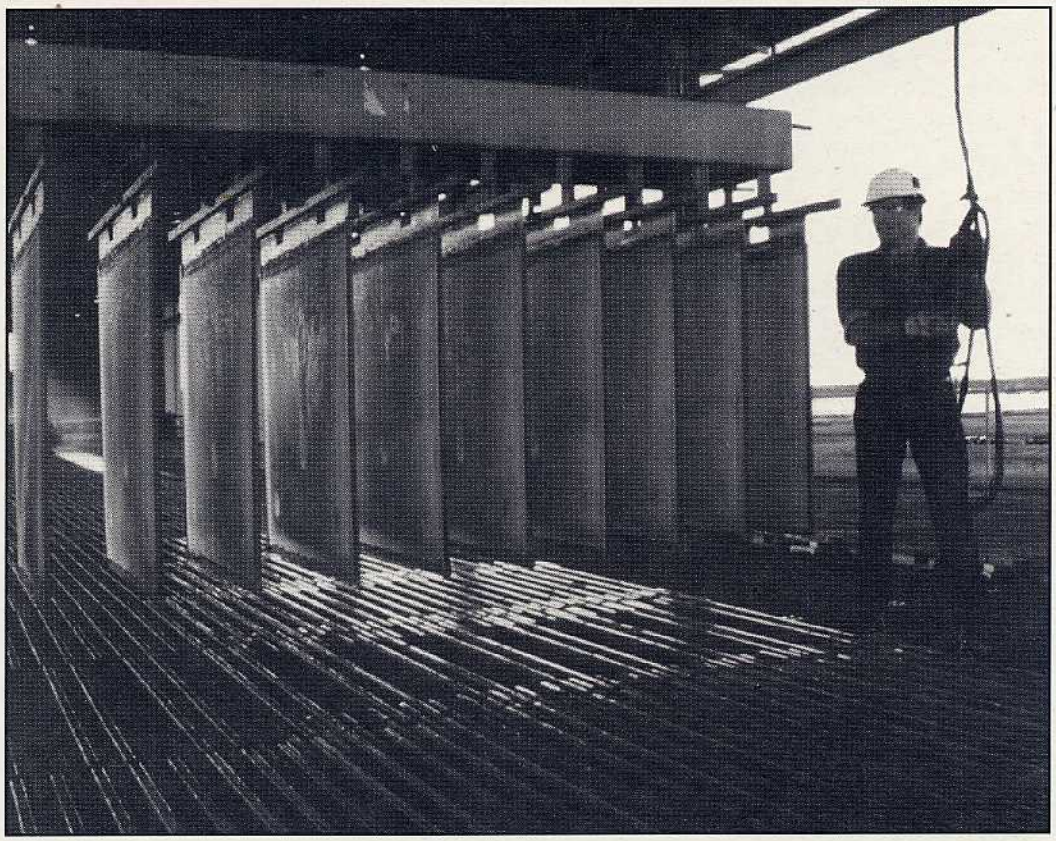
FACT SHEET 3

BASE METALS (Copper Lead Zinc)



Δ *Copper collecting cathodes emerge from a tank at the Nifty Copper operations in WA's Pilbara.*

Introduction

Base metals refer to a group of metals which are neither noble (gold, silver and platinum) nor ferrous (iron or manganese).

The three most common base metals are copper, lead and zinc — all of which have played an important part in the history of mankind as well as the development of modern industrial society.

These metals are commonly associated with each other in nature, and all share a number of the same properties.

History

Copper and lead are two of the world's oldest known metals. Copper was first used for making tools, weapons and ornaments, around 8000 BC, by people in the Tigris and Euphrates Rivers areas (present-day Iraq). Bronze was discovered around 3500 BC, and ushered in the Bronze Age, when metallic vessels, weapons, tools and ornaments replaced the more primitive artefacts of the Stone Age.

Lead was used extensively by the ancient Romans in their plumbing and sewerage systems. Even earlier, the metal was used for lining coffins, and as pans for holding plants in the Hanging Gardens of Babylon (ca 600 BC).

