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STATUS OF THE SOUTH AFRICAN SMALL AND JUNIOR DIAMOND MINING SECTOR

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STATUS OF THE SOUTH AFRICAN SMALL AND JUNIOR DIAMOND MINING SECTOR

The Small and Junior diamond mining industry, which is dominated by alluvial diamond miners, and a few remaining small kimberlite operations, produced a high proportion of diamonds in South Africa in the late 1950s and early 1960s, prior to the discovery and development of major kimberlite mines such as Finsch and Venetia, in the 1970's and 80's. Subsequent to these discoveries the Small and Junior sector remained an active and important participant in the local diamond industry, particularly in respect of the highly sought after top-quality gemstone diamonds produced from the extensive alluvial deposits of South Africa. Since 2004 the sector has shown a strong decline. This report highlights the challenges faced by the Small and Junior diamond miners and makes recommendations for the revival of this sector.

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Exceptional quality gemstone diamonds from the Holpan-Klipdam alluvial deposits located between Barkly West and Windsorton in the Northern Cape Province – the 7.28 carat Hoplan pink, realised a price of R7 million (US$740 000 or US$101 000 per carat) in 2008.

IN SUMMARY

In terms of the overall diamond mining and production scenario in South Africa, in 2005 total diamond production for South Africa reported in the official Kimberley Process (KP) records amounted to about 15.96 million carats, whereas 2019 figures show a total of 7.18-million carats, representing a decrease of about 55%.

Mantle xenoliths and Karoo inclusions from the Kimberley pipes

This decrease has been immensely negative for the economy, foreign earnings, employment, and communities in key mining provinces, especially so for areas such Namaqualand on the West Coast of South Africa, the Northern Cape Province (NCP), including the once famous diamond centre of Kimberley, and the North West Province (NWP).

The majority of the Small and Junior diamond mining operations have always been located in the remoter parts of the Northern Cape Province (NCP), including the West Coast, North West Province (NWP), with outliers in Limpopo (LP), Gauteng (GP), Free State (FSP), and Eastern Cape (ECP) Provinces. Significantly these operations provide economic benefit to these Provinces by drawing labour, supplies, and services primarily from small and remote towns and surrounding communities. Other than farming, which is becoming increasingly mechanised, the small diamond sector was, and still is, a key employer in the NCP (including the West Coast), and NWP.

A study by Farrell in 2012, which focussed mainly on land based alluvial diamond mining operations in the Northern Cape Province (particularly along the Vaal and Orange Rivers), noted the sharp decline (over 50%) in Small and Junior diamond miners following promulgation and implementation of new mineral legislation in 2004.

This latest study of the Small and Junior diamond mining sector was initiated in late-2018 to update the previous study, ascertain the current health and status of this sector, and given its overall importance in terms of providing economic benefits and employment in remote and depressed regions of the country, and production of exceptional gemstone diamonds, identify key drivers for its ongoing contraction and provide recommendations to revive the sector.

Key results

The outcomes to this study are summarised in the figure below right and once again reaffirm the decline in the number of small diamond mining operations since 2004. Notably these latest results highlight the urgent need for the revision of mineral and mining policy and regulations to support and stimulate the Small and Junior mining sector for diamonds (and other commodities) in South Africa, and thereby reverse the strong contraction in the number of active operations, and employment numbers since 2000.

Study objectives

The study set out to review the Small and Junior diamond Sector in detail, and in the process identify and document the key reasons for the on-going decline of the industry. Consequently, the key building blocks of this study involved the following:

- Literature reviews to pinpoint Small and Junior diamond mining areas and operations
- Interaction with DMRE offices and personnel in the Kimberley and Klerksdorp offices to access non-sensitive data for Small and Junior mining licences and permits issued in South Africa
- Site visits to as many Small and Junior diamond mining operations as possible across the country

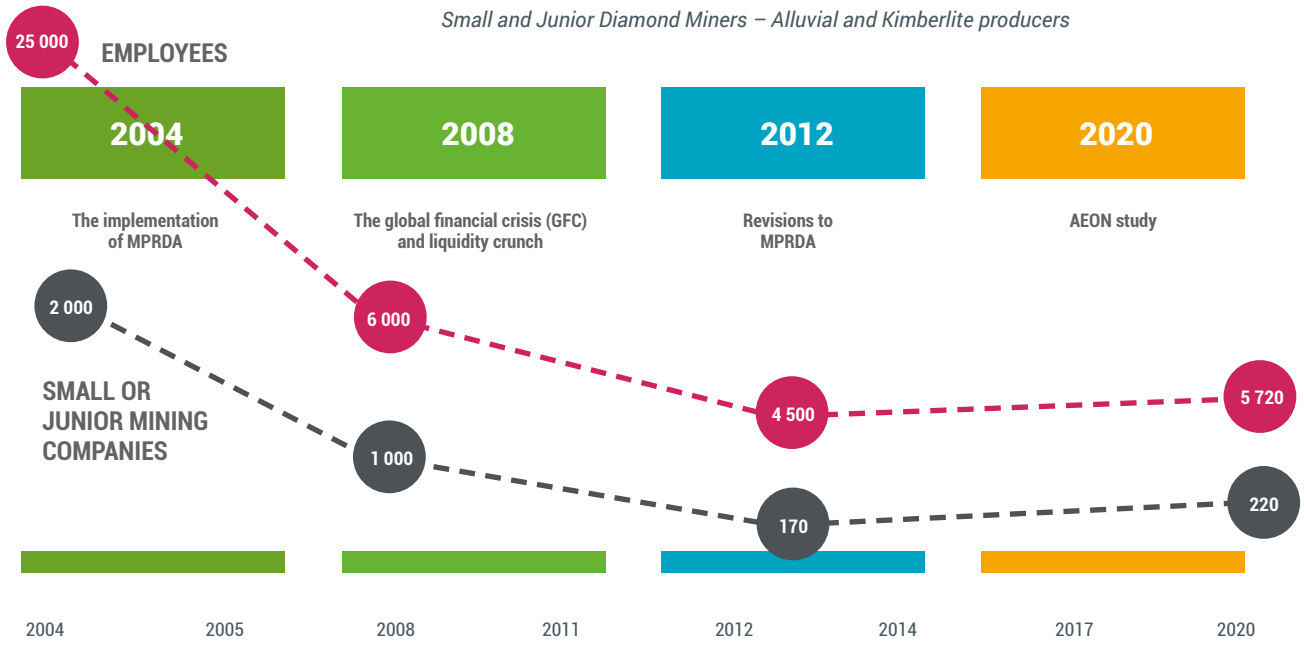
- Interviews conducted according to a carefully structured questionnaire to document data, information, and responses during interviews with owners, management, and operators
- Construction of a comprehensive ***Database of Small and Junior Mining Operations*** for all positively identified, and visited alluvial and small kimberlite diamond operations
- Supplementing of the information gathered during site visits with public domain information for private and listed diamond companies
- Surveys via small aircraft to gather information from more remote and isolated areas
- Analysis and interpretation of the data obtained and compiled
- Completion of a Report on the Status of the industry with recommendations for its revival
- Subsequent regular update of this database.

LOCALITIES	OPERATIONS VISITED	FLIGHT POINTS RECORDED	OTHER SOURCES	TOTAL	COMMENTS
LP			2	2	Krone alluvials, and Thornybush (Klipspringer) kimberlite fissures
NWP	26	52	2	80	
NCP	10	34	1	45	Primarily Vaal and Orange River
MOR	8	9	0	17	Mainly between Douglas and Prieska
LOR	4	0	7	11	Old Trans Hex Operations
West Coast (Alexkor)	10	0	4	14	Orange River mouth to Port Nolloth coastal land and marine strip; Mainly small-boat and beach operations, limited number of land-mining ventures
West Coast (The Punt)	0	0	6	6	Olifants River mouth area; mostly small boat and beach mining operations)
Small kimberlites	6		14	20	Primarily located in the NCP
Tailings Operations	1		3	4	Kimberley (Ekapa), Jagersfontein (Reunert), Leicster (Golden Falls). Robert Victor (Private)
Care and Maintenance	4		11	15	
Start-up Projects	3		3	6	
TOTAL	**72**	**95**	**53**	**220**	

Information gathering

The table above shows that in the course of this study an overall 72 operations were visited, 66 of which were operating, a further 95 over-flight points were recorded, and additional information was obtained for a further 53 localities from company press releases, published sources, and telephonic conversations. Collectively this study indicates that country-wide there were approximately 220 Small and Junior mining operations, projects, start-up, care and maintenance, and closed operations in March 2020. A total of sixty two (62) interviews were conducted during site visits with information from the remaining 10 localities obtained from the internet and discussions with experienced diamond geologists actively involved at some of the sites, or having long term experience of the diamond sector, including the important Small and Junior diamond mining operations and their product. ▶

Small and Junior Diamond Miners – Alluvial and Kimberlite producers



Klipdam Health and Safety signage

Sector challenges

Questionnaires were constructed to interview and collect key information at the operations visited from the persons responsible for the ownership, management, or supervision of the sites visited and thereby gather factual information on the challenges, 'health' and outlook of the industry. A total of 62 on-site interviews were conducted, with supplementary information gathered from other sources including industry experts. The results collected as consequence of the site visits and completion of the questionnaires are summarised below.

In respect of the results from the questionnaires and interviews, **6 key concerns** expressed by the owners and operators were:

1. The safety and security of their operations and personnel
2. Lengthy waiting periods for licence applications to be processed and granted and general inefficiency of the DMRE offices
3. Unreliable and increasingly expensive Eskom electricity supply
4. Challenges in respect of BBBEE compliance
5. Finding and retaining skilled labour
6. Labour costs given poor education, and skills sets.

The above 6 concerns were flagged by 86%, 83%, 69%, 64%, 62% and 52% of the owners and operators interviewed in the NWP, Vaal River (NWP and NCP), MOR (NCP), LOR (NCP), and West Coast respectively. These responses, and additional concerns raised by industry drivers are presented and elaborated on in **Table 6** of the comprehensive document that follows.

Recommendations

Based on the interviews with Small and Junior diamond mining operators, and supporting information gathered, the key factors impacting the profitability and future existence of the alluvial diamond mining industry were reviewed and analysed. A series of recommendations, which are listed in the table opposite, set out the interventions and requirements needed to revive and rebuild a sustainable business model for this sector.

Every effort should be made by the key stakeholders, particularly Government policy makers, the Department of Minerals and Energy, the Small and Junior mining sector, the South African Diamond Producers Organisation (SADPO), and other stakeholders and role-players to introduce modernised fit for purpose enabling mineral policies and regulations to revive this key sector.

The great majority of the Small diamond mining operations are in remote and economically depressed areas of the Northern Cape Province (NCP), including the West Coast, and North West Province (NWP). The Junior diamond mining business in South Africa draws employment mainly from small towns and surrounding communities in these areas, and other than farming which has become highly mechanised, the Small and Junior sector is a key employer in these regions. ■

	RECOMMENDATIONS	PROCEDURES/BENEFITS	COMMENTS
1	**Construct a 'Fit for Purpose' Artisanal, Small, and Junior (ASM) Mining Charter Policy and Regulations** Rewrite Charter to reflect small-scale nature of operations Create **Standard Templates** for mineral right application procedures and requirements for different rights – viz. 1. ASM operations 2. Mining Permits 3. Exploration and Prospecting Rights 4. Mining Rights	Unlock value from vast low-grade alluvial diamond deposits that occur in the NWP and NCP Ensure that a Standard Template is used and applied consistently in all DMRE offices across the country and at HO The Draft ASM Mining Policy 2021 recently published by the DMRE is a positive development	Implement modern Regulations, including Operational Codes of Practices, Environmental Practices, Water License requirements, to reflect **small-scale needs** Discard cumbersome and costly old-apartheid MH&S law-book and requirements
2	**Replace/Modernise the SAMRAD system and streamline processes for granting of minerals rights** Create a functional and professional One-Stop Shop to harmonise processes and requirements of different departments	Encourage new investment, particularly foreign investment Ensure that new entrants and HDSA's are able to acquire rights rapidly	Create certainty, transparency, and long-term Mineral Policy consistency. For example, the Internationally recognised **Spatial Dimension/ Trimble** cadastre system, a local Cape Town based product, should become the new South African standard
3	**Artisanal and Small-scale Mining Permits:** Establish effective: 5-ha and 45-ha Mining Permit application and monitoring procedures Revise and streamline requirements for the granting of Mining Permits to fast-track official grants to: 1. Small-scale operators 2. Emerging miners 3. New entrants 4. Existing informal (illegal) operators 5. Up to 10 operators/employees NEMA and present Water-Use Licence requirements should not apply. Simplify environmental and rehabilitation requirements and reports eg. Basic Assessment Report (BAR)	Implement a Tick-box application procedure, process Grant licences in 60 days (6 – 8 weeks), for a minimal cost (R2 500 application fee) and nominal rehabilitation bond Fast-track Mining Permit applications and grants Progress transformation and Black ownership	5ha Mining permits apply to Artisanal 'pick-and shovel' operations 45ha operations apply to small-scale operators with limited mechanised mining equipment, and up to two 14foot rotary-pans The growth of the informal and illegal diamond mining sector should be more thoroughly researched and formalised Ensure simple and practical H+S and environmental practices are implemented to uplift the growing informal (Zama-Zama) sector
4	**Small-miners – Prospecting/Mining Rights:** Establish efficient/functional Prospecting and Mining Licences for Small-miners utilising shallow-open cast mining with the following parameters: 1. Mechanised mining equipment 2. 2 x 16 foot rotary pans <50 000 tpm of mined/processed gravel 3. 25 employees 4. 4. At grade of 0.25 cpht production 5. -125 carats per month	Grant licences in 90 days (3 months) for cost of R5 000 application fee, and R5000 – R10 000 rehabilitation bond As in #3 above, NEMA and present Water Use Licence requirements should not apply Simplified environmental and rehabilitation requirements should be followed eg. Basic Assessment Report (BAR)	These operations are typically short term - 18 – 36 months May involve contractor operations which must be accommodated in regulations Licence granting regulations must include mechanisms to accommodate progression of mining faces and operations across property /farm boundaries as alluvial-terrace deposits are followed
5	**Junior-miners – Prospecting/Mining Rights:** 1. Mechanised mining equipment 2. 4 x 16-foot rotary pans 3. <100 000 tpm mined/processed gravel (at 0,25 cpht) 4. 50 employees 5. >250 carats per month	Grant licences in 120 days (4 months) for a minimal cost (R5 000 application fee) and R50 000 rehabilitation bond Streamline existing process to fast-track granting of licences and simplify monitoring procedures	Appropriate Environmental Management Program (EMP) and Water Use Licence (WUL) to apply Contractor operations to be accommodated in regulations Include mechanisms to accommodate progression of mining faces and operations across farm boundaries as contiguous alluvial-terrace deposits are exploited
6	**Provide Financial Support for Emerging Miners** (eg. Small Miners Development Fund) – see # 7 below	Professionally managed and administered fund to provide financial support to emerging and Small miners Drive transformation and black ownership	Expansion and development of the small-scale or Junior exploration and mining sector should be a policy imperative
7	**Implement a Small Miners Levy or Royalty (eg. 2%) to underwrite a Fund to contribute to the following:** • Small Miners Development Fund • Implement effective SLP and other programs on a region by region basis • Government to contribute on a Rand for Rand basis	Replace ineffective SLP's, Procurement, and related requirements with Miners Levy and Development Fund	Accommodate other Implementation Guideline requirements in this levy or royalty structure
8	**Develop Enabling and Effective Mineral Policies and Interventions** • To Formalise Illegal (Zama Zama) Miner and Revitalise the Small-scale Diamond Mining Sector • Ensure that transparent marketing and sales structures are set up to purchase goods from Artisanal and small-scale miners and prevent illegal sales and loss of revenue to the State	Leverage experience, skills, modern technology applied to Small and Junior diamond mining Leverage exceptional high-quality diamonds recovered from unique RSA alluvial deposits Leverage job creation abilities of entrepreneurs and small businesses	Reduce red-tape: Encourage entrepreneurs to utilise their considerable skills, experience, and new technologies to revive the sector The recently published discussion document on Artisanal and Small Scale Mining Policy (DMRE 17 June 2021) is a positive in this respect
9	**One-stop Shop** Create a Functional and Coordinated One-Stop Shop portal for handling all mineral right and environmental applications to revive the local Small and Junior mining sector	This has been promised in the past by various Ministers but never implemented	Need for harmonised exploration and mining development policy, and related environmental and job-creation policies that will promote Small mining businesses, SME's, and entrepreneurs.

Notes: cpht – carats per hundred tonnes; NWP – North West Province; NCP – Northern Cape Province

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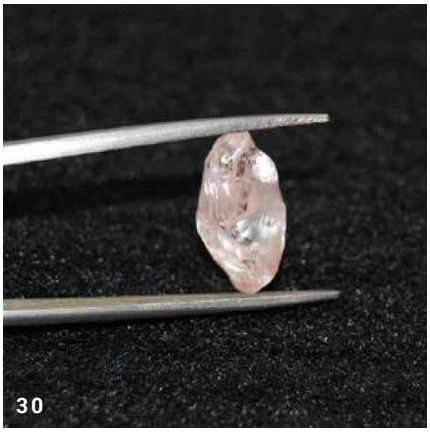
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SMALL AND JUNIOR DIAMOND MINERS DATABASE

RESULTS OF DATA COLLECTED: LATE-2018 TO EARLY-2020

ECONOMIC-DECLINE AND UNEMPLOYMENT IN THE NCP

CONCLUSIONS

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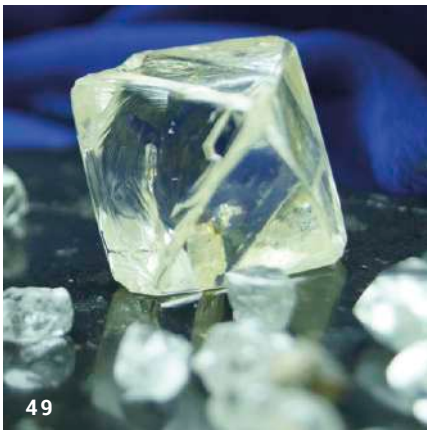

INTRODUCTION

History of the industry

South Africa has been one of the leading producers of many of the world's high demand minerals over the past 150 years, and diamonds are no exception. The discovery of the first diamond in 1866 or 1867, on the banks of the Orange River in the Northern Cape, represented the catalyst that ignited the modern mining evolution of Southern Africa. Today South Africa is the fifth largest supplier of natural diamonds in the world in terms of carats.

Diamonds were discovered in South Africa in late 1866 or early 1867 (de Wit et al., 2016), and the first diamond rush in the country took place along the banks of the Orange and then Vaal Rivers in 1869, in what is today the Northern Cape Province. Initial discoveries were of alluvial diamonds, and then in 1871 kimberlites (Dutoitspan and Bultfontein pipes) were discovered that lead to the development of the famous town of Kimberley (Davenport, 2013). From 1872 until the First World War South Africa produced more than 97% of the world's diamonds, and became the home of the modern diamond industry (Wilson et al., 2007).

The country dominated world diamond supply producing more than 50% of global production until the early 1930's, at the time of the Great Depression. Though no longer the dominant producer and supplier, South Africa continues to be a significant producer of high-quality gemstones (including rare coloured stones and exceptionally pure Type-II D-flawless stones mostly found in kimberlite mines in Lesotho and along the Middle Orange River). It is this unique attribute which is a key focus of this report.

Of the estimated 4.5 billion carats of diamonds that have been produced globally, South Africa is estimated to have produced about 15%. South Africa is furthermore the only country in the world where diamonds are produced from large (world class) and small kimberlite pipes, blows (the roots of pipes), dykes (fissures), as well as from eluvial, alluvial, and marine sediments. The west coast of South Africa and Namibia is host to the only known mega-placer deposit recognised in the world.

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Given the variety of deposits large and small, and varying product mix (boart, Indian goods (near gem), top-quality gemstones), South Africa has ever since the inception of diamond mining, supported large scale mining by senior companies (often multi-nationals), mid-tier operations, and many small private operations, typically owner/operator family businesses, also known as 'Diggers' or 'Delwers'.

Looking back at the history of diamond mining in South Africa, alluvial deposits were traditionally mined by small, private companies while large companies like

The following statistics provide brief insight into the South African diamond industry and its performance since 2005:

In **2005** production of diamonds in carats and estimated splits were as follows:

- **primary (kimberlite)** – 14,5 million carats (90.8% of total)
- **alluvial –** 1,4 m carats (8.8% of total)
- **marine deposits** – 0,06 m carats (0.4% of total)
- **Total:** 15.96 million carats (revenue – US$1,32 billion: $84,78 per carat)

In **2018** the production was as follows with estimated splits as follows:

- **kimberlites –** 9.25 million carats (De Beers: 4.90m carats; Petra: 4.35m carats)
- **other small kimberlites** – 0.04 million carats
- **alluvial deposits** – 0.36 million carats
- **marine deposits** – 0.25 million carats
- **Total:** 9.91 million carats (revenue – $1,22 billion; at $123,97 per carat)

In **2019** the production was as follows with estimated splits below:

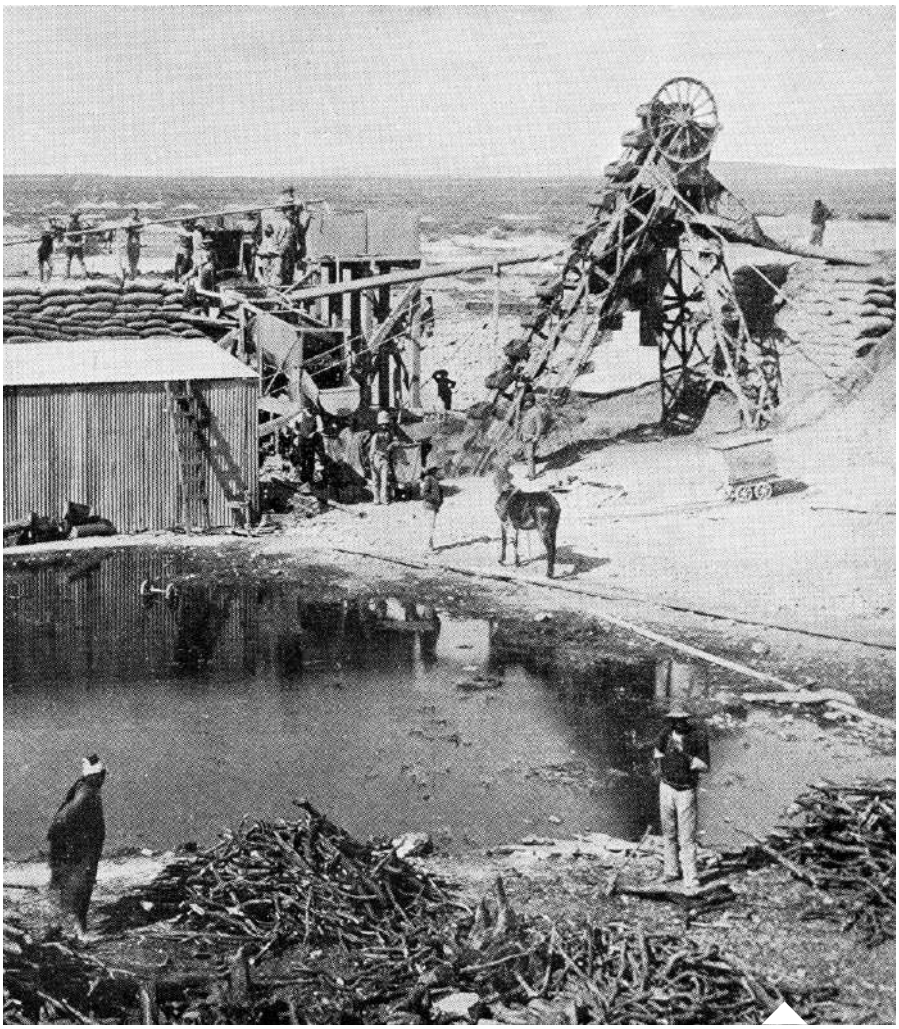
- **kimberlites** – 6,73 million carats
- **land based alluvials** – 0,30 million carats
- **marine alluvials** – 0,15 million carats
- **Total:** 7,18 million carats (revenue – US873 million; at $122 per carat)

De Beers mined kimberlite deposits. The main reasons for this are:

- the high costs required to prospect, evaluate and mine kimberlites compared to alluvials
- the much more widespread occurrence of alluvial deposits which allowed easy access to Small miners and
- the fact that most kimberlites are either barren of diamonds or are sub-economic to mine.

The above-mentioned statics indicate a strong and steady decline in South Africa's diamond production, with consequent negative impacts for the economy, foreign earnings, employment, and communities in key mining provinces and areas, especially along the West Coast of South Africa. This should not be the case as the dispersal of diamonds from their primary sources (kimberlites) into streams and rivers, and ultimately to the sea (West Coast), is generally accompanied by an increase in average value per carat because flawed stones are progressively destroyed with greater transport distance (Gurney et al, 1991). ■

Large volumes of these land and marine based alluvial gravel deposits are still available for mining as is highlighted later in this report in Table 9.



Industrial Mining Sluice at Diamond Mine in Kimberley, South Africa – 19th Century

103 carat yellow stone, Saxendrift, MOR

Definition of Artisanal, Small and Junior diamond mining operations

In the literature, there is a wide range of definitions to describe a Junior Miner, none of which can be accurately applied to alluvial diamond mining. Based on the data collected for this study, the following definitions are applied:

Artisanal miner	*– employing 10 persons or less per shift per operation*
Small-scale miner	*– employing 25 persons or less per shift per operation*
Junior miner	*– employing 50 persons or less per shift per operation*

The highest number of employees per company found during this study was 105 in the Middle Orange River (MOR) area. In respect of these various groupings and number of employees, the recent draft policy Discussion Document on Artisanal and Small-Scale Mining Policy 2021 issued by the Department of Mineral Resources and Energy (DMRE) on 5th May 2021 provides further information in respect of the activities and employees within these categories. It is useful and a good start in trying to hopefully set out a process that may lead to the formalisation of this sector, including the currently extensive and destructive informal or illegal (Zama Zama) miners. ■

Classification and models of diamond deposits

Diamond deposits can be classified as either primary (kimberlites) or secondary (alluvial). Marine alluvial deposits are typically ancient beach deposits which have either been raised above the modern day mean seal level (msl), or beach deposits which are below msl and also referred to as drowned beaches.

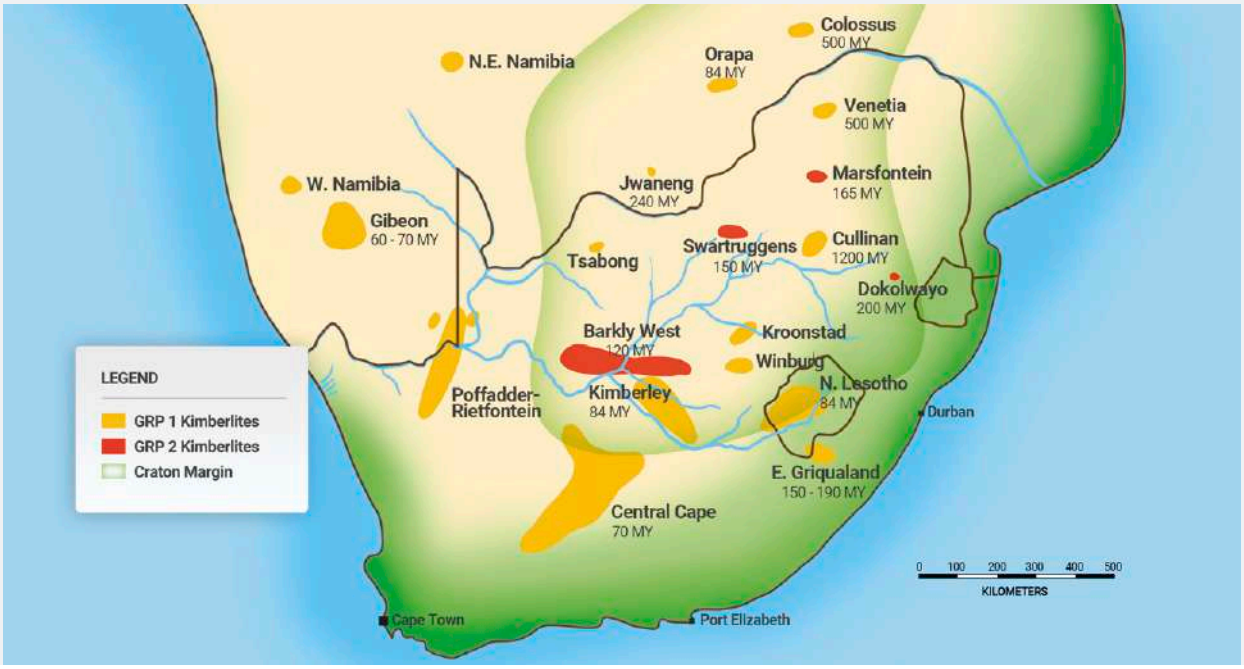
Classic examples of each exist in South Africa (De Wit et al., 2016). Small wind-ablation deposits are known in Namibia but are absent south of the Orange River.

Kimberlites are the primary source and host of diamonds, and represent ancient volcanic features or volcanoes that were intruded from great depth. These ancient intrusions may be represented by crater features where the original surface of the intrusions are preserved, diatremes or pipes, or small blows or dykes representing root zones of these ancient volcanoes. A very low proportion of kimberlite pipes contain economic quantities of diamonds, and most are barren, with ages of southern African kimberlites ranging in age from about 60 million years to 1 700 million years. The summary map in **Figure 1** shows the different kimberlite clusters with their ages.

The diamonds found in alluvial deposits have been eroded from the host rock Kimberlite, and subsequently spread out over large parts of southern Africa by wind, water in rivers and marine environments, and glacial processes. **Figure 2** shows the distribution of land and marine alluvial deposits in Southern Africa. The nature of diamondiferous alluvial gravel deposits is such that the diamonds do not occur evenly spread throughout the deposit. Diamonds are heavy minerals and are concentrated by water action in very specific areas or 'trap sites', thus the 'nugget effect'. Crude mining methods and the small scales of operation used in the past, often limited small miners to these high-grade areas. The 'picking of the eyes' of these deposits have for a long time made the remainder of the deposits less or unprofitable to mine.

The proportion of gem quality diamonds found in alluvial and especially in the West Coast marine deposits is over 90 percent (Gurney, Levinson, and Smith 1991). The percentage of gem quality diamonds in kimberlites is highly variable. Harben and Nötstaller (1991) quoted figures of 40% for the Kimberley Mines and 55% for the Premier Mine.

FIGURE 1: Map showing the distribution of the main kimberlite clusters across Southern Africa (Botswana, Lesotho, Namibia, South Africa, and Swaziland).



Technological advances made during the past 20 years and the strength of the $US to other currencies have progressively changed the economic parameters and many previously unprofitable deposits are now being mined. The main difference in the business has been the size of the operations and the typical alluvial miner of today owns a significant earth moving fleet.

Importantly there are still very significant reserves of alluvial diamond deposits available for mining in South Africa, possibly for another 100 years **(see Table 9)**. These remaining deposits produce exceptional quality gemstone diamonds, typically with ROM average prices in excess of $400 per carat **(see Table 8, and Figure 15)** but are characterised by very low or ultra-low grade in terms of carats per hundred tonnes (cpht). Convincing investors to invest in alluvial diamond deposits has always been difficult. The main reasons for this are the low grade and the 'nugget effect' of these deposits, the difficulty of determining the profitability and predicting the grade and the low success rate achieved by companies who have attempted to mine these deposits. ■

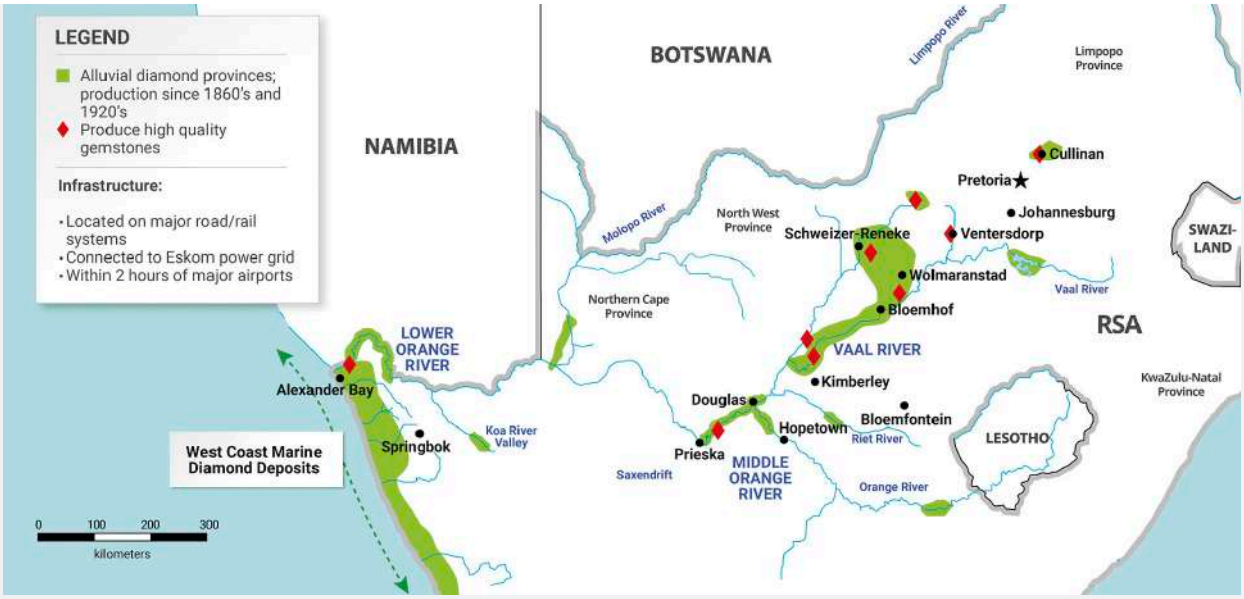


FIGURE 2: Distribution of land and marine alluvial deposits across Southern Africa
Note their locations close to small towns in the NCP and NWP which provide labour, supplies, spares, repairs, maintenance, fabrication, and other services.

Project objectives

The key focus of this study will be to undertake a comprehensive review and investigations of the Small and Junior diamond mining sector to establish the status and health of this immensely important industry.

As noted above South Africa is fortunate to host a multitude of large and small kimberlite pipes, fissures, blows, and extensive alluvial deposits. A significant proportion of these diamond deposits have in the past been successfully exploited hence creating and supporting:

- ***Large and small business opportunities***
- ***Economic growth***
- ***Employment opportunities for skilled and unskilled workers, and communities***
- ***Diamond marketing and sales***
- ***A local cutting and polishing industry to drive beneficiation***
- ***Other upstream and downstream industries such as plant and equipment manufacture, and technology development.***

Importantly most of the small diamond deposits and mining operations, which are the subject of this study, are located in remote areas of the economically depressed and challenged NWP, NCP, western FSP, and West Coast (Namaqualand) of South Africa. Employment and economic activity related to the Small diamond sector has in the past been crucial for many small towns in these provinces by way of job creation and benefits for communities.

