





# lst **Gold resources**

Australia has the world's largest gold resources. Department of Industry, Science and Resources



# **3**rd

Largest producer In 2022, Australia was the 3rd largest gold producer. Department of Industry, Science and Resources



# \$24bn

Export value Value of Australia's gold exports in 2022-23.

Department of Industry, Science and Resources

**228**t Export volume Volume of Australia's gold exports in 2022-23.

Department of Industry, Science and Resources

22% World share Australia's share of global gold resources in 2022-23. Department of Industry, Science and Resources

# Australia's top gold customers

33% \$8.1 billion China

15% \$3.8 billion Hong Kong



14% \$3.5 billion Singapore

9% \$2.2 billion Switzerland



ABS, International Trade in Goods, September 2023

# **\$1** trillion

A golden era Australian gold's contribution to the world since 1851 Our World in Data

25,800 **Gold industry iobs** Direct gold industry jobs in Australia in 2021. Australian Bureau of Statistics

\$3.9bn

Industry wages Wages to gold industry workers in 2022-23. Derived from Australian Bureau of Statistics

\$151,500 Annual wades Average annual wage paid



to mine workers in 2022-23. Australian Bureau of Statistics

\$1.33bn **Gold exploration** 



**Gold** exploration expenditure in 2022-23. Australian Bureau of Statistics



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# Responsible MINING

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# Barriers to investment must be addressed to harness the full potential of Australia's gold industry

Gold has long been valued for its allure and wealth, but today its significance extends far beyond traditional applications.



Golden: The rise of industrial gold delves into the transformative impact of gold across modern and emerging industries, from hightech electronics and advanced medicine to the growing field of industrial nanotechnology, as well as its ongoing contribution to the Australian economy.

Gold's unique properties – its unparalleled malleability, conductivity, and resistance to corrosion – have made it a unique asset in the evolution of technologies that are at the forefront of human progress.

Australia's relationship with gold is both historic and dynamic. Gold mining profoundly influenced our nation's journey, contributing to its development, economic growth and shaping our identity on the global stage.

In 2022-23, Australia's gold exports generated \$24.4 billion in revenue, underscoring the precious metal's economic importance. The gold rushes of the late 19th century, driven by discoveries in Bathurst, Ballarat, Mount Alexander, Bendigo and Kalgoorlie, not only marked Australia's first mining boom but played a pivotal role in tripling the nation's population between 1851 and 1860. This period laid the foundation for Australia's rich mining heritage, positioning us as a global gold industry leader.

Today, the role of gold extends beyond its use to store wealth and for jewellery to the high stakes of space exploration, telecommunications, and advanced manufacturing, proving its value across millennia.

In the realm of electronics, it serves as the backbone for efficient electrical signal transmission where it is indispensable in the circuitry of the world's most sophisticated devices. In modern medicine, gold's biocompatibility and inertness make it a key player in diagnostics, drug delivery systems, and cancer treatments.

The story of gold's industrial applications is testament to its significant contribution to modern innovation. *Golden* illuminates the ways this metal facilitates human advancement, often behind the scenes, yet playing a crucial role in the future.

# Learn more about how gold shapes our world

# **Everyday electronics**

For those of us who can't imagine life without our favourite devices, there is no greater use of industrial gold.

## PAGE 20

# Advanced manufacturing

Industrial gold is finding critical new functions in advanced manufacturing with every decade that passes. PAGE 22

# **Space exploration**

Gold is onboard every spacecraft, withstanding extreme temperatures and shielding against solar radiation. PAGE 24

# Resourcing tomorrow Australian Mining





# **Quantum computing**

Quantum computers require near absolute zero temperatures to operate to protect delicate quantum bits, or qubits, from thermal noise and vibrations. Engineers achieve this by using a layer of gold to coat components of the quantum computer. Gold reflects heat, in the form of infrared radiation, away from core components, keeping the computer cold during operation.

Learn more on page 21.

Turning our focus to modern Australia, we witness a gold industry that is not only thriving but pivotal to the nation's economic fabric. Home to the world's largest known gold resources, Australia is at the forefront of meeting global demand for this precious metal.

Gold is Australia's third-largest mineral export and a key contributor to our merchandise trade. The gold industry's workforce provides highly skilled jobs to about 26,000 directly employed Australians and supports an additional 55,000 jobs indirectly.

These skilled workers are at the forefront of navigating complex geological terrains, pushing the boundaries of technology, and ensuring that Australia remains at the cutting edge of sustainable mining practices.

However, the path forward is not without its challenges. As we look to harness the full potential of Australia's gold industry, we must address barriers to investment and foster a conducive environment for innovation.

This includes streamlining regulatory approvals and enhancing international competitiveness to ensure the industry's sustainable growth and continued contribution to the global economy. Golden offers a comprehensive look at the multifaceted role gold plays in shaping our world. It is a story of enduring value, innovation, and progress. Harnessing the opportunities to support this industry will ensure that gold mining can continue driving us towards a more prosperous, technologically advanced, and interconnected world.

ania lanstalle

Tania Constable Chief Executive Officer Minerals Council of Australia

# **Advanced medicine**

PAGE 26

New gold applications in diagnostics, therapies and preventative healthcare are being discovered every year.

# Wealth building

No other token of exchange has endured like gold – the bedrock of modern economies.

PAGE 28

# **Golden millennia**

Throughout the ages, gold has been worshipped for its beauty and revered as a symbol of immortality. PAGE 30



From advanced manufacturing to space exploration, industrial gold has emerged as an indispensable thread weaving its unique properties through today's technologies and tomorrow's.

Long revered for its aesthetic allure and historical significance, gold today is playing an increasingly important role in the critical technologies shaping our future. Gold's exceptional properties of malleability, conductivity, and resistance to corrosion have positioned it as a key input to the evolution of future-facing technologies.

From high-end electronics to advanced medicine and emerging fields of industrial nanotechnology, this report explores the depths of gold's influence on diverse sectors. In the realm of electronics, gold assumes a pivotal role as a conductor. Its ability to transmit electrical signals with high efficiency makes it an irreplaceable component in the circuitry of our most advanced devices. Gold's biocompatibility and inert nature also find application in the medical field, where it plays a crucial role in diagnostics, drug delivery systems, and even the treatment of certain cancers.

As we venture further into its industrial applications, it will become evident that gold, often hidden from the limelight, is a key part of modern innovation. *Golden: The rise of industrial gold* aims to shed light on the intricate ways in which this noble metal is facilitating human progress.

# A brief history

The use of industrial gold dates back thousands of years. Although primarily a symbol of wealth and power in ancient times, gold's unique properties found new purpose in emerging industrial applications as civilisations advanced.

One of the earliest uses of gold was in the production of jewellery and ornaments. Gold's malleability and resistance to tarnish made it an ideal material for creating intricate designs. Additionally, gold was used in ancient Egypt for gilding statues and buildings, showcasing its aesthetic appeal.

By the late 19th century, the industrial use of gold expanded beyond artisan jewellers and master gilders, and began to be used in the electrical industry due to its excellent conductivity. As technology advanced, gold became an essential material in the production of telegraph wires, electrical contacts, and other electrical components.

It was in the 20th century that industrial gold found many more uses – computers, smartphones, and televisions all rely on goldfabricated components. Here on earth, and in space, gold is a critical input for advanced manufacturing. NASA relies on gold's high reflectivity and resistance to heat to protect its spacecraft, satellites and astronauts from solar radiation.

Gold has also found its way into the medical industry in more recent times, due to its durability and biocompatibility. It is used in the production of medical devices, such as pacemakers, hearing aids, and dental crowns. Gold nanoparticles are also being researched for their potential applications in drug delivery and cancer treatments.



.....

"The Australian mining industry is uniquely positioned to lead the world in resourcing the new energy future whilst serving as the role model for safe, sustainable and responsible mining."



TOM PALMER President and CEO | Newmont



**Properties &** characteristics



# Malleable & ductile

Gold can be flattened into thin sheets and drawn into long wires, making it ideal for intricate shapes and coatings.



# **Highly conductive**

choice for connectors and

switches on circuit boards.

