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Economic Accounting of Mineral Resources in Botswana

Technical Report

WAVES

Wealth Accounting and the
Valuation of Ecosystem Services
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Global Partnership for Wealth Accounting and Valuation of Ecosystem Services (WAVES)

Wealth Accounting and Valuation of Ecosystem Services (WAVES) is a global partnership led by the World Bank that aims to promote sustainable development by mainstreaming natural capital in development planning and national economic accounting systems, based on the System of Environmental-Economic Accounting (SEEA). The WAVES global partnership (www.wavespartnership.org) brings together a broad coalition of governments, UN agencies, nongovernment organizations and academics for this purpose.

WAVES core implementing countries include developing countries-Botswana, Colombia, Costa Rica, Guatemala, Indonesia, Madagascar, the Philippines and Rwanda-all working to establish natural capital accounts. WAVES also partners with UN agencies-UNEP, UNDP, and the UN Statistical Commission-that are helping to implement natural capital accounting. WAVES is funded by a multi-donor trust fund and is overseen by a steering committee. WAVES donors include-Denmark, the European Commission, France, Germany, Japan, The Netherlands, Norway, Switzerland, and the United Kingdom.

Country work on natural capital accounting and their policy applications are reported in a publication series, WAVES Technical Reports.

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These are preliminary mineral accounts compiled from publicly available data as of December 31 2013. The mineral accounts and associated macroeconomic indicators will be updated in future reports.

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Abbreviations and Acronyms

5yma	5-year moving average
AIM	Alternative Investment Market
ANNS	Adjusted net national savings
ASX	Australian Stock Exchange
BoB	Bank of Botswana
CBM	Coal-bed Methane
DBGSS	De Beers Global Sightholder Services
GDP	Gross Domestic Product
GoB	Government of Botswana
GOS	Gross Operating Surplus
mcts	million carats
mtpa	million metric tons per annum
MFDP	Ministry of Finance and Development Planning
MMEWR	Ministry of Minerals, Energy, and Water Resources
NRA	Natural Resource Accounts
P	Pula
RRoC	Rate of return on capital
SEEA	System of Environmental-Economic Accounting
StB	Statistics Botswana
TRR	Total resource rent
TSX	Toronto Stock Exchange
WAVES	Wealth Accounting and the Valuation of Ecosystem Services.

1| Introduction

This report is part of an ongoing project under the Wealth Accounting and Valuation of Ecosystem Services (WAVES, www.wavespartnership.org) global partnership, being carried out by the Government of Botswana (GoB) and the World Bank. The WAVES project has a number of components, including the preparation of water accounts, energy accounts, mineral accounts, and appropriate macroeconomic indicators. These elements were selected as the first components of the WAVES project following a scoping report prepared in February 2012.[1, 2]

This report follows on from some earlier work conducted in the same field, in particular Lange and Wright (2004), the set of mineral accounts prepared by the Department of Environmental Affairs and the Centre for Applied Research in May 2007, and a preliminary report prepared for the WAVES project in 2014.[3] In several respects, this report updates and builds up the earlier results, and is structured in a similar fashion.

The mining sector continues to be the backbone of Botswana's economy, despite efforts to diversify. Mining is still, by some measures, the largest contributor to gross domestic product (GDP), generates the majority of export earnings, and makes a major contribution to government fiscal revenues. The use of the revenues generated by the mining sector is, therefore, of critical importance for sustainable development. Botswana has received widespread praise for the way in which it has converted mineral rents to fiscal revenues and invested them in education, health care, and other forms of assets. It has also been praised for its macroeconomic management of a mining economy. In some respects, it has managed to avoid what is commonly known in the literature as the "mineral curse" and "Dutch disease," through appropriate macroeconomic, exchange rate, and fiscal policies.

However, it is important that past success should not lead to complacency, and to recognize that policy changes may be required in response to changing circumstances, both domestically and internationally. The peak of the economic contribution of minerals appears to have passed, and the economic importance of minerals is likely to decline in future. At the same time, some Dutch Disease and resource curse characteristics can be observed, such as high unemployment, high income inequality, slow growth of non-mining exports, poor quality public investment decisions and management.

The decision to include the construction of mineral accounts in the WAVES project reflects the importance of the mining sector and the need to ensure that appropriate decisions are taken regarding the investment of mineral revenues to provide for future economic growth. This study has the following objectives:

- Quantifying the major physical trends in resource stocks for major minerals;
- Quantifying the major monetary trends in resource stocks for major minerals;
- Estimating the rent generated by each of the major minerals;
- Producing estimates of national mineral wealth;

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1 "The Global Partnership for Wealth Accounting and Valuation of Ecosystem Services (WAVES): Report of the Botswana Preparation Phase," prepared for World Bank/WAVES by the Centre for Applied Research and Econsult Botswana, February 2012.

2 An accompanying document on "Guide to Updating the Mineral Accounts" provides a step by step guide to the process, identifying exact data sources etc.

3 "Towards Mineral Accounts for Botswana," prepared by the Department of Environmental Affairs and Centre for Applied Research, May 2007.

- Producing estimates of mineral depletion; and
- Identifying challenges that need to be addressed for the future compilation of mineral accounts.

Other work carried out as part of the WAVES project (and presented in separate reports on the public finance aspects of mineral rents and on macroeconomic accounts) builds upon this mineral accounts work by:

- Exploring the extent to which the government has captured the resource rents from mineral extraction for the country's development and growth;
- Identifying the uses to which mineral revenues have been put;
- Identifying any challenges with regard to measuring the appropriation and use of resource rents;
- Preparing measures of national wealth including produced capital, mineral wealth and financial assets
- Preparing measures of adjusted net national savings (ANNS), taking account of mineral asset depletion.

More broadly, this report and the related reports form part of Botswana's efforts to prepare a broader range of sectoral and macroeconomic statistics in line with the System of Environmental-Economic Accounting (SEEA), an extension of the conventional System of National Accounts (SNA) used for the compilation of conventional macroeconomic data.

The report is structured as follows: Section two describes the role and importance of minerals in the economy of Botswana. Section three explains the concept of resource rent, the conditions necessary for non-renewable resources such as minerals to contribute to sustainable development, and the methodology used to measure rent and the economic value of mineral assets. Section four presents physical asset accounts and provides an estimate of resource rent generated by mining during the period 1994 to 2012. Both physical and monetary accounts are constructed for diamonds, copper-nickel, coal, gold and soda ash. The section concludes with a calculation of the estimated value of mineral assets. Section five concludes.

2| Minerals, the Mining Sector, and the Economy of Botswana

2.1| Introduction

The mining sector has long been the dominant sector of the Botswana economy. For most of the past 35 years, it has been the largest contributor to GDP, the largest contributor to government revenues, and the source of the large majority of export earnings. The importance of mineral production to the Botswana economy is summarized in Table 1 below.

The main driver of mining sector growth and earnings has been diamonds, although there have been smaller contributions from base metals (copper, nickel, and cobalt), coal, soda ash, and gold. This situation has been changing in recent years, and is likely to continue evolving in the future. Government revenues from minerals appear to have peaked (relative to GDP and to overall revenues). The share of GDP accounted for by the mining sector has been in decline, and—depending on the measure used—may no longer be the largest economic sector. In 2014, the most recent full year for which data is available, mining was the largest economic sector when measuring GDP/value added at current prices, but at constant (2006) prices, mining was the second largest economic sector, after trade, hotels and restaurants.

There are a variety of reasons for the declining economic role of mining in Botswana:

- The diamond mining industry, which is the largest contributor to mining, has reached maturity; production (in terms of carats) peaked in the mid-2000s and has since declined.
- The global financial crisis of 2007–9 and its aftermath led to a sharp reduction in demand for diamonds, lower prices for copper and nickel, and delays in some planned mining investments.
- Economic diversification policies have to some extent succeeded, as a result of which the non-mining sector of the economy has experienced rapid growth.[4]

While it is certain that minerals will remain important to the Botswana economy, the nature of the sector and its economic impact are likely to change.

2.2| Mineral Production

Diamond production started in 1970 and increased over the years to reach a peak of 34 million carats (mcts) in 2006. Production was cut back significantly (to 18 mcts) in 2009 during the

Table 1: Economic Importance of Mining

Macroeconomic Indicator	1985–1994	1995–2004	2005–14
Mining % of GDP	42.2	30.9	22.0
Minerals % of government revenues	50.9	52.0	39.9
Minerals % of merchandise export revenues	77.4	76.9	71.6
Mining % of overall GDP growth	22.1	29.9	–12.8

Source: Econsult Botswana, based on information from Statistics Botswana.
Note: export data excludes re-exports of aggregated diamonds.

[4] Over the decade from 2004–14, the non-mining private sector grew by 128 percent, while the mining sector shrank by 13 percent (measured in terms of constant price GDP).

global financial crisis, but has since recovered somewhat and has varied between 21 and 24 mcts from 2010 to 2014. Diamonds are produced from six mines. Two of these are very large (Jwaneng and Orapa), while there are three smaller mines (Letlhakane, Damtshaa and Karowe, all located in the Orapa area). All five of these mines are open pit operations. The sixth and newest mine is Ghagoo, in the Central Kgalagadi Game Reserve, which is Botswana's first underground diamond mine. Orapa, Jwaneng, Letlhakane, and Damtshaa are operated by Debswana (a joint venture between the GoB and De Beers), while Karowe is operated by Lucara Diamond Corp and Ghagoo is operate by Gem Diamonds. Two very small mines (BK11 and Lerala) are mothballed, although Lerala is expected to re-open in late 2015.

For many years, all diamonds were exported in rough form, with sales and marketing largely taking place outside of the country. This situation is changing, however. Around 20 diamond cutting and polishing operations have been established, which in part use Botswana diamonds. Furthermore, as of 2013, De Beers's global sales operations have been relocated from the United Kingdom to Botswana, which means that diamonds from all of the De Beers group mines are sold from Gaborone. There are also other diamond marketing platforms, including the GoB-owned Okavango Diamond Company, which sells a share of Debswana's production outside of De Beers's channels, and Lucara Diamonds. All of these operations are helping to establish Botswana as a global diamond marketing hub.

Base metals (copper-nickel) production also started in the early 1970s. As at mid-2015 there are three mines in operation: Selebi-Phikwe (operated by BCL), Phoenix (BCL/Tati Nickel), and Mowana (African Copper). Selebi-Phikwe is an underground mine, while the others are open pit operations. There are three mothballed mines: Thakadu (African Copper), Boseto (Discovery Metals), and the underground nickel mine at Selkirk (Tati Nickel). BCL also operates a smelter at Selebi-Phikwe, which processes concentrate from the mines and produces semi-refined copper-nickel matte; the matte is exported for final refining elsewhere. Nickel production has been declining in recent years, as reserves have been worked out, while copper mining has been increasing as new mines have opened. Small quantities of cobalt and silver also are produced (although the majority of the value is accounted for by the nickel content). Despite the decline in nickel production, it accounts for the majority of the value of Botswana's base metals output. A new mine is due to be opened Western Botswana by Khoemacau Copper Mining, who have also taken over the bankrupt Discovery Metals.

Soda ash and salt are produced from brine deposits located at the Makgadikgadi salt pans, through an evaporation process. During the past five years, the production of soda ash averaged 250,000 metric tons a year, while salt averaged 440,000 metric tons a year; apart from small quantities of salt sold domestically, all of the production is exported. Botswana is the fourth largest producer of natural soda ash in the world (after the United States, Turkey and Kenya), although it has the second-largest reserves.

Coal is produced in small quantities, mainly for domestic consumption, with the main usage being for power generation. Historical production has been just under 1 million metric tons per annum (mtpa), from a single mine at Morupule, although output has now risen to 2–3 mtpa to supply the new coal-fired Morupule B power station. Nevertheless, output is very low compared to reserves that have been estimated at around 40 billion metric tons and total resources of more than 200 billion metric tons.

Gold has been mined in northeast Botswana intermittently for several hundred years, although at present there is only one mine in operation (Mupane), which commenced production in 2005. Production is relatively low, less than 1,000 kilograms in 2014, and is declining as reserves are depleted, although the exploitation of satellite deposits around Mupane is helping to extend mine life.

Table 2: Botswana Mineral Production, 2014

Mineral	Units	Physical Production	Value of production (P million)
Diamonds	Mcts	24.7	33,242
Copper	thousands of metric tons	47.4	7,547 [1]
Nickel	thousands of metric tons	14.9	[1]
Cobalt	metric tons	196	[1]
Soda Ash (natural)	thousands of metric tons	268.5	849.7 [2]
Salt	thousands of metric tons	515.3	[2]
Coal	thousands of metric tons	1,711.6	493.0
Gold	kg	884	363.7

Source: Statistics Botswana, Dept. of Mines.
Notes: [1] value includes copper, nickel cobalt [2] value includes salt and soda ash.

2.3| Prospects for the Mining Industry

Botswana's mining sector is likely to become more diversified over the next two decades, as diamond production declines in relative terms and other minerals develop.

Diamonds: The mainstay of Botswana's diamond production, the large Debswana mines at Orapa and Jwaneng, can keep producing on the basis of current investments for another 10–15 years. However, there are reserves that can be exploited beyond this time, although this will require significant investments to deepen and broaden the pits, or to go underground. With an anticipated upward trend in real diamond prices over the next two decades, driven by emerging supply-demand imbalances as major deposits are worked out, such investments should be worthwhile. The large tailings dumps at Orapa, Letlhakane and Jwaneng can also be processed. However, the main deposit at Letlhakane mine is nearing exhaustion. Production is likely to remain well below historical peaks of 30-plus mcts a year; and, as production costs rise, the rents generated and mineral revenues earned by the government are expected to decline as a proportion of gross output value. Although new mines have opened in recent years, these are much smaller than Orapa and Jwaneng,[5] and are more marginal economically.[6] There is extensive prospecting taking place for diamonds, and although many kimberlites have been discovered, their economic viability is yet to be established. The prospects for diamond mining are also subject to uncertainty related to the growth of synthetic diamond production.

