

## **Mineral and Petroleum Resources Royalty Bill**

### **Unrefined and refined minerals**

#### **THE FIRST SALEABLE POINT**

The Mining and Petroleum Resources Royalty Bill will be brought into being as a means of extracting a charge (resource rent) from the extractors of our mineral resources for the benefit of all South Africans.

The minerals sector has some unique attributes that have to be taken into account when determining the Royalty rate.

- Mineral resources are not only non-renewable but in certain cases are in decline as their extraction has been in progress for over a hundred years<sup>1</sup> and their value has long ago gone into establishing commercial centres as London overseas and Johannesburg at home.
- The commodities generally are traded on international markets and the producers have little control over prices.
- The process of extraction to arrive at a final saleable product is accompanied by many intermediate costs.
- There are significant mineral exploration costs before mining can commence.
- The extraction rate can be regulated over the life of the deposit to maximise profits.
- There is permanent and collateral damage to the environment when a mine is developed. While closure costs are included under the MPRDA, these can only have limited scope and cannot take into account every future requirement.

There have to date been several attempts at determining the point in the process flow stream at which to charge a royalty<sup>2</sup>.

As a general rule it is desirable that the minerals be taxed as close as possible to source in the mine, where a transaction would usually occur and a mutually acceptable value of the commodity would normally be agreed between buyer and seller<sup>3</sup>. The product that exchanges hands at this "First Saleable Point" is generally in the form of "concentrate".

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<sup>1</sup> For instance gold and diamonds.

<sup>2</sup> Reflected in the fact that this is the third revision of the Bill.

<sup>3</sup> This value is usually verified independently by the shipper.

## CONCENTRATES OF SPECIFIC MINERALS: Unrefined

### Antimony

Main pre-concentration process: milling and screening

Stibnite and arsenopyrite are the principal antimony minerals. 65% Sb is required to be in the concentrate at the first saleable point.

### Barite

Main pre-concentration process: milling and screening

The mining of barite ore serves as a source of two significant products: barite and barium sulphate. Barium sulphate is derived by flotation. Concentrates of 90% min  $\text{BaSO}_4$  are offered with buyers willing to only buy a high-grade product in excess of 97%  $\text{BaSO}_4$ .

### Beryllium

Main pre-concentration process: milling and screening

The mineral beryl contains less than 15%  $\text{BeO}$ . Where this is mined commercially and at large-scale, flotation is used as the primary concentrating stage. Where this is exploited on a small-scale, hand-picking is also used. Concentrates grading 70% beryl concentrate are acceptable to the market as a first saleable point.

### Bauxite

Main pre-concentration process: milling and screening

There is no bauxite mining taking place in South Africa. Deposits are too small to be uneconomic. Bauxite ore, partially processed to give alumina, is imported into South Africa and further treated here.

### Chromium

Main pre-concentration process: milling and screening

The chromium mineral or ore is called chromite ( $\text{FeO} \cdot \text{Cr}_2\text{O}_3$ ). It is largely sold with two critical variables considered:

1. Chrome content and
2. Cr:Fe ratio.

Concentrates grading 30% - 45% is usually on offer. In South Africa the *in-situ* chrome typically contains between 40% and 46%  $\text{Cr}_2\text{O}_3$ . Buyers are presently requesting concentrations of 47% and higher. We set the first saleable point at **46%  $\text{Cr}_2\text{O}_3$ ; to be revised as changes become apparent.**

The Cr:Fe ratio is important when used for the manufacture of ferrochrome sector. A good concentrate ratio for resale is 10:1.

### Clay

Main pre-concentration process: washing

South Africa has numerous types of clay. Of significant importance is the clay used for the manufacture of bricks (construction stream) and clay, like kaolinite, used in the paper and ceramic sectors.

Clay used for the manufacture of bricks is typically dug from the ground and immediately manufactured into bricks by being mixed and the paste set into moulds, ready for firing. We draw a distinction between clay mining and clay blending (with other components).

There is no free market for the trade of brick clay as these are typically vertically integrated products and subject to local variability in price and composition.

Kaolinitic clay would undergo additional processing after washing. Hydro-cycloning and classifying may be used. The fine kaolin is then retained for the paper industry and the coarse kaolin for the filler industry.

### **Coal**

Main pre-concentration process: milling followed by washing.