Gold is an excellent conductor of electricity, making it a top

# **Catalytic properties**

At the nanoscale, gold can catalyse certain chemical reactions, making it useful in industrial manufacturing.

# **Biocompatible**

Gold does not react with or adversely affect human tissue, making it suitable for use in implantable medical devices.



# **Corrosion resistant**

Gold is resistant to rusting, making it useful in electronic components where moisture could degrade other metals.



# **Chemically inert**

Gold does not readily react with other elements, making it a durable metal for various industrial applications.

# **Highly reflective**

Gold is highly reflective, making it a useful reflector on spacecraft to dissipate heat during missions.



# **Gold geology**

Gold exists in greater abundance in Australia than any other country in the world. Australia's gold totalled more than 22 per cent of global gold resources, or about 12.000 tonnes in 2023.1

Western Australia's Yilgarn Craton is the nation's premier gold province with major Archean greenstone-hosted deposits such as Kalgoorlie, Granny Smith and Boddington. About 44 per cent of economic resources of gold is found in Western Australia.<sup>2</sup>

Substantial gold deposits can also be found in Fosterville in Victoria (quartz-vein related), Cadia in New South Wales (porphyry gold copper) and Mount Carlton in Queensland (epithermal). South Australia's Gawler Craton hosts the major iron oxide-coppergold-uranium Olympic Dam deposit and the Northern Territory hosts the world-class, low-sulphide, quartz vein Tanami deposit.3

# World-class producer

Australia is the world's second-largest gold producer after China. accounting for about 10 per cent of total world gold production.<sup>4</sup> Domestic mine production was 301 tonnes in 2022-23, arowing by 11 per cent over the decade, with a number of new projects expected to come online by the end of 2024.5

Mined in all Australian states and the Northern Territory, gold is the primary output of around 70 mining operations across the country. Australia exports gold to more than 55 countries, generating \$24.4 billion in export revenue in 2022-23.6

Australia's status as a world-class gold producer is anchored in its cutting-edge mining technology and skilled workforce. Advanced exploration, extraction and processing methods also underscore the industry's commitment to a safe, efficient and sustainable gold industry.

# What's driving demand?

Gold's unique properties and enduring gualities continue to find new markets and applications in the 21st century. While the electronics sector dominates industrial demand for gold, the advent of nanotechnology is driving new uses for the precious metal in medicine, engineering and environmental management.

In 2023, annual gold demand was 2.168 tonnes (49 per cent) for jewellery; 1,983 tonnes (45 per cent) for investment, including central banks and other institutions: and 298 tonnes (7 per cent) for technology.7

The rising economic power and emerging consumer class of East Asia is a long-term driving force of gold demand. As the world becomes more interconnected and the pace of renewable energy technologies grows, gold will play an increasingly critical role in industrial uses, in importance if not volume.



# **Gold exports**

Australia's gold exports have nearly doubled in value over the past decade from \$13.3 billion in 2013-14 to \$24.4 billion in 2022-23.<sup>8</sup> The total value of gold exports across that period was \$198.6 billion.<sup>9</sup> Gold's consistently strong export performance has seen it ranked as Australia's third largest mineral export and fourth largest export earner of all merchandise trade in 2022-23.<sup>10</sup>

The outlook for gold is strong, with all indicators showing gold will remain a significant export earner for Australia into the future. Gold's prominence as a safe-haven asset, ongoing uncertainty in the global geopolitical environment, and expectations for a mixed macroeconomic performance among major economies suggest that the gold market will remain strong, if volatile, in coming years.<sup>11</sup>

# **Royalties and taxes**

Australia's gold industry has generated more than \$3 billion in royalties over the last decade. Levied on gold production, royalties represent a vital revenue stream for state government budgets and help fund essential services and infrastructure in regional communities. With gold operations in all states and the Northern Territory, the gold industry is a cornerstone of Australia's mining sector. Gold royalties ensure a sustainable income source across mining jurisdictions.<sup>12</sup>

Australia's gold producers also contribute other payments to government including company tax, payroll tax and stamp duty as well as state mining and exploration fees and levies, and a host of other state and local government charges. Beyond the fiscal benefits, gold mining fosters job creation and supports regional development.

# **High-skilled** jobs

Around 26,000 Australians are directly employed in the gold industry, with a further 55,000 employed indirectly.<sup>13</sup> The bulk of jobs are located in regional and remote centres. The industry employs a diverse range of skilled professionals, including engineers, environmental scientists, electricians, geologists, diesel mechanics, geophysicists, mathematicians, boilermakers and finance experts.

Gold mining workers are also highly paid. Industry wages average \$151,500 per year, making mining consistently the highest paying of all Australian industries.<sup>14</sup> The gold industry's experienced and highly skilled workforce is critical for navigating complex geological terrains with precision, utilising cutting-edge technology and ensuring world-leading sustainability practices.

#### FIGURE 2

Gold exports have doubled in value in less than two decades

Source: Department of Industry, Science and Resources





#### **Purity measures**

# Karats (K)

A measure of gold purity expressed as a fraction of 24. For example, 18K is 18 parts gold and 6 parts other metals (18/24 = 75% gold). The higher the karat, the purer the gold.

#### **Millesimal fineness**

Precisely expresses gold purity as a 3-digit number indicating parts of gold per thousand. For example, 24K is equivalent to 999 fine (99.9% pure gold). "Responsible gold mining should be championed because it safeguards our environment while providing the world with a treasured financial asset that has been used by mankind for millennia. In the present day it supports true social and economic development."



ALBERTO CALDERON CEO | AngloGoldAshanti

# Value adding

Australia is not only a major producer and exporter of gold, it is also a key player in the global gold refining industry. Australia has two accredited precious metal refiners – the Perth Mint Refinery in Western Australia and the ABC Refinery in New South Wales. These refineries process domestically mined gold, as well as gold mined in New Zealand and other Pacific countries and South East Asia, along with a significant amount of recycled gold.

Gold ore is a natural mineral or rock that contains varying amounts of gold and other minerals.<sup>15</sup> It has a wide range of fineness depending on its purity and the minerals it is mixed with. Refining gold removes impurities such as silver, copper, zinc and nickel from raw gold ore, resulting in gold bullion that is at least 99.5 per cent pure.



**24**K

Pure 99.9% gold with only trace elements of other metals. Too soft for everyday jewellery.

18k 750 fineness 75% gold and 25% other metals like silver or copper. A more durable option

**14K** 585 fineness 58.5% gold with a mix of other metals like silver and copper. Commonly used for jewellery.

for jewellery.

purity for jewellery.

**10**K 417 fineness 41.7% gold with other metals like silver and copper. Considered the minimum

#### FIGURE 3

### Australian gold production has endured through good times and bad

Source: surbiton.com.au; ABS, Australian Mining Industry, 1998-99; Our World in Data; DISR REQ





# Why exploration matters

Gold production begins with exploration. Australia's continued success as a global producer depends on the efforts made by gold explorers today, and in particular their willingness to keep committing large amounts of investment to exploration. Gold explorers are no slouch in this regard. Over the last decade, gold explorers spent more than double – \$9.5 billion – the amount spent searching for iron ore (\$4.5 billion).<sup>16</sup>

While Australia has the world's largest share of known gold resources, it also remains one of the biggest untapped mineral exploration targets in the world. The last major deposit of gold (>6 million ounces) was discovered around 30 years ago. Australia's share of global gold exploration expenditure in 2023 was 18 per cent.<sup>17</sup> The low likelihood of a gold exploration target progressing all the way to an operational mine exposes investors to significantly more risk than other industries.

# **Exploration activities**

Exploration begins with target identification, a process aimed at identifying smaller areas which warrant further testing. Early-stage exploration includes geological mapping, rock-chip sampling, local-scale airborne geophysical surveys and geochemical surveying. Narrowing the field is key. The likelihood that early stage exploration delivers a discovery is around 1 in 660.

Testing a target for a mineral deposit usually involves drilling. Drill rigs can be quite compact or very large and mounted on trucks or tracked vehicles. Drilling collects physical data for chemical analysis and to identify the rocks that occur at any given depth below the surface. In 2016, exploration uncovered a massive gold deposit at Fosterville in central Victoria – the ultra-high grade Swan Zone. This discovery transformed Fosterville into one of the world's richest gold mines.

