Asia-Pacific mining sector study

A final report prepared for APEC Business Advisory Council (ABAC)
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Executive summary

CRU has been commissioned to prepare this report by the APEC Business Advisory Council (ABAC). This report outlines the current status of the mining industry in the APEC region, discusses the importance of the mining sector and the various ways it can positively contribute to individual economies and their populace. It explains the positive steps governments can take to encourage investment in the mining sector, and goes on to describe the importance and benefits of mining companies maintaining best practices. This executive summary aims to draw out the key findings from the study in a digestible format – of these, the most important headlines are the following:

- **APEC economies are crucial suppliers of mined commodities**, collectively producing more than half of the world’s iron ore, more than 70% of the its copper, nickel, silver, lead, zinc, nickel, bauxite and tin, and more than 90% of its coal and molybdenum.

- **The mining industry can contribute as much as 24%** to individual APEC economies’ GDP, with **mineral rents for APEC as a whole accounting for more than $430bn in 2013**.

- **Government policies are important in attracting and sustaining investment in the mining industry**. Governments are encouraged to adopt best practices to create favourable conditions for sustainable mining to realize mineral potential. **It is crucial that host governments are educated as to the fundamental aspects of the mining industry**, including its inherent challenges for mining companies, as well as the positive impacts of mining, particularly those that are less immediately obvious.

- **Mining companies should be highly sensitive to the environment where they are planning to operate** – they should understand the development objectives of the host economy. A one-size-fits-all template in terms of project planning and operation is not feasible.
Mining is a significant contributor to many APEC economies’ GDP...

All of the 21 APEC economies covered by this report, with the exception of Brunei Darussalam, Hong Kong SAR and Singapore, earned a proportion of their GDP through mineral rents\(^1\) in 2012/2013. The proportion of GDP that can be attributed to mineral rents in APEC economies is highly variable, as can be seen in the chart below. The bubbles represent mineral rent as a percentage of GDP – a broad measure of the mining sector’s importance to a particular economy – for the year 2012, and their position is 2013 GDP plotted against the number of commodities each APEC economy has in the form of reserves.

There are four APEC economies for which mineral rents contributed more than 5% to GDP in 2012: Papua New Guinea (24.01%), Chile (15.27%), Peru (8.64%) and Australia (5.53%). Another group of economies shows less dependence on mineral rent as a contributor to GDP however the contribution is still important (1% to 3%): these are the Philippines, China, India, Indonesia, and Malaysia.

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\(^1\) Mineral rent: the difference between the value of production for a stock of minerals at world prices and their total costs of production. Note that mineral rent is not the same as value added to GDP: rent is pure profit (price less marginal cost multiplied by quantity), whereas value-added is the sum of earnings from production that are due to residents, for example, the salaries of resident mine workers are included in GDP value-added while they are not included in rent.
Indonesia, Russia and Mexico. In the final group of economies mineral rent contributes less than 1% to GDP: Canada, New Zealand, Vietnam, Malaysia and the United States.

**Mining is an important factor in everyday life...**

The mined commodities which are the subject of this study are used to produce a wide variety of materials which impact on every aspect of everyday life, from buildings to cars to electronic equipment; from dentistry and cooking utensils to batteries and power generation.

Taking just one example, copper has a wide variety of end uses, most of which take advantage of the material’s high thermal and electrical conductivity, including: electric cables and wires, switches, plumbing, heating, roofing and building construction, chemical and pharmaceutical machinery, alloys (brass, bronze), electroplated protective coatings and cooking utensils. APEC economies account for more than 70% of global mined copper production, with Chile the world’s largest copper miner by some distance.

Alternatively, nickel is widely used in over 300,000 products for consumer, industrial, military, transport/aerospace, marine and architectural applications. The public may recognise nickel in coins, as it is used for this purpose in pure or alloy forms by many countries, or as bright and durable electrolytically-applied coatings on steel (nickel plating). The biggest use, however, is as an alloying metal along with chromium and other metals in the production of stainless and heat-resisting steels. These are mostly used in industry and construction, but also for products in the home such as pots and pans, kitchen sinks, etc. Stainless steels are produced in a wide range of compositions to meet special industry requirements for corrosion and heat resistance, and also to facilitate a clean and hygienic surface for food and other processing. APEC economies accounted for more than three-quarters of global mined nickel production in 2013.
Mining also contributes to economies in other important ways...

The mining sector provides benefits to host economies in three ways:

- **Direct**: these are the impacts which result from the expenditures associated with constructing and operating the mine, such as the labour employed, materials purchased, capital invested etc – this is the type of contribution to GDP discussed above.

- **Indirect**: these are the impacts that result from suppliers to the mine purchasing goods and services and hiring workers to meet demand from the mine. *Importantly, these additional purchases and the hiring of extra workers would not have occurred were it not for the construction and operation of the mine.*

- **Induced**: these are the economic impacts resulting from employees at the mine using their wages to purchase goods at a household level.

These classifications apply to GDP contribution, and job creation, but mining projects also contribute in the following ways:

- **Infrastructure provision**: many mining projects involve the construction of transport infrastructure (roads, rail, ports), power generation, water provision, etc – all of which stand to benefit the economy by precipitating additional mining or other industrial projects, as well as the local community by providing community infrastructure such as schools, government building and sanitation and healthcare infrastructure.

- **Government revenues** through taxation of mining projects improves the national balance sheet and – particularly in developing economies where mining tax take is an important source of revenue for the government – provide funds for public services. This is an important benefit, though this may seem rather abstract compared to say the provision of funding for a local school or health centre.

In Chapter 2, CRU presents a case study on the Escondida mine in Chile which demonstrates these additional economic benefits – highlights of the case study are provided below.

### Labour

In 2004 the Escondida mine accounted for 2,810 **direct employees**, over 99% of which were employed at the mine site or at port facilities. Of the 2,810, 11 were foreign and 2,799 were Chileans. There were 2,345 permanent contractors (**indirect employees**) employed by Escondida in 2004, with an additional 2,938 **contractors** being employed on the expansion projects that were underway at that time.
In 1999, Escondida’s secondary employment was estimated. This includes all employment in the Antofagasta region that is the result of both the mine and the mine employees’ spending. It was determined that the employment multiplier could vary between 3.1 and 5.7, with evidence from a purchasing survey indicating a likely value of 4.2. In 2004 estimated induced Escondida employment was 9,495 people.

It is estimated that in 2004 there were 8,813 dependents of Escondida employees, which gives a dependency multiplier of 2.9. If this is also applied to indirect and induced employment (11,840 in total), then the total number of dependents increases to around 35,700. However, the study mentions that this number maybe too high, as some individuals that have been classed as dependents may also work at the mine.

**GDP value-add**

In 2003 the ‘value-added’ by Escondida to Chile’s economy was USD$1.2 billion, and USD$2.7 billion in 2004, this is equivalent to 1.7% of Chile’s GDP in 2003 and more than 3.5% in 2004. The majority of the value generated remained within the Chilean economy. If it is assumed that all payments made to shareholders were repatriated, and that 40% of the amount reinvested went to foreign suppliers, the retained value-added figure is USD$1.7 billion or about 2.4% of Chile’s 2004 GDP.

**Infrastructure**

Escondida is dependent upon a range of infrastructure. Power and water supply have been sourced from distant locations. In theory, these power and water supplies could have been made available to others; but given the remote location of the mine, the benefits of these infrastructure services for local communities are limited. However, the large investment in power supply in the Antofagasta region in order to meet the needs of the mines is believed to have reduced the cost of power for the public in general. What is more, when the mine eventually closes the concentrate pipeline that runs from the mine down to the port in Antofagasta could be used to transport water and thus increase the availability of fresh water in the city. Due to the mine’s remote location, roads between Antofagasta and the mine were constructed. The roads were completed in 1990 at a cost of USD$8.5 million, these roads are maintained by the mine (at an annual cost of USD$850,000 in 2004) and are open for public use.
Several APEC economies have very high mineral potential...

Many APEC economies have substantial mineral resources – this is evidenced by the fact that they are destinations for two-thirds of global non-ferrous mineral exploration expenditure. The table below shows a summary of the positive and negative factors affecting the eventual mineral potential rating of each APEC economy denoted by CRU.

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<td>Major unexplored regions are in challenging mining environments</td>
<td>High</td>
<td>Mining expansion likely within established mining regions, though some potential for increased growth in other areas, through e.g. Plan Nord</td>
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<tr>
<td>Australia</td>
<td>Substantial resource base, mining friendly jurisdiction, very highly rated in terms of pure mineral potential in Fraser Institute survey</td>
<td>-</td>
<td>High</td>
<td>Growth expected in output of esp. bulk commodities; largest volumes from brownfield expansions but also increased output from new junior miners, e.g. Roy Hill</td>
</tr>
<tr>
<td>United States</td>
<td>Substantial resource base, untapped resources (notably in Alaska, Nevada), remains a significant destination for exploration investment</td>
<td>-</td>
<td>High</td>
<td>Majority of mining expansion most likely to come through organic growth within established mining regions</td>
</tr>
<tr>
<td>Mexico</td>
<td>Large copper, gold and silver reserves, with room for significant expansion; relatively mining friendly gov't</td>
<td>Mining sector more exposed to gold/silver price movements than others, which aren't strongly connected to supply/demand fundamentals</td>
<td>High</td>
<td>Output of most minerals expected to grow steadily over next few years, thanks to brownfield and greenfield projects</td>
</tr>
<tr>
<td>Indonesia</td>
<td>Large volumes of untapped resources, some of which are not readily available in the same volumes in other locations - e.g. Sn, Ni.</td>
<td>Very high Fraser Institute 'room for improvement' rating, showing disparity between investment attractiveness under current legislative conditions compared to theoretical 'best practice'.</td>
<td>High</td>
<td>Significant uncertainty regarding mining/export laws making investors and project owners very hesitant to drive projects forward in the short term.</td>
</tr>
<tr>
<td>Chile</td>
<td>Despite substantial existing mining sector, there are still significant untapped resources. Most attractive investment climate in South America; high level of exploration activity</td>
<td>Some concern about rising costs in future, mining sector tied to a relatively small number of commodities.</td>
<td>High</td>
<td>High potential for strong growth in the mining sector, with few obvious negatives/drawbacks.</td>
</tr>
<tr>
<td>Philippines</td>
<td>Large volumes of untapped resources of various minerals - rated highest globally on Fraser Institute mineral potential index</td>
<td>Very high Fraser Institute 'room for improvement' rating, showing disparity between investment attractiveness under current legislative conditions compared to theoretical 'best practice'.</td>
<td>High</td>
<td>Sector is not currently perceived to be highly attractive to investors, but good mineral endowment means that there is potential for investment to increase, but could require a shift in government policy towards supporting mining investment.</td>
</tr>
<tr>
<td>Peru</td>
<td>Substantial mineral wealth and untapped reserves, mining established as an important part of the economy, significant exploration activity</td>
<td>Policy environment is not currently as attractive to investors as e.g. Chile</td>
<td>High</td>
<td>High potential for strong growth in the mining sector, both in terms of output at existing mines and major new projects</td>
</tr>
<tr>
<td>Papua New Guinea</td>
<td>Substantial mineral wealth and untapped reserves; mining established as an important part of the economy; significant exploration activity</td>
<td>High 'room for improvement' rating, suggesting current policy environment is not as encouraging of investment as it could be</td>
<td>High</td>
<td>Importance of mining to the PNG economy and significant untapped reserves should continue to drive the mining sector, but growth might be quicker under 'best practice' jurisdiction</td>
</tr>
</tbody>
</table>

Table E.1: CRU mineral potential rating

Continued
### Table E.1: CRU mineral potential rating (continued)

<table>
<thead>
<tr>
<th>APEC economy</th>
<th>Positive factors</th>
<th>Negative factors</th>
<th>CRU mining potential</th>
<th>Notes/comments/expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>Potential for consolidation of mining sector, as well as other improvements - both technical and legislative - that would increase FDI. Some important untapped resources.</td>
<td>Reserves of many minerals declining; mines generally high cost; with currency, labour and power costs expected to increase.</td>
<td>Medium</td>
<td>Consolidation of fragmented mining sector and closure of higher cost operations should improve mining practices, though output not expected to grow substantially.</td>
</tr>
<tr>
<td>Russia</td>
<td>Large resource base, with significant untapped resources</td>
<td>Some resources are significant distances from consumers, leading to logistical constraints/need for on-site downstream processing.</td>
<td>Medium</td>
<td>Good potential for growth, FDI in Russia mostly focused outside mining sector (excl. coal) at present.</td>
</tr>
<tr>
<td>Vietnam</td>
<td>Substantial reserves of coal, which forms an important part of the economy</td>
<td>Reserves other than Bx and coal not substantial, FDI in mining has been minimal and constrained by regulatory issues, investment and market access challenges.</td>
<td>Medium</td>
<td>Coal output not expected to increase substantially despite rapidly increasing demand, but bauxite production expected to make strong gains</td>
</tr>
<tr>
<td>Thailand</td>
<td>Relatively mining-friendly environment</td>
<td>Limited mineral resources, mining not an important part of the economy, little exploration spend</td>
<td>Low</td>
<td>Existing mining sector mostly expected to maintain output</td>
</tr>
<tr>
<td>Malaysia</td>
<td>Some potential for coal expansion, government perceived as relatively mining-friendly</td>
<td>Limited / declining mineral resources for most minerals, greater focus on downstream power-intensive processing sector</td>
<td>Low</td>
<td>Reserves sufficient to support existing (relatively small) mining operations for some time, but little expansion expected</td>
</tr>
<tr>
<td>New Zealand</td>
<td>Current reserves expected to sustain existing mining at least over the medium term</td>
<td>Reserves are not substantial, little exploration activity or expansion plans</td>
<td>Low</td>
<td>Little expansion of relatively small mining sector expected, but no decline expected either</td>
</tr>
<tr>
<td>Japan</td>
<td>-</td>
<td>Limited mineral resources</td>
<td>Low</td>
<td>Little expectation for expansion of mining sector, though some interest/exploration for rare earths</td>
</tr>
<tr>
<td>Korea</td>
<td>-</td>
<td>Limited mineral resources</td>
<td>Low</td>
<td>Minimal exploration or expansion in mining sector expected</td>
</tr>
<tr>
<td>Chinese Taipei</td>
<td>-</td>
<td>Limited mineral resources</td>
<td>Low</td>
<td>No significant exploration or expansion in mining sector expected</td>
</tr>
<tr>
<td>Singapore</td>
<td>-</td>
<td>Negligible mineral resources</td>
<td>Low</td>
<td>No real potential for expansion of mining sector</td>
</tr>
<tr>
<td>Hong Kong SAR</td>
<td>-</td>
<td>Negligible mineral resources</td>
<td>Low</td>
<td>Negligible potential for expansion of mining sector</td>
</tr>
<tr>
<td>Brunei Darussalam</td>
<td>-</td>
<td>Negligible mineral resources</td>
<td>Low</td>
<td>Negligible potential for expansion of mining sector</td>
</tr>
</tbody>
</table>

*Data: CRU, Fraser Institute Mining Survey 2013*
This mineral potential may be being constrained by policy factors...

The chart below shows data from the 2013 Fraser Institute Global Mining Survey indicating the difference between how readily respondents to the survey would invest in exploration in a variety of mining jurisdictions under two scenarios:

- **Best practices:** i.e. world class regulatory environment, highly competitive taxation, no political risk or uncertainty, and a fully stable mining regime – this is therefore an approximate surveyed assessment of each region’s pure mineral potential, without including policy-related issues.

- **Current practices:** i.e. whether or not a jurisdiction’s mineral potential under the current policy environment (i.e., regulations, land use restrictions, taxation, political risk, and uncertainty) encourages or discourages exploration.

The index therefore shows the gap between how encouraging of mining exploration a jurisdiction would be under theoretical best practice compared to the current policy environment, or its ‘room for improvement’. The APEC economies (marked in red on the chart) of the Philippines, Indonesia, and China are the top scorers on this index, demonstrating how the current policy environment is not encouraging mining investment to nearly the same extent as it could be. Papua New Guinea and Russia also are ranked high on this index.

The relatively little difference between current practice and best practice for most Australian, USA and Canadian jurisdictions means that they have far smaller ‘room for improvement’.
Investment attractiveness can be improved by host governments...

Four factors generally dictate the attractiveness of an economy to investment in exploration and mining, three of which are subject to government policy:

- Geological prospectivity
- Country risk
- Mining sector policy subject to government policy
- Infrastructure

**Geological prospectivity** is outside the control of governments. However, they may be able to improve their attractiveness to exploration companies by carrying out basic geological surveying and mapping. In addition, geological attractiveness may have an impact on government policy in general. For example a geologically attractive economy may feel it can have a more aggressive taxation policy than a less attractive economy. Many APEC economies have good geological prospectivity, as demonstrated in the CRU mineral potential ratings provided above. This means that there is great potential for investment attractiveness to be improved by host governments.

**Country risk** covers a multitude of factors, including political stability, internal security and risk of war or civil unrest, risk of expropriation or major policy changes, and so on. Below that general level of country risk there are issues of the rule of law, property rights and contract law, the strength of the courts, the efficiency of administration, and the level of corruption. At the next level we find overall government policy, particularly on macro-economic issues such as exchange rates, monetary stability and policy towards foreign direct investment.

Governments looking to improve their performance relating to the factors listed above are likely to also improve their attractiveness to mining investment.

**Infrastructure** provision is an important determinant of the attractiveness of an economy for exploration and mining investment. This includes the provision of roads and other transport infrastructure, power supplies, water supply. Softer issues of education, training and healthcare can also be important. It is obviously easier to carry out exploration and mining in an economy with a developed infrastructure.

**Mining sector policy** constitutes the elements of policy directed specifically at the mining sector. This will generally include the system for licensing areas for exploration and mining, as well as any mining specific taxation. Regulation of mining is often codified in a single Mining Act. Alternatively, some economies regulate mining by means of individual agreements with
Asia-Pacific mining sector study

major projects. In addition, there may be specific policies aimed at the small scale artisanal mining sector.

Governments can improve their attractiveness from a mining sector policy perspective through:

- **Taxation:**
  - Mining companies generally have a preference for direct taxes on profits over indirect taxes such as production royalties.
  - A preference for a progressive tax regime that automatically responds to changing conditions, since this is perceived as more stable and will reduce the likelihood of ad hoc demands to tax excess profits.
  - Tax stability is more valuable than getting an initial favourable tax deal whose legitimacy may later be challenged.

- **Mining policy:** the following factors are desirable qualities of a jurisdiction’s mineral concessions policy from a mining company perspective:
  - Administrative simplicity and efficiency
  - Low transactions costs – for example avoiding overlapping or multiple layers of jurisdiction
  - Security of tenure, within the law
  - The ability to freely mortgage or transfer the rights
  - Transparency
  - Minimal administrative discretion

**Mining companies are responsible for ensuring best practice operation...**

Mining is a high-visibility industry (particularly in smaller economies), with a relatively poor public reputation in many regions. Mining involves the removal of a non-renewable resource, and because of the finite life of any mine the issue of sustainability in mining has focused on the sustainable and responsible use of the non-renewable resource. It is therefore important for mining companies to minimise their impact both socially and environmentally, in order to reduce resistance to mining projects at both the public and governmental level.
Throughout the lifecycle shown above it is important for mines to address the following issues:

**Environmental impacts:**
- Biodiversity
- Air emissions
- Noise and vibrations
- Water management

**Social impacts:**
- Community engagement
- Community development
- Indigenous communities
- Labour practices

For example, during exploration it is crucial for mining companies to engage with local communities at this early stage in order to influence future relationships – the greater the effort during this stage, the more the reward during other phases of the mining cycle. At the same time, they should be looking to minimise noise, vibrations and adverse impacts on biodiversity whilst performing exploratory drilling.

Generally, fulfilling the environmental and sustainability standards set out by host governments is considered a minimum requirement by most mining companies, who instead look to go much further with their CSR and sustainability efforts. For example, Groote Eylandt Mining Company (GEMCO), operated by BHP Billiton, employs and trains members of the local aboriginal community to rehabilitate the areas that are no longer being mined. This way, the rehabilitation process is carried out as mining continues, and the aboriginal community’s knowledge of the area makes rehabilitation easier, making this a win-win situation for the company and the local indigenous community.
The following are CRU’s main recommendations for APEC’s member economies

**Host government education:** It is crucial that host governments are educated as to the fundamental aspects of the mining industry, including its inherent challenges for mining companies, as well as the positive impacts of mining, particularly those that are less immediately obvious.

**A project-specific approach should be taken by mining companies:** Mining companies should be highly sensitive to the environment where they are planning to operate – they should understand the development objectives of the host economy. More broadly it could be said that a one-size-fits-all template in terms of project planning and operation is not feasible, as site-specific factors should be considered at all stages of the mining lifecycle. **This recommendation also strongly applies to host governments** – a policy which is suitable for one operation, project, geographical region, or commodity may be completely unsuitable for another – it is crucial to consider the reasonableness of a policy across all projects under the jurisdiction, and the wider, less immediately obvious, impact that a policy change might bring about. In addition, **a gradual, transparent, change from one policy environment to another is more likely to be advantageous** to all parties than a radical shift which could bring about unexpected consequences.

**A stable mineral policy that incentivises exploration will attract investment:** From a government perspective, a good minerals concession policy should act as an incentive (rather than a deterrent) to attracting bona fide mineral explorers and miners to a jurisdiction. It should facilitate exploration and mining activity, but not at undue expense to the environment or other stakeholders; confer secure, undisputed title to the concession holder in return for periodic rental payments; and create economic incentive for concession holders to conduct meaningful exploration (and mining) activity rather than simply to ‘hibernate’ the concession. **Policy stability is extremely important** to mining companies given the immovable nature of their assets. If the policy environment in a host government is perceived to not be very stable, then this can have a damaging impact on the attractiveness to mining investment in that economy.

**Involve industry associations to help facilitate mining best practice:** CRU also recognises the importance of industry associations as excellent sources of data, knowledge and expertise regarding mining best practice. They can assist mine operators - particularly smaller players or new entrants to the market - with ensuring that their project is optimally managed from a social and environmental perspective. This stands to improve the mining sector’s reputation in general, garnering buy-in from local communities at the same time. Associations also have a role to play in negotiating with potential host governments as to the benefits of prospective mining projects – presenting a case on behalf of the sector as a whole rather than an individual company stands to improve the amenability of a host government to the proposition as well as reducing the
possibility of corruption. CRU therefore recommends mining companies to involve industry associations in these kinds of discussions, as well as governments to collaborate with associations when drawing up regulations regarding mining operations. Similarly, a regular and transparent public-private consultation process can form the basis for a sustainable partnership with industry associations as well as business groups and the investor community (e.g. Chamber of Commerce, Business Associations).
Chapter 1 – Introduction

This short introductory chapter provides some background to the study that has been conducted by CRU Consulting on behalf of ABAC. It initially explains the purpose of the study, and then goes on to provide some preliminary high-level contextual information on the mining sector in general.

1.1 Background to the study

Who are ABAC?

Recognising the integral role of business and the value of representative business advice on key issues, APEC leaders established the APEC Business Advisory Council (ABAC) in 1995. This private sector body presents recommendations to APEC Leaders in an annual dialogue and advises APEC officials on business sector priorities and concerns. ABAC consists of 63 senior executives from APEC’s 21 member economies, which includes a number of international companies with interests in the mining sector1.

One of ABAC’s objectives for 2014 is to work with APEC and the greater international mining community to develop a mining study that serves as a platform for business input into APEC’s discussions and recommendations on mining. Based on CRU’s extensive experience in the mining industry, ABAC commissioned CRU to author such a study.

Who are CRU Consulting?

CRU Consulting is the consultancy arm of CRU International2, one of the foremost providers of independent market analysis in the metals, mining and fertilisers sectors. CRU Consulting is a specialist consultancy providing independent, exclusive and proprietary advice to the world’s leading metals and mining companies, financial institutions and governments.

Goals and objectives of the study

The goal of the study is to provide a high-level yet comprehensive overview of the mining industry, currently and in the future, of the 21 APEC member economies. In support of this goal, CRU has set the following objectives:

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1 www.abaconline.org/

2 www.crugroup.com/
• Analyse the current and future potential of the Asia-Pacific region hard-rock and bulk mining sector, including resource endowment, production, investment and overall economic importance

• Identify the socio-economic effects of mining in APEC member economies, including GDP, employment and infrastructure development, and local/regional impacts

• Outline best practices for responsible and sustainable mining, both socially and environmentally, using case studies as examples.

• Assess the impact on mining sector investment of national government policy and regulations on the mining sector.

**Scope of the study**

The report covers the 21 APEC member economies: Australia; Brunei Darussalam; Canada; Chile; China; Hong Kong, China; Indonesia; Japan; Malaysia; Mexico; New Zealand; Papua New Guinea; Peru; The Philippines; Russia; Singapore; South Korea; Chinese Taipei; Thailand; the United States and Viet Nam.

The following table demonstrates the World Bank classifications of each of these economies according to its income status. Low-income economies are defined as those with a GNI (Gross National Income) per capita, calculated using the World Bank Atlas method\(^3\), of $1,045 or less in 2013; middle-income economies are those with a GNI per capita of more than $1,045 but less than $12,746; high-income economies are those with a GNI per capita of $12,746 or more. Lower-middle-income and upper-middle-income economies are separated at a GNI per capita of $4,125. This table provides important context as many of the subjects of this report - mining economic impacts, policy issues related to mining etc - tend to be more important in smaller and/or less developed economies.

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The report does not focus heavily on the provision of detailed statistics on the mining or consumption of any one commodity for each individual economy, rather it focuses on general trends across the industry and region, substantiating this by providing specific examples and case studies from individual economies. The exception to this are the statistics on GDP and mine production and reserves provided in Chapter 1.

Nonetheless, for reference purposes, we believe it is helpful to define the scope of the ‘mining industry’ as it is be considered in this study. Therefore, throughout the report, the discussion of the mining industry will be provided within the context of the mining and concentration (but not smelting or other downstream processing) of the following main commodities:

- Copper
- Gold
- Silver
- Molybdenum
- Zinc
- Lead
- Nickel
- Bauxite
- Iron ore
- Coal
- Tin
- Manganese

CRU notes that some APEC economies, such as Japan and Korea, have limited domestic resources, but are still closely involved in the mining industry through investment abroad – for example a private company taking a minority shareholding in a mining project, or a government export credit authority providing loans to foreign mining projects. Furthermore, these same economies may also import significant volumes of mined commodities for downstream processing – for example, importing iron ore to make steel and other downstream products. Therefore, whilst little mining may occur in some APEC economies, the mining industry as a whole remains very important to them, and can still contribute to the economy through the returns on FDI. Nonetheless, though these indirect linkages to the mining industry are important, the aim of this report is largely to discuss the importance of mining from the
perspective of its contribution to host economies – it is these governments who set the policies which have the ability to encourage or discourage investment in the mining sector.

1.2 Characteristics of the mining industry

1.2.1 The mining industry in everyday life

The mined commodities which are the subject of this study are used to produce a wide variety of materials which impact on every aspect of everyday life:

- **Bauxite**: used to produce aluminium, which is widely used in construction, transportation, and packaging. In transport, aluminium is used in cars (engine blocks, cylinder heads, transmission housings and body panels), trucks and buses (sheet and plate for bodies), in railway stock and in aircraft. In construction, aluminium is used in sheet products for roofing and wall cladding, in extrusions for windows and doors, and in castings for builders' hardware. In packaging, aluminium is used in the form of alloy sheet for beverage can bodies and tops, as foil for household and commercial wrap, and in manufactured packaging products such as cartons for fruit juice and packaging for pharmaceuticals. In the electrical sector, aluminium is used in the form of wire, normally reinforced with steel to form cables.

- **Copper**: has a wide variety of end uses, most of which take advantage of copper’s high thermal and electrical conductivity, including: electric cables and wires, switches, plumbing, heating, roofing and building construction, chemical and pharmaceutical machinery, alloys (brass, bronze), electroplated protective coatings and cooking utensils.

- **Gold**: used in dentistry and medicine, jewellery and arts and in medallions and coins for scientific and electronic instruments.

- **Silver**: uses include photography, chemistry, jewellery, electronics, as currency, alloys, chemical reaction vessels, water distillation, a catalyst in manufacture of ethylene, mirrors, electric conductors, batteries, plating, table cutlery, dental, medical, and scientific equipment, electrical contacts, bearing metal, magnet windings and solder.

- **Iron ore**: is the primary raw material in the production of steel, arguably the most important industrial material in the world, used in a variety of different sectors: construction, transportations, appliances and household goods, energy and packaging.

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4 References: IMnI, IMoA, INSG, Eurofer, World Coal Association, ILA, IZA, Rio Tinto Alcan, CDA
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- **Molybdenum**: is used as an alloying agent in steel production to enhance strength, hardenability, weldability, toughness, elevated temperature strength, and corrosion resistance. In nickel-base alloys, it improves resistance to both corrosion and high-temperature creep deformation. Steels with these qualities are used in aerospace applications, tool and high-speed steels (e.g. drill bits), as well as in the chemical processing, pharmaceutical, oil & gas, petrochemical and pollution control industries.

- **Manganese**: the main use of manganese is in steel production for desulphurisation and as an alloying element, improving wear resistance and hardness.

- **Nickel**: is widely used in over 300,000 products for consumer, industrial, military, transport/aerospace, marine and architectural applications. The public may recognize nickel in coins, as it is used for this purpose in pure or alloy forms by many countries, or as bright and durable electrolytically-applied coatings on steel (nickel plating). The biggest use, however, is as an alloying metal along with chromium and other metals in the production of stainless and heat-resisting steels. These are mostly used in industry and construction, but also for products in the home such as pots and pans, kitchen sinks, etc. Stainless steels are produced in a wide range of compositions to meet special industry requirements for corrosion and heat resistance, and also to facilitate a clean and hygienic surface for food and other processing.

- **Zinc**: More than half of zinc is used for galvanizing to protect steel from corrosion. Approximately 14% goes into the production of zinc base alloys, mainly to supply the die casting industry and 10% to produce brass and bronze. Significant amounts are also utilized in rolled zinc applications including roofing, gutters and down-pipes.

- **Lead**: Lead-acid batteries are the mainstay of storage technologies for renewable energy sources, such as solar cell and wind turbines and are used to power cars, trucks, buses, motorbikes, electric vehicles and hybrid vehicles, and as back-up emergency power supply. It is also used to provide protection from radiation in hospitals, dental surgeries, laboratories and nuclear installations.

- **Coal**: can be classified in two categories, **metallurgical** – used in steelmaking and the production of ferroalloys, and **thermal** – used in coal-fired power plants which generate 41% of the world’s electricity, and 50% of APEC economies’.

- **Tin**: main uses are in tin plating of steel, solder and in the manufacturing of chemical compounds which are used in a wide variety of ways, including fire-proofing, and the production of PVC stabilisers, pesticides and wood preservatives. Tin-plated steel cans are used in the packaging industry.
1.2.2 Characteristics of the mining industry

The characteristics of the mining industry are discussed in greater detail in Chapter 4, but as part of the introduction we present a high-level perspective on certain key features of the mining industry which need to be considered when assessing its importance in the APEC region. The slide below lists the key features of the mining industry and also shows the phases in the life-cycle of a mine for reference.

Each of these key features are addressed and discussed in subsequent chapters. However, some discussion of two characteristics – namely large upfront investment and long period before revenues – is provided now as context for the remainder of the report.

The chart overleaf demonstrates the approximate investment intensity required throughout the mining lifecycle. The figures and timescales below are based on an average sized mining project, such as a 50,000 tonne per year copper mine or a 2-4m tonne per year iron ore mine; but it is important to note that both investment requirement and timeframes can vary substantially depending on the commodity, jurisdiction, and site-specific factors, for reasons including the following:

- Large bulk commodity (iron or manganese ore, coal) projects are likely to have longer design and construction periods, skewed by the requirement for the construction of substantial infrastructure – railways and ports. These not only take longer to construct
and involve larger capital expenditures, but also increase the complexity of obtaining permitting and completing feasibility studies and social and economic assessments.

- Conversely, small-scale projects which are quick to design and construct, such as high-grade gold mines, may be able to move rapidly from discovery to operation in as little as 3-5 years (for example Sandfire Resources’ deGrussa project).

- Closure costs in particular can be highly dependent on mine type and jurisdiction. Mines with smaller footprints will generally require less expenditure on closure costs, though their location and the requirements of the host governments will also be important factors. Operations and mining processes that involve greater volumes of tailings which are more challenging to reclaim (due to their chemical or physical characteristics, for example), will also have greater closure costs.

- The operating life of a mine is dependent on its identified economically-extractable reserves and the volume it produces per year. The former may change during the lifespan of a mine for three main reasons:
  - An increase in the value of a commodity may increase reserve volumes, as higher prices may mean that some lower grade resources become economic to extract. Of course, the reverse is also true, as declines in long-term price expectations can also reduce the size of a mine’s reserves.
  - Technology improvements or other cost reductions may also make lower grade resources (which might otherwise be too costly to process) economic to extract.
  - Exploration expenditure on existing mine sites may lead to the discovery of additional reserves, potentially prolonging the life of the mine.
The chart shows that investment peaks during the construction phase, but that substantial sustaining capital expenditures are required during the operation phase as well. In this average theoretical example, more than $350m is spent and 15 years pass before the project begins operation and starts generating revenues.

There is of course significant risk that the market landscape has changed during this long lead time, and that the mine’s eventual revenues are lower (or indeed greater) than had been expected. This often leads to conservatism on the part of project financiers, particularly those providing debt financing: these companies simply look for the project to remain profitable for the duration of the loan in order that the full amount loaned, plus interest, is repaid – they do not stand to profit from the mine generating greater revenues than initially expected. Financiers taking an equity stake in a project, however, may not be as conservative when assessing projects – at least from a price projection perspective – as they stand to benefit from excess profits where debt financiers do not.
Chapter 2 – Current and future potential of the Asia-Pacific region mining sector

2.1 Introduction

This chapter provides a statistical background to the Asia-Pacific mining sector, by collating data which demonstrate the size of the mining sector in different Asia-Pacific economies and historical trends in growth. The chapter will therefore show how important the mining sector is to each of the APEC economies, and the commodities on which the industry in each economy is based. We will discuss what this is dependent on and how it might change in the future. Specifically, the chapter provides a statistical underpinning of the following:

- How important the mining industry is as a part of the overall economy, in terms of contribution to GDP
- Which commodities in particular are important to each economy in terms of reserves and production
- Which APEC economies have significant mineral potential, i.e. strong prospects for growth in mining exploration and output.

The chapter concludes with a discussion of the potential for growth in the overall size of the mining sector in the Asia-Pacific region, based on the key drivers of growth in the medium and long term, along with any risk factors.
2.2 The mining industry in APEC economies: overview

All of the 21 APEC economies covered by this report, with the exception of Brunei Darussalam, Hong Kong SAR and Singapore, earned a proportion of their GDP through mineral rents\(^1\) in 2012/2013. The proportion of GDP that can be attributed to minerals rents varies greatly between economies, as can be seen in the chart below.

The bubbles represent mineral rent as a percentage of GDP – a broad measure of the mining sector’s importance to a particular economy – for the year 2012\(^2\), and their position is 2013 GDP plotted against the number of commodities each APEC economy has in the form of reserves. The chart therefore allows us to see the relative importance of mining’s contribution to GDP in each economy, coupled with an indication of the mineral resources available and the size of each respective economy. Note that the horizontal axis is on a logarithmic scale to clarify differences.

There are four APEC economies for which mineral rents contributed more than 5% to GDP in 2012: Papua New Guinea (24.01%), Chile (15.27%), Peru (8.64%) and Australia (5.53%).

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\(^1\) Mineral rent: the difference between the value of production for a stock of minerals at world prices and their total costs of production.

\(^2\) The latest available data from the World Bank’s World Development Indicators (WDI).
Australia is considered to be a large, developed economy (high income economy), Chile is also now classified as a high-income economy\(^3\) by the World Bank whereas the remaining two are classified as middle-income economies.\(^4\) There is then another group of economies which shows less dependence on mineral rent’s contribution to GDP however the contribution is still important (1% to 3%): these are the Philippines, China, Indonesia, Russia and Mexico. In the final group of economies mineral rent contributes less than 1% to GDP: Canada, New Zealand, Vietnam, Malaysia and the United States. It can be seen from the chart that, with the exception of Australia, as total GDP increases the relative importance of mining within the economy decreases. This is an indication of the diversification that occurs as an economy grows, with less dependence on one individual sector.

The following chart shows an estimation of the USD dollar value of mineral rents in each of the APEC economies in 2013.

When translated into values, the picture changes slightly. China’s GDP earnings from mineral rents were the highest in 2013, reaching more than USD$180 billion, followed by Australia (~USD$80 billion), Chile (~USD$40 billion) Russia (~USD$30 billion) and the United States

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\(^3\) High-income economies are those with a GNI per capita of $12,616 or more (World Bank).

\(^4\) Middle-income economies are those with a Gross National Income per capita of more than $1,035 but less than $12,616 (World Bank).
Papua New Guinea’s mining industry, in spite of its economy’s high dependence on mineral rent, generated an estimated USD$4 billion in rents in 2013.

This final set of charts shows the relative importance of each of the APEC economies as producers of the commodities covered by this report. China is by far the most prominent APEC mining economy: it is currently the world’s largest producer of gold, molybdenum, zinc, lead, coal and tin, and falls within the top ten producers for the remainder of the commodities. Australia also features heavily, falling within the top ten producers for 11 of the 12 commodities, and is currently the world’s largest producer of bauxite and iron ore.
A good forward indicator of the future of the mining industry in any economy is the level of exploration expenditure in a given year, as this expenditure could lead to new mining projects. The information in the following chart is taken from SNL MEG’s Corporate Exploration Budgets Strategies, which surveyed 2,129 mining companies’ nonferrous exploration budgets for 2013, and used this to produce an estimate of worldwide exploration budgets for 2013. The APEC member economies of Canada, China, Peru, Mexico, Chile, Australia, Russia, United States and South East Asia have some of the highest exploration budgets for 2013.
In order to gauge the importance of mining to a nation’s economy the International Council on Mining & Metals (ICMM)’s Metal Contribution Index (MCI) can also be used. This index seeks to go beyond traditional economic indicators (such as mineral rents as a percentage of GDP), and looks to capture the overall impact of the extraction and production of mining, minerals and metals in each economy of the world. The MCI is calculated based on aspects of mining and metals contribution to national economies where economy-by-economy data exists. At present the MCI takes into account three variables:

- **Mineral export contribution 2010**: this is mineral and fuel exports in 2010 as a percentage of total merchandise exports (United Nations Conference on Trade and Development (UNCTAD) data);

- **Increase / decrease in mineral export contribution 2005 to 2010**, and;

- **Mineral production value as a percentage of GDP in 2010**: this is 2010 production value (metallic minerals) from Raw Materials Group (RMG) divided by 2010 GDP from the World Bank.