Base metals: Botswana's base metals mines have had mixed fortunes in recent years and have been adversely affected by low prices (especially for nickel), declining reserves and ore quality (especially at Tati Nickel), production problems, and difficulties in achieving anticipated ore processing volumes (especially for African Copper and Discovery Metals). However, it has been

[5] New mines (including the two mothballed mines) have production capacity in the range of 250,000–1 mcts a year (compared to +/– 10 mcts a year at Jwaneng and Orapa).
[6] As demonstrated by the closure/mothballing of the two smallest mines soon after opening.

Table 3: Botswana Mines, 2014

Mineral	Name of Mine	Owner	Beneficial Owners
Diamonds	Jwaneng	Debswana	GoB (50%) / De Beers (50%)
	Orapa	Same	same
	Letlhakane	Same	same
	Damtshaa	Same	same
	Karowe	Boteti Mining	Lucara Diamond Corp. (listed on Toronto Stock Exchange & Botswana Stock Exchange)
	Ghagoo	Gem Diamonds	Gem Diamonds (listed on AIM, London)
	Lerala	Lerala Diamond Mines Ltd.	Kimberly Diamonds Ltd (listed on Australian Stock Exchange)
	BK11	Monak Ventures	Firestone Diamonds/Tango Mining (TSX)
Copper-nickel (& cobalt)	Selebi-Phikwe	BCL	GoB (100%)
	Phoenix	Tati Nickel Mining Co.	GoB (100%)
	Selkirk	Tati Nickel Mining Co.	GoB (100%)
	Mowana	African Copper (Listed on AIM, London)	ZCI Ltd (Listed on JSE, Johannesburg)
	Thakadu	Same	Same
	Boseto	Discovery Metals	Khoemacau Mining / Cupric Canyon / Barclays Bank
Coal	Morupule	Morupule Colliery Ltd	Debswana (100%)
Soda Ash (& salt)	Sua	Botswana Ash	GoB (50%) / Chlor-Alkali Holdings (50%)
Gold	Mupane	Galane Gold (Listed on Toronto Stock Exchange)	

Note: * not currently in operation.
Source: MMEWR, authors.

established that there are substantial unexploited base metal deposits around Selebi-Phikwe and in northwest Botswana (the Ghanzi district and Ngamiland); the latter may contain an extension of the Zambian copperbelt. It is likely that further base metal mines will open in the coming years, although much depends on the availability of transport and power infrastructure, as well as price developments.

Uranium: A substantial uranium deposit exists in northeast Botswana, and—unlike some of the known base metals deposits—is well served by existing infrastructure. The deposit is relatively easy to mine, but depends on a recovery of global uranium prices for it to be economically viable.

Coal and coal-bed methane (CBM): Probably the main potential for large-scale development of mining development in Botswana lies with coal. Although there is no publicly available comprehensive and up-to-date survey of Botswana's coal resources, it is widely agreed that there are extensive deposits spread throughout much of eastern and central Botswana. A significant ramp-up in production requires an export market, whether for coal itself or for products derived from coal, such as electricity or chemicals. Developing a significant coal export market will, in turn, require the provision of dedicated rail infrastructure to either the east coast of Africa (via Zimbabwe, Mozambique, or South Africa), or the west coast (Namibia). These are large and expensive projects, and various options are under consideration. Mining of coal for export also has substantial water requirements, for washing, and the availability and cost of sufficient water is another factor to consider when developing large-scale coal production.

There are also substantial deposits of CBM (similar to shale gas), which could be exploited as an energy source (liquid petroleum gas), a fuel for power generation, or a chemical feedstock. The viability of exploiting CBM deposits is under investigation.

While there is nothing definitive regarding the likely development of coal or CBM production, the potential is large, and there should be more clarity over the next 2–3 years regarding development prospects.

2.4| Downstream Processing

The majority of Botswana's minerals are exported in unprocessed or semi-processed form. However, there is a gradual move along the value chain, at least for diamonds. Rough diamonds have long been sorted and valued in Botswana. In recent years, some diamonds have been cut and polished locally. Since 2013, the entire production also has been marketed locally, since the relocation of De Beers Global Sightholder Services (DBGSS) from London to Gaborone. In addition, the newly-established Okavango Diamond Company (ODC) is marketing a portion of Debswana's output in Botswana (but outside De Beers' channels), and other diamond mining companies (e.g., Lucara) also have established marketing operations in Botswana. There is also some jewellery production.

Many of the transactions involved in the sale of rough diamonds are non-market transactions, and it is therefore possible that a portion of the mineral rent is transferred to these later stages (i.e., may not fully appear in the mining sector of the national accounts, but in the manufacturing or business services sectors).

It is intended that the downstream processing sectors will be included in the mineral accounts calculations, in future, when the necessary data is available.[7]

Coal is already processed locally to produce electricity. Other possible downstream processing activities on the basis of current mineral products include copper-nickel refining, fabrication of metal products, and glass production from soda ash. Coal also may be used for much larger-scale electricity production for export, or for chemical or liquid fuel production. Future CBM production also can be used as the basis for a variety of downstream products.

[7] This requires the production of separate data on the diamond manufacturing (cutting and polishing) and diamond business services (sorting, valuing, trading) sectors by Statistics Botswana.

3| The Framework for Mineral Accounts

3.1| Introduction

Section 2 showed that Botswana's mining industry is very important to the economy, and in the case of diamonds, is significant on a global scale. This suggests that minerals probably form a major component of Botswana's national wealth, where national wealth includes produced, human, natural and financial capital that can be used to generate income and livelihoods. From a sustainable development perspective, it is important to track changes in national wealth over time. This applies to all economies, but especially to mineral economies, as the extraction of minerals can easily lead to a diminution of national wealth, if declining mineral assets are not compensated by increasing assets of other forms (produced capital, intangible and human capital, and financial assets). If national wealth is not sustained or increased, in the long term, real incomes will decline.

Botswana does not produce any consolidated picture of national wealth in official statistics—i.e., there is no national balance sheet. Indeed, there is little information on the various individual components of national wealth, several of which are not yet calculated. The current assignment of preparing mineral accounts therefore represents a contribution to a broader assignment of calculating the level of national wealth, changes in wealth, and genuine net savings.

As with the 2007 exercise (Department of Environmental Affairs/Centre for Applied Research), this report focuses on asset accounts for minerals. Most minerals historically have been exported in unprocessed or semi-processed form, and there are few linkages to other economic activities in Botswana. However, this is gradually changing. An increasing proportion of diamonds are cut and polished locally rather than exported as rough. Even for rough diamonds, there is an increasing amount of sorting, valuing, and marketing being carried out in Botswana. Furthermore, there are plans to use much larger amounts of local coal for power generation, both domestically and in export markets. Other downstream uses of coal and CBM also are being considered. There also may be scope for further processing of base metals, extending the smelting already carried out at BCL through to refining and possible further downstream uses. In due course, therefore, it will be important to prepare use accounts for minerals as well as asset accounts.

3.2| Mineral Resources and Reserves

In constructing mineral stock accounts, one of the most important starting points is the classification of mineral deposits in the ground. Essentially, any mineral deposit can be classified according to the level of confidence regarding the geological structure of the deposit—this will depend on both the nature of the mineral and the type of prospecting and exploration that has been carried out. For a hard mineral, for instance, which typically would be explored using borehole drilling and core sample evaluation, the closer together the test drill holes, the more confidence regarding the geology of the deposit. The level of geological confidence will be fairly stable, although can be changed through more intensive exploration (e.g., infill drilling) or new geochemical techniques for sample evaluation.

In addition to the level of geological confidence, a deposit can be classified according to the economic viability of the deposit. For instance, there may be a high level of geological confidence regarding a deposit, but it may be of low grade or difficult to extract, such that it is not economically viable to do so given existing mining and processing techniques and market prices. The level of economic viability of a deposit will be less stable than the level of geological confidence, given that prices and price expectations can change considerably.

Figure 1: McKelvey Diagram for Classification of Mineral Deposits

<table>
<tr><td rowspan="5">---Economic confidence---></td><td></td><td colspan="3">Identified Resources</td><td>Undiscovered resources</td></tr>
<tr><td></td><td>Measured</td><td>Indicated</td><td>Inferred</td><td>Hypothetical/ speculative</td></tr>
<tr><td rowspan="2">Economic</td><td colspan="2">Reserves</td><td rowspan="2">Inferred resources</td><td rowspan="3"></td></tr>
<tr><td>Proven</td><td>Probable</td></tr>
<tr><td>Sub-economic</td><td colspan="2">Demonstrated sub-economic resources</td><td>Inferred sub-economic resources</td></tr>
<tr><td colspan="5"><---------Geological confidence------</td></tr>
</table>

Source: Adapted from McKelvey (1972, 32–40).

Any mineral deposit can therefore be evaluated across these two dimensions, as shown in the "McKelvey" diagram below. Identified (i.e., discovered) resources can be divided into Measured, Indicated, and Inferred, with progressively lower degrees of confidence as to the geology of the deposit. In terms of economic classification, deposits are either economic (i.e., mineable) or sub-economic.

Deposits that are both economic and identified with a reasonably high degree of geological confidence (measured or indicated) are classified as "reserves," which may be further subdivided into proven and probable categories. Other identified deposits that are either in the geological inferred category, or are sub-economic (or both) are classed as "resources." Mineral reserves are of primary economic interest, although mineral resources can be moved into the reserves category over time, due to either changing economic conditions (such as higher prices), or further geological assessment or exploration work. In the current exercise, we focus on reported reserves, except in the case of diamonds where—for reasons of differences in geology between diamonds and other minerals—we also include inferred resources. Where data on reserves are not published by mining companies, we used measured and indicated resources instead.

3.3| Measuring Resource Rent and Valuing Mineral Assets

The economic value of a mineral resource is measured by the *resource rent*. This is the economic return earned from the sale of a mineral over and above the costs of extracting the mineral. Resource rent occurs because of the scarcity of a resource.

Unless there are specific policies to recover resource rent from mineral producers, much of it will accrue as "windfall" or "super-normal" profits to mining companies—i.e., a profit that is over and above that which would be normally required to reward the mining company for the capital employed in the mining operation and the risks incurred in mining investment and operation.

In many countries, relevant law prescribes that minerals belong to the state. Mining companies are then given licences entitling them to exploit (mine and sell) the mineral resource. However, as the owner of the resource, the government is entitled to a return on it.

From an economic perspective, sustainable and equitable resource management requires that the resource rent be recovered by the government through appropriate taxes and used for the benefit of all citizens. Non-renewable resources like minerals eventually will be depleted, and the employment and incomes generated by this activity will come to an end. It is especially important

that resource rents from minerals be invested in other kinds of economic activity, which can replace the employment and income from the mineral-based industries once they are exhausted. In this way, exploitation of minerals can be *economically* sustainable—because it creates a permanent source of income—even though non-renewable resources are, by definition, not physically sustainable, and the revenues derived directly from minerals are consequently unsustainable.

Most countries, including Botswana, levy special taxes and royalties on minerals to capture resource rent. While the principle of capturing resource rent is well established and widely accepted, doing so in practice is quite difficult, for several reasons. First, there is room for disagreement between what is an acceptable rate of return on capital (RRoC) for the investor, including an allowance for risk. Second, the taxation regime should have a relatively low or normal rate of tax on profits when profits are low, but a higher rate of tax when profits are high, to capture any windfall gains—so a variable profits tax rate is required, which must be carefully designed. Third, there is a commitment and trust problem. Governments may agree to a tax regime that is favourable to mining companies prior to a mining investment, but once the capital (which is largely immovable) is committed, the government may impose a more draconian tax regime to the disadvantage of the investor, who is by then committed; hence mining investors often will seek legally enforceable pre-commitments from governments, such as through tax stability agreements. Fourth, there is scope for transfer pricing, because investors can transfer profits out of the mining jurisdiction (where taxes may be high) to tax havens or lower-tax jurisdictions. Fifth—partly to address the transfer-pricing issue—mineral royalties on the gross value of production are by far the simplest kind of tax to impose on mining companies, but have the disadvantage of making some mineral deposits sub-economic, by raising the costs of mining.

The present exercise involves calculating the historical value of mineral rents, in part to make an assessment of the effectiveness of fiscal policy in capturing those rents, but also to enable construction of a historical series relating to the value of mineral assets on the national balance sheet.

The value of natural capital is the present discounted value of the stream of income (rent) that it is expected to generate in the future, or what is called the present value. There are two steps in calculating the present value of mineral assets:

- calculating the rent per unit of output generated by current production;
- estimating future rents; and
- calculating the economic value of the mineral deposit as the discounted value of future rents.

The calculations and assumptions required are described in more detail in Appendix 2.

4| Mineral Accounts and Resource Rent

4.1| Physical Accounts

The construction of physical accounts for minerals is an important step in constructing economic accounts, whereby the changes in the economic value of the country's natural capital can be tracked.

As Table 2. shows, diamonds dominate the economic value of Botswana's mineral production. Base metals (copper, nickel, and cobalt) are also economically important. Other minerals—gold, soda ash, salt, and coal—are relatively insignificant at present, although coal may have the potential to become much more important in future. Mineral accounts are presented below for diamonds, copper-nickel, coal, soda ash and gold.

4.1.1| Diamonds

Physical accounts for diamonds are presented in Information on the physical production of diamonds and physical diamond reserves is presented in Figure 2. for the period 1979 to 2014. Information on diamond extraction/production is compiled by the Department of Mines (DoM) and published by Statistics Botswana. It is also obtainable from Debswana and other mining companies.

Obtaining information on the stock of diamonds in the ground, or reserves, is much more problematic. Information on reserves for the Debswana mines was published by De Beers in its 1999 annual report. This included reserve figures for each of the mines then in operation—Jwaneng, Orapa, and Letlhakane—in the categories of probable, inferred, and indicated. However, De Beers did not publish similar reserve figures for subsequent years. Reserves could therefore be estimated by deducting annual production from this 1999 base for subsequent years, and by adding back annual production for prior years. However, this meant that reserves could not be updated by the addition of new resources identified through new discoveries, whether by Debswana or other diamond mining companies. Thus, the physical stock estimated in this manner is an underestimate.