A study by Farrell (2012), which is dealt with in more detail in Section 1.5, showed that with the review of the Mineral and Petroleum Resources Development Act, Act 28 of 2002 (MPRDA) in 2004, the Junior diamond sector had shown a strong decline. This trend has continued until recently, and many small and medium sized operators have left the business due to several reasons. This includes policy uncertainty, lack of investment, rising costs, and the unintended consequences of the MPRDA legislation. Unfortunately, very little additional information is available as publications like ***The Operating Mines and Quarries of South Africa*** that used to be published by the Mineral Economics Department of the DMRE, are no longer available, and have not been published by the DMRE since 2015 and 2016.

This study has set out to review the Small and Junior diamond industry in detail, and in the process identify and document the key reasons for the on-going decline of the industry. Consequently, the key building blocks of this study involved the following:

- Literature reviews to pinpoint Junior diamond mining areas and operations
- Interaction with DMRE offices and personnel in the Kimberley and Klerksdorp offices to access non-sensitive data for Junior mining licences and permits issued in South Africa
- Site visits to as many Small and Junior diamond mining operations as possible
- Interviews conducted according to a carefully structured questionnaire to document data, information, and responses during interviews with owners, management, and operators

This study has set out to review the Small and Junior diamond industry in detail, and in the process identify and document the key reasons for the on-going decline of the industry.

- Construction of a comprehensive ***Database of Junior Mining Operations*** for all positively identified, and visited Small and Junior diamond operations
- Supplementing of the information gathered during site visits with public domain information for private and listed diamond companies
- Surveys via small aircraft to gather information from more remote and isolated areas
- Analysis and interpretation of the data obtained and compiled
- Completion of a Report of the Status of the industry with recommendations for its revival
- Subsequent regular update of this database

Finally, based on the facts gathered, the key factors impacting the profitability and future existence of the alluvial diamond mining and small kimberlite mine industry were analysed, and recommendations made on what is required to revive and build a sustainable business model for the future are presented later in this report. ■

Mining Rooikoppie weathered into fractured Ventersdorp Lava Bedrock along the lower-Vaal River

Previous study of the Small and Junior diamond sector

In a previous study undertaken by Farrell (2012), the author found that subsequent to the promulgation of the Mineral and Petroleum Resources Development Act, Act 28 of 2002 (MPRDA) in 2004, the Junior alluvial diamond operations in the Northern Cape (primarily in the case of the Farrell study), North West and Free State Provinces decreased drastically in numbers.

The author further noted that the sustainability of, especially the smaller mining operations, is of great importance for the economy of smaller towns within these three Provinces. The study area of Farrell was restricted to the diamond activities in the vicinity of the confluence of the Orange and Vaal Rivers in the Northern Cape Province.

The objectives of the study by Farrell (2012) were to examine the concept of sustainable development, its origin and relevance to the MPRDA and the Mineral and Petroleum Resources Development Amendment Act, Act 49 of 2008 (MPRDAA), and the overall importance of the Small diamond mining sector for the Northern Cape Province in respect of jobs, employment, and economic activities.

The factors and impacts which led to the downscaling of the alluvial diamond mining industry were examined in detail.

The impacts were further evaluated against the intention of sustainable development which is promoted through the Constitution of South Africa, the MPRDA, and the National Environmental Management Act, Act 107 of 1998 (NEMA). ▶

Farrells 2012 study highlighted the following:

- *A flourishing Junior alluvial diamond mining industry existed in South Africa before the implementation of the MPRDA in 2004*
- *There was a sharp decline from 2004 which was further exacerbated by the downfall of global economic markets in the Global Financial Crash during 2008/2009*
- *Subsequently disjointed and ineffective current legislation and regulations (MPRDA) and proposed legislation (MPRDAA) and red-tape have continued to impact negatively on the fragile Small mining industry.*

The key conclusion from Farrells study was that the MPRDA which replaced the South African Minerals Act, Act 50 of 1991:

- *Did not make adequate provision for the needs of the Small and Junior mining sector, and that the existence of this specific mining sector was mainly affected by economic factors and inadequate mineral policy*
- *threatened the existence of the alluvial diamond mining industry in South Africa.*

Figure 3 below illustrates the decline of the Small and Junior diamond industry (comprising predominantly alluvial operations) over time, and how the industry was clearly affected by the implementation of the MPRDA. Importantly the work, research, and results from Farrell was focussed primarily on the Northern Cape Province (NCP) land-based small scale, with some small overlap into the North West Province (NWP) and Free State Province (FSP) during the period 2000 to 2012.

No direct work and information collection was for example done for the West Coast Small and Junior diamond mining operations. Within this context (ie. focus on land-based operations in the NCP) the results of this latest study were collected across the complete geographic spread from the West Coast to Limpopo Province (LP), and for a range of Small and Junior diamond mining operations (alluvial's and kimberlite's). Results from this latest study effectively show that the decline in the industry is even more severe than the study by Farrell (2012) indicated.

These latest results once again reaffirm the stark decline of the Small and Junior diamond miners and contraction of employment numbers (jobs) in this important sector.

Subsequent to the work by Farrell (2012), the results of this recent AEON study and outcomes for the period 2019-2020 have been added to **Figure 3** with a fourth column dated 2020 reflecting the latest number of operators and project employment numbers.

These latest results reaffirm the stark decline of the Small and Junior diamond miners and contraction of employment numbers (jobs) in this important sector. ■

Zama Zama living conditions

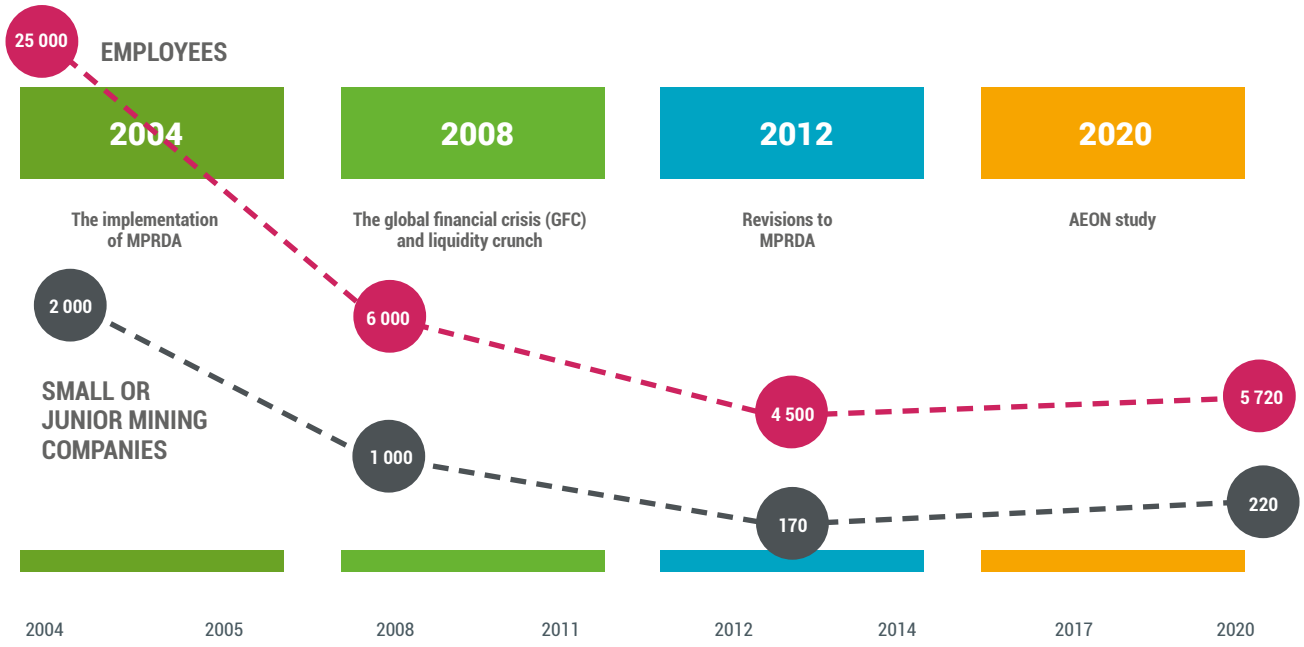


FIGURE 3: Diagram indicating the decline of the primarily self-funded Small and Junior diamond mining sector (primarily alluvial diamond operators) since the implementation of the MPRDA in 2004 (Sources: This study, Farrell, 2012, SADPO; Global Diamond Network)


Vaal River gravel - Windsorton

Importance of the Small and Junior diamond sector

Diamond production from 'Diggers' and small operations typically working on 'Claims' supported many small communities subsequent to the discovery of diamonds on the Orange River in 1866, and in the early 1900's.

Interestingly in 1871, it is estimated that approximately 5 000 people were living near diggings operating along the Vaal River adjacent to Klipdrift, known today as Barkley West (Babe, 1872).

The Small and Junior diamond mining industry, which is dominated by alluvial diamond miners, and a few remaining small kimberlite operations, produced a high proportion of diamonds in South Africa in the late 1950s and early 1960s prior to the discovery of major kimberlite mines such as Finsch Mine and Venetia (De Wit, 2016).

The great majority of the Small and Junior diamond mining operations are in remote and economically depressed areas of the Northern Cape Province (NCP), including the West Coast, and North West Province (NWP). This sector draws employment mainly from small towns and surrounding communities in these areas, and other than farming, which is becoming increasingly mechanised, the small diamond sector is a key employer in these regions.

As noted in **Figure 3** opposite, the Small and Junior diamond sector has shown a strong contraction in the number of active operations, and employment numbers since 2000. There is a critical need to reverse this situation.

The following sections, tables, figures, and annexures provide a thorough review of this important sector and industry, highlighting its problems and challenges, and provides recommendations to revive the Small and Junior diamond mining sector. ■

PROJECT STUDY AND DATA-COLLECTION

Methodology and area coverage

This research project was initiated in June 2018 during a visit to the NCP and NWP, and implemented fully in January 2019 with a review and acceptance of the proposal that was submitted to the African Earth Observation Network (AEON) at Nelson Mandela University (NMU) by the author of this report in late 2018.

Zama Zamas operating on the Kimberley Floors

Thereafter, and with the support of the South African Diamond Producers Organisation (SADPO) based out of Kimberley and a number of experienced geologists, field trips were undertaken to as many small diamond mining operations as possible. Working visits were also undertaken to the Department of Minerals and Energy (DMRE) offices in Kimberley (NCP) and Klerksdorp (NWP), the intention being to collect geospatial information of issued diamond permits, prospect, and mining licences. Further information was collected from remote areas by light-aircraft overflights, and additional data was sourced from literature searches.

The project was initiated in earnest in early 2019, with a visit in January 2019 to DMRE offices in Kimberley which lasted a month. The outcome of this visit was the collection of a total of 869 licences (78 Mining Rights, 655 Mining Permits and 136 Prospecting Rights) issued between 2005 and 2019. In June 2019 the North West DMR offices (located in Klerksdorp) were visited. This latter visit lasted for two weeks and yielded the collection of a total of 270 licences (56 Mining Rights, 65 Mining Permits and 149 Prospecting Rights).

Following visits to provincial DMRE offices, 72 operations were visited in person to collect information of spatial, financial, operational and geological information. During these site visits a total of 62 interviews were conducted with owners, contractors, and operators about the status and challenges faced by the Small and Junior diamond miners and operators, also known as the Small Diamond Mining Industry (SDMI). The information was collected using questionnaires for inland alluvial and West Coast alluvial diamond deposits.

As noted above additional operations were counted during light-aircraft surveys of more remote areas. Information from these plane rides was incorporated into the study and database. ■

Site visits and interviews

The research project aimed to survey and collect information on the Small and Junior diamond producers, represented by either owner operators holding prospecting rights, mining rights or 5ha mining permits, or represented by contract operators.

TABLE 1 below provides a summary of the field trips undertaken during this study. This includes visits to operations, basic geological examinations, and conducting interviews with the manager or person in charge of the operation.

DATE	PROVINCE, AREA, TOWNS	OWNER/OPERATOR	SITES VISITED	COMMENTS
2018				
19 June	NCP, Kimberley area	De Beers	Big Hole Diamond Museum	Review history of the diamond mining industry of South Africa and the world
20 June	NCP, Kimberley Area	Illegal Miners (Zama Zamas)	Kenilworth Floors and Settlement	Small scale illegal artisanal mining operations visit with journalist
20 June	NCP, Kimberly area	GF Mining, Vaal River west of Barkly West	Vaal River alluvial deposits	Pre-Interview visit
20 June	NCP, Windsorton Area	Windsorton	The Island, Vaal River	Pre-Interview visit
21 June	NWP, Bloemhof Area; Doringbult	Gawie van Niekerk	Shallow alluvial deposits covered by red sand	Health and Safety Consultant from Klerksdorp outlined the many challenges and unnecessary costs faced by small diamond miners
2019				
January	Northern Cape Province, Kimberley	The Department of Mineral Resources, South Africa	Department of Mineral Resources Offices	Period spent reviewing diamond licences in DMR Office Kimberley
May	NWP, Klerksdorp	The Department of Mineral Resources, South Africa	Department of Mineral Resources Offices	Period spent reviewing diamond licences in DMR Office Klerksdorp
3 June	NCP, Windsorton, Holpan	Various Operations	Lower Vaal River	Karoo Supergroup shale, Ventersdorp Supergroup lava and Transvaal Supergroup dolomites as bedrock to alluvial gravels
10 June	NCP, Middle Orange River, Douglas Area	Various Operations	Middle Orange River	1 to 2 m Rooikoppie mining.
5 August	NWP, Mooirivier/Rysmierbult area, Ventersdorp, Coligny, Lichtenbrg Alluvials	Klaus van Aswegen; Jaap and Johan van Heerden	Sterkfontien Twee Buffelsskiet	Extensive N-S trending deposits across dolomitic bedrock, includes large sink-hole deposits
6 August	NWP, Lichtenberg, Bakerville, properties NE of Bakerville, Ottosdal, Wolmaranstad	Lucas Steyn, Oom Jaap and Johan van Heerden	LaReystad	
12 August	NWP, Taung Alluvials; NCP, Longlands on Vaal River	Amo Marengwa Mr K	Taung Alluvials, Mr K's 5ha Mining Permit	
13 August	NCP, Boshoff Rd kimberlites	Gavin Rickets, Tony Pike	Roberts Victor, New Elands, Zout en Zuur, Goedgevonden, small kimberlite mines	
25 August	NCP, Sendelingsdrif	Various Diggers: Berne, Lal Visser, Martin Grobler	Grootderm Section 10, Baken, Sandelingsdrif	
27 August	NCP, West Coast, Alexander Bay and Port Nolloth	Various Diggers: Johan Labuschagne, Michael Nicholson, Ronald Coraizin		
2020				
January	Write up of information, fact checking, verification and collection of information from additional sources			
February	Interaction with emerging black small miners attempting to apply for 5 ha mining permits in the Bakerville (NWP) and Longlands (NCP) areas, and provision of advice and assistance to some of the parties			
March to December	The Covid-19 pandemic which impacted the entire globe and which has been devastating for the world diamond industry negatively impacted the final parts of the project and its timely completion due to lockdown requirements, inability to travel, and related challenges. The sad death of the head of AEON at NMU, and promoter of this study also had an impact on this study.			
2021				
Jan - Feb	Monitoring and support where possible to 5ha mining permit applicants			
Mar – May	Updating, compilation, editing, and final write-up of this study			

Structure of questionnaires

Data for this report was collected using questionnaires with open ended questions. There were two different questionnaires: one for inland deposits and the other for marine deposits in the West Coast of South Africa.

The questionnaires included questions pertaining to locality of the mined deposit, general financial details of the mine (e.g. capital value of the business), challenges that are faced by diggers and most importantly, the impact that the industry has on surrounding communities in terms of employment.

These questionnaires were completed during personal interviews on site, off site, or emailed to the relevant people. Personal interviews that were conducted on site allowed the opportunity to observe and photograph the geology, mode of operation, and situational challenges at various operations. The photographs were used to support the main information that was gathered during the interviews.

Inland Alluvial Mining Operations

The Inland Alluvial Deposit Questionnaire was developed to be completed by Junior miners operating in the Northwest and Northern Cape provinces of South Africa. In order to measure the size of mining operations questions relating to the amount of diamond bearing gravel or ore an operation moves (e.g. stripping ratio and gravel cut-off size), diesel consumption and number of employees were asked. Financial questions relating to business investment and were also asked. These questions helped with measuring the commitment of the diggers to the community and the business.

West Coast Alluvial Operations

The West Coast Deposit Questionnaire was developed to be completed by divers (diamond miners in the West Coast) operating in the West Coast Alluvial gravel deposits. These deposits are also mostly found in the Northern Cape province of South Africa and the border with Namibia. The main difference between the Inland Alluvial Deposit Questionnaire and the Alluvial Deposit Questionnaire is that the in the West Coast Alluvial Deposit Questionnaire the question about salary spend was asked in terms of diamond sale percentage because divers do not sell their diamonds themselves and do not normally have continuously employed labour. ■

These questionnaires were completed during personal interviews on site, off site, or emailed to the relevant people.

Information from additional sources

To ensure that as much information could be gathered on the Small and Junior diamond sector within the time and budget constraints of the project, additional information was sourced from a series of small aircraft over flights of more remote and less accessible areas of the NCP, NWP, and FSP.

Information was also gathered by working visits to DMRE offices, and there was important and useful interaction with a wide range of experienced diamond experts at different University departments and in private practice.

Overflights of Remote Areas

During the course of this study important additional regional information was obtained from generally more remote area by means of four flights in light aircraft. This ensured considerable cost and time saving, and provided information that may otherwise not have been obtained. The flight dates and areas flown are summarised in **Table 2**.

TABLE 2: Record of flights taken over remote areas and rivers in the NCP and NWP, including the Orange, Vaal, and Makwassie Rivers, to gather additional information on Small and Junior mining operations

DATE	PROVINCE	AREA	SITES	COMMENTS
2019				
#1	Northern Cape (March 2019)	Middle Orange River (MOR) – Hopetown, Douglas, Prieska, Marydale; Schmidstdrift on return leg	11	This flight highlighted the vast remaining extent of alluvial gravels on the sections of the MOR that were overflown
#2	Northern Cape into North West (September 2019)	Schutsekama, Vaal River northwards to Christiana	32	As noted above, this flight again highlighted remaining areas alluvial gravel along the Riet River, though large parts of the deposits in the Schutsekama area are depleted
#3	North West (September 2019)	Christiana, Schweitzer Reyneke, Makwassie (traversed on a grid pattern)	28	Extensive areas of interfluve gravel/Rooikoppies remain to be delineated and mined following new interpretations and a revised geological model for this region
#4	Aerial Survey #4 (NW Province) (18 October 2019)	Makwassie Spruit to Bamboes Spruit, to Klerksdorp (Grid pattern)	24	Gravel deposits in the traditional 'Spruit' areas are largely mined-out. Few areas remain, and many of the old heaps and tailings should be reprocessed with new technology

Working Visits to DMRE Offices (Kimberley and Klerksdorp)

During January and May of 2019, several weeks were spent in the Kimberley and DMRE offices in Kimberley and Klerksdorp respectively working with department officials to gather mineral rights information related to Small and Junior mining permits, prospecting and mining rights off the South African Mineral Resources Administration System (SAMRAD). According to the DMRE Website this system should allow the general public to view the locality of applications, rights and permits made or held in terms of the Mineral and Petroleum Resources Development Act (Act 28 of 2002) (The MPRDA), and where applications in terms thereof can be submitted electronically. Although the exercise was generally informative, and department officials were most helpful, and a large amount of information was accessed over the period of several weeks, the system was slow and difficult to use, and at the end of day the nature of the data and information reviewed was not particularly beneficial to this project. Further discussion in this respect is provided in Chapter 5.

DMRE Publication

Previously the Directorate of Mineral Economics of the Department of Minerals (DMR) published annual reports that related to mining (large, mid-sized and small) and quarrying activities being conducted throughout the Republic of South Africa. (see for example DMR 2013, 2015 a and b, and 2016 references). However, on investigation it was found that the annual DMR reports compiled by the Minerals Economics Directorate ceased to be published after the last versions referenced above. Given the 'dated' nature of these past publications, information contained therein was of little use to the current study. ■

Summary

The two previous sections of this work and report that were initiated in earnest in early 2019 provide background to the planning and activities pursued.

It is noted that the visits to the DMRE offices in Kimberley (January 2019), DMRE offices in Klerksdorp (June 2019) to collect possible information that would assist and add value to this study) were not particularly useful. Consequently, the information and data collection activities were somewhat revised to ensure maximum possible coverage by actual on the ground site visits, supplemented by over-flights of more remote areas.

In the subsequent sections of the report the setting and geology of the kimberlite and alluvial deposits are covered, the data and information collected is interpreted and analysed, and observations, recommendations, and conclusions are presented.

To add value to this study it will be important that the database created and used in this study is updated and added to on a regular basis in the future.

KIMBERLITE AND ALLUVIAL DEPOSITS

Kimberlites or primary deposits

Kimberlite has been defined by Clement et al. (1984) as a volatile-rich, potassic, ultrabasic igneous rock which occurs as small volcanic pipes, dykes and sills. It has an inequigranular texture resulting from the presence of macrocrysts (phenocrysts and xenocrysts) set in a fine-grained matric. The mineralogy comprises olivine with several of the following: phlogopite, calcite, serpentine, diopside, monticellite, apatite, perovskite and ilmenite.

Kimberlite commonly contains well-rounded fragments (xenoliths) of upper-mantle-derived ultramafic rocks, such as peridotite and eclogite, and xenocrysts such as pyrope garnet, picro-ilmenite, chrome spinel and chrome diopside. Kimberlite may contain diamond, but only as a very rare constituent. More details and description of these rocks, including their typical settings, diamond characteristics, and the unusual (non-kimberlitic) occurrences of some diamonds can be found in the following publications – Bristow (1985), Field et al. (2008), Kornprobst (1974), Levintson et al. (1992), Mitchell (1991), Orlov (1973), Pearson and Nixon (1996), Scott Smith and Skinner (1984), Shilo et al. (1978), Slodkevich (1983), and Sobolev and Shatsky (1990).

Over 850 kimberlite occurrences are known in South Africa, but only about 50 carry quantities or grades of diamonds that can be measured by diligent sampling (approximately 5%) (Vorster, 2003). Of these 50 occurrences, many are considered sub-economic either because the quantity or quality of diamonds, or the quantity of ore is insufficient for sustainable long term economic mining **(Figure 4)**.

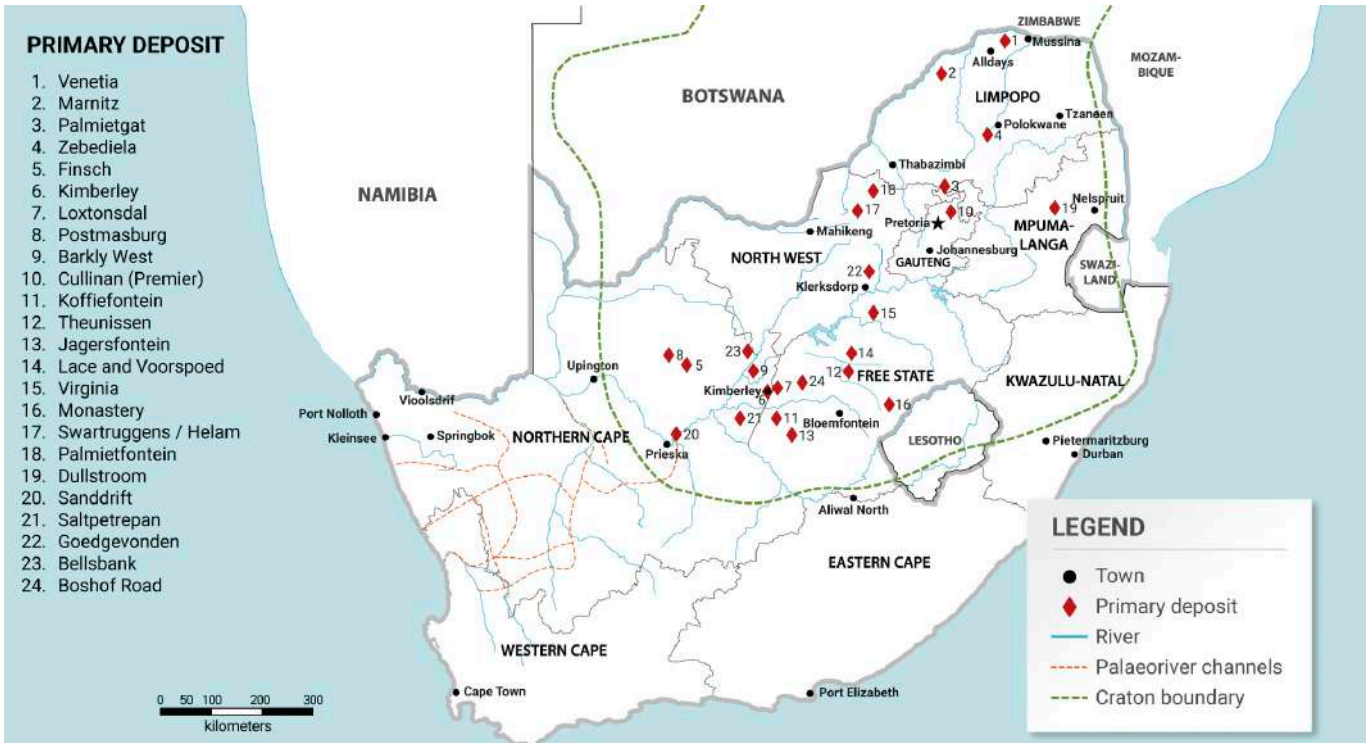


FIGURE 4: Diamondiferous kimberlites of South Africa, including closed and existing mines. Diamondiferous kimberlites occur within the boundary of the Kaapvaal Craton represented by the dashed outline (from Field et al., 2008, Vorster, 2003).

Over 850 kimberlite occurrences are known in South Africa, but only about 50 carry quantities or grades of diamonds that can be measured by diligent sampling (approximately 5%) (Vorster, 2003).

Table 3 below provides a brief summary of the large (or world class) diamond mines that have provided the bulk of South Africa's diamond production since the discovery of the famous Kimberley mines in 1869, and small kimberlite diamond producers that have over the years sustained small scale economic production, often intermittently, and other small kimberlites which were sampled with the objective of developing small mines but have never supported sustainable exploitation. ▶

TABLE 3: Summary of Southern African large and small kimberlite diamond mines.

RSA - LARGE WORLD CLASS KIMBERLITE MINES	OWNER/PROVINCE
Venetia (operational)	DeBeers; Limpopo Province (mine in the process of transitioning from open-pit to underground operation)
Cullinan (operational)	Petra Diamonds; Gauteng Province
DuToitspan/Bultfontein ('Joint-shaft', operational)	Ekapa Mining; NCP
Wesselton (operational)	Ekapa Mining; NCP
DeBeers Mine, Kimberley Mine (closed)	Mined-out and closed; NCP
Kimberley mines tailings retreatment operations (active operations)	Ekapa Mining; NCP
Finsch (operational)	Petra Diamonds; NCP
Koffiefontein (operational)	Petra Diamonds; FSP
RSA – small kimberlite mines	
Bellsbank/Dan Carl Fissures (flooded), Frank Smith (care and maintenance, tailings retreatment ceased), Helam Fissures (Swartruggens), Jagersfontein (flooded, reprocessing tailings), Kareevlei West (Blue Rock Diamonds), Loxtondal (care and maintenance), Marsfontein (mined-out); Newlands (closed), Roberts Victor (closed, tailings retreatment ceased - uneconomic), Samada (Kaalvallei), Sover Fissures (mined out/closed); Star Fissure mine (closed/flooded, plant vandalised, removed for scrap), The Oaks (mined out), Voorspoed (care and maintenance)	This group lists small kimberlite, blows, and fissure diamond mines; Includes the Marsfontein pipe (0,5ha) which was an exceptionally rich (high-grade) kimberlite blow in Limpopo Province that repaid its capital development costs (Capex) in 3 days
RSA – other small kimberlites	
Goedgevonden, Kamfersdam (some past tailings retreatment), Kimberley-West, Klipspringer fissures, Kouewater, Lace (flooded, in liquidation), Leicester (Golden Falls), Makganyene, Montrose, National, New Elands, Palmietgat, Paardeberg-East, Pieserton, Postma (Postmasberg), Riverton Station (tailings), Saltpetrepan fissures, Schuller, Thornybush fissures (extension of Klipspringer fissures), Una fissures, West-End, Zout-n-Zuur	Small kimberlites (pipes, blows, and fissures) that were bulk sampled or mined for short periods, but were never economic on a sustainable basis
Lesotho diamond mines	
Kao, Letseng, Liqhobong (closed, uneconomic), Mothae	Letseng and Mothae produce exceptional large white Type-2a diamonds
Swaziland	
Dokolwayo	Small Group-2 kimberlite mined out by Trans Hex Group – eastern Swaziland adjacent to Mbuluzi River

Sources: Site visits, Company Annual Reports, Bristow pers comm, DeMeillon (PhD in preparation), Scott, K. (2005), Company presentations, News Releases, Diamond Tender Houses, and small mine producers.

The presences of these 'old' diamonds in extensive Archean glomerates older than about 2 700 suggests that there may have been deep-seated Archaean kimberlite or similar intrusives that transported diamonds to the earth's surface in the Archean.

In South Africa two main types of kimberlite rocks are recognised, namely Group-1 monticellite kimberlites named after the type locality at Kimberley, and Group-2 micaceous kimberlites, a typical example being the Finsch kimberlite and mine in the Northern Cape near Postmasburg. These types were previously documented by Wagner (1914):

- **Group-I,** or olivine-rich, monticellite-serpentine-calcite kimberlites correspond in general to the 'basaltic' kimberlites of Wagner (1914)
- **Group-II**, or micaceous kimberlites correspond to the 'micaceous' lamprophyric kimberlites described by Wagner (1914).

Smith (1983a) determined that these distinctive groups are derived from sources in the earth's mantle which are either slightly depleted (Group-I), or enriched (Group II), with respect to light rare-earth elements. This enrichment and depletion provide evidence of past metasomatic (mineralogical changes imparted by fluids) processes which occurred in the earth's mantle. It is likely that the highly potassic and isotopically enriched melts are probably derived from ancient preserved subcontinental lithospheric mantle because these were isolated from general mantle convection for long periods of time. Most kimberlites are thought to have derived from old lithosphere or sub-lithospheric domains that may extend into or below the transition zone or lower mantle.

Ages of Kimberlite Intrusions in Southern Africa

Ages of kimberlite intrusions that have been dated reliably in South Africa range in age from the early-Proterozoic to Cretaceous. Diamonds showing radiation damage were also recovered from gold bearing conglomerates in the Witwatersrand Basin. The presences of these 'old' diamonds in extensive Archean glomerates older than about 2 700 suggests that there may have been deep-seated Archaean kimberlite or similar intrusives that transported diamonds to the earth's surface in the Archean.

A summary of some of the well-known kimberlites in Southern Africa is shown in **Table 4**.

TABLE 4: Ages of kimberlite intrusions, including diamondiferous pipes and dykes in Southern Africa and for inferred source rocks that transported diamonds into the Witwatersrand Basin.

AGE-PERIOD	AGE-BRACKET MA	KIMBERLITES	COMMENTS
Jurassic-Cretaceous	240 - 80	DeBeers, Kimberley, Orapa, Koffiefontein, Fisnch, Loxton, Roberts Victor, Marsfontein, Dokolwayo (Swaziland), Jwaneng (Botswana), Letseng, Mothaoe, Kao, Liqhobong (Lesotho)	The majority of mines in southern Africa have been in this age bracket
Late-Proterozoic	600 - 550	Venetia, The Oaks, Mooikloof, Murowa (Zimbabwe), Martins Drift (Botswana)	Venetia is a world class asset operated by DeBeers transitioning from open-pit to underground mine at considerable cost
Mid-Proterozoic	1 200 – 1 000	Cullinan, National, Schuller, Montrose, Martins Drift (Botswana)	The famous Cullinan diamond mine has undergone a modernisation programme to end its LOM
Early-Proterozoic	1 700 – 1 600	Zero, Elston, Riries, White Ladies	Kuruman area of N Cape Province
Archean	>2 900	Diamonds recovered from Witwatersrand gold bearing conglomerates	These diamonds show extensive radiation damage

Sources: Bristow, unpublished data, De Wit (2010), Skinner et al. (1985), Smith et al. (1994).

Evaluation of Kimberlites

The very low abundance of diamonds in kimberlites (parts per million and parts per trillion) and the typical nugget effects makes it difficult to predict whether a kimberlite will carry diamonds in economic quantities without bulk sampling (Rombouts, 2003). Advances in the study of the chemistry of kimberlite indicator minerals (KIM's) from disaggregated mantle xenoliths (particularly peridotitic and ecologitic garnets, chromites, and to some extent ilmenites) as well as micro-diamond analysis studies can provide good indications as to the potential (McClenaghan, 2005) of samples derived from kimberlites.

For kimberlitic rocks, or other primary source rocks such as lamproites, to contain diamonds, it is a requirement that the intrusion (which forms at lithospheric depths) passes through diamond-bearing mantle (diamondiferous peridotite and/or eclogite within the lithospheric roots of cratons). Kimberlites and lamproites act effectively as passenger trains which must stop at stations to collect their passengers, in this case diamond bearing lithospheric mantle, for transport to their destination, in this case the earth's surface.

A further important aspect regarding the existence of diamonds is that once the source rocks are sampled and assimilated in significant quantities by the kimberlite, the disaggregated diamonds must be preserved (rather than resorbed) within the kimberlite (Fipke et al.,1995), although in many cases diamonds recovered from their primary host rocks may show some signs of resorprion, probably by the kimberlite magma becoming somewhat 'oxidising' in character, rather than reducing.

Kimberlites intrusions typically occur in clusters, often characterised by a large range in size. The Orapa-cluster in north-east Botswana is a classic example of this, with over 50 known intrusive pipes, the largest, AK-1 or now famous Orapa main pipe being 1.5 X 1 km in dimensions or about 120 ha in size, whereas most of the other intrusions are much smaller, with some being no more than 1 or 2 hectares in size. ■

Alluvial or secondary diamond deposits

Major alluvial-diamond deposits, or diamond placers, develop on or adjacent to cratonic source areas where there is a favourable interplay between climate, basin dynamics, regional and local structures, and local geomorphic factors (Helgren, 1979, Lynn, 1991, Spaggiari et al. (1999). Regions where humid tropical palaeo-climatic conditions alternated with semi-arid conditions are most favoured.