# **Environmental impact**

Exploration occurs under strict conditions and only after an exploration licence has been granted by the relevant state authorities. Prior to undertaking any exploration activities, an explorer must also negotiate a land access arrangement with landholders and consult with the community.<sup>18</sup>

Well-planned exploration projects have little to no lasting environmental impact. Clearing is kept to a minimum and drilled areas are rehabilitated. Explorers must also lodge a bond that is only returned once rehabilitation is complete. Drilling operations carefully manage waste water, reduce noise by operating at certain times as agreed with the landholder and with noise abatement sheds, and protect biodiversity which is strictly monitored. When exploration is successful, a separate, comprehensive environmental and social approval process involving community input begins for any proposed mine.<sup>19</sup>

#### FIGURE 4

# Victoria leads the nation in gold exploration growth

Long-term average growth in exploration expenditure over 30 years



Source: ABS, Mineral and Petroleum Exploration Australia, 2023.

# FIGURE 5

# Gold exploration outpaces every other commodity

Decadal exploration expenditure by commodity, 2013-14 to 2022-23, \$millions



Source: ABS, Mineral and Petroleum Exploration Australia, 2023.

"We are determined to shed the historic legacy of past mining practices, by ensuring that our activities not only significantly benefit the wider community, but also by mitigating the impact of our activities upon the environment."



LANCE FAULKNER General Manager – Fosterville | Agnico Eagle

# Advanced technology

From early exploration activities through to core sampling and metallurgical testing, new technologies are constantly under development to reduce environmental impacts. Geophysical techniques, including aeromagnetic surveys, gravity gradiometry, electromagnetics and reflection seismology and seismic refraction are used to create 3D models of highly prospective areas by measuring the physical properties and variations of the subsurface.

Data can be collected in ground surveys or from airborne platforms such as fixed wing aircraft or helicopters, and also from satellites up to 1000km above the Earth. Drones are also increasingly being used to produce high quality photography and digital terrain models. Drones use high-resolution true-colour cameras and laser-scanning sensors, and can also carry lightweight magnetic and hyperspectral sensors.

> For every dollar raised from gold production in Victoria, 20 cents goes back into exploration.

Source: DISR REQ, ABS, Mineral and Petroleum Exploration Australia, 2023.

## FIGURE 6

Nothing carries more investment risk than setting out to build a mine Source: Prof RG Eggert, *Mineral exploration and development: Risk and reward*, Colorado School of Mines 2010







Australia's gold industry has made significant strides to meet community expectations for strong environmental, social, and governance (ESG) performance. Gold projects must be safe, environmentally friendly, and socially responsible to contribute economically and support societal goals such as the UN Sustainable Development Goals and the Paris Agreement.

The gold industry has a long history of collaboration, improving practices and driving ESG performance, including pioneering the sector's first Code of Environmental Practice in 1997 and the 'Enduring Value' framework in 2005. Many Australian gold companies are now implementing the Towards Sustainable Mining (TSM) accountability framework.

# **Environmental stewardship**

The Australian gold industry's sustainability credentials are recognised globally, and its expertise and leading practice is exported around the world. The industry has earned its global reputation through strict commitment to environmental regulation – often going further than required by regulation to ensure environmental outcomes are achieved.

Through the adoption of innovative technologies, working cooperatively with regulators, and a proactive approach to community engagement, the gold industry continues to showcase how environmental stewardship can drive innovation and foster sustainable development.

Australia's gold miners are not only safeguarding ecosystems, but enhancing the industry's reputation and ensuring its longevity for future generations.

# **Chemical management**

Safe management of chemicals is a critical part of all industrial processes. For gold mining, sodium cyanide plays a key role in extracting gold and can liberate associated metals such as silver, copper and zinc.<sup>20</sup>

While government regulations provide a framework for managing cyanide, the gold industry proactively implements additional measures beyond regulatory requirements to enhance safety and minimise risks.

One example is the International Cyanide Management Code, a program adopted by Australian gold companies. The Code sets standards for the manufacture, transport, and use of cyanide in gold production, aiming to protect workers, communities, and the environment. Compliance is verified through independent audits, ensuring that companies meet only the highest standards.<sup>21</sup>

FIGURE 7

# **Producing Australian gold**

The mining process includes controlled blasting, hauling, crushing, leaching, processing and beneficiation. Although the process varies between individual mines below is an indicative path.



"In South Australia we established the Mining School of Excellence at Olympic Dam to create new opportunities for people without experience in mining. Almost 600 people have started at the school over the last three years."



# Water management

Gold companies have put in place strategies for responsible water use at all stages of the mine life cycle. This includes supply, storage, usage and discharge monitoring, risk assessments, maintenance of site-wide water balances and water conservation programs.

No other industry's water use is more heavily assessed and regulated. Water is acquired through planning and entitlement regimes, state government environmental and planning approvals, independent expert scientific committee review and specific approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999.

The industry is a global leader in water use transparency. Through the MCA, the industry developed a sector-leading MCA Water Accounting Framework which is now reflected in international reporting standards.

# Indigenous partnerships

Aboriginal and Torres Strait Islander Traditional Custodians and communities are fundamental partners in mining, and integral to the social and economic contribution mining makes to Australia.

Achieving improvements in intergenerational health and wealth among Indigenous communities is a key objective of mining's Indigenous partnerships, and the gold industry is working toward these outcomes through initiatives supporting community development and Closing the Gap strategies.

These efforts, including promoting co-design principles and creating business opportunities, have increased Indigenous representation in mining, especially in apprenticeships. Mining also significantly supports Indigenous businesses, strengthening ties between sectors.

# Healthy and safe workplaces

EDGAR BASTO

Chief Operating Officer | BHP

The Australian mining industry's core value and commitment is the safety, health and psychological wellbeing of its workforce, where everyone who goes to work returns home safe and healthy.

Australia's gold industry is committed to eliminating fatalities, injuries and occupational illnesses and building respectful workplaces. That means for every individual, regardless of where they work, who they work for, how they are employed, or the tasks they undertake, companies work to deliver a high standard of workplace safety, health and wellbeing.

Leadership, culture, behaviour and systems are key areas for the industry in achieving healthy and safe workplaces. The industry also collaborates with government to strengthen individual company efforts to continuously improve safety and health outcomes.





FIGURE 8

# **Refining Australian gold**

Australian refineries use three types of processes to add value to mined doré bars, ingots, coinage, and scrap.





## **Miller process**

Chlorine is introduced to melted bullion in a crucible furnace. The gas reacts with impurities to form chlorides, which bubble and rise to the surface of the molten bullion and are removed. The molten gold is then cast into bars.

## Wohlwill process

Gold ingots are melted and placed in an electrolyte solution of hydrochloric acid and gold chloride. When an electric current is passed through this solution, gold ions migrate to the cathode, where they are deposited as pure gold.

#### Aqua regia process

A mixture of nitric acid and hydrochloric acid is used to dissolve gold. After dissolution, the addition of sulfur dioxide gas precipitates the gold. The fine metallic powder is then melted and cast into gold bullion.



Australia's gold mining industry stands to benefit from increased demand due to gold's safe haven properties, its role in central banking, and growing applications in industrial technologies. However, realising this potential requires effective domestic policies that address emerging challenges to new gold mining projects and support sustainable growth in gold production.

The right policy settings can help Australia's gold mining industry improve its productivity and international competitiveness, support the expansion of gold production in Australia and boost the industry's already significant contribution to the economy.

# International competitiveness

Australia is among the world's largest gold producers. In 2021, Australia held the top title but has since slipped two places to sit behind China and Russia. China accounts for about 10 per cent of world gold production. With a rising number of lower grade deposits, innovation through digitalisation, operational efficiencies and a competitive investment environment is critical.

