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Inventory, Draw-down and Replenishment

Introduction

2.1 Australia ranks as one of the world's leading mineral resources nations. It has the world's largest Economic Demonstrated Resources (EDR)[1] of mineral sands, nickel, tantalum, uranium and lead, zinc and cadmium. In addition, its EDR is in the top six worldwide for bauxite, bismuth, black coal, brown coal, cobalt, copper, gold, iron ore, lithium, manganese ore, rare earth oxides, silver and gem / near gem diamonds. In contrast, Australia's EDR of platinum group metals is extremely small and Australia lacks substantial resources of chromium.[2]

2.2 Australia's petroleum EDR are very small in global terms. Australia has only a fraction of a percent of the world's known oil reserves and a couple of percent of gas reserves. But the high level of oil self sufficiency it has enjoyed over the past 30 years, mainly from offshore production, has meant that Australia has been isolated from concern about security of oil supplies.[3]

2.3 Minerals exploration and mining contributes significantly to all aspects of the Australian economy. In 2001-02, Australian minerals and energy production was valued at $53.3 million.[4] Minerals and energy exports

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1 The term Economic Demonstrated Resources (EDR) is defined by Geoscience Australia as resources for which profitable extraction or production under defined investment assumptions is possible. For EDR, tonnages and grades have been computed from samples of the resource taken from points spaced to provide assured resource continuity.

2 Geoscience Australia, *Submission No. 53,* p. 639.

3 Geoscience Australia, *Submission No. 53,* p. 660.

4 *Australiancommodities vol 10 no 2 June quarter 2003,* p. 225.

represent 46 percent of Australian merchandise exports and 36 percent of total exports. Over the past 18 years, Australia's exports of minerals and petroleum have earned $565 billion, some 50 percent higher than exports of the agricultural sector.[5]

2.4 Exploration is an essential part of the resources cycle, necessary to replace extracted reserves. The industry would be unsustainable were it not for the new deposit discoveries through successful exploration. Modern successful exploration involves high skill levels, advanced technology, innovation, and strong commitment and perseverance. It also requires considerable capital and involves major risk-taking by exploration companies. The reality is that very few exploration programs lead to discoveries of commercial resources.

How Long Will it Last?

2.5 New resources projects now take between seven and ten years to proceed from discovery to production. There have been few significant new resources discoveries in Australia over the last five to eight years. The Australian Institute of Geoscientists stated that in another five years, a large proportion of mines currently in production will have closed, or be nearing the end of their operational lives. This will result in reduced exports, slower business activity, lower employment and fewer opportunities for economic and infrastructure development, particularly in regional Australia.[6]

2.6 The Australian Institute of Geoscientists advised that a recent list of minerals and energy projects published by the Australian Bureau of Agricultural and Resource Economics (ABARE) included only 12 new mining project commitments across Australia, and a further eight advanced projects. This level of project development falls far short of that needed to sustain mining's contribution to the Australian economy and will continue to decrease unless resources exploration in Australia is revitalised.[7]

2.7 According to the Queensland Mining Council, based on current technology, known reserves and current production rates, ten mines will close in Queensland by 2010, another five will be mined out by 2015, and all but one base metal mine will be mined out by 2015. Even assuming that

5 Geoscience Australia, *Submission No. 53,* p. 631.

6 Australian Institute of Geoscientists, *Submission No. 22*, p. 158.

7 Australian Institute of Geoscientists, *Submission No. 22*, p. 158.

all known gold, silver, lead, zinc and copper projects already being evaluated proceed in the next five years, all will be mined out by about 2015.[8]

2.8 The Western Australian Government considers that the gold sector in Western Australia may shrink to only one quarter of its present size over the next 20 years unless inferred resources are successfully upgraded, new projects are commissioned, and new discoveries made. In addition, the Western Australian diamond industry is based on one mine (since the submission was lodged, the Ellendale diamond mine has commenced production, but the sentiment of the WA Government's comment is unchanged) and unless other large economic deposits can be found quickly, at the present rate of production, only an additional 13 years of mine life remain.[9]