Zinc was probably not isolated as a separate metal until relatively modern times. However, zinc ores were mixed with those of copper to make brass between 1000 BC and 600 BC.

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Properties

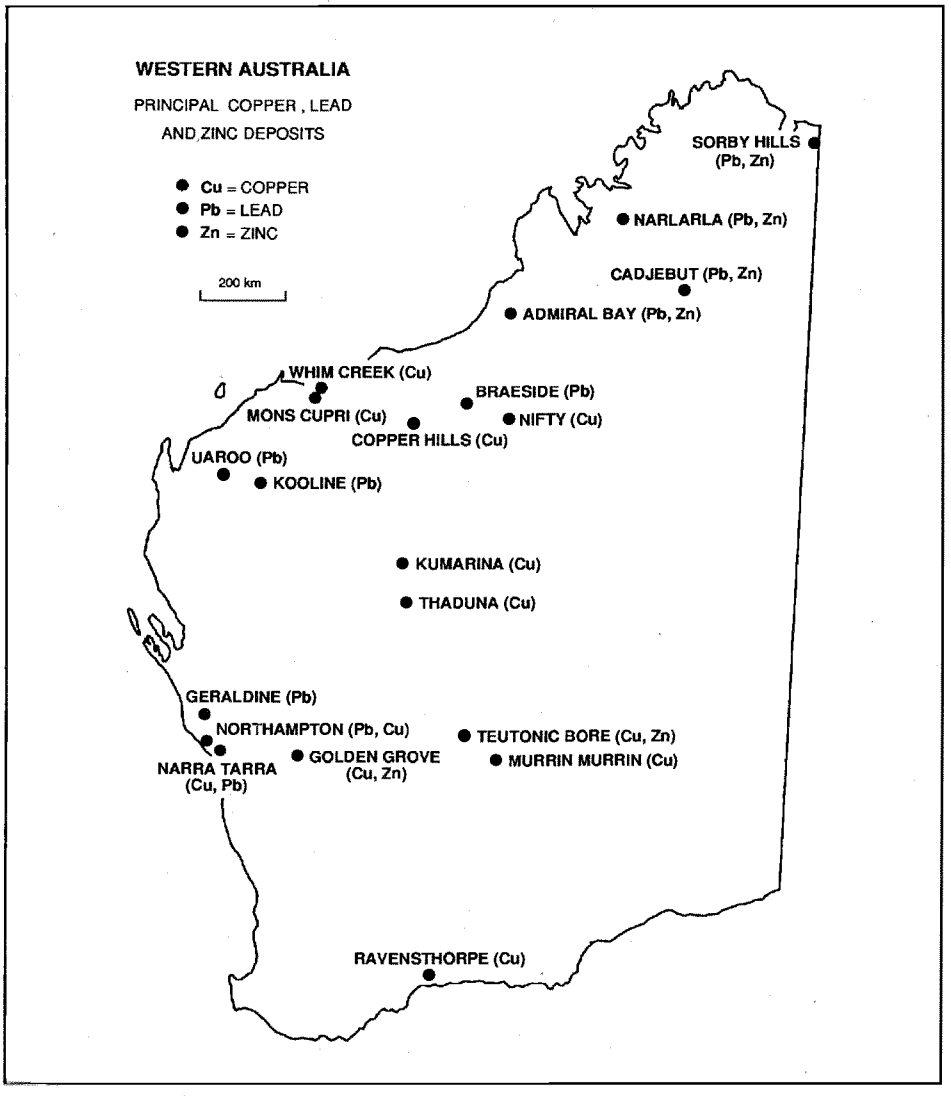
Copper (Cu), lead (Pb) and zinc (Zn) are good electrical conductors; they are malleable, ductile and moderately resistant to corrosion. They can also be alloyed with one another, and with several other metals, to produce alloys with many useful properties.

World production and uses

World production of copper is about 9.5 million tonnes per year, mostly from western North and South America, Zambia, the former Soviet Union, China, Indonesia and Poland. Approximately 60% of the copper produced is used in the electrical industry. Important uses for the remainder are in the manufacture of alloys, fertilisers and cooking utensils.

