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International Raw Materials Observatory

Fostering international raw materials cooperation

Analysis on Industry and Trade

Operational report

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Abstract

This report contains the operational analysis on Industry and Trade of mineral raw materials in reference to five countries: Australia, Canada, Japan, South Africa and the USA. This is the outcome of INTRAW Work Package 1.4, mapping the context, the evolution and the performance of industry and trade in these reference countries. The aims of this report are to review the mining and raw materials competitive context and framework among the reference countries.

Authors

Nuno Bonito, Nelson Cristo, Marta Peres and Tânia Peças (Assimagra).

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1. Executive summary

The specific aims of this report include the characterisation of industrial clusters related to raw materials in Australia, Canada, Japan, South Africa and the United States (USA) and the way these clusters affect trade and global competition. The methodology for the analysis of the mineral raw materials industry and trade follows the economic model developed by Michael Porter (Porter, 1990). This model, also known as the *Diamond* model, addresses industry competitiveness and economic development,

With the exception of Japan, all reference countries have rich mineral endowments. Australia is the world leader in the production of brown coal, lead, rutile, zircon, nickel, uranium, and zinc. It ranks among the world top-five producers for bauxite, copper, gold, iron ore, ilmenite, silver, tantalum, industrial diamonds, lithium, and black coal. Canada is the world leader in the production of potash and it ranks among the top-five global producers for diamonds, uranium, aluminium, cobalt, tungsten, and platinum group metals (PGMs). South Africa is the first in the production of PGMs and has also significant production of gold, diamonds, and iron ore. The USA also have a rich mineral endowment, but they currently prefer imports over domestic production. The USA are one of the biggest economies in the world, and they produce 21 of the 65 non-fuel mineral commodities used in the national economy. However, domestic production meets less than 50% of the demand and the USA are 100% reliant on imports for some rare elements or metals, such as indium, niobium, and tantalum.

All these countries show, from the second half of the XX century, a coupled evolution, matching complementary comparative advantages (e.g. rich mineral endowments and large manufacturing industries), bringing together raw materials suppliers and consumers. Key Critical Success Factors of the mineral industry in the export orientated countries (Australia, Canada and South Africa) include:

1. Rich and diverse mineral endowment, with large ore deposits;
2. Stable rule of law (security of tenure, protection of property, reliable legal system);
3. Stable mining regulatory framework;
4. Proximity to consumers of mineral resources;
5. Absence of trade barriers;
6. Facilitated access to land (low levels of competition between different land-uses;
7. Stable political and societal context;
8. Reliable transport infrastructure (roads, railways, ports);
9. Efficient access to capital;
10. Competitive energy prices;
11. Availability of a skilled workforce.

Key CSFs for a successful mineral industry that emerge from the analysis of Japan and the USA (trade oriented countries) include:

1. Free trade agreements and active economic co-operation with raw materials producing countries;
2. Stable institutional and societal environments;
3. Competitive energy prices;
4. Large domestic market with spending power;
5. Sophisticated R&D infrastructure;
6. Availability of skilled and well-educated workforce;
7. Highly industrialised economy, based on the manufacturing of knowledge-intensive and high-quality, high value-added products.

The most relevant determinants of the minerals industry competitiveness that arise from the analysis of the reference countries, according with Michael Porter's *Diamond* model, are:

Factor Conditions:

- Rich mineral endowment (or no mineral endowment - Japan);
- Stable legal framework;
- Stable taxation framework;

- Sparsely populated areas/no social conflicts;
- Skilled and well-educated workforce;
- Access to reliable transport infrastructure;
- Strong education and R&D culture.

Demand Conditions:

- Proximity to market;
- Sophisticated demand of downstream industries (pushing all stages of the value chain).

Context for firm strategy and rivalry:

- Stable rule of law (security of tenure, protection of property, legal system;
- Access to land/defined mineral ownership scheme;
- Free trade agreements and active economic co-operation;
- Simple mining permitting processes;
- Competitive energy prices (leveraging vertical integration
- Access to risk finance.

Related and Supporting Industries:

- Developed supporting industries (mining equipment, technology and services sector);
- Availability of public reliable geological data.

2. Introduction

2.1 Objectives and structure

The transactional analysis of industry and trade (D1.5) is the output of INTRAW Work Package 1.4, undertaking a systematic analysis of industry and its agents in the mineral raw materials sector in five reference countries: Australia, Canada, Japan, South Africa and United States of America (USA). This will contribute to the development of action plans for industry, trade, recycling and substitution in Work Packages 2.4 and 2.5, and to the design and functions of the EU International Observatory for Raw Materials in Work Package 3. It will be disseminated through the activities in Work Package 4.

As a review Work Package 1 has mapped the contextual environment of Australia, Canada, Japan South Africa and the USA (D1.2). The findings from this contextual analysis were the starting point for the development of a transactional analysis on raw materials in the reference countries, presented in three reports that addresses respectively Research and Innovation (D1.3), Education and Outreach (D1.4), and Industry and Trade (this report, D1.5).

The specific aims of this report include the characterisation of industrial clusters related to raw materials in the reference countries, and the way these clusters affect trade and global competition. This will allow the identification of key drivers beyond successful industrial development and trade of raw materials.

The analysis is based on: a) desk research; b) collection of insight offered by the panel of international experts on industry and trade that is cooperating with INTRAW; c) organisation of data and information on each country in a structured way; d) validation of data and information collected by raw materials experts from each reference country.

The results are presented by country. For each country the following six chapters are provided:

1. **The Industry in a Global Context.** This includes a global overview of the territorial organisation, the governance regime and the mineral raw materials industry structure, including the mining and processing activities. Recent data on strategic and significant minerals exploited and processed is provided in detail, highlighting the relation of this sector with the general economy. Energy and industrial minerals used in agriculture are not considered and will be referred only in the context of the analysis and whenever the sources of statistical information do not provide disaggregated data. Recycling of metals is also addressed, to facilitate the understanding of the evolution of the dependence on external sources of mineral raw materials in each reference country.
2. **Economic and Market Assessment.** This chapter includes an economic analysis considering not only trade but also production and reserves of selected mineral raw materials, expenditures, taxes/royalties and internal consumption of minerals. Considering the lack of accurate data on domestic consumption the estimates are based in the apparent metal consumption rate. This chapter also includes a brief reflection on the reasons behind the country's ranking in mining investment attractiveness and competitiveness.
3. **Assessment of the Regulatory framework.** This chapter provides a general overview over the legislative framework pertaining to the mining industry and the mineral raw materials supply in each country.
4. **Assessment of Raw Materials Supply.** This includes considerations on the (perception of) supply risks of mineral raw materials, providing insight on the strategies each country is using to ensure a stable supply of strategic and critical minerals.
5. **Strategic Analysis.** This chapter identifies the Strengths, Weaknesses, Opportunities and Threats (SWOT) of

the minerals industry in each country. The SWOT analysis evaluates the internal and external factors that are favourable and unfavourable to reinforcing the position of the minerals raw materials industry. This structured evaluation informs the analysis of the industry competitive context, highlighting the factors that shape the competitiveness of the mineral raw materials industry and trade in each country.

6. **Conclusions.** This chapter summarises the key drivers behind successful industrial development and trade of mineral raw materials.

This report also includes a general conclusion chapter that provides a comparative evaluation of the outcomes of the competitive context, highlighting critical success factors and key drivers of the mineral raw materials industry in the five reference countries.

2.2 Scope and method of assessment

This report includes a systematic analysis of the competitive context of the mineral raw materials industry and trade in the five reference countries. Energy and agricultural mineral raw materials are not within the scope of INTRAW, and therefore are not addressed in this report. Since the five reference countries produce, process and trade mainly metallic minerals, industrial and construction minerals are largely produced and consumed domestically, and for this reason are not relevant for the purposes of this report.

It is important to highlight that information on minor metals (e.g. cadmium, gallium, mercury, indium), usually produced as by-products of base metals, is scarce or absent. This is the case because many of these metals had little or no economic value in the past, and only recently become valuable (or critical) for some new industrial processes. In addition, the recovery of many of by-product metals normally happens during the smelting operation and the information on recovery rates is not disclosed by the smelters. These metals are being used in electronics and information technologies and are attracting increasingly attention by governments, including the EU, Japan and the United States.

In some cases the statistical data on resources and reserves are unclear, likely because of unclear concepts in some compilations. Therefore, the figures on the percentage of the world reserves and on the life expectancy of mining until depletion must be considered with caution.

The methodology for the analysis of the mineral raw materials industry and trade follows the economic model developed by Michael Porter in his book *The Competitive Advantage of Nations* (Porter, 1990). This model, also known as the *Diamond* model, addresses industry competitiveness and economic development, highlighting the role of industrial clusters to explain economic prosperity in certain countries and regions.

This *Diamond* model as applied here uses historical data of the economy and industry in each of the five reference countries. It classifies the data gathered on six interrelated broad factors that interact with each other to creating conditions, where innovation and improved competitiveness occurs. It thus represents the dynamics of the processes that lead to competitive advantages. The six broad factors considered are:

1. **Factor Conditions,** including mineral endowment, human resources, physical resources, knowledge resources, capital resources and infrastructure. A country's relative position in vital factors such as skilled labour or infrastructure, determines its national competitiveness. Both, the level of individual factors and the overall composition of the resource mix, are considered. Factors can be country specific or industry specific;
2. **Context for Firm Strategy and Rivalry** encompasses specific determinants of the mineral raw materials industry, namely cost inputs, drivers of innovation and existing constraints. This context determines how companies are created, organized and managed in each reference country, as well as the nature and extent of rivalry;
3. **Demand Conditions** of the market push industries to innovate faster

and to enhance the value of their products. The nature of demand for industries' products and services requires consideration of both quantity and quality of demand. However, as the market for metals has expanded in the last years in Asia, the fast-growing demand and its impact on short-term prices affected in some cases the established standards for metal commodities. The evolution of Asian financial markets (and the current global downturn) is bringing back to normalcy demand specifications for metal commodities;

4. **Related and Supporting Industries** produce inputs that are important for innovation and internationalisation. The existence of an industrial cluster[1] that provides cost-effective inputs boosts the efficiency and competitiveness of the companies included in that cluster. On the contrary, the absence of competitive suppliers and related industries does not favour or leverage competitive advantages;
5. **Chance Events,** as disruptive developments outside the control of companies and governments that allow entry of new players who exploit opportunities arising from a reshaped industry structure;
6. **Government Action** by the definition of policies that influence each of the first four factors.

The analysis undertaken included two adaptations in the terms of reference of the *Diamond* model:

- Government action was included in the Factor 'Conditions' or in the 'Context for Firm Strategy and Rivalry', because mining and trade are intrinsically dependent on national and international government policies;
- The impact of multinational companies on the competitive context of the reference countries was incorporated into the first four factors of the *Diamond* model. The consideration of the active presence and action of multinational companies in all five reference countries, tapping into the location advantages of other countries to reinforce their competitiveness is especially relevant in the analysis of Australia, Canada, Japan and the United States.

The analysis of the competitive context contributes to a better understanding of drivers that foster the mineral raw materials industry. This approach allows the definition of critical success factors and key drivers that must be considered in developing country based strategies and policies for the mineral raw materials industry.

1 Michael Porter (in Porter, 1990) defines industry cluster as a *geographical proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and externalities*. They include, for example, suppliers of specialized inputs such as components, machinery, and services, and providers of specialized infrastructure. Clusters also often extend downstream to channels and customers and laterally to manufacturers of complementary products and to companies in industries related by skills, technologies, or common inputs. Finally, many clusters include governmental and other institutions—such as universities, standards-setting agencies, think tanks, vocational training providers, and trade associations—that provide specialized training, education, information, research, and technical support.

3. Australia

3.1 The industry in a global context

3.1.1. General Economy

Australia is considered a trading nation (Adams et al., 2014). The ratio of trade to GDP currently stands at a 42%, with exports contributing to around 20% of GDP (2012). The mining sector is a major driver for export growth (between 2000 and 2010, the value of exports from mining rose by over 120% (Garnett, 2015). The table below summarises Australia's general economic data.

Table 3.1: Australia's general economic data.

General Data[1].	
AREA:	7,692,024 Km^2.
POPULATION (2014):	23.7 million, 1.4% annual growth.
WORLD RANKING (Largest Export Economy, 2013):	19th.
GROSS DOMESTIC PRODUCT (GDP, 2014):	In 2014 the total GDP was USD 1.45 trillion and the GDP per capita was USD 67,558[2]. It represents 2.34% of the world economy.
EMPLOYMENT (2014):	6.1% unemployment; 11.8 million employed.
INDUSTRIAL SECTORS (Contribution to GDP, 2013):	Services (58%); Construction (9%); Manufacturing (7%); Mining (7%); Retail Trade (5%).
TOP MINERAL EXPORTS (2013):	Iron ore (USD 68.2 billion); gold (USD 21.6 billion); copper ore (USD 5.91 billion); manganese ore (USD 1.51 billion); zinc ore (USD 1.43 billion); lead ore (USD 1.23 billion); nickel ore (USD 789 million); bauxite (USD 635 million).
TOTAL EXPORTS (2013):	USD 265 billion.
TOTAL IMPORTS (2013):	USD 224 billion.
TRADE BALANCE (2013):	USD 40.4 billion.

1 The Observatory of Economic Complexity – (OEC) (data provided by UN-COMTRADE – 2013) and Reserve Bank of Australia (http://www.rba.gov.au/snapshots/economy-snapshot/index.html).

2 OECD, Country Statistical Profile: Australia 2015.

3.1.2. Territorial Organization

Australia has a federal regime, with three levels of government (Federal, State and Local) and is organized in eight major divisions (6 states and 2 mainland territories[1]):

All the Australian states and territories have important mineral resources, but for their contribution to the economy the most significant are Western Australia, Queensland and the Northern Territory.

1 Although there are several other minor territories, the two most relevant are Australian Capital Territory (ACT) and Northern Territory (NT).

3.1.3. Minerals Industry Contribution to Economy

Since the 19th century, Australia has been one of the largest world producers of various mineral raw materials. Australia produces about 43 elements from the periodic table, has known resources for another 13 and is prospective for further nine[2]. In the country there are 405 operating mines and 235 mineral processing centres[3].

2 http://www.ga.gov.au/data-pubs/data-and-publications-search/publications/australian-minerals-resource-assessment/introduction
3 http://www.australianminesatlas.gov.au/mapping/downloads.html#spreadsheets

Figure 3.1: Australia – States and Territories (source: http://www.nationalmap.gov.au/).

The most economically significant metal ores considering existing resources and production/exports are bauxite, copper, gold, iron, manganese, mineral sands (zirconium or titanium), nickel, tantalum, uranium, zinc, lead and silver.

Other important minerals are produced in smaller scale and with less relative economic significance (diamonds, lithium, rare earth elements). The production of other industrial/construction minerals is also significant; however, these materials are not included in the group of commodities considered in this analysis, because they are not normally traded internationally.

The most significant processing industries (by scale of operations) are cement production (not in the scope of this report), base metal (e.g. copper, nickel) smelting and refining, the production of alumina and aluminium from bauxite, and iron- and steel-making from iron ore.

Contribution to GDP and Employment

The mineral sector in Australia is one of the most important industrial sectors in the country, being the 4th largest contributor among all industrial sectors to the gross domestic product (GDP). The contribution values were around 8% in 2009-2010 (ABS) – 2012) 10% in 2011-12 and 7.2% in 2014-15 (ABS, 2015).

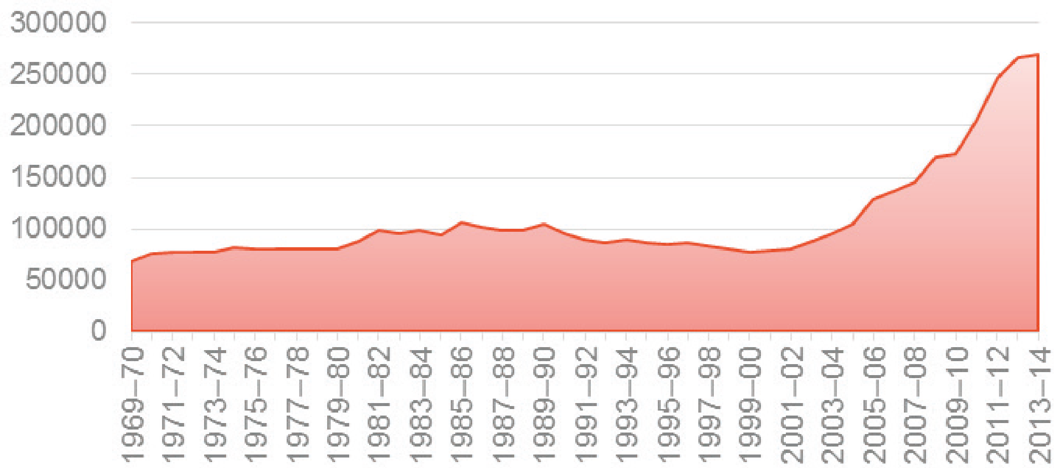
In 2013-2014 the sector generated direct employment for 269,000 people (Australian Government, 2014). ***Figure 3.2*** presents the evolution of employment in Australia's mining industry for the last 45 years.

Mining was the industry sector in Australia with the fastest rate of job growth over the past decade, driven by the reaction of companies to the strong demand for minerals from Australia's trading partners. In the last decade the employment in mining doubled as the industry responded to historically high mineral prices with the construction of new capacities.

The average mining contribution to the total employment of the country over the last 45 years is around 1.4%, achieving a maximum of 2.3% from 2012 to 2014 (***Figure 3.3***).

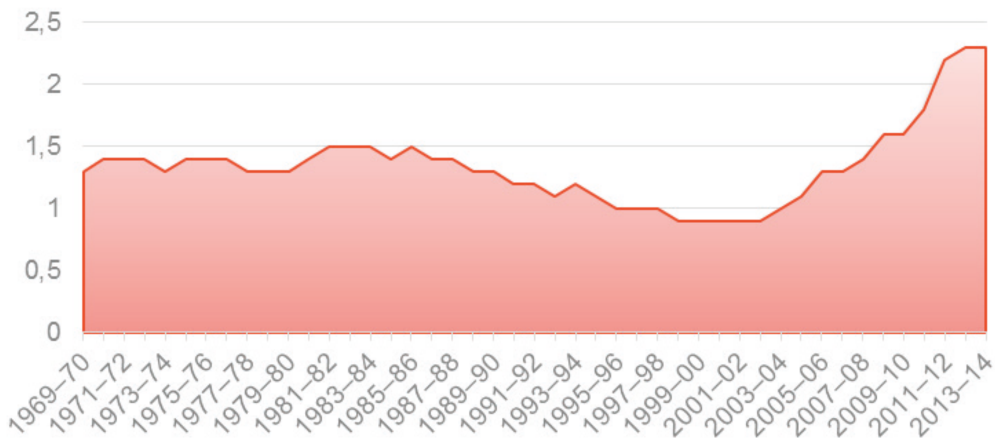
Direct employment for the main mineral commodities is shown in ***Table 3.2*** (Australian Bureau of Statistics, 2014). Despite the general growth of direct employment in mining, the numbers of employment in the non energy minerals sector started to

Figure 3.2: Employment in the Australian Mining Industry between 1969 and 2014.



Source: Government of Australia, 2014

Figure 3.3: Contribution to total Employment from the Australian Mining Industry between 1969 and 2014 (in percent).



Source: Government of Australia, 2014

decrease in 2012 (-8.7% in 2014 in comparison to 2012), expressing the effect of the slowdown of the world economy. The decrease of employment in copper (16.9%), bauxite and nickel mining was considerable (- 67.4%), expressing the direct effect of the reduction of prices and exports of these commodities. On the other hand, employment in the mineral sands (10.1%) and oil and gas extraction (28.5%) sectors increased significantly between 2012 and 2014.

Contribution to Total Exports

In 2013 the mining sector, excluding the energy minerals or derivates, contributed to more than 40% of Australia's total exports (value)[4].

4 OEC - http://atlas.media.mit.edu/en/profile/country/aus/#Exports

Table 3.2: Direct employment in the mining industry in Australia (number of workers and change in percent).

		2011-12	2012-13	2013-14	2011-12 to 2012-13	2012-13 to 2013-14
		no. of workers	no. of workers	no. of workers	% change	% change
06 Coal mining		45,016	43,147	43,383	-4.2	0.5
07 Oil and Gas Extraction		17,435	18,935	22,406	8.6	18.3
08 Metal ore mining						
	0801 Iron ore mining	25,654	28,182	30,213	9.9	7.2
	0803 Copper ore mining	7,087	7,210	6,061	1.7	-15.9
	0804 Gold ore mining	17,102	16,566	14,973	-3.1	-9.6
	0805 Mineral sand mining	3,207	3,188	3,530	-0.6	10.7
	0807 Silver-lead. Zinc, mining	4,926	5,238	4,851	6.3	-7.4
	0802,0806,0809 Bauxite, nickel and other metal ore mining	*9,512	6,705	5,680	-29.5	-15.3
Total 08 Metal ore mining		**67,489**	**67,089**	**65,308**	**-0.6**	**-2.7**
09 Non-metallic mineral mining and quarrying		13,320	12,754	12,249	-4,2	-4
10 Exploration and other mining support services		50,944	49,165	43,575	-3,5	-11,4
Total mining		194,205	191,090	186,920	-1,6	-2,2

* estimates have a relative standard error of 10% to less than 25% and should be used with caution (source: http://www.abs.gov.au/AUSSTATS/abs@.nsf/mf/8415.0).

3.1.4. Non-Energy Non-Agricultural Minerals

3.1.4.1. Major Metallic Minerals[5] [6]

The tables below summarise data on resources, production and exports of minerals. The values of resources and reserves provided are, unless otherwise specified, based on public reporting made accordingly with CRIRSCO[7]-aligned reporting standards.

5 Values for resources and production provided by the Australian Government, 2014 and Australian Bureau of Statistic, 2012, unless otherwise specified.

6 Values for export destination provided by the Observatory of Economic Complexity (http://atlas.media.mit.edu/en/visualize/tree_map/hs92/export/aus/show/2603/2013/) unless otherwise specified.

7 CRIRSCO is a grouping of representatives of organisations that are responsible for developing mineral reporting codes and guidelines in Australasia (JORC), Canada (CIM), Chile (National Committee), Europe (PERC), Mongolia (MPIGM), Russia (NAEN), South Africa (SAMREC) and the USA (SME). The combined value of mining companies listed on the stock exchanges of these countries accounts for more than 80% of the listed capital of the mining industry (http://www.crirsco.com/).

Table 3.3: Bauxite resources, production and exports.

Bauxite (Alumina and Aluminium)	
Economic Demonstrated Resources (EDR;[1] 2014)	
Quantities:	6,464 Mt
World Ranking:	2nd.
World %:	23% of the global resources.
Production (2013-14)	
Quantities:	80 Mt of bauxite.
World Ranking:	Bauxite-1st, alumina - 2nd and aluminium – 6th.
World %:	31% of global production of bauxite.
Production Centres The main production centres are located at the Gove Mine in Northern Territory; the Weipa Mine in the northern part of Queensland; and the Huntly, Willowdale, and Worsley Mines in Western Australia (USGS, 2013).	
Mines:	6 operating mines.
Processing Centres	27 mineral processing centres (refineries, smelters, other; ABS, 2012).
Exports (2013-14)	
Volume:	Bauxite: 15,688 Kt; alumina: 18,492 kt; aluminium: 1,541 Kt.
Value:	Bauxite: AUD 546 Million; alumina: AUD 5,711 Million; aluminium: AUD 3,475 Million.
Destinations (2013):	Japan (29%), South Korea (21%), Thailand (11%), Indonesia (7.5%), China (5.8%), Malaysia (4.5%), other Asia (14%), others (7.2%).

1 "EDR is a measure of the resources that are established, analytically demonstrated or assumed with reasonable certainty to be profitable for extraction or production under defined investment assumptions. Classifying a mineral resource as EDR reflects a high degree of certainty as to the size and quality of the resource and its economic viability" (http://www.abs.gov.au/). It should be noted that this term is not recognized for public reporting in CRIRSCO-aligned reporting standards and codes, and is defined purely for Australian government use. However, there are disagreements over the form of measurement used by the government, While EDR figures are used for Australian government purposes, it is important to note that within the Australian resources industry there is a school of thought that considers the methodology used to calculate EDR's is flawed and has resulted in an unrealistic and optimistic government view of Australia's mineral resources that can be economically extracted. There is now an industry-funded research project underway applying a different methodology, however, the results from this project are not yet available. On this matter, there is non published draft discussion paper from July 2011, authored by Chris Cairns, and titled: "*Failure of Geoscience Australia's 'Economically Demonstrated Resources' to Properly Inform Government Policy on Mineral Exploration Incentives*".

Table 3.4: Copper resources, production and exports.

Copper	
Economic Demonstrated Resources (EDR; 2014)	
Quantities:	93.1 Mt (Cu metal).
World Ranking:	2nd .
World %:	13% of the global resources.
Production (2013-14)	
Quantities:	985 Kt of copper.
World Ranking:	5th.
World %:	6% of global production.
Production Centres[1] Major Australian copper deposits occur at Olympic Dam in South Australia and at Mount Isa in Queensland. Smaller projects occur in New South Wales, Queensland, Western Australia and Tasmania.	

Mines:	13 operating mines dedicated exclusively to copper exploitation are referenced, but copper is also produced in significant quantities in mines where other minerals are exploited, such as Olympic Dam (Cu-Au-U). 87 operating mines are registered where copper is or can be extracted.
Processing Centres:	20 copper processing centres are registered, most of them in Queensland.
Exports (2013-14)	
Volume:	1,035 Kt of copper.
Value:	AUD 8,263 Million.
Destinations:	China (30%), Japan (23%), India (23%), South Korea (11%), Philippines (5%), Germany (3.5%), Bulgaria (3%), other (1.5%).

1 http://www.australianminesatlas.gov.au/?site=atlas

Table 3.5: Gold resources, production and exports.

Gold	
Economic Demonstrated Resources (EDR;2014)	
Quantities:	9,808 t
World Ranking:	1st.
World %:	18% of global resources.
Production (2013-2104)	
Quantities:	In 2014-15 Australia produced 272 t of gold, according to the Department of Industry and Science (Australian Government, 2015). The historic high for gold production - 306 t - occurred in 1997-98.
World Ranking:	2nd.
World %:	10% of global production.
Production Centres Gold resources occur in all Australian states and the Northern Territory. Western Australia produces the largest amount of gold in the country, with around 70% of total.	
Mines:	Major production is concentrated in 15 mines and 50% of the reserves are located in Western Australia (Boddington and Kalgoorlie), South Australia (Olympic Dam) and New South Wales (Cadia East).
Processing centres:	Usually gold is processed onsite.
Exports (2013-14)	
Volume:	277 t of gold.
Value:	AUD 13,009 Million.
Destinations:	Hong Kong (37%), China (36%), Turkey (7.1%), India (6.4%), Thailand (6.1%), United Kingdom (3.2%), Other (4.2%).

Table 3.6: Iron ore resources, production and exports.

Iron Ore	
Economic Demonstrated Resources(EDR; 2014)	
Quantities:	52,578 Mt.
World Ranking:	1st.
World %:	28% of global resources.
Production (2013-14)	
Quantities:	678 Mt.
World Ranking:	2nd.

World %:	20% of global production.
Production Centres More than 97% of the iron ore production occurs in Western Australia in the Pilbara region.	
Mines:	40 operating mines.
Processing Centres:	Two iron ore smelters and steel making plants, one in South Australia and the other in New South Wales.
Exports (2013-14)	
Volume:	651 Mt of iron ore and pellets, 874 Kt of iron and steel.
Value:	Combined value of AUD 75,408 Million.
Destinations:	China (77%), Japan (13%), South Korea (7.4%), Other Asia (2.6%).

Table 3.7: Lead, silver and zinc resources, production and exports.

Lead, Silver and Zinc	
Economic Demonstrated Resources (EDR; 2014)	
Quantities:	Lead: 35 Mt; silver: 82.5 Kt; zinc: 62.3 Mt.
World Ranking:	Lead: 1st / silver: 2nd / zinc: 1st.
World %:	Lead: 40% / silver: 16% / zinc: 25%; of global resources.
Production (2013-14)	
Quantities:	Lead: 722 Kt / silver: 1,898 t / zinc: 2,119 Kt.
World Ranking:	Lead: 2nd / silver: 4th / zinc: 2rd.
World %:	Lead: 13% / silver: 7% / zinc: 11% of global production.
Production Centres Queensland is the region with the largest amount of Australian resources.	
Mines:	21 Mines.
Processing Centres:	7 lead and zinc plants (smelter, refinery and concentrates). 1 silver plant. Also some processing can occur in the mines to produce concentrates as raw material for the plants referred above.
Exports (2013-14)	
Volume:	Lead: 861 Kt / zinc:3,208 Kt / silver: 465 t.
Value:	Lead: AUD 1,954 Million / zinc: AUD 2,476 Million / silver: AUD 587 Million.
Destinations:	Lead: South Korea (29%), Belgium-Luxembourg (21%), China (17%), Japan (14%), Germany (12%), Others (7%). Zinc: China (36%), Belgium-Luxembourg (17%), South Korea (16%), Japan (11%), Spain (5.1%), Germany (3.2%), Others (11.7%). Silver: United Kingdom (35%), Switzerland (34%), United States (11%), China (7.6%), India (6.3%), Singapore (3.1%), Others (3%).

Table 3.8: Manganese resources, production and exports.

Manganese	
Economic Demonstrated Resources (EDR; 2014)	
Quantities:	186.8 Mt[1].
World Ranking:	5th.
World %:	11% of global resources.
Production (2013-14)	
Quantities:	7,434 Kt of beneficiated manganese ore.
World Ranking:	3rd.

World %:	19% of Global production.
Production Centres The major production in Australia comes from three mines – Woodie Woodie in Western Australia, and Groote Eyland and Bootu Creek in the Northern Territory.	
Mines:	5 operating mines are registered.
Processing Centres:	3 plants (2 smelters and 1 for concentrates).
Exports (2013-14)	
Volume:	7,138 Kt of manganese ore.
Value:	AUD 1,522 Million.
Destinations:	China (70%), South Korea (12%), India (7.2%), Japan (3.6%), Others (7.2%).

1 http://www.ga.gov.au/scientific-topics/minerals/mineral-resources/manganese

Table 3.9: Mineral Sands – Titanium and Zirconium resources, production and exports.

Mineral Sands – Titanium and Zirconium	
Economic Demonstrated Resources (EDR; 2014)	
Quantities:	Ilmenite: 200.2 Mt / rutile: 32.1 Mt / zircon: 57.8 Mt.
World Ranking:	Ilmenite: 2nd / rutile: 1st / zircon: 1st.
World %:	Ilmenite: 11% / rutile: 56% / zircon: 61% of global resources.
Production (2013-14)	
Quantities:	Ilmenite: 1,351 Kt / rutile: 242 Kt / zircon: 681 Kt.
World Ranking:	Ilmenite: 1st / rutile: 1st / zircon: unknown.
World %:	Ilmenite: 18% / rutile: 43% / zircon: unknown.
Production Centres Mineral sands are produced in major quantities in Western Australia, Queensland and Victoria.	
Mines:	12 operating mines.
Exports (2013-2014)	
Volume:	Ilmenite: 1,218 Kt / rutile: 326 Kt / zircon: 751 Kt.
Value:	Ilmenite: AUD 180 Million / rutile: AUD 288 Million / zircon: AUD 229 Million.
Destinations:	Titanium: Malaysia (84%), United Kingdom (5.2%), Papua New Guinea (5%). Zirconium: Germany (39%), United States (25%), China (14%), Thailand (11%), Vietnam (2.5%).

Table 3.10: Nickel resources, production and exports.

Nickel	
Economic Demonstrated Resources (EDR; 2014)	
Quantities:	19 Mt.
World Ranking:	1st.
World %:	25% of global resources.
Production (2013-14)	
Quantities:	214 Kt.
World Ranking:	4th.
World %:	9% of global production.

Production Centres Nickel is produced mainly in Western Australia (90%), Queensland and Tasmania.	
Mines:	17 operating mines.
Production Centres:	1 smelter and 3 refineries.
Exports (2013-14)	
Volume:	242 Kt.
Value:	AUD 3,216 Million.
Destinations:	China (82%), Canada (8.3%), Brazil (5.4%), India (2.4%), Japan (1.3%), Others (0.6%).

Table 3.11: Tantalum resources, production and exports.

Tantalum	
Economic Demonstrated Resources (EDR; 2014)	
Quantities:	67 Kt.
World Ranking:	1st.
World %:	67%.
Production (2013-14) Australia has historically been the world's largest producer of tantalum (as tantalite concentrates), providing approximately half of the world's mine output.	
Production Centres 77% of tantalum (tantalite concentrates) production is located in Western Australia and New South Wales.	
Mines:	2 operating mines.
Refineries/Smelters:	1 beneficiation plant.
Exports:	Japan (100%).

Table 3.12: Tin resources, production and exports.

Tin	
Economic Demonstrated Resources (EDR; 2014)	
Quantities:	366 Kt.
World Ranking:	5th.
World %:	5% of global resources.
Production (2013-2014)	
Quantities:	6.5 Kt.
World Ranking:	7th.
World %:	3% of global production.
Production Centres Tin ore is exploited mainly in Queensland, New South Wales and Tasmania.	
Mines:	4 operating mines.
Processing Centres:	1 smelter.
Exports (2013-2014)	
Volume:	12,611 t.
Value:	AUD 131 Million.
Destinations:	Malaysia (99.7%), Others (0.3%).

3.1.4.2. Major Industrial Minerals

Table 3.13: Diamonds resources, production and exports.

Diamonds	
Economic Demonstrated Resources (EDR; 2014)	
Quantities:	250.5 Mc (Million carats).
World Ranking:	1st.
World %:	34% of global resources.
Production (2013-14)	
Quantities:	10.4 Mc.
World Ranking:	4th for industrial grade diamonds.
World %:	15% of global productions.
Production Centres Western Australia (Argyle; Ellendale; Venus Smoke Creek) and Northern Territory (Merlin).	
Mines:	2.
Processing centres:	2.
Exports (industrial diamonds; 2013-14)	
Volume:	11.4 Mc.
Value:	AUD 309 Million.
Destinations:	United Kingdom (55%), United States (11%), Singapore (8.4%), Hong Kong (7.9%), Canada (7.6%), Japan (3.1%), Thailand (1.4%), Others (5.6%).

Table 3.14: Lithium resources, production and exports.

Lithium	
Economic Demonstrated Resources (EDR; 2014)	
Quantities:	1,538 Kt.
World Ranking:	3rd.
World %:	11%.
Production (2012)[1]	
Quantities:	Spodumene Concentrates: 452 Kt.
Production Centres Mount Cattlin Mine in Western Australia.	
Mines:	1.
Refineries/Smelters:	1.
Exports	
Destinations:	Indonesia (85.7%), India (8.7%) and Netherlands (5.6%).

1 http://www.ga.gov.au/scientific-topics/minerals/mineral-resources/lithium

Table 3.15: Rare Earth Elements resources, production and exports.

Rare Earth Elements (REE)	
Economic Demonstrated Resources (2014)	
Quantities:	3.19 Mt
World Ranking:	4th
World %:	2%
Production (2014)	
Quantities:	2,500 t

Production Centres	
Mt Weld mine is located in Western Australia. It is considered the first significant rare earth mine opened outside of China and is the richest known deposit of rare earths in the world[1]	
Mines:	1
Processing Plants:	1
Exports	
Destinations:	No reliable recent information was found. Australia historically exported heavy mineral sands for the extraction of REE and thorium with amounts reaching 265 Kt in 2008. Indonesia (87%) and Germany (13%) are indicated as the main destinations in 2013 for a group that includes Rare Earths and unwrought/waste or scrap. Mt Weld mine is expected to be in production for twenty years, producing an estimated 33 000 tonnes annually of rare earth concentrates.

1 http://www.australianmining.com.au/news/mt-weld-rare-earths-mine-officially-open

3.1.5. Recycling

The increase in world demand for metals and the forecast for continued growth in the coming years poses a major challenge to a sustained supply of raw materials.

Even countries with large mineral deposits and major producers, such as Australia, are looking into the recycling/re-use of metals as fundamental to balance supply and demand of raw materials in the future.

Regardless of whether it is an increasingly important industrial activity to recover metals, recycling is also closely related to minimisation or prevention of the environmental impacts of mining. Recycling activities are covered by regulations in all reference countries. The impact of recycling regulations in mining does not only contributes to increasing the sustainability of the industry, but also helps in gaining better public opinion on mining and metals production.

From the economic perspective, the re-use of metals, such as aluminium, iron/steel or copper, for the ‘secondary’[8] production of commodities can be beneficial, if these materials can be utilised in conventional processing plants without additional costs.

Australia has a high (public) acceptance of metal recycling, achieving recycling rates of 90% of the total household waste produced (figures from 2008-2009; Hyder Consulting Pty Ltd, 2011b, p. 41 in Brulliard et al., 2012). From the 5,001,300 t of metal waste produced, 4,512,700 t (above 90%) was reprocessed into recycled materials. The high recovery rate achieved for metals is partially driven by the higher value of metals compared to other recyclables, and financial incentives to limit disposal to landfills.

The good position of Australia in recycling is exemplified by aluminium beverage can recycling rate (Figure 3.4). In 2010 Australia recycled 67% of these cans, a rate above the USA, the UK, France or Spain[9]. As a consequence, more than 2 Mt of scrap are shipped overseas every year (Golev and Corder, 2014), mainly to China and India, representing a significant export income[10].

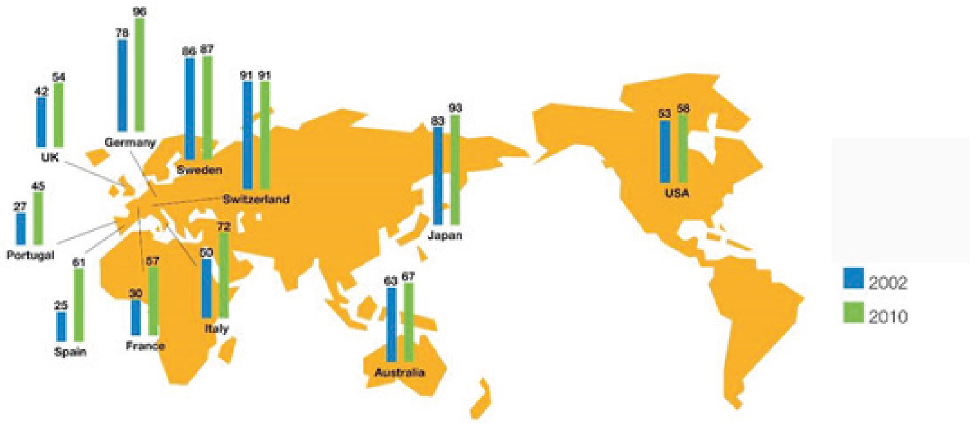
Australia is also making progress on electronic waste (e-Waste) recycling. The Australian Government established the National Television and Computer Recycling Scheme (NTCRS) in 2011 to encourage recycling of e-Waste (Government of Australia – Department of Environment, 2014). This scheme introduced a compulsory requirement for manufacturers that make or import TV sets and computers above a certain volume to financially support the recycling of these products. This measure helped to establish the infrastructures to develop recycling and the figures show that in 2012-2013 40,813

8 The term ‘secondary production’ is used to distinguish the metals recovered/recycled from scrap from those resulting from ‘primary’ mine production.

9 Although there is space for improvement, as the Switzerland and Japan examples show.

10 The main issue that justifies the export of scrap instead of “domestic” processing is the high price of shipping costs inside Australia.

Figure 3.4: Aluminium beverage can recycling % by country.



Source: Planet Ark, 2012

t of e-Waste were recycled (a recycling rate of near 30%), with estimated values for 2013-2014 above 65%, exceeding the defined growth target. The goal of NTCRS is to achieve a recycling rate of e-Waste of 80% by 2021-22 (Government of Australia – Department of Environment, 2014).

Apart from the environmental benefits related to improved waste management (less landfilling, emissions, etc.) e-Waste recycling is important from an economic perspective, as e-Waste contains significant quantities of high value metals, such as rare earths or gold. The recycling of critical metals (e.g. rare earths), which is being developed primarily in consumer countries that are highly dependent on imports (e.g. Japan), could represent an important opportunity to increase the availability of these raw materials in Australia, where they can be recovered not only from waste, but also as by-products from mining and the processing of other minerals. Considering this, the Australian mineral recycling industry has a significant growth potential.

The following key points highlight the potential for enhancing recycling of metals in Australia (Golev, and Corder, 2014):

- Approximately AUD 4.3 Billion of income per year would be generated, if waste metals were fully recovered;
- The recovery of metals from waste streams could cover 50% of the annual metal consumption;
- A large quantity of the scrap metal collected in Australia is currently being exported to smelter facilities in South East Asia. This is due to the high costs of domestic transport;
- The energy requirement for most recycled metals is 50% up to 99% lower compared to primary metal production: ferrous metals (58%), aluminium (92%), copper (65%), nickel (90%), zinc (76%), lead and tin (99%);
- More than 98% of the metals used in developed countries are iron, aluminium, copper, zinc, and manganese.

3.2 Economic and market assessment

3.2.1. Reserves and Production

Australia holds for several minerals some of the world's largest resources. It has the world's largest reserves of (non-industrial) diamonds, iron ore, gold, lead, ilmenite, rutile, zircon, nickel and tantalum, lead, zinc and the second largest for bauxite, copper, and silver (***Figure 3.5***).

Five elements account for 90% of Australia's total metal production (in volume): iron, aluminium, copper, zinc and manganese.

This report considers the Economic Demonstrated Resources (EDR) and the Accessible Economic Demonstrated Resources (AEDR)[11]. The Joint Ore Reserves Committee (JORC) code is used in Australia to report the ore resources and reserves in the country, but EDR gives a wider perspective of the resources and

11 AEDR are the resources included in the EDR that are accessible for mining, considering the technical, the economic, political, social and environmental aspects.

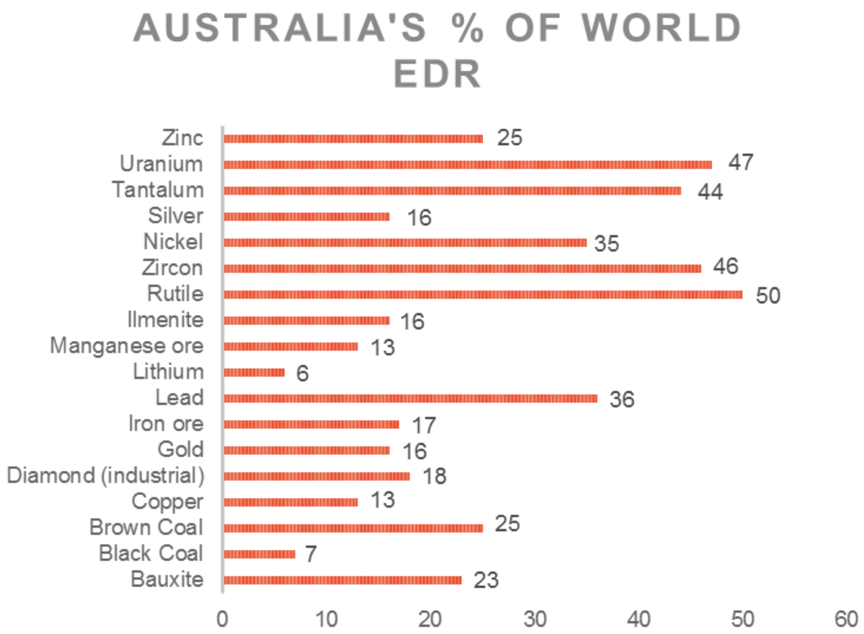
is considered the key national reporting category[12]. EDR is the highest category in the national inventory and combines categories of the JORC code ("Proved Reserves" plus "Probable Reserves") plus the measured resources and indicated resources.

The Australian Government uses the ratio between AEDR and current mine production as an indicator of a resource's expected life. For most of the Australian commodities, the AEDR can sustain current mine production rates for several decades (Geoscience Australia, 2014)[13]. The resources with the longest life at the current rates of production are brown coal (465 years), uranium (170 years), ilmenite (145 years), rutile (115 years) and black coal (100 years). Resources with a life of less than 50 years at current rates of production are diamonds (20 years); manganese ore (30 years), gold (35 years), zinc (40 years) and silver (45 years).

12 Australia's National Classification System for Identified Mineral Resources (2009) (http://www.ga.gov.au/data-pubs/data-and-publications-search/publications/aimr/appendix-2#heading-1)

13 http://www.ga.gov.au/corporate_data/82311/82311_Identified_Minerals.pdf

Figure 3.5: Australia's percentage of World Economic Demonstrated Resources.



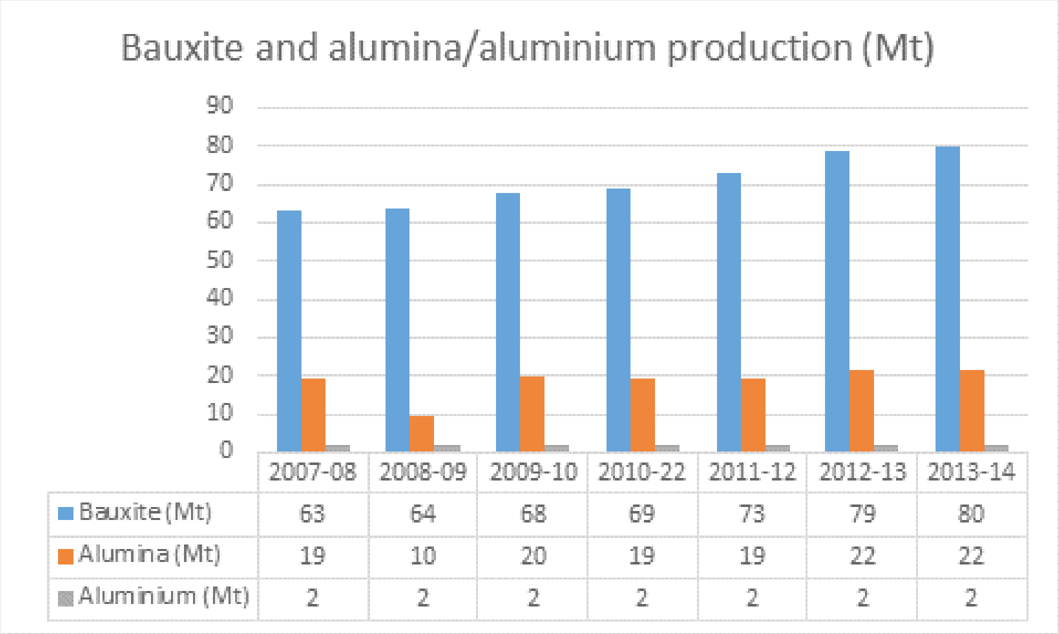
Source: ABS, 2012

The resource life is merely indicative and obviously does not guarantee that the resource will be extracted Because global mining companies use a global approach, looking for the sites where mineral deposits offer the most attractive returns on investment, exploitation rates of a given deposit in a given country can change dramatically over time. Several variables influence exploitation rates, including the quality of the resource, environmental, social and political factors, land access, infrastructure, and scale and location of the mining operation.

A snapshot of the added value potential of the minerals industry in Australia can be obtained by comparing ores produced and products processed. ***Figures 3.6 and 3.7*** show respectively, the relation between mine production of bauxite and iron, and the relation to their processed products (alumina, aluminium and raw steel) for the period 2007-2014.

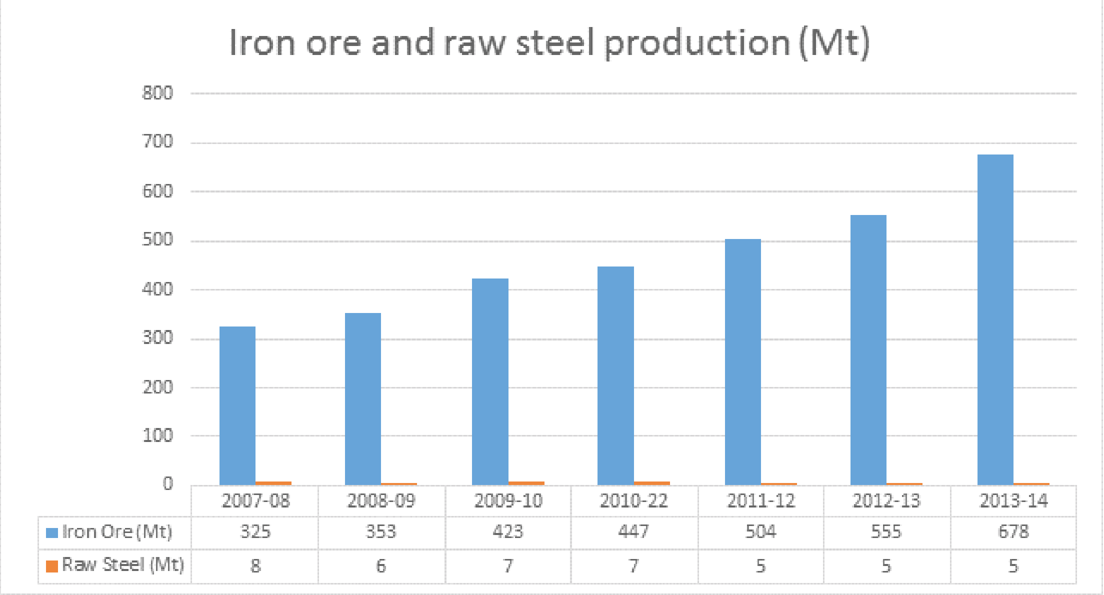
From the previous figures it is possible to understand the main relations between production, namely the imbalance, between bauxite and iron ore on one side, and derived processed products, such as alumina or raw steel, on the other side. Bauxite mine production has remained constant over the period shown, whereas iron ore production has almost

Figure 3.6: Mine production of bauxite and processed products (alumina and aluminium) (2007-2014).



Source: Australian Resources and Energy Statistics, 2013

Figure 3.7: Mine production of iron ore and processed products (raw steel) (2007-2014).



Source: Australian Resources and Energy Statistics, 2013

doubled, mainly due to the increase in demand from the Asian market. The processed products (alumina, aluminium, and raw steel) for these two metals did not follow the same trends. Raw steel production has decreased, indicating that the iron ore was not processed in Australia.