2.9 The minerals industry in Tasmania relies on a small number of major operations, many of which have a limited reserve base. According to the Tasmanian Government, all but one of the six major mines have less than ten years of reserves and three had less than five years reserves.[10] The Tasmanian Minerals Council forecasts that the mining industry in Tasmania will end within 15 years unless new ore bodies are found quickly.[11]

2.10 The Northern Territory Minerals Council commented that more mines are closing than opening.[12]

2.11 The Victorian Minerals and Energy Council advised that the Bass Strait oil and gas resources are declining.[13]

Mineral Resources

2.12 Over the three decades of systematic assessment, EDR for all major mineral commodities have, on average, either increased or been maintained despite substantial levels of production. None has decreased significantly. According to Geoscience Australia, much of the success in maintaining EDR can be attributed to the sustained exploration activity that Australia has enjoyed until recently, and to the highly prospective

8 Queensland Mining Council, *Submission No. 60,* p. 780.
9 Government of Western Australia, *Submission No. 84,* p. 1281.
10 Tasmanian Government, *Submission No. 86,* p. 1381.
11 Tasmanian Minerals Council, *Submission No. 88,* p. 1393.
12 Northern Territory Minerals Council Inc., *Submission No. 87,* p. 1385.
13 Victorian Minerals and Energy Council, *Submission No. 63,* p. 859.

nature of the continent. The depletion of EDR by mining has also been offset by technical and economic changes that have allowed formerly sub-economic deposits to be reclassified as economic.[14]

2.13 The EDR to production ratios provide an indication of the time until economically recoverable resources are exhausted. Geoscience Australia provided EDR/production ratios as assessed at 5 year intervals since 1975 which are shown in the following table.

Table 2.1 Years of economic demonstrated resources at the production level for the year

Commodity	1975	1980	1985	1990	1995	2000
Coal	255	270	210	250	205	140
Bauxite	145	100	90	135	60	80
Iron Ore	180	155	175	135	125	80
Nickel	25	30	20	45	35	120
Copper	30	25	60	20	65	30
Zinc	40	45	30	20	40	25
Gold	10	20	15	10	15	15

(rounded to nearest 5 years)

Source *Geoscience Australia,* Submission No. 53*, p. 643.*

2.14 Geoscience Australia commented that it is clear from these figures that Australia has major resources of the bulk commodities: coal, bauxite, and iron ore. There are other substantial known resources for the bulk commodities that could become EDR given impetus to bring new mines on stream. However, the markedly lower EDR/production figure for iron ore in 2000 indicates how rapid changes can result from major increases in production, coupled with reassessment of resources. The situation for gold and some base metals (particularly zinc) is less secure.[15]

2.15 The Minerals Council of Australia (MCA) believes that the EDR/production ratio is only a partial indicator of the future viability of a particular commodity sector because the ratio can be influenced by:

- further discoveries of EDR;
- changes in production levels;
- upgrading or downgrading of resources through ongoing assessments of what are known in the JORC Code[16] as "modifying factors" (mining,

14 Geoscience Australia, *Submission No. 53,* p. 639.

15 Geoscience Australia, *Submission No. 53,* pp 642-3.

16 The Joint Ore Reserves Committee (JORC) consists of The Australasian Institute of Mining and Metallurgy, Australian Institute of Geoscientists and Minerals Council of Australia which

metallurgical, economic, marketing, legal, environment social and governmental factors); and

- upgrading of resources through ongoing assessments that results in an increasing level of geological knowledge or confidence.[17]

2.16 The EDR / production ratio is based on an overall assessment, rather than the current commercial objectives of the companies holding the resource. In MCA's view, they represent an overestimate (or at best, a maximum estimate) of the national resource inventory for a particular mineral commodity.

