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Indium
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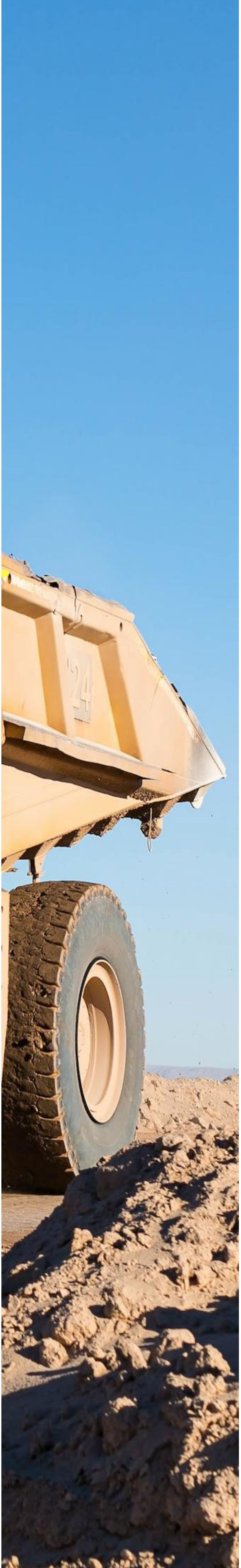
# Indium

## China Controls the Market, and Transparency is an Issue

Critical Minerals Commodity Report

August 2025



# Contents

*Front picture: Thin-film coating - Stanford Advanced Materials*

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# Executive Summary

## Introduction

This report on indium is the fourth in our 2025 series on critical minerals. Due to their use in clean energy technologies and semiconductors, critical minerals have gained prominence in government policy agendas and captured the public's interest. Many of these commodities face increased demand, supply chain bottlenecks, volatile price fluctuations, and geopolitical concerns. The markets are also becoming more complex as China has begun to exploit its strong position as a supplier of many critical minerals by imposing certain export restrictions.

While many valuable reports are available on critical minerals more broadly, few concentrate on the actual market dynamics of individual commodities. This lack of coverage partially reflects the relatively small size of some of these commodity markets (many are mainly produced as a by-product), the limited number of mining and processing companies, and the scarce opportunities for equity investment. Access to data is challenging, and industry facts are hard to find, resulting in a general opaqueness in the supply and demand picture. Our reports will aim to explore the available information and analyse some of the key risks to these commodity supply chains.

## Critical Minerals

Critical minerals lack a universally accepted definition and are classified based on current technological requirements and the respective supply and demand dynamics applicable to different countries and markets. For example, the United States identifies 50 minerals as critical, the European Union 34, Japan 34, and Australia 31. Seventeen commodities are common to all these countries, including indium.

Indium is prominently featured on the critical minerals lists of most countries due to its reliance on imports, primarily from China, and its essential role in producing goods vital to regional economies and national security.

## Indium Output Dominated by China

The indium market is extremely small and lacks transparency on both the supply and demand side. China dominates global indium production, with its primary use being in touchscreens for electronic devices. In 2024, China accounted for 70% of the world's refined indium output, sourced mainly as a by-product from zinc concentrates at zinc refineries. Other global producers include South Korea (17%), Japan (6%), and Canada (3%) (see Figure 8). However, the global trade situation has become more complicated since China implemented export restrictions on indium in February 2025.

**Figure 1. Indium Price 2022- 2025 (US$/kg)**

Source: Bloomberg. Indium Ingot 99.99% FOB.

## Current Indium Production

The indium industry is extremely small compared with the scale of activity associated with most other metals. The total world production of refined indium is approximately 1,080 t/y, which has an annual value of about US$367 m at the 2024 average price of US$340/kg. Detailed information on both production and consumption is limited, making it very difficult to analyse the indium supply chain. This also makes it difficult for market participants to anticipate market imbalances.

Indium is not particularly scarce, but it does not occur in concentrations high enough to enable mining as a primary product. Indium is associated with base metal deposits containing ores enriched with zinc, copper, lead, and tin. A 2017 geological review indicated that the largest indium resources are found in Bolivia (20%), China (18%), Russia (14%), Canada (12%), and Japan (11%) (see Figure 2). Together, these five countries possess about 75% of the total resources. The total identified resources amount to 356 kt, which is sufficient to meet the demand for indium for the remainder of this century, assuming an overall recovery rate of 30%.

Indium is mined as a by-product of minor importance and is only sometimes recovered during the smelting of mine concentrates or from dusts and residues produced. Some 95% of indium production is reported to be derived from zinc concentrates, with the balance derived from copper and tin operations. These zinc concentrates are often produced in one country but refined in a different country, with China being the main destination for zinc concentrates containing indium.

## Essential for Transparent Touchscreens

Indium, combined with tin, can be made to be both electrically conductive and transparent. These properties make it suitable for thin-film coatings in electronics, particularly for coating touchscreen display glass on smartphones, flat-panel displays, tablets, and other devices. The coatings are made of indium tin oxide (ITO) and are the largest end-use for indium. However, several different materials are being developed for glass coating applications, although the potential long-term impact of these alternative technologies remains unclear. This poses a significant risk to demand prospects.

Indium also enhances the strength, hardness, and corrosion resistance of alloys. Therefore, indium is used in metal alloys (particularly solders). Other uses include special semiconductors used in optoelectronic devices, as well as copper-indium-gallium-selenide (CIGS) thin-film photovoltaics. Indium demand for CIGS solar PV is expected to increase, but it will remain a relatively small portion of overall indium demand, as thin-film technologies are projected to remain a niche market.

There is limited recycling of end-use indium. The highly dissipative nature of indium in consumer products and the difficulty in recovering it result in very little old scrap being recycled. While there is substantial recycling of scrap generated during manufacturing, particularly of ITO products, this mainly involves closed-loop recycling of new scrap.

## New Production Potential Unidentifiable

Identifying new indium production potential is difficult. It is generally not economic to mine indium directly due to its low concentrations in ore deposits, and so increased supply must come from increased production of other metal deposits (particularly zinc), which also host indium. The indium content is often not reported, but RFC Ambrian has identified 19 active projects where indium is contained and reported in the deposit data. However, most of these companies make limited mention of indium recovery in their reports. The exception is the West Desert project in Utah, United States. American West Metals reports that the zinc deposit hosts a large indium resource, although its development remains uncertain.

There is also limited data regarding increases in zinc smelter capacity where indium is recovered as a by-product in the process, the installation of new indium recovery facilities at existing zinc smelters, or the planned indium recovery at new zinc smelters currently under construction.

