Available online at www.sciencedirect.com
SCIENCE DIRECT
Resources Policy 30 (2005) 168–185
RESOURCES POLICY
www.elsevier.com/locate/resourpol

Exploration and discovery of Australia's copper, nickel, lead and zinc resources 1976–2005

A.L. Jaques *, M.B. Huleatt, M. Ratajkoski, R.R. Towner

Minerals Division, Geoscience Australia, GPO Box 378, Canberra, ACT 2601, Australia

Received 22 February 2005; received in revised form 27 June 2005; accepted 5 August 2005

Abstract

Examination of copper, nickel, lead and zinc (base metals) exploration expenditure and discovery in Australia over the period 1976–2005 reveals some significant trends. Australia's base metal resource inventory grew substantially as a consequence of successful exploration over the period, both through addition of resources at known deposits and new discoveries, notably a small number of very large deposits that underpin the resource base. In 2005, Australia had the world's largest economic demonstrated resources (EDR) of nickel, lead and zinc, and the second largest EDR of copper. Growth in nickel resources has been especially strong owing to discovery of large laterite resources in the late 1990s. Resource life, in average terms based on current EDR and production, is approximately 30 years for lead and zinc, 40 years for nickel sulphide (120 years for all nickel EDR) and 50 years for copper. Despite this success, major increases in production over the period (copper, nickel and zinc output increasing 3–4 fold, lead output doubling) and a fall in discovery rates during much of the 1990s means that resource life for lead and zinc is lower and nickel sulphide comparable now to that in 1976; only the resource life of copper has grown substantially over the period. Current published ore reserves are sufficient for at least 15 years operations at current production levels, but only a small number of the largest deposits currently being mined are likely to still be in production in 20 years. However, several mines have substantial inferred resources that may allow production beyond current mine reserves and there is a substantial number of undeveloped deposits that may provide the foundation for extended or new mining operations. The discovery record is strongly cyclical with resource growth for all the base metals punctuated by the discovery of giant (world-class) deposits each decade: these underpin current and future production. Recent higher metal prices and renewed interest in base metals, especially nickel, has reversed a 10 year decline in base metal exploration attended by reduced rates of discovery and resulted in record expenditure, new nickel, copper and zinc discoveries, and increased resources at a number of existing deposits, notably the Olympic Dam copper–uranium–gold deposit. With the exception of the Prominent Hill copper–gold and West Musgrave nickel–copper deposits, most of the recent discoveries, especially zinc (-lead) deposits, are of small tonnage (some of high grade). Nevertheless, these new discoveries have helped stimulate further exploration and also highlight the potential for further discoveries in little-explored provinces, especially those under regolith and shallow sedimentary cover.

Keywords: Mineral exploration; Base metals; Australia; Mineral resources; Discovery; Nickel; Copper; Lead; Zinc

Introduction

Australia is a leading producer and large holder of resource inventory of the base metals—copper, nickel, lead and zinc. Production and resources are underpinned by a relatively small number of giant or world-class (Singer, 1995) deposits, some of which have been mined for many years. The huge Broken Hill lead–zinc–silver deposit, for example, has been mined since, 1883 and has produced more than 200 Mt of high grade ore. Some of these deposits, such as Broken Hill, are now reaching, or will reach within the next 10–15 years, the end of their mining life. This raises the question: how long can Australia's current base metal resources sustain mine production? In this paper, we review Australia's base metal resource inventory, rates of discovery, and resource addition over the past 28 years; identify patterns and emerging trends in the context of current exploration activity; and examine their implications for the future of the Australian base metal production.

The resource information used is drawn largely from the annual assessment of Australia's mineral resources by Geoscience Australia and its predecessors—the Bureau of Mineral Resources, Geology and Geophysics (BMR) and the Australian Geological Survey Organisation (AGSO)—since

* Corresponding author. Tel.: +61 2 6249 9745; fax: +61 2 6249 9983.
E-mail address: lynton.jaques@ga.gov.au (A.L. Jaques).

0301-4207/$ - see front matter © 2005 Elsevier Ltd. All rights reserved.
doi:10.1016/j.resourpol.2005.08.003

1976. The mineral resource classification scheme for national resource assessment used by Geoscience Australia is based on the widely-used McElvey system (BMR, 1984). This system is compatible with the Australian Code for Reporting Mineral Resources and Ore Reserves (JORC Code) used by mining companies to report reserve and resource data for individual deposits. Economic demonstrated resources (EDR) reported in the annual assessment includes the JORC ore reserves and those parts of the combined measured and indicated resources for which, at the time of determination, profitable extraction or production under defined investment assumptions has been established, analytically demonstrated, or assumed with reasonable certainty. Background information on resource classification systems and reserve depletion can be found in mineral economics texts and publications (e.g. Adelman et al., 1983). Location maps and resource information for individual deposits are available on-line at the Australian Mines Atlas website (www.australianminesatlas.gov.au).