The same applies to other commodities, for instance Manganese ore appears as an important mining product, but it has no equivalent in refined products. This seems to imply that manganese is essentially traded as ore or used in aggregate final products, such as ferroalloys. The same applies to several other minerals. It is an indicator that major volumes of mineral ores exploited in Australia are processed overseas.

3.2.2. Internal Consumption

The internal consumption of minerals typically is difficult to estimate due to the lack of accurate data. Australia is not an exception to this and does not systematically collect internal consumption data (Golev, and Corder, 2014).

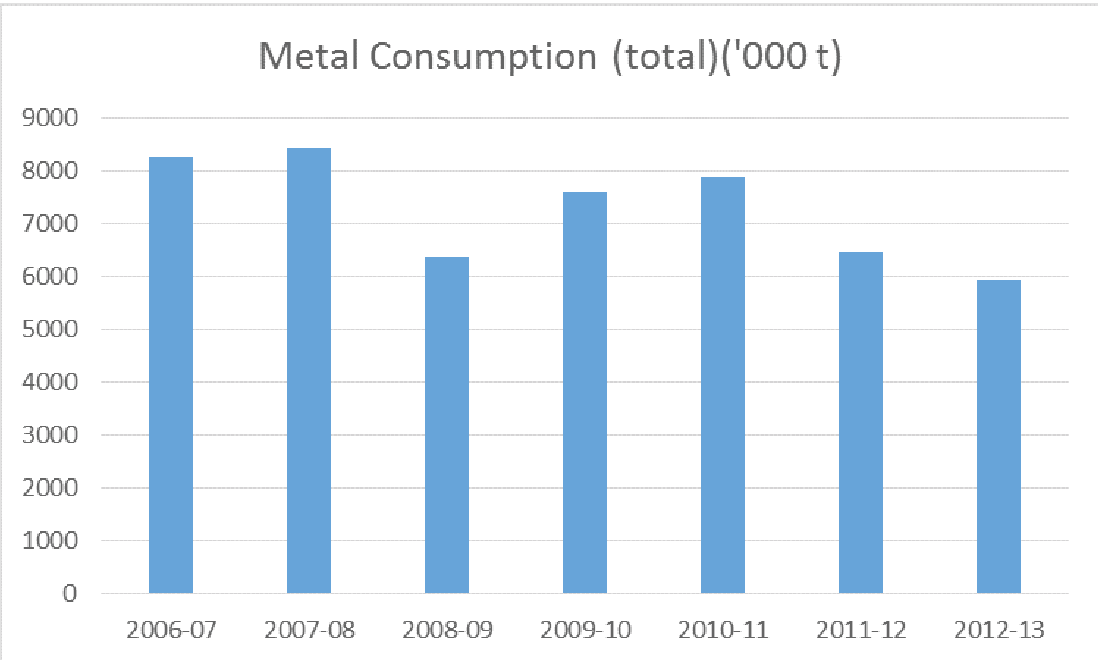
Domestic consumption is normally estimated using the calculated apparent metal consumption rate (based on the difference between production and export-import flows). The trends for five selected minerals in the period 2006-2013 are indicated in ***Table 3.16 and Figure 3.8***.

Table 3.16: Apparent (industrial) consumption of selected metals in Australia.

	Selected Metals, '000 t					Total Selected Metals ('000 t)	Per capita Kg
Year	Iron and Steel	Al	Cu	Zn	Pb		
2006-07	7,679.6	330.8	144	86.7	25.6	8,266.6	401
2007-08	7,868	314.1	153	84.9	24.9	8,444.9	403
2008-09	5,908.5	225.1	141	70.9	21	6,366.6	299
2009-10	7,073.1	294.4	131	70.6	20.6	7,589.7	348
2010-11	7,388.2	2,551.6	142	64.7	28.1	7,874.6	357
2011-12	6,038.3	234.6	111	55.1	19.7	6,458.7	289
2012-13	5,534.4	219.7	91	72.6	22.8	5,940.6	262

Source: BREE, 2013

Figure 3.8: Metal consumption in Australia (2006-2013).



Source: BREE, 2013

The industrial consumption of metals in Australia decreased in 2008-09 and 2010-13, with the lowest value in 2012-2013. These numbers likely reflect the effect of the global financial crisis with the contraction of general consumption. Another factor to consider is the decline of manufacturing as a result of the increasing value of the Australian Dollar, affecting Australia's international competitiveness in 2010-2013, which is directly linked to the growth of minerals sector.

3.2.3. Trade (Export and Import)

Australia is an export-oriented mining country, driven by the availability of large reserves of various minerals and the capacity to meet world-wide demand.

Close trade relationships with several Asian countries make Australia the prefered supplier for several minerals or mineral products, such as bauxite/aluminium, iron and nickel.

More than 90% of the minerals mined in Australia are exported directly. When factoring-in metal concentrates, this figure comes close to 98% (Golev and Corder, 2014).

In 2012-13 Australia exported more than 300 Mt of metals. Some metals were exported as concentrates (e.g. iron ore, alumina, copper, zinc, lead, manganese) and others in the form of refined metals (e.g. nickel, gold, silver) or chemicals (e.g. titanium dioxide pigment).

Australia is one of the world's leading exporters of alumina, cobalt, iron ore, and uranium (USGS, 2013). In the 2014-15 financial year, Australia exported AUD 105 billion worth of minerals, the vast majority of which were exported to Asia. Exports to China alone accounted for 55% of Australia's total mineral exports (***Figure 3.9***).

Mineral exports are extremely important for the Australian economy representing in 2015 more than 55% of Australia's total exports (Government of Australia, 2015)[14]. From 2011 to 2015, exports have decreased by 5%, although the contribution of the mineral sector has always remained above 50% of Australia's total exports (Resources and Energy Quarterly, September 2015).

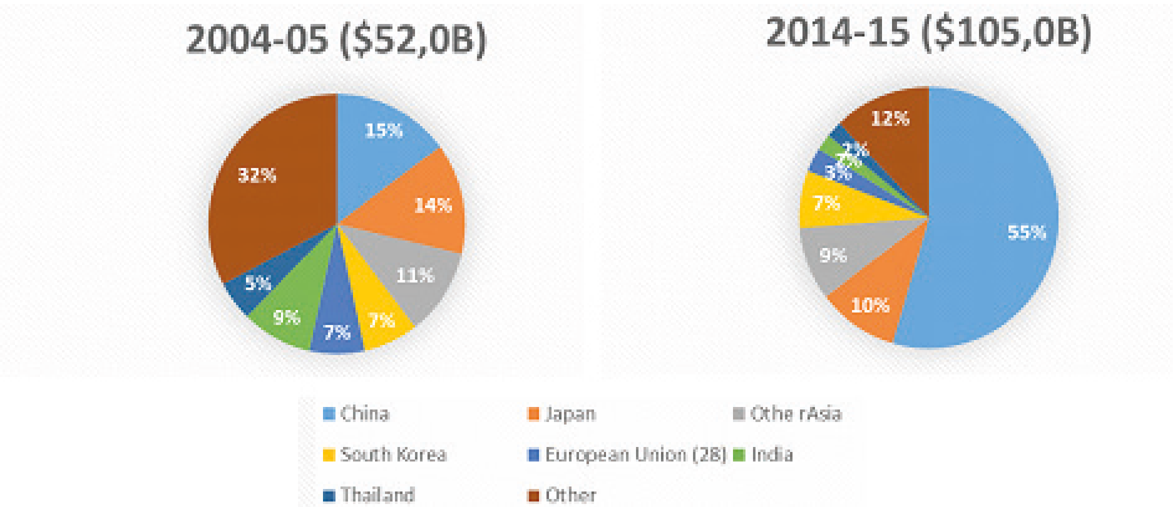
Australia's port infrastructure is among the most developed in the world. Bulk commodities, such as ores and petroleum, account for over 70% of domestic coastal shipping movements. By volume, the major iron ore and coal exporting ports in Australia are: Port Hedland (the world´s largest bulk export port), Dampier, Cape Lambert, Newcastle (the world´s largest coal export port), Hay Point and Gladstone. Together they account for around 80% of total mineral export volumes.

The major Australian mineral resources imports are petroleum products and natural gas[15] (***Figure 3.10***). The major Australian suppliers of manufactured goods are China, the USA and Japan (***Figure 3.11***).

Figure 3.12 summarises metal flows (including imports and exports) in Australia, showing an approximate image of the trade relations in the mineral industry, from a life cycle perspective.

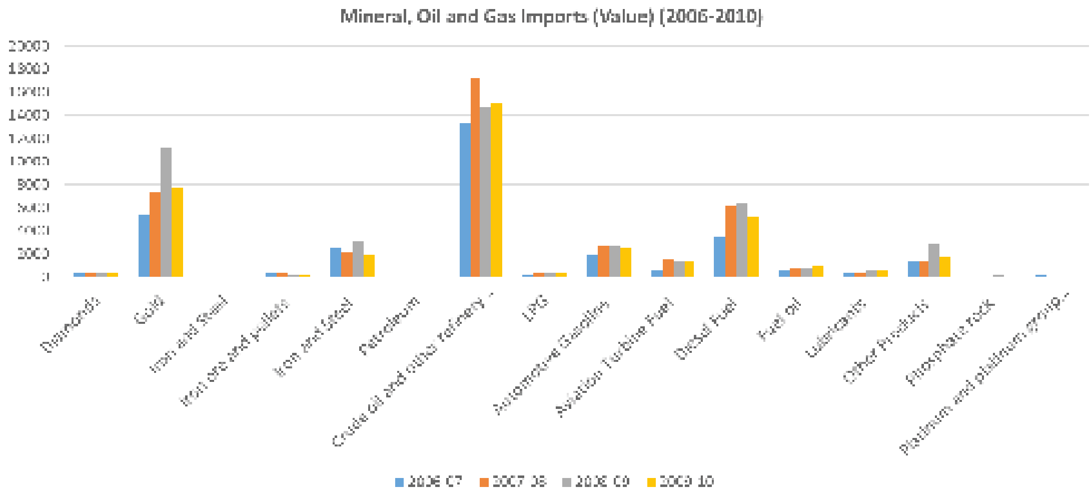
14 http://www.industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/req/Resource-and-Energy-Quarterly-September-2015.pdf
15 Just referred for context since they are not in the scope of this report.

Figure 3.9: Major markets for Australian exports ($=AUD).



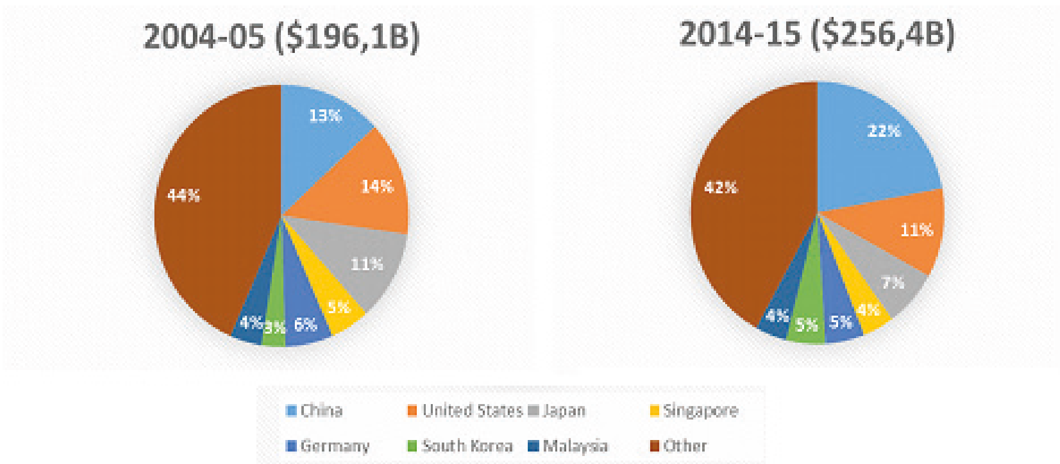
Source: Resources and Energy Quarterly, 2015

Figure 3.10: Imports of major minerals, oil and gas ($=AUD).



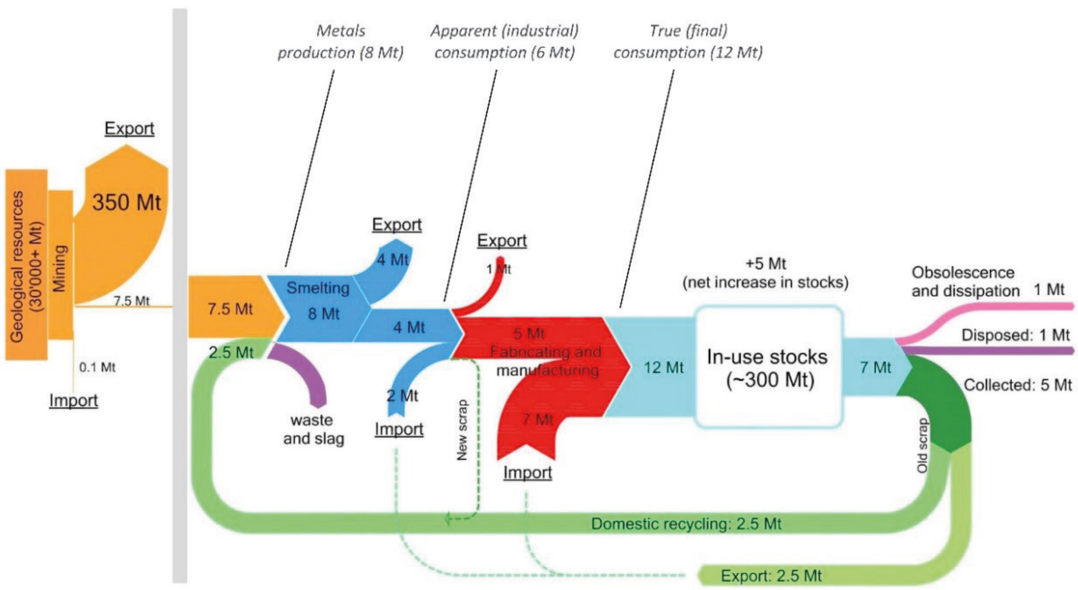
Source: ABS, 2012

Figure 3.11: Countries of origin for Australian imports ($=AUD).



Source: Resources and Energy Quarterly, 2015

Figure 3.12: Metal flows in Australia.



Source: Golev and Corder, 2014

Australia has well developed strategic international and diplomatic relations and is actively present in several groups, including the Asia–Pacific Economic Cooperation forum (APEC - since 1989), the Organisation for Economic Co-operation and Development (OECD - since 1971), the United Nations (UN since 1945, as a founding member), and the Commonwealth of Nations (one of 53 Member States).

Australia has ten active bilateral Free Trade Agreements (FTA) with Japan, Korea, New Zealand, Singapore, Thailand, US, Chile, the Association of South East Asian Nations (ASEAN), China and Malaysia.

Australia is currently engaged in seven other FTA negotiations[16], two bilateral FTA negotiations with India and Indonesia respectively, and five multilateral FTA negotiations concerning the Trans-Pacific Partnership (TPP), the Gulf Cooperation Council (GCC), the Pacific Trade and Economic (PACER Plus), the Regional Comprehensive Economic Partnership (RCEP), and the Trade in Services (TiSA) respectively.

3.2.4. Expenditure, Taxes/Royalties, Investment and Competitiveness

Business legislation has been in general very favourable to promote investments.

16 Government of Australia – Department of Agriculture and Water Resources, http://www.agriculture.gov.au/market-access-trade/fta

Australia ranks 10th in the world under the indicator "Ease of doing business", particularly driven by a high credit rating, enforcement of contracts and ease of starting a business (World Bank, 2014).

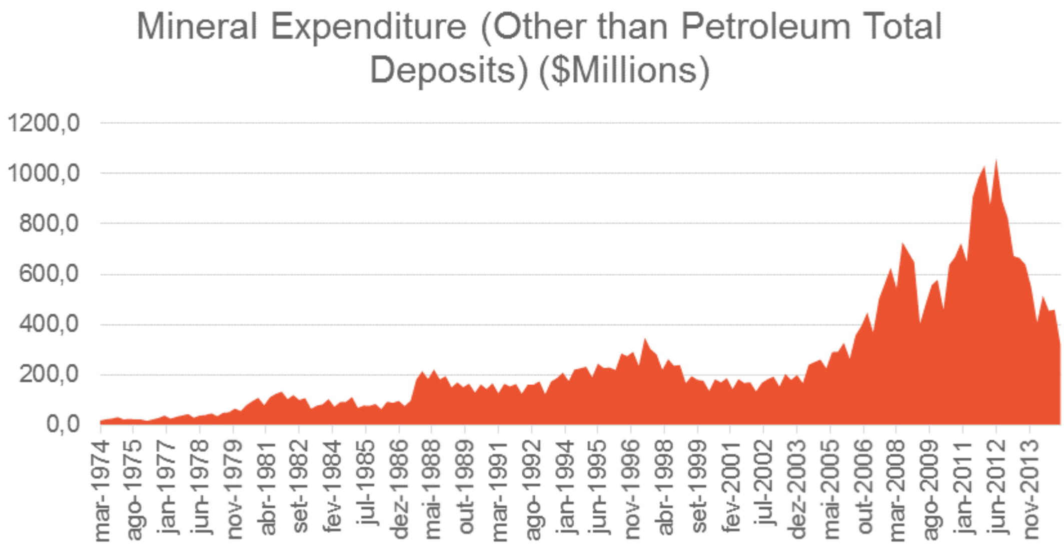
Expenditure in mineral exploration has increased greatly over time (***Figure 3.13*** shows the trend for 40 years). From 2006-07 to 2010-11, values almost doubled (USGS figures show an increase of 72%), which reveals the huge investment made recently in this industry. The investment in mining reached a peak in 2012 and has been decreasing since then.

In 2014-15 capital expenditure was AUD 76 billion, 16% less than in 2013-14 (Resource and Energy Quarterly, 2015).

In 2012 Australia accounted for about 13% of global exploration expenditure, being ranked it in the top five regions in the world for exploration expenditure. On a country-by-country basis, Australia has the second highest mineral exploration expenditure, after Canada (BREE, 2013).

Also according to the sources while mineral exploration expenditure in Australia did reach new heights during the last boom (2006-2012) much of this increased expenditure was also due to unprecedented spending on exploration in the bulk commodities sector like iron ore and coal. A break-down of the exploration expenditure by commodity, and in constant dollars, shows that expenditures on base and precious metal exploration did not exceed the expenditures of the

Figure 3.13: Evolution of the expenditure on mineral exploration in Australia.



Source: http://www.abs.gov.au/

mid-1990's and, for some metals, was less than in previous booms.

The high expenditure on bulk commodities vs other mineral resources is an important feature, distinguishing the recent boom from previous cycles (and reflecting the rise of China as a customer for coal and iron ore). It also resulted in rising exploration costs across all sectors, as metals companies (mainly juniors) struggled to compete for skilled and technical personnel.

Taxes received from the exploitation of mineral resources are obviously very important for the Australian economy. The mineral resource taxation consists of output based royalties that are applied by Federal, State and Territory governments, in addition to taxation applied to industry in general.

The resource rent in Australia considers (Hogan and McCallum, 2010):

- Rent Based Taxes (applied to the net cash flow of a resource project);
- Income based taxes or royalties;
- Output based royalties (target either the value of production or volume).

The taxes applied to the mineral industry in Australia can be grouped as (PwC, 2012)[17]:

- Corporate Income Tax (CIT): flat rate of 30%. Applied at Federal Level;
- Mineral Taxes:
    - State Royalties. Applied at state level considering the volume of minerals extracted: (Copper: 2.7%-3.5%; Gold: 0%-2.5%; Iron Ore: 6.5%-7.5%; Coal: 7%-10%). This is deductible from the CIT;
    - Mineral Resource Rent Tax (MRRT)[18]: Applied at Federal Level considering the mining profit. Applied only to Iron Ore and Coal with a rate of 22.5% was deductible in CIT calculation. From 2015 on this tax is not applied, due to the context of the commodity market downturn.

A survey made by Delloite (Deloitte Access Economics, 2014) on several Australian mining companies in the fiscal year 2012-13 shows the minerals sector paid nearly half of every dollar of profit as royalties and company tax to State and Federal Governments.The total tax take ratio as calculated across all the surveyed companies was 47.1%. The difference between this figure and the sum of CIT and State Royalties shows other taxes are affecting the mining industry, on top of the taxes described above.

The government of Australia supports openly the mining industry, funding publically available geoscience data and facilitating licensing and access to land and water trough the ownership rights scheme (Ashurst, 2013).

Thus, in 2012 the Australian Government launched the "UNCOVER" initiative, a partnership between Australia's federal, state and Northern Territory governments, industry and academia, with the aim of building a global competitive advantage for Australian mineral exploration (uncoverminerals.org.au). In practical terms, this initiative is promoting the exploration of mineral deposits that extend deep under thick layers of sediment.

State governments normally also assist in negotiations with Aboriginal Australians to secure land access agreements. In Western Australia an Exploration Incentive Scheme co-funds exploration drilling programmes.

The Fraser Institute has been collecting since 1992 information from mining company executives around the world, who evaluate mining policies worldwide. Based on an annual survey the Institute developed a Mining Investment Attractiveness Index, and ranks jurisdictions according to it. ***Table 3.17*** shows the ranking for the Australian states and territories in 2014.

In 2014 Western Australia was rated as the forth most attractive jurisdiction in the world for mining investment, falling behind Nevada (USA), Canada (Saskatchewan) and Finland. In 2015 Western Australia moved up into the first position[19]. But the different positions in the rank of other Australian states and territories remained, re-

17 http://www.pwc.com/gx/en/industries/energy-utilities-mining/publications/corporate-income-taxes-mining-royalties-and-other-mining_taxes.html
18 The Minerals Resource Rent Tax ("MRRT") is no longer applied and was a Federal Tax applied only to iron ore and coal (bulk commodity) projects in Australia. Entered into force in 1 July 2012, and excluded "small miners" (less than AUD 75m of MRRT mining profits per year).

19 https://www.fraserinstitute.org/sites/default/files/survey-of-mining-companies-2015-exec-summary.pdf

Table 3.17: Mining Investment Attractiveness Index for Australia.

2014	Score	Rank
Western Australia	82,0	4/122
Queensland	71,5	27/122
South Australia	75,1	19/122
Northern Territory	68,5	31/122
Tasmania	65,3	39/122
New South Wales	58,9	51/122
Victoria	51,2	66/122

Source: Jackson, 2014

vealing the impact of State and Territories regulations and policies.

3.2.5. Industry Structure

The mineral industry in Australia is regulated at state and territory government level. The regulation includes the administration of the register of land titles, issuing exploration and development permits, and the collection of royalties and taxes payable. States and territories also administer all inspections regarding health, safety, and environmental regulations.

The Commonwealth (Federal) Government holds ultimate control over Australia's mineral production, due to its ability to restrict mineral exports (USGS, 2013).

The Australian mining industry is based on a system of free enterprise in which private companies are involved in exploration, mine development, production, mineral processing, and marketing.

The majority of companies in Australian mineral ventures are affiliates or subsidiaries of companies headquartered in other countries, including Japan, India, and the USA. In fact, foreign companies control a majority of the mining, smelting, and refining sectors and a significant portion of the petroleum and natural gas sectors (Emma, 2015).

Australia's mineral industries cover a substantial part of the value chain, producing ores, concentrates and other intermediate products. The production of refined metal or other end products within the country is not so frequent. The database of the Australian Geological Services (Geoscience Australia, http://www.ga.gov.au/) lists more than 150 different enterprises covering many aspects of the minerals industry value chain, from mining to processing.

The mining cluster in Australia includes the mines (operating miners) and extends to the mining equipment, technology and services (METS) firms. METS firms do not operate the mines themselves, but have evolved in Australia to support the mining industry (Emma, 2015). METS businesses cover the entire value chain, from equipment and machinery manufacturing to procurement, transport, construction, waste and water services, wholesale trade, accommodation and food services, education and training, insurance, health care and assistance, and communication and information technologies. These businesses are highly diversified and often work across several minerals sectors and more than one phase of the mining lifecycle. Many of them have also transferred their skills into other industries, helping them to smooth market fluctuations and mitigate risk[20]. METS are very important for the Australian economy and are seen as a new driver for growth related to the mining industry. This sector comprises a diverse range of companies that provide technologically advanced products and services for mining companies worldwide. Of the METS companies 16% are foreign and 84% are Australian owned. They have a combined revenue of AUD 90 Billion and employ 386,000 Australians. This sector is on a growth trajectory - about 55% of the companies are exporters (and an increasing number are planning to export), reporting total values of exports around AUD 27 billion.

20 Austmine:http://www.austmine.com.au/Portals/25/Content/Documents/Austmine%20Survey%20Highlights.pdf

In this context, Australia's mining cluster is transforming from an endowment cluster (based on the existence of mineral deposits) to a knowledge based cluster. Evidence of this transformation comes also from the success of the internationalisation of Australian mining companies (e.g. BHP Billiton, Fortescue, Newcrest, Rio Tinto), who became global firms, handling a portfolio of different minerals, mined in different locations, using different technologies. These firms are technology-driven, pursuing constantly a competitive costs position. This facilitates access to funds, used to boost cost advantages on a global scale.

Together with a large number of smaller miners, global miners represent about 20% of the market capitalisation and 1/3 of all companies listed in the Australian Stock Exchange (ASX)[21].

3.3 Assessment of the regulatory framework

Australia is a federal constitutional monarchy, with division of powers over mineral resources between the Commonwealth and the states (6 states and 2 Territories). The Constitution delegates the primary responsibility to legislate and govern the exploration and extraction of minerals and petroleum to Australia's six states, and two territories (Australian Capital Territory and Northern Territory).

A regulatory framework for the mining sector exists since the 19th century. Each state and territory is autonomous within its boundaries. The Commonwealth Government can override legislation in the two territories.

The Commonwealth is responsible for offshore natural resources; however, from 1979 on, the States and the Northern Territory have been able to regulate operations in their coastal waters.

The licensing regimes vary between jurisdictions in some details but have common features. All cover at least two stages, namely exploration and production.

An exploration licence gives the holder the exclusive right to explore for specific minerals in the area specified in the licence, in accordance with the conditions imposed. Explorers are required to pay compensation to the landowner for access to the land, as well as the relevant royalties and taxes for the natural resources. They are also required to maintain a minimum annual expenditure to retain the license.

Mine licensing is regulated by the various state mining acts (that enable the States to grant licenses and/or mining leases over defined areas) and state agreements for particular large projects.

The first Australian mining law was enacted in New South Wales in 1871 and defined the Crown´s right to all the gold discovered in New South Wales. Subsequently, each state has enacted its own mining acts:

- Western Australia is regulated by the Mining Act of 1978, Mining Regulations 1981 of and Offshore Minerals Act of 2003;
- New South Wales the Mining Act of 1992;
- South Australia he Mining Act of 1971 and Mining Regulation of 2011.

The Australian mining framework is designed to facilitate the progress of the mining industry in the country, which helps to explain the significant development of this economic sector over the last century, even compared to other resource-rich countries such as the USA.

The government actively encourages foreign investment in Australia, having introduced legislation to encourage and regulate this practice (Ashurst, 2013). This approach is fundamental to capturing the necessary funds to support not only large mining projects, but also the settling of smaller investors - (In Australia the junior companies are very significantly represented in the Australian Stock Exchange).

Environmental protection is the responsibility of each State, although Commonwealth powers may overlap or interact with State and Territory mining laws. Mining projects and variations to them may require approval from the Commonwealth Environment Minister under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act[22]).

21 https://web.archive.org/web/20060422141538/http://www.asx.com.au/investor/industry/mining/asx_involvement.htm)

22 http://uk.practicallaw.com/1-525-5694#a624001.

Environmental issues are dealt within legislation via several mechanisms, including:

- **Environmental Impact Statement (EIS).** This is a technical study that describes the potential impacts of the mining operation on the environment and documents the measures to avoid, minimize, mitigate or compensate the negative impacts identified;
- **Social Impact Assessment (SIA).** It refers to the assessment of the social consequences of a project, namely the impacts on affected groups of people and on their way of life, life chances, health, culture and capacity to sustain these;
- **Environmental and Social Management Plan:** Plans defined in order to structure and organise the procedures necessary to deal with identified impacts.

To protect the state/public from the potentially adverse effects of a bankruptcy or an unexpected closure of a mining company, Western Australia introduced in 2012 (regulated in 2013) the Mining Rehabilitation Fund (MRF[23]) which is a pooled fund contributed to by the State's mining operators. This fund will be available to remediate abandoned mine sites.

The traditional rights of Aboriginal Australians to land and waters are recognised by the Commonwealth Native Title Act 1993[24]. The Act recognises and protects native title rights to important cultural areas against any future dealings, including mining projects. In a practical sense, this Act gives Aboriginal Australians the right to negotiate with project developers over projects on traditionally owned lands.

Most of Australia's population lives along the eastern and south-eastern coast while many of the important mining regions are sparsely populated. However, the 'social license to operate' is becoming increasingly important in Australia, as in other developed countries. This concept is not cast into regulations, but is relevant as it expresses public acceptance or even support for a mining project.

23 https://www.slp.wa.gov.au/legislation/statutes.nsf/main_mrtitle_12984_homepage.html

24 https://www.legislation.gov.au/Series/C2004A04665.

3.4 Raw material supply assessment

In the last 25 years more than 12 new, world-class mineral deposits have been discovered in Australia. The vast regions and reserves at depths greater than 100 meters that are yet to be exploited suggest that the continued discovery of mineral resources may still have great potential for the Australian economy. The Government and Geological Survey refer to the country as an "under-explored continent" (Government of Australia, 2015). This explains the initiatives in order to provide Australia with new mines. The relation between the Economic Demonstrated Resources (EDR) and current production rates suggest that the major mineral commodities produced in the country have life expectancies in excess of 20 years (e.g. diamonds). The ongoing investment into new exploration will potentially lead to an increase of the EDR and the availability of these resources will be extended, which in theory will guarantee the sustainability of the supply. An example of exploration efforts is the initiative UNCOVER[25], that is focused on providing the "knowledge base and technology that will substantially increase the success rate of mineral exploration beneath post-mineralisation cover in Australia".

Supply risk is an important indicator that together with the economic importance of a certain mineral commodity gives the level of criticality of that commodity. The factors that influence supply risks are (BREE, 2013) geological scarcity, geopolitical stability of supplier countries, the level of concentration of resources, production and processing within particular countries or by individual companies, methods of recovery (e.g. as a by-product of a major commodity) and trade policies.

Since Australia is essentially a producer/exporter of mineral commodities, and because the country hosts world-class mineral deposits and has a stable political, legal and social framework, the country plays an important role as provider of 'critical' commodities to other countries.

An assessment of Australia's potential to provide critical raw materials concluded that it has a high resource potential for 12

25 http://www.uncoverminerals.org.au/purpose

of the most critical commodities for several countries/regions, such as the EU, Japan, South Korea and the United States. The minerals concerned are antimony, chromium, cobalt, indium, manganese, magnesium, molybdenum nickel, niobium, platinum-group elements (PGE), rare-earth elements (REE), and tungsten (Australian Government, 2013).

Several of the critical minerals that Australia has the potential to provide are by-products from the refining of major commodities such as zinc, copper, lead, gold, aluminium or nickel. This increases in the future the possibility of a higher production of these strategic and high value minerals in Australia through the development of the necessary processes and technology.

The recovery of electronic waste has also a great potential to expand. Further, the development of the METS sector in Australia is a strong driver for the development of the necessary technology to improve the exploration and processing of critical raw materials, along with recycling and reuse processes.

3.5 Strategic analysis

3.5.1. SWOT

Table 3.18 synthesises the analysis of Strengths, Weaknesses, Opportunities and Threats of Australia's mineral raw materials industry.

Table 3.18: Strengths, Weaknesses, Opportunities and Threats of Australia's mineral raw materials industry.

	STRENGTHS	WEAKNESSES
INTERNAL FACTORS	• Rich mineral endowment with large and diverse, easy to exploit, mineral deposits; • Stable institutional and social environments, with rule of law (security, protection of property, political stability); • Stable mining regulatory framework; • Easy access to high-quality geosciences data; • High geological potential for new discoveries; • Strong and sophisticated knowledge-based mining cluster, covering the entire value chain needs; • Favourable geographic location, close to important Asia-Pacific markets (e.g. Japan, China, Indonesia, Korea); • Existing Free Trade Agreements that favour exports to Asian countries; • Efficient access to capital; • Availability of skilled workforce; • Efficient export infrastructure (deep, well equipped deep-water ports); • Vast country with low population density; • Government support to exploration; • Strong potential to attract Foreign Direct Investment.	• High taxes (considering total values); • High dependence on exports of mineral commodities; • Exports focused mainly on mineral ores (with low added-value when compared to processed products); • High costs of skilled workforce; • Different levels of competitiveness across Australian states and territories; • Lack of infrastructure in remote mining regions; • High domestic transport costs; • Energy supply limitations in some mining regions; • Environmental, economic and social impact of the use of non-renewable energy sources; • Underdevelopment of e-Waste recycling; • Despite the stable mining regulatory framework pointed as a strength, the regulatory environment is also an ongoing cause for complaints from explorers and producers: in most states the regulations needed to access land for exploration are frequently described as time consuming and expensive.

EXTERNAL FACTORS	OPPORTUNITIES	THREATS
	• Growth in world demand for critical raw materials; • Internationalisation of METS firms, reinforcing the domestic knowledge-based mining cluster; • Technological development and new technologies in exploration and mineral processing activities; • Improvements in the mineral recycling industry, including the use of secondary sources of raw materials.	• Downturn of the Asian market; • Price competition for important commodities (such as iron and copper) from low-cost countries; • Decrease of commodities value (due to currency and price changes); • Decrease in the demand of major commodities such as bauxite or iron; • Investment in supporting requirements, such as education of mining professionals, R&D and infrastructure exposed to commodity price swings; • Discovery of mineral deposits in other countries with better returns on investment; • Global movement for the decarbonisation of the energy sources; • Availability and security of energy and water resources; • Exploration companies are cash poor and activities are on-hold during downturns.

3.5.2. Competitive Context

Figure 3.14 defines the profile of the mineral raw materials industry in Australia.

3.6 Conclusions

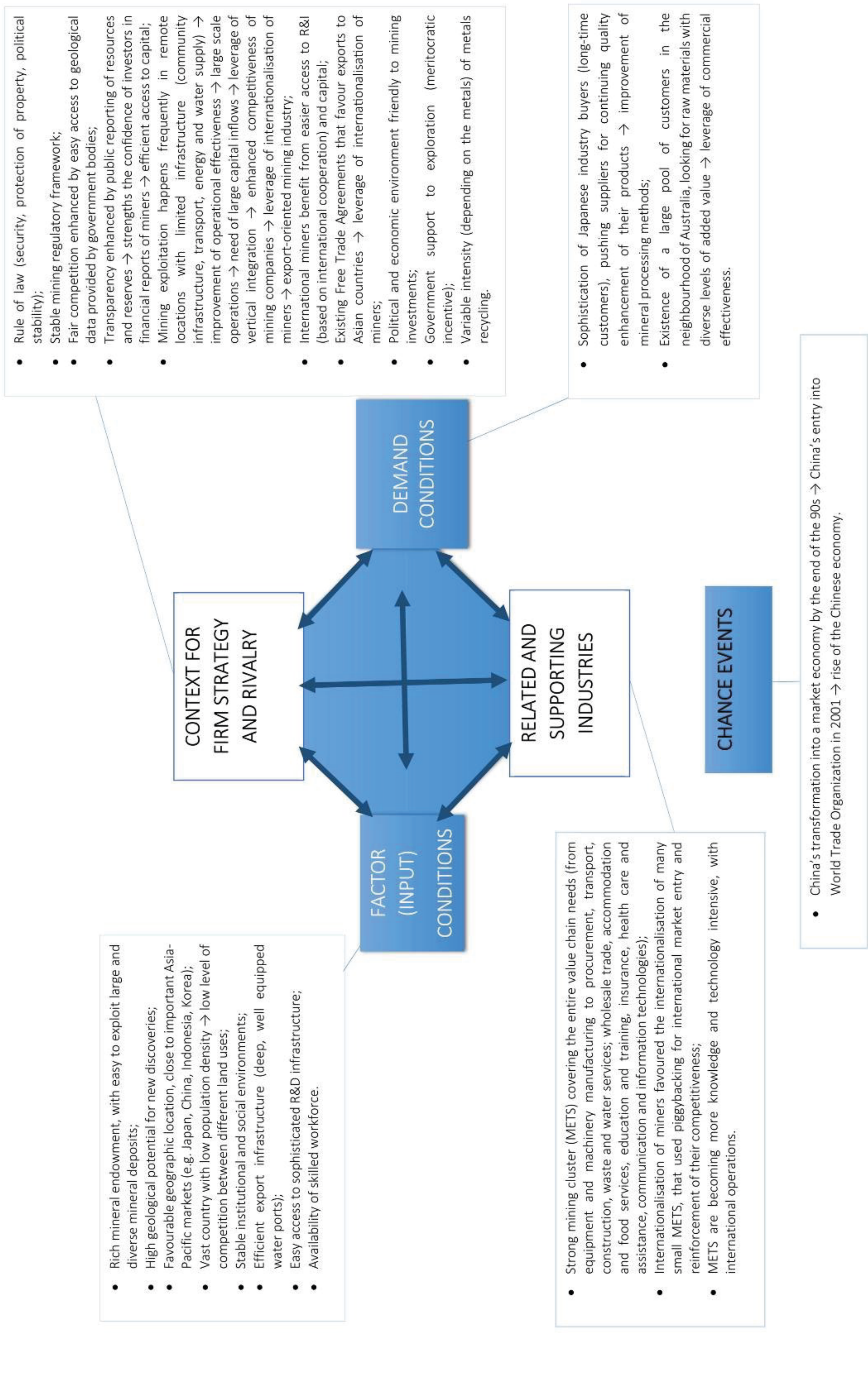
Australia is one of the largest mineral producers in the world. Australia holds some of the world's largest economic demonstrated resources (EDR) for several minerals. The major explored non-energetic minerals are bauxite, copper, gold, iron and manganese ore, mineral sands, nickel, tantalum, zinc, lead, and silver, where Australia is ranked first in the world. There are also known resources of several critical metals, which place Australia in a strong strategic position as supplier of these raw materials.

Australia is able to provide about 56 elements of the periodic table and is prospecting actively for others. Even considering this significant availability of minerals, Australia is considered an underexplored continent, which suggests that an enormous potential still exists. A future challenge is the ability to provide a sustained supply of minerals that are regarded as critical raw materials, due to their strategic importance. Australia is one of the best positioned countries in the world to help meet the worldwide demand for most of these minerals, nevertheless this will require finding new deposits and new ways to exploit existing assets.

As an export-oriented mining country, driven by a rich mineral endowment, Australia directly exports more than 90% of its ores and about 98% of the concentrates produced. Australia has ten active bilateral Free Trade Agreements and is working on another seven. The preferred trade partners are mainly the Asian markets, promoted in part by geographical proximity.

Australia's economy is the 22nd most competitive in the world according to the World Economic Forum, and is considered an innovation-driven economy. The mining industry makes an important contribution to this competitiveness (e.g. Western Australia was considered in 2015 the most attractive jurisdiction for investment in mining, out of 122). The impor-

Figure 3.14: Competitive context of Australia's mineral raw materials industry.



tance of mining is reflected directly in its contribution to the gross domestic product, the creation of direct and indirect employment, and its position as the largest export sector for Australia.

The position of government towards mining is generally favourable and the country is open to foreign investment. Australia is engaged in various joint ventures worldwide and benefits from the proximity of the Asian market for its mineral trade. This advantage can also be a risk, increasing Australia vulnerability to volatility in these markets (e.g. the current crisis in the iron ore sector).

The regulatory framework is stable and each State regulates its own mining industry largely independently. However, the Commonwealth Government controls offshore resources and has powers over the environmental approval of mining projects. In addition, the interests of Aboriginal Australians are protected by a specific Act and their rights must be considered in areas where native titles over land have been recognised.

Mineral recycling is already a developed activity. If metal 'direct' recycling is considered (for materials such as iron, steel, aluminium or copper), Australia already shows a good performance, with recycling rates of 90% of the total waste produced. In recycling of electronics waste (a secondary source of several critical and precious metals) Australia is taking the first steps, encouraged by government policies.

One significant risk to the Australian mineral sector is competition from other countries, where the exploitation of important minerals, such as iron or bauxite, can be made at lower costs and, therefore, with higher profitability. In addition, the strong dependence on the Asian markets for the export of the major metals produced can result in constraints due to declining or potentially unreliable demands.

Australia's mineral industry is one of the most competitive in the world because of the strong influence of several factors including (but not only): 1) a rich mineral endowment; 2) strong relation with Asian markets; 3) stable legislation (access to exploration permits); 4) the availability of a skilled workforce (enhanced by labour immigration, when necessary), and 5) the government support and engagement with the mining sector. The mining cluster in Australia includes the mining and processing operations and extends to the mining equipment, technology and services companies (METS). METS businesses cover the entire value chain, and work across several minerals and more than one phase of the mining life-cycle. This cluster is transforming from a endowment cluster to a knowledge based cluster. Evidence of this transformation comes also from the success of the internationalisation of Australian mining companies, who became global firms, technology-driven, pursuing a leading cost position.

4. Canada

4.1 The industry in a global context

4.1.1. General Economy

Canada is often described as a trading nation as its total trade is worth more than two-thirds of its GDP. Canada ranks 8th in the United Nation´s Human Development Index, its citizens enjoy high living standards and its mining industry has become a global leader in exploration, mine development and operation, financing, and site remediation. The table below summarises Canada's general economic data.

Table 4.1: Canada's general economic data.

General Data[1]	
AREA:	9,984,670 Km^2
POPULATION[2] (2014):	35.467 Million
WORLD RANKING (Largest Export Economy, 2013):	12th
GROSS DOMESTIC PRODUCT (GDP, 2013):	In 2014 the total GDP (current prices) was USD 1,794 billion and the GDP per capita (current prices) was USD 51,958.
EMPLOYMENT (2014):	6.97 % unemployment. 17.8 million Employed.
INDUSTRIAL SECTORS (Contribution to GDP[3], 2013):	Community, business and personal services (13%); real estate, rental and leasing (13%); manufacturing (11%); mining (including milling) and quarrying, and oil and gas extraction (7%); construction (7%).
TOP MINERAL EXPORTS (2013):	Crude Petroleum (USD 80.5 billion); refined petroleum (USD 18.6 billion); petroleum gas (USD 12.6 Billion); coal briquettes (USD 5.61 billion); iron ore (USD 4.89 billion); and copper ore (USD 2.89 billion).
TOTAL EXPORTS (2013):	USD 438 billion.
TOTAL IMPORTS (2013):	USD 437 billion.
TRADE BALANCE (2013):	USD 1.69 billion.

1 OEC, 2016a. The Observatory of Economic Complexity – (OEC) (data provided by UN-COMTRADE – 2013).
2 International Monetary Fund.
3 Marshall, B., 2014.

4.1.2. Territorial Organization

Canada is a federation composed of ten provinces and three territories, a parliamentary democracy and a constitutional monarchy, with Queen Elizabeth II as head of state - a symbol of the historical ties of Canada with the United Kingdom (KPMG, 2014).

Canada has a bicameral federal parliament. The legislative branch comprises the Senate (the Upper House, 105 members) and the House of Commons (the Lower House, 308 members) (Marshall, 2014).

Seats in the Senate are equally divided among four regions: Maritimes (comprising New Brunswick, Prince Edward Island and Nova Scotia), Quebec, Ontario, and the West (British Columbia, Alberta, Saskatchewan and Manitoba), with special status for Newfoundland and Labrador, and Northern Canada ('the North', comprising Yukon, Northwest Territories and Nunavut).

Figure 4.1: Canada Political Divisions.

Source: https://en.wikipedia.org/wiki/List_of_regions_of_Canada

4.1.3. Minerals Industry Contribution to Economy

Canada is an economically and technologically developed country, based not only on the wealth from natural and agricultural resources but also from manufacturing, construction and service industries. It is one of the most developed nations in the world with a very open, competitive and market oriented economy.

Canada's economy has changed radically since the Second World War, from an agricultural to an industrial economy.

The mining industry is very significant to the economic strength of Canada (Marshall B., 2014):

- Mining contributed with CAD 54 billion to Canada's Gross Domestic Product (GDP) in 2013;
- The industry represented 19.6% of the value of Canadian goods exported in 2013;
- Canada's value of mineral production was nearly CAD 43.6 billion in 2013;
- The total mining industry payments to Canadian federal and provincial governments was CAD 71 billion in taxes and royalties over the last decade (2003-2012).

Canada is one of the most significant mining nations in the world, producing more than 60 minerals and metals, and ranks in the top five countries for global production of 11 major minerals and metals (Marshall B., 2014):

- First in potash;
- Second in uranium and cobalt;
- Third in aluminium, tungsten and diamond producer by value, 5th by carat volume
- Fourth in platinum group metals, sulphur and titanium;
- Fifth in nickel and diamonds.

Canada is the third largest producer of minerals in the world and exports 4/5 of all ores produced. Canada produces other minerals in addition to the above mentioned, such as coal, iron, zinc, copper, lead, gold and bauxite.

Contribution to GDP and Employment

Historically, the value of minerals and metals to Canada's economy has ranged between 2.7% and 4.5% of the country's gross domestic product (GDP). In 2013 this industry's contribution remained within this range at 3.4% (Marshall, 2014).

The extractive industry, which combines mineral extraction with oil and gas extraction, contributed with CAD 113.5 billion, or nearly 7.2%, to Canada's GDP in 2013 (Marshall, 2014).

Figure 4.2: Canada´s Real Gross Domestic Product contribution by Industry (CAD billion), 2008-2013.

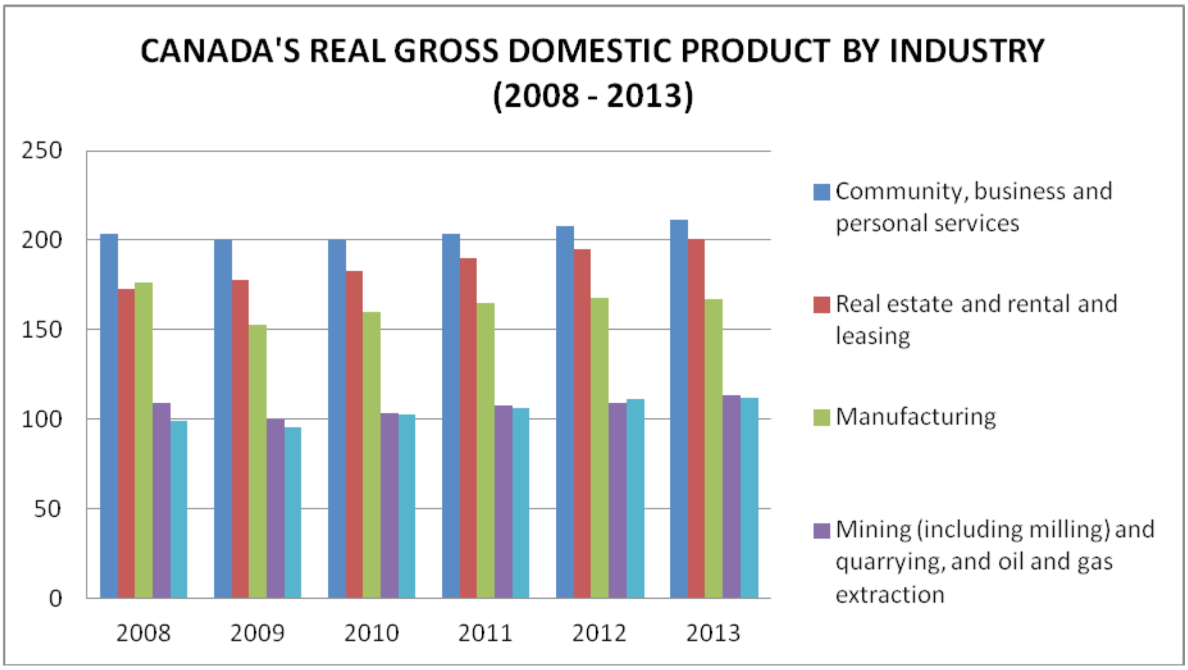
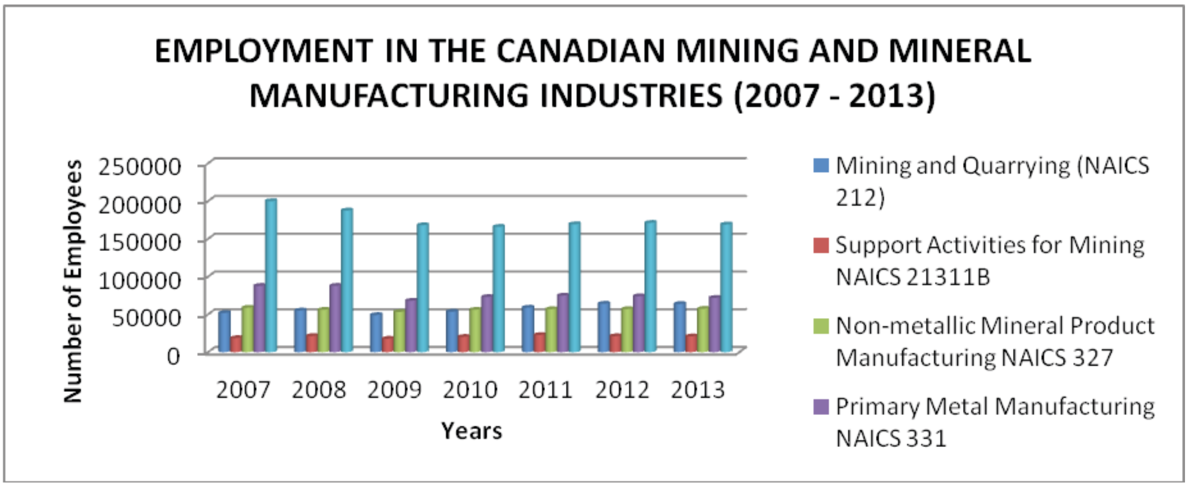


Figure 4.3: Employment in the Canadian Mining and Mineral Manufacturing Industries, 2007-2013.