## Conclusion

**The lack of data and transparency in the indium market is a problem. On the supply side, China is the dominant producer of refined indium; however, there is limited data on the current mined sources of indium, making it challenging to identify potential sources of future production. On the demand side, uncertainty remains about the strength of future demand for indium, given the threat of it being replaced in some touchscreen applications, its primary area of consumption. The lack of both supply and demand data leaves significant uncertainties about the current and future market balance, as well as the future direction of indium prices.**

# 1. The Industry Basics

The indium industry is extremely small compared with the scale of activity associated with most other metals. The total world production of refined indium in 2024 was approximately 1,080 t, with an annual value of about US$367 m at the 2024 average price of US$340/kg (1).

In 2024, the largest producers of refined indium were China (70%), South Korea (17%), Japan (6%), and Canada (3%), which combined accounted for 96% of annual refined production (see Figure 8). In recent years, production in China has grown strongly, while output in Canada, Belgium, and France has declined (see Figure 7).

The indium market is relatively opaque. Data on both production and consumption are limited within the supply chain, and the accuracy of the available data is questionable.

## Indium Geology

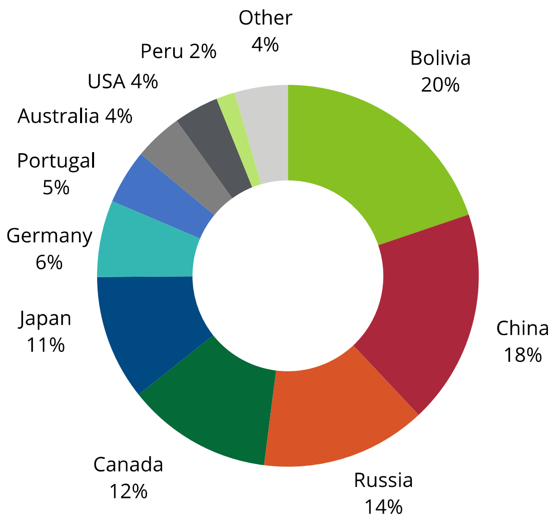
Indium (chemical symbol In) is a soft, silvery-white metal that does not occur naturally in its native form. It is considered a semi-precious non-ferrous metal. Although indium is not particularly rare, it is not found in concentrations high enough to enable mining as a primary product. Indium is associated with base metal deposits containing ores rich in zinc, copper, lead, and tin. It is recovered as a by-product due to the low concentrations in these minerals, which typically average around 0.021% or 210 parts per million (ppm). The most common technique for extracting indium is through the processing of ores enriched in zinc- and copper-bearing minerals from underground mines.

Currently, the most important sources of indium are the volcanic-hosted massive sulphide (VHMS) and polymetallic vein-type deposits which are mined for zinc, lead, and tin. Minor amounts of cadmium, silver, gold, and bismuth may also be present. The most economically significant mineral is sphalerite (zinc sulphide - ZnS), and over 95% of global indium production is derived from the zinc processing. Appendix 1 contains a more detailed explanation of indium resource types.

## Indium Resources

Global indium reserves and resources are not reported. Not even the USGS reports resource data on indium, unlike for many other commodities. Due to indium being mainly recovered as a by-product of zinc production, the occasional indium reserves and resource calculations in scientific papers are generally derived from zinc reserve and resource data, using an average indium content found in zinc ores. The most recent and possibly most thorough evaluation was conducted by Werner in 2017 and presented in a report on indium (2).

**Figure 2. Indium Resources by Country**



Source: Werner 2017

The study found that at least 356 kt of indium exists within 1,512 known mineral deposits of various types, including VMS, skarn, epithermal, and sediment-hosted lead-zinc deposits. Out of these, 101 deposits have reported indium content, totalling approximately 76 kt of contained indium. The remaining 1,411 deposits show mineralogical signs that suggest they are indium-bearing, with the potential to contain 280 kt of indium. An additional 219 deposits have been identified with indium enrichment; however, the content remains unquantified. This suggests a global resource of at least 356 kt of contained indium.

A limited number of case studies also indicate that a further minimum of 24 kt of indium is present in mine wastes, a total that is believed to be smaller than the actual amount, given the minimal reporting of mine waste indium concentrations and the extensive volume of historical mine wastes.

The 101 deposits are a mixture of operating mines and projects where indium data have been reported. The size of the 101 deposits identified in the report varied from a few million tonnes of ore to several hundred million tonnes, with an average of 36 Mt of ore. The indium grade of these deposits ranged from a few ppm to several thousand ppm, with an overall average of 210 ppm.

Table 1 and Figure 2 give the global resources by country of the 101 indium deposits. The table also includes a breakdown of those resources according to the quality of the information from the original data. The data suggests that the largest indium resources are located in Bolivia (20%), China (18%), Russia (14%), Canada (12%), and Japan (11%). Combined, these five countries hold approximately 75% of total resources.

**Table 1: Global Indium Resources of 101 Deposits with Reported Indium Contents**

| Country | Low quality resources kt | Medium quality resources kt | High quality resources kt | Total indium resources kt |
|---|---:|---:|---:|---:|
| Bolivia | 10,199 | 2,508 | 2,341 | 15,048 |
| China | 13,832 | 0 | 0 | 13,832 |
| Russia | 10,640 | 0 | 0 | 10,640 |
| Canada | 4,507 | 3,339 | 1,502 | 9,348 |
| Japan | 8,056 | 0 | 0 | 8,056 |
| Germany | 2,214 | 0 | 2,726 | 4,940 |
| Portugal | 0 | 3,496 | 0 | 3,496 |
| Australia | 0 | 3,116 | 0 | 3,116 |
| United States | 1,189 | 170 | 1,529 | 2,888 |
| Other | 3,040 | 1,596 | 0 | 4,636 |
| **Total** | **53,678** | **14,224** | **8,098** | **76,000** |

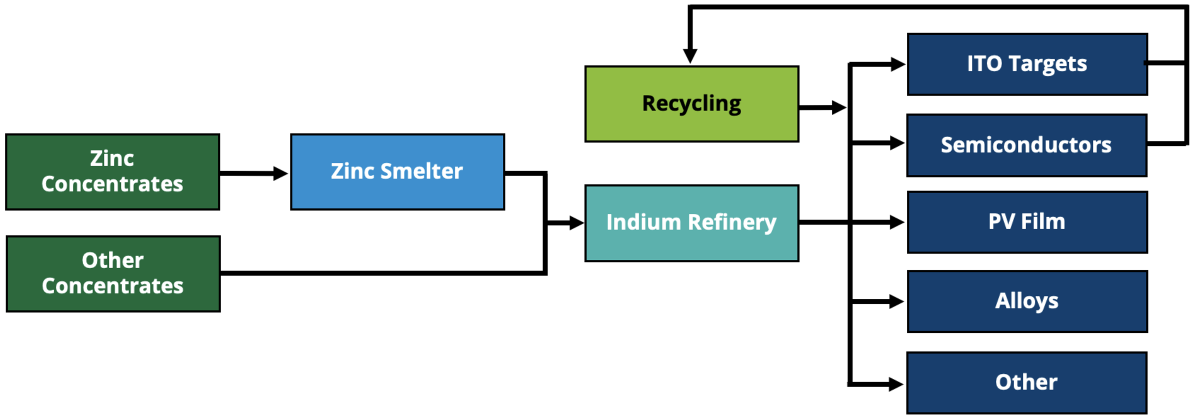
Source: Werner 2017 – A global Assessment of Indium Resources. NB 'Quality' is of reporting information.