The MCI provides a reasonable first approximation of the relative importance of mining and metals to each national economy. However, it is important to note that there are many more direct and indirect ways that the mining sector can contribute to an economy. These are discussed further in Chapter 2.
Some economies which have no apparent mineral production, notably Brunei Darussalam, Singapore and Hong Kong, show a positive MCI value. In the case of Brunei Darussalam, this is the result of the weighting given to mineral export contribution within the MCI calculation. This also includes fuel exports, which are significant in Brunei Darussalam given the large amount of crude oil and natural gas which can be found within the economy’s borders. With regards to Hong Kong, there are currently no commercial mining or prospecting licences operating in Hong Kong, however the region is home to one of the world's largest ports which acts as an intermediate port for mineral and fuel shipments from other economies in Asia. For this reason minerals show a positive export contribution in Hong Kong’s MCI calculation. Finally, Singapore, also an economy with no mineral production of its own, shows a positive MCI due to the contribution of mineral exports to its economy. The economy is also home to one of the world’s largest and busiest ports and acts as an oil trading hub, meaning that a large quantity of crude oil passes through the port on the way to its final destination.

### Table 2.1: APEC economies Mining Contribution Index

<table>
<thead>
<tr>
<th>Rank</th>
<th>Economy</th>
<th>Mining Contribution Index (MCI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Papua New Guinea</td>
<td>95.5</td>
</tr>
<tr>
<td>2</td>
<td>Chile</td>
<td>92.1</td>
</tr>
<tr>
<td>3</td>
<td>Peru</td>
<td>88.0</td>
</tr>
<tr>
<td>4</td>
<td>Australia</td>
<td>87.9</td>
</tr>
<tr>
<td>5</td>
<td>Philippines</td>
<td>69.9</td>
</tr>
<tr>
<td>6</td>
<td>Hong Kong SAR</td>
<td>69.3</td>
</tr>
<tr>
<td>7</td>
<td>Canada</td>
<td>67.1</td>
</tr>
<tr>
<td>8</td>
<td>Indonesia</td>
<td>66.4</td>
</tr>
<tr>
<td>9</td>
<td>Mexico</td>
<td>55.5</td>
</tr>
<tr>
<td>10</td>
<td>Thailand</td>
<td>49.9</td>
</tr>
<tr>
<td>11</td>
<td>United States</td>
<td>49.8</td>
</tr>
<tr>
<td>12</td>
<td>Russia</td>
<td>47.6</td>
</tr>
<tr>
<td>13</td>
<td>Vietnam</td>
<td>44.0</td>
</tr>
<tr>
<td>14</td>
<td>New Zealand</td>
<td>43.2</td>
</tr>
<tr>
<td>15</td>
<td>Singapore</td>
<td>42.2</td>
</tr>
<tr>
<td>16</td>
<td>Japan</td>
<td>36.2</td>
</tr>
<tr>
<td>17</td>
<td>Korea</td>
<td>35.1</td>
</tr>
<tr>
<td>18</td>
<td>Malaysia</td>
<td>33.4</td>
</tr>
<tr>
<td>19</td>
<td>China</td>
<td>32.0</td>
</tr>
<tr>
<td>20</td>
<td>Brunei Darussalam</td>
<td>20.3</td>
</tr>
<tr>
<td>21</td>
<td>Chinese Taipei</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Data: ICMIM 2012
2.3 Economy summaries

This section provides an overview of the mining industry within each of the APEC member economies. Each economy summary contains a table with commodity production, reserves and GDP for the period 2000 to 2018, along with mineral rent as a % of GDP for the period 2000 to 2012. The data sources for this section are as follows:

- **Commodity production volumes:** CRU
- **Reserves:** United States Geological Service (USGS), SNL & World Energy Council
- **GDP:** International Monetary Fund (IMF)
- **Mineral rent as a % of GDP:** World Development Indicators, The World Bank.

Please note that coal production is split into thermal and metallurgical coal. The reserves data shown for coal is that of bituminous and anthracite, approximately 99% of which is made up of thermal and metallurgical coal, with 1% anthracite.

The data in the economy summary tables comes from the following sources:

<table>
<thead>
<tr>
<th>Commodity Source Data and unit</th>
<th>Commodity Source Data and unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRU Copper Market Outlook April 2014</td>
<td>Thousands of tonnes of contained copper in concentrates and recoverable EW cathode</td>
</tr>
<tr>
<td>CRU Gold Market Outlook July 2013</td>
<td>Gold mined production (thousands of tonnes)</td>
</tr>
<tr>
<td>CRU Precious Metals Outlook March 2014</td>
<td>Silver mined production (thousands of tonnes)</td>
</tr>
<tr>
<td>CRU Moly Market Outlook December 2013</td>
<td>Moly mined production (thousands of tonnes)</td>
</tr>
<tr>
<td>CRU Zinc Market Outlook April 2014</td>
<td>Actual and Committed Zinc Mine Production by Region (‘000 tonnes)</td>
</tr>
<tr>
<td>CRU Analysis Lead Team</td>
<td>Mined lead production (thousands of tonnes)</td>
</tr>
<tr>
<td>CRU Nickel Market Outlook May 2014</td>
<td>mine production ‘000 tonnes contained nickel</td>
</tr>
<tr>
<td>CRU Analysis Aluminium Team</td>
<td>Mined bauxite production (‘000 tonnes)</td>
</tr>
<tr>
<td>CRU Analysis Iron Ore Market Outlook April 2014</td>
<td>Apparent production of pellets, lump and iron ore fines ‘000 tonnes</td>
</tr>
<tr>
<td>BP Statistical Review of World Energy 2013</td>
<td>Millions of tonnes of coal production</td>
</tr>
<tr>
<td>CRU Analysis Tin Team</td>
<td>World mine production of tin ‘000 tonnes of tin in concentrate</td>
</tr>
<tr>
<td>CRU Analysis Manganese Team</td>
<td>Manganese ore production (contained manganese)</td>
</tr>
<tr>
<td>IMF World Economic Outlook April 2014</td>
<td>GDP in billions of USD</td>
</tr>
<tr>
<td>IMF World Economic Outlook April 2015</td>
<td>GDP per capita in USD</td>
</tr>
<tr>
<td>The World Bank</td>
<td>% of GDP</td>
</tr>
<tr>
<td>United States Geological Service, SNL, BP, Camimex</td>
<td>Reserves expressed in same units as production</td>
</tr>
<tr>
<td>Reserves data divided by 2014 production (2012 production in the case of coal)</td>
<td>Years of production remaining</td>
</tr>
</tbody>
</table>
2.3.1 Australia

Australia is one of the world’s leading mining economies, and in 2013 it was within the top ten producers for 11 of the 12 commodities covered by this report, furthermore it was the world’s number one producer of bauxite and iron ore\(^5\) in 2013, with output of 78 million tonnes and 620 million tonnes respectively. Australia is one of the APEC economies that receives a large proportion of its income from mining. In 2012 mineral rents contributed an estimated 5.53% to GDP. The MCI for Australia was 87.9, placing it within the top 20% of economies when considering how important mining is to the national economy. These figures do not take into account the wider-reaching benefits of the economy’s mining industry. For example, the Mount Isa and Olympic Dam operations mentioned above both support large communities, with the benefits of mining extending far beyond the contribution of the company’s profits to GDP.

As a result of the economy’s vast mineral wealth it is practically self-sufficient in most mineral commodities, whilst also exporting important amounts of the minerals to be processed overseas, notably iron ore and coal. The main export destinations for Australian minerals are the Asian economies of China, Japan, South Korea, and India.

With the exception of the Australian Capital Territory, all Australian states and territories have identified mineral resources and established mineral industries. The mining in each state and territory is governed by its respective government, and therefore each has its own set of mining laws and regulations. All minerals in the ground are the reserve of the Crown, and royalties are levied by state and territorial governments. In most cases this royalty is payable on a percentage of value or a flat rate per unit basis, with each State setting its own rate. Australia’s most important mining area is Western Australia, which produces iron ore, gold, nickel, lead, zinc and coal. There are also important mining operations in Southern Australia, for example the Olympic Dam mine, which is based around a huge iron oxide-copper-gold deposit, and the Mount Isa mining cluster in Queensland, which produces copper, zinc, lead and gold. New South Wales also produces, lead, zinc, gold, copper and silver. New South Wales and Queensland are also home to significant coal-bearing basins, making them the main coal producing states in Australia.

A national mineral resources rent tax (MRRT) was implemented in July 2012. At present the tax only applies to coal and iron ore mining. It is set at 22.5%, and it applies to profits rather than production, with the aim being that it targets large, highly profitable projects. The current Australian Government, however, has pledged to abolish the tax to reduce business costs and further improve Australia's attractiveness as an investment destination for mining projects.

\(^5\) On a 62% Fe content equivalent basis. China produces more iron ore than Australia on a run-of-mine basis, but generally at a lower Fe grade than Australian material.
Table 2.3: Australia mining data

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>1000 t contained Cu</td>
<td>861</td>
<td>918</td>
<td>870</td>
<td>922</td>
<td>957</td>
<td>969</td>
<td>989</td>
<td>917</td>
<td>0.35%</td>
<td>87,000</td>
<td>90</td>
</tr>
<tr>
<td>Gold</td>
<td>tonnes Au</td>
<td>263</td>
<td>263</td>
<td>260</td>
<td>259</td>
<td>259</td>
<td>262</td>
<td>264</td>
<td>245</td>
<td>-0.40%</td>
<td>9,900</td>
<td>38</td>
</tr>
<tr>
<td>Silver</td>
<td>tonnes Ag</td>
<td>1,976</td>
<td>2,441</td>
<td>2,129</td>
<td>2,003</td>
<td>2,022</td>
<td>1,964</td>
<td>1,913</td>
<td>1,844</td>
<td>-0.38%</td>
<td>88,000</td>
<td>45</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>1000 t Mo</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>79</td>
<td>-</td>
</tr>
<tr>
<td>Zinc</td>
<td>1000 t Zn contained</td>
<td>1,408</td>
<td>1,368</td>
<td>1,473</td>
<td>1,510</td>
<td>1,498</td>
<td>1,604</td>
<td>1,544</td>
<td>1,324</td>
<td>-0.34%</td>
<td>64,000</td>
<td>40</td>
</tr>
<tr>
<td>Lead</td>
<td>1000 t Pb in concentrate</td>
<td>675</td>
<td>767</td>
<td>663</td>
<td>610</td>
<td>694</td>
<td>780</td>
<td>782</td>
<td>770</td>
<td>0.73%</td>
<td>36,000</td>
<td>46</td>
</tr>
<tr>
<td>Nickel</td>
<td>1000 t contained Ni</td>
<td>135</td>
<td>185</td>
<td>193</td>
<td>230</td>
<td>238</td>
<td>236</td>
<td>241</td>
<td>235</td>
<td>3.12%</td>
<td>18,000</td>
<td>76</td>
</tr>
<tr>
<td>Bauxite</td>
<td>m tonnes</td>
<td>48</td>
<td>57</td>
<td>68</td>
<td>75</td>
<td>79</td>
<td>80</td>
<td>87</td>
<td>97</td>
<td>3.98%</td>
<td>6,000</td>
<td>75</td>
</tr>
<tr>
<td>Iron ore</td>
<td>m tonnes</td>
<td>168</td>
<td>262</td>
<td>441</td>
<td>525</td>
<td>620</td>
<td>706</td>
<td>770</td>
<td>879</td>
<td>9.65%</td>
<td>17,000</td>
<td>24</td>
</tr>
<tr>
<td>Coal</td>
<td>m tonnes</td>
<td>312</td>
<td>375</td>
<td>424</td>
<td>431</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>76,400</td>
<td>177</td>
<td></td>
</tr>
<tr>
<td>Tin</td>
<td>1000 t Sn in concentrate</td>
<td>9.1</td>
<td>2.7</td>
<td>6.4</td>
<td>5.9</td>
<td>6.2</td>
<td>6.5</td>
<td>7.8</td>
<td>20.9</td>
<td>4.69%</td>
<td>240</td>
<td>37</td>
</tr>
<tr>
<td>Manganese</td>
<td>1000 t contained</td>
<td>1,048</td>
<td>1,765</td>
<td>2,930</td>
<td>3,253</td>
<td>3,483</td>
<td>3,259</td>
<td>3,268</td>
<td>3,314</td>
<td>-</td>
<td>97,000</td>
<td>30</td>
</tr>
</tbody>
</table>

2.3.1.1 Mining potential and associated risks

Australia is a resource-rich economy with significant resources of metallic and non-metallic minerals. Mineral commodity production and exports are an important part of the economy. As a result of strong growth in world demand for mineral commodities, especially in Asia, the Australian economy is expected to continue to benefit from high commodity export earnings.

However, if the slow economic recovery in the United States and the European Union continues, the volume of imports of manufactured goods from China and other Asian economies to the United States and the European Union is expected to continue to decline. This in turn could affect China’s demand for mineral commodities from Australia.

Western Australia is Australia’s leading state for metallic mineral exports, and New South Wales and Queensland are its major coal exporting States (as well as being important producers of lead, zinc and bauxite, amongst others); however, to sustain growth in exports through expanded mining operations in the future, the economy’s infrastructure may require significant expansion and improvement so that minerals for export can be transported from inland locations to port terminals. Australia is expected to remain a major mineral exporting economy.

In 2013 Australia was the economy with the 2nd highest exploration budget after Canada, at around USD$1.89 billion, representing 13% of the global non-ferrous exploration budget for 2013, and a decrease of USD$626 million when compared to 2012, one of the smallest...
decreases among the regions. This is a good indication of the attractive mining investment environment in Australia and continued importance of the Australian mining industry going forward.

### 2.3.1.2 Major mining projects

The Roy Hill iron ore mine owned by Hancock Prospecting is under construction and due to come on stream in the second half of 2015. The mine has an expected life span of more than 20 years. In addition to the mine itself, the project also involves construction of a dedicated 2-berth port facility at Port Hedland and a 344km high speed railway from the mine to the port.

Also in iron ore, the Australian majors are undertaking substantial brownfield expansions of their existing operations, with Rio Tinto and BHP Billiton looking to increase output from their Pilbara mining systems to 360m tonnes per year (increase of 70m tpy) and 270m tonnes per year (increase of 46mntpy) respectively through a variety of relatively low-capex mine expansions and de-bottlenecking programs over the next few years.

The Merlin molybdenum-rhenium project (owned by Chinova Resources Ltd) is anticipated to process around 500,000 tonnes of mineral per year and produce 4,700 tonnes of molybdenum. The projected mine life of the project is approximately 15 years. The project is located in Northwest Queensland. We believe that the project will come on stream during 2014. Chinova are expecting the project to be extremely profitable, given the high grade of the resources and the relatively shallow depth of the deposit.

The Weipa bauxite operation (owned and operated by Rio Tinto Alcan) is located on the Western Cape York Peninsula in Queensland. In 2012 the mine produced 23.7 million tonnes of metal-grade bauxite. The original (northern) bauxite reserves are gradually being depleted, however given the continued demand for bauxite Rio Tinto Alcan are keen to extend the life of the operation and have identified considerable reserves south of the Embley River. The State government has approved an extension of the mine, which will look to exploit these additional reserves (the South of Embley project). This is expected to extend future mining operations for another 40 years.

Carmichael is a proposed, large-scale thermal coal mine located in Queensland's Galilee Basin. It is 100% owned by Adani Group, an Indian power and infrastructure corporation. It is one of several projects proposed for developments within the Galilee Basin; most are characterised by low calorific value coals and high capital requirements, especially for infrastructure, although high output levels would result in extremely competitive mining costs. The mine has an estimated 90 year mine life. Annual production is expected to peak at 60 million tonnes. Adani expect the first coal to be produced during the first quarter of 2017.
2.3.2 Canada

Canada, like Australia, is also one of the world’s major mining economies. The economy’s mineral reserves are concentrated in the Provinces of British Colombia, Manitoba, New Brunswick, Ontario and Quebec. In 2013 the economy was within the top ten producers for 7 of the 12 commodities covered by this report. Canada’s mineral industry is very much export-focused, with the majority of exports going to its neighbour, the United States.

Provincial governments are responsible for administering the mining activity within their respective provinces, however the Canadian Parliament is able to legislate on matters covered by the Constitution and it has responsibility for the territories. The federal government is responsible for the mineral activities of Federal Crown Corporations and mineral activities on federal land and offshore.

Although Canada’s is one of the world’s largest producers of mined commodities, mineral rent makes up a relatively small proportion of GDP, given the diversified nature of its economy. In 2012 mineral rents made up just 0.08% of Canada’s GDP. The MCI for Canada is 67.1, which places it in the top 20% of economies when considering how important mining is to the national economy. Despite mineral rent’s relatively low contribution to GDP, Canada’s MCI ranking is boosted by the large mineral contribution to exports, which in 2010 was around 36%.

Table 2.4: Canada mining data

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>'000 t contained Cu</td>
<td>619</td>
<td>596</td>
<td>499</td>
<td>582</td>
<td>623</td>
<td>666</td>
<td>679</td>
<td>598</td>
<td>10,000</td>
<td>15</td>
<td>-0.20%</td>
<td>10,000</td>
<td>15</td>
</tr>
<tr>
<td>Gold</td>
<td>tonnes Au</td>
<td>121</td>
<td>121</td>
<td>91</td>
<td>131</td>
<td>120</td>
<td>126</td>
<td>132</td>
<td>142</td>
<td>920</td>
<td>7</td>
<td>0.88%</td>
<td>7,000</td>
<td>14</td>
</tr>
<tr>
<td>Silver</td>
<td>tonnes Ag</td>
<td>1,212</td>
<td>1,124</td>
<td>596</td>
<td>688</td>
<td>585</td>
<td>504</td>
<td>506</td>
<td>500</td>
<td>7,000</td>
<td>14</td>
<td>-4.80%</td>
<td>7,000</td>
<td>14</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>'000 t Mo</td>
<td>6.8</td>
<td>7.7</td>
<td>8.6</td>
<td>9.1</td>
<td>9.1</td>
<td>9.5</td>
<td>9.5</td>
<td>1.89%</td>
<td>220</td>
<td>23</td>
<td></td>
<td>7,000</td>
<td>23</td>
</tr>
<tr>
<td>Zinc</td>
<td>'000 t Zn contained</td>
<td>1,010</td>
<td>657</td>
<td>645</td>
<td>641</td>
<td>425</td>
<td>390</td>
<td>430</td>
<td>461</td>
<td>7,000</td>
<td>18</td>
<td>-4.26%</td>
<td>7,000</td>
<td>18</td>
</tr>
<tr>
<td>Lead</td>
<td>'000 t Pb in concentrate</td>
<td>149</td>
<td>79</td>
<td>65</td>
<td>65</td>
<td>25</td>
<td>5</td>
<td>17</td>
<td>23</td>
<td>950</td>
<td>90</td>
<td>-9.85%</td>
<td>450</td>
<td>90</td>
</tr>
<tr>
<td>Nickel</td>
<td>'000 t contained Ni</td>
<td>181</td>
<td>192</td>
<td>158</td>
<td>204</td>
<td>224</td>
<td>248</td>
<td>253</td>
<td>269</td>
<td>3,300</td>
<td>13</td>
<td>2.21%</td>
<td>3,300</td>
<td>13</td>
</tr>
<tr>
<td>Bauxite</td>
<td>'000 t</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Iron ore</td>
<td>m tonnes</td>
<td>35</td>
<td>29</td>
<td>36</td>
<td>40</td>
<td>42</td>
<td>40</td>
<td>41</td>
<td>44</td>
<td>2,300</td>
<td>58</td>
<td>1.32%</td>
<td>2,300</td>
<td>13</td>
</tr>
<tr>
<td>Coal</td>
<td>m tonnes</td>
<td>69</td>
<td>68</td>
<td>68</td>
<td>67</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>6,582</td>
<td>98</td>
<td></td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

GDP (current $USD) billions USD 739 1,164 1,614 1,821 1,825 1,769 1,850 2,103 5.98% - -

GDP per capita (current $USD) USD 24,128 36,152 47,531 52,489 51,990 49,838 51,594 56,982 4.89% - -

Mineral rent as a % of GDP % 0.22% 0.44% 0.82% 0.80% n/a n/a n/a n/a - -

2.3.2.1 Mining potential and associated risks

The Canadian mineral industry is well positioned to expand, based on its mineral resource base and its access to the markets of China, Europe, Japan, and North America. However,
globalization of the mineral industry, notably competition from developing economies with mineral deposits that are less costly to develop, could reduce the competitiveness of the Canadian mining industry in the near future.

In 2013 Canada was the economy with the world’s largest non-ferrous exploration budget, marginally beating Australia at USD$1.92 billion, representing 13% of the global non-ferrous exploration budget for the year. However, it also saw the largest decrease when compared to 2012: with its non-ferrous exploration budget falling USD$1.33 billion, and its total share of the global budget falling from 16% to 13%. These decreases are predominantly the result of weaknesses in the economy’s junior mining sector. Most junior mining companies do not receive revenue from existing operations with which to fund exploration, and instead usually rely on equity financings. Investor interest has been poor since the Global Financial Crisis, with many junior mining companies choosing to merge and combine resources, whilst others have chosen to leave the mining industry altogether.

2.3.2.2 Major mining projects

Goldcorp’s Eleonore gold project, located in James Bay, Quebec, is anticipated to start producing during the second half of 2014. Plant throughput is expected to be 7,000 tonnes of mineral per day, contributing to an average gold production of 600,000 ounces (17 metric tonnes) per year.

CRU expects Royal Nickel’s Dumont nickel project to start producing during the first half of 2016. The Dumont nickel project is a large nickel sulphide deposit in Quebec, Canada. For the first four years of mine life nickel in concentrate production is forecast to average 33,000 tonnes annually, for the remaining 15 years of mine life nickel production will increase to an average of 54,000 tonnes per year.

Anglo American is set to bring the Roman Mountain metallurgical coal project onto the market in 2015. Construction began at the site, which is adjacent to the Trend mine, in August 2013. The project will use much of the existing infrastructure from the Trend mine, although it will need to increase plant capacity and employ additional mining equipment. First shipment is expected in 2015.

2.3.3 Chile

Chile is the world’s largest copper miner, accounting for over 30% of world copper mine production in 2013, some 5.8 million tonnes. In the same year it also fell within the world’s top ten producers of silver and molybdenum, the majority of which is output as a by-product at the economy’s copper mines. Much of the mining in Chile is carried out in the Atacama and Antofagasta regions. The State owned Codelco mining company is currently the largest copper miner in the world, with all of its production originating in Chile. In 2013 Codelco mined 1.6
million tonnes of copper from its Chuquicamata, Radomiro Tomic, Ministro Hales, Salvador, Andina, El Teniente and Gaby operations. After Codelco, the copper mining companies with the largest presence in Chile are BHP Billiton, producing 1.4 million tonnes in 2013 (the majority of which came from the world’s largest copper mine Escondida), followed by the Chilean company Antofagasta Minerals, which mined 737,000 tonnes of copper in 2013 from its Los Pelambres, El Tesoro, Michilla and Esperanza operations.

**Table 2.5: Chilean copper mined copper production, 2013 (‘000 tonnes) by company**

<table>
<thead>
<tr>
<th>Company</th>
<th>Mine</th>
<th>2013 Cu production ('000 tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Codelco</strong></td>
<td>Chuquicamata</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Radomiro Tomic</td>
<td>379.6</td>
</tr>
<tr>
<td></td>
<td>Ministro Hales</td>
<td>33.5</td>
</tr>
<tr>
<td></td>
<td>Salvador</td>
<td>54.3</td>
</tr>
<tr>
<td></td>
<td>Andina</td>
<td>236.7</td>
</tr>
<tr>
<td></td>
<td>El Teniente</td>
<td>450.4</td>
</tr>
<tr>
<td></td>
<td>Gaby</td>
<td>128.2</td>
</tr>
<tr>
<td></td>
<td><strong>Total Codelco</strong></td>
<td><strong>1,621.7</strong></td>
</tr>
<tr>
<td><strong>BHP Billiton</strong></td>
<td>Escondida (BHP Billiton 70%, Rio Tinto 30%)</td>
<td>1,193.7</td>
</tr>
<tr>
<td></td>
<td>Cerro Colorado</td>
<td>73.6</td>
</tr>
<tr>
<td></td>
<td>Spence</td>
<td>151.6</td>
</tr>
<tr>
<td></td>
<td><strong>Total BHP Billiton</strong></td>
<td><strong>1,418.9</strong></td>
</tr>
<tr>
<td><strong>Antofagasta Minerals</strong></td>
<td>Los Pelambres</td>
<td>419.2</td>
</tr>
<tr>
<td></td>
<td>El Tesoro</td>
<td>102.6</td>
</tr>
<tr>
<td></td>
<td>Michilla</td>
<td>38.3</td>
</tr>
<tr>
<td></td>
<td>Esperanza</td>
<td>177.1</td>
</tr>
<tr>
<td></td>
<td><strong>Total Antofagasta Minerals</strong></td>
<td><strong>737.2</strong></td>
</tr>
<tr>
<td><strong>Freeport McMoran</strong></td>
<td>El Abra</td>
<td>155.6</td>
</tr>
<tr>
<td></td>
<td>Candelaria</td>
<td>168.0</td>
</tr>
<tr>
<td></td>
<td><strong>Total Freeport McMoran</strong></td>
<td><strong>323.6</strong></td>
</tr>
<tr>
<td><strong>Anglo America</strong></td>
<td>Anglo American Norte</td>
<td>111.3</td>
</tr>
<tr>
<td></td>
<td>Anglo American Sur</td>
<td>467.3</td>
</tr>
<tr>
<td></td>
<td><strong>Total Anglo American</strong></td>
<td><strong>578.6</strong></td>
</tr>
<tr>
<td><strong>Barrick</strong></td>
<td>Zaldívar</td>
<td>126.5</td>
</tr>
<tr>
<td><strong>Minera Collahuasi (Anglo American &amp; Glencore)</strong></td>
<td>Collahuasi</td>
<td>444.5</td>
</tr>
<tr>
<td><strong>Teck</strong></td>
<td>Quebrada Blanca</td>
<td>56.2</td>
</tr>
<tr>
<td><strong>Glencore</strong></td>
<td>Lomas Bayas</td>
<td>74.2</td>
</tr>
<tr>
<td><strong>Other companies</strong></td>
<td>Various</td>
<td>405.6</td>
</tr>
<tr>
<td><strong>Total Chile copper production</strong></td>
<td></td>
<td><strong>5,787.0</strong></td>
</tr>
</tbody>
</table>

Data: Cochilco - COMISION CHILENA DEL COBRE
Although many of the mining operations are located within the Andes mountain range, the geography of Chile, with its long, thin shape, facilitates the seaborne exportation of copper concentrate, as no mine is located more than 240 km from the coast. The abundance of copper resources in Chile has made mining a key sector of Chile’s economy. The economy also has a reputation for being one of the most attractive business destinations in South America, as the rule of law is strong and it had a well functioning market economy accompanied by sophisticated financial markets.

In 2012 mineral rents accounted for 15.27% of GDP, making Chile one of the more mining industry-reliant APEC member economies. In addition to the important contribution that mineral rents make to GDP, they also account for over 60% of the economy’s exports. Chile’s MCI index is 92.1, which further demonstrates the importance of mining to the national economy. Of the APEC member economies it is second only to Papua New Guinea, with an MCI of 95.5.

### Table 2.6: Chile mining data

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>0000 t contained Cu</td>
<td>4,661</td>
<td>5,356</td>
<td>5,419</td>
<td>5,470</td>
<td>5,787</td>
<td>5,891</td>
<td>5,953</td>
<td>5,489 0.91%</td>
<td>190,000</td>
<td>32</td>
</tr>
<tr>
<td>Gold</td>
<td>tonnes Au</td>
<td>40</td>
<td>40</td>
<td>38</td>
<td>40</td>
<td>51</td>
<td>52</td>
<td>54</td>
<td>57 2.02%</td>
<td>4,000</td>
<td>76</td>
</tr>
<tr>
<td>Silver</td>
<td>tonnes Ag</td>
<td>1,246</td>
<td>1,400</td>
<td>1,287</td>
<td>1,218</td>
<td>1,191</td>
<td>1,209</td>
<td>1,308</td>
<td>1,338 0.40%</td>
<td>77,000</td>
<td>64</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>0000 t Mo</td>
<td>33</td>
<td>49</td>
<td>37</td>
<td>35</td>
<td>39</td>
<td>49</td>
<td>73</td>
<td>71 4.35%</td>
<td>2,300</td>
<td>47</td>
</tr>
<tr>
<td>Zinc</td>
<td>0000 t contained Zn</td>
<td>31</td>
<td>28</td>
<td>26</td>
<td>25</td>
<td>29</td>
<td>35</td>
<td>37</td>
<td>38 1.10%</td>
<td>n/a</td>
<td>-</td>
</tr>
<tr>
<td>Lead</td>
<td>0000 t Pb in concentrate</td>
<td>0.8</td>
<td>0.9</td>
<td>0.7</td>
<td>0.8</td>
<td>1.2</td>
<td>0.8</td>
<td>0.9</td>
<td>1.0 1.30%</td>
<td>n/a</td>
<td>-</td>
</tr>
<tr>
<td>Iron ore</td>
<td>m tonnes</td>
<td>7.6</td>
<td>6.0</td>
<td>5.8</td>
<td>7.5</td>
<td>6.8</td>
<td>6.1</td>
<td>6.5</td>
<td>7.0 0.46%</td>
<td>n/a</td>
<td>-</td>
</tr>
<tr>
<td>Manganese</td>
<td>0000 t contained</td>
<td>13</td>
<td>40</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GDP (current $USD)</th>
<th>billions USD</th>
<th>78</th>
<th>123</th>
<th>217</th>
<th>266</th>
<th>277</th>
<th>263</th>
<th>281</th>
<th>347</th>
<th>8.64%</th>
<th>-</th>
<th>-</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP per capita (current $USD)</td>
<td>USD</td>
<td>5,064</td>
<td>7,565</td>
<td>12,712</td>
<td>15,300</td>
<td>15,776</td>
<td>14,856</td>
<td>15,736</td>
<td>18,968</td>
<td>7.61%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mineral rent as a % of GDP</td>
<td>%</td>
<td>6.63%</td>
<td>12.76%</td>
<td>17.61%</td>
<td>15.27%</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

### 2.3.3.1 Mining potential and associated risks

Chile is widely considered to have the best investment climate in Latin America for mining and there are still a considerable amount of copper reserves left to exploit in Chile. Chile’s mining industry is not as diversified as that of other APEC economies, as it is very dependent on copper – several of the other minerals which Chile produces in significant quantities are generally by-products of copper mining. The main export destination for Chilean copper concentrate is China, therefore the fortune of the Chilean copper industry is reliant upon the continued growth of the Chinese economy.

Another important issue which could affect the competitiveness of Chile’s copper industry is that of costs. As mentioned above, copper resources in Chile are fairly abundant, however many
of the these deposits are found high up in the Andes mountains or in the middle of the Atacama desert, which increases development costs. For example, those operations located in the desert often have to construct desalination plants on the coast and water pipelines to the operation, due to the scarcity of natural water resources. What is more, the cost of energy in Chile is high compared to that of other mining economies, and labour costs have been escalating in recent years without any real increase in productivity.

Chile’s non-ferrous exploration budget in 2013 was around USD$860 million, placing it slightly ahead of its neighbour Peru, which had a non-ferrous exploration budget of USD$700 million. This is down from around USD$1 billion in 2012, however its proportion of the worldwide non-ferrous exploration budget has remained constant at 5%, and it is still the economy that attracts the most exploration investment within the South American region, with Peru a close second.

### 2.3.3.2 Major mining projects

**Sierra Gorda**, owned by KGHM International (55.0%) and Sumitomo (45%), is a copper concentrate project (with a significant molybdenum by-product) located in the Antofagasta region of Chile. The project’s expected start date is during the third quarter of 2014. Construction of the project started during the second half of 2011, and includes the construction of a mine and concentrating plant, filtration plant and water and concentrate pipelines running between the operation and the coast. The concentrating plant will have an initial capacity of 110,000 tonnes per day, which will eventually be increased to 190,000 tonnes per day. Annual production is estimated to be around 220,000 tonnes of refined copper, and 11,000 tonnes of molybdenum by-product, making it one of the world’s largest molybdenum producers.

**Pascua Lama**, owned by Barrick, is a gold project, located in the Andes mountain range, on the border between Chile and Argentina. It is one of the world’s largest gold and silver deposits, with 17.9 million ounces (507 tonnes) of proven and probable gold reserves and 676 million ounces (19,000 tonnes) of silver contained within the gold reserves. The project has been plagued by various problems. Construction started in 2012, however it is currently suspended, in part a cost saving initiative by Barrick but also due to various environmental and construction errors. There is considerable community opposition to the project from the Diaguita community of Huasco Alto, who believe that the mine will affect the nearby glaciers that feed the rivers that they use for farming. If this project goes ahead, CRU expects it to start producing no earlier than 2019, with an anticipated annual production of 750,000 ounces (21 tonnes) of gold.

### 2.3.4 China

The Chinese economy is one of the world’s largest, second only to the United States. It is also one of the world’s leading mineral producing and consuming economies. In 2013 China was the world’s largest producer of gold, molybdenum, zinc, lead, coal and tin, and was within the top
Asia-Pacific mining sector study

ten producers for the remainder of the commodities covered by this report. The unprecedented
growth of the Chinese economy over the last two decades, the result of a combination of trade
and investment, had a huge impact on the global commodities market. China’s demand for
minerals and metals was especially strong.

China is the world’s leading producer of coal, gold, and most rare earth minerals. However, the
economy has limited resources for certain commodities, such as high-quality metallurgical coal
and nickel. China’s mining industry is highly fragmented, with many small-scale, unregulated
mines. This has resulted in a lack of transparency in the economy’s mining industry, as it is very
difficult to obtain accurate production figures for such small, and often illegal, operations. The
large number of small scale operations has also resulted in very poor mine safety records.

Take for example the Chinese molybdenum industry. China has a long history of molybdenum
mining. Unlike other major molybdenum producing regions in the rest of the world, China is
highly fragmented, with a large number of small-scale operations each contributing to the total
output. While it is relatively easy to follow the developments of large-scale operations, it is
challenging to follow those of small-scale ones. Large-scale operations are more readily
identifiable, relatively few in number and, due to a more competitive cost position and
consistent product quality, their output tends to be more stable over time, and less sensitive to
market prices. This is primarily supported by a continuous order flow from downstream users.
Smaller operations, by contrast, are numerous, often producing without a licence, liable to
produce intermittently and add only small volumes to supply, which may scarcely impact upon
the supply picture except in aggregate. The development of the molybdenum mining industry in
Huludao from 2000-2007 provides a relatively representative outline of the situation. There
were about 50-70 mines in Huludao in the period 2000-2004, approximately double the number
of molybdenum mines in the whole of the rest of the world (excluding China). Most of those
operations were not licensed. In mid-2004, a number of mines were closed down by the local
government for tax evasion, whilst other small mines were closed because they did not hold
licences. In 2005, exploration licences were auctioned by the local government. Further closures
occurred over the period 2005-2007 for a variety of reasons. This included a large number of
closures in late 2006 for causing water pollution. By the end of 2007 just 12 mines remained in
operation in the province, the largest of which was Lianshan Molybdenum, controlled by the
local government.

In 2012 mineral rents accounted for 2.06% of China’s GDP. Although a relatively small
percentage of national income, in monetary terms this represents more than USD$180 billion.
This makes China’s mining industry the highest grossing in the world, with Australia a distant
second with around USD$80 million of income from mineral rents. China’s MCI is 32.0, which
places it within the lowest 40% of the economies surveyed, and indicates that mining is not of as
significant importance as some other sectors of the economy. Furthermore, despite the vast quantities of minerals that are produced in China, very little is exported, with the majority being used by domestic industry and manufacturing. It is these downstream products that are more likely to be exported.

The Chinese government is currently seeking to change the economy’s pattern of economic growth, moving it away from an export-orientated economy to one that is driven by domestic consumption. At the same time it hopes to build a more energy efficient and environmentally friendly society. This includes reducing carbon emissions, particularly those of the industrial sector, notably in iron and steel production.

### Table 2.7: China mining data

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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>000 t contained Cu</td>
<td>517</td>
<td>788</td>
<td>1,211</td>
<td>1,473</td>
<td>1,577</td>
<td>1,644</td>
<td>1,740</td>
<td>1,766</td>
<td>7.06%</td>
<td>30,000</td>
<td>18</td>
</tr>
<tr>
<td>Gold</td>
<td>tonnes Au</td>
<td>173</td>
<td>209</td>
<td>341</td>
<td>413</td>
<td>427</td>
<td>440</td>
<td>449</td>
<td>440</td>
<td>5.32%</td>
<td>2,000</td>
<td>5</td>
</tr>
<tr>
<td>Silver</td>
<td>tonnes Ag</td>
<td>1,600</td>
<td>2,200</td>
<td>3,000</td>
<td>3,650</td>
<td>3,850</td>
<td>4,000</td>
<td>4,125</td>
<td>4,175</td>
<td>5.47%</td>
<td>43,000</td>
<td>11</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>000 t Mo</td>
<td>45</td>
<td>35</td>
<td>71</td>
<td>86</td>
<td>85</td>
<td>80</td>
<td>60</td>
<td>40</td>
<td>0.59%</td>
<td>4,300</td>
<td>54</td>
</tr>
<tr>
<td>Zinc</td>
<td>000 t contained Zn</td>
<td>1,635</td>
<td>2,330</td>
<td>3,345</td>
<td>3,975</td>
<td>4,100</td>
<td>4,275</td>
<td>4,450</td>
<td>5,150</td>
<td>6.58%</td>
<td>43,000</td>
<td>10</td>
</tr>
<tr>
<td>Lead</td>
<td>000 t contained Pb in concentrate</td>
<td>750</td>
<td>1,295</td>
<td>1,950</td>
<td>2,425</td>
<td>2,575</td>
<td>2,675</td>
<td>2,760</td>
<td>2,975</td>
<td>7.96%</td>
<td>14,000</td>
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<td>000 t contained Ni</td>
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<td>60</td>
<td>79</td>
<td>92</td>
<td>92</td>
<td>94</td>
<td>96</td>
<td>94</td>
<td>3.36%</td>
<td>3,000</td>
<td>32</td>
</tr>
<tr>
<td>Bauxite</td>
<td>m tonnes</td>
<td>8</td>
<td>14</td>
<td>45</td>
<td>61</td>
<td>74</td>
<td>81</td>
<td>84</td>
<td>101</td>
<td>15.33%</td>
<td>830</td>
<td>10</td>
</tr>
<tr>
<td>Iron ore</td>
<td>m tonnes</td>
<td>114</td>
<td>234</td>
<td>320</td>
<td>311</td>
<td>297</td>
<td>272</td>
<td>260</td>
<td>228</td>
<td>3.94%</td>
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<tr>
<td>Coal</td>
<td>m tonnes</td>
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<td>3,650</td>
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<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
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<td>114,500</td>
<td>31</td>
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<td>Tin</td>
<td>000 t tin in concentrate</td>
<td>114</td>
<td>89</td>
<td>96</td>
<td>92</td>
<td>95</td>
<td>95</td>
<td>96</td>
<td>92</td>
<td>-1.8%</td>
<td>1,500</td>
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<td>2,632</td>
<td>2,546</td>
<td>2,870</td>
<td>3,377</td>
<td>n/a</td>
<td>44,000</td>
<td>14.02%</td>
<td>114,500</td>
<td>31</td>
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</table>

### 2.3.4.1 Mining potential and associated risks

China’s economy is expected to continue growing in the future, albeit at a slower rate than in previous decades. The Chinese government has set a GDP growth rate target of 7.5% for the past three years, and it is anticipated that this target will stay the same in the short term, as the economy matures and its growth starts to slow.

