Use and misuse of historical estimates and data – Examples from diamond projects

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Synopsis

Projects with long histories must be documented in current disclosures with transparency and materiality, using historical data and historical estimates. Historical data may be of great value if it is from a reliable source, and the raw data can be validated and/or duplicated. Historical estimates can and should be reported, but with qualification of the ever-changing economic parameters of 'Reasonable Prospects for Eventual Economic Extraction' (RPEEE). The SAMREC Code requires current sampling results and diamond valuations, without which RPEEE cannot be assessed; consequently, historical estimates cannot ever be declared as current Diamond Resources or Reserves.

The SAMREC Code defines historical estimates and provides guidance on the use of historical data. Examples from real projects and reports in the public domain are reviewed in this paper. Opinions on use and misuse are those of the writer; judgment on good or bad practice is not the intention and is left to the opinion of the reader. Comparison, with both the JORC Code (Australasia) and CIM Definition Standards and National Instrument 43-101 (Canada), is provided. The SAMREC Code appears to be more closely aligned with the Canadian standards.

Keywords
project valuation, historical data, code compliance, diamonds, SAMREC.

Introduction

Mineral exploration is necessarily a process starting with and building on any geological or other relevant information that may be available to the prospector. Such information may be in the public domain in the form of national or international reports or publications concerning any region or area of interest. This information forms the basis for building a database upon which an exploration strategy and target can be developed. With a specific intent in mind, it is certain that an explorer will search for reports on any prior mineral exploration in the area of interest, and about the commodity of interest. These reports contain historical data, and perhaps historical estimates.

It is the scope of this paper to consider and discuss the nature of the historical data and estimates in the context of the SAMREC Code, and modern good practice in the application and usage of such data and estimates. Discussion will consider the definitions and guidance in the SAMREC Code (SAMREC, 2016a). Examples of the use and misuse of historical data and estimates are presented with reference to public disclosure reports.

SAMREC Code definitions

The glossary of terms provided at the very beginning of the SAMREC Code presents a succinct definition of a historical estimate:

> '*... an estimate of the quantity, grade, or metal or mineral content of a deposit that an issuer has not verified as a current Mineral Resource or Mineral Reserve. The estimate predates the issuing of the Code and/or was prepared before the issuer acquiring, or entering into an agreement to acquire, an interest in the property that contains the deposit.*'

In this paper emphasis is placed on mineral exploration and resources, but could and should be understood to also include Mineral Reserves, although such inclusion would undoubtedly require significantly more comment than space here allows.

The word 'issuer' must be taken to mean the current owner of title to the project in question and being reported on by a Competent Person (CP). In the context of the Code and its relationship to the Johannesburg Stock Exchange, 'issuer' should be understood to mean a public company listed on the JSE. However, any Public Report, as that term is defined in the SAMREC Code, may be prepared and presented as compliant with the Code if the technical aspects of such disclosure are the responsibility of a CP. 'Issuer' might safely be defined in this context as the current project owner or operator, where 'current' should be taken literally as meaning compliance with the Code on the date under consideration. Any 'issuer' that is a private company and that elects to invoke compliance with the SAMREC Code is subject to all the responsibilities of the required minimum standards for Public Reporting.

Care should be taken in interpreting this meaning because the SAMREC Diamond Guidelines (SAMREC, 2016b) to the Code include a clear statement that diamond valuation for Mineral Resource estimation 'should be less than six months old.' The Code also states, for all minerals, that estimation cannot be undertaken in the absence of sampling information (Clause 23); diamonds for valuation are recovered from sampling and thus, for diamonds, 'current' has to mean less than six months. More generally 'current' must relate to the validity of parameters and assumptions relevant to the outcomes of work in progress. The most obvious example of this is the commodity price, which may fluctuate over time with either a positive or negative impact on project economics. The Diamond Guidelines include this specific instruction because diamond valuation is deposit-specific, in contrast with most metallic minerals for which there are daily book prices. Where considerations of cost adversely impact a decision to retain a bulk sample diamond parcel, the project operator may be advised to retain the diamonds at least until a specific point along a development timeline.

The original SAMREC Code was issued in March 2000, and this must inform the primary date limitation on a historical estimate. The secondary limitation arises whenever there is a change of ownership of the project in question. In such cases, although the issuer may rely on a historical estimate in the due diligence for project acquisition, once the transaction is completed the implication is that the new owner should take steps to convert or update the estimate to current status. The Diamond Guidelines contain a recommended template Table of Contents, stipulating that Chapter 4 ('Project History') 'may also include a discussion of relevant historical estimates.' This makes it clear there is a difference between a 'Previous Diamond Resource Estimate' (by the current owner) and a historical estimate.

The Diamond Guidelines modified the Clause 23 guidance and include the powerful statement that 'Grade and value data that are not SAMREC compliant may not be used to estimate a Diamond Resource – purely historical or anecdotal estimates are insufficient.' The equally strong statement in the Diamond Guidelines Clause 67 that 'Resource estimates shall not be based on unverified or unverifiable historical or artisanal results only' recognizes the reality that the sometimes shady world of diamonds has a sad record of projects and promoters who wish to appear persuasive with a handful of diamonds, often of undemonstrated provenance or representivity.

