

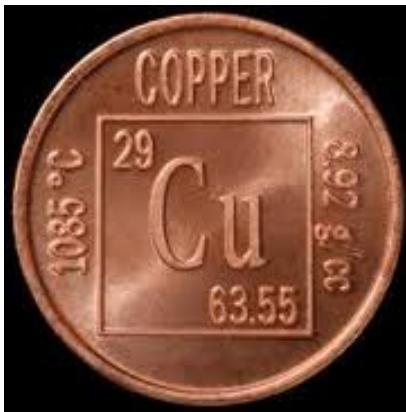
Copper

Copper is one of the earliest metals discovered and worked by humans. Since it is in the same group (11) of the Periodic Table as gold and silver it shares similar properties: all three metals can be found in the natural state, possess high ductility, have good electrical and thermal conductivity and most importantly, malleability. These properties enable copper to be widely used in everyday life.

Copper has been used as a constituent of metal alloys for thousands of years. Historically used for weapons and tool manufacture, its primary use today is in electrical applications and in pipes. Other uses include the production of compounds for nutritional supplements and in fungicides for agriculture. Copper is found in animal tissue, liver, muscle and bone.

There are several types of copper alloys; bronze and brass are the two most common. Bronze is composed of copper and tin whereas brass is an alloy of copper and zinc. The copper alloys differ in appearance and physical properties. The Bronze Age (mainly tools and weapons) replaced the Stone Age and predated the Iron Age and the subsequent development of steel.

The oxidation of copper takes place rapidly. However, the oxide layer that results generally protects the metal from further oxidation under a wide range of exposure conditions with the exception of the corrosive marine environment. This problem was overcome by the discovery that bronze could resist seawater corrosion making it suitable for use in ship fittings and in the manufacture of ship propellers. The durability of bronze was better than some of the early iron alloys (steel) in this respect. Bronze also had the added advantage that when struck against hard materials it did not give off sparks.



銅

銅是其中一種人類最早發現及利用的金屬，與金及銀一樣在元素週期表中屬同組(11)，擁有相似的特質：三種金屬都是自然存在，高度柔軟、具良好導電及導熱性，以及最重要的展延性。以上種種特點令銅在日常生活中得到廣泛應用。

過去數千年，銅一直作為金屬合金的成份。歷史上銅是製作武器及工具的原料，但今天則主要用於電子組件及水管。其它用途還包括營養補充劑中的化合物及農業殺真菌劑。另外，動物的

組織、肝臟、肌肉及骨骼中都含有銅。

銅合金有幾種，其中最常見的兩種是青銅及黃銅。青銅是由銅及錫組成，而黃銅則是由銅及鋅組成的合金。不同的銅合金外表及物理特質各異。銅器時代(以器具及武器為主)取石器時代而代之，又早於鐵器時代及後鋼的發展。

銅經常出現氧化的情況，然而因氧化而出現的氧化層卻保護金屬在大部份環境下免受進一步氧化，但腐蝕性的海洋環境則例外。然而青銅的發現則克服了這個問題，因為青銅能抵抗海水浸蝕，是製造船具及螺旋槳

的理想材料。在耐用程度方面，青銅比早期的鐵合金(鋼)更佳，同時亦有與硬物磨擦撞擊不會產生火花的優點，因此青銅會被製成鐵鎚及大頭鎚在易燃的環境中使用。此外，青銅亦常用於製作雕像及獎牌，因為起初的擴張可以填滿模子中的所有



Left: Statue of Liberty was originally a dull copper colour but eventually turned green (also known as patina or verdigris) due to oxidation of the copper skin; Above: The Wall Street Charging Bull is another famous bronze statue weighing 3,200kg

左：自由女神像原是一個單調的銅色，但由於表層的銅受到氧化，最終變成了綠色（又稱銅鏽或銅綠）；上：華爾街銅牛是另一個著名的銅像，重達3,200公斤

細節，而冷卻後出現的收縮則可輕易地讓人把成品取出。

另外，青銅亦因為能夠保持樂音而用於多種弦樂器上，包括低音提琴、鋼琴及

This allowed it to be used in tools such as hammers and mallets in a combustible atmosphere. Many statues and medals are also made from bronze since it expands slightly before setting allowing it to fill the finer details of the mold. Subsequent shrinkage on cooling allows easy removal.