Assuming the current annual refined production of approximately 1,080 t in 2024, the resources outlined in the 101 deposits alone are sufficient to meet demand for indium for most of this century. In addition to an adequate supply on a longer-term view, the report by Werner (2017) concludes that the global indium supply chain could be fairly flexible in the medium term, primarily because the geographic distribution of indium resources identified deviates significantly from the current sources of indium supply.

## Indium Recovery

Around 90% of zinc smelting and refining is carried out through hydrometallurgical processes. The four stages of this process include: roasting and calcining, leaching, purification, and electrowinning. Indium and other metals are recovered during the purification stage when impurities (from the zinc process) are removed. These impurities, along with dusts and residues, are processed in a primary refinery to separate the various by-products. Information on the metallurgical processing of indium is limited, as this data is often proprietary and confidential. Electrolysis is the main process used in refining zinc, lead, and tin to produce metallic indium, with some zinc circuits recovering indium through cementation with aluminium. Figure 3 illustrates a simplified supply chain for indium.

**Figure 3. Simplified Indium Supply Chain**



Source: RFC Ambrian

Indium is typically refined to a purity of 99.99% (four nines or 4N) and then sent to a special metals refinery or plant, where it is further refined to 6N or 7N purity or manufactured into products, including indium tin oxide (ITO), alloys, and compounds. Significant indium recovery currently occurs from the recycling of new scrap (manufacturing waste), particularly from ITO production.

## Indium Export Restrictions

In September 2024, the United States imposed a 25% ad valorem tariff on critical minerals, including indium, of Chinese origin. In February 2025, China implemented export restrictions on indium, as well as tungsten, tellurium, bismuth, and molybdenum. These restrictions require exporters to obtain licenses for each shipment and to report on foreign end-users. This move is seen as a response to previous export controls imposed by the US on Chinese goods.

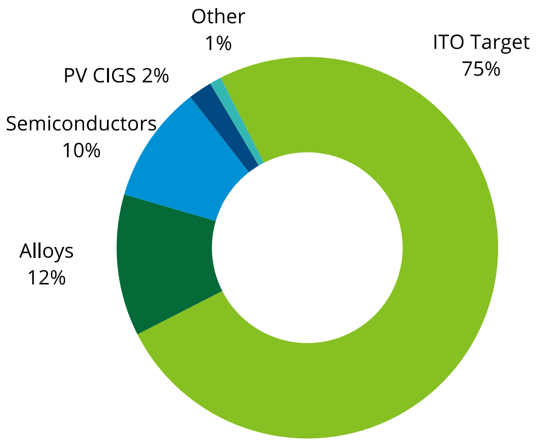
The controlled items include specific materials and technologies related to indium. Exporters of these items from China must apply for permission from the relevant authorities. The list of materials subject to the controls includes indium phosphide, trimethylindium, triethylindium, and production technologies and materials for these items (3).

Western consumers are believed to have built up stockpiles prior to the imposition of tariffs and China’s export restrictions. However, the ex-China market is considered to be finely balanced, with limited material being exported from China.

# 2. Demand Fundamentals

Detailed indium consumption data is generally not available, and broader estimates are typically based on import figures. Project Blue estimates that the majority of the indium demand is concentrated in Asia. Chinese indium demand is estimated to be around 53% of the global total, with Japan and South Korea accounting for 26%, driven by the strong electronics manufacturing hubs in these regions. Demand in the US accounts for around 5% of the total (4).

**Figure 4. Indium Consumption**



Source: RFC Ambrian estimates.

Indium is recovered as a metal, which can be produced in various forms, including ingots, foil, powder, ribbon, shot, and wire. Generally, indium enhances the strength, hardness, and corrosion resistance of alloys. Due to its low melting point, indium is ductile and malleable and can undergo almost limitless deformation. It also has high electrical conductivity and is transparent. Figure 4 shows the breakdown of demand for indium applications.

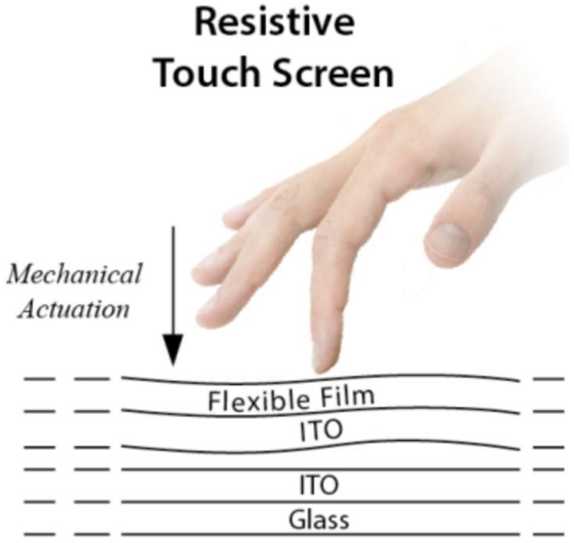
The largest end use for indium is in indium tin oxide (ITO), which is utilised for thin-film coatings in electronics. ITO coats touchscreen display glass on smartphones, flat panel displays, tablets, and other electronic devices. Indium metal is used in alloys and solders. Indium compounds are used to construct semiconductor layers for lasers, light-emitting diodes (LEDs), and electronic circuits, including those used in 5G telecommunications networks. Copper indium gallium selenide (CIGS) is utilised in thin-film PV solar panels. Other specialised uses include dental fillings.

### Indium Tin Oxide

ITO is the leading global usage of indium, accounting for about 75% of consumption. It is one of the most widely used transparent conducting oxides due to its high electrical conductivity and optical transparency, ease of deposition as a thin film, chemical resistance to moisture, and ability to withstand ambient temperature fluctuations. Additionally, ITO can block electron radiation, ultraviolet rays, and far-infrared rays, which can be harmful to health.