Historical estimate

Although the SAMREC definition of a historical estimate does not include any specific reference to age, it is clear that March 2000 may be a threshold date. Alternatively, a change of ownership may define the age, and this could be a matter of days, weeks, or months. However, in either case, the Diamond Guidelines require that any current estimate is based on a diamond valuation no more than six months old. We thus have three defining points on a project timeline that may determine an estimate as a historical estimate: March 2000, date of change of ownership, and/or date of last diamond valuation. The latter may just be a previous estimate that can be fairly easily updated if the diamond parcel has been retained and can be revalued.

The raw data collected, on which an estimate is based, should be immutable, and this will be discussed in the next section. The economic and other parameters and assumptions that support the assessment of viability are not invariable, and it is this reality that is the basis for scrutinizing historical estimates and providing suitable comment.

Diamond valuation has already been mentioned, and it should be no surprise that changes in the diamond value will impact an estimate update, either positively or negatively. For a metals project the commodity price, available as a daily book price, is an integral part of determining a cut-off grade. Diamond value is deposit-specific and not, like metals projects, subject to a daily book price. While diamond projects may not consider cut-off grade in the same way as for metals projects, the diamond value is also still an integral part of the economic outcome, as defined by 'Reasonable Prospects for Eventual Economic Extraction' (RPEEE).

Hard rock diamond mining is most often carried out to the physical limits of the kimberlite pipe, and thus the cut-off grade is zero and is mapped as the kimberlite/country rock contact. Sometimes a kimberlite pipe may contain kimberlite lithologies of differing grade; and these internal contacts may define the cut-off grade, although it is probable that mining would be constrained by visual or other lithological differences. This was the case when De Beers mined the Letšeng Main Pipe in the 1970s (Lock, 1980).

The SAMREC Code makes it very clear that, for diamond projects, the selected bottom cut-off screen size (Clause 60) must be stated. The reason for this is that a larger bottom screen opening will allow more diamonds to pass through as tailings, thus reducing the grade; equally, a larger opening will reduce the number of smaller, lower value diamonds being recovered, thus increasing the average value. Preferred changes over time to the bottom cut-off thus critically affect the economic outcome.

While diamond value may be the most obvious economic parameter that changes with time, we cannot ignore the changes to other technical parameters and matters that individually and collectively can transform a historical estimate into nothing more than Mineralization, as defined by the SAMREC Code, *i.e.* 'A concentration (or occurrence) of material of possible economic interest.' Achieving RPEEE requires the assessment of a range of matters (Lock, 2020, this volume) such as mining and processing costs and constraints of a legal or environmental nature. Each of these may change over time in ways that can impact a historical estimate in a positive or negative way; thus, what was a Mineral Resource may no longer be so, and equally what was just Mineralization may be a Mineral Resource, after current estimation.

The SAMREC Code is clear and firm in its guidance to the definition of a Scoping Study (Clause 44) that historical estimates

may not be included. This exclusion goes with the same restriction in the use of Exploration Results, Exploration Targets, or Mineralisation in a Scoping Study. The nature and reliability of the information from any of these sources is determined to be beneath the threshold acceptable for any Technical Study.

The Diamond Guidelines (SAMREC, 2016b) provide a report template that includes a chapter entitled 'Project History' with subsections on Previous Mineral Resource and Reserve Estimates. These may be valid and compliant if the estimates postdate the first SAMREC Code in 2000 and the ownership has not changed during this period. However, any historical estimate disclosed in this chapter should be appropriately discussed.

Historical data

In all cases, in line with Clause 20 of the main Code and the Diamond Guidelines defining and guiding Exploration Results, 'Historical data and information may also be included if, in the considered opinion of the Competent Person, it is relevant and reliable, giving reasons for such conclusions.' Care should be taken in applying this guidance as it is explicitly limited to Exploration Results. Conceivably, historical data might be incorporated into a statement of an Exploration Target, but extreme care would be required to avoid implying the discovery of any potentially economic mineralization; Public Reporting of any such Exploration Target requires the support of an explicit exploration programme.

There are many reasons why historical information should be treated with care, and not assumed to be acceptable for a current Mineral Resource estimate. While historical information may have been accumulated under the work practices of the day, times have changed and standards have generally evolved with a more rigorous approach to the collection and storage of data, whether this be rock samples or drill core, analytical results or reports. As an industry, we continue to aspire to improving our practices with the objective of transparency and reliability of our data, such that future generations may place greater confidence in historical data than is usually possible today. Our exploration database management practices are central to the achievement of this aspiration.

Current exploration project work practices and data management should be undertaken with an attitude of compliance with the SAMREC Code, so that Mineral Resource and Reserve estimation can be undertaken in a timely manner. These compliant work practices provide guidance in understanding the value of historical data. A form of due diligence, as might be undertaken for a buyer in a property acquisition, can be envisaged as necessary in evaluating the worth of historical estimates, and demonstrating why they cannot be simply adopted as a current estimate. In other words, a review of the historical estimate in a test of compliance with modern practices is necessary as a starting point. There are several typical problem areas that could be reviewed, including a broken audit trail, non-representivity of geology and/or grade, contamination affecting grade, and database issues. Any problems identified should be flagged and discussed in reporting of historical estimates to ensure a balanced comparison with current practices.