Gold production is more widely distributed than ever before – more than 40 countries mine gold today. A decade ago, the United States and Canada were among the leading producers, but emerging production from Asia, Latin America and Africa is placing more established producers under increased pressure. For Australia to maintain its status as a leading producer, policy settings need to attract investment.<sup>22</sup>

# **Streamlining approvals**

Australia's gold mining industry is internationally recognised as a leader in science-based, responsible and accountable environmental management. The industry works collaboratively with regulators and research organisations to continuously improve sustainability outcomes through a life-of-project management approach. However, prospective gold projects face delays in regulatory approvals as well as increasing costs and uncertainty from duplicative and overly complex processes. These regulatory burdens add to costs and make investment conditions worse.

Government has a major role in ensuring regulatory settings are timely, efficient and fully integrated with state and territory processes. This requires full consultation with affected parties.

## FIGURE 9

# Australia's mining industry's net capital stock is plateauing

Source: ABS, Australian System of National Accounts, table 58, released 28 October 2022.



"The gold industry has an opportunity to lead the way in innovation, transparency and sustainability. We will continue to accept the challenge to safely mitigate our environmental impacts, and make a positive difference in the areas where we operate by partnering to build a better future."



SUZY RETALLACK Chief Safety and Sustainability Officer and Executive Australia | Newmont Australia

# Affordable, reliable energy

Access to affordable, reliable and low emissions electricity is of critical importance to the gold mining industry's ability to meet Australia's 2030 and 2050 emissions targets and remain internationally competitive. All fuels and technologies, including carbon capture, utilisation and storage and currently prohibited advanced nuclear technologies, can play a part in maximising opportunities for Australia by facilitating an effective transformation to reliable, competitive, zero emissions energy.

The mining industry is heavily investing in clean energy transport and energy systems as they become commercially available. Commonwealth and state governments must be prepared to assist in providing the necessary public infrastructure and goods and services to support the mining industry in reducing emissions.

## No new taxes

For Australia to attract new gold mining investment there must be no new or extra tax imposts. Australia's effective tax rates are already among the world's highest. While the budget bottom line is a primary concern for Australian governments, the threat of further taxes or royalties is a significant deterrent to mining investment and will only reduce the industry's future economic contribution.<sup>23</sup>

Piecemeal approaches to revenue raising levied on the minerals industry, such as reducing or removing the fuel tax credit (which is a road use tax), are particularly damaging and would only increase taxation on regional and remote Australian businesses. This would result in lost output and reduced international competitiveness, and decelerate the expansion of gold production in Australia.

## Workforce productivity

Australia's gold mining industry has led from the front on global mining productivity through its deployment of innovative and cutting-edge technologies, and its strong commitment to investing in and building the skills of employees.

Skills shortages continue to be a risk to the mining industry's productivity. The mining sector is undergoing a digital transformation that is enhancing existing occupations and creating new ones. Both Commonwealth and state and territory governments have a role to play in preparing the education and training sectors and in workforce planning to develop the pipeline of skills that will be needed in the future. Ensuring that workforce planning is focused on STEM pathways will support growth and development of materials supply chains.

#### FIGURE 10

## Economy-wide effect of policies that reduce the mining industry's productivity

Source: Modeling undertaken by CIE, 2023

#### Labour productivity

Legislation that reduces workers' incentives and effort, or business workforce flexibility, cause large reductions in labour productivity.



#### **Fuel tax credits**

Abolishing the fuel tax credit would lead to increases in the effective tax rate owing to limited options for substitution away from diesel.



# **NEIGHBOURS**

Costerfield

Mandalay Resources (VIC)

partnered with Taungurung

the local community during

restoration of 3.7 hectares

of farmland neighbouring its

Splitters Creek Evaporation

Facility back to its original

Mandalay Resources

Traditional Owners and



# Stawell

Stawell Gold Mine (VIC)

SGM has supported dozens of local groups over the years through its Community Grants Program, such as Stawell Inter-Church Council Cottage, Project Platypus, Wildlife Rescue, sporting groups and schools, as well as sponsorships, such as the Stawell Gift.

# **Boddington** Newmont (WA)



Newmont's Boddington team shared the festive spirit by sourcing and delivering Christmas trees from its pine plantation to local residents at the Shire of Boddington's Christmas Celebration.



# Fosterville

Agnico Eagle (VIC)

Fosterville and its contractor Friswell Electrical partnered with BlazeAid to support clean up efforts after flooding at Goornong by undertaking electrical upgrades at the local recreation reserve.

# Cadia

Newmont (NSW) Newmont raised more than \$125,000 for local charities from the auction of Cadia's limited edition one-ounce gold coins commissioned as part of its 25 year celebrations.



# Sunrise Dam

AngloGold Ashanti has proudly partnered with Carey Mining, Australia's largest 100% First Nation-owned commercial enterprise, since 1995.



# **Taxes and royalties**

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Gold mining taxes and royalties help pay for services and infrastructure that benefit all Australians. Over the last decade, the gold mining industry has contributed more than \$3 billion in royalties. This helps pay for:

- Roads
- Schools
- Hospitals
- Community services
- National parks.

# **Regional jobs**

From rehabilitating mine sites to developing robotics to engaging with communities, the gold mining industry offers a long list of well paid careers across Australia.

- **7** Mining engineers
- **7** Geologists
- Environmental scientists
- Haul truck drivers
- オ Metallurgists
- **7** Boilermakers
- Diesel mechanics
- Indigenous engagement specialists.

# Indigenous communities

Australia's gold miners are a major stakeholder in the economic priorities of Aboriginal and Torres Strait Islander communities. Mining supports these aspirations through:

.....

- Apprenticeships and cadetships
- Employment pathways
- Career development initiatives
- Indigenous procurement programs
- **7** Community and infrastructure investment
- **7** Governance support.





# Costerfield

**Eva Copper** 

Harmony (QLD)

Harmony's sponsorship

of the Quamby All Sports

Association saw Eva Copper

volunteers host refreshments

at the Quamby Rodeo for local

Mandalay Resources (VIC)

Mandalav Resources is a longtime sponsor of the O'Keefe Challenge, a fun run celebrating fitness, nature and community spirit in Heathcote and Bendigo. Funds support the Heathcote Dementia Alliance.



**Mount Isa** 

Glencore (QLD)

Yunbenun Land and Sea

Wildlife Clinic was one of 64

community projects to benefit

from funding from Glencore's

The Tanami Regional **Biodiversity Monitoring Project** collects flora and fauna data across 89 sites using Indigenous knowledge and scientific survey techniques to support remote conservation efforts.



Tanami

# Fosterville Community Grants Program supports local groups and activities with annual grants up to \$5000. Now in its 19th year, the program has distributed over \$500.000 to 258 community groups.



A renewable Power Purchase Agreement (PPA) with Neoen is expected to meet half of Olympic Dam's electricity needs from FY2026. The PPA is expected to supply 70MW of electricity to Olympic Dam.

BHP (SA)



**Tropicana** AngloGold Ashanti (WA)

AngloGold Ashanti staff volunteered their time at a Foodbank facility in the lead up to Christmas, sorting donations of food and hygiene products and packing 944 hampers of frozen meals for people in need.



# **Good neighbours**

Whether it's distributing supplies to remote communities during a global pandemic or redeploying employees and equipment to fight bushfires, Australia's gold miners are good neighbours to have in bad times.

- **7** Emergency services
- Community projects
- Sporting partnerships
- **7** Charitable donations
- Family and childcare services
- Remote medical assistance.

# **Buying local**

Gold mining operations support regional and remote businesses through local procurement and a network of mining equipment, services and technology firms. External service providers include:

- Steel fabricators
- Geoscience services
- Environmental services
- Scientific services
- Equipment suppliers
- Service industry
- Accommodation sector.

# Innovation and R&D

Innovation is a hallmark of Australia's gold mining sector and drives industry partnerships with universities and research bodies. Australia's gold mining R&D is in demand across the world. Partners include:

- **7** Universities
- **7** Technology partners
- Cooperative Research Centres
- Research laboratories
- Government bodies (CSIRO).



## Australia's major gold deposits and select gold projects

Source: Geoscience Australia and company reports

## Fosterville

| Agnico Eagle N   | lines (VIC)       |
|------------------|-------------------|
| Commodity        | Au, Ag            |
| Production       | (2023) 277,694 oz |
| One of the world | l's highest grade |

gold mines, located near Bendigo.