South Africa, like many other countries, produces various types of coal (bituminous, anthracitic etc). The coals are similarly processed to achieve different specifications; Predictable behaviour of the coal is required with respect to heat content and waste products. Treatment of coal also includes grading into distinct sizes. Though there are numerous grades of coal the ultimate use of coal is linked to its physico-chemical properties. The three definitive properties for coal are Type, Grade and Rank. The industry already classifies coal by its calorific value (CV).

The CV ranges used in South Africa are;

Grade A	CV larger than 27.5GMJ/kg
Grade B	CV greater than 26.5 GMJ/kg and less than 27.5 GMJ/kg
Grade C	CV greater than 25.5 GMJ/kg and less than 26.5 GMJ/kg
Grade D	CV less than 25.5 GMJ/kg

Grade D, in South Africa represents nearly 90% of what is produced and is used for the production of electricity.

### **Cobalt**

Main pre-concentration process: washing

Cobalt is typically a by-product of copper mining. Zambia has some of the largest cobalt resources in Africa. The lack of substantial copper mining in South Africa at present means that cobalt production is low. Exploration for copper and nickel ores is ongoing in South Africa and cobalt could re-emerge as a mineral commodity.

Cobalt is acceptable at 7% Co in a polyminerale matte<sup>4</sup>. This is the first saleable point.

### **Copper**

Main pre-concentration process: numerous

Copper ores vary in copper content as well as other physico-chemical properties. Many methods of extraction are employed. In South Africa there is one significant producer

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<sup>4</sup> Matte is an intermediate product after firing

although there are numerous exploration programs underway. Copper concentrate of 20-30% Cu marks the first saleable point.

### **Diamonds**

Main pre-concentration process: milling and screening

Diamonds are found in three predominant geological settings; kimberlites, alluvial (including fluvial) and marine settings. In South Africa in excess of 80% of the volume of diamonds is derived from kimberlites with the remainder coming from alluvial and marine sources.

Within the earth's crust diamonds have a very low concentration. A grade of 5cph is equivalent to 0.000001%.

Marine deposits would require screening and alluvial deposits may require some crushing before screening. A final concentrate may have a ratio of 5:1 or 2:1 (other heavy minerals: diamonds). Once the diamond is separated its value is determined. This valuation is a process agreed to between the Government Diamond Valuator and the mining company. Only at this point of agreed valuation has the product reached its first saleable point.

### **Dimension-Stone**

Main pre-concentration process: slabbing

In South Africa Granite is the largest dimension-stone product. Other dimension-stones would include sandstone, slate and shale. These are typically cut from the deposit and dressed before resale. No grade is available to quantify the product, however the valuation is influenced by other variables like colour and texture. The first saleable point for dimension stone would therefore be where an independent and verifiable valuation can be made of the partially processed block (similar to uncut diamonds).

### **Fluorspar**

Main pre-concentration process: milling and screening

Fluorspar reaches its first saleable point at a concentration of 80% concentrate.

### **Germanium**

Main pre-concentration Process: milling and screening

Germanium occurs within zinc and copper ores. Its first saleable point is as a 99.99% refined product.

### **Graphite**

Main pre-concentration process: milling followed by flotation

Graphite schists are one of the most common sources of graphite. These would have graphite concentrations below 10% carbon. Upgrading of the graphite yields intermediate products that are not readily saleable. These include 60% - 80% carbon content. At 86% carbon content graphite reaches its first saleable point.

## **Iron**

Main pre-concentration process: roasting and magnetic separation

Iron ore occurs as haematite and magnetite. Iron is also derived from ilmenite (FeTi). Gravity concentration and flotation are also used in the concentrating of iron ores. 61% Fe content is acceptable as a first saleable point.

## **Lead**

Main pre-concentration process: gravity concentration followed by leaching or flotation

Lead carbonate (cerussite), lead sulphide (galena) and lead sulphate (anglesite) are the predominant lead ores. Galena is by far the most dominant mineralogical source of lead. Lead reaches its first saleable point at a concentrate with 50% Pb.

## **Limestone**

Main pre-concentration process: milling and screening

Limestone, also referred to as calcite, is the most important source of calcium carbonate. Limestone is treated by milling and screening. Some froth flotation may be used if a finer particle size or slurry fraction is required.

Limestone reaches its first saleable point when it contains 54% CaCO<sub>3</sub>.