Here, the deep weathering of rocks during humid periods leads to efficient liberation of weathering-resistant minerals (such as diamond), and the stripping of the deep regolith during semi-arid phases leads to the transportation of the released diamonds (De Wit, 1996).

Changes in the base level of a river basin produce alternating periods of local sediment erosion (degradation) and deposition (aggradation), which are conducive to the local concentration of diamonds (Adams et al., 1978). These changes also lead to the development of terraces, as the river cuts downwards to equilibrate with a lowered base level (Oldknow and Hooke, 2017). A terrace is a preserved section of river sediment (usually gravel) abandoned by a river as in incises downwards in response to a lowering of its base level (by, for example, a lowering of the sea level). Terraces may occur at different heights above modern river level, the higher terraces being the oldest (Dorren and Rey, 2004).

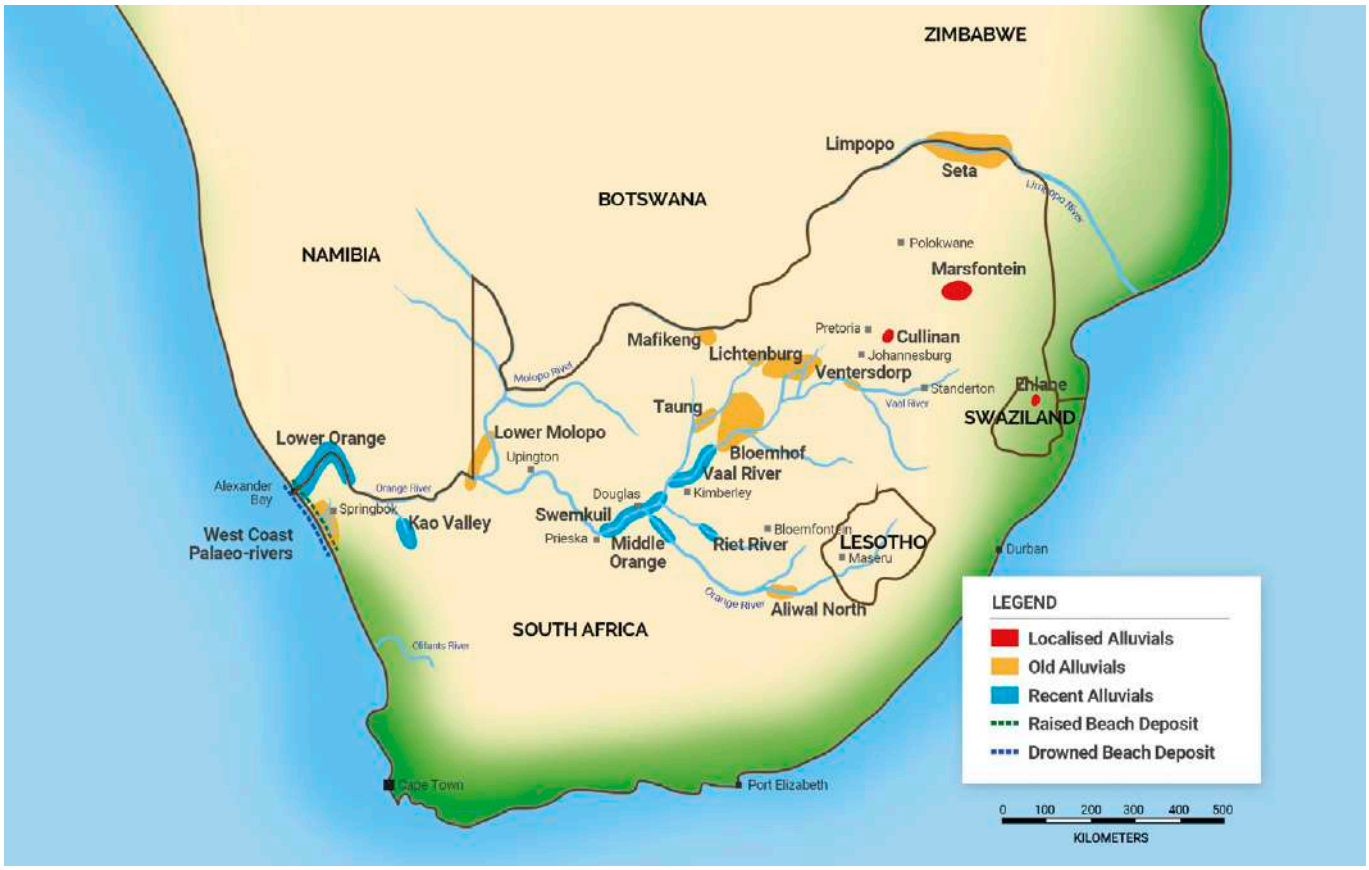
Further important controls on the formation of alluvial deposits and their diamond concentration are summarised, and the distribution of South Africa's land and marine alluvial diamond deposits is presented in summary form in **Figure 5** over page.

Liberation and Transport of Diamonds

When kimberlite or other rocks containing diamonds are weathered, the diamonds within the rocks are liberated as the rocks break down. In some cases, they are concentrated into alluvial deposits above or near the kimberlitic source known as residual placer deposits (Bluck et al., 2005). In the vast majority of cases, however, they are transported, along with the weathered rock fragments, down active drainage channels.

Mass flow of sedimentary loads in high energy flood periods, and progressive river transport over millions of years, causes diamonds with fractures, points of weakness, imperfections and planes of weakness within them, to progressively break into smaller stones with fewer cracks and fractures. Consequently, whereas ▶

FIGURES 5: Simplified map showing the distribution of land and marine alluvial deposits across Southern Africa. Small towns shown provide labour, supplies, equipment, and services to the Small and Junior diamond miners.



kimberlite pipes are characterised by low average ROM diamond values that are seldom higher than $200 per carat, alluvial diamonds typically show ROM values that may be several orders of magnitude higher in value than kimberlite goods **(see Table 8)**.

As alluvial diamonds are transported from their sources down drainage systems or through wind corridors, as for example on the Namibian west coast, some are deposited in suitable trap sites, forming alluvial or transient placer deposits. Because good quality diamonds (typically the gemstone component) are so hard and resistant to breakage and abrasion, they are not broken down by attrition to the same extent as other minerals and they may survive extremely long distances of transport within active drainage systems, some reaching the river mouth at the coast where they are concentrated to form terminal placer deposits (Marshall and Baxter-Brown, 1995).

South Africa's Kaapvaal craton fulfills the requirements for the formation of extensive alluvial diamond deposits and mega-placer diamond deposits.

This remarkable craton comprises:

- a very large stable platform that has undergone uplift and extensive weathering and erosion
- numerous diamond-bearing kimberlitic intrusions, both pipes some of which are still of considerable size in spite of considerable erosion, and dyke or fissure systems
- multiple ages of kimberlite intrusions, including diamondiferous pipes, stretching from the Cretaceous to the Proterozoic, which were eroded over a considerable period of time, providing an ongoing source of diamonds to the drainage channels
- two very extensive conduits or conveyor belts forming westward-flowing drainage off the Kaapvaal craton that has been efficient, partly because of the craton's uplift, to the point that much of the Kaapvaal craton lies more than 1 km above sea level, which is much higher than the 400-500 m elevation of most cratons in the world (Nyblade and Robinson, 1994) and this has maintained a strong flow along the drainage channels

Though the rivers draining the Kaapvaal craton, in particular the Orange and its' Vaal River tributary, Olifants and other rivers draining the Namaqualand region, are believed to have changed over time (e.g. De Wit, 1996), they have, nevertheless, focused the supply of diamonds and sediment within two reasonably limited areas, creating an extensive land-based as well as the west coast mega-placer to develop. In addition there was enough wind and wave energy, along with strong coastal currents, in the terminal placer to ensure that much of the sediment accompanying the diamonds has been removed from the placer site, thus ensuring a suitable environment for deposition and reworking at the terminus, and lastly a key point highlighted by Bluck *et al*. (2005) is that these conditions occurred contemporaneously, to the point that a mega-placer was formed off the west coast of South Africa and Namibia.

Diamond mega-placer deposits are defined as deposits containing more than 50 million carats of diamonds, 95% of which are gem quality (Bluck *et al.*, 2005). The only two mega-diamond placers known in the world have formed along the West Coast of Southern Africa. One off the mouth of the Orange River and the other further to the south. It is believed that onshore and offshore mining operations along the West Coast of South Africa and Namibia have recovered some 200 million carats of diamonds. Moore and Moore (2004) and (Levinston et al., 1992) estimated a total resource of 1,5 billion carats in this area. The main groups of controls that lead to the development of mega-placers are: (1) the craton; (2) the drainage; (3) the nature of the environment at the terminus, and (4) the timing of the deposition (Bluck et al., 2005).

The Orange-Vaal River Drainage System or 'Conveyor-belt:

The Orange-Vaal River system is the principal fluvial conduit draining the bulk of the central and western parts of Southern Africa **(Figure 5)** and the Kaapvaal craton. It is a large, long-lived continental-scale river system with a drainage basin of approximately 1 million square kilometres, 60% of which falls within South Africa, the remainder falling within Lesotho (where the river originates at an altitude of 3 100m above sea level), Botswana and Namibia. In a detailed study, Jacob (2005) calculated the length of the Orange River to be 2 600 km, using GIS measurements.

Approximately half-way along its length, its main tributary, the Vaal River joins the Orange River. The Orange-Vaal system traverses a variety of rock types from Archaean to Cainozoic in age and passes through climatic zones from wet (at its source), becoming increasing arid towards its outlet into the Atlantic Ocean in the west.

An important aspect of these two key rivers, namely the Vaal and Orange Rivers, and their tributaries including the Harts, Riet, and Molopo Rivers, is that their gradients also played a role in the concentration of diamonds and formation of alluvial deposits. Gradients of the above westerly flowing rivers are very low, compared to the generally far steeper gradients of the many east flowing rivers which flow off the Kaapvaal Craton as shown in **Table 5**. ▶

TABLE 5: Gradients of large rivers flowing to the west and east off the diamond-yielding Kaapvaal and Zimbabwe cratons.

RIVERS	FLOW-DIRECTION	GRADIENT (METRE-FALL PER KM)	ADJACENT DIAMONDIFEROUS KIMBERLITES	COMMENT
Vaal	West	0,22	Numerous	Extensive alluvial deposits
Orange	West	1.4	Numerous in Lesotho	Extensive alluvial deposits
Save (Zimbabwe)	East	2.3	Kimberlites associated with Marange deposits	Sparse uneconomic alluvial diamond deposits east of Mozambique border
Limpopo	East	0.5	Venetia, Beitbridge	No significant downstream alluvial deposits other than Krone deposits proximal to Venetia
Mbuluzi (Swaziland)	East	5	Dokolwayo (and Ehlane alluvials)	No alluvials
Tugela	East	6	Lesotho kimberlites	No alluvials

Sources: DeMeillon (PhD in progress), Google-pro map; Various topographic map sheets; Wikipedia sources.

Several of the headwaters and courses of easterly flowing rivers and their tributaries, including the Save (Zimbabwe), Limpopo, Mbuluzi, and Tugela Rivers originate in, or adjacent to, well known diamond deposits, but none of these rivers contain alluvial deposits which have ever been delineated over large areas or exploited on a long-term sustainable basis, as is the case with the west-flowing Vaal and Orange drainages.

Table 5, shows that with the exception of the Limpopo River, the easterly flowing rivers are considerably steeper than the westerly flowing rivers, and what diamonds were transported off the craton would have been rapidly flushed (not given time to concentrate) and buried in and under the extensive sand-covered coastal plains of Mozambique and eastern KZN, or transported into the Indian Ocean.

The evolution and positions of the west-flowing drainages that transported diamonds westwards across and off the Kaapvaal craton, and into the Indian Ocean, are obvious insofar as the modern river systems are concerned, but far less so back to the Cretaceous period.

Considerable quantities of small diamonds (on average < 1 carat and predominantly in the 0.5 – 0.25 carat range) are found in ancient marine terraces represent raised and drowned beaches along the West Coast of South Africa and Namibia, that formed subsequent to the break-up of Gondwanaland. These diamonds were transported from the hinterland to the west coast Atlantic Ocean coastal belt where they were reworked by water and wind action to create the world's largest diamond placer deposit along the west coast of Southern Africa. ■

Calcretised Cretaceous Mahura Muthla gravels, Ghaap Plateau

Ages of the alluvial deposits

Most of the known pre-Karoo kimberlites occur in areas that are considered to have been cratonic highlands during the Carboniferous (–300 my) Dwyka period, and would therefore have been subjected to extensive down wasting and ice scouring during Dwyka glaciation (Moore and More, 2004).

Several authors have discussed the potential significance of Dwyka glaciation on the distribution of diamonds in South Africa (Harger, 1909; Du Toit, 1951; Stratten, 1979; Marshall, 1986; Maree, 1978; Moore and Moore, 2004) and increasingly evidence is being presented supporting the importance of the Carboniferous glaciers and their end products (diamictites with coarse boulders) in respect of the alluvial deposits.

Some of the diamond-bearing sediments eroded and transported during pre-Karoo and Dwyka times would have been deposited in alluvial deposits upstream of the mouth on the present Atlantic coast. These would have formed a second, more proximal source of diamonds near the present West Coast when they were re-eroded and transported once Gondwana broke up and the present Atlantic coast of South Africa developed (Moore and Moore, 2004). The origins of the extensive and massive west coast diamond placer deposits comprising well sorted and rounded high quality (<98% gems) remains a matter of contention, which is not discussed in this report.

The origins of the extensive and massive west coast diamond placer deposits remains a matter of contention, which is not discussed in this report.

A summary of the main alluvial deposits of South Africa and their likely ages of deposition, is presented in **Table 6**, bearing in mind that in many cases the older river graves and terraces would often have been eroded, reworked, even removed, with this material and diamonds redeposited into younger terraces and deposits. ■

TABLE 6: Summary of main age periods of deposition of diamond bearing alluvial Gravel deposits of Southern Africa (Sources: De Jager, De Meillon, pers comm; De Wit et al, 2000; Coetsee, 1976; Jacob, 2000; Van der Westhuizen, 2012; Wilson et al, 2007).

AGE PERIOD	DEPOSIT AND LOCALITY(IES)	COMMENTS
Pleistocene (<1.8 my)	• Younger (<20 m) gravel Terraces of the Orange River – NCP • Rietputs and Riverton Formations of the Lower Vaal River – NCP	
Pliocene (5.3 – 1.8 my)	• 60-30metre sediment packages of the Atlantic coastline – NCP • Meso-gravels of the Renosterkop area and LOR – NCP • Proksch Koppie and Wedburg Tce's of the Lower Vaal River Basin – NCP	
Miocene (23 – 5.3 my)	• Pre-and Proto-LOR gravels – NCP • Bosluispan and Galputs in Kao River Valley – NCP • Renosterkop Upper-potholes, and Daberas Potholes in the Augrabies area • Intermediate Tce remnants of MOR (eg. Tce-B of Saxendrift deposit) – NCP • Harts Valley (NWP), Holpan-Klipdam deposits of proto-Vaal River – NCP	Klipdam deposits fill an old glacial scour channel
Cretaceous (145.5 – 65.5 my)	• Mafikeng and high-level (+100m) Terrace remnants of MOR • Nooitgedacht and Droogeveld 'Sluit' gravels of NCP • Late and Pre-Cretaceous dolomite karst hosted gravels of Ventersdorp-Lichtenberg area (NWP) • Mahura Mutlha gravels of the Ghapp Plateau	Mahura Muthla gavels are preserved in highly calcretised sinuous channels probably representing remnants of original drainage systems
Permian	Extensive NWP-Triangle gravel deposits (eg. London Run, Panfontein, Bamboes Spruit, other properties)	Contain distinct population of well sorted and rounded gemstone diamonds; Marine Reworking of Dwyka deposits in an Ecca (Karoo) marine basin
Carboniferous	NWP-Triangle gravel deposits coarse gravel deposits	Low grade weathered angular 'gravels' encountered on London Run representing Dwyka glacial deposits
Archean	Witwatersrand placer diamonds	Show strong radiation damage. Example of 194 carats recovered from Modderfontein 'B' Gold mine

Abbreviations: MOR – Middle Orange River; LOR – Lower Orange River; NCP – Northern Cape Province: NWP – North West Province: FM's – Formations; Tce's – Terraces.

Controls in the formation of alluvial deposits

(Trap-sites, Deflation and Enrichment {'Rooikoppies'}, Lithification and Other)

The interplay of a range of regional and local geology, structures, bedrock lithology, topography and geomorphic factors, and erosion influence and control the formation of alluvial deposits and their associated concentration of diamonds. Bedrock that erodes to produce good trap sites, such as gullies and potholes and also contributes coarse clasts to the river sediment, generally yield the richest alluvial deposits.

Because of their high relative density, and durability, diamonds tend to concentrate in the lower parts of a deposit where they are more likely to become trapped in bedrock irregularities such as potholes. While the pothole is active (i.e. sediment is passing through and light material is escaping while heavy minerals remain), attrition between minerals occurs until a critical size is attained, at which time a mineral is washed out. Since diamonds are very hard, they suffer little attrition, and are further concentrated relative to other heavy minerals. This also leads to the **nugget affect** which is ubiquitous in alluvial deposits, and to a lesser extent in kimberlites, and which presents challenges to the systematic and reliable evaluation of primary and secondary diamond projects Examples of the types of rocks, structures and bedrock that exert control and help develop alluvial deposits which lead to the concentration of diamonds in alluvial settings are highlighted overleaf: ▶

- **Erosion of cover rocks** – in the central and western areas of the Kaapvaal craton an important control in respect of the formation of South Africa's exceptional alluvial diamond deposits was the erosion of cover rocks down to the point that the **Carboniferous Dwyka diamictite** were exposed at the base of the Karoo rocks. The exposure of the diamictites played a key role in enhancing the entrapment of diamonds on land for three reasons: **(1)** the alluvial system now had enough coarse material eroded from the Dwyka diamictite to build gravel bars to trap more diamonds on land, **(2)** the pre-Karoo topography that was then being exhumed is characterised by steep gorges and splays that creates significant bed-roughness and turbulence for the concentration of heavy minerals like diamonds, and **(3)** the progressive exposure of numerous clast and boulders **('Erratics')** during the downward erosion of the Dwyka diamictite provided important irregularities and flow-disturbances which assisted in the local entrapment of diamonds on the bedrock. The Dwyka sediments could also be an additional source of diamonds from pre-Karoo kimberlites.

- **Ventersdorp Supergroup lavas** – as noted previously there are a variety of good examples in South Africa where a strong correlation exists between alluvial deposits and Ventersdorp lava bedrock in the Vaal-Harts River basin (Lynn, 1991), the best example being the Nooitgedacht area, about 15kms north-west of Kimberley, where fractured and weathered lavas have in the past yielded some exceptional diamonds.

- **Droogeveldt Sloots** – large and extensive north-east, south-west trending fractures in Ventersdorp lavas which have been weathered out into narrow gulley's and 'sloots' are prevalent to the west of Barkly West. The Droogeveld Sloots and similar structures extending onto Rooipoort are famous for yielding high quality diamonds and high localised grades of alluvial goods.

- **Karoo dolerite dykes** – a few isolated deposits that are found on Karoo bedrock are either associated with intrusive dolerite dykes and sills (eg. on the farm Klipfontein 35 near Aliwal North) or with hardened and indurated Karoo sediments, such as the Seta deposit in the Limpopo Province. The deposits which do occur on Karoo bedrock are generally of lower grade than those that have formed on harder substrates (De Wit, 1990).

- **Waterfalls and plunge-pools** – these settings are important for diamond concentrations and in the past have yielded super-enrichment of high-quality diamonds, well known examples being the famous Ochta 'glory-hole' locality on the LOR, and the Saxendrift fault 'waterfall' zone on the west-side of this property in the MOR. At Ochta high concentrations of diamonds were also found on the up-slope 'push-bar' down-stream of the actual waterfall plunge-pool, and is also a common zone to find enriched diamond concentrations.

- **Banded-ironstone (high-Specific gravity) control in the MOR** – approximately 30km downstream of the confluence of the Vaal and Orange Rivers, a large ancient drainage introduced massive volumes of banded ironstone clasts, weathered from the adjacent Asbestos Hills Formation, into the fluvial system. This sudden increase in bedload density had a pronounce impact on the diamond concentration ability of this section of the river.

- **Weathered Proterozoic gneisses and schists** of the Lower Orange River and West Coast marine alluvial played a key role in the concentrations of diamonds in the lower reaches of the Orange River. Millions of carats of small diamonds (typically 1 carat and less) have been found on ancient beach deposits of the West Coast between the Olifants River in the south, and Orange River in the north. The high-grade marine deposits have been extensively mined by small, medium and large companies since the late 1920's.

- **Pothole formation** – The longer a pothole is active the higher the relative diamond concentration may become. Changes in slope and sites, where rivers exit from the confines of gorges, are also favoured localities for the development of placers. Concentrations of diamonds are higher in areas of a river where coarse gravel has been trapped and retained for long periods of time. The highest grades and coarsest diamonds occur in the sedimentary settings that can extract and retain the passing population of diamonds effectively, notably in fixed bedrock trap-sites (Jacob et al., 1999).

- **Terrace and 'Rooikoppie' deposits** – The formation of Terraces and their preservation or erosion has been explained in above. Once formed, the subsequent recurrence of wet and humid tropical conditions after the initial formation of a diamondiferous terrace may lead to the enrichment of the terrace. As the terrace material weathers, the labile component will be washed out, leaving a deposit enriched in resistant minerals such as quartz, agate and, of course, diamond. The highest (and oldest) Rooikoppie gravel terraces and associated deflation-deposits of the Vaal River basin, and Middle Orange River (eg. Brakfontein and Saxendrift) are good examples of such deposits.

- **Lithification** – Alluvial deposits may become metamorphosed, lithified, silicified, and cemented by carbonates or calcretes to form hard and solid rock, and are commonly known as palaeo-placers. The Witwatersrand gold deposits produced minor quantities of diamond along with gold, uranium and other by-products are an example of this. Records from the Modderfontein 'B' Mine showed that in one year it produced about 194 carats (Coetzee, 1976). Later weathering and reworking of these deposits provide a mechanism for releasing diamonds into the system, and excellent example being the exceptionally high grade colluvial and eluvial Marange diamond deposits in south-east Zimbabwe. ■

Mining low- and ultra-low grade alluvial deposits

Today's Small and Junior diamond miners make use of large-scale earthmoving equipment in order to acquire the economies of scale required to mine the remaining low-grade deposits. Many deposits are covered by hard-pan calcrete that requires blasting or large dozers to rip and break up. Some are buried under thick overburden.

The development of mobile screens now makes it possible to screen out 60-70% of the ROM material at the mining face which reduces transport costs and rehabilitation costs. New technologies like the use of bulk X-Ray machines and X-Ray Transmission (XRT) have made it possible to recover diamonds more efficiently.

Most Small and Junior alluvial diamond miners of today de-sand the product from their scalping screens before processing through the concentration plants. The main reason being that the value of the larger diamonds outweigh the value of the smaller diamonds by an order of magnitude. If de-sanding is done at 6mm, 35% or more of the plant feed can be replaced by a coarser fraction. At 6mm, approximately 75% of the diamonds would be screened out but this represents only about 5-7% of the value (De Meillon, pers com). The average size and value of the diamonds recovered now increases significantly.

De-sanding at the scalping screen or at the plant before processing has many additional benefits. The sand recovered can be used for rehabilitation and mined areas can recover much quicker. Slimes dams are now up to 90% smaller as the sand fraction has been removed as a dry product before processing. Water usage at the rotary pan plants used by most junior miners is reduced by up to 90% as the puddle mixture in the pan can now be re-circulated.

A further important point about this sector is that the mining and recovery processes utilised by the small or Junior diamond miners are environmentally friendly as no dangerous chemicals are used, and high rehabilitation standards are set by most operators.

Alluvial diamond mining is the only migrant mining industry in South Africa. Self-funded companies with limited cash-flow cannot afford to mine in areas where the grades are too low and their equipment insufficient. Most of the plant and equipment used by Junior alluvial diamond miners are mobile and can be hooked up and moved at short notice. The main reasons why these operators are successful are their ingenuity, adaptability and ability to move and start up a new operation in a very short space of time (less than 6 weeks).

Small and Junior miners have themselves developed considerable 'home-grown' expertise covering basic geology, shallow strip or open-cast mining, fine-sand screening, gravel processing, diamond recovery, water recycling, and rehabilitation of these unique deposits. Equally as shown in **Table 7** there has been considerable improvement and innovation in the technology available which adds value to the industry and assists with the exploitation of ultra-low grade gravel deposits. ■

TABLE 7: Modern Smart-technology applications and support systems available to successful Small and Junior diamond miners

	EQUIPMENT	APPLICATIONS	COMMENTS
1	**Modern Drone Technology**	Accurate surveys, for monitoring shallow open cast mining operations, calculating resource depletion, and surface elevations to identify terraces and channels	Excellent for delineating old deflated (Rooi Koppie) deposits, as well as monitoring rehabilitation programs
2	**Reverse-Circulation Drilling**	Accurate mine planning to identify minable gravels and stripping levels	Preserves the stratigraphy of deposits, essential for delineation of bed-rock features, scours, plunge-pools, and other features
3	**Digital Elevation Modelling**	Modeling of drill bedrock data to identify scours in the ancient river bedrock to identify areas where heavy minerals would concentrate	Allows recognition of many regional and local terrain features which are key for prioritising targets in deposits
4	**Geographical Information Systems (GIS) and Data-bases**	Manage large volumes of surface elevation, survey and drill data	Cost effective mapping, delineation, recording, and data compilation systems
5	**3D-Moddeling packages**	Used to identify potential high-grade areas	Allows rapid and effective delineation of geological and bedrock controls that create localised areas of diamond concentration
6	**In-Pit Screening Units**	Efficient removal of the oversize at the mining face has led to large cost savings	Large cost savings, water savings, and reduces excessive handling of non-pay gravel component
7	**High-frequency De-sanding Screening**	Efficient removal of -6 mm fraction has revolutionised the industry; allows the mining of ultra-low grade, high diamond value deposits	Considerably enhances processing plant efficiencies and reduces costs
8	**Modern diamond X-Ray Recovery systems e.g., Bourevestnik (BV) technology (Russian)**	Primary and concentrate diamond recovery; reprocessing of tailings deposits	Modular and containerised units; high security; used in process-flow and recovery circuits to reduce diamond breakage
9	**X-Ray Tomography Mineral Particle Sorters (XRT)**	Efficient recovery of large and exceptional stones e.g. Type IIa and IIb diamonds; minimises diamond breakage	Key reason why many large stones have been recovered in the past 5 years
10	**Remote CCTV Security and Site-Monitoring Technology**	Local and remote monitoring of sensitive areas on mining, processing, and final recovery operations; ideal for monitoring access routes to guard against armed incursions and related theft	Minimises product and other theft; powerful management tool Has enhanced operating efficiencies and reduced diamond shrinkage

SUMMARY OF THE ALLUVIAL DEPOSITS

Introduction

As noted in the previous sections of this report, the ages of alluvial diamond deposits in South Africa vary from 2.9 Billion years (diamonds in the Witwatersrand gold deposits) to recent, though the majority of the deposits that have been preserved and are mined today vary in age from recent to Miocene age (1 – 25 my).

With the exception of 3 isolated deposits, most alluvial deposits occur along the north-western rim of the Karoo basin (de Wit, 1996). Alluvial diamond deposits which have been successfully mined across South Africa can be divided broadly into deposits occurring in the NWP, the NCP and the West Coast deposits. There are also localised and smaller alluvial diamond deposits in Gauteng, in drainages running off the Cullinan diamond mine and other small kimberlites such as Montrose, National and Schuller, the FSP, Eastern Cape Province (Aliwal North) and Limpopo Province (Seta, Krone). Most of these deposits are closely associated with known kimbelite clusters (and well known mines), and in some instances have been largely depleted (e.g. the deposits around Cullinan). ■

Exceptional gemstone diamond populations

Following the rapid erosion that had taken place during the early Cretaceous, it would logically be expected that the diamond populations along current drainages would be a good mixture of diamonds from most of the kimberlites, especially if the possible contribution of diamonds from the Dwyka sediments is also considered.

This is however not the case and there are significant differences in diamond size, quality and value between the different areas and river systems. The main reason for this is the highly variable topography of the pre-Karoo surface where large areas of high

ground acted as watersheds between different kimberlite and older alluvial sources of diamonds.

Regardless, the alluvial diamond deposits of South Africa represent the highest value per carat diamond supply in the world with some areas averaging upwards of US$7 000 per carat. **Table 8** below shows typical grades and ROM average diamond values of some of the key alluvial diamond deposits and kimberlites in South Africa.

The challenge in mining these deposits is that the grades expressed in carats per hundred tonnes (cpht) can at best be described as ultra-low. Consequently delineation, evaluating, and successful exploitation of these deposits is challenging. However, generations of local Small alluvial diamond miners, and a lesser number of Small kimberlite miners and operators, have developed the skills, experience, and understanding to mine these varied gravel deposits. They generally utilise world class earth moving equipment, processing and treatment plant, and cutting-edge recovery equipment to successfully produce, market, and sell the exceptional diamonds recovered from the alluvial deposits.

De Meillon (PhD in preparation) and Bristow (pers comm) have conducted extensive studies of all the alluvial deposits across South and Southern Africa, including an analysis of their distribution and controls by constructing digital terrain models (DEM's) of their drainages and setting. These have been utilised in this study with the kind permission of Lyndon De Meillon and John Bristow. ■

TABLE 8: ROM average diamond and grade values for alluvial deposits of Southern Africa

ALLUVIAL DEPOSITS (LAND AND MARINE)	COMPANY OR OPERATOR	ROM VALE US$ PER CARAT	COMMENTS
Krone alluvials (LP)	Diamcore Mining	~ 185 - 250	Deposits adjacent to Venetia kimberlite – high sand content
Lichtenburg-Coligny Area (NWP)	Various private operators	~ 350 - 500	~ 1 – 1.5 cpht ~ 0'6 carats per stone
Ventersdorp area (NWP)	Two mid-sized private operators	~ 350 - 500	~ 0.5 – 1.0 cpht ~ 0.5 carats per stone
Schweitzer Reyneke-Bloemhof-Wolmaranstad Triangle (NWP)	Large number of small private mining operators	~ 600 - 700	~ 0.5 – 1.0 cpht ~ 0.8 carats per stone
Vaal River (NWP)	Makwassie, Bloemhof, Christiana	~ 700	~ 0.5 – 1.0 cpht
Proto-Vaal River (NCP)	Holpan, Klipdam, other	~ 1 500	~ 0.5 – 1.5 cpht ~ 1.0 carats per stone
Vaal River (NCP)	Schmidsdrift, Rooiport,	~ 900	~ 0.7 cpht
Riet River (NCP)	Schutsekama and downstream thereof	~ 1 400	Low-grade deposits
MOR (Hopetown to Douglas) (NCP)	Limited mid-sized private operators	~ 3 500	Ultra low-grade deposits, typically <0.35cpht 3 carats per stone
MOR (Douglas to Prieska) (NCP)	Various mid-sized private operators	~ 2 200	Low-grade deposits ~ 2.4 carats per stone
Lower Orange River (Baken deposits) (NCP)	Lower Orange River (Private Company)	~ 1 200	~ 1.2 carats per stone
West Coast marine deposits (NCP)	Alexkor – production from small and medium land, beach and shallow water Contract miners	~ 400 - 600	~ 10 – 25 cpht Stone sizes: ~ 0.50 – 0.25 carats per stone
Olifants River mouth marine deposits (WCP)	De Punt (THG) – shallow water operations off small boats	~ 400 - 600	Local concentrations of diamonds are similar to the old beach deposits found to the north, but are more difficult to exploit

Sources: Company Annual Reports, presentations, and news releases, Diamond Tenders, Small mining producers, Bristow pers comm, De Meillon, PhD in preparation)

Note: Average diamond price estimates and grades in table above are based on a lower cut-off screen size of about 2mm unless otherwise indicated. Many inland alluvial diamond operators are using bottom cut-off screen sizes of 4 – 6 mm, which increases processing efficiency, lowers costs, and has the effect of producing higher average prices at reduced grade.

NWP alluvial deposits

Figure 6 shows a Digital Elevation Model (DEM) of the North West Province with the major towns and drainages indicated.

The main occurrences of alluvial diamond deposits are found in the Bakerville area north of Lichtenberg, in north-south trending broad drainages across karstic dolomitic topography between Lichtenberg and Ventersdorp, and in a triangle comprising Schweitzer Reyneke-Bloemhof-Wolmaranstad. The Vaal River flows through the southern edge of the NW Province and also carries excellent quality alluvial diamonds.

All these areas have been extensively mined in the past, but still contain extensive areas of unexploited low grade-gravels. Recent modern geological studies and reinterpretation of the NW Province 'Triangle' has also led to a complete revision of the geological model for the area, and considerable enhancement of the diamond resources available in this 'Triangle'.

Mahikeng Area

The alluvial gravel in the Mahikeng area represents a remnant of a broad alluvial plain that has been mined quite extensively (De Wit, 1996). The gravels have been deposited on Ventersdorp Lava bedrock that has undergone intense weathering to a yellowish clay. On the basis of its similar alteration characteristics to the Lichtenburg gravels, De Wit (1996) has interpreted the gravels to be at least of Late Cretaceous age.

The discovery of the Lichtenburg field in 1926 was one of the major diamond discoveries in South Africa and has yielded around 9 700 000 cts.

The average diamond values in the area varies between 350 – 500 US$/ct with grades of 0,5 – 1 cpht.

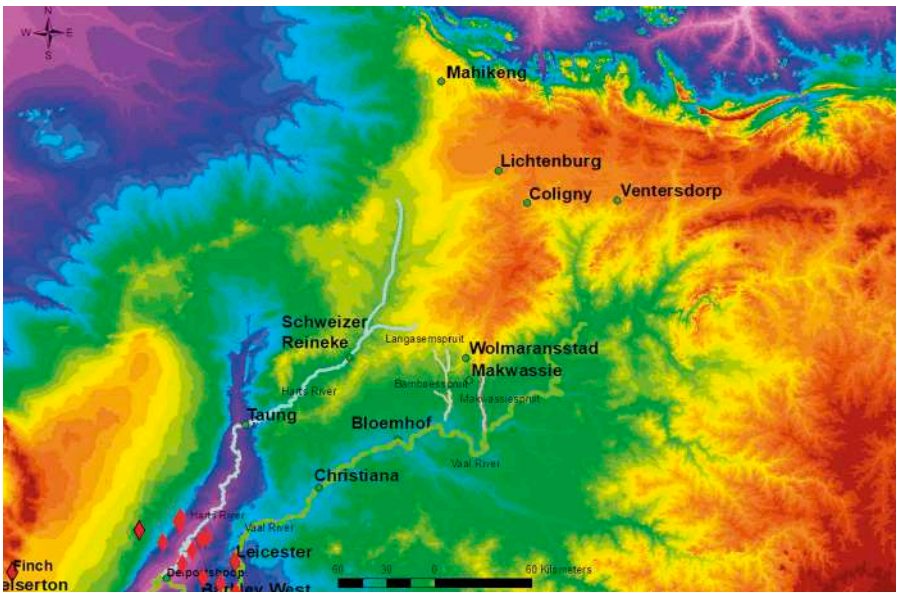


FIGURE 6: Digital Elevation Model (DEM) of the North West province showing the major drainages impacting this area.