About 5.4 million tonnes of lead are used each year, mainly in lead storage batteries (for aircraft, motor vehicles etc.). Other uses include paints, dyes explosives, insecticides, and rubber products. In the past, tetra-ethyl lead was added to petrol to improve engine performance. This application is declining with the increasing use of lead-free petrol, because of its contribution to air pollution, and the harmful effects of lead fumes and dust to the human body. Only about 2.7 million tonnes of new lead are produced each year, the remainder being made up by recycling of scrap lead.

World annual zinc production is about 6.9 million tonnes. The main use for zinc is as a protective agent for iron and steel (galvanised steel). The zinc oxidises in the air to zinc oxide which forms a protective coating on the iron or steel. Zinc is also used in die-casting, and zinc compounds are used in cosmetics, plastics, rubber products, soaps, paints and inks. It finds a major use in luminous dials (for clocks, TV screens, fluorescent lamps, etc.).



The following alloys are important:

Brass (copper + zinc): for hardware, domestic ornaments and fixtures, musical instruments (the "brass section").

Bronze (copper + tin): for casting various products, including statues. Bronze was probably more important historically than it is today.

Solder (lead + tin): the low melting point of lead is used to advantage in this alloy which is used for joining metal surfaces.

Base metals in Australia and Western Australia

Australia is the fifth largest producer of copper, with 4% of total world production. In 1993, Australia produced 392 000 tonnes of copper, mainly from Mount Isa in Queensland, Cobar in New South Wales, and Olympic Dam in South Australia. Australia also produces significant amounts of lead (514 000 tonnes) and zinc (990 000 tonnes). The main producing localities are Mount Isa, Cobar and western Tasmania. Production from very large deposits at Broken Hill, in New South Wales, has been declining in recent years as the resource is depleted. However, several new deposits in the West Kimberley region of Western Australia have been discovered in recent years. One of these, Cadjebut, commenced production of lead and zinc in 1988, and others are planned to come onstream in the 1990s. Production of copper and zinc from the Scuddles mine at Golden Grove, south of Yalgoo, also began recently and a new copper mine may be established at Nifty in the Pilbara region.

Western Australia's contribution to the nation's base metal production is not great, but will improve as the West Kimberley deposits move into production, and as output increases at Golden Grove. The State's production has been sporadic, reflecting demand and other economic factors. Localities of the main deposits are shown on the opposite page.

Lead was first mined commercially in WA during 1850 from the Geraldine mine,

discovered in the bed of the Murchison River by A. C. Gregory's exploratory party in 1848. Copper and lead were discovered in the Northampton area in 1855, and mined during the 1860s and 1870s. Mining helped settle the area, as many miners turned to agriculture after the mines closed down in the 1880s. Other discoveries followed. Copper was found at Whim Creek (1888), Murrin Murrin (1898) and Ravensthorpe (1899). Lead and zinc were discovered at Uaroo, Braeside and Narlarla, all in the early 1900s.