From ***Figure 4.2*** it is possible to understand the importance of the mining industry (including mineral processing), quarrying and oil and gas extraction to the country, constituting in 2013 the 4th largest contribution to Canada's gross domestic product (GDP).

Mining and mineral processing industries employ more than 380,000 persons in Canada, and mining is the largest private sector employer of aboriginal peoples in the country (Marshall, 2014).

People who work in mining receive higher wages than all other industries in Canada exceeding the average wages in forestry, manufacturing, finance and construction areas (Marshall, 2014).

Contribution to Total Exports

Canada was in 2013, the 12th exporter and 12th importer worldwide (OEC, 2016a). Despite being a strong economy, Canada showed a trade balance deficit in 2009 and 2010, which can be explained by market volatility and the difficulties of the U.S. economy, Canada's main business partner. In 2011 and 2012 the results were positive (World Trade Organization, 2012a).

The mining industry contributed in 2013 with rates above 19% to the total exports of the country.[1]

4.1.4. Non Energy Mineral Industries

4.1.4.1. Major Metallic Minerals[2]

The tables below summarise data on resources, production and exports of minerals. The values of resources and reserves provided are, unless otherwise specified, based on public reporting made according to CRIRSCO-aligned reporting standards.

1 The Mining Association of Canada, 2016.
2 Source: U.S. Geological Survey, 2015; and OEC, 2016a; and OEC, 2016b, unless otherwise specified.

Table 4.2: Aluminium resources, production and exports.

Aluminium	
Production (2014)	
Quantities:	2,940 Mt
World Ranking:	3rd
World %:	6% of global production.
Production Centres	
The main aluminium production centres are located in Quebec and British Columbia.	
Processing Centres:	9 primary aluminium smelters.
Exports (2013)	
Volume:	Aluminium: 2,967 Mt.
Value:	Aluminium: USD 5.9 billion
Destinations:	USA (76%), Mexico (4.8%), Netherlands (4.3%), South Korea (2.9%), Japan (2.3%), Others (9.7%).

Table 4.3: Cobalt resources, production and exports.

Cobalt	
Reserves (2014)	
Quantities:	250,000 Mt.
World Ranking:	6th.
World %:	4% of global reserves.
Production (2014)	
Quantities:	7,000 Mt.
World Ranking:	3th.
World %:	6% of global production.
Production Centres	
Processing Centres:	1 primary smelter and 1 processing plant in Ontario; 1 primary smelter and 1 refinery in Manitoba; and 1 refinery in Alberta.

Exports (2013)	
Volume:	4,580 Mt.
Value:	USD 254 million.
Destinations:	Norway (23%), Japan (17%), USA (13%), Belgium-Luxembourg (12%), United Kingdom (4.8%), Germany (4.1%), Singapore (3.1%), China (2.3%), Hong Kong (2.2%), Other Asia (10%), Others (8.5%).

Table 4.4: Copper resources, production and exports.

Copper	
Reserves[1] (2014)	
Quantities:	11,000 Kt.
World %:	2% of global reserves.
Production	
Quantities:	Copper ore: 613,500 Mt.
World Ranking:	9th.
World %:	4% of global production.
Production Centres	
A major, new open-pit copper mine, Copper Mountain, opened in British Columbia (NRCAN, 2015g).	
Mines (2009)[2]:	26 copper mines are operating in Canada. The largest number of copper mines are in B.C. Copper is also mined in Newfoundland and Labrador, Quebec, Ontario, Manitoba, Saskatchewan and Yukon.
Processing Centres:	1 refinery and 1 primary smelter in Quebec; 1 refinery, 1 processing plant and 1 primary smelter in Ontario; 1 primary smelter and 1 refinery in Manitoba and 1 refinery in Alberta.
Exports (2013)	
Volume:	2,160 Mt.
Value:	USD 2.89 billion.
Destinations:	China (33%), Japan (30%), India (7.7%), South Korea (6.6%), Germany (6.2%), Spain (2.6%), USA (2.4%), Philippines (2.4%), Others (9.1%).

1 USGS, 2015
2 NRCAN, 2013b

Table 4.5: Gold resources, production and exports.

Gold	
Reserves (2014)	
Quantities:	2,000 Mt.
World Ranking:	7th.
World %:	4% of global reserves.
Production (2014)	
Quantities:	160,000 Mt.
World Ranking:	5th.
World %:	6% of global production.
Production Centres	
Mines:	The active gold mines are located in Quebec, Manitoba, Ontario and Saskatchewan.
Processing Centres:	1 refinery and 1 primary smelter in Quebec, 2 refineries, 1 processing plant and 2 primary smelters in Ontario, 1 primary smelter, 1 refinery and 1 processing plant in British Columbia, 1 on BC and 1 on Nunavut.

Exports (2013)	
Value:	USD 10.2 billion.
Destinations:	USA (32%), Hong Kong (24%), United Kingdom (18%), Switzerland (10%), Japan (5%), United Arab Emirates (4.5%), Turkey (2.3%), Others (4.2%).

Table 4.6: Iron ore resources, production and exports.

Iron Ore	
Reserves (2014)	
Quantities:	6,300 Mt (Crude ore) and 2,300 Mt (Iron content).
World Ranking:	8th (Crude ore) 6th (Iron content).
World %:	3% (Crude ore) and 3% (Iron content) of global reserves.
Production	
Quantities:	41 Mt.
World Ranking:	10th.
World %:	1% of global production.
Production Centres	
Virtually all of Canada's iron-ore production has been from western Labrador and north-eastern Québec.	
Mines:	Carol Lake (Newfoundland and Labrador) and Bloom Lake (Quebec).
Processing Centres:	About 20 centres distributed between Newfoundland, Québec and British Columbia.
Exports (2013)	
Volume:	1 Mt
Value:	USD 4.89 billion
Destinations:	China (40%), Germany (9.9%), France (8.4%), Netherlands (6.9%), Japan (6.1%), USA (6%), Trinidad and Tobago (4.1%), Spain (3.9%), United Kingdom (3.2%), Others (11.5%).

Table 4.7: Platinum Group Metals resources, production and exports.

Platinum Group Metals (PGMs)	
Reserves (2014)	
Quantities:	310,000 Mt.
World Ranking:	4th.
World %:	1% of global reserves.
Production (2014)	
Quantities:	7,200 Mt.
World Ranking:	4th.
World %:	5% of global production.
Production Centres	
Most PGM in Canada are by-products of nickel mining in Sudbury. There is a primary PGM mine at Lac des Iles, Ontario (ON), and by-product production from Raglan in Quebec.	
Exports (2013)	
Value:	USD 209 million.
Destinations:	United Kingdom (47%), USA (44%) and Germany (8.4%), Others (0.6%).

Table 4.8: Titanium resources, production and exports.

Titanium	
Reserves (2014)	
Quantities:	Ilmenite: 31,000 Mt.
World Ranking:	Ilmenite: 7th.
World %:	Ilmenite: 4% of global reserves.
Production (2014)	
Quantities:	Ilmenite: 900 Mt.
World Ranking:	Ilmenite: 4th.
World %:	Ilmenite: 14% of global production.
Production Centres All Canadian Titanium is produced in Quebec.	
Mines:	1 operating mine
Processing Centres:	1 production plant in Salaberry-de-Valleyfield, Quebec.
Exports (2013)	
Volume:	4,130 Mt.
Value:	USD 24.3 million.
Destinations:	USA (56%), Sweden (7.9%), United Kingdom (6.8%), Mexico (5.2%), India (4.0%), China (3.1%), Germany (2.2%), Others (14.8%).

Table 4.9: Nickel resources, production and exports.

Nickel	
Reserves (2013)	
Quantities:	2,900 Mt of Nickel Ore.
World Ranking:	10th.
World %:	4% of global reserves.
Production (2013)	
Quantities:	233 Mt Nickel ore.
World Ranking:	4th
World %:	10% of global production.
Production Centres	
Mines:	Most are in Ontario, in the Sudbury area. There are also nickel mines in Newfoundland and Labrador, Quebec and Manitoba.
Processing Centres:	1 refinery in Quebec, 1 refinery, 2 processing plants and 2 primary smelters in Ontario, 1 primary smelter and 1 refinery in Manitoba, 1 refinery in Alberta.
Exports (2013)	
Value:	USD 4,722 billion.
Destinations:	Saudi Arabia (53%) and China (47%).

Table 4.10: Tungsten resources, production and exports.

Tungsten	
Reserves (2014)	
Quantities:	290,000 Mt.
World Ranking:	2nd.
World %:	9% of global reserves.

Production (2014)	
Quantities:	2,200 Mt.
World Ranking:	3th.
World %:	3% of global production.
Production Centres	
Mines:	1 mine, in the Northwest Territories that closed in November 2015.
Exports (2013)	
Value:	USD 86.1 million
Destinations:	USA (39%), Netherlands (28%) and China (29%), Others (4%).

4.1.4.2. Major Industrial Minerals

Table 4.11: Diamonds resources, production and exports.

Diamonds	
Reserves and Production	
After the discovery in 1991 of evidence of diamond-bearing kimberlite pipes in the Northwest Territories, the deposit was proven to be commercial and mining there began in 1998. By 2006, three major mines were producing over 13 million carats of gem-quality diamonds per year. This placed Canada as the third largest producer of diamonds in the world.[1]	
Production Centres	
Mines:	Northwest Territory and Ontario (5 mines). There are currently three mines in NWT (one is on care and maintenance) and one in Ontario. Another mine is due to start up in Quebec this fall so by year end there will actually be 5 diamond mines in Canada.
Exports (2013; industrial diamonds)[2]	
Value:	USD 1.96 billion.
Destinations:	United Kingdom (47%), Belgium-Luxembourg (33%), South Africa (11%), India (5.3%), Israel (1.7%), Others (2%).

1 http://geology.com/articles/gem-diamond-map/
2 Observatory of Economic Complexity (http://atlas.media.mit.edu/en/visualize/tree_map/hs92/export/can/show/7102/2013/)

Table 4.12: Potash resources, production and exports.

Potash (Potash and potassium compounds)	
Reserves (2014)	
Quantities:	4,700 Mt.
Production (2014)	
Quantities:	9,800 Mt.
World Ranking:	1st.
World %:	28% of global reserves.
Production Centres Potash is exploited essentially in Saskatchewan (10 mines).	
Exports (2013)	
Value:	USD 5,849 billion.
Destinations:	Mexico (57%), USA (18%), New Zealand (11%), Israel (4%), Czech Republic (3%), India (2.4%), Philippines (2.2%), Croatia (2.1%), Japan (0.3%).

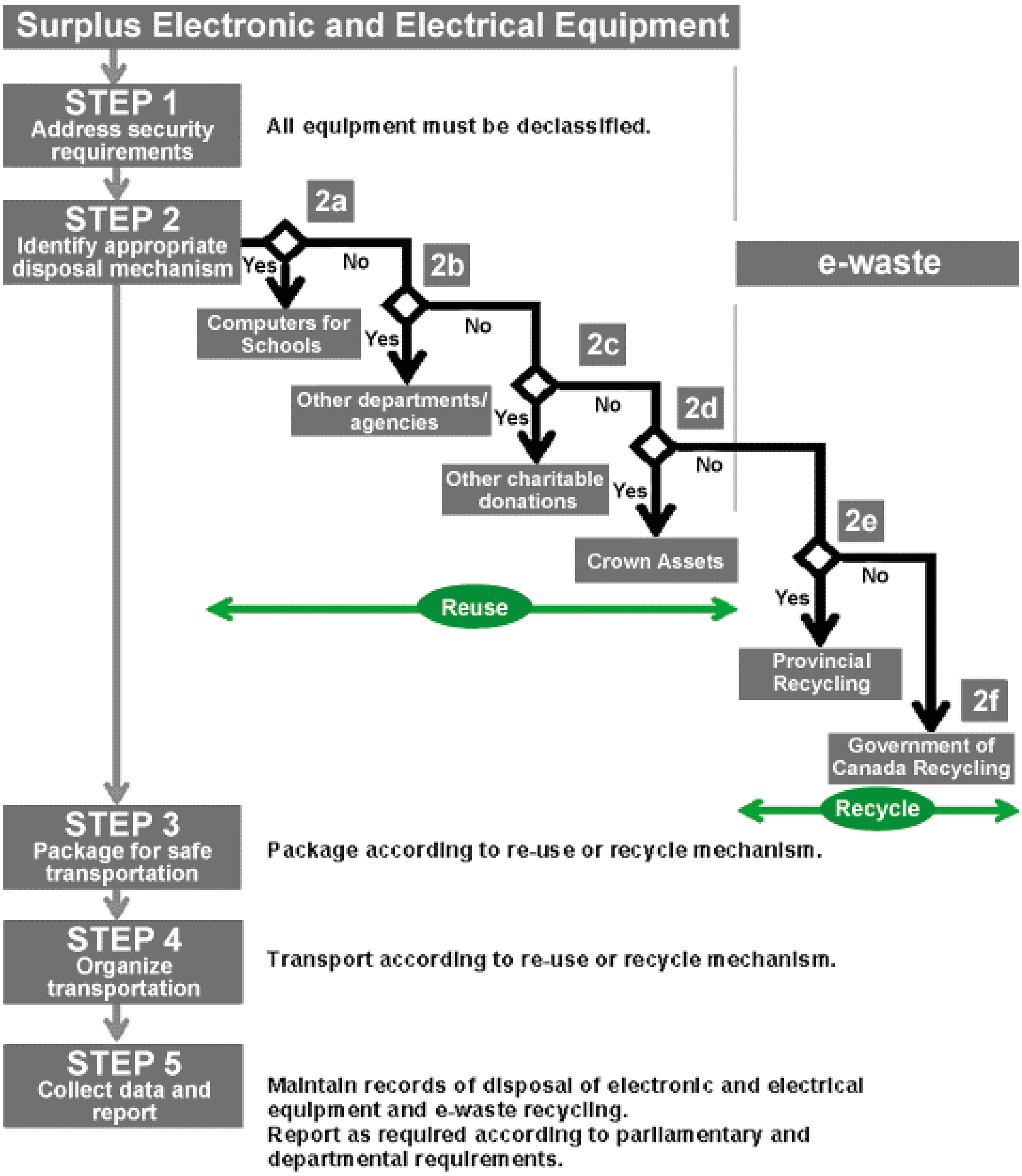
4.1.5. Recycling

Canada's metals recycling sector is mature and extensive. It includes the capital intensive primary and secondary smelters, fed by large number of small and medium-sized companies involved in the collection and segregation of scrap. The secondary smelters process scrap of several metals, including copper, brass, aluminium beverage cans, and stainless steel. Scrap that is difficult to process and requires several processing steps is processed in primary smelters. Primary smelters are well equipped to recycle complex metallic composite materials, such as e-Waste, and the refining facilities enable the extraction of all the valuable metals including precious ones. This explains why Canada's share of global imports of precious metal waste and scrap in 2010 was 14%, second to Germany's share of 23% (NRCAN, 2013b).

According with the Canadian Association of Recycling Industries (CARI[3]), Canadian recyclers process between 16 and 18 million tonnes of scrap metal each year. Canada's primary trading partner

3 https://cari-acir.org/

Figure 4.4: Key steps in the disposal process for surplus electronic and electrical equipment.



Source: Government of Canada, 2014b

in recycled metals is the USA. In 2009, Canada exported 5.9 Mt of ferrous and nonferrous metal scrap valued at USD 2.6 Billion (NRCAN, 2013b). Of the Canadian metal scrap exports 56% went to the USA and 93% of all Canadian imports were from the USA. Total Canadian exports of ferrous scrap and slag represented 78% of total scrap exports, while nonferrous scrap, ash, and residue accounted for 58% of all scrap imports, both by weight.

Canada's steel recycling rate stands in excess of 60%, according to the Canadian Steel Producers Association[4]. There are no recent figures on the recycling rates of other metals[5]. Assuming steel is among the most recycled materials, there is possibly scope for improvement in the recycling of other ferrous and non ferrous metals.

The amount of e-Waste generated in Canada is increasing, as in virtually all developed countries. In 2011, for example, Canadians possessed over 31 million electronic devices (Marshall B., 2014) that are destined to become obsolete at some stage.

The Federal Government of Canada is carrying on the Federal Electronic Waste Strategy since February 2010. This strategy was first implemented at Federal level to set an example. Between 2011 and 2012 the investment in this area was estimated at CAD 1.2 Billion and included promotion of reuse/recycling of computers, laboratory, medical, security, telecommunications, audio-visual, and office equipment (Government of Canada, 2014a).

The Directive on Disposal of Surplus Material mentions the "reuse and environmentally sound and secure recycling" (Government of Canada, 2014a).

Each province and territory of Canada has a government department or office to manage the issue of recycling (Government of Canada, 2014a) and the country is recycling the following electronic waste: TVs, desktop and portable computers, mobile phones and devices, certain medical and monitoring devices, stereos, printers, DVD players, cameras, and audio and video game consoles (Marshall, B., 2014).

4 http://canadiansteel.ca/steel-facts/#recycling
5 Data are masked by the integration of recycling industries and suppliers in Canada and in the USA.

Figure 4.4 shows the steps in the disposal process for surplus electronic and electrical government-owned equipment. The goal of reuse of electronic equipment is to extend the useful life of the equipment. According to the Federal Electronic Waste Strategy reuse options are:

- Computers for Schools (CFS) – Qualifying equipment is refurbished for reuse:
- Crown Assets Distribution (CAD) – Equipment in working condition can be sold for reuse;
- Gratuitous transfer to other federal organizations or donation to other recognized charitable/non-profit organizations.

The metals that are classified as urban ore suitable for recycling are: zinc, lead, germanium, indium, cadmium, arsenic, mercury, copper, gold and silver.

4.2 Economic and market assessment

4.2.1. Reserves and Production

Canada has a rich mineral endowment, the exploitation of which contributes significantly to the national economy. Resource industries play a critical role in providing jobs, economic growth and prosperity for Canadians (NRCAN, 2015b).

Canada is the global leader in the production of potash and it ranks among the top-three global producers for uranium, aluminium and platinum group metals (PGMs). Canada trades essentially in raw aluminium processed in the country. Canada does not have bauxite mines, but has very competitive energy prices and a qualified labour force for the processing of aluminium, leading to the establishment of a world class industry.

In the 30-year period from 1980 to 2010, Canada's reserves of base metals declined continuously at annual average rates varying from 0.69% for molybdenum to 8.86% for lead. This period of prolonged decline resulted in some metal reserve levels of less than half of the known ore reserves reported at the end of 1980. Reserves in 2010 were 64% of 1980 reserves for copper, 37% for nickel, 46% for molybdenum, 15% for zinc, 4% for lead, and 20% for silver. Gold reserves saw an

Figure 4.5: Major mineral reserves forecast for the Canada (millions tons). PGM - Platinum Group Metals.

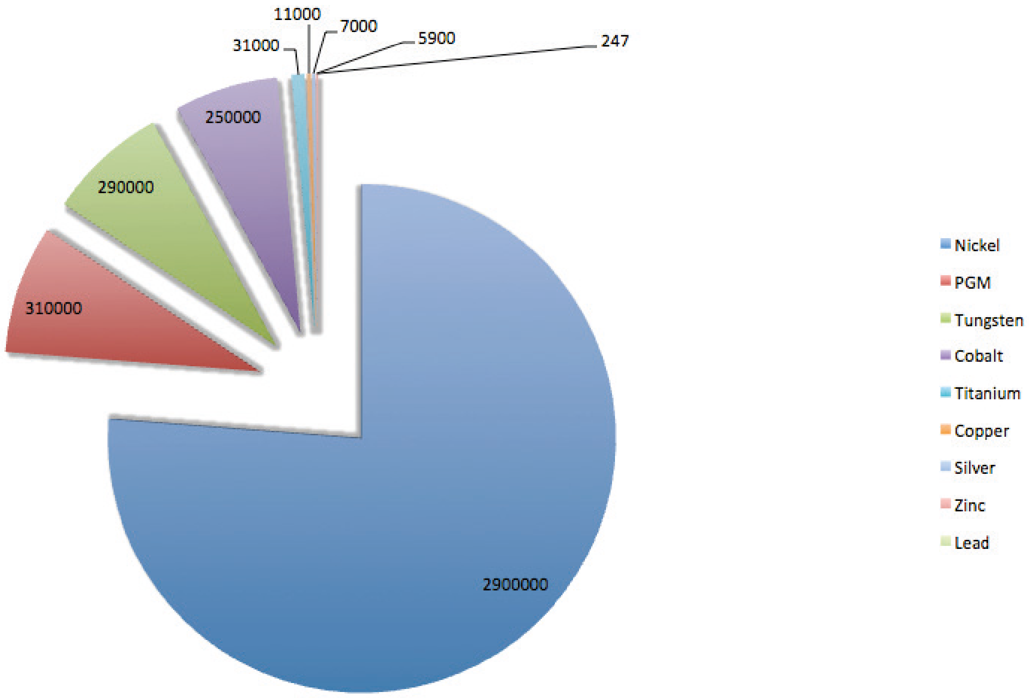


Table 4.13: Canadian reserves of selected metals, by province and territory (values as of December 2010.

	Copper	Nickel	Lead	Zinc	Molybdenum	Silver	Gold
	000 t	000 t	000 t	000 t	000 t	t	t
Newfoundland and Labrador	433	623	-	113	-	60	6
Nova Scotia	-	-	-	-	-	-	-
New Brunswick	28	-	241	610	-	714	1
Quebec	266	331	36	1,17	-	1,174	574
Ontario	2,599	1,606	27	827	-	1,97	623
Manitoba	321	514	-	610	-	385	52
Saskatchewan	-	-	-	-	-	-	11
British Columbia	6,854	-	31	306	254	1,102	83
Yukon	245	-	65	496	-	1,511	15
Nortwest Territories	-	-	-	-	-	-	-
Nunavut	-	-	-	-	-	-	108
Canada (1)	10,747	3,074	400	4,133	254	6,916	1,473

(1) May not balance due to rounding at the provincial or territorial level.

Source: http://www.nrcan.gc.ca/mining-materials/exploration/8294#t3

increase of 178% over that same period

According to the data of ***Figure 4.5***, the major mineral reserves forecast (in value) for Canada are PGMs, followed by tungsten and cobalt (values from U.S. Geological Survey, 2015).

According to the National Resources of Canada[6] it is possible to indicate some reserves (values from December 2010) of reference minerals in the producing territories. ***Table 4.13*** summarises the Canadian reserves of selected major metals,

6 http://www.nrcan.gc.ca/mining-materials/exploration/8294.

Table 4.14: Production of Canada's leading minerals, 2013.

Commodity	Production 2013 (p)	Change From 2012	Value 2013 (p)	Change From 2012
	(000 t except where indicated)	(%)	(CAD$ millions)	(%)
METALLIC MINERALS				
Gold (kilograms)	124,054.2	16.6	5,898.9	3.4
Iron ore	42,769.7	10.0	5,333.9	9.4
Copper	613.5	9.5	4,629.9	4.0
Nickel	214.7	5.3	3,356.9	-5.3
Uranium (1)	7.5	-21.4	771.5	-35.6
Zinc	413.8	-31.2	809.0	-30.9
Other metals	n.a.	n.a.	2,370.0	-9.2
Total metals	n.a.	n.a.	23,170.1	-1.6
NONMETALLIC MINERALS				
Potash (K_2O) (2)	10,140.0	13	6,102.9	-3.8
Diamonds (000 carats)	10,561.6	0.3	1,963.5	-2.1

(p) Preliminary; n.a. Not applicable.
(1) Uranium value is calculated using spot market prices. (2) Excludes shipments to potassium sulphate plants.
Note: Numbers may not add to totals due to rounding.

Source: NRCAN, 2013a

by province and territory.

Table 4.14 presents the Canadian national production of selected minerals. According to this Table, the value of metallic minerals production fell by 1.6% in 2013 to CAD 23.2 billion. This decrease in production was due to the uranium decline, with a fall by 35.6% on lower prices and output. Nickel production values also fell by 5.3% due to a price decline. Zinc also fell on price and volume. Despite a price decline for gold in 2013, its produced volumes and values increased (NRCAN, 2013a).

4.2.2. Internal Consumption

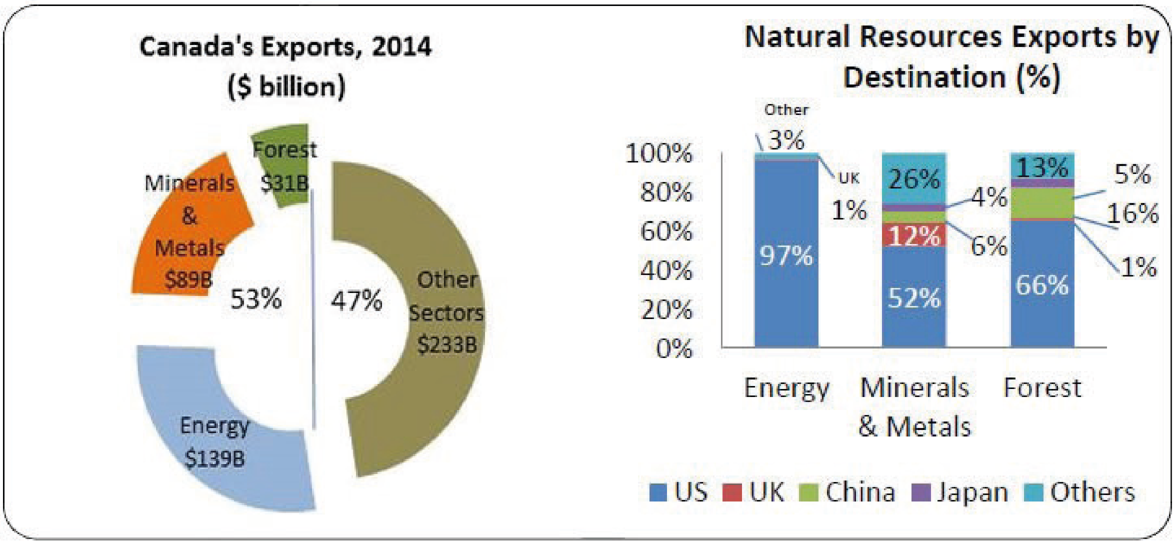
In Canada, the mining industry is export-oriented and it is difficult to find data for domestic consumption of minerals. The availability of several minerals that are consumed in downstream industries allows them to be considered as 'low-cost' materials, which together with great availability of also 'low-cost' energy, is a competitive advantage of Canada. The country is self-sufficient in many of the raw materials needed and does not rely on third countries for its supplies, thus contributing to the excellent position of the economy. In the overall imports for 2013, metals or non-metal minerals hardly reached 6% of total.

4.2.3. Trade (Export and Import)

In 2013 Canada had a positive trade balance of USD 1.69 billion in net exports (OEC, 2016a). In 2013 Canada exported USD 438 billion worth of goods, making it the 12th largest exporter in the world (OEC, 2016a). The main mineral resources exported by Canada in 2013 were crude petroleum 62% (USD 80.5 billion), refined petroleum 14% (USD 18.6 billion), petroleum gas 9.7% (USD 12.6 billion), coal briquettes 4.3% (USD 5.61 billion), Iron Ore 3.8% (USD 4.89 billion) and copper ore 2.2% (USD 2.89 billion) (OEC, 2016b).

In 2013, the top export destinations of Canada were the United States (USD 320 billion), China (USD 20.6 billion), Japan (USD 11.1 billion), the United Kingdom (USD 9.7 billion) and Mexico (USD7.68 bil-

Figure 4.6: Canada´s Exports 2014. Note: in 2014 1 CAD was around 0.91 USD.



Source: NRCAN, 2015d

lion) (OEC, 2016b).

According to ***Figure 4.6*** (NRCAN (2015d), the value of Canada's exports of minerals and metals in 2014 reached CAD 89 billion (18% of total exports). Natural resources, valued at CAD 259 billion, accounted for more than half of Canada's exports. The USA (78%), the UK (5%), and China (4%) were the three main destinations of natural resources exports. The USA were the destination of 52% of all minerals and metals exports.

In 2013 Canada imported USD 437 billion worth of goods, making it the 12th largest importer in the world (OEC, 2016a).

The top import origins are the USA (USD 230 billion), China (USD 48.9 billion), Mexico (USD 23.6 billion), Germany (USD 13.9 billion), and Japan (USD 12.8 billion) (OEC, 2016a).

The main mineral resources imported by Canada in 2013 were crude petroleum (46%; USD 24.3 billion), refined petroleum (32%; USD 17 billion), petroleum gas (8.8%; USD 4.65 billion), iron ore (1.7%; USD 894 million), lead ore (1.5%; USD 814 million), and coal briquettes (1.3%; USD 692 million) (OEC, 2016a). All this trade was facilitated by an efficient and secure ports infrastructure[7].

Of the total trade undertaken by Canada, around 75% is done with countries that are party of free trade agreements, primarily the USA. The treaty of free trade (FTA) between Canada and the USA of 1988 eliminated tariffs between the two, while the free trade agreement of North America (NAFTA) provided full integration between economies of Canada and the USA. It was expanded in 1990 to include Mexico.

Canada also has free trade agreements with Israel (1997), Chile (1997), Costa Rica (2002), Iceland, Norway, Switzerland and Liechtenstein (2009), Peru (2009), Colombia (2011), Jordan (2012), Panama (2013), and South Korea (2015). As of 2015, Canada has concluded two trade agreements that are potentially larger than NAFTA, one with the European Union (CETA), and the other being the Trans-Pacific Partnership, but they have not entered into force yet. The Trans-Pacific Partnership was ratified in February 2016, while the CETA is waiting for approval by the European Council and Parliament.

4.2.4. Expenditure, Taxes/Royalties, Investment and Competitiveness

Expenditure on mineral exploration and deposit assessment has increased greatly over time in Canada. In 2010 it increased by 43% to reach CAD 2.8 billion, compared to the CAD 1.9 billion recorded in 2009, when activities decreased temporarily during the financial crisis (NRCAN, 2015e). When associated capital, repair and maintenance costs are included,

7 Products from mining contributed nearly 41% to all traffic in and out of the port of Vancouver (Canada's busiest, handling about half of the total containers that go through Canadian ports) in 2006.

total exploration and deposit appraisal expenditures reached CAD 3.4 billion in 2010, or a 24% share of total mining investment. Comparable totals stood at CAD 3.8 billion or 30% of total investment in 2008 and at CAD 2.2 billion or 21% of total investment during the 2009 downturn (NRCAN, 2015e). In 2011 expenditures on exploration and deposit assessment increased again 37% to reach CAD 3.8 billion (or CAD 4.6 billion when including the associated capital costs, for an estimated 28% of total investment) (NRCAN, 2015e).

As reported by the Mining Association of Canada, from 2002 to 2011, global exploration spending grew by 585%. Canadian companies accounted for approximately 31% of global exploration spending budgets during that period, the largest share of all nations (Canadian German Chamber of Industry and Commerce INC, 2016a). In 2014 nearly 800 Canadian companies were actively exploring outside of Canada in over 100 countries. Hence, Canadian firms also account for large exploration spending not only in Canada, but also in the USA, Central and South America, Europe and, most recently, Africa (Canadian German Chamber of Industry and Commerce INC, 2016a).

A key reason for the success of Canada in establishing a cluster of junior mining exploration firms has been the Canadian tax and finance system that has provided junior firms (via the Canadian Mineral Exploration Credit[8] and a flow-through shares mechanism, with capital that they could otherwise not obtain from banks, that tend to be averse to mineral exploration given that it represents high-risk investment. The Canadian Mineral Exploration Credit allows prospectors to place exploration expenditures into a special tax-deductible pool that has no expiry date, allowing firms to carry forward the tax-credit until they have taxable income. The flow-through shares allow prospectors to pass the mineral exploration credit to an investor, who can take advantage of it immediately. In essence, flow-through shares reduce the risk to investing in mining exploration by guaranteeing some return in the form of lower taxes (The Canadian Chamber of Commerce, 2013:30).

Canada has three levels of mining taxation (NRCAN, 2015f):

Federal government:

- **Corporate income** taxes under the Income Tax Act (Part I, corporate income tax 15%, and Part XIII, withholding tax);
- **Goods and Services Tax (GST)**, a value-added tax that applies to virtually all goods and services purchased (but GST paid on business expenditures is refunded) and sold (but exported products and services are zero-rated);
- **Payroll levies** (e.g., Employment Insurance, Canada Pension Plan, or Quebec Pension Plan for a business located in Quebec), property taxes, and indirect taxes;
- **Excise taxes**, which are of limited application to mining, but are levied on selective business expenditures, such as fuel; the tax can either be a specific tax or an ad valorem tax (percentage of value); and
- **Custom duties**.

Provincial and territorial governments:

- **Corporate income taxes** in all provinces and territories (10% to 16%);
- **Mining taxes and royalties** (10% to 18%) related to the exploitation of natural resources (on their respective territory as well as offshore);
- **Payroll levies** as health and/or post-secondary education taxes (in Manitoba, Ontario, Quebec, Newfoundland and Labrador, Nunavut, and the Northwest Territories) and Workers' Compensation in all provinces and territories;
- **Value-added taxes** in Quebec, New Brunswick, Nova Scotia, Newfoundland and Labrador, and Ontario; and
- **Excise taxes** (particularly on fuel) and sales taxes (Prince Edward Island, Manitoba, Saskatchewan, and British Columbia).

8 The Mineral Exploration Tax Credit. is a 15% non-refundable tax credit on eligible expenses. Companies can apply it against the federal income tax that would otherwise be payable for the taxation year in which the investment was made. The credit can be carried back 3 years and forward 20. More information available on http://www.nrcan.gc.ca/mining-materials/taxation/8874.

Municipalities' taxation is limited to taxation on properties, licences, and fees.

In many respects, Canada's tax environment is favourable to mining activities. Canadian tax policies effectively address each phase of the mining cycle ensuring the growth of the industry and a fair share to the public sector. Some of the advantages include a stable mineral taxation regime, a transparent consultative process and carry-forward scheme. These tax credits for exploration and mine development expenses reduce the tax liability of corporations; such credits can be carried forward for a period of 20 years. Operating losses can be carried forward for 20 years, making it almost certain that a taxpayer will be able to use start-up losses if it does develop viable mining operations (KPMG, 2014).

Government Policy has until recently been a major driver for Canada's mining industry as Government cost shared many large scale regional infrastructure projects to open up areas (e.g. rail line to Pine Point mine, rail lines to the iron ore fields in Labrador, hydro power for Yellowknife Gold mines etc.). More recently Government fiscal policy mechanisms such as flow-through shares and loans from agencies such as Export Development Canada have become more important drivers than direct/indirect financial support to the industry.

Provincial Government spending has been important for prospecting via the various Prospectors Assistance Programs[9]. It provides direct financial support, through grants, to individuals (traditional "grass root" exploration), and it supports eligible exploration costs for junior exploration companies (e.g. in Newfoundland and Labrador) to conduct diamond drilling, ground and airborne geophysics and geochemical surveys.

Canada promotes Foreign Direct Investments (FDI) in the minerals sector by providing full access to geoscience information and statistics on minerals and metals, repatriation of profits, no currency restrictions, no import or export restrictions, and low withholding taxes. Canada also remains an important exploration investment country.

9 http://www.nr.gov.nl.ca/nr/mines/exploration/mip/prospectorast.html.

According to the Fraser Institute's 2014 annual survey of mining companies (Taylor, J., 2014), Saskatchewan ranks as the 2nd most attractive jurisdiction in the world out of 122 for investment. The Fraser Institute combines two indices in order to understand the investment attractiveness – The Best Practices Mineral Potential Index and The Policy Perception Index. In the Investment Attractiveness Index five Canadian jurisdictions are listed: Saskatchewan (2nd), Manitoba (5th), Quebec (6th), Newfoundland & Labrador (8th), and Yukon (9th).

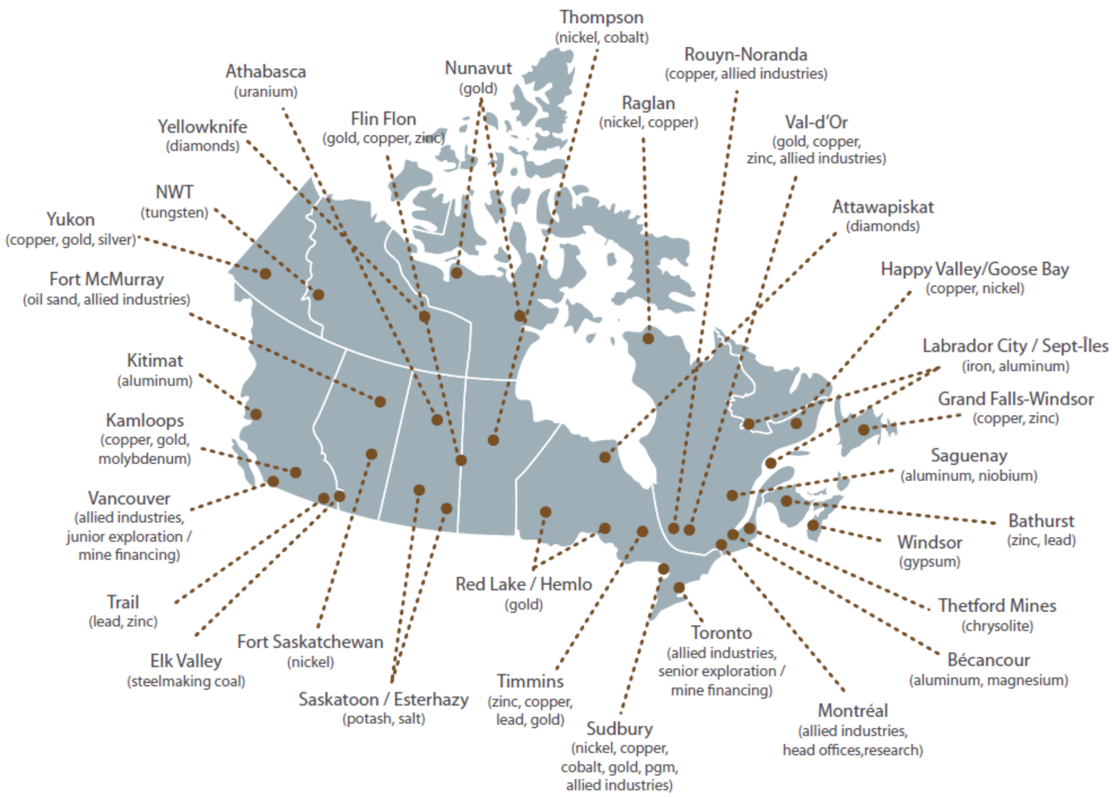
Canada was in 2014 the 15th most competitive economy of the world out of 144, according to the World Economic Forum (WEF, 2014).

4.2.5. Industry Structure

In 2010 Canada had a total of 968 mining establishments, with 71 metal mines and 897 non-metal mines, distributed in regional clusters (***Figure 4.7***). Canada has the world's second-largest mining supply sector after the USA, with 3,215 mining suppliers (KPMG, 2014). The extraction and processing of minerals is an important part of Canada's industrial sector, jobs and government revenue. Canada´s mining industry is a global leader in exploration, mine development and operation, and financing (The Canadian Chamber of Commerce, 2013).

Canada has been particularly successful in fostering the development of junior mining firms that focus on exploration, and this contingent of junior firms (based in Toronto or Vancouver) has created a number of key advantages for the Canadian mining sector as a whole. Toronto and Vancouver are global mining centres with outstanding expertise and depth of experience (KPMG, 2014). Vancouver features the world's leading cluster of exploration companies, while Montreal is home to major aluminium and iron ore firms. Edmonton, the capital of Alberta, has become a global centre for oil sands expertise and Saskatoon, the capital of Saskatchewan, for uranium and potash (Marshall, 2014). Toronto hosts the Prospectors & Developers Association of Canada (PDAC) Convention, which is the

Figure 4.7: Canadian mining clusters.



Source: Marshall (2014)

largest in the exploration industry. Calgary houses the nation´s energy cluster and is also of importance with a highly skilled talent pool and a strong capital market, extensive networks of tax treaties and investment protection agreements, especially for investment in mining activities outside Canada (KPMG, 2012). Sudbury (home of former the Inco Ltd., now part of Vale, and of Falconbridge, now merged within Glencore) is another traditional centre of mining expertise and a cluster of mining innovation, namely the Centre for Excellence in Mining Innovation (CEMI), or the Northern Centre for Advanced Technology (NORCAT). Sudbury's emerging mining supply and technology cluster is the 'mining superstore' of Ontario, with potential to become a global leader (The Canadian Chamber of Commerce, 2013).

The mining industry is represented at the provincial, territorial, and federal levels by a number of organisations such as: Alberta Chamber of Resources, Association of Mining Exploration of Québec (AEMQ), Canadian Aboriginal Minerals Association, Canadian Association for Mining Equipment and Services for Export (CAMESE), Canadian Council of Professional Geoscientists, Canadian Diamond Drilling Association, Canadian Institute of Mining, Metallurgy and Petroleum, Canadian Mining Industry Research Organisation, Coal Association of Canada, Mining Associations in British Columbia and Nova Scotia, the Mining Association of Canada (MAC), Northern Prospectors Association, NWT & Nunavut Chamber of Mines, Ontario Mining Association, Prospectors and Developers Association of Canada (PDAC), among others.

In Canada the mining industry is divided into two groups: a) senior companies, and b) junior companies. Senior companies normally derive their income from mining or other business ventures (they do not need to be mining companies), rather than from the issue of shares (KPMG 2014).

Senior companies are:

- Integrated Global Producers;
- Smaller Global Producers;
- One mine companies;

Junior companies can be (KPMG 2014):

- Junior Exploration/Mining Companies

or private exploration companies: Small companies involved in exploration, but no production;
- Small or medium sized companies focused on a few minerals/metals, with one or two producing mines.

There have been attempts to identify characteristics of firms that can be used to delineate their organizational function in the mining industry. For example, Canaccord Capital (MacDonald and Talmac, 2002) breaks down the gold exploration sector into two groups: (a) exploration divisions of major companies, and (b) juniors/mid-sized companies, of which there are three types:

- Type 1: "Single Purpose" juniors whose entire corporate existence hinges on developing deposits to sell to majors (the examples they use are Pangea Goldfields and Argentina Gold). These firms comprise some 81% of the total population of companies;
- Type 2: "Transition" firms (expansionary juniors or intermediates), who attempt to develop deposits to become producers (e.g. TVX Gold, Bema Gold). Nine per cent of all firms in the gold sector are considered to be in transition; and
- Type 3: "Professional" companies (called "Management Groups" here), that manage a portfolio of companies for sale or joint venturing (e.g. Hunter Dickenson, Lundin Group). Significantly, about 10% of the population of firms in the gold sector is considered 'professional' or under the umbrella of a professional company. These companies are becoming more important over time.

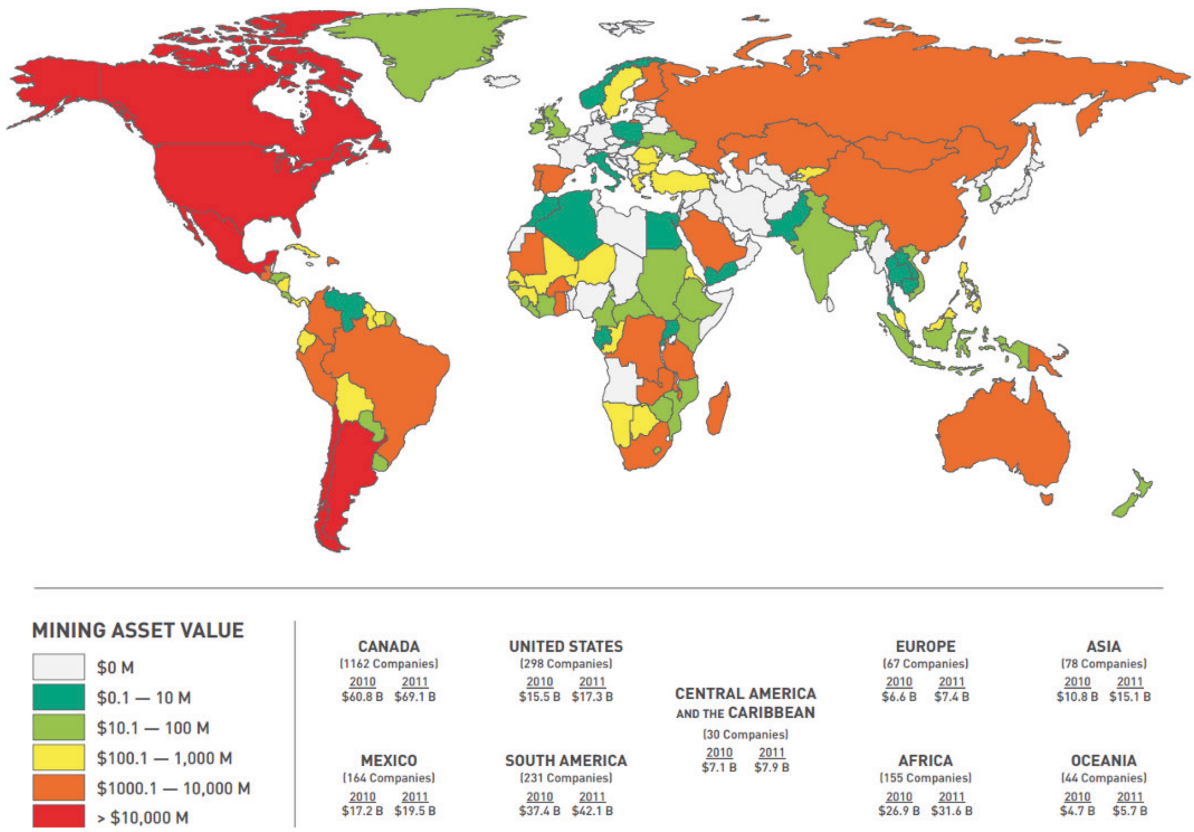
With respect to Canada's role in the exploration industry, there are two important points that should be made:

1: A very large proportion of the industry financing is provided in Canada by the Toronto Stock Exchange Senior and Venture exchanges. More than 60% of listed mining companies trade on these exchanges.

2: Canada is the largest target for exploration expenditures (in 2014 14% of total expenditures).

More than 800 Canadian companies

Figure 4.8: Canada's Mining Assets, 2011.



Source: Marshall (2013)

work and invest worldwide (***Figure 4.8***). Canada has mining assets all over the world, making it the most entrepreneurial mining country in the world.

The Toronto Stock Exchange (TSX) is the dominant financial market for global mining, and a leader in global mining equity financing in comparison to other stock exchanges around the world. The TSX is the 7th largest stock exchange in the world by market capitalisation, the 3rd largest financial centre in North America (after New York and Chicago), and it is the main exchange venue for Canada´s capital markets (banks, insurance companies, pension funds). TSX and TSX Venture Exchange were home to 57% of the world's publicly-listed mining companies and traded more than CAD$ 200 billion of mining stock in 2013. Together, the two exchanges handled 48% of global mining equity transactions in 2013 and accounted for 46% of global mining equity capital that year (Marshall, 2014). They are the most important markets for junior mining companies. Lately, there have also been an increasing number of junior issuers listing on the recently rebranded Canadian Securities Exchange (CSE). TSX features a high concentration of precious metal companies especially gold, as well as uranium and potash miner. The Canadian market is characterised by a high concentration of small capital companies and an investor community willing to evaluate exploration assets, including many international projects. Canada is also a world-leader in raising equity for mineral exploration and development. In 2011, almost 40% of the world's equity financing for mineral exploration and mining was raised by companies listed on Canadian stock exchanges (NRCAN, 2013).

Each of Canada's 13 provinces and territories has its own securities commission or equivalent authority that oversees the regulation of securities - the largest being the Ontario Securities Commission- and its own set of laws, regulations, rules and policies. However, provincial and territorial regulators work closely to coordinate capital markets through the Canadian Securities Administrators, and there exists a mandatory national mineral reporting standard (CRIRSCO aligned) for companies in the mining sector, the National Instrument 43-101[10].

Globally, Canada is recognized for its leadership in safety and sustainability. Mining companies in Canada were the first in the world to develop an externally verified performance system for sustainable mining practices with issuing the commitment 'Towards Sustainable Mining' (TSM) by the Mining Association of Canada (MAC). TSM governs key activities of companies in all sectors of mining and mineral processing industry. This is a pioneering initiative in the field of corporate social responsibility that helps mining companies assess their environmental and social responsibilities. The MAC makes the participation in TSM mandatory for all its members. The three topical areas on which the companies evaluate themselves are: 1) communities and people; 2) environment; and 3) energy and efficiency.

4.3 Assessment of the regulatory framework

The mining legislation in Canada is stable and the rights over minerals are recognised since the early 1900s. Rights to unexplored land and the underlying minerals are granted by the Crown, which owns them. In Canada surface and mineral rights are separated, indicating that a mining company may obtain a lease to develop and exploit a mineral deposit without the need to own (purchase) the land (surface rights). Mineral rights are government-owned and cannot be purchased, only leased by individuals or companies (via online staking – mineral claim). Mining leases in Canada are issued for a specific term that is renewable, subject to an annual rental charge and transferable with the prior written consent of the government. The Canadian permitting procedure for mining is considered stringent, but very effective with a permitting delay of around two years, similar to that of Australia (SNL Metals & Mining, 2015). This is considered one of the key drivers of mining success in the country.

The rights are granted for certain tenure, on a first come, first serve basis (KPMG, 2014) under two systems: 'free-entry'

10 http://web.cim.org/standards/MenuPage.cfm?sections=177,181&menu=229.