Lichtenburg – Ventersdorp Area

The discovery of the Lichtenburg field in 1926 was one of the major diamond discoveries in South Africa and has yielded around 9 700 000 cts. The bulk of the deposits are confined to the highly karsified dolomites of the Transvaal Sequence. The setting of the gravel deposits in the Ventersdorp area is similar to that of Lichtenburgh in karsified dolomites. Some of the deposits have been mined to a depth of 40 m or more.

The average values in the area varies between 350 – 500 US$/ct with grades varying between 0,6 – 1,2 cpht.

Schweitzer Reynecke-Bloemhof-Wolmaranstad Triangle

The gravel deposits in this triangle comprise by far the largest areal extent (+- 100km^2). These deposits have been described in detail by Marshall (1986, 1990). The mining operations in this area consists mainly of shallow, surficial workings.

The latest hypothesis by De Jager and Ward (pers comm) is that these deposits were formed from reworking of diamond-bearing glacial deposits transported by Carboniferous Dwyka ice sheets, which were reworked in a Karoo inland basin or sea during the Permian. This gave rise to extensive shallow deposits (generally referred to as 'Rooikoppies") which blankets the area, including remnants of diamondiferous gravels formed along the shoreline in the vicinity of Schweitzer Reyneke. These gravels and diamonds were subsequently reworked into the younger north-south trending Bamboes, Makwassie and Langasem drainages. Close to Bloemhof and Wolmaranstad, some of these older deposits have been reworked into the Vaal River.

The average values in the area varies between 500 - 800 US$/ct with grades varying between 0,5 – 0,8 cpht.

Vaal River Alluvial Deposits

Alluvial gravel terraces associated with the modern Vaal River have been mined extensively between Bloemhof and Christiana, in both the Free State and North West provinces. The major source of diamonds to these terraces would be diamonds eroded from the deposits to the north and brought down by drainages like the Bamboesspruit and the Makwassiespruit into the current river systems **(Figure 1)**. Note that there are also significant drainages draining from the Ventersdorp area into the Vaal River (Skoonspruit).

The Harts River was once a major drainage in the area.

The average value of diamonds mined along the Vaal River in North West varies between US$800 and 1 000/ct with minable grades varying between 0.5 – 2 cpht.

Harts River Valley Alluvial Deposits

The Harts River was once a major drainage in the area before it was captured by the Vaal River **(Figure 6)**. The main sources of diamonds to the Harts River would be diamonds eroded from the Lichtenburg and Mafikeng alluvial deposits as well as from the Bellsbank kimberlites on the Ghaap plateau.

The average value of diamonds mined from the Harts river varies between US$600 – US$800/ct. ■

Northern Cape Province (NCP) land-based deposits

The Northern Cape Province is endowed with many kimberlite intrusions. Most of them are uneconomical but contain some diamonds while others have been world class diamond mines like the mines around Kimberley, Koffiefontein, Jagersfontein, and Lime Acres (Finch).

These numerous kimberlites, even those of low-grade, contributed a vast 'budget' of diamonds over millions of years into the Vaal River system, including its numerous tributaries. They are also one of key sources of diamonds to the Orange and Riet River systems.

Figure 7 shows a DEM of the Northern Cape Province. Note that we have now moved down onto or very close to the base of the Karoo Succession and large parts of the channel morphology of all the major rivers in the Northern Cape is now determined by the pre-Karoo topography.

Vaal River Alluvial Deposits

As the Vaal River enters the Northern Cape, the first significant gravel splay occurs at Windsorton. Here the river exits a (pre-Karoo) gorge between Warrenton and Windsorton and dumped it load as a series of terraces over time, varying from 60m (Holpan) to 0-20m (Riverview Estate). ▶

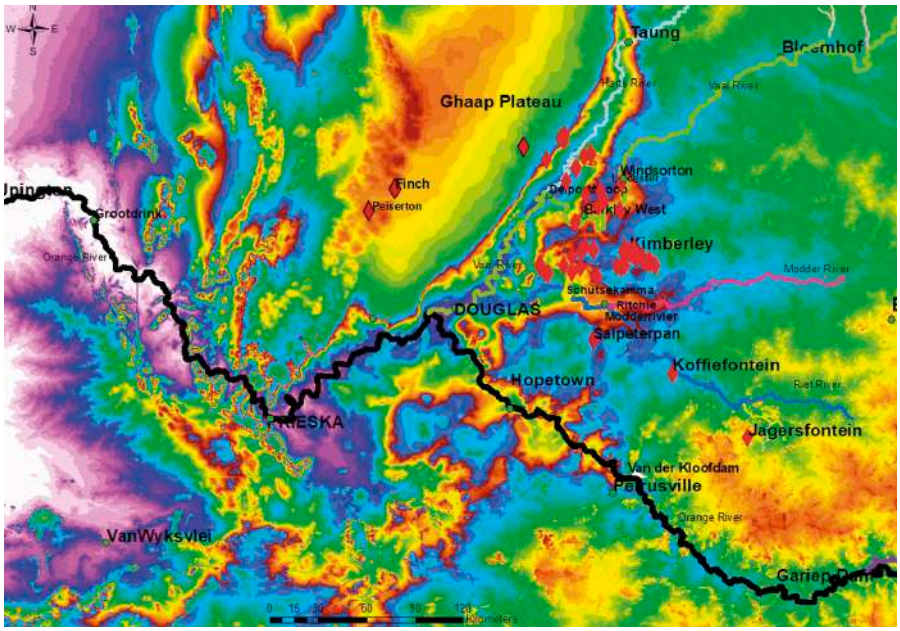


FIGURE 7: DEM of the Northern Cape showing the different drainages and major towns. Kimberlites are shown as red diamonds.

This is seen clearly on the DEM in **Figure 7**. This type of feature is typical of all the larger scale deposits in the central area of the Northern Cape.

Further down, the river enters another gorge feature near Barkley West **(Figure 8)**. As it exits this feature the well-known Waldecks gravel splay was deposited. After the confluence of the Vaal and Harts Rivers further down, the sequence is repeated as the river exits the Bushmanskloof Gorge upstream of Schmidsdrift.

Note that the kimberlites in the Kimberley area are situated to the north of the high which separates the Vaal River drainage from the Riet/Modder River drainage. This implies that the Kimberley kimberlites supplied the Vaal River system with diamonds, certainly since the time that the pre-Karoo high that separates these drainages became exposed.

Average values of diamonds mined along the Vaal River in the Northern Cape at a 2mm cut off are about $800 – 900 per carat, and at a 5mm bottom cut-off vary between US$1200 – 1400/ct. Minable grades vary between 0.3 – 1 cpht.

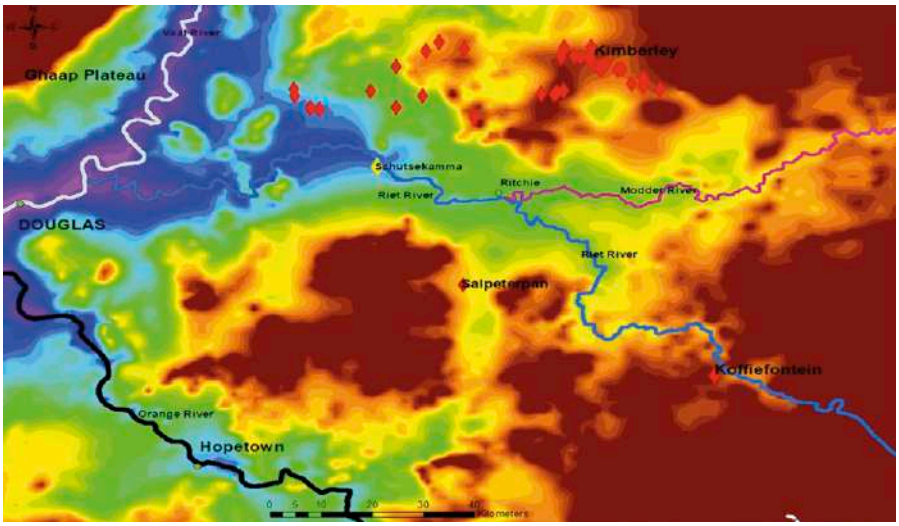


FIGURE 9: DEM showing the Riet River drainage area.

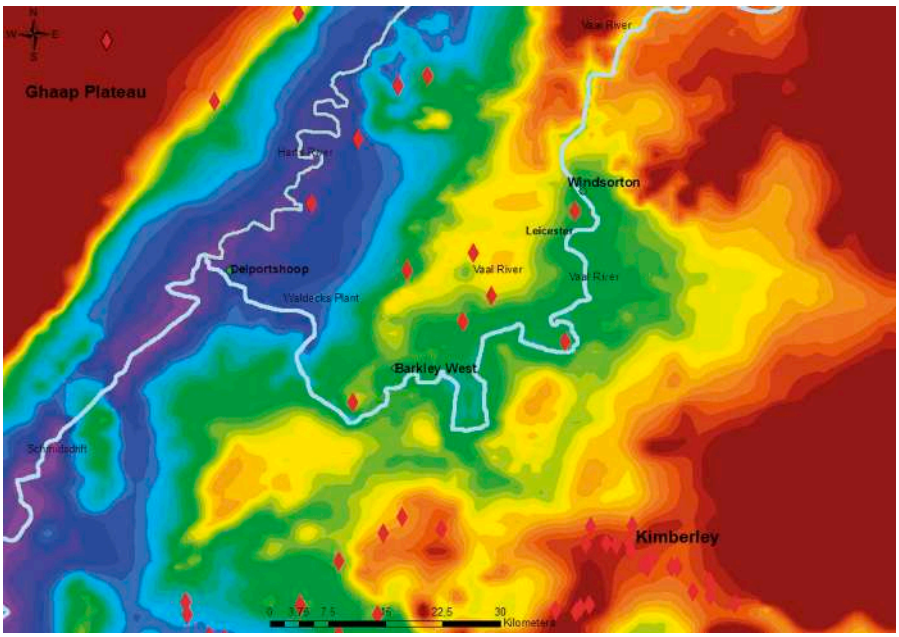
The Riet River Alluvials

The Riet River is the youngest of all the major diamondiferous drainages. **Figure 9** shows a DEM of the Riet River drainage. The major source of diamonds to the Riet River system was the Koffiefontein Kimberlite. The Jagersfontein kimberlite higher up in the drainage as well as the Salpeterpan fissure would also have contributed diamonds.

Above the confluence of the Riet and Modder Rivers, the Riet river flows mainly over Dwyka shales and there is not enough material to build significant gravel bars or bed roughness to trap diamonds. Immediately downstream of the town of Ritchie, the river enters a pre-Karoo gorge that had been filled up with Dwyka diamictite. As the river system exhumed the pre-Karoo topography it carried the clasts that it eroded from the Dwyka with it to the point where it exits the gorge on the farm Schutsekama **(Figure 9)**. The gravel splay that developed at the exit of the gorge became a very good trapsite for diamonds brought down the river. The splay at has an aerial extent of about 10 km long by 2km wide.

A second splay developed approximately 30km downstream from the farm Schutsekama as the river exits a much smaller gorge feature **(Figure 9)** before it joins the Vaal River.

FIGURE 8: DEM showing the Vaal River and Harts River drainages in the Northern Cape.



Middle Orange River (MOR) (Hopetown – Douglas)

The Orange River has its origins in the mountains of Lesotho **(Figure 10)**. The main sources of diamonds to the Orange River before its confluence with the Vaal River are the kimberlites in Lesotho. Upstream of Hopetown, the Orange River flows mainly over Karoo Sediments and the only significant concentration of diamonds was found on the farm Klipfontein near Aliwal North, where a plunge pool created by a dolerite dike crossing the river at right angles, trapped some diamonds.

Smaller deposits preserved as small scours or potholes are preserved on the farms Wicklow and Slypsteen

Only downstream of Hopetown does the Orange River gain access to sufficient Dwyka clasts to start building gravel bars to trap diamonds in significant quantities. Here the river once again exhumes a pre-Karoo gorge filled with Dwyka diamictite. Where the river exits this gorge at Ettrick, the first significant gravel deposits are found **(Figure 11)**.

Smaller deposits preserved as small scours or potholes are preserved on the farms Wicklow and Slypsteen upstream of Ettrick as well as between the Van der Kloof dam and Hopetown. Downstream of Ettrick, several neck and splay features create more areas of turbulence and bed roughness where diamonds can be trapped. Further down towards the confluence a large low elevation cut-off meander can be observed.

Note the significant pre-Karoo bedrock high to the east that separates the Riet River and the Orange River pre-confluence drainages and diamond populations.

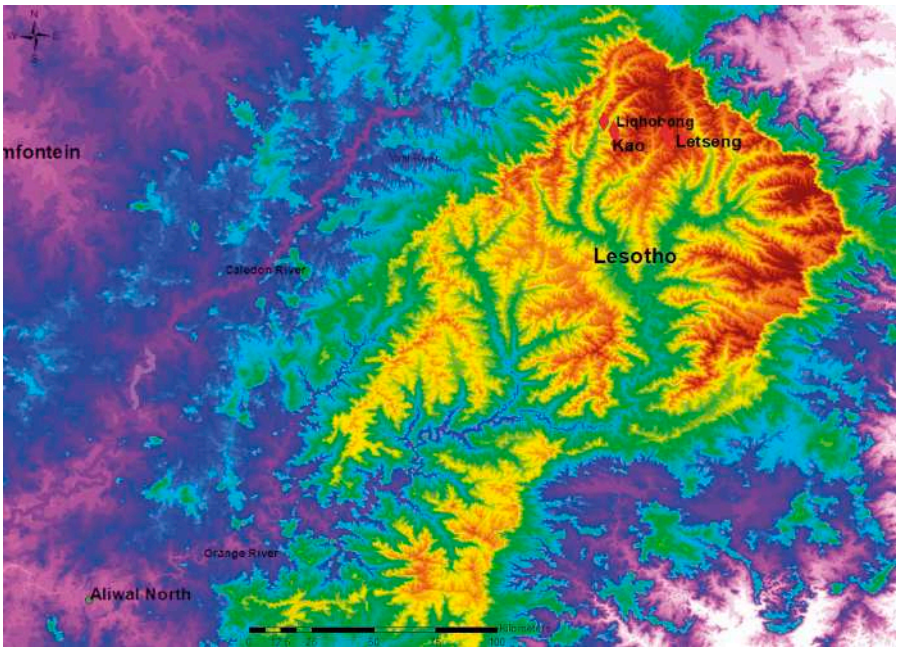


FIGURE 10: DEM showing the headwaters of the Orange River as well as the position of some of the well-known kimberlites in Lesotho.

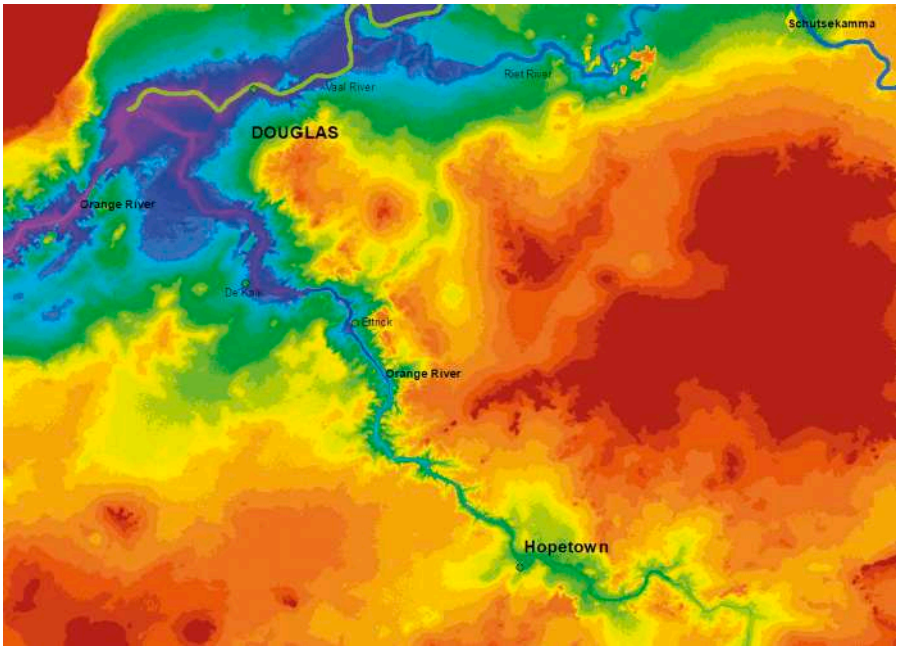


FIGURE 11: DEM showing the Orange River channel between Hopetown and Douglas.

The average values in the area (at a 5 mm bottom cut-off) can be up to US$7 000 per carat and even higher closer to the exits of gorges where bigger stones are preferentially trapped.

Further downstream of the gorge exits, values of +US$3 000 per carat are common. The grades in this area are however extremely low with average minable grades of 0.1 – 0.25 cpht. ▶

This, together with the fact that the Orange, Vaal and Riet Rivers have now combined, have made this stretch of the river such a prolific source of exceptional diamonds over the past 100 years.

MOR (Douglas – Prieska)

The gradient of the Orange River after the confluence is less than the gradient before the confluence with the Vaal River. The result is a much more meandering river system with more terraces left behind as a result of cut-off meanders. **Figure 12** shows a DEM of the river between Douglas and Prieska.

The **red-X** in **Figure 12** indicates the point where banded ironstone (BIF) weathered from the Asbestos Hills Formation to the north enters the Orange River. From this point downstream, the Orange River is inundated with BIF. McCarthy (1983) estimates that based on the volume of BIF in the Orange River gravels, this tributary might have been of a similar size or even larger that the Orange River at its peak.

The presence of a large percentage of BIF in the gravel would have a significant impact on the grade. Gravel bars are now more difficult to erode and would be in place for longer periods of time. This, together with the fact that the Orange, Vaal and Riet Rivers have now combined, have made this stretch of the river such a prolific source of exceptional diamonds over the past 100 years.

The average values in the area varies between US$2 100 – 2 700/ct with minable grades varying between 0,25 and 0,5cts/100 tonnes. ■

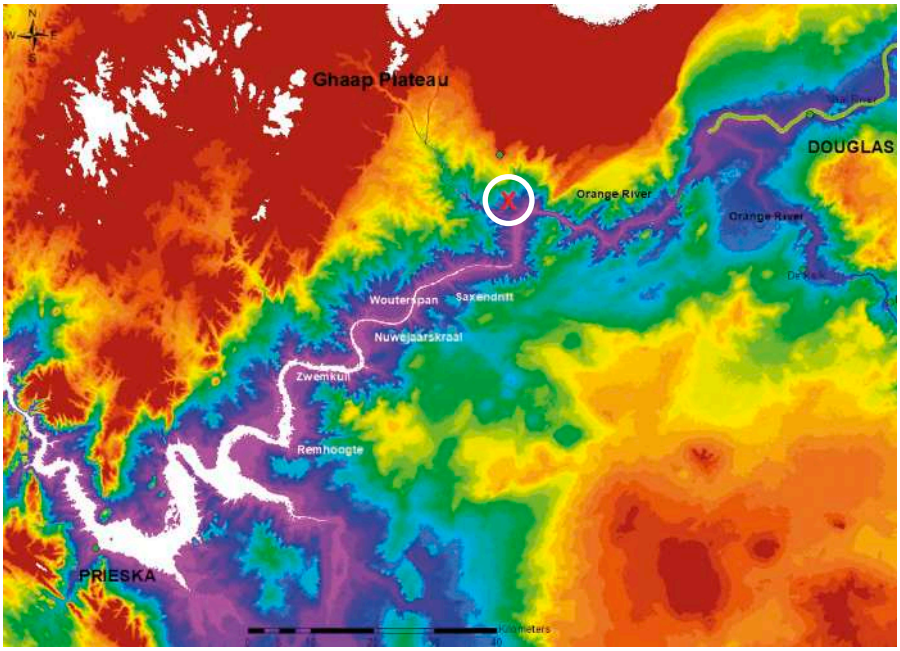


FIGURE 12: DEM of the Orange River between Douglas and Prieska with some of the well-known deposits indicated. The **X** indicates the point where banded ironstone weathered from the Asbestos Hill Formation enters the Orange River drainage.

Lower Orange River (LOR)

Traditionally, 2 broad ranges of palaeo-Orange River deposits are recognised along the lower reaches of the Orange River namely:

***Proto- Orange deposits** – these occur primarily as terraces at elevations >40m above the current river and*

***Meso-Orange deposits** – these occur at elevations<40m above the current Orange River*

Historically, the proto terraces have a significantly higher grade and have been mined extensively while the Meso terraces have been proven to be economic in localised areas only.

Although diamonds have been recovered in terraces downstream of Prieska, very little large-scale mining has taken place between Prieska and the Augrabies falls. The first significant gravel splay downstream of Augrabies is found at Grasdrift **(Figure 13)**. This is again a typical gorge and splay feature with small remnants of Proto gravel and extensive lower terraces of Meso gravel. Downstream from Grasdrift, deposits like Oena, Reuning, Bloedrift and Baken have been mined extensively with smaller scale mining on some of the Meso terraces closer to Alexander Bay.

Diamond values along the lower Orange River averages at around US$800 – 1 500/ct at a bottom cut-off of 3mm. Minable grades vary from 0,8 cpht to +5 cpht in the Proto gravels with much lower grades of 0,15 – 0,5cpht in the Meso gravels. ■

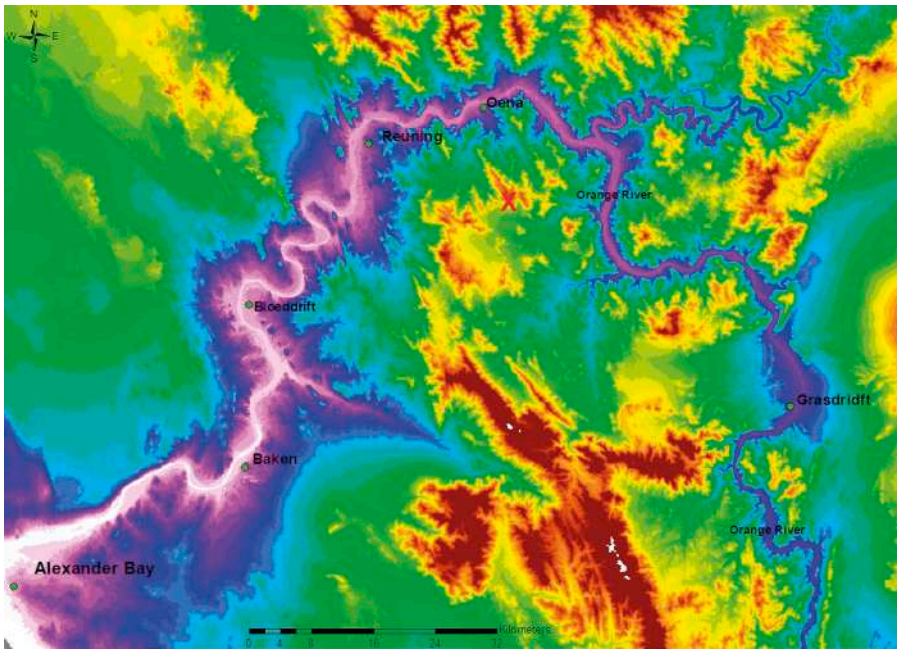


FIGURE 13: DEM of the Lower Orange River

FIGURE 14: South Africa's west-coast marine deposits and concession divisions

West Coast marine deposits

Extensive, high quality marine diamond placer deposits exist on raised and drowned-beaches of the West Coast of South Africa (south of the Orange River mouth) and in Namibia (north of the Orange River mouth. The South African deposits were discovered by Jack Carstens in 1925 (Carstens, 1962) just south of the Orange River mouth.

Remnants of theses deposits are still being mined at Alexkor south of the Orange River and down to The Punt near the mouth of the Olifants River **(Figure 14)** in the south. The author of this report visited and interviewed small land and marine miners in 2019, and also gathered information for small boat operators working out of The Punt.

The diamond from these deposits are of excellent quality with a very high proportion of well sorted clean gem quality stones (~95 – 98% gem). Average size of diamonds found along the coast vary from about 0,25 – 1,00cts with values varying between about $250 – 700 per carat.

Jacob (2005) has provided a useful summary of ideas for the origin of these marine deposits, and there is also more recent and ongoing work on their formation. In an early observation, Du Toit (1910) noted that the Vaal and Harts Rivers flow subparallel to the Ghaap Escarpment and that these rivers, along with the middle Orange River, are presently eroding and exhuming the pre-Dwyka drainage system. These pre-Dwyka river valleys still contain Dwyka Group sediments and the interfluves are composed of more resistant Archaean rocks, mainly Ventersdorp lavas. McCarthy (1983) also proposed the existence of a trans-Tswana River that flowed from the north, across the Kalahari, to join the palaeo-Orange River about 20 kilometres downstream of the Orange-Vaal River confluence.

Other theories on the drainage evolution include that of Dingle and Hendey (1984), who recognised that the Orange-Vaal system had been the most important drainage conduit for diamonds from the Kaapvaal craton since the break-up of Gondwana. Their theory proposed that the position of the Orange River mouth switched during the Palaeogene (~65 – 23 my) from its present position (at 20°S) to that of the present day Olifants River mouth (at 31°S), then back again around 23 Ma ago.

De Wit (1993, 1999) proposed the existence of two parallel westward-flowing drainages during the Cretaceous. The northern 'Kalahari' River system stretched into Botswana, possibly via the Fish River, whereas the southern "Karoo" River, had headwaters corresponding to those of the Molopo River. The course of part of the palaeo-Molopo River is defined by a deep sediment-filled channel, parallel to, but south of, the modern course of the Molopo (Haddon, 1999), and it reached the coast at the present Orange River mouth. De Wit (1999) proposed that tributaries of ▶

the northern "Kalahari" River captured the upper part of the southern "Karoo River, forming the present-day Orange-Vaal drainage".

Studies of sediment off the West Coast suggest a large outflow from the current Olifants River mouth between 117.5 and 103 Ma (Brown et al., 1995), which could represent the "Karoo" River of De Wit (1999). The mouth of this river switched to the vicinity of the present Orange River mouth, between 103 and 68 Ma, where a large river was already active at the start of this period (Brown et al., 1995; Jacob, 2005).

Revised Source and Transport Models for the West Coast diamond deposits

More recent work on the drainage, evolution and diamond distribution of the lower Orange River system by Van der Westhuizen (2012) and others, has led to a revised diamond-dispersal model operated in the lower Orange River system, which included the effects of: **(1)** pre-Karoo drainages; **(2)** Dwyka ice sheets and glaciers, and **(3)** post-Karoo drainages, of which the Orange-Vaal system has been the most important for at least the last 100 Ma (Jacob, 2005).

Although it has been proposed that South Africa's deeply weathered Cretaceous (66 – 145 my) kimberlites were the main source of the inland and West Coast alluvial Diamonds (De Wit, 1996, 1999), clusters of older diamondiferous pipes are likely to have also shed diamonds which ended up on the west coast. Important diamondiferous kimberlite clusters, including the much older Premier (~1 200 my) and Venetia (~ 550 my) deposits, predate Karoo sedimentation, which took place between 300 and 190 Ma ago.

These older kimberlites would have been subjected to rock-mass destruction and transport by Carboniferous Dwyka glaciers and their associated drainage systems. Pre-Karoo weathering and erosion with weathered material and detritus moving within pre-Karoo drainages would have also contributed additional diamonds.

Overall it is likely that diamonds deposited on the west coast placer were transported in several stages and events from the cratonic-hinterland areas of South Africa and possibly Botswana, before (even if only in part), and post the break-up of Gondwanaland. Once transported to the coastal area and available in the marine west-coast setting they were reworked into the mega-placer of the Atlantic Ocean margin.

In summary, diamonds from older diamondiferous kimberlites (such as Cullinan and Ventia age pipes) would have liberated and transported to the south-west and western parts of the continent by Carboniferous Dwyka-glaciers (Bosch, 2017; Bristow, pers comm, Hager (1909), Van der Westhuizen, 2012).

Weathering of the diamondiferous kimberlites such as Jwaneng (~240 my) and younger pipes including those at Swartruggens, Kimberley and in Lesotho areas (~165 to 84 my) would have contributed diamonds for transport westward by subsequent post-Gondwana break-up transport systems via the proto-Vaal and Orange Rivers (Bristow pers comm; De Meillon pers comm, De Wit, 2010).

In addition, the possibility of diamonds being released from Nama sediments (~1 000 my), and hence kimberlites of 1 200 my and older, has been proposed by Moore and Moore (2004).

The west coast of southern Africa (RSA and Namibia) thus received inputs of diamonds transported from the hinterland of Southern Africa over a considerable period of time from kimberlites of multiple ages, the collective transport mechanisms in the form of glacial and large ancient rivers, and the likely weathering of Nama sediments. Concentration of the end deposits (ancient river terrace remnants, and marine beach deposits) was affected by water, wave action, and wind along the west coast. ■

Outliers

There are also interesting and important outliers of alluvial diamond deposits found around the country, which are generally (but not always) associated with kimberlite clusters and kimberlite diamond mines.

Examples include Seta and Krone (near the world class Venetia diamond mine in LP), the localised Marsfontein alluvials located to the south of the Marsfotein pipe and Klipspringer fissures, the Beynespoort alluvial deposits adjacent to the Cullinan diamond mine in GP which have been largely mined out and are also in a Game Reserve which makes exploitation unlikely, and a small alluvial deposit downstream of Aliwal North created by a dolerite dyke.

The Krone deposit has been the focus of a detailed delineation, evaluation, and development program by Diamcor Mining Inc, a listed Canadian (TSX) Junior mining company. A 2015 National Instrument technical report (NI 43-101) by Grobbelaar and Hawkins reported an Inferred-resource of about 20 million tonnes of gravel with a grade of about 12.7cpht, and average diamond value of approximately $186 per carat. Additional low grade gravel deposits are also present and collectively the combined diamond resource has been reported as about 58 million tonnes by these authors. The main challenge with these deposits is sandy nature of the gravel deposits, and extensive and thick sand cover.

Recent 2021 tender diamond sales by the company have yielded prices in the range of $200 – 300 per carat. The deposit also regularly yields high quality special (+10.8 carat) stones, and given that Venetia mine produces large high quality exceptional diamonds it is possible that the Krone deposit could also yield occasional exceptional stones.

Summary

South Africa is host to unique alluvial gravel deposits that yield exceptional high-value gemstone diamond deposits. The deposits are ubiquitous in the N Cape and NW Provinces and on the Atlantic West Coast of South Africa (and Namibia).

Overall, the alluvial diamond deposits of South Africa consistently represent the highest value per carat diamond supply in the world with some areas averaging upwards of US$7 000 per carat. As a consequence these diamonds are highly sought after by international buyers and manufacturers, and are found to populate some of the world's most expensive retail diamond jewelers **(Figure 15)**.

The defining characteristic of these diamondiferous alluvial gravel deposits is that they are very-low, or ultra-low grade (as expressed in carats per hundred tonnes), and the diamonds that are found in these deposits do not occur evenly spread throughout the deposit. Diamonds are heavy minerals and are concentrated by water, wind, and other related mechanisms in specific areas or 'trap sites', thus showing a very strong 'nugget effect'. Crude mining methods and the small scale of operation used in the past, often limited small miners to the high-grade areas. The 'picking of the eyes' of these deposits have for a long time made the remainder of the deposits unprofitable to mine. Technological advances made during the past 20 years and the strength of the US $ to other currencies have progressively changed the economic parameters and many previously unprofitable deposits are now being mined. The main difference in the business has been the size of the operations and the typical alluvial miner of today owns a significant earth moving fleet, and leading-edge processing, treatment, and final recovery plant. There are still significant reserves of alluvial diamond deposits available for mining in South Africa, possibly for another 100 years. The remaining deposits comprise low and ultra-low grade in terms of carats per 100 tonnes (cpht).

In spite of the low grades of these deposits, the application of new geological interpretations, careful delineation and evaluation of the deposits, the use of new technologies (eg, de-sanding), and efficient operators, to cost effectively exploit these deposits. What is lacking is practical, fit for purpose enabling mineral policies and regulations (less red-tape) to assist in the regrowth of the Small and Junior diamond mining sector, thereby reviving economic development and job creation in remote and poor areas of the NWP and NCP. Extensive un-exploited low and ultra-low grade alluvial (gravel) diamond deposits occur in the LP, NWP, MOR and LOR and other areas of the NCP. Land based and shallow marine deposits of the west coast have been highly exploited over the past 92 years and hence are depleted, but large resources of diamonds remain in the mid (B-Concessions), and deep-water (C-Concessions) of the west coast from about the Olifants River mouth in the south to Orange River mouth in the north.

High-level estimates are summarised in **Table 9** overleaf. ■

FIGURE 15: Summary of the exceptional diamond qualities found in the alluvial deposits of South Africa. Synthetic gem diamond data is included for reference (Source: Global Diamond Network, Bristow pers comm)

TABLE 9: High-level volume estimates of low- and ultra-low grade alluvial diamond deposits in the NCP, NWP and LP. Large variations in grade of some deposits are indicative of certain older terraces that had higher grades. Most higher-grade deposits have been depleted.