2.17 MCA considers that known resources of zinc, and particularly gold, are not sufficient to support current production levels beyond the medium-term. MCA notes that there are a number of reasons for not being complacent about the state of Australia's national resource inventory and Australia's future prospectivity without ongoing exploration, namely:

- discovery costs have increased and Australia is relatively "mature" in a minerals exploration sense with most of the accessible surface deposits already known; and
- the long lead times involved in bringing an operation into production.[18]

Petroleum Resources

2.18 Australia's commercial reserves of crude oil are estimated to be 1213 million barrels (mmbbl), and of condensate to be 758 mmbbl (as at 1 January 2000), which is equivalent to about six years current consumption. Estimates of reserves that have not yet been declared commercially viable are 452 mmbbl and 1407 mmbbl respectively. While reserves of condensate are significant, their potential rate of production depends in part on the commercialisation of the associated gas resource. According to the Australian Petroleum Production and Exploration Association (APPEA), unless there are significant new discoveries, Australia will be importing 60 percent of its requirements by the year 2010.[19]

2.19 Geoscience Australia advised that crude oil reserves peaked in 1994, declined by 19 percent by the year 2000 and now stand at levels not

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prepares the JORC Code, which sets out minimum standards for reporting of exploration results.

17 Minerals Council of Australia, *Submission No. 81,* p. 1161.

18 Minerals Council of Australia, *Submission No. 81,* pp 1162-3.

19 Australian Petroleum Production and Exploration Association, *Submission No. 39,* p. 486.

encountered since the 1980's. It is clear that the rate of discovery of new oil reserves has not kept up with production. In the period 1990-1994, a total of 869 million barrels of crude oil was produced and 751 million barrels found. In the period 1995-1999, a total of 769 million barrels of crude oil was produced and 317 million barrels found.

2.20 Commercial reserves of crude oil have stayed constant or grown slightly over the last decade whilst total reserves have declined. The decline is due to a decrease in non-commercial reserves which have been declared commercial. However, reserves have not been replenished through exploration. This indicates that the new reserves, which can be brought into production in the near term, are limited.[20]

2.21 Gas resources have grown continuously over the period since 1965, and continue to grow rapidly. In recent years many super-giant gas fields (each greater than 3.5 trillion cubic feet) have been discovered. However, because of the remote offshore location of many of the largest discoveries, the growth in commercial reserves has been much less than the growth in non-commercial reserves.[21] To ensure that there are adequate gas supplies over the period to 2020, either more commercial gas will have to be found, or more reserves will need to be proved commercial and gas resources developed and transported to markets in time to meet growing demand.[22]

2.22 Geoscience Australia advised that Australia's natural gas has a current "life" estimated at 54 years, but past estimates have ranged between about 38 and 65 years. The consumption of crude oil and condensate in 1999 could be sustained by remaining EDR in 1999 for 11.8 years.[23]

Minerals Exploration

2.23 Exploration is a high-risk activity. Greenfields exploration is extremely high risk. "Few [projects] succeed, most fail".[24] Expenditure on exploration is an ongoing and necessary expense of a minerals company as it costs, on average around $US 50 million (but it can be up to $US 200 million) to discover and assess the feasibility of a world-class ore body. This typically takes five to fifteen years to develop from initial discovery (depending *inter alia* on the size of the mine).[25]

20 Geoscience Australia, *Submission No. 53,* p. 662.

21 Geoscience Australia, *Submission No. 53,* p. 662.

22 Australian Petroleum Production and Exploration Association, *Submission No. 39,* p. 488.

23 Geoscience Australia, *Submission No. 53,* p. 666.

24 Earthsearch Consulting Pty Ltd, *Submission No. 108,* p. 1576.

25 Minerals Council of Australia, *Submission No. 81,* p. 1165.

2.24 Gold has accounted for the major share of real mineral exploration expenditure over the past two decades. Gold exploration expenditure as a proportion of aggregate Australian mineral exploration expenditure was 51.7 percent in 2001-02, slightly below the average share of 57 percent in the 1990s but higher than the average share of 42 percent in the 1980s. The share of base metals and nickel fell to 20.7 percent in 2001-02, compared with an average of 23 percent in the 1990s and 1980s. Over the past two decades, the shares for mineral sands and iron ore have increased, while the shares for coal and uranium, diamonds and the other category have decreased.[26]