However, the situation changed in 2012 following the acquisition by Anglo American plc of the 40 percent of De Beers held by the Oppenheimer family, through Central Holdings Ltd. This took the Anglo American shareholding in De Beers to 85 percent; the other 15 percent is held by the GoB. Given that Anglo American is listed on several major international stock exchanges, disclosure rules require that figures on mineral reserves be provided to investors and published as part of the annual accounts. Hence, since 2012, Anglo American annual reports on mineral reserves and resources have included figures for all four Debswana mines—the above three plus Damtshaa, which opened in 2000. Resources are identified for the kimberlite mines themselves, and for the separate Tailings Mineral Resources (TMR) associated with past mining. Going forward, this data provides the basis for a more accurate calculation of Botswana's diamond reserves. The Debswana figures can be supplemented by similar information published by the smaller diamond miners—Lucara and Gem Diamonds—which also are publicly listed companies.

In 1999 De Beers reported Debswana reserves of 767 mcts and in 2012 Anglo reported Debswana reserves of 747 mcts, a decline of 20mcts. However, over this period, production of diamonds by Debswana totalled 356 mcts. Hence the reserves must have been boosted by new discoveries of 336 mcts over this period. We assume that this comprised the identification of additional resources at Orapa and Jwaneng. In the absence of any further information, we assume that the amount was split equally between the two mines. Since 2012, Debswana's

resources have risen each year, and the new detail published in the Anglo reports makes it possible to identify where these increases have taken place. In 2013 this came from the inclusion of the Letlhakane and Jwaneng tailings dumps, while in 2014 it came from additional resources at Orapa. In addition, we include the discovery of commercially viable diamond deposits at the Karowe, Ghagoo Lerala and BK11 mines. However, these are relatively small; total resources at these four mines are less than the resources in the Debswana tailings dumps.

One of the interesting results is that the pace of new discoveries has more or less matched the pace of extraction, so that overall resources at the end of 2014 were similar to the level at the end of 1994.

This illustrates an important characteristic of mining projects, which is that there is no real need to prove up reserves far ahead of anticipated production. For most purposes, identification of reserves or resources sufficient for mining up to 15 years ahead is sufficient. Given that identifying resources is expensive, it is rational to delay this process until it is required. Hence, for mines that are not nearing exhaustion, identified resources are likely to underestimate true resources.

Table 4: Resource Estimates for Diamond Mines (million carats)

Type of reserve/resource	Mine	1999	2012	2013	2014
DEBSWANA MINES					
Probable	Orapa	169	86	90	135
	Letlhakane	3	1	1	0
	Jwaneng	49	88	77	64
	Damtshaa	—	4	4	4
	Tailings			9	9
	Total	**221**	**179**	**181**	**211**
Indicated	Orapa	32	119	110	270
	Letlhakane	2	8	4	4
	Jwaneng	4	84	74	63
	Damtshaa	—	6	6	6
	Tailings			9	9
	Total	**38**	**218**	**203**	**353**
Inferred	Orapa	121	254	253	173
	Letlhakane	12	2	1	1
	Jwaneng	375	269	269	269

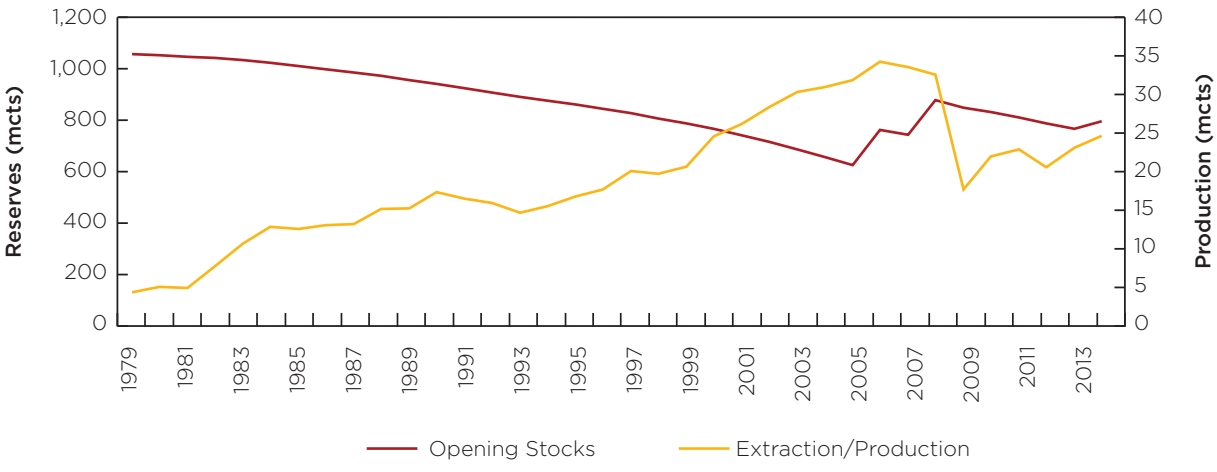
(continued on next page)

Table 4: Resource Estimates for Diamond Mines (million carats) *(continued)*

Type of reserve/resource	Mine	1999	2012	2013	2014
	Damtshaa	—	5	5	4
	Tailings			30	31
	Total	**508**	**530**	**559**	**478**
Total	Orapa	322	373	364	443
	Letlhakane	17	10	5	5
	Jwaneng	428	353	343	333
	Damtshaa	—	11	11	10
	Tailings			39	40
	Total	**767**	**747**	**762**	**830**
Non-Debswana Mines					
Karowe (Lucara)	Total		5	11	n/a
Ghagoo (Gem)	Total		15	21	n/a
Lerala	Total			3	n/a
BK11	Total				1

Source: De Beers 1999 annual report (44–45); Anglo American plc Annual Report, 2012 and Ore Reserves & Mineral Resources Reports, 2013 & 2014; www.lucaradiamond.com; www.gemdiamonds.com; kdl.com.au; tangomining.com
Note: indicated resources include probable reserves in the 2012 & 2013 figures, while they do not in 1999.

Figure 2: Diamond Extraction and Stocks (million carats)



Source: Author's calculations, based on data from Statistics Botswana, De Beers, Anglo American, Lucara, Gem Diamonds, Kimberley Diamonds, Tango Mining.

4.1.2| Copper-Nickel

Information on extraction, production, and reserves of copper-nickel was published in the Department of Mines annual report until 1987. Since that time, a much more limited range of information has been published, covering only the production of copper-nickel matte and its metal content. Estimates of resource stocks can be derived from the 1987 data by subtracting data on annual extraction; however, this is increasingly inaccurate as it does not contain information on new discoveries or identification of reserves. On the basis of the 1987 figures, copper-nickel reserves would have been depleted by 2007.

Although the DoM no longer publishes reserve figures, some information can be obtained directly from the mining companies involved. All of the four companies involved in copper-nickel mining—BCL, Tati Nickel, African Copper and Discovery Metals—have published reserve and resource estimates on their websites, although at different dates. As part of the WAVES exercise, the MMEWR DoM has obtained some updated information for the unlisted companies (BCL and Tati Nickel). The reserves and resources detailed by these companies are summarized below.

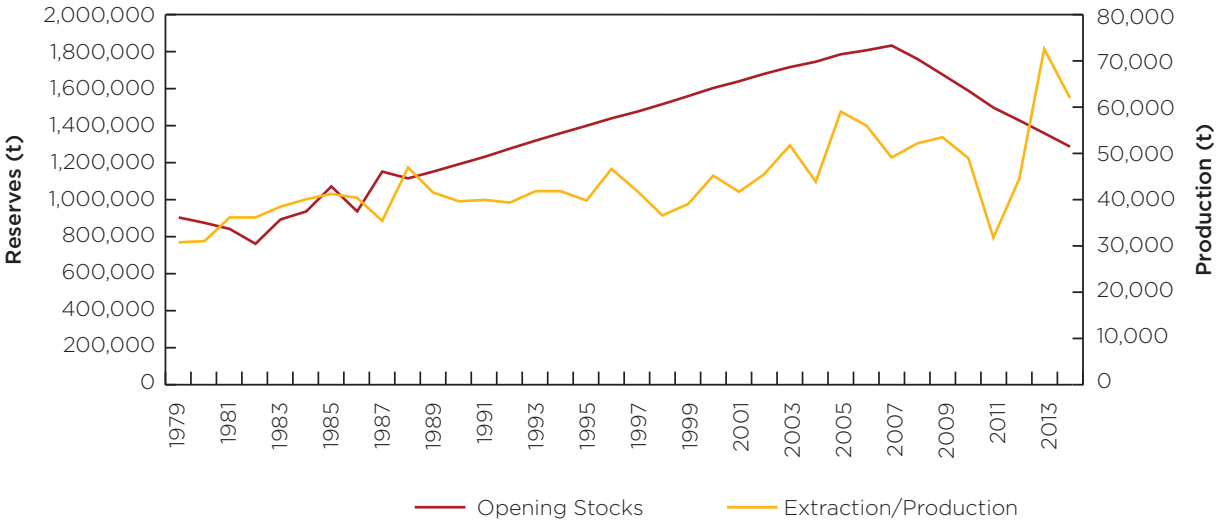
Combining these figures with the 1987 reserves figures and production data since 1987, we can calculate the implicit increase in reserves due to new discoveries etc.. On average, between 1987 and 2007, reserves increased by 81,800 tonnes a year, while between 2008 and 2014 they decreased by 30,200 tonnes a year.

Table 5: Base Metals (copper-nickel) Resources and Reserves

Company	Date	Reserves (thousands of metric tons)	Resources (thousands of metric tons)
BCL	30/06/2011	704	1,368
	31/12/2013	496	1,491
	31/12/2014	494	1,375
Tati Nickel	31/12/2009	556	1,446
	31/12/2013	387	582
	31/12/2014	290	581
African Copper	26/11/2007	199	914
	06/08/2009	248	n/a
Discovery Metals	22/07/2013	195	1,413
	14/10/2014	199	2,293
Total (2009)	**Various**	**1,568**	**2,874**
Total (2014)	**Various**	**1,122**	**4,249**

Sources: www.africancopper.com; www.bcl.bw; www.nornik.ru; www.discoverymetals.com; MMEWR.

Figure 3: Copper-nickel Stocks and Production (thousands of metric tons)



Source: Author's calculations.

Overall, the reserves figure (based on company reports) in 2014 was similar to the last figure reported by the Department of Mines, in 1987. Over this period of 27 years, therefore, total production was largely matched by the identification of new reserves.

In principle, the 2014 reserve figures would cover some 20 years of extraction at current rates. However, this may not in fact be the case, as some of the reserves (especially those at Tati Nickel) are very low grade, and continued mining may not be viable—obviously depending on copper and nickel prices.

It is important to note that this refers to the level of mineral reserves, i.e. excluding mineral resources (which are less definitive). In due course, a portion of the identified resources may be converted to reserves as the quality of prospecting data is upgraded, which could extend the life of the reserves further.

4.1.3| Coal

Eleven coalfields have been identified in Botswana. However, only one of them is being mined (Morupule), and only two (Morupule and Mmamabula) have historically been explored to a significant degree. Reserves for these two coalfields were originally measured during the 1970s, and totalled 7.2 billion metric tons. In addition, there were 28.8 billion metric tons of indicated reserves in other coalfields, and 176 billion metric tons of inferred resources. More recently, the coalfields at Mmamantswe, Sese, Takatokwane and Mabesekwa have been prospected to quantify resources.

Clearly, these coal reserves are very large in relation to current production, which has averaged just under 1 mtpa until recently. The Morupule coal mine has been expanded to meet the needs of the new Morupule B power station, and extraction is expected to increase to 2.5 mtpa. In addition to domestic demand, small quantities of coal are exported.

Little exploration of Botswana's coalfields took place between the 1970s and the mid-2000s, due to the large size of the then-identified reserves relative to extraction levels, and the lack of apparent channels for monetizing the remaining resources. Since then, there has been a revival of interest, prompted by regional energy shortages and the potential for export-oriented large-

scale coal-fired power stations, and also the possibility of direct coal exports using planned new rail routes. Hence, there has been widespread prospecting and firming up of resource estimates.

A more recent presentation provided the following information on Botswana's coal resources:

Table 6: Coal Resources (millions of metric tons)

	Measured Resources	Indicated Resources	Inferred Resources	Total
Morupule	2,864	2706	15,574	21,144
Mmamabula	494	20,215	5,005	25,714
Eastern		339	17,809	18,148
SE		9,283	132,810	142,093
Total	**3,358**	**32,543**	**171,198**	**207,099**

Source: Paya (2012).

The Coal Roadmap (Wood Mackenzie 2011), commissioned by the GoB, indicated the following potential uses of Botswana's coal:

Table 7: Potential uses of Botswana's Coal Resources (million metric tons per annum)

Potential Use	Potential Annual Volume (mtpa)
Coal exports	90
Export power generation	30
Domestic power generation	3.0
Coal-to-liquid	3.5
Cement	0.05

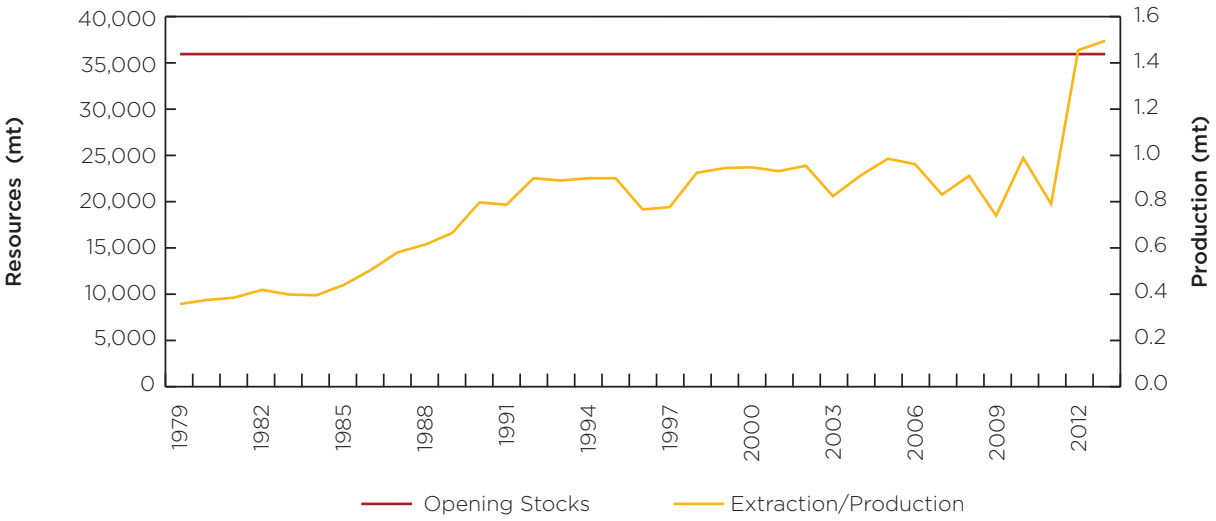
Source: Wood Mackenzie Coal Consulting (2011).