DEPOSITS/AREA	GRAVEL ESTIMATES (TONNES)	GRADE (2MM CUT-OFF)	AVE US$/CT 2MM CUT-OFF)	COMMENTS
Krone – Limpopo River Valley (LP)	58 000 000	1,0 – 12,77	~ 185 – 250	Deposits are in close proximity to the Venetia kimberlite mine: Extensive sand content in gravel, and sand cover
Lichtenburgh – Ventersdorp area (NWP)	150 000 000	0,5 – 1,5	~ $350 – 500	Extensive alluvial deposits which occur in dolomitic karst /pothole settings/fillings, and broad drainage channels linking potholes
Mahikeng – Ghaap Plateau (NWP)	10 000 000	0,5 – 1,2	~ $500	Small sinuous remnant deposits; volumes uncertain
Harts River Valley (NWP, NCP)	250 000 000	0,3 - 0,5	~ $800 – 1000	Requires modern work and delineation; Extensive gravels, uncertain volumes
Schweiser Reyneke, Wolmaranstad, Bloemhof (NWP)	200 000 000	0,5 – 1,0	~ $500 – 700	Work by De Meillon and Bristow, Pieter Bosch, P DeJager, others indicates a 'Karoo' age model for these deposits; Estimates might be on low side
Vaal River (NWP)	100 000 000	0,35 – 0,8	~ $700	Extensive mining in past has depleted high-grade deposits; Remaining remnants difficult to delineate
Vaal River (NCP)	250 000 000	0,35 – 0,8	~ $900	Large and extensive Splay and older deposits filling glacial channel and outwash deposits
Harts River (NWP, NCP)	250 000 000	0,3 – 0,8	~ $300 – 800	Extensive gravel deposits which require modern study, delineation, and diamond population studies
Riet River (NCP)	25 000 000	0,35	~ $1 400	Splay deposit with low grades, and large stone diamond population: source of diamonds likely to have been Koffiefontein kimberlites
Orange River (pre-confluence) (NCP)	400 000 000	0,1 – 0,25	~ $3 500	Extensive ultra-low grade gravels, exceptional large stone (Type-II) diamond population, rare coloured stones; Lesotho kimberlite diamond population
Orange River Douglas to Upington (NCP)	500 000 000	0,2 – 0,6	~ $2 200	Extensive low-grade deposits preserved in multiple stepped-Terrace deposits; mixed diamond population Lesotho, Kimberley, Koffiefontein, and Finsch/Postmasburg Ghaap Plateau kimberlite sources
Lower Orange River (NCP, Namibia)	400 000 000	0,25 – 5	~ $1 200	High quality diamond population (averaging ~1.25 cts per stone); mixed population – Orange River (Kaapvaal Craton) and Botswana Craton (via proto-Fish River): also likely Carboniferous Dwyka Tillite diamond contribution
West Coast land and marine alluvial deposits (including marine, beach, and old channel deposits) (Orange River to Olifants River mouths)	>200 000 000	~ 10 – 25	~ $400 - 600	Extensive marine deposits remain largely unexplored with new technologies, land deposits have been extensively exploited in the past, but low-grade deposits require new delineation & evaluation.

Sources: A.C.A. Howe (2007), African Diamonds AB (2015), Bosch (2017), Bristow, pers comm, De Jager (2017), De Meillon PhD in preparation, Diamcor (2021), Grobbelaar and Hawkins (2015), Norton et al. (2007), Snowden (2018), Van Der Westhuizen (2012), Venmyn Rand (2008), Venmyn Rand (2010), other unpublished sources and studies.

SMALL AND JUNIOR DIAMOND MINERS DATABASE

Introduction

At the outset of the Small and Junior diamond miners project, the intention was to collect up-to-date information in the field, with visits to current mining and project operations in the NWP, and NCP including the West Coast, with outliers in the FS, LP, and Gauteng Provinces.

Because of the exceptionally large footprint of the small diamond mining sector, which effectively covers five provinces, spread from the Atlantic coast-line to the Limpopo Valley in the far north-east of the country, and time and cost constraints, it was not possible to visit every operation spread over this very large area. Consequently, as noted previously, four light aircraft flights were conducted over the somewhat more remote parts of the Orange, Vaal and Riet Rivers, and the NWP diamond-triangle (Schweitzer Reyneke–Bloemhof–Wolmaranstad) to collect additional locality information.

Details of the information gathering processes including site visits and flights undertaken to cover remote areas and major river drainages are summarised in **Tables 1 and 2** of this study.

It was anticipated that additional, important and useful information would be gained from the DMRE through direct interaction with their offices in the NCP (Kimberley) and NWP (Klerksdorp), as well as from DMR publications in the public domain. However these sources proved to be disappointing in respect of providing additional useful information for this project and are discussed further.

Database structure

The method of information collection, database structure and fields, and content was premised on the authors personal experience of work done collecting ground water survey data from drilling programs, farmers, and other sources in the Karoo. This study was successfully published as an AEON sponsored MSc degree at Nelson Mandela University (Dlakavu, 2019).

In addition, other studies of this type of work were researched and reviewed, including the previous key study of the Small and Junior diamond mining sector completed by Farrell (2012). This comprehensive study published in 2012 provided an important benchmark for comparison purposes, and likewise provided important criteria and guidelines for the construction and content of the Small and Junior Diamond Mining Database (SDMD) database constructed and populated by the author of this study.

An Excel spreadsheet was used to compile the database given its low cost, portability, flexibility, and compatibility with many other database, GIS, and related applications. A summary of the structure and types of information collected and compiled in the database is shown in **Table 10**.

In addition to the summarised databased compilation, questionnaires were compiled and used as the basis for interviews with Small and Junior miners to collect information during site visits, and in some cases telephonically from operators. The information gathered from these interviews was summarised and documented in spread-sheets included with the database.

It has also been recommended to SADPO that the existing database should continue to be updated and refined on an annual basis, and that it becomes a key tool for the medium and long-term monitoring and management of this critically important Small and Junior mining sector. The structure of the existing Excel Database is such that it can be easily updated in the future, and new categories and data sets added to the initial document created in 2019/2020. ■

INFORMATION TYPE	PARAMETER	COMMENTS
Method of Collection	Site visit, Over-flight, Literature searches, company reports, latitude and longitude	Various approaches were utilised to optimise time and costs
Contact Details	Owner/manager/operator/contractor, or other suitably qualified persons	
Mineral Right Details	Mine or Project name, Holder, Farm name, closest town, water Use Licence, waiting period	DMRE challenges repeated highlighted
Personal Information	Age of owner/operator, years of experience, Industry outlook,	
Life of Mine (LOM)	How frequently do operators move	Major challenge in respect of maintaining businesses
Employee Details	Employee complement, education and skills, Race, Females, Feeder-towns/communities, turnover, BEE compliance	For use in terms of estimating number of persons employed per area or Province, and economic information
Operational Details	Size/number of pans, production mode (no. of shifts)	
Costs and Turnover	Fuel, maintenance, wages, power, H&S, Security, Training	
Geology	Grade, Average diamond Dollar value per carat	Key geological and mineral resource information
Other	Other useful information	For present and future use

TABLE 10: Summary of key fields and information included in the Small and Junior Diamond Miners Database (SDMD) constructed and utilised by the author of this study and document

DMR directorate of mineral economics publications

Previously the Directorate of Minerals Economics of the Department of Minerals (DMR) published annual reports that related to mining (large, mid-sized and small) and quarrying activities being conducted throughout the Republic of South Africa (see for example DMR 2015a and b, and DMR 2016 references).

These reports documented important and useful information relating to mining and quarrying operations, including for example:

- **the localities of operations**
- **ownership details**
- **contact details of the private owners or company**
- **type of commodity**
- **mining method employed (e.g. underground, open-pit, or open-cast)**
- **and other relevant and important information.**

It was hoped at the start of the project that recent and current versions of these DMRE documents would still be available and helpful to this project, provide useful locality and other information on the small diamond miners, and assist in fast-tracking the project by providing additional useful data and localities that time and costs constraints would limit access to.

However on investigation it was found that these annual DMR reports on mining and quarrying information compiled by the Minerals Economics Directorate ceased in the period 2015/2016. Consequently, given the 'dated' nature of these publications, information contained therein was of little use or benefit to this study. ■

Data gathering from NCP and NWP DMRE offices

With the assistance of the Chairperson of SADPO, and the Regional Managers (RM) of the Kimberley and Klerksdorp DMRE offices, time was spent in both these offices with the intention of reviewing and interrogating information and data for mining permit, prospecting, and mining licences for Small scale diamond miners and operators in the NCP and NWP.

Information regarding licences was downloaded from SAMRAD ONLINE. This included:

- **Issued diamond Prospecting Rights**, which are licences that allow individual(s) or a company to inspect an area of land for identifying an actual or probable mineral deposit (valid up to five years)
- **Issued diamond Mining Permits**, which are licences that are issued to conduct mining operations (valid for two years)
- **and issued Mining Rights**, which are licences that are issued to mine minerals within a certain area (valid for a maximum of 30 years).

Working with the SAMRAD system proved to be challenging, though the individuals in charge of the minerals section were helpful in respect of providing assistance wherever possible. A large amount data was reviewed and accessed, but disappointingly it was found that records for 2018 and 2019 were not complete at the time of the visits by the author (January 2019 in Kimberley, and June 2019 in Klerksdorp).

Overall, the SAMRAD system was not at all user friendly, information was most difficult to access, and trying to sort and extract data in terms of date ▶

periods, localities, and licence types were also difficult. As a consequence, much of the information that should have been in the system was still to be found in the DMRE paper-filing system. This presented a further challenge and level of complexity. Individuals working on different files were again helpful in providing assistance where possible to the author of this work, but if they were busy or out the office then information could not be accessed.

The information that was accessible is summarised and discussed in the following section. The initial intention was to use the DMRE information for the Small and Junior mining sector to construct maps that would help to identify where the greatest concentration of active operations were located so that these could be visited to collect information and data from the actual operations.

However, as explained above, this exercise was not particularly useful, although the experience gained at the two DMRE offices did clearly highlight why one of the key challenges and complaints documented during interviews with Small and Junior diamond miners was the difficult and long waiting periods for mineral rights applications to be processed and awarded. ■

Map compilations

The information for diamond licences, including coordinates obtained from the Northern Cape DMRE office in Kimberley, and North West facility in Klerksdorp were used to create shapefiles which were in turn loaded into a QGIS system to create maps. A series of maps were thus created with the intention of using these to highlight where active prospecting and mining operations were being conducted.

Due to the incomplete nature of data and information gathered in the DMRE offices in the NCP and NWP, and the difficulty of compiling and correlating the most important and relevant data in respect of size of activity, period for which the operations had been active, whether the licences were still valid and for how long, or whether the licences had expired or operations had been stopped, this overall exercise was found to be of most limited value.

Hence, although a series of maps were constructed to show the distribution of Prospecting, Mining Permits, and Mining Rights issued in the NCP and NWP, they are not included in this document and have been provided to SADPO for filing.

In the interests of making sure that the project work would be able to collect and interpret robust and reliable information, and would ensure a value-add outcome, the decision was made to visit as many sites as possible within the time frame and budget constraints. As noted previously

Due to the difficulty of compiling and correlating the diamond licensing data and shape file information, this exercise was found to be of limited value.

information was also collected via over-flights of key and remote areas as outlined in Chapter 2 **(Tables 1 and 2)**, and important additional data was gathered for publicly listed companies off the internet, as well as from knowledgeable and reliable geologists active in the diamond sector.

Hence, although a series of maps were constructed to show the distribution of Prospecting, Mining Permits, and Mining Rights issued in the NCP and NWP, and interrogated by the author and other knowledgeable experts, they are not included in this document and have been provided to SADPO for filing.

Information pertaining to the number of Prospecting Rights, Mining Permits and Mining Rights issued by the DMRE in the NCP for the overall period of 2004 to 2019, and NWP for the overall period 2009 – 2019, are however summarised for interest in Figures 16 to 21. ■

NCP licences (DMRE Kimberley office)

Prospecting Rights (2009-2018)

The approximate total number of issued Prospecting Rights for diamonds between 2009 and 2018 is 136. The highest number of Prospecting Rights issued in one year during this period was 21. These were issued in both 2010 and 2017. The lowest number of Prospecting Rights issued in one year during this period was 5 as issued in 2013. The number of Prospecting Rights increased by 7 between 2009 and 2010, decreased over a 3-year period thereafter from 21 to 5. After 2013 the number of issued Prospecting Rights followed a volatile trend between consecutive years **(Figure 16)**.

Mining Permits (2004-2019)

The total number of issued Mining Permits for diamonds between 2004 and 2019 is 655. The highest number of Mining Permits issued in one year during this period is 149. These were issued in 2006. The lowest number of Mining Permits issued in one year during this period is 6. This quantity was issued in 2016. The number of Mining Permits increased between 2004 (11) and 2006 (149) and has been since decreasing **(Figure 17)**.

What is particularly interesting about the numbers of Mining Permits recorded in **Figure 17**, are the large number of Mining Permits issued during the period 2004 to 2011 (149 in 2006) which would suggest that it was easier and quicker for applicants to apply for 5ha Mining Permits and get into operation rapidly, and probably also extend and mine outside the original boundaries of the permit area. Unfortunately on further interrogation of the SAMRAD system it was difficult to ascertain why so many permits had been issued in this period, and how they had been monitored. Of interest is that the number of Mining Permit grants then drops considerably from 2012 onwards.

The DMRE information included in **Figure 17** below is confusing and at odds with the detailed study carried out by Farrell (2012). Farrell's study found that there were only about 200 Small mining diamond operations active in the NCP, whereas the data presented in **Figure 18** overleaf implies that there should have been considerably more Small mining operations taking place on 5Ha mining permits alone.

Overall, these types of inconsistencies and the inability to rapidly interrogate and find explanations for such situations, highlights the challenges and lack of user friendliness of the SAMRAD system. ▶

FIGURE 16: Bar graph showing the number of issued prospecting rights for diamonds between 2009 and 2018 from the Kimberley (NCP) DMRE office.

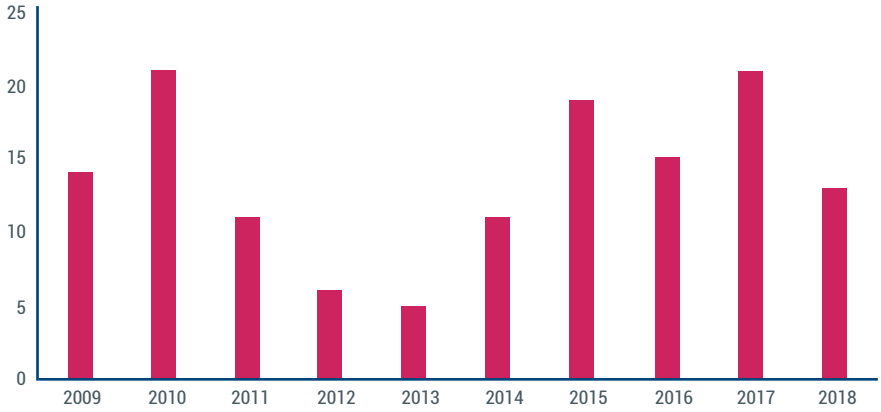
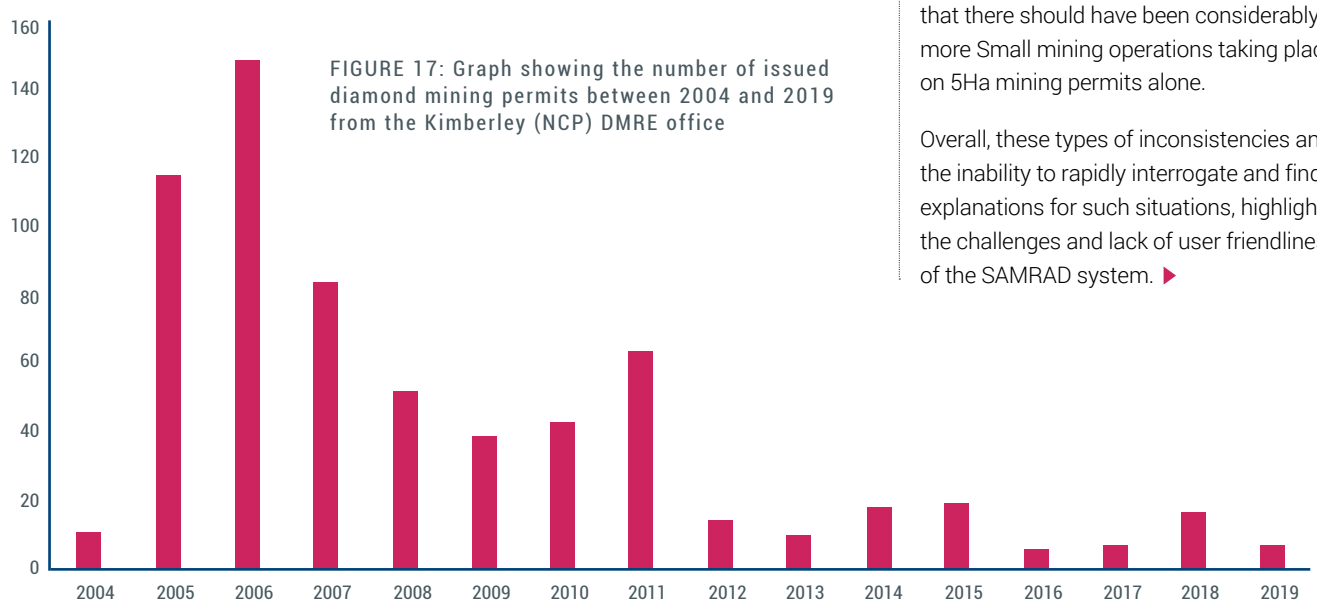


FIGURE 17: Graph showing the number of issued diamond mining permits between 2004 and 2019 from the Kimberley (NCP) DMRE office



Mining Rights (2005-2018)
The total number of issued Mining Rights between 2005 and 2018 is 78. The highest number of Mining Rights issued in one year during this period is 16. These were issued in 2010. The lowest number of Mining Rights issued in one year during this period is 2. This quantity was issued in 2005, 2013 and 2016. The number of Mining Rights increased between 2005 and 2010 and generally decreased thereafter. ■

NWP licences (DMRE Klerksdorp office)

Prospecting Rights (2013-2019)
The total number of issued Prospecting Rights for diamonds between 2013 and 2019 was 149. The highest number of Prospecting Rights issued in one year during this period is 44 (issued in 2018). The lowest number of Prospecting Rights issued in one year during this period (2013-2018) was 6 as issued in 2013.

Mining Permits (2013-2019)
The total number of issued Mining Permits for diamonds between 2013 and 2019 was 62. The highest

FIGURE 18: Bar graph showing the number of issued diamond mining rights between 2004 and 2018 from the Kimberley (NCP) DMRE office

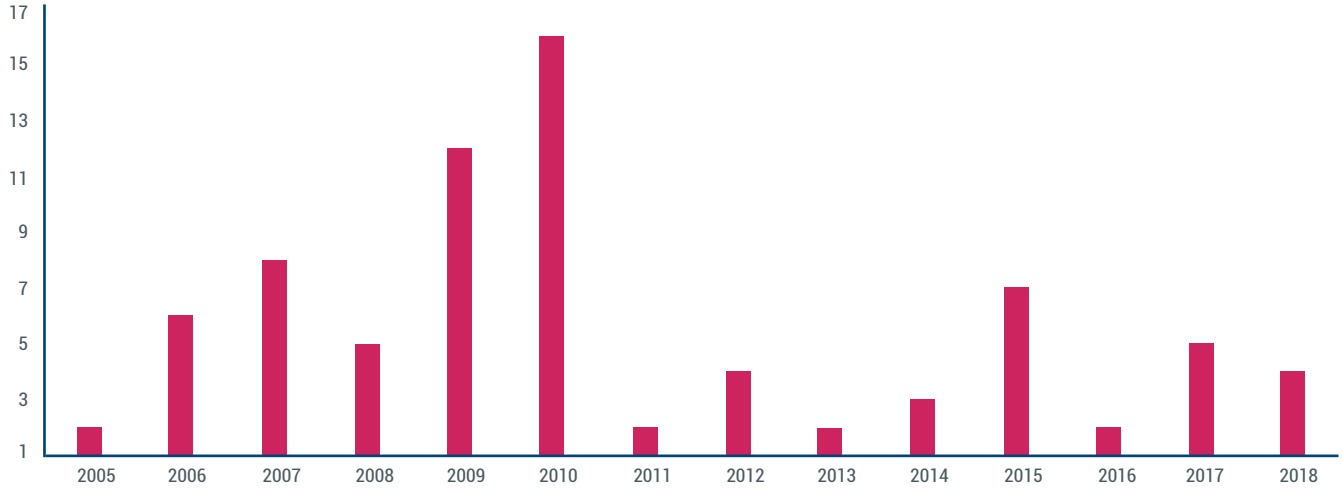
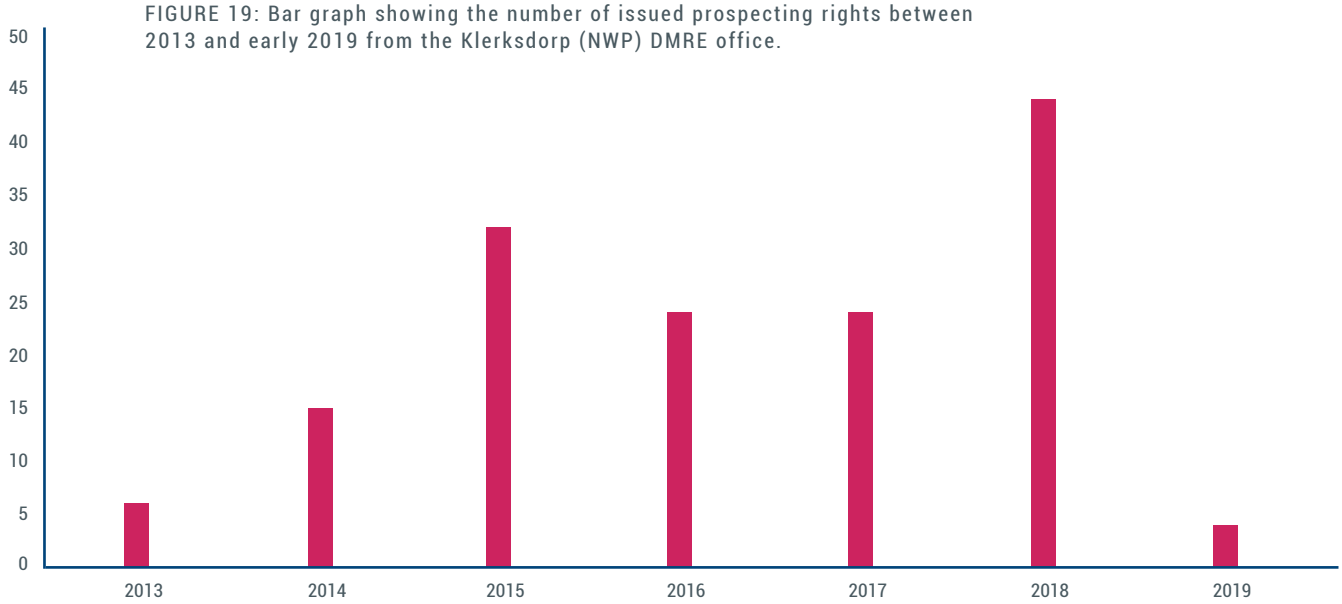


FIGURE 19: Bar graph showing the number of issued prospecting rights between 2013 and early 2019 from the Klerksdorp (NWP) DMRE office.



number of Mining Permits issued in one year during this period was 17 (issued in 2017). The lowest number of Mining Permits issued in one year during this period was 3 issued in 2014 **(Figure 20)**.

Mining Rights (2009 – 2019)

The total number of issued Mining Rights for diamonds issued in the NWP between 2009 and 2019 was only 44 **(Figure 21)**. The highest number of Mining Rights issued was 19 and has no date.

The lowest number of Mining Rights issued in one year during this period was 1 as was the case in 2011 and 2012. For the year 2010 there are no records of issued Mining Rights for diamonds from the North West province. ■

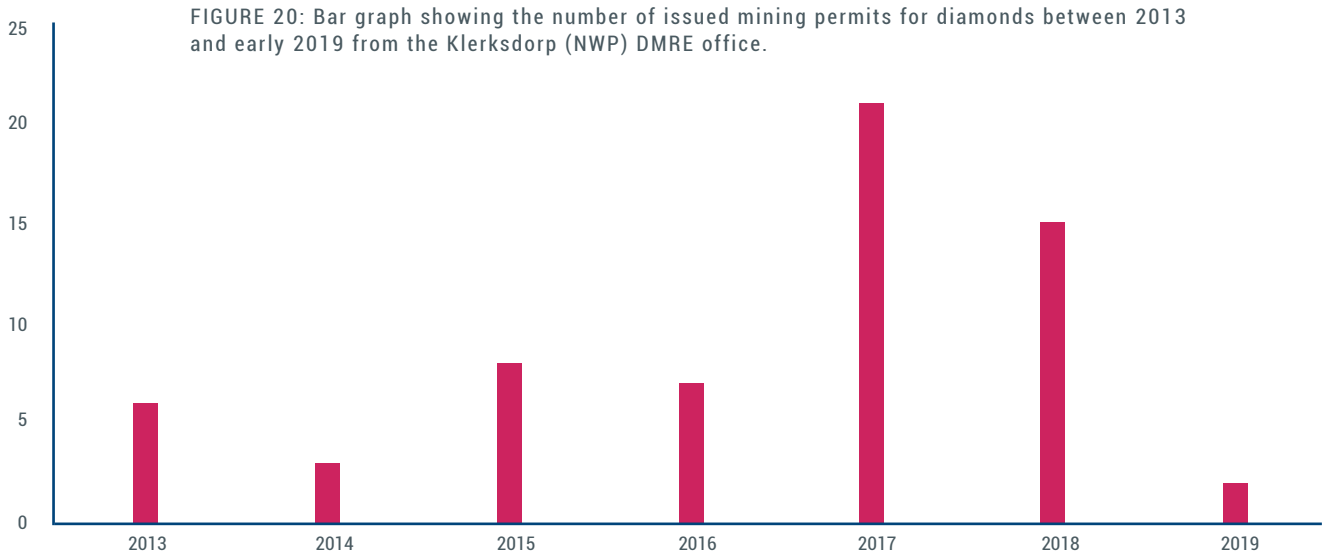


FIGURE 20: Bar graph showing the number of issued mining permits for diamonds between 2013 and early 2019 from the Klerksdorp (NWP) DMRE office.

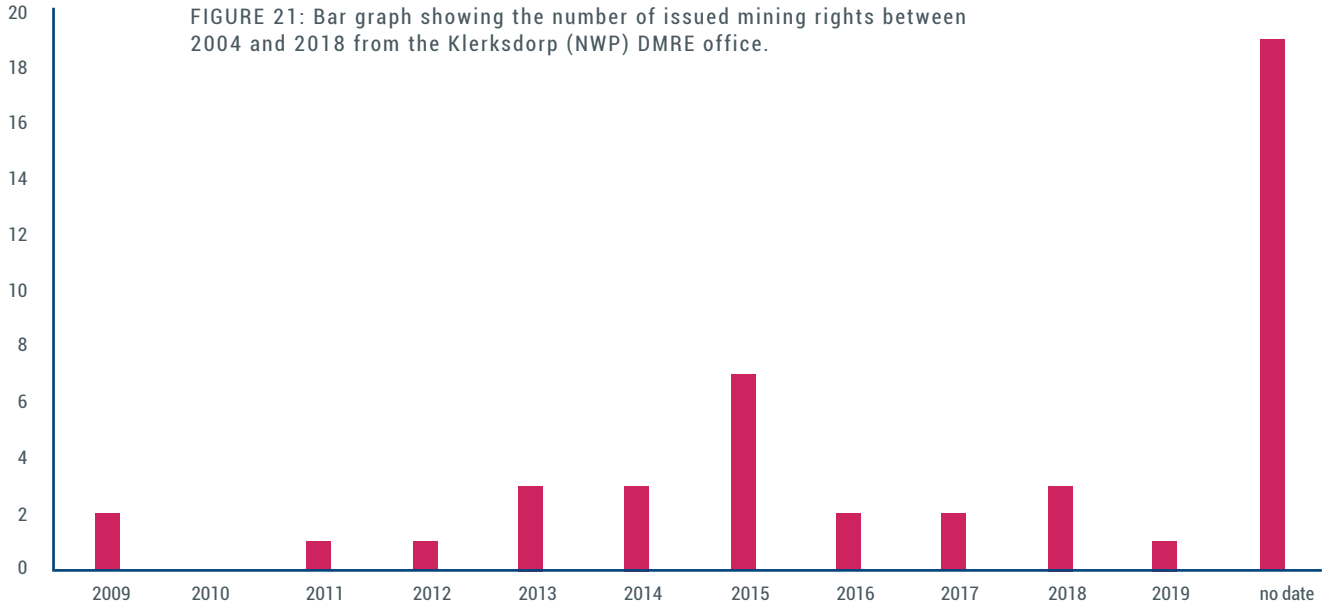


FIGURE 21: Bar graph showing the number of issued mining rights between 2004 and 2018 from the Klerksdorp (NWP) DMRE office.

SAMRAD system and departmental administration challenges

SAMRAD ONLINE is *"a system where the general public can view the locality of applications, rights and permits made or held in terms of the MPRDA, and where applications in terms thereof can be submitted electronically"* (DMR Online Licence Application Portal, 2021).

According to the DMR (2011) the purpose of the SAMRAD system was to provide an integrated managerial system of information to improve the management of the administrative process supporting the mineral licensing administration. However from the personal experience gained during this project, interviews completed, a review of the literature, and the excellent study of the small diamond mining sector completed by Farrell (2012), it is clear that the SAMRAD licencing application system, which was meant to introduce transparency and to reduce the administrative burden on potential investors, has proven to be an obstacle to efficient, rapid, and cost effective licence and permit applications almost from the day it was launched.

In the lead up to the launch of the SAMRAD system in 2011, Minister Susan Shabangu placed a moratorium on all new prospecting right applications under the MPRDA for an initial period of six months from the 31st August 2010, so that existing applications could be loaded into the new system. This moratorium was then extended until 28th February 2011 (Faurie, 2011), and then again until the 18th April 2011 (Shabangu, 2011, 2012). During this period no new prospecting or mining rights could be submitted.

The research by Farrell published in 2012 indicated that only half of applicants who tried to log onto the SAMRAD system were successful and significantly, more than 69% of Small mining applicants never even tried to access the online system.

The COM (now the MC of South Africa) took the initiative to investigate the operational success of the system and a small working committee was formed with the DMR to eradicate arising problems. The DMR observed that one of the major problems was, that originally the SAMRAD system had been designed to only deal with applications, but had subsequently been expanded, which resulted in the system being unable to cope with the workload.

The DMR apologised to the COM (MC) and industry for the problems arising from the SAMRAD system (Mtsele, 2012). The challenges, namely:

(a) human resources;
(b) financial resources;
(c) change management; and
(d) training, were mainly due to short timeframes for testing the system's effectiveness.

A task team was appointed in April 2012 to train DMR officials in each province and to eradicate problems identified by the COM review committee.

During this initial inadequate functioning of the SAMRAD system no new prospecting rights were being processed, which for larger companies, had a huge impact on business continuity plans, especially where current licences were due to expire. Other practical problems were also soon apparent and remain to this day. The NCP for example has a huge number of semi-literate people. Most of the Small-scale Artisanal miners are illiterate, not trained in computer skills and do not have access to computers.

The SAMRAD system does not allow applicants to fill in forms and directly submit copies thereof. Completing templates in Word and Excel format and uploading in pdf format complicated matters further and effectively excluded small and emerging miners from being able to lodge legitimate applications cost effectively. The DMR previously indicated that they will assist Small scale miners with the uploading of documents unto the system but will not complete documents on their behalf (Mazabane, 2008) but this was also an inefficient intervention given the lack of capacity within the DMR.

Regrettably the outcome of the poorly researched and implemented SAMRAD system is that Small and Junior miners, and explorers, were forced to resort to the use of expensive consultants and legal advisors to manage and drive the application system on their behalf. This simply adds to the costs, time delays, and frustrations of Small operators, and caused many to exit the industry or operate illegally.

Large companies and mining houses already had large legal, environmental and compliance departments which could process and track applications but the system still added unnecessary costs. Foreign investors were also put off by the challenges of applying for exploration, prospecting, and mining rights, given that in many other parts of the world applications for early-stage exploration and prospecting rights can be done remotely via tick-box approach with simple, and cost-effective application, processing and monitoring procedures. ■

Summary

In summary a number of activities, engagements and interventions were undertaken to collect reliable and meaningful data and information relating to the structure, activities, successes and frustrations of the Small and Junior diamond mining sector.

The information collected was primarily from alluvial diamond operations, but a number of small kimberlite operations, including closed operations were also visited.

The primary data included in the SDMD as outlined in **Table 10** was summarised in an Excel spreadsheet which can be easily updated and continuously improved in the future, while supplementary information gathered through interviews and from other sources and searches has been documented and summarised in tables included in the following chapter.

In spite of concerted attempts to locate and utilise additional information and supplementary information from other sources, including DMRE publications and regional offices in the NCP and NWP, this proved to be generally disappointing and not particularly helpful. It was difficult to locate and extract precise information such as locality, size of the mining activity, period for which the operations had been active, whether the licences were still valid and for how long, or whether the licences had expired. On the other hand, internet searches and company documents for publicly listed entities proved most useful.

Overall, the two periods spent in the DMRE Kimberley (approximately 4 weeks) and Klerksdorp DMRE office (2 weeks) through the kind efforts and support of the Regional Managers, was informative for the project, but added little useful beneficial data for the overall project.

RESULTS OF DATA COLLECTED: LATE-2018 TO EARLY-2020

Following the construction of the Small and Junior diamond miner's database as outlined previously, much of 2019 was spent undertaking surveys and collecting information across those areas of the country where alluvial and small kimberlite operations are most prevalent, in particular the NCP, including the West Coast, and NWP.

The database was continually updated and enhanced as new information was collected and extra data-fields were added, or existing fields were modified. Additional information was collected during the course of the lockdown period during 2020 and used to supplement and add value to the research.

A large amount of information is now included and available in the Small Diamond Miners Database (SDMD) and hopefully this database will continue to be updated. A summary of the most pertinent information, interviewee opinions, and data collected during the study is presented in two parts.

As also noted in previous sections, questionnaires were constructed to collect key information at the operations visited and from the persons responsible for the ownership, management, or supervisors of the Small and Junior diamond mining activities. From the outset it was found that respondents were most positive in respect of taking time to engage with the author, answer and respond to questions, and offer comment about their experiences, challenges, and suggestions for improvement.

This methodology and positive outcome and results was largely driven from the experiences of the author during her previous study of collecting ground water data from bore holes drilled in the southern Karoo by farmers, and companies.

Undertaking personal site visits to engage with owners and management was undoubtedly more time consuming and costly given the exceptionally large footprint of the alluvial diamond sector, but at the same time the benefit of one-on-one interaction was found to far outweigh sending questionnaires via email. This methodology and positive outcome and results was largely driven from the experiences of the author during her previous study of collecting ground water data from bore holes drilled in the southern Karoo by farmers, and companies.

The results collected as a consequence of the site visits and completion of questionnaires are presented and discussed in the next sections. ■

Number of operations identified and visited

Table 11 shows that an overall 72 operations were visited, 66 of which were operating, a further 95 over-flight points were recorded, and additional information was obtained for a further 52 localities from company press releases, published sources, and telephonic conversations.

Collectively this study indicates that there were approximately 220 Small and Junior mining operations, projects, start-up, care and maintenance, and closed operations in March 2020 **(Table 11)**.

A total of sixty two (62) interviews and discussions were conducted during site visits with information from the remaining 10 localities obtained from the internet and discussions with geologists involved at some of the sites.