# **Olympic Dam**

| BHP        | (SA)                     |
|------------|--------------------------|
| Commodity  | Cu, Au, Ag, U, REE       |
| Production | (2023) <b>204,421 oz</b> |

Underground and surface mine located 488km northeast of Adelaide.

| Sunrise Dam                        |                          |
|------------------------------------|--------------------------|
| AngloGold Ashanti (WA              |                          |
| Commodity                          | Au                       |
| Production                         | (2022) <b>232,000 oz</b> |
| Underground and open pit operation |                          |

located 50km south of Laverton.

# Carrapateena

| BHP            | (SA)                  |
|----------------|-----------------------|
| Commodity      | Cu, Au, Ag            |
| Production     | (2023) 56,969 oz      |
| Underground co | pper. gold and silver |

mine, 160km north of Port Augusta.

# Tropicana

| AngloGold  | Ashanti | (WA)       |
|--|---------|------------|
| Commodity  |         | Au, Ag     |
| Production   | (2022)  | 306,000 oz |
| Open pits and underground mine 330km east-northeast of Kalgoorlie. |         |            |

# Prominent Hill

| BHP            | (SA)              |
|----------------|-------------------|
| Commodity      | Cu, Au, Ag        |
| Production     | (2023) 65,242 oz  |
| Underground mi | ine located 200km |

# Gold is mined in all Australian states and the Northern Territory.

Hobart

# Mt Isa smelter Townsville refinery Glencore Queensland Metals

| Commodity | Cu, Au, Ag |
|-----------|------------|

Smelt gold in Mount Isa as a secondary product and further refine this via the world class electrolytic copper refinery in Townsville.

# The Perth Mint

Government of Western Australia

| Established | 1899                 |
|-------------|----------------------|
| Processed   | (2022-23) 244 tonnes |

Australia's largest gold refiner and manufacturer of precious metal coins.

# A1 mine

| Kaiser Reef | (VIC) |
|-------------|-------|
| Commodity   | Au    |
| Established | 1861  |

A long-running high-grade mine located near Jamieson in Eastern Victoria.

# **Boddington**

| Newmont    | (WA)                     |
|------------|--------------------------|
| Commodity  | Au, Cu, Ag               |
| Production | (2022) <b>798,000 oz</b> |

Boddington hosts the gold sector's first fully autonomous haul fleet.

# The world's leading gold miner Newmont operates two of the world's Top 10 gold mines -



## Tanami

| Newmont    | (NT)              |
|------------|-------------------|
| Commodity  | Au, Ag            |
| Production | (2022) 500,000 oz |

Australia's most remote mine, Tanami is 540km northwest of Alice Springs.

# **ABC Refinery**

| Pallion Group | (NSW   |
|---------------|--------|
| Commodity     | Au, Ag |
| Established   | 1978   |

Australia's largest independent refinery located near Sydney Airport.

#### **Eva Copper** Harmony

| Паннону  | (QED)   |
|--|---|
| Commodity  | Cu, Au, Ag  |
| A greenfield<br>located 75kr<br>poised to be<br>mine in Quee | copper-gold project<br>n north of Cloncurry,<br>the largest new metal<br>ensland. |

# Costerfield

| Mandalay R | lesources (VIC   |
|------------|------------------|
| Commodity  | Au, St           |
| Production | (2023) 36,000 02 |
|            |                  |

A high grade gold mine near Heathcote, and Australia's only antimony mine.

# **Cadia East**

| Newmont                              | (NSW)             |  |
|--------------------------------------|-------------------|--|
| Commodity                            | Au, Cu, Ag, Mo    |  |
| Production                           | (2022) 597,000 oz |  |
| Australia's largest underground mine |                   |  |

located about 25km south of Orange.

Boddington and Cadia - in Australia.



#### Telfer

| Newmont                             | (WA)                     |  |
|-------------------------------------|--------------------------|--|
| Commodity                           | Au, Cu, W, Zn, Pb, Ag    |  |
| Production                          | (2022) <b>349,000 oz</b> |  |
| Fly-in-fly out underground and open |                          |  |

pit mine, 400 km from Port Hedland.

# Stawell

| Stawell Gold Mine       | (VIC       |
|-------------------------|------------|
| Commodity               | Au, Ag     |
| Established             | 198        |
| Underground mine operat | ting since |

1981, 240km northwest of Melbourne.

# FIGURE 12

# Australia's world share of gold reserves

Source: USGS, Mineral Commodity Summaries 2024



#### FIGURE 13

## Australia's world share of gold production

Source: USGS, Mineral Commodity Summaries 2024





| Кеу | Au Gold     | Ag Silver        | Cu Copper  | Mo Molybdenum  | Pb Lead                 |
|-----|-------------|------------------|------------|----------------|-------------------------|
|     | Sb Antimony | <b>U</b> Uranium | W Tungsten | <b>Zn</b> Zinc | REE Rare earth elements |

# ELECTRONICS

Perhaps the most important industrial use of gold today is the manufacture of electronics - especially for those of who can't imagine life without their favourite devices!

# **SMARTPHONES**

#### Powering communication .....

Gold's conductivity makes it a crucial metal in smartphones. Its malleability aids in the manufacture of intricate components, and because it is corrosion resistant, longevity is typically ensured. With more than 1.3 billion smartphones sold globally each year, tech companies are cashing in on this gold mine of their own making by investing in recycling programs. Apple's robotic system, Daisy, can disassemble up to 1.2 million phones a year.



More gold could be extracted from a tonne of old computers than from 17 tonnes of gold ore. USGS



# **DID YOU KNOW?**

# Mining gold from e-scrap

E-scrap is one of the fastest growing segments of the recycling industry. While the small amount of gold in a smartphone is not worth a lot on its own (around \$3.64 on today's prices), it adds up when e-waste is recycled by the tonne. A tonne of smartphones contains around 10 troy ounces (a troy ounce is 31.1 grams of gold: a standard ounce is 28.3 grams), while 200 laptops yields around 5 troy ounces, according to Dell.

# Why recycling precious metals matters

Around \$430 million worth of e-waste materials are sent to landfills every year in Australia.

# **53.6** Mt

## **GLOBAL E-WASTE**

Global e-waste dumped in landfill in 2019, the equivalent of 350 cruise ships - and a 21 per cent increase in five years. UN Global E-waste Monitor 2020

# 511,000kg

# **AUSTRALIAN MADE**

E-waste generated in Australia in 2019, a figure projected to rise by almost 30 per cent to 657,000 tonnes by 2030.

Department of Climate Change, Energy, the Environment and Water

# **21.7**kg

E-waste generated every year by the average Australian, compared to the global per

# PER AVERAGE AUSSIE

# person average of 7kg.



Where to find gold in electronics







Capacitors









## **QUANTUM COMPUTING**

# Keeping the cores cool

\_\_\_\_\_

Quantum computing uses quantum bits, or 'quibits' instead of the traditional binary bits (one and zero). Every quibit adds an exponential amount of processing power to make light work of complex simulations and subatomic modelling. It's not only gold's superconducting properties that make it a powerful quantum partner, but its ability to reflect heat. Quantum computers require extremely cold temperatures for stability.



## **DID YOU KNOW?**

## Going for (recycled) gold

Medallists at the Tokyo 2020 Olympic Games were awarded medals made from recycled e-scrap. Almost 79,000 tonnes of discarded devices were collected and the metals melted down to make the medals as part of a nation-wide campaign in the lead up to the Games to reduce e-waste.

.....

# EVERYDAY ELECTRONICS

## Circuit boards hold the mother lode

Gold has been used in telecommunications equipment since the 1930s. From fuses to switches to microchips in computers, gold is a preferred material for its high conductivity and its resistance to corrosion. Everyday electronics, from laptop computers to programmable whitegoods, gaming consoles to fitness trackers, rely on the conductivity of gold-plated circuit boards, connectors, sockets, ports and pins.

# Why gold is used in electronics



# HIGHLY CONDUCTIVE

Electricity flows through gold with minimal resistance



**MALLEABLE** & DUCTILE Easy to shape or flatten without becoming brittle

In fact

Even the identification

microchip implanted in your

family pet likely contains gold.