ITO is applied to the glass surface of electronic devices to enable touchscreen functionality. Without the ITO layer, touchscreens would be unable to detect or respond to touch commands. ITO coatings are also used for optically transparent, ultra-thin films in the production of liquid crystal displays (LCDs), solar cells, sensors, and medical devices. Approximately 75% of ITO consumption is for flat panel displays.

**Figure 5. ITO Resistive Touch Screen**



Source: Stanford Advanced Materials

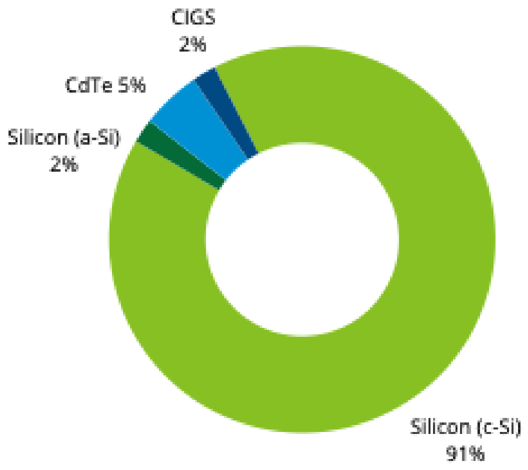
ITO consists of varying proportions of indium, tin, and oxygen. Depending on the oxygen content, it can be classified as either a ceramic or an alloy. Indium tin oxide typically contains 74% indium, 18% tin, and 8% oxygen by weight, making it an oxygen-rich composition. It is transparent and colourless in thin layers, while in bulk form, it appears yellowish to grey. In the infrared region of the spectrum, it behaves as a metal-like mirror. Thin films of ITO are most commonly deposited on surfaces using physical vapour deposition methods, usually through either electron beam evaporation or sputter deposition methods.

ITO is primarily produced and consumed in China, Japan, South Korea, and Taiwan, with China being the largest end-market consumer.

## Indium in Alloys

Indium-containing alloys are the second most important end use of indium. They are commonly employed as solders in a wide range of applications due to indium's high ductility, malleability, high thermal conductivity, and low melting point. Indium alloys are especially used when soldering two metals that expand at different rates. Different expansion rates can cause a cracked solder joint with most solders. Indium accommodates these varying expansion rates, cushioning the joint. It also reduces thermal fatigue-related joint failures, thereby decreasing field failures and enhancing product quality.

**Figure 6. PV Solar Technologies**



Source: Solar Magazine

Adding indium to alloys of bismuth, cadmium, lead, and tin lowers their melting points. These alloys can be used to hold in place diverse objects, such as eyeglass lenses or turbine blades, while these items are being worked on. After completion, the alloy can be melted and removed at relatively low temperatures without harming the object.

Indium metal is also present in many fusible alloys. These alloys are engineered to melt at precise temperatures. For example, fusible alloys are utilised in fire sprinkler systems. When a fire ignites and reaches the melting point of the alloy, water is released, extinguishing the fire.

## CIGS Photovoltaics

There are three main technologies currently dominating the global solar PV markets and supply chains: crystalline silicon (c-Si) modules, which account for approximately 95% of global production; cadmium telluride (CdTe) thin-film PV technology, making up about 4%; and copper indium gallium selenide (CIGS), representing approximately 1% (5).

Figure 6 illustrates the distribution of the PV solar market by technology type. China holds a leading position as a manufacturer of solar wafers, cells, and modules, with its share in all manufacturing exceeding 80%. The IEA states that thin-film technologies, such as CIGS, a-Si, and GaAs cells, do not currently constitute a significant or expanding share of the global market, and some are only used for very specific applications.

CIGS is a highly stable, high-performance, and mature thin-film PV technology that uses indium sulphide ($In_2S_3$) as a buffer layer in solar cells. Its proven performance under diffuse light, high temperatures, and partial shading makes it suitable for a variety of applications where other PV materials might not be appropriate. CIGS modules are effectively utilised in construction materials, including building facade glass and windows, as well as fully integrated PV roofing systems. In addition to glass, the photovoltaic CIGS semiconductor stack can be applied to flexible substrates, such as stainless steel and polyimide films.

These can then be integrated into PV modules that are lightweight, flexible, and durable, making them ideal for electric cars, buses, trucks, trains, and membrane roofing structures. Small, flexible modules can also be integrated into consumer electronic devices, including chargers and accessories such as luggage and backpacks. Indium is also commonly used in multi-junction PV cells employed in concentrator photovoltaics (CPV) and satellites.

CIGS cell efficiencies have exceeded all other thin film PV technologies, reaching 23.4% for the cell and 17.5% for the module. Indium accounts for approximately 7% of the cost of a CIGS module.

CIGS manufacturers include Solar Frontier (Japan), which operates two CIGS plants in Japan; Midsummer AB [MIDS: FN Stockholm]; Ascent Solar Technologies [Nasdaq: ASTI]; Avancis (Germany); Flisom (Switzerland); and Siva Power (United States). However, a significant number of companies have abandoned the production of CIGS thin-film solar technology.

## Indium Semiconductors

Indium phosphide (InP) is a binary semiconductor made from indium (In) and phosphorus (P), belonging to a group of materials known as III-V semiconductors. InP is used in high-power and high-frequency electronics, and it has a higher electron velocity compared to more common semiconductors, such as silicon and gallium arsenide. Its direct band gap also makes it suitable for producing opto-electronic devices such as laser diodes and infrared sensors. Artificial intelligence is expected to increase demand for specialised chip materials, including those made of InP, that enable more advanced computation.

Companies that produce InP polycrystalline ingot or substrates include AXT [Nasdaq: AXTI], Ascent Solar [Nasdaq: ASTI], inPACT (France), JX Nippon Mining & Metals (Japan), NeoPhotonics Corp. [NYSE: NPTN], Phostec (Slovakia), Sumitomo Electric Industries [TYO: 5802], and Wafer Technology (United Kingdom).

## Other Indium Uses

Indium is also used in dental alloys. The ductile nature and casting properties of indium have encouraged the use of indium alloys with gold and palladium in dental applications.

## Substitution of Indium

Indium can be substituted in many of its uses, but usually at a cost to production efficiency or product quality. Silicon has, for the most part, replaced indium in transistors. Gallium can be used as a substitute for indium in certain alloys, although it is more expensive. Hafnium can replace indium in nuclear reactor control rod alloys.

In glass-coating applications, the USGS reports that antimony tin oxide coatings have been developed as an alternative to ITO coatings in LCDs and have been successfully annealed to LCD glass; graphene has been developed as an alternative to ITO coatings in flexible displays, solar cells, and touch screens; poly(3,4-ethylenedioxythiophene) (PEDOT) has also been developed as a substitute for ITO in flexible displays and organic light-emitting diodes; and copper or silver nanowires have been explored as substitutes for ITO in touch screens. Researchers have developed a more adhesive zinc oxide nanopowder to replace ITO in LCDs.