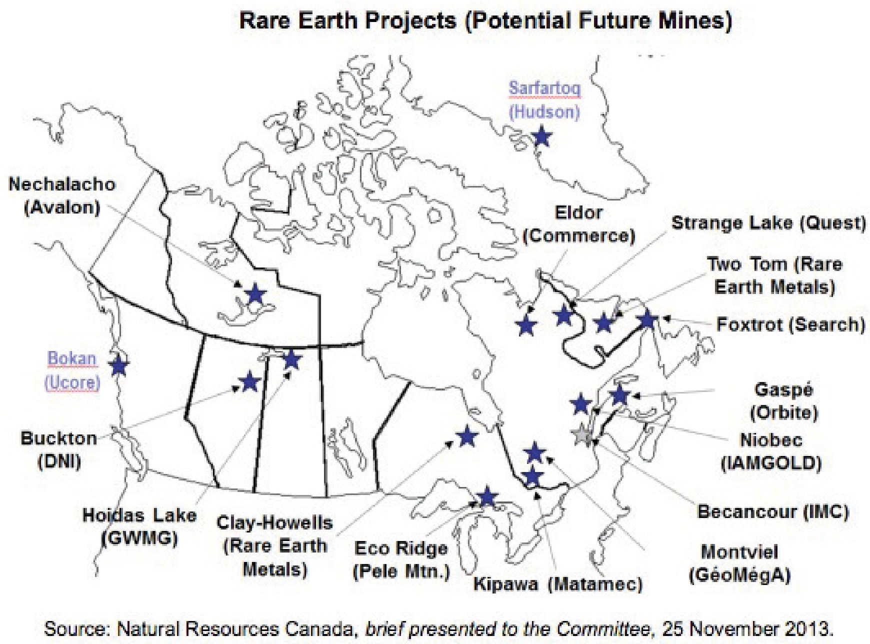
and 'Crown discretion'. Under 'free-entry' regimes prospectors can apply to the Crown to register mining claims on Crown land. Once mining claims are registered, the regime authorizes prospectors to subsequently carry out exploratory work on those claims. This regime does not provide the Crown with any discretion in determining whether to register mining claims once a prospector has submitted an application, and no further Crown authorisation is necessary in order for the prospector to carry out exploration activities. The Crown discretion system permits the Province to refuse an application, or defer the acceptance of an application for a license where it believes the application is not in the best interests of the Province. Virtually the entire country operates using a variant of the free miner entry system, which initially made it very low cost for prospectors to enter into the industry and move from province to province in response to discoveries.

Mineral exploration, development, conservation and management are controlled by the provincial governments, while jurisdiction in matters such as environmental and taxation is shared between the federal and provincial governments. Each jurisdiction has its own mining, environmental and occupational health and safety legislation. All jurisdictions have separate mining rights legislations (for acquiring mineral tenure) except Nunavut, which is regulated by the Department of Aboriginal Affairs and Northern Development, and the Northwest Territories which as of April 2014 fall under the Department of Industry, Tourism and Investment.

In the Northwest Territories, individuals and companies must obtain a prospecting license before engaging in mineral exploration. In Yukon, Alberta, Saskatchewan, Prince Edward Island, and Newfoundland and Labrador, one can carry out prospecting activities or operations without a license, but must have a license to actually acquire mineral rights (or «stake credits») to protect what one has found (NRCAN, 2015h).

The first and key environmental responsibility rests with the Provinces. All mining projects in Canada are subject to provincial/territorial environmental assessment and permitting. When the projects involve Federal matters they are subject to the Canadian Environmental Assessment Act (CEAA) and, depending on the details of the project and the mine site, they may require approvals under other federal legislation, such as the Fisheries Act and the Navigation Protection Act

Figure 4.9: Canadian REE projects in an advanced exploration stage in 2013.



Source: http://www.mining.com/canada-identifies-top-rare-earth-projects-48319/

(Marshall, 2014).

Major regulations for the mining sector at the provincial/territorial levels are the Mineral Act, the Mining Act, the Mineral Resources Act, and the Mineral Tenure Act. A review of the Metal Mining Effluent Regulations (MMER) is ongoing (NRCAN, 2015h).

4.4 Raw material supply assessment

Canada holds enormous resources of metals and the size and diversity of the mineral endowment of Canada has been a major factor in driving the growth of the country's mining industry. The continued discovery of mineral resources suggests

Table 4.15: Strengths, Weaknesses, Opportunities and Threats of Canada's mineral raw materials sector.

	STRENGTHS	WEAKNESSES
INTERNAL FACTORS	• Rich and diverse mineral endowment, with world-class deposits; • Stable political and social contexts, with rule of law (security of tenure, protection of property, legal system); • Stable mining regulatory framework; • Full access to geoscience information and statistics on minerals and metals; • Strong and sophisticated mining cluster, distributed by regions/sectors and including also exploration junior companies, specialised financial services and support industries (mining equipment, technology and services) with global activity; • Geopolitical location, next to the world's major consumer of natural resources (USA); • Absence of trade barriers and strong integration with the USA economy; • Strong trade network; • Reliable and adequate transport infrastructure (railways, ports, roads); • Very efficient access to capital; • The Toronto Stock Exchange is the dominant financial market for global mining, listing 57% of the world's public mining companies, and a leader in global mining equity financings in comparison to other stock exchanges around the world; • Low corporate taxes; • Availability of a highly educated population (and workforce) with high attainment levels; • Low population density; • Regulatory framework favourable to mining; • Government fiscal policy mechanisms such as flow-through shares and loans from agencies such as Export Development Canada; • Canada recognition for its leadership in sustainable mining practices.	• The exploration in specific regions (like northern Canada) has very high operating costs and lacks infrastructure to support the mining industry; • Different levels of competitiveness among Canadian provinces and territories.

	OPPORTUNITIES	THREATHS
EXTERNAL FACTORS	• Economic growth in the Asian market; • Technological development and new technologies; • Potential to increase the added value (of mineral commodities) trough enhanced mineral processing methods; • Raising world demand for critical raw materials; • Large areas remain underexplored, especially in northern Canada.	• Decrease in the commodities value (currency and price); • Elimination of Government incentives (Corporate Mineral Exploration and Development Tax Credit, the Atlantic Investment Tax Credit for resources, Accelerated Cost of Capital Allowance); • Decrease in the demand of major commodities like bauxite or iron. • Weakening demand from China; • Strong dependence on the USA market; • Deepening European financial crisis; • Increasing sustainability domestic standards (including the Social License to Operate, environmental responsibility and fair compensation to aboriginal people).

the great potential for mining that Canada holds.

Among recent discoveries, it is important to highlight the metallogenic province named Ring of Fire, located 500 kilometres northeast of Thunder Bay, Ontario, discovered in 2007. This area contains very important resources of chromite - among the best deposits in the world - plus nickel, copper, platinum group elements, gold, zinc and vanadium. More recently, in 2014, it was announced that mining will begin in the world's largest (by reserves) undeveloped gold-copper project, the Seabridge Gold's KSM project in British Columbia. In the second half of 2016, the Gahcho Kué diamond mine, which will be one of the world's largest diamond mine, will start producing.

Canadian Companies also actively invest in exploring rare earth (REE) deposits, and it accounts for approximately 40% to 50% of the world's known REE reserves. In 2013 Canada had 15 Canadian REE projects in an advanced exploration stage, all of which are Canadian owned (***Figure 4.9***).

Considering this rich mineral endowment, and also the stable political and social framework, Canada's role as a trustable supplier of mineral raw materials will be reinforced in the future, providing many critical commodities to foreign countries.

4.5 Strategic analysis

4.5.1. SWOT

Table 4.15 below synthesises the analysis of the Strengths, Weaknesses, Opportunities and Threats of Canada's mineral raw materials sector.

4.5.2. Competitive Context

Considering Porter's Framework is possible to establish a profile of the country regarding the drivers that lead to their comparative advantages (***Figure 4.10***).

4.6 Conclusions

Canada is the third largest producer in the world of minerals, exporting 80% of all exploited ore. It ranks in the top five countries in the global production of 11 major minerals and metals: first in potash; second in uranium and cobalt; third in aluminium, diamond and tungsten; fourth in platinum group metals, sulphur, and titanium; fifth in nickel. It produces more than 60 elements of the periodic table, which contributes significantly to the national economy. Canadian economy was in 2014 the 15th most competitive economy of the world, according to the World Economic Forum (WEF, 2014). Canada is an example of a mineral exporting economy that relies on endogenous resources. The mining industry is one of the most impor-

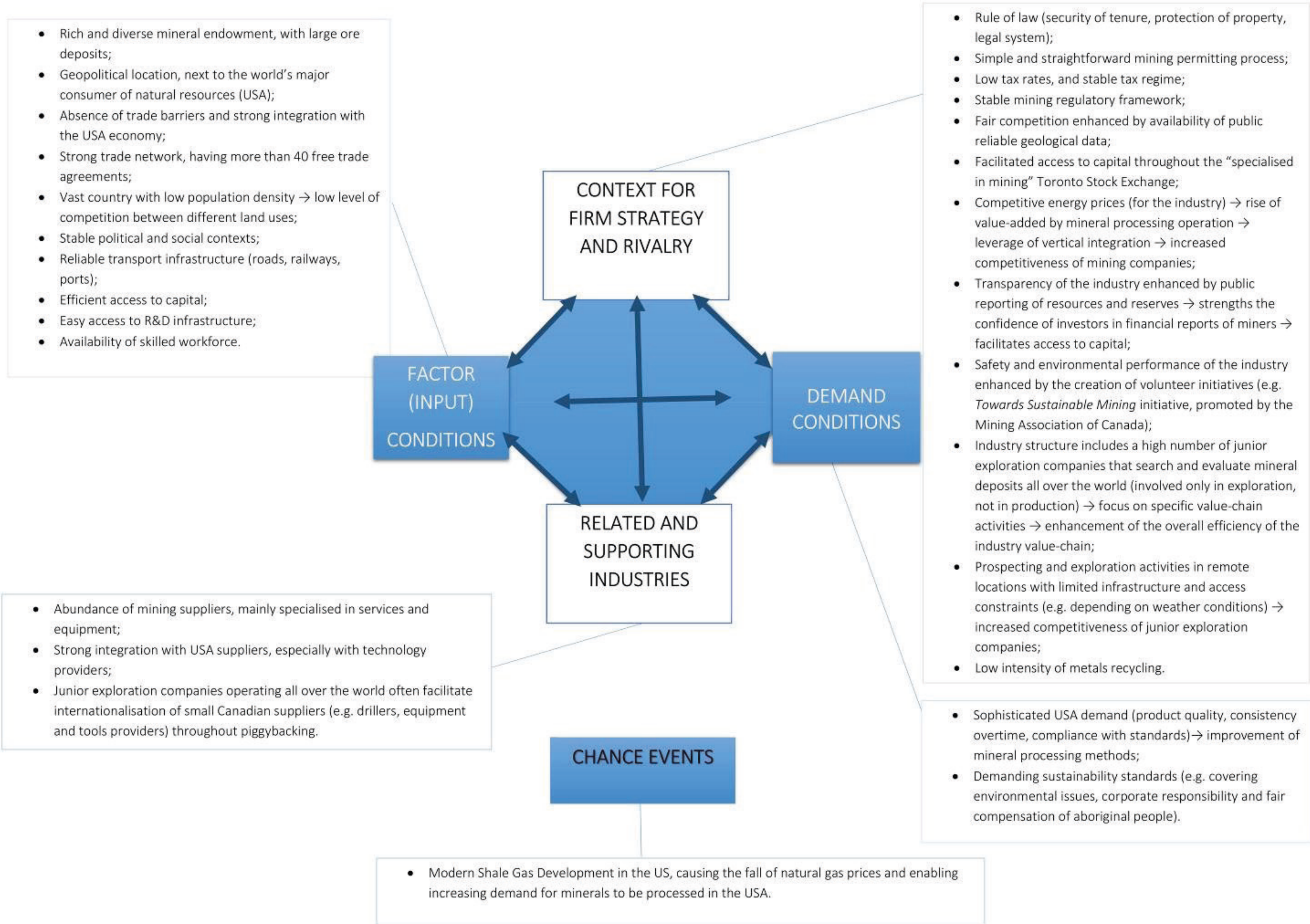


Figure 4.10: Canada's competitive context.

tant industrial sectors in the country and the 4th largest contributor to the country's gross domestic product (GDP), with values around USD 54 billion in 2013 (7%).

The regulatory framework of Canada is stable and the mining permitting process is relatively fast and simplified. There is distinction between the regulatory system for granting of mineral rights (which is mostly straightforward vs the regulatory system for environmental operating permits for a mine which can be slow and expensive. Government Policy has until fairly recently been a major driver for Canada's mining industry, as the Government shared the costs of many large scale regional infrastructure projects in remote areas. More recently, Government fiscal policy mechanisms, such as flow-through shares and loans from agencies, such as Export Development Canada, have become more important drivers for the development of the mining industry.

These fiscal mechanisms were fundamental for the successful establishment of a strong cluster of junior mining exploration firms, providing to these firms (via the Canadian Mineral Exploration Credit and a flow-through shares mechanism), the capital they could otherwise not obtain from banks.

The industry structure is consolidated, with a large number of multi-national and junior companies of Canadian origin working worldwide. Canada is the country with the most exploration enterprises operating overseas, having about 800 firms active in more than 100 countries. The Canadian mining cluster includes integrated global miners, specialised investors and financial services, several industry and professional associations, a huge mining supply sector (equipment, technology, services), many processing plants, and specialised government agencies acting at provincial or territorial levels. This cluster is clearly a knowledge-based cluster, covering the entire value chain and showing geographic specialisations on specific minerals or activities, spreading all over Canada.

Canada attracts investment to the minerals sector by providing full access to geoscience information and statistics on minerals and metals. Foreign investors can also repatriate profits, have no currency restrictions, no import or export restrictions, and benefit from low withholding taxes. Investment flows are facilitated through the Toronto Stock Exchange. The majority (57%) of the world's public mining companies are listed on the TSX and TSX-Venture Exchanges. Together, the two exchanges handled 48% of global mining equity transactions in 2013, and accounted for 46% of global mining equity capital for that year.

With the (soon expected) entry into force of the Trans-Pacific Partnership and CETA trade agreements, Canada will become one of the world's countries with most free trade agreements, leveraging its capacity do supply mineral raw materials to all developed and developing countries.

Canada's metals recycling sector is mature and extensive and includes the capital intensive primary and secondary smelters. Primary smelters are well equipped to recycle complex metallic composite materials, such as e-Waste, and this will certainly foster the recycling of electronic waste in the near future.

The major concerns for Canada's mineral raw materials sector include the strong dependence on the USA market and the weakening demand from China. To deal with raising concerns over sustainability issues, the industry developed an externally verified performance system for sustainable mining practices with the launch of the Mining Association of Canada's (MAC) initiative Towards Sustainable Mining, reinforcing Canadian miners' reputation in safety and sustainability.

The continued discovery of mineral resources suggests the great potential for mining that Canada contains. Considering its rich mineral endowment, and also the stable political and social framework, Canada's role as a reliable supplier of mineral raw materials will be reinforced in the future, providing many critical commodities to foreign countries.

5. Japan

5.1 The industry in a global context

5.1.1. General Economy

During the 20th and early 21st centuries Japan became the 5th largest economy in the world (by GDP – purchasing power parity) and it ranks as one of the most innovative countries, being the World leader in terms of patents in force and patent applications. Manufacturing provides for most of the nation's exports, with Japan ranking as the 4th largest exporting economy in 2013 (OECD Factbook Statistics, 2015). Japan's reserves of metallic ores are scarce, and the industry depends entirely on imports of fossil fuels (oil, gas) and ores of ferrous and nonferrous metals. The mineral processing industry is large and includes the processing and production of chemicals, fabricated metal products, industrial mineral products, iron and steel, non-ferrous metals, and petroleum products for manufacturing and construction industries. The table below summarises Japan's general economic data.

Table 5.1: Japan's general economic data.

General Data[1].	
AREA (2014):	390,688 Km^2.
POPULATION (2014):	127.08 million.
WORLD RANKING (Largest Export Economy, 2013):	4th.
GROSS DOMESTIC PRODUCT (GDP, 2014):	Approx: USD 4,343.5 billion.
EMPLOYMENT (2014):	3.6% Unemployment. 65.51 million employed.
INDUSTRIAL SECTORS (Contribution to GDP, 2013):	Services (70%); industry (29%) and agriculture (1%).
TOP MINERAL EXPORTS:	Iron and steel products.
TOTAL EXPORTS (2014):	USD 690 billion.
TOTAL IMPORTS (2014):	USD 812 billion.
TRADE BALANCE:	Minus USD 122 billion.

1 Ministry of Internal Affairs and Communications, Statistics Bureau; Statistical Handbook of Japan, 2015; OECD Factbook Statistics, 2015; and Observatory of Economic Complexity.

5.1.2. Territorial Organization

Japan is an archipelago with more than 6,800 small islands in East Asia. There are five major islands (Honshu, Hokkaido, Kyushu, Shikoku and Okinawa), which constitute the main districts. The country is organised in eight regions and 47 prefectures (***Figure 5.1***).

The mining industry in Japan is of minor importance. However, the mineral processing and other related industries are very important. The major manufacturing industries and industrial areas in Japan are located along the Pacific coast of southern Honshu, usually known as the 'Pacific Industrial Belt' (***Figure 5.2***).

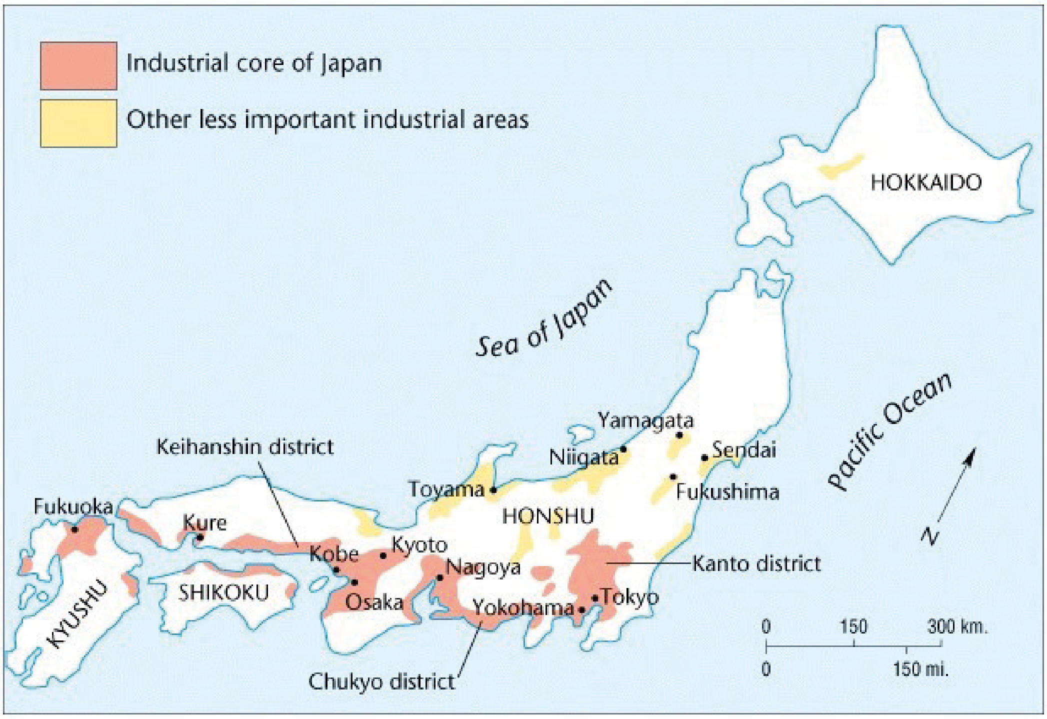
5.1.3. Minerals Industry Contribution to Economy

Being a minor producer and a major consumer of mineral raw materials, Japan relies on resources from other countries, from where it imports mainly ores and metal concentrates. The development of Japan as a "processing country" has been enabled by a successful long-term policy of securing a stable supply of mine-

Figure 5.1: Japan's Territory[1].

1 https://en.wikipedia.org/wiki/Prefectures_of_Japan.

Figure 5.2: Major industrial areas in Japan.



Source: Jordan-Bychkov et al. in INTRAW – D1.2, Contextual Analysis: Country Report for Japan, MinPol, 2015 ral commodities, particularly via securing imports and stockpiling. Such minerals policy has enabled the country to overcome its shortage of raw materials. For this reason, and though mining is of no relevance in Japan, the raw minerals processing industry is sophisticated and one of the most technologically advanced in the world. This supports Japan's manufacturing advantages, leveraging its world leader position as supplier of high quality iron and steel products alongside with other non-ferrous metal products.

Japan is one of the world's major producers (and a major consumer) of cadmium, the leading producer of selenium metal, electrolytic manganese dioxide and titanium sponge metal; the second-leading producer of iodine, pig iron, nickel metal, and crude steel; the third-largest producer of copper metal, zinc metal; and the fourth-largest producer of cement[1]. Cadmium, selenium, gallium, indium and many other minor metals are by-products of the beneficiation and smelting of base metals. These rare metals (many of them are nowadays critical to the electronics, IT and automotive industries) are not mentioned in the data on mining, and only arise in data provided by processing companies. They are now quite valuable and critical for many industrial processes.

Contribution to GDP and Employment

While mining as such in Japan today is of almost negligible importance – it is the smallest sector of Japan's industry based economy, contributing to the GDP with only 0.1%-0.2%, the mineral processing sector is very important for the country's GDP and sustains Japan's leadership in the production of metals.

The contribution of mineral rents to GDP, including that from tin, gold, zinc, iron, copper, nickel, silver, bauxite, and phosphate mining was in 2013 close to 0.01%. This is not new; the biggest contribution of mineral rents to Japan's GDP over the past 43 years occurred in 1970, with a mere contribution of 0.06% (while the lowest value was 0% in 2001; ***Figure 5.3***; World Bank[2]).

In consequence, in terms of employment the primary industry in general is not significant in Japan and has been decreasing over the years. The exploration of minerals (mining and quarrying) in 2014 employed approximately 30,000 persons (0.04%). In contrast, the manufacturing sector, including the processing of minerals, employs about 17% of the total workforce and the tertiary sector is the leading employer, providing more than 70% of the jobs.

Data from 2013 (Statistical Handbook of Japan, 2015) show that the iron and steel industry generated employment for approximately 216,000 persons (approx. 3% of total employment) and that the fabricated metal products industries employed around 572,000 persons (approx. 9% of total employment; ***Figure 5.4***).

Contribution to Total Exports

Japanese exports are characterised by products manufactured using advanced technologies and with high added value, such as motor vehicles, electronic components and equipment or general electrical machinery.

Japan is mainly a consumer/importer of mineral resources. Nevertheless, the export of several processed minerals is important for the country's economy. In the minerals sector Japan major exports are iron and steel, which achieved 5.4% of the country total exports in 2014 (Statistical handbook of Japan, 2015).

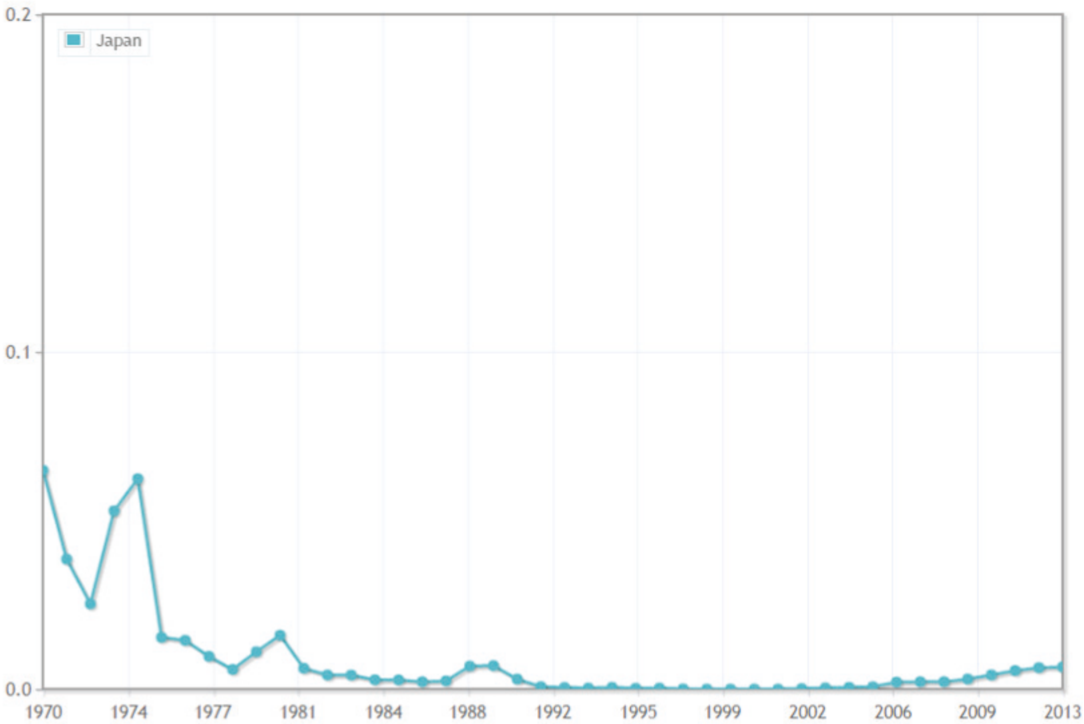
5.1.4. Non Energy Mineral Industries

The mineral resources of Japan are almost depleted, with the exception of gold and some non-metallic minerals. The low tonnage and grade made mining unfeasible for most minerals. For this reason Japan is one of the largest importers of mineral commodities, essentially ores and concentrates, that are processed, used by the country industries, and also expor-

1 http://www.nationsencyclopedia.com/Asia-and-Oceania/Japan-MINING.html#ixzz3tHHAbUO4. As mentioned before construction minerals are not in the focus of this report. However, Japan's relevant position in the world ranking of cement production highlights the country high level of urbanisation and infrastructure.

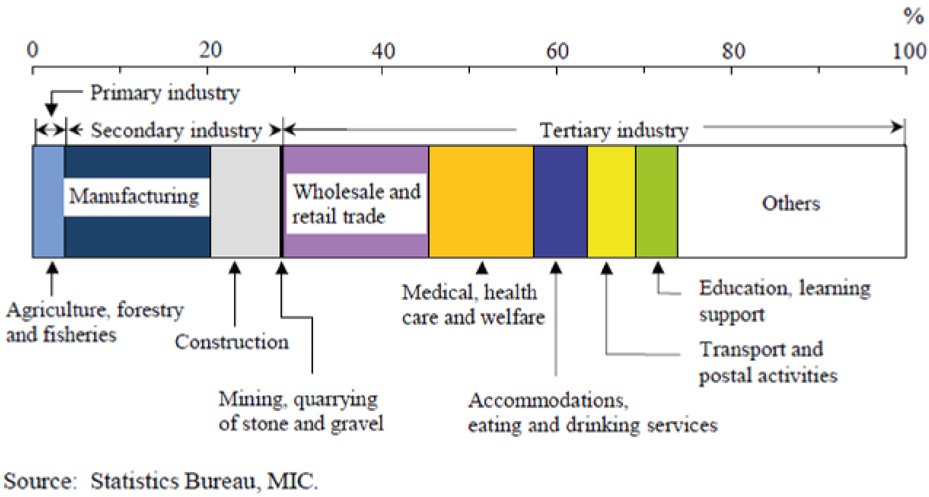
2 Mineral rents are the difference between the value of production for a stock of minerals at world prices and their total costs of production (http://data.worldbank.org/indicator/NY.GDP.MINR.RT.ZS/countries?display=map)

Figure 5.3: Evolution of the mineral rents in Japan (% of GDP).



Source: World Bank in http://www.indexmundi.com/facts/indicators/NY.GDP.MINR.RT.ZS/compare#country=jp, accessed on January 2016

Figure 5.4: Distribution of employment by industry in Japan in 2014.



Source: Statistical Handbook of Japan – 2015

ted in some minor quantities.

The shortage of the necessary mineral resources to develop the Japanese economy encouraged the development of a technologically extremely advanced mineral processing industry, which brought enormous benefits for the efficient processing of minerals acquired overseas.

Japan is neither a mining country, nor a large producer of raw materials, at least not within its geographic boundaries. Hence, the analysis of the minerals industry in Japan in this report considers the minerals through the perspective of the processing and production of final products, rather than focusing on domestic resources or on mineral exploration/exploitation. This is an adaptation of the approach within INTRAW used to map the other reference countries that have large domestic endowment of mineral resources.

In this context, the profiling of the use of major minerals in Japan reflects the importance of the processing industry, taking into account key minerals for the country, related to the volumes involved and their importance to the manufacturing industry and economy. For this reason, the presentation of data in the following subchapter will not follow the same structure used in the other countries' chapters.

5.1.4.1. Major Metallic Minerals[3]

Aluminium

In 2014 Japan imported a total of 2,072,539 t of primary aluminium and alloy and approximately 123,000 t of other aluminium products (Japan Aluminium Association, 2015). Most of the aluminium was for internal consumption (94%), but the country also exported 251,000 t of aluminium products in 2014.

Japan's supply of aluminium is totally dependent on metal imports, on domestic production from recycling[4], and on the conversion of imported alumina. According to the USGS (USGS, 2014) in 2012 Japan produced 137,000 t of secondary aluminium and 3,100 t of primary aluminium.

3 The considered data refers to USGS (2014) information unless otherwise specified.
4 Japan Aluminium Association, 2015: http://www.aluminum.or.jp/english/common/pdf/e_industry.pdf

Copper

Japan imports copper ore from producing countries and processes it into the metal. According to the Japan Copper and Brass Association the world's copper consumption in 2012 was 20.43 M tons, of which China consumed 40%, five EU nations consumed 16%, the USA 9% and Japan approximately 5% (***Figure 5.5***). From the internally processed copper ore Japan's own consumption of copper metal was 0.91 M tons in 2012, 63% for electric wires and 37% for copper and copper alloys. Apart from the domestic demand, nearly 0.6 M tons of copper metal was exported[5].

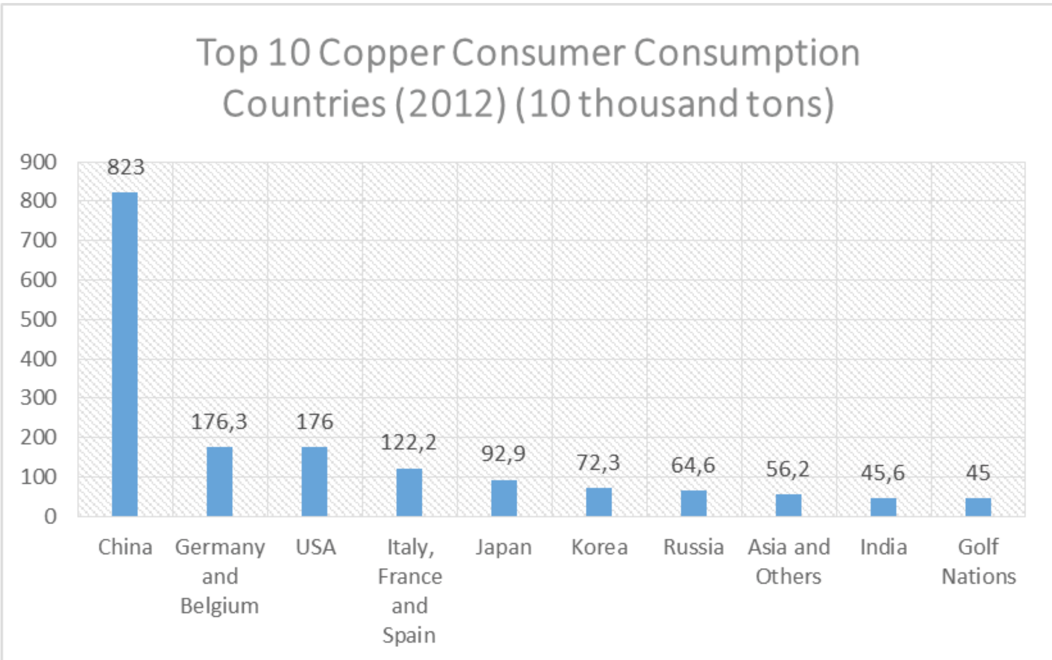
Japan produced about 1.3 Mt of anode and blister copper from primary ores and 304,000 t from scrap. It also produced about 1.52 Mt of refined copper primarily from imported ore (83.8%), scrap (10.4%), and from other sources (5.8%) (USGS, 2014).

Gold and Silver

The Hishikari mine, located in the Kagoshima prefecture, is the most important production centre for gold in Japan. This mine, in operation since 1985, is one of

5 Japan Copper and Brass Association (http://www.copper-brass.gr.jp/english/shindouhin/domesticmetal.html

Figure 5.5: Top 10 copper consumption countries in 2012.



Source: http://www.copper-brass.gr.jp/english/shindouhin/domesticmetal.html the richest gold mines in the world, with an average grade of 40 g/t of ore (a 'normal' average grade is around 5-6 g/t). Another advantage of Hishikari is that the ore deposit is near the surface (150-250 m depth), which reduces the exploitation costs[6].

According to USGS (2014), Japan produced about 104 t of gold in 2012. Not all the gold was produced through 'domestic' mining: only 13% of the production was derived from domestic ore. The majority of the gold was produced from imported ores (64%) and also a significant value was obtained from recycling (13%). Japanese gold is attracting the interest of foreign investors and there are western companies (such as Southern Arc from Canada[7]) applying for exploration licenses.

Japan produced in 2012 about 1,765 t of silver, mostly from imported ores (62%). Recycling represented 17% of the silver produced, while the production from domestic ores was negligible (0.4%) (USGS, 2014).

6 http://www.mbendi.com/indy/ming/gold/as/jp/p0005.html.
7 http://www.southernarcminerals.com/

Iron and Steel

The Japanese iron and steel industry is entirely dependent on imports of iron ore. In 2014 Japan imported 136.444 M tons of iron ore (with increasing imports in three consecutive years). Australia was the main supplier with a 60.7% share of Japan's imports, with Brazil being the second largest supplier with a 27.1% share. South Africa as third, Canada as fourth, and India as fifth were only minor suppliers (Statistical Handbook of Japan, 2015).

Japan produces around 110,000 t/year of steel, being the 2nd largest steel producer in the world after China (Table 5.2). According to the Japan Iron and Steel Federation (JISF)[8], Japan's iron and steel exports in 2014 were above 40 Mtons for the fifth consecutive year. However, exports decreased for the first time in three years. The primary cause was declining exports to South Korea, China, and the ASEAN region, as there was an ample supply of steel due to higher production in other Asian countries, combined with the deceleration of Southeast Asian economy.

8 http://www.jisf.or.jp/en/statistics/

Table 5.2: Crude Steel production in selected countries (values x1000 t).

Country	2005	2010	2012	2013	2014
China	355,790	638,743	731,040	822,000	822,698
Japan	112,471	109,599	107,232	110,595	110,666
USA	94,897	80,495	88,695	86,878	88,174
India	45,780	68,976	77,264	81,299	86,530
South Korea	47,820	58,914	69,073	66,061	71,543

Source: Statistical Handbook of Japan, 2015

Lead

According to USGS (2014) Japan produced a total of 252,000 t of lead in 2012. To accomplish this value Japan processed primary ore (36%), scrap and material from other sources (47%) and also re-melted lead (17%). Refined lead was used in batteries (87%), pipes and sheet (6%), chemicals (2%), solder (0.7%), and other miscellaneous applications (4%) (USGS, 2014).

Nickel

Until 2014 Indonesia (the world's largest primary producer of nickel) was the largest supplier of nickel to Japan. However, a mineral export ban of Indonesia in early 2014 (affecting unprocessed nickel) created the need to find other suppliers, such as New Caledonia, the Philippines and the Solomon Islands (USGS, 2014).

Japan is (after China) one of the major producers and suppliers of stainless

Table 5.3: The world's largest consumers of nickel in 2006.

Rank	Country	% of world nickel use in 2006
1	China	19%
2	Japan	14%
3	USA	11%
4	Germany	9%
5	South Korea	7%

Source: Nickel Institute, 2009

Table 5.4: World's largest consumers of Nickel in 2013.

Rank	Country	Nickel consumption in 2013 (Kt)
1	China	4,333.5 Kt
2	Japan	1,193.8 Kt
3	USA	1,025.3 Kt
4	Germany	727.3 Kt
5	South Korea	590.1 Kt

Source: Australia Department of Industry, 2014

steel. This is directly reflected in the use/consumption of nickel. Data from 2006 and 2013, from different and not comparable sources, shows Japan as the world's second largest consumer of nickel (***Table 5.3 and Table 5.4***).

According to USGS (2014) Japan produced a total of 167,000 t of nickel products in 2012. As a producer of refined nickel Japan exports part of the production mainly to South Korea and Taiwan, as the largest importers of nickel products from Japan (Nickel Institute, 2009).

Titanium

According to the International Titanium Association Japan is the third largest exporter of titanium after the USA and Russia. In 2012, Japan produced 63,400 t of titanium sponge, of which approximately 31,000 t were exported (62% to USA, 27% to Europe, and 11% to other countries). In 2012 Japan had about 23% of the world's total capacity for titanium sponge production (International Titanium Association, 2013).

Zinc

Japan is a large producer of zinc: in 2012 the total production of zinc was 606,000 t, of which 80% was from imported ore, and the remaining from recycling and other sources. Zinc is used mainly for the production of galvanized sheet steel and other galvanized products (64%), brass (14%), chemicals (7%), and other uses (1%) (USGS, 2014).

5.1.4.2. Major Industrial Minerals

Limestone

Japan is a lead producer of calcium carbonate which is manufactured from limestone of which the country has significant resources. This mineral is used as a substitute for kaolin, among other applications, by the paper industry for fillers and coatings. Limestone represents by far the largest reserves from all the mineral commodities in Japan (40.4 billion tons in 2012; USGS, 2014).

Rare Earth Elements

Rare Earth Elements (REE) are critical components for several products and technologies and are essential to the Japanese economy for the development of cutting–edge applications in electronics, computers, cellular phones and vehicle motors. The demand of rare earths for Japan's car industry will follow the increase of production of hybrid and electric vehicles, which require parts that contain REE.

Japan is a leading importer of REE,

mainly from China, which is the world's leading producer. China was (from 2010 until mid-2015) imposing restrictions on the exports of rare earths, thus disrupting many supply chains and affecting many sectors of the global industry. For this reason Japan started developing strategies and efforts to guarantee that at least 60% of its rare earth needs would be sourced in countries other than China, namely establishing contacts with India and Kazakhstan. Japan is increasing the rare earths recycling industry and is also trying to reduce their consumption by developing the use of substitute materials[9].

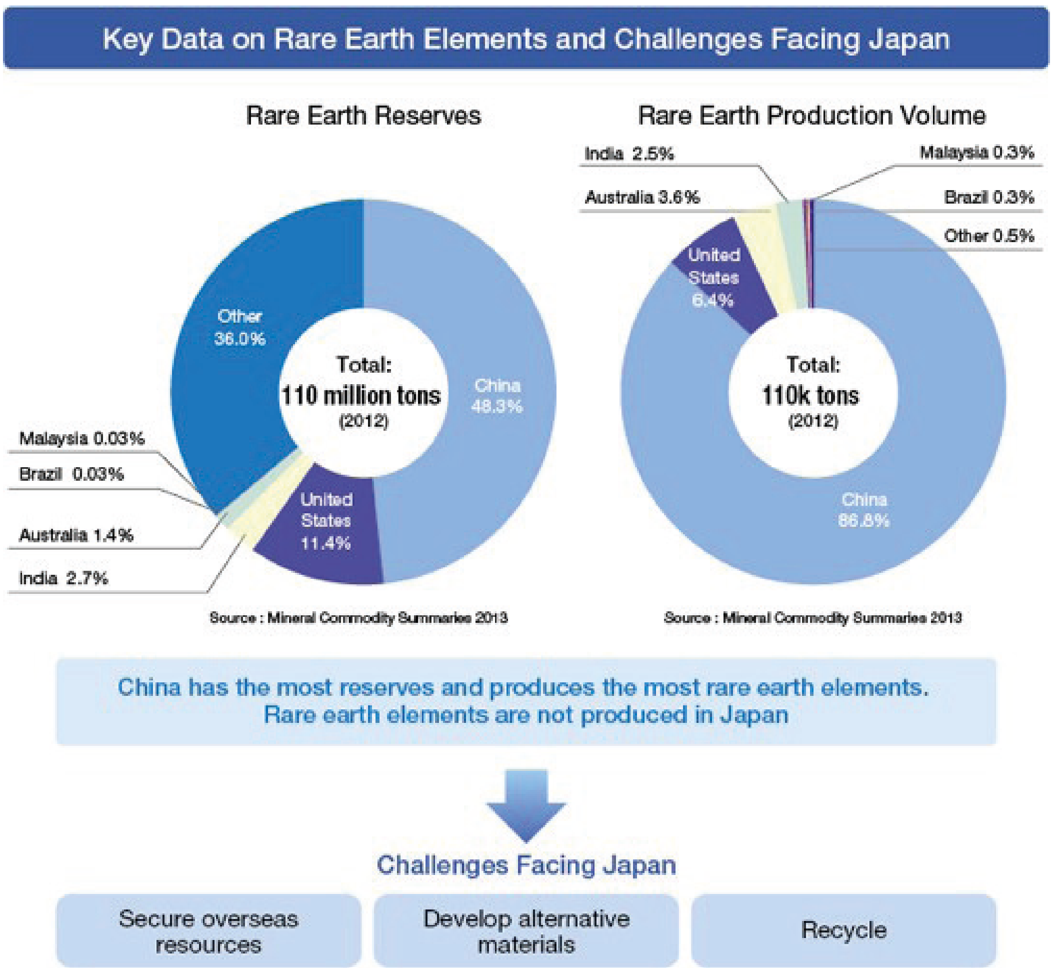
Figure 5.6 gives some key data and major challenges facing Japan on the supply of REE.

The investment of Japan into the discovery of rare earth deposits on the Pacific Seabed (Minami-Torishima Island) that "can be mined at a very low cost and would produce materials 20 to 30 times more concentrated than those coming from China"[10] can give Japan autonomy and guarantee the supply of REE in the future. The start-up of production in REE mines in Australia and the various exploration projects for REE under way in Canada will probably change the demand-supply balance of REE in the near future, ending the Chinese control over these elements.

9 Japan is carrying out R&D projects on processes for recovering rare metals and rare-earth metals from recycling, having developed the world's first mass-recycling effort for rare earths. This includes also the recovery of REE from secondary sources, as demonstrated in the joint venture between Sumitomo Corp. and the National Atomic Co. who is recovering REE from tailings of uranium-ore in Kazakhstan,(USGS, 2014). Alongside, private companies, research bodies and government organisations are investing in research to substitute critical metals. One of the best known initiatives is the 'Element strategy' that aims to understand the function of each element deeply with the objective of substituting, reducing and recycling critical raw materials (Nakamura and Sato, 2011 in MinPol 2015).

10 http://www.mining.com/japans-massive-rare-earth-discovery-threatens-chinas-supremacy-89013/

Figure 5.6: Rare Earths in Japanese Economy.



Source: http://www.mitsubishielectric.com/company/environment/ecotopics/rareearth/why/index.html

5.1.5. Recycling

Metal recycling is extremely important to the Japanese economy and is a sophisticated industry in constant evolution, searching for improved technical solutions to enhance materials recovery and reuse.

The development of recycling is being driven by the dependence of Japan's manufacturing industry on imported mineral raw materials. Other important drivers for recycling are the lack of space for landfills and the growing environmental concerns with waste burning and disposal. Taken together, and underpinned by appropriate policies and a wide involvement of all stakeholders, these factors fostered the development of one of the most developed recycling industries in the world.

Japan was an early follower of the principles of circular economy, where recovering and recycling plays a role as important as other industrial stages. Japan is pursuing these principles since 1991, and this has given the country competitive advantages (compared to other countries) in securing the supply of raw materials.

Everyone is involved and assumes an important role in Japan's recycling system since the start: the public (end user) separates the waste and contributes for the sustainability of the system throughout a recycling tax; manufacturers incorporate more recycled materials in products that last longer, and are easier to repair and recycle. Therefore, recycling is considered and tested from the product design and conception stages on. This circular economy approach has three key features: 1) a consumer-friendly collection system; 2) the costs of recycling are paid, when products are purchased; and 3) there are incentives for manufacturers to co-own recycling infrastructures. The system is based on collaboration, rewards honesty, and applies penalties for non-compliance.

Japan recycles major and minor metals and REE. The development of new recovery methods are a R&D priority. Figures from 2006 show recycling already played (in that year) a major role in answering the Japanese industry's materials needs (***Table 5.5***). Considering the high level of demand of Japan's manufacturing industries, the numbers of 2006 are notable.

It is important to note that for some

Table 5.5: Metal recycling amount and ratios between demand and recycled material availability in Japan in 2006

	(a) Recycled	(b) Demand	(a)/(b)		(a) Recycled	(b) Demand	(a)/(b)
	t	t	%		t	t	%
Fe	34,686,000	116,226,000	29.8	In	408	905	45
Cu	1,235,000	2,667,000	46.3	Ag	317	3,847	8.2
Al	1,121,000	4,201,000	26.7	Cd	119	3,102	3.8
Cr	163,000	923,000	17.7	Ba	108	13,716	7.8
Mn	150,000	633,000	23.7	Ga	93	168	55.2
Pb	112,000	318,000	35.2	Pd	32	52	61.4
Za	108,000	650,000	16.6	Se	26	788	3.3
Ni	29,800	236,300	12.6	Be	25	89	28.1
Co	9,117	14,639	62.3	Au	24	307	0.7
W	2,616	25,180	10.4	Bi	13	1,391	0.9
Mo	1,798	26,200	6.9	Li	8	1,007	0.8
Sn	1,092	37,976	2.9	Pt	7	35	19.5
Ti	983	63,858	1.5	Cs	4	115	3.2
Sb	690	6,983	9.9	Rh	1	26	5.7
V	439	2,719	16.1	Hg	0.198	0.258	76.6

Source: http://www.mitsubishielectric.com/company/environment/ecotopics/rareearth/why/index.html elements these numbers may be difficult to raise, not only because the rise of demand surpasses the recycling capacity, but also because metals are often combined in alloys and some elements cannot be economically separated from these alloys.

The reaction of Japan to the announcement by China of export restrictions for REE in 2010 is indicative of Japanese policies regarding recycling. Facing supply restrictions, the Japanese government created a grant programme to accelerate rare earth recycling technologies. This action led to the development and improvement of REE recovery from car batteries and Honda and the Japan Metals and Chemicals Company[11] are operating since 2013 a recycling facility that is able to recover annually 400 t of rare earths. This was the world's first mass-recycling effort for rare earths (MinPol, 2015).

Another example is given by the Summit Atom Rare Earth Co. LLP, which is a joint venture between Sumitomo Corp. and the National Atomic Co. of Kazakhstan, which opened a plant at Stepnogorsk in Kazakhstan in November 2012 to recover rare-earth elements from tailings of uranium-ore that Kazakhstan had mined in the past. The plant had set a total output target of 1,500 t/yr of rare-earth oxides (REOs) during the initial years and planned to export the REOs to Japan in 2013 in MinPol, 2015).

Japan keeps investing into research on metallurgical technologies to recover REE and rare metals from waste products and on processing technologies for refractory ores at domestic non-ferrous smelters. Alongside private companies and the Japanese Oil, Gas and Metals National Corporation (JOGMEC[12])), some national bodies are working on research to substitute critical raw materials. One of the best known initiatives is the 'Element strategy' that aims to develop new magnets, free from rare earth elements, that can replace and have the same properties as the rare-earth magnets currently in use.

For comparison, the UK in 2008 recycled approximately 52% of its metals[13]. More recent numbers appear not to be available, but considering the efficiency of Japan's recycling system and the R&D efforts, one expect further improvements to the recycling rate.

Recycling is also very important from a socio-economic point of view, as it employed 650,000 people already in 2007 (Ministry of the Environment, 2010).

In 2008 the National Institute for Materials Science[14] calculated the amount of metals accumulated in Japan with potential to recycle into metal resources. The calculation was based on trade statistics and the main conclusion was that for many metals Japan has 10% of the world reserves: gold – 16%; silver – 22%; indium - 61%; tin – 11, and tantalum – 10%.

5.2 Economic and market assessment

5.2.1. Reserves and Production

Japan's mineral endowment is poor and in general mining is not economically feasible, with the exception of gold and limestone.

Gold reserves are significant and exploited in one of the most important high-grade gold mines in the world. Limestone is a mineral resource that exists in considerable quantities, used for construction and for the production of pure calcium carbonate (***Table 5.6***).

The vertical integration of Japan's manufacturing industry was a consequence of the country's poor mineral endowment and dependence on raw materials. The upstream integration, towards ore processing and smelting, was a necessity in order to secure the characteristics and the quality of metals and alloys used in manufacturing. This lead to Japan's leadership in ore processing and production of high quality steel and speciality alloys.

The efforts of Japanese manufacturing companies to actively participate (as shareholders or in joint ventures) in mining projects[15] worldwide is another

11 http://world.honda.com/environment/face/2013/case17/episode/episode01.html

12 This government agency permanently supports the domestic and overseas development of the minerals industry, both primary and secondary, fostering innovation and cooperation.

13 https://www.the-ies.org/analysis/circular-economy-japan

14 http://www.nims.go.jp/eng/news/press/2008/01/p200801110.html

15 Japanese companies have an influential share of ownership in over 40 iron, nickel, copper, zinc and gold mines in Southeast Asia, Australia, North and South America, and Africa (INTRAW – D1.2, Contextual Analysis: Country Report for Japan MinPol, 2015).

Table 5.6: Reserves of Major Mineral Commodities in Japan in 2012.

Commodity	Reserves
	('000 metric tons unless otherwise specified)
Coal[1]	773,000
Dolomite	913,000
Gold Ore, Au content (Kg)	159,000
Ioadine	5,000[e]
Limestone	40,400,000
Pyrophyllite	59,700
Silica Sand	73,600
Silica Stone, White	462,000

eEstimated.

1Recoverable reserves, including brown coal.

Source: USGS, 2014

step forward in the upstream vertical integration process. This move can improve mining processes by sharing of information and improved visibility of demand, demand changes, and inventories.

Japan today is one of the major suppliers of high quality products and products with high added value, which include processed mineral commodities such as aluminium, copper, iron, and steel. This linkage is evident in the evolution of the production of minerals in Japan in the pe-

Table 5.7: Production of Major Mineral Commodities in Japan in 2012.