2.25 Exploration for minerals (non-petroleum) steadily increased between 1992-93 and 1996-97 (increasing by 83 percent during this period) but has fallen since then (by 44 percent between 1996-97 and 2001-02). A change in expenditure on exploration for gold has been the principal driver behind the overall exploration expenditure trends. Since 1996-97, mineral exploration expenditure in Australia has declined by 44 per cent to $641 million in 2000-01, the lowest level since 1978-79. The outcome in 2001-02 is $83 million lower than the 1991-92 trough and $133 million lower than the 1985-86 trough.

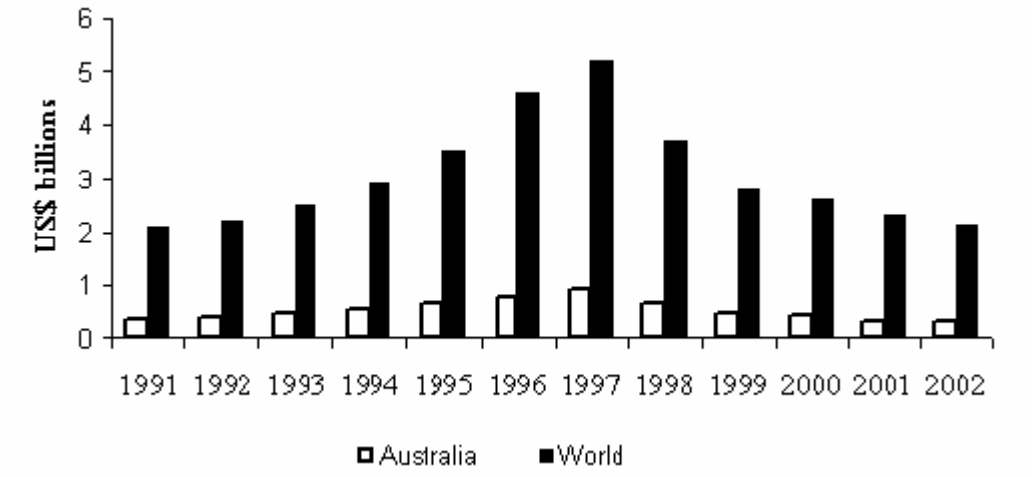
2.26 According to MCA the recent downturn is largely due to reduced spending on exploration for gold and base metals, although exploration expenditure has also declined in recent years for coal and uranium, diamonds and iron ore.[27]

2.27 Global and Australian exploration budgets are shown in figure 2.1.

26 Minerals Council of Australia, *Submission No. 81*, p. 1166; Australian Bureau of Statistics, *catalogue # 8412.0, March 2003*, p. 18.

27 Minerals Council of Australia, *Submission No. 81*, p. 1168.

Figure 2.1 Global Exploration Budgets 1991-2002



Sources *Geoscience Australia,* Submission No. 53*, p. 646 and updated data; Australian Bureau of Statistics,* Catalogue #8412.0*, March 2003, p. 18.*

2.28 The data show that the decline in minerals exploration in Australia is in line with the global pattern, which experienced a fall of around 45 percent between 1997 and 2002. Detailed Australian mineral exploration expenditure data shown in Table 2.2, confirm this pattern.