It is reported that currently over 90% of the display market uses ITO (6). An article from U.S.-based Indium Corp. [private] suggests that ITO alternatives have seen limited adoption in the display industry (7). Alternatives might eventually be employed in niche applications, but none are ‘drop-in’ replacements for the established ITO infrastructure. The caveat is that as the price of indium increases, so do the R&D efforts by display companies to use thinner coatings or alternatives. However, the potential long-term extent of penetration by alternative technologies in the coatings industry remains unclear. A more comprehensive analysis is required to understand the impact on future indium demand. This could be crucial for the long-term outlook of indium.

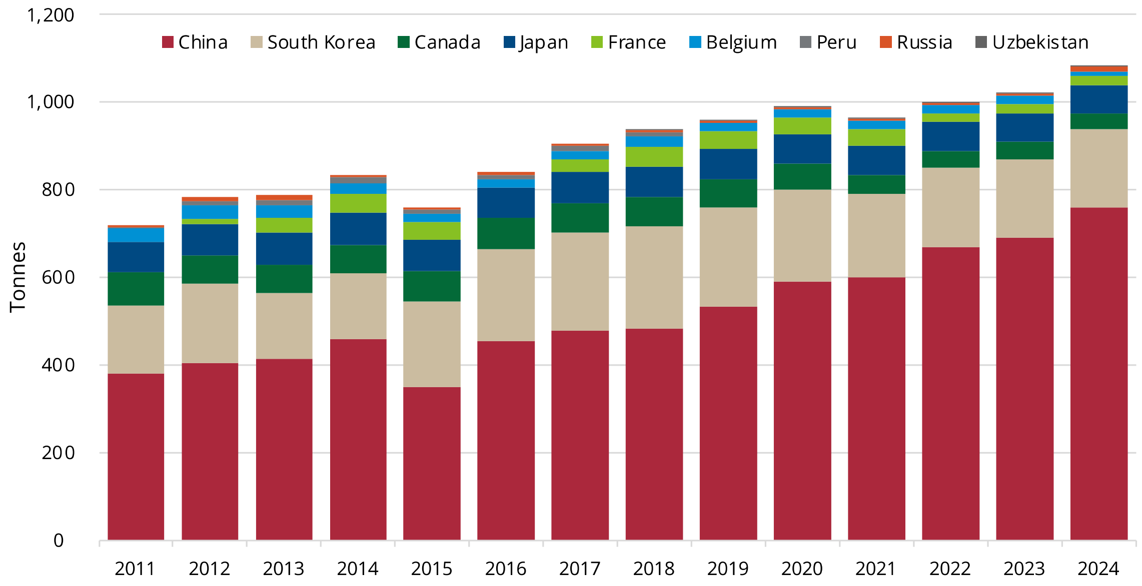
# 3. Supply Fundamentals

Indium is primarily produced as a by-product from zinc concentrates, with smaller amounts obtained from copper and tin operations. Data on mine supply of indium is unavailable, and production estimates are only available at the refined production level. This is because indium is of minor significance to these operations and is recovered during the smelting of mine concentrates or from dusts and residues produced.

Figure 7 shows the overall refined production of indium, which has increased from 720 tonnes in 2011 to approximately 1,080 tonnes in 2024. This is a CAGR of 4.2%, with the strongest growth coming from China (7.2% CAGR). Some of the growth during this period was driven by artificial demand generated through investment stockpiling by the Fanya Exchange in China (see below). Figure 8 shows the 2024 refined indium production breakdown by country.

The overall recovery of indium from mining, processing, and smelting is generally reported to be low, although no actual data were found. A study conducted by US-based Indium Corp. suggested that the overall recovery rate is approximately 30%, whereas a report by NREL indicated it was closer to 15 to 20% (8).

**Figure 7. Refined Indium Production by Country 2011-2024**



Source: USGS data.

The major causes of a low overall recovery rate include:

- Only 50 to 70% of the indium contained in the mined zinc ore reports to the zinc concentrate.
- Only 70% of the indium-containing zinc concentrates are sent to zinc smelters that recover indium.
- The recovery of indium at the zinc smelter from the mine concentrate is approximately 50%.
- The recovery of the indium at the indium refinery averages approximately 80%.

The USGS reports that refined indium production over the past decade has averaged 68 ppm (0.0068%) of the annual mined zinc production. Over this period, this apparent recovery has increased slightly.

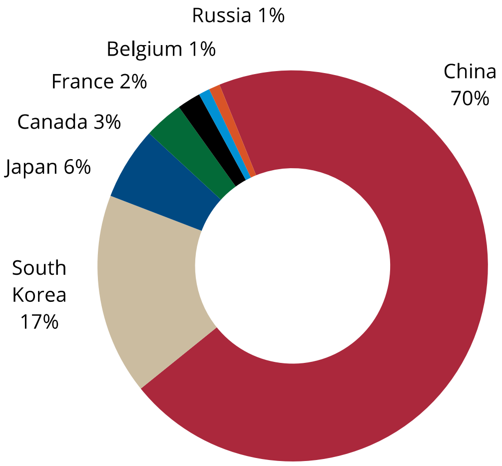
### Table 2. Identified Operating Mines Containing Indium

| Mine | Primary commodity | Country | Owner |
|---|---|---|---|
| Broken Hill | Zinc-Lead | Australia | Zhongjin Lingnan |
| Bolivar | Silver-Zinc-Lead | Bolivia | Santacruz Silver Mining |
| Cerro de Pasco | Zinc-Lead-Silver | Peru | Volcan Compañía Minera |
| Kidd Creek | Copper-Zinc | Canada | Glencore |
| Neves Corvo | Zinc-Copper | Portugal | Boliden |
| Penasquito | Zinc-Lead-Gold-Silver | Mexico | Newmont Corp. |
| Puna (Pirquitas) | Tin-Silver | Argentina | SSR Mining |
| Red Dog | Zinc | Canada | Teck Resources |
| San Vincente | Silver-Lead-Zinc | Bolivia | Pan American Silver |
| Wenshan Dulong | Zinc-Tin | China | Yunnan Hualian Zinc & Indium |

Source: RFC Ambrian, Company reports

Using this figure and working backwards from the recovery rates outlined above suggests that the grade of mined ore has been approximately 405 ppm (compared with 210 ppm from the 101 deposits, a mixture of operating mines and projects).

### Figure 8. Refined Indium Production 2024



Source: USGS 2025.