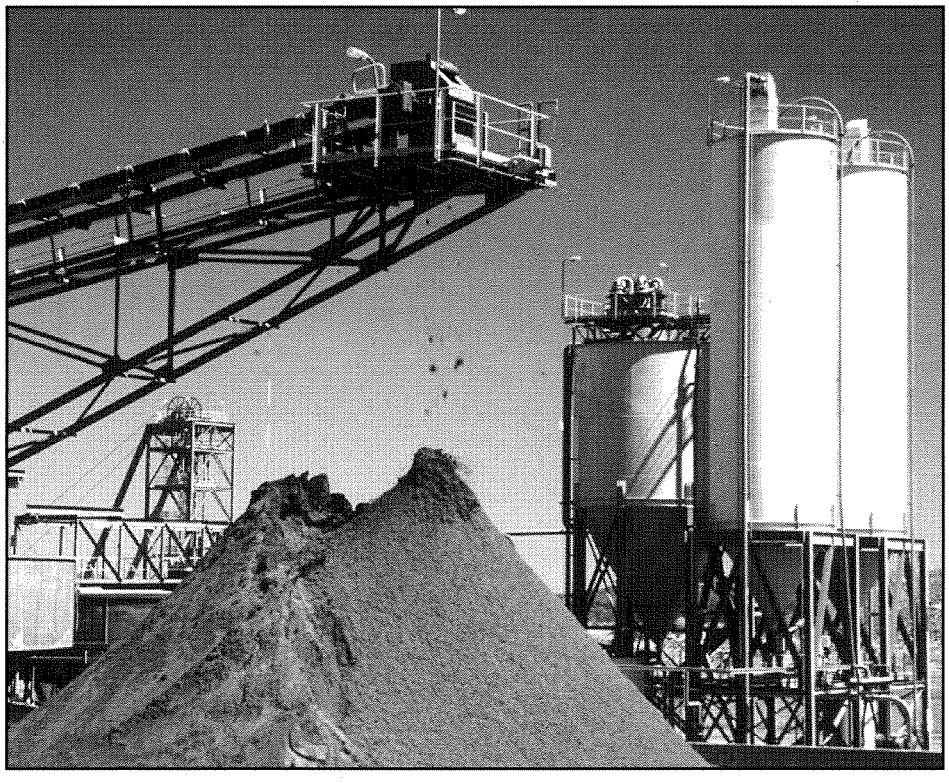
Copper production was stimulated in the 1950s and 1960s by the development of a local market for fertilisers, as agriculture expanded into sand plain areas. Most mines, however, had closed by the late 1960s. In 1971, WA's last copper mine closed, at Ravensthorpe. At present, the only copper produced in WA is as a by-product from the mining of nickel, zinc and gold.

Following a boom in the 1950s when the Korean War produced high prices, lead mining stopped almost completely during the period 1970 to 1988. The opening of the Cadjebut mine late in 1988 saw lead production resume as a co-product of zinc.

Western Australia's output of zinc amounted to less than 3 000 tonnes until the Teutonic Bore mine was opened in 1981. Almost all of this early production came from the Narlarla mine in the West Kimberley region. Currently the metal is mined at Cadjebut and Golden Grove.

Base metal deposits

Base metals occur in nature as sulphide minerals. The main copper sulphide minerals are chalcopyrite, bornite and



▷ *Zinc/copper concentrates is stockpiled at the Golden Grove mine.*

▽ *Copper ore is loaded into 75 tonne capacity haul trucks at the Nifty open-cut mine.*

chalcocite. Native (elemental) copper also occurs, but is relatively rare. Lead sulphide is called galena, and zinc sulphide is called sphalerite. Near the Earth's surface, oxygen-charged groundwater oxidises primary sulphide concentrations, and leaches the metal content, redepositing the metals near the water table. Supergene deposits formed in this way are commonly much richer in metal content than the primary ore from which they were derived. Supergene ores comprise oxides and carbonates of copper (cuprite, malachite, azurite), and carbonates and sulphates of lead (cerrusite, anglesite) and zinc (smithsonite, goslarite).

Copper, lead and zinc are mined from several different types of deposits, often in association with gold (copper) or silver (lead-zinc). Much of the world's copper production is derived from open-pit mining of very large, low-grade deposits comprising numerous, very small veins and disseminations of sulphide minerals (porphyry copper deposits). The style of mineralisation is not important in Australia, but is the major source of copper from Papua New Guinea and South America. A small porphyry copper deposit occurs at Coppins Gap, in the Pilbara.

Another important source of copper is from sedimentary sequences, often containing volcanic rocks, in which the copper appears to have been deposited as an original component of the rock assemblage. Such deposits are smaller, but generally richer than the porphyry coppers, and are the most important source of copper mineralisation in eastern Australia. There are also some deposits of this type in Western Australia (e.g. Whim Creek, Mons Cupri, Nifty, Teutonic Bore and Golden Grove). The last two examples are also an important source of zinc.