Table 2.2 Australian Mineral (state and national) and Petroleum (national) private expenditure data for 1994-95 to 2001-02

Period	NSW	Vic	Qld	SA	WA	Tas	NT	Aus	Aus
$M	*Min*	*Min*	*Min*	*Min*	*Min*	*Min*	*Min*	*Min*	*Pet*
1994-95	79	31	176	21	496	15	76	893	682
1995-96	80	43	181	24	520	19	94	960	725
1996-97	94	52	161	35	692	26	89	1149	853
1997-98	88	43	133	45	660	21	76	1067	981
1998-99	66	37	94	42	523	12	65	838	868
1999-00	56	34	83	23	415	9	58	676	723
2000-01	57	33	83	30	424	9	48	683	1044
2001-02	48	34	93	32	381	4	49	641	884

Source Australian Bureau of Statistics (cat # 8412.0, Mineral and Petroleum Exploration, years 1994-95 to 2001-02)

Petroleum Exploration

2.29 Petroleum exploration activity in Australia has fluctuated considerably over the last three decades. Overall, exploration and production are affected by a range of factors, including access to acreage, prospectivity, prices, rig and seismic mobilisation costs, geographic location, perceptions

of risk / rewards (eg potential field sizes), international competition for funds and the fiscal regime.

2.30 As measured by the number of exploration wells drilled, petroleum exploration and development for onshore Australia has declined in recent years although there has been a pick up since the low of 2000. Exploration wells drilled offshore Australia have continued at a more consistent level but with some decline after the peak of 1998. While the recent improvement in exploration levels overall is encouraging, APPEA believes it is far from adequate in the face of the massive imminent decline in liquid fuels self-sufficiency. In addition, the drilling success rate associated with activities in Australia (particularly offshore) is generally regarded as being poor in relative terms compared with other countries.[28]

2.31 While the level of expenditure incurred for Australia's offshore areas has remained relatively static, there has been a noticeable and consistent reduction in the level spent onshore. There are a number of potential factors that have contributed to such a trend, but one concern that is consistently identified by junior exploration companies is their inability to attract capital as a result of the operation of the company tax system.[29]

2.32 Exploration investment in Australia has varied between $723 million and $1044 million annually over the last three years (see Table 2.2). This expenditure is largely a reflection of commitments made in the bidding rounds which may have been made several years earlier.

2.33 Between 1998 and 2000 Japanese companies ceased bidding on new acreage offered by the Commonwealth. This reluctance by some Japanese companies to acquire new acreage in Australia in part reflected changed priorities associated with the reorganisation of the "parent" national oil company. With the exception of the American explorers, however, a similar trend to minor involvement in bidding is also observed with other foreign companies. Expenditures attributed to junior Australian explorers have also declined though the fall is less pronounced than for the major companies.[30]

2.34 In recent years, junior explorers have been increasingly represented in exploration permits located in a variety of sedimentary basins. Acreage awarded to junior explorers has ranged from mature to immature and is generally located in shallow to mid-range water depths. High exploration costs and risks associated with frontier acreage militate against involvement of junior companies in these areas.

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28 Australian Petroleum Production and Exploration Association, *Submission No. 39,* p. 490.

29 Australian Petroleum Production and Exploration Association, *Submission No. 39,* p. 519.

30 Geoscience Australia, *Submission No. 53,* p. 670.

2.35 This increased reliance on junior Australian companies to commit funding to Australia's offshore exploration is a reflection of the global nature of the petroleum sector. With an international portfolio of acreage, the major companies have a greater ability to move exploration expenditures overseas in response to changing perceptions of prospectivity, while junior explorers frequently, but not exclusively, focus on exploration within Australia.[31]

Decline in Minerals Exploration

2.36 Geoscience Australia and minerals sector representatives have stated that the fall in expenditure reflects the major structural changes that are taking place in the minerals sector, and a number of related factors.