## Indium Midstream Producers

Only three companies are reported to operate fully integrated zinc-indium mining, smelting, and refining facilities: JX Advanced Metals [T.5016] in Japan, Teck Resources [TSE: TECK.B] in Canada, and Hunan Nonferrous Metals Corp. [state-owned] in China. Many mines produce indium in zinc concentrate, which is then shipped to a refinery in another country for toll processing. Therefore, the refinery production figures in Figure 8 do not necessarily reflect the original country of source of the mined indium.

Identifying mines that produce indium is challenging because few mines report indium content. Table 2 lists ten large mines known to contain indium. Some countries, including Bolivia, the United States, and Australia, are major producers of indium-bearing zinc concentrates but do not produce refined indium domestically; instead, the indium is recovered elsewhere. In Europe, significant refining operations are located in France and Belgium, where imported concentrates are processed.

The USGS reports some 29 refineries producing primary indium. Table 3 gives the ten largest refineries. Geographically, the largest producers of refined indium in 2024 were China (70%), South Korea (17%), Japan (6%) and Canada (3%). However, apart from China, the largest producers of mined zinc concentrates produce little or no refined indium. Figure 9 shows the largest producers of mined zinc concentrates. These are China (34%), Peru (11%), Australia (9%), India (7%), and the United States (7%).

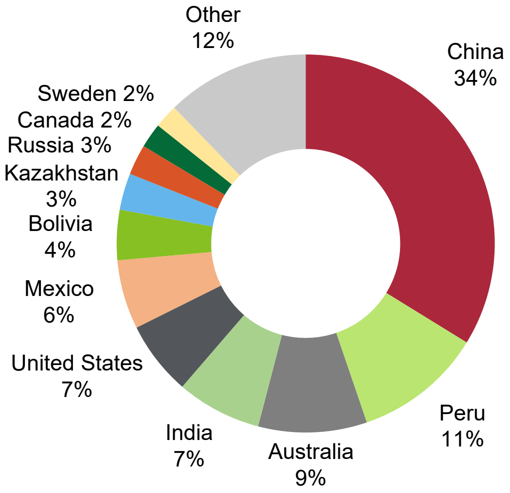
**Table 3. Largest Refineries Producing Primary Indium (tonnes)**

| Refinery | Country | Owner | Annual Capacity |
|---|---|---|---:|
| Takehara, Hiroshima | Japan | Mitsui Mining and Smelting | 200 |
| Onsan | South Korea | Korea Zinc | 120 |
| Sukpo | South Korea | Young Poong Corp. | 100 |
| Guangxi, Liuzhou | China | Guangxi Debang Technology. | 85 |
| Trail, British Columbia | Canada | Teck Resources | 75 |
| Hunan, Xiangtan | China | Xiangtan Zhengtan Nonferrous Metal | 75 |
| Iijima, Akita | Japan | Dowa Metals and Mining | 70 |
| Liaoning, Huludao | China | Huludao Nonferrous Metals Group | 60 |
| Yunnan, Wenshan | China | Yunnan Hualian Zinc and Indium | 60 |
| Yunnan, Honge | China | Yunnan Mengzi Mining and Smelting | 60 |

Source: USGS, Company reports.

Teck Resources is the largest producer of indium outside of Asia. Indium is produced as a by-product of the zinc smelting process at its integrated refinery in Trail, Canada. Teck produces indium metal with a minimum purity of 99.99%. It reports that in recent years, it has expanded its production capability to meet the growing demands of indium-tin-oxide (ITO) manufacturers.

**Figure 9. Mined Zinc Production 2024**



Source: USGS 2025.

## Above-Ground Indium Stocks

Large above-ground stocks of indium metal may still exist in China. This includes stocks which were accumulated by the Fanya Metal Exchange (FME) between 2011 and 2015. FME was a state-backed exchange based in Kunming, Yunnan Province, which claimed to be the world's largest platform for trading rare metals. The exchange focused on metals, including indium, used in technologies promoted in China's official strategic plan. In the three years after its establishment, the exchange raised as much as US$6.4 bn.

In 2015, the exchange was exposed as a Ponzi scheme, and its executives faced charges of embezzlement and market manipulation. The exchange's warehouses reportedly held approximately 3,610 t of indium, equivalent to about four years of primary production. Vital Materials is believed to have purchased the indium stock in 2020 for US$416 m, and no further reports about the stockpile have been made.

US-based SMG Indium Resources was formed in 2008 to stockpile indium and had accumulated a stockpile of 47 t before selling it in 2014 and changing its name and business.

## Indium Recycling

Recycling of indium can come from two sources: new scrap, which is waste produced during manufacturing, and old scrap, which includes end-of-life (EOL) consumer products. Currently, most indium recovery occurs from recycling new scrap (manufacturing waste). However, very little old scrap is recycled at present because indium is highly dissipative in consumer products and difficult to recover. The primary source of new indium scrap is spent ITO sputtering targets, such as those used in liquid crystal displays (LCDs). Overall, indium recovery is high in a closed-loop system between the manufacturer and the recycler. This recycling of new scrap occurs in Japan, China, and South Korea, near the primary locations of LCD manufacturing. The technology used in recycling indium is mostly proprietary.

# 4. New Indium Projects

New indium production could be sourced from the expansion of existing producers or from the establishment of new production capacity. However, many mines do not report the presence of indium in their reserves.

## Expansion of Existing Producers

There are currently 16 zinc mines undergoing expansion, according to data from S&P Global Intelligence. The only zinc mine known to contain indium that is under expansion is the Red Dog mine in Alaska, United States. However, this is a longer-term project and involves the development of two large new prospects to the north, known as Aktigiruq and Anarraaq. Additionally, it is unknown whether the new deposits contain indium, and it is unclear whether this project will increase capacity or simply replace existing operations that are scheduled to be exhausted in 2031.

**Table 4. Identified Active Mining Projects Containing Indium**

| Project | Primary Commodity | Country | Development Stage | Operator |
|---|---|---|---|---|
| Tellerhauser | Tin | Germany | Feasibility | First Tin |
| Kempfield | Gold | Australia | Feasibility | Argent Minerals |
| Conrad | Silver | Australia | Prefeas/Scoping | Rapid Lithium |
| Ayawilca | Zinc | Peru | Prefeas/Scoping | Tinka Resources |
| West Desert | Zinc | USA | Prefeas/Scoping | American West Metals |
| Iska Iska | Silver | Bolivia | Prefeas/Scoping | Eloro Resources |
| Pinguino | Silver | Argentina | Prefeas/Scoping | Unico Silver |
| San Roque | Gold | Argentina | Reserves Dev. | Int. Iconic Gold Explor. |
| Silver Range | Silver | Canada | Reserves Dev. | Broden Mining |
| Thor | Silver | Canada | Reserves Dev. | Taranis Resources |
| Doradilla | Tin | Australia | Reserves Dev. | Sky Metals |
| Fox | Tungsten | Canada | Reserves Dev. | Metal Energy Corp. |
| Ajana | Lead | Australia | Reserves Dev. | Anson Resources |
| Bathurst Camp | Zinc | Canada | Reserves Dev. | Lode Gold |
| Garnet Lake | Zinc | Canada | Reserves Dev. | Compton Mineral Corp. |
| Kildare | Zinc | Ireland | Reserves Dev. | Zinc of Ireland |
| Arapaima | Lithium | Brazil | Exploration | Spark Energy Minerals |
| Georgetown | Gold | Australia | Exploration | Emu |
| Victoria Lake | Tin | Canada | Exploration | Green Mining Innov. |

Source: S&P Global, Company reports.