Bronze is also used in several types of stringed musical instruments including the double bass, piano and harpsichord because of its ability to sustain musical notes.

Likewise, the acoustic properties of brass have similarly resulted in its extensive use in musical instruments, notably the trombone, tuba and horns as well as in organ pipes.

One of the key advantages of brass is its yellow colour which can be similar in appearance to gold. Since it provides reasonable resistance to tarnishing and can be easily polished, it is widely used for decorative purposes and for coins. Its high malleability and its spark prevention properties permits its use in small fittings where there is a risk of explosion (e.g. boilers).

Geological Deposition

Copper occurs widely in the Earth's crust but due to its low concentration is often not economically viable to work. Native copper is relatively rare and it mainly exists as sulphides (i.e. chalcopyrite (CuFeS_2) and chalcocite (Cu_2S)), oxides (i.e. cuprite (Cu_2O)) and carbonates (i.e. azurite ($\text{Cu}_3(\text{CO}_3)_2(\text{OH})_2$) and malachite ($\text{Cu}_2\text{CO}_3(\text{OH})_2$)).

Copper occurrences are often related to magmatic intrusions between tectonic plate boundaries: in this case it occurs as a copper porphyry. As magma cools and interacts with other fluids, some will successfully form a porphyry copper deposit. These are usually vein type in nature and the concentration of copper is typically in the 0.4% - 1.5% range with cut-off values approaching 0.5%. Other minerals, such as lead (Pb), zinc (Zn), cobalt (Co), molybdenum (Mo), silver (Ag) and gold (Au) are associated with such deposits and can also be recovered, if proven economically viable in terms of operating efficiency. Copper carbonate minerals tend to occur when limestone is present during the intrusive formative stage resulting in brightly coloured green malachite and blue azurite. Apart from being sources of copper ore, these rocks are also used for decorative purposes.

In wet sub-tropical and tropical environments, the near-surface rocks and minerals are chemically weathered and oxidized. Oxide minerals tend to concentrate within the oxidized zone and this process is called supergene enrichment and there are several large copper deposits of this type.

Mining and Processing

Typical open pit and underground mining will be adopted to extract ore according to the nature of the deposit.

Before beneficiation process, the extracted rock will be crushed and ground into smaller pieces to separate the gangue from the copper ore. Different types of minerals have different beneficiation process. Typically, the oxides and the carbonates will be treated by heap leaching where the ore will be stockpiled in an extensive open area for acid spraying. The acid dissolving the copper from the heap will be collected for copper recovery through an electrowinning process.

撥弦古鋼琴。

同樣地，黃銅的音響特質亦令它廣泛用於多種樂器，例如長號、大號、小號及管風琴。

黃銅的一個主要優點是其黃色與金相似。由於黃銅具有抗污性而且容易擦亮，因此多用於裝飾用途和鑄幣。另外，其高度展延性以及不易產生火花的特性亦適合製造置於有可能發生爆炸地方的小型器具（如鍋爐）。

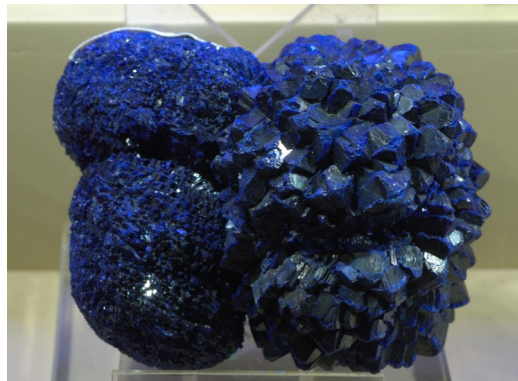
地理分佈

銅在地殼十分常見，只是蘊藏濃度不高令開採不符合經濟成本效益。天然銅相對較為罕見，主要以硫化礦物（即黃銅礦(CuFeS_2)及輝銅礦(Cu_2S)）、氧化礦物（即赤銅礦(Cu_2O)）、碳酸鹽礦物（即藍銅礦($\text{Cu}_3(\text{CO}_3)_2(\text{OH})_2$)及孔雀石($\text{Cu}_2\text{CO}_3(\text{OH})_2$)）的形態出現。