The conclusion is almost certain to be an understanding that historical data cannot generally be accepted into a current estimation. There may be exceptions to this guidance based on a reasonable assessment of the nature and source of the information, as will be discussed with two project examples.

Primary or interpreted

In a reliable exploration database the raw, or primary, data will be stored and archived in such a way that a new analysis and estimate can be undertaken from first principles. To appreciate the possible difference between primary and interpreted data, it is sufficient to show that drill-hole information recording only lithological intersections or sample grade interpretations of an economically mineralized section incorporates bias or assumptions from earlier times. While this may not be true for all commodities, kimberlite descriptive terminology and classification has undergone fundamental revision over several decades, necessitating careful cross-referencing into the modern scheme of Scott Smith *et al.* (2013). These interpretations may change with changing terminology, technology, or economics. Access to primary data allows for an unbiased new analysis.

Source/reliability

It is surely good practice when reviewing historical estimates and data to at least consider the reputation of the practitioner or company that generated the historical report. Despite changing times, it should be reasonable, in a first parse of old reports, to consider this and to place the report in a virtual spectrum of reliability. It ought to be possible to distinguish the extremes of 'good' and 'bad' in this way, even if there is no immediate acceptance or rejection from this simple parsing. Well-known public companies with a long and reputable history should cluster towards the 'good' part of the spectrum, in contrast to little-known or tainted practitioners who may cluster towards the 'bad' part. While this may seem unfair, closer inspection should allow for a revision of first impressions of either 'good' or 'bad'.

In either case a review of historical estimates and data should always lean towards cautious conclusions, and move to an inclusive approach in any current estimation only in exceptional circumstances, as will be illustrated.

Diamond valuation data

The use or misuse of old diamond valuation reports is perhaps the single most problematic aspect of bad practice. Unlike other commodities where the price is date-specific, diamond value is deposit-specific as well as date-specific. Indeed, any diamond valuation is also subject to the effect of bottom cut-off screen size, as has been discussed.

Bringing old diamond project reports into current reporting may be one challenge, but the copying and pasting of old diamond valuations will always be fraught with serious issues of reliability. Fortunately, SAMREC (2016a) explicitly requires that a diamond valuation no older than six months is used in any current estimate. Notwithstanding this serious constraint, there may be good reason to access and apply historic diamond size distribution data together with current, perhaps limited, data, to build a size-value model that can become the first step in developing a reliable new diamond price estimate, as will be shown for the Letšeng Mine case.

Duplication and validation

While direct use of historical data may be unacceptable in almost all circumstances, the integration of old data with new could be considered as a path to improving the confidence in an estimate. If an initial test of source and reliability is passed, a programme of duplication and validation may provide the confidence for this integration to be agreed. Again, this mimics some typical detailed

due diligence studies that demand limited duplicate drilling and assaying of selected parts of a project. A twinned/duplicate drill-hole should be expected to closely match in lithology even if the sample assays differ to some extent, dependent on the type of mineralization and nugget effect.

The scope of the duplication and validation work that is undertaken may help determine the degree of integration that may be tolerable. It is probable that cost considerations will encourage as little duplication work as possible, but this factor should be carefully balanced against the desired technical objectives.

Project examples of 'use'

Braúna kimberlite, Bahia State, Brazil

The Braúna kimberlites are a cluster located in the interior of Bahia State of northeast Brazil that were discovered by De Beers in the early 1990s, although artisanal mining of diamonds was known in the area from 1927. A long period of exploration and evaluation has progressed to the definition of the Braúna 3 kimberlite South Lobe as a viable diamond resource. Mining, of what is Brazil's first kimberlite diamond mine, commenced in 2016 under the ownership of a private company named Lipari Mineração Ltda.

Vaaldiam Mining Inc., a Canadian public company, undertook a Preliminary Assessment of the Braúna project in 2010 and 2011 (Lock *et al.*, 2011).

The long history of the project can be summarized thus:

1927–1953	Artisanal 'garimpeiro' mining
1980–1998	De Beers: exploration and discovery of primary kimberlite bodies
2000–2004	Artisanal activity
2004	De Beers data sold to Majescor
2005–2008	Vaaldiam 60% buy-in and operator, 100% buy-in
2010	Vaaldiam bulk sample and maiden diamond resource by ACA Howe (Leroux, Roy, and Masun, 2010)
2011	Vaaldiam Preliminary Assessment, after resource audit by Coffey Mining (Lock *et al.*, 2011).

Despite the indicated viability, Vaaldiam declined to progress the project and ownership passed in a private transaction to Lipari Mineração Ltda; this company progressed project development leading to a production decision and mine construction in 2015.

Our preliminary assessment was based on current information generated by Vaaldiam during their ownership period, and is thus not historical data, or estimates, as defined by the SAMREC Code. Additionally, the diamond valuation used in the maiden resource estimation was dated 1 November 2010, and thus less than six months prior to the report date; it was compliant with then current SAMREC requirements even though this was not specified in the SAMREC Code or NI 43-101 at that time.