2.37 Abundant supply and consequent low metal prices have squeezed profitability and resulted in poor returns on capital invested in mining. In recent years returns from mining have commonly been less than the cost of capital resulting in a loss of shareholder wealth.[32] The average return on shareholders funds during the period 1996-97 to 2000-01, was 5.3 percent. This compares to the average return on a 10-year Commonwealth Treasury bond (an essentially "risk-free" investment) of 6.3 per cent over the same period.[33]

2.38 Discovery costs have increased significantly, a reflection of poor discovery rates through the 1990s, particularly world-class deposits on which the sector is built. The obvious deposits in accessible places have been found, but the overall declines in real commodity prices constrain the chances of finding new economic mineralisation.[34]

2.39 Access to capital, particularly venture capital for junior exploration companies, has been increasingly difficult to obtain in recent years. There is a variety of reasons for this, particularly competition from biotechnology, communications and information technology stocks, the so-called "dot.com" boom of the late 1990s that, for a brief period at least, offered prospects of better investment returns and capital growth than investment in mineral exploration companies.

2.40 The globalisation of the minerals industry means that investment decisions are increasingly being made in overseas head offices and

31 Geoscience Australia, *Submission No. 53,* p. 671.

32 Geoscience Australia, *Submission No. 53,* p. 646.

33 Minerals Council of Australia, *Submission No. 81,* p. 1169.

34 Geoscience Australia, *Submission No. 53,* p. 646.

Australian exploration projects are being ranked against competing projects in other countries.[35]

2.41 MCA asserts that while the impact of the economic circumstances facing the industry are undoubtedly fundamental, regulatory factors also deserve special attention. They may in some cases expose evidence of market failure or policy impediments that hamper efficiency in the level of mineral exploration expenditure in Australia and thus be amendable to policy interventions and / or corrections. Some of the major regulatory factors contributing to the significant fall in exploration expenditure that has taken place since 1996-97 include:

- Native Title legislation;
- environmental legislation;
- legislative, policy and decision-making developments related to protected areas;
- cultural heritage legislation;
- operating requirements for exploration activities relating to tenements, the environment and cultural heritage, and
- fiscal arrangements.[36]

2.42 These aspects are discussed in later chapters of the report.

Prospects for Australia's Minerals and Petroleum

2.43 In broad terms new mineral deposits continue to be found both in proven mineral mining districts and in new provinces. But the future of Australia as a major mining nation depends on the discovery of major deposits to sustain large, low cost mining operations.

2.44 Mineral production companies are under increasing pressure from their shareholders to increase profitability and thus dividends. One way is for them to reduce the risks and outlays on exploration. Accordingly, recent mineral exploration by the majors has increasingly focused upon near mine brownfields sites, which, if the exploration is successful certainly provide incremental increases in ore reserves, but generally fail to identify new mines.[37]

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35 Geoscience Australia, *Submission No. 53,* p. 648.

36 Minerals Council of Australia, *Submission No. 81,* p. 1143.

37 Australian Institute of Geoscientists, *Submission No. 22,* p. 159.

2.45 Rio Tinto Exploration advised that, from a major company perspective, it is usually less risky and more cost-effective to explore close to existing mining operations. Such brownfields exploration can add significant value through discovery of incremental resources. Near-mine mineral exploration therefore may postpone mine closures by some years, but will not contribute the new ore body discoveries needed to replace mineral production from the ultimately exhausted mines. The long-term sustainability of the mining industry depends upon discovery of large new high-quality resources through greenfields work.[38]

2.46 Data collected by the Western Australian Government show that, for instance, in that state the number of granted greenfields tenements declined by 43 percent over the four year 1997-2001. Greenfields tenements now represent only 7 percent of the granted tenements. Of those pending tenements, only 11.5 percent are in greenfields areas.[39] The Committee is aware that some upwards adjustment to the low proportion of greenfields tenements on issue may take place in due course as Native Title matters are resolved. In any event, the structural implications of even a temporary focus on brownfields exploration and the incentives to encourage further greenfields exploration, are discussed in greater detail in the next chapter.