Japan Production of Mineral Commodities (tonnes (t) unless otherwise specified)						
Commodity		2008	2009	2010	2011	2012
Aluminium	Alumina	320,000	310,000	300,000	280,000	250,000
	Aluminium hydroxide	700,000	710,000	700,000	690,000	650,000
	Primary metal - Regular grades	7,000	6,000	5,000	4,000	5,000
	Primary metal - High-purity	52,000	33,000	49,000	43,000	26,000
	Secondary metal	149,000	111,000	126,000	142,000	137,000
Copper:	Blister and anode - Primary	1,366,310	1,297,943	1,382,655	1,168,284	1,304,916
	Blister and anode - Secondary	259,060	243,859	260,245	269,748	303,900
	Total	1,625,370	1,541,802	1,642,900	1,438,032	1,608,816
Gold	Mine output, Au content (Kg)	6,868	7,708	8,544	7,922	7,233
	Metal - Primary (Kg)	81,399	89,281	98,398	95,549	74,735
	Metal - Secondary (Kg)	43,433	43,979	37,413	36,288	29,544
	Total (Kg)	124,832	133,260	135,811	131,837	104,279
Iron and Steel	Pig iron ('000 t)	86,171	66,943	82,283	81,028	81,405
	Electric-furnace Ferroalloys	827,823	722,277	892,937	833,817	908,416
	Steel, crude ('000 t)	118,739	87,534	109,599	107,601	107,232
	Semi manufactures - Ordinary steels ('000 t)	84,000	68,000	67,000	65,000	66,000
	Semi manufactures - Special steels ('000 t)	21,000	16,000	15,000	15,000	16,000

Lead metal, refined	Primary	107,005	96,794	101,610	100,078	91,037
	Secondary	117,900	95,402	114,218	114,896	117,957
	Total	224,905	192,196	215,828	214,974	208,994
Nickel		158,000	144,000	166,000	157,000	170,000
Silver	Mine output, Ag content (Kg)	2,043	1,500	1,200	4,486	3,577
	Metal - Primary (Kg)	2,042,604	1,865,936	1,898,208	1,724,218	1,764,533
	Metal - Secondary (Kg)	253,374	326,487	313,931	325,373	348,620
	Total (Kg)	2,295,978	2,192,423	2,212,139	2,049,591	2,113,153
Titanium	Dioxide	225,228	161,928	207,561	214,417	185,320
	Metal	45,000	35,000	38,000	40,000	38,000
Zinc	Oxide	77,000	75,000	72,000	66,325	52,896
	Metal - Primary	502,910	435,905	470,057	444,446	459,322
	Metal - Secondary	112,623	104,699	103,951	100,228	111,990
	Total	615,533	540,604	574,008	544,674	571,312
Rare Earths		8,435	5,121	10,699	10,700	10,800

Source: USGS, 2014

riod 2008-2012 (***Table 5.7***). The decrease in metals production since 2009 was a consequence of the global 2008 financial crisis and the correspondent slow-down of the world economy. The recovery rate is being affected by the deceleration of China's growth.

5.2.2. Internal Consumption

For reasons already specified, in particular a very effective and productive manufacturing industry, Japan is among the largest consumers of several mineral raw materials.

The demand for these materials is satisfied by the domestic processing of imported mineral ores, materials recovered through recycling processes, and (on a smaller scale) imports of finished products.

The large quantities of minerals processed in Japan are mainly for internal consumption, although the exports of

Table 5.8: Statistics on iron and steel internal consumption.

	Production	Consumption	Sales	Inventory
Pig-iron for steel making (t)	83,554,885	80,125,940	3,116,704	759,976
Ferro-Alloys (t)	922,548	242,125	950,991	156,378
Crude Steel (t)	110,666,068	110,869,569	40,725	91,974

Source: METI, 2014

Table 5.9: Statistics on selected non-ferrous metals internal consumption.

	Production	Consumption	Sales	Inventory
Electrolytic Gold (g)	101,498,494		99,848,737	5,337,972
Electrolytic Silver (Kg)	1,791,816	730	1,794,852	84,564
Blister copper (t)	1,893,017	1,679,821	34,164	
Electrolytic copper (t)	1,554,224	44,860	1,425,653	63,645
Lead bullion (t)	199,012	166,319	32,743	1,169
Electrolytic Lead (t)	202,673	4,874	193,247	26,976
Zinc (t)	583,021		576,127	32,055

Source: METI, 2014

some processed minerals are significant for the economy (e.g. iron and steel products). ***Tables 5.8 and 5.9*** below show the values of the internal consumption of some metals in 2014.

The major industries in Japan, some of them leading world suppliers of goods, consume large quantities of mineral raw materials, especially those related to the production of motor vehicles and machinery, as well as electric and electronic equipment, circuits, parts, and communication electronics. The evolution of new high-end applications constantly increases the number of raw materials incorporated in end products. For this reason, securing the supply of raw materials will continue to be an increasingly complex and demanding activity, critical for maintaining Japan's leading position as manufacturer of high-quality sophisticated products.

5.2.3. Trade (Export and Import)

Japan´s prosperity is intrinsically linked to a very distinctive performance in international trade. What Japan has sold to the world has changed continuously and dramatically over time and, at the same time, Japan has consistently imported a remarkably low amount of manufactured goods (Saxonhouse, 1993 in MinPol, 2015).

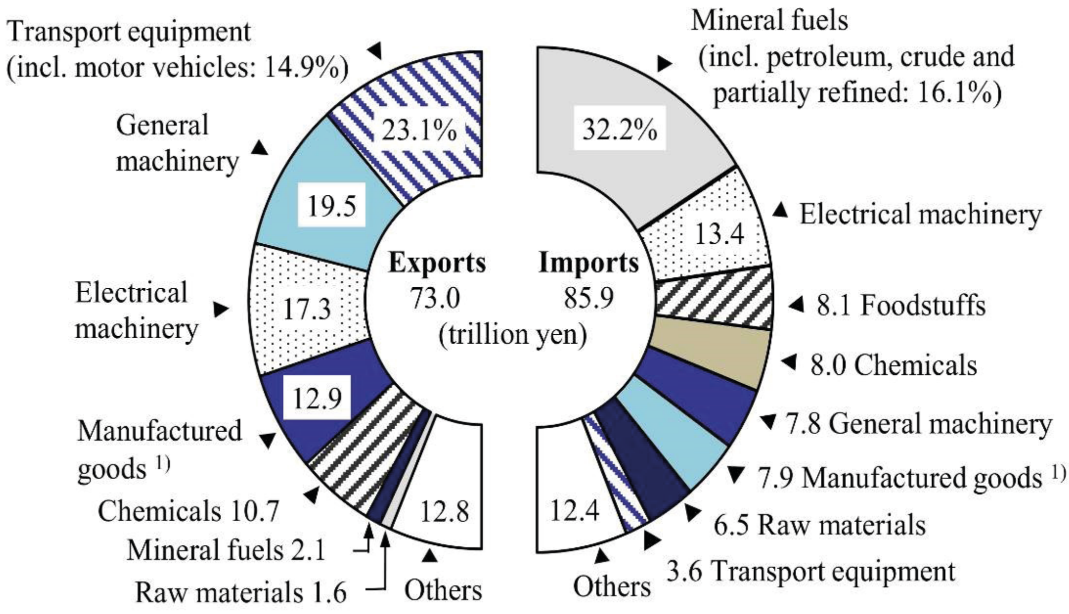
Japan's exports in 2013 consisted mainly of transport equipment (cars, vehicle parts), which accounted for the largest portion of total export value (23.4%), followed by general and electrical machinery, making up 19.1% and 17.3%, respectively. Motor vehicles, which are in the transport equipment category, constituted 14.9% of the total export value. One characteristic of Japan's exports is the large proportion of products with high value added, manufactured with advanced technologies, such as motor vehicles, parts, integrated circuits, and machinery having specialised functions.

The most significant mineral exports from Japan are iron and steel products, which are included in the manufactured goods category, together with other products (***Figure 5.7***).

The contribution of iron and steel products to Japan total exports is 5.4 % (Statistical Handbook of Japan, 2015). ***Figure 5.8*** represents the main destinations of iron and steel exports.

In general Japan relies on imports of all groups of minerals, particularly petroleum, iron ore, copper concentrate, primary aluminium, ilmenite, rutile and indium. For some of the imported minerals, such

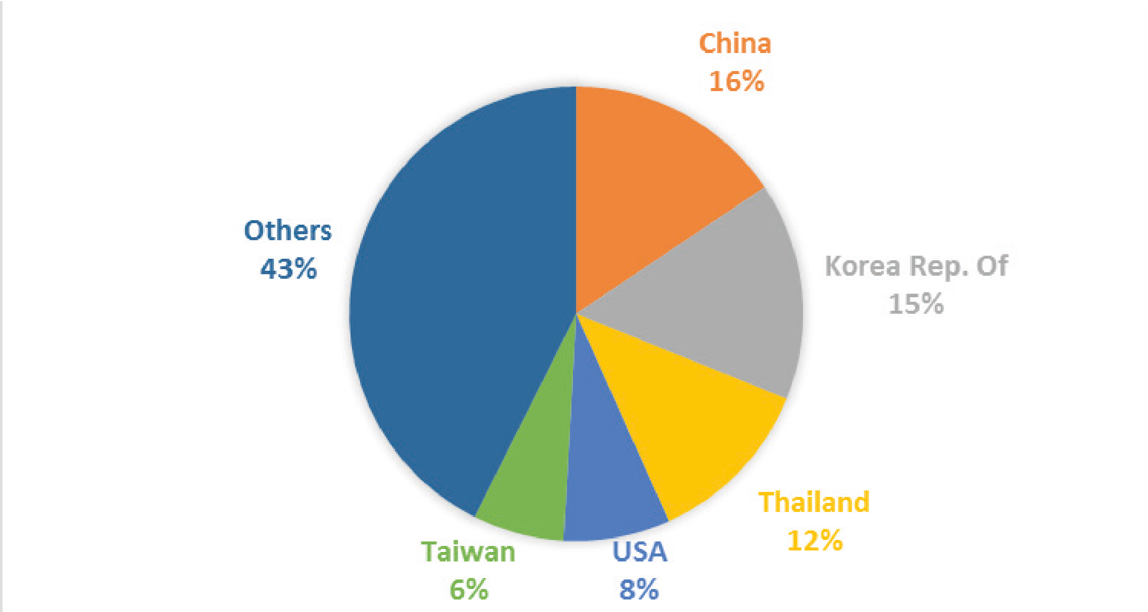
Figure 5.7: Trade by commodity in Japan in 2014.



1) Consisting of iron and steel products, non-ferrous metals, textile yarn and fabrics, etc.
Source: Ministry of Finance.

Source: Statistical Handbook of Japan – 2015

Figure 5.8: Major iron and steel export destinations.

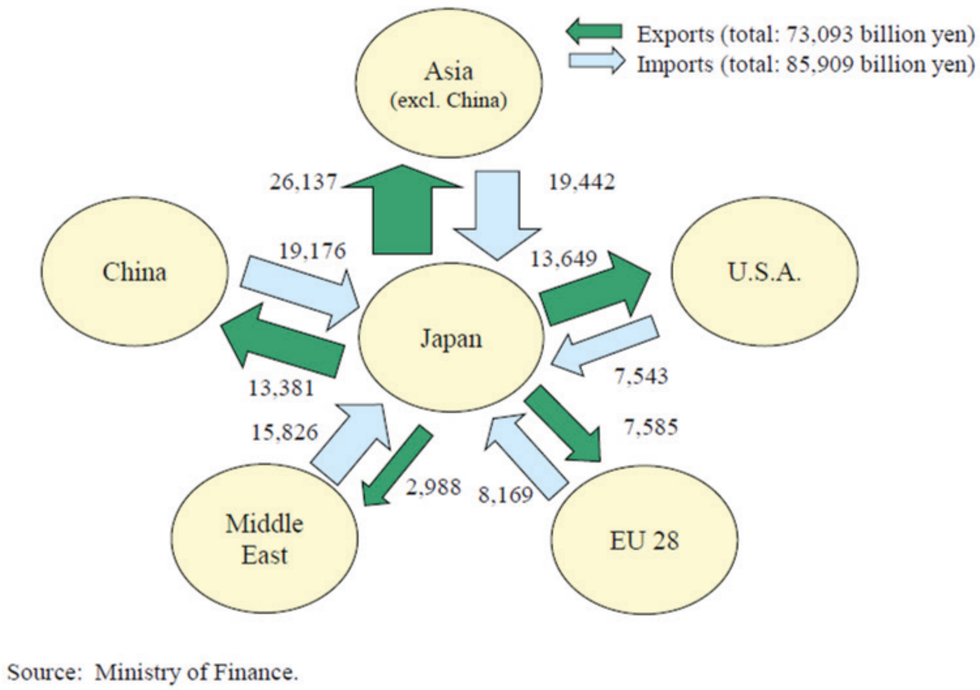


Source: Statistical Handbook of Japan – 2015

as copper or indium, Japan is the world's largest consumer. Energy minerals are the most significant imports, while other raw materials amount to 6.5% of the total import value, and non-ferrous metals to 2%. Japan's trading policy has consistently used an ABC approach (where ABC stands for Australia, Brazil and Canada), a term applied to describe a diversification of source markets for raw materials. This policy has been applied to maximise supply security and favourable costs, and has been complemented with stockpiling and overseas joint ventures in mining projects (McMillan, 1996 in MinPol, 2015).

Japan has a strong policy fostering Free Trade Agreements (FTAs, dubbed Economic Partnership Agreements) resulting in 15 active FTAs with: Singapore (2000), Mexico (2004), Malaysia (2004), Philippines

Figure 5.9: Japan Foreign Trade by Country/Region.



Source: Statistical Handbook of Japan – 2015

(2006), Indonesia (2007), Chile (2007), Thailand (2007), Brunei (2007), ASEAN (2008), Vietnam (2008), Switzerland (2009), India (2011)y Peru (2011)y Mongolia (2015), and Australia (2015). Further FTAs are being negotiated, among others, with the EU[16]. These policies have a very important role in securing the raw materials supply, and successfully support trade with raw materials rich countries (e.g. Indonesia, Chile, Peru, Mongolia, and Australia).

In terms of commercial relations, Japan has a trade surplus with Asia and the USA, and a deficit with the Middle East and Oceania, where the import value is higher than the exports. China is the most important trade partner of Japan, with trade values that are approximately the double of that for Europe (***Figure 5.9***).

Japan's imports of raw materials are facilitated by a tightly integrated, highly efficient transport infrastructure that connects foreign mines to ports, these to ports in Japan, and from there to smelters and downstream fabricators (Bunker and Ciccantell, 2005 in MinPol, 2015).

Japan participates in several strategic international and diplomatic treaties and organisations including APEC (Asia–Pacific Economic Cooperation[17]), OECD (Organisation for Economic Co-operation and Development[18]), ASEAN – (Association of Southeast Asian Nations and United Nations[19]), as well as G7 and G20, which are informal gatherings of heads of states and their aides[20].

5.2.4. Expenditure, Taxes/Royalties, Investment and Competitiveness

In Japan, the indicators related to expenditure, taxes or investment attractiveness in mining are not relevant, considering the small contribution of the mining industry to the country's economy.

The tax revenues of companies are among the highest in the OECD and corporate tax rates were reduced from 40% in 2006 to 32.11% in 2015). However, the general taxes imposed on Japanese firms represent a well-focused system that aims to promote the growth of the economy and strongly promotes external (overseas) investments. In 2009 the Ministry of Economy, Trade and Industry (METI) announced changes in the policy of territorial taxation as part of "a new growth strategy", developed to stimulate innovation in Japan. This included support to Japanese firms in foreign markets and to the repatriation of overseas earnings[21]. These changes were a response to concerns of the government over the accumulation of foreign earnings held overseas and the awareness that this could increase the risk of re-allocation of R&D operations and production outside Japan. Japan has now a 95% tax exemption for foreign-source dividends, which allows also tax deductions of all "necessary and reasonable expenses" associated with foreign investments.

The government of Japan supports openly Japanese mining investments in foreign countries. The support is designed and routed throughout an administrative agency, the Japanese Oil, Gas and Metals National Cooperation (JOGMEC). JOGMEC consists of a network of 13 overseas offices worldwide that gathers relevant information. Its activities also includes the provision of financial assistance to Japanese companies for mineral exploration and deposit development, the gathering and analysing of information on mineral and metal markets to better understand risk supply, and the management of Japan´s stockpiles of oil, liquefied petroleum gas, and rare metals. JOGMEC seeks to secure the supply from overseas resources by promoting early-stage exploration and supporting advance-stage projects, by developing recovery technologies for recycling, developing alternative materials, and stockpiling. JOGMEC also closely watches strategic minerals considered of high importance, including zinc, chromium, cobalt, manganese, molybdenum, nickel, tungsten, vanadium, PGMs, and lithium (Katayama, 2012 in MinPol, 2015).

In 2014, according to the World Economic Forum (WEF, 2014) Japan's economy was the 6th (out of 144) most competitive and was included in the group of

16 http://www.meti.go.jp/policy/trade_policy/epa/english.html
17 www.apec.org.
18 www.oecd.org.
19 www.asean.org.
20 http://ec.europa.eu/economy_finance/international/forums/g7_g8_g20/index_en.htm.

21 http://taxfoundation.org/article/japan-disproves-fears-territorial-taxation-0#_ftn3.

the 37 most advanced economies and those considered as 'innovation-driven'. To further promote the competitiveness of its companies and attract investment, In 2014 Japan announced plans to lower its corporate tax rate[22]. METI affirms that a "corporate tax reform is expected to encourage wage increase, enhance business investment, and create positive ripple effects on subcontractors, as well as Small and Medium-sized Enterprises, through which Japan will achieve a virtuous economic cycle". In 2016 METI will reduce the corporate tax, foreseeing a rate of 31.33%.

5.2.5. Industry Structure

All establishments of the mineral industry processing sector are private, comprising approximately 26 different Japanese companies[23]. This sector has a high level of integration between mineral processing activities and downstream industries.

The Japanese industry structure is characterized by strong relations between private companies and the Government. Those relations are framed by a triangle formed by government bureaucracy, the Liberal Democratic Party (LDP), and business (Keyo University, 2007).

Government bureaucracy is represented by the Ministry of Economy, Trade and Industry (METI; formerly Ministry of International Trade and Industry), established in 1949. METI is responsible for guiding the development of industries and their outward activities, and also for the co-ordination of Japan`s foreign trade and commercial actions and for managing specific areas, such as raw materials and energy supplies. In a central position between government and companies, bringing together all interests, stands the LDP, the Liberal Democratic Party. Business is represented by Federations and Committees for economic development, namely the Japan Chamber of Commerce and Industry, and trade Associations, such as (for minerals) the Japan Mining Industry Association (JMIA).

This particular and symbiotic relationship is a strong point of the industry structure because it ensures the direct involvement of all parties towards common aims. The government (METI) is represented in both, LDP and in corporations by retired bureaucrats, strengthening bonds and cooperation and fostering the same vision and objectives.

This frames the active role the government agency JOGMEC plays in approaching resource-rich countries. JOGMEC supports joint ventures and provides training, equity capital, loans and liability guarantees to Japanese companies, among other support mechanisms. In 2014 JOGMEC pioneered the signing of the world's first cobalt-rich ferromanganese crust exploration contract with the International Seabed Authority and secured exclusive interests. Another important achievement of JOGMEC was the discovery of a REE rich deposit near Minami-Torishima island in the Pacific. In order to verify and advance the commercial exploitation of this deposit, researchers from the University of Tokyo and the Tokyo Institute of Technology joined Mitsui Mining and Smelting, the offshore drilling rig operator Modec and the rare earths alloy-maker Santoku, among other partners, in a consortium to exploit REE from seabed (Asian Nikkei, 2014 in MinPol, 2015) .

The industrial conglomerates business model in Japan is known by the Japanese designation "Keiretsu" referring to large industrial groups, or corporations, with common economic interests. The most important group in Japan are dubbed the 'Big Six', and include Mitsubishi, Mitsui, Sumitomo, Fuji, Dai-Ichi Kangyo, and Sanwa.

These groups are made up of affiliated companies within different industry sectors that work as a single business through a common source of control. The manufactured products move up in vertical integration pyramid through supply companies and the 'parent' companies distributes the finished goods through a network of distributors and retailers.

A typical Japanese industrial group has about 70% of its shares held by a large number of companies that have some kind of transactional relationship

22 http://www.ey.com/GL/en/Services/Tax/International-Tax/Alert--Japanese-Government-announces-plan-to-lower-corporate-tax-rate-to-below-30-percent.

23 USGS, 2014 and http://www.mbendi.com/a_sndmsg/org_srch.asp?gloc=L164&INDY=IMING

between them and also with other shareholders (banking, insurance, etc.). Shareholding is reciprocal among companies and firms holding each other's shares as 'stable stakeholders' (Keyo University, 2007, 2007).

The direct advantages of this system come from the strong relationships between the companies inside the group and the impossibility of any eventual takeover. The disadvantages are mainly related to some inflexibility.

This sophisticated industrial structure tends to be stable because it integrates processes that add value at all production stages. The mineral processing industry illustrates this, because it is critical for feeding complex downstream industrial clusters, including the production of vehicles and machinery, electric and electronic equipment, circuits, parts, and communication electronics.

However, the industrial structure in Japan is facing changes as the Japanese manufacturers are increasing the production offshore, not only to reduce labour costs, but also because of the challenges due to an ageing workforce.

The effects of these changes on the minerals industry are not clear. Nevertheless this sector is one of those where Japan is active overseas, mainly in partnerships and joint ventures with country-based companies focused essentially on mineral exploration, although some mining and processing operations are also being developed.

5.3 Assessment of the regulatory framework

The rule of law in Japan is independent and provides secure protection of real and intellectual property rights.

The basic rules for mining in Japan are determined by the Mining Act of 1950[24]. Until 2011 this document had not been revised, and METI promoted an amendment delivered on 22 July 2011 (implemented on January 2012) aiming to "ensure both the proper management of mineral resources in Japan and the rational development of these resources by appropriate entities"[25].

The Mining Act establishes the government's power to grant the right and acquire minerals that are yet to be mined, defining and listing the applicable minerals. The Act concerns not only to prospecting for and extraction of minerals, but also mineral processing, smelting and other pertinent activities.

Mining policy in Japan is supported by four pillars (Kikkawa, 2013):

1. Promotion of domestic exploration to maintain the economic viability of domestic mines, which are the most stable source of supply of mineral resources;
2. Support for overseas resource development activities and technical cooperation for resource development with developing countries, in order to secure stable overseas mining resources;
3. Creation of a rare metals stockpiling system from the standpoint of national economic stability and security;
4. Prevention of mine contamination from closed or abandoned domestic mines.

Japanese legislation is focused on developing and protecting the stability of the supplies of mineral raw materials. Based on the general approach in the Mining Act, several specific acts where issued to address particular questions related to mining activities, for instance the "Act on Special Measures for Contamination Caused by the Metal Mining Industry"[26].

Legislation not specific, but directly related to mining industry includes policies to establish in Japan a recycling-oriented society. Several laws, in the sphere not only of the environment, but also of the industry, have been promoting a significant recovery of minerals through the promotion of recycling.

The Fundamental Plan for Establishing a "Sound Material-Cycle Society" was first set up in 2001 and revised in 2008). The national strategy aims to increase sustainability through measures that will foster a low carbon society, a sound material-cycle society and a society in harmony

24 http://www.meti.go.jp/english/policy/energy_environment/stable_supplies/pdf/mineral_mining_act01.pdf

25 Ibidem.

26 http://www.meti.go.jp/english/information/data/laws.html.

with nature. METI is responsible for encouraging recycling in private companies, supported by the Law on "Promotion of Effective Utilisation of Resources"[27] (promulgated April 26, 1991).

This law is the basis for promoting the reduction, re-use and recycling (3 Rs) of resources, defining measures to be implemented the design and production stages, labelling for separated collection, and the development of a voluntary collection and recycling system for manufacturers (Tanaka, 2009).

Despite the positive results, the law was revised (in 1993, 1999 and 2000) in order to further promote the efficient use of resources for the growth of domestic industries, as well as improving the supply of resources, such as rare metals. The main issues discussed for the revision of the law were (METI, 2007 in Tanaka, 2009):

1. Promotion of environmentally-conscious design (i.e. Design for the Environment) with a life cycle perspective;
2. Information and dissemination of environmental information on products to the consumers;
3. Exports of recovered materials for the purpose of recycling;
4. Promotion of voluntary collection and recycling of used goods;
5. Promotion of re-use / recycling of by-products from raw material industry.

Overall, the mix of instruments used to implement environmental policies is highly effective. Regulations are strict, well-enforced, and based on strong monitoring capacities. These policies, combined with financial grants and other government incentives are giving very positive and practical results for the leverage of the recycling industry, especially for metals, establishing Japan as a world leader in recycling.

5.4 Raw material supply assessment

Japan is a large consumer of several minerals, and the assessment of the risk associated to the supply of these materials is a constant concern and priority for the government. The strong dependency on other countries has led to the development of policies and incentives to ensure the stable supply of several key and critical minerals (iron ore, base metals, rare metals and rare earths, besides energy minerals). This is why part of Japan´s outward Foreign Direct Investment flow is directed towards securing the supply of specific minerals for Japan's minerals processing industry. JOGMEC plays an important role coordinating this, as it provides key technical, intelligence, and financial assistance for active investments in exploration and development made by Japanese companies abroad. Alongside this, Japan's diplomatic efforts aim not only for political, but also for strong economic relations with a range of countries, materialised in the FTAs. Japan also fosters International Investment Agreements (IIA) on all continents (OECD, 2015). These agreements relate not only to trade, but to the liberalisation, promotion and protection of investments in foreign countries.

The factors that affect the risk of raw materials supplies for Japan are directly related to the scarcity of "domestic" resources, geopolitical stability of supplier countries, concentration of the supply within particular countries, and trade policies. Considering these factors, Japan's strategy to secure the supply of mineral raw materials is based on five pillars:

1. Maintaining strong diplomatic relations with suppliers;
2. Constant search and evaluation of new suppliers;
3. Strong investment in recycling, reuse of metals and search for substitute materials;
4. Improvement of the design of products to reduce metal consumption;
5. Overseas investment.

The dependence on a small group of suppliers or the centralisation of the supply is a constraint increasing the risks inherent to that supply. For this reason the government of Japan is constantly seeking for new countries to invest into the exploration of raw materials. Rare earths and nickel are two commodities that Japan is actively looking for since both, China (major supplier of rare earths controlling more than 90% of global production) and Indonesia (the world's biggest exporter of

27 http://www.meti.go.jp/policy/recycle/main/english/law/promotion.html.

nickel) imposed restrictions on their raw materials exports. These restrictions led to reactions in Japan, to develop not only recycling, but also to seek joint ventures overseas (e.g. in Kazakhstan[28] for rare earths), and new suppliers for nickel in New Caledonia, Philippines, and the Solomon Islands.

28 http://kazcham.com/rare-earth-metals-plant-opened-in-kazakhstan/

5.5. Strategic analysis

5.5.1. SWOT

Table 5.10 below summarises the analysis of the Strengths, Weaknesses, Opportunities and Threats of Japan's mineral sector.

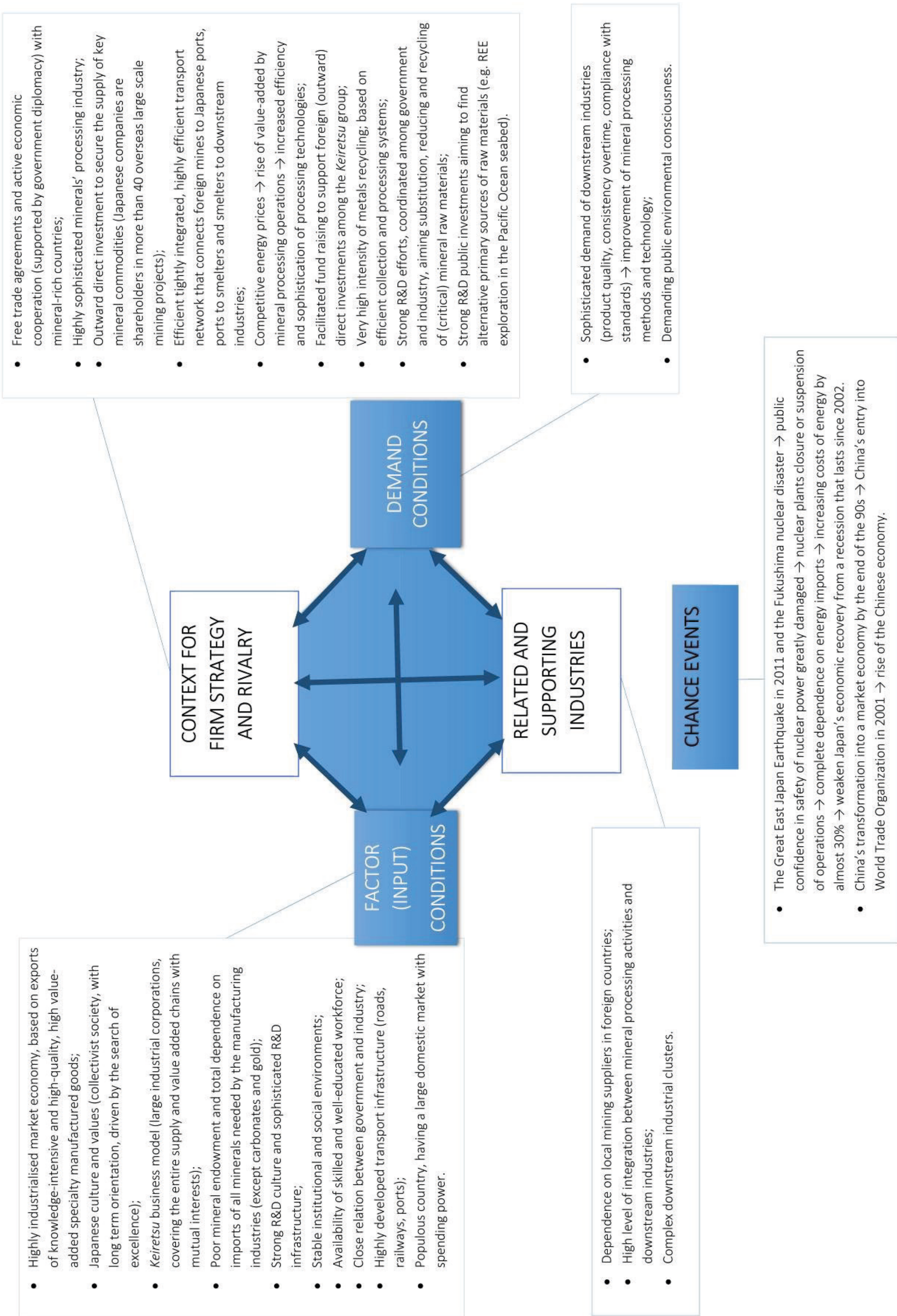
Table 5.10: Strengths, Weaknesses, Opportunities and Threats of Japan's mineral sector.

	STRENGTHS	WEAKNESSES
INTERNAL FACTORS	• Active government policy towards stable sourcing of mineral raw materials, combining diplomatic action and direct support to Japanese companies; • Free trade agreements and active economic cooperation (supported by government diplomacy) with mineral-rich countries; • Industry structure ('Keiretsu' model) with high level of integration between mineral processing activities and downstream industries; • Developed and sophisticated mineral processing industry, supplying complex downstream industrial clusters; • Efficient highly integrated and efficient transport network; • Very high effectiveness of metals recycling and developed recycling industry, supported by clear policies fostering a circular economy; • Strong investment in R&D, seeking efficient use of raw materials and substitution; • Stable institutional and social environments; • Ethics and cultural norms.	• Poor mineral endowment; • Strong dependence on foreign countries for the supply of mineral raw materials and energy; • High population density; • Ageing population.
	OPPORTUNITIES	**THREATHS**
EXTERNAL FACTORS	• Improved effectiveness and efficiency of recycling; • Start of exploration of raw materials (e.g. REE and rare metals) in the Pacific Ocean seabed; • Investments made by many countries in exploration of REE and rare metals.	• Trade restrictions and resource nationalism; • Fluctuation of commodities' prices; • Increasing global competition for mineral raw materials and energy; • Increasing use of REE and rare metals in high end technologies.

5.5.2. Competitive Context

Considering Porter's Framework is possible to establish a profile of the country regarding the drivers that lead to their comparative advantages (***Figure 5.10***).

Figure 5.10: Japan's competitive context.



5.6 Conclusions

Japan's domestic mineral reserves are depleted, or are not economically or technically feasible to exploit, with the exception of gold (with one of the most valuable gold mines in the world) and limestone. The mining sector has no importance for the country's economy. To the contrary, the manufacturing industry is one of the most developed in the world, working with cutting edge technologies and producing products with high added-value, demanding a stable and constant supply of diverse mineral raw materials. This is guaranteed through a sophisticated mineral processing sector, that imports ores and produces a variety of mineral-based end products that feed complex downstream industrial clusters, including the production of vehicles and machinery, electric and electronic equipment, circuits, parts, and communication electronics.

The sophisticated demand (requesting product quality, consistency over time, and compliance with standards) led to a refinement of mineral processing methods and technologies, which made Japan a specialised producer of high quality metal alloys and metal products.

The structure of the mineral processing industry is consolidated and functional, working in large groups that cover the whole value chain of a product within a circular economy approach, where recycling and re-use of materials are taken into account in product design and development.

The development of Japan as a 'processing country' has been enabled by a successful long-term policy of securing a stable supply of mineral commodities, particularly via securing imports. Such mineral policy was enacted via multiple parallel strategies encompassing: i) systematic development of domestic mineral resources (onshore and offshore); ii) active promotion of exploration and exploitation of overseas mineral resources (onshore and offshore) through economic cooperation with mineral-rich developing countries via resource diplomacy and commercial agreements (e.g. with Australia) and via exploration in international deep-sea floor resources; and iii) national stockpiling in Japan and abroad of minerals.

International cooperation is actively supported by the Government through JOGMEC. This agency conducts overseas geological surveys (on land and on the deep-sea floor) to help Japanese companies secure mineral interests, provides equity capital (for asset acquisition), loans and liability guarantees for metal exploration and development by Japanese companies, works in the development of human resources, and develops joint ventures between Japanese and foreign companies.

Japan´s resources policy includes not only securing the supply of primary raw materials via agreements with other countries, but also direct investments of private capitals in overseas mines. Over the years, Japan has invested into base metals, rare metals, and rare earths mines in Asia, Australia, North and South America, and Africa. Most of these investments have been made with the objective of securing an influential share of ownership in the target companies. Recycling is also part of Japan's resources policy. Japan has probably the most sophisticated recycling industry in the world, with recycling rates of metals above 98%. Recycling is considered from the product conception stage on together with resource efficiency considerations.

The strong technological and innovation culture in Japan is a fundamental driver for the development of its industry. Together with the active involvement of the government, the social ethics, and the sophisticated organisation of industries it explains the success of Japan's mineral processing industries.

6. South Africa

6.1 The industry in a global context

6.1.1. General Economy

South Africa has become again one of the most stable countries on the African continent, with a favourable business and investment environment and a relatively open economy. South Africa is one of the largest economies in Africa, with significant regional influence. The gold, platinum group metals, coal, and iron ore mining sectors remains crucial to the economy in terms of foreign exchange earnings, although mining accounts for only about 8% of the overall GDP. The table below summarises South Africa's general economic data.

Table 6.1: South Africa's general economic data.

General Data[1].	
AREA:	1,221,000 km².
POPULATION (2014):	53,699 millions.
WORLD RANKING (Largest Export Economy, 2013):	36th.
GROSS DOMESTIC PRODUCT (GDP, 2014):	In 2014 the GDP of South Africa was USD 341,216 billion.
EMPLOYMENT (2014):	25 % unemployment; 8.0 million employed.
INDUSTRIAL SECTORS (Contribution to GDP, 2013):	Services (58%); construction (9%); mining (8%); manufacturing (7%); retail trade (5%).
TOP MINERAL EXPORTS (2013):	Gold (17.8%); diamonds (8.3%) and platinum (6.8%) of total exports[2].
TOTAL EXPORTS (2013):	USD 114 billion.
TOTAL IMPORTS (2013):	USD 109 billion.
TRADE BALANCE (2013):	USD 5 billion.

1 The Observatory of Economic Complexity – (OEC) (data provided by UN-COMTRADE – 2013).
The World Bank - http://data.worldbank.org and International Fund Bank (2014).
2 Minerals Bureau, Department of Mineral Resources, 2014 in "Chamber of Mines of South Africa" – Facts & Figures 2013/2014).

6.1.2. Territorial Organization

South Africa has a constitutional multiparty, three-tier (local, provincial, national) democracy. The capitals are Pretoria (administrative), Cape Town (legislative) and Bloemfontein (judicial). The Constitutional Court is located in Johannesburg (***Figure 6.1***).

All of South Africa's nine provinces have important mineral resources, but for their established mining industry the seven provinces mentioned in ***Table 6.2*** are the most important.

6.1.3. Minerals Industry Contribution to Economy

Historically, South Africa's mining industry has been crucial to the country economic development. South Africa's mineral endowment is one of the richest worldwide. With the discovery of diamond and world-class gold deposits in the 19th century South Africa became the world supplier of gold and precious stones, developing a commodity export-oriented economy. Today, platinum and gold are among the largest sectors of South Africa's mining industry in terms of

Figure 6.1: Territorial Organization of South Africa.

Table 6.2: Mining Industry in the South African provinces.

Provinces – Mining Industry	
Free State	• 12 gold mines; • Producing 30% of South Africa's output; • Gold mines also supply a substantial portion of the total silver produced in the country. Uranium occurring in the gold-bearing conglomerates of the goldfields is extracted as a by-product.
Gauteng	• The major gold and diamond mining companies all have their headquarters in Johannesburg, the biggest being Anglo American and De Beers • Mining produces 6% of Gauteng's total income and 31% of export earnings.
Limpopo	• Has abundant mineral resources, making mining the critical sector of the province's economy by contributing with 22% to the gross domestic product; • Metals include platinum, chromium, nickel, cobalt, vanadium, tin, limestone and uranium; • Other resources include antimony, phosphates, fluorspar, gold, diamonds, copper, emeralds, scheelites, magnetite, vermiculite, silicon, mica, black granite, limestone, corundum, feldspar and salt.
Northern Cape	• Mining contributes with 27.6% to the gross regional domestic product; • Iron-ore mining in the north-eastern corner of the province has been expanding despite the global recession; • Sishen is the biggest iron-ore mine in the country and its owner, Kumba Iron Ore, is engaging in a new project at Kolomela (previously known as South Sishen). New manganese projects are also underway; • Diamond mining, has seen declining volumes and job losses. Diamond mining is increasingly moving away from the older mines to alluvial mining along the Orange River and its tributaries and in the Atlantic Ocean.

North West	•	Mining contributes with 23.3% to North West's economy, and makes up 22.5% of the South African mining industry.
	•	The Rustenburg and Brits districts produce 94% of the country's platinum, which is more than any other single area in the world;
	•	In addition to granite, marble, fluorspar and diamonds, the province also produces a quarter of South Africa's gold. Employment along the Platinum Corridor, from Pretoria to eastern Botswana, accounts for over a third of the province's total employment.

Source: South African Government (http://www.gov.za/about-sa/south-africas-provinces)

employment, investment and revenue generation.

The South African mining industry is the fifth largest in the world, considering all mineral resources available and produced. South Africa exploits the following major non –energy minerals[1]:

- Copper - Palabora, a large copper mine, smelter and refinery complex managed by the Palabora Mining Company in Limpopo is South Africa's only producer of refined copper;
- Diamonds - South Africa plans to process a greater proportion of its gems locally, to increase the added value in the country. The Government wants to cut and refine 70% of the diamonds mined in South Africa by 2023;
- Ferrous minerals - In March 2013, the Minister of Mineral Resources unveiled the 1 Billion Rand expansion project at BHP Billiton's Metalloys manganese smelter in Meyerton, south of Johannesburg;
- Gold - There are 35 large-scale gold mines operating in South Africa. In 2013, South Africa had fallen from being the world's biggest gold producer to the number six position, with a 6% contribution to the total global gold production, despite still having abundant gold resources.
- Manganese - South Africa has significant proven manganese reserves, but exploitation of the mineral has not reflected its

1 Government Pocket Guide 2013/2014.

development potential.
- Palladium - South Africa is the world's second largest palladium producer. All of South Africa's production is sourced from the Bushveld Igneous Complex that hosts the world's largest resource of platinum group metals (PGMs). Palladium, together with platinum, is more abundant than any of the other PGMs;
- Platinum - the country possess over 80% of the world's PGM reserves.

Contribution to GDP and Employment

The mineral industry accounted for 8.3% of the gross domestic product (GDP) in 2013. The mining Industry direct employment in 2013 was 510,099 (***Table 6.3***).

Figure 6.2 and Table 6.3 show that, in relative terms, the distribution of employment in the mining industry between 2011 and 2013 did not suffer relevant changes.

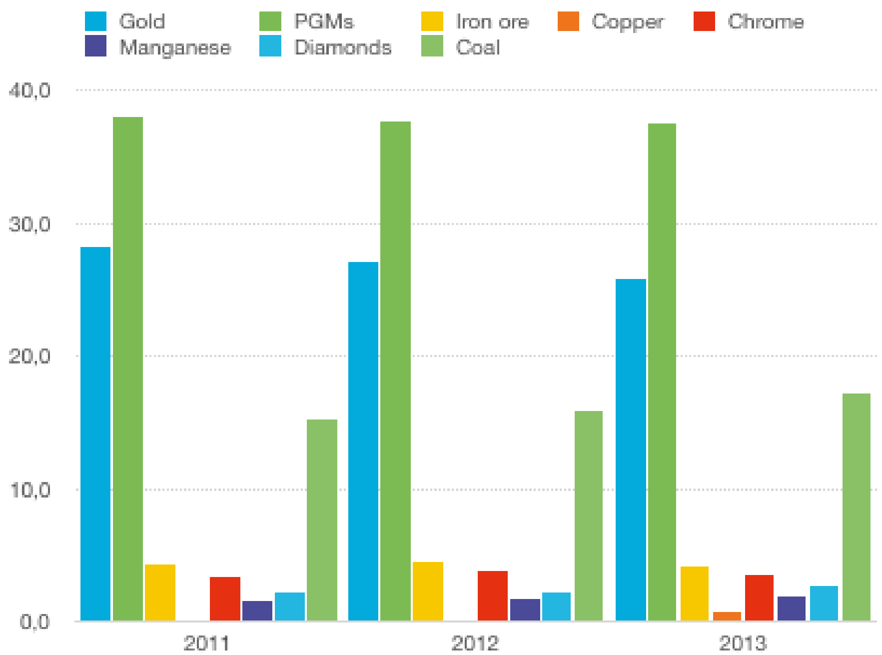
However, in absolute terms, and over a period of 10 years (2004-2013), employment in the mining industry shows impor-

Table 6.3: South Africa´s employment in the Mineral Industry (%) – 2011, 2012, 2013[1].

MINERAL INDUSTRY	2011	2012	2013
Gold	28,2	27,1	25,8
PGMs	38,0	37,7	37,5
Iron ore	4,4	4,5	4,1
Copper	na	na	0,7
Chrome	3,3	3,8	3,6
Manganese	1,5	1,7	1,9
Diamonds	2,3	2,3	2,7
Coal	15,3	15,9	17,2
Aggregate and Sand	1,4	1,4	1,5
Other Mines and Quarries	5,6	5,7	5,0

1 Minerals Bureau, Department of Mineral Resources, 2014 in "Chamber of Mines of South Africa" – Facts & Figures 2013/2014.

Figure 6.2: South Africa´s employment in the Mineral Industry (%) 2011, 2012, 2013[1].



1 Ibidem.

tant variations. From 2004 to 2008 employment increased by 70,000 (a growth of nearly 20%). From 2008 to 2010 employment declined, with a loss of about 20,000 jobs. In 2011, there was an increase of 14,000 jobs. In 2012 the growing trend continued, and there was an increase of approximately 11,000 jobs in the mining industry. In 2013 there was a loss of 14,500 jobs (Statistics South Africa, 2015).

These variations in employment in South Africa's mining industry seem to be related with global economic trends and downturns, being indicative of the country dependence on exports.

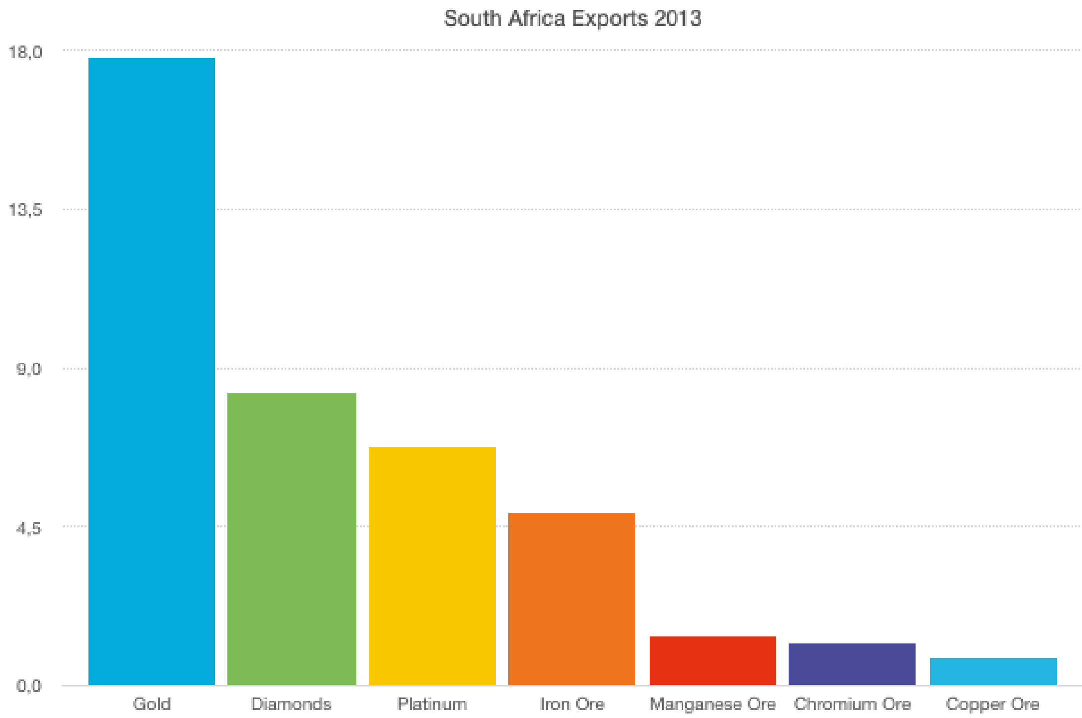
Contribution to Total Exports

Between 2009 and 2013 exports of South Africa have increased at an annual rate of 1.7%. The mining industry had a crucial importance in this. The top export destinations of South Africa in 2013 were China, the USA, the United Kingdom, Hong Kong, and India. In the same year, the three top export products of South Africa were gold (17.8% of total exports of South Africa), followed by diamonds (8.3%), and platinum (6.8%). ***Figure 6.3*** presents the country's major mineral exports in 2013.

In spite of these results, Statistics South Africa flagged the declining role of gold mining in 2015 (Statistics South Africa, 2015). South Africa has around 6,000 t of proven gold reserves. At current production levels, these reserves will exhaust in 39 years.

For platinum group metals (PGM) Statistics South Africa estimates a growth of current production levels (Statistics South Africa, 2015). South Africa will exhaust its proven PGM reserves in 248 years (proven PGM reserves are sitting at approximately 63,000 t).

Figure 6.3: Mineral Exports of South Africa in 2013.



Source: Observatory of Economic Complexity – 2013 - http://atlas.media.mit.edu/en/profile/country/zaf

6.1.4. Non Energy Mineral Industries

6.1.4.1. Major Metallic Minerals[2]

The tables below summarise data on resources, production and exports of minerals. The values of reserves provided are, unless otherwise specified, based on public reporting made accordingly with CRIRSCO-aligned reporting standards.

2 Values for resources and production provided by the Minerals Bureau, Department of Mineral Resources, 2014 in "Chamber of Mines of South Africa" – Facts & Figures 2013/2014" and by the US Geological Survey, 2013 Mineral Yearbook South Africa 2012, unless otherwise specified.

Table 6.4: Copper ore resources, production and exports.

Copper ore	
Reserves (2014)	
Quantities:	11,000 Kt.
World Ranking:	11th.
World %:	2% of global reserves.
Production (2014)	
Quantities:	45,000 t.
Exploration/Production Centres	
Palabora, a large copper mine, smelter and refinery complex managed by the Palabora Mining Company in Limpopo is South Africa's only producer of refined copper. Producing about 80 000 t per year, it supplies most of South Africa's copper needs and exports the surplus.	
Exports (2013)	
Value:	USD 464.6 million[1].
Destinations:	Finland (34%), Switzerland (28%), China (20%), Belgium-Luxembourg (8%), Philippines (3.4%), Bulgaria (2%), South Korea (1.9%), Others (2.7%). [2]

1 World´s richest countries (2014) http://www.worldsrichestcountries.com/top-copper-exporters.html

2 Observatory of Economic Complexity (2013) - http://atlas.media.mit.edu/en/profile/country/zaf/

Table 6.5: Chromium resources, production and exports.

Chromium	
Reserves (2014)	
Quantities:	3,100 Mt.
World Ranking:	1st.
World %:	85% of global reserves.
Production (2014)	
Quantities:	11,31 Mt.
World %:	46% of global production.
Exploration/Production Centres	
The Bushveld Complex is known for platinum group metals (PGMs) but has also chromium, exploited in 2 mines.	
Exports (2013)	
Value:	USD 1.37 billion.
Destinations:	China (68%), USA (3.4%), Mozambique (3.3%), Turkey (3%), Hong Kong (2.7%), Germany (2.6%), India (1.7%), Others (15.3%).

Table 6.6: Iron ore resources, production and exports.

Iron ore	
Reserves (2014)	
Quantities:	670 Mt.
World Ranking:	12nd.
World %:	1% of global reserves.
Production (2014)	
Quantities:	67.1 Mt.

World Ranking:	6th.
World %:	2 % of global production.
Exploration/Production Centres	
The Bushveld Complex is known for platinum group metals (PGMs) but also has chromium and vanadium-bearing titanium, iron ore formations and industrial minerals, including fluorspar and andalusite. The Transvaal Supergroup contains enormous deposits of manganese and iron ore (4 mines)[1].	
Exports (2013)	
Volume:	58 Mt.
Destinations:	China (45%), Japan (23%), Netherlands (7.1%), South Korea (6.1%), United Kingdom (4.2%), Singapore (5.6%), Germany (3.9%), Italy (1.8%), Others (3.3%)[2].

1 Government of South Africa (2014/2015), South Africa year book/ Mineral Resources.

2 The observatory of economic complexity. http://atlas.media.mit.edu/en/profile/country/zaf/#Exports.

Table 6.7: Gold resources, production and exports.