In terms of general information and observations, the oldest interviewee was 78 years old and the youngest about 30 years old. The interviewees had mining experiences ranging between about 2 to 55 years. The average experience was about 26 years, reflecting an ageing population of Junior miners, and a shortage of young entrepreneurs and miners entering the industry.

About 45% of the interviewees expressed a negative outlook for the industry, with these opinions including general frustration about ineffective mineral and mining policy and DMRE inefficiency and performance, feelings of wanting to quit, scepticism, and worry about security, and related aspects.

Only 22% of the overall interviewees expressed a positive outlook on the industry, with the rest being non-committal. The majority of the sites visited were of alluvial diamond operations, which included small, medium and large inland operations, marine diamond mining contractors on the west coast, and contract mining operators (mainly marine, and some land-based) at Alexkor and the Lower Orange River (LOR). Six (6) small kimberlite diamond mines including tailings retreatment operations, tailings retreatment activities, and closed operations, were also visited. ■

TABLE 11: Details of the Small and Junior diamond mining operations visited and documented from late-2018 to beginning of 2020. Data in this table reflects primarily alluvial operations unless otherwise indicated.

Localities	Operations Visited	Flight Points Recorded	Other Sources	Total	Comments
LP			2	2	Krone alluvials, and Thornybush (Klipspringer) kimberlite fissures
NWP	26	52	2	80	Mainly located in NWP diamond- triangle and Vaal River proximity
NCP	10	34	1	45	Primarily Vaal and Orange River
MOR	8	9	0	17	Between Douglas and Prieska
LOR	4	0	7	11	Old Trans Hex Operations
West Coast (Alexkor)	10	0	4	14	Orange River mouth to Port Nolloth coastal land and marine strip; Mainly small-boat and beach operations, limited number of land-mining ventures
West Coast (The Punt)	0	0	6	6	Olifants River mouth area; mostly small-boat and beach mining operations)
Small kimberlites	6		14	20	Primarily located in the NCP **(see Table 12)**
Tailings Operations	1		3	4	Kimberley (Ekapa), Jagersfontein (Reunert), Leicster (Golden Falls). Robert Victor (Private)
Care and Maintenance	4		11	15	
Start-up Projects	3		3	6	
TOTAL	72	95	53	220	

TABLE 12: Summary of information gathered in respect of small kimberlite diamond mines and projects visited, or where information was acquired from company websites, reports and presentations, or telephonically. Localities visited are highlighted with an # and light-blue background.

	KIMBERLITE MINES (NAMES AND OWNERSHIP)	LOCALITY	HISTORY/CURRENT STATUS	COMMENTS
1	Bellsbank/Dan Carl (Frontier Diamonds Ltd, ASX)	Ghaap Escarpment (Barkly West District); NCP	Flooded (Company has ceased operations)	Type-2 kimberlite; unlikely to be re-developed, historically produced high quality diamonds; previous owner Sedibeng/Petra Diamonds
2	Frank Smith (Private company)	Barkly West District; NCP	Care and maintenance; recent drilling work completed; same owner as Loxton below (#14)	U/g mine; Very low grade but high quality diamonds; requires major recapitalisation; Some remaining tailings retreatment potential
3#	Goedgevonden (Private company)	Boshoff Road; FSP	Intermittent small scale tailings retreatment	U/g mine; Needs recapitalisation
4#	Roberts Victor (Private company)	Boshoff Road; FSP	U/g sealed off due to fatalities caused by a mud-rush; Tailings retreatment ceased in late 2019	Limited tailings retreatment options, but small, low value diamonds
5#	New Elands (Private company)	Boshoff Road; FSP	Closed	Old mine, marginal. Unlikely to be redeveloped
6#	Zout n Zuur (Private company)	Boshoff Road; FSP	Fissure mine, small past production; Flooded	Unlikely to be redeveloped; mineral rights were hijacked, litigation costs pre-empted development work
7	Helam Fissure Mine (Private Owner)	Swartruggens, NWP	Redevelopment and modernisation underway subject to adequate funding being available (Information source – J Davidson pers comm)	U/g mine; planned new development will provide +10year LOM, initially support ~ 170 employees; presently reworking tailings
8	Jagersfontein (Reunert, Private company)	FSP	Actively retreating old tailings	Marginal operation; badly impacted by political/ community interference requiring excessive legal costs
9	Kareevlei West Kimberlites (Blue Rock Diamonds; Public company, AIM, London)	Ulco area, Ghaap Plateau; NCP	Original De Beers discovery: Developed and mined by Junior mining company, Blue Rock Diamonds	Small open-pit operation; listed on AIM (Alternate Investment Market) in London
10	Kimberley Tailings dumps(Ekapa Mining, private mining company)	Kimberley; NCP	Costs of security, illegal miners, and depressed diamond prices for small goods impacting sustainability	Employs about 2 000 local people in Kimberley; Ekapa Mining, private mining company.
11	Kouewater Kimberlite (Private company)	NW of Postmasburg; NCP	Small kimberlite pipe undergoing sampling and testing (similar to Makganyene in same general area)	Small Group-2 kimberlite under evaluation; some previous sampling done by Moonstone Diamonds in last-1990's
12	Lace Mine (Liquidators/IDC)	Kroonstad District: FSP	Flooded	U/g mine; Unlikely to be reopened and redeveloped; 8 kms from Voorspoed
13#	Leicester (Golden Falls) (Private company)	Windsorton area; adjacent to Holpan alluvial mine; NCP	Chequered past history involving fraud and misappropriation of shareholder funds	Type-1 kimberlite; Low grade; limited tailings retreatment potential; Current owner Golden Falls Mining
14	Loxton Mine (Private owner)	Samaria Road (east of Kimberly); FSP	Care and maintenance	Small Type-2 kimberlite, U/g mine; Owner out of Hong Kong looking to redevelop this mine, as well as Frank Smith
15#	Newlands Fissure mine (Private owner)	Barkly West District; NCP	Care and maintenance; up for sale?	Type-2 kimberlite; Small scale fissure mining operations; westerly extension of the Sover fissures
16	Samada/Kaalvallei (Private owners)	Near Welkom, FSP	Mined briefly 1980's, 90's then closed; prospecting planned to test tailings, possibly redevelop	Type-1 kimberlite; high ilmenite content; possible large=stone producer, hence renewed interest
17	Star Fissure mine (Frontier Diamonds Ltd)	Theunissen; FSP	Closed, infrastructure and headgear stripped in 2020	Group-2 kimberlite; Fissure mine
18	Thornybush Fissures (Botswana Diamonds; public company, AIM, London)	Limpopo Province	Prospecting program underway	Type-2 micaceous kimberlite; Extension of Klipspringer (Marsfontein) fissures
19	Voorspoed (De Beers)	Kroonstad District; FSP	Care and maintenance	Type-1 kimberlite; Open-pit, requires drilling, detailed resource work, and new development; should be developed in conjunction with Lace
20	West End Mine (Private company ownership)	Postmasburg; NCP	Past small-scale production; business sold in 2019 to Black mining group	Small pipe/blow; will need recapitalisation and redevelopment; challenging given it is an old mine

Small Kimberlite-mine Results

Information was also gathered and reviewed for small kimberlite diamond deposits (small pipes, blows, or fissures) located in the NCP (primarily), the FSP, and LP **(Table 12)**. Previously and particularly in the 1980's and 90's South Africa had an active small kimberlite mining sector which provided important employment and economic opportunities in mostly remote parts of the country.

Unfortunately, this sector has also shrunk along with the rest of the Small and Junior diamond mining sector.

Almost all of the small kimberlite localities visited (6 in total), and documented in **Table 12** were closed, standing idle, and unlikely to ever be reopened.

Only one locality, Helam fissure mine near Swartruggens (NWP), was being recapitalised and redeveloped, and prospecting of diamondiferous fissures was being conducted at Thornybush (Klipspringer) in LP **(Table 12)**.

Problems and challenges faced and experienced by existing and previous Small kimberlite mine operators were once again the same as those experienced by the alluvial mining operators. ■

Cost and expenditure results

Table 13 (below) and Figure 22 (overleaf) show key costs (financial data) and employment parameters which were interrogated in the course of the study.

Cost information included salaries, employee training, compliance (including health and safety – H+S), diesel and maintenance costs, and electrical power (either from Eskom or by self-generation using expensive generator sets), and capital costs.

Of these costs, salary spend (or costs) is generally the most expensive component of individual miners and operators budget and costs based on the cross-section of operations visited.

Compliance and training costs are exceptionally and disproportionally high as compared with large mining operations. Typically large mining operations have multiple operations, developments, and mining faces which ensures that these costs can be shared across multiple operations and hence reduced on a unit basis. Small diamond miners who only have one, maybe two, operations do not have this luxury and face disproportionally high costs in comparison.

Other costs such as rehabilitation guarantees and costs, social and labour costs (SLP's), the costs of black economic empowerment (BEE) requirements, security which is now days essential for personnel and product in remote areas where most operations take place, transport to remote sites, accommodation, the inevitable time delays and inefficiencies involved in DMRE licence applications and grants, and the need to engage with increasingly expensive lawyers and consultants to facilitate the licensing process due to the process complexity **(see Annexures 1 and 2)** are also summarised in **Table 13**.

All in all, Small and Junior miners face never ending cost challenges and increases, hence the decline in the number of operations highlighted in **Figure 3**. ■

TABLE 13: Details of the Small and Junior miners operating costs expressed as a percentage of Annual Turnover (AT)

	NWP & VAAL RIVER NCP	MOR	LOR	WEST COAST (MARINE)	AVERAGE %
# Salary spend	26%	25%	22%	18%	~ 23%
# Employee training	5%	3%	3%	3%	~ 4%
# Compliance (H+S, SLP, RS Levies, BEE, License applications, legal and consultant fees)	5%	8%	4%	3%	~ 5%
* Diesel and lubricants, repair and maintenance	26%	25%	26%	15%	~ 23%
* Eskom power / self generation	5%	4%	4%	3%	~ 4%
* Security and insurance	1%	2%	1%	1%	~ 1%
* Interest financing and loans	11%	12%	10%	5%	~ 10%
* Royalties (State and permit holders)	11%	12%	22%	35%	~ 20%
* Diamond sales (1.5 – 2%)	2%	2%	2%	2%	~ 2%
* Profit	8%	7%	6%	15%	~ 9%
TOTAL	**100%**	**100%**	**100%**	**100%**	
* Capital cost of plant, equipment (estimates)	~ R90 m (2x16 foot Pans operation)	~ R150 m (4 x16 foot Pans, de-sanding, operation)	~ R150 m (4 x 16 foot Pans, de-sanding operation)	~ R5 – 50 m (subject to size of venture, shore or boat operation)	

Sources: # - Information compiled in the Small Miners survey and database from this study; * Estimates from a limited number of operators and equipment suppliers, and additional supporting data from DeMeillon (2018, and PhD in preparation).

Bed-rock sweeping to recover small gemstone diamonds off ancient beaches, Alexkor Diamond Mine, West Coast, Namaqualand

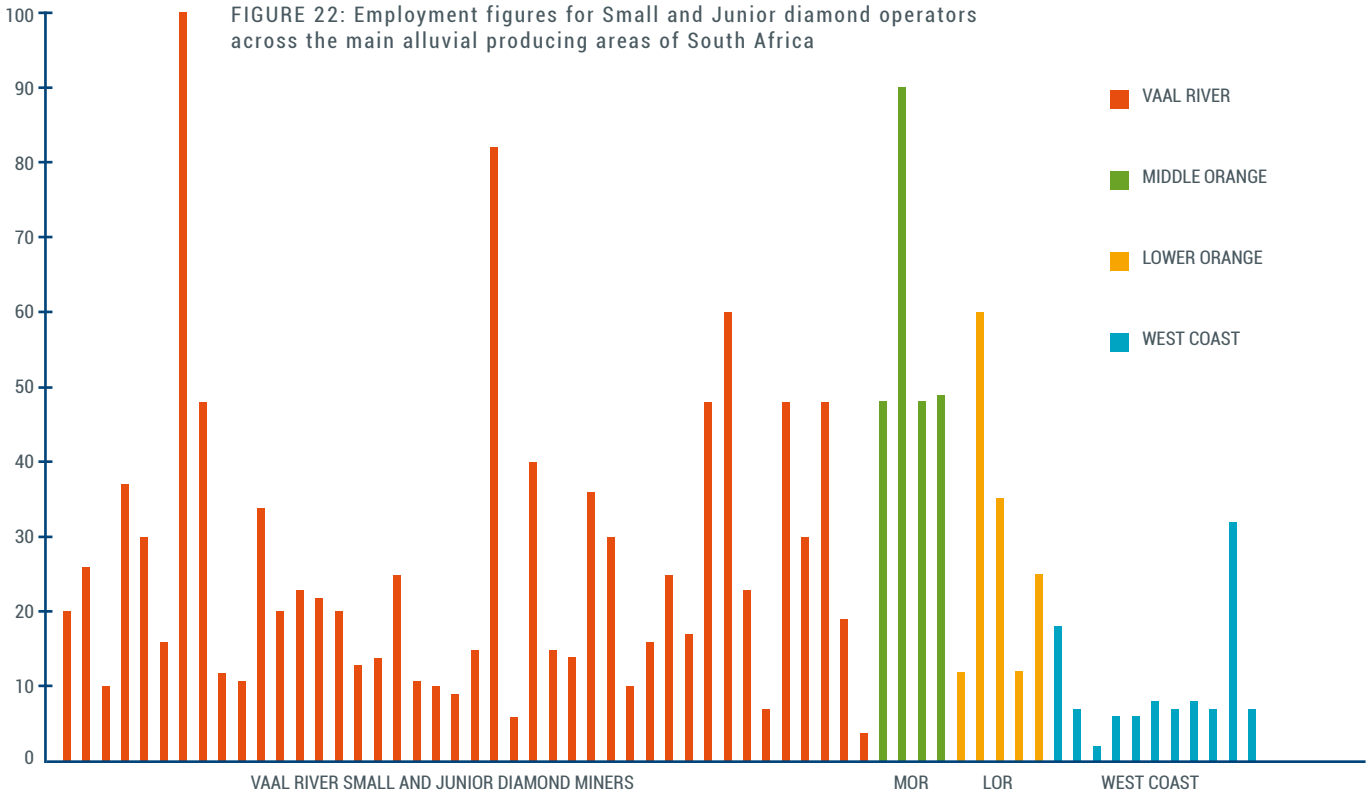
Employee numbers

Overall, the study and data collected shows that the Small and Junior diamond operators on average employ 26 employees and spend an average of about 23% of their Annual Turnover on salaries.

The MOR operations employ the most people (average 56) with these larger operations spending proportionally less (approximately 22%) of the Annual Turnover on employee remuneration and more on operational costs such as diesel, maintenance, and equipment, given the more challenging geology and hard calcrete layers covering the gravel deposits in this area.

The West Coast diving operations employ the least number of people, with an average of about 10 per operation. These are generally smaller than inland operations and typically involve small converted fishing boat diving and dredging operations, or shallow water diving operations with suction pumps off the shore line. ■

FIGURE 22: Employment figures for Small and Junior diamond operators across the main alluvial producing areas of South Africa



Questionnaire responses

A summary of the results of interviews undertaken with Small and Junior diamond miners are presented in Table 14. The interviews and discussions with owner/operators from a range of operations were particularly informative. In all cases the owners and operators were most positive and forthcoming about their operations and expenditures, though from the outset it was decided that getting into sensitive financial details would be counterproductive to the aims of this study.

The study was focussed on reviewing the extent and footprint of the existing industry, the number of operators still active in the sector (for comparison with numbers determined in previous studies), the overall geology and characteristics of the deposits, the style of operations, financial information and the challenges and frustrations faced by the existing operators. There is still additional information and work to be done on this sector, but the intention of this report was to provide an initial overview of the existing industry, and a platform and database for ongoing future studies.

In respect of the results from the questionnaires and interviews, 6 key concerns expressed by the owners and operators were:

1. **The safety and security of their operations and personnel**
2. **Lengthy waiting periods for licence applications to be processed and granted and general inefficiency of the DMRE offices**
3. **Unreliable and increasingly expensive Eskom electricity supply**
4. **Challenges in respect of BBBEE compliance**
5. **Finding and retaining skills labour**
6. **Labour costs given poor education, and skills sets**

These 6 concerns were flagged by 86%, 83%, 69%, 64%, 62% and 52% respectively, of the operators from the NWP, Vaal River (NWP and NCP), MOR (NCP), LOR (NCP), and West Coast respectively and results are presented in **Table 14, part A** overleaf.

Other concerns raised and documented in respect of the six most common challenges were the difficulty of attracting and finding skilled labour and labour costs given the poor levels of education and productivity.

Because operators in the West Coast of South Africa mostly operate as contractors on licences held by companies such as Alexkor, LOR (Lower Orange River), and Trans Hex, the issue of waiting periods for the granting of licences was less of a concern. However, several contract diver-operators on the West Coast of South Africa expressed a longing to be able to go through the licence application process so as to operate on their own licences.

Other concerns raised and documented in respect of the six most common challenges were the difficulty of attracting and finding skilled labour and labour costs given the poor levels of education and productivity.

The lack of recognition of the sector by large operators, and stakeholders was also seen as a very real and worrying aspect of the sector.

The other concerns summarised in **Part B of Table 14** overleaf are again highly relevant and were raised repeatedly by all the parties interviewed, including small and informal miners encountered during the study, as well as consultants and a range of interested parties with involvement in the industry.

Item 11, the lack of recognition of the sector by numerous operators and stakeholders was also seen as a very real and worrying aspect of the sector. ■

TABLE 14: Analysis of interview responses from Small and Junior diamond miners. The sample comprised 62 interviews with private owners, operators, contractors, and emerging miners with mining permit grants or applications. Areas included the NWP, NCP, FSP, and West Coast including Alexkor.

	QUESTIONS POSED	% OF COMMON RESPONSES	COMMENTS
Part-A: Responses to the question – What were the key 6 challenges and impediments faced by the sector?			
1	**Safety and Security**	86	Small operators and miners are located in remote areas and voiced serious concern about the safety and security, and ineffectiveness of law enforcement agencies such as the SAPS
2	**DMRE** • Waiting period for Licence Grants • Compliance, MH+S Requirements • SLP's, • Environmental requirements • Excessive Red-tape, paperwork; inefficiency	83	Existing legislation and regulations, **Mining Charter #3 (MC-3)** and **Implementation Guidelines** considered unsuitable for small diamond operators; costs of compliance and DMR inefficiency were excessive and excessively expensive; un-harmonised legislation/regulations add costs and time as for example the NEMA requirements
3	**Electricity supply** – Costs and unreliability of Eskom supply	69	Excessive and Rising costs, unreliability, and load-shedding was unsustainable for the industry
4	**BEE Compliance**	64	BEE ownership requirements were impractical for small entrepreneurial businesses; operators were all supportive of genuine transformation and real black ownership, but proposed that other more effective models be considered
5	**Finding skilled labour**	62	Operators had no problem paying a living wage but the scarcity of skilled labour was a challenge and debilitating for the sector. The operational, HSE, and other skills transfer of portable skills was considered positive for the employees, operating companies, and country
6	**Labour costs**	52	Labour costs were acceptable considering that the majority of employees were unskilled, had limited schooling, and there were no technical training facilities in most of the provinces and towns in which the small diamond sector was found. With better State education and technical training operators felt productivity and pay-rates could be enhanced, thereby benefiting communities, companies, and the regions small towns and economies.
Part-B: Additional concerns, comments, and response from parties interviewed – Points of view expressed in respect of additional concerns and comments raised during interviews with the author of this report			
7	**Absence of useful Geological information**	Several of the operators noted that the Council for Geoscience (CGS) was a state organisation supposed to provide geological and other information to assist exploration and mining but was ineffectual, and most data and maps were out of date; past projects by the DMRE and CGS to assist informal and emerging miners had also been a waste of money.	
8	**No Technical support for new-Entrants**	Support from the likes of MINTEK was considered negligible; the majority of operators questioned the relevance of this institution, likewise the CGS	
9	**Need for a Small-miners Development Fund**	This was proposed by a number of respondents, particularly new Black entrants, and small and emerging black operators who had made application for 5ha Mining Permits	
10	**Requirements for 5-ha Mining Permits were unrealistic (took too long, costs were excessive)**	Repeatedly raised by emerging Black miners who indicated that there was no-support from Government and the DMRE to create black ownership, transformation, and jobs	
11	**Lack of recognition of the sector, and absence of partnerships between stakeholders**	There was unanimous comment about the fact that Small Scale (Junior) diamond miners were a 'non-entity' in RSA, regardless of their skills, use of technology, and the essential role they played in providing employment in poor rural areas, and mining the highest-value run of mine diamonds found anywhere in the world.	

Complexity and costs of applications

5ha Mining Permit Responses

During this study, emerging Small-scale Black diamond miners were engaged with and their challenges in respect of trying to become committed and long-term alluvial diamond miners were shared and documented. From the outset of these discussions, it was apparent that this aspiring group of small miners are severely hampered in respect of trying to become alluvial miners, regardless of them being unequivocally historically disadvantaged South Africa citizens. They more than anyone receive no support for their endeavours regardless of the many promises made over the years by the likes of the Minister and Deputy Ministers of Minerals and Energy.

Four individuals trying to establish small scale mining prospects and operations were engaged with. They included Mr K (and his three Sons) from Longlands north-west of Barkly West, Mr R and Mr J (trying to obtain 5ha mining permits at Bakerville), and Mr M trying to revive and renew a mining licence also at Bakerville. In every case the lack of institutional support, including access to information (CGS), basic technical support (Mintek), mentoring (DMRE), and seed-funding to cover costs were unattainable and non-existent. Mr K had through an acquittance managed to have a Basic Assessment Report (BAR) completed for his 5ha Mining Permit at Longlands at a discounted cost of about R65 000, but then had no money left for mining tools and access to water so was unable to operate.

In the case of the Bakerville applicants, Mr R was endeavouring to initiate a pick and shovel operation on a previously mined piece of ground at Bakerville, an area which has experienced almost 100 years of intensive alluvial diamond exploitation with minimal rehabilitation. In this case an experienced diamond geologist offered to act as benefactor for the licence process and costs required for his 5ha mining right. This process was officially launched in January 2020 after wasting nearly a month trying to sort overlapping applications and grants on the ineffective SAMRAD system.

This situation is one of the key reasons and drivers for the burgeoning illegal and unmanaged artisanal and Zama Zama mining growth in all commodities across South Africa.

To drive this application process, it was essential to utilise the resources of an experienced Consultant Group to handle the public consultation process and ensure paperwork was processed and moved through the DMRE office. The Covid-19 situation caused delays of about 6 weeks, and the grant was finally officially signed-off and awarded to Mr R some 13 months after lodging the application in mid-January 2021 at an all-in cost of about R130 000 **(Annexure 1)**.

This situation whereby a 5ha mining permit takes as long as 13 months is untenable, and for an emerging honest HDSA Small-scale miner is unaffordable and unacceptable. This situation is one of the key reasons and drivers for the burgeoning illegal and unmanaged artisanal and Zama Zama mining growth in all commodities across South Africa.

Prospecting Rights

Alluvial Diamond Mining is a nomadic mining sector where deposits are difficult to evaluate as diamonds are only concentrated in specific areas. In practice, the majority of Small alluvial diamond miners move their whole mining operation at least once every 15 months, typically onto adjacent properties (Farms) on contiguous alluvial terrace or 'runs' that may stretch over hundreds of square kilometres and which don't adhere to man-made farm boundaries.

A further key contributor to this challenge is that many deposits have also been worked extensively in the past, typically without utilising known geological information and less efficient technology. Hence some of the previously mined contiguous areas will be unprofitable, whereas other parts of these same geological deposits can be mined profitably today using modern mining methods. Modern mapping, revised geological interpretations and new geological models of areas that were considered in the past to be depleted due to historical mining, have now shown the existence of extensive previously unrecognised diamond resources, as for example in the Schweitzer Reynecke-Christiana-Wolmaranstad diamond-triangle of the NWP.

For the above reasons it is crucial that Prospecting Right (and Mining Right) applications be expedited and issued in a timely manner, for example a maximum of four (4) months after application, to ensure that continuous operations can progress across farm boundaries. Ideally in these situations Permits should be automatically extended and granted across farm boundaries where the size and format of the operations do not change, instead in many cases, taking months and years to be granted. In these latter circumstances the time delays and costs of stop-start operations are unaffordable, causing mine closures, job losses and economic hardship.

Mining Rights

A consistent complain from all participants was the time it took permits and rights to be approved. Mining rights for alluvial diamond operations should as a maximum be issued within 180 calendar days of acceptance of an application to compensate for the nomadic nature of the industry, though there is no reason why this process cannot be shortened.

It was also suggested that the prospecting right of an applicant must remain valid until decision-making in respect of the application for the mining right is finalised. Many participants complained that the BBBEE requirements were too onerous, especially when a new operation is starting up. A phased approach to BBBEE was suggested by some participants.

National Environmental Management Act (NEMA)

The National Environmental Management Act No 107 of 1998 (NEMA) was written for the protection and management of the environment and for matters connected to it or incidental thereto. The Department of Mineral Resources and Energy is responsible for enforcing the NEMA as far as prospecting and mining activities are concerned.

Applicants for a prospecting or mining right must apply for and obtain an environmental authorisation under NEMA before the right is granted. Depending on the activities that the applicant will undertake, the applicant must conduct either a basic assessment or a scoping assessment and environmental impact assessment to investigate and assess the impacts of the activities on the environment.

NEMA processes must include a public participation process with all interested and affected persons. The outcomes of the assessment, investigations and public participation process are included in a report and submitted to the DME for consideration. If the DME is satisfied with the report and the mitigation measures contained therein, an environmental authorisation may be issued. In terms of the One Environmental System, this process should take 300 days (Lexology, 2020).

The legal requirements and time constraints of the NEMA has placed an enormous burden on Small and Junior mining companies. This came out clearly in the questionnaires where the use of the many consultants required to comply with legislation was lamented by nearly all participants.

In general, the operations visited were neat and organised, while the levels of rehabilitation and environmental care observed at some operations were outstanding. The poor rehabilitation record that used to plague the industry in the pre- 2000 period has been largely turned around. There appears to be 3 reasons for this:

1) Most operations are de-sanding their screened product at 6mm before processing through the plant. This implies that they are screening out most of -2ct diamonds but because this fraction represents up to 40% of their plant feed, they are feeding a much higher value product into their plant that increases the average size and value of diamonds recovered.

2) The sand (-6mm fraction) recovered as a mainly dry product can immediately be used for rehabilitation. This coupled with the fact that most operations use mobile screens situated at the mining face, means that the mining footprint can be kept very small.

3) As there is minimal sand now introduced into the processing plant (pans), the density medium (puddle) in the pans can now be re-circulated, which effectively reduces the size of the slimes dams by 90% or more.

Water usage has decreased by a similar margin. Most operations that use de-sanding and puddle recirculation systems use less than 5 000 m^3 of water per month (compared to about 11 000m^3 per ha per annum for irrigation farming activities).

Water Use Licences (WUL)

Small and Junior diamond miners are also required to register as water users and obtain a water use licence (WUL) from the Department of Water Affairs. Again, the lengthy waiting period and inefficiency of the Department of Water Affairs in respect of processing and granting WUL's for water use was highlighted by most interviewees as one of their major challenges and problems. This process adds further considerable time and cost constraints before a right or permit can be issued.

Due to the low environmental impact of the modern diamond miner, serious consideration should be given to allow the DMRE to issue water rights and environmental authorisations for operations using less than 7500 m^3 per month with slimes dams smaller than 0,75 ha which typically applies to small operators.

As with the other policy and regulation challenges that apply to Small and Junior prospectors and miners, enabling mineral policy that is 'fit for purpose', rather than 'one-size fits all' legislation and regulations, that is flexible and compatible with the size and scale of Small and Junior alluvial and kimberlite mining operations should be a priority to sustain and grow this sector.

A composite summary table showing the numerous and complex requirements, and considerable costs involved in the application for, and granting of prospecting and mining rights to Small and Junior diamond prospectors and miners is included in this document as **Annexure 2**. ■

Illegal miners (Zama Zamas)

The presence of Zama Zamas in the gold mining industry and their negative impact on the income of gold mining industries, loss of income to the state, and the degrading impact on law and order in the areas that they operate in, is well documented.

During the past 5 years, the Zama Zamas phenomena has spilled over to the diamond mining industry in the Kimberley and West Coast areas. The main reasons for this are:

- **High rates of unemployment** in the surrounding communities
- The **withdrawal of large companies** that owned these deposits and the inability of smaller companies with fewer resources to secure these areas
- The **inability of the local law enforcement** agencies to apply the rules of law due to corruption, lack of resources and skill
- The **inability of the local DMRE offices** to mediate between the different parties to legalise these operations
- **Frustration from Small mining entrepreneurs** with the slow and expensive permitting system.

As these issues were not addressed right from the onset, it allowed organised crime syndicates a foothold and the situation especially in Kimberley has generally been chaotic. Small mining entrepreneurs that were issued with permits under a deal with Ekapa Mining in Kimberley (who were previously in a joint venture with Petra Diamonds) have been forced off their ground by syndicates and disgruntled residents who did not get ground to mine on.

There are however also examples where collaboration between small miners from local communities and larger companies have proven very successful. For example the collaboration between the Lower Orange River (LOR) mid to large scale diamond mining operations, and the small artisanal miners from local communities, first instituted and successfully operated under the previous ownership of the Trans Hex Group (see THG, 1998), provides an excellent example whereby artisanal operators and larger companies can work together if the type of deposit allows it. ■

Local beneficiation

In order to make diamonds available for local beneficiation, local producers can obtain exemption from a 5% export levy enacted by the South African Diamond and Precious Metals Regulator (SADPMR), provided they ensure that 15% by value of their production is beneficiated over a 6 months production cycle.

By exporting to large diamond centres like Dubai, Antwerp, Israel and India, small diamond producers product (rough diamonds) are exposed to a much larger audience than those prepared to travel to South Africa and they can potentially earn higher prices.

Hardly any of the producers interviewed considered using this process to export their diamonds. The main reason was that 15% of their value was too high to beneficiate as their operations were too cash flow sensitive and they could not wait for the returns if they had to beneficiate themselves. There are also not enough beneficiation license holders in South Africa that would be able to purchase the high average size and value diamonds produced by specifically the alluvial diamond mining sector.

Unfortunately, the diamond beneficiation sector in RSA has also shown a strong decline since about 2000, in spite of efforts by the State Diamond Trader (SDT) to ensure that up to 10% of local rough production is bought at effectively 'discounted' market prices for redistribution to historically disadvantaged cutters and polishers.

However, at this point the matter of beneficiation in RSA is not a focus of this study, though it is a related challenge for Small diamond miners and requires attention for the benefit of all parties, including new entrants to diamond manufacturing. ■

Famous Kimberley mine "Big-Hole" - now part of a museum

Summary

Compared with its heyday between the 1990s and early 2000s, today's Small and Junior diamond mining sector is but a shadow of its past. In 2000, prior to South Africa's changes to mineral policy ownership and regulations, and introduction of new ownership requirements, this sector supported some 2 000 small and medium sized private and listed operators (Farrell, 2012).

Results collected in this study in terms of the number of operations and their employment numbers are summarised, together with previous information from other sources including Farrell (2012), DMRE publications from prior to 2015, literature reviews, and interviews and discussions with several experienced diamond geologists and proprietor of Global Diamond Network all attest to the strong decline of the industry since 2012 as shown in **Figure 3**.

This recent study has highlighted that there are currently about 216 operations and projects either on care and maintenance or being restarted, representing a decline of about 90% since the year 2000. A small part of this (at most 20%) can possibly be ascribed to the 'age' of the sector and past or historical exploitation of easy to mine higher grade deposits. However as highlighted in Chapter 3 (**Table 4**) there have been substantive technological advances in the geological understanding, delineation of deposits, mining, processing, and in particular recovery of diamonds which more than offset the decline in grades.

Based on this study the problems and challenges documented in the two-part **Table 14**, including ineffective mineral policy, challenging regulatory requirements such as a "one size fits-all" approach, excessive red-tape, have been tremendously detrimental to the sector, and are fully compatible with the concerns and causes documented previously by Farrell (2012).

As a consequence of the steep decline (~90%) in the number of Small and Junior diamond miners from the year 2004 to 2020, there has been a concomitant significant loss of jobs as employee numbers have decreased from about 25 000 in year 2000, to about 5 278 in year 2020 as shown in **Figure 3**.

The economic impact of these job losses amongst communities and small town such as Port Nolloth, Prieska, Douglas, and Kimberley in the NCP, and Bloemhof, Schweitzer Reynecke, and Wolmaranstad, amongst others in the NWP, are obvious and significant in terms of economic decline in these regions. This aspect is discussed further in **Chapter 7**.

ECONOMIC-DECLINE AND UNEMPLOYMENT IN THE NORTHERN CAPE PROVINCE

Introduction

In this section developments in the mining sector and the impacts the decline in mining activity, including the very obvious contraction of the small diamond mining sector is considered broadly against the backdrop of the economic challenges, impacts, and unemployment situation faced by the Northern Cape Province. At the outset it should be noted that obtaining reliable and up-to-date economic, GDP, employment, and sectorial information for the individual provinces is challenging, and hence this initial analysis has been done at a high level, with the intention of following up with more detailed analysis at a later stage.

Economic summary

South Africa has a total of nine provinces: Northern Cape, Eastern Cape, Free State, Western Cape, Limpopo, North West, KwaZulu-Natal, Mpumalanga and Gauteng.