As mentioned above, the mining industry within China is highly fragmented and generally high cost, with the products often of low quality relative to international benchmarks – for example in the case of manganese ore and iron ore production. There is therefore a likely move towards closure or consolidation of higher-cost mines, which will improve the average cost position of the mining industry as well as reducing its environmental impact. This is in part driven by China’s 12th five-year plan. For example, in the coal industry the aim is for 11,000 coal...
enterprises to be reduced to 4,000, and eventually only 8 to 10 coal companies are expected to account for nearly two-thirds of all coal production within the next few years.

China’s economy is expected to continue to grow in the near future. The economy has replaced Japan as the second largest economy in the world behind the United States, and the Government has set the economic growth rate target at 7.5% for the coming years. The Government recognizes that the economy cannot depend solely on exports to sustain its economic growth and that the economy needs to increase domestic consumption and to have a more transparent financial and legal system. The expected continuation of China’s economic growth implies that a strong demand for mineral commodities is likely to continue. China has shortages of supply of most major minerals relative to demand, including bauxite, chrome, copper, iron, lead, manganese and nickel, leaving it reliant on imports. This trend is expected to continue in the long term. As a consequence, the Chinese Government encourages businesses to invest in mineral-rich economies such as Australia, Brazil, Myanmar, Chile, Indonesia, and Mongolia in order to secure minerals for domestic economic development and growth. In addition, the Government is expected to continue its effort to protect the economy’s resources of minerals, such as coal and molybdenum, rare earths, tin, and tungsten, and to avoid overexploitation.

In recent years China’s imports of raw minerals have been increasing. The Chinese Government, in reaction to this, have been promoting reduced dependency on mineral commodity imports and encouraging the production of high value-added and high-quality downstream products. As progress is made toward these goals, the economy’s dependence on major mineral commodities could decline; however, it is likely that China will continue to play an important role in the world’s metal and mineral markets for the foreseeable future. China’s overall outward investment is expected to continue to increase and may soon exceed inward foreign direct investment.

One negative point with regards to the Chinese mining industry is that it has a poor record when it comes to environmental, health, safety and social performance. The Government has published a set of environmental guidelines targeting the mining industry, but progress towards acceptance of these at all operations has been fairly slow. The Government plans to continue its effort to address the sustainable development of the mining and metal sectors through air and water pollution prevention and treatment, land protection, mine safety, and reclamation of mine sites.

In 2013, China attracted 4% of the global non-ferrous exploration budget, approximately USD$600 million. This was down from USD$800 million in 2012, however it maintained its share of 4% of the global non-ferrous exploration budget. Note that this figure doesn’t include exploration for important minerals such as iron ore and coal, which reportedly accounts for as
much as half of China’s exploration expenditure – more than in most other APEC and other economies.

2.3.4.2 Major mining projects

China Power Investment Corporation (CPI)’s Guizhou Wuzhengdao Coal-Power-Aluminium Integrated Alumina project was approved by the National Development and Reform Committee in 2010. The project, which will be located in the aluminium industry zone of Wuchuan County, possesses two million tonnes per year of bauxite ore (coming from the mines of Guizhou Wuchuan Dazhuyuan and Guizhou Wuchuan Wachangping), 800,000 tonnes per year of alumina, 400,000 tonnes per year of primary aluminium and four aluminium fabrication projects, each with a capacity of 200,000 tonnes per year. Initial production is expected in 2016.

Yichun Luming is the only new Chinese primary molybdenum operation that CRU expects to commission and ramp up in the forecast period. The project is owned by China Railways Resources Group. The mine is expected to produce a concentrate with 51% molybdenum content and 4% moisture. Concentrate production may reach as high as 28,000 tonnes per year gross weight. Once the mine enters operation the company will commence construction of downstream processing facilities for molybdenum oxide, ferromolybdenum and molybdenum chemicals and molybdenum metal.

2.3.5 Indonesia

In 2013 Indonesia fell within the top ten producers of copper, gold, bauxite, coal and tin, and was the world’s largest producer of mined nickel. It is one of the world’s leading exporters of bituminous coal. In 2012 mineral rents made up 1.41% of GDP, with coal rents contributing an additional 1.29%. The MCI for Indonesia is 66.4, which places it directly below Canada with an MCI of 67.1 and in the top 20% of economies globally when considering how important mining is to the national economy. The economy has abundant mineral resources, with many years of production left should current reserves continue to be exploited at the same rate.

On May 1st 2012 a new regulation which restricts ore exports came into effect. The regulation stipulates the minimum level of processing that certain minerals must be subject to before they can be exported. The legislation aims to increase the added value of minerals through processing and refining by developing the economy’s domestic mineral processing industry and deriving more domestic revenue from the mineral sector. Some companies operating in Indonesia have already invested in downstream processing facilities. For example, the export of tin ore was banned in 2010 and PT Timah has already constructed tin smelters and now exports refined tin. Just before the regulation came into force, the government repealed some aspects, reducing the minimum processing requirements for copper, manganese, lead zinc and iron ore to ‘concentrate’. However, minerals that require at least some refining before export include
Asia-Pacific mining sector study

bauxite, nickel, tin, gold and silver. It is important to note that coal is not included in the export ban.

Furthermore, the government has also introduced new rules which came into effect in 2012 requiring foreign companies to gradually reduce their stakes in mines so that domestic ownership is at least 51%.

Table 2.8: Indonesia mining data

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>tonnes Cu contained</td>
<td>1.006</td>
<td>1.064</td>
<td>0.873</td>
<td>0.398</td>
<td>0.508</td>
<td>0.530</td>
<td>0.912</td>
<td>0.851</td>
</tr>
<tr>
<td>Gold</td>
<td>tonnes Au</td>
<td>139</td>
<td>139</td>
<td>128</td>
<td>164</td>
<td>93</td>
<td>112</td>
<td>134</td>
<td>153</td>
</tr>
<tr>
<td>Silver</td>
<td>tonnes Ag</td>
<td>323</td>
<td>308</td>
<td>236</td>
<td>154</td>
<td>213</td>
<td>233</td>
<td>290</td>
<td>342</td>
</tr>
<tr>
<td>Nickel</td>
<td>tonnes Ni contained</td>
<td>48</td>
<td>135</td>
<td>296</td>
<td>632</td>
<td>750</td>
<td>268</td>
<td>405</td>
<td>567</td>
</tr>
<tr>
<td>Bauxite</td>
<td>m tonnes</td>
<td>1.7</td>
<td>6.2</td>
<td>23.3</td>
<td>25.2</td>
<td>49.9</td>
<td>8.8</td>
<td>10.7</td>
<td>16.8</td>
</tr>
<tr>
<td>Iron ore</td>
<td>m tonnes</td>
<td>0.0</td>
<td>0.8</td>
<td>8.5</td>
<td>10.4</td>
<td>20.5</td>
<td>8.9</td>
<td>6.8</td>
<td>4.9</td>
</tr>
<tr>
<td>Coal</td>
<td>m tonnes</td>
<td>77</td>
<td>153</td>
<td>275</td>
<td>386</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>5,529</td>
</tr>
<tr>
<td>Tin</td>
<td>tonnes tin in concentrate</td>
<td>54</td>
<td>138</td>
<td>100</td>
<td>97</td>
<td>92</td>
<td>86</td>
<td>82</td>
<td>61</td>
</tr>
<tr>
<td>Manganese</td>
<td>tonnes contained Mn</td>
<td>0</td>
<td>7</td>
<td>84</td>
<td>20</td>
<td>14</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
</tbody>
</table>

GDP (current USD): billions USD
- 165 | 286 | 709 | 878 | 870 | 859 | 900 | 1,156 | 11.42%
GDP per capita (current USD): USD
- 800 | 1,291 | 2,985 | 3,591 | 3,510 | 3,417 | 3,529 | 4,345 | 9.86%
Mineral rent as a % of GDP
- 1.44% | 2.07% | 1.96% | 1.41% | n/a | n/a | n/a | n/a | -

Indonesian iron ore reserves are the sum of the reserves at the Jigokaka (Indomines) and Nalo Baru (Earth Resources) operations.
Indonesian silver reserves are the sum of reserves at the Grasberg, Martabe, Batu Hijau and Pongkor projects.

2.3.5.1 Mining potential and associated risks

The ore export ban and requirement for domestic mineral processing is expected to stimulate domestic and foreign investments in downstream mineral extraction industries. However, there are concerns over how beneficial the ore export ban will actually be for the Indonesian economy – especially in the short term, where the sharp fall in exports has severely reduced export revenues, with knock-on implications on GDP growth and government tax take. The World Bank has stated that the regulation has damaged investor confidence and is threatening state finances. During the first quarter of 2014 the economy’s growth rate was the slowest in five years, the result of tens of thousands of workers being made redundant, and the halt of mineral exports, which were worth USD$11 billion in 2013.

Investment in the Indonesian mining sector has slowed dramatically since the ban was introduced, with many mining companies awaiting the outcome of the presidential elections in July 2014, with the hope that the ban will be reversed. Nonetheless, it appears that the regulation is encouraging investment in downstream processing, as companies have announced investments in Indonesian based processing facilities, which would not exist were the ban not in force. However, the World Bank does not think that the economics of creating a domestic
The World Bank has calculated that the export ban will reduce Indonesian export revenue in 2014 by around USD$6 billion, and reduce government revenues by USD$6.5 billion through to 2017. What is more, the legislation for the ban was passed in 2009, and the market situation has changed since then. There is now highly significant metals processing capacity (smelting, refining, steel mills, etc) in China, which brings into question how competitive and profitable Indonesian mineral processing facilities may actually be. For the ban to be considered successful, the new downstream facilities created in Indonesia will need to provide a greater positive effect on the economy (through direct and indirect impact on jobs, GDP, infrastructure creation and so on, as is discussed in the next chapter) than the existing mining export operations. There remain significant questions over whether this will be so, as it may instead be the case that existing mining operations are more competitive on a global basis, and therefore a more secure provider of positive effects on the economy than the prospective downstream facilities. Another question is whether the ban will bring about investment in downstream facilities across all the mineral commodities covered by the export ban – for example, whilst this may be the case for nickel, it may not be for iron ore.

South East Asia attracted 7% of the global non-ferrous exploration budget in 2013, equivalent to around USD$1 billion. Of that around USD$820 million went to the three prominent mining economies within the region, Papua New Guinea, Indonesia and the Philippines, down from $USD1.1 billion in 2012.

2.3.5.2 Major mining projects

The Balangan thermal coal project, majority owned by Adaro, is expected to begin production late in 2014. The Balangan project is part of the same geological basin in South Kalimantan as current operations at Adaro Indonesia, and the coal characteristics are similar to Adaro Indonesia’s Envirocoal product. A ramp-up production target of 8 million tonnes per year is expected. The project will also include a power generation project, which will support the company’s mines as well as providing power to the national power grid.

The Grasberg Block Cave mine and the Deep Mill Level Zone (DMLZ) project, owned by Freeport-McMoran, is expected to commence production in 2015. The project looks to extend the life of the current Grasberg operation, owned by Freeport McMoran Copper & Gold (54.38%), Rio Tinto (40.00%) and the Indonesia Government (5.62%). Grasberg is the largest gold mine in the world and one of the largest copper mines. The Deep Mill Level Zone (DMLZ) is due to commence production in 2015, and the underground block caving of the remaining part of the Grasberg deposit will be mined from 2017. The DMLZ project has an expected annual production of 140,000 tonnes of copper in concentrate and 52,000 tonnes of gold in concentrate, whilst the Grasberg Block Cave project has an expected annual production of over 325,000 tonnes of copper in concentrate and 78,000 tonnes of gold in concentrate.
Concentrate exports from Grasberg have been on hold since January 2014, pending negotiations with the Indonesian government concerning the newly introduced 25% tax on exports.

BHP Billiton holds a majority stake (75%) in the Indomet coal project, a joint venture with Adaro Energy. This project consists of an estimated 774 million tonnes of coal reserves in five coal deposits, each with an estimated mix of thermal and metallurgical coal and spread over an area of 865,000 acres. BHPB is currently rethinking its development timelines. The central issue with the Indomet project is the large investment required for infrastructure.

Asia Mineral Corporation Limited, Bracken International Mining, Kupang Resources and Western Mining Network Ltd are all hoping to produce high grade manganese in Indonesia. Indonesia’s 2009 Mining Law stipulated that exports of unprocessed ore would be banned from January 12th 2014. However, shortly ahead of the implementation of the ban, the ministry announced plans to ease the ban in order to allow some miners to continue exporting until 2017. The new legislation allows the export of manganese ore which has been processed to a minimum Mn grade of 40%, as opposed to 60% in the original agreement. By way of an alternative, the ministry of finance has issued a progressive export tax under the new regulation in order to continue to encourage the building of smelters in the economy. The tax structure for Manganese ore is as follows: Manganese ore of 49% Mn and greater will be taxed at 20% during 2014; 30% during 2015 H1; 40% during 2015 H2; 50% during 2016 H1 and 60% during 2016 H2. Manganese ore exports will then be banned from 2017. In 2017 and 2018 we expect higher levels of ore output from Indonesia as an integrated ore and alloy project by Asia Mineral Corporation comes online. We anticipate that the ferromanganese plant will come online in 2017 and, as a result the company will ramp up its domestic ore production to feed the alloy unit. Beyond our forecast period we expect the emergence of ferroalloy producers in the economy will allow the ore resources here to be more fully exploited, however, in the meantime output of ore is constrained given the outcomes of the government’s mining law.

2.3.6 Japan

Japan, in comparison with other APEC member economies, is relatively resource-poor. The country’s reserves of nonferrous metals, such as lead, silver, and zinc, are small, with the exception of a medium gold reserve. The economy also has some coal reserves (350,000 tonnes of bituminous and anthracitic coal) however these are not currently exploited.

The Japanese mineral industry is characterized by small-scale low-tonnage mining operations and high-value-added mineral and metal processing and manufacturing activities. In 2012 mineral rent contributed 0.01% to Japan’s GDP and it has an MCI of 36.2, placing it in the lowest 40% of the world’s economies when considering the importance of mining to the national economy. The substantial manufacturing base in Japan generally relies on the import of
raw materials rather than the domestic mineral production. Recognising the need to secure raw material supplies, many major Japanese metals processing corporations have invested in mining projects abroad – for example, the now colossal Australian iron ore export industry was in fact originally founded in the 1960s thanks to long term offtake contracts with Japanese steelmakers, and the provision of Japanese mining machinery and equipment. This trend continues to this day, with Japanese corporations holding stakes in a wide variety of mining operations around the world, including copper in Chile and Peru, iron ore and coal in Australia, and nickel in Indonesia, New Caledonia, and the Philippines.

### Table 2.9: Japan mining data

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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold</td>
<td>tonnes Au</td>
<td>8.4</td>
<td>8.3</td>
<td>7.7</td>
<td>6.2</td>
<td>6.3</td>
<td>6.2</td>
<td>6.2</td>
<td>6.8</td>
<td>6.8</td>
<td>6.8</td>
<td>-1.2%</td>
<td>159</td>
<td>25</td>
</tr>
<tr>
<td>Silver</td>
<td>tonnes Ag</td>
<td>104</td>
<td>54</td>
<td>3.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>-15.5%</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Zinc</td>
<td>1000 t Zn contained</td>
<td>64</td>
<td>42</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-100%</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Lead</td>
<td>1000 t Pb in concentrate</td>
<td>9.90</td>
<td>3.40</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-100%</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Coal</td>
<td>m tonnes</td>
<td>3.13</td>
<td>1.11</td>
<td>0.92</td>
<td>1.32</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>-</td>
<td>350</td>
<td>265</td>
</tr>
</tbody>
</table>

Given Japan’s small quantity of mineral reserves, the economy does not present itself as an attractive mining investment destination. Little mining exploration takes place domestically within Japan, and in the future CRU does not expect any significant expansions to Japanese mining capacity for any major minerals.

### 2.3.7 Malaysia

Malaysia has identified mineral resources of bauxite, iron ore, thermal coal, tin and manganese, and currently produces all of these commodities. In 2013 Malaysia was within the world’s top ten producers of manganese. During the 20th century mineral production was an important sector of the Malaysian economy, with the economy also producing copper. It also used to be one of the world’s most important tin producers. However, in recent years tin concentrate production has fallen and Malaysia has had to depend on imported raw materials from Australia and Indonesia in order to meet the demand for feedstocks for its smelter and refinery. In 2012 mineral rents contributed 0.31% to GDP and coal rents 0.05%. Malaysia has an MCI of 33.4, placing it in the lowest 40% of the world’s economies when considering the importance of mining to the national economy.

In Malaysia the extraction of minerals is governed by the Mineral Development Act 1994 and the State Mineral Enactment. The Mineral Development Act outlines the Federal Government’s
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power to regulate mineral exploration whilst the State Mineral Enactment grants the State the power to issue mineral exploration licences and mining leases. Mining companies are required to pay Corporate Tax to the Federal Government plus a value based royalty to the State in which the mine is located.

Table 2.10: Malaysia mining data

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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bauxite</td>
<td>'000 tonnes</td>
<td>150</td>
<td>150</td>
<td>100</td>
<td>170</td>
<td>170</td>
<td>170</td>
<td>170</td>
<td>170</td>
<td>0.70%</td>
<td>n/a</td>
<td>-</td>
</tr>
<tr>
<td>Iron ore</td>
<td>m tonnes</td>
<td>0.1</td>
<td>0.2</td>
<td>2.8</td>
<td>8.9</td>
<td>12.4</td>
<td>8.7</td>
<td>7.0</td>
<td>5.1</td>
<td>25.25%</td>
<td>285</td>
<td>33</td>
</tr>
<tr>
<td>Coal</td>
<td>'000 tonnes</td>
<td>0.4</td>
<td>0.8</td>
<td>2.4</td>
<td>3.1</td>
<td>3.1</td>
<td>3.1</td>
<td>3.1</td>
<td>3.1</td>
<td>12.22%</td>
<td>4,000</td>
<td>1,307</td>
</tr>
<tr>
<td>Tin</td>
<td>'000 t in concentrate</td>
<td>6.3</td>
<td>2.9</td>
<td>2.7</td>
<td>3.7</td>
<td>3.7</td>
<td>3.4</td>
<td>3.4</td>
<td>3.4</td>
<td>-3.45%</td>
<td>250</td>
<td>75</td>
</tr>
<tr>
<td>Manganese</td>
<td>'000 t contained</td>
<td>0</td>
<td>0</td>
<td>272</td>
<td>360</td>
<td>444</td>
<td>400</td>
<td>400</td>
<td>400</td>
<td>n/a</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

| GDP (current $USD) | billions USD | 94 | 144 | 248 | 305 | 312 | 343 | 380 | 491 | 9.63% | - | - |
| GDP per capita (current $USD) | USD | 3,992 | 5,421 | 8,659 | 10,387 | 10,548 | 11,387 | 12,419 | 15,235 | 7.72% | - | - |
| Mineral rent as a % of GDP | % | 0.02% | 0.05% | 0.21% | 0.31% | n/a | n/a | n/a | n/a | - | - | - |

2.3.7.1 Mining potential and associated risks

Peninsular Malaysia has little mineral resources, and therefore little potential for expanded or new mining operations. Sarawak and Sabah states do have reserves of iron ore and coal, and coal in particular is being assessed for increased production, though increases in output are not expected to be substantial. Generally, however, much of Malaysia’s recent investment in the metals sector is in downstream processing, particularly in Sarawak where new hydro power facilities are encouraging strong growth in power-intensive industries such as aluminium, silicon and ferroalloy smelting.

2.3.8 Mexico

Mexico is one of the more prominent mining economies within APEC. In 2013 it was the world’s largest silver producer, producing 5,500 tonnes. It also fell within the top 10 producers of gold, molybdenum, zinc and lead. The mineral industry is one of the more significant sectors of the Mexican economy, with mineral rents contributing around 1.01% to GDP in 2012, and coal rents 0.03%, in addition to providing the Mexican Government with a major source of income in the form of taxes and royalties. What is more, the mineral industry is an important source of foreign currency for the economy. The prominent mineral producing areas of the economy are located in the north and west-central regions, producing copper, molybdenum, gold, silver, zinc and lead.

With regards the structure of the Mexican mining industry, there are a few large domestic companies which produce a large proportion of the economy’s mineral output. These include: Fresnillo, Grupo Acerero del Norte and Grupo Mexico amongst others.
Under the Mexican Constitution minerals are considered to be part of the nation’s natural patrimony. The law allows for a 100% private equity ownership stake in the exploration, production, and development of mineral resources, including resources previously reserved for direct Government exploitation, such as coal and iron ore. The mining sector is administered by the Secretaria de Economia. The Direcccion General de Minas is the organization in charge of making revisions to the mining law and its regulations, as well as granting concessions and titles. Another piece of legislation which is of particular importance to the Mexican mining industry is that which governs foreign investment (The Law of Foreign Investment). This law seeks to regulate the degree and form of foreign investment in Mexico. Articles 10 to 14 deal with foreign investment in the mineral sector.

### Table 2.11: Mexico mining data

<table>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>'000 t contained Cu</td>
<td>336</td>
<td>368</td>
<td>262</td>
<td>465</td>
<td>452</td>
<td>520</td>
<td>696</td>
<td>748</td>
<td>4.54%</td>
<td>38,000</td>
<td>73</td>
</tr>
<tr>
<td>Gold</td>
<td>tonnes Au</td>
<td>31</td>
<td>31</td>
<td>70</td>
<td>101</td>
<td>99</td>
<td>103</td>
<td>108</td>
<td>116</td>
<td>7.60%</td>
<td>1,400</td>
<td>14</td>
</tr>
<tr>
<td>Silver</td>
<td>tonnes Ag</td>
<td>2,660</td>
<td>2,913</td>
<td>4,351</td>
<td>5,190</td>
<td>5,458</td>
<td>5,322</td>
<td>5,836</td>
<td>6,321</td>
<td>4.93%</td>
<td>37,000</td>
<td>7</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>'000 t Mo</td>
<td>6.8</td>
<td>4.1</td>
<td>10.4</td>
<td>10.9</td>
<td>12.2</td>
<td>13.6</td>
<td>13.2</td>
<td>15.0</td>
<td>4.48%</td>
<td>130</td>
<td>10</td>
</tr>
<tr>
<td>Zinc</td>
<td>'000 t Zn contained</td>
<td>400</td>
<td>473</td>
<td>548</td>
<td>615</td>
<td>610</td>
<td>647</td>
<td>672</td>
<td>769</td>
<td>3.62%</td>
<td>18,000</td>
<td>28</td>
</tr>
<tr>
<td>Lead</td>
<td>'000 t Pb in concentrate</td>
<td>138</td>
<td>134</td>
<td>192</td>
<td>238</td>
<td>252</td>
<td>267</td>
<td>268</td>
<td>306</td>
<td>4.52%</td>
<td>5,600</td>
<td>21</td>
</tr>
<tr>
<td>Iron ore</td>
<td>m tonnes</td>
<td>20</td>
<td>26</td>
<td>27</td>
<td>28</td>
<td>30</td>
<td>25</td>
<td>24</td>
<td>23</td>
<td>0.80%</td>
<td>2,021</td>
<td>79</td>
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<tr>
<td>Coal</td>
<td>m tonnes</td>
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<td>11</td>
<td>12</td>
<td>14</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>1,211</td>
<td>88</td>
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<td>Manganese</td>
<td>'000 t contained</td>
<td>91</td>
<td>129</td>
<td>162</td>
<td>177</td>
<td>201</td>
<td>208</td>
<td>208</td>
<td>208</td>
<td>-</td>
<td>5,000</td>
<td>-</td>
</tr>
<tr>
<td>GDP (current USD)</td>
<td>billions USD</td>
<td>684</td>
<td>866</td>
<td>1,051</td>
<td>1,184</td>
<td>1,259</td>
<td>1,286</td>
<td>1,361</td>
<td>1,608</td>
<td>4.87%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>GDP per capita (current USD)</td>
<td>USD</td>
<td>6,977</td>
<td>8,184</td>
<td>9,194</td>
<td>10,111</td>
<td>10,630</td>
<td>10,767</td>
<td>11,269</td>
<td>12,925</td>
<td>3.48%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mineral rent as a % of GDP</td>
<td>%</td>
<td>0.07%</td>
<td>0.22%</td>
<td>0.73%</td>
<td>1.01%</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>-</td>
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</tr>
</tbody>
</table>

### 2.3.8.1 Mining potential and associated risks

The mineral sector will continue to be of great importance to the Mexican economy, with a large quantity of mineral reserves still be exploited. As mentioned above, the mineral industry is a very important source of foreign currency for Mexico, and will become even more so if the prices of copper, gold and silver increase. What is more, the continued growth of the Mexican economy has helped all industries, with expectation of further growth in the short to medium term. The promotion of the mineral industry in Mexico is carried out by the Subsecretaria de Minas, a government agency created in 2007 to coordinate and promote the development of the mineral industry in Mexico.

In 2013 Mexico attracted 6% of the global non-ferrous exploration budget, equivalent to approximately USD$900 million, placing it inside the top 10 economies in terms of non-ferrous exploration spending. This figure is down from USD$1.2 billion in 2012.

Asia-Pacific mining sector study
2.3.8.2 Major mining projects

Fresnillo’s Saucito II expansion project is due to enter into production during the last quarter of 2014. The project had annual anticipated production of 8.4 million ounces of silver (~238 tonnes) and 35,000 ounces (~1 tonne) of gold. The project comprises the construction of a beneficiation plant.

The Juanicipio project, located in the Fresnillo district, is a joint venture between Fresnillo (56%) and MAG Silver (44%). At present the Juanicipio property hosts three significant high-grade silver (gold, lead and zinc) veins, making it one of the world’s largest undeveloped silver resources. Underground development at the Juanicipio project started in October 2013. The project has anticipated annual production of 153 million ounces of silver, 430,000 ounces of gold and 584 million pounds of zinc from the production of lead, zinc and pyrite concentrates.

2.3.9 New Zealand

The output of the mineral industry of New Zealand is relatively small compared to that of the other APEC member economies. The economy currently produces gold, silver and coal. It also produces iron concentrates produced from mineral sands, which also contain titanium and vanadium. In 2012 mineral rents contributed 0.58% to GDP and coal rents 0.07%. The MCI for New Zealand is 43.2, placing it within the bottom 60% of economies globally when considering how important mining is to the national economy.

The Crown Minerals Act provides a legislative framework for all prospecting, exploring for and mining of Crown-owned minerals. The Ministry of Economic Development, through the Crown Minerals Group, is responsible for the overall management of all state-owned minerals in New Zealand. Crown-owned minerals include gold and silver and all minerals on or under Crown-owned land.

Table 2.12: New Zealand mining data

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Gold</td>
<td>tonnes Au</td>
<td>14</td>
<td>14</td>
<td>15</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>15</td>
<td>0.35%</td>
<td>317</td>
<td>0.35%</td>
<td>22</td>
</tr>
<tr>
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<td>43</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>1.02%</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
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<td>m tonnes</td>
<td>3.5</td>
<td>5.3</td>
<td>5.3</td>
<td>4.9</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>1.02%</td>
<td>571</td>
<td>115</td>
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</table>

GDP (current $USD) billions USD 53 112 142 170 181 196 205 232 8.50% -
GDP per capita (current $USD) USD 13,833 27,118 32,518 38,385 40,481 43,429 44,958 49,735 7.37% -
Mineral rent as a % of GDP % 0.15% 0.18% 0.52% 0.58% n/a n/a n/a n/a -

Gold reserves based on reserves at active gold operations in New Zealand.

2.3.9.1 Mining potential and associated risks

Most of the minerals produced in New Zealand are consumed locally, with coal and gold being the leading export commodities. Production of other metallic minerals, such as bauxite, copper,
lead, and zinc, could potentially be economically feasible if technologies and prices become favourable. It is important to note that the development of the mining industry in New Zealand is constrained by the population’s concerns over environmental issues and the ecological sensitivity of the economy, coupled with the fact that New Zealand is located a considerable distance away from the world’s major industrial markets. For these reasons New Zealand’s mineral development is expected to grow in size at a very slow rate, if at all.

2.3.10 Papua New Guinea

Of the APEC member economies, Papua New Guinea is the economy that depends most heavily on the mining sector, with mineral rents contributing 24.01% to GDP in 2012. What is more, the MCI for Papua New Guinea is 95.5, which places it in the highest 20% of economies globally when considering the importance of the mining industry to the national economy. That said, Papua New Guinea is the smallest of the APEC member economies, with a GDP of just USD$15.97 billion in 2013, and therefore in terms of production quantity it is not as significant as other APEC member economies. Papua New Guinea currently produces gold, silver and copper, however copper production may cease in the near future due to the depletion of the Ok Tedi mine, which was nationalised by the Papua New Guinean government in 2013.

Several private international mining companies are majority owners or shareholders in producing metals operations in Papua New Guinea, including Newcrest Mining Ltd. of Australia, which wholly owned the Lihir Island Mine.

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</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>1000 t contained Cu</td>
<td>203</td>
<td>193</td>
<td>160</td>
<td>125</td>
<td>120</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-100.00%</td>
<td>17,690</td>
</tr>
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<td>tonnes Au</td>
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<td>69</td>
<td>67</td>
<td>58</td>
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<td>62</td>
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</tr>
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<td>tonnes Ag</td>
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<td>50</td>
<td>86</td>
<td>70</td>
<td>71</td>
<td>67</td>
<td>67</td>
<td>67</td>
<td>0.48%</td>
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</tr>
<tr>
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<td>1000 t contained Ni</td>
<td>-</td>
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<td>-</td>
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<td>11</td>
<td>24</td>
<td>28</td>
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<td>86</td>
<td>70</td>
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<td>67</td>
<td>67</td>
<td>67</td>
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<td>28</td>
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<tr>
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<td>Silver</td>
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<td>24</td>
<td>28</td>
<td>31</td>
<td>n/a</td>
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<td>125</td>
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<td>100</td>
<td>-</td>
<td>-</td>
<td>-100.00%</td>
<td>17,690</td>
</tr>
<tr>
<td>Gold</td>
<td>tonnes Au</td>
<td>69</td>
<td>69</td>
<td>67</td>
<td>58</td>
<td>61</td>
<td>62</td>
<td>63</td>
<td>67</td>
<td>0.17%</td>
<td>1,200</td>
</tr>
<tr>
<td>Silver</td>
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<td>73</td>
<td>50</td>
<td>86</td>
<td>70</td>
<td>71</td>
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<td>67</td>
<td>67</td>
<td>0.48%</td>
<td>n/a</td>
</tr>
<tr>
<td>Nickel</td>
<td>1000 t contained Ni</td>
<td>-</td>
<td>-</td>
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<td>5.28</td>
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<td>24</td>
<td>28</td>
<td>31</td>
<td>n/a</td>
<td>4,277</td>
</tr>
</tbody>
</table>

2.3.10.1 Mining potential and associated risks

Papua New Guinea is a mineral-rich nation, and its economy is expected to see positive economic growth in the short term if commodity prices remain high. Mineral resources in Papua New Guinea are owned by the State.

Within South East Asia, Papua New Guinea is one of the top non-ferrous exploration budget destinations, along with Indonesia and the Philippines. In 2013 South East Asia attracted 7% of
the global non-ferrous exploration, equivalent to around USD$1 billion. Of that around USD$820 million went to the three prominent mining economies within the region, Papua New Guinea, Indonesia and the Philippines, down from USD1.1 billion in 2012.

2.3.10.2 Major mining projects
In January 2013 Newcrest Mining Limited announced the expansion of their Lihir operation on Niolam Island in the New Ireland Province of Papua New Guinea. The gold deposit at Lihir is within the Luise Caldera, an extinct volcanic crater that is geo-thermally active, and is one of the largest known gold deposits in the world. Most of the gold ore is refractory in nature (meaning that it is resistant to the traditional beneficiation processes of standard cyanidation and carbon adsorption). For this reason, the ore at Lihir is treated using pressure oxidation before the gold is recovered via a conventional leach process. The expansion involves the installation of a new crushing facility, upgrades to the ore processing plant and additional power generation capacity and water supply. The expansion should increase annual gold production from around 650,000 ounces (~18 tonnes) to 1.2 million ounces (~34 tonnes).

2.3.11 Peru
In 2013 Peru fell within the top 10 producers for 7 of the 12 commodities covered by this report. What is more, it is the third most mining dependent APEC member economy after Papua New Guinea and Chile, with mineral rents contributing 8.64% to GDP in 2012, and an MCI of 88.0, placing in the top 20% of economies globally when considering how important mining is to the national economy.

Peru currently produces significant quantities of copper, gold, silver, molybdenum, zinc, lead, iron ore, thermal coal and tin. In 2013 Peru was the third largest miner of copper after Chile and China, and the third largest miner of silver after Mexico and China. The main copper and silver miners that currently operate in Peru are listed in the table below. The largest copper miner in Peru at present is Minera Antamina, with the mine producing 461,000 tonnes of copper in 2013. This operation is a joint venture between BHP Billiton, Glencore, Teck and Mitsubishi. The largest silver producer in Peru in 2013 was Compañía de Minas Buenaventura S.A.A, producing 529 tonnes of silver.
Asia-Pacific mining sector study

The majority of the economy’s domestic private investment (DPI) is sustained by projects in the mining and hydrocarbon sectors, with the mining sector also receiving about a quarter of the economy’s foreign direct investment (FDI). DPI and FDI have been increasing thanks to economy’s macroeconomic stability, laws encouraging investment and the community involvement initiated by some mining operating companies. Furthermore, the FDI in Peru helps to encourage technology transfer and brings with it additional management expertise. The stability of the Peruvian judicial framework has also helped to encourage investment in mining.

### Table 2.14: Major copper and silver miners in Peru, 2013.

<table>
<thead>
<tr>
<th>Company</th>
<th>Mine</th>
<th>Cu production ('000 tonnes)</th>
<th>Ag production (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minera Antamina</td>
<td>Antamina</td>
<td>461</td>
<td>521</td>
</tr>
<tr>
<td>Southern Peru Copper Corporation</td>
<td>Cuaione 1</td>
<td>126</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>60</td>
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</tr>
<tr>
<td></td>
<td>Toquepala 1</td>
<td>52</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Acumulacion Cuaione</td>
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<tr>
<td></td>
<td>Simarrona</td>
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<td>8</td>
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<tr>
<td></td>
<td>Cocotea</td>
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<td>5</td>
</tr>
<tr>
<td></td>
<td>Total Southern Peru Copper Corporation</td>
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<td>112</td>
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<tr>
<td>Minera Cerro Verde</td>
<td>Cerro Verde</td>
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<td>Glencore (Minera Antapaccay)</td>
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<td>Minera Milpo</td>
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<td>Total Minera Milpo</td>
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<td>Julcani</td>
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<td>84</td>
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<td>Mallay</td>
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<td>Breapampa</td>
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<td></td>
<td>Orcopampa</td>
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<td>Total Compañía de Minas Buenaventuras S.A.A.</td>
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<td>Andaychagua</td>
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<td>111</td>
</tr>
<tr>
<td></td>
<td>Carahuaica</td>
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<td>34</td>
</tr>
<tr>
<td></td>
<td>Colombia y Socabon Santa Rosa</td>
<td>0</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Ticlio</td>
<td>1</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Morada</td>
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<td>0</td>
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<tr>
<td></td>
<td>Santa Cecilia</td>
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<td>0</td>
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<td></td>
<td>Total Volcan Compañía Minera S.A.A</td>
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<td>Minera Suyamarca S.A.C</td>
<td>Acumulación Pallancata</td>
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<tr>
<td>Others</td>
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<td></td>
<td>150</td>
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<tr>
<td>Total Peru production (Cu &amp; Ag)</td>
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<td>3,674</td>
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Data: DIRECCIÓN GENERAL DE MINERÍA - DPM - Estadística Minera
Asia-Pacific mining sector study

Table 2.15: Peru mining data

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</thead>
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<td>1,441</td>
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<td>161</td>
<td>148</td>
<td>-1.87%</td>
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<tr>
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<td>3,640</td>
<td>3,481</td>
<td>3,674</td>
<td>4,033</td>
<td>4,257</td>
<td>4,376</td>
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<td>17</td>
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<td>18</td>
<td>20</td>
<td>31</td>
<td>42</td>
<td>10.27%</td>
<td>450</td>
<td>23</td>
</tr>
<tr>
<td>Zinc</td>
<td>'000 t Zn contained</td>
<td>895</td>
<td>1,138</td>
<td>1,398</td>
<td>1,183</td>
<td>1,255</td>
<td>1,267</td>
<td>1,347</td>
<td>1,412</td>
<td>2.57%</td>
<td>24,000</td>
<td>19</td>
</tr>
<tr>
<td>Lead</td>
<td>'000 t Pb in concentrate</td>
<td>271</td>
<td>319</td>
<td>262</td>
<td>249</td>
<td>267</td>
<td>279</td>
<td>294</td>
<td>307</td>
<td>0.71%</td>
<td>7,500</td>
<td>27</td>
</tr>
<tr>
<td>Iron ore</td>
<td>m tonnes</td>
<td>2.69</td>
<td>5.02</td>
<td>4.60</td>
<td>6.35</td>
<td>6.68</td>
<td>8.37</td>
<td>8.38</td>
<td>7.22</td>
<td>5.64%</td>
<td>10,853</td>
<td>1,297</td>
</tr>
<tr>
<td>Coal</td>
<td>m tonnes</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Tin</td>
<td>'000 t tin in concentrate</td>
<td>37</td>
<td>42</td>
<td>34</td>
<td>26</td>
<td>24</td>
<td>24</td>
<td>23</td>
<td>21</td>
<td>-3.12%</td>
<td>91</td>
<td>4</td>
</tr>
</tbody>
</table>

GDP (current $USD) | billions USD | 53 | 79 | 154 | 200 | 207 | 217 | 236 | 296 | 9.98% | - | - |
GDP per capita (current $USD) | USD | 2,117 | 2,917 | 5,205 | 6,555 | 6,674 | 6,895 | 7,396 | 8,848 | 8.27% |
Mineral rent as a % of GDP | % | 0.56% | 3.92% | 9.15% | 8.64% | n/a | n/a | n/a | n/a | - | - | - |

2.3.11.1 Mining potential and associated risks

Peru has large quantities of yet to be exploited mineral resources. Furthermore, the economy has a stable economy and law which encourage investment in mining by way of joint venture, consortia, privatizations and direct acquisitions.