銅的形成通常與板塊與板塊之間的岩漿浸入有關，而透過這個過程產生的銅一般稱作斑岩型銅礦。岩漿冷卻與其他液體產生作用後，可能會變成斑岩型銅礦床。這類礦床一般屬於脈型，含量介乎 0.4 至 1.5%，而邊際品位大約為 0.5%。其它例如鉛(Pb)、鋅(Zn)、鈷(Co)、鉬(Mo)、銀(Ag)及金(Au)等礦物亦與礦床相關，可從礦石中回收，但前提是在營運效率方面需經濟上可行。碳酸銅的主要成因是在岩漿浸入的位置有石灰岩，以致造成明亮的綠色孔雀石及藍銅礦。這些礦物除了是銅礦的來源以外，還有裝飾的用途。

Left: Blue azurite. Below: Green malachite.

左：藍銅礦 下：綠色孔雀石



在潮濕的亞熱帶及熱帶地區，接近地表的岩石及礦石會受化學風化和氧化。氧化礦物一般會在氧化帶聚積，過程稱為次生富集，此類的大型銅礦床有數個。

開採與加工

一般會根據礦床的性質而決定採用露天或地底開採法。

被開採出來的礦石在拿去作選礦處理前會先被敲碎成小塊，以把銅礦中的脈石分隔出來。不同種類的礦石會接受不同的選礦處理。基本上，氧化物與碳酸鹽會經過堆浸法，過程

中礦石會堆放於一大片空地然後被灑上酸性液體。用作分解礦物堆中所含的銅的酸會被收集起來，然後再透過電解冶金法提取銅。

雖然硫化物不會受硫酸侵蝕，但在某些特定細菌的催化下仍然可以浸出銅，這過程稱為細菌氧化堆浸法，同樣是透過電解冶金法來提取銅。

硫化物沒有氧化物及碳酸鹽那麼易溶，因此要處理硫化礦一般成本較高，而且較耗能。利用化學品把硫化銅黏在汽泡上的泡沫浮選法就成為提取銅的可行方法：泡沫浮在表面時就能把硫化銅收集起來，而這些濃縮物在被電解前會先被熔煉以除掉鐵及其他雜質。



Although the sulphides are resistant to sulfuric acid, some can still be leached under the presence of specific bacteria which acts as a catalyst. This is called bacterial oxidation heap leach. Again, the copper is collected through electrowinning from the resulting solution

Sulphides are less soluble than their oxide and carbonate counterparts and processing sulphide ores is normally more costly and more energy intensive than that of the more soluble oxide and carbonates. Froth flotation, which uses chemicals to bind copper sulphide minerals to air bubbles is used: the copper sulphides are collected as the bubbles float to the surface. These concentrates are smelted to remove iron and other impurities before electro-refining.

Market

Due to its high electrical conductivity, the major application for copper is electrical wiring (60%). Roofing and plumbing uses about 20% of the copper produced as it is more resistant to water and moisture than most steels. The remainder is used to produce industrial machinery (15%) and copper alloy (5%).

Most of the copper products can be recycled and reused, through processes similar to the ones used for extracting copper in the first place.

Today, thousands of years after its discovery and early applications, copper remains one of the metals in highest demand throughout the world.



市場

由於銅具有高度導電的特性，因此其主要用途為電線(60%)，而屋頂鋪設及配管則佔銅總生產量的兩成，因為銅比大部分鋼材更防水和防濕。至於其餘的用途還包括工業

機器(15%)及銅合金(5%)。

大部分銅製品都可被回收或重用，處理過程與原礦提取銅的差不多。

在銅被發現和應用的數千年後的今日，它仍然是全球最炙手可熱的金屬之一。

Grasberg Mine

The world's largest copper porphyry deposit occurs in Papua, Indonesia, where the Indo-Australian and the Pacific tectonic plates collide.

It has 2.6 billion tonnes of ore with about 1.13% copper, 1.05g/t gold, and 3.8g/t silver. It is a primarily a copper mine but, at the same time, as a by-product, it is also the world's largest gold-producing mine.

The ore is being mined by open pit and underground. Copper and gold is recovered through the flotation process. The open pit operation started in 1972 and has created a crater over 1.6km wide at the surface.