Even if all of these projects came to fruition, total coal reserves (measured and indicated) shown above would be sufficient to supply coal for nearly 300 years, even before further exploration moves some of the identified deposits from the inferred category to the measured or indicated categories.

4.1.4| Gold

Botswana currently has only one gold mine—Mupane—ownership of which has changed hands several times since it commenced operations in 2005. Gold production figures are available from the DoM, but information on gold reserves has never been published by the Government. As only

Figure 4: Coal Resources and Production (millions of metric tons)

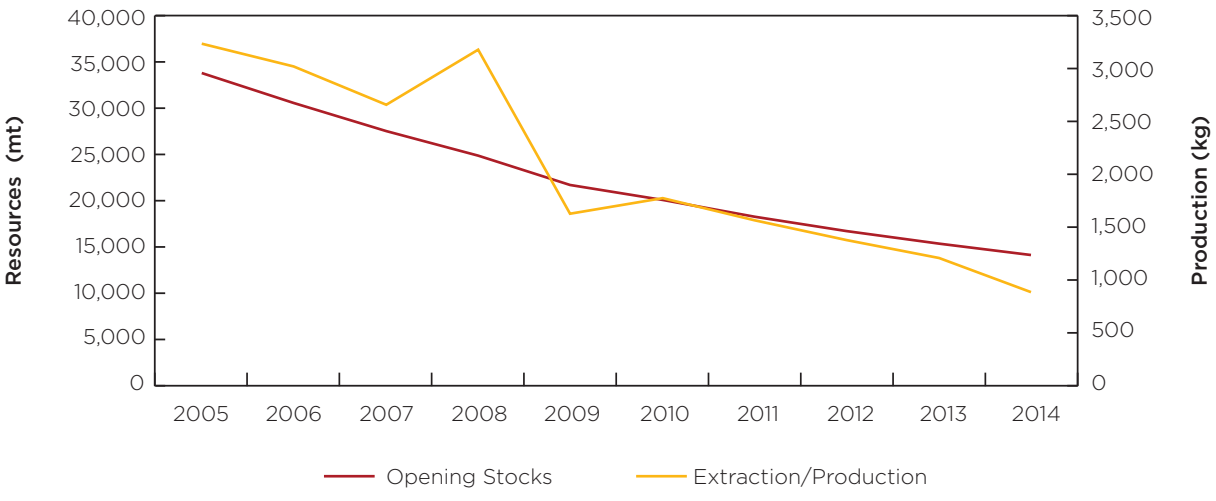


Source: Author's calculations, based on data from Statistics Botswana, MMEWR and company websites.

one company is involved in gold mining in Botswana, some information can be derived from company publications and information obtained from the company by MMEWR. No information on gold reserves is produced, but information on Measured, Indicated and Inferred Resource is produced. Using these resource and production figures, the series for gold resources can be extrapolated back to 2005.

The economically-exploitable gold resources are not very large, and production has been declining as the deposits have been worked out. The anticipated life of the mine, unless new reserves are identified, is less than 15 years.

Figure 5: Gold Production and Resources



Source: Author's calculations, based on data from Statistics Botswana and MMEWR.

4.1.5| Soda Ash

Soda ash is an unusual mineral in that it is to some extent renewable, in that the brine extracted from Sua Pan, from which soda ash and salt are produced, is replenished by water inflows.

Based on modelling reports of extraction and recharge flows, and discussions with Botash management, we assume that current rates of extraction (of soda ash) can be maintained for 35 years. Reserve figures are derived indirectly, with the closing stock calculated as the level needed to keep producing at current rates for 35 years. For present purposes, we ignore extraction and reserves of salt, and deal only with soda ash.

4.2| Resource Rent and Monetary Accounts

Resource rent has been calculated for the five major minerals mined in Botswana—diamonds, copper-nickel, coal, soda-ash and gold—for the period 1994–2014—i.e., the period for which updated and rebased national accounts data are available.[8] The methodology used is as described in Section 3 above and in Appendix 2. The results are shown in Table 8 and Figure 6 below.

One of the uncertainties in resource rent calculations is the rate of return on capital (RRoC) that should be assumed. Return on capital is conceptually part of the costs of production, but is not normally calculated as part of financial accounts, and hence is not a published number and therefore needs to be calculated. Most of the calculations carried out here use a 20 percent RRoC, in line with previous exercises. This is justified as follows. Given that all figures are presented in nominal (current price) terms, an appropriate RRoC must take into account inflation in order to arrive at an appropriate real rate of return. Inflation averaged 8.1 percent a year during the period 1994–2014, as measured by the GDP deflator, yielding a real return on capital, in Pula terms, of 11%.

In choosing an appropriate RRoC, a trade-off needs to be made between simplicity and accuracy. The appropriate RRoC may vary across time and across projects. A real pre-tax rate of return of 11% would probably be considered too low by private investors in risky, new mining projects, but may be too high for a mature mining project with little geological uncertainty and stable offtake agreements. For example, a coal mine selling to a power station under a long-term take-or-pay contract with an agreed pricing formula faces lower risks than a copper mine selling into the global spot market. For present purposes, simplicity is favoured with a single RRoC of 20% used for all years and all minerals except coal, where the rate is 15%. In future calculations of mineral rents it may be appropriate to use a lower RRoC, given that Botswana inflation is now significantly lower than in the past.[9] It may also be appropriate to use different RRoCs for different minerals.[10]

In practice, the choice of RRoC does not make a great difference to the overall rent calculation. This is because diamonds account for the majority of mineral rent, and in the diamond sector the rent makes up a large proportion of operating surplus, and the deduction for return on capital is relatively small. However, for other minerals, the rent calculation is more sensitive to the assumed RRoC.

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[8] The national accounts data for the copper-nickel mining sector are currently being reviewed by Statistics Botswana. Hence the data used here are preliminary and may change if revisions to the data are made.

[9] CPI inflation fell to 3% in 2015, compared to a long-term average inflation rate of over 8%. However, this may not be translated directly into lower inflation as measured by the GDP deflator, or to a lower rate of depreciation of the Pula against the USD (which is of particular interest to international investors, who would focus on the RRoC in USD).

[10] The framework for calculating mineral rents etc. can accommodate different values for the RRoC for different minerals, and for different years from 2014 onwards.

Table 8: Calculation of Total Resource Rent, all Mining Activities, 1994–2014 (Pula million)

	Operating Surplus	Consumption of Capital	Capital Stock	Return on Capital	Total Resource Rent
1994	2,881	260	1,442	286	2,335
1995	3,374	265	1,461	290	2,819
1996	4,494	271	1,425	283	3,940
1997	5,146	283	1,378	273	4,590
1998	5,164	300	1,477	293	4,571
1999	6,970	316	1,655	328	6,326
2000	8,813	333	1,894	376	8,103
2001	9,123	379	2,289	455	8,289
2002	8,737	451	2,869	570	7,715
2003	8,377	518	3,512	699	7,160
2004	9,252	625	4,435	883	7,745
2005	14,212	829	5,985	1,193	12,191
2006	17,044	1,097	7,374	1,470	14,478
2007	17,283	1,476	9,953	1,978	13,830
2008	16,559	1,974	13,182	2,618	11,967
2009	8,710	2,135	12,989	2,576	3,999
2010	13,681	2,339	13,863	2,737	8,605
2011	23,324	2,800	17,879	3,506	17,018
2012	18,792	3,498	20,694	4,066	11,227
2013	23,798	4,011	23,543	4,635	15,152
2014	27,947	4,702	27,107	5,349	17,896

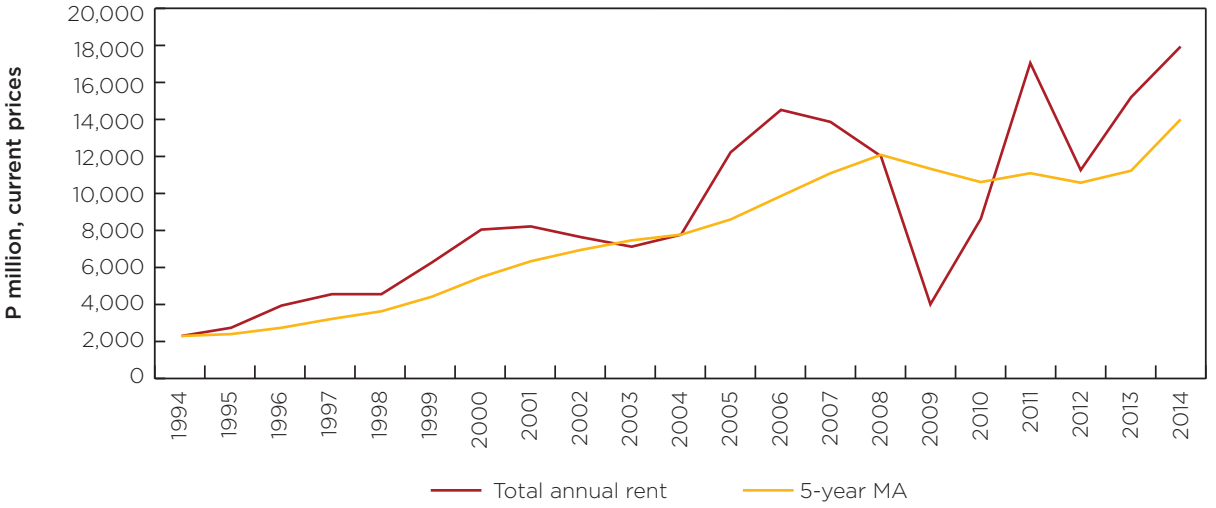
Source: Author's Calculations.

These results produce a number of conclusions:

- Annual resource rents have been quite volatile, depending on mineral prices and production volumes—indicating that a 5-year moving average of rents gives a more representative long-term trend;[11]

[11] Most countries valuing subsoil assets use the moving average approach. These calculations use a lagged 5-year moving average (hence no figures are available for the first four years of the series).

Figure 6: Total Resource Rent, Annual and 5-year Moving Average

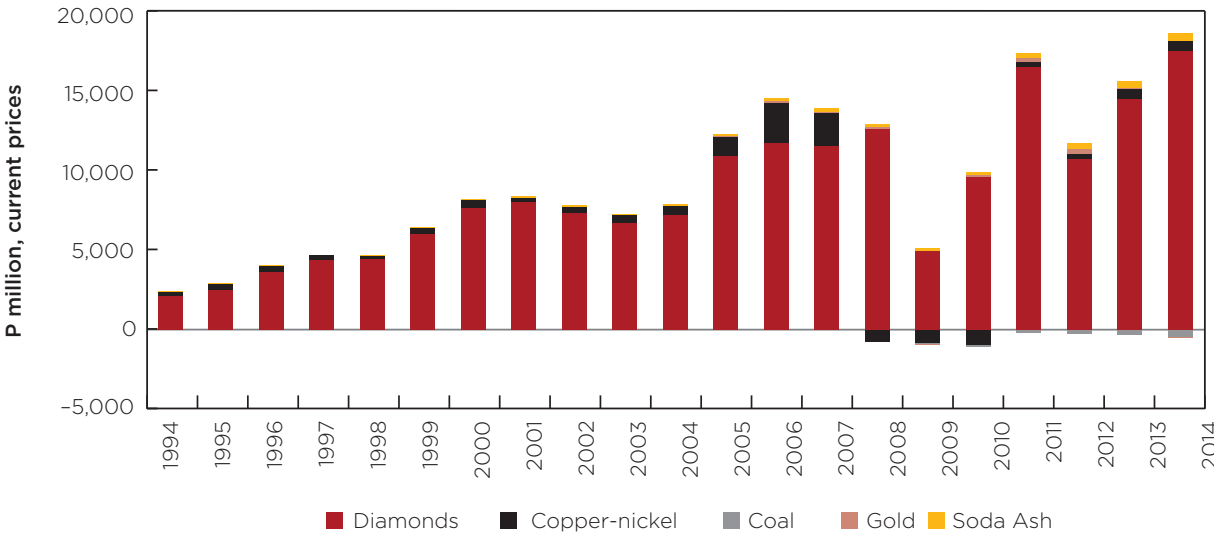


Source: Author's calculations.

- The impact of the global financial crisis of 2008–9 was very large, causing a sharp fall in resource rents; and
- Overall resource rents are dominated by rents received from diamonds—an average of 94 percent of the total. Rents from copper-nickel have been much smaller, but positive in most years, except for 2008–10. Rents from coal have been consistently negative, although generally small until the last five years, when a large investment program at Morupule sharply increased the level (and cost) of capital employed.

Besides being by far the largest contributor to rents, diamond rents were also much more stable over the period as a whole than those from other minerals, despite the disruption caused by the global financial crisis.

Figure 7: Resource Rent, by Mineral, 1994–2014 (current prices)



Source: Author's calculations.