In 2013 Peru attracted 5% of the global non-ferrous exploration budget, equivalent to around USD$700 million, making it the second most important non-ferrous exploration investment destination in South America after Chile.

In the future it is expected that the mineral sector will continue to play an important role in the Peruvian economy, and increased demand for copper, gold, iron ore and silver and increased metals prices are likely to encourage mining companies to invest in modernising and expanding their operations.

One aspect of the Peruvian mining environment which could inhibit future mining in the economy is that of community opposition to projects. Several projects have experienced significant delays due to worker strike action and local community-led road blockages or disruptions. This is something that is currently being addressed, with extra emphasis being placed on community approval of projects, in addition to well thought out social responsibility initiatives for every new mine.

2.3.11.2 Major mining projects

Hochschild’s Inmaculada gold and silver project is located in Southern Peru, around 210 kilometres southwest of Cusco. Project construction started during the final quarter of 2013. The life of mine is estimated at 6.3 years, which annual average gold production of 124,000 ounces.
and 4.2 million ounces of silver. It is anticipated that the plant will process 3,500 tonnes per day of ore. The commissioning date for the project is currently set as the second half of 2014.

Chinalco’s Toromocho project will produce copper with a molybdenum by-product. The operation will include a concentrating plant able to process up to 117,000 tonnes of material per day, with an expected annual production of 250,000 tonnes of copper in concentrate and 10,000 tonnes of molybdenum by-product, making it one of the most significant molybdenum by-product projects (after Sierra Gorda in Chile). The project was commissioned at the start of 2014, and the company has reported that the ramp-up schedule is on course.

2.3.12 Philippines

In 2013 the Philippines was the world’s second largest producer of mined nickel after Indonesia, producing 302,000 tonnes. The economy also produces copper, gold, silver, zinc and coal. In 2012 mineral rents represented 2.46% of GDP and coal rents 0.06%. The MCI for the Philippines is 69.9, placing it within the top 20% of economies globally in terms of the importance of mining to the national economy.

The 1995 Philippine Mining Act regulates mineral resource development, requires the Government to monitor mining data (production, trade, and value) and maintain a database of mineral reserves, and encourages direct investment by the private and public sectors in mineral exploration and development activities in the Philippines. It is considered a world-class legal framework for minerals development, and was affirmed by a 2005 Supreme Court decision. However, the Act is not necessarily respected and implemented throughout the country – for example, some local governments have closed their provinces to mining. Furthermore, a moratorium is currently in place on the approval of mining projects pending the passage of a law on the revenue sharing scheme between industry and government, preventing progress on greenfield mines. The government has also implemented a series of ‘no-go’ zones in which new mining operations are not permitted, which cover more than 50% of the Philippines’ land mass.

Some of the main producers of mineral commodities in the Philippines are CGA Mining Ltd. of Australia (gold and silver); Lafayette Mining Ltd. of Australia (copper, gold, and silver); and Nickel Asia Corp. of the Philippines (nickel) amongst others.
South East Asia attracted 7% of the global non-ferrous exploration budget in 2013, equivalent to around USD$1 billion. Of that around USD$820 million went to the three prominent mining economies within the region, Papua New Guinea, Indonesia and the Philippines, down from USD1.1 billion in 2012.

It is expected that the mineral sector will continue to play an important role in the Filipino economy in the future. The production of copper, gold and nickel is expected to increase as major exploration activities result in new discoveries and increases in resources and as proposed developments are commissioned in the near future, such as the Tampakan project mentioned below. It should be noted, however, that government mining policy is currently acting as a deterrent to mining investment, and that this could be a risk to future growth in the economy’s mining industry.

### 2.3.12.2 Major mining projects

The **Tampakan** project is an open-pit Greenfield copper and gold mine in the south east of the southern island of Mindanao. It is a joint venture between Glencore (25%), Indophil Resources NL (15%) and the Tampakan Group of Companies (60%). A controlling 40% equity of the Tampakan copper-gold project resides with Sagittarius Mines Inc. (SMI), a joint-venture between Glencore Xstrata (62.5%) and Indophil (37.5%). Recently Glencore has expressed an interest in divesting its stake in the project, which may put the future of the project in doubt if another investor cannot be found. The project, if it goes ahead, would be one of the world’s largest copper and gold operations, with an annual average production of 375,000 tonnes of copper in concentrate and 400,000 ounces of gold, over a 33 year mine life. At present, CRU expects the project to start operating in 2025.

### Table 2.16: Philippines mining data

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</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>'000 t contained Cu</td>
<td>33</td>
<td>16</td>
<td>58</td>
<td>65</td>
<td>90</td>
<td>88</td>
<td>89</td>
<td>38</td>
<td>5.71%</td>
<td>28,371</td>
<td>321</td>
</tr>
<tr>
<td>Gold</td>
<td>tonnes Au</td>
<td>38</td>
<td>38</td>
<td>41</td>
<td>41</td>
<td>40</td>
<td>41</td>
<td>43</td>
<td>50</td>
<td>1.49%</td>
<td>1,422</td>
<td>35</td>
</tr>
<tr>
<td>Silver</td>
<td>tonnes Ag</td>
<td>23</td>
<td>19</td>
<td>21</td>
<td>21</td>
<td>17</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>-0.77%</td>
<td>n/a</td>
<td>-</td>
</tr>
<tr>
<td>Zinc</td>
<td>'000 t contained Zn</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>20</td>
<td>16</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>n/a</td>
<td>-</td>
</tr>
<tr>
<td>Nickel</td>
<td>'000 t contained Ni</td>
<td>19</td>
<td>32</td>
<td>190</td>
<td>304</td>
<td>302</td>
<td>312</td>
<td>316</td>
<td>333</td>
<td>17.23%</td>
<td>1,100</td>
<td>4</td>
</tr>
<tr>
<td>Coal</td>
<td>m tonnes</td>
<td>1.4</td>
<td>2.9</td>
<td>6.7</td>
<td>6.7</td>
<td>8.0</td>
<td>8.0</td>
<td>8.0</td>
<td>8.0</td>
<td>10.37%</td>
<td>316</td>
<td>40</td>
</tr>
</tbody>
</table>

| GDP (current USD) | billions USD | 81  | 103  | 200  | 250  | 272  | 292  | 333  | 466  | 10.21%            | -                              | -                         |
| GDP per capita (current USD) | USD | 1,055 | 1,209 | 2,155 | 2,612 | 2,790 | 2,935 | 3,279 | 4,334 | 8.17%            | -                              | -                         |
| Mineral rent as a % of GDP | % | 0.25% | 0.55% | 2.69% | 2.46% | n/a  | n/a  | n/a  | n/a  | -                 | -                              | -                         |
2.3.13 Russia

Russia is one of the world’s leading mining economies, and in 2013 was within the top 10 producers of 9 of the 12 commodities covered by this report. In 2012 minerals rents contributed 1.31% to GDP and coal rents 0.88%. The MCI for Russia is 47.6, placing it in the top 40% globally when considering the importance of mining to the national economy.

A strategy for development of the geological industry of the Russian Federation until 2030 was approved in June 2010. The key objective of the strategy is to provide the competitive ability of the country’s geological industry in the conditions of globalisation and escalating competition in international markets of mineral resources, maintenance services, and subsoil plots offered for use. In February 2011 the Russian Government adopted a new program for the development of the economy’s coal industry through to 2030. Annual coal production is currently around 355 million tonnes a year, however this is set to increase significantly, potentially doubling over the next 20 years. The coal development program also includes actions that need to be carried out in order to facilitate growth of the Russian coal industry, such as infrastructure improvements.

The Russian economy is driven by commodities thanks to the economy’s large stock of natural resources, and more than two-thirds of Russia’s stock market is dominated by extractive industries. Russia attracted a considerable amount of Foreign Direct Investment (FDI) in mineral extraction in the early 2000s, with FDI peaking in the mid-2000s following the liberalisation of certain sectors of the economy. Although FDI is yet to match the peak seen during the last decade Russia still remains an FDI destination. The FDI is concentrated in the resource rich regions and is motivated by the continued strong growth of the Russian consumer market and affordable labour costs. However, when compared with other emerging markets Russian net FDI is low, at just 2.51% of GDP (compared to 6.01% in Peru and 11.24% in Chile). One concern expressed by investors relates to a perception that the rule of law in Russia does not provide sufficient guarantee that a company’s property rights will be protected. This is of particular importance to mining companies, as the construction of a mining operation can take up to 10 years and requires a significant amount of investment up-front before any revenues are generated. One foreign mining company that has successfully invested in operations in Russia is the Canadian gold miner Kinross, who has been operating in Russia since 1995.
Russia will continue to be an important mining economy in the future and one of the world’s leading mineral producers. It has large reserves of a variety of commodities.

In recent years volatility in the price of minerals has lead some Russian mining companies to diversify their project holdings, for example Norilsk Nickel’s interest in coal and iron ore. Furthermore, Russia is starting to use Government regulation to influence the mineral industry and encourage production of strategic minerals that are not deemed attractive on a purely market economy, such as tin. Given these trends, it is likely that Russia’s mineral sector will become more resilient to the price volatility of minerals, technology changes and the cyclical nature of the economy.

In 2013 Russia attracted 5% of the global non-ferrous exploration budget, equivalent to approximately USD$700 million, an increase from around USD$600 million in 2012.

### 2.3.13.2 Major mining projects

The [Project Natalka gold](#) project, which belongs to Russia’s largest gold producer, Polyus Gold International, is due to be commissioned in 2015. Natalka has the potential to eventually reach an annual output of 1.5 million ounces (~43 tonnes). It is located about 400 km from the sea port of Magadan in the Far East of Russia, and is one of the largest known undeveloped gold deposits in the world. The mine is expected to have a processing capacity of 10 million tonnes.

### Table 2.17: Russia mining data

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>'000 t contained Cu</td>
<td>495</td>
<td>628</td>
<td>649</td>
<td>650</td>
<td>664</td>
<td>695</td>
<td>711</td>
<td>747</td>
<td>2.31%</td>
<td>30,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gold</td>
<td>tonnes Au</td>
<td>172</td>
<td>172</td>
<td>189</td>
<td>218</td>
<td>223</td>
<td>228</td>
<td>234</td>
<td>232</td>
<td>1.67%</td>
<td>5,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silver</td>
<td>tonnes Ag</td>
<td>625</td>
<td>1,260</td>
<td>1,150</td>
<td>1,400</td>
<td>1,407</td>
<td>1,264</td>
<td>1,264</td>
<td>1,257</td>
<td>3.96%</td>
<td>n/a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molybdenum</td>
<td>'000 t Mo</td>
<td>3.63</td>
<td>4.99</td>
<td>4.99</td>
<td>4.99</td>
<td>4.08</td>
<td>5.44</td>
<td>5.44</td>
<td>5.44</td>
<td>2.28%</td>
<td>250</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zinc</td>
<td>'000 t contained Zn</td>
<td>158</td>
<td>183</td>
<td>241</td>
<td>265</td>
<td>249</td>
<td>255</td>
<td>268</td>
<td>293</td>
<td>3.48%</td>
<td>n/a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead</td>
<td>'000 t Pb in concentrate</td>
<td>14</td>
<td>36</td>
<td>97</td>
<td>134</td>
<td>144</td>
<td>160</td>
<td>168</td>
<td>190</td>
<td>15.59%</td>
<td>9,200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nickel</td>
<td>'000 t contained Ni</td>
<td>262</td>
<td>281</td>
<td>273</td>
<td>275</td>
<td>264</td>
<td>264</td>
<td>264</td>
<td>264</td>
<td>0.03%</td>
<td>6,100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bauxite</td>
<td>m tonnes</td>
<td>5</td>
<td>6</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>0.56%</td>
<td>200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron ore</td>
<td>m tonnes</td>
<td>87</td>
<td>86</td>
<td>91</td>
<td>99</td>
<td>99</td>
<td>96</td>
<td>100</td>
<td>100</td>
<td>0.76%</td>
<td>14,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coal</td>
<td>m tonnes</td>
<td>258</td>
<td>298</td>
<td>322</td>
<td>335</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>157,010</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tin</td>
<td>'000 t tin in concentrate</td>
<td>4.7</td>
<td>4.1</td>
<td>0.5</td>
<td>0.4</td>
<td>0.4</td>
<td>0.5</td>
<td>9.5</td>
<td>3.93%</td>
<td>350</td>
<td>875</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manganese</td>
<td>'000 t contained manganese</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>6</td>
<td>10</td>
<td>30</td>
<td>48</td>
<td>118</td>
<td>n/a</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 2.3.13.1 Mining potential and associated risks

Russia will continue to be an important mining economy in the future and one of the world’s leading mineral producers. It has large reserves of a variety of commodities.

In recent years volatility in the price of minerals has lead some Russian mining companies to diversify their project holdings, for example Norilsk Nickel’s interest in coal and iron ore. Furthermore, Russia is starting to use Government regulation to influence the mineral industry and encourage production of strategic minerals that are not deemed attractive on a purely market economy, such as tin. Given these trends, it is likely that Russia’s mineral sector will become more resilient to the price volatility of minerals, technology changes and the cyclical nature of the economy.

In 2013 Russia attracted 5% of the global non-ferrous exploration budget, equivalent to approximately USD$700 million, an increase from around USD$600 million in 2012.
per year of ore at the launch of its operations. Mill throughput will then gradually be increased to 40 million tonnes of ore per year.

The key coal project on the horizon in Russia is the Elga Coal Complex owned by Mechel. The deposit is located in South Eastern Yakutia and the company was originally aiming to reach a raw coal output of 9 million tonnes per year by 2014, of which 2.4 million tonnes would be metallurgical coal. We expect that impact of this project on total Russian coal production will be seen in the latter years of our forecast period.

### 2.3.14 South Korea

South Korea has limited mineral resources, and currently produces a very small amount of iron ore, coal and molybdenum. Most of the economy’s mineral resource requirements are met through imports. As with Japan, many South Korean metal processors have investments in mining projects to secure raw materials – for example POSCO, the economy’s largest steelmaker, holds a share in the Roy Hill iron ore project. No reserves estimates are publicly available for Korea.

Korea has an MCI of 35.1, placing it in the lowest 40% of economies globally when considering the importance of mining to the national economy. The economy does not have significant mining potential.

#### Table 2.18: South Korea mining data

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Molybdenum</td>
<td>'000 tonnes of Mo</td>
<td>-</td>
<td>-</td>
<td>0.45</td>
<td>0.45</td>
<td>0.45</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>n/a</td>
<td>-</td>
</tr>
<tr>
<td>Zinc</td>
<td>'000 t contained Zn</td>
<td>11.50</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Iron ore</td>
<td>m tonnes</td>
<td>0.33</td>
<td>0.45</td>
<td>0.10</td>
<td>0.11</td>
<td>0.11</td>
<td>-0.00</td>
<td>-0.00</td>
<td>-0.00</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Coal</td>
<td>m tonnes</td>
<td>4.15</td>
<td>2.81</td>
<td>2.08</td>
<td>2.09</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>126</td>
<td>60</td>
</tr>
</tbody>
</table>

| GDP (current $USD) | billions USD | 533 | 845 | 1,105 | 1,130 | 1,222 | 1,308 | 1,396 | 1,739 | 6.79% | - | - |
| GDP per capita (current $USD) | USD | 11,347 | 17,551 | 20,540 | 22,590 | 24,329 | 25,931 | 27,553 | 33,885 | 6.27% | - | - |
| Mineral rent as a % of GDP | % | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | - | - |

#### 2.3.15 Chinese Taipei

Chinese Taipei is an island with very few mineral resources. Chinese Taipei used to have significant resources of gold, copper and coal, however, after several decades of mining nearly all the recoverable coal and metallic minerals have been depleted. Chinese Taipei has a substantial downstream metals processing industry, including significant volumes of steelmaking capacity, which rely on imported raw materials.
### Table 2.19: Chinese Taipei mining data

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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>m tonnes</td>
<td>0.08</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-100%</td>
<td>1</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>GDP (current $USD)</td>
<td>billions USD</td>
<td>326</td>
<td>365</td>
<td>428</td>
<td>475</td>
<td>489</td>
<td>502</td>
<td>534</td>
<td>651</td>
<td>3.92%</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>GDP per capita (current $USD)</td>
<td>USD</td>
<td>14,641</td>
<td>16,023</td>
<td>18,488</td>
<td>20,396</td>
<td>20,930</td>
<td>21,436</td>
<td>22,743</td>
<td>27,524</td>
<td>3.57%</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

### 2.3.16 Thailand

Thailand, similar to Chinese Taipei, also has very limited natural resources. The economy currently produces small quantities of silver, zinc and manganese. In 2012 mineral rents contributed 0.05% to GDP and the economy has an MCI of 49.9, placing it in the top 40% of economies globally when considering the importance of mining to the economy. It is important to note that the data used to calculated the MCI was from 2010, which may provide a slightly distorted figure as a significant amount of manganese was mined in Thailand in 2010, which fell dramatically in subsequent years.

The Ministry of Industry is the principal government agency that oversees the economy’s mineral sector. The Ministry’s Department of Primary Industry and Mines (DPIM) administers the Minerals Act and issues mining regulations. The DPIM also provides technical assistance to the metallurgical, mineral processing, and mining industries. The Department of Mineral Resources (DMR) drafts national mineral policies and provides technical assistance for geologic prospecting and mineral exploration. However, given the relatively limited mineral wealth of the economy, little potential for expansion of the mining industry in Thailand is expected. In fact, Thailand is expected to stop mining one of its major products – zinc – by 2018.

### Table 2.20: Thailand mining data

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</tr>
</thead>
<tbody>
<tr>
<td>Silver</td>
<td>tonnes Ag</td>
<td>5</td>
<td>8</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>0.00%</td>
<td>n/a</td>
<td>100%</td>
</tr>
<tr>
<td>Zinc</td>
<td>'000 t Zn contained</td>
<td>27</td>
<td>51</td>
<td>26</td>
<td>31</td>
<td>30</td>
<td>30</td>
<td>0</td>
<td>-0.37%</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Lead</td>
<td>'000 t Pb in concentrate</td>
<td>11</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-100%</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Tin</td>
<td>'000 t tin in concentrate</td>
<td>0.1</td>
<td>0.1</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>170</td>
<td>567</td>
<td>-</td>
</tr>
<tr>
<td>Manganese</td>
<td>'000 t contained Mn</td>
<td>-</td>
<td>-</td>
<td>26.9</td>
<td>8.1</td>
<td>6.7</td>
<td>6.7</td>
<td>6.7</td>
<td>6.7</td>
<td>n/a</td>
<td>n/a</td>
<td>100%</td>
</tr>
<tr>
<td>GDP (current $USD)</td>
<td>billions USD</td>
<td>123</td>
<td>176</td>
<td>319</td>
<td>366</td>
<td>387</td>
<td>374</td>
<td>393</td>
<td>464</td>
<td>7.67%</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>GDP per capita (current $USD)</td>
<td>USD</td>
<td>1,983</td>
<td>2,708</td>
<td>4,740</td>
<td>5,390</td>
<td>5,674</td>
<td>5,450</td>
<td>5,704</td>
<td>6,659</td>
<td>6.96%</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Mineral rent as a % of GDP} % 0.01% 0.03% 0.06% 0.05% n/a n/a n/a n/a n/a n/a - -}
2.3.17 USA

The United States has a large and varied mining sector. In 2013 it was within the top ten producers for eight of the 11 commodities covered by this report. It is an important producer of gold, copper, coal, iron ore, zinc, lead, molybdenum and silver. In 2012 mineral rents contributed 0.15% to GDP and coal rents 0.15%. The United States has a MCI of 49.8, ranking it 11 out of the 21 APEC economies when considering how important mining is to the national economy.

Copper production is concentrated in the states of Arizona, Utah, New Mexico, Nevada, and Montana, with around 30 copper mines currently operational in the United States. The United States also has a well developed downstream copper industry.

The United States was the world’s 3rd largest gold producer in 2013, producing around 225 tonnes. The economy’s gold production is mainly concentrated in Alaska and the Western states. It was also the world’s 8th largest silver producer, producing 112,000 tonnes in 2013. Alaska is the economy’s leading silver producing state, followed by Nevada.

Iron ore production predominantly takes place in the states of Michigan and Minnesota, with 11 iron ore mines operational in 2013. In 2013 the economy was the 9th largest producer of iron ore, producing 50 million tonnes. Nearly all iron ore is concentrated and/or pelletized before shipment, with the vast majority being consumed by the domestic iron and steel industry and only a small percentage being shipped abroad.

Lead is produced in the states of Missouri, Alaska and Idaho. The United States was the world’s 3rd largest producer of lead in 2013. The amount of primary refined lead (from mined lead converted into concentrates), 347,000 tonnes, produced in 2013 was eclipsed by the large quantity of secondary refined lead (from scrap) that was produced, around 1.1 million tonnes. The majority of the lead produced was consumed domestically by manufacturing industries, mainly the lead-acid battery industry. Also, the United States was the world’s 5th largest zinc producer in 2013, with production of 775,000 tonnes.

Molybdenum is produced as a by-product by the US copper industry, and there are also several molybdenum mines in Colorado and Idaho. Downstream processors then convert the molybdenum concentrate produced by the mine into molybdic oxide from which intermediate products are manufactured. These intermediate products are then used in the production of special steels and superalloys, as well as in other industries.

The largest coal producing State is Wyoming, responsible for around 40% of the United States coal production in 2013, followed by West Virginia (11%), Kentucky (8%), Pennsylvania (6%) and Illinois (5%). The majority of the coal mined in the United States is consumed domestically,
with thermal coal used in power generation, and metallurgical coal used in the iron and steel industry.

### Table 2.21: USA mining data

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</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>'000 t contained Cu</td>
<td>1,454</td>
<td>1,121</td>
<td>1,131</td>
<td>1,143</td>
<td>1,282</td>
<td>1,445</td>
<td>1,447</td>
<td>1,285</td>
<td>-0.68%</td>
<td>39,000</td>
<td>27</td>
</tr>
<tr>
<td>Gold</td>
<td>tonnes Au</td>
<td>256</td>
<td>256</td>
<td>231</td>
<td>258</td>
<td>225</td>
<td>223</td>
<td>221</td>
<td>209</td>
<td>-1.13%</td>
<td>3,000</td>
<td>13</td>
</tr>
<tr>
<td>Silver</td>
<td>tonnes Ag</td>
<td>1,860</td>
<td>1,230</td>
<td>1,270</td>
<td>1,020</td>
<td>1,120</td>
<td>1,248</td>
<td>1,259</td>
<td>1,270</td>
<td>-2.10%</td>
<td>25,000</td>
<td>20</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>'000 t Mo</td>
<td>41</td>
<td>58</td>
<td>60</td>
<td>61</td>
<td>60</td>
<td>62</td>
<td>63</td>
<td>71</td>
<td>3.10%</td>
<td>2,700</td>
<td>43</td>
</tr>
<tr>
<td>Zinc</td>
<td>'000 t Zn contained</td>
<td>850</td>
<td>750</td>
<td>725</td>
<td>740</td>
<td>775</td>
<td>758</td>
<td>767</td>
<td>775</td>
<td>-0.51%</td>
<td>10,000</td>
<td>13</td>
</tr>
<tr>
<td>Lead</td>
<td>'000 t Pb in concentrate</td>
<td>458</td>
<td>432</td>
<td>363</td>
<td>346</td>
<td>347</td>
<td>373</td>
<td>371</td>
<td>366</td>
<td>-1.24%</td>
<td>5,000</td>
<td>13</td>
</tr>
<tr>
<td>Nickel</td>
<td>'000 t contained Ni</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>21</td>
<td>16</td>
<td>-</td>
<td></td>
<td>160</td>
<td>64</td>
</tr>
<tr>
<td>Bauxite</td>
<td>'000 tonnes</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td>20,000</td>
<td>-</td>
</tr>
<tr>
<td>Iron ore</td>
<td>m tonnes</td>
<td>61</td>
<td>52</td>
<td>42</td>
<td>50</td>
<td>50</td>
<td>52</td>
<td>55</td>
<td>61</td>
<td>0.05%</td>
<td>2,100</td>
<td>40</td>
</tr>
<tr>
<td>Coal</td>
<td>m tonnes</td>
<td>974</td>
<td>1,026</td>
<td>984</td>
<td>922</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td></td>
<td>237,295</td>
<td>257</td>
</tr>
</tbody>
</table>

| GDP (current $USD) | billions USD | 10,290 | 13,095 | 14,958 | 16,245 | 16,800 | 17,528 | 18,366 | 21,180 | 4.09% | - | - |
| GDP per capita (current $USD) | USD | 36,450 | 44,224 | 48,294 | 51,709 | 53,101 | 54,980 | 57,158 | 64,388 | 3.21% | - | - |
| Mineral rent as a % of GDP | % | 0.01% | 0.03% | 0.13% | 0.15% | n/a | n/a | n/a | n/a | - | - |

### 2.3.17.1 Mining potential and associated risks

The United States has a well developed mining sector and extensive mineral reserves that are yet to be developed. In 2013 7% of the global exploration budget was destined for the United States, equivalent to around USD$1 billion. The economy is stable and well developed, with an extensive network of mining industry suppliers and good infrastructure. Mining will continue to be an important sector of the United States’ economy.

### 2.3.17.2 Major mining projects

Teck recently announced the reactivation of its Pend Oreille zinc project. The operation is an underground lead/zinc mine, located in north-eastern Washington state. First production is expected in during the final quarter of 2014, with a mine life of 5 years at a production rate of 44,000 tonnes of zinc in concentrate per year. The zinc and lead concentrates produced at the Pend Oreille operation will be shipped to Teck’s nearby Trail Operations for processing.

Lundin Mining completed the acquisition of the Eagle copper-nickel sulphide project in Michigan, US, from Rio Tinto in mid-July 2013. The project is expected to ship first saleable concentrate during the final quarter of 2014. Production is expected to average 17,000 tonnes per year of nickel and 17,000 tonnes per year of copper in concentrates over the eight year life of mine, with further by-product credits from cobalt, gold, and platinum group metals.
2.3.18 Vietnam

Vietnam currently produces zinc, nickel, bauxite, coal and manganese. In 2012 mineral rents represented 0.46% of GDP and coal rents 0.05%. The economy has an MCI of 44.0, placing it in the top 40% of economies globally when considering the importance of mining to the economy.

Vietnam has large coal reserves, concentrated in the northern area in Quang Ninh province and the Red River Delta basin. Coal is one of the primary sources of energy for the domestic market, and also one of the economy’s most important export commodities. However, as part of Vietnam’s power plan it aims to build more than 70 new coal-fired power stations by 2030, and it is therefore anticipated that economy will move from being a net exporter of coal to a net importer. With the exception of coal and bauxite, most deposits discovered to date have been too small to be economically viable for international mining companies. Foreign investment in mining has been minimal and constrained by regulatory issues, investment and market access challenges. The Vietnamese mining industry is dominated by the state-owned Vietnam Coal and Minerals Industries Corporation (Vinacomin). Under Vinacomin there are two groups of companies: coal and minerals.

Table 2.22: Vietnam mining data

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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc</td>
<td>'000 t of contained Zn</td>
<td>22</td>
<td>48</td>
<td>36</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td>2.10%</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Nickel</td>
<td>'000 t of contained Ni</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.5</td>
<td>6.0</td>
<td>6.5</td>
<td>3.0</td>
<td>-</td>
<td>54</td>
<td>9</td>
<td>n/a</td>
</tr>
<tr>
<td>Bauxite</td>
<td>m tonnes</td>
<td>-</td>
<td>0.0</td>
<td>-</td>
<td>0.7</td>
<td>1.3</td>
<td>1.6</td>
<td>3.1</td>
<td>-</td>
<td>2,100</td>
<td>1,566</td>
<td>4</td>
</tr>
<tr>
<td>Coal</td>
<td>m tonnes</td>
<td>11.6</td>
<td>32.6</td>
<td>44.0</td>
<td>41.9</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>150</td>
<td>4</td>
<td>n/a</td>
</tr>
<tr>
<td>Manganese</td>
<td>'000 t of contained Mn</td>
<td>5.6</td>
<td>16.2</td>
<td>23.8</td>
<td>5.6</td>
<td>5.6</td>
<td>5.6</td>
<td>5.6</td>
<td>5.6</td>
<td>0.00%</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

GDP (current USD) billions USD | 31 | 58 | 113 | 156 | 171 | 188 | 205 | 249 | 12.24% | - | - | - |
GDP per capita (current USD) USD | 402 | 700 | 1,297 | 1,753 | 1,902 | 2,073 | 2,234 | 2,637 | 11.02% | - | - | - |
Mineral rent as a % of GDP | % | 0.05% | 0.15% | 0.46% | 0.46% | n/a | n/a | n/a | n/a | - | - | - |

2.3.18.1 Mining potential and associated risks

Given Vietnam’s large coal reserves, there is some potential for further mining in the economy. However, a complicated transaction system, strong competition and a lack of transparency in the procurement process can make doing business difficult within the mining sector. Language can also be a barrier to market entry.

Over the last several years Vietnam has witnessed an increase in foreign investments, resulting in increased exploration and the expansion and commissioning of new bauxite, copper and gold projects. In the short to medium term Vietnam’s mineral production is expected to increase as projects which began development in 2010 and 2011 start to be commissioned. For example, the
Tan Rai alumina and bauxite complex was commissioned in September 2013, with an annual production capacity of 650,000 tonnes of alumina. A further expansion is anticipated for 2015, increasing the plant’s annual capacity to 1.2 million tonnes of alumina.

The Vietnamese governed has also outlined some goals related to its mineral industry, which are very similar to those recently imposed by Indonesia. It wishes to improve the geological information available by carrying out surveys and to promote a mineral processing industry within the economy and to ban the export of ore in order to create more economic value for the Vietnamese economy.

### 2.3.19 Brunei Darussalam, Hong Kong & Singapore

The APEC economies of Brunei Darussalam, Hong Kong and Singapore do not possess significant mineral reserves.

**Brunei Darussalam** is located in Southeast Asia, on the northwest end of Borneo Island, where it shares a border with the Malaysian state of Sarawak. Brunei Darussalam has one of the highest per capita incomes in all of Southeast Asia, predominantly the result of its significant natural gas and oil resources. Per capita GDP was USD$39,943 in 2013, giving Brunei the 6\(^{th}\) highest GDP per capita of the APEC economies, after Australia, Singapore, United States, Canada and New Zealand. Total GDP for 2013 was USD$16.21 billion.

**Hong Kong SAR** is a city state, and is one of the world’s leading financial centres, encouraged by low taxation and free trade. The economy is also highly dependent on international trade: the value of goods and services trade, including the sizable share of re-exports, is about four times GDP. Of the APEC economies, Hong Kong has the 8\(^{th}\) highest GDP per capita, at USD$37,777. Total GDP for 2013 was USD$273.66 billion.

**Singapore** is a sovereign city-state and island economy. In 2013 Singapore has the 2\(^{nd}\) highest GDP per capita of the APEC member economies, with USD$54,776 per capita. Total GDP for 2013 was USD$295.74 billion. Singapore’s successful economy is due in large part to its free-market policies. The main drivers of the economy are: exports, notably those of consumer electronics, information technology products and pharmaceuticals; and the expanding financial services sector.
### Table 2.23: Brunei Darussalam, Hong Kong & Singapore GDP data

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</tr>
</thead>
<tbody>
<tr>
<td><strong>Hong Kong</strong></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP (current USD)</td>
<td>billions USD</td>
<td>172</td>
<td>182</td>
<td>229</td>
<td>263</td>
<td>274</td>
<td>294</td>
<td>315</td>
<td>386</td>
<td>4.61%</td>
</tr>
<tr>
<td>GDP per capita (current USD)</td>
<td>USD</td>
<td>25,578</td>
<td>26,554</td>
<td>32,421</td>
<td>36,590</td>
<td>37,777</td>
<td>40,175</td>
<td>42,748</td>
<td>50,936</td>
<td>3.90%</td>
</tr>
<tr>
<td>Mineral rent as a % of GDP</td>
<td>%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>-</td>
</tr>
<tr>
<td><strong>Singapore</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP (current USD)</td>
<td>billions USD</td>
<td>94</td>
<td>125</td>
<td>233</td>
<td>284</td>
<td>296</td>
<td>304</td>
<td>318</td>
<td>361</td>
<td>7.75%</td>
</tr>
<tr>
<td>GDP per capita (current USD)</td>
<td>USD</td>
<td>23,414</td>
<td>29,403</td>
<td>45,954</td>
<td>53,516</td>
<td>54,776</td>
<td>55,568</td>
<td>57,442</td>
<td>63,449</td>
<td>5.69%</td>
</tr>
<tr>
<td>Mineral rent as a % of GDP</td>
<td>%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>-</td>
</tr>
<tr>
<td><strong>Brunei Darassalam</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP (current USD)</td>
<td>billions USD</td>
<td>6</td>
<td>10</td>
<td>12</td>
<td>17</td>
<td>16</td>
<td>17</td>
<td>17</td>
<td>18</td>
<td>6.38%</td>
</tr>
<tr>
<td>GDP per capita (current USD)</td>
<td>USD</td>
<td>18,477</td>
<td>26,587</td>
<td>31,982</td>
<td>42,402</td>
<td>39,943</td>
<td>40,859</td>
<td>39,886</td>
<td>41,583</td>
<td>4.61%</td>
</tr>
<tr>
<td>Mineral rent as a % of GDP</td>
<td>%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>-</td>
</tr>
</tbody>
</table>


### 2.4 Conclusion: APEC economies’ mineral potential

This section summarises the information provided above, as well as introducing some results from the 2013 Fraser Institute Global Mining Survey regarding the mining industry understanding of the mineral potential of APEC economies.

**2.4.1 Fraser Institute Survey**

The following chart is one of the results of the 2013 Fraser Institute Global Mining Survey. It shows how the respondents to the survey perceive each mining area (note that Australia, USA, Canada and Argentina are split into regions, but each other jurisdiction is listed individually) based on ‘best practices’, i.e. world class regulatory environment, highly competitive taxation, no political risk or uncertainty, and a fully stable mining regime – this is therefore an approximate surveyed assessment of each region’s pure mineral potential, without including policy-related issues.

It shows that most of the APEC economies listed (marked in red on the chart) are ranked very highly – notably many American, Australian and Canadian states, but also Chile, the Philippines, Indonesia, Mexico, Papua New Guinea and Peru. This demonstrates a perception within the mining industry that the listed APEC economies have substantial untapped mineral resources.

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The next chart is the same survey’s measurement of the mineral potential of each mining jurisdiction under ‘current practices’, specifically: “whether or not a jurisdiction’s mineral potential under the current policy environment (i.e., regulations, land use restrictions, taxation, political risk, and uncertainty) encourages or discourages exploration”. Again, the APEC economies are marked in red. Here we can see some important differences – where the mineral potential based purely on the geology of the region was very high for the majority of listed APEC regions, we now see a slightly different picture, as regions where the policy is not as encouraging of mining investment do not score as well. However, the chart shows that the most highly regarded regions as encouraging of mining exploration and investment worldwide are situated within the APEC economies of the USA, Australia, Canada and Chile.
The final chart in this section shows the difference between the previous two indices for each jurisdiction, i.e. the gap between how encouraging of mining exploration a jurisdiction would be under theoretical best practice compared to the current policy environment, or its ‘room for improvement’. Tellingly, the Philippines, Indonesia, and China are the top scorers on this index, demonstrating how the current policy environment is not encouraging investment to nearly the same extent as it could be. Papua New Guinea and Russia also are ranked high on this index. At the other end of the scale, relatively little difference between current practice and best practice for most Australian, USA and Canadian jurisdictions means that they have far smaller ‘room for improvement’. Interestingly, the South East Asian economies of Vietnam, Thailand and Malaysia appear to have relatively little difference between their current practices and best practices, despite their not being major destinations for exploration investment.
Note that a more detailed discussion of the impact of mining regulation on investment is provided in Chapter 4.

### 2.4.2. CRU mineral potential rating

Based on the above sections, CRU has prepared a table outlining the major positives and negatives regarding mineral potential in each APEC economy, resulting in a high, medium or low mineral potential rating.

Many APEC economies are believed to have a high mineral potential, and these can be sorted into three main categories:

- **Developed economies**, such as USA, Canada, Chile and Australia, where there are substantial untapped resources and growth will be driven by continued exploration under mining-friendly jurisdictions.

- **Less-developed economies**, such as the Philippines, Indonesia and Papua New Guinea, where there are significant resources that remain untapped but the pace of growth is somewhat hindered by the existing regulatory environment - and this hurdle presents the largest obstacle in the path towards a large mining industry.

- **Economies which fall between the above two descriptions** – Mexico and Peru – which both provide good examples of the progression towards a ‘best practice’ mining
regulatory environment and the positive impact that this can have on investment in the mining sector. Generally, these economies can be described as having moved from a less encouraging mining investment environment to a more positive one over the past two decades, simultaneously seeing strong growth in their mining sectors. This has also coincided with the economies’ development in terms of income per capita.