# 158 million

# **TIMES FASTER**

A quantum computer is 158 million times faster than the world's most sophisticated supercomputer. livescience.com

# 10,000 yrs

A quantum computer can do in four minutes what would take the world's most sophisticated supercomputer 10,000 years. livescience.com



# **DID YOU KNOW?**

# **Fraud prevention**

Gold is the superhero sidekick we need in a world rampant with identify theft. It is often used in the manufacture of high security features including holograms, security threads and microchips in passports and other identification documents, banknotes and credit cards. These features help prevent counterfeiting and fraud.



# CHEMICALLY INERT

Does not react to air or water and does not corrode

# Gold emerged as an essential industrial metal in the late 20th century, and is finding new critical functions in advar manufacturing with every decade that passes in the 21st

20th century, and is finding new critical functions in advanced manufacturing with every decade that passes in the 21st century.

# **DEFENCE INDUSTRIES**

#### **Critical gold applications** .....

From ground defence to guidance systems, gold's unique properties make it a critical metal in defence manufacturing. Deployed for its exceptional conductivity and corrosion resistance, gold is used in electrical connectors and components in navigation, radar and communication systems. Thin coatings of gold enhance reflectivity in lenses and infrared sensors, and ensure longevity and performance of precision instruments and equipment.



# 0000





#### **DID YOU KNOW?**

# Industrial catalyst

Gold nanoparticles are an effective catalyst in modern manufacturing. Catalysts reduce the amount of energy needed to turn raw materials into useful products (from food and clothing to plastics and pharmaceuticals) by speeding up the chemical reaction. Newer cars have a catalytic converter to reduce harmful engine emissions.

:

# In fact...

Gold can replace mercury as a catalyst in the production of PVC plastic.



# \$470m **MARKET SIZE (USD)**

Value of the gold plating chemicals market in 2022. Annual growth of 4.6% to 2032 is forecast on the back of aerospace applications. Global Market Insights

Gold use in low emissions energy generation



Solar High efficiency solar cells, contacts



Hydroelectric Control boards. switches, sensors



Wind Electronics, slip rings, transmission



Hydrogen Catalysts, sensors, electronics, contacts



**Batteries** Connector pins, terminal contacts



Nuclear Radiation shielding. advanced reactors



CCUS Catalysts, electronics, control systems



**Biomass** Control systems, connectors, sensors

## **RENEWABLE ENERGY**

# High efficiency photovoltaics

Gold plays an important role in technologies supporting the global transition to a low carbon economy. It is used in high efficiency photovoltaics to improve how the sun's energy is captured and used, according to the World Gold Council. Gold catalysts are also being developed to help convert  $CO_2$  into low carbon fuels and gold nanomaterials are being investigated to enhance hydrogen fuel cell performance.



### **DID YOU KNOW?**

# Quantum research at Stawell

Stawell Gold Mine is an unlikely partner in the global search for dark matter and for advancing quantum research. Scientists from around the world aim to unlock the secrets of the universe, and advance cutting-edge technologies, from an underground research laboratory at the mine – the first of its kind in the southern hemisphere.

## **HIGH PERFORMANCE**

## Gold takes grid position

McLaren's Formula 1 team uses 22 karat gold to shield critical engine components from heat damage. Around 16 grams of the malleable metal reflects radiant heat from the engine and the exhaust system, the former reaching temperatures up to 2600°C. Thin layers of gold, just a few atoms thick, can dissipate radiant heat sufficiently to keep the fuel tank at an optimal temperature and importantly, protect the drivers.



The melting point of gold is 1064°C. At this temperature, gold transitions from a solid to a liquid. Its boiling point is 2836°C. World Gold Council



# **3.2** million

**ROOFTOP SOLAR** Almost one-third of all Australian households have solar panels — the highest rate in the world. Clean Energy Regulator



In fact... A F1 racing car cockpit can reach temperatures up to 60°C during a race, even with gold plating to deflect heat from the engine.

annun



## **DID YOU KNOW?**

# **Fighting crime**

Gold can add crime fighting to its impressive array of unique uses. Australian Federal Police forensic teams and the University of Technology Sydney developed a technique using gold to recover fingerprints from polymer notes using a custom built vacuum chamber. The technique causes a gold vapor to form a thin film, less than an atom thick, to detect 'invisible' fingerprints.

**11.2** million

If all the world's gold was pulled into a 5 micron thick wire it could wrap around the world 11.2 million times. World Gold Council



# EXPLORATION

In fact...

A gold-coated cable

space walk in 1965.

**DID YOU KNOW?** 

NASA launched the Voyager

Golden Records - two gold-

plated copper phonograph

records containing sounds

space in 1977. Intended for future spacefarers or intelligent

and images from Earth - into

lifeforms, the records contain

greetings in 55 languages and

sounds ranging from rain and

thunder to birds and children,

Australian Aboriginal songs

Morning Star and Devil Bird.

.....

along with recordings of

Golden records

connected Colonel Ed White to Gemini 4 during NASA's first To infinity and beyond! Gold is the dependable, multi-purpose metal of choice on every space mission - able to withstand extreme temperatures, shield against solar radiation and resist corrosion.

## **MISSION POSSIBLE**

# Gold at frontier of space exploration

.....

Extreme conditions and the need for enduring reliability make gold a critical mineral for space missions. Gold-coated visors protect astronauts' eyes from dangerous rays in space, while gold plating on surfaces of spacecraft, modules and space stations protect against solar radiation. As technology advances and humanity ventures further into space, new applications for gold will continue to emerge.

## Gold use in space NASA

Thermal insulation Maintain stable temperatures



# LARGE HADRON COLLIDER (LHC)

# Turning particles into gold (or did they?)

Alchemists have spent millenia trying to turn common metals into gold. In 2015, bullion. directory reported maintenance crews in the Large Hadron Collider - a 27km underground ring of superconducting magnets in Switzerland - discovered a thin film of gold forming on the interior of the particle accelerator. It turned out to be an April Fools joke - a widely accepted one to this day. We may be waiting a few more millenia before scientists achieve anything remotely close to the myth of King Midas and his golden touch.



# What is the LHC?

The LHC is a particle accelerator, propeling and colliding protons at nearly the speed of light. Scientists study their behaviour to better understand the physical laws that govern everything from matter and energy to space and time.

Telescopes & instruments Mirrors and optical components



Propulsion systems Thrust chambers and nozzles



# 99.9999991%

# ...OF LIGHT SPEED

.....

The speed with which trillions of protons race around the LHC 27 km ring - that's 11,245 laps a second! CERN













#### **JAMES WEBB TELESCOPE**

# Searching for first light

NASA's James Webb Space Telescope is equipped with 18 gold-coated hexagon mirrors that reflect infrared light to observe the earliest formation of stars and search for potentially habitable exoplanets. Launched in 2021, the Webb telescope has reached its cosmic base 1.5 million km from Earth. It is so sensitive to infrared light it can detect the heat signature of a bumblebee at the distance of the moon.



### **MISSION PSYCHE**

# NASA launches golden mission

A giant asteroid between Mars and Jupiter named 16 Psyche could contain more than 700 quintillion dollars in gold and other precious metals – that's enough to give every person on Earth \$93 billion! NASA launched its Psyche spacecraft in 2023, with an asteroid arrival date of August 2029. The spacecraft will spend 26 months in orbit to observe the ore-rich asteroid, which is 226 km wide and rotates on its side.





# [n fact...

NASA is developing technologies to send its first astronauts to Mars as early as the 2030s.







Telescope's mirrors can see back almost to the beginning of time – some 13.7 billion years ago!



## **DID YOU KNOW?**

## Space rocks

Nearly all the gold on earth came from meteorites that hit the planet more than 4 billion years ago. Scientists believe a 200 million-year-long meteorite shower brought 20 billion tonnes of space rock – rich with gold and precious metals – to earth. Hot liquids that flowed through the goldbearing rock delivered the veins of gold we mine today.



# **DID YOU KNOW?**

# **Creating air on Mars**

Gold is critical to the operation of MOXIE, a device on NASA's Perserverance rover which produces oygen from carbon dioxide. The size of a car battery, MOXIE is encased in gold to protect against heat and corrosion. It aims to demonstrate the technology can keep future astronauts safe in space.