Table 9: Resource Rents from Major Minerals (P million, current prices)

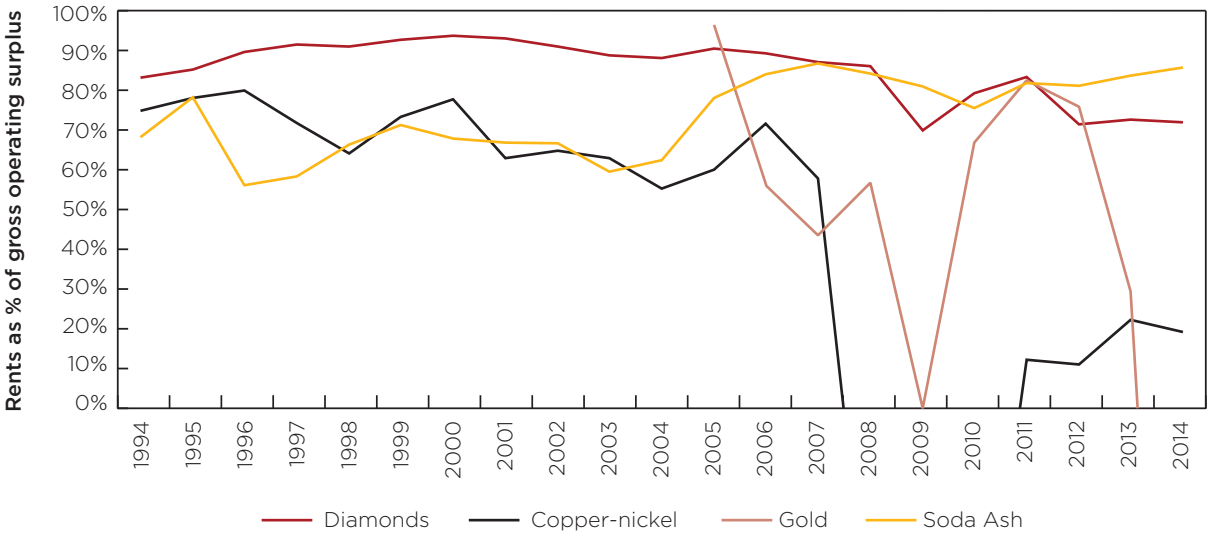
	Diamonds	Copper-nickel	Coal	Gold	Soda Ash
1994	2,001	283	-7	n/a	169
1995	2,360	366	-7	n/a	270
1996	3,469	441	-7	n/a	86
1997	4,258	296	-5	n/a	90
1998	4,298	224	-6	n/a	112
1999	5,884	378	-7	n/a	124
2000	7,500	543	-8	n/a	106
2001	7,911	303	-9	n/a	121
2002	7,208	425	-11	n/a	131
2003	6,573	533	-12	n/a	90
2004	7,099	590	-9	n/a	81
2005	10,786	1,211	-5	66	142
2006	11,692	2,474	-4	136	181
2007	11,421	2,127	-12	66	229
2008	12,501	-879	-25	151	219
2009	4,815	-964	-67	-3	218
2010	9,462	-1,052	-134	177	154
2011	16,406	346	-280	257	289
2012	10,639	304	-389	326	347
2013	14,370	712	-421	51	441
2014	17,442	602	-601	-56	509

Source: Author's calculations.

As Figure 8 shows, mineral rents account for a large proportion of the operating surplus for both diamonds and soda ash. For coal, rent has generally been negative, while for copper-nickel and gold it has been highly variable.

Resource rents have been extremely important to the Botswana economy, and contributed on average 19 percent of GDP during the period 1994–2014. However, it is evident that the relative contribution of resource rents has been in decline over the past decade. This is due to the decline

Figure 8: Rents as % of Gross Operating Surplus, by Mineral



Source: Author's calculations.

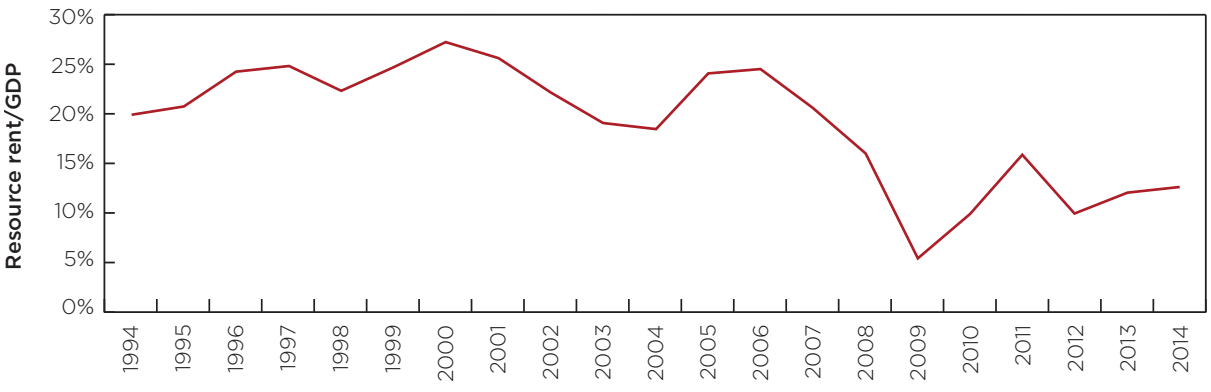
in mineral production, particularly diamond production, as a share of GDP, as well as to rising costs of production.

4.3| Valuation of Mineral Assets

4.3.1| Valuation of Assets as at 2014

One of the important outcomes of mineral rent calculations is the ability to value unexploited mineral assets. The economic value of any mineral in the ground is the flow of future income that it can generate. Income in this case is the rent that will be generated, over and above the costs of producing the mineral (i.e. the costs of turning it from a sub-soil deposit to a marketable commodity).

Figure 9: Resource Rent as a Percentage of GDP



Source: Author's calculations.

Making such a valuation depends on many unknowns, including:

- future mining costs and minerals prices;
- the pace of future exploitation (production); and
- the proportion of saleable reserves.

For present purposes we utilise the values calculated in this exercise for resource rent per unit of production, taken as the most recent 5-year moving average, and assume that:

1. Resource rents stay constant in real terms;
2. Known reserves are exploited at the current (constant) rate until exhaustion;
3. There are no new discoveries or additions to reserves; and
4. The applicable discount rate for the purposes of present value calculation is 10 percent, as the calculation is in real terms.[12]

The formula for calculating the net present value of the mineral deposit is as follows:

$$NPV = \frac{R.X\left((1+r)^{n}-1\right)}{r(1+r)^{n}}$$

where: R = per unit rent; X = annual output; r = real discount rate; and n = lifetime of deposit.

The following resource valuations are derived:

Table 10: Present Value of Mineral Reserves, 2014

Mineral	Resource rent per unit of production (5yma, P)	Life of mine (years)	Present Value of Reserves (pula million)
Diamonds	598	35	142,300
Copper-nickel	3,146	19	1,631
Coal	-278 (0)	21,000	0
Gold	95,996	11	550
Soda ash	1,465	32	3,580
Total			**148,062**

Source: Author's calculations.

Coal reserves are valued at zero because of the negative calculated resource rent. However, the coal industry may undergo significant expansion and transformation, which would change the economics of the industry and the resource rent calculations. A rough estimate can be made of the value of coal reserves based on such a future trajectory. Based on estimated reserves of 25 billion metric tons, production of 50 mtpa, and resource rent of P50 (USD5) per metric ton, the

[12] The Government of Botswana uses a real discount rate of 8% for (virtually) risk-free projects, and recommends discount rates of up to 12% to reflect higher risk (MFDP, 2010).

present value of Botswana's coal resource rents would be P25,000 million, i.e., substantially more than the copper-nickel deposits, but much less than diamonds. However, this would be dependent on achieving a sales price for coal on world markets that is substantially above current market prices, as well as access to the necessary export infrastructure.

This illustrates the point that the economic value of an unexploited mineral asset is zero if it cannot be mined profitably.

4.3.2| Changing Value of Mineral Assets Over Time

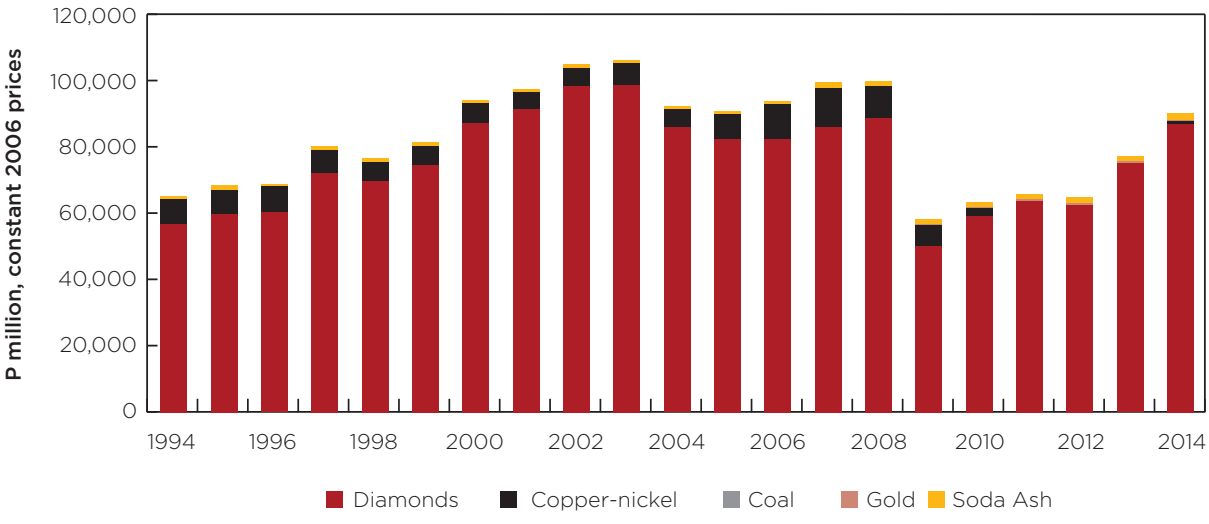
It is generally assumed that the value of a nation's mineral assets will decline over time as minerals are mined and sold. However, this is not necessarily the case, as the value is also dependent upon exploration and discovery of new reserves, as well as the evolution of market prices.

Figure 10 shows the valuation of Botswana's mineral assets over the period 1994–2014 (measured in constant price terms to remove the impact of inflation). It shows that despite steady mining and exploitation of mineral assets, the value of unexploited mineral assets rose steadily from 1994 until the time of the global financial crisis in 2008. The global crisis caused a sharp drop in the value of mineral assets, due to the impact on prices. Since that time there has been some recovery, but the value of mineral assets remains below the peak in 2003. This is partly due to price effects but also because production levels have been reduced; this means that production will be spread over a longer period and hence has a lower present value.

4.3.3| Mineral Depletion

Notwithstanding the fluctuation in the value of mineral assets from year to year, either positively or negatively, the extraction and sale of minerals necessarily involves the depletion of an asset. This may or many not be offset by other developments, such as new discoveries or price changes. However, it is necessary to calculate the depletion component of mineral consumption, as part of the mineral accounts, in order to provide input data for the calculation of Adjusted Net National Savings (ANNS), part of the System of Environmental-Economic Accounting (SEEA).

Figure 10: Valuation of Mineral Assets (constant 2006 prices)



Source: Author's calculations.

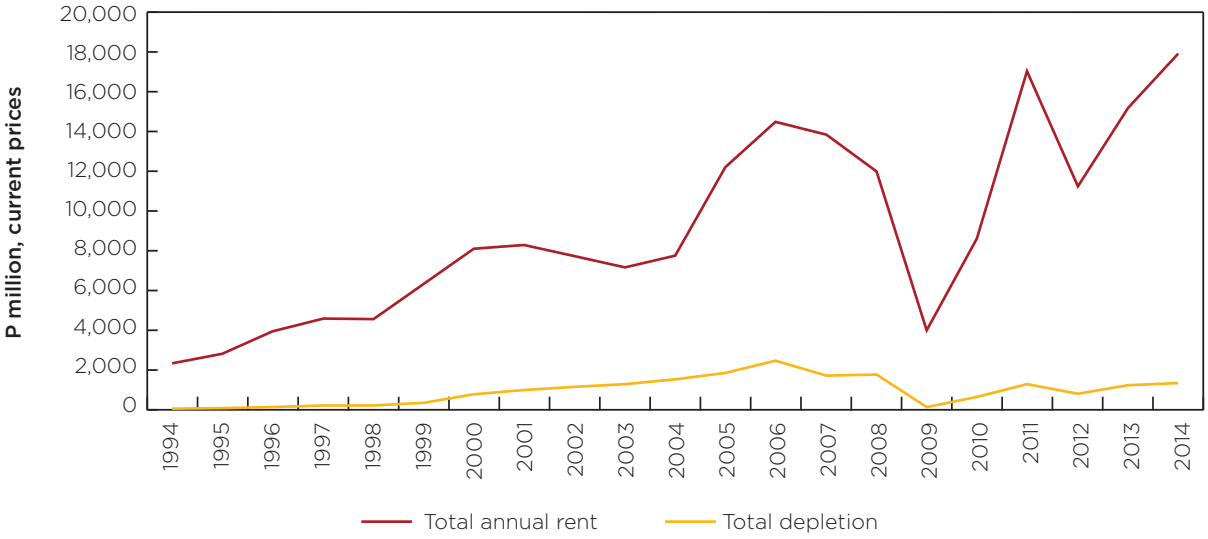
Under the SEEA, resource rents in a given year are divided between a depletion component and a return (income) component, according to the following formula:

$$Depletion = \frac{RR}{(1+r)^n}$$

where RR = annual resource rent, r = chosen discount rate and n = lifetime of mineral deposit (to exhaustion). The remaining portion of the resource rent is the income component. Hence the depletion component gets larger as the remaining lifetime of the deposit gets shorter.

Because the lifespan of most of Botswana's mines (notably diamond mines) is relatively long, the depletion component is in turn relatively small.

Figure 11: Resource Rents and Depletion



Source: Author's calculations.