Several APEC economies – those rated as having a low mineral potential – are not expected to show substantial growth in their mining sectors, primarily due to the absence of significant resources for exploitation, rather than a restrictive policy environment or other regulatory hurdle.

The APEC economies rated as medium – China, Russia and Vietnam – in terms of their mineral potential each have a complex series of drivers for their mining industries. All have generally struggled to attract significant FDI in the mining sector, despite having substantial domestic resources of one or more minerals. For example, the Chinese mining industry is generally quite fragmented and high cost, though this is expected to improve through consolidation in coming years. Cost pressures will remain through labour and power price increases, as well as currency effects, and the mining industry is expected to remain largely controlled by domestic corporations. This has the effect of making the size of the Chinese mining industry fairly dependent on prices, as many higher cost operations will only produce when prices are sufficiently high.
### Asia-Pacific mining sector study

**Table 2.24: CRU mineral potential rating**

<table>
<thead>
<tr>
<th>APEC economy</th>
<th>Positive factors</th>
<th>Negative factors</th>
<th>CRU mining potential</th>
<th>Notes/comments/expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>Substantial resource base, mining friendly jurisdiction, very highly rated in terms of pure mineral potential in Fraser Institute survey</td>
<td>Major unexplored regions are in challenging mining environments</td>
<td>High</td>
<td>Mining expansion likely within established mining regions, though some potential for increased growth in other areas, through e.g. Plan Nord</td>
</tr>
<tr>
<td>Australia</td>
<td>Substantial resource base, mining friendly jurisdiction, very highly rated in terms of pure mineral potential in Fraser Institute survey</td>
<td>-</td>
<td>High</td>
<td>Growth expected in output of exp. bulk commodities; largest volumes from brownfield expansions but also increased output from new junior miners, e.g. Roy Hill</td>
</tr>
<tr>
<td>United States</td>
<td>Substantial resource base, untapped resources (notably in Alaska, Nevada), remains a significant destination for exploration investment</td>
<td>-</td>
<td>High</td>
<td>Majority of mining expansion most likely to come through organic growth within established mining regions</td>
</tr>
<tr>
<td>Mexico</td>
<td>Large copper, gold and silver reserves, with room for significant expansion; relatively mining friendly govt'</td>
<td>Mining sector more exposed to gold/silver price movements than others, which aren't strongly connected to supply/demand fundamentals</td>
<td>High</td>
<td>Output of most minerals expected to grow steadily over next few years, thanks to brownfield and greenfield projects.</td>
</tr>
<tr>
<td>Indonesia</td>
<td>Large volumes of untapped resources, some of which are not readily available in the same volumes in other locations - e.g. Sn, Ni</td>
<td>Very high Fraser Institute 'room for improvement' rating, showing disparity between investment attractiveness under current legislative conditions compared to theoretical 'best practice'.</td>
<td>High</td>
<td>Significant uncertainty regarding mining/export laws making investors and project owners very hesitant to dive projects forward in the short term.</td>
</tr>
<tr>
<td>Chile</td>
<td>Despite substantial existing mining sector, there are still significant untapped resources. Most attractive investment climate in South America; high level of exploration activity</td>
<td>Some concern about rising costs in future, mining sector tied to a relatively small number of commodities.</td>
<td>High</td>
<td>High potential for strong growth in the mining sector, with few obvious negatives/drawbacks.</td>
</tr>
<tr>
<td>Philippines</td>
<td>Large volumes of untapped resources of various minerals - rated highest globally on Fraser Institute mineral potential index</td>
<td>Very high Fraser Institute 'room for improvement' rating, showing disparity between investment attractiveness under current legislative conditions compared to theoretical 'best practice'.</td>
<td>High</td>
<td>Sector is not currently perceived to be highly attractive to investors, but good mineral endowment means that there is potential for investment to increase, but could require a shift in government policy towards supporting mining investment.</td>
</tr>
<tr>
<td>Peru</td>
<td>Substantial mineral wealth and untapped reserves, mining established as an important part of the economy, significant exploration activity</td>
<td>Policy environment is not currently as attractive to investors as e.g. Chile</td>
<td>High</td>
<td>High potential for strong growth in the mining sector, both in terms of output at existing mines and major new projects</td>
</tr>
<tr>
<td>Papua New Guinea</td>
<td>Substantial mineral wealth and untapped reserves; mining established as an important part of the economy; significant exploration activity</td>
<td>High 'room for improvement' rating, suggesting current policy environment is not as encouraging of investment as it could be</td>
<td>High</td>
<td>Importance of mining to the PNG economy and significant untapped reserves should continue to drive the mining sector, but growth might be quicker under 'best practice' jurisdiction</td>
</tr>
<tr>
<td>China</td>
<td>Potential for consolidation of mining sector, as well as other improvements - both technical and legislative - that would increase FDI. Some important untapped resources.</td>
<td>Reserves of many minerals declining; mines generally high cost; with currency, labour and power costs expected to increase.</td>
<td>Medium</td>
<td>Consolidation of fragmented mining sector and closure of higher cost operations should improve mining practices, though output not expected to grow substantially.</td>
</tr>
<tr>
<td>Russia</td>
<td>Large resource base, with significant untapped resources.</td>
<td>Some resources are significant distances from consumers, leading to logistical constraints/need for on-site downstream processing.</td>
<td>Medium</td>
<td>Good potential for growth, FDI in Russia mostly focused outside mining sector (excl. coal) at present.</td>
</tr>
<tr>
<td>Vietnam</td>
<td>Substantial reserves of coal, which forms an important part of the economy</td>
<td>Reserves other than Bx and coal not substantial, FDI in mining has been minimal and constrained by regulatory issues, investment and market access challenges.</td>
<td>Medium</td>
<td>Coal output not expected to increase substantially despite rapidly increasing demand, but bauxite production expected to make strong gains.</td>
</tr>
</tbody>
</table>

Continued
<table>
<thead>
<tr>
<th>APEC economy</th>
<th>Positive factors</th>
<th>Negative factors</th>
<th>CRU mining potential</th>
<th>Notes/comments/expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thailand</td>
<td>Relatively mining-friendly environment</td>
<td>Limited mineral resources, mining not an important part of the economy, little exploration spend</td>
<td>Low</td>
<td>Existing mining sector mostly expected to maintain output</td>
</tr>
<tr>
<td>Malaysia</td>
<td>Some potential for coal expansion, government perceived as relatively mining-friendly</td>
<td>Limited / declining mineral resources for most minerals, greater focus on downstream power-intensive processing sector</td>
<td>Low</td>
<td>Reserves sufficient to support existing (relatively small) mining operations for some time, but little expansion expected</td>
</tr>
<tr>
<td>New Zealand</td>
<td>Current reserves expected to sustain existing mining at least over the medium term</td>
<td>Reserves are not substantial, little exploration activity or expansion plans</td>
<td>Low</td>
<td>Little expansion of relatively small mining sector expected, but no decline expected either</td>
</tr>
<tr>
<td>Japan</td>
<td>-</td>
<td>Limited mineral resources</td>
<td>Low</td>
<td>Little expectation for expansion of mining sector, though some interest/exploration for rare earths</td>
</tr>
<tr>
<td>Korea</td>
<td>-</td>
<td>Limited mineral resources</td>
<td>Low</td>
<td>Minimal exploration or expansion in mining sector expected</td>
</tr>
<tr>
<td>Chinese Taipei</td>
<td>-</td>
<td>Limited mineral resources</td>
<td>Low</td>
<td>No significant exploration or expansion in mining sector expected</td>
</tr>
<tr>
<td>Singapore</td>
<td>-</td>
<td>Negligible mineral resources</td>
<td>Low</td>
<td>No real potential for expansion of mining sector</td>
</tr>
<tr>
<td>Hong Kong SAR</td>
<td>-</td>
<td>Negligible mineral resources</td>
<td>Low</td>
<td>Negligible potential for expansion of mining sector</td>
</tr>
<tr>
<td>Brunei Darussalam</td>
<td>-</td>
<td>Negligible mineral resources</td>
<td>Low</td>
<td>Negligible potential for expansion of mining sector</td>
</tr>
</tbody>
</table>

Data: CRU, Fraser Institute Mining Survey 2013
Chapter 3 – Socio-economic effects of mining

3.1 Introduction

Building on the background provided in Chapter 1, this chapter outlines how the mining industry positively affects the wider economy, both directly and indirectly. The major topics discussed are as follows:

- **GDP**: Chapter 1 contains statistics on the contribution of mining to domestic GDP in the APEC member economies. In this chapter we provide more detail, and discuss indirect benefits of mining projects on GDP.

- **Employment**: We comment on direct mining sector employment, providing approximate figures for each economy in the region. We then discuss indirect mining sector employment, and quantify our arguments with a case study of the number of people gaining employment as a result of the planning, construction and then operation of a single major mining project.

- **Infrastructure**: we discuss how mining projects can result in the provision of much-needed infrastructure which could otherwise struggle to gain investment – ports, railways, roads, power generation, water provision, etc – which can allow for more rapid economic growth as well as improving standards of living.

Throughout this chapter we support the points made with reference to specific examples from the Asia-Pacific region, based on CRU’s experience and archived projects, as well as secondary sources and incorporating responses from interviews with mining stakeholders.

3.2 Mining, GDP, and Employment

3.2.1 Domestic GDP income contribution

The starting point for the measurement of economic impact is GDP, value-added income. For an economy as a whole, GDP value-added measures the real income paid to domestic residents. The basic idea is to subtract the payments made to non-residents for imports, for example any imported raw materials and physical capital goods used in mining, from gross revenues earned by residents. Analogously, the GDP or value-added of a sector measures the revenue generated by that sector minus the costs of inputs purchased from other sectors or from abroad. This difference is the incomes earned by workers and owners of capital in that sector, i.e. the ‘value-added’.
The real value-added of the whole economy is the sum of the real value-added of its sectors, of which one would be mining and extraction:

\[ GDP = \sum GDP_i \]

If gross revenue were used as the basis of calculating the contribution of a sector or a company to GDP, the result would be a massive overestimation of national GDP. Consider a mine which produces copper concentrate, this copper concentrate is then sold to a smelter/refinery, which sells refined copper to a copper semi procedure, which sells copper tubes to a plumber, who then installs these copper tubes in houses. If the revenue earned by each of these companies/individuals from the sale of the various intermediate copper products were included in GDP, it would lead to double counting. The correct amount of GDP generated or value-added is calculated by isolating each stage of production and deducting the cost of inputs to production from output price at each stage. At each stage of production there is a positive value-added as each producer is able to create output that has a higher market value than its inputs to production. Therefore, the total value-added at each stage of production is what is included in GDP. It is important to note that any imported inputs to production would not be included in the value-added calculation.

It follows that the most immediately obvious measure of the economic impact of minerals on an economy, is the GDP value-added of that sector as a share of total GDP value-added.

\[ Share_{minerals} = \frac{GDP_{minerals}}{\sum_i GDP_i} \]

This measures the relative contribution of the mineral sector in terms of the real net income it generates for workers and owners of capital and tax payment receipts in that sector.

The information included in Chapter 1 of this report, mineral rent as a percentage of GDP, is the difference between the value of production for a stock of minerals at world prices and their total costs of production. Mineral rent is not the same as value added: rent is pure profit (price less marginal cost multiplied by quantity), whereas value-added is the sum of earnings from production that are due to residents, for example, the salaries of resident mine workers are included in GDP value-added while they are not included in rent. As shown in Chapter 1, mineral rent as a percentage of GDP for some APEC economies can be substantial: as high as 24.01% (Papua New Guinea), 15.27% (Chile), 8.64% (Peru) and 5.53% (Australia).

However, GDP value-added should not be considered as a comprehensive measure of the contribution of minerals to GDP for the following reasons:
Asia-Pacific mining sector study

- GDP is not adjusted for repayments of debt (interest) and equity (dividends) in foreign owned mining interests; repatriated profits. Consider that the gross national income of an economy is its gross domestic product plus net income from non-residents, where debt and equity repayments are included in the net income figure. In order to take account of the repatriation of property income from minerals, we would have to know the income payments made by each sector to non-residents. This data is not readily available:

\[ \text{GNI} = \text{GDP} + \text{Net Income from non-residents} \]

- Secondly, we typically only have data on the GDP of the mining and extraction sector, which includes oil and gas rents. For economies where oil and gas production is important – including APEC economies such as Russia – this will be a poor measure of the GDP value-added by minerals. Probably for this reason, it is more common to see estimates of the share of production value of mining in whole economy GDP than GDP value-added, even if the second is more relevant.

- GDP value-added does not measure the benefit to other sectors within the economy which supply intermediate inputs to the sector concerned or use its product in their economic activity. These linkages are captured by impact multipliers presented in the next subsection.

### 3.2.2 Economic impact analysis

In contrast to GDP value-added, which measures the income earned in that sector, economic impact analysis measures the consequences of an expansion of a sector on other domestic sectors.

Economic impact studies use financial and economic data to generate estimates of output, GDP, employment and tax revenues that would be associated with changes in the level of economic activity of the project or industry being analyzed. In general, these impacts are classified in one of three ways:

- **Direct**: these are the impacts which result from the expenditures associated with constructing and operating the mine, such as the labour employed, materials purchased, capital invested etc.

- **Indirect**: these are the impacts that result from suppliers to the mine purchasing goods and services and hiring workers to meet demand from the mine. *Importantly, these additional purchases and the hiring of extra workers would not have occurred were it not for the construction and operation of the mine.* This indirect impact is also known as
a ‘backward’ or ‘upstream’ impact, as it aims to capture the extent to which a sector demands inputs from other sectors of the economy.

- **Induced**: these are the economic impacts resulting from employees at the mine using their wages to purchase goods at a household level.

One way to look at this is to consider what will happen when a new mine is exploited: it will not only raise income for mine workers, the resident owners of the mine and the government (in the form of taxes), it will also benefit suppliers to the mine and those industries which use the mine’s output. For example, the Sierra Gorda copper mine, that is currently under construction in Chile, will also benefit domestic smelters and refineries if the mine sells concentrates to domestically, as well the domestic copper semi-fabricated products industry as they will both use the mine output. What is more, the workers that receive a wage from the mine will spend this money in the wider economy to purchase a variety of products, such as food, clothes and cars.

### 3.2.2.1 Impact multipliers: principles and methods

Economic theory attempts to calculate these impacts via impact multipliers. As mentioned above, the injection of some form of capital into an economy (in this case, the construction of a mine), will more than likely result in a proportional increase in income at a regional and national level. The theory suggests that an injection of capital into an economy will result in the generation of income in the wider economy that is greater than the original amount of capital injected.

The **backward linkage** captures the extent to which a sector demands inputs from other sectors in the economy, i.e. the relationship between the activity in a sector and its purchases. The larger this multiplier, the more the economy might be expected to be stimulated by an increase in the size of the sector concerned, in this case the mining sector. This is also called an ‘upstream impact’. In the case of a copper mine, this would be the effect of an increase in demand from the mine (via an expansion for example), on suppliers of mining machinery or raw materials to the mine, transportation providers etc.

A backward linkage can be calculated as the first-round backward linkage demand for domestic inputs. However we might also want to take account of the fact that each sector buys inputs from other sectors. Hence we can also calculate the final demand of input, which includes the effects of many rounds of purchases within domestic sectors. Each round has to allow for the leakage of demand through imports.

A **forward linkage** indicates the proportion of sector output that serves as inputs to all sectors in the economy, i.e. the relationship between the activity in a sector and its sales. The larger a sector’s forward linkage, the more its output is used as an input to production in the economy.
and the more an increase in its productivity would stimulate the economy, through providing a cheaper input. For example, forward linkage would enable us to capture the positive effect of a new copper mine on the domestic copper semis industry. This is also called a downstream impact. Just as with backward linkages, we can calculate either the first-round impact or the final impact (after multiple rounds of the domestic intermediate trade).

These calculations should take account of the fact that some of these upstream and downstream demands will be for imports, and hence the methodology adjusts for import leakage. For example in a small island economy, such as Papua New Guinea, with a small and specialized industrial base, we would expect a large amount of mining expenditure leakage outside of the economy. In contrast, in an economy such as the United States, with a more developed industrial base, the leakage would be far less. Similarly, the amount spent on local wages depends in turn on the composition of the construction workforce between locals and expatriates. The government can attempt to increase the regional or national content of construction expenditure by trying to maximise the local component of the workforce.

In economic theory a Type I multiplier attempts to capture the direct and indirect impacts of an injection of capital, that is to say both backward and forward linkages, whereas a Type II multiplier also attempts to quantify the induced impacts. These multipliers are usually calculated via the use of input-output tables in an economy’s National Income accounts. These tables show the input-output relationships between different sectors of the economy. Some of the input will be sourced domestically, others imported: the higher the proportion of domestic sourcing, the higher the multiplier effect.

Nowadays, it is increasingly important to emphasise the wider reaching, positive economic impacts of mining projects and the mining industry as a whole, in order to engage local communities, and garner support from government and private stakeholders. A good example of a company actively promoting local employment can be seen at Newmont’s Jundee gold mine in Western Australia, which is located on the ancestral lands of the Martu people. In 2008 an agreement was established in order to enhance the Martu community’s socio-economic development opportunities. Newmont is a signatory to this agreement, and one component of the company’s commitment is to provide jobs to community members. Martu members are employed to conduct environmental compliance and rehabilitation services across two million hectares surrounding the Jundee mine. This partnership provides the Martu people with employment opportunities that draw on their more than 40,000 years of specialized land management skills and gives them a schedule that works with their cultural calendar. In turn, the Martu rangers help Newmont achieve its goals for Indigenous employment, environmental stewardship and advancing the rights and empowerment of the Martu people.
3.2.2.2 Alternative methodologies

These estimates of linkages are based on the assumption that each sector buys a quantity of intermediate product from other sectors in fixed proportion (determined by observing historical transactions). This assumption (called the Leontieff assumption) takes no account of the adjustment of relative prices, demand substitution and supply constraints. Computable general equilibrium models were developed to fill this gap. In these models, the effect of one sector is felt both on volumes and on prices. Thus if the sectors that supply miners are supply constrained, prices will rise and imports will increase to fill in the gap, reducing the backward impact of a mining expansion. However, the improvement that these models can deliver over the Leontieff calculation is dependent upon good estimates of demand and supply elasticities.

3.3 Infrastructure

Mineral reserves are often located in remote or relatively underdeveloped locations. For example: in Chile mines are located in the Atacama desert and high up in the Andes mountain range, meaning that before the mineral resource can be exploited a certain amount of infrastructure needs to be put in place in order to access the mine site.

The bulkier the commodity the more infrastructure is likely to be needed in order to transport the commodity from the mine to the market or next stage of production: iron ore mines often require large quantities of infrastructure, including roads, railways and ports, whereas a less bulky commodity such as gold can be flown out of a mine site and so would only require a small airstrip. Most mines also require a source of power for their operations and a communications system. Where this infrastructure is missing the mining company will build it. It is often the case that this infrastructure not only benefits the mine, but also the local community, as it helps to open up the region to other types of trade.

Nowadays more importance is placed on the social licence to operate, as community opposition can bring a project to a halt. For this reason mining companies not only construct the infrastructure necessary for the mine, but also go a step further and provide some form of community infrastructure for the people living near the mine location. Providing infrastructure that not only serves the mine but also the local community is a way of attracting investment into the region and contributing long term social and economic benefits, which will continue to exist even once the mine has come to an end.

Poor sanitation and healthcare infrastructure in the local community could lead to unhealthy workers (assuming a large proportion of mine staff are recruited from local areas), poor local transport infrastructure could impact logistics and insufficient power and water systems could cause operational interruptions. Addressing these issues ensures the social licence to operate
remains whilst also developing the area around the mine and ensuring smooth operations at the mine.

### 3.4 Employment

The contribution of mining to an economy’s employment rather than to income is often of interest. One of the concerns associated with oil exploitation for example is that although it generates massive revenue for that economy, it employs few domestic workers. For mining, we would expect a wider employment impact than for capital intensive oil extraction.

There are various measures of employment impact, just as with income impact:

- **Direct employment in the minerals sector**: This can be calculated fairly easily as the number of domestic workers employed by the mining industry. Data comes from employment surveys. It is also of interest to calculate the average wage of workers within the mining industry and to find out about the nature of the workers’ contracts.

- **The impact contribution of an expansion in mining on the employment of domestic suppliers, through backward linkages**: This is calculated by adjusting the impact contribution (explained in the previous section) to take account of the propensity of each sector to employ more or less workers. For example, for each additional one thousand US dollars spent by the minerals sector on the rubber sector, one extra worker would be hired.

- **Impact contribution of minerals on employment from forward linkages**: We first calculate how much a less expensive mineral output helps the productivity of domestic mineral purchasers who might then go on to expand their output. We have to then estimate the extent to which this will result in more workers being hired in these forward sectors.

Employment effects are better measured when we allow for the elasticity of the supply and demand for labour. It might well be the case that mining, or any other sector linked to mining, needs skilled labour, but these workers are not available. Hence the employment multiplier may be lower than an estimate implied by the historical proportion of employees to output.

The following tables show mining employment numbers for APEC member economies in 2011 (where available) and as a percentage of the population.
In terms of total number employed (and where statistics are available), Russia had the largest number of people engaged in mining activities in 2011, at just over 1 million which was equal to 0.74% of the population. Australia was the economy that had the highest proportion of the population employed in mining, at 0.84%, which is equivalent to 182,000 people. These statistics do not include people employed in the informal mining sector, which could be substantial, particularly in the less-developed economies.

### 3.5 Export and rent contributions

A developing economy with a strong flow of exports will have strong foreign currency inflows. It is easier to secure foreign capital on the back of strong foreign currency flows, and these funds can be used to build up capital and promote development. Mineral export can be a source of important dollar inflows.

This motivates a measure based on the share of minerals in export revenues. Mineral export shares should not be thought of as a substitute to GDP measurement but rather as a complement...
which focuses on contributions to dollar revenues. This is because the ultimate purpose is to measure the economic impact of minerals on domestic incomes, and as such, it should not matter that income is earned in domestic sales rather than in export sales.

Export revenue contributions can be compared against rent income contributions (discussed in Chapter 1). Rents are the revenue earned by minerals in excess of the costs required to bring those minerals to the market. This tells us how much average pure profit has been earned in a resident economy, though not necessarily by those economies’ residents. Another problem of course with rental income is that it does not adjust for the risk to the return on mining activities as we emphasized in the introduction.

The chart below shows the export share of minerals and the mineral rent share of APEC economies (except for Chinese Taipei).

The chart shows that, with the exception of Australia, Chile, Papua New Guinea and Peru, ore and metal exports make up less than 10% of export income in APEC member economies, and for Vietnam and Brunei this percentage contribution is less than 1%. In some cases, such as Hong Kong and Japan, this may indicate re-exports, that is to say an economy may ‘import’ ore or metal and then ‘export’ it on to its final destination. However, for the other APEC member economies, this suggests that mining is an important source of export revenue, without dominating the tradable sector.
In terms of mineral rents, the only APEC member economies with significant sources of rent from minerals are again Australia, Chile, Papua New Guinea and Peru. In all other economies, there is no large amount of pure profits earned in through mineral extraction and processing. This highlights the point that mining, for the most part, produces only modest economic rents, especially when compared to the oil and gas sector, even when one ignores the volatility that is emphasized in Chapter 1.

3.6 The APEC effect

Up to this point we have considered only the effect within a domestic economy. All benefits for non-residents have been excluded and all foreign inter-linkages ignored. However, in so far as we are interested in the APEC as a whole, we should also acknowledge that the benefits of a mining project may spread more widely than between national borders. For example a large proportion of iron ore produced in Australia is sold to Chinese (and Japanese, Korean, and Chinese Taipei) steel mills. Indeed, many of these consumers have shareholdings in Australian iron ore companies – for example POSCO (Korea) and China Steel Corporation (Chinese Taipei) together hold 15% of the Roy Hill project. A productivity improvement in Australian mines will have benefits for Chinese steel mills and ultimately even the consumers of steel products in APEC.

3.7 Case study I: Escondida mine, Chile

The information for this case study is taken from the 2007 ICMM paper: ‘Chile: The Challenge of Mineral Wealth: using resource endowments to foster sustainable development’. Part of the paper looks at the impact that the Escondida mine has had on a regional and national level. The paper was published in 2007.

The Escondida mine is located in Chile’s Antofagasta region. Within the region nearly all of the population live within urban areas, predominantly due to the fact that the region is one of the driest on Earth. The remoteness of the region coupled with the lack of natural water sources means that it is very difficult to carry out a wide range of economic activities. As a result, the region’s main economic activity is mining. Mining in the region started to expand rapidly in the 1990s, and this has caused a rapid increase in GDP per capita for the region. According to 2012 figures the Antofagasta region had a GDP per capita of USD$37,205, the highest of all Chile’s regions and more than seven times that of the region with the lowest GDP per capita, the Araucania region, at USD$4,641. What is more, in 2012 mining accounted for around 25% of the region’s employment.

1 Based on information from the Banco de Chile, Cuentas Nacionales.
The Escondida mine opened in the late 1980s, and was the second large mine to open in the region after Chuquicamata, which has been in operation since 1910. It is owned by BHP Billiton (70%) and Rio Tinto (30%). In 2013 it produced 1.1 million tonnes of copper (100 percent basis). There are now many mines in the region, however all of them are smaller in size than Escondida, which is the world’s largest copper mine. Since it was commissioned, Escondida has nearly always been under expansion. At present OGP1 (Organic Growth Project) is underway which will add an additional 300,000 tonnes per year of copper concentrate once it is completed in 2015. In order for the mine to maintain high levels of production, it is dependent upon a range of infrastructure, supplies, services, including around 320MW of power and a large quantity of ground water, which is drawn from wells. The new OGP1 plant will use seawater, which requires the construction of a desalination plant and pipeline.

### 3.7.1 Employment

In 2004 the Escondida mine accounted for 2,810 **direct employees**, over 99% of which were employed at the mine site or at port facilities. Of the 2,810, 11 were foreign and 2,799 were Chileans. There were 2,345 permanent contractors (**indirect employees**) employed by Escondida in 2004, with an additional 2,938 **contractors** being employed on the expansion projects that were underway at that time.

The Catholic University of Antofagasta (Patricio Aroca-Gonzalez) in 1999 estimated Escondida’s secondary employment, which includes all employment in the Antofagasta region that is the result of both the mine and the mine employees’ spending. It was determined that the employment multiplier could vary between 3.1 and 5.7, with evidence from a purchasing survey indicating a likely value of 4.2. In 2004 the estimated induced Escondida employment was 9,495 people.

It is estimated that in 2004 there were 8,813 dependents of Escondida employees, which gives a dependency multiplier of 2.9. If this is also applied to indirect and induced employment (11,840 in total), then the total number of dependents increases to around 35,700. However, the study mentions that this number maybe too high, as some individuals that have been classed as dependents may also work at the mine.

### 3.7.2 Value-added

In 2003 the ‘value-added’ by Escondida to Chile’s economy was USD$1.2 billion, and USD$2.7 billion in 2004, this is equivalent to 1.7% of Chile’s GDP in 2003 and more than 3.5% in 2004.

The majority of the value generated remained within the Chilean economy. The split of the value-added was as follows:
### Table 3.2: Value-added Escondida, 2004 (USD$ ‘000)

<table>
<thead>
<tr>
<th>Recipient</th>
<th>2004 (USD millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employees</td>
<td>146.4</td>
</tr>
<tr>
<td>Contractors</td>
<td>164.4</td>
</tr>
<tr>
<td>State of Chile</td>
<td>476.3</td>
</tr>
<tr>
<td>Shareholders</td>
<td>333.2</td>
</tr>
<tr>
<td>Community</td>
<td>12.5</td>
</tr>
<tr>
<td>Reinvestment</td>
<td>1,483.9</td>
</tr>
<tr>
<td>Financial suppliers</td>
<td>65.6</td>
</tr>
<tr>
<td><strong>Total Value Added</strong></td>
<td><strong>2,662.4</strong></td>
</tr>
</tbody>
</table>

Data: ICMM, Escondida

If it is assumed that all payments made to shareholders were repatriated, and that 40% of the amount reinvested went to foreign suppliers, the retained value-added figure is USD$1.7 billion or about 2.4% of Chile’s 2004 GDP.

#### 3.7.3 Infrastructure

As mentioned above, in order to operate, Escondida is dependent upon a range of infrastructure. Power and water supply have been sourced from distant locations. In theory, these power and water supplies could have been made available to others, however given the remote location of the mine, the benefits of these infrastructure services for local communities are limited. However, the large investment in power supply in the Antofagasta region in order to meet the needs of the mines is believed to have reduced the cost of power for the public in general. What is more, when the mine eventually closes the concentrate pipeline that runs from the mine down to the port in Antofagasta could be used to transport water and thus increase the availability of fresh water in the city. Due to the mine’s remote location, roads between Antofagasta and the mine were constructed. The roads were completed in 1990 at a cost of USD$8.5 million, these roads are maintained by the mine (at an annual cost of USD$850,000 in 2004) are open for public use.

#### 3.7.4 Analysis of economic linkages: the impact of the mining industry on the Antofagasta region

An input/output matrix was constructed for the Antofagasta region by a group of economists at the Universidad Catolica del Norte in order to determine the effects of mining on the region’s economy. This matrix thinks of the region as an independent economy and therefore considers all purchases from outside the region as imports, and all sales outside of the region as exports.

The multipliers included in the following tables have been estimated based on two alternative hypotheses:
1. **Open system:** this assumes that *none* of the additional labour income associated with a change in demand from the mining industry is spent within the region (and that none of it flows back into the region through trade with other regions).

2. **Closed system:** this assumes that *all* of the additional labour income associated with a change in demand from the mining industry is spent within the region.

These two different approaches have been used because a significant proportion of those who work in the mining industry live outside of the Antofagasta region, and the study therefore assumes that they spent the majority of their income in their home region. Furthermore, a portion of the income of the inhabitants of the Antofagasta region is also spent outside of the region. Calculating the two sets of multipliers provides us with a range.

*The data used in the study is from 1995, however the ICMM has been in contact with the researchers of the study and it is understood that the coefficients have remained relatively stable over time.*

### 3.7.4.1 Output multipliers

<table>
<thead>
<tr>
<th>Sector</th>
<th>Open system multiplier</th>
<th>Closed system multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real estate services</td>
<td>1.02</td>
<td>2.33</td>
</tr>
<tr>
<td>Other services</td>
<td>1.11</td>
<td>2.52</td>
</tr>
<tr>
<td>Agriculture</td>
<td>1.14</td>
<td>1.76</td>
</tr>
<tr>
<td>Construction</td>
<td>1.21</td>
<td>2.2</td>
</tr>
<tr>
<td>Transport and communication</td>
<td>1.27</td>
<td>2.35</td>
</tr>
<tr>
<td>Mining</td>
<td>1.28</td>
<td>1.8</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>1.28</td>
<td>1.79</td>
</tr>
<tr>
<td>Retailing</td>
<td>1.31</td>
<td>2.54</td>
</tr>
<tr>
<td>Fishing</td>
<td>1.35</td>
<td>2.08</td>
</tr>
<tr>
<td>Business services</td>
<td>1.41</td>
<td>2.93</td>
</tr>
<tr>
<td>Public administration</td>
<td>1.47</td>
<td>3.96</td>
</tr>
<tr>
<td>Utilities</td>
<td>1.66</td>
<td>1.92</td>
</tr>
</tbody>
</table>

*Data: Aroca, 1999, ICMM*

As can be seen from the table above, the multiplier varies according to sector. For example, in an open system if one additional dollar of final demand is spent in the utilities sector the output of the region increases by USD$1.66, or by USD$1.28 if the dollar is spent in the mining sector. However, if we assume that the additional dollar is spent within the Antofagasta region (closed system), the multipliers change: in that case the mining industry shows a multiplier of 1.80. The impact on the region’s total output is greater if the extra dollar is spent in the service sectors, as these are more labour intensive.

It is important to note that there is a significant difference in multipliers depending upon whether an open or closed system is considered. The multipliers are higher in the closed system.
which illustrates the important impact that wages have on the demand directed towards a sector. What is more, the multipliers appear fairly low compared to what would be expected from the national input/output matrices. This is a consequence of the lack of economic diversification within the region. Also, the ranking among sectors is different than that which would be expected for an economy: mining and manufacturing have the same multipliers, whereas if the matrix were for Chile we would expect manufacturing to have a higher multiplier.

As mentioned above an additional dollar spent in the mining industry will generate USD$1.28 of additional output (open system) and USD$1.80 (closed system). The study looks at where the additional output generated by the mining industry is spent.

Table 3.4: Output linkages between the mining sector and other sectors, 1995, cents per dollar.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Open system multiplier</th>
<th>Closed system multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business services</td>
<td>11.5</td>
<td>19.7</td>
</tr>
<tr>
<td>Utilities</td>
<td>8.9</td>
<td>16.3</td>
</tr>
<tr>
<td>Retailing</td>
<td>5.7</td>
<td>12.7</td>
</tr>
<tr>
<td>Manufacturing</td>
<td></td>
<td>9.8</td>
</tr>
<tr>
<td>Other services</td>
<td></td>
<td>8.8</td>
</tr>
<tr>
<td>Transport and communication</td>
<td></td>
<td>6.7</td>
</tr>
<tr>
<td>Real estate services</td>
<td></td>
<td>4.8</td>
</tr>
<tr>
<td>Other sectors</td>
<td>1.7</td>
<td>1.3</td>
</tr>
<tr>
<td>Total</td>
<td>28</td>
<td>80</td>
</tr>
</tbody>
</table>

Data: Aroca, 1999, ICMM

The table shows that the mining sector has the strongest links with the business services, utilities and retail sectors. When considering the closed system, linkages with manufacturing, transport and communication and other services are also important.

3.7.4.2 Employment multipliers

The table below shows the impact of one additional employment in a particular sector on the other sectors in the region. Escondida has been separated from the rest of the mining sector in the region, which at that time was predominantly made up of Codelco’s Chuquicamata mine.
Table 3.5: Antofagasta region employment multipliers, 1995

<table>
<thead>
<tr>
<th>Sector</th>
<th>Open system multiplier</th>
<th>Closed system multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real estate services</td>
<td>1.01</td>
<td>1.34</td>
</tr>
<tr>
<td>Other services</td>
<td>1.04</td>
<td>1.21</td>
</tr>
<tr>
<td>Agriculture</td>
<td>1.06</td>
<td>1.13</td>
</tr>
<tr>
<td>Construction</td>
<td>1.2</td>
<td>1.57</td>
</tr>
<tr>
<td>Transport and communication</td>
<td>1.12</td>
<td>1.22</td>
</tr>
<tr>
<td>Rest of mining sector</td>
<td>2.04</td>
<td>2.76</td>
</tr>
<tr>
<td>Escondida</td>
<td>4.1</td>
<td>6.71</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>1.39</td>
<td>1.57</td>
</tr>
<tr>
<td>Retailing</td>
<td>1.1</td>
<td>1.27</td>
</tr>
<tr>
<td>Fishing</td>
<td>1.22</td>
<td>1.25</td>
</tr>
<tr>
<td>Business services</td>
<td>1.45</td>
<td>2.34</td>
</tr>
<tr>
<td>Public administration</td>
<td>1.04</td>
<td>1.21</td>
</tr>
<tr>
<td>Utilities</td>
<td>4.54</td>
<td>6.29</td>
</tr>
</tbody>
</table>

Data: Aroca, 1999, ICMM

The figures show that if Escondida were to hire one additional employee between 3.1 and 5.7 additional jobs would be generated in other sectors. Both the Escondida and ‘rest of mining sector’ categories have fairly high employment multipliers as the mining sector is capital intensive, therefore each additional employee requires a lot more inputs than in other sectors. Furthermore, mining employees tend to have higher wages than those in other sectors, therefore if household spending of mining employees is also taken into account (closed system) then a larger number of employment opportunities can be created in lower wage sectors such as retailing.

The difference between the Escondida employment multiplier and that of the rest of the mining sector is very large and requires explanation. The main explaining factor is that Escondida outsourced as many functions as possible, whereas the rest of the mining sector, which in this case is mainly Codelco, internalized their functions.

The outsourcing carried out by Escondida may have provided local suppliers with growth opportunities thus enabling them to deliver their goods and services to other mines in and outside of the region. This group of suppliers could have therefore formed the beginnings of a mining cluster, which is defined as a group of businesses that are linked to each other by both sales and purchases, as well as other links which create synergies. In the late 1990s the regional and Chilean government implemented an initiative, with the aim of creating a mining cluster in the Antofagasta region. Both the Government and mining companies operating in the region have funded the program. One of the notable achievements of the program was a drive for ISO 9000 and 14000 certification amongst mining suppliers. It is thought that the certification will make Antofagasta region suppliers more competitive, especially when it comes to exporting their goods and services to mining companies in other economies.
3.8 Case study II: The socio-economic impact of the nickel industry in Canada

This case study is taken from the PwC Canada report for the Nickel Institute ‘Socio-Economic Impact of the Nickel Industry and Nickel Value Chain in Canada’, published in 2009. The report looks at the economic impact of the nickel value chain on the Canadian economy, including its effect on value-added and employment.

The value chain methodology used in the PwC report follows the distinct stages of production in the material flow: direct nickel industry, first-use and end use. The direct nickel industry is of most interest to us, as this is made up of mines, smelters and refineries. This includes the transport and logistical activities related to the movement of nickel and the activities related to the import of raw materials for refining and refined nickel. What is more, the direct nickel industry also includes all activities associated with the recycling of nickel containing products.

The data used in the PwC study is from 2006.

3.8.1 Overview of the Canadian nickel industry

In 2006 Canada mined 233,000 tonnes of nickel, which was equivalent to 15.3% of global nickel production. The economy had an estimated 4.9 million tonnes of nickel reserves, 7.65% of global reserves. In 2006, Canada was the world’s second largest producer of nickel after Russia (it has since slipped down the ranking, and in 2013 was the world’s 5th largest producer after Indonesia, Philippines, Russia and Australia).

In 2006 Ontario was the province that produced the largest quantity of nickel (53% of total Canadian output), followed by Newfoundland (21%), Manitoba (16%) and Quebec (10%).

In 2006 there were 10 operational nickel mines in Canada, three smelters and two refineries. Much of the nickel extracted from Canadian mines is sent to the USA and Norway for refining before being shipped on to China, where it is used in stainless steel production.