Despite the sale to Majescor of the De Beers data for Braúna, the records of their surface trenching were patchy and considered too unreliable for integration into any future resource evaluation work. The results were in any case essentially duplicated and validated by the more extensive Vaaldiam programme. All the core drilling undertaken for deposit modelling was undertaken by Vaaldiam, and was not historical data. New microdiamond and mini-bulk sample diamond recovery was also undertaken by Vaaldiam, but while of some value in a comparative sense, this data was not used in the estimation.

Our report described the history in a separate chapter, as required for NI 43-101. Reporting of all the exploration undertaken, including the earlier work of De Beers, was presented chronologically with the current work of Vaaldiam. Although this may have been misleading with regard to a compliant description of the De Beers historical data, this information was not used (and therefore not misused) in resource estimation. The diamond resource estimate was based on the 2010 bulk sample of just under 5000 t that produced 1057 ct. Geology, volume, density, and diamond value were all based on the Vaaldiam work.

Thus, there was no historical estimate, and the historical data was reported in a transparent and material manner that aided comparison, where appropriate, with the current data. It is also worth noting that new geological models, based on reinterpretation of primary lithological logging and relogging, or drill core, have been significant in improving the estimates for this kimberlite.

Messina and Star diamond mines, South Africa

Snowden Mining Industry Consultants (Retter and Snowden, 2003) were commissioned in 2003 to prepare valuations of the Messina and Star diamond mines in the Northern Cape and Free State Provinces of South Africa, respectively. The valuations were needed in connection with a transaction involving Majestic Resources NL, an Australian public company and Messina Investments Pty Ltd (Minvest), a South Africa company, whereby Majestic would pay cash and shares for 100% of the shares of Minvest.

Both mines presented significant challenges to valuation due to their long and chequered history. In this paper, only the Messina story will be discussed, although the methodology applied was the same for both mines.

The earliest mining of the Bobbejaan Fissure atop the Ghaap Plateau west of Barkley West was in the 1930s. This progressed to more systematic small-scale mining through the 1950s to 1981, when operations were consolidated under Minvest as Messina Mine. Messina Diamond Corporation acquired Minvest in 1996 and it was this corporate entity and subsidiaries that carried renewed production through to 2003.

Clearly, much of the information on the mining operations should be considered as historical data because it pre-dates SAMREC. However, the ownership bridges the SAMREC Code threshold, and the valuation report is post-SAMREC 2000. Finally, as the mine was in operation on the valuation date, the diamond value was current and based on actual production sales.

The Bobbejaan Fissure is a kimberlite dyke that, by its nature, has geological, grade, and density continuity along strike and to depth. However, the nature of the deposit and ownership, as well as the history bridging the publication of the first SAMREC Code, are such that current mining operations are based on historical experience, both geological and mining. Formal Mineral Resources of a compliant nature probably never existed over much of the life of the mine. A typical exploration database almost certainly did not exist, but detailed production records did.

Retter and Snowden (2003) took the important decision to use discretion in developing a Mineral Resource estimation methodology, using historical data that may have been viewed as entirely unacceptable if it were not for the high regard in

which Retter and Snowden are held globally. They made the bold assumption that historical mining performance can be used as a guide to future performance (Figure 1).

The down-dip continuity of the kimberlite fissure and its assumed diamond grade was drill-tested with a very limited underground drilling programme. Retter and Snowden (2003) then considered the following:

- Fissure thickness past and present
- Mine's historical diamond grade and grade over the last twelve months
- Evidence for an increase or decrease in grade with depth
- Likely grade in the next 240 m below the lowest current mining level.

This comprehensive and complex analysis allowed them to declare Mineral Resources on the following basis:

- Measured Resource: one mining level (40 m) below the base of the current working levels
- Indicated Resource: two mining levels (80 m) below the base of the Measured Resource
- Inferred Resource: three mining levels (120 m) below the Indicated Resource.

The result of this analysis was a preferred value in the range R54 million to R109 million.

It could well be argued that, by 'the letter of the law' (read SAMREC Code), this analysis was highly irregular and could have been rejected by the regulatory authorities. Perhaps so. Before jumping to this conclusion, consider the record of recent historical resource estimates reported by le Roux (2017), who tabulates four combined estimates for Messina (Sedibeng) and Star by Petra Diamonds after the Retter and Snowden (2003) report and before the le Roux (2017) report. In all cases the diamond grade falls in the range 73.3 to 75.6 cpht (carats per 100 t) based on an undiluted diamond grade derived from real production data, and not new sampling data. The very fact of consistency from integration of old and new production data lends considerable confidence to the method applied and the declared Diamond Resources reported. The production data is in fact bulk sample data under another name. This JORC (2012) compliant report was prepared to support the listing of Frontier Diamonds Ltd on the Australian Stock Exchange in October 2017. Although the Retter and Snowden report may no longer be available online, it is referenced in the le Roux report as a revised 2004 document, and is the basis, with updates, for his resource declaration.

There was no published or known historical estimate for the Messina Mine, but the current resource estimate is profoundly dependent on historical data that has been used with discretion in difficult circumstances to fulfill the valuation need to consider an arm's length transaction based on 'willing buyer, willing seller'. The transaction was accepted by the parties and endorsed by the Australian regulators.