Gold	
Reserves (2014)	
Quantities:	6,000 t.
World Ranking:	2nd.
World %:	12% of global reserves.
Production (2014)	
Quantities:	154,178 kg.
World Ranking:	6th.
World %:	54% of global production.
Exploration/Production Centres	
Mines:	There are 53 gold mines operating in South Africa. The main exploitation area is the Witwatersrand Basin.
Exports (2013)	
Value:	USD 20.4 billion.
Destinations:	Hong Kong (34%), India (18%), Thailand (7.8%), United Kingdom (5.7%), Italy (4%); Turkey (2.7%), Saudi Arabia (1.5%), Others (26.3%)[1].

1 The observatory of economic complexity. http://atlas.media.mit.edu/en/profile/country/zaf/#Exports

Table 6.8: Manganese resources, production and exports.

Manganese	
Reserves (2014)	
Quantities:	150 Mt of manganese ore.
World Ranking:	1st .
World %:	24% of global reserves.
Production (2014)	
Quantities:	4.7 Mt.
World Ranking:	2nd.
World %:	26% of global production[76].
Exploration/Production Centres	
Mines:	The largest manganese mines in South Africa occur in the Northern Cape. There are 5 operating manganese mines.

Exports (2013)[1]	
Value:	USD 1.63 billion.
Destinations:	China (50%), India (12%), Japan (10%), Norway (5.5%), South Korea (4.5%), Spain (3.4%), Hong Kong (2.7%), Russia (2.6%), Others (9.3%).

1 The observatory economic complexity http://atlas.media.mit.edu/en/profile/country/zaf/#Exports

Table 6.9: PGM resources, production and exports.

PGM[1]	
Reserves (2014)	
Quantities:	63 Kt of PGM's.
World Ranking:	1st.
World %:	95% of global reserves.
Production (2014)	
Quantities:	Platinum: 110 t; Palladium: 60 t.
World Ranking:	Platinum: 1st[2]; Palladium: 2nd.
World %:	Platinum: 68% of global production; Palladium: 32% of global production.
Exploration/Production Centres The Bushveld complex has the largest reserves in the world (26 mining projects).	
Mines:	53 Mines.
Exports (2013)[3]	
Value:	Platinum: USD 7.85 billion.
Destinations:	Platinum: Japan (33%), USA (18%), Switzerland (11%), United Kingdom (9.4%), Hong Kong (8.4%), Germany (8%), China (5%), South Korea (2.7%), Others (4.5%).

1 US Geological Survey, 2015.
2 Chamber of Mines of South Africa (2012).
3 The observatory economic complexity http://atlas.media.mit.edu/en/visualize/tree_map/hs92/export/zaf/show/7110/2013/.

6.1.4.2. Major Industrial Minerals

Table 6.10: Diamonds resources, production and exports.

Diamonds	
Reserves (2013)	
Quantities:	70 Mc (million carats).
World %:	9.6% of global reserves.
Production (2013)	
Quantities:	2 Mc
World Ranking:	6th.
World %:	3.3% of global mine production.
Exploration/Production Centre	
Mines:	Most production is sourced from kimberlites, followed by alluvial and marine. There are 388 known deposits.
Exports (2013)[1]	
Value:	USD 9.52 Billion.
Destinations:	United Kingdom (40%), Belgium-Luxembourg (18%), United States (9.9%), China (9.1%), Israel (7.7%), United Arab Emirates (3.3%), India (2.6%), Switzerland (2.5%), Others (6.9%).

1 Observatory of economic complexity (http://atlas.media.mit.edu/en/visualize/tree_map/hs92/export/zaf/show/7102/2013/)

Table 6.11: Rare Earth Elements resources, production and exports.

Rare Earth Elements (REE)
The Steenkampskraal Mine in Western Cape Province produced REE from monzanite from 1953 to 1963. Great Western Minerals Group Ltd. (GWMG) of Canada planned to reopen the mine in the first quarter of 2013. GWMG and Ganzhou Qiandong of China planned to build a rare-earths separation plant that would process rare-earth chlorides from Steenkampskraal, producing about 5,000 t/yr of rare-earth oxides. GWMG also planned to process thorium from the monzanite and store it until demand increases[1]. In December 2011, Frontier Rare Earths Ltd. of Luxembourg signed a joint-venture agreement with Korea Resources Group (Kores) to develop the Zandkopsdrift rare-earths project. Frontier planned to complete a prefeasibility study on a new mine at Zandkopsdrift in 2013 and a feasibility study in 2014. Depending on the results of the studies, Frontier and Kores could start mining at the Zandkopsdrift monzanite deposit by late 2015. The mine's production would be processed at a rare-earths separation plant at Saldanha, with a capacity of 20,000 t/yr of rare-earth oxides.

1 Great Western Minerals Group Ltd., 2013, p. 18-22.

6.1.5. Recycling

Metal and urban waste/recycling in South Africa is being widely discussed and, but for the time being this is only in an initial stage of development.

Accordingly to the Minister of the Environmental Affairs of South Africa, Mrs. Edna Molewa, in her speech to the National Consultative Conference on e-Waste Management in 2015 "the e-Waste makes up 5% to 8% of municipal solid waste in South Africa and is growing at a rate three times faster than any other form of waste"[3]. The increased use of electronic equipment is the reason for this, but it is a complex issue to deal with, as e-Waste contains many different materials including hazardous substances.

In 2008 established the e-Waste Association of South Africa (e-WASA) was established. The mission of this association is to manage a sustainable and environmentally sound e-Waste management system for the country. The e-WASA initiative is supported by the Information Technology Association (ITA[4]), which has been working closely with the Swiss State Secretariat for Economic Affairs (SECO[5]) and the Swiss Federal Laboratories for Materials Testing and Research (EMPA[6]) to study the situation of e-Waste recycling in developing and transition countries. EMPA's international 'Knowledge Partnership in e-Waste' programme[7] has had successes in many countries in finding local, economically viable solutions for the responsible management of e-Waste. In South Africa the SECO programme is facilitating the development of a national e-Waste management strategy jointly with ITA and e-WASA. In practical terms it supports 'Green e-Waste Channels' for Cape Town, Durban and Johannesburg, guaranteeing safe and controlled disposal of e-Waste.

The focus of e-WASA has been, since 2008, the development of viable business models for managing e Waste along a value-added process, maximising opportunities for refurbishment, repair, re-use, recycling, and new product development from e-Waste components, while providing opportunities for entrepreneurial activities based on job creation and poverty alleviation. All local initiatives are designed to remain in line with the waste minimisation efforts of the government and international treaties.

Government support to these initiatives came with the promulgation of the Waste Act in 2008[8], which prohibits individuals or companies to dispose of as ordinary waste anything that constitutes 'hazardous waste' (e-Waste is in this category).

Concerning metal recycling, and according to the Metals Recycling Association of South Africa[9], in 2012 the scrap metal industry was worth between R15 and

3 https://www.environment.gov.za/mediarelease/molewa_E-Waste_conference (accessed at 22.02.2016)
4 http://ita.org.za
5 http://www.seco-cooperation.admin.ch
6 www.empa.ch
7 http://ewasteguide.info
8 https://www.environment.gov.za/sites/default/files/legislations/nema_amendment_act59.pdf
9 http://www.mra.co.za.

R20 billion. There are no official figures for scrap metal recycling in South Africa, but the Association believes, that most scrap metal is recycled (an estimate between 2.5-3 Mt/year). Because scrap metal has a higher value than any other recyclable material, any metal that ends up on streets or in landfills is generally collected by informal waste collectors and sold to scrap metal dealers. The same source says that South Africa exports scrap.

One of the issues facing the scrap metal industry in South Africa is the illicit trade in scrap resulting from high levels of theft, particularly of copper cables. To minimize this problem, the Second Hand Goods Act was passed in 2012 "to regulate the business of dealers in second-hand goods and Pawnbrokers, in order to combat trade in stolen goods; to promote ethical standards in the second-hand goods trade; and to provide for matters connected therewith"[10]. With this act scrap dealerships are required to record the details of sellers and to report any incidences of burnt cable to the police.

6.2. Economic and market assessment

6.2.1. Reserves and Production

Mining and related industries are critical to the country's socio-economic development. South Africa's mineral wealth is found in well-known geological formations and settings, i.e. the Witwatersrand Basin (gold deposits), the Bushveld Complex (PGM deposits) and the Karoo Basin (coal deposits). Iron and steel is also a significant industry in South Africa. In 2014 iron ore production was about 67.1 Mt.

Gold

There are 35 large-scale gold mines operating in South Africa[11]. More than 50,055 t of gold have been mined so far from the Witwatersrand Basin, that stretches 400 km through Gauteng and Free State. Significant mining takes place in the greenstone belts in Mpumalanga and North West.

From 2002 to 2012, the South African share of world gold production decreased from 15% to about 6% (***Figure 6.4 and Table 6.12***). To this fact contributed increasing production costs, mine depths as great as 4 kilometres leading to difficult mining conditions, high ore haulage and mine ventilations costs to abate high down-mine temperatures, low labour productivity, and an unfavourable global market situation.

Over the ten-year period from 2003 to

10 http://www.saps.gov.za/resource_centre/acts/downloads/juta/shg_act_6_2009.pdf.

11 Pocket Guide to South Africa 2013/14.

Figure 6.4: Gold production and volumes sold, 2003-2012 (t).

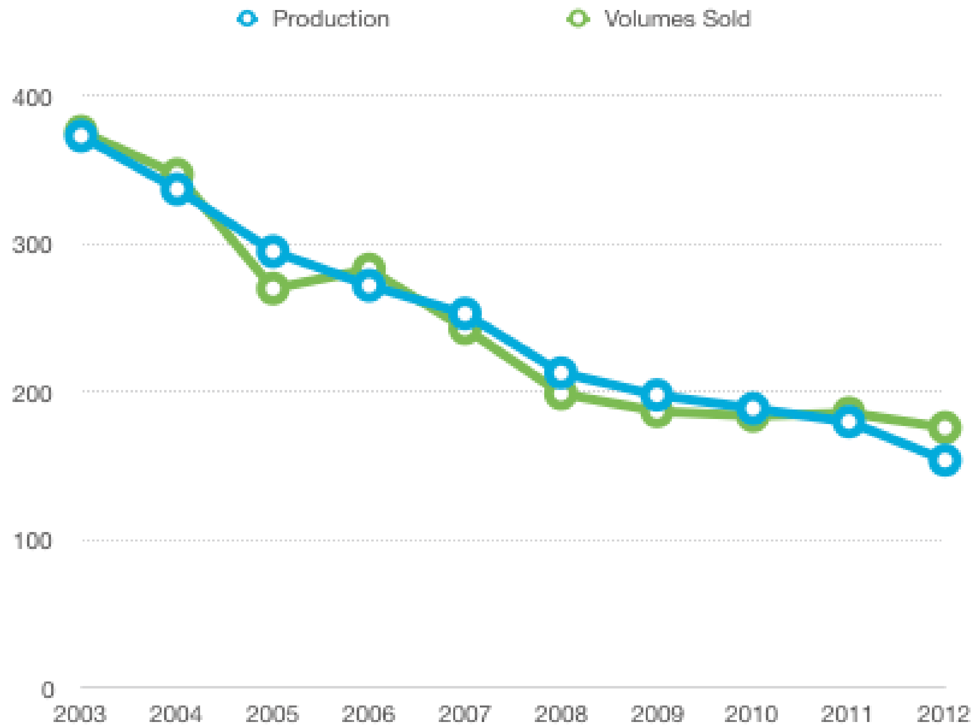


Table 6.12: Gold production and volumes sold, 2003–2012 (t).

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Production	373	337	295	272	253	213	198	189	180	154
Volumes Sold	376	347	270	283	243	199	187	184	186	176

Source: Statistics South Africa. Environmental Economic Accounts Tables - Report No.: 04-05-20 March 2015.

Figure 6.5: Gold reserves, 2003-2012 (t).

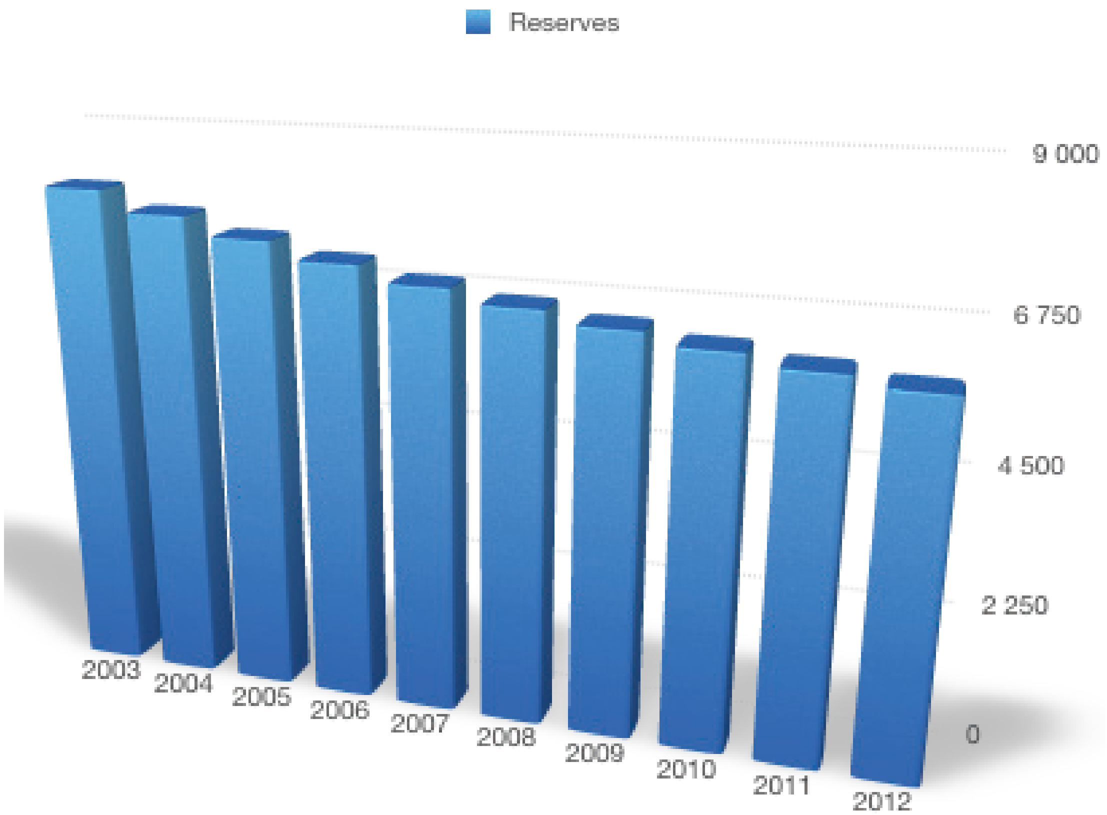


Table 6.13: Gold reserves in South Africa.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Reserves (tonnes)	8 091	7 754	7 459	7 157	6 934	6 721	6 523	6 334	6 154	6 000

Statistics South Africa. Environmental Economic Accounts Tables - Report No.: 04-05-20 March 2015).

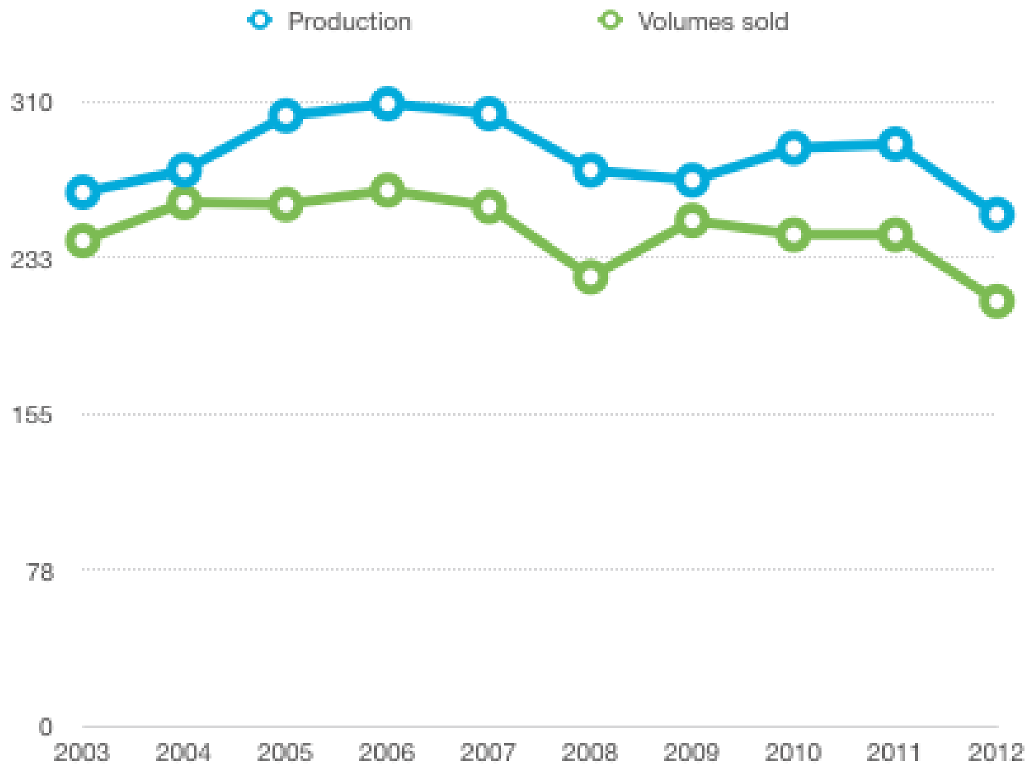
2012 the gold production decreased by 58.7%. The total amount of gold sold, in the same period, decreased by 53.2%. Despite the decreasing production and amounts sold, the total value of gold sales in 2012 increased 3.5%, because of a higher market price.

Proven gold reserves were 6.000 t in 2012. The decrease in proven gold reserves over the ten-year period from 2003 to 2012 was 25.8% (***Figure 6.5 and Table 6.13***). The estimated number of years to depletion for proven gold reserves in 2012 was 39 years.

PGM

South Africa is the world's largest producer of platinum, with major producers being Anglo American Platinum (Amplats), Anooraq, Impala Platinum (Implats), Northam Platinum, Aquarius Platinum, and Lonmin. As for gold, the platinum sector has been negatively affected by the unfavourable global economic environment, which had an adverse bearing on their long-term viability. Technological changes in the automotive industry (e.g. increasing production of electric vehicles) also contributed to

Figure 6.6: PGM production and volumes sold, 2003–2012 (t).



Source: Statistics South Africa. Environmental Economic Accounts Tables - Report No.: 04-05-20 March 2015.

Table 6.14: PGM production and volumes sold, 2003–2012 (t).

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Production	**265**	**276**	**303**	**309**	**304**	**276**	**271**	**287**	**289**	**254**
Volumes sold	241	260	259	266	258	223	251	244	244	211

Source: Statistics South Africa. Environmental Economic Accounts Tables - Report No.: 04-05-20 March 2015.

Figure 6.7: PGM reserves, 2003–2012 (t).

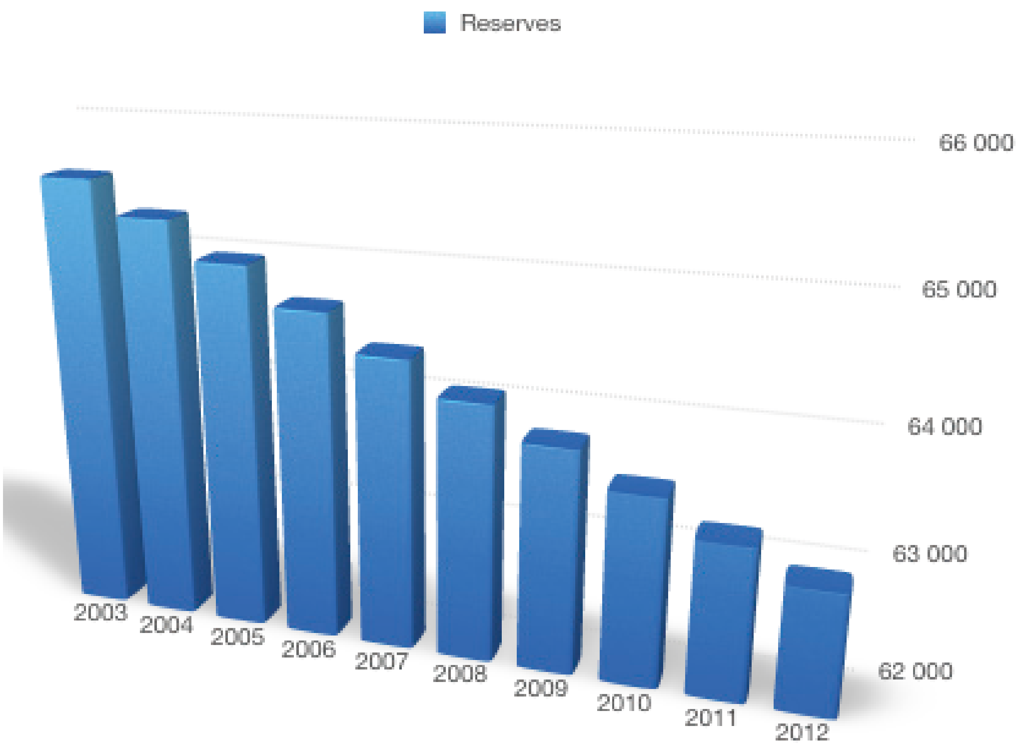


Table 6.15: PGM reserves, 2003–2012 (t).

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Reserves	65 569	65 293	64 990	64 681	64 377	64 101	63 830	63 543	63 254	63 000

Source: Statistics South Africa, 2015

the market downturn of platinum.

PGM production decreased 4.2% over the ten-year period from 2003 to 2012. The total volume of PGMs sold decreased by 12.4% over the same period (StatsSA, 2015). According to the same source, the total value of PGM sales for 2012 decreased by 10.7% from 2011 to 2012 (***Figure 6.6 and Table 6.14***).

Proven PGM reserves were 63,000 t in 2012, which is down by 2,569 t from 2003 due to the mined amounts (cf. ***Table 6.6***), i.e. by 3.9% (***Figure 6.7 and Table 6.15***). The estimated number of years to depletion of proven PGM reserves in 2012 was 248 years.

Iron Ore

Iron ore for the steel industry is produced by three major companies; Assmang, Highveld Steel, and Vanadium and Kumba Iron Ore (Anglo American Group).

Assmang produces iron ore at the Beeshoek Mine in Northern Cape, which has a rated capacity of 6 Mt/yr. Assmang opened in 2008 the Khumani Mine with an expected life of 30 years. Assmang had plans to increase the production capacity from 8.4 Mt/yr to 10 Mt/yr, mainly for exports[12].

Highveld Steel and Vanadium exploits the Mapochs open cast mine in Limpopo[13]. Magnetite iron ore is exploited and directly supplied to Highveld Steelworks.

Kumba Iron Ore operates the Sishen Mine and the Kolomela Mine in Northern Cape. Before the iron ore price crisis the company was planning to double output of these mines by 2019[14].

6.2.2. Internal Consumption

The percentage of domestic consumption of mineral commodities produced in South Africa varies significantly from commodity to commodity. Due to the small domestic market for most commodities, the South African mineral industry is export-oriented.

According the 2012 U.S. Geological Survey Minerals yearbook (USGS, 2012) the domestic consumption of manganese ore was 15%; of PGMs, 16%; of manganese alloys and nickel, 28%; and of coal, 32%. The consumption of coal was mainly used for the production of electricity. South Africa has coal, iron ore and steel-making facilities, but the production of steel in South Africa is under threat driven by imports of low-cost steel. The domestic demand is not sophisticated and the global crisis stopped investments into infrastructure. In 2008, Kumba sold only 8% of its iron ore domestically and this percentage has since decreased[15].

There are no data available on the internal consumption of gold; however, it can be concluded, from the 2013 export data, that the apparent domestic consumption of gold in South Africa was near 4%.

6.2.3. Trade (Export and Import)

South Africa is the 36th largest export economy in the world and the 45th most complex economy according to the Economic Complexity Index (ECI[16]). In 2013 South Africa exported USD114 Billion and imported USD109 Billion, having a positive trade balance.

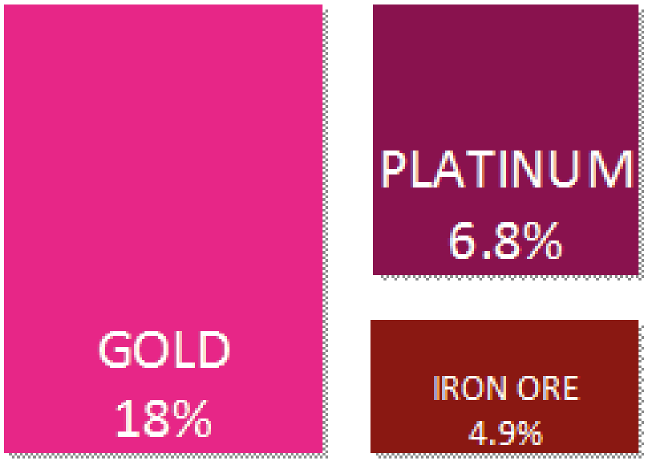
In 2013 South Africa exported commodities and goods worth USD114 billion and imported commodities and goods worth USD109 billion, thus having a positive trade balance.

Mineral commodities, such as gold, PGMs, and iron ore were among the 5 top exports of South Africa in 2013, according to the Observatory of Economy Complexity (OEC). Gold is also part of the top 5 imports of South Africa[17]. ***Figures 6.9 to 6.14*** illustrate the proportion of exports of

12 http://www.exxaro.com/pdf/icpr/a/mining_assets/iron.htm.
13 http://www.miningweekly.com/topic/mapochs-mine.
14 http://www.exxaro.com/pdf/icpr/a/mining_assets/iron.htm.

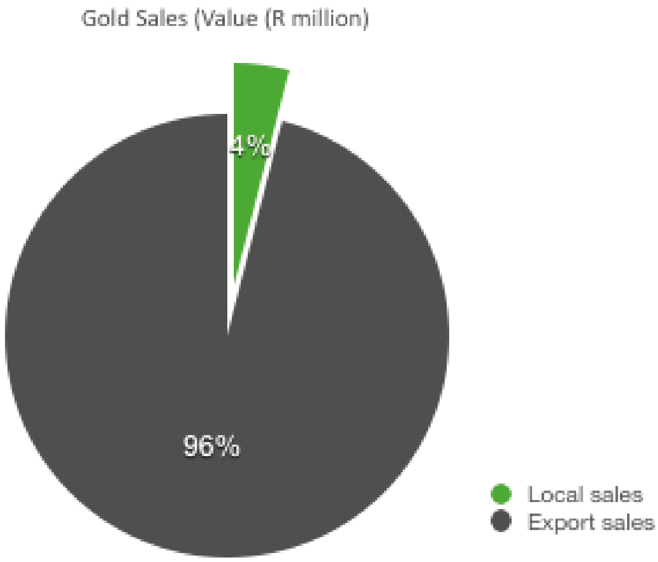
15 Ibidem.
16 http://atlas.media.mit.edu/en/profile/country/zaf/.
17 Ibidem.

Figure 6.8: 2013 Top 3 mineral exports.



Source: OEC, http://atlas.media.mit.edu/en/profile/country/zaf/

Figure 6.9: 2013 export percentage of gold sales.

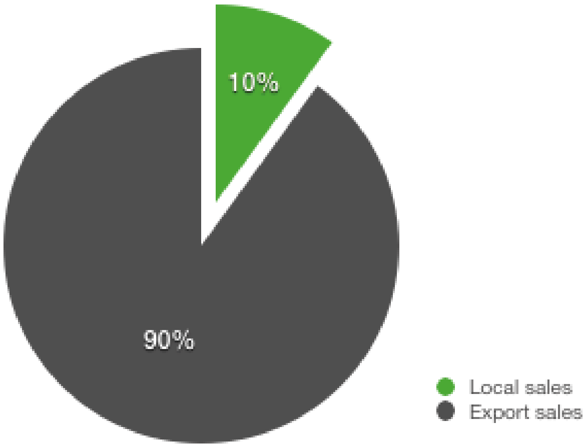


Source: Statistics South Africa – Report No. 20-01-02 (2012) – Mining Industry

Figure 6.10: 2013 Top 3 gold exports destinations.

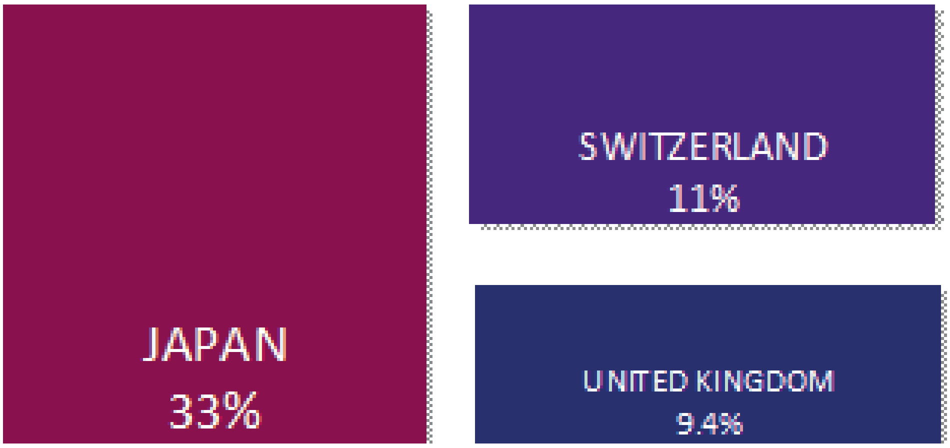
Source: OEC, http://atlas.media.mit.edu/en/profile/country/zaf/

Figure 6.11: 2013 export percentage of platinum sales.



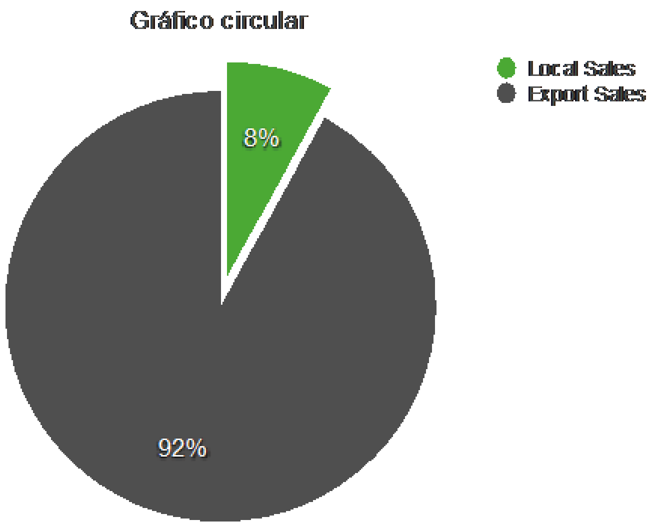
Source: Statistics South Africa – Report No. 20-01-02 (2012) – Mining Industry.

Figure 6.12: 2013 Top 3 platinum exports destinations.



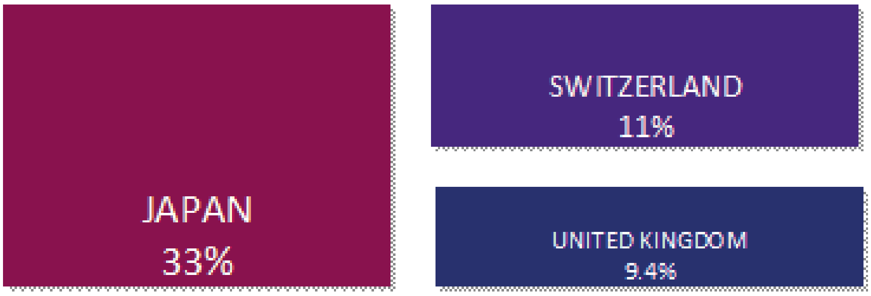
Source: OEC, http://atlas.media.mit.edu/en/profile/country/zaf/

Figure 6.13: 2013 export percentage of iron ore sales.



Source: Source: Statistics South Africa – Report No. 20-01-02 (2012) – Mining Industry

Figure 6.14: 2013 Top 3 iron ore exports destinations.



Source: OEC, http://atlas.media.mit.edu/en/profile/country/zaf/

different raw minerals and correspondent destinations.

South African mineral exports rely on a sophisticated port infrastructure, that provides reliable access to international markets. The country has six ports that handle ores. Of these ports, Richards Bay and Saldanha are highly developed and account for 90% of the total ore transport (Development Bank of South Africa, 2012).

Table 6.16 summarises the existing trade agreements of South Africa. It is interesting to note that, despite political agreements with other BRICS countries (Brazil, Russia, India, China), free trade agreements with these are not in place. The Department of Trade and Industry of South Africa contributed to the India-Brazil-South Africa Dialogue Forum[18], particularly in negociating Preferential Trade Agreements with MERCOSUR and India. With regard to China, the Department is implementing a 'Partnership for Growth and Development' that aims to promote value-added South African exports to China and increase inward investment into projects for beneficiation (Department of Trade and Industry, 2014).

Currently, the European Union (EU) is the most important trading partner of South Africa. According to an European Union official source[19]:

- South Africa is the EU's largest trading partner in Africa;
- South Africa's exports to the EU are growing and the composition of these exports is becoming more diverse. South Africa is gradually moving from mainly commodity-based products to a more diversified

18 http://www.ibsa-trilateral.org/

19 http://ec.europa.eu/trade/policy/countries-and-regions/countries/south-africa/)

Table 6.16: Main Trade Agreements between South Africa and the rest of the world.

Type of Agreement	Countries Involved	Products Involved
Customs Union		
Southern African Customs Union (SACU)	South Africa, Botswana, Lesotho, Namibia and Swaziland	All products
Free Trade Agreements		
Southern African Development Community (SADC)	Between 12 SADC Member States	Most Products
Trade, Development and Cooperation Agreement (TDCA)	South Africa and the European Union (EU)	There is currently a review of the agreement underway, which is aimed at broadening the scope of product coverage. This is taking place under the auspices of the Economic Partnership Agreement (EPA) negotiations between SADC and the EU
Preferential Trade Agreements (PTAs)		
SACU-Southern Common Market (Mercosur)	SACU and Argentina, Brazil, Paraguay and Uruguay	About 1,000 product lines on each side of the border
Non-reciprocal Trade Arrangements		
Africa Growth and Opportunity Act - unilateral assistance measure	Granted by the US to 39 Sub-Saharan African (SSA) countries	Duty free access to the US market under the combined AGOA/ GSP programme stands at approximately 7,000 product tariff lines.

Source: Department of Trade and Industry, 2014 export profile that includes manufactured products;

- South Africa's primary exports to the EU are fuels and mining products, machinery and transport equipment, and other semi-manufactured goods.
- The EU is by far South Africa's most important development partner, providing for 70% of all external assistance funds.

6.2.4. Expenditure, Taxes/Royalties, Investment and Competitiveness

South Africa has a well-capitalized banking system, well developed regulatory systems, research and development capabilities and an established manufacturing base, alongside with the rich mineral endowment (World Bank, 2015 in MinPol, 2015).

Expenditure in the mining industry has increased greatly since 2002. Until then, mineral and petroleum resources were privately owned, meaning the payment of royalties for the exploitation of these resources happened only under certain circumstances, e.g. where mining had been conducted on State-owned land.

To bring South Africa in line with prevailing international norms, the Department of Minerals and Energy promulgated the Mineral and Petroleum Resources Development Act (MPRDA) in 2002, making these resources recognized as belonging to the nation, the State being their custodian. A major implication of the Act was that mineral rights, previously in private hands, became subject to "use it or lose it" rule, leading to greatly increased exploration activity in South Africa.

According to Statistics South Africa[20] the total expenditure in the mining industry in 2012 was 317,664 Million Rand, representing 84% of total sales. The expenditure in the mining industry by province is detailed in ***Table 6.17***.

North West and Mpumalanga were the provinces with higher expenditure in 2012. Mining of PGM ore has the highest expenditures (33% of total expenditure of all mining industry). The expenditures in mining of gold and uranium ore represent 16%, and iron ore mining represents 8% of

20 Statistics South Africa – Report No. 20-01-02 (2012) – Mining Industry.

Table 6.17: Expenditure by province in the mining industry, 2012.

Province	Total Expenditure in R Million	Total Expenditure in %
Eastern Cape	536	0
Free State	14 856	5
Gauteng	33 288	10
KwaZulu-Natal	6 525	2
Limpopo	35 762	11
Mpumalanga	82 485	26
North West	109 252	34
Northern Cape	27 457	9
Western Cape	7 503	2
TOTAL	317 664	

Source: Department of Trade and Industry, 2014 total mining expenditure.

The royalties and other fees must be paid by companies that hold: 1) a prospecting or a mining right; 2) a retention permit; 3) an exploration right; 4) a mining permit or production permit; or 5) a lease or sublease in respect of such a right.

The royalties for minerals and petroleum exploitation are determined according to a formula laid down in the 'Mineral and Petroleum Resources Royalties Act' of 2008 that differentiates between refined and unrefined conditions of the resources extracted. Currently the royalties are:

- for refined mineral resources: from minimum of 0.5% to a maximum of 5%;
- for unrefined mineral resources: from minimum of 0.5% to a maximum of 7%.

Figure 6.15 shows the royalties in billion Rand paid by the Mining Industry over the period from 201o to 2013.

The tax differentiation between refined and unrefined conditions of the resources mined was introduced by South African government with the aim of increasing the level of ore beneficiation in the country, with the intention of creating jobs in the mining industry and maximising the value and benefits of mineral deposits.

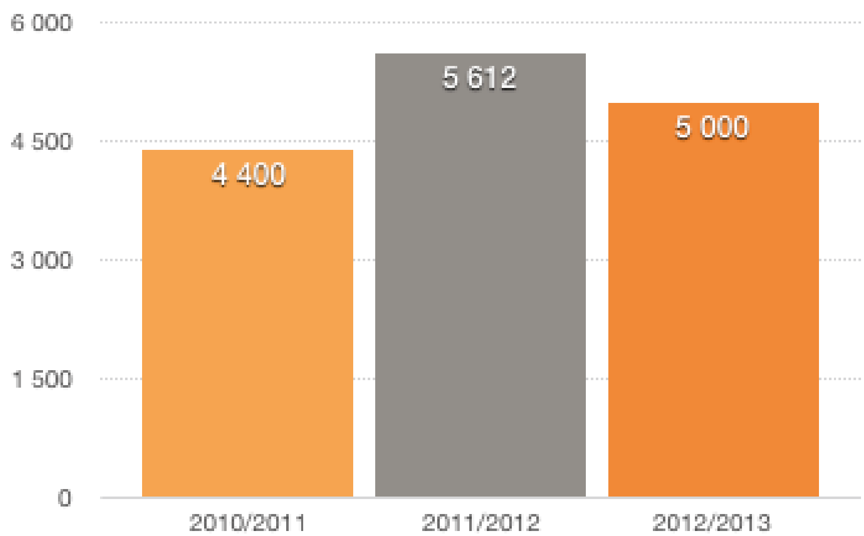
A stable fiscal framework, with no significant post-apartheid changes, has been instrumental in enabling the success of the mining industry. A key feature has been the permission to repatriate profits from all industries. Also permitting times in South Africa have acted as an incentive, i.e. permitting takes on average currently 12 months for exploration licenses, and the conversion between the exploration and the mining permit is straightforward, providing security of tenure (MinPol, 2015). However, companies are not allowed to transfer the prospecting and mining rights, unless they have written permission of the Minister of Minerals and Energy.

The stability of the legislative environment is paramount to ensure the future success of mining in South Africa. Apart from the legislative environment, access to land, mining permits and access to energy and water will also play an important role for the industry. In the past there was sufficient supply of water and energy. At present, with increased population numbers and as a result of urbanisation, the supply of energy and water are constrained due to increased demand. This challenge is recognised by the South African government, and efforts are being made to increase the energy output[21].

According to the Fraser Institute Survey of Mining Companies 2014, South Africa´s rank has fallen from 53th in 2013 to 64th in 2014 in the Investment Attractiveness Index). The Index is constructed by com-

21 https://www.iaea.org/OurWork/ST/NE/Pess/assets/South_Africa_Report_May06.pdf

Figure 6.15: Mining Industry, royalties paid - Billion Rand (National Treasury Revenue Estimates, 2013 in Chamber of Mines, 2012). Note: The values for 2012/2013 were estimated.



bining the Best Practices Mineral Potential Index, which rates regions based on their geological attractiveness, and the Policy Perception Index, a composite index that measures the effects of government policy on attitudes toward exploration investment. Uncertainty over the government nationalisation policy is partly to blame for this fall.

6.2.5. Industry Structure

The Mining House and the Chamber of Mines were founded in 1889, after the discovery of diamonds and gold reserves in South Africa[22]. These organisations dominated the mining industry in South Africa until mid 1990's, building up a profitable industry that took advantage of a rich mineral endowment and low labour costs. With the end of apartheid and the reintegration of South Africa into the global economy, the mining conglomerates were broken up by the sale of their non-core assets and new, leaner companies emerged.

Many of these new companies developed strategies to attract international capital, throughout mergers, and the commodity sector in South Africa experienced a fast growing period, becoming a strong contributor to country's economy (reaching 20% of the GDP). This period ended in 2008, when the global financial crisis emerged and affected severely the commodity industries worldwide.

South Africa today has a well-established, export orientated mining industry (coal is the only exception due to the energy sector's dependence on it). South Africa exports raw metal ores, while the main beneficiation and fabrication is done abroad.

Including side-stream and downstream

22 http://www.chamberofmines.org.za/about/history.

Figure 6.16: Mining industry contribution to other sectors.

Source: Chamber of Mines, 2012

linkages, the mining industry generates approximately 18% of South Africa economy's activity[23]. The key downstream industries – industries that use mineral resources – are the electricity sector, as 94% of electricity is produced from domestic coal; the steel sector, in which 80% is produced from domestic inputs; and the cement industry, where around 99% of the product is made from locally mined raw materials. The main side-stream industries – industries that sustain the mining sector – are housing, equipment manufacturing and infrastructural projects, such as rail and ports.

Currently, the mining industry in South Africa faces two problems that could strangle its long-term competitiveness: 1) 10% of people in South Africa depend on the wages that are paid by the mining industry79; reflecting the industry limited level of automation and 2) the high level of the unskilled labour in the Sector. Despite these constraints, the mining industry contributes in several other ways to the economy (***Figure 6.16***).

Despite being one of the richest countries in the world in mineral resources, mining is not growing in South Africa. Statistics SA shows that the steep decline in physical production volumes after the Marikana incident[24] had still not been compensated. All the authors and analysts attest to the same reasons for the recent decline of the mining sector[25]: 1) cost inflation; 2) labour unrest and 3) political uncertainty around the minerals and mining sector. These factors are keeping investors away.

In July 2013, mining companies, trade unions and government departments met to sign the Framework Agreement for a Sustainable Mining Industry, that aims at rooting out unrest and restoring investor confidence in the sector.

The South African mining industry now consists of a wide range of firms with widely differing business strategies and ownership profiles, including:

- Multinational global mining entities (e.g. Anglo American);
- World-class single commodity companies engaged in the mining of long-life, high-yield deposits (e.g. Goldfields Ltd);
- Medium-sized black empowered single commodity companies (e.g. Eyesizwe Coal);
- Small companies dedicated to high productivity exploration of marginal ores from mature operations (e.g. Metorex);
- Small entrepreneurial companies targeting smaller reserves considered too small to be profitably mined by the large companies (e.g. SA Chrome); and
- Numerous junior exploration companies, many with Australian or Canadian links.

Many South African mining companies are key players in the global industry, with a high level of technical and production expertise, as well as comprehensive research and development activities. The country is a world leader of some specific technologies, such as a ground-breaking process that converts low-grade superfine iron ore into high-quality iron pellets or mining at great depths[26].

The South African mining cluster is factor-endowment based, supported by low labour costs and being commodity export-oriented. A weak internal market makes the sector very vulnerable to external effects. Key strengths of the South African mining cluster are, alongside with the presence of major global sophisticated mining companies, the existence of strong investor and intellectual property protection.

Critical challenges for the South African mining industry are to enhance labour relations and to stimulated domestic demand. Pour labour relations are a legacy of apartheid, fostered by poor secondary education systems, low representation of blacks in tertiary education, under-in-

23 Chamber of Mines 2012.

24 In August 2012, mineworkers at Lonmin's platinum mine at Marikana went on a strike demanding a minimum salary of R12, 500 a month. For days the striking miners camped on top of a koppie near Nkaneng informal settlement demanding that Lonmin officials negotiate with them at the koppie. The strike turned violent and 34 people, mostly mineworkers, died in a clash with police on August 16. The police were apparently attempting to disarm and disperse them. Ten other people, including two policemen and two Lonmin security guards, were killed in the preceding week.

25 See http://www.pwc.co.za/en/press-room/sa_s-mining-industry-sees-steep-decline-in-financial-performance.html and http://uk.reuters.com/article/uk-south-africa-mining-idUKLNE71303020110204.

26 http://www.southafrica.info/business/economy/sectors/mining.htm#.Vv5936QrLIU#ixzz44aDT2w3S

vestment into infrastructure in black townships, and inadequate work force training for non managerial staff. The acceleration of infrastructure development can rouse domestic demand, reducing the vulnerability to external factors and stimulating the improvement of mineral processing activities.

6.3 Assessment of the regulatory framework

The mining industry and the mineral resources in South Africa are underpinned by a number of legislative acts. The main legislation is the Minerals and Petroleum Resources Development Act (MPRDA)[27], which provides for equitable access and sustainable development of the nation's mineral and petroleum resources. The MPRDA transferred minerals ownership to the Nation, with the State as custodian. Before the Act, mining companies were content to own mineral rights with the intent of exploiting them in the future. Now, operators licensed to mine are obliged to exploit, or they will lose their licenses.

In 2003, in order "to pursue a shared vision of a globally competitive mining industry that draws on the human and financial resources of all South Africa's people and offers real benefits to all South Africans" and create an industry that reflects a non-racial South Africa, mining stakeholders and the government settled on the 'Amendment of the Broad-Based Socio-Economic Empowerment' (BBSEE) Charter for the South African Mining and Minerals Industry[28]", which was updated in September 2010. The objectives of this act are to:

- Promote equitable access to the nation's mineral resources to all people of South Africa;
- Substantially and meaningfully expand opportunities for Historically Disadvantage South Africans (HDSA), including women, to enter the mining and minerals industry and to benefit from the exploitation of the nation's mineral resources;
- Utilise the existing skills base for the empowerment of HDSAs;
- Expand the skills base of HDSAs in order to serve the community;
- Promote employment and advance the social and economic welfare of mining communities and the major labour sending areas; and to
- Promote beneficiation of South Africa's mineral commodities.

Other legislation that regulates the Mining Industry are:

- The National Environmental Management Waste Act of 2008, which regulates waste management in order to protect health and the environment by providing reasonable measures for the prevention of pollution and ecological degradation. The Act came into effect on 1 July 2009, and has since been amended through the National Environmental Management Waste Amendment Act of 2014[29] which was assented to on 2 June 2014. It is important to note that the Waste Act provides measures to deal with both general and hazardous waste and treat e-Waste as hazardous waste in line with a precautionary principle;
- The Mineral and Petroleum Resources Royalty (Administration) Act of 2008 – regulates the issues concerning registration, transfer, calculation and payment of royalties;
- The Mine Health and Safety Act, 1996[30] amended in 2008, (Mine Health and Safety Amendment Act[31]) provides for protection of the health and safety of employees and other persons at mines.

Government support to mining was reaffirmed in 2010, in the framework of the New Growth Path strategy for economic policy and jobs creation[32]. The mining value chain is prioritised in this programme that aims to create 5-million jobs and reduce unemployment from 25% to 15% by 2020.

The mining legislative framework is efficient and permitting takes on average currently 12 months for exploration li-

27 Act no. 28 of 2002.
28 http://www.gov.za/sites/www.gov.za/files/33573_838.pdf

29 Act no. 26 of 2014.
30 Act no. 29 of 1996.
31 Act no. 74 of 2008.
32 http://www.economic.gov.za/communications/publications/new-growth-path-series.

censes. The conversion between the exploration and the mining permit is straightforward, ensuring security of the tenure[33].

The "social license to operate" topic has a specific context in South Africa. Conflicts with the mining industry are normally driven by labour disputes, and the use of non-violent fair treatment to solve labour disputes, alongside with labour arbitrations, fosters acceptance of mining activities by local populations.

6.4 Raw material supply assessment

According to the Ernst & Young's "survey of business risk in mining 2015-2016" the main risks for the mining industry in South Africa are:

- Energy shortages. Mining is an energy intensive activity with the cost of energy representing up to 40% of total company expenditure. Underinvestment in electricity generation and rising domestic demand for energy has given rise to power shortages in South Africa[34];
- Economic Nationalism. South Africa favours economic nationalism over nationalisation. Resource nationalism is a balancing act between promoting investment and maximising in-country benefit. Its elements include increases in taxes and royalties, more costly and demanding conditions and social investment requirements and restrictions on foreign ownership. Ernst & Young's survey clearly demonstrates the growing concerns about resource nationalism, as it has consistently been a top five global mining risk in the last three years. The South African government currently promotes beneficiation in the country, with the intention of creating jobs in the mining industry and maximising the use of mineral deposits. Mining companies with operations in South Africa are involved in discussions with the government about how mineral beneficiation could enhance the country's benefits directly from its resources.
- Labour. The South African Labour Unions are frequently protesting, using strikes to call for increased wages. These disagreements between unions and mining companies have resulted in production stoppages, which in turn have led to economic losses. Despite the commodity price downturn and falling labour productivity, workers and organised labour in many mines are still seeking increases in real wages and using strikes and stoppages as pressure tools. Mines in South Africa that have a higher labour intensity are most exposed to this risk..

Government efforts to push the in-country processing of raw materials and increase the added value of ores are a step in the right direction to counter these risks. The acceleration of infrastructure development can solve energy shortages and, in a broader sense, stimulate domestic demand. But these efforts must be underpinned by workforce training programmes capable of solving the shortage of skills, improved flexibility of the labour market and a stable political context.

6.5 Strategic analysis

6.5.1. SWOT

Table 6.18 synthesises the analysis of the Strengths, Weaknesses, Opportunities and Threats of South Africa's mineral sector.