3.8.2 Economic impact of the direct nickel industry

PwC used data from Statistics Canada and Natural Resources Canada (NRCan) to calculate the value of nickel ore mining and processing to the Canadian economy in 2006. Furthermore, as mentioned in section 2.2.2.1, the mining industry impacts other sectors of the economy via ‘backward linkages’. In the case of the direct nickel industry these sectors include the transportation and logistics industry, services to mining (contract exploration and other services), and nickel scrap recycling. In order to calculate the multiplier effect of the direct
nickel industry on other sectors of the economy PwC used data input/output tables from Statistics Canada.

The data in the following table is the economic impact of the direct nickel industry in Canada as calculated by PwC. All values are expressed in Canadian dollars (CAD).

<table>
<thead>
<tr>
<th>Table 3.6: Economic impact of the direct nickel industry in 2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nickel ore and mine processing</td>
</tr>
<tr>
<td>Output ($ millions)</td>
</tr>
<tr>
<td>Value-added ($ millions)</td>
</tr>
<tr>
<td>Employment (no. of employees)</td>
</tr>
<tr>
<td>Salaries &amp; wages ($ millions)</td>
</tr>
</tbody>
</table>

3.8.2.1 Output

Output refers to the total value of production attributable to nickel. In the case of the direct nickel industry (nickel ore mining and processing), this is the value of the mine and smelter production. In the mining services or retail sector output it is equal to sales. As can be seen in the above table, output attributable to the Canadian nickel industry was estimated to be CAD$11 billion. Over CAD$7 billion (64%) of this output was generated by nickel ore mining and processing. Around CAD$3.5 billion (32%) of output was generated by mining support as a consequence of nickel mining, plus the additional multiplier effect in other sectors.

3.8.2.2 Value-added

The nickel mining and processing industry generated CAD$4.2 billion of value added, plus an additional CAD$1.8 billion of value-added coming from the mining support industry and other sectors as a result of the multiplier effect. This is therefore a CAD$6.3 billion contribution to GDP, which was equivalent to 0.43% of Canada’s 2006 GDP.

3.8.2.3 Employment

In 2006 around 13,000 people were employed by the nickel ore mining and processing industry in Canada (this is direct employment), and a further 22,000 were employed in support industries (this includes both indirect and induced employment, the study does not differentiate between the two).

3.8.2.4 Salaries & wages

The salaries for different roles within the nickel industry vary, however in general they are above the Canadian average. Salaries and wages in the nickel ore mining and processing sector were equal to CAD$985 million in 2006, and salaries in mining support services and induced employment were CAD$870 million.
3.8.3 Summary

Canada’s nickel industry produces widespread and significant social and economic benefits for the economy. The economic impact of the nickel ore mining and processing stage is estimated to be CAD$6.2 billion, which is equal to around 0.43% of Canada’s 2006 GDP. The nickel ore mining and processing stage was also responsible for the employment of 37,700 individuals, who in total earned CAD$1.8 billion in wages in 2006.

3.9 Case study III: PT Newmont Minahasa Raya (PTNMR) gold mine in Indonesia – Community infrastructure

The information in this section is taken from a report prepared by the Australian Centre for Geomechanics in 2012. The report looks at the economic conditions in the local area before, after and during mining and outlines the steps taken by the mining company to ensure that the local community benefited from the mine. The PTNMR gold mine was commissioned in 1994 and closed in 2004/05.

3.9.1 Before the start of mining operations

There were three main communities within the project area:

- Basaan Village
- Ratatotok I and II Villages
- Buyat Village.

Prior to the arrival of commercial mining in the area the local population earned a living through dry land agriculture, tree crops, fisheries and small scale mining and the local economy was based in fisheries and agriculture. There were two junior high schools and one senior high school in the Ratatotok II village. However, a very small percentage of local residents completed their high school education, less than 1%.

The main road (around 125km) that connected the area to Manado (the nearest regional capital) and other nearby towns was in poor condition. If local residents wanted to sell their fishery and agricultural products to markets in other areas they would usually use marine transportation. With regards to public transportation, there were only two station wagon-type vehicles, each with a 12 passenger capacity, available in Ratatotok prior to commercial mining.

The public health of members of the local community was fairly good, apart from the prevalence of various infectious diseases such as malaria, diarrhoea and influenza. There were some health facilities provided by the government. Only 15% of households had a functioning toilet. Furthermore, the drainage in the villages was uncontrolled and most people used to
discard their waste in the river or beach. None of the villages had their own doctor, meaning that locals with serious medical conditions had to travel to the local regional capital of Manado for medical care.

### 3.9.2 Community development programs

During the initial years of the mining project PTNMR focused on building infrastructure that would improve the poor living conditions in the villages of Ratatotok and Buyat. Main roads were built and maintained in order to connect the villages with the surrounding local area and to each other, this in turn facilitated the local economy through easier access and reduced travel time.

The infrastructure within villages was also improved. The main community development programs included:

- **Building roads and bridges**: Main road, village road, village bridges
- **Building schools**: Elementary, junior and high school, library
- **Building health facilities**: Community health centre, village health centre, public toilets
- **Building water systems**: Small scale irrigation for agriculture, water tank (supplying water to the villages), water supply (potable water)
- **Village level facilities**: Government offices, village meeting hall, market complex, terminal for buses, fish market point

All of the infrastructure projects were constructed using local labourers. The aim of constructing the facilities was to attract new settlers to the villages, to develop the existing facilities and help the villages develop.

### 3.9.3 After closure of the mine

The mine was closed in 2005, and there was some concern from local communities that the local economy would suffer without the mine. Communities were worried that closure of the mine would remove the primary resources of local contractors and local employees’ income.

PTNMR has considered these concerns as part of their mine closure plan and with the help of local communities had identified the socio-economic impacts of closure and had helped to develop programs that would mitigate these impacts.

The objectives of PTNMR’s sustainable development are as follows:

- To create a reclamation forest that will be sustained after the mine closes
- To create new industry for the mine that will be sustained after closure
- To create an independent and self reliant community after closure
Some examples of the programs initiated by PTNMR are mentioned below:

3.9.3.1 Artificial reef program
In order to ensure environmental sustainability PTNMR funded the construction and monitoring of an artificial reef program in the Buyat Bay and Totok Bay areas. It is hoped that the results of this program will help to sustain the livelihoods of local fisherman for many years to come. The aim of the artificial reef program was to enhance fish stock, increase skills within the local community and provide an additional source of income.

3.9.3.2 Creating a new industry
PTNMR built a cold storage building and ice block facility at what used to be the old port location. Before construction of the mine local fisherman would have to travel long distances to buy high quality ice blocks, however thanks to the new ice block factory in Ratatotok they were able to reduce their production cost and improve product quality.

3.9.4 Summary
This example of the PTNMR gold mine serves to demonstrate the large socio-economic impact that a mine can have on a region, especially through the construction of community infrastructure. Mining is so often negatively portrayed by the media, however the PTNMR gold mine shows how a region can be improved by hosting a mine, and is a good example of the large socio-economic impact it can have on the local communities, not only during the life of the mine but also one the mine has been decommissioned.

3.10 Conclusion
The above theory and examples highlight the wide reaching impact that a mining project or the mining industry can have on a region or an economy. The financial impacts of mining go far beyond the revenue generated by the mine and salaries paid to workers, as demonstrated by the economic impact analysis of the Escondida mine in Chile. What is more, these impacts can to a certain extent be managed by local and national governments. In the case of Escondida, the mine actively sought to outsource a lot of the services needed, which helped to stimulate a ‘mining cluster’ in Chile’s Antofagasta region. The creation of the mining cluster was further funded by the regional and national government, which now not only serves the mines in the region but is now able to export its products and expertise overseas.

Obtaining and maintaining a social licence to operate is now more important than ever before, and many mining companies are actively trying to engage local communities. As mentioned in the PTNMR gold mine example in Indonesia, an effective way of gaining local community support is through community infrastructure projects, as these projects demonstrate to the community that the mine will not only benefit its shareholders but it will also leave a lasting
legacy for the local people. In the case of PTNMR the community was significantly more developed after the decommissioning of the mine than it would have been had the mine never existed.

Finally, the nickel industry of Canada example serves to show the contribution of nickel mining to the entire Canadian economy. Similarly to the Escondida example, the impact of nickel ore mining and processing go far beyond the profits generated by the industry and employment at the mine and processing sites. The linkages extend through various sectors of the economy.
Chapter 4 – Best practice for responsible mining

4.1 Introduction

This chapter discusses the importance of responsible mining in order to ensure its long term sustainability. It presents the life cycle of a mining project, from permitting, planning and construction to eventual depletion, disassembly and land reclamation. Within this format we will comment on the drivers of best practice at each stage focusing on:

- **Environmental factors**: how mining projects can minimise their impact on the local environment before, during, and after operation.

- **Corporate social responsibility**, including:
  - Good labour practice, including the observance and monitoring of health & safety and labour rights.
  - Social impact assessments.
  - Dissemination of technology and skills.

- The role of **governments and associations** in ensuring best responsible mining practice

This discussion is evidenced by a series of real-world examples, provided by interviews that CRU has conducted with mining industry stakeholders (including Teck, Newmont, and UC Rusal) as well as other information sources – company sustainability reports, ICMM documentation on mining best practices, etc.
4.2 Life cycle of mining projects

Developing a mine is a very lengthy and capital intensive process. There are many steps that must be followed, each step requiring different amounts of time depending on the magnitude of the project, location, available services in the area, characteristic of the deposit, mineralization and available capital among other things.

In general, the life cycle of a mine starts with the exploration process, followed by design, construction, production and finally, closure.

The exploration phase begins by finding an area of interest that could potentially be a deposit, based on a geological knowledge of the area and/or a visual search for geological anomalies. Once an area of interest has been defined and necessary permits have been approved, the prospecting process begins: a geological mapping can be done through aerial photos and satellite information, as well as physical and chemical analysis of the rock on the surface. If enough evidence of interesting mineralization is found, the next step involves starting a drilling campaign to understand the size, shape and nature of the deposit. The core samples obtained are tested and an initial estimation of resources can be made.

The exploration phase can take up to 10 years and usually does not result in the development of a mine, because the resource is not of sufficient economic interest. The next phase in the life of mine cycle, the design phase, can be started at different levels of exploration. However, drilling
and sampling usually continue even during production in an effort to gain more knowledge about the deposit.

The design phase can start during early exploration, determining basic things such as the preferred mining method (open pit or underground) and estimating costs based on similar deposits. As exploration advances, more information is gathered and the decision is made to keep moving forward, the design becomes more detailed. The final phase of design before construction works is usually linked to a final feasibility study, in which the economics of the project are studied in more depth. Feasibility studies include a mine design, production schedule, plant design, plant recovery, consideration of environmental issues (including future reclamation activities), detailed capital and operating costs estimates, and an economic model of the project. Based on the economic model for the specific operation design, construction is started if the decision is made to continue with the project.

The construction phase involves building the infrastructure needed for the production phase. This includes construction for the mine and the plant itself, connecting roads or railways and, in some cases, infrastructure needed to assure water and power supply. Prior to actual construction a series of permits are needed, including an Environmental Impact Study (EIS).

The next step after construction is the actual production phase, where the mineral is extracted and sometimes treated through different beneficiation processes. Production lasts until resources are depleted or it becomes uneconomical to extract them.

Once the mine stops producing the final stage of the mining cycle comes: closure. The closure process should be planned during the design phase, and production should be led with an eventual closure in mind. The objective of this phase is to rehabilitate the areas where mining activity took place. To achieve this, the equipment is moved and infrastructure is dismantled. Different treatments are needed in different lands depending on the environmental characteristics of the area, the mining method used and the final objectives stated by the company regarding closure. Furthermore, contemporaneous land restoration ensures the smallest active area for mining operations, reducing the environmental impact and demonstrating the company’s commitment to restoring the land to conditions equal to or better than before mining. As a part of the closure process, there is constant monitoring and maintenance for some time to ensure all the objectives regarding the rehabilitation of the land have been met.

In some cases, it is possible for economic and market circumstances to change over time in a way that would make the closed mine an area of interest again. In this case, exploration can begin again.
4.3 Environmental practices

4.3.1 Overview

Mining can have a strong impact on the environment. This impact can be direct and easily identifiable, or indirect and harder to see and/or link to the operation itself. It terms of time it can have an effect in the short run, in the long run and even have a cumulative impact. As with all other aspects of a mining project, the steps taken to manage environment issues in a sustainable way vary throughout the mining lifecycle. Typically low at the start, the intensity of the impact increases markedly through the construction and operation phases and diminishes as planned closure occurs. This section will cover environmental practices throughout the mining cycle linked to:

- Biodiversity management
- Air pollution, noise and vibrations control
- Water management

It is important to notice that several aspects related to the impact of mining activity on the environment are measured based on how these changes will affect the communities surrounding the area.

In order to provide some legal and regulatory context, the main tools used for the assessment and management of environmental factors are presented next.

4.3.1.1 Environmental Impact Assessment (EIA)

In a mining context, an Environmental Impact Assessment (EIA) is a process used to identify the future consequences, positive or negative, that a specific project will have on the environment. The purpose of an EIA is to ensure that decision makers take into consideration environmental impacts when making decisions regarding projects.

Legislative requirements and practices regarding EIAs vary around the world, although in most economies it is required by authorities before certain permits are issued. Because of this, EIA is usually associated with the exploration and design stages of the mining project cycle, and is usually completed in parallel with the feasibility studies.

4.3.1.2 Environmental Management System (EMS)

The Environmental Management System (EMS) provides a framework for the management of environmental factors during operations and closure. The EMS itself does not dictate a level of environmental performance that must be achieved, but rather helps companies achieve their own environmental goals through the consistent control of their processes.
The most commonly used framework for an EMS is the one developed by the International Organization for Standardization (ISO) for the ISO 14001 standard. The five main stages of an EMS as defined by the ISO 14001 standard are:

- Commitment and policy
- Planning
- Implementation
- Evaluation
- Review

This specific framework for an EMS has been adopted by much of the mining industry.

### 4.3.2 Exploration and Design

In the early stages of exploration the effects on the environment are limited. However, as exploratory drilling begins, the direct impacts become more extensive. Drilling is an invasive process – drill sites must be cleared and new access roads are sometimes required for equipment. The drilling itself might affect biodiversity and generate dust and noise. The presence of exploration camps, no matter how simple, disturbs the regular state of area.

In some legal jurisdictions, the permitting process can require some level of environmental analyses to be undertaken at this stage. If not, it may still be prudent to invest earlier in a more rigorous screening to better understand the environmental context. A good example of this approach are the measures taken by the IndoMet Coal Project (IMC), 75% owned by BHP Billiton. IMC is located in the Indonesian part of the island of Borneo. It has a lease for 355,000 hectares, most of which are covered by tropical forest. Given the high biodiversity of the area, IMC has since 2000 commissioned seven biodiversity surveys in order to better understand the biodiversity management challenges. As a result, key issues were identified and IMC’s Biodiversity Strategy was built around them.

Some recommended practices for limiting impacts on biodiversity during exploration include:

- Avoiding road building by using existing tracks when possible
- Using lighter and more efficient equipment to reduce overall impact
- Positioning drill holes away from sensitive areas
- Removing and reclaiming roads and tracks that are no longer needed
Since most exploration campaigns do not become mining projects, it is important to minimise the impact during this phase to avoid unnecessary damage in areas that ultimately will not be economically profitable.

- As the design phase begins and studies are started, information should continue to be gathered and analysed under the framework of an ongoing EIS. The company in charge should determine the “biodiversity value” of the particular area they are interested in, in order to set accurate objectives in terms of conservation.

- At these stages, there is usually a limited amount of activity that will generate significant emissions, noise or vibrations. Nevertheless, any drilling, excavation and handling or transport of materials that could potentially impact on nearby communities should be conducted with that impact in mind. The following measures could be taken:

  - Location of exploration camps to minimise disturbance.
  - Managing the timing of drilling activities so that noise and vibrations will have minimal impact.
  - Watering of dusty operations that are close to sensitive areas to avoid an excess of dust generation.
  - The noise and vibration management plan should be developed during the detailed design phase, usually as part of an EIA. Measures which are commonly adopted under the noise and vibration management plan include:
    - Selecting lower noise plant and equipment incorporating available noise control kits.
    - Adding attenuators to mine ventilation fans, in the case of underground mining.
    - Providing acoustical enclosures and acoustical treatment of process buildings. This is a very effective solution for crushing plant.
    - LGL Ballarat’s management of community issues with dust, noise and vibrations during the planning phase of one of their construction projects is an excellent example of how careful planning can minimise problems down the road. In 2006 LGL started the design process for a ventilation shaft that would be located near a residential area in the south of Australia\(^1\). When consulting the community about their main concerns about this project, noise, vibrations and dust generation were by far their biggest issues (during both construction and production). LGL Ballarat strived to minimise the impact on the

\(^1\) LGL sold its Ballarat assets in 2009. In 2010, LGL was acquired by Newcrest Mining.
community, rather than simply achieve the compliance limits set by regulators. Regarding dust, recycled mine water was used as a suppressant and sprinklers were added to the main infrastructure design to reduce dust rising out of the shaft during blasting. To control noise, a 6 metre-high wall was built using a local noise attenuate product. Also, noise-attenuated diesel power generators were chosen over regular ones. Finally, on the subject of vibrations, several community members were concerned about the possible damage blasting vibrations could cause to their houses. To provide assurance, the company commissioned house inspections by a qualified independent building inspector.

- In terms of water management, the exploration and design stages are of great importance. Water allocation within any region is usually an issue where several players are involved. Supply for domestic use, agriculture, other industries and the environment are all needed. With this in mind, the exploration and design stages are the ones where the company has the chance to start an early dialog with the community and entities involved to address water allocation issues and state a water management plan for the future. During design, it is essential to ensure that water management is integrated into the overall management system of the mining operation. The following considerations need to be taken into account:

  - Water supply – identification and quantification.
  - Impacts of water abstraction and/or diversion on local water resources/users.
  - Water storage and treatment.
  - Dust suppression and dewatering discharge.
  - Waste water disposal.

Projects such as Teck’s Relincho and Quebrada Blanca Phase 2, located in Chile, are already addressing the issue of water supply in an arid region where nearby communities use the existing water for domestic use and agriculture. The company plans to use desalinated seawater in order to protect and conserve local freshwater sources.

### 4.3.3 Construction

Construction is usually the phase that is the most environmentally disruptive during the mining project cycle. The intersection between construction elements and the environment needs to be addressed as part of the EIA. Also, during intense construction period, many contractors and subcontractors could be on-site at any given time under a lot of pressure to deliver on time. In these situations, the responsibilities for mitigation measures can be forgotten. Under this scenario it is important to allocate the responsibility for implementing these measures.
In terms of **biodiversity**, the exploration and design phase are the most critical since the impact of the project is measured and determined during these phases. The construction stage generally focuses on two things: monitoring changes and mitigating impact to the extent that has been planned during the design phase.

**Air pollution** can be considerable during the construction phase, as there is a range of activities such as earthmoving and road construction which generate dust. In certain parts of the project site, dust generation might be even more severe during this stage than during production. If those parts of the site are close to sensitive areas, attention will need to be given to controlling dust emissions, especially under adverse dry and windy conditions. If there is a potential for dust impacts on close communities, the situation may warrant the installation of one or more dust-monitoring instruments which can be used to capture real time data and send an alarm when a predefined dust concentration is reached. In this way, activities can be controlled to minimise short-term dust events.

Regarding **noise**, a comprehensive monitoring and audit program should be implemented during construction and the following stages. The monitoring program provides the company with a means to maintain a continuous record of environmental noise emissions and respond to complaints in a timely and professional manner.

### 4.3.4 Production

During the exploration, design and construction phases efforts are focused almost exclusively on impact prediction and mitigation, while the operational phase often provides opportunities for **biodiversity** protection and enhancement.

Biodiversity protection usually applies specifically to the operation area, while biodiversity enhancement concerns measures that involve a wider area of influence. Within the fence-line of an operation, natural habitats in undisturbed areas can be managed to enhance their biodiversity value, or habitats that have been subject to historical disturbance can be improved or restored. Beyond that limit, enhancement opportunities might exist in the form of:

- Enhancing scientific knowledge of ecosystems or species
- Linking to existing conservation initiatives. This provides an opportunity to generate relationships with local organizations and government entities.

At the operational stage, the major **emissions and air quality** issues occur, requiring an ongoing management plan that is both rigorous and flexible. Activities such as drilling and blasting, beneficiation of the material and power plant operations can generate SO$_2$ and NO$_X$ emissions which need to be carefully managed. Monitoring, recording, doing quality checks and constantly reporting information are all necessary steps.
Noise and vibrations are a problem that arises mainly from drilling and blasting. Some measures commonly adopted to control its impact, which are also in line with using resources in an optimal manner, are:

- Reducing the charge mass.
- Eliminating the exposed detonating cord and secondary blasting.
- Optimising the stemming height.

During the pre-stripping stage in Codelco’s Ministro Hales mine in Chile, air pollution, noise and vibrations were a major concern. Not only was this one of the largest pre-stripping operations ever done, but the mine is also a mere 5 kilometres away from Calama city. To deal with this, a sophisticated system that monitors air quality was implemented. Collected information is fed to a separate system that regulates the operation of mining equipment. This system also forecasts meteorological conditions such as wind intensity and direction, and simulates blasting at different times of the day so that the best time to blast can be adequately chosen.

In terms of water management, there are three areas that need attention during production: water supplies and how they are managed in relation to other interested parties, efficient site water use and water treatment after it has been used, including the possibility of re-injecting it into the watercourse. Overall, the actions taken in each of these areas should be in line with what was planned and discussed during the design phase.

The coal-producing Bulga complex, located in New South Wales, Australia, and owned now by Glencore after it bought Xstrata, has undergone a series of changes regarding its water managing system. After a severe dry weather experience in 2007, the company decided to decrease its reliance on its nearby river and use stored water more efficiently. A short and long term water balance model was developed to assist day to day decisions. This model identifies the benefits of on-site water storage and its desirable size, diminishing the requirement for river water. Changes were made to the tailings system to increase the water available for recycling and appropriate filtration systems were installed.

4.3.5 Closure

Achievable objectives and targets for biodiversity re-establishment are essential to give the company a framework on which to base its rehabilitation program and to provide measurable standards against which regulatory authorities and other stakeholders can determine whether the company has met all necessary requirements. These targets and objectives for biodiversity should be integrated into the EMS.
When looking at these objectives, it is expected for companies to rehabilitate biodiversity to the levels observed before mining activities began. However, this might not always be possible and in that case, it is of extreme importance to take into account the stakeholder’s opinion and positions on where the rehabilitation process should be heading. Placer Dome’s Misima Mine, located in Papua New Guinea, produced gold and silver from 1990 to 2001, when the mine closed after the exhaustion of its reserves. After recognizing that full restoration of the pre-impact ecosystem was not a realistic objective, the company focused on developing a rehabilitation strategy that would meet the requirements of the local people. Deconstruction was finalised in 2005 and the rehabilitation process – divided in three stages – lasted from then to 2012. The original vegetation was predominantly wet tropical rain forest without much direct use, whereas now the area is used by local villagers as a source of building timbers, food (edible fruits and nuts, hunting and egg collecting), flowers for decoration and medicinal and ceremonial fruits and leaves.

When possible, it is considered good practice to aim for more than just restoring biodiversity to its previous state and commit to enhancing biodiversity in the area. For example, those mining in heavily cleared areas may choose to re-establish a vegetation community with significantly higher conservation values than existed before mining. Again, it is important to have a discussion with the stakeholders prior to the setting of rehabilitation objectives in order to capture opportunities for biodiversity improvement that the community may not have the technical or financial resources to implement. In Peru, Compañía Minera Antamina is an example of how a mining company can have a positive effect on biodiversity beyond its operational area. Compañía Minera Antamina is a joint venture between BHP Billiton, Xstrata, Teck and Mitsubishi Corporation. Its mine is located in the Peruvian Andes, at a high elevation with an ecosystem composed largely of grasses and shrubs that can withstand the climatic extremes. However, some forests composed of Polylepis trees can also be found in that topography, although not in the specific area where Antamina operates. The Polylepis trees are the habitat of several bird species that are considered in danger by the International Union for Conservation of Nature (IUCN), and therefore Antamina decided to start a voluntary project to protect these trees. The local community and government entities where also asked to participate. The project started in early 2005 and was carried out until 2008. The project’s outcome was the conservation of approximately 200,000 hectares, out of which 50,000 hectares were directly acted upon.

**Air pollution, noise and vibration** impacts are likely to be significantly reduced during the closure and rehabilitation phase, compared with the normal operations of a mine. However,
impacts from closure and rehabilitation cannot be ignored, as earthmoving equipment remains operational and often operates in exposed locations as the final landform is created. Any environmental management plans for the mine should remain in operation for closure and rehabilitation to allow for ongoing monitoring and community consultation as required.

In the case of **water management**, monitoring measures and water treatment can go on for years after a mine is closed. This is the case for the Toyoha mine in Japan.

The Toyoha mine, owned by JX Nippon Mining & Metals, is located near the city of Sapporo. The mine produced zinc, lead, silver, and indium from 1914 to 2006. The tailing dumping sites and used pits in closed mines that were left after the mine was closed pose a risk of producing acidic wastewater that contains metals. Therefore, it is necessary to permanently process this wastewater to prevent water contamination of the surrounding rivers, which are ultimately used for Sapporo city water supply. In order to purify wastewater more efficiently in future years, new treatment facilities were constructed at the Toyoha mine in 2008. These facilities were designed and constructed in close cooperation with the Hokkaido government's Industrial Safety and Inspection Department and Sapporo City. They were completed at the end of 2011 and have been working since.

### 4.4 Stakeholder interaction

#### 4.4.1 Overview

Mining companies have always interacted with a diversity of groups such as governments, regulators, nearby communities and employees, all recognized as stakeholders since they are affected by the company’s decisions and actions. In recent years, many companies have started positioning these interactions as part of their commitment to sustainable development and corporate social responsibility (CSR).

This section will focus specifically on the interaction between mining companies and communities and employees, covering the following subjects:

- Community engagement
- Community development
- Indigenous communities
- Labour practices

In order to provide some context, the main tools used to assess the impact of mining operations from a social point of view are presented below.
4.4.1.1 Social Impact Assessment (SIA)
A Social Impact Assessment (SIA) is a methodology to review the social effects of a certain project. According to the International Association for Impact Assessment, SIAs should go beyond this and include “the processes of analyzing, monitoring and managing the intended and unintended social consequences, both positive and negative, of planned interventions (policies, programs, plans, projects) and any social change processes invoked by those interventions”.

A SIA can be required by law, but it is usually carried out voluntarily as part of good practice.

4.4.1.2 Health Impact Assessment (HIA)
Assessment and management of community health, safety and wellbeing are increasingly considered part of the social responsibility of mining operators. A Health Impact Assessment (HIA) is a systematic approach to predicting and managing the potential positive and negative health effects of projects on local communities.

HIA assesses both the direct physical health impacts on community health (emissions into the air, water and soil among others) and the indirect impacts on health via health determinants (what the community eats and drinks, where they live and work, what kind of health services they have available, etc.). Since health determinants overlap with social and environmental elements, an HIA can be conducted as a standalone assessment or integrated with EIA and SIA.

4.4.1.3 Occupational Health Risk Assessment (HRA)
While HIA is focused on measuring health impact on the community surrounding a mining operation, an Occupational Health Risk Assessment (HRA) is directed towards protecting the health of company employees. An HRA is a structured and systematic identification and analysis of workplace hazards with the aim of reducing the risks of exposure to these hazards. It involves four steps:

- Identification of hazards,
- Examination of the potential health effects,
- Measurement of exposures, and
- Characterisation of the risk.

4.4.2 Exploration and Design
During the last decade, the mining industry has come to understand that local communities have the ability to influence the industry’s access to resources. Given this scenario, it is during exploration activities that a company’s community engagement should begin. The quality of community engagement at this early stage is very important as it will influence future
relationships – the greater the effort during this stage, the more the reward during other phases of the mining cycle. In some cases, this is especially true for foreign companies.

The Chatree mine, located in Thailand, is an excellent example of how foreign-owned companies can work optimally in developing economies. The mine is owned by Akara, a subsidiary of the Australian company Kingsgate Consolidated. Thailand is a challenging economy for mining companies to gain access to mineral resources – NGOs and community groups are active and there is a general anti-mining atmosphere. Being aware of this, Akara has worked particularly hard on its community relations since the very beginning. As a result, Akara has an outstanding performance in terms of sustainability and has been recognized for its CSR achievements.

Some community engagement activities that can be done during the exploration phase include having a continuous dialogue for the purpose of getting permission to access land, negotiate land use, inform people of ongoing activities and manage their expectations and concerns about them. During design, it is a good idea to involve the community by making them part of any baseline monitoring of environmental, social and cultural aspects. They should continue to be informed of major developments, and consulted regarding permits, land and water use to avoid surprises in the future.

All of the above apply regardless of a community’s racial or ethnic composition. However, special care must be taken in some areas when engaging indigenous people. Some things to keep in mind when engaging this specific group are:

- Issues with Free, Prior and Informed Consent (FRIC) – meaning, the ability of the community to make a choice freely and with full understanding of what it entails – are more likely to arise in indigenous groups, mainly because of conflicts related to their pursuit of the right to self-determination and the rights to lands and territories.

- Indigenous groups may have a special connection to their land, advocating that they are its rightful owners (regardless of whether their right over it is legally recognized).

- They might not have been exposed to mining before, and therefore the communication of technical information must be carefully made.

For Twin Metals Minnesota, a large underground copper project in the United States, early engagement is an important part of its strategy. In the company’s own words, “although construction of the mine is several years away, Twin Metals sought to develop a meaningful new stakeholder-engagement and community-expectation strategy”. In conjunction with Business for Social Responsibility (BSR), an organization which works with a variety of businesses to promote sustainable development, it developed an early-engagement strategy that
included interviewing a broad range of stakeholders and incorporate these interviews into the company’s emerging strategy. The attention given to stakeholders helped built a credible strategy that has the support of the community, and valuable insight was gained on risks and opportunities that could arise in the future.

Lumina Copper’s approach to dealing with indigenous communities in Chile is also a good example of early engagement and its benefits. Although the consultation process of indigenous communities is not yet regulated in Chile, Lumina Copper conducted a formal consultation process during the design stage of its Caserones project between January 2011 and April 2012. The Caserones project includes the construction of a 19-kilometre power line across indigenous territory, and it was important for the company to make sure there would not be any conflict with local people and organizations because of it. After studying the project, the community expressed its discomfort with certain sections of the initial route of the power line. As a result of this, a team with company people and community representatives was formed to set a new path that would accommodate all interested parties. Once this important step was achieved, other agreements followed: the community would receive training on the subject of the power line and supervise its construction and maintenance, while the company would train its contractors on the traditions of the local indigenous community.

In response to the sustainable development agenda, a growing number of companies are now focused on how they can contribute to development of communities beyond the life of a mine. This approach has emerged relatively recently, which explains why the methodologies and approaches in these areas are still evolving. Community engagement is usually stronger than community development during these stages. However, some steps can be taken to start community development in the right way, such as facilitating employment opportunities for local people in areas related to exploration activity.

During design, a community development program can be worked on in collaboration with community groups. This is the case for the Caserones project presented above. As part of the agreements reached during the consultation process regarding the route of the power line, a community development program was designed. This program has four major areas: sustainable technological innovation in renewable energy, risk, agroforestry development and tourism; training and capacity building for the provision of mining services; cultural development and the strengthening of the local people’s committee; and monitoring and promoting the environment.

**4.4.3 Construction**

Once construction starts and major changes start to happen, it is not unusual for communities to become restless. Community engagement during this stage must be focused on understanding
and addressing the community’s concerns about the environmental and social impacts of large-scale construction activity. Expectations about employment and economic opportunities during construction and beyond should also be managed.

In terms of **community development** activities, at this stage it is a good idea to start implementing programs to help integrate employees and their families into the community. It is also a good time to start providing training, employment and business opportunities for local people (which should extend to the production phase). Special attention might need to be given to **indigenous people** who might not have access to regular communication channels, and therefore might not be exposed to these opportunities. In terms of training, it is also important to understand the limits of the group’s education as we see it traditionally – many skills that are needed to even apply to a training program might not be part of the indigenous community’s education system. In this case, special programs might be needed in order to include all interested parties.

**4.4.4 Production**

At this stage of the mining cycle, **community engagement** is expected to be at an advanced level. Constructive dialogue should be maintained even in the middle of conflict, and the mining company should strive to keep its actions transparent and to share all available information with the community. Good procedures for dealing with grievances are also important. Some companies have established formalised grievance processes, which can include involving a third party to mediate on a particular issue.

Although it is always recommended to engage the community in the early stages of the project, it is never too late to do so. An example of this is Rio Tinto’s situation with its Argyle Diamond Mine in Western Australia. The mine is located in an area of major spiritual significance for traditional landowners of the region. After 20 years of production, in 2001 the company and landowners recognized that a more formal relationship was needed. Argyle Diamonds personnel made a point of listening to the Traditional Owners and apologizing for mistakes of the past, which allowed the traditional owners to keep an open mind and to engage in open dialogue. Members of the communities were taken on site tours, including the underground mine. A number of visual aids were used to explain the impact of the mining activity on the surrounding area, and translators were used to ensure that everyone could follow and participate in the negotiations. In a reciprocal process, the Traditional Owners provided the company with information about their customs, and performed ceremonies to ensure that the mining operation could be conducted safely and free from interruption by ancestral spirits.

**Community development** should also be advanced, already at a point where there is collaboration between the company and the community to tackle issues that are of interest to
both, focusing on building a sense of mutual cooperation. Although mining projects can bring prosperity to an area and improve the living standards of local people, new goods and services can also impact negatively some sectors of the local economy. Employment opportunities in a new project may also preclude people from carrying out other important roles that they previously fulfilled, such as child care, food gathering, and leadership roles in the community. The employment of women may have particularly significant effects on family and community social relationships, and therefore appropriate support mechanisms should be considered. These are all issues that the company and the community should address together.

Local recruitment and training programs are another area where great value can be achieved, especially regarding indigenous people. An example of an Indigenous recruitment strategy is Barrick Gold’s Cowal gold mine. The Cowal Gold Mine is located in New South Wales, Australia. Barrick has entered into an agreement with a Native Title Party representing the Wiradjuri people. As part of this agreement, the Wiradjuri Condobolin Corporation (WCC) was formed. In partnership with the WCC, Barrick designed an Introduction to Mining course meant to prepare indigenous people who wish to apply for positions on the mining site. At the completion of the first course, 19 people out of 21 enrolled fully completed the course and eight graduates were hired by Barrick and construction companies on site.

Groote Eylandt Mining Company (GEMCO), operated by BHP Billiton, mines manganese from the Groote Eylandt Island in Australia. Since 1997, GEMCO employs and trains members of the local aboriginal community to rehabilitate the areas that are not longer being mined. This way, the rehabilitation process is carried out as mining continues. Since there is not much documented knowledge of plant species in this part of Australia, the aboriginal community’s knowledge of the area makes rehabilitation easier, making this a win-win situation for the company and the local indigenous community.

**Safe mining operations** are an important factor in a company’s social license to operate. Effective health and safety systems can improve production because work procedures are improved throughout the organization; fewer accidents results in fewer down-times and other interruptions. They can also help avoid costly shutdowns, reduce insurance costs, worker's compensation and emergency response costs; and limit loss of sales and shareholder value, among other costs. The general public, investors, potential employees and members of the community look to an organization's safety record as an indicator of a company that not only cares about its employees, but also cares about its performance in other areas of responsibility, including the environment and its relationships with the community. Mining is in competition for good employees, and excellence in mining safety and health is a strong recruiting tool.
For example, the CORESafety program is a partnership led by the members of the National Mining Association in the United States. It is an approach to mining safety and health which aims to prevent accidents before they happen, using a system that involves leadership, management, and assurance. Its objective is to have zero fatalities and a 50 percent reduction in mining’s injury rate within five years. The CORESafety system has been customized to mining and is based on successful safety and health management systems used in other industries that have successfully improved their health and safety performance.

4.4.5 Closure

Mine closure has the potential to have a strong impact on a community. When a mine closes and migrant workers leave, it is not only the mining jobs that are lost, but local businesses, supplying goods and services to the mine and its workers, are also affected in ways that cannot be reversed when the project closes. In such a situation a return to traditional industries, such as agriculture, may not be possible if land use has changed and skills have not been passed on from one generation to the next. Good enhancement and mitigation measures with a focus on enhancing local skills and developing plans for what will happen when the project closes are likely to minimise the potential negative impacts.

Teck’s Sullivan mine, a lead, zinc, silver and tin-producing underground mine located in the city of Kimberley, Canada, gives a good example of how companies can help community development in the long term. After 91 years of production, the mine closed in 2001. The company helped the community prepare for the closure of the mine years in advance through education programs and building infrastructure such as schools, hospitals, roads and other services. In the early 1990s, Teck teamed up with the city of Kimberley to transform the city into a tourist and retirement destination. This goal was achieved and today Kimberley is known for its skiing resorts and potential for outdoor activities such as snowboarding, fishing, kayaking, and golfing. The Kimberley ski hill and golf course were both developed with the help of Teck.

The establishment of a consultative closure committee, integrated into an overall stakeholder engagement strategy, can be a useful forum in which long-term objectives can be discussed with a wide range of stakeholders and community representatives. These forums have shown to be a powerful means of engaging stakeholders and demonstrating to regulators that there is community support and input into the overall plan. An example of such a committee is the one formed during the closing of BHP Billiton’s Beenup mine, in Western Australia. The Beenup Consulting Groups (BCG) was formed by a variety of people, including landowners and business and conservation group representatives. The BCG played an active role when deciding how the mine would look like after rehabilitations, helped identify key issues to be dealt with in the implementation process and provided a communication channel for the Government to
obtain information from. Another example of a successful closure committee is the Mine Closure Steering Committee created by Kelian Equatorial Mining (KEM) in Indonesia when they closed their gold mine in 2005. This committee was especially relevant since the economy was in a state of political unrest at the time.

4.5 Role of governments and industry associations in best practice mining

4.5.1 Governments

Whilst the responsibility for best practice operation at mining projects clearly rests with the mining company itself, host governments also have a role to play in supporting this endeavour.

At a minimum, this involves the creation of legislation outlining appropriate standards in the mining industry throughout the lifecycle – e.g. the requirement for environmental and social impact studies, an appropriate regulatory environment for mining exploration, construction and operation in terms of its impact on local communities, limits on emissions, etc. Most large mining companies aim to keep their own standards which are often well beyond the minimum imposed by host governments, but this legislation is nonetheless important, particularly for junior and mid-tier companies which may require more direction, and to try to legitimise artisanal mining which may operate with few controls on worker health and safety, environmental impact etc.

