flow resulted in a monoclinal flexure (the Panvel flexure) facing the Arabian Sea Subsequent to the Deccan Traps event, the WCI underwent another spell of rifting (~62Ma), resulting in the breakup of Seychelles micro-continent and the genesis of a new MOR – the Carlsberg ridge This was followed by the subsidence of the region south of Saurashtra peninsula, under the influence of SONATA and Gulf of Cambay rifts/ faults India's largest oil field, Bombay Offshore, is located in the subsided portion of the landmass

About 40 Ma ago, a Mid Oceanic Ridge (MOR) which was close to the Madagascar became extinct and a new MOR originated close to India The new MOR – Central Indian Ridge, resulted in the separation of Mascarene Plateau from the Lakshadweep-Chagos ridge The impact of shifting of the MOR on the evolution of the southern part of WCI is not fully understood

Sea floor spreading in the Indian Ocean and the resistive forces in the Himalayan collision zone have resulted in a compressional regime throughout the Indian plate Under the influence of this, the equatorial region in the Indian

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