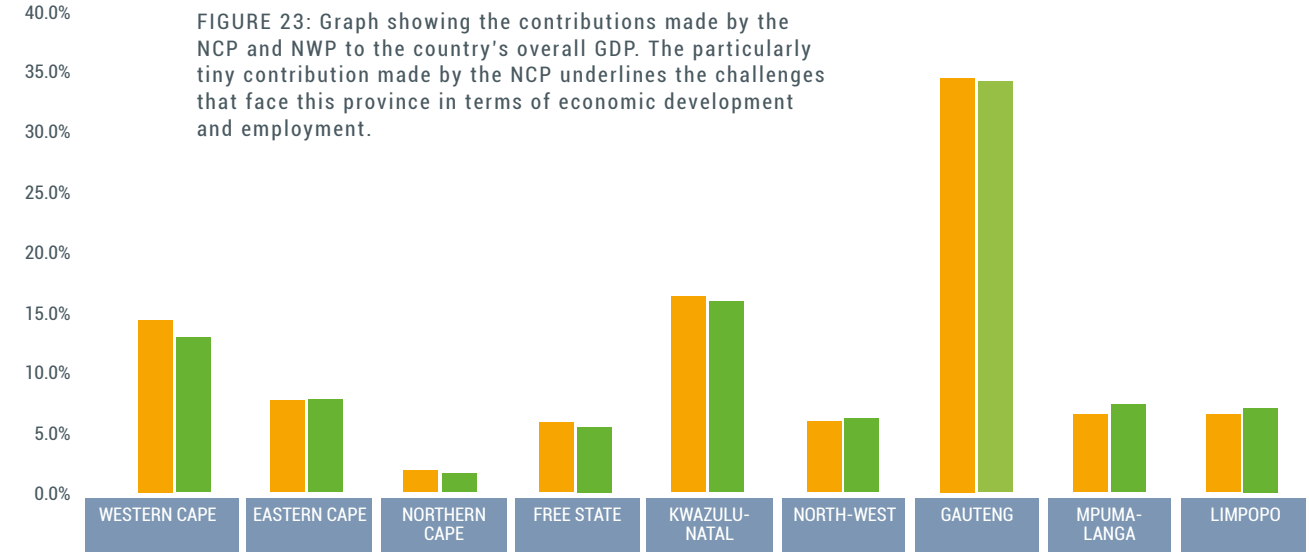
Key details of the Northern Cape Province (NCP) are the following:

- It is the largest (372 889 km^2) and most sparsely populated (population density = 3.1/km^2) province bordering the North West, Free State, Eastern Cape and Western Cape provinces
- It comprises five district municipalities (Namakwa, Pixley Ka Seme, ZF Mcqawu, Frances Baard and John Taolo Gaetsewe)
- It has the smallest population share in the country, constituting only about 2% (1 263 875) of the South African population (Northern Cape Provincial Treasury, 2018) and in 2014 had an average population growth rate of 0.7% (Department of Economic Development and Tourism, Northern Cape Research and Development Unit, 2014)
- Approximately 10% of its population comprises of older persons (≥60 years old). This is the second largest proportion of elderly people in a province following the Eastern Cape Province (11.3%) (Statistics South Africa, 2019)
- The earliest known exploration for minerals in South Africa was undertaken in the far west of the NCP in 1852 and lead to the discovery and mining of copper near the modern day town of Springbok
- The NCP has hosted a treasure trove of minerals in the past, a large portion of which (particularly diamonds) have been mined out since their discover over 150 years ago – mineral deposits include diamonds, tigers eye, copper, zinc, iron ore, manganese, wollastonite, dimension stone, tantalum, rare-earth minerals hosted in monazite), heavy minerals, limestone, building materials and sand. Large areas of the Province are unexplored in a modern sense
- Mining was the largest primary industry contributor to the NCP economy (20.2% in 2015, and 17.5% in 2016)
- The overall largest contributor the NCP economy is community services (22.0% in 2015; 22.5% in 2016), which falls under the tertiary sector.
- The economy of the NCP made the smallest contribution to South Africa's ▶

GDP in 2016 and 2017 at 2%, and in 2017 the Province's Gross Domestic Product decreased to a negative value (-2.7%) after having shown some improvement following the global financial crisis of 2008/2009 **(Figures 23 and 24)**.

This negative economic growth highlighted in the last bullet point above and in **Figures 23 and 24** is largely attributed to a decrease in the economic activity of two primary sector industries: mining (e.g. -0.2% in 2015; -8.5% in 2016) and agriculture (e.g. 0.7% in 2015; -6.2% in 2016) (Northern Cape Provincial Treasury, 2018). Though the NCP economy picked up slightly in 2018, the overall negative trend, concomitant job losses, economic hardship, and poor service delivery is ongoing.

FIGURE 23: Graph showing the contributions made by the NCP and NWP to the country's overall GDP. The particularly tiny contribution made by the NCP underlines the challenges that face this province in terms of economic development and employment.



	WESTERN CAPE	EASTERN CAPE	NORTHERN CAPE	FREE STATE	KWAZULU-NATAL	NORTH-WEST	GAUTENG	MPUMA-LANGA	LIMPOPO
2006	14.5%	7.7%	2.2%	5.5%	16.4%	5.7%	34.8%	6.6%	6.6%
2016	13.6%	7.8%	2.1%	5.1%	16.0%	6.0%	34.7%	7.5%	7.2%

FIGURE 24: Graph showing GDP growth rates for the Northern Cape Province and RSA for the period 2006 to 2016. Unpublished data suggests the NCP situation improved slightly in 2017 and 2018 but remains depressed with high unemployment. Covid-19 pandemic and lockdowns of 2020 have had further negative impact.

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
SA	5.3%	5.4%	3.2%	-1.5%	3.0%	3.3%	2.2%	2.5%	1.7%	1.3%	0.3%
NC	3.8%	3.3%	1.7%	-2.3%	2.2%	2.0%	3.2%	2.4%	2.9%	0.9%	-2.7%

Notable also is that the overall decline in economic activity highlighted in **Figure 24**, shows a broadly similar declining trend to that shown by the progressive fall in diamonds production expressed in carats shown in Chapter 1, which in turn shows the alarming decline in the large diamond mining sector reflected by the withdrawal of Trans Hex from their Baken and LOR operations, De Beers Kleinsee from their once highly productive West Coast operations, and De Beers exit of the Kimberley mines, all immensely damaging to the NCP.

Added to the above challenges has been the equally stark decline of the Small and Junior diamond mining sector, as reflected in **Figure 3** at the start of this report. Regrettably the downward trend in numbers of small diamond mining operators and attendant job losses, is symptomatic of the challenges faced by entrepreneurs and small business across the country, all of whom are constrained by poor policy regimes and excessive red tape.

Because mining has been the largest contributor to the province's economy ever since the discovery of diamonds in the province in 1866, and subsequently other world class mineral deposits, developing related secondary industries such as beneficiation of primary sector outputs, would have been beneficial and commendable.

Particularly damaging to the NCP economic and unemployment scenario, is that nearly all the Small and Junior diamond miners operate in remote areas and draw their employees from small towns and communities such as Warrenton, Barkly West, Douglas, Prieska, Springbok, Port Nolloth, and Alexander Bay. In a scenario of already limited job opportunities, the related decline in farming employment due to mechanisation, and rising costs of fuel and electrical power, the consequences of the progressive decline in the number of small self-funded diamond operators and related jobs shown in **Figure 3** is immensely damaging to the small towns and communities listed above, and larger towns such as Kimberley.

Because mining has been the largest contributor to the province's economy ever since the discovery of diamonds in the province in 1866, and subsequently other world class mineral deposits, developing related secondary industries such as beneficiation of primary sector outputs, would have been beneficial and commendable. However, many attempts to develop sustainable diamond cutting and polishing facilities in Kimberley to boost local beneficiation have failed dismally (Kravitz, 2011, and Kolver, 2013).

The only potential recently proposed value-add diamond activity in the 'home' of diamonds is provided by Kimberley International Diamond and Jewellery Academy (KIDJA) which is intended to provide training (about 405 to date) interested in the diamond valuation, and cutting and polishing sector. This organisation has also found it challenging to keep its doors open. In similar vein, Vedanta Zinc International which recently made one of the largest private sector investments of approximately US$400 million (Global Africa Network, April, 2019) in the NCP at their Gamsberg zinc mine, is proposing that they will look to secure off-shore smelting options due to the costly and unreliable electrical power from Eskom in RSA.

Unemployment in the Northern Cape Province is officially about 29% (Northern Cape Provincial Treasury, 2018; Statistics South Africa, 2021). If the expanded unemployment rate, "which includes the unemployed as well as those available for work who did not look for work" (Patsy, 2017) is included, then this unemployment figure is between about 42 and 50% (Statistics South Africa, 2018, 2021). In 2017 the province had about 65 000 discouraged jobseekers, a situation which has almost certainly got worse as employment in the mining and agriculture sectors has continued to fall through 2018 and 2019, and has been further exacerbated by the Covid-19 pandemic of 2020.

The decline in the Small diamond mining sector which has been confirmed in this study is regrettably part of a far larger job loss scenario being experienced across South Africa.

Mining remains an important employer employing about 10.6% of the labour force in the third quarter of 2017 (Northern Cape Provincial Treasury, 2018). Previously De Beers mining operations in Kimberley, Finsch, and Kleinsee on the west coast were a key mainstay of the economy, but Kimberley operations have contracted strongly and the old mines and tailings are now owned by Ekapa Mining, and the Kleinsee operations in Namaqualand have shutdown with dire consequence for employment in the region. Trans Hex, once a thriving Junior diamond miner on the Lower Orange River and coastal deposits has also ceased operating in the Northern Cape, and Alexkor, the state diamond miner, is also struggling and retrenched employees in 2019.

Large mining companies still operating in the province include Kumba Iron-Ore an Anglo American plc subsidiary), Assmang Manganese (jointly owned and managed by African Rainbow Minerals and Assore), South32 Manganese, Kgalagadi Manganese, Vedanta lead and zinc (Black Mountain), and Petra Diamonds, with some mid-tier operations also active in the manganese sector.

Orion Minerals is also looking to reopen ▶

the Copperton copper project previously owned by Anglo Vaal to the west of Prieska and has recently purchased old copper mining projects of Okiep Copper Mines. However the mining operations and activities of these companies are unlikely to be able to off-set the significant and continued job losses reflected in the NCP mining sector employment statistics and underlying economic hardship.

Most of the labour force in the province is comprised of unskilled workers (Department of Economic Development and Tourism, Northern Cape Research and Development Unit, 2014), which could gain skills working in the Small diamond mining industry. Small and Junior diamond miners are increasingly becoming an important supplier of rough diamonds as big companies are looking to discount exploration expenditures by partnering with small companies, which might have more luck finding new projects (Ehud, 2016).

The decline in the Small and Junior diamond mining sector which has been confirmed in this study, and which has been highlighted in **Figure 3** is regrettably part of a far larger job loss scenario being experienced across South Africa.

Though overshadowed in the past by the large-scale mining sector of South Africa, the role played by the Small and Junior diamond mining sector in the NCP (including the West Coast), NWP and elsewhere in the country cannot be underestimated in the context of its overall contributions (or untapped potential), and benefits to the desperate state of South Africa's economic and unemployment situation. ■

Declining large-scale mining industry

Diamonds found in the Northern Cape, be they old tailings deposits, kimberlite mines, low grade alluvial deposits, or the remnants of once extensive marine alluvial deposits on the Namaqualand west coast are finite and rapidly declining assets. The majority of the primary diamond sources (kimberlite pipe mines) of the province are some 150 years old and rapidly approaching final closure.

Production from the once famous five large underground Kimberly diamond mines has almost ceased, reprocessing of the extensive old mine tailings dumps around Kimberley is also declining and becoming marginal, and diamonds being recovered from "floors" and remnants of tailings by the Artisanal Mining co-operative, for example, are expected to run out in about five years. Likewise the deposits of the West Coast such as Alexkor have been exploited for some 90 years, and the large tracts of beach deposits mined previously by De Beers at Kleinsee and Trans Hex along the west coast are largely depleted.

In the case of the project created by Ekapa Mining and its then partner Petra Diamonds, the view of 44-year-old miner Kagiso Nofomela who hails from the town of Kuruman some 242kms away was that "our dream is that, when we give the land back to Ekapa, 90% of us will have something in our pockets, we must have money, cars, homes and our kids must be educated." Unfortunately, examples from South Africa and the rest of Africa show that very few informal miners ever accumulate real wealth, and instead unemployment continues to grow, and disease and poor working conditions result in illness and death. ■

Kenilworth tailings dump 'Floors' – Zama Zama processing plant

Unemployment and illegal mining – Zama Zamas

During this study of South Africa's Small and Junior diamond miners, there were also visits and engagements with illegal artisanal miners active on the Kenilworth Floors (previously a large kimberlite tailings dump) on the north-east side of Kimberley.

The more extensive activities of illegal diamond miners around greater Kimberley were also noted on trips to this town, and equally in Namaqualand where illegal mining activities are prevalent in the old Kleinsee mine workings and tailings, the Lower Orange River areas previously mined by the Trans Hex Group, and parts of the Alexkor concession. The activities of Ekapa and Petra Diamonds in respect of their efforts to formalise illegal artisanal activities around Kimberley were also followed during the course of this study.

Mine owners Ekapa Diamonds and Petra Diamonds (Petra has subsequently exited their joint venture with Ekapa) granted more than 800 unlicensed, or informal, Small-scale miners the right to legally mine about 600ha of diamond-rich waste fields. This project was launched in the middle of 2018 in Kimberley, the site of a 19th-century diamond rush that lured fortune-seekers from about the world. Regrettably this first South African project to bring illegal miners or Zama Zamas into the formal fold has been plagued by violence in diamond capital Kimberley, creating challenges to national efforts to stem a booming illicit trade.

The aim of the government-backed scheme was to curb illegal mining and black-market trade of diamonds, and serve as a blueprint for future attempts elsewhere in the country, not only in the diamond sector, but also potentially manganese, gold and chrome. However the project has suffered from regular violence, with informal miners not included in the scheme attacking infrastructure, cutting and stealing fences, petrol-bombing three Ekapa trucks, blocking access roads with rocks and burning tyres, attacking security guards, and even members of the newly licensed co-operative, according to mine owner Ekapa Minerals, which is running the initiative.

The issues faced by this pilot scheme is a challenge to wider corporate and governmental efforts to bring SA's estimated tens of thousands of informal miners, or Zama Zamas, into the mainstream, to boost productivity and curb crime. According to 2017 estimates by the Minerals Council of South Africa, illicit mining and mineral trading cost about $1.5bn (R17,87bn) a year in lost sales, taxes and royalties, and sees criminal networks exploit vulnerable workers struggling to make ends meet.

While the government had previously acted in an advisory capacity, particularly so the previous Deputy Minister Godfrey Olifant, it indicated it may take a more active role in the Northern Cape/ Kimberley diamond project, the first to attempt so-called formalisation of artisanal activities in the local mining industry. Asked in November 2019 whether he was pleased with the results of the Ekapa project, Minerals and Mining Minister Gwede Mantashe said he was not, and that *"We will have to assign somebody to work on it"*, and went on to add *"I am not happy because it (informal mining) must be in the mainstream of mining, it must not be in the periphery"* (Reuters, 2019).

The Ekapa project's troubles demonstrate the downside of piecemeal formalisation of projects and policy in a country whose regulation of Small-scale mining lags far behind its African counterparts. Ekapa and Petra Diamonds (previously a joint venture partner of Ekapa), launched the initiative in 2018 at Kimberley, in the Northern Cape, hoping to address the problem of an influx of Zama Zamas, a Zulu-derived word which loosely translates as "keep trying".

Zama Zama with 'Shaker-screen'

Estimates made by Ekapa indicated that as much as R6m (approximately US$400 300) worth of diamonds were being taken by illegal miners each month. In a bid to stem that, the company formed 836 miners into the Batho Pele mining co-operative and gave them a licence to mine the fields. Subsequent to its initiation the overall track record on the ground is not promising. Illegal miners who are not part of the co-operative have stolen fences, petrol-bombed Ekapa trucks, regularly blocked access roads with rocks and burning tyres, sabotaged a waste pipeline, shutting down the mine processing plant. Ekapa security teams have been attacked with knives, slingshots, rocks, petrol bombs and, in one instance, a hunting rifle, the company said.

Increased security activities and bolstering of its security defences, and health and safety procedures to deal with the illegal miners drove Ekapa's security costs up to about R3m ($200,160) per month before the project began, and the company has had to continually enhance security processes at considerable cost. It also resorted to using alternative, longer routes for its trucks, adding to the company's financial burden. A police spokesperson interviewed in November 2019 said its records showed 22 criminal incidents linked to illegal mining across Ekapa's property and the area mined by Batho Pele between March and October in 2019, including an attempted murder and three serious assaults. Members of the co-operative, who cannot afford formal security, have also been targeted.

"The problem that we are encountering now is from the other Zama Zamas. They want to enter this thing with force," said Batho Pele cooperative member Victor Taku. *"They come here with weapons, others come here with firearms, others come here with a spade"* (Reuters, 2019). The 44-year-old Taku paid for his son's university fees with the money he made mining. With joblessness in South Africa at an 11-year high and the economy in distress, that income is out of reach for many South Africans.

The Ekapa project's considerable challenges and related costs of safety and security, highlights the need for the government to provide clear policy on small-scale or artisanal mining using rudimentary techniques. In contrast with other African countries such as Mali, Democratic Republic of Congo, and Tanzania, South African law has no provisions for this. South Africa's legislative framework *"is just missing in action when it comes to artisanal and small-scale mining,"* according to David Perkins, an economist at Mining Dialogues 360, an NGO (Heiberg and Reid, November 2019). Illegal mining issues and attempts to formalise the activities of Zama Zamas are too big for companies to handle on their own, and far greater efforts including research of the problem, a review of artisanal or informal mining structures applied in countries north of South Africa, dialogue with all the parties, education, and meaningful policy interventions will be required as a priority.

The 44-year-old Taku paid for his son's university fees with the money he made mining. With joblessness in South Africa at an 11-year high and the economy in distress, that income is out of reach for many South Africans.

Interestingly in Sierra Leone, a well known diamond producing country with extensive shallow alluvial deposits, and small kimberlite mines, the DeBeers Group launched a pilot project called GemFair (http://gemfair.com) in April 2018 incorporating digital innovation to trace and sell ethically sourced artisanal and small-scale mined (ASM) diamonds. The project involves the development of a toolkit that can be used in the field to create secure and transparent source to market tracking (a Responsible Supply Chain of Minerals process), at the same time seeking to improve ethical standards, working conditions, and value for small-scale miners in this sector (Zerouki, 2019).

According to a recent update of the project progress from DeBeers (Zerouki, 2020), the Sierra Leone initiative now has 94 mining sites participating in the project, from an initial start of 16 sites. It is regrettable that after nearly 150 years of diamond mining and experience in South Africa, a similar diamond initiative has not been implemented by the world's best known diamond company in what used to be its own backyard.

Greater collaboration between law enforcement, government departments such as the DMRE, companies, and NGO's will be needed to provide long term solutions for this challenge. Equally collaboration between law enforcement agencies, Government departments such as the DMRE, private security firms, and communities will be needed to try and address the multimillion-rand criminal operations that benefit from illegal mining.

Efforts to bring illegal mining into the mainstream are also hindered by a lack of accurate data about how many Zama Zama's are involved, what income they generate, and under what conditions they work. In respect of the illegal miners around Kimberley, Northern Cape police commissioner Lieutenant-General Risimati Shivuri noted in 2019 "*We have so many people that we don't even know where they come from. That is the challenge we are having*". Researcher Pontsho Ledwaba (2017), of the Witwatersrand University in Johannesburg, has stated that there could be as many as 100,000 informal miners across RSA.

To plug this data gap the World Bank has proposed to government that it conduct a comprehensive study of artisanal mining, and may even fund it *"Accurate, reliable data is an essential first step to understanding the sector, recognising miners and formalising their work"*. However while the World Bank is apparently in continuing dialogue with the South African government, no study of the sector is planned at this time. Even should formalisation projects such as that at Kimberley ultimately prove successful, another important question looms in the longer term: What happens to the small-scale miners when the resources run out, and where do they go? ■

Untapped inland alluvial diamond potential

In stark contrast to the situation facing the large diamond sector and the closure of operations by the likes of DeBeers and Trans Hex, as has been documented above, there are still large resources of high-quality alluvial diamonds contained in the extensive ancient river gravels of the Vaal, Harts, Orange, and Riet Rivers, and related ancient paleorivers, glacial, and marine systems of the NCP (see Table 9).

Importantly the experience, skills, technology, and markets exist to ensure the successful recovery, exploitation, and marketing of the exceptional diamonds that are recovered from these deposits.

South and Southern Africa has been blessed with remarkable geological, geomorphological and climatic conditions which liberated diamonds from kimberlitic sources and concentrated diamonds along major paleo-rivers such as the Vaal and Orange Rivers, and in west coast marine placer deposits. These ancient river beds and inland marine deposits of the NCP and West Coast contain millions of tonnes of low-grade diamond bearing gravels **(see Table 9)**, which have yielded exceptional high-value gemstone diamonds ever since the discovery of the first diamond in an alluvial setting on the banks of the MOR at De Kalk between Hopetown and Douglas in 1866.

Likewise, there has been extensive mining of ancient diamond bearing land and marine based beach-deposits on the west coast of Namaqualand, including the once rich deposits of Alexkor, Kleinzee, and De Punt. Shallow and easy to access deposits are largely mined out, but large volumes of gravel still exist on shore under thick cover, and in deeper portions of the marine off-shore (drowned beach) deposits.

Enabling 'fit for purpose' mineral and mining policy (rather than a 'one size fits all'), and a commitment from Government and key stakeholders (such as the Provincial Government, CGS and Mintek) to revive the Small and Junior diamond mining sector, could reverse the decline in the number of operators highlighted in **Figure 3**, drive transformation and ownership challenges in the sector, assist job creation, and provide a measure of economic recovery in the NCP. ■

Summary

The economic challenges and joblessness outlined above are not unique to the NCP. They are increasingly been faced by every other province in South Africa and the country as a whole, and point to an urgent need for enabling mineral and mining policies that will encourage development and new investment in the untapped resources of the NCP (and West Coast), NWP, and country as a whole.

It is interesting to note that in 2012 *"The Department of Mineral Resources believes that small-scale mining has an important role to play in the community upliftment, job creation and poverty alleviation"* (Brand South Africa, 2012). Subsequently similar statements have been made by Government Ministers over the years in respect of small scale mining. This has included efforts to formalise illegal mining activities in the Kimberley area in mid-2018. However, a mixture of the ineffective legislative changes, rising costs, and other challenges such as unreliable and increasingly expensive electrical supply post the global financial crash (GFC) of 2008/2009 has, following a short-lived economic rebound, seen the economy of the NCP continue to show a decline and related loss of jobs. Interestingly other knowledgeable parties in the diamond industry have suggested that in spite of the setbacks imposed on the industry by the global financial crash GFC in 2008/2009 the extent and impact of the diamond mining activities across the Northern Cape, the industry had the potential to employ about 4 000 to 9 000 people more after 2009 (Kravitz, 2011).

CONCLUSIONS

Decline of the Small and Junior diamond mining sector

An extensive regional study and survey of the Small and Junior diamond mining sector, which comprises primarily alluvial diamond operations, and minor kimberlite tailings and small kimberlite mine activity, was completed from late-2018 through to 2021 with the Covid-19 pandemic unfortunately impacting the project in 2020.

The geographical coverage and nature of the survey work, data collection, database structure, and analysis are summarised comprehensively in the previous sections of this report.

This study has confirmed that this previously productive and successful small or Junior diamond mining industry has experienced steady decline since 2004 **(Figure 25)** when the Mineral and Petroleum Resources Development Act (MPRDA) was implemented, and continues to experience on-going challenges as highlighted in this report and summarised in **Table 15** (see also African Mining, 2019; Bristow, 2017, 2018).

The Covid-19 pandemic of 2020 has had further far reaching negative impact on the international and local diamond sector and been immensely challenging for the Small and Junior diamond sector. There is an urgent requirement for an immediate review of the existing disabling mineral and mining policy frameworks that apply to this sector. Unless far reaching changes, and enabling and sustaining mineral policy interventions are implemented as soon as possible, the Small and Junior diamond mining and development sector will contract further, with negative consequences for employment and job creation in the depressed NCP (including the West Coast), NWP and elsewhere in South Africa.

At the time of the implementation of the MRDPA, there were approximately 2 000 diamond miners employing some 25 000 people (Farrell, 2012). Today that figure

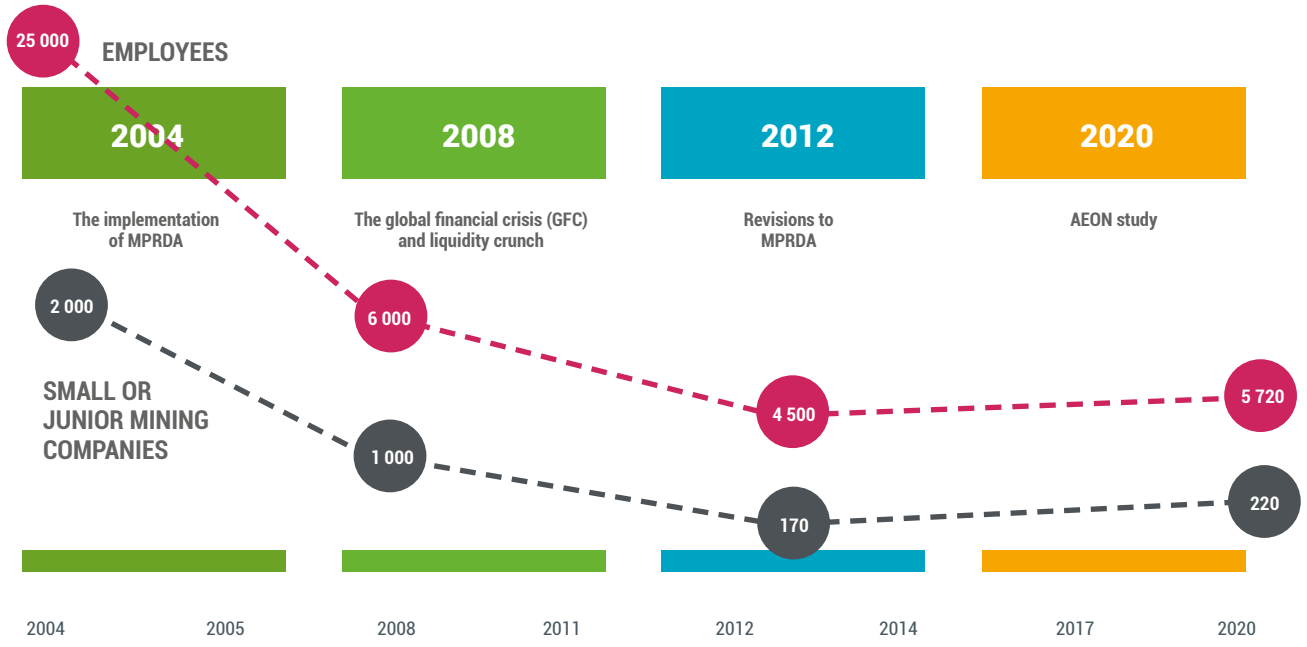


FIGURE 25: Diagram showing the decline of the Small and Junior diamond miners over the period 2004 to 2020.

has plummeted to about 220 Small and Junior mining operators with a drastic reduction in employment numbers projected to be about 5 720. Since 2013, there also appears to have been about a 61% decrease in prospecting right applications in the NCP where the bulk of alluvial diamond mining takes place – largely the ambit of entrepreneurs, local private operators, and farmers. Like many other mining sectors, the diamond mining sector is also seeing rapid growth of illegal operations. Much of this on the back of poorly-considered policy.

This important Small mining sector faces considerable challenges and further decline unless its potential contributions in respect of the exceptional quality of its diamond production, financial contributions, and job creation benefits, are recognised and supported, and enabling mineral and mining policy is introduced as a priority

Whereas the Small and Junior diamond industry previously employed about 25 000 people in 2000 (Farrell, 2012), this latest study shows that employee numbers are about 5 720 with an annual salary bill of approximately R550 million. It is the primary employer in remote rural areas in the NWP and NCP where over 90% of the alluvial diamond mining is conducted, and where existing unemployment levels are officially at 50%, but in many small towns are considered to be as high as 80%.

Whereas the sector previously produced approximately 300 000 carats per year valued at R4.2 billion (~USD300 000 000 at an average price of USD1 000 per carat) with foreign exchange earnings from production estimated at R3.2 billion (SADPO, 2019), the industry faces declining production and revenue trends, and these have been further negatively impacted by the Covid-19 pandemic.

This important Small mining sector faces considerable challenges and further decline (De Meillon and Bristow, 2002) unless its potential contributions in respect of the exceptional quality of its diamond production, financial contributions, and job creation benefits, are recognised and supported, and enabling mineral and mining policy is introduced as a priority. ■

Makondo 'sloot' from which Rooikoppie gravels have been mined, MOR

Challenges faced by the sector

A collective summary which draws on the content of Table 14 and the authors extensive investigation of the Small and Junior diamond mining sector summarising the key causes for the decline of the industry is presented in Table 15 overleaf.

These challenges are causing operators to consider leaving the industry, and unless meaningful interventions are made to address this situation the industry will continue to decline with further job losses and negative economic consequences already economically stressed NCP (including the West Coast), NWP, and elsewhere in the country.

Current mineral and mining policies, the Mining Charter 3 (MCIII) and associated Implementation Guidelines, and 'one-size fits all' MH+S Regulations make no distinction between the geology, mineral resources, structure, size, and funding differences between Small or Junior miners versus large private or publicly listed mining companies.

Unless the key differences between the two sectors are recognised, and enabling 'fit for purpose' mineral and mining policies are implemented for the Small and Junior mining sector, there will be an ongoing decline of South Africa's entrepreneurial miners and job losses in vulnerable rural communities. ■

TABLE 15: Key challenges faced by Small and Junior diamond miners, including emergent miners based on research conducted during this project.

	CHALLENGES	ACTIVITIES	IMPACTS/COMMENTS
1	**Safety and Security**	· Rising crime and lawlessness in rural and remote areas is becoming a challenge for small operators and their employees · Existing policing and safety networks are incapable of addressing these challenges	Providing site security including CCTV, private security patrols, and other measures to secure and move goods is adding excessive costs
2	**Mineral and Mining Policy Uncertainty**	· 3 Mining Charters in 3 years · Charter is unsuitable for small miners · Implementation guidelines are unworkable for small operators in remote areas	Policy uncertainty has discouraged new investment, and discouraged local private operators
3	**Inefficiencies in the DMRE Systems and Processes**	· SAMRAD system is clumsy and requires replacement with a modern user-friendly system · Extremely slow processing and granting of Licence applications; may be up to 4 years	SAMRAD mineral tenure system is obsolete and should be replaced. 'Time is money' and lengthy delays in granting licences is unaffordable for small operators
4	**Access to Information and Technical support**	· Impossible to secure geological information for small alluvial and kimberlite deposits · No technical support available for small miners	Council for Geoscience (CGS) and MINTEK should be restructured to provide meaningful information and technical support to small diamond miners
5	**Onerous Mine Health and Safety Requirements**	· Current situation of 'one size fits all' application of MH+S requirements is untenable	MH+S requirements applied to large mining industry, is not effective for small scale diamond miners
6	**Water Use Licences and NEMA Requirements**	· Department of Water Affairs (DWA) is dysfunctional and time periods to attend to applications are untenable · NEMA Requirements are inefficiently applied, and too onerous for small scale diamond operations	Construct appropriate small-scale mining regulations. Recognise that diamond mining and processing does to utilise unsafe and hazardous chemicals such as cyanide and acids
7	**Complex and Expensive Environmental and Rehabilitation requirements**	· NEMA requirements are appropriate to large mining operations such as deep-level gold mines, and large PGM operations · There should simplified environmental requirements for small scale miners	Regulations should reflect shallow open-cast nature of small scale diamond mining operations, low water usage, and absence of harmful pollution
8	**Social and Labour Plans**	· Operations are mostly in remote areas with short LOM's · Municipalities lack resources and capacity to implement SLP's	Current SLP system is not adding value to local economic development plans and Communities; A system whereby Small mining companies SLP's funds are consolidated on a regional basis, managed, and implemented on a transparent basis by a functional agency should established as a priority
9	**Unsustainable Compliance Costs**	· Compliance costs are typically as much as 5 – 10% of turnover for small operators which is disproportionate compared to large mining operations · Small scale operators are typical one mine ventures and costs cannot be spread over multiple operations	Simply the legislation such that it serves the requirements of small open cast operations, and enhance development of new mining entrepreneurs and job creation in remote and economically depressed regions
10	**Lack of Coordination between different Departments**	· Application processes for mineral rights involves several departments including DMRE, Water Affairs, Environment, Heritage. local Municipalities · Lack of coordination between these institutions is confusing, time consuming, and costly · Particularly challenging and costly for 5ha Mining Permit applicants, detrimental to new entrants and transformation	There is urgent need for harmonisation of the different Laws and Regulations; Require standard Templates setting out mineral right application processes and requirements to ensure efficiency, consistency and transparency of granting rights
11	**Rising Costs destroying profitability**	· Inefficiencies of granting process, and Increased compliance costs, impacting profitability · Eskom price hikes and unreliability (load-shedding) are also challenging to small operators	Small operators do not have benefit of bank and shareholder funds to accommodate costs challenges
12	**Volatile business**	· Diamond business and pricing has changed significantly since GFC of 2008/09 · Price volatility has increased and small goods (Melee) are being impacted by synthetic or laboratory grown diamonds	The diamond business, particularly rough diamond pricing is becoming increasingly volative Covi-19 pandemic will also impact negatively
13	**'Ownership' of Mineral Rights**	· Substantial numbers of Mineral Right Licences are held in ownership structures that flaunt BEE objectives	Small miners are forced into being Contractors to absentee mineral rights holders. This adds costs and complexity, and negates development of sustainable long-term mining projects, and employment

Key failings of RSA minerals and mining policy

The overriding and continued key failings of existing policy and series of mining charters published over the past several years, including the MC-III is that none of these policies and proposals acknowledge that South Africa's mining sector is not a homogenous grouping of only large mining conglomerates. It is made up of players of all sizes from Small, Junior, Mid-tier, privately funded operators and mid-sized operations (collectively referred to as Junior miners), to large privately held multinational and publicly-owned operations.

MC-III overlooks the cost constraints and economic plight of the Small and Junior diamond operators, in an environment where these diamond producers are price-takers and cannot cover the additional burden of costly BEE deals, increasingly onerous compliance requirements, unrealistic procurement obligations, enterprise development, and employment equity by simply raising selling prices.

The requirements of MC-III and Implementation Guidelines tabled in December 2018, is that aside from being impractical from a situational perspective, they further complicate and increase operating costs of mining operations, unsustainably for Junior operations. The inevitable outcome will be the ongoing shutdown of operations and retrenchments in rural areas where there simply are no other prospects of decent employment.

The inevitable outcome will be the ongoing shutdown of operations and retrenchments in rural areas where there simply are no other prospects of decent employment.

The downstream impact will also be significant – diamond traders, cutting and polishing industries, jewellery manufacturing and retail sales into global markets will be severely impacted. The collapse of entrepreneurial businesses that have been shut out of the industry by onerous and ineffective policies and Charters, and the large mining industry will be disastrous. Upstream suppliers of goods and services could for example stand to lose some R2.1 billion in annual turnover derived from alluvial diamond mining activities (SADPO, 2019; De Meillon, 2020). ■

Upstream suppliers of goods and services could for example stand to lose some R2.1 billion in annual turnover derived from alluvial diamond mining activities

In-pit mobile gravel screening plant, MOR

RECOMMENDATIONS TO REVIVE THE SMALL AND JUNIOR DIAMOND SECTOR

Potential of the alluvial sector and the Small and Junior miners

As reported in this study (see Figure 25, and Table 14) the Small diamond mining sector has shown a strong decline in the number of operations and jobs since 2000. This has impacted negatively on the economically challenged NCP and NWP, the West Coast, and many small towns and communities in remote parts of these provinces.