A robust legislative environment that protects the rights of the local communities affected by the mine is also important as a way to get these communities to engage with the project itself. Communities are likely to be more positive about a project if they feel that the host government has their interests protected, both in terms of minimising the impact of the project on the local environment, and ensuring that workers on the mine site are protected by labour and safety laws. Of course, legislation which allows for mining returns to be distributed to the affected communities are also important, and this is covered in more detail in Chapter 5.

Governments are also important players at the mine closure stage, and need to take an active role, working in collaboration with the mining company, in helping prepare a community for the loss of a major employer. They also should take responsibility for ensuring that land reclamation is carried out to a sufficiently high standard.

4.5.2 Industry associations

Industry associations – whether industry-wide, region- or commodity-specific – hold important advantages for mining companies attempting to achieve best practice operation throughout the mining lifecycle. These can be classified in two ways – assistance with government and
community engagement, and as a repository for knowledge and expertise. To a certain extent, these associations can effectively determine and represent mining best practice, disseminating information to assist all producers to move towards this standard, and being at the forefront of research and development to improve mining sustainability.

4.5.2.1 Government and community engagement

Working with host governments as a sector, represented by an appropriate association, rather than approaching as an individual company, can be advantageous, particularly for jurisdictions less familiar with the mining industry. Associations can help explain how the sector works, and encourage a level playing field on regulations compared to other jurisdictions. This kind of approach also creates less opportunity for corruption and conflict; there is a more obvious indication that any approach is not purely being made in the interest of an individual company – as opposed to the benefit of the host government and the local community – when discussions involve an association instead of single players.

Similarly, when approached by an industry association which has nothing specific to gain from a particular project, a community may react more positively and engage more readily than if the approach is made directly by a mining company. This could be particularly true if the association involves experts in community engagement, for example those that have experience in working with indigenous groups, or in demonstrating the value of mining projects to local communities. Associations may be better placed to get this message across than individual mining companies.

4.5.2.3 Knowledge repository

Industry associations often act as a forum for producers on matters of common concern, allowing members to share opinions and data, and providing access to expertise which can be of great assistance with various aspects of mining best practice.

- **Data:** industry associations often have vast volumes of data relating to best practice mining, which can be shared amongst members. This can range from production statistics, to performance benchmarking data and industry trend modelling. It can also relate to the regulatory environment: for example, the International Nickel Study Group (INSG) provides on an annual basis an updated summary of the various EHS (environment, health & safety) legislative initiatives from national and international authorities as well as voluntary agreements which may affect nickel producers. The INSG monitors new legislative actions and collects information relating to developments in INSG member countries and other countries.

- **Research and development:** Associations can be a central location for organising, funding and managing the development of new technologies for the production of
metals, and their end uses. For example, the International Copper Association (ICA) have partnered with researchers to re-engineer the copper heat exchanger to reduce material use by 30 percent and improve efficiency. Additionally, a new protective coating technology which prevents corrosion of copper heat exchangers exposed to nitric and sulfuric acids from gas combustion and is capable of withstanding 1000°C in copper heat exchangers has been developed by a partner supplier.

- **Access to experts:** many associations have expert committees relating to specific topics, such as indigenous peoples rights, mining land reclamation, technological aspects and issues related to pollution control, amongst many others. These committees can help companies which may not have encountered a particular issue in the mining lifecycle before handle it in the best possible way, by using the committee’s exceptional mining industry expertise.
Chapter 5 – The impact of government policy on mining sector investment

5.1 Introduction

This chapter outlines in general terms, and with specific examples, the impact that Government can have on investment in the mining sector. We begin by asking the question: why should mining be treated any differently to other industrial or business sectors. In other words what are the key features of the mining industry that have to be taken into account by both government and business. Next, we consider what constitutes an attractive environment for the mining industry, and to what extent is this within the control of government. Having defined the areas of government policy that impact mining, we outline the policies that can either encourage or discourage investment in exploration and mining. These are divided into general and macro-economic policies on the one hand, and mining specific policies on the other. Finally, we look at the issues connected with multiple layers of jurisdiction (national, regional and local). The chapter concludes with an examination of some of the summary measures that are used to capture the attractiveness of an economy for mining investment.
5.2 Key features of the mining sector

Why do governments (and companies) treat the mining sector any differently from any other sector of the economy? And what are the economic features that shape policy?

Non-renewable resource
The first key feature is that minerals are a non-renewable resource. They are also almost universally owned by the State (the important exception being the USA). Access to, and exploitation of mineral deposits therefore requires land to be leased to a mining or exploration company by the State. One of the most important functions of the State therefore is the granting of exploration and mining licences, the means by which they are granted, and the terms on which they are granted. Because the resource is non-renewable, the State is granting a licence for the use of a one-off economic opportunity. This is the basic rationale for the payment of mining royalties.

Any individual mine has a finite life, and goes through a life-cycle from exploration to eventual closure, as illustrated in the chart. As a result, government has to develop policy to take account of each stage of the mine’s life cycle. This obviously affects environmental regulations, but also, less obviously, taxation – for example, should exploration expenses be allowable against future taxes from operations. Again, because of the finite life of any mine, the issue of sustainability in mining has focused on the sustainable and responsible use of the non-renewable resource.
Large upfront investments

Mine projects obviously vary in scale according to the size of the resource and the annual capacity. However, major mines require very large capital investments, stretching over several years, before operations can commence. For example, the Oyu Tolgoi copper mine in Mongolia, which shipped its first copper concentrate in 2014 had a first stage capital cost of $6.2bn. Capital is required not just for the development of the open pit or underground workings, but also for the beneficiation equipment, and also for the often large investments needed in infrastructure in remote locations – such as access roads, ports, power supply, water, townships and so on. In addition to high capital costs, mining projects can have very long gestation periods. CRU estimates that the average lead time for a copper project, from discovery to first production is over 10 years.

One implication of the large upfront investment, especially in major projects, is the need for foreign direct investment (FDI). Less developed economies (and even small developed economies) do not have the domestic capital resources to develop large mining projects. Even for better resourced Governments, large mining investments may not be regarded as a priority call on the public purse. Because of the need for FDI, government policy towards foreign ownership and FDI generally is an important aspect of the overall policy framework for mining.

A further implication of the large investment for major projects is the relative scale of the development and construction impact on a small or developing economy. Even during
development, a major project can stretch the limited administrative capacity of a developing country government. During construction there may be a large temporary bulge in imports impacting the trade balance, or the social and economic impact of a large temporary in-migration of construction workers. Governments and mining companies need to work together to mitigate these impacts.

For mining companies, the large investment and long lead time of major projects poses a significant risk. This is connected to the immobility of the investment, once committed, and the potential for a change in government policy or attitude \textit{ex ante} and \textit{ex post} the investment.

**Immovable assets**

As mentioned, by its nature, a mine is an immovable asset. As such, mining companies are vulnerable to any change in the ‘rules of the game’ after committing to the investment. \textit{Ex ante}, mining companies have a choice of where to allocate their capital, which may give rise to competition among economies to attract the investment. However, \textit{ex post} the capital is immobile, and the assets have very little value unless \textit{in situ}. The bargaining positions have reversed, and this may be exploited by for example a change of governing party.

The above is why mining companies tend to value policy stability above all else.

**Volatile revenues**

Most of the main mined commodities have very volatile prices. Many metals are traded on international commodity exchanges such as the London Metal Exchange (LME), which sets benchmark prices which change daily. The mineral concentrates are then priced on the basis of the LME metal price. Whether traded on an exchange or not, mineral prices are inherently volatile because of the cyclical nature of demand, and the inflexibility of production in the short to medium term. Even commodities which historically have had more stable prices, such as iron ore and bauxite, have moved, or are moving to ‘index pricing’ where prices vary at least weekly according to indexes published by various price reporting agencies (PRAs).

A further factor contributing to the volatility of mining company profit margins is the fluctuation in exchange rates. This is because for most commodities prices are set in US dollars (US$), while a proportion of costs, including labour and local purchases, are set in local currency. For any mine this means that a currency appreciation against the US$ will raise its costs when expressed in US$, and vice versa. During the last ten years this has been a big factor in affecting the production cost of mines in Canada, Australia and Chile, which have all experienced a strong appreciation against the US$.

Thus mining company margins are affected by volatile commodity prices (revenues) and exchange rates (costs). This implies that profits are also volatile, and profit margins are highly
leveraged to these external factors. Profits may therefore fluctuate from very high one year to very low (or even losses) the next, for an extreme example note the fall in profits between 2008 and 2009.

An implication of this volatility is that mining companies are vulnerable to accusations of making ‘excess’ profits if one year is taken in isolation. During the commodity boom of the 2000s successive years of high commodity prices from 2004 to 2008 led to pressure from various governments to revise mining taxation to obtain a larger share of profits.

There are three clear implications for mining companies.

- A preference for direct taxes on profits over indirect taxes such as production royalties. Indirect taxes raise production costs, raise the breakeven price level, and may therefore distort production decisions.

- A preference for a progressive tax regime that automatically responds to changing conditions, since this is perceived as more stable and will reduce the likelihood of ad hoc demands to tax excess profits.

- Tax stability is more valuable than getting an initial favourable tax deal whose legitimacy may later be challenged.

Volatility of profits also is a problem for host governments, especially in smaller economies where the tax take from the mine or mines is a high proportion of government revenue, such as Papua New Guinea. Governments can deal with this by means of their budgetary processes – for example by means of a revenue stabilisation fund, or investment of surplus income in a sovereign wealth fund.

**Long period before revenues**

This feature is related to the high capital costs and long lead times of mines. For the mine operator, the generation of positive cash flow from the mine is delayed by the long construction period, and extended by a period of ramp up to planned production. Once at full production, and generating cash, it will usually take many years before the cash generated has repaid the capital invested in the mine, even under the best of conditions, and even excluding any interest on the capital. These periods are called the payback period (not including interest) and discounted payback period (including interest). Under most tax regimes it is likely that payment of tax will begin before the end of the payback period. And indirect taxes such as production royalties will begin as soon as production begins.

Mining companies will generally prefer that tax is delayed until the mine is in profit, and in an ideal world tax would be loaded in the period after initial capital has been recovered.
However, such an approach presents difficulties for a host government. The delay of any tax receipts for several years may be politically difficult especially in a small country where a major project has high political visibility. This is one reason put forward as to why production royalties persist – they generate some revenue from day one of production, regardless of profitability. It is sometimes argued that governments should be able to accept delayed tax receipts because they have lower discount rates than mining companies – that is that their preference for current over future revenue is less than the mining company. However, in terms of realpolitik the time horizon of a government minister may be equal to or less than that of a company CEO.

**Visibility**

Mining projects have a high political visibility. Citizens correctly recognize that the mineral deposit being exploited is their own birthright. This is especially so in a small or developing economy, where the mine is identified as a key asset, and where the main issue is how to use the sales of this asset to improve the wellbeing of current and future citizens. But even in large and developed economies such as Australia, major projects still have high visibility, although the issues are more likely to be environmental and social, rather than the division of economic benefits.

One of the issues related to visibility is that the economic benefits of the mine are not very visible, or are perhaps not well publicised. The main benefit is generally in higher tax receipts rather than in local economic linkages. Higher tax receipts that will eventually feed into better public services may seem rather abstract compared to say the provision of funding for a local school or health centre. In addition, this argument relies on the public’s faith that the tax receipts will be wisely and efficiently spent. This is something the mining company has no direct control over.

**Economic rent**

Economic rent is defined as a return on capital in excess of that which is necessary to induce an investment in a particular activity. Rent in a particular activity may exist for a number of reasons, such as monopoly, or patent protection. However, economic theory suggests that in most cases rent will eventually be competed away by the free movement of capital, for example when a patent expires on a proprietary drug, profits will be competed away by the entry of generic copies. In the case of mining or oil and gas this is not the case, since the rent is caused by natural factors – the quality and location of the natural resource. For example, if the marginal copper mine has an ore grade of 0.6% copper, a mine with 2% copper has the opportunity, other things being equal to make economic rents. Similarly, if the marginal oil producer is Canadian tar sands, or offshore deep wells, then the onshore producer in Saudi Arabia, which can produce at a fraction of the cost, will certainly make a large economic rent.
Economic rent is much more obvious in oil and gas production, where it is often captured by outright state ownership by National oil companies (NOCs), or by production sharing agreements. The degree of rent in mining is much less, which is why government policy towards the oil and gas sector is usually different from the mining sector. Indeed, it is very important that Governments recognise that economic rents in mining are an order of magnitude smaller than in petroleum, and that many marginal mines will not produce any rent at all.

Governments can try to capture a share of economic rent by imposing taxes in addition to the normal corporate income tax (CIT). These may take the form of Resource rent taxes (RRT), profit based royalties, or free carried equity.

Classification of APEC economies

Many of the implications of the features of mining for host governments vary in impact according to the size and development status of the host economy. The policy responses of government may also vary. For this reason we have classified the APEC economies in Chapter 1 according to the World Bank classification of economic development.

5.3 Economy attractiveness for mining

What makes an economy attractive for mining investors? To what extent are these within the control of government?
**Geological prospectivity**

Geological prospectivity is not something within the ambit of government policy. However, economies may be able to improve their attractiveness to exploration companies by carrying out basic geological surveying and mapping. In addition, geological attractiveness may have an impact on government policy in general. For example a geologically attractive economy may feel it can have a more aggressive taxation policy than a less attractive economy. The geological prospectivity of APEC members, as evidenced by the Fraser Institute, was outlined at the end of Chapter 2.

**Country risk**

Country risk covers a multitude of factors, including political stability, internal security and risk of war or civil unrest, risk of expropriation or major policy changes, and so on.

Below that general level of country risk there are issues of the rule of law, property rights and contract law, the strength of the courts, the efficiency of administration, and the level of corruption.

At the next level we find overall government policy, particularly on macro-economic issues such as exchange rates, monetary stability, policy towards foreign direct investment.

**Infrastructure**

The provision of infrastructure is an important determinant of the attractiveness of an economy for exploration and mining investment. This includes the provision of roads and other transport infrastructure, power supplies, water supply. Softer issues of education, training and healthcare can also be important. It is obviously easier to carry out exploration and mining in an economy with a developed infrastructure. On the other hand, where infrastructure is lacking, the provision of infrastructure by the mining company may be one of the benefits provided by a mining project.

**Mining Sector policy**

Mining sector policy constitutes the elements of policy directed specifically at the mining sector. This will generally include the system for licensing areas for exploration and mining, as well as any mining specific taxation. Regulation of mining is often codified in a single Mining Act. Alternatively, some economies regulate mining by means of individual agreements with major projects. In addition, there may be specific policies aimed at the small scale artisanal mining sector.
5.4 The impact of Government

5.4.1 General policy

At its most fundamental level, political stability means the absence of war or civil strife, the security of people and property (from the above factors, or from organised crime), and the ability to transfer power peacefully by political means. Without these basic conditions it is difficult to attract investments, in mining or otherwise.

At the next level down come the rule of law (as opposed to political or administrative fiat), the establishment of property rights, sanctity of contracts, efficiency of administration and the system of courts.

In addition to the above issues, the level of corruption is a deterrent to investment. It is probably true that no economy is entirely free of corruption in government-business or business to business relationships. However, there are some in which corruption is endemic, and a major impediment to the efficient conduct of business. Corruption can slow down the completion of a project as well as increase costs. As with other aspects of government policy, international indices of the level of corruption are available.
The World Bank calculates and reports on many aspects of a countries’ governance in its Worldwide Governance Indicators series. Among these are measures of the Rule of Law and Control of Corruption.

Even in the absence of any of the problems above, smaller economies can struggle with hosting major mining projects due to lack of institutional capacity – for example in Government departments that are responsible for permitting, negotiating agreements, mine safety, environmental law, taxation and so on. Some jurisdictions may have model legislation based on best practice, but a chronic lack of capacity to implement policy.

As well as all the above factors, mining companies must consider the likelihood of extreme events such as nationalisation, or expropriation of property, or any other events that could prevent the mine from producing and exporting its product, for example the blockade of a key transport route.

We have not mentioned democracy here, for the simple reason that there are corrupt and inefficient democracies, as well as well run single party states. That does not imply any value judgement about democracy in any other respect.

Examples of good practices and cooperation can be found in the ICMM’s input into consultation on the Natural Resource Charter of 2011. For example they explain how in Ghana some companies engage with District Government to plan expenditure, thereby supporting effective government public finance management.

5.4.2 Macro-economic policy

In this section we consider macro-economic policy from two different angles. Firstly, we look at the impact of macro-economic policy on an economy’s attractiveness to mining investment. Secondly, we examine the impact of another subset of macro policy on the legitimacy and sustainability of mining, and the distribution of benefits. This centres on the so-called “resource curse” debate.

5.4.2.1 The impact of macro-economic policy on attracting mining investment

The macro-economic conditions that will be supportive of mining investment are those that will support inward investment in general.

- Monetary policy that supports low and stable inflation
- Full currency convertibility
- Light regulation of foreign direct investment. For example, in some economies some sectors are barred to FDI, while others require majority local ownership.
• The burden of general taxation – corporate income tax, indirect taxes. The overall burden of taxation has to be considered in conjunction with any mining specific taxes

• Bilateral and multilateral taxation and trade agreements, such as double taxation treaties with the country originating the FDI.

5.4.2.2 The impact of macro-economic policy on maintaining legitimacy and distributing benefits from mining

Past history and recent experience has shown us that the earnings from the extraction and sale of natural resources has not always resulted in an improvement in the sustained well being of the citizens of these countries. One view is that a failure to convert natural resources into human wealth is inevitable. The following reasons are typically offered as explanations:

a) Large export earnings from mineral resource exploitation lead to an appreciation of the nominal exchange rate. In part this is because of the current account inflow from export earnings, but also from the capital account inflow as funds are sourced from abroad to invest in mining. The exchange rate appreciation harms other less productive tradable sectors such as manufacturing and agriculture and is costly to deal with.

b) The earnings from subsoil assets are volatile, as we highlighted in the introduction to this chapter. This volatility makes it difficult for private citizens or governments on their behalf to plan investments in development assets.

c) As we explained in the introduction, earnings from mining typically are from large scale production. Hence they accrue to one source, typically to the government. The emphasis is therefore on how the government saves or distributes those earnings. If the government’s distribution is seen as unfair and open to lobbying, this can trigger what is called a “voracity effect”. According to this effect, mineral earnings are grabbed and spent as quickly as possible to prevent other competing groups acquiring the same revenues. These massive disorderly bursts of spending of a large resource rent are severely prejudicial to the long-term economic prospects of a country.

In summary, according to this view, natural resource extraction, including mineral extraction, typically leads to bad macroeconomic outcomes—hence it is called the natural resource curse. While this is a commonly expressed view, the consensus from the massive economic literature which has studied this effect is more nuanced:

Studies have indeed confirmed that many countries have failed to fully convert natural resource revenues into sustained economic wealth, but this is certainly not the case for all countries nor for all historical episodes. The 2008 study by the ICMM, entitled Sustainable Development in the Mining and Minerals Sector analyzed the experience of 33 mineral
dependent economies from 1965-2003 and concluded that the resource curse is not preordained for mineral rich economies.

Furthermore unintended macroeconomic side effects are greater when the pure earnings (rent) from the resource are large such as is the case with gas and oil and also tend to be worse when domestic political institutions are weak.

Thus while it is important to be aware and prepare for the headwinds generated from mineral extraction revenues, the literature on this theme argues that they can be avoided by a careful design of policy. In fact, analysing each of the arguments a), b) and c) above do not readily generalize to mineral rents in APEC economies.

In the first instance, mineral exploitation would only imply large exchange rate changes when mineral rents are a large share of exports or imply large FDI inflows. As we have discussed in Chapter 1, the extraction of minerals need not always trigger large FDI inflows in relation to GP and do not always lead to a dominance of exports; this depends on the size of the rest of the economy.

Also it is widely agreed that the underlying model (called the Dutch Disease model) that was first used to explain this effect is too simplistic to describe modern economies, including those of the APEC group. The Dutch Disease model assumed that three sectors: a natural resource sector, a manufacturing or agricultural sector for export and a non-tradable sector with labour fully mobile between the three and no banking sector. Only the non-tradable sector imports inputs. The simple structure rules out many of the instruments available to policymakers to deal with resource rent appreciations.

In reality, modern globalized economies feature subsectors that serve both the domestic and export market (such as food processing) and subsectors that import much of raw material (car assembly) for domestic or export resale. These sectors can benefit or at least will be shielded from an appreciation, because the costs of their inputs fall with the appreciation. In fact, this positive spending effect of the appreciation often dominates the losses faced by other exporters, and the overall consequence of a resource boom on other sectors and on GDP is net positive. Hence the appropriate solution is rather more a question of encouraging the diversification of suffering exporting subsectors and discouraging booms in importing sub sectors.

As far as diversification is concerned, this is about a sustainable strategy for other less productive exporting sectors—the losers from a natural resource boom. In this context, it is interesting to revisit the policy responses in an APEC member Malaysia to the boom and appreciations caused by its oil exports. Given the threats (in particular from synthetics)
faced by Malaysia’s historic rubber industry, the state incentivised improvements in the productivity of rubber estates and smallholders, through replanting grants directed towards new yields in the 1960s and 1970s. Once it was clear that dollar rubber prices were likely to be permanently lower, a diversification into palm oil was organized. Later on, there was further diversification into manufacturing, and agro-industry, and away from tropical products. For example, Malaysia is now an important global producer of rubber gloves, as it once was for rubber. At the same time, the number of different Malaysian products is reported to have increased, with a greater emphasis on the domestic market and on processed food exports. Challenges remain: at the current time, it appears that labour-intensive plantations are dependent on foreign workers and are under some strain, as they struggle to compete for native workers attracted by higher-paid manufacturing and services employment and urban living, while at the same time facing lower prices for their product. But the example still shows that diversification initiatives are possible. Another favourable example is the Chilean’s state promotion of salmon farming, which has grown to reach over a third of world exports within the shadow of copper exports.

The second arm of a policy response to a natural resource exports is in terms of preventing booms in those domestic sectors boosted by the exchange rate appreciation spending effect. Policymakers in the past have relied on blanket measures such as interest rate rises, or tighter overall credit. These untargeted policies have the undesirable side effect of further tightening the pressure on other exporting sectors whilst no doing enough to curb booms in the nontradable sector.

Thus, a more recent emphasis is on the use of targeted instruments to curb excessive credit creation during resource booms in the nontradable sector, such as housing and consumption. This recognizes that modern economies feature a banking sector that can exacerbate the boom if it is allowed to operate procyclically. For example, the health of balance sheets generally, but also especially of non-tradable service sectors, were important in explaining the export growth led Asian crisis, and real exchange rate appreciations might well have helped fuel unproductive investments. Indeed in Malaysia over the 1990s, financial stability actions were especially targeted at retail borrowers. For example, maximum loan-to-value ratios on mortgage lending and car finance were imposed or lowered, perhaps helping to limit the effect of the crisis. For example, Indonesia, Malaysia, and Singapore actively manage controls on maximum loan-to-value ratios on house loans.

Finally, it is also worth carefully considering how a government can spend and distribute the revenues earned from minerals. Here again there are several options available to the state.
A common strategy is to save most of the revenues as they are earned in sovereign wealth funds. Funds are then spent or invested in the domestic economy gradually so that the fund becomes both a buffer and a means of transferring wealth to future generations. Studies typically indicate that, for a typical volatility of mineral resource earnings, only about 10 to 20% should be spent on accrual and the rest saved.

However research has also shown that more important than having a fund are the rules that govern how the money will be invested or consumed. The 2008 ICMM study emphasized that the impact of mining in mineral rich economies depends a great deal on how government resources are used. If citizens are unable to verify the flows in and out of these funds and are unclear about its objectives and social investment returns, their incentive might well be to seek to appropriate these funds themselves through lobbying or voting for spending governments. Hence, the mere existence of a fund per se is unlikely to deter dangerous voracity effects. What matters more are the transparency and accounting institutions surrounding the fund. At the extreme, if the state is felt to be incapable of handling these revenues, there is also a widely discussed suggestion to distribute revenues on a lump sum per capita basis directly to citizens (as with Alaska’s oil) and simultaneously encourage private sector saving.

Securing a favourable macroeconomic outcome from mineral extraction is therefore far from being a hopeless endeavour. It does depend however crucially on the accountability and transparency of the revenues earned from mineral rights. These were discussed in such initiatives such as the Natural Resources Charter.

All this reminds us that the ultimate macroeconomic or social purpose of resource extraction is the conversion of one type of asset (minerals) into another (sustainable economic wealth typically in human and physical capital). The World Bank estimates how much actual wealth creation has taken place in countries and has called this metric adjusted net savings. Adjusted net saving is calculated as the sum of net financial saving, minus the depreciation of physical capital plus educational expenditure (human capital creation) minus energy and non energy mineral depletion minus environmental degradation. Hence this measure attempts to take account of the costs and benefits of mineral exploitation. A negative adjusted net saving implies that total wealth is falling.
The charts below show the average adjusted net savings for APEC members (excluding Chinese Taipei, Papua New Guinea and Hong Kong for which there are no data) and compares this value to the depletion of energy resources (crude oil, natural gas, and coal (hard and lignite)) and mineral resources (tin, gold, lead, zinc, iron, copper, nickel, silver, bauxite, and phosphate).
The charts show that in general there is no correlation across economies in terms of their adjusted net saving and their depletion of either energy or mineral resources. Some APEC economies are able to translate resource depletion into wealth, but some are not. Some economies such as Singapore have been able to increase net wealth per capita without any resource exploitation on their territory.

The chart also shows that apart from Australia, Chile and Peru, the scale of mineral depletion is far smaller than the scale of energy depletion. In general most of the lessons and discussions in this chapter are to do with oil, which tends to imply very large rents relative to a country’s GDP or population: mineral rents are usually smaller in scale.

Summing up, if the exploitation of mineral resources is accompanied by well crafted policies and good institutions, the revenues generated must confer a benefit to citizens, the ultimate owners of the resource. But the exploitation of minerals is not the determining factor in the success of the state in achieving these goals.

### 5.4.3 Levels of jurisdiction

In many economies, mining sector policy is divided between the various levels of government – national, state or provincial, and local. Even where local government has few formal powers, maintaining good relations with local government, and other local stakeholders is seen as increasingly important for the maintenance of goodwill towards the mine – the so-called “social
license to operate”. Clearly, devolution of important aspects of mining policy is more prevalent in large, de-centralised polities, such as the USA, Canada and Australia, and less so in smaller (physically and economically) polities. The division of mining sector policy among the various levels of government throws up a number of issues.

- *A priori* it might be felt that businesses would prefer a “one stop shop” in dealing with government. Even at the national level, dealing with a host of government agencies with overlapping responsibilities may be a challenge. However, a high degree of centralisation of government powers risks ignoring local issues and sensibilities, to the long term detriment of the mine.

- The issue of capacity deficit in government can become even more acute where administrative responsibility is highly devolved. In developing economies, having a sufficiently qualified and experienced administrative cadre is problem enough just at the national level.

- Devolution of powers can produce conflicts between national, provincial and local government, especially where the allocation of responsibilities is not clear, or where there are taxation powers at multiple levels. Conflicts between different levels of Government can make life very difficult for a mining company. For example, the Bougainville Copper Mine in Papua New Guinea was closed by a Bougainville secessionist movement in the 1980s, but even before that local feeling was fuelled by dissatisfaction over the split of revenues between central and provincial levels, as well as other local grievances.

- Governments can split taxation revenues by means of **fiscal decentralisation** or by means of **revenue sharing**. Fiscal decentralisation devolves some revenue raising powers to sub-national levels of government – for example, the raising and collection of royalties may be devolved to provincial level. Revenue sharing involves central collection of revenues, but a hypothecation – or earmarking of certain revenues for certain local purposes.

- Where revenue raising powers are split, national and provincial government may work at cross purposes, or compete with each other over their shares of a given cake. For example, let’s say that a provincial government may raise a production royalty, while central government levies a tax on profits. If the royalty payment is an allowable expense against corporate income tax, the provincial government may increase its share of revenues by raising the royalty rate, and hence reducing the central government take from income tax.
The ICMM, in its 2009 report *Minerals Taxation Regimes*, noted that Chile and Peru provided examples of a highly centralised tax regime (Chile), and a more decentralised one (Peru). In Chile the collection and allocation of tax revenues is highly centralised. It is argued that the central government is in the best position to make a fair allocation of revenues to serve the economy’s development goals. This should take into account that the mining areas are already likely to be among the wealthier regions of the economy, without any special allocation of extra revenues. In Peru, by contrast there is both fiscal decentralisation (royalties collected at sub-national level) as well as revenue sharing (by means of the *Canon Minera*). The different approaches stem partly from the fact that Peru has a bigger problem of obtaining local consent to mining activity.

Given the above factors, it is difficult to be definitive about whether mining companies prefer centralisation or decentralisation of mining policy, but some useful general points can be made.

- Administrative simplicity is best served by a centralisation of powers over the mining sector, whether this be at national or provincial level.

- Where powers are devolved the responsibilities of each level of government should be clearly delineated, and each level needs to have the administrative capacity efficiently to implement policy.

- What is often critical for the individual mine is engagement at the very local level. This may be with stakeholders who have no formal administrative identity or boundary, and no formal powers to regulate the mine. However, this is the constituency that experiences the most direct impact of the mine.

### 5.4.4 Trade policy

A government’s trade policy can also affect its attractiveness to mining investment, in the following main ways:

- **Trade taxes and tariffs**: heavy taxes on exports of mined commodities can negatively impact the attractiveness of a jurisdiction to mining project operators and investors. Such taxes may occur in tandem with a drive to encourage in-state beneficiation and downstream processing. Taxes on imports of mining machinery and equipment, as well as consumables used in the mining process, can also affect investor attractiveness – if a government provides tax breaks or delays tax payments on imports of such equipment then this can ease the significant up-front capital burden involved in mining projects. From an investor’s perspective, the stability of these regulations is all-important; mining companies want to have confidence that any export taxes due will remain consistent throughout the project – uncertainty here makes understanding the potential profitability
of a project very difficult, and therefore increases risk to operators and investors. Further discussion of taxation issues is provided in section 5.5.3.

- **Quotas and trade restrictions:** similar to the point above, some jurisdictions may introduce quotas limiting volumes of imports or exports of certain commodities. On the import side, quotas – or even a perceived uncertainty regarding the possible enactment of such policies – can impair the willingness of miners to enter into long term agreements with potential trade partners who might be affected by an import quota, and therefore may for example be unable to take their full contractual volume. Such a quota might be introduced to protect domestic production from import competition. Whilst this is outside the jurisdiction of a mining project’s host government, it is worth noting as a host government is likely to have greater negotiating power with its peers than an individual mining company, and also can discourage the introduction of tit-for-tat trade restrictions against other economies. On the export side, in the same manner as export taxes explained above, quotas that may limit the volume of output a project can export abroad are unsurprisingly contributors to dissuading potential investment.

- **World Trade Organisation (WTO) membership:** Accession to the WTO – and accordingly committing to its free trade principles – can be a significant factor in increasing investment in jurisdictions, in the mining industry as well as other sectors. Note that some of these advantages might also apply to multilateral and regional trade agreements. The impact of WTO accession on investment is difficult to calculate, given that investment can be concurrently affected by a wide range of other factors, whether policy and macroeconomic. Nonetheless, statistics suggest that in the five years following Vietnam’s accession to the WTO (2007-2011), FDI totalled $144bn, which is roughly double the total FDI over the prior 19 years (1988-2006) of $78bn. Furthermore, a World Bank paper stated that China’s WTO accession would:

  - Increase the competitiveness of Chinese exports through removal of tariffs helping to reduce export prices, and also through improved access to imported technology which could help reduce operating costs.

  - Increase foreign investment in China, as trade liberalization lowers production costs and the price of capital goods, and increases the rental rates, resulting in rising returns to capital in China.

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2 https://openknowledge.worldbank.org/bitstream/handle/10986/18127/multi0page.pdf?sequence=1
o Improve transparency and predictability of trade policy, specifically: “The general WTO policy rules include among other things the need to publish trade rules and regulations. The specific commitments involve uniform application of the trade regime, independent judicial review and a mechanism to bring problems of local protectionism to the attention of the central government. This means that access to China's market will be secured and disputes will be resolved following international standards. This will be an important benefit to China's trading partners.”

- Inefficient Bureaucracy: Eliminating inefficiencies in the bureaucracy and administration required in the export process, and increasing its transparency, can increase a jurisdiction’s investment attractiveness. Mining companies want to have confidence in the supply chain, and to avoid unnecessary delays in exporting.

5.5 Mining sector policy

In this section we deal with aspects of government policy that are specific to the mining sector. For example this excludes general taxation (such as VAT or CIT), but includes mining specific taxation, such as royalties or resource rent tax. Important aspects of mining policy are licensing of exploration and mining rights, taxation, mine safety and occupational health, environmental policy specific to mining, and so on.

5.5.1 Mining law

The law relating to exploration and mining may be codified into a national statute (Mining Act) that applies to all-comers. This is most likely to be the situation in developed economies. In many ways this is seen as the preferable situation, as the laws are clear, enshrined in statute, and there is no scope for discrimination. In addition, negotiation and transaction costs are minimised. This is the case in Chile, for example. However, in some developing economies there may be no precedent and so no codified law, and so mining is governed by individual Mining Agreements. Even in developed economies there may be a preference for individual mining agreements, certainly for major projects. Historically, this has been the case in Australia, for example. In addition, even where there is a general Mining Act, major projects may be so complex that they may also need an individually negotiated Supplemental Agreement.

Whether the regulation of mining is by a Mining Act, or by individual Agreements, the scope of a mining agreement is exhaustively outlined in the Model Mine Development Agreement (MMDA) published by the International Bar Association (IBA). The purpose of the MMDA is not to recommend particular policies, but to act as a checklist to ensure all aspects have been considered, while presenting alternative options for each aspect of policy, as well as examples.
The full list of contents of the MMDA is too long to reproduce here. At its core are the conditions of **tenure** (area, term, minerals covered, legal title to minerals, etc) and the **financial** terms (annual rental, royalty, tax, customs duties, etc). In addition the **rights and obligations** of the company and the state are covered, including such company obligations as treatment of local suppliers and businesses, local community agreement, local employment, safety, closure and post closure obligations. The MMDA also covers **environmental issues**, such as the requirement for an EIS, and an environmental management plan. Note that the MMDA does not cover the regulation of exploration.

In the next two sections, we cover two of the most important aspects of policy – licensing and taxation.

### 5.5.2 Licensing policy

Licensing policy is central to an economy’s mining regime. If an economy wants to encourage growth in its mining sector, then it must first encourage exploration activity. Exploration may not lead to mine development (indeed in most cases it will not), but there certainly will be no mine development without exploration. The key issues in exploration and mining licensing are shown in the diagram below, and outlined in the following sections.

![Exploration and mining regulation](image)

<table>
<thead>
<tr>
<th>Key issues</th>
<th>Investors perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ownership of minerals (usually the State)</td>
<td>Administrative simplicity and efficiency</td>
</tr>
<tr>
<td>Permitting (exploration, mining, artisanal)</td>
<td>Low transaction costs</td>
</tr>
<tr>
<td>General law or individual agreements or contracts</td>
<td>Security of tenure within the law</td>
</tr>
<tr>
<td>Level of jurisdiction (eg Provincial in Canada)</td>
<td>Mortgageability/transferability of rights</td>
</tr>
<tr>
<td>Mode of granting licences (eg auction, first come first served)</td>
<td>Transparency</td>
</tr>
<tr>
<td>Reporting requirements</td>
<td>Minimal administrative discretion</td>
</tr>
</tbody>
</table>
5.5.2.1 Key issues in exploration and mining regulation

Ownership of minerals. In almost all economies minerals under the ground are owned by the State, irrespective of who owns the land above. The main exception is the USA which retains the historic principle of “free entry” for mineral prospecting on Federal lands, which originated in medieval Europe. In addition, land owners own the minerals under their land. This free entry system spread to many economies (such as Canada and Australia) in the colonial era, but has been almost universally replaced by State ownership of minerals under modern mining legislation. Therefore, to explore for or exploit minerals, companies need a licence or permit from the State. The State’s usual payment for this right is a royalty.

Exploration, mining and other permits. There are four types of permit. First is a (usually non-exclusive) reconnaissance licence, which is used by only a few economies. Secondly an (exclusive) exploration licence. Thirdly an exploitation, or mining licence. Finally, some economies have separate regulations for small scale artisanal mining. The focus of our concern is the two most important – the exploration and mining licences. Note that in a few economies, such as Peru, the exploration and mining licences are combined into one. An important feature of an exploration licence is that the holder has a right to move on to a mining licence if an economic resource is discovered.

Codes or agreements. Most economies have mining regulations codified under a general mining law (Chile for example). Others have tended to work via individual Mining Agreements, certainly for major projects (notably Australian States). A third option is a hybrid system whereby most of the law is codified, but there is room for variation via individual Mining Agreements. In Australia and Papua New Guinea Mining Agreements have had the force of law by being attached as schedules to Acts of Parliament.

Responsible agency and level of Government. The responsible agency is usually the Ministry of Mines, or its equivalent, or an Agency thereof. Responsibility for implementing regulations may lie at the National level, or may be mostly devolved to Provincial Governments, as in Canada. Sometimes jurisdiction may be split between national and provincial government.

Mode of granting licences. As mentioned, most economies work on a first come first served basis for the granting of licences. There may be a requirement for pre-qualification – to show that the applicant has the technical and financial capability to carry out its programme. An alternative is to allocate licences by means of some form of auction, though this is usually reserved for special cases, and is more common in the oil and gas sector.

3 Licences are variously known as licences, permits, leases, rights, etc. However we use the generic term licences
Exploration licences. Exploration and mining licences generally need to specify the following:

- Fee. The annual fee for the licence, which may escalate over time
- Size. Minimum or maximum size of area granted
- Duration. How many years the licence is issued for
- Renewal. Whether, and how many times a licence can be renewed
- Relinquishment. Conditions under which the licence must be relinquished
- Minimum spend, work programme. In order to prevent licensees “banking” their licences there may be a specified work plan or else a minimum spend as a condition of holding the license. Minimum work plans, minimum spend and escalating fees are all ways to prevent hoarding of licences.
- Environment plan. An environmental impact statement may be required, although in most jurisdictions this is normally not needed until there is an application for a mining licence.
- Social requirement. Similar to the environmental impact statement, there may be a social requirement – for example for impact studies, anthropological studies, etc.
- Reporting. What are the reporting requirements for holding the licence. These may be minimal or extensive.
- Rights of holder. One of the most important rights is security of tenure, and the right to progress to a Mining Licence if an economic resource is found.
- Mortgageability and transferability. Can the licence be used as a security for borrowing? Is the licence freely transferable, with or without government consent.