.....



Gold is so rare it makes up only **3 parts per billion** of the Earth's outer layer. Geoscience Australia

# HOW RARE IS GOLD?

Imagine you had 1 billion red smarties and only three of them were yellow. That's how rare gold is. 1oz +

You have more chance of finding a 5 carat diamond than a **1 ounce nugget of gold**. World Gold Council

The world pours more steel in one hour than it has poured gold since the beginning of recorded history.



Medical scientists are discovering new opportunities for the application of gold in the delivery of diagnostics, therapies and preventative healthcare every year.

# **GOLD NANOPARTICLES**

New frontier for cancer therapies

Gold nanotechnology is the new frontier of early detection, diagnosis and treatment of diseases. Gold nanoparticles are being used to target and deliver antibodies directly into cancerous tumours, enhance the effectiveness of radiation therapy and drug delivery, and enhance the contrast in various diagnostic imaging techniques. They are also being engineered to attach to cancerrelated proteins to aid earlier detection.

# Benefits of gold in cellular imaging

sciencedirect.com

LARIA TESTS

gold-reliant rapid tests are

More than 400 million

produced every year to

diagnose malaria.

World Gold Council

# Light scattering

Gold nanoparticles scatter light intensely and are much brighter than chemical fluorophores.

# Easier detection

Gold nanoparticles do not photobleach and they can be detected in as low as 10–16 micron concentration.

# **DID YOU KNOW?**

## Antibacterial properties

Hearing aids and implants are often coated with gold to prevent bacterial infections. Gold is also used for its antimicrobial properties to combat antibiotic-resistant bacteria in wound dressings, as well as the gold plating of surgical tools. It is also used in the wires of pacemakers and stents for its durability.

# FUTURE OF MEDICINE

# Gold at heart of critical breakthroughs

Gold is a critical industrial metal and there is no more critical industry than medicine. Technologies driving advances in nanoscience, genomics, advanced robotics, and even telemedicine, rely on the conductivity, malleability and corrosion resistance of gold. Between its application in health and research electronics to the burgeoning field of gold nanotechnology, gold will change lives and save thousands.



Gold-reliant rapid tests have been diagnosing lifethreatening illnesses, such as malaria, for 40 years. World Gold Council





In fact...

Surgical lasers use gold-coated reflectors to focus light energy.



DENTISTRY

Gold in modern dentistry

As far back as 700 B.C., Etruscan 'dentists' used gold wire to fasten replacement teeth into mouths. Methods may have changed, but gold remains an important material in dentistry today. As it's durable, nontoxic and stain-resistant, gold is used by dentists for fillings, crowns and even tooth replacements. Gold is also used in some orthodontic wires and brackets due to its biocompatibility and resistance to corrosion.

U.2mg

The amount of gold that exists naturally in the human body.

That equates to 1 troy ounce

per 155,000 people.

.4mg

SEWAGE SLUDGE

The amount of gold estimated

sludge. Globally, the total value

in every kilogram of sewage

could be around \$2.6 million.

World Gold Council

World Gold Council

# **DID YOU KNOW?**

# **Closing the lid**

Gold weights are used to restore eyelid function in facial paralysis patients. Small curved weights are surgically inserted in the upper eyelid to assist the lid to close, an important function protecting the health of the eye. The proven treatment is used to manage conditions such as paralytic lagophthalmos.



COVID-19 rapid tests relied on tiny gold particles to trigger a colour change and thereby indicate the result.

# Gold uses in medicine





Pregnancy tests



Cancer therapies



Dental crowns & implants







Anti-inflammatory therapies



Malaria treatments



COVID rapid tests



Wound healing



# Gold-plated surgical tools



Across centuries, gold has been at the centre of the quest for a universal human elixir. The Egyptians believed ingesting gold could purify the body, mind and spirit. The Chinese believed gold could cure or prevent everything from small pox to measles. Some rural villagers still cook their rice with a gold coin to replenish the mineral in their bodies. In medieval Europe, gold pills and baths were popular. Alchemists (who claimed to be able to transmute base metals into gold) mixed powdered gold into drinks for patients with sore limbs.

**ANCIENT ALCHEMY** 

.....

A cure for everything



# **DID YOU KNOW?**

# **Bubonic plague**

Medieval Europeans thought drinking molten gold and crushed emeralds might cure the 14th century bubonic plague, known as Black Death, which killed 25 million people. Although easy to dismiss as a little crazy today, strange concoctions have a way of finding proponents during desperate times.

.....



From cowrie shells to copper ingots to the polymer notes we use today, no other tokens of exchange throughout history has endured like gold – the bedrock of modern economies and national wealth building.

#### **RECESSION BUSTER**

# Gold prevails in tough times

Gold has long been a safe haven asset preferred by investors when the economic tide turns. As a physical asset, gold cannot be printed nor its value impacted by decisions of government. When recesssion does strike, the Dow/Gold ratio, which shows how much gold it would take to buy one share of the Dow, can indicate how much strife the economy is in. In 2009, the Dow/Gold ratio was headed towards the same depths as the 1930s and 1980s.





**BRIEF HISTORY** 

Golden coins of Lydia

The first known use of gold coins as money

dates back 6000 years to Lydia, a region of

present day Turkey. Minted by order of King

merchants from around 560 B.C. Made from

'electrum', a mix of 63% gold and 27% silver,

the coins were stamped with a lion or bull on

one side and a seal on the other. By 546 B.C.,

which is why the ultra-wealthy are sometimes

Lydia had amassed a huge trove of gold

still referred to as being 'rich as Croesus.'

Croesus, gold coins were used by Lydian

.....

# **DID YOU KNOW?**

# India's golden wealth

Indian households possess more than 21,000 tonnes of gold (mostly jewellery) – more than the combined holdings of the world's major banks, according to the World Gold Council. Often inherited or gifted at weddings, the staggering value of this personal hoard of gold is estimated around \$1.5 trillion.



# **400**k

# **BANK OF ENGLAND**

The number of gold bars stored in underground vaults below Bank of England. Total value? Around £200 billion. Bank of England

# **6331**t

# NY FED RESERVE

Gold bullion stored in vaults beneath the Federal Reserve Bank of New York. That's around 507,000 gold bars. Federal Reserve Bank of NY



# **DID YOU KNOW?**

## As secure as Fort Knox

Shrouded in secrecy and protected behind a 20 tonne blast proof door lies the gold vault of the US Bullion Depository at Fort Knox, Kentucky. Lined with granite walls, the vault holds around 147.3 million ounces, or 4600 tonnes, according to the US Mint. That's about 2% of the world's entire gold supply.



# 'Gold is money. Everything else is credit.'

J.P. Morgan Industrialist and banker Testimony to Congress 1912





# **400** toz

.....

**GOOD DELIVERY BAR** The 400 troy ounce Good

Delivery Bar is the standard gold bullion bar used in the international gold trade. It weighs 400 troy ounces

(about 12.4 kilograms) and meets stringent quality and purity standards set by organisations like the London Bullion Market Association . London Bullion Market Association

# **SUPERANNUANTS** A store of value in self-managed super

# ..... Gold is a mainstay in the self-managed superannuation funds of many Australians. With historically superior returns during stagflationary periods, Australia's sovereign wealth fund even repositioned its \$200

billion portfolio in 2022 to include gold as a hedge against a world of higher inflation and increased volatility. Since the turn of the century, gold has delivered an annualised return of 8.48% to the end of June 2019.

The hallmarking of In fact... precious metals was first established at Goldsmith's Hall, London in 1300.





# tonne

# THE LARGEST COIN The world's largest coin is the

'1 Tonne Australian Kangaroo'. Minted in 2011 by Perth Mint, it measures 80 cm by 12 cm. Perth Mint

# \$1 million

LEGAL TENDER Although it has a face value of \$1 million, at today's gold prices the metal alone is worth a whopping \$49.3 million. Perth Mint

The UK established the

a value of 77 shillings to gold

In fact... The UK established the Gold Standard in 1717, linking

at mint price.