5| Summary and Way Forward

The above discussion leads to the following conclusions:

- Mineral (resource) rents have made a major contribution to Botswana's economic growth; however, rents are declining in real terms and in relation to GDP.
- The vast majority of resource rents have been derived from diamond mining, with a small contribution from copper-nickel mining; the resource rent from coal has been negative, which suggests that it has been under-priced relative to the economic cost of production.
- The declining contribution of resource rents to GDP means that new sources of growth will be needed, emphasising the importance of economic diversification.
- The valuation of mineral assets shows that the value of un-mined deposits does not necessarily go down as mining takes place, as depletion can be offset by new discoveries of mineral reserves, and changes in prices (and unit rents). Hence the value of mineral assets in 2014, in real terms, was higher than in 1994, despite the fact that 20 years of mining had taken place in the interim.
- This exercise has helped to improve the quality of official data, to enable the calculation of resource rent and to value mineral assets reliably and regularly. In particular, Statistics Botswana is now carrying out annual valuations of produced capital stock at the level of the economy and for mining. StB is also producing output data on mining sub-sectors annually. However, some aspects of the calculations are dependent on data sources that are only available intermittently and from non-official sources, and further improvement in data sources is necessary. These are outlined below.

The Way Forward, Including Data Requirements

A key requirement is the availability of official data that will enable calculations of resource rent and mineral wealth to be carried out frequently and reliably, and also to be improved over time. This requires the following:

- For Statistics Botswana and MMEWR
  - Ensuring consistency between DoM EVP figures and StB gross output figures.
  - Revising the returns submitted by mining companies to obtain the data required by both StB and MMEWR for mineral accounts purposes.
- For Statistics Botswana
  - Providing data on capital stock for mining subsectors (gold, coal and soda ash as well as for diamonds and copper-nickel, as at present);
  - Providing data on downstream activities—particularly diamond processing—by separating out diamond cutting and polishing and diamond sorting, valuation, and marketing/trading as separate sub-industries in the national accounts (within the manufacturing and business services sectors, respectively). This will in due course enable downstream mineral processing to be included in the mineral accounts.
- For MMEWR (mineral accounts team)
  - Providing data on mineral reserves/resources, new discoveries, and other changes, on an annual basis, or as frequently as possible by monitoring published information from mining companies and requesting reserve/resource data where unpublished;
  - Regular review of choice of discount rates and RRoC:

    - Ongoing review of appropriate RRoC rates (in the mineral rent calculations) to reflect the cost of capital, including reward for risk, which it may be appropriate to vary across minerals and over time; and
    - Liaison with MFDP to ensure that discount rate used in mineral account calculations (present value of mineral stocks - asset valuations) is aligned with MFDP recommendations for the real discount rate and the appropriate level of risk.
- The following must happen with national accounts (linkages to separate WAVES project):
  - Combine the mineral accounts with regular calculations of the value of produced assets;
  - Develop the capacity to produce valuation of intangible assets/human capital;
  - Use as the basis for producing national balance sheets and estimates of genuine net savings.

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Appendix 1: Mining Sector Tables

Table 11: Mineral Sector Output (value added, Pula million)

Year	Diamonds	Copper	Coal	Soda Ash	Gold	Total Mining [2]	Total GDP	Mining % of GDP
1994	2,651.9	484.2	14.9	113.6		3,369.7	11,434.6	29%
1995	3,047.8	600.6	13.6	168.8		3,975.1	13,114.2	30%
1996	4,255.7	706.6	13.7	87.3		5,175.6	16,114.9	32%
1997	5,120.1	529.0	17.6	92.3		5,923.3	18,327.8	32%
1998	5,193.5	448.7	17.9	111.2		5,932.2	20,244.0	29%
1999	6,980.3	660.6	17.0	131.1		7,986.7	25,361.4	31%
2000	8,803.3	893.4	17.0	133.5		10,024.1	29,530.9	34%
2001	9,354.1	616.8	16.4	167.5		10,418.2	32,065.9	32%
2002	8,722.9	841.3	16.4	184.3		10,090.3	34,416.0	29%
2003	8,145.6	1,087.6	18.1	146.8		9,725.8	37,181.6	26%
2004	8,867.8	1,342.5	24.3	167.9		10,801.5	42,036.6	26%
2005	13,116.6	2,341.0	32.10	225.3	76.0	16,105.1	50,752.2	32%
2006	14,243.3	3,893.6	38.20	277.6	285.2	19,019.0	59,106.9	32%
2007	14,373.2	4,280.1	59.10	342.0	181.8	19,567.7	67,152.7	29%
2008	15,933.6	1,868.1	70.90	348.8	319.2	18,643.5	74,720.9	25%
2009	8,150.4	2,090.3	55.50	367.4	163.2	11,209.6	73,462.4	15%
2010	13,459.5	2,033.3	39.69	272.8	322.3	16,660.8	86,867.4	19%
2011	21,619.5	3,788.2	24.92	453.2	375.5	26,792.2	107,243.0	25%
2012	16,573.0	3,733.2	155.24	537.8	496.5	21,997.5	112,704.6	20%
2013	21,675.3	4,105.5	65.42	642.1	243.3	27,567.7	125,809.6	22%
2014	26,593.6	4,150.9	(87.99)	731.4	91.9	32,557.1	141,942.3	23%

Source: Statistics Botswana.
Notes: [1] includes gold, industrial minerals; [2] total includes informal sector, which is not included in subsector totals.

Table 12: Mineral Exports (Pula million)

Year	Diamonds	Copper-Nickel	Soda Ash	Gold	Botswana Rough Diamonds	Total Mining	Total Exports	Mining %
1994	3,718	259	37		3,727	4,013	4,965	80.8%
1995	3,984	328	22		3,994	4,334	5,941	72.9%
1996	5,722	445	69		5,272	6,236	8,133	76.7%
1997	7,670	481	110		7,675	8,260	10,391	79.5%
1998	6,040	436	98		6,061	6,575	8,697	75.6%
1999	9,706	558	107		9,813	10,371	12,228	84.8%
2000	11,384	830	98		11,398	12,312	14,260	86.3%
2001	12,086	597	128		11,259	12,811	14,658	87.4%
2002	13,223	710	79		12,474	14,013	16,109	87.0%
2003	10,681	1,337	84		11,707	12,103	13,910	87.0%
2004	12,435	1,578	107		12,964	14,119	16,490	85.6%
2005	16,864	2,315	198	130	16,692	19,507	22,507	86.7%
2006	19,432	3,957	182	212	19,313	23,783	26,436	90.0%
2007	20,043	6,771	151	305	19,967	27,270	31,563	86.4%
2008	20,793	5,924	221	387	20,859	27,325	32,301	84.6%
2009	15,234	3,620	312	532	12,959	19,698	24,318	81.0%
2010	21,780	4,231	624	535	18,846	27,170	32,040	84.8%
2011	30,248	2,940	461	546	28,851	34,195	40,077	85.3%
2012	36,143	3,312	452	642	23,237	40,548	45,566	89.0%
2013	52,239	4,616	499	471	28,469	57,825	63,190	91.5%
2014	65,327	4,197	408	373	35,511	70,305	76,038	92.5%

Sources: Statistics Botswana, except data on Botswana rough diamonds, which are from Bank of Botswana. Diamond exports include re-exports.

Table 13: Mineral Rent Calculations, Diamonds (Pula million)

	Operating surplus, gross	Consumption of fixed capital	Capital stock	Return on capital stock	Total rent	Total rent, 5yma	Per unit rent (P)	Rent/ GOS
1994	2,412.4	208.7	1,014.2	202.8	2,000.9	2,016.8	128.7	83%
1995	2,772.5	211.3	1,006.6	201.3	2,359.8	2,106.1	140.4	85%
1996	3,871.3	213.6	945.8	189.2	3,468.5	2,402.8	195.9	90%
1997	4,657.6	221.8	888.8	177.8	4,258.1	2,862.9	211.7	91%
1998	4,724.3	233.4	966.9	193.4	4,297.6	3,277.0	217.4	91%
1999	6,349.8	243.3	1,110.4	222.1	5,884.4	4,053.7	284.3	93%
2000	8,008.0	250.8	1,284.4	256.9	7,500.4	5,081.8	304.9	94%
2001	8,509.1	282.5	1,577.0	315.4	7,911.3	5,970.3	302.0	93%
2002	7,934.9	331.7	1,974.0	394.8	7,208.4	6,560.4	253.8	91%
2003	7,409.8	369.8	2,333.0	466.6	6,573.3	7,015.6	216.2	89%
2004	8,066.8	424.9	2,714.0	542.8	7,099.0	7,258.5	229.0	88%
2005	11,931.7	509.3	3,183.7	636.7	10,785.7	7,915.5	338.1	90%
2006	13,104.4	641.8	3,854.6	770.9	11,691.7	8,671.6	340.9	89%
2007	13,134.4	800.6	4,566.5	913.3	11,420.5	9,514.1	339.9	87%
2008	14,550.1	973.5	5,379.1	1,075.8	12,500.8	10,699.6	383.5	86%
2009	6,915.0	1,038.9	5,307.2	1,061.4	4,814.6	10,242.7	272.0	70%
2010	11,968.0	1,214.0	6,461.4	1,292.3	9,461.7	9,977.9	430.1	79%
2011	19,733.8	1,523.8	9,020.3	1,804.1	16,405.9	10,920.7	716.4	83%
2012	14,948.3	1,916.7	11,961.1	2,392.2	10,639.4	10,764.5	516.0	71%
2013	19,870.3	2,418.6	15,409.1	3,081.8	14,369.9	11,138.3	621.2	72%
2014	24,323.6	3,051.9	19,146.3	3,829.3	17,442.4	13,663.9	707.4	72%

Source: Author's calculations.

Table 14: Mineral Rent Calculations, Copper-Nickel (Pula million)

	Operating surplus, gross	Consumption of fixed capital	Capital stock	Return on capital stock	Total rent	Total rent, 5-yr. moving avg	Per unit rent	Rent/ GOS
1994	379.1	40.9	277.6	55.5	282.6	253.9	6,758.3	75%
1995	470.1	43.4	303.7	60.7	366.0	279.1	9,219.0	78%
1996	553.2	47.0	324.5	64.9	441.3	317.6	9,477.4	80%
1997	414.1	50.6	337.1	67.4	296.1	329.5	7,088.9	71%
1998	351.3	55.9	356.7	71.3	224.0	322.0	6,127.3	64%
1999	517.2	61.7	386.6	77.3	378.1	341.1	9,686.8	73%
2000	699.4	70.0	432.2	86.4	543.0	376.5	12,013.8	78%
2001	482.9	81.5	493.4	98.7	302.7	348.8	7,269.9	63%
2002	658.6	102.5	654.4	130.9	425.2	374.6	9,348.7	65%
2003	851.4	130.8	938.2	187.6	532.9	436.4	10,310.3	63%
2004	1,073.2	185.2	1,490.6	298.1	589.9	478.7	13,432.5	55%
2005	2,028.3	303.4	2,567.4	513.5	1,211.4	612.4	20,532.8	60%
2006	3,462.5	383.1	3,027.8	605.6	2,473.8	1,046.7	44,264.1	71%
2007	3,696.8	608.8	4,805.8	961.2	2,126.8	1,387.0	43,297.8	58%
2008	1,432.0	907.8	7,016.0	1,403.2	-879.0	1,104.6	-16,875.2	-61%
2009	1,398.4	987.7	6,872.0	1,374.4	-963.7	793.9	-18,039.2	-69%
2010	1,253.7	1,027.0	6,395.8	1,279.2	-1,052.5	341.1	-21,526.8	-84%
2011	2,965.5	1,189.4	7,152.2	1,430.4	345.6	-84.5	10,875.6	12%
2012	2,915.2	1,251.8	6,795.1	1,359.0	304.3	-449.0	6,839.0	10%
2013	3,259.2	1,297.9	6,246.7	1,249.3	711.9	-130.9	9,813.6	22%
2014	3,208.7	1,391.8	6,074.0	1,214.8	602.1	182.3	9,730.8	19%

Source: Author's calculations.

Table 15: Mineral rent calculations, Gold (Pula million)

	Operating surplus, gross	Consumption of fixed capital	Capital stock	Return on capital stock	Total rent	Total rent, 5-yr. moving avg	Per unit rent	Rent/ GOS
2005	69.0	1.2	6.7	1.3	66.5		20,542.8	96%
2006	243.7	56.3	258.9	51.8	135.6		44,875.7	56%
2007	153.6	49.4	189.4	37.9	66.4		24,993.8	43%
2008	275.4	73.3	255.1	51.0	151.1		47,566.4	55%
2009	111.9	78.3	181.3	36.3	-2.6	83.4	-1,605.4	-2%
2010	265.7	69.2	99.0	19.8	176.7	105.4	99,581.6	67%
2011	312.8	35.3	101.2	20.2	257.3	129.7	164,750.0	82%
2012	431.9	58.1	236.6	47.3	326.5	181.8	237,107.5	76%
2013	175.9	88.8	181.0	36.2	50.9	161.7	42,173.4	29%
2014	29.5	42.6	215.7	43.1	-56.2	151.0	-63,633.6	-190%

Source: Author's calculations.

Table 16: Mineral Rent Calculations, Soda Ash (Pula million)

	Operating surplus, gross	Consumption of fixed capital	Capital stock	Return on capital stock	Total rent	Total rent, 5-yr. moving avg	Per unit rent	Rent/ GOS
1994	85.9	7.1	102.1	20.4	58.3	29.5	334.7	68%
1995	127.6	7.2	103.5	20.7	99.7	43.9	494.4	78%
1996	66.0	7.6	108.0	21.6	36.9	47.0	313.2	56%
1997	69.8	7.6	108.2	21.6	40.6	51.8	202.8	58%
1998	84.0	7.4	105.7	21.1	55.5	58.2	292.6	66%
1999	99.1	7.4	106.1	21.2	70.4	60.6	308.0	71%
2000	100.9	8.5	121.1	24.2	68.3	54.3	358.4	68%
2001	126.6	10.9	156.3	31.3	84.5	63.8	336.2	67%
2002	139.3	12.1	173.5	34.7	92.5	74.2	331.8	66%
2003	111.0	11.7	167.3	33.5	65.8	76.3	281.0	59%
2004	105.2	9.8	98.1	19.6	75.8	75.3	286.3	72%
2005	170.0	9.7	90.6	18.1	142.2	88.1	504.2	84%
2006	215.5	9.3	128.6	25.7	180.5	107.3	755.5	84%
2007	264.2	8.6	134.3	26.9	228.7	134.6	818.0	87%
2008	260.8	9.6	160.0	32.0	219.2	169.3	831.7	84%
2009	269.8	13.7	190.4	38.1	218.0	197.7	1,028.6	81%
2010	203.7	10.2	200.1	40.0	153.5	200.0	637.3	75%
2011	354.1	22.2	214.8	43.0	289.0	221.7	1,120.9	82%
2012	428.4	31.1	252.7	50.5	346.7	245.3	1,394.6	81%
2013	528.5	40.4	235.5	47.1	441.0	289.7	1,934.8	83%
2014	595.7	40.3	230.2	46.0	509.4	347.9	1,897.0	86%

Source: Author's calculations.