Letšeng, Lesotho

The Letšeng kimberlite pipe has proved to be the most significant of the Lesotho Maluti Mountains diamond discoveries. From the moment that Peter Nixon almost stumbled over a weathered outcrop in a stream bed in 1957, the progression through government diggings in 1959 to the recovery of the Lesotho Brown, the 601 ct stone found by Ernestine Ramaboa, and the history of bringing this deposit to production in the 1970s, there has been a sense of inevitability that production would be renewed, even after the mine first closed as a De Beers operation in 1981.

The author worked with De Beers at Letšeng from 1973 to 1976, undertook research for a PhD immediately thereafter (Lock, 1980), and led a technical team that assisted Gem Diamonds through the due diligence and valuation process for their bid to JCI in 2005. This knowledge provided an exceptional experience of what historical estimates and data are in reality. The Letšeng Diamond Mine has been back in continuous production since 2004. During this time the operation has been both profitable and has produced several of the world's largest diamonds ever recovered, including the 910 ct Lesotho Legend, the 603 ct Lesotho Promise, the 550 ct Letšeng Star, and the 493 ct Letšeng Legacy.

Despite this very positive story, there is no doubt that the unusual, if not unique, combination of low diamond grade and high diamond value may have presented insurmountable obstacles to compliant estimation of mineral resources if the SAMREC Code had been operative in the 1970s when RTZ and De

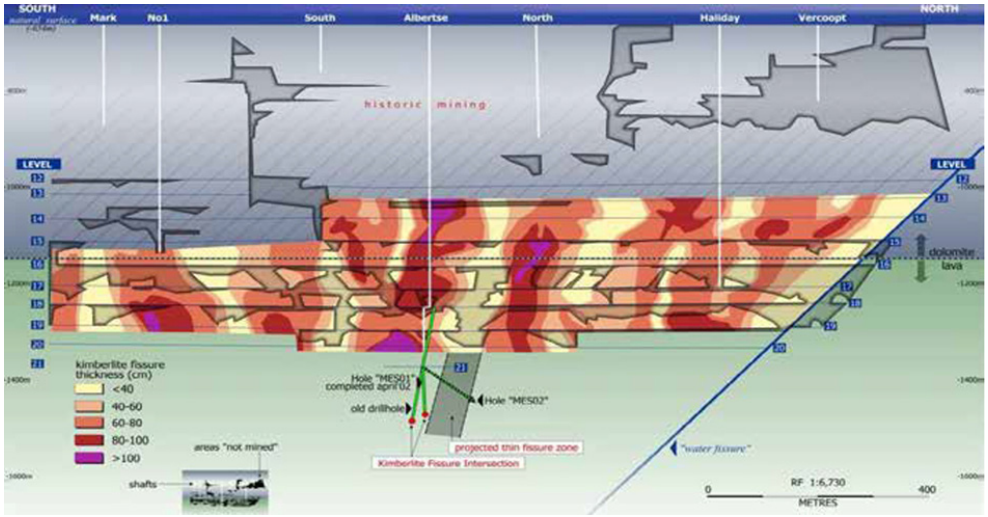

Figure 1—Sedibeng (Messina) core drilling showing locations of boreholes MES01 and MES02 and modelled kimberlite fissure widths to 20 level – Star diamonds (Retter and Snowden, 2003). Figure 7 of le Roux (2017)

Beers first evaluated, and then mined, the kimberlite. Arguably, it is this feature of the geology and mineralization that has encouraged the current operating company to steer clear of the more restrictive and prescriptive stock exchanges such as Toronto and Johannesburg.

In summary, the history of Letšeng is:

1957	Discovery by Peter Nixon
1959–1968	Artisanal diggers
1967	Famous 601 ct 'Lesotho Brown'
1968–1972	RTZ evaluation of main and satellite pipes; not viable, and option abandoned
1973–1974	De Beers one-year option
1975–1982	De Beers pre-production and production
1996	Letšeng Diamonds Company formed
2004	Letšeng Diamonds production commences
2006	Gem Diamonds buy effective 70% share in Letšeng Diamonds
2007	Gem Diamonds lists on London Stock Exchange Main Board.

In the twenty-first century, since the reopening of the mine in 2004, there has been significant new geological study of the Letšeng kimberlites, driven primarily by a need to understand more about the source and genesis of the large, high-quality Type IIA diamonds. Notwithstanding the importance of this work, the earlier interpreted distribution of the internal kimberlite phases has largely stood the test of time (*cf.* Lock, 1980 and Hetman *et al.*, 2017). This was important at the time the historical data was reviewed in 2005, and used in the Mineral Resource declaration for the Gem Diamonds prospectus when they listed on the London Stock Exchange (Stacey and Telfer, 2007).

The Main Pipe is dominated by K1 kimberlite with the later, centrally-disposed, higher grade K6 (the pipe within a pipe) and a small area of barren K4 hypabyssal kimberlite. The Satellite Pipe was mapped in 1980 with a single kimberlite phase that was petrographically similar to the Main Pipe K1.