# **DID YOU KNOW?**

# Gold bullion ATMs

Whether it's a bag of crisps or gold bars you're craving, there's a vending machine for that. The Gold to Go brand operates gold bullion dispensing ATMs around the world, including in the UK and US. The ATM tracks gold prices in real time and prices its products, including gold bars and coins, accordingly.

'Troy ounce' is named for the French town of Troyes, which created a system of weights for metals in the Middle Ages.



In fact...



# **31.1** gm **TROY OUNCE**

There are 31.103 grams of gold in a troy ounce. World Gold Council

# **STORE OF VALUE**

# Purchasing power by loaves

None of the world's major currencies has retained its purchasing power like gold, a fact demonstrated by the World Gold Council. It determined that King Nebuchadnezzar of Babylon, who reigned in 600 B.C., could buy 350 loaves of bread for an ounce of gold. That same ounce of gold, valued today at around \$1200, and a loaf of bread at \$2.50, could buy around 480 loaves. It seems not much has changed in the last 2500 years.



Throughout the ages, gold has been exalted across civilisations as the most precious of the precious metals – worshipped for its beauty, imbued with divinity, and revered as a symbol of immortality.

# ANCIENT EGYPT

# Gold revered as the 'flesh of the Gods'

Egyptians discovered gold in the Nile River as far back as 5000 B.C. Revered as divine and indestructible, gold took on many associations. The royal tomb was called The House of Gold; the Sun God was known as the Mountain of Gold; and the Pharaohs became The Golden Horus. King Tutankhamun's death mask, made of solid gold and crafted with extraordinary skill, would prove the Egyptians right. Discovered by archaeologists some 3000 years later, the mask was intact and just as shiny. Gold was indestructible.





# **DID YOU KNOW?**

# God, gold and glory

European exploration of the Americas (late 15th century) was driven by the pursuit of gold, as well as the desire to open new trade routes and spread the word of God. But conquering new lands was an expensive business. and colonisation fraught with historical complexities. Nevertheless, gold helped finance the voyages of explorers like Christopher Columbus and Hernán Cortés, which changed the course of world history.

:

# 110.4 kg

The solid gold casket in which Tutankhamun's mummified body was interred before it was discovered in 1922. Egypt Museum

# STORY TIME

# Eye of the beholder

Au, the chemical symbol for gold, derives from the Latin word 'aurum', meaning 'glowing dawn' or 'shining dawn'. Gold takes its name from the Old English word for yellow – 'geolu'. The Aztecs also had a word for gold – 'teocuitlatl'. This translated as 'excrement of the gods' for the way it seemed to seep from the earth. At one point, they valued gold less than the bright feathers of the quetzal, a tropical bird native to the region.

# **1200** kg

# PRECIOUS ARTIFACTS

Total weight of gold items and jewellery recovered from Tutankhamun's tomb – around 4000 artifacts in total. Global Intercold



# **DID YOU KNOW?**

# Medieval nanotech

The first nanotechnologists were medieval artisans who discovered mixing various amounts of gold chloride in molten glass created tiny gold spheres that reflected light to produce different colors. Stained-glass windows are some of the earliest examples of gold nanotechnology at work. The Lycurgus Cup – a 4th century Roman glass cup – is another.



# **DID YOU KNOW?**

# Gold is edible

Safe to digest, gold has been a decorative additive to food for centuries. Europeans have been putting gold leaf in liquor bottles since at least the 1500s, a practice continued by high-end brands today. Some Asian countries add gold to fruit and beverages. Costing between \$50 to \$60 per gram, gold contains no taste, calories or expiration date.

.....

# **GOLD GILDING**

The world's most malleable metal

Applying micro-thin layers of gold leaf to surfaces dates back to around 2500 B.C. The Greeks and Romans adopted the technique from the Egyptians, who used gold leaf to adorn sarchophogi and funeral offerings. Statues, jewellery, manuscripts and eventually the architectural details and domes of buildings and cathedrals were gilded – the world's most malleable metal being a durable and corrosion-resistant covering.



A single ounce of pure gold can be hammered thin enough to cover nine metres square.



# 3600 BC

# Egyptian conquest

Egyptians were some of the earliest gold conquistadors, although it wasn't until 3600 B.C. that gold was smelted by Egyptian goldsmiths. Yet to hold monetary value, it was nevertheless highly sought as a trading commodity.



# 50 BC -

# **Greek conquest**

The Greeks began mining gold by 550 B.C., prompting speculation about the yellow metal's origins from Plato and Aristotle. It was thought to be a dense combination of water and sunlight given its frequent proximity to water.



# 100 BC

# Roman conquest

The Romans greatly expanded on earlier efforts, engineering some of the first stream-based hydraulics, sluices, long toms and water wheels. They also ventured underground using mostly slave and prison labour.

# **IDES OF MARCH**

## A modern day tale of intrigue

One of the world's most famous ancient gold coins, the Eid Mar, was the focus of a modern day global antiquities scandal. Minted in morbid commemoration of the murder of Julius Caesar on March 15, 44 B.C. by one-time friend Brutus, only three are known to remain today. Valued at \$4.2 million, it was found to have been looted and fraudulently auctioned to an American billionaire in 2020. Grateful Greek officials were returned the coin in March 2023.



# 212,582 t

Around 212,582 tonnes of gold has been mined since the beginning of civilisation. World Gold Council



In fact...

In 1422, Venice minted a record 1.2 million gold ducats, each containing around 3.5 grams of 98.6% fine gold.



# **DID YOU KNOW?**

# The Venetian ducat

First minted in 1284, the Venetian ducat was one of the highest purity gold coins for the next 500 years. Latin for duke, the word 'ducat' echoed through the ages, from Shakespeare's *Romeo and Juliet* to modern day literary feats – like Ice Cube rapping about 'getting juiced for his ducats' in N.W.A's 1988 'gansta rap' '*I ain't tha 1*'.

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"Australia plays a critical role in the global gold market, consistently one of the top three producers globally; and will continue to be important, not least in providing gold for new technological applications like quantum computing and cancer treatments." WORLD GOLD COUNCIL gold.org





- <sup>1</sup> Department of Industry, Science and Resources, Commonwealth of Australia, *Resources and Energy Quarterly*, December 2023, pg. 91.
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- <sup>4</sup> Department of Industry, Science and Resources, Commonwealth of Australia, *Resources and Energy Quarterly*, December 2023, Table. 10.1.
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- <sup>6</sup> ABS, *International Trade in Goods, Australia*, Table 12b Merchandise Exports, Standard International Trade Classification, FOB Value, Released 5 February 2024.
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- <sup>10</sup> ABS, International Trade in Goods, Australia, Table 12b Merchandise Exports, Standard International Trade Classification, FOB Value, Released 5 February 2024.
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- <sup>18</sup> Resources Victoria, Government of Victoria, <u>Understanding Minerals Exploration</u>, viewed 22 February 2024.
- <sup>19</sup> Ibid.
- <sup>20</sup> Cyanide Facts, The Cyanide Code, accessed 1 March 2024. (cyanidecode.org/cyanide-facts)
- <sup>21</sup> Full Code documentation available at https://cyanidecode.org/
- <sup>22</sup> USGS, Gold Statistics and Information, *Mineral Commodity Summaries*, 2024, accessed 4 March 2024.
- <sup>23</sup> Mintz P. Bazel and J. Mintz, *Corporate tax reform to help address Australia's weak investment performance*, School of Public Policy, University of Calgary, prepared for the MCA, 2022.

# **Figures**

Gold production by state FIGURE 1 FIGURE 2 Gold has doubled in value in less than two decades FIGURE 3 Gold production has endured through good times and bad Victoria leads nation in gold exploration growth FIGURE 4 Gold exploration outpaces every other commodity FIGURE 5 Nothing carries more risk than setting out to build a mine FIGURE 6 Producing Australian gold FIGURE 7 Refining Australian gold FIGURE 8 Australia's mining industry's net capital stock is plateauing FIGURE 9 Economy-wide effect of policies that reduce the mining industry's productivity FIGURE 10 Australia's major gold deposits and select gold projects FIGURE 11 Australia's world share of gold reserves FIGURE 12 Australia's world share of gold production FIGURE 13







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