33 http://www.gov.za/documents/minerals-and-mining-policy-south-africa-green-paper%20.

34 Cheaper power can also help maximize output from a mine by making "uneconomic reserves" economically extractable.

Table 6.18: Strengths, Weaknesses, Opportunities and Threats of South Africa's mineral sector.

	STRENGTHS	WEAKNESSES
INTERNAL FACTORS	• Existence of abundant mineral resources and a substantial percentage of the world's reserves in platinum group metals, gold and manganese; • Mining is a well-established sector of South Africa's economy and has a high degree of technical expertise; • Research and innovation capabilities, delivering ground-breaking technologies for the mining sector; • Stable fiscal framework; • Government support to mining; • Efficient permitting process and security of tenure; • Trade agreements with major regional markets (MERCOSUR and EU); • Efficient ports infrastructure; • Sophisticated and sound banking and financial services, using public reporting data of resources and reserves.	• Low vertical integration, with mostly exports of minerals and ores, but with potential for further processing; • Underdeveloped mining cluster, with incipient presence of suppliers of technologies, materials and services, with low international competitiveness; • Shortage of skilled and trained workers for technology-driven positions; • Increasing costs of labour and abundance of strikes that results in production stoppages; • Low productivity; • High energy costs; • Shortage of energy and water supply; • Political uncertainty.
	OPPORTUNITIES	**THREATHS**
EXTERNAL FACTORS	• Commodities needs in other, fast growing economies; • Renovation and development of domestic infrastructure; • Potential for the discovery of world-class deposits in areas yet to be exhaustively explored; • New trade agreements with China and other Asian countries; • Ongoing investments in education and skills development programmes; • Variable intensity of metals recycling.	• Global competition from mining countries with lower production costs; • Rising labour and energy costs; • Social unrest; • Economic nationalism that could lead to increased taxes and royalties, demands more costly social expenditure and restrict foreign ownership; • Fall in global demand for platinum and other minerals due to recession; • Corruption; • Rising inflation and (global) economic depression.

6.5.2. Competitive Context

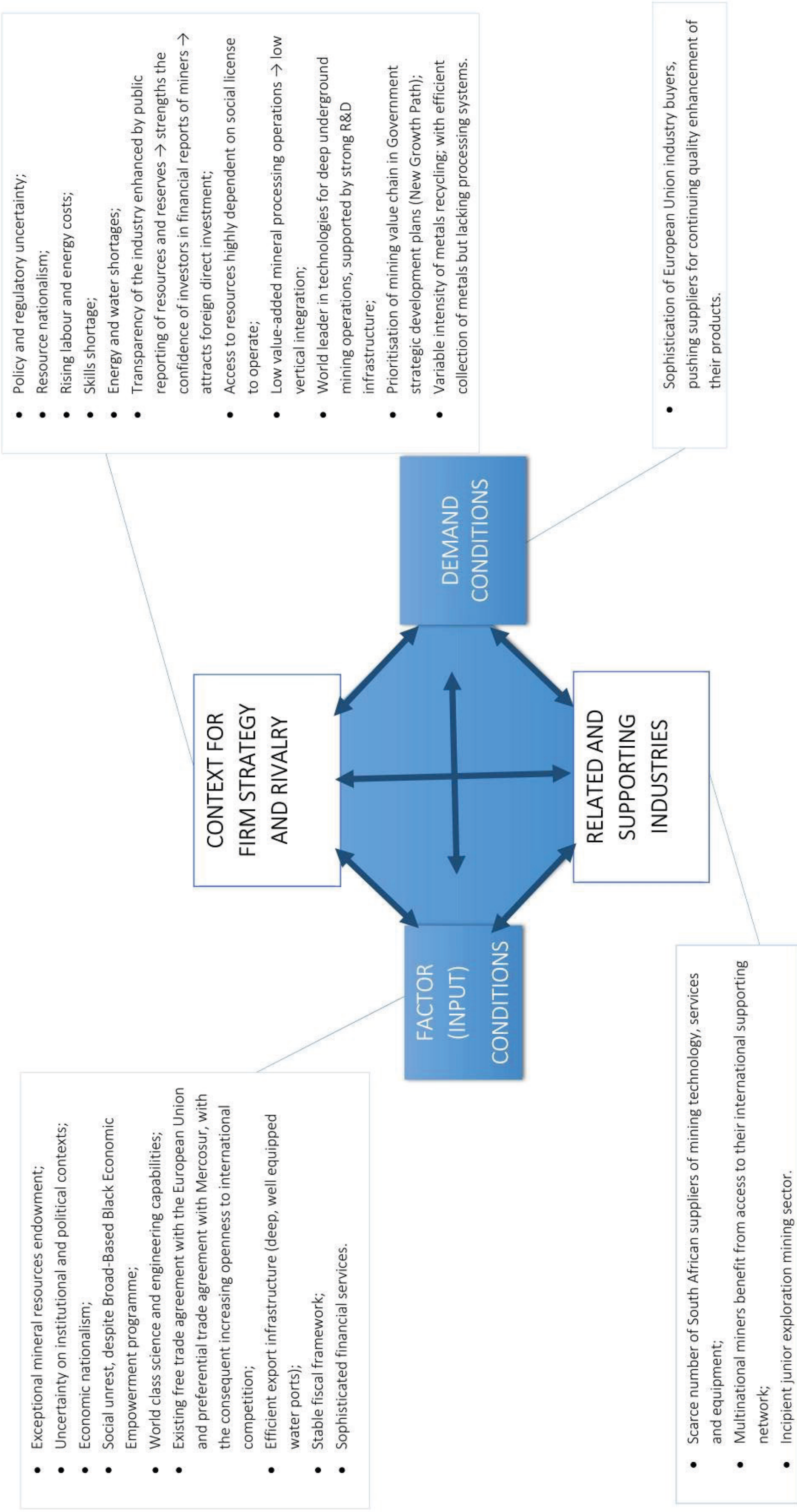
Considering Porter's Framework is possible to establish a profile of the country regarding the drivers that lead to their comparative advantages (***Figure 6.17***).

6.6 Conclusions

South Africa´s mining industry has successfully developed as a commodity export-led one and it has evolved based on an exceptional mineral resources endowment. The country has profited from substantial reserves of gold, platinum group metals, diamonds, coal, chromium, and manganese. The gold, platinum group metals, coal, and iron ore mining sectors remains crucial in terms of foreign exchange earnings for the economy. Over the past 20 years, with the growth of South Africa's secondary and tertiary industries, the relative contribution of mining to South Africa's gross domestic product has declined. However, as a net exporter, the mining sector remains the single most important earner of foreign exchange for the economy.

The mining industry evolution was based on a legal framework favourable to big mining companies and a monopolised structure. This changed in the post-apartheid era, with the reversion of mineral

Figure 6.17: South Africa's competitive context.



rights to the State, allowing new entrants into the market by releasing new exploration and mining licences. A stable fiscal framework, with no significant post-apartheid changes, has been instrumental in enabling the success of this change. Short permitting times and security of tenure also facilitated this (permitting currently takes on average 12 months for exploration licenses, and the conversion between the exploration and the mining permit is straightforward).

South Africa benefits from sophisticated financial services, well-developed regulatory systems, research and development capabilities, and an established manufacturing base. However, the country's position in the Fraser Institute´s Investment Attractiveness Index ranking has fallen from 53 in 2013 to 64 in 2014. This reflects several challenges that are affecting the mining industry in South Africa, namely low productivity, labour conflicts, high energy costs, energy and water shortages, and political uncertainty. At the same time, there is social unrest and some organized groups have called for mines to be nationalized, and there are ongoing debates about licenses, royalties and ownership. The government already rejected the nationalisation of mines and is discussing proposals to ensure the country would benefit more from mining, without disrupting the sector.

To capture the country's mining potential and improve the industry's competitiveness, South Africa needs to address problems that are rooted in the apartheid era: productivity and workforce capabilities must be improved through training programmes; industry-labour relations must be normalised through appropriate policies for labour disputes and labour arbitration; the domestic demand must be stimulated; and the energy infrastructure needs to be renovated. All these key aspects must be framed by stable government policies, since regulatory ambiguity leads to investors shying away.

7. United States of America

7.1 The industry in a global context

7.1.1. General Economy

The United States of America (USA), which are inhabited by 5% of the world´s population, is among the world´s largest economies (alongside China and the European Union) consuming roughly 20% of the global primary energy supply and 15% of all extracted materials (Gierlinger and

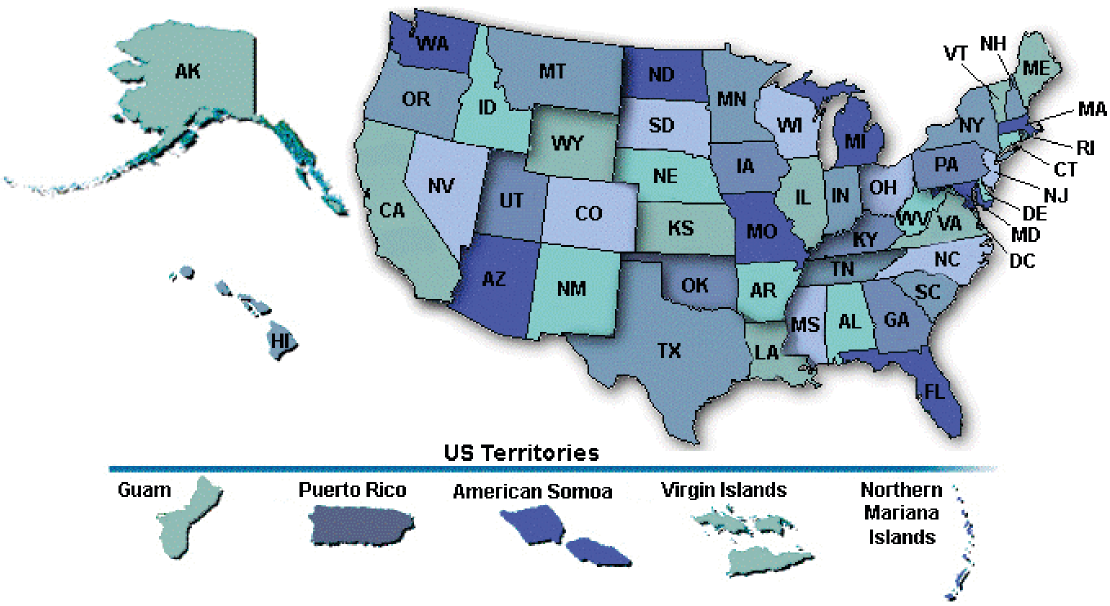
Table 7.1: General economic data for the USA

General Data	
Area:	9,833,517 km².
Population (2013):	318.9 million, annual growth of 0.78%.
World ranking (largest export economy, 2014):	2nd.
Gross domestic product (GDP, 2014):	USD 17,419 billion.
Employment (2015):	5 % of unemployment[1] 153.1 million employed.
Industrial sectors (2014):	Agriculture (1.6%), industry (20.6%); services (77.8%).
Top mineral exports (2013):	Representing 10% of total exports: refined petroleum (68%), petroleum gas (8;6%), coal briquettes (8.3%), crude petroleum (3.4%), petroleum coke (3.3%), coal tar oil (1.8%), copper ore (1.2%), iron ore (1%), and zinc ore (0.6%).
Total exports (2013):	USD 1.42 trillion
Total imports (2013):	USD 2.13 trillion
Trade balance (2013):	- USD 0.71 trillion

1 In 2015 these values decreased to 5%

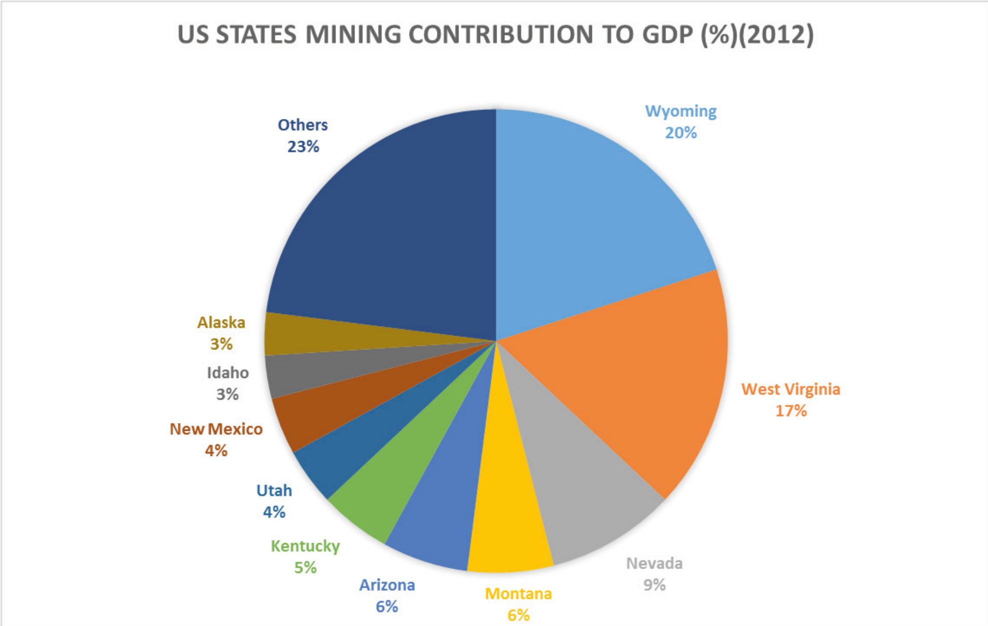
Source: The Observatory of Economic Complexity – (OEC) (data provided by UN-COMTRADE – 2013), OECD, 2015 and the World Fact Book (https://www.cia.gov/library/publications/the-world-factbook/geos/us.html)

Figure 7.1: USA States and Territories (list in annex 10.3).



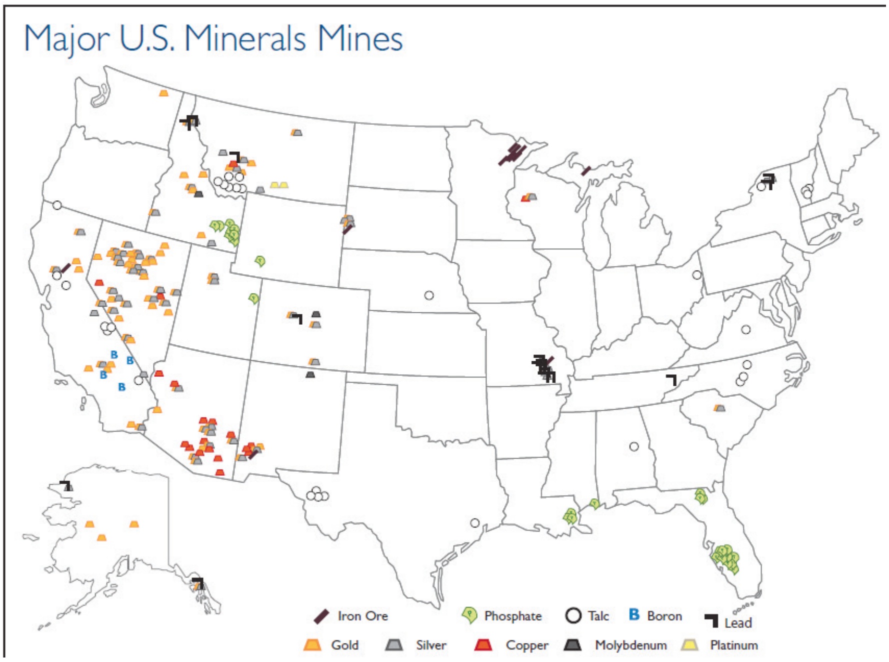
Source: http://www.ilru.org/projects/cil-net/cil-center-and-association-directory

Figure 7.2: Mining contribution of top USA states to GDP (%, 2012)



Source: National Mining Association, 2014

Figure 7.3: Major USA minerals´ mines (2013).



Source: USGS, http://minerals.usgs.gov/minerals/pubs/mapdata

Krausmann, 2012). The USA consumes a large proportion of the global resource base via imports and remains a net importer of energy and of many non energy mineral commodities. ***Table 7.1*** summarises the general economic data for the USA.

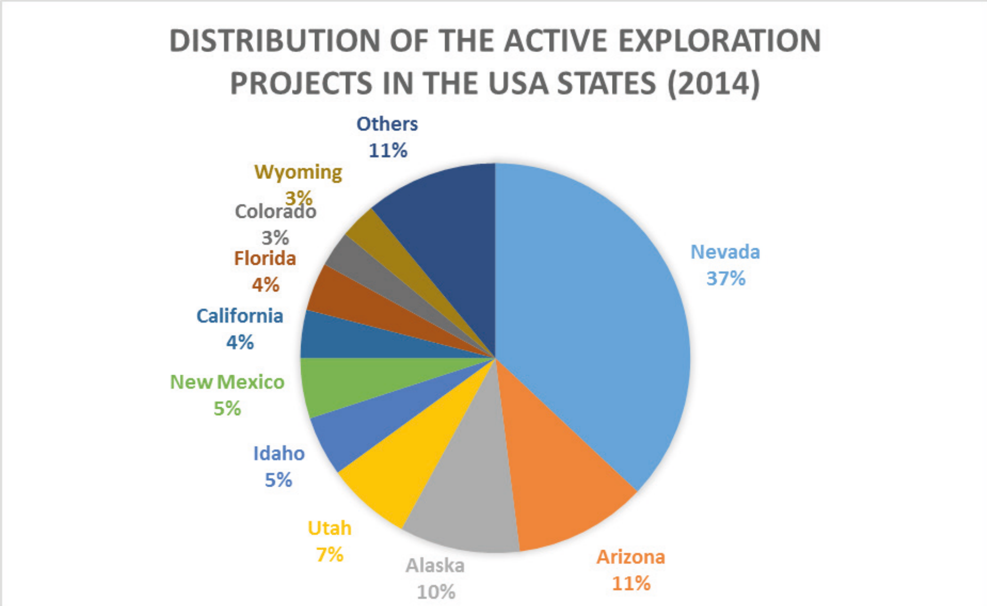
7.1.2. Territorial Organization

The USA are a federal republic with 50 states, a federal district (District of Columbia) and 5 major territories, scattered around the Pacific Ocean and the Caribbean Sea (***Figure 7.1***).

The USA are the 3rd largest country in the world as measured by area. All states have mining activities, but the states with the largest contribution to GDP in 2012 (total of mining contribution)[1] were: Wyoming (20%), West Virginia (17%), Nevada

1 These values consider coal mining, metal mining (the most representative) and non-metallic mining. They exclude petroleum.

Figure 7.4: Distribution of active exploration projects in the USA in 2014 (adapted from Wilburn, 2015).



(9%), Montana (6%), Arizona (6%), Kentucky (5%), Utah (4%), New Mexico (4%), Idaho (3%), and Alaska (3%) (***Figure 7.2***). Energy minerals remain a major value source for mining in the United States, as is reflected by Wyoming and West Virginia as the leading mining states by value. Major non-energy mineral mines are located in the West of the USA (***Figure 7.3***).

In 2014, 226 exploration projects were active in the USA, focused mainly on precious metals (84% of explorations reviewed by the USGS; Wilburn et all, 2015). ***Figure 7.4*** shows the distribution of active exploration projects among states.

The data from ***Figure 7.4*** shows that exploration is concentrated in states were active mines exists.

7.1.3. Minerals Industry Contribution to Economy

The United States GDP in 2014 accounted for 28% of the world economy, the largest share of the global economy since 1960[2].

Although the USA are one of the world's leading mining countries, when measured by production value this industrial sector is almost a "forgotten industry over-shadowed by the profile, size, and success of other sectors" (MacDonald, 2002).

In 2012 the USA had more than 14,000 mine operations for coal, metal ores, and non-metallic minerals (National Mining Association, 2012). The mining industry for non-energy minerals developed because of a relatively rich mineral endowment and a long and continued history of exploration and discovery of mineral deposits driven by a growing domestic demand for mineral resources (e.g. for construction, for the technology and military industry, for R&D, etc.).

The major non energy minerals[3] produced in the USA are beryllium, copper, lead, molybdenum, phosphates, rare earth elements, uranium, bauxite, gold, iron, mercury, nickel, potash, silver, tungsten, and zinc (USGS, 2015).

Of the top 10 minerals produced in the USA in 2012 by value, only copper (5th), gold (6th), and iron ore (7th) are metals. Gold (32%), copper (30%) and iron ore (18%) account for about 80% of total metals production in the USA. Coal alone is much more important than the entire metals sector, representing about 27% of the world's total reserves (MacDonald, 2002).

Contribution to GDP and Employment

The minerals sector in the USA is one of the smaller industrial sectors in the country, considering its contribution to gross domestic product (GDP), contribu-

2 http://www.worldbank.org/en/country/unitedstates.

3 Energy minerals play a fundamental role in US economy but they are out of the scope of this report.

ting only by 1.4% to the GDP in 2012. Nevertheless, a great part of the technological and economic success of the country depends on this industry, since without the access to raw materials down-stream activities would obviously not develop. Domestic supply is viewed as a critical component of ensuring economic security, and when global availability of specific commodities is limited, there is a record of ramping up production, (e.g. the reopening of Mountain Pass REE mine shortly after China decided to limit Rare Earths exports).

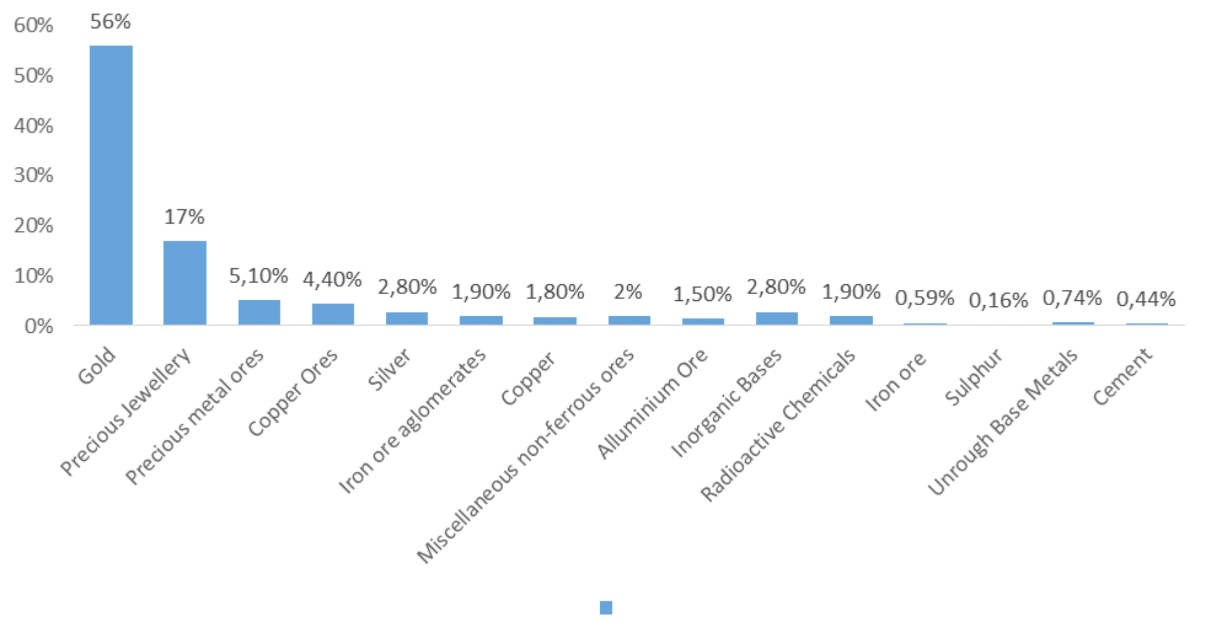
The non-energy mining sector is responsible for about 1.1% of total employment in the country. When viewed in absolute numbers, in 2012 the sector supported about 2 million jobs, directly and indirectly (National Mining Association, 2014).

Contribution to Total Exports

The mining sector contributes, by value, to 10% of the total exports, if refined petroleum and derivatives, which are the largest exported mineral commodities by value, are included.

In 2014 net exports of metal raw materials and metal scrap contributed an additional USD 15.0 billion to the economy (USGS, 2015). ***Figure 7.5*** represents the distribution of main non-energy mineral exports in 2013.

Figure 7.5: Main non-energy USA Mineral Exports in 2013.



Source: Observatory of Economic Complexity, http://atlas.media.mit.edu/en/visualize/tree_map/sitc/export/usa/all/show/2013/

7.1.4. Non Energy Mineral Industries

7.1.4.1. Major Metallic Minerals[4]

The tables below summarise data on resources, production and exports of minerals. The values of reserves provided are, unless otherwise specified, based on public reporting made accordingly with CRIRSCO-aligned reporting standards.

4 Values provided by the United States Geological Survey (2015). Exports Values and Destinations refer to 2013 (http://atlas.media.mit.edu/en/visualize/tree_map/sitc/export/usa/show/2873/2013/) unless otherwise specified.

Table 7.2: Bauxite resources, production and exports.

Bauxite (Alumina and Aluminium)	
Production (2014)	
Quantities:	Alumina 4,200 Kt, Aluminium 3,420 Kt (1,700 Kt primary aluminium and 1,720 Kt secondary, from scrap).
Production Centres	
Refineries/Smelters:	4 Bauxite refineries and 9 Aluminium smelters.
Exports	
Volume (2014):	Bauxite: 18 Kt; Alumina:2,200 Kt; Aluminium: 3,260 Kt.
Value (2013):	Aluminium Ores and Concentrates: USD 7.67 million.
Destinations (2013):	Aluminium Ores and Concentrates: Canada (27%), Brazil (12%), Nigeria (11%), Denmark (11%), Italy (5.1%), Mexico (5.1%), Belgium-Luxembourg (3.4%), France (2.3%), Others (23.1%).

Table 7.3: Beryllium resources, production and exports.

Beryllium	
Reserves (2014)	
Quantities:	15,000 t.
Production (2014)	
Quantities:	240 t.
World Ranking:	1st.
World %:	89% of global production.
Production Centres	
Utah – Spor Mountain (5 mines) and Gold Hill; Alaska – Seward Peninsula.	
Exports	
Volume (2014):	28 t.
Value (2013):	USD1.05 million.
Destinations (2013):	Hong Kong (46%), Nigeria (14%), China (9.5%), Russia (9.1%), Mexico (5.6%), Germany (4.9%), Japan (3.3%), France (1.9%), Others (5.7%).

Table 7.4: Copper resources, production and exports.

Copper	
Reserves (2014)	
Quantities:	93.1 Mt.
World Ranking:	5th.
World %:	5% of global reserves.
Production (2014)	
Quantities:	1,340 Kt in mine, 1,120 Kt refined (50 Kt from scrap).
World Ranking:	5th.
World %:	7% of global production.
Production Centres	
Arizona, Utah, New Mexico, Nevada, and Montana — in descending order of production — accounted for more than 99% of domestic mine production.	
Mines:	27 mines.
Refineries/Smelters:	Three primary smelters, 3 electrolytic and 4 pyro-metallurgic refineries, 14 electro winning facilities

Exports	
Volume(2014):	Ores and Concentrates 390 Kt; Refined 100 Kt.
Value (2013):	Copper Ore: USD1.85 billion.
Destinations (2013):	Copper Ore: China (42%), Mexico (17%), Canada (11%), Japan (7.4%); Spain (13%), South Korea (4.4%), Others (5.2%)

Table 7.5: Gold resources, production and exports.

Gold	
Reserves (2014)	
Quantities:	3,000 t.
World Ranking:	5th.
World %:	5% of global reserves.
Production (2014)	
Quantities:	Mine 211 t, Refinery 400 t (200 t primary and 200t secondary from new and old scrap).
World Ranking:	4th.
World %:	7% of global production.
Production Centres	
Mines:	Gold was produced at about 45 lode mines, a few large placer mines (all in Alaska), and numerous smaller placer mines (mostly in Alaska and in the Western States).
Exports	
Volume (2014):	430 t.
Value (2013):	USD 28.9 billion.
Destinations (2013):	Switzerland (44%), Hong Kong (31%), United Arab Emirates (5.4%), India (5.0%), Thailand (4.7%), Others (9.9%).

Table 7.6: Iron ore resources, production and exports.

Iron Ore	
Reserves (2014)	
Quantities:	Iron Ore (crude ore) 6,900 Mt.
World Ranking:	5th.
World %:	4%.
Production(2014)	
Quantities:	Iron ore 58 Mt, pig iron 29 Mt, Steel 88 Mt
World Ranking:	Iron Ore 7th
World %:	Pig iron - 2%, Raw Steel – 5%
Production Centres Indiana accounted for 25% of total raw steel production, followed by Ohio (13%), Michigan, (6%), and Pennsylvania, (6%).	
Mines:	12 iron ore mines (9 open pits and 3 reclamation operations).
Processing:	9 iron ore concentration plants, 10 pelletising plants, 2 direct-reduced iron (DRI) plants, and 1 iron nugget plant. Pig iron was produced by 4 companies operating integrated steel mills in 11 locations.
Exports	
Volume (2014):	Iron Ore 13 Mt.
Value (2013):	USD 1.56 billion.
Destinations (2013):	Canada (57%), China (27%), Mexico (9.8%), Others (6.8%).

Table 7.7: Lead, silver and zinc resources, production and exports.

Lead, Silver and Zinc	
Reserves	
Quantities:	Lead: 355 Kt, Silver: 82.5 Kt, Zinc: 62.3 Mt.
World Ranking:	Lead 6th Silver: 2nd, Zinc: 6th.
World %:	Lead: 6%, Silver: 5%, Zinc: 4%.
Production (2014)	
Quantities:	Mine Lead: 355 Kt, Refinery Lead (primary and secondary) 1,151 Kt. Mine Silver: 1,170 t, Refinery Silver (primary and secondary) 2,200 t. Zinc: 820 Kt.
World Ranking:	Lead: 3rd, Silver: 7th, Zinc: 5th.
World %:	Lead: 7%, Silver: 4%, Zinc: 6%.
Production Centres Alaska is the country's leading silver-producing State, followed by Nevada. Zinc was mined in 4 States at 14 mines.	
Mines:	Silver was produced at 3 silver mines and as a by-product or coproduct from 39 domestic base and precious metal mines.
Refineries/Smelters:	Several secondary lead smelters[1]. 24 silver refineries. Four facilities, one primary and three secondary produced commercial-grade zinc metal.
Exports	
Volume (2014):	Lead: 355 Kt, Zinc: 650 Kt, Silver: 300 t.
Value (2013):	Lead: USD 612 million, Zinc: USD 910 million, Silver: USD 1.57 billion.
Destinations (2013):	Lead: China (41%), Canada (21%), South Korea (18%), Belgium-Luxembourg (7.5%), Japan (4.1%), Mexico (3.8%), Italy (2.4%), Germany (1.9%), Others (0.3%). Zinc: Canada (30%), South Korea (17%), Japan (15%), Spain (11%), Belgium-Luxembourg (7.5%), Australia (5.9%), Finland (4.4%), Germany (4.3%), Italy (4.1%), Others (0.8%). Silver: Canada (33%), Mexico (8.4%), India (6.8%), China (5.5%), Japan (4.8%), Germany (4.5%), South Korea (4.1%), France (3.9%), Hong Kong (3.5%), Singapore (2.9%), United Kingdom (2.4%), Others (20.2%).

1 1 primary lead smelter (Missouri) closed in 2013.

Table 7.8: Platinum Group Metals resources, production and exports.

Platinum Group Metals (PGMs)	
Reserves (2014)	
Quantities:	900,000 kg
World Ranking:	3rd
World %:	1% of global reserves
Production (2014)	
Quantities:	Platinum 3,650 kg; Palladium 12,200 kg.
Production Centres	
One mining company exploiting Stillwater and East Boulder Mines in south-central Montana.	
Exports	
Volume (2014):	Platinum 16,000 kg; palladium 24,000 kg, rhodium 700 kg; other PGMs 1,000 kg.
Value (2013):	Platinum USD1.5 Billion.

Destinations (2013):	Platinum: Switzerland (17%), Germany (13%), Japan (12%), China (10%), United Kingdom (9.5%), Italy (7.8%), South Korea (7.6%), Canada (5.7%), Brazil (2.6%), France (2.4%), Others (18.4%)

Table 7.9: Titanium resources, production and exports.

Titanium	
Reserves (2014)	
Quantities:	Ilmenite and rutile 2,000 Kt.
World %:	3% of global reserves.
Production (2014)	
Quantities:	Titanium dioxide 1,310 Kt, ilmenite and rutile 100 Kt.
World %:	Ilmenite and rutile: 1% of global production.
Production Centres Titanium sponge metal was produced by 3 operations in Nevada and Utah, and titanium ingot was produced by 10 operations in 8 states. Titanium dioxide (TiO_2) pigment was produced by 4 companies at six facilities in five States. Two firms produce ilmenite and rutile concentrates from surface-mining operations in Florida and Virginia.	
Exports	
Volume (2014)	Titanium dioxide 685 Kt; Ilmenite and rutile 2 Kt.
Value (2013)	Titanium: USD 1.64 billion.
Destinations (2013)	Titanium: United Kingdom (19%), France (14%), Japan (10%), Germany (8.4%), South Korea (8.3%), Canada (5%), Italy (4.6%), Mexico (3.7%), Switzerland (3.4%), China (3.3%), Others (20.3%).

7.1.4.2. Major Industrial Minerals

Table 7.10: Rare Earth Elements resources, production and exports.

Rare Earth Elements (REE)	
Reserves (2014)	
Quantities:	1,800,000 t.
World Ranking:	5th.
World %:	1% of global reserves.
Production (2014) Bastnäsite concentrates: 7,000 t.	
Exploration/Production Centres Rare earths were mined by one company in 2014. Bastnäsite, a fluorocarbonate mineral, was mined and processed into concentrates and rare-earth compounds at Mountain Pass (CA). Exploration and development assessments in the United States included Bear Lodge (WY), Bokan Mountain (AK), Diamond Creek (ID), Elk Creek (NE), La Paz (AZ), Lemhi Pass (ID-MT), Pea Ridge (MO), Round Top (TX), and Thor (NV).	
Exports	
Volume (2014):	Cerium and other rare-earth compounds: 6,240 t.
Value (2013):	Rare-earth compounds: USD59.9 million.
Destinations (2013):	Rare-earth compounds: China (17%), Estonia (14%), France (13%), Vietnam (11%), Germany (8.3%), United Kingdom (7%), Mexico (6.4%), Austria (2.3%), Japan (1.8%), Canada (1.7%), Hong Kong (1.6%), Others (15.9%).

7.1.5. Recycling

Recycling is well developed in the USA. In 2003 more than a half of the metal supply by weight and 40% by value was provided through recycling (Sibley, 2004). In a decade recycling expanded, and so did market needs. ***Table 7.11*** illustrates the recycling intensity of selected metals in the USA (USGS, 2015).

Recycled scrap consists of approximately 59% post-consumer (old, obsolete goods) scrap, 23% prompt scrap (arising in steel-product manufacturing plants), and 18% home (scrap from industrial operations (USGS, 2015).

The USA are also recycling electronic waste (e-Waste), and figures for 2010 show that: 40% of computers were recycled (168,000 t), 33% of monitors (194,000 t), 33% of hard copy devices (97,000 t), 10% of keyboards and mice (6,460 t), 17% of televisions (181,000 t), and of 11% of mobile devices (2,240 t). This gives a total of 649,000 t of e-Waste recycling corresponding to 27% of the total produced (Facts and Figures on e-Waste and Recycling)[5]. In 2012 29.2% of e-Waste was recycled (***Figure 7.6***).

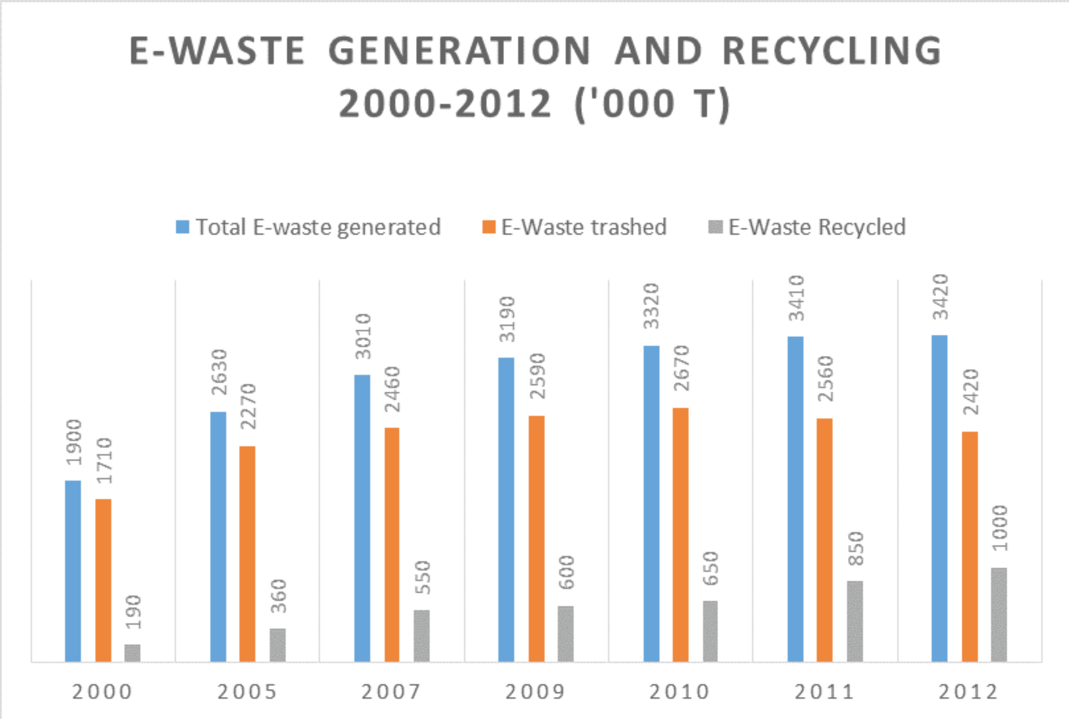
The figures of recycling in the USA highlight the potential for enhancing domestic recycling of metals.

Table 7.11: Recycling of metals in USA (USGS, 2015).

Metal	Description
Aluminium	In 2014, about 3.63 Mt from purchased scrap were recovered. New scrap (from manufacturing) accounted for 53% and old scrap (discarded products) the other 47%. In total the aluminium recycled from old scrap was equivalent to about 33% of apparent consumption.
Copper	The recycling of copper contributed to 32% of the copper supply. Old scrap provided 180,000 t, equivalent to 10% of apparent consumption, and purchased new scrap contributed with 22%, with 640,000 t of contained copper.
Gold	In 2014, 200 t of new and old scrap was recycled, more than the reported consumption.
Lead, silver and zinc	In 2014, about 1.15 million t of secondary lead was produced, an amount equivalent to 70% of apparent domestic lead consumption. Nearly all secondary lead was recovered from old (post-consumer) scrap at secondary smelters.
Titanium	About 50,000 t of scrap metal was recycled by the titanium industry in 2014. Estimated use of titanium scrap by the steel industry was about 11,000 t; 1,100 t by the super alloy industry; and 1,000 t in other industries.
Platinum Group Metals (PGMs)	An estimated 155,000 kilograms of platinum, palladium and rhodium was recovered from new and old scrap in 2014, including about 50,000 kilograms recovered from automobile catalytic converters.
Rare Earth Elements	Limited quantities were recycled; from batteries, permanent magnets, and fluorescent lamps.
Iron ore, Iron and Steel products	The steel and foundry industries are dependent on recycle scrap as a key supply to the whole production process. For old steel scrap, the main source is automobile recycling with recycling rates of about 85% in 2013, corresponding to more than 14 million t of steel. 82% of appliances and 70% of steel cans were recycled. In 2013 construction materials had recycling rates of about 98% for plates and beams and 72% for reinforcement steels and other materials.

5 http://www.electronicstakeback.com/wp-content/uploads/Facts_and_Figures_on_EWaste_and_Recycling.pdf

Figure 7.6: e-Waste Generation and Recycling in USA 2000-2012 ('000 t,



Source: http://www.electronicstakeback.com/wp-content/uploads/Facts_and_Figures_on_EWaste_and_Recycling.pdf

7.2 Economic and market assessment

7.2.1. Reserves and Production

The USA have substantial reserves of several minerals, nevertheless they relies heavily on imports. From a list of 65 mineral commodities only 21 are below 50% of imported volumes. For 19 minerals, the USA are 100% reliant on imports (USGS, 2015). ***Table 7.12*** summarizes information on minerals having important reserves in the USA.

The estimated value of metal mine production in 2014 was USD 31.5 billion, slightly less than that of 2013. Together with recycled metals, the USA processed mineral materials worth USD 697 billion, which, considering the final products from

Table 7.12: Reserves of selected minerals in USA, 2014 (USGS, 2015).

Mineral	Reserves	World Ranking	Contribution to World total (%)
Beryllium	15,000 t	1st	n.a.[1]
Copper	93.1 Mt	5th	5%
Gold	3,000 t	5th	5%
Iron Ore	6,900 Mt	5th	4%
Lead	355 Kt	6th	6%
Silver	82.5 Kt	2nd	5%
Zinc	62.3 Mt	6th	4%
Titanium (ilmenite and rutile)	2,000 Kt	3%	
Platinum Group Metals (PGMs)	900,000 t	3rd	1%
Rare Earth Elements (REE)	1,800,00 t	5th	1%

1 The value of world Beryllium reserves is not available.

downstream industries, led to an estimated value added to the economy of USD 2.5 trillion (USGS, 2015). ***Table 7.13*** shows the evolution of production for selected minerals between 2010 and 2014.

Table 7.13: Production trends for selected minerals in USA between 2010 and 2014 (USGS, 2015).

Mine Production	2010	2011	2012	2013	2014
Beryllium (t)	180	235	225	235	240
Copper (Kt)	1110	1110	1170	1250	1370
Gold (t)	231	234	235	230	211
Iron Ore (Mt)	49,9	54,7	54	53	57,5
Lead (Kt)	369	342	345	340	355
Silver (t)	1280	1120	1060	1040	1170
Zinc (t)	748	769	738	784	820
Titanium (ilmenite and rutile) (Kt)	200	300	300	200	100
Platinum Group Metals (PGMs) (kg)	15050	16100	15970	16320	15850

Table 7.14: Apparent consumption trends of minerals in USA between 2010 and 2014 (USGS, 2015).

Consumption (apparent)	2010	2011	2012	2013	2014
Beryllium (t)	456	333	265	262	270
Copper (Kt)	1760	1730	1770	1770	1810
Gold (t) - reported	180	168	147	160	165
Iron Ore (Mt)	47,9	49,1	48,1	47,1	47,8
Lead (Kt)	1440	1540	1500	1700	1660
Silver (t)	7530	7920	5930	6620	6900
Zinc (t)	907	939	891	940	990
Titanium (ilmenite and rutile) (Kt)	1230	1300	1390	1390	1150
Platinum Group Metals (PGMs) (kg)	140	153	147	144	150

7.2.2. Internal Consumption

The internal consumption of minerals in countries is usually difficult to determine. The main indicator is the 'apparent consumption' which estimates the consumption from a materials flow perspective, considering the difference between the inputs (mine production, secondary refined production and imports) and the outputs (exports). In the USA the most consumed metals are iron ore (the most traded mineral commodity worldwide) followed by aluminium, copper, lead, and zinc (National Mining Association, 2014)[6]. ***Table 7.14*** shows the apparent consumption for selected minerals between 2010 and 2014 (USGS, 2015).

6 http://www.nma.org/pdf/m_consumption.pdf

Data on domestic production and apparent consumption clearly show that the USA use all minerals they produce. This is a consequence of a strong domestic market, with demand using all the available production.

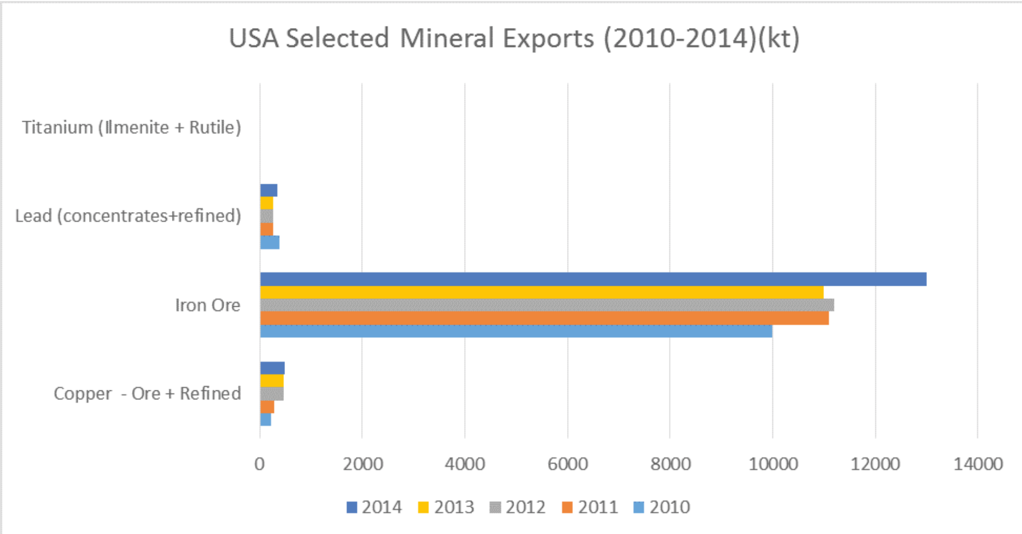
7.2.3. Trade (Export and Import)

According to USGS (2015) the non-fuel minerals trade is very important for the economy of the USA. If 2014 values are considered, mineral raw materials saw a net export of USD 2.7 billion, with exports valued at USD 10.6 billion and imports at USD7.9 billion. The USA also exported scrap at a net export value of USD 12.3 billion, with exports reaching USD 18.7 billion and imports USD 6.4 billion.

Table 7.15: Exports of selected minerals (2010-2014) (USGS, 2015).

Export	2010	2011	2012	2013	2014
Beryllium (t)	39	21	55	35	28
Copper - Ore + Refined (Kt)	215	292	460	461	490
Gold (t)	383	644	695	691	430
Iron Ore (Mt)	10	11.1	11.2	11	13
Lead (concentrates+refined)(Kt)	384	270	267	258	355
Silver (t)	709	904	946	409	300
Zinc (Ore + concentrate)(t)	756	671	605	681	665
Titanium (ilmenite and rutile) (Kt)	11	16	24	7	2
Platinum Group Metals (PGMs) (kg)	61,040	45,820	43,510	39,640	41,700

Figure 7.7: USA selected mineral exports 2010-2014 (USGS, 2015).



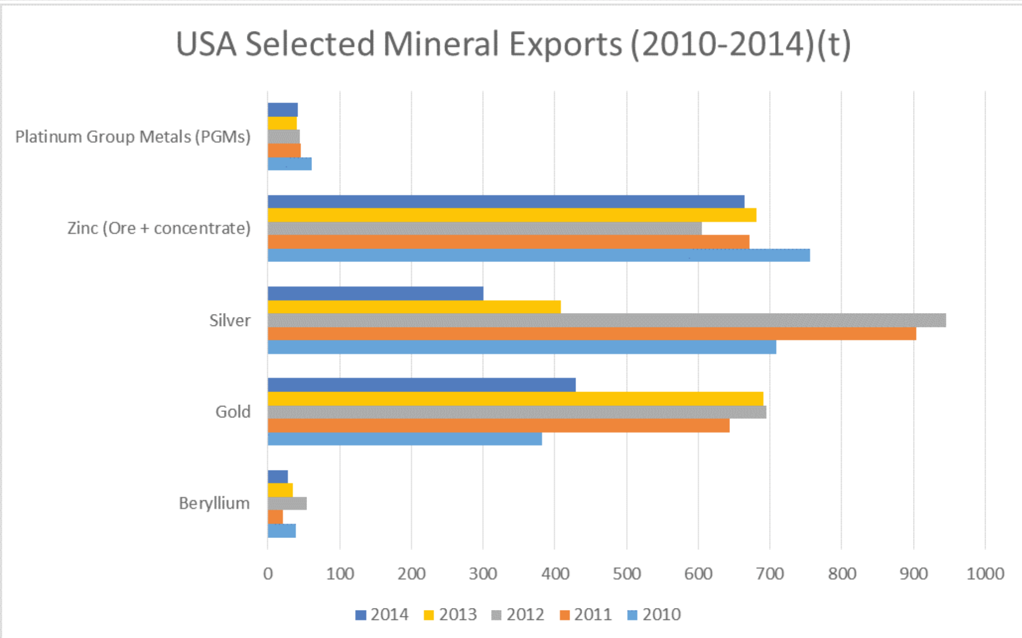
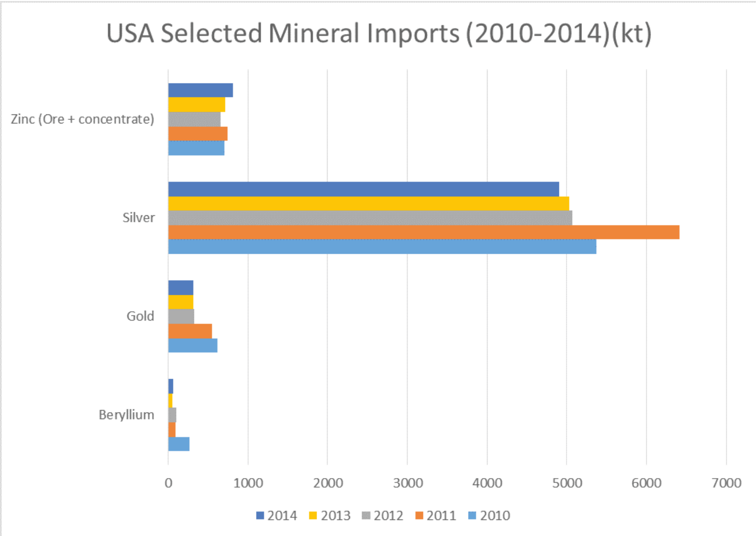
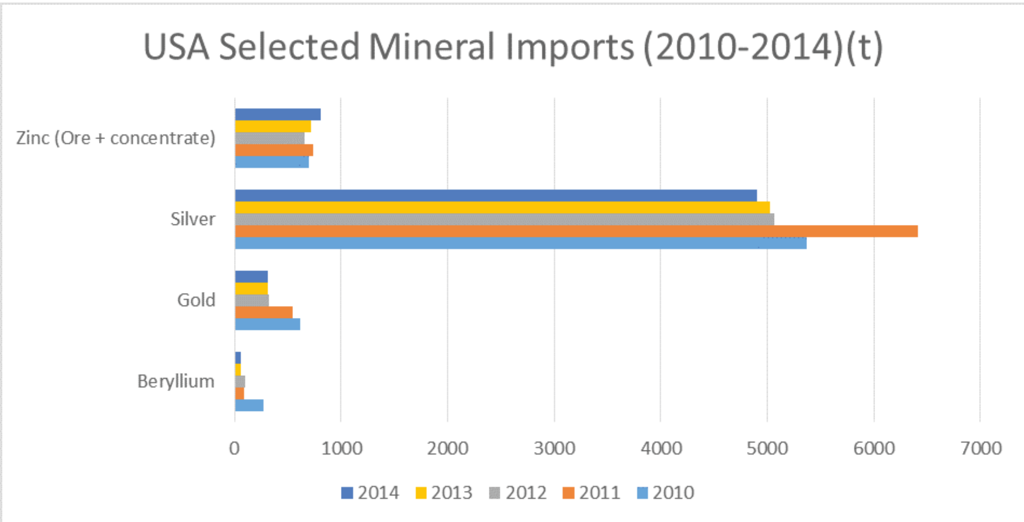


Table 7.16: USA imports of selected minerals (2010-2014) (USGS, 2015).