Most of Western Australia's copper production (including that from Murrin Murrin and Ravensthorpe) has come from large veins of uncertain affinities.

As with copper, most historical production of lead and zinc in Western Australia comes from vein deposits in igneous and metamorphic rocks. However, the metals also occur in sedimentary and volcanic rock associations similar to those that yield important copper deposits. Deposits of this type include all the main producers in eastern Australia. The new discoveries in the Kimberley region take the form of sphalerite and galena in vein and cavity fillings, and replacement bodies, in an ancient limestone reef. They are similar to the famous deposits of the Mississippi Valley, USA. The large Admiral Bay deposit situated at a depth of about 1 400 metres in the western part of the Great Sandy Desert, is also hosted by limestone.

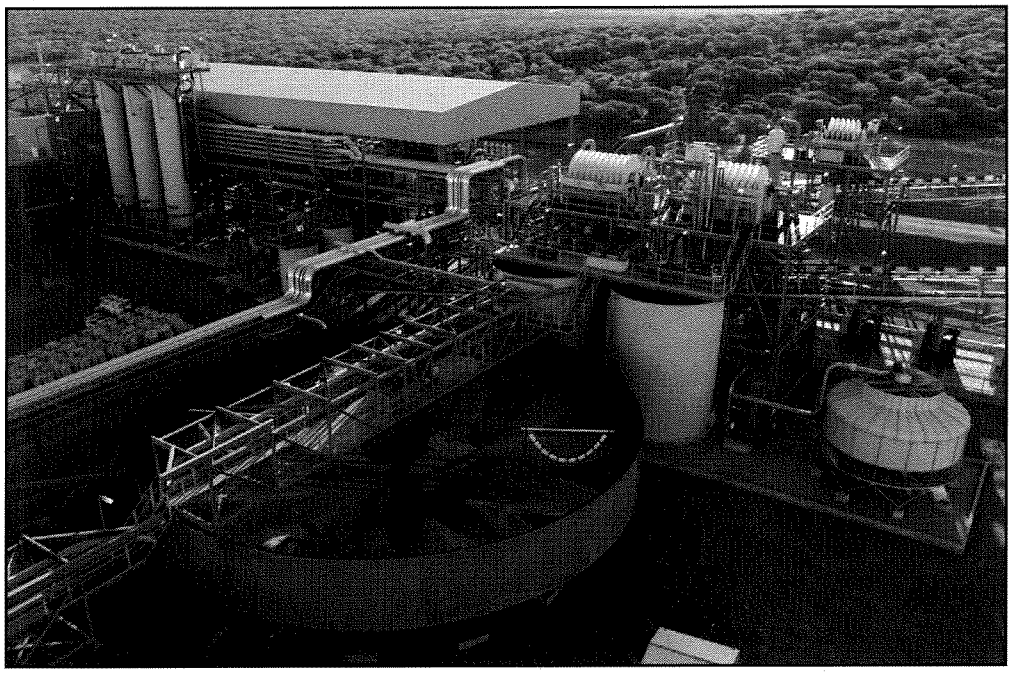
Extraction of base metals from natural ore

Copper is extracted from sulphide ore by crushing and forming a slurry with water. The process used to separate copper minerals from the others is called flotation. During flotation, fine sulphide particles adhere to air bubbles which are deliberately produced in the slurry, and rise to the surface. The froth is then scraped off and dried, yielding a concentrate containing 20% to 30% copper.

The copper concentrate is usually roasted in two stages, with sand and oxygen added to each stage. Some impurities are removed in the waste gas. Others react with the sand to form a slag which rises to the top of the melt during the smelting process. The slag is eventually skimmed off and discarded.

The first roasting stage produces and intermediate product called copper matte which contains between 40 and 55% copper metal. The second stage completes the process, yielding a "blister" copper of 93% to 98% copper. For industrial use the copper is refined further by electrochemical processing to produce metal of 99.99% purity.

■ Produced by the Public Affairs Branch, Department of Minerals and Energy, Western Australia. 1/96



◁ *A section of the treatment plant at the Golden Grove zinc/copper mine.*