Grasberg Mine

格拉斯伯格礦

格拉斯伯格礦

世界上最大的斑岩型銅礦床位於印度-澳大利亞板塊和太平洋板塊發生碰撞的印尼巴布亞省。

它擁有 26 億噸礦石約 1.13%的銅，1.05 克/噸黃金，和 3.8 克/噸銀。它主要是一個銅礦，但在同一時間，作為一種副產品，它亦是世界上最大的黃金生產礦山。

正在由露天和地下開採礦石。通過浮選工藝回收銅和黃金。露天作業，自 1972 年開始，已經在地表上創造了超過 1.6 公里寬的礦坑。

References: Freeport-McMoRan Copper & Gold Inc.
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分析:中國需求推動銅價破萬? (節錄)

Copper Pricing Analysis

6/2/2012 <鉅亨網新聞中心>

作為一個整體，金屬價格今年1月份呈現出2010年12月以來的最佳單月表現，倫敦金屬交易所(LME)一籃子期貨價格上漲10.9%，而錫價則以26.5%的幅度領漲。

此番價格上漲，再次引發了市場對於銅價升至每噸1萬美元的議論。去年2月，在市場樂觀情緒的推動下，銅價曾短暫“破萬”。但隨著價格在去年10月跌至每噸6635美元的低點，“破萬”的可能性似乎越來越小。從今年年初開始，銅價累計上漲11%，周二的交易價格為每噸8440美元。

銅金屬廣泛應用於建築業和製造業，因此是全球工業生產的先行指標。銅價的上漲，顯示出最近幾周投資者對全球宏觀經濟前景的預期發生了變化。金屬價格上漲也提升了礦業的市場人氣，富時(FTSE)歐洲礦業指數自今年年初已上漲了17.4%。

交易者對於2011年底困擾市場的兩大主要擔憂已感到更為輕鬆。首先，至少從目前來看，歐元區債務危機對全球經濟的影響，似乎已經由於歐洲央行(ECB)采取的緊急措施而延后。其次，也是對金屬市場遠為重要的一點是，去年12月份中國銅進口量創下紀錄，再加之貨幣政策放鬆的跡象，大宗商品交易者對於中國的需求變得更加樂觀。

銅價的漲勢并非只是趕上了一波市場普遍樂觀的浪潮。今年年初，市場的注意力再次關注於銅供應吃緊的長期趨勢。

全球最大的銅礦商中，多數報告2011年產量有所下降，儘管過去一年中，平均價格達到了創紀錄高點。倫敦上市的大型采礦企業——必和必拓(BHP Billiton)、斯特拉塔(Xstrata)、英美資源(Anglo American)和力拓(Rio Tinto)——總產量較2010年下降了27.3萬噸，降幅8.2%。嘉能可(Glencore)尚未公布全年產量數據。

產量數據令人失望的同時，在LME註冊倉庫的總庫存也出現顯著下降。從去年10月初，銅存貨減少了30%。除去有待交割的金屬，LME庫存達到了2008年10月以來的最低水平。“存貨在某種時間點上的確會造成影響，尤其是可見交割庫存。如果降低到關鍵水平以下，可能會有爆炸性的后果，”托克公司



Cash seller and settlement copper prices

Source: LME

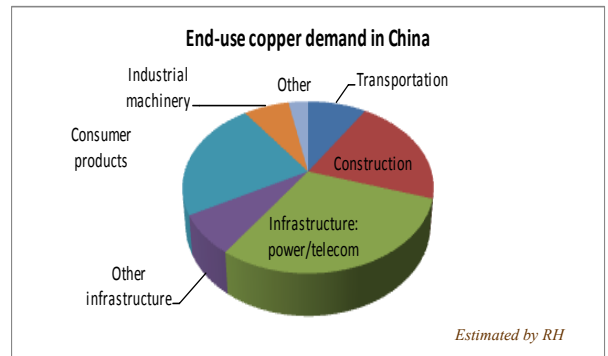
(Trafigura)精煉金屬部門負責人西蒙柯林斯(Simon Collins)表示。“銅價有可能上升到每噸一萬美元。”

但儘管如此，警惕心理仍普遍存在。去年投資者對銅市盲目的樂觀情緒，隨著中國交易者削減進口而迅速破滅。有了去年那次的痛苦經歷，投資者都很緊張。