Import	2010	2011	2012	2013	2014
Beryllium (t)	271	92	100	57	62
Copper - Ore + Refined (Kt)	1,189	1,334	1,264	1,467	1,190
Gold (t)	616	550	326	315	315
Iron Ore (Mt)	6.4	5.3	5.2	3.2	5.5
Lead (concentrates+refined)(Kt)	273	316	351	487	550
Silver (t)	5,370	6,410	5,070	5,030	4,900
Zinc (Ore + concentrate)(t)	703	743	661	716	810
Titanium (Ilmenite + Rutile) (Kt)	1,040	1,010	1,110	1,190	1,050
Platinum Group Metals (PGMs) (kg)	253,206	257,138	276,460	227,297	253,735

Figure 7.8: USA selected mineral imports 2010-2014 (USGS, 2015).





Putting these values together, the mineral trade in the USA in 2014 achieved net export values of USD 15 billion.

When considering the volumes in minerals trade, iron ore was the most traded mineral, followed by copper and titanium. ***Tables 7.15 and 7.16*** and ***Figures 7.6 and 7.7*** sum up the trends in exports and imports for selected minerals between 2010 and 2014.

USA's top trade partners are (for exports and imports) Canada and Mexico (under the North American Free Trade Agreement, NAFTA), followed by China, the EU, and Japan.

The USA are the world's third biggest exporter, yet exports account only for 13% of GDP, with main exports being: capital goods (39% of total exports) and industrial supplies (28 %).

The USA are the world's second biggest importer with main imports being capital goods (29 %) and consumer goods (26%), followed by industrial supplies (24%), motor vehicles, parts, and engines (15%). Shipments from China represent 19% of the total imports, followed by Canada (14.5%), Mexico (12%), Japan (6%), and Germany (5%) (Trading Economics, 2015).

The USA has 14 free trade agreements in force with 20 countries including Australia, Bahrain, Canada, Chile, Colombia, Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras, Israel, Jordan, Korea, Mexico, Morocco, Nicaragua, Oman, Panama, Peru, and Singapore. The country is also in negotiation of a regional, Asia-Pacific trade agreement, known as the Trans-Pacific Partnership (TPP) Agreement and the Transatlantic Trade and Investment Partnership (T-TIP) with the European Union (USTR, 2015).

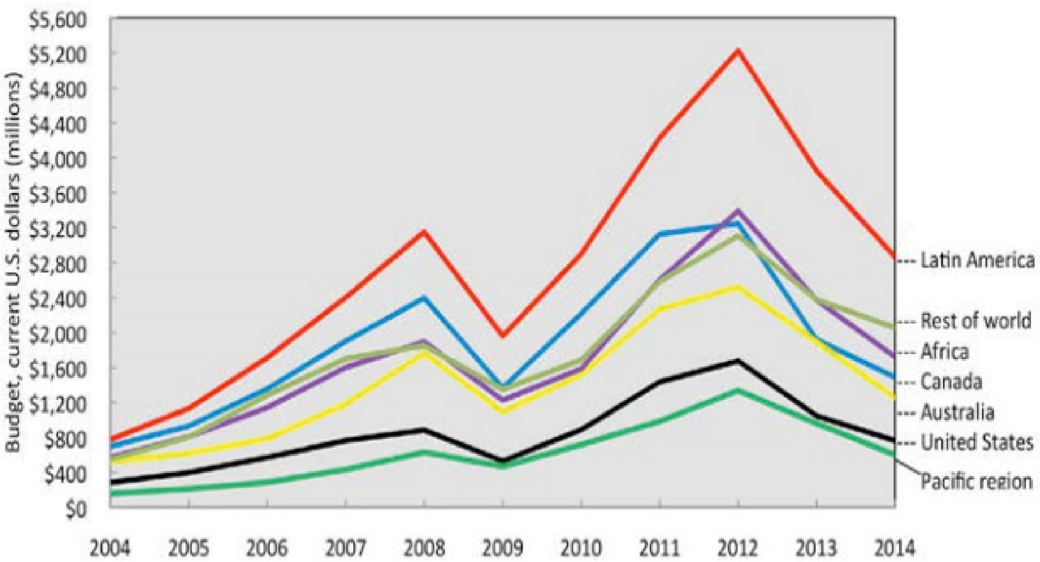
The USA´s approach to trade policy is based on the belief that nations have comparative advantages and a market-based trading system enables nations to achieve those advantages to the benefit of consumers. This has led the USA to focus mostly on signing trade agreements, and to rely on imports of raw materials from foreign countries. Canada plays an important role in this framework, providing for an important share of the USA's industry energy and raw materials needs, a situation that is beneficial for both countries, facilitated by the full integration of their economies under the NAFTA.

7.2.4. Expenditure, Taxes/Royalties, Investment and Competitiveness

The budget allocated for the exploration of minerals in the USA is historically smaller than that of other countries where mining plays an important role in the economy, like for example Canada or Australia.

The evolution of exploration budgets between 2004 and 2014 shows a similarity worldwide, with expenditure increa-

Figure 7.9: Trends in reported exploration budgets in selected regions (Wilburn et al, 2015).



sing with commodities bull market and decreasing after 2012 (***Figure 7.9***, Wilburn *et al*., 2015).

The exploration budget in the USA for 2014 was less than USD 800 million, decreased 27% from 2013. The percentage of the USA of the world exploration budget was 7% in 2014 and gold was the principal non-energy mineral targeted for exploration, followed by copper and uranium. The investment in early stage exploration was about 30% of the total industry exploration budget.

The United States has one of the world's highest corporate income tax rates. It also has a very complex set of deductions and credits designed to influence the behaviour of all taxpayers, including mining companies[7].

The taxes applicable to the mining industry are levied at various governmental levels. For minerals mined on public lands the federal government receives a royalty on production. Likewise, in most states, mining on state lands is also subject to royalties or taxes. In addition, some states, such as Nevada, levy taxes on production (the Nevada Net Proceeds Tax).

The federal government levies income taxes on all corporations (35%) and most states also levy a corporate income tax ranging from 4%-12%, though there are several states, including Nevada, which do not levy a pure income tax.

Capital investments, land improvement amortisation, and cost of plant and machinery can often be deducted from the income for tax purposes. While this provides incentives for investment, it also results in widely varying effective tax rates for companies that depend on location and investment activity.

Unlike most other developed countries in the world, taxes in the USA are based not only on domestic income, but also on worldwide income. This makes a significant difference for mining since the repatriated foreign profits are directly taxed and has led to a dramatic reduction in the number of based mining companies based in the USA that operate at a global level.

Beyond the aforementioned income taxes and royalties, mining companies, like all corporate entities in the USA also are responsible for other taxes, including employee wages (federal), property taxes on equipment and structures (state and local) and excise taxes on output (National Mining Association, 2014).

Both Federal and state/local taxes are divided into four categories:

- Corporate Income Taxes;
- Personal Taxes;

7 http://www.pwc.com/gx/en/industries/energy-utilities-mining/mining/territories/united-states.html#footnote-477

Figure 7.10: Mining Federal Taxes in the USA in 2012 (National Mining Association, 2014).

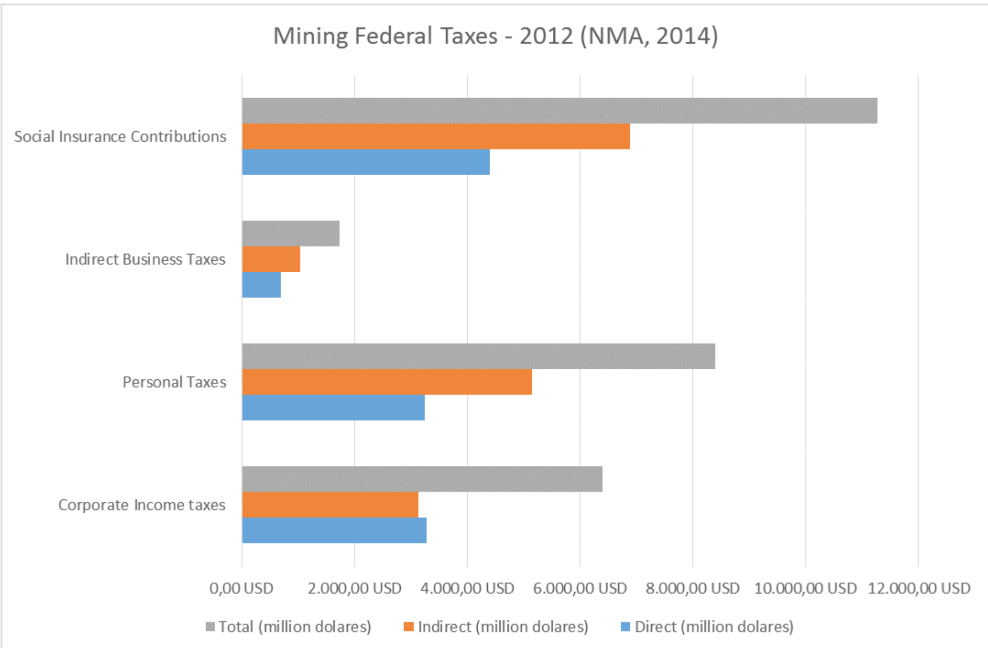
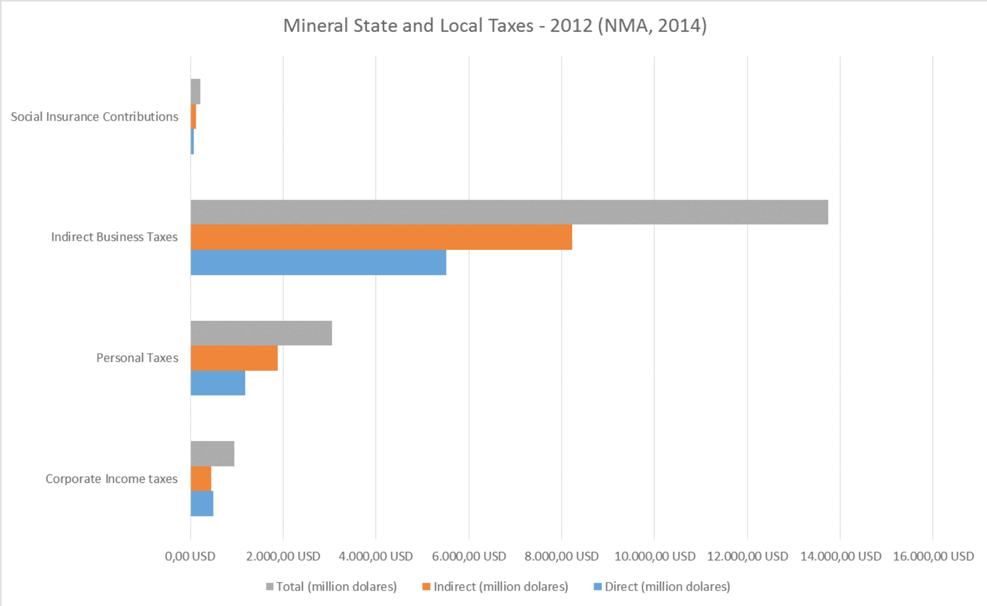


Figure 7.11: Mining State and Local Taxes in the USA in 2012 (National Mining Association, 2014).



- Indirect Business Taxes;
- Social Insurance Contributions.

In 2012 Federal taxes totalled USD 27,815 million (Direct and Indirect), while State and local amounted to USD 17,958 million (Direct and Indirect). ***Figures 7.10 and 7.11*** represent the distribution of mineral taxes in USA in 2012.

Mining activities generated USD 28 billion in federal taxes and another USD 18 billion in state and local taxes, for a total of USD46 Billion in 2012.

With regard to the availability of risk finance for the mining industry, financing is acquired on the market, and finance markets in the USA tend to be very liquid, with ready access to global capital. The country is home to the largest and most influential financial markets in the world including major stock and commodities exchanges such as NASDAQ or NYSE. The NYSE alone is more than three times larger than any other stock market in the world. Besides, the USA has the largest consumer market in the world (as measured by the household final consumption expenditure) and this is a strong driver for domestic investments (WEF, 2014).

Federal government support to mining comes as a nominal investment (although not as much as in oil and gas), usually delivered as specific tax credits and other tax incentives, not direct investments.

A critical factor enabling the competitiveness of the USA minerals sector is the availability of geoscience data provided by the U.S. Geological Survey (established in 1879) and the state geological surveys.

The Fraser Institute's 2014 annual survey of mining companies puts three USA regions in the top 10 of the Investment attractiveness index: Nevada 3rd, Wyoming 7th and Alaska 10th.

The Fraser Institute combines the Best Practices Mineral Potential Index and The Policy Perception Index to build up the Investment Attractiveness Index. ***Table 7.17*** shows the USA States ranking in this index.

This ranking highlights that for all factors considered, but particularly for minerals policy and regulations, in the States' governance is quite influential, in some cases even more than federal.

In 2014, the USA was the 3rd most competitive economy worldwide (out of 144), maintaining its 2013 position, behind only Switzerland and Singapore (WEF, 2014). The report attributes this position to the result of high sophistication and innovation of US American companies, supported by "an excellent university system that collaborates admirably with the business sector in R&D", all of this combined with "flexible labour markets" and the "sheer size of its domestic economy".

This impacts also the minerals industry, which developed within a stable institutional framework that respects the rule

Table 7.17: *Investment Attractiveness Index for the USA (Fraser Institute, 2014).*

2014		Rank				
		2013	2012	2011	2010	
USA	Alaska	10/122	5/112	6/96	4/93	6/79
	Arizona	18/122	22/122	26/96	25/93	22/79
	California	48/122	54/112	62/96	65/93	67/79
	Colorado	32/122	42/112	32/96	37/93	41/79
	Idaho	20/122	30/112	31/96	30/93	40/79
	Michigan	36/122	28/112	49/96	38/93	63/79
	Minnesota	16/122	35/112	46/96	40/93	33/79
	Montana	34/122	38/112	34/96	5/93	50/79
	Nevada	3/122	2/112	3/96	6/93	2/79
	New Mexico	38/122	45/112	51/96	44/93	39/79
	Utah	14/122	15/112	14/96	28/93	12/79
	Washington	75/122	68/112	74/96	66/93	74/79
	Wyoming	7/122	11/112	7/96	14/93	15/79

of law and private enterprise, and was encouraged by a culture of entrepreneurship and risk taking. The industry also benefitted from a large domestic market with a sophisticated demand and particular affinity towards high quality innovative and technology products.

7.2.5. Industry Structure

The USA have a long-standing and well-developed mining industry, that is dominated in domestic operations by small to medium sized companies that predominantly focus on domestic prospects. The companies that characterise the USA mining industry structure can be categorized as Investment Juniors, Exploration Juniors, Mid-Sized and Seniors, with the following general characteristics:

- Investment Juniors
  - 46% of all USA-based mining companies;
  - Focused on a specific geographical area, most often close to their head office;
  - Do not have the technology, funding and/or business process to develop past the initial exploration stages.
- Exploration Juniors
  - 22% of all USA-based mining companies;
  - Have a dedicated focus on delineation and development of one to several exploration prospects;
- Development and Production-focused Juniors, Mid-sized firms and Seniors
  - Almost 32% of all USA-based mining companies;
  - About 25% are vertically-integrated companies (own the complete supply chain of the product).

Not in these categories, but also worth mentioning are the global/foreign (multinationals) mining companies with operations in the USA. The "large mining firms" sector in the USA is limited; in 2002 only 11 companies were qualified as global miners. Nevertheless these companies are globally competitive, also with success exploring overseas, e.g. the Freeport McMoran Copper and Gold is the 7th richest mining company in the world with revenue of USD 18.3 Billion in 2013).

A quarter of the US American mining companies and the majority of multinational ones established in the USA are vertically integrated with some degree of control over their supply chain. The majority of mineral mining in the USA is oriented towards exploitation of domestic resources. Nevertheless, there is a minority of companies, including some expansionary juniors, that are competitive worldwide. For instance, Newmont is said to be the largest gold producer in the Western Hemisphere and Phelps Dodge (acquired by Freeport-McMoRan in 2007) was the second largest copper producer in the world (MacDonald, 2002).

The size of the mining sector is quite small compared with other sectors of the economy, and it is considered highly vulnerable to merger and acquisition activities by both, domestic and international companies (MacDonald, 2002).

The absence of a national strategic vision in domestic exploration is mentioned as one of the main reasons, why much of the exploration and development in the metals sector in the USA is foreign controlled, with a strong presence of Canadian firms.

Although the great majority of firms in the USA have domestic interests, there are a few focused on overseas exploration as their defining core business. This was the evolution pattern of some truly competitive US American firms that have the majority of their investments abroad and left domestic interests to smaller companies.

The mining cluster in the USA includes a large diversity of mining companies, exploring tens of strategic minerals in many hundreds of mines of all types. The cluster is geographically/endowment-driven, with suppliers of equipment and services normally concentrated around traditional mining areas (heavy equipment firms, machinery suppliers, metal recyclers, construction companies, banks, manufacturers, transportation services, tire dealers, chemical companies, engineering firms, and insurance firms). There are suppliers of all sizes, from the local to the country level, depending on the nature of the services provided and the type of management and organisational structure. Many of these suppliers are not industry specific, but have a level of sophistication that facilitates adaptation to the mining industry needs and requirements. This is also common in engineering and technology services, which normally do not focus on mining, but are capable of delivering tailor-made solutions.

The potential of the USA mineral endowment, combined with the manufacturing industry's dependence on the stability of supply chains may, in the future, leverage the exploitation of domestic mineral resources and the consequent reinforcement of the country mineral cluster.

7.3 Assessment of the regulatory framework

The mining industry in the USA expanded due to a politically and institutionally stable framework with a high respect for the rule of law and security of tenure, attractive to mining investments from domestic and international sources. The USA has had stable mineral laws for over 100 years and a well-defined protection of property rights.

However, mining is regulated under a complex and intricate framework of laws and regulations at Federal, State and local levels. From a general perspective one must consider:

- The fundamental Federal legislation defined by the 'General Mining Act' of 1872 which is still in force. This is the law that governs prospecting and mining for economic minerals on federally owned lands and defines the 'mining claim' and 'sites' or the right to explore and extract minerals from these lands. There are two main types of claims, that have rules for licensing and exploration, Lode Claims and Placer Claims.
- Mining acts defining specific regulations and changes to the General Mining Act, such as revisions of the application of claims to several minerals (some examples below):
    - Mineral Leasing Act of 1920 closed the coal, petroleum and oil shale (among other resources like phosphate or sodium) deposits to claim staking[8].
    - Multiple Mineral Use act of 1954 considered the development of several minerals in the same area of land[9].
    - Multiple Surface Use Mining Act of 1955 removed several common minerals (sand, stone, gravel, pumice, pumicite, cinders, and petrified wood) from the valuable

8 http://uscode.house.gov/statviewer.htm?volume=41&page=450

9 https://www.law.cornell.edu/cfr/text/43/3740.0-1

mineral deposits list in order to provide that "nothing shall affect the validity of any mining location based upon discovery of some other mineral occurring in or in association with this kind of deposit"[10] .

- Federal Land Policy and Management Act of 1976 (FLPMA) redefines claim recording procedures and abandonment, if the procedures are not followed. The FLPMA was the legislation that imposed the most significant changes in the provisions of the 'General Mining Act' of 1872, with the revision of surface uses allowed, considering restrictions for unnecessary or undue degradation of public lands.

- Laws/regulations governing the relationship between private landholders and mining companies, providing for fair compensation. These regulations were introduced mainly by State governments to address the issues of separability of land and mineral property rights. These regulations created an "intricate web of federal, state and local laws and restrictions…» (McDonald, 2002).

There is a portfolio of federal environmental laws that govern many activities, including mining[11], such as the Clean Air Act, the Clean Water Act , the Safe Drinking Water Act, the Solid Waste Disposal Act, the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), the Toxic Substance Control Act, the Endangered Species Act, the Migratory Bird Treaty Act, the Surface Mining Control and Reclamation Act, the National Historic Preservation Act, and the Federal Mine Safety and Health Act among others.

The involvement of a wide range of government agencies enforcing the various laws creates a complex system that can constrain the development of a project. Each mine can face a unique set of regulatory requirements depending on several variables including whether it is located on state, federal, tribal, or private land.

The Federal agencies in the USA with regulatory or operational interests in mining activities include:[12] the U.S. Geological Survey (USGS), the U.S. Army Corps of Engineers (USACE), the U.S. Department of Interior's Bureau of Land Management (BLM), the National Park Service (NPS), the Office of Surface Mining (OSM), the U.S. Agriculture's Forest Service (USFS), the U.S. Department of Labour's (DOL), the Mine Safety and Health Administration (MSHA), the Environmental Protection Agency (EPA); U.S. Securities and Exchange Commission (SEC), and the U.S. Internal Revenue Service (IRS). In addition, many States also have state agencies with varied interests in mining activities within the remit of their jurisdiction. The overlapping laws and agencies provide a complex network of regulatory oversight over mining activities, from exploration and permitting through to closure, remediation and site re-use.

The complexity of the regulatory framework for mining in the USA is a critical impediment to the development of the sector and is one potential cause for the great dependence on raw materials imports. In order to find solutions toward a more efficient permitting process and to provide incentives for the sustainable development of the domestic mineral supply, proposals such as the 'National Strategic and Critical Minerals Production Act' of 2013 were introduced in the U.S. Congress.

The basic consideration in the mineral laws of the USA is that minerals are owned by the owner of the surface. However, mineral rights and surface ownership are separable, which makes it possible (and often desirable) for a mining company to purchase the mineral rights without the landownership. This distinction has played a significant role in the development of the resource extraction industry in the USA. This option facilitates access to land for mining under four possible ways (MinPol, 2015):

- Ownership through claims or patents on public land (excluding national parks, wilderness areas, Indian reservations, military installations and

10 https://www.law.cornell.edu/uscode/text/30/611

11 http://www.nma.org/index.php/federal-environmental-laws-that-govern-u-s-mining.

12 http://www.un.org/esa/dsd/dsd_aofw_ni/ni_pdfs/NationalReports/usa/mining.pdf

others);
- Leasing of public land;
- Ownership of private land;
- Leasing of private land.

More recently the industry is facing challenges with respect to securing a 'social licences to operate' because the USA overall does not view themselves as a mining country anymore. The typical public view of mine operations is negative, primarily because of ongoing impacts from abandoned mines from the 19th and early 20th centuries.

7.4 Raw material supply assessment

The supply risk is an important indicator that, together with the economic importance of a certain mineral commodity, gives the level of criticality of that commodity.

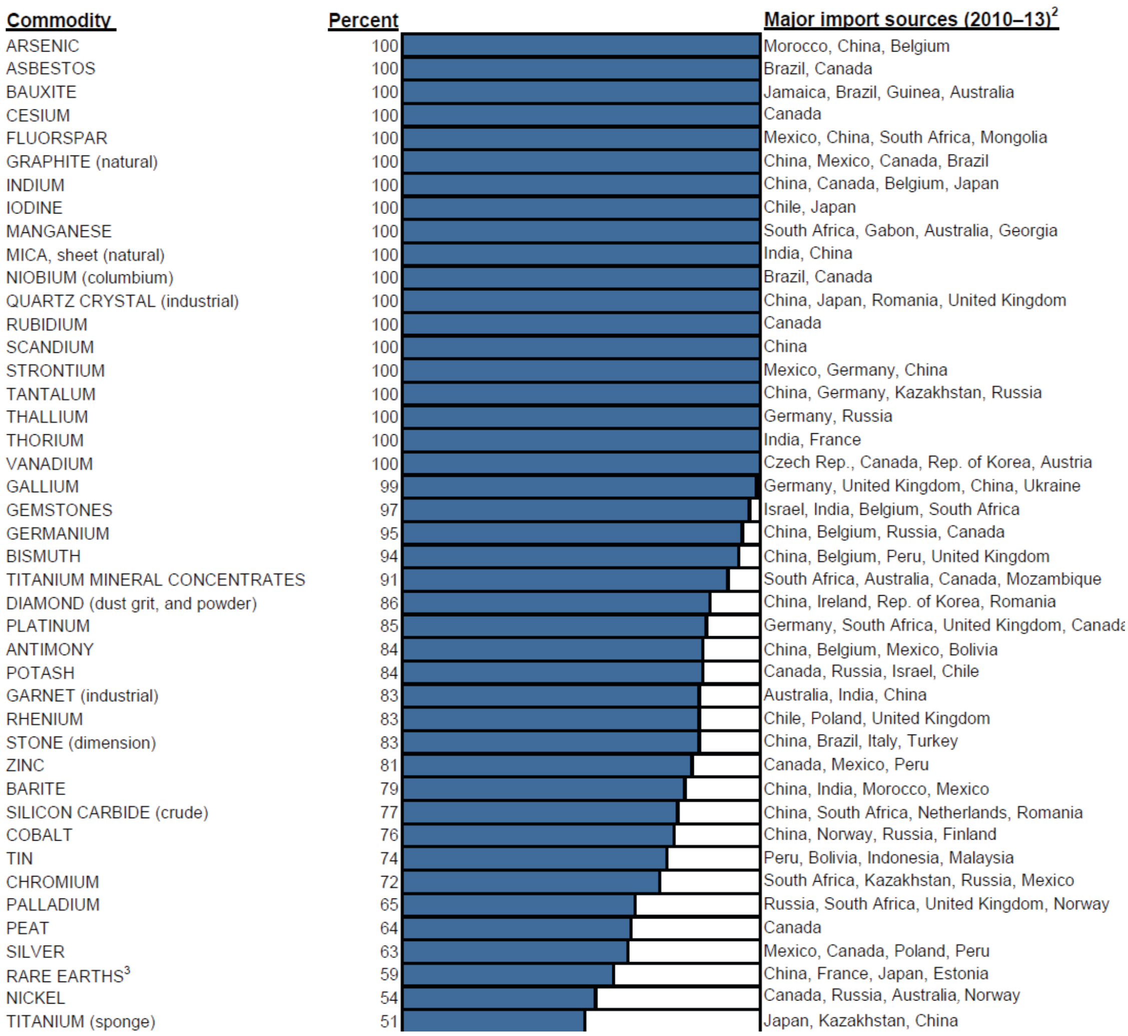
The USA are 100% reliant on imports for 19 of the 65 non-fuel mineral commodities used in the national economy. These minerals include some materials designated as 'critical' or 'strategic' such as indium, niobium, and tantalum. Of these 65 minerals, 21 are produced domestically, but this meets less than 50% of the demand (National Mining Association, 2014; ***Figure 7.12***).

Considering the importance of minerals for the economy of the USA, ongoing supply risk assessments are being conducted to ensure supply security with special attention to those minerals considered critical for the processing industry. These assessments normally consider three fundamental indicators: supply risk, production growth, and market dynamics (National Research Council, 2008).

Other studies (National Research Council of the National Economies, 2007[13]) consider the following five dimensions, matching the concerns of countries

13 http://www.nma.org/pdf/101606_nrc_study.pdf

Figure 7.12: Mining State and Local Taxes in USA – 2012 (National Mining Association, 2014).



where mineral commodities have an important role in the economy (export or import):

- Geological Availability;
- Technical Availability;
- Social and Environmental Availability;
- Political Availability;
- Economical Availability.

The availability of a specific mineral, coupled with its market demand, provides indications on the supply risks of that mineral. In the USA, this assessment is being made for several minerals (e.g. copper, rare earth elements, PGM, gallium, indium, lithium, manganese).

The expansion of domestic production to offset external supply constraints has been used in the past and depends on three factors: 1) market needs; 2) mineral specifications; and 3) the political framework.

The short and medium-term factors for supply risk (over a time-scale of a few months to a few years, but no more than a decade)[14] identified in the USA are (National Research Council, 2008):

- Demand may increase significantly and unexpectedly;
- Relatively narrow or small markets: Can be important for minor metals related to their actual demand and production volumes (e.g. gallium, tantalum, or vanadium). Small markets may imply that the production capacity may take a lot of time to react to the demand;
- Production concentration in a small number of mines, producing countries, or companies;
- Dependence on by-product production. The minerals dependent on this source are also exposed to the risks related to the main mineral production;
- Underdeveloped recovery from scrap (recycling/re-use).

14 These factors can lead to significant restrictions of supply leading either to physical unavailability of a mineral or more likely to higher prices.

Two other risks are identified:

- **Import dependence.** It is considered that import dependence should not be interpreted as less secure than domestic production. Import reliance on a specific mineral would not be detrimental for the economy, if the imported mineral has a lower cost than and/or a similar quality as an alternative domestically produced mineral. If import reliance is high, the risk can be reduced if supplies come from several countries or companies. Sometimes the imports are related to trade relations within the vertical supply chain of the same company;
- **The reserve/production ratio.** It is considered that the interpretation "the shorter the estimated life-time of the reserves, the grater the supply risk" may not be totally correct (National Research Council, 2008). The limitation of known reserves normally motivates firms to invest in exploration of new reserves. Usually the reserves are not explored until the end of the currently exploited mineral resources approach their end, so reserve development is an ongoing process in the mines. Technological innovation can be also important in reducing supply risks since it may facilitate the exploration and exploitation of reserves that previously were inaccessible.

7.5 Strategic analysis

7.5.1. SWOT

Table 7.18 below synthesises the analysis of the Strengths, Weaknesses, Opportunities and Threats of USA's mineral sector.

7.5.2. Competitive Context

Figure 7.13 defines the profile of the mineral raw materials industry in the USA.

Table 7.18: Strengths, Weaknesses, Opportunities and Threats of USA's mineral sector.

	STRENGTHS	WEAKNESSES
INTERNAL FACTORS	• One of the most developed economies in the world; • Large domestic market; • Rich mineral endowment; • Stable institutions, mineral legislation and tax regime; • Protection of property rights; • Availability of public reliable geological data; • Availability of capital markets and risk finance; • Competitive energy prices; • Free trade agreements with a wide number of countries and strong economic integration with Canada; • Risk-taking and entrepreneurship culture; • Leading country in technology and innovation; • Labour flexibility; • Well educated workforce; • Sophisticated domestic demand, fostering vertical integration and enhancing the added value in the supply chain; • Availability of sophisticated technological and engineering services suppliers.	• High taxes and royalties; • Very high reliance on imports of several critical minerals; • Complex legal framework; • Long permitting times; • Poor public and political opinion on mining;
	OPPORTUNITIES	**THREATHS**
EXTERNAL FACTORS	• Potential for full vertical integration of mining and manufacturing industries; • High potential of the recycling industry; • Price competition for some important commodities, facilitating imports (e.g. iron) ;	• Increase of commodities value (currency exchange rate and price) ; • Trade restrictions imposed by supplier countries; • Global competition for critical raw materials, and increasing the supply risk; • Social opposition to mining;

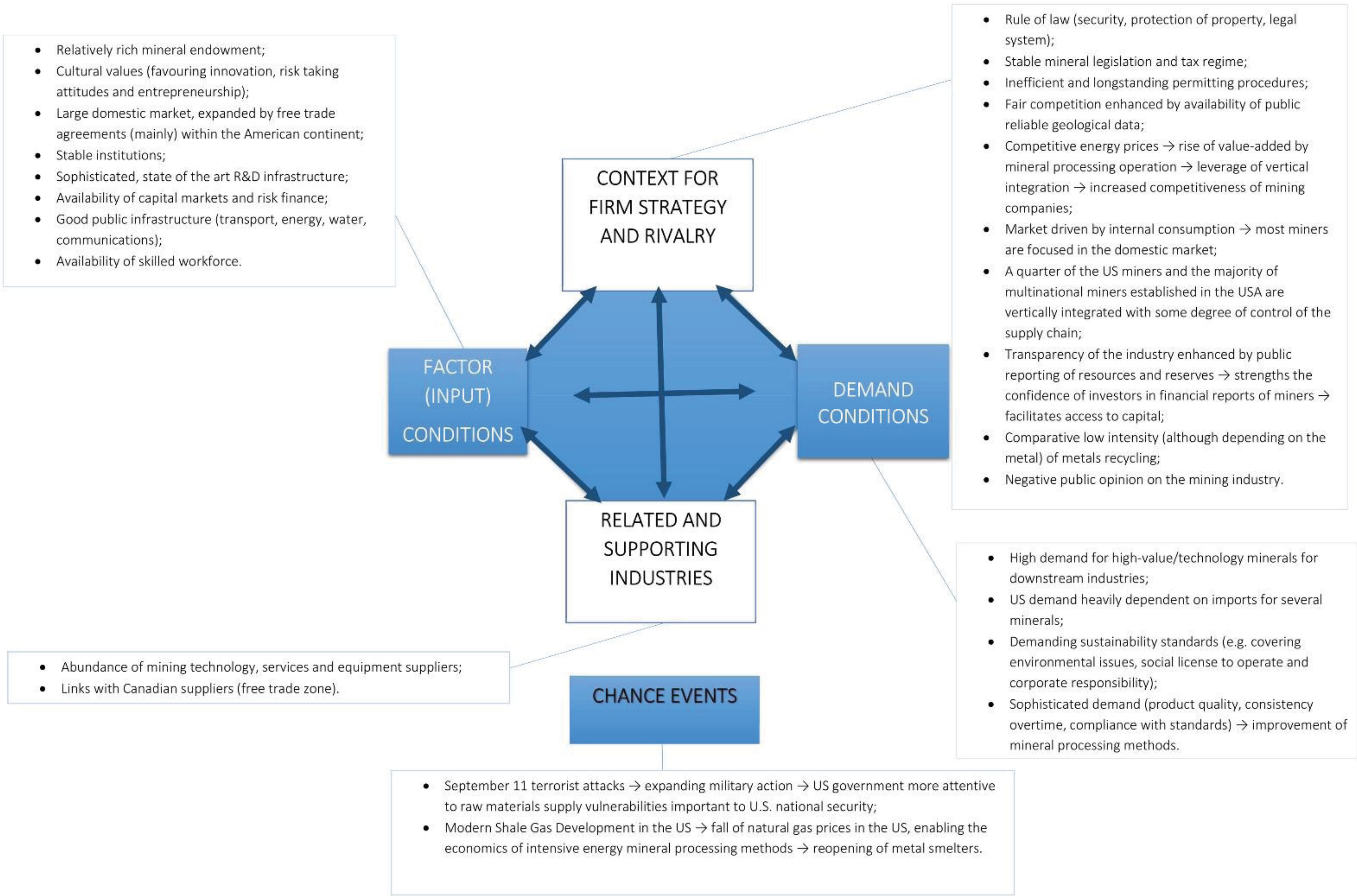


Figure 7.13: The competitive context of the USA.

7.6. Conclusions

Even though it has lost position relative to other international, more attractive locations for mining investments (e.g. Canada, Finland, Australia), the USA remain internationally important as a mining nation. This is due to a stable mineral legislation, that has been in place for over a 100 years, that has favoured resource exploration and development, and has been supported by well-defined protection of property rights. Other factors of importance have been:

- the mineral ownership rights scheme, that separates surface and mineral rights and encourages exploration;
- a large domestic market;
- availability of capital markets and risk finance;
- a skilled workforce;
- a well-developed services industry; and
- access to land, water, energy and a well developed infrastructure network.

Most companies operating in the USA work in the domestic market. The majority of the mining companies are small or midsized, but there are also a few globally competitive companies with some degree of vertical integration and control over supply chains.

The regulatory system is complex and permits take a long time to obtain, which hampers the development of the domestic mining industry. In these processes State governance is quite influential, crossing economical, environmental, and social regulations.

Apart from the important mineral endowment, the USA has built extensive trade relationships in order to import those minerals that are not available in the country or that are cheaper to buy than to produce. The USA rely on imports of several minerals, and for some of them they are 100% dependent on imports (19 minerals in 2014).

The dependence on other countries and recent experiences with trade restrictions imposed on the supply of rare earths directed political attention to mineral supply risks. Concerns over supply risks and the strategic value of specific metals could trigger a growing cycle of the mineral sector in the USA. Access to low cost energy (natural gas) could increase the intensity of mineral processing operations in the USA, enhancing the domestic added value. This is happening in the steel industry and might spread to other mineral supply chains, especially to those considered strategic to the USA industry and security. In this context, the attention to efficient use of resources and recycling (particularly rare metals and minerals) will increase.

8. Conclusions

This report was prepared to offer a systematic analysis of the mineral industry and its agents in five reference countries. The objective was to collect information on best practices and to understand the competitive context of the minerals industry in countries that, for their performance, are considered the most advanced in the world.

The countries within the scope of this study are Australia, Canada, Japan, South Africa and the USA. In all of them the mineral sector is representative and fundamental for the sustainability of developed economies.

With the exception of Japan, all these countries have rich mineral endowments. Australia, Canada, and South Africa are ranked as major producers of a wide range of non-energy minerals, some of them considered strategic, and have economies strongly based on this industry.

Australia is the world leader in the production of brown coal, lead, rutile, zircon, nickel, uranium, and zinc. It ranks among the world top-five producers for bauxite, copper, gold, iron ore, ilmenite, silver, tantalum, industrial diamonds, lithium, and black coal. Canada is the world leader in the production of potash and it ranks among the top-five global producers for uranium, aluminium, cobalt, tungsten, and platinum group metals (PGMs). South Africa is the first in the production of PGMs and has also significant production of gold, diamonds, and iron ore.

The USA also have a rich mineral endowment, but they currently prefer imports over domestic production. The USA are one of the biggest economies in the world, and they produce 21 of the 65 non-fuel mineral commodities used in the national economy. However, domestic production meets less than 50% of the demand and the USA are 100% reliant on imports for some rare elements or metals, such as indium, niobium, and tantalum.

Japan's development has been enabled by a successful long-term policy of securing a stable supply of mineral commodities, particularly via securing imports. The sophisticated demand of the Japanese industry (requesting product quality, consistency overtime, and compliance with set standards) led to a refinement of mineral processing methods and technologies, that made Japan a specialised producer of high quality metal alloys and metal products. In order to be able to face the scarcity of raw materials, Japan has pioneered a circular economy approach, where recycling and re-use of materials are taken into account already in product design and development.

All these countries show, from the second half of the XX century, a coupled evolution, matching complementary comparative advantages (e.g. rich mineral endowments and large manufacturing industries), bringing together raw materials suppliers and consumers.

Australia has a very rich mineral endowment and it evolved as an export-oriented economy, where mineral exports correspond to around 55% of total exports. This has been fundamental to the growth of the Japanese industry. Japan benefits from the geographical proximity to Australia for obtaining ores and coal that support the country's 'processing economy', boosted by cultural values that favour productivity and continuing improvement.

The same occurred with Canada and the USA. Minerals and energy extracted in Canada have been propelling the USA economy, until recently the biggest in the world. Canada developed a sophisticated mining cluster, which includes all types of services, from junior exploration companies to leading mining equity financing. The USA opted for relying on trade (mainly from the neighbouring countries) to supply an increasingly sophisticated manufacturing industry, driven by a technologically advanced market economy, instead of developing the exploitation of domestic mineral resources. The preferential trade relationship between Canada and the USA was reinforced by the integration of both economies under NAFTA.

South Africa has also evolved as a raw materials supplier, supporting Europe's economy. Today the EU still is the biggest commercial partner of South Africa, despite the geographical distance between South Africa and Europe. This situation certainly is a reflection of the weak economies of its neighbouring countries and the cost-effectiveness of sea-transport vs. land-transport.

Key Critical Success Factors (CSF) for a strong mineral industry that emerge from the analysis of Australia and Canada include:

1. Rich and diverse mineral endowment, with large ore deposits;
2. Stable rule of law (security of tenure, protection of property, reliable legal system);
3. Stable mining regulatory framework;
4. Proximity to consumers of mineral resources;
5. Absence of trade barriers;
6. Facilitated access to land (low levels of competition between different land-uses. Although in Canada there is increasing pressures for large conservation related land withdrawals impacting this, especially in Northern area);
7. Stable political and societal context;
8. Reliable transport infrastructure (roads, railways, ports);
9. Efficient access to capital;
10. Competitive energy prices;
11. Availability of a skilled workforce.

Key CSFs for a successful mineral industry that emerge from the analysis of Japan and the USA include:

1. Free trade agreements and active economic co-operation with raw materials producing countries;
2. Stable institutional and societal environments;
3. Competitive energy prices;
4. Large domestic market with spending power;
5. Sophisticated R&D infrastructure;
6. Availability of skilled and well-educated workforce;
7. Highly industrialised economy, based on the manufacturing of knowledge-intensive and high-quality, high value-added products.

Note that the CSFs of the reference countries are essentially endowment driven for the export orientated countries and knowledge driven for manufacturing, trade oriented countries.

Figure 8.1 defines a basic framework beneath a developed mineral industry, taking into consideration basic determinants and country-specific settings. This encompasses indispensable conditions and defines, based on factor conditions, two distinct pathways that determine, if a minerals industry development is export oriented or import oriented.

The USA are, among the countries analysed, the single one that could combine both approaches. However, since the USA prefers[1] trade over exploitation, it suggests an evolution trend that favours specialisation, thus supporting a conception of regional competitiveness based on business strategy economics instead of natural endowments.

The analysis of the five reference countries, complemented by insights collected from the INTRAW panels of experts, draws attention to the following determinants of the minerals industry competitiveness.

Factor Conditions:

- Rich mineral endowment (or no mineral endowment - Japan);
- Stable legal framework;
- Stable taxation framework;
- Sparsely populated areas/no social conflicts;
- Skilled and well-educated workforce;
- Access to reliable transport infrastructure;
- Strong education and R&D culture.

Demand Conditions:

- Proximity to market;
- Sophisticated demand of downstream industries (pushing all stages of the value chain).

Context for firm strategy and rivalry:

- Stable rule of law (security of tenure,

1 Naturally onerous permitting procedures (reflecting the generally negative stance of the population and law-makers towards mining), made mining enterprises expensive and economically hazardous. And until recently raw materials dependency was not a strategic issue and, therefore, it was not of relevance to politics and industry.

Figure 8.1: Outline for basic factors determining the development of a minerals industry.

BASIC DETERMINANTS

Rule of law
Stable institutions
Availability of skilled workforce (LABOUR)
Competitive energy prices (ENERGY)
Transport infrastructure (INFRASTRUCTURE)
Availability of capital markets and risk finance (CAPITAL)

SPECIFIC CONDITIONS
Rich mineral endowment

COMPETITIVE ADVANTAGES

- Mineral ownership rights scheme (access to land)
- Stable mining regulatory framework and tax regime
- Public reliable geological data
- Low population density
- Government support

OUTPUT
Export oriented minerals industry

SPECIFIC CONDITIONS
Large domestic market

COMPETITIVE ADVANTAGES

- Sophisticated demand
- Easy access to R&D infrastructure

OUTPUT
Import oriented minerals industry (processing industry)

protection of property, legal system;
- Access to land/defined mineral ownership scheme;
- Free trade agreements and active economic co-operation;
- Simple mining permitting processes;
- Competitive energy prices (leveraging vertical integration
- Access to risk finance.

Related and Supporting Industries:

- Developed supporting industries (mining equipment, technology and services sector);
- Availability of public reliable geological data.

Because 'developing' and 'emerging' economies are also competing for mineral resources, and because the number of chemical elements utilised by the industry (especially in high-technology fields) is increasing, all sophisticated economies are now facing import dependencies for some raw materials. Although competition for mineral raw materials pushes for an increased integration of raw material suppliers and consumers, resource nationalism and the emergence of new players is affecting the current balance of supply / demand and disrupting supply chains.

In this new framework, the determinants for the competitive context of the minerals industry will certainly change or have different weights in the future. Most probably, the importance of endowment factors will increase and the response of the five reference countries to this new framework corroborates this. All the reference countries are now actively seeking for the expansion of trade agreements, alongside country-specific approaches.

Australian mining companies are seeking to cut operational costs, improve margins (which is boosting research and development), and expanding their geographical influence (searching for new markets). The Australian government is investing into the exploration of new mineral bodies (both common and rare mineral commodities) and remains supportive to mining.

Japan's government is investing into research with the aim of substituting scarce chemical elements in industrial processes and is actively supporting Japanese investments in mining countries at different locations. Japanese firms are also investing into the recycling industry (the most developed in the world) and into improving the efficiency of raw materials uses.

Canada's provinces actively encourage mining (in some cases smoothing the permitting processes) and Canadian junior exploration companies are seeking out deposits of valuable and scarce raw materials, in Canada and all over the world.

The government of the USA is assessing supply risks and matching concerns of other countries (e.g. Japan and the EU) where mineral commodities have an important role in the economy.

South Africa is trying to diversify its export markets and to enhance the domestic added-value, despite the legacy of apartheid, which left pronounced social inequalities and a shortage of skilled labour.

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Annex

10.1. List of abbreviations

kg	kilogram
Km^2	Square Kilometers
t	ton (metric ton) – 1000 kilograms
Kt	Kiloton – 1000 tons
Mt	megaton – 1 000 000 tones
GDT	Gross Domestic Product
AUD	Australian Dollar
CAD	Canadian Dollar
USD	United States Dollar
¥	yen
ct	carat
Mct	Million carats
ABARES	Australian Bureau of Agricultural and Resource Economics (now ABARES)
ABS	Australian Bureau of Statistics
BREE	Bureau of Resources and Energy Economics
e-Waste	Electronic waste
e-wasa	E-Waste Association of South Africa
EDR	Economic Demonstrated Resources
AEDR	Accessible Economic Demonstrated Resources
GA	Geoscience Australia
WEF	World Economic Forum
USGS	United States Geological Survey
METS	Mining Equipment Technology Services
ASX	Australian Stock Excange
NRCAN	National Resources Canada
ASEAN	Association of Southeast Asian Nations
FTA	Free Trade Agreement
OECD	Organization for Economic Co-operation and Development
METI	Ministry of Economy Trade and Industry (Japan)
REE	Rare Earth Metals
PGMs	Platinum Group Metals
ZAR	South African Rand
JORC	Joint Ore Reserves Committee
Fe	Iron
Cu	Copper
Al	Aluminium
Cr	Chromium
Mn	Manganese
Pb	Lead
Zn	Zinc
Ni	Niguel

Co	Cobalt
W	Tungsten
Mo	Molybdenum
Sn	Tin
Ti	Titanium
Sb	Antimony
V	Vanadium
In	Indium
Ag	Silver
Cd	Cadmium
Ba	Barium
Ga	Gallium
Pd	Palladium
Se	Selenium
Be	Beryllium
Au	Gold
Bi	Bismuth
Li	Lithium
Pt	Platinum
Cs	Cesium
Rh	Rhodium
Hg	Mercury

10.2. Non energy metals main use (general description)

Non Energy Minerals Main Use	
Mineral	Main Use
Bauxite (Alumina and Aluminium)	Bauxite is the raw material for the production of alumina and aluminium. Alumina is used in the production of Aluminium and also as an abrasive and refractory material. Aluminium is a very important metal in several economic activities due to its ductility and lightness.
Chromium	Used as an alloy and in stainless and heat resisting steel products. Used in chemical and metallurgical industries (chrome fixtures, etc.)
Cobalt	Uses include super alloys, mainly in aircraft gas turbine engines, in cemented carbides for cutting and wear-resistant applications, in various other metallic applications and in a variety of chemical applications.
Copper	Copper is one of the most important metals used in industry mainly because of its high electrical conductivity, ductility and malleability, and also because it is an important component of alloys like bronze and brass.
Diamond	Uses include jewellery, computer chip manufacture, drill bit facing, stone cutting and polishing (industrial diamonds).
Gold	Used in jewellery and arts, dentistry, medicine, for the production of medallions and coins, in ingots as a store of value, for scientific and electronic instruments and as an electrolyte in the electroplating industry.
Iron ore	Iron is the major metal used in industry. Primary iron is the main metal in the production of steel and for the production of alloys with other metal and non-metal materials.

Lead	The largest use is in batteries for transport vehicles and communication. Less important uses are cable sheathing, solder, casting alloys, chemical compounds, ammunition.
Lithium	Largely used for the production of ceramics, glasses and rechargeable batteries.
Manganese	Used in metallurgic alloys (steel and aluminium), as gasoline additive, in organic chemistry and for batteries. Ore is essential to iron and steel production. Also used in the making of manganese ferroalloys. Used also in construction, machinery and transportation.

10.3 Alphabetic list of US states and territories

Alabama; Alaska; American Samoa; Arizona; Arkansas; California; Colorado; Connecticut; District of Columbia; Delaware; Florida; Georgia; Guam; Hawaii; Idaho; Illinois; Indiana; Iowa; Kansas; Kentucky; Louisiana; Maine; Maryland; Massachusetts; Michigan; Minnesota; Mississippi; Missouri; Montana; Nebraska; Nevada, New Hampshire; New Jersey; New Mexico; New York; North Carolina; North Marianas Islands; North Dakota; Ohio; Oklahoma; Oregon, Pennsylvania; Puerto Rico; Rhode Island; South Carolina; South Dakota; Tennessee; Texas; Utah; Vermont; Virginia; Virgin Islands; Washington; West Virginia; Wisconsin; Wyoming.

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