## New Mine Production Potential

To increase the supply of indium, it is generally not economically feasible to mine indium directly due to its low concentrations in ore deposits. Instead, increased supply may be achieved through increased production of the host metals. RFC Ambrian has identified 19 active projects where indium is present and reported in the deposit data. These projects were initially identified using S&P Global Intelligence data. Table 5 lists these projects, ordered by development stage, comprising five zinc projects, five silver projects, three tin projects, three gold projects, a tungsten project, a lithium project, and a lead project. These projects are all at various stages of development, from exploration to feasibility.

Additionally, seven new zinc mines are either under construction or planned (Anznacollar, Bunker Hill, Dairi, Oued Amizour, Ozemoya, Prairie Creek, and Qinhai Hongxin M1), although it is unknown whether these mines contain indium.

The two projects at the feasibility stage and the five projects at the prefeasibility stage in Table 4 make limited mention of indium in their reports, apart from acknowledging its presence in the mineralisation, with two exceptions. The first is Tinka Resources [TSXV: TK], which reports that the zinc concentrate from its Ayawilca project in Peru has a high indium content (around 650 ppm) and will receive a US$20/dmt credit in concentrate shipped to Asia. The second is the West Desert project located in Utah, United States and owned by American West Metals [ASX: AW1]. The company reports that a significant JORC-compliant zinc-copper-indium-silver-gold resource has been defined at the project, which includes 23.8 Moz of indium. American West is evaluating strategies to unlock the value of the asset.

## Zinc Smelter Capacity

Another potential area for increasing indium production is at the zinc smelter stage. This could be done through the capture of more indium in the zinc concentrates at existing smelters (through increased recoveries) or through the construction of indium refinery capacity at zinc smelters where the indium is currently not being captured. Increasing recoveries or constructing additional indium refineries sound like straightforward solutions; however, these would need to be economic decisions based on the capital and operating costs of these steps, measured against the potential revenues they would return. This equation is partly dependent on the indium price. The fact that it appears not to be happening would suggest that indium prices so far have not been high enough to justify the investment.

Additional indium capacity may also be added with the construction of new zinc projects that have an indium content in their feed. According to data from S&P Global Intelligence, ten new zinc smelters are currently being commissioned, and a further five have started construction. This totals approximately 1.2 Mt of zinc capacity, equivalent to a 10% increase in global refined zinc production of 12.0 Mt in 2024.

While this data may be indicative of potential indium capacity coming on stream, there is no supporting information to indicate whether any of these smelters will also produce indium. Seven of these smelters are in China, two in Turkey, and one each in Russia, Indonesia, Iran, India, Spain and Vietnam.

# 5. Indium Markets & Prices

## Indium Trade

Trade databases do not have a separate category for indium; it is grouped with gallium, germanium, hafnium, niobium, rhenium, and vanadium, according to the Observatory of Economic Complexity (OEC).

The global trade of indium-containing semifinished goods is also challenging to identify and quantify because these goods are typically a subset of broader product categories recorded in trade statistics databases. Moreover, a considerable fraction of indium-containing alloys eludes the conventional classification schemes because of the lack of an unequivocal definition.

The USGS reports that China is the leading global exporter of indium, having shipped 347 t of indium in the first 9 months of 2024, roughly the same as during the same period in 2023. Exports mainly went to the Republic of Korea (74%), Malaysia (10%), and the United States (10%). During this period, China imported 180 tons of indium.

## Indium Prices

There are no official prices for indium as it is not traded on any Western metal exchange. The price is mainly determined by negotiation between buyers and sellers, and most contracts between indium producers and processors are long-term (and confidential), with spot prices sourced from specialist trade magazines. Some metal is traded on the Zhonglianjin e-exchange, a Chinese electronic trading platform for various commodities, including indium. Fastmarkets reports that speculative activity on this exchange has occurred and impacted the price of indium in China (9). Figure 10 illustrates the performance of indium prices from 2015 to 2025.

Between 2006 and 2015, the price of indium fluctuated between US$400 and US$800/kg. In 2015, the Fanya Metal Exchange collapsed after investing in and stockpiling indium since 2011. It was reported that the Chinese government purchased approximately 3,610 tonnes of indium stocks; however, the overhang of stocks (and likely incremental sales) resulted in the price remaining depressed, trading around US$200/kg until 2023. Since then, the price has somewhat recovered, recently reaching US$400/kg. In 2024, the USGS reports an average US warehouse FOB price of US$340/kg, a 42% increase from 2023.

**Figure 10. Indium Price 2015 to 2025 (US$/kg)**

Source: Bloomberg. Indium Ingot 99.99% FOB

# 6. The Indium Market Outlook

The indium industry is small, and its supply chain remains highly opaque. The amount and quality of data available to all stakeholders are limited. This creates a risk to the supply chain because, without reliable estimates of resources, supply, and demand, the market's ability to sustainably manage indium supply is constrained. This is particularly significant for indium because its supply is a by-product mainly driven by the economics of the zinc market, while demand is primarily influenced by the ITO market.

## Supply Side Issues

The supply outlook for indium is largely unknown. In the medium term, ongoing production as a by-product from existing zinc smelters is likely sufficient to meet global demand, although the market has been complicated by China's imposition of export restrictions on indium in February 2025. In the longer term, based on resource calculations by Werner (2017), there appears to be an ample supply of indium in the world. However, uncertainty remains about whether it can be accessed, exploited, and recovered to fulfil future demand.

RFC Ambrian has identified 19 mining projects where indium is present; however, each of these is primarily driven by the economics of an alternative primary commodity, primarily zinc. Only two projects are currently at the feasibility stage, and there's no guarantee that any of them will proceed to production or even produce indium. Additionally, there is no data indicating potential increases in zinc smelter capacity where indium could be recovered or for the establishment of new indium facilities at existing zinc smelters.