In a confidential report to Gem Diamonds in support of their bid valuation, and in the Stacey and Telfer (2007) technical report included in the Gem Diamonds prospectus, the crucial sampling and production grade historical data was applied to understand and estimate a diamond grade for each of the kimberlite phases of economic interest. The Stacey and Telfer (2007) estimate has been declared as compliant with the SAMREC Code. In summary, the historical and current data used originated from:

1968–1972	RTZ sampling
1976–1979	De Beers sampling
1977–1981	De Beers production
2004	Letšeng Diamonds sampling
2004-2007	Letšeng Diamonds production.

While it might be contested as to whether the historical data could be used in this way, it must be further understood that the mine had been back in production for three years before the prospectus was prepared; thus the historical data and current production data could be integrated to achieve a fair and reasonable assessment as to the practical mining grade outcome to be expected in actual production. This integration was effectively duplication and validation. The De Beers production alone amounted to about 7 Mt from the Main Pipe and 2 Mt from the Satellite Pipe, producing in aggregate over 200 000 ct. Diamond production since reopening the mine in 2004 exceeded 5 Mt and 100 000 ct up till September 2006, the cut-off for the prospectus.

One should consider, in situations similar to this, the reputation of the companies involved. Stacey and Telfer (2007) stated that:

> '*The RTZ data was obtained by Letšeng Diamonds from the Department of Mines in Maseru and was also included in the information obtained by Letšeng Diamonds from De Beers. It is assumed that the sampling was accurately undertaken and that, as a consequence of strict security at all times, the results are reliable. Also, RTZ is an international mining company which was genuinely interested in exploiting the deposit for their own account. There has been no independent verification of the results.*'

Should this data have been used to estimate mineral resources? That may be a moot point, but the estimate has stood the test of time and new production.

Project examples of 'misuse'

Koidu, Sierra Leone

The history of diamond mining in the Yengema area of northeast Sierra Leone dates back to 1934 under the ownership of the Sierra Leone Selection Trust (SLST), part of the Consolidated African Selection Trust group that found the first diamonds in Botswana in 1959. The original discoveries were of alluvial diamonds but in 1948 kimberlite source rocks were also found, including Koidu Pipes 1 & 2 and Dyke Zone A. The further history of this diamondiferous kimberlite pipe is presented below:

1948	Discovery of Koidu by Sierra Leone Selection Trust (part of CAST)
1970	National Diamond Mining Company/SLST JV
1980	BP acquired SLST interest
1984	BP divested SLST interest
1986	Production decline and records incomplete
1991–2002	Civil war
1995	Branch Energy mining lease.

After the end of the civil war, attempts at rehabilitation of mining operations eventually led to ownership and production under Energem Resources Inc, a TSX company, and with Benny Steinmetz Group Resources Ltd and Magma Diamond Resources Ltd, both minority private equity partners. In 2005 a NI 43-101 report was prepared (Telfer, Clay, and Bloomer, 2005); this report provides the background for the review and comment described here, together with a 2003 report by the same consultant company (Clay, Bloomer, and Freeman, 2003) before the involvement of Energem.

The small Koidu 1 kimberlite pipe had a modest surface area of 0.45 ha but a good grade and diamond value. Open pit mining into the granite-hosted pipe was followed by a novel vertical pit mining technique that took full advantage of the competent wallrock. The open pit mining was supported by the 2003 resource report that developed an 'estimate' purely on the basis of historical estimates. Table I lists the historical estimates that were available in 2003, but not supported by the actual historical data, as had been the case with Letšeng at about the same time.

The independent consultant chose to declare Indicated and Inferred Diamond Resources to a depth of 300 m by the simple adoption of the NDMC/Outokumpu historical estimate. Clay, Bloomer, and Freeman (2003) argued that 'the mineral resource and reserve statement prepared by NDMC/Outokumpu (1988) is the most reliable. In the absence of any of the raw historical data,

Table I

Historical estimates for various resource and/or reserve categories (Clay, Bloomer, and Freeman, 2003)

Year	Company	Depth	Tons	Grade	Carats
1978	SLST	to 316 m	1.9 Mt	0.6 ct/t	1.2 million
1988	NDMC/Outokumpu	to 300 m	1.7 Mt	0.7 ct/t	1.1 million
1995	Branch Energy	to 305 m	1.9 Mt	0.7 ct/t	1.3 million
1996	WGM	to 305 m	1.7 Mt	0.6 ct/t	1.0 million

Venmyn has retained the tonnages and grades proposed but has reclassified the resources in accordance with the SAMREC Code and CIM Standards.'

A slightly different approach was adopted in 2005 when a resource diamond grade was estimated by averaging the historical (sampling grade) estimates (Telfer, Clay, and Bloomer, 2005), together with some current production data (Table II). Previously (Clay, Bloomer, and Freeman, 2003) it was admitted that little of the historical (raw) data was available except in summary form, and that no verification had been possible; there is no evidence that this changed for the 2005 report.