2.47 Exploration activity has declined not because Australia is considered to be "fully explored". New ideas and geoscientific theories continuously refocus attention on previously explored and even previously mined areas. Recent discoveries such as Newcrest's Cadia Hill and Ridgeway mines in New South Wales and the extensive new reserves delineated at the Telfer Mine in Western Australia demonstrate the manner in which new ideas can contribute to the revitalisation of old mining fields.[40]

2.48 Many areas of Australia have received little or no exploration attention in the past. New geophysical technologies are, however, beginning to enable geoscientists to see beneath cover sequences, resulting in major discoveries including Olympic Dam in South Australia, and the Cannington and Ernest Henry mines in Queensland.[41] More giant ore-bodies undoubtedly exist in Australia, but are likely to be buried and hard to locate. Possible new geophysical technologies to see through the cover material are discussed in more detail in chapter four.

2.49 A substantial impediment to further exploration for natural gas is the lack of available gas markets — either domestically, or for Liquefied Natural

38 Rio Tinto Exploration, *Submission No. 46*, p. 562.

39 Government of Western Australia, *Submission No. 84*, p. 1311.

40 Australian Institute of Geoscientists, *Submission No. 22*, p. 160.

41 Australian Institute of Geoscientists, *Submission No. 22*, p. 160.

Gas, exports. Australia has abundant discovered gas but the vast majority of it is remote from markets. Further exploration in gas-prone areas needs to be in those areas where the chance of also finding either gas-liquids or crude oil is relatively high.[42]

2.50 Japan Australia LNG (MMI) stated that there are few impediments to oil exploration in Australia that rival the generally very low chance of success for finding crude oil - especially without also being associated with large volumes of gas. The perceived limited remaining prospectivity for oil in currently developed areas should naturally turn the search for new oil resources to more frontier andor deep-water areas, but which also carry additional cost and risk burdens.[43]

2.51 In all likelihood, future discoveries will be either:

- small oil discoveries that are more expensive to develop than those found to date;
- in new, frontier basins, remote from existing facilities and as a consequence more expensive to develop;
- in deepwater areas, in technology frontiers, and as a result more expensive to develop, or
- gas, with consequent dependence on markets to establish economic viability.[44]

2.52 Australia is an expensive place to explore for hydrocarbons. It is geographically remote from other oil and gas producing regions of the world, adding time to all aspects of the life cycle and making transportation of critical equipment costly. In addition, in some of the offshore areas weather and ocean conditions are harsh and unpredictable.

2.53 Because of its geology, Australian exploration success rates are among the lowest in world. A recent industry study found that offshore Australia ranked 46th in the world in exploration drilling success, with a commercial success rate of a little over 6 percent. This compares with other locations such as Malaysia with a commercial success rate above 50 percent and Angola with over 40 percent.[45]

2.54 The petroleum sector representatives argued that consideration of ways to increase exploration in Australia should take into account possible

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42 Japan Australia LNG (MMI), *Submission No. 7,* p. 33.

43 Japan Australia LNG (MMI), *Submission No. 7,* p. 33.

44 ExxonMobil Australia Pty Ltd, *Submission No. 18,* p. 135.

45 ExxonMobil Australia Pty Ltd, *Submission No. 18,* p. 135.

measures to improve Australia's global ranking as an investment destination for oil and gas development. ExxonMobil Australia stated that:

> It should capitalise on Australia's economic and political stability by offering an attractive investment environment that acknowledges the risks and uncertainties for the whole of the sector rather than being focused on penalising the few successful explorers with a high tax environment[46].

2.55 Overall, the levels of exploration activity will be determined primarily by world commodity prices. However, access to capital and taxation arrangements are likely to play key roles in Australia's minerals and petroleum industry's future. These matters are discussed in the following chapter.

46 ExxonMobil Australia Pty Ltd, *Submission No. 18*, p. 136.