Table 17: Mineral Rent Calculations, Coal (Pula million)

	Operating surplus, gross	Consumption of fixed capital	Capital stock	Return on capital stock	Total rent	Total rent, 5-yr. moving avg	Per unit rent	Rent/ GOS
1994	3.8	3.3	47.7	7.2	-6.7	-5.3	-7.4	-177%
1995	3.4	3.3	47.1	7.1	-7.0	-6.2	-7.8	-205%
1996	3.4	3.3	46.5	7.0	-6.8	-6.4	-8.9	-198%
1997	4.4	3.0	43.5	6.5	-5.2	-6.2	-6.6	-117%
1998	4.5	3.3	47.5	7.1	-6.0	-6.3	-6.5	-133%
1999	4.3	3.6	51.9	7.8	-7.1	-6.4	-7.6	-168%
2000	4.3	4.0	56.6	8.5	-8.2	-6.7	-8.7	-192%
2001	4.1	4.3	61.8	9.3	-9.5	-7.2	-10.2	-230%
2002	4.1	4.7	67.5	10.1	-10.7	-8.3	-11.3	-261%
2003	4.5	5.2	73.7	11.1	-11.7	-9.5	-14.2	-257%
2004	7.3	4.7	80.5	12.1	-9.5	-9.9	-10.4	-130%
2005	13.3	5.6	87.9	13.2	-5.5	-9.4	-5.6	-41%
2006	17.8	6.1	103.7	15.6	-3.9	-8.3	-4.1	-22%
2007	34.4	8.1	256.9	38.5	-12.3	-8.6	-14.9	-36%
2008	40.9	10.2	371.4	55.7	-24.9	-11.2	-27.4	-61%
2009	15.3	16.6	438.2	65.7	-67.1	-22.8	-90.9	-439%
2010	-10.2	18.2	707.2	106.1	-134.5	-48.5	-136.1	1315%
2011	-42.2	29.4	1,390.2	208.5	-280.2	-103.8	-355.7	664%
2012	68.4	240.6	1,448.5	217.3	-389.5	-179.2	-267.8	-569%
2013	-35.6	165.1	1,470.9	220.6	-421.4	-258.5	-281.7	1183%
2014	-210.1	175.0	1,440.8	216.1	-601.2	-365.3	-351.3	286%

Source: Author's calculations.

Appendix 2: Mineral Rent Calculations

Introduction

Mineral or resource rent can be defined as the value of production minus the costs of production, or equivalently, as the share of the GOS not attributable to the fixed assets used in production. It can be calculated as follows:

Income from sale of resource = value of output

minus intermediate consumption

equals gross value added

minus compensation of employees

minus net taxes on production

equals gross operating surplus

minus consumption of fixed capital

equals net operating surplus

minus normal return to capital

equals net resource rent

Cost of Capital

This calculation requires an assumption about the normal return to capital, or the opportunity cost of capital. The idea of opportunity cost in this instance is that an investor always has at least several alternative investment opportunities. To convince the investor to put their money in any one business, the profit on the investment must be at least as great as the average, or "normal," opportunity for profit from other economic activities that they could invest in, adjusted for the degree of risk relative to other economic activities.

Choosing an appropriate "normal" rate of return to use in the calculation is difficult. Possible reference points are the average RoC in an economy, or the average cost of borrowing, i.e., the long-term bond rate. The main problem with this is that any average will not reflect the level of risk involved in mining investments, which is an important omission because mining is an inherently risky activity. The reference cost of capital also has to appropriately take into account inflation and currency/exchange rate issues. The cost of capital also depends on the nature of the company, with a large mining multinational facing a lower cost of capital than a small, junior explorer.

For Anglo American (a large mining multinational), the cost of capital is said to be 15 percent, presumably measured in U.S. dollars.[13] Junior mining companies presumably would expect the cost of capital to be higher. Private equity investors would typically expect a return on capital of at least 25%.

For Botswana mineral rent calculations, we use a RRoC of 20 percent (for accounts measured in current price pula terms). With an average 5 percent annual depreciation of the pula against the U.S. dollar, this would be broadly comparable to AA's cost of capital.

[13] Anglo American plc Chief Executive Mark Cutifani was quoted in MiningNews.net on December 13, 2013, as saying, "Fifteen per cent RoC is a break-even number."

Appendix 3: Data Availability and Limitations

In conducting rent and natural capital calculations for the present exercise, there have been major data limitations. This largely reflects gaps in the data collected by official bodies, such as the MMEWR and Statistics Botswana. The main data gaps relate to the size of mineral reserves and new discoveries, and the coverage of economic statistics on the mining sector. The WAVES project involves establishing a consistent framework for the collection and compilation of mineral reserves data.

Table 18: Data Availability and Approaches to Resolving Gaps

Variable	Data Availability	Comment
Physical Stock Calculations		
Reserves of minerals by type	Official government data generally not published for reserves or new discoveries. Data published at company level for listed companies, although not annually.	MMEWR does not collect data on reserves from mining companies on a regular basis.
Diamonds	Data available for 1999 and since 2012 for Debswana.	Extrapolate based on historical figures and known production levels; assume increases spread evenly over relevant time period.
Copper-nickel	Data available up to 1987 and for 2013, 2014 for BCL, Tati Nickel & Boseto.	
Coal	Mixture of 1970s data for two major coalfields only, plus more recent data for other fields.	Renewed exploration in other coalfields is improving data availability.
Gold	Data provided for 2012/13/14 only	Extrapolate back to start of production (in 2005)
Soda Ash	Not available	Estimates based on extraction sustainability report from Botash
Mineral extraction by type	Available from DoM/Statistics Botswana	Some delay in incorporating new mining operations. . Generally reported by producer, although BCL and Tati not distinguished
Economic Rent Calculations		
Value of production (EVP)/gross output	EVP data from DoM is not consistent with GO data from StB — but the two sources should agree.	
Gross operating surplus (GOS)	Not published, but provided by SB on request for the period 2004–2014, for the five main minerals.	For pre-2004, approximation of GOS made on the ratio of value added/GOS since 2004.

(continued on next page)

Table 18: Data Availability and Approaches to Resolving Gaps (*continued*)

Variable	Data Availability	Comment
Value added	Data on value added available at the level of most individual minerals since 1994, and for five main minerals since 2004.	VA for individual minerals estimated for pre-1994.
Compensation of employees; consumption of capital (depreciation)	As with GOS	As with GOS
Capital stock	Provided by StB for diamonds, copper-nickel and "other mining" as part of national capital stock data series.	Capital stock data for gold, coal and soda ash estimated by dividing "other mining" series in proportion to data reported by StB at the sub-sectoral level.
Return on capital	No agreed figure to use, especially for valuation of risk	Calculated using 20% (nominal), for all minerals except coal (15%). See earlier discussion
Data on downstream processing	Not yet available	StB to separate data on diamond cutting & polishing from manufacturing, and on diamond sorting, valuation and trading from business services.
Calculation of Value of Mineral Resource Stocks		
Magnitude of deposits	Possible new future discoveries	Ignore possible new discoveries (conservative)
Discount rate for present value calculation	No agreed figure	Used 10% (real). Based on MFDP Planning Offices Manual range (8% for risk-free to 12%)
Future extraction	Not known	Assume current extraction rate until exhaustion.
Future rents	Not known	Assume stable at current levels (in real terms)

Appendix 4

Table 19: Diamonds physical stock accounts (millions of carats)

	Opening Stocks	Extraction/ Production	New Discoveries	Other volume changes	Closing Stocks
1979	1,057.5	4.4	0.0	0.0	1,053.1
1980	1,053.1	5.1	0.0	0.0	1,048.0
1981	1,048.0	5.0	0.0	0.0	1,043.0
1982	1,043.0	7.8	0.0	0.0	1,035.2
1983	1,035.2	10.7	0.0	0.0	1,024.5
1984	1,024.5	12.9	0.0	0.0	1,011.6
1985	1,011.6	12.6	0.0	0.0	999.0
1986	999.0	13.1	0.0	0.0	985.9
1987	985.9	13.2	0.0	0.0	972.7
1988	972.7	15.2	0.0	0.0	957.4
1989	957.4	15.3	0.0	0.0	942.2
1990	942.2	17.4	0.0	0.0	924.8
1991	924.8	16.5	0.0	0.0	908.3
1992	908.3	15.9	0.0	0.0	892.4
1993	892.4	14.7	0.0	0.0	877.6
1994	877.6	15.6	0.0	0.0	862.1
1995	862.1	16.8	0.0	0.0	845.3
1996	845.3	17.7	0.0	0.0	827.6
1997	827.6	20.1	0.0	0.0	807.5
1998	807.5	19.8	0.0	0.0	787.7
1999	787.7	20.7	0.0	0.0	767.0
2000	767.0	24.6	0.0	0.0	742.4
2001	742.4	26.2	0.0	0.0	716.2
2002	716.2	28.4	0.0	0.0	687.8

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Table 19: Diamonds physical stock accounts (millions of carats) *(continued)*

	Opening Stocks	Extraction/ Production	New Discoveries	Other volume changes	Closing Stocks
2003	687.8	30.4	0.0	0.0	657.4
2004	657.4	31.0	0.0	0.0	626.4
2005	626.4	31.9	0.0	168.1	762.6
2006	762.6	34.3	0.0	15.0	743.3
2007	743.3	33.6	0.0	168.1	877.8
2008	877.8	32.6	0.0	5.0	850.2
2009	850.2	17.7	0.0	0.0	832.5
2010	832.5	22.0	0.0	0.0	810.5
2011	810.5	22.9	0.0	0.0	787.6
2012	787.6	20.6	0.0	0.0	767.1
2013	767.1	23.1	0.0	52.4	796.3
2014	796.3	24.7	0.0	93.6	865.2

Table 20: Diamonds, monetary asset accounts (in millions of pula, 5 year moving average, current prices)

	Opening Stock	Extraction/ Production	New Discoveries	Other volume changes	Revaluation	Closing Stock
1979						
1980						
1981		5-year moving average starts in 1983				
1982						
1983	0.0	178.9	0.0	0.0	1,968.1	1,789.2
1984	1,789.2	225.2	0.0	0.0	687.0	2,250.9
1985	2,250.9	277.0	0.0	0.0	794.1	2,768.1
1986	2,768.1	390.4	0.0	0.0	1,523.0	3,900.7
1987	3,900.7	542.9	0.0	0.0	2,066.2	5,424.0
1988	5,424.0	884.5	0.0	0.0	4,282.8	8,822.4
1989	8,822.4	1,198.7	0.0	0.0	4,329.7	11,953.5
1990	11,953.5	1,597.4	0.0	0.0	5,518.7	15,874.8
1991	15,874.8	1,741.1	0.0	0.0	3,185.5	17,319.2
1992	17,319.2	1,855.5	0.0	0.0	3,001.6	18,465.3
1993	18,465.3	1,860.1	0.0	0.0	1,931.8	18,537.1
1994	18,537.1	1,969.2	0.0	0.0	3,024.2	19,592.1
1995	19,592.1	2,229.1	0.0	0.0	4,743.8	22,106.8
1996	22,106.8	2,617.0	0.0	0.0	6,375.9	25,865.7
1997	25,865.7	3,330.2	0.0	0.0	10,040.9	32,576.4
1998	32,576.4	3,535.6	0.0	0.0	5,521.9	34,562.8
1999	34,562.8	4,345.7	0.0	0.0	11,968.7	42,185.7
2000	42,185.7	5,973.5	0.0	0.0	20,157.8	56,370.0
2001	56,370.0	6,917.9	0.0	0.0	14,616.3	64,068.4
2002	64,068.4	7,737.8	0.0	0.0	13,353.7	69,684.3
2003	69,684.3	8,275.9	0.0	0.0	10,814.0	72,222.3

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Table 20: Diamonds, monetary asset accounts (in millions of pula, 5 year moving average, current prices)

	Opening Stock	Extraction/ Production	New Discoveries	Other volume changes	Revaluation	Closing Stock
2004	72,222.3	8,096.6	0.0	0.0	5,039.2	69,165.0
2005	69,165.0	8,543.5	0.0	45,021.0	-28,959.0	76,683.4
2006	76,683.4	9,453.2	0.0	4,134.1	11,184.7	82,548.9
2007	82,548.9	9,838.8	0.0	49,223.1	-31,703.2	90,230.1
2008	90,230.1	10,636.3	0.0	1,631.3	16,280.9	97,506.1
2009	97,506.1	5,927.2	0.0	0.0	-32,977.0	58,601.9
2010	58,601.9	7,771.8	0.0	0.0	24,567.1	75,397.2
2011	75,397.2	9,809.7	0.0	0.0	28,811.2	94,398.7
2012	94,398.7	9,558.8	0.0	0.0	7,991.3	92,831.1
2013	92,831.1	11,824.5	0.0	26,766.5	6,026.5	113,799.6
2014	113,799.6	14,750.5	0.0	55,942.3	-12,691.1	142,300.2

Table 21: Coal, physical stock accounts (million tons)

million tonnes	Opening Stocks	Extraction/ Production	New Discoveries	Other volume changes	Closing Stocks
1979	35,909	0.4			35,909
1980	35,909	0.4			35,908
1981	35,908	0.4			35,908
1982	35,908	0.4			35,907
1983	35,907	0.4			35,907
1984	35,907	0.4			35,907
1985	35,907	0.4			35,906
1986	35,906	0.5			35,906
1987	35,906	0.6			35,905
1988	35,905	0.6			35,904
1989	35,904	0.7			35,904
1990	35,904	0.8			35,903
1991	35,903	0.8			35,902
1992	35,902	0.9			35,901
1993	35,901	0.9			35,900
1994	35,900	0.9			35,900
1995	35,900	0.9			35,899
1996	35,899	0.8			35,898
1997	35,898	0.8			35,897
1998	35,897	0.9			35,896
1999	35,896	0.9			35,895
2000	35,895	0.9			35,894
2001	35,894	0.9			35,893
2002	35,893	1.0			35,892
2003	35,892	0.8			35,892