Exploration expenditure data is drawn from the Australian Bureau of Statistics (ABS) quarterly collections of data on exploration spending reported in their serial publication number 8412.0. The ABS surveys include the cost of all exploration activities, feasibility studies, construction of pilot plants and administrative overheads associated with these functions but exclude development or production costs. Data on base metal mineral exploration spending in Australia published by the ABS has historically been reported as an aggregate of spending on zinc, lead, silver, copper, and nickel (including cobalt) exploration. Separate data for nickel–cobalt, copper, and zinc–lead–silver exploration are only available from mid-1999. All data are reported in 2004–2005 Australian dollars (A$) unless otherwise stated. ABS current dollar exploration expenditure was converted to constant dollars by Geoscience Australia using CPI data originally provided by the ABS. Base metal production data are taken from publications of the Australian Bureau of Agricultural and Resource Economics (ABARE) and publicly available company information.

Nickel exploration figures for the period 1976–1991 are taken from Mackenzie et al. (1997). For the period 1991–1999 nickel exploration expenditure is estimated from the base metal exploration budgets for exploration in Australia contained in the annual compilation and report on global non-ferrous metal exploration budgets by the Metals Economics Group in their Corporate Exploration Strategies. Nickel budgets were identified from knowledge of the exploration interests of the companies concerned and from information provided separately to Geoscience Australia by the global majors engaged in nickel exploration in Australia at that time.

Base metal exploration: historical overview

Exploration trends

Base metals have been important targets for Australian mineral exploration. Australian base metal exploration expenditure increased to about $150 million annually in the early 1980s, declined in the late 1980s, rose to a peak of about $250 million annually in the mid-1990s then declined to just over $130 million in 2001–2002, but rebounded strongly to a record $261 million in 2004–2005 (Fig. 1). The peaks in base metal exploration expenditure in the periods 1981–1984, 1992–1997 and 2003-current coincide with peaks in overall mineral exploration activity in those periods. These periods coincide with upturns in global economic conditions and enhanced demand for base metals.

The relative importance of base metal exploration in Australia declined steadily from 1969–1970 when it amounted to 52% of total Australian mineral exploration expenditure to about 19% in 2003 but then increased to about 25% in 2004–2005 (Fig. 1). The decline in the relative importance of base metal exploration in Australia over the past 30 years coincides with the growth in importance of gold exploration which has dominated Australian mineral exploration spending since 1984. The lowest percentage of base metal exploration was recorded in the period 1986–1989, coinciding with a major peak in Australian gold exploration (Huleatt and Jaques, 2005).

Expenditures on base metal exploration as a proportion of annual base metal production declined significantly from a peak of more than 9% in 1981 to around 4% in early to mid 1990s to less than 2% in 2002 before rising to an estimated 2.6% in 2004–2005 (Fig. 2). The long-term (1976–2004) Australian average expenditure on base metal exploration as a percentage of base metal production is around 4%, significantly above the 1–2% long term world average for base metals (Doggett, 2000): this reflects the high historic levels of exploration in Australia.

Nickel discoveries 1966–1971 ('nickel boom')

The focus of exploration spending for the base metals has changed significantly over time depending on prevailing global and local factors. The period 1967–1971 saw a major focus on nickel exploration immediately following the discovery of nickel in 1966 at Kambalda, in the Eastern Goldfields of

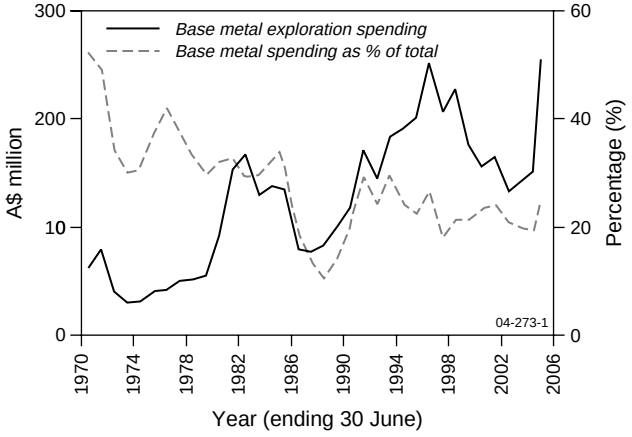

Fig. 1. Australian base metal exploration expenditure and as a percentage of total Australian mineral exploration spending in that year. Data from the Australian Bureau of Statistics (ABS).