Although the report includes some qualifying comments on the process adopted, it is questionable whether this could be accepted as good practice or compliant with the CIM Standards under which the resources were declared. Be that as it may, the purpose here is to use these project reports to illustrate what is not acceptable or compliant under the current Code (SAMREC, 2016a). In addition to misuse of historical estimates and data, the Consultant has downplayed or ignored such basic requirements as:

- Bottom cut-off screen size
- Reasonable Prospects for Eventual Economic Extraction
- The fundamental issue of the absence of the raw historical data.

Lace, South Africa

The Lace (or Crown) Mine in the Free State of South Africa has a long history dating back to the nineteenth century. Although there was intermittent production until the global depression in 1931, closure at that time led to a period of inactivity and eventual sale to De Beers in 1939. Periodic technical review may have kept the project lukewarm, but the advent of the New South Africa encouraged De Beers to relinquish the project in a divestment programme perhaps aimed at economic empowerment. Ironically, the project (and its problems) was eventually sold to the Christian Potgieter Trust. The alluvial diamond background of that organization was not optimal for successful development. Attempts to option the property finally found DiamondCorp plc and the project was listed with that company on the AIM in London. This history is summarized thus:

1896	Discovery
1902–1907	First open pit production; sold in debt
1907–1918	Open pit operation but closure during WW1
1918–1924	Intermittent development and production
1924–1931	Open pit and underground production
1931–1939	Care and maintenance
1939	Sold to De Beers; no mining
1997	Sold to Christian Potgieter Trust.

Historical data from the early years of the mine was compiled and periodically reviewed by De Beers during the many years of quiet ownership by that company. Some attempts may have been made to use or integrate this data into our modern practices, but the reliability cannot be accepted for anything but a chronological narrative. Personal knowledge of some of the De Beers reports viewed in 1995, while a Canadian company employee, may have attributed some credence to the documents but, as a public company, disclosure of the information as anything other than history was not permitted, even before CIM Definition Standards and the SAMREC Code.

In 1997/1998, MPH Consulting of Toronto undertook geological drilling and microdiamond sampling work for Rupert Resources Ltd, a Canadian company that had optioned the property from the Potgieter Trust. It must be clearly understood that the results of this work are historical data as that phrase is defined in the SAMREC Code (2016a), because the data predates the SAMREC Code (2000). The fact that the work was commissioned by Rupert Resources, and not the current owner DiamondCorp, means that the ownership change also precludes using this data. However, there is good reason for using discretion in this latter regard as MPH Consulting has had a bridging relationship with the technical progress of the project, and was both the CP for Rupert Resources in 1998 and the DiamondCorp prospectus (Sobie, 2006).

Notwithstanding the use of discretion, this should be applied primarily for the core drilling that has provided a solid foundation for a geological model that has stood the test of time over the last decade, during which when underground access was been re-established and further drilling from surface and underground undertaken. However, the same cannot be agreed for the interpretation of microdiamond recoveries by Lennard Kleinjan,

Table II

Historical and current sampling and production data (Telfer, Clay, and Bloomer, 2005) used to estimate a weighted average grade, but excluding the two high-grade outliers

Source	Type	Tons	Carats	Grade (ct/t)
SLST (historical data)	Surface bulk sampling Surface bulk sampling K Shaft sinking	23 362 3 558 3 540	14 080 2 650 2 709	0.60 0.74 0.77
NDMC (historical data)	Surface bulk sampling	63 867	41 167	0.64
Koidu Holdings (current data)	Open pit mining Open pit mining (excl. grease)	138 000 76 619	76 176 34 679	0.55 0.45
Total tons and carats	**Average grade (high grades excluded)**	**301 848**	**166 102**	**0.55**

a De Beers geologist of good standing, and Luc Rombouts, an independent geologist who has contributed to progress in the mathematical background of microdiamond data interpretation.

Kleinjan's methodology, which was developed while he was employed by De Beers and working with Martinus Oosterveld, the first expert on microdiamond grade estimation, is purely visual. It depends on a comparison with microdiamond grades from known kimberlites and their macrodiamond production grades. While this was a useful first indication of potential grade (for internal use) and was developed into a semi-quantitative method by Oosterveld, it should not be relied upon for macrodiamond grade extrapolation.

Rombouts's methodology, while based on complex mathematical modelling, is in its simplest expression also a visual approach. The so-called 'extreme value statistics' is a plot of the cumulative diamond grade for samples of microdiamonds (possibly including macrodiamonds) from smallest to largest. Cumulation is for individual stones with measured weights, and the resultant plot is asymptotic to a maximum diamond grade that can be truncated to remove the stones below any chosen bottom cut-off size.

In practice this visual method is critically subject to the 'wagging tail of the dog' where the tail is the asymptote and the large-stone portion of the curve, where a single stone could seriously impact the interpretation either negatively or positively. For this reason, the technique has not been adopted across the diamond industry, whereas further development of the Kleinjan and Oosterveld method has gained ground and become standard practice. Oosterveld's work remains hidden in De Beers' internal reports but Ferreira (2013), in his thesis, has acknowledged the mentorship and knowledge legacy he benefited from in the development of current practice.

A report reviewing resources for the Lace project (Zweistra, 2012) discussed the historical estimates, the MPH-acquired microdiamond data, and results from a then-current underground bulk sampling programme. The mixed sources would always prove problematic in attempts at estimating a compliant diamond resource, but one aspect of the methodology needs highlighting to illustrate the fallibility in this specific case.