There are however still considerable resources of low-grade alluvial diamond deposits in the NWP, NCP, and LP which could be exploited to yield increased diamond production and revenue, additional job creating, and provide economic benefits to towns and communities in these provinces. Importantly the entrepreneurial skills, experience, and technology exists to exploit these deposits, will also be lost unless the importance of this sector is recognized and supported, and enabling mineral policy and regulations are introduced to revive its capacity and contributions.

As is already the case the informal and illegal (Zama Zama's) diamond mining sector will expand if greater efforts are not made to properly support and grow the formal Small or Junior mining sector. ■

The role of the Small and Junior explorers and miners

Worldwide, including in many countries in Africa such as Botswana and Namibia, Small and Junior exploration and mining businesses are the backbone of a healthy minerals industry.

History shows that most discoveries of new deposits are made by prospectors and Junior explorers and miners, as they are typically less risk-averse and more focused on exploration and early-stage development as a means of survival, compared to risk averse Large or Senior mining companies.

Mineral discoveries that are 'small' or 'mid-tier' are exploited by Junior miners, whereas bigger deposits requiring large capital expenditure are typically built and mined through joint ventures between Junior and Senior companies or sold to Senior companies. This synergy between Junior and Senior companies is well documented worldwide and benefits the entire minerals sector.

A further reality is that ore bodies are finite thus there is a need for synergy between Junior explorers who are fleetfooted and make discoveries to replace old and

depleted assets mined by the Senior mining operators, thereby ensuring the long-term sustainability of the minerals sector. This synergy is lacking in the current South African mining industry.

While low- and ultra-low grade alluvial diamonds are amongst the highest risk commodity to mine globally, the industry also has the lowest cost-entry relative to other minerals for Small and Junior miners. Given the many changes taking place in the international diamond industry, including the rapid growth and impact of synthetic or laboratory grown diamonds (LGD's) on Melee and smaller diamond sizes (< than 2 carats), and impact of technology such as Sarine, Galaxy, and lasers, in the cutting and polishing sector (middle of the 'Pipeline'), the high quality and typically large alluvial gemstones mined from South Africa's alluvial deposits are ideally positioned to benefit from these changes. The increasing demand for quality natural diamonds to fill niches in the middle and high-end value segments of the international diamond market provide opportunities for this sector.

Equally there have been considerable improvement and innovation in the technology available to delineate deposits, treat gravels, and recover diamonds, which add value to the industry.

Another key aspect of the low-grade alluvial deposits found in the NWP and NCP province is that the Small and Junior miners have themselves developed considerable 'home-grown' expertise covering the geology, shallow strip or open-cast mining, fine-sand screening, gravel processing, diamond recovery, water recycling, and rehabilitation of these unique deposits.

Equally there have been considerable improvement and innovation in the technology available to delineate deposits, treat gravels, and recover diamonds, which add value to the industry and assist with the exploitation of ultra-low grade gravel deposits **(see Table 7)**.

Recommendations, interventions, and changes to revive South Africa's Small and Junior diamond mining sector are presented in **Table 16**. ■

Small diamond mining vessels (converted fishing boats) in Port Nolloth harbour, West Coast, Namaqualand

Enabling policy framework

Properly researched and implemented enabling policy regime, including recognition and support for the existing, and previously much larger formal Small-mining sector, is clearly lacking in the local informal and small diamond mining sector, including the Ekapa efforts and Government's formalisation of the Kimberley artisanal-miners or Zama Zama situation.

The current ineffective and challenging policy environment as depicted in **Figure 26** opposite is hindering the survival and growth of the existing Small, Junior, and Large mining sectors and making it difficult to find solutions to sustain and grow these key sectors. The Small and Junior diamond mining sector with its entrepreneurial approach, experience, skills and technology could be creating many more jobs and economic benefit to financially stressed Provinces, and be providing increased production of high-quality gemstones to support more in-country beneficiation, and generate foreign exchange through international marketing and sales.

In contrast to the situation reflected in **Figure 26**, **Figure 27** opposite reflects the situation in an optimally functioning minerals and mining regime where enabling minerals policy and reduced red-tape ensure growth and positive spin-offs for owners (companies), government, employees, job creation, and communities. ■

FIGURE 26: Policy parameters and consequences in a poor-policy and weak-regulation minerals and mining environment (from Kitaw, 2015).

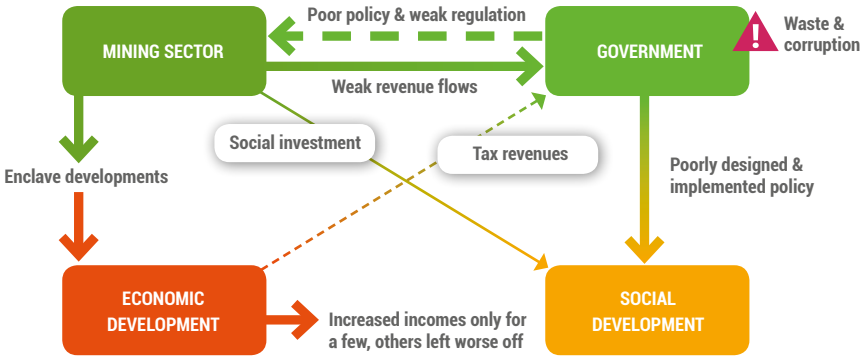
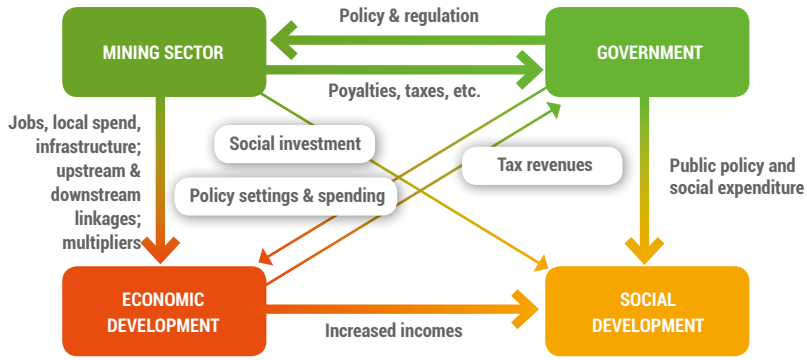


FIGURE 27: Policy parameters and consequences in a positive and enabling policy regime and growth focussed mineral and mining sector (from Kitaw, 2015).



Recommendations

The alluvial deposits, experience, skill sets and technologies exist in the country to revitalise and expand the small diamond mining sector. This will benefit financially challenged provinces such as the NW and N Cape, and create new employment. A number of key recommendations or interventions are presented in **Table 16** opposite address the challenges being experienced by the industry.

With revised and customised enabling mineral policy and regulations, the Small and Junior and less capital-intensive diamond mining sector should be a driver of transformation and an incubator of black-owned and operated entrepreneurial mining businesses. This will only happen if the MC-III policy makers recognise the pitfalls and problems of applying a 'one-size fits all' approach designed for a handful of large publicly-owned companies, to an industry dominated by small, privately-funded, entrepreneurial mining businesses. There is an urgent need for consultation between Government and the Junior mining industry to agree on amendments to MC-III policies and regulations that will enhance and promote transformation and empowerment in the industry, and at the same time ensure that the Junior sector is able to survive and continue to play a vital role in SA's broader minerals industry. ■

TABLE 16: Recommendations to facilitate the revitalisation of the Small and Junior diamond mining sector

	RECOMMENDATIONS	PROCEDURES/BENEFITS	COMMENTS
1	**Construct 'Fit for Purpose' Artisanal, Small-scale, (ASM) and Junior Mining Charter Policies and Regulations** • Rewrite Charter and policies to reflect small-scale nature of operations • Create Standard Templates for mineral right application procedures and requirements for different rights – viz. • ASM operations • Mining Permits • Exploration and Prospecting Rights • Mining Rights	• Unlock value from vast low-grade alluvial diamond deposits that occur in the NWP and NCP • Ensure that the Standard Template is used and applied consistently in all DMRE offices across the country and at HO • The Draft ASM Mining Policy 2021 recently published by the DMRE is a positive development	• Implement modern Regulations, including Operational Codes of Practices, Environmental Practices, Water License requirements, to reflect small-scale needs • Discard cumbersome and costly old-apartheid MH&S law-book and requirements
2	**Replace/Modernise the SAMRAD system and streamline processes for granting of minerals rights** • Create a functional and professional One-Stop Shop to harmonise processes and requirements of different departments	• Encourage new investment, particularly foreign investment • Ensure that new entrants and HDSA's are able to acquire rights rapidly	• Create certainty, transparency, and long-term Mineral Policy consistency • Internationally accepted Spatial Dimension/ Trimble mineral cadastre system and local product (Cape Town based company) should become the new South African standard
3	**Artisanal and Small-scale Mining Permits Establish effective:** • 5-ha and • 45-ha Mining Permit application and monitoring procedures • Revise and streamline requirements for the granting of Mining Permits to fast-track official grants to: • Small-scale operators • Emerging miners • New entrants • Existing informal (illegal) operators • Up to 10 operators/employees • NEMA and present Water Use Licence requirements should not apply • Simplified environmental and rehabilitation requirements should eg. Basic Assessment Report (BAR)	• Implement a Tick-box application procedure, process • Grant licences in 60 days (6 – 8 weeks), for a minimal cost (R2 500 application fee) and nominal rehabilitation bond • Fast-track Mining Permit applications and grants • Progress transformation and Black ownership	• 5ha Mining permits apply to Artisanal 'pick-and shovel' operations • 45ha operations apply to Small-scale operators with limited mechanised mining equipment, and up to two 14foot rotary-pans • The growth of the informal and illegal diamond mining sector should be more thoroughly researched and formalised • Ensure simple and practical H+S and environmental practices are implemented to uplift the growing informal (Zama-Zama) sector
4	**Small-miners – Prospecting/Mining Rights** • Establish efficient/functional Prospecting and Mining Licences for Small-miners utilising shallow-open cast mining with the following parameters: • Mechanised mining equipment • 2 x 16 foot rotary pans <50 000 tpm of mined/ processed gravel • 25 employees • At grade of 0.25 cpht production • ~125 carats per month	• Grant licences in 90 days (3 months) for cost of R5 000 application fee, and R5000 – R10 000 rehabilitation bond • As in #3 above, NEMA and present Water Use Licence requirements should not apply • Simplified environmental and rehabilitation requirements should be followed eg. Basic Assessment Report (BAR)	• These operations are typically short term – 18 – 36 months • May involve contractor operations which must be accommodated in regulations • Licence granting regulations must include mechanisms to accommodate progression of mining faces and operations across property /farm boundaries as alluvial-terrace deposits are followed
5	**Junior-miners – Prospecting/Mining Rights** • Mechanised mining equipment • 4 x 16-foot rotary pans • <100 000 tpm mined/processed gravel (at 0,25 cpht) • 50 employees • >250 carats per month	• Grant licences in 120 days (4 months) for a minimal cost (R5 000 application fee) and R50 000 rehabilitation bond • Streamline existing process to fast-track granting of licences and simplify monitoring procedures	• Appropriate Environmental Management Program (EMP) and Water Use Licence (WUL) to apply • Contractor operations to be accommodated in regulations • Include regulation mechanisms to accommodate progression of mining faces and operations across property /farm boundaries as contiguous alluvial-terrace deposits are followed and exploited
6	**Provide Financial Support for Emerging Miners (eg. Small-miners Development Fund) – see # 7 overleaf**	• Professionally managed and administered fund will provide financial support for emerging and small miners • Drive transformation and black ownership	• Expansion and development of the Small- and Junior exploration and mining sector should be a policy imperative

TABLE 16: Recommendations to facilitate the revitalisation of the Small diamond mining sector continued

7	**Implement a Small Miners Levy or Royalty (eg. 2%) to underwrite a Fund to contribute to the following:** • Small Miners Development Fund • Implement effective SLP and other programs on a region by region basis • Government to contribute on a Rand for Rand basis	• Replace ineffective SLP's, Procurement, and related requirements with Miners Levy and Development Fund	• Accommodate other Implementation Guideline requirements in this levy or royalty structure
8	**Develop Enabling and Effective Policies and Interventions** • To Formalise Illegal (Zama Zama) Miner and Revitalise the Small-scale Diamond Mining Sector • Ensure that transparent marketing and sales structures are set up to purchase diamonds from Artisanal and Small-scale miners and prevent illegal sales and loss of revenue to the State	• Leverage experience, skills, and modern technology applied to Small and Junior diamond mining • Leverage exceptional high-quality diamond product recovered with unique RSA alluvial deposits • Leverage job creation abilities of entrepreneurs and small businesses	• Reduce red-tape: Encourage entrepreneurs to utilise their considerable skills, experience, and new technologies to revive the sector • The recently published discussion document on Artisanal and Small Scale Mining Policy (DMRE 5 May 2021) is a positive in this respect
9	**One-stop Shop** Create a Functional and Coordinated One-Stop Shop portal for handling all mineral right and environmental applications to revive the local Small and Junior mining sector	This has been promised in the past by various Ministers but never implemented	Urgent need for co-ordinated and harmonised minerals exploration, and mining development, and related environmental and job-creation policies that will promote Small mining businesses, SME's, and entrepreneurs.

Notes: cpht – carats per hundred tonnes; NWP – North West Province; NCP – Northern Cape Province

Future developments and the impact of the Covid-19 pandemic

In respect of the future of the Small and Junior diamond mining sector, SADPO and its many committed members have over the past three and a half years made considerable efforts and interventions to highlight necessary legislative and regulatory challenges, reduce red-tape, and to provide solutions to sustain and grow this key sector and drive transformation.

South Africa currently lacks a healthy Junior exploration and mining sector. Key members of the SAPO management team, including Amo Mangena, Gert Van Niekerk and Lyndon De Meillon, and many existing and aspiring small miners, amongst others, consider the revival of South Africa's Small and Junior diamond sector as the catalyst for the growth of the sector, revival of job creation, and importantly, transformation and creation of genuine HDSA ownership.

SADPO has also highlighted that the Covid-19 pandemic and world-wide lockdowns in 2020 and 2021 and the consequences thereof, are proving to be most challenging for the international and local diamond sector. However, the Small and Junior diamond entrepreneurs are resilient and already many of these operators are adapting to the harsh challenges created by Covid-19.

Notably, the large size-ranges and exceptional gemstone quality of the unique alluvial diamonds produced by the Small and Junior operators in South Africa, including the NWP, NCP and West Coast, have been amongst the first diamond production parcels to show recovery of demand and prices as the constraints of the pandemic eased in early 2021.

The turnaround and renewed growth of this sector has excellent upside potential if an enabling mineral and mining policy environment is implemented to assist in reviving economic growth in the NCP, including the West Coast, and NWP as a priority. **Every effort and opportunity should be pursued with and by Government, the DMRE, policy makers, the mining and operating entities, employees, and communities, to drive positive interventions and enabling mineral policies to revive this sector for the benefit of all stakeholders.**

Importantly these interventions should be aimed at driving transformation of the Small and Junior sector, creating economic development and employment, and uplifting communities in remote and depressed regions. ■

ABBREVIATIONS AND ACRONYMS

cpht carats per hundred tonnes (measure of tenor or grade of diamonds typically used for kimberlites)

cpm cubed carats per cubic metre (diamond grade measurement often applied to alluvial deposits)

u/g under-ground mining method

o/c open cast mining method

ha hectares

LOM Life of mine

ROM Run of mine values

Tce(s) Terrace or Terraces

Tpm tonnes per month

US$/carat Method of expressing values of diamonds

FSP Free State Province

GP Gauteng Province

LP Limpopo Province

NCP Northern Cape Province

NWP North West Province

WCP Western Cape Province

AEON African Earth Institute Network

ADI Alluvial Diamond Industry

ANC African National Congress

ASM Artisanal and Small-scale Mining

BBBEE Broad Based Black Economic Empowerment

BEE Black Economic Empowerments

CGS Council for Geoscience (previously the Geological Survey)

COM Chamber of Mines – renamed the Minerals Council (MC)

DMR Department of Mineral Resources

DMRE Department of Mineral Resources & Energy

DWAF Department of Water Affairs and Forestry

EIA Environmental Impact Assessment

EMP Environmental management programmes

ESKOM Electricity Supply Commission

Fm Formation

GDP Gross Domestic Product

HDI's Historically Disadvantage Individuals

HDSA's Historically Disadvantage South Africans

HIV/AIDS Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome

HRD Human Resource Development

I&AP's Interested and Affected parties

IDP Integrated Development Plan

LOR Lower Orange River – section of Orange River from Upington to the Orange River mouth where it exits into the Atlantic Ocean in north-west Namaqualand

MC Minerals Council of South Africa – previously the Chamber of Mines (COM)

MH&S Mine Health and Safety

MINTEK State funded research and development (R&D) organisation specialising in mineral processing, extractive metallurgy, and related technology

MOR Middle Orange River – section of Orange River located between Lesotho and Upington, more specifically the Hopetown-Douglas-Prieska river section

MPRDA Mineral and Petroleum Resources Development Act, Act 28 of 2002

MPRDAA Mineral & Petroleum Resources Development Amendment Act, Act 49 of 2008

MPRRA Mineral & Petroleum Resources Royalty Act, Act 28 of 2008

MPRRAA Mineral & Petroleum Resources Royalty (Administration) Act, Act 29 of 2008

NEMA National Environmental Management Act, Act 107 of 1998

NGO's Non-governmental Organisations

NMU Nelson Mandela University

RDP Reconstruction and Development Programme

SADPO South African Diamond Producers Organisation

SAMRAD South African Mineral Resources Administration system

SARS South African Revenue Service

SLP Social and Labour Plan

SRA Surface Rights Agreement

Stats SA Statistics South Africa

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Rosika Delport of Aftershock Studios is thanked for her compilation and construction of the excellent geological map images, and figures 3, 23, 24, 25, 26 and 27 reproduced in this Report.

Finally, I am eternally thankful and appreciative of the dedicated support and sacrifices made by my family throughout my academic journey. The year 2020 was a difficult year for everyone and it is with great sadness that we unfortunately lost my sister (Funiwe Dlakavu) who through her genuine excitement for my projects always pushed me to work hard. ■

ANNEXURES

ANNEXURE 1: Table showing the processes, timing, and costs of Bakerville 5ha mining permit application applied for in late 2019 and awarded in early 2021.

ACTIVITIES UNDERTAKEN				DATES								
				2020/2019								2021
				FebJanDec	Mar-Jun	July	Aug	Sept	Oct	Nov	Dec	Jan
APPLICATION PHASE												
– Check SAMRAD for Overlapping Licences				15/12/19								
– Complete and submit application form					27 March - 30 June (Covid-19 affected time-frames) Officials returned to Office on Level-3							
– Environmental Approval (EA) Application form				24/01/20								
– Application submission date				27/01/20								
DRAFT BASIC ASSESSMENT REPORT & EMPR												
– Information gathering				28/01/20								
– Report writing				03/02/20								
– Circulate Draft BAR and EMPR				14/02/20 to 15/03/20								
PUBLIC PARTICIPATION PHASE												
– Registered Letters				14/02/20								
– Advertisements in Press				28/02/20								
– Site Notices					11/03/20							
– Visit to Site					11/03/20							
– Public Participation (PP) Meeting of IAF's					11/03/20							
– Complete PP Report					6-8/04/20							
FINAL BAR & EMPR PHASE												
– Submission of Final BAR and EMPR						17/07/20						
REGULATIONS PROVIDE DMRE 107 DAYS (3,5 months) TO REVIEW APPLICATION												
16/07/20 until 02/11/2020 (DMRE Official was hospitalised for 2 weeks during period)												
FOLLOW-UP WITH DEPARTMENT'S PROGRESS												
							Follow-up with Department					
EA ISSUED												
										13/11/20		
APPEAL PHASE												
– Notify IAFP of Outcome										19/11/20		
– Lapsing Date of Appeal Period											09/12/20	
FINAL EXECUTION OF MINING PERMIT by DMRE REGIONAL MANAGER 11/01/2021 **TOTAL COST (including Application Fees, Lawyers, Consultants, Public Consulation, and DMRE Guarantee of ~ R10 000): R130 004,00**												

ANNEXURE 2: Summary of current requirements for applications for a 5ha mining permit, prospecting right, and mining right for diamonds. This information is a summary outline/interpretation of the key requirements, timelines, and costs. See also section on specialist-studies and notes at end of Table.

	ACTIVITY (COSTS, AND TIMELINES)	MINING PERMIT (5HA)	PROSPECTING RIGHT (PR)	MINING RIGHT (MR)
1	**Background Work undertaken by Applicant**	Valid for period specified on Permit, not exceeding 2 years, may be renewed for 3 more periods of a year each; 5ha area Absence of readily available and up-to-date geological information and technical support is a challenge for small diamond miners **(Timeline: 1 – 3mnths)**	Valid for 5 years, may request renewal for no longer than 3 years; allows surveys or investigation to identify an actual or probable mineral for purpose of mining Absence of readily available, up-to-date geological information & technical support presents challenges for small diamond miners **(Timeline: 3 – 6mnths)**	MR may not exceed 30 years; only granted if minerals can be mined optimally, a financing and technical capability plan is in place, there will be no pollution or environmental damage, financial provision has been made for an SLP (Social & Labour Plan); the operations must conform to the Mining Charter. Absence of readily available up-to-date geological information and technical support is a challenge for small miners **(Timeline: 3 – 6mnths)**
2	**Preparation of Application Documents for lodging with the DMR**	Check availability of mineral rights, ensure no overlap/conflict with other grants – very difficult on the inefficient SAMRAD system	Check availability of mineral rights – very difficult with inefficient SAMRAD system; must have technical capability, financial resources, not cause pollution, and comply with MHSA (Act 29 of 1996)	Check availability of mineral rights – very difficult with inefficient SAMRAD system; must show technical capability, financial resources; not cause pollution, and comply with MHSA (Act 29 of 1996)
3	**Submission of Application**	Apply on-line, pay the prescribed non-refundable fee; Regional Manager (RM) will advise once application is accepted (On-line application seldom functions, multiple hard copies will also be submitted)	Apply on line, pay non-refundable application fee, Apply for environmental authorisation. (On-line application seldom functions, multiple hard copies will also be submitted)	Apply on-line, apply for environmental authorization, pay the non-refundable fee (On-line application seldom functions, multiple hard copies will also be submitted)
	Mineral Law Administration Process	**R100**	**R500**	**R1000**
4	**Receipt of Acknowledgement Letter from DMR;** Completion of EMP, and Consultation with I&A Parties **(Estimates of Timelines and Costs for #1 – 4 above)**	Once accepted, RM will request submission of an EMP, as well as Consultation with legal land occupier or other I&A Parties **(Timeline: 6 – 12 months)** **(Costs: R35 000 to R65 000)**	If accepted will be necessary to consult with land-owner, legal occupier, other affected parties; submit outcome of consultations to RM in 30 days. **(Timeline: min 12 months)** **(Costs: ~R35 000 – R100 000)**	If system accepts the application, applicant will be notified, must then notify and consult all I& A parties with 180 days from notice of application accepted by DMR **(Timeline: min 12 months)** **(Costs: ~R80 000 – R150 000**

5	**Water Use Licence Application (WUL)**	If necessary, a Mining Permit requires a Section 21 (a) (b) (g) Sometimes if there are non-perennial or perennial streams a (c) and (i) application the same requirements apply as for a Prospecting Right with bulk sampling, or a Mining Right **Additional costs could be in excess of R150 000 (Timeline: min of 6 months, often longer due to inefficiency of the Dept Water Affairs)**	**Cost R150 000: does not include specialist studies** If required specialist studies may include IWWMP stormwater management plan, aquatic assessment, and designs for slimes-dams as a minimum Additional costs: could be in excess of R250 000 per individual study depending on scale of the project **(Timeline: min 12 months, often longer due to inefficiency of Dept of Water Affairs)**	**Cost R150 000: does not include specialist studies.** If required specialist studies may include IWWMP stormwater management plan, aquatic assessment, and designs for slimes-dams as a minimum Additional costs: could be in excess of R250 000 per individual study depending on scale of the project **(Timeline: min 12 months, often longer due to inefficiency of Dept of Water Affairs)**
6	**Environmental Authorisation Application** NB: See also below (#7) **National Environmental Management Act (NEMA)** requirements now in place which override previous MPRDA environmental requirements	If no listed activities (List 2) are triggered a Basic Assessment Report (BAR) can be done As a minimum Heritage and Palaeontological studies required in terms of the National Heritage Resources Act. **(Timeline: 2 - 4 months)** **(Costs: ~R35 000 and R65 000)**	(See NEMA Requirements, Section #7) If no listed activities (List 2) are triggered a BAR can be undertaken. If any bulk sampling is planned listed activities from List-2 will be triggered and then a Scoping EIA or EMP will be required As a minimum Heritage and Palaeontological studies are required. Other studies that could be triggered by the planned activities may include ecological, surface water, ground water, waste water handling, noise, dust, socio economic, visual impacts, and others **(Timeline: min 12 months, likely longer due to inefficiency of Dept of Environment and cumbersome legislation and regulations)** **(Costs: Each Specialist-study listed above may cost in order of R15 000 to R120 000: cumulative costs can be >R1 million)**	(See NEMA Requirements Section #7) Scoping EIA EMP required As a minimum requires Heritage and Palaeontological studies as well as any other necessary studies triggered by the planned activities. May include ecological, surface water, ground water, noise, dust, socio- economic, visual impacts, and other activities **(Timeline: min 12 months, likely longer due to inefficiency of Dept of Environment and cumbersome l egislation and regulations)** **(Costs: Each Specialist-study listed above may cost in order of R50 000 to 120 000; cumulative costs can be >R1 million)**

7	**National Environmental Management Act (NEMA) Requirements (Act No. 107 of 1998)** Reconnaissance, exploration, prospecting, & mining operations require authorisation in terms of NEMA, read with the Environmental Impact Assessment Regulations of 2014. NEMA overrides MPRDA environmental requirements Registration of EAP's (Environmental Assessment Practitioners) required to undertake and monitor environmental requirements in terms of the NEMA Act No. 107 of 1998 has severely backlogged, hence impacting smooth implementation of NEMA requirements	Permits and licences that may be required depending on activities and the receiving environment include: • WUL as per NWA • Waste management licence as per NEMAQA • Atmospheric emissions licence as per NWMAQA • Protected fauna/flora licence as per NEMBA • Grave relocation permits as per NHRA • Heritage collection, removal permits as per NHRA • Heritage building permits as per NHRA • Re-zoning approval in terms of local Municipal bylaws • Public participation and consultation also a requirement **(Timelines: causes added time delays to environmental permitting, and should not apply to most small and medium-diamond operations, including Mining Permits, Prospecting Rights, and Mining Rights)**	Permits and licences that may be required depending on activities and the receiving environment include: • WUL as per NWA • Waste management licence as per NEMAQA • Atmospheric emissions licence as per NWMAQA • Protected fauna/flora licence as per NEMBA • Grave relocation permits as per NHRA • Heritage collection, removal permits as per NHRA • Heritage building permits as per NHRA • Re-zoning approval in terms of local Municipal bylaws • Public participation and consultation also a requirement **(Timelines: causes added time delays to environmental permitting, and should not apply to most small and medium-diamond operations)** **(Costs: These are included for most part in Section#6, #7 above. Biggest cost factor is the time wastage associated with engaging several different Government Departments and local Municipalities and their inherent inefficiencies)**	Permits and licences that may be required depending on activities and the receiving environment include: • WUL as per NWA • Waste management licence as per NEMAQA • Atmospheric emissions licence as per NWMAQA • Protected fauna/flora licence as per NEMBA • Grave relocation permits as per NHRA • Heritage collection, removal permits as per NHRA • Heritage building permits as per NHRA • Re-zoning approval in terms of local Municipal bylaws • Public participation and consultation also a requirement **(Timelines: causes added time delays to environmental permitting, and should not apply to most small and medium-diamond operations)** **(Costs: These are included for most part in Section#6, #7 above. Biggest cost factor is the time wastage associated with engaging several different Government Departments and local Municipalities and their inherent inefficiencies)**
8	**Social and Labour Plan (SLP) Preparation and Acceptance**	Not required	Not required	Comprehensive Social and Labour Plan (SLP) required to benefit local communities, and employees. Typically done in conjunction with local Municipality and their Economic Development Plan **(Timelines: 6 – 12 months, but often considerably longer)** **(Costs: R50 000 – R100 000)**
9	**Registration in the Mining Titles Office**	Not-applicable	Costs and time involved in making appoints, legal fees for providing paperwork and agreements to complete process	Costs and time involved in making appoints, legal fees for providing paperwork and agreements to complete process

TOTAL: COST ESTIMATES (from Application to Granting, including Lawyer and Consultant fees; Estimates exclude WUL #5)	**R65 000 – R130 000** (Depending on the DMRE office and work programmes required – see notes below)	**From R350 000 - R1,5 million**	**From R500 000 to R2 million**
TIME-LINE ESTIMATES (Elapsed from Application to Grant; Estimates exclude WUL)	Min of 6 – up to 13 months or longer	Min. of 12 months but typically 18 months or longer (Scope of work and size of operations will dictate costs and timelines e.g. drilling and bulk-sampling programs will add to time and costs)	Min. of 2 years but typically 3 to 4 years (Nature and size of operations, WUL etc. will dictate costs and timelines)
SPECIALIST-STUDIES Other Specialist-studies that could be triggered by the planned prospecting and mining activities may include:– ecological, surface water, ground water, waste water handling, slimes dam structures, noise, dust, socio economic, visual impacts, and others. Costs that apply to these Specialist-studies vary considerable in-line with the scope and magnitude of the work that is required to be undertaken by specialist environmentalists, geologists, engineers, health and safety experts, and others.			
EXAMPLE – **TREE LICENCE APPLICATIONS**	Must be undertaken by a Botanist; required in any protected trees are present or identified within the application area **(Timeline: min 1 month)** **(Cost: min R15 000)**	Must be undertaken by a Botanist; required in any protected trees are present or identified within the application area **(Timeline: min. 1 month)** **(Cost: min R15 000)**	Must be undertaken by a Botanist; Required in any protected trees are present or identified within the application area **(Timeline: min 1 month)** **(Cost: min R15 000)**

Notes:

1. General – All of the above requirements may vary considerably in detail, time, and costs between individual DMRE offices (e.g. Limpopo, NW Province, Free State, N Cape) given inefficiencies of processes, different interpretations of the regulations and requirements, plate, and inconsistent interpretations and application of regulations. A key challenge all these with these processes is that there are no standard templates and tick-box processes which are applied consistently across all regional DMRE offices, and Head Office in Pretoria.

2. Necessity to use Lawyers and Consultants – Because of the inherent inefficiencies of the DMRE offices, the dysfunctionality of the SAMRAD system, and other regulatory challenges, it has become a standard operating practise to utilise expensive lawyers and consultants (eg. environmentalists, hydrologists, engineers, and other disciplines) to assist with mineral rights applications. These specialists also typically end up shepherding the paperwork through the DMRE systems to unsure that documents don't get lost of forgotten about. Losing documents (sometimes as much as 3 times), the inefficiency of the SAMRAD system, and the need for parallel paper-filing systems which are poorly managed and coordinated, present considerable time delays and added costs to the process.

3. Impact on Small and Junior Miners – The consequences of the information requirements, activities, timelines, and costs itemised in the Table above is that Small and Junior miners can no longer afford the costs and lengthy time periods required for even the simplest of mineral right applications, as for example a 5ha Mining Permit. Consequently, more and more self-funded professional Small and Junior diamond miners are exiting the sector, which is simultaneously attracting large and rapidly increasing numbers of informal and illegal small-scale miners (Zama Zama's). This is progressively adding to lawlessness and crime, negative environmental impacts, and loss of revenue and royalties to the State.

4. Although all Small and Junior diamond miners understood and support the need for Transformation and BEE, the rigid way that it was enforced in the alluvial diamond mining industry is a further reason for the lack of growth in the industry. Due to the high financial risk associated with alluvial diamond mining, there are no finance mechanisms available for new BEE entrepreneurs to enter the industry or to buy into existing operations. In order to become compliant, an existing operation has to finance the 26% BEE ownership in-house which in most cases is not possible (due to the low profit margins and high financial risk) and has resulted in many businesses closing down. A more flexible Transformation and BEE compliant mechanism is required for the industry.

5. The requirement to appoint a permanent engineer if an operation generates more than 2500 kW was questioned and noted as impractical by many participants. The mining and processing operations of most Small and Junior alluvial diamond mines are shallow, uncomplicated, and generally only exceed the 2500 kW limit where one or 2 large earthmoving units are required to break the hard calcrete layers. In remote areas there are also very few qualified engineers available to serve the industry. This is another example of unnecessary costs loaded onto an already struggling industry.

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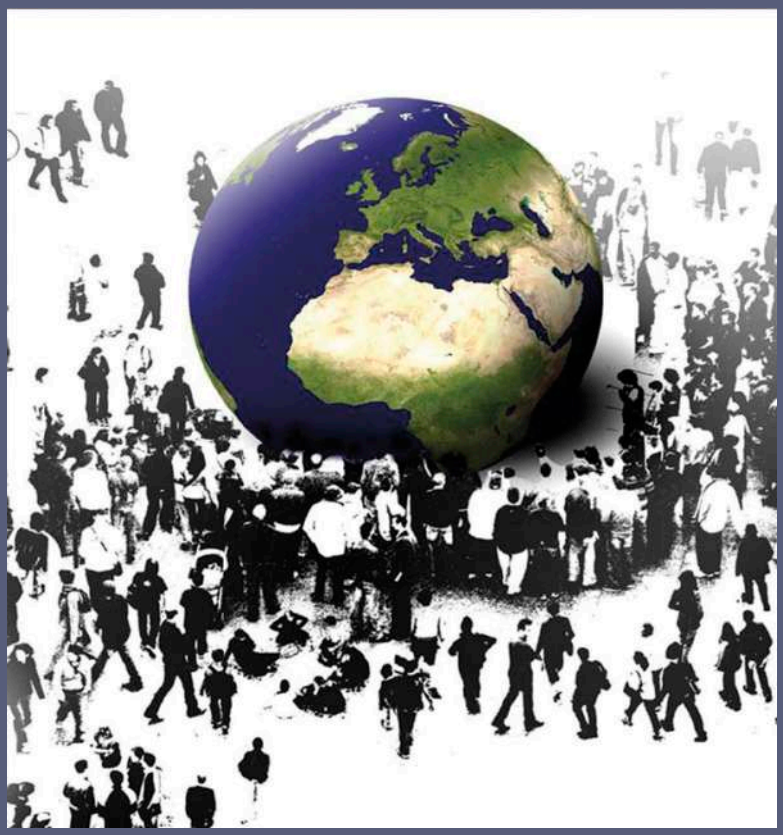

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