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Table 21: Coal, physical stock accounts (million tons) *(continued)*

million tonnes	Opening Stocks	Extraction/ Production	New Discoveries	Other volume changes	Closing Stocks
2004	35,892	0.9			35,891
2005	35,891	1.0			35,890
2006	35,890	1.0			35,889
2007	35,889	0.8			35,888
2008	35,888	0.9			35,887
2009	35,887	0.7			35,886
2010	35,886	1.0			35,885
2011	35,885	0.8			35,884
2012	35,884	1.5			35,883
2013	35,883	1.5			35,882
2014	35,882	1.7			35,880

Table 22: Coal, monetary asset accounts (in millions of pula, 5 year moving average, current prices)

million tonnes	Opening Stock	Extraction	New Discoveries	Other volume changes	Revaluation	Closing Stock
1979						
1980		5-year moving average starts in 1983				
1981						
1982						
1983	0.0	0.2	0.0	0.0	2.0	1.8
1984	1.8	0.4	0.0	0.0	2.1	3.6
1985	3.6	0.8	0.0	0.0	4.9	7.7
1986	7.7	1.4	0.0	0.0	7.7	13.9
1987	13.9	2.3	0.0	0.0	11.7	23.3
1988	23.3	3.5	0.0	0.0	14.7	34.5
1989	34.5	4.7	0.0	0.0	17.2	47.0
1990	47.0	6.0	0.0	0.0	19.1	60.1
1991	60.1	5.6	0.0	0.0	1.2	55.7
1992	55.7	5.7	0.0	0.0	6.9	56.9
1993	56.9	4.7	0.0	0.0	-5.6	46.7
1994	46.7	3.6	0.0	0.0	-7.2	35.9
1995	35.9	2.8	0.0	0.0	-4.8	28.3
1996	28.3	2.5	0.0	0.0	-1.0	24.9
1997	24.9	3.6	0.0	0.0	14.3	35.6
1998	35.6	4.8	0.0	0.0	16.7	47.6
1999	47.6	5.0	0.0	0.0	7.4	50.0
2000	50.0	5.2	0.0	0.0	7.4	52.1
2001	52.1	4.9	0.0	0.0	1.2	48.5
2002	48.5	3.4	0.0	0.0	-11.5	33.7

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Table 22: Coal, monetary asset accounts (in millions of pula, 5 year moving average, current prices) *(continued)*

million tonnes	Opening Stock	Extraction	New Discoveries	Other volume changes	Revaluation	Closing Stock
2003	33.7	1.9	0.0	0.0	-12.4	19.3
2004	19.3	-0.6	0.0	0.0	-20.0	0.0
2005	0.0	-2.5	0.0	0.0	-2.5	0.0
2006	0.0	-3.6	0.0	0.0	-3.6	0.0
2007	0.0	-5.6	0.0	0.0	-5.6	0.0
2008	0.0	-11.4	0.0	0.0	-11.4	0.0
2009	0.0	-21.1	0.0	0.0	-21.1	0.0
2010	0.0	-54.0	0.0	0.0	-54.0	0.0
2011	0.0	-98.5	0.0	0.0	-98.5	0.0
2012	0.0	-255.4	0.0	0.0	-255.4	0.0
2013	0.0	-338.7	0.0	0.0	-338.7	0.0
2014	0.0	-476.7	0.0	0.0	-476.7	0.0

Table 23: Copper-nickel, physical stock accounts (tonnes)

tonnes	Opening Stocks	Extraction/ Production	New Discoveries/ Classification	Other volume changes	Closing Stocks
1979	903,354	30,736	0	0	872,618
1980	872,618	30,995	770	0	842,394
1981	842,394	36,097	-44,728	0	761,569
1982	761,569	36,131	166,161	0	891,599
1983	891,599	38,477	84,695	0	937,817
1984	937,817	40,075	171,669	0	1,069,411
1985	1,069,411	41,257	-90,337	0	937,817
1986	937,817	40,310	255,151	0	1,152,658
1987	1,152,658	35,461	-2,198	0	1,114,998
1988	1,114,998	46,967	2,014	0	1,070,045
1989	1,070,045	41,468	2,014	0	1,030,592
1990	1,030,592	39,634	2,014	0	992,972
1991	992,972	39,870	2,014	0	955,116
1992	955,116	39,286	2,014	0	917,844
1993	917,844	41,753	2,014	0	878,105
1994	878,105	41,821	2,014	0	838,298
1995	838,298	39,701	2,014	0	800,611
1996	800,611	46,562	2,014	0	756,063
1997	756,063	41,764	2,014	0	716,314
1998	716,314	36,563	2,014	0	681,765
1999	681,765	39,037	2,014	0	644,742
2000	644,742	45,195	2,014	0	601,561
2001	601,561	41,636	2,014	0	561,939
2002	561,939	45,486	2,014	0	518,467
2003	518,467	51,689	2,014	0	468,792

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Table 23: Copper-nickel, physical stock accounts (tonnes) *(continued)*

tonnes	Opening Stocks	Extraction/ Production	New Discoveries/ Classification	Other volume changes	Closing Stocks
2004	468,792	43,914	2,014	0	426,892
2005	426,892	58,998	2,014	0	369,909
2006	369,909	55,888	2,014	0	316,035
2007	316,035	49,121	2,014	0	1,758,340
2008	1,758,340	52,086	-32,834	0	1,673,420
2009	1,673,420	53,425	-31,910	0	1,588,085
2010	1,588,085	48,890	-41,110	0	1,498,085
2011	1,498,085	31,780	-38,220	0	1,428,085
2012	1,428,085	44,501	-25,499	0	1,358,085
2013	1,358,085	77,542	4,895	0	1,285,438
2014	1,285,438	61,875	-41,973		1,181,590

Table 24: Copper-nickel, monetary asset accounts (in millions of pula, 5 year moving average, current prices)

	Opening Stock	Extraction	New Discoveries	Other volume changes	Revaluation	Closing Stock
1979						
1980		5-year moving average starts in 1983				
1981						
1982						
1983	0.0	-9.7	-21.3	0.0	11.6	0.0
1984	0.0	-4.1	-17.4	0.0	13.4	0.0
1985	0.0	8.6	-18.9	0.0	104.1	76.5
1986	76.5	25.9	164.2	0.0	27.6	242.4
1987	242.4	45.2	-2.8	0.0	235.1	429.4
1988	429.4	97.7	170.1	0.0	380.4	882.2
1989	882.2	130.4	257.2	0.0	210.8	1,219.7
1990	1,219.7	163.1	336.5	0.0	153.9	1,547.0
1991	1,547.0	199.9	410.0	0.0	147.1	1,904.2
1992	1,904.2	221.9	461.7	0.0	-16.4	2,127.6
1993	2,127.6	254.5	498.4	0.0	58.8	2,430.3
1994	2,430.3	263.0	514.2	0.0	-160.4	2,521.1
1995	2,521.1	274.8	566.0	0.0	-150.9	2,661.4
1996	2,661.4	352.5	619.0	0.0	424.9	3,352.8
1997	3,352.8	325.2	636.7	0.0	-514.8	3,149.5
1998	3,149.5	283.7	634.5	0.0	-711.6	2,788.7
1999	2,788.7	325.9	682.6	0.0	48.3	3,193.6
2000	3,193.6	402.6	728.4	0.0	379.8	3,899.2
2001	3,899.2	352.5	692.3	0.0	-789.1	3,449.8
2002	3,449.8	405.8	729.4	0.0	172.9	3,946.4
2003	3,946.4	504.6	798.1	0.0	603.6	4,843.5

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Table 24: Copper-nickel, monetary asset accounts (in millions of pula, 5 year moving average, current prices) *(continued)*

	Opening Stock	Extraction	New Discoveries	Other volume changes	Revaluation	Closing Stock
2004	4,843.5	461.3	858.8	0.0	-724.6	4,516.5
2005	4,516.5	719.8	997.5	0.0	2,014.1	6,808.3
2006	6,808.3	1,095.0	1,601.9	0.0	3,152.9	10,468.1
2007	10,468.1	1,295.6	2,156.5	0.0	1,199.7	12,528.7
2008	12,528.7	1,090.2	-687.2	0.0	-359.6	10,391.7
2009	10,391.7	781.9	-467.0	0.0	-1,783.4	7,359.3
2010	7,359.3	304.3	-255.9	0.0	-3,920.2	2,879.0
2011	2,879.0	-14.4	17.3	0.0	-2,910.7	0.0
2012	0.0	-344.7	197.5	0.0	-542.2	0.0
2013	0.0	-174.7	0.3	0.0	-174.9	0.0
2014	0.0	194.7	-132.1	0.0	1,958.2	1,631.4

Table 25: Soda ash, physical stock accuonts (tonnes)

[units] [2]	Opening Stocks	Production – soda ash	Production – salt	Other volume changes	Closing stocks
1991	2,273,544	63,154	6,733		2,210,390
1992	3,368,985	122,367	79,917		3,246,618
1993	3,760,412	126,000	106,922		3,634,412
1994	4,424,473	174,222	252,233		4,250,251
1995	5,013,329	201,641	392,258		4,811,688
1996	5,311,522	117,739	107,961		5,193,783
1997	5,937,134	199,990	184,533		5,737,144
1998	6,372,744	189,700	139,805		6,183,044
1999	6,793,034	228,693	167,610		6,564,341
2000	6,676,766	190,489	184,755		6,486,277
2001	7,671,976	251,234	179,792		7,420,742
2002	8,250,948	278,767	315,113		7,972,181
2003	8,518,169	234,236	229,432		8,283,933
2004	8,800,642	264,695	216,745		8,535,947
2005	9,458,332	281,976	196,443		9,176,356
2006	9,329,254	238,942	208,412		9,090,312
2007	9,375,943	279,625	262,852		9,096,318
2008	9,565,194	263,566	170,994		9,301,628
2009	9,144,563	211,975	237,414		8,932,588
2010	8,885,940	240,898	364,734		8,645,042
2011	9,035,256	257,851	446,525		8,777,405
2012	8,809,062	248,629	367,749		8,560,433
2013	8,538,775	227,913.0	521,306.0		8,310,862
2014	8,975,269	268,529.0	515,311.0		8,706,740

Table 26: Soda ash, monetary asset accounts (in millions of pula, 5 year moving average, current prices)

	Opening Stock	Extraction/ Production	New Discoveries	Other volume changes	Revaluation	Closing Stock
1991						
1992		5-year moving average starts in 1994				
1993						
1994	0.0	62.0	89.7	0.0	531.5	559.2
1995	559.2	82.7	160.9	0.0	104.5	741.9
1996	741.9	46.7	42.8	0.0	-277.7	460.2
1997	460.2	81.9	75.6	0.0	311.8	765.8
1998	765.8	81.9	60.4	0.0	38.1	782.3
1999	782.3	96.9	71.0	0.0	150.1	906.5
2000	906.5	74.7	72.5	0.0	-186.0	718.2
2001	718.2	99.1	70.9	0.0	241.8	931.8
2002	931.8	118.9	134.5	0.0	164.2	1,111.5
2003	1,111.5	99.7	97.7	0.0	-146.7	962.8
2004	962.8	104.6	85.7	0.0	54.0	997.8
2005	997.8	111.5	77.7	0.0	100.5	1,064.5
2006	1,064.5	109.4	95.4	0.0	14.6	1,065.1
2007	1,065.1	149.4	140.4	0.0	370.4	1,426.5
2008	1,426.5	164.6	106.8	0.0	220.1	1,588.9
2009	1,588.9	165.5	185.4	0.0	16.5	1,625.2
2010	1,625.2	196.1	297.0	0.0	171.3	1,897.3
2011	1,897.3	228.8	396.2	0.0	134.0	2,198.7
2012	2,198.7	249.3	368.7	0.0	81.0	2,399.2
2013	2,399.2	278.8	637.7	0.0	-56.4	2,701.7
2014	2,701.7	375.1	719.8	0.0	534.1	3,580.5

Table 27: Gold, physical asset accuonts (in kilograms)

	Opening Stocks	Extraction/ Production	New Discoveries/ Classification	Other volume changes	Closing Stocks
2005	33,760.4	3,235.0		0.0	30,525.5
2006	30,525.5	3,021.0		0.0	27,504.5
2007	27,504.5	2,655.0		0.0	24,849.5
2008	24,849.5	3,175.6		0.0	21,673.9
2009	21,673.9	1,626.0		0.0	20,047.9
2010	20,047.9	1,774.2		0.0	18,273.7
2011	18,273.7	1,561.5		0.0	16,712.2
2012	16,712.2	1,377.0		0.0	15,335.2
2013	15,335.2	1,205.9		0.0	14,129.3
2014	14,129.3	883.6	-3,568.5	0.0	9,677.3

Table 28: Gold, monetary asset accounts (in millions of pula, 5 year moving average, current prices)

	Opening Stock	Extraction/ Production	New Discoveries	Other volume changes	Revaluation	Closing Stock
2005						
2006		5-year moving average starts in 2009				
2007						
2008						
2009	0.0	44.3	0.0	0.0	350.9	306.5
2010	306.5	76.4	0.0	0.0	247.9	478.0
2011	478.0	104.7	0.0	0.0	296.3	669.5
2012	669.5	150.8	0.0	0.0	467.2	986.0
2013	986.0	130.7	0.0	0.0	24.0	879.3
2014	879.3	84.8	-342.6	0.0	97.6	549.6

Wealth Accounting and the Valuation of Ecosystem Services

Wealth Accounting and the Valuation of Ecosystem Services (WAVES) is a global partnership led by the World Bank that aims to promote sustainable development by ensuring that natural resources are mainstreamed in development planning and national economic accounts.

www.wavespartnership.org