5.5.2.2 Desirable features of licensing policy
The grant of mineral concessions or licences to exploration and mining companies represents one key area of minerals policy. Specifically, again from a government perspective, a good minerals concession policy should:

- Facilitate exploration and mining activity, but not at undue expense to the environment or other stakeholders
- Confer secure, undisputed title to the concession holder in return for periodic rental payments
- Be low cost to administer, and minimise opportunities for administrative discretion – which can lead to corruption.
Be as simple as possible, avoiding, as much as is practicable, unnecessary multiple ‘layers’ of licensing over the same ground area (e.g. surface rights, mining rights, prospecting rights, water rights)

Create economic incentive for concession holders to conduct meaningful exploration (and mining) activity rather than simply to ‘hibernate’ the concession

Generate a level of economic return of itself, independent of mineral discovery, through periodic payments made to government for the leasing of mineral rights

Differentiate between exploration and mining activities – for example with more stringent operating conditions attached to the grant of mining concessions (otherwise referred to as exploitation licences) than to exploration concessions

Overall, act as an incentive (rather than a deterrent) to attracting bona fide mineral explorers and miners to a jurisdiction

The following are characteristics of a minerals concession policy that are valued as being attractive by mining companies, leaving aside the fiscal characteristics.

- Administrative simplicity and efficiency
- Low transactions costs – for example avoiding overlapping or multiple layers of jurisdiction
- Security of tenure, within the law
- The ability to freely mortgage or transfer the rights
- Transparency
- Minimal administrative discretion

These summarised attributes of an ‘idealised’ mineral concessions system contain a number of implicit economic trade-offs however. For example, choosing to increase the annual rent paid to the government for holding an exploration concession acts to satisfy the ‘ideal’ concession system attribute of delivering an economic return to the state independent of actual mineral discovery. Conversely however, the effect of these same increased rental payments may simultaneously be to discourage exploration companies from holding multiple concessions – and thereby essentially acts to redirect funds in payments to the government that otherwise would have been used by the company in the search for new mines. A lower discovery rate is the eventual outcome of such a policy change – deferring the more sizeable tax revenues from mining activities. That is, the net result of the additional early economic returns to the government (from higher concession rental charges) may actually be a net loss over time (due to fewer mines being discovered).
In part as a result of these implicit trade-offs, mineral concession systems for the grant of mineral rights differ markedly from jurisdiction to jurisdiction around the world. As yet, there is no single recognised ‘best’ or ‘ideal’ system in operation – although there is little doubt that some concession systems administered by governments act far more efficiently and effectively than do others. Clearly it is in the interests of all governments to manage their mineral concessions policy as efficiently and effectively as possible with a view to growing exploration and mining investment.

All minerals concession systems, good or bad, should contain clear details on each of the following issues:

- The initial acquisition process through which mineral rights will be conferred, for example whether a bidding (auction-based) system is used or else by fixed-rate rental payments by concession area, or a combined system whereby auctions are preferred for high value ground and a fixed-rate system elsewhere with concessions conferred on a ‘first come, first served’ basis. Where granting of licences is on a first come first served basis, there may be a pre qualification step – to ensure that the applicant has the technical and financial capability to carry out the work.

- The scope of the granted mineral rights, for example whether the concession confers a right to conduct simply prospecting activities, exploration activities (including drilling), or actual mineral exploitation rights via mining. Most economies issue separate exploration and mining licences, but a few simply have one combined licence. Where the licences are separate, an important element of the exploration licence will be the right of the applicant to continue to the mining stage.

- The maintenance process of mineral concessions. For example, should companies holding concessions be required by regulation to conduct a certain level of exploration/mining activity per annum, either in terms of minimum spend, or a specified work programme, else can the mineral concession be maintained in good standing simply by the timely payment of rental charges?

- The reporting system for activities undertaken on mineral concessions. For example, are technical reports and accompanying data containing all key details of the exploration activities that were undertaken on the concession required for each and every licence? Conversely, is a single activities report sufficient for a number of grouped concessions in close proximity to each other etc.?
5.5.3 Taxation

### Measuring the “Tax take” by Governments
Calculating the “tax take” involves many different elements

Governments raise revenue from mining companies in many ways:

<table>
<thead>
<tr>
<th>Taxes on profits</th>
<th>Taxes on production</th>
<th>Indirect taxes</th>
<th>User fees</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Corporate income tax - universal</td>
<td>• Production based royalties (specific or ad valorem) – Colombia</td>
<td>• VAT, customs duties, payroll taxes, sales taxes, property taxes, stamp duty</td>
<td>• Against this Government may incur costs in the form of subsidies or infrastructure provision.</td>
</tr>
<tr>
<td>• Profit based royalties – as in Chile, Canada</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Resource rent tax – Australia, PNG</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Free carried equity – Guinea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Withholding taxes – on dividends etc</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.5.3.1 Classification of taxes

Governments derive revenue from a mining project through a variety of tax instruments, as illustrated in the chart above.

Mining taxes can be categorised in several different ways. For example as direct or indirect taxes; or as specific mining taxes and general taxes. Our categorisation is as follows:

- **Output based royalties.** These can be specific (fixed amount per tonne) or *ad valorem* (percentage of revenue). They can also be graduated, with higher royalty rates kicking in at higher commodity price levels.

- **Profit based taxes and royalties.** This includes corporate income tax (CIT), and profit based royalties. CIT is not a mining specific tax, although some economies do levy a higher rate of CIT on extractive industries (especially petroleum). Traditionally the term “royalty” referred to a production tax. However, increasingly royalties are being levied on profits rather than production. It is important to distinguish between the two types, even though they are both called “royalties”. Profit-based royalties are often used now as a way of capturing economic rent – as in Chile.

- **Rent based taxes.** Economic rent is a term used to denote a rate of return on investment that is over and above the economic cost of developing a deposit, including a market
return on capital. It is a gift of nature, rather than a reward for enterprise, since it depends on the quality differentials in ore deposits. Because in most economies minerals below ground belong to the State, it is posited that the economic rent, or at least a substantial part of it, belongs to the State. The most obvious example of rent is in the oil industry, where the price of crude oil exceeds the cost of production at onshore fields in Saudi Arabia by a substantial multiple. This is so-called “Ricardian rent”. In the oil industry it is common for States to capture all the rent by means of State ownership, or by production sharing agreements. Economic rent is less obvious in non-fuel minerals, and so the method of capturing it is usually through taxes. Various taxes exist to capture the rent including classic Resource Rent Taxes (RRT), or Additional Profits Taxes (APT). As mentioned above, profit based royalties, especially graduated taxes, may also be used as a way of capturing economic rent.

- **State Equity.** The state may take equity in a mining project on normal commercial terms, or it may stipulate a “free carried equity”. In the latter case the State receives a share of dividends once a threshold rate of return has been passed. It can be shown to be equivalent to a RRT.

- **Other taxes.** Other taxes of significance may include customs duties (import duties may greatly increase capital costs) and withholding taxes levied on dividends and interest payments disbursed overseas. Export taxes have been used recently to encourage domestic processing of minerals, rather than as a revenue raising measure as such.

### 5.5.3.2 Assessment Criteria

The following are the criteria used in the evaluation of taxes – either of the fiscal regime as a whole, or of an individual tax.

- **Revenue raising potential.** This can be measured by means of the NPV of tax revenues over the life of the project. Government Take can be compared using AETR.

- **Neutrality.** A neutral tax is one that does not affect an investor’s marginal decisions regarding production, investment or trade. Neutrality is thus a desirable property. As an example, a production royalty is not neutral, in that it may affect production decisions at the margin.

- **Risk to the Government.** Does the Government prefer a higher return with higher risk, or would it prefer a lower return with lower risk. This may be a function of the importance of mineral revenues in the overall government budget.

- **Stability and Timing.** Related to the above is the stability and timing of revenues. The Government’s preference for front end loaded versus back end loaded revenue will be a function of its discount rate – its time value of money. This may affect its choice
between production royalties (received as soon as production begins) and profit taxes – received only when profits are made. RRT revenues will be usually payable, if at all, after many years of production. Auctions, though rare in non-fuel minerals, deliver maximum upfront cash.

- **Investor perceptions.** Reputational issues are important. An investor may require a lower rate of return, other things equal, in a country with a record of a stable fiscal regime. Investors will be sceptical of protestations of stability, and so reputation building takes time. Frequent and ad hoc changes in taxation will be regarded poorly by investors.

- **Adaptability and progressivity.** A progressive tax takes a higher proportion in tax as profitability increases. A regressive tax does the opposite. Profits and RRT taxes are generally progressive, while production based royalties are generally regressive. This item will have an impact on investor perceptions, since investors prefer to be taxed only once they have made a profit. Adaptability signifies the tax regime’s ability to adapt to changing conditions – such as high or low commodity prices. A regime which is adaptable – ie is designed to cope with a range of states of the world – may be perceived as being more stable than a rigid regime. In the latter case external changes may trigger demands for renegotiation if the original settlement is perceived to be unfair.

- **Simplicity and ease of administration.** These factors may be particularly important in emerging economies with limited institutional capacity to monitor and police complex taxes. An often cited advantage of royalties is their simplicity and ease of administration. Ironically this is not the case in Colombia because of the complex method of calculating mine mouth value. Again, in emerging economies where there is considerable information asymmetry, complex taxes may afford the investor opportunities to “game” the system through creative accounting. RRT type taxes are often criticised as being unsuitable for countries with low institutional capacity. However, royalties may also be complex, and RRTs can be simplified.

- **Tradeoffs.** When assessing different tax instruments and the overall fiscal regime there are inevitably tradeoffs between these different objectives. For example Government may wish to maximise revenue at a certain discount rate, but subject to receiving a certain minimum annual revenue. For this reason alone it is often stated that government objectives are unlikely to be served by any single tax instrument. This is why in most economies we find a mixture of taxes fulfilling different functions. Most economies for example levy a production royalty however minimal (Chile is an exception) in order to generate some revenue even in bad times. This argument is reinforced when royalty is directed to the local community and impacts the “social
license to operate”. Again, all counties levy a CIT, and headline rates tend to cluster in a small range. However, for CIT even more than royalty, the devil is in the detail – in the form of accelerated tax depreciation allowances, tax loss carry forward and back, tax holidays, and allowable deductions. Capturing economic rent is less universal, although graduated royalty rates are becoming common methods of capturing rent without too much administrative complexity.

5.5.3.3 Pros and cons of different instruments

- **Output based royalties.** These score well on revenue stability and timing of revenues, as well as (with some exceptions) simplicity. They carry low risk for the Government, but they score poorly on neutrality, flexibility and progressivity.

- **Corporate income taxes.** Are more progressive generally than royalties, and more flexible. On revenue timing they are worse than production royalties but better than RRT. They are profit based, and so are geared to commodity prices, and should contribute to regime stability. They are medium risk for the Government.

- **Profit based royalties.** These have a similar profile to CIT

- **Rent taxes.** RRT does well in terms of neutrality, progressivity, regime stability and flexibility. Its drawbacks are revenue delay, high risk for the Government, and potentially complexity in administration and compliance.

- **Carried equity.** Similar in impact to an RRT, but may be simpler to administer.

5.5.3.4 Measuring the overall impact of tax

In order to produce a tractable metric a certain degree of simplification is necessary. The three most significant sources of revenue are royalties (production or profit based), corporate income tax and resource rent taxes (including free carried equity which is equivalent to a RRT). For the sample of comparable economies we may also include any other taxes that are significant, which may include import and export taxes and withholding taxes, but excluding most indirect taxes.

In devising a fair metric we need also to take the following into consideration:

- **Subsidies.** If there are significant subsidies, such as grants or infrastructure costs, then these should be subtracted from the tax take.

- **Headline tax rates cannot be meaningfully compared without considering the tax base.**

- **Project life.** Tax take cannot be fairly compared by just taking a single time period, such as a year. This is because different fiscal regimes will give a different time profile of revenues. It is also important to consider tax take during the life of the project, including...
construction and operation. Ideally we should also include tax treatment on closure and decommissioning, but we exclude this for purposes of simplification. Our metric therefore needs to aggregate revenues over multiple time periods.

- Project profile. We cannot make a fair comparison between the Government Take from Project A in country X and Project B in country Y if Projects A and B are significantly different. This is because we will simply be measuring differences in profitability of the projects. For example, if Project A is marginal, and makes little or no profit, the tax take will be low even if country X has an aggressive profits tax. Our metric therefore needs to compare the tax take from the same or similar projects. This can be done in two ways. Either use an actual project for comparison, or use a typical hypothetical project.

- Time value of money. In forming a metric that aggregates revenues over the life of project we need to consider the time value of money for the Government. If we did not do this we would simply consider an undiscounted sum of revenues. Implicitly this says that revenues in 10 years time have the same value as revenues today – and this is extremely unlikely. The choice of discount rate reflects the Government’s time value of money and can be extremely important. For example, the rankings of two countries in terms of tax take could be reversed depending on the discount rate chosen. The following slide summarises the arguments

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**Tax Take Metric**

- Having calculated the total tax take from all relevant taxes less subsidies, we can then express it as a proportion of
  - Revenue
  - Pre-tax profit
  - Cash flow.
- But, since we are interested in tax take over the life of a project, we need to find a way of aggregating the tax take over a period of time
  - NPV of government revenue/ NPV of pre-tax cash flow
- This metric is called the Average Effective Tax Rate (AETR)

---

The chosen metric is the Average Effective Tax rate (AETR) calculated as NPV of tax revenue as a proportion of NPV of pre-tax cash flow over the life of the project. We noted the
importance of the choice of discount rate in making these comparisons. We can also look at the proportion of profit based revenue to production based revenue across countries. We noted the importance of using the same actual or model project in order to compare regimes, as well as choosing a sample of relevant countries.

It should be noted that there may be legitimate reasons why country A has a higher AETR than country B. These include that A may have a lower country risk, so can levy higher taxes other things being equal. Another reason is that A may be inherently more prospective geologically than country B.

The following chart shows the AETR, and the AEBR (which excludes capital costs) for a sample of nickel producing economies.

Finally, the chart below summarises the key desirable features of a mineral tax regime from both a government and company perspective.
5.5.4 State ownership

An aspect of government mineral policy we have so far not mentioned is the extent to which governments take a full or partial equity interest in mining projects. The fact that this issue is no longer centre stage perhaps reflects the decline of state ownership in the mining sector since its peak in the 1970s and early 1980s.

There are several reasons that are usually advanced in favour of state ownership in the mining sector. These include – maximising revenue and economic rent capture by the state; ensuring the transfer of technology and skills to the host country; influencing decision making at Board level on matters of interest to the government; ensuring the mine is run for the benefit of the host country rather than a foreign multi-national. Finally, a minority holding by the state may be argued to give the foreign investor comfort that the host government has ‘skin in the game’ and is committed to the project, thus encouraging investment.

Government equity can take many forms, from outright ownership to a minority stake of, for example 5-20%. The equity may be acquired on normal commercial terms, as for other shareholders; or it may be acquired on preferential terms – for example by an option to buy shares at a predetermined price; or the government may be granted a free carried equity. In a free carried equity arrangement, the government is granted shares, which have to be paid for (with interest) out of the future flow of dividends. Once the shares are paid for, then it will
receive cash dividends. A requirement for up to 15% of free carried equity was introduced into
the new mining code in Guinea in 2013).

It was mentioned previously that economic rents in oil and gas are an order of magnitude higher
than in non-fuel minerals. For this reason state ownership is much more prevalent (through
National Oil companies (NOCs)) as a means of capturing the economic rent. State ownership is
now much less prevalent in the mining industry, and even where it exists – for example
Codelco, the state owned copper company in Chile – the companies are likely to be run on
commercial lines. Economic rent in the mining industry, such as it exists, is usually captured via
taxation.

It has been argued, and is probably now a consensus view, that the various objectives of state
ownership can be achieved by an appropriate mix of other policy measures – including
regulation and taxation. For example, a free carried equity can be shown to be equivalent to a
resource rent tax (RRT), which kicks in at a certain return on equity. Government objectives on
employment, local content, environment issues, and so on can be handled by appropriate
regulation.

Is a minority state interest attractive to mining companies? There is no general rule on this.
There may be circumstances where state equity (on commercial terms) is welcome as a means
of demonstrating government commitment to a project, but this will depend very much on the
particulars of each case.

For governments, state ownership can also result in potential conflicts of interests between the
state’s role as regulator, tax collector and owner. Even in Chile, for example, there are clearly
tensions between Codelco’s need to invest in new projects, and the state’s wish to maximise its
dividend from the company for general revenues.

5.5.5 Other policies

It was mentioned in the comments on the MMDA, that there are several other aspects of
government policy towards mining, including labour and training regulations, health and safety
regulations, environmental requirements, local content and local procurement requirements, and
so on. These “softer” issues are often important to host countries, especially at the local level,
and they are increasingly recognised as important to mining companies in maintaining good
relations with the local stakeholders. Mining companies are likely to be accommodating to
efforts to use local supplies, maximise local employment, encourage local businesses, etc – as
long as they are not required to compromise the commercial operation of the business. For
example, it is legitimate to require a mine to have a training and development programme to
gradually replace expatriate workers with locals over time, but it is not legitimate to impose an
arbitrary quota on expatriate workers regardless of whether there is an adequate supply of local
replacements. Similarly, a preference for local supplies is legitimate, as long as those supplies are suitable in terms of quality and price.

5.5.6 Downstream processing

Finally, an increasingly topical issue is the policy of governments towards development of downstream processing industries. Governments are often keen to “add value” to their mineral production by encouraging the establishment of downstream processing – smelters and fabrication plants. The arguments for doing so include adding as much value as possible to the natural resource in-country; creating employment; strengthening forward linkages and hence local multipliers. In the extreme, governments may wish to encourage ‘clusters’ of downstream and other related industries (such as service providers) in order to promote synergies. We saw an example from the Antofagasta region of Chile in Chapter 2.

A good example of maximising downstream development (though not from APEC), in the development of aluminium and phosphate based industries in Saudi Arabia. The Kingdom has used the exploitation of bauxite and phosphate deposits in the centre of the country as the basis for a complete downstream industry in both aluminium and fertilisers. Thus the bauxite mine has become the basis for an alumina refinery, aluminium smelter, aluminium rolling mill, and potentially further semi-fabricating plants. There are even plans to form an automotive cluster, based on the production of aluminium-intensive vehicles. Similarly, the phosphate mine has given rise to a fully integrated phosphate fertiliser complex. Saudi Arabia is fortunate in having ample supplies of capital as well as low cost energy in order to pursue its plans, and involving private capital only as a minority interest. Very few other economies are in that fortunate position.

Recently, Indonesia has taken a different approach to the encouragement of more mineral processing in-country. The policy measures it has chosen are the ban of unprocessed mineral exports, as well as previously raising export taxes. The measures are aimed at encouraging the construction of copper smelters, alumina refineries and nickel smelters. The issue is a major one, not just for Indonesia and the companies involved, but especially for China, which has relied very heavily on Indonesia for imports of bauxite and nickel ores.

Regardless of the approach taken by Indonesia, there are some general points to be made about the merits of downstream processing of minerals.

- There is basic confusion about what it means to “add value”. If a downstream plant is unprofitable or requires explicit or implicit subsidies, then it is quite possible that it does not “add value” to GDP at all – in the strict sense described in Chapter 2. If the total of profits (or losses), minus subsidies, plus payments to workers is negative, then it is possible that a downstream plant will actually lose value and reduce an economy’s
GDP. One of the main implicit subsidies offered to downstream plants is the sale of an input at below its opportunity cost – especially energy. In addition, transfer of the intermediate product may take place at below market price.

- This is more than just a theoretical observation. Take the case of copper smelting. In the case of a tonne of copper metal, only 5-10% of the total cost is incurred at the smelting stage, so the absolute addition to the value of output is small. In addition, the copper smelting business suffers from chronically low profitability, for a number of reasons – including excess smelting capacity compared to mine capacity. Thus the probability of incurring losses in copper smelting is not trivial.

- The factors governing the optimal location of downstream plants is not the same as for mines. Take aluminium for example, which requires plentiful supplies of low cost power. The Gulf Co-operation Council (GCC) has over 5 million tonnes/year of aluminium smelting capacity without any domestic bauxite production (except in Saudi Arabia). Aluminium may be an extreme example of the separation of mining from smelting, because of different locational factors, but similar arguments can be made for other minerals. For example, copper smelter profitability, at the margin, may depend on the ability to process by-product metals and to find markets for sulphuric acid.

It is not the intention of this report to portray downstream processing as a ‘good thing’ or a ‘bad thing’. It is entirely legitimate for a government to want to encourage the establishment of a downstream mineral processing industry. However, downstream projects need to be looked at on their own merits, and should not rely on explicit or implicit subsidies to bring them into being. Governments are free to invest in downstream operations, but should not expect private companies to do so unless the economics are favourable. Even for governments, there is a real danger that the economic rents earned in mining are dissipated in a marginally profitable downstream processing operation.

### 5.6 Summary measures of attractiveness

There are several summary measures that investors can use to establish the attractiveness of the mining policy environment in any country. In turn these can be used to deduce the factors that determine attractiveness.

#### 5.6.1 Government Take

The measurement of ‘government take’ was described in section 4.5.3 of this chapter. The first point to make is that simple comparisons of headline rates of taxes and royalties are not particularly helpful. The concept of average effective tax rate (AETR), is the recommended method for comparing tax regimes.
The value added by a mine is its revenue minus the cost of all purchased goods and services. The surplus is distributed to workers (wages), government (taxes less subsidies), and providers of capital (shareholders and lenders). If wages are regarded as an operating cost, then what is left (free cash) is distributed to government and owners of capital. But we are not just interested in this distribution for one time period, but over the whole life of the mine. We must also recognise the time value of money, by means of discounting cash flows. The AETR is the NPV of government revenues as a percentage of the total pre-tax NPV of the project. In carrying out an AETR comparison, we must be careful to compare like with like – by choosing to model the same project in different jurisdiction, in order to isolate the purely fiscal effects.

It does not follow necessarily that the jurisdiction with the lowest AETR is the most attractive for investors. A low tax regime might be regarded as unstable if is perceived as unfair and therefore prone to demands for renegotiation. As mentioned previously, stability of the tax regime is also important. Another important metric is the split between profit based and production based taxes, and the overall progressiveness of the regime.

Because some taxes are mineral-specific, particularly royalties, AETR comparisons need to be made for a particular commodity. An example for nickel producing countries was shown in Section 4.5.3.

### 5.6.2 Fraser Institute

The Fraser Institute, based in Vancouver, Canada, carries out an annual survey of exploration and mining companies in order to establish the attractiveness of different jurisdictions for mining investment. The 2013 survey was based on 690 questionnaire responses from 4,100 circulated. The survey is based therefore on perception, rather than hard data. However, it is no less useful for that, as perception is important in business allocation of exploration and investment spending.

The survey produces several composite measures of jurisdiction attractiveness, such as the Policy Perception Index, and the Investment Attractiveness Index. The Room for Improvement index was presented in Chapter 2. The composite indices are based on the answers to 15 questions regarding the many aspects on jurisdiction attractiveness, including the legal system, tax regime, regulatory uncertainty or duplication/inconsistencies, labour force skill, land claims, environmental regulations, political stability, trade barriers, security, infrastructure quality, etc.

Governments can use this information to assess the attractiveness of their economies for exploration and mining. It may be that in some cases perceptions are false, and so the issue is one of communication, rather than altering policy.
Several other indicators are published to rank economies on the basis of different parameters, including transparency and corruption (for example the World Bank Worldwide Governance Indicators). The current allocation of exploration spending by country is estimated by several commercial organisations, and can serve as a proxy for current country attractiveness from a geological and political perspective.

Finally, it is important to note the limitations of these overall measures of country attractiveness, since these are carried out at national or provincial level. For any mine a thorough assessment of the local situation is indispensable, as this may differ substantially (for better or worse) from the picture at national level.
Chapter 6 – Recommendations

6.1 Introduction

This chapter sets summarises the key points of the previous chapters, and also draws out some recommendations.

6.2. Report summary

Chapter 2 demonstrated that the importance of mining varies across the different APEC economies, and showed that most economies fit into one of four general categories:

- Resource-rich, but a mature and/or diversified economy means that mining isn’t a highly important part of the overall economy, e.g. USA, Canada
- Resource-rich, developed economies, where mining is a key part of the total economy, e.g. Australia, Chile.
- Resource-rich developing or intermediate economies, where mining is by some margin the primary contributor to the economy, e.g. Papua New Guinea, Peru.
- Resource-poor economies, where resources have either been depleted or simply don’t exist, and as such mining is not an important part of the overall economy, e.g. Japan, Singapore, Chinese Taipei, South Korea, Hong Kong SAR. Note that these economies may well still be involved in the mining industry through investment in projects abroad, for example Japanese corporations taking minority stakes in various mining projects in Chile, Australia, etc.

The following table summarises the importance of mining to the different APEC economies, and also their mineral potential as rated by CRU. Many APEC economies are believed to have a high mineral potential, and these can be sorted into three main categories:

- Developed economies, such as USA, Canada, Chile and Australia, where there are substantial untapped resources and growth will be driven by continued exploration in mining-friendly jurisdictions
- Less-developed economies, such as the Philippines, Indonesia and Papua New Guinea, where there are significant resources that remain untapped but the pace of growth is somewhat hindered by the existing regulatory environment - and this hurdle presents the largest obstacle in the path towards a mining industry achieving its full potential.
- Economies which fall between the above two descriptions – Mexico and Peru – which both provide good examples of the progression towards a ‘best practice’ mining
regulatory environment and the positive impact that this can have on investment in the mining sector. Generally, these economies can be described as having moved from a less encouraging mining investment environment to a more positive one over the past two decades, simultaneously seeing strong growth in their mining sectors. This has also coincided with the economies’ development in terms of income per capita.

![Table 6.1: Summary of mining importance in APEC economies](image)

As described in Chapter 3, the mining sector provides substantial other benefits to host economies beyond mineral rents and direct contributions to GDP, which can be classified in three ways:
• **Direct**: these are the impacts which result from the expenditures associated with constructing and operating the mine, such as the labour employed, materials purchased, capital invested etc – this is the type of contribution to GDP discussed above.

• **Indirect**: these are the impacts that result from suppliers to the mine purchasing goods and services and hiring workers to meet demand from the mine. *Importantly, these additional purchases and the hiring of extra workers would not have happened if it were not for the construction and operation of the mine.*

• **Induced**: these are the economic impacts resulting from employees at the mine using their wages to purchase goods at a household level.

These classifications apply to GDP contribution, and job creation, but mining projects also contribute in the following ways:

• **Infrastructure provision**: many mining projects involve the construction of transport infrastructure (roads, rail, ports), power generation, water provision, etc – all of which stand to benefit the economy by precipitating additional mining or other industrial projects. These infrastructures also serve the local community in many other ways.

• **Government revenues** through taxation of mining projects improves balance sheet and – particularly in developing economies where mining tax take is an important source of revenue for the government – provide funds for public services. Though less tangible than say the provision of funding for a local school or health centre, this is an important benefit.

This highlights the wide reaching impact that a mining project or the mining industry can have on a region or an economy. The financial impacts of mining go far beyond the revenue generated by the mine and salaries paid to workers. These impacts can to a certain extent be managed by local and national governments, for example through the creation of a ‘mining cluster’ which may be built up around an individual project.

Governments also have a significant amount of influence over how attractive their economy is to mining investment. The Fraser Institute survey described in Chapter 2 demonstrates that many APEC economies are highly attractive to investment in terms of their geological prospectivity, but that some of these are currently less attractive to investment than they could be due to their current policy environments, particularly the Philippines, China, and Indonesia, as well as Russia and Papua New Guinea.
Chapter 4 discussed the need for mining companies to try and achieve best practice operation, supported by various examples of positive actions carried out by mining companies in collaboration with host government and local communities. This is a crucial factor in securing the goodwill of the host government and general population. Chapter 5 outlined some of the aspects of general and mining-specific policy that governments can address to improve their appeal to mining investment – for example, reducing country risk by ensuring the enforceability of contracts or the security of tenure of exploration licenses and mining concessions. The content of both of these chapters is referred to, and expanded upon, in the following recommendations section.

6.3 Recommendations

This section sets out recommendations for the governments of APEC’s member economies and APEC’s Mining Task Force, as they relate to advisable actions for both governments and mining companies at the different phases of the mining lifecycle. This is preceded by general recommendations related to the education of governments and other mining authorities. The general aim is to highlight actions by governments which can enhance the benefits of allowing mining companies to explore or operate within their jurisdiction, as well as improve the attractiveness of mining investment in different APEC economies, and how this can be supported by mining companies operating or exploring in the region.

6.3.1 Mining authority education

Some of the key features of mining are that it involves the extraction of a non-renewable resource, over a finite period, and is generally high-visibility both politically and social/environmentally. Unsurprisingly, a host government (as the actual owner of the mineral deposit, except in the USA) – and by extension the populace who may consider such land or deposits their birthright – of a mining project will therefore expect some repayment for granting a licence to a mining company for the use of a one-off economic opportunity.

It is crucial that host governments are educated as to the fundamental aspects of the mining industry, including its inherent challenges for mining companies, as well as the positive impacts of mining, particularly those that are less immediately obvious. Fully understanding this quid pro quo – i.e. mining projects provide substantial benefits to a host economy, and project operators will take the majority of the financial risk in return for a license to deplete a non-renewable resource – will ensure that governments and mining companies can collaborate on projects on a level playing field. Equally, it will enable governments to take action to improve their attractiveness to mining investment. It is important to note that mining companies should also be highly sensitive to the environment where they are planning to operate – they should understand the development objectives of the host economy, and therefore the reasoning
behind certain mining, macroeconomic or other policies. If one such policy is perhaps unattractive to a mining company but is fundamental to governmental objectives, then negotiating over other benefits the government could provide – a tax holiday for early years of operation, for example, may prove more beneficial for both parties, and maintain goodwill. Mining companies should also take into account the rights and demands of local communities that may be affected by mining operations, and any other social or environmental requirements: a one-size-fits-all template in terms of project planning and operation is not feasible, as site-specific factors should be considered at all stages of the mining lifecycle.

This recommendation also strongly applies to host governments – a policy which is suitable for one operation, project, geographical region, or commodity may be completely unsuitable for another – it is crucial to consider the reasonableness of a policy across all projects under the jurisdiction, and the wider, less immediately obvious, impact that a policy change might bring about. For example, policies which aim to encourage downstream processing may be suitable for one commodity but not another, as market dynamics can be substantially different between commodities. The establishment of a marginally profitable downstream industry can see the mineral rents accrued at the mining stage dissipated. Similarly, a tax environment that seems appropriate in one price environment may be unsuitable if prices rise or fall. In addition, a gradual, transparent, change from one policy environment to another is more likely to be advantageous to all parties, by allowing operators and other stakeholders (e.g. employees and the mining service sector) to prepare for the change in policy. Radical decisions which substantially alter the local or global market can lead to unexpected consequences.

A fundamental challenge faced by mining companies is the delayed and uncertain pay off as expenditures are upfront and irreversible and revenues potentially volatile. If governments recognise the positive economic and wider impacts of mining projects (as discussed at length in Chapter 3 and elsewhere in this report), then they can enact mining policies which can help to minimise the risks to mining project that these challenges bring about, and therefore potentially ensure a consistent source of government revenues, employment etc, over a long period of time.

The following section discusses some of the actions governments can take at each phase of the mining lifecycle to improve their appeal to investors and establish a policy environment which best enables mining companies to provide benefits to the host economy. In turn, it also provides recommendations for how mining companies can minimise their impact and improve their sustainability.
6.3.2 Exploration, design and construction

6.3.2.1 Recommendations for governments

- Regardless of geological prospectivity, governments can improve their attractiveness to exploration companies by carrying out basic geological surveying and mapping.

- Governments should ensure that minimum standards for social and environmental practices for mining companies are in place, including the requirement for detailed social and environmental impact studies.

- From a government perspective, a good minerals concession policy should:
  - Facilitate exploration and mining activity, but not at undue expense to the environment or other stakeholders
  - Confer secure, undisputed title to the concession holder in return for periodic rental payments
  - Create economic incentive for concession holders to conduct meaningful exploration (and mining) activity rather than simply to ‘hibernate’ the concession
  - Generate a level of economic return of itself, independent of mineral discovery, through periodic payments made to government for the leasing of mineral rights
  - Differentiate between exploration and mining activities – for example with more stringent operating conditions attached to the grant of mining concessions (otherwise referred to as exploitation licences) than to exploration concessions
  - Overall, act as an incentive (rather than a deterrent) to attracting bona fide mineral explorers and miners to a jurisdiction
  - In addition, all minerals concession systems should contain clear details on each of the following issues: The initial acquisition process through which mineral rights will be conferred, the scope of the granted mineral rights, the maintenance process of mineral concessions, and the reporting system for activities undertaken on mineral concessions.

- Particularly in smaller economies, governments should prepare for the economic and social implications of influx of workers, particularly during the most labour-intensive construction period.
• Ensure that local procurement and employment requirements are reasonable: it is legitimate to require mines to have a training and development programme to gradually replace expatriate workers with locals over time, but it is not legitimate to impose an arbitrary quota on expatriate workers regardless of whether there is an adequate supply of local replacements. Similarly, a preference for local supplies is legitimate, as long as those supplies are suitable in terms of quality and price.

6.3.2.2 Recommendations for mining companies

• Early engagement with local communities is key to establishing a collaborative relationship. Some community engagement activities that can be done during the exploration phase include having a continuous dialogue for the purpose of getting permission to access land, negotiate land use, inform people of ongoing activities and manage their expectations and concerns about them. During design, it is a good idea to involve the community by making them part of any baseline monitoring of environmental, social and cultural aspects. They should continue to be informed of major developments, and consulted regarding permits, land and water use to avoid surprises in the future.

• During exploration: avoid road building by using existing tracks when possible, use lighter and more efficient equipment to reduce overall impact, positioning drill holes away from sensitive areas, remove and reclaim roads and tracks that are no longer needed.

• Minimise impact during drilling and especially construction, with a particular attention to sensitive sites, work in combination with local communities to identify and mitigate any concerns – e.g. dust or noise. Such issues should also be raised in the corresponding environmental impact assessment. Closely monitor emissions, noise, dust etc, and minimise periods of excess.

• The exploration and design stages are the ones where the company has the chance to start an early dialog with the community and entities involved to address water allocation issues and state a water management plan for the future. During design, it is essential to ensure that water management is integrated into the overall management system of the mining operation.

• Where feasible, favour local procurement of equipment and services. Similarly, favour local employment where skilled labour is available, and perhaps also instigate a training system to replace expatriate labourers with locals over time. This applies throughout the lifecycle of the mine.
6.3.3 Production

6.3.3.1 Recommendations for governments

- **Taxation policy**: The volatility of revenues for mining companies due to price fluctuations has three clear implications regarding taxation policy from host governments:
  
  o A **preference for direct taxes on profits** over indirect taxes such as production royalties. Indirect taxes raise production costs, raise the breakeven price level, and may therefore distort production decisions.
  
  o A preference for a **progressive tax regime** that automatically responds to changing conditions, since this is perceived as more stable and will reduce the likelihood of ad hoc demands to tax excess profits.
  
  o Tax **stability** is more valuable than getting an initial favourable tax deal whose legitimacy may later be challenged. This also applies more generally to a desire for **policy stability**, which is extremely important to mining companies given the immovable nature of their assets.
  
  o **Transparency regarding the eventual use of mining tax receipts** is also important in order to maintain goodwill regarding the project from the local community, as well as the mining company themselves. Mining companies are more likely to resist taxation policies where the benefits to the general populace are unclear. Equally, citizens are more likely to be hostile to mining if the flows of revenues are not transparent and accountable.
  
  o Governments should **calculate their overall tax take** from a mining project, so that the impact of possible changes to taxation policies can be quantified, which is important when trying to understand the pros and cons of such a decision.

- **Trade policy**: governments should aim to have stable and transparent trade policies, with a minimum of associated bureaucracy. Accession to the WTO is an important step in assuring potential investors as to the reasonableness of a host government’s trade policies, and as such often acts to encourage mining investment.

6.3.3.2 Recommendations for mining companies

- Closely **monitor emissions**, air quality, noise and vibrations, and act quickly to ensure that limits are not exceeded.

- Enforce strict **water management**, in collaboration with other parties, particularly in arid areas. Recycle wastewater within operations where possible.
• There should be a focus on biodiversity protection and enhancement during the operational phase. Natural habitats in undisturbed areas can be managed to enhance their biodiversity value, or habitats that have been subject to historical disturbance can be improved or restored. In addition, projects can contribute to enhancing scientific knowledge of ecosystems or species, and can link to existing conservation initiatives.

• Encourage local recruitment and training programs, particularly involving indigenous people.

• Tightly control and monitor employee health and safety; ideally exceed requirements and regulations set out by host governments.

6.3.4 Closure

6.3.4.1 Recommendations for governments

• Calculate impact on balance sheet from loss of taxation revenues, and prepare for this – if the economy needs the support of future mining projects, then for example exploration could be incentivised, possibly using tax revenues from the existing mining project.

• Prepare mining communities well in advance for loss of main employer and plan for diversification of local economy. This should be done in collaboration with community and the mining company.

• Some tax revenues from the mining operation could be collected specifically in order to fund projects which will maintain the economic stability of the region after mine closure.

6.3.4.2 Recommendations for mining companies

• When possible, it is considered good practice to aim for more than just restoring biodiversity to its previous state and commit to enhancing biodiversity in the area. For example, those mining in heavily cleared areas may choose to re-establish a vegetation community with significantly higher conservation values than existed before mining.

• Before investing in mines, mining companies should plan what will happen to the area after the mines shut down. The establishment of a consultative closure committee, integrated into an overall stakeholder engagement strategy, can be a useful forum in which long-term objectives can be discussed with a wide range of stakeholders and community representatives.
• Environmental requirements do not stop with the cessation of operations at the mine: for example, in the case of **water management**, monitoring measures and water treatment can go on for years after a mine is closed.