## **Lithium**

Main pre-concentration process: roasting followed by leaching

Lithium is a product derived from spodumene, itself containing between 5% and 7.5% Li. Lithium does not have an intermediate concentration product that is saleable and therefore reaches its first saleable point at 99.5% LiCO<sub>3</sub> (lithium carbonate).

## **Manganese**

Main pre-concentration process: hand-sorting; DMS or jigging

Manganese is concentrated by several methods. More modern methods, to handle higher volumes, combine a combination of dense media separation and jigging. The first saleable product is the Mn-ore required for furnaces. These need to have the following minimum specifications:

- Mn 48%, and
- Si + Al less than 11%

## **Mercury**

Main pre-concentration process: milling and screening before going into a furnace.

Cinnabar is the main mercury-containing mineral. Gravity separation and flotation may be used in the pre-concentration step. When heated in a kiln the mercury vapours that arise are drawn off and condensed. A high-grade product is made and mercury reaches at least 99.9% purity at its first saleable point.

## **Mica**

Main pre-concentration process: milling and screening

Mica is a pegmatite mineral. Crushing is important for liberation but it is always more sought as larger “book sizes”. Small mica pieces (less than ~25mm) are called scrap and are crushed and concentrated. The first saleable point for mica is 48% concentrate.

### **Molybdenum**

Main pre-concentration process: milling and screening

Molybdenum occurs within copper sulphide ores. Its first saleable point is as a 99.99% refined product.

### **Nickel**

Main pre-concentration process: roasting followed by flotation

Primary nickel is, without exception, derived from poly-mineralic ores that also contain copper, PGM's, Co and Fe. Intermediate concentrates of Ni-Cu matte. Concentrations close to 5% Ni are typical with high-grade Ni concentrates grading at +12%. However when Ni reaches 1.4% content then it is a saleable product.

### **Niobium**

Main pre-concentration process: milling followed by flotation

Perovskite and pyrochlore are the primary niobium minerals. The first saleable product is a concentrate of 45% Ni<sub>2</sub>O<sub>5</sub>.

### **Silver**

Main pre-concentration process: flotation

Silver-sulphide minerals are the dominant source of silver. These minerals are common in poly-mineralic base metal deposits and will occur in these deposits. The first saleable product is when a polymineralic base metal ore is upgraded to contain 800g/t Ag.

### **Talc**

Main pre-concentration process: dry milling and screening

The largest consumer of talc is the paint industry which requires talc to be 98.5% and minus 325 m mesh. This represents the first saleable point.

### **Tin**

Cassiterite is the dominant tin mineral. This is separated in the same way as heavy minerals sands. Some tin deposits are hard-rock and require milling before proceeding. The first saleable point is at 80% cassiterite concentration.

### **Titanium (Ilmenite; Rutile)**

Main pre-concentration process: gravity separation

Ilmenite and Rutile are the primary titanium minerals. These occur in modern as well as palaeo beach sands. After a process of gravity separation a concentrate mixture of rutile, ilmenite and other heavy minerals like monazite and zircon could be present. These are separated using wet magnetic separation or flotation. The concentrate of ilmenite and rutile are at the first saleable point when they are:

- 38% TiO<sub>2</sub> concentration in ilmenite, and
- 53% rutile concentration

### **Tungsten**

Scheelite (CaWO<sub>4</sub>) and wolfram are the principal tungsten minerals. These are not mined in South Africa and the depressed prices for several decades has meant that most of South Africa's tungsten deposits are uneconomic.

### **Uranium**

Main pre-concentration process: milling and screening

Uranium occurs as a component in several minerals and in at least 24 geological settings. The concentration of uranium is therefore limited by the type of paragenesis and uranium concentrate. Uranium concentrate is called "yellow cake" and contains 80-90% uranium at the first saleable point. Restrictions on the transport of uranium means that "yellow cake" is the only saleable product.

### **Zinc**

Main pre-concentration process: roasting followed by flotation

The primary zinc mineral is sphalerite. These are commonly present in polymineralic base metal deposits. After the flotation of galena (lead separation), sphalerite is floated. The first saleable product is when a concentrate of 27% Zn is produced.

### **Definitions of Refined Minerals**

Gold: Gold is refined once processed to at least 99,5 per cent purity.

Silver: Silver is refined once processed to silver metal or silver nitrate.

Platinum Group Metals: Platinum Group Metals are refined once processed to at least 99,9 per cent purity.