For the Main Pipe K6 tuffisitic kimberlite breccia the 2012 estimate was not able to use any of the current underground bulk sampling data for this phase because the sample was not 'representative'; it was mined from close to the pipe margin and contained excessive dilution. Fair comment. As an alternative, the historical estimates were taken and added to the grade from a tailings retreatment sampling campaign carried out between 2007 and 2009. Thus a grade of 24.4 cpht was 'guesstimated' and declared by adding a 'historically mined grade' of 16 cpht and a tailings grade of 8.43 cpht.

By 2016 a new estimate including microdiamonds properly analysed by Johannes Ferreira (Sobie *et al.*, 2016) estimated a much more robust grade for K6 of 10 cpht. Thus, the fallibility of the 2012 estimate was exposed. The only possible saving grace might be that the earlier guesstimate was stated at a bottom cut-off of 1 mm, and the later estimate at 1.25 mm, but it is doubtful this change of cut-off would have such a great impact on the grade.

For the Main Pipe K4 hypabyssal kimberlite the 2012 estimate could not be used to develop an estimation method as there were no historical estimates or current underground sampling results. An alternative method was conceived based on the historical (microdiamond) estimate, but not the Rombouts estimate, only the Kleinjan estimate. From the Kleinjan grades (Table III) for K4 and K6 a ratio of 2.33 (70/30) can be computed. Even though this ratio is meaningless, the number was used to determine a grade for K4 by multiplying the K6 grade discussed above by 2.33; thus 24.4 × 2.33 = 56.8 cpht.

No explanation was given as to why the Rombouts 'ratio' of 3.00 (90/30) was not used; clearly a higher K4 grade could have been evaluated, but a conservative approach was adopted.

Zweistra (2012) states that in their review of these estimates, Garner, Roux, and Noppe (2007) of Snowden Mining Industry Consultants note that 'the statistical validity of the two methods employed relies on knowing the relationship in the tested kimberlite between macro- and microdiamond populations, and that this is not available for Lace. Snowden therefore downgrades the validity of these estimates.'

Thus, we have an unreliable K6 diamond grade multiplied by a questionable ratio, based on low-confidence microdiamond grade estimates, used to guesstimate a K4 diamond grade.

The 2016 resource update (Sobie *et al.*, 2016) for K4, similarly to K6, again exposes the fallibility of the method with a new grade estimate of 40 cpht (*cf.* 56.8 cpht in 2012) even though the reduction is not as dramatic as for K6. The change in bottom cut-off is unlikely to explain the difference.

In addition to the fundamental issue of the reliability of the historical data and the concept of prediction *versus* estimation, the consultant has ignored the basic requirement for RPEEE.

Sobie (2006) noted that there are 'extremely positive indications of potentially mineable grades' based on the microdiamond results. That report made certain predictions but did not report any diamond resources. By 2012, using the same microdiamond data integrated with both historical estimates and current sampling data, DiamondCorp was able to proclaim diamond resources derived from a mix-and-match process of questionable industry practice.

Discussion and conclusions

Comparison of the two most familiar codes to the SAMREC Code may be useful. These are JORC (2012) in Australasia and the CIM Definition Standards (CIM, 2014) and National Instrument 43-101 (CIM, 2011) in Canada.

The Australasian JORC Code and CIM Definition Standards make no explicit reference to historical estimate.

Canadian National Instrument 43-101 contains careful and explicit guidance for the disclosure of historical estimates (subsection 2.4) that includes identifying the source and date, and commenting on the relevance and reliability, and other technical matters. The disclosure must include discussion of the work needed to bring the estimate in line with current practice, and provide appropriate qualifying statements to affirm that sufficient work to declare a Mineral Resource or Reserve has not

Table III

Microdiamond grade estimates for the 1997/1998 MPH consulting data (Table 7a, Sobie, 2006)

Kimberlite facies	Kleinjan estimate (cpht)	Rombouts estimate (cpht)
TKB – K6	30	30
HYP – K4	70	90

been undertaken and that the historical estimate is not being treated as a current Mineral Resource or Reserve.

There are also complex requirements where project ownership may have changed and there is a previous estimate that could be defined as a historical estimate. The new property owner may choose to disclose this historical estimate as an Exploration Target (subsection 2.3(2)); alternatively, if the previous owner is already an issuer, as that term is defined, the new owner may elect to disclose the estimate with the proviso that a new technical report will be filed within 180 days (subsection 4.2(7)).

In conclusion it appears that Australasia has not formally paid close attention to guidelines for historical estimates and data. Canada, however, has expressed similar guidance in its distinctive contrary manner.

While it may be desired company practice to achieve a declarable Diamond Resource as early as possible, and by whatever method that can be devised, when it comes to the use of historical estimates and data there is such a thing as good practice. As laid out in the scope of the SAMREC Code and Guidelines, it is intended to 'provide a required minimum standard for the Public Reporting of Exploration Results, Mineral Resources and Mineral Reserves'. These reports 'are prepared as information for investors or potential investors and their advisers'. With this in mind we must all be reminded of the liability we hold.

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