Some market commentators suggest that there is an opportunity to improve the efficiency of indium extraction, expand capacity at existing indium refineries at zinc smelters, and build new indium refineries at zinc smelters that currently do not extract indium. This approach could enable a greater proportion of the mined indium resources to be converted into refined indium. While this may be accurate, the technological and economic practicalities remain unclear, particularly given that the quantities of indium recovered are very small and have little economic significance for zinc producers. Any improvements in recovery (if achievable) or increases in capacity would entail capital and operating costs, which would need to be justified economically, largely based on the price of indium. However, there is no evidence that any of these steps are currently taking place.

## Demand Side Factors

The demand outlook for indium is equally opaque, caused in part by the small size of the end markets and the lack of information given by the participants (possibly for competitive reasons). Various reports (mostly dated) suggest that demand for the main use of indium, ITO, will remain robust based on continued use in flat panel displays. This might be the case, but there is also a risk that several different materials being developed for glass coating applications may eventually replace the use of ITO. This might be accelerated if the price of indium increases substantially.

Indium phosphate demand is expected to increase with the development of 5G technologies, although no information is available on potential demand.

Policy support remains a key driver of solar PV deployment worldwide. However, regarding indium demand for CIGS solar PV, the IEA base case outlook suggests that crystalline silicon will continue to be the leading PV technology. Thin film technologies are expected to stay niche over the coming decades, despite improvements in efficiency and reductions in cost. Their application is likely to be limited to cases where lighter weight and/or greater flexibility are needed. As a result, indium demand for CIGS solar PV is likely to increase, but it will remain a relatively small part of overall indium demand in the foreseeable future.

## Indium Market Balance

The lack of both supply and demand data leaves significant uncertainties about the market balance and the future direction of the indium market.

# Appendix 1 – Indium Resource Types

The major geologic host environments for indium mineralisation include (10):

- Volcanic massive sulphide (VMS) deposits.
- Sediment-hosted deposits.
- Epithermal deposits.
- Active magmatic systems.
- Porphyry deposits.
- Skarn deposits.

## Volcanogenic Massive Sulphide (VMS)

VMS deposits form from heated, hydrothermal fluids discharged from vents in submarine volcanic environments at or near the sea floor, which then precipitate massive sulphides. They produce metals through interactions between source rocks, such as epidosites, and modified seawater. VMS deposits are known to host a wide variety of metals that are often present at high grades.

## Sediment-hosted Deposits

The sediment-hosted lead-zinc class of deposits include orebodies that are not genetically related to igneous activity, are sediment-hosted, and have lead and/or zinc as their primary commodity. These deposits represent the world's most important source of lead and zinc and are therefore of considerable interest for their indium content. The two primary subsidiary classifications of sediment-hosted lead-zinc deposits are sedimentary exhalative (SEDEX) and Mississippi Valley-type (MVT) deposits. In terms of commodities, SEDEX and MVT deposit types are both dominated by lead and zinc, though they can also be important sources of silver and copper.

## Epithermal Deposits

Like VMS deposits, epithermal deposits can host economic quantities of a wide range of metals. These most commonly include silver and gold, although epithermal deposits can also contain zinc, copper, lead, arsenic, stibnite, and tin, all of which are particularly important for indium. Epithermal mineral deposits form at temperatures of up to 300 degrees Celsius and in shallower depths (less than 1.5 km) within subaerial hydrothermal systems, driven by magmatic heat sources commonly found within volcanic arc settings.

## Active Magmatic Systems

The anhydrous melting of the lower crust (during mantle plume-related underplating), the melting of igneous or sedimentary rocks during metamorphism, or extreme fractionation of mafic magmas can generate highly evolved magmas. When these magmas cool and solidify, they can form either coarse-grained igneous rocks, known as granites, or their compositionally identical fine-grained equivalents, rhyolites, after cooling and solidification. Rhyolites are either intruded near the Earth's surface or erupted. Both granites and rhyolites host indium mineralisation.

## Porphyry Deposits

Porphyry deposits are large-tonnage, low- to medium-grade mineral deposits that are genetically linked with porphyry intrusive magmatism. They are the world's most important source of copper, as well as being associated with molybdenum, gold, and silver. As mentioned in the other deposit type classifications above, porphyry deposits are often associated with other mineral deposit types, such as epithermal, skarn, and manto mineralisation. Typically, porphyry copper deposits are not well known for significant indium endowments; however, some notable examples of the porphyry-type tungsten–molybdenum subclass of deposits are known to contain significant concentrations of indium.

## Skarn Deposits

Skarn mineral deposits form during the interaction between magmato-hydrothermal fluids derived from plutons and associated deeper magma chamber systems, and the surrounding wall rocks. While not always the case, skarns can be genetically related to porphyry and epithermal deposits within larger magmato-hydrothermal systems. Zinc, tin, and copper skarns are believed to be the most important for indium mineralisation.

# Bibliography

1. **USGS 2025.** [Online] https://pubs.usgs.gov/periodicals/mcs2025/mcs2025-indium.pdf.

2. **Werner et al.** *Ore Geology Reviews - A Global Assessment of Indium.* [Online] https://www.sciencedirect.com/science/article/abs/pii/S0169136816300932.

3. **IEA.** Decision to implement export controls on indium. [Online] https://www.iea.org/policies/26795-decision-to-implement-export-controls-on-tungsten-tellurium-bismuth-molybdenum-and-indium-related-items.

4. **Project Blue.** *Chinese export restrictions may disrupt indium market.* [Online] https://projectblue.com/blue/news-analysis/1132/chinese-export-restrictions-may-disrupt-indium-market-.

5. **IEA.** *Special Report on Solar PV Global Supply Chains 2022.* [Online] https://www.iea.org/reports/solar-pv-global-supply-chains.

6. **Paragraf Ltd.** *Replacing Indium Tin Oxide (ITO) with Next-Generation Graphene in Electronic Devices.* [Online] https://www.paragraf.com/step-change-in-the-potential-of-high-tech-devices-of-the-future-graphene-replaces-indium-used-in-mobile-phone-screens/.

7. **Indium Corp.** *Supply Chain Strong, Demand Continues to Grow 2020.* [Online] https://iconnect007.uberflip.com/i/1243344-smt007-may2020/57?.

8. **NREL.** *The Availability of Indium 2015.* [Online] https://docs.nrel.gov/docs/fy16osti/62409.pdf.

9. **Fastmarkets.** *Strong indium buying in China and cuts to Western production stir up market.* [Online] https://mmta.co.uk/strong-indium-buying-in-china-and-cuts-to-western-production-stir-up-market/.

10. **Werner, TT.** *Ore Geology Reviews (2017) - A global assessment of indium.* [Online] https://www.sciencedirect.com/science/article/abs/pii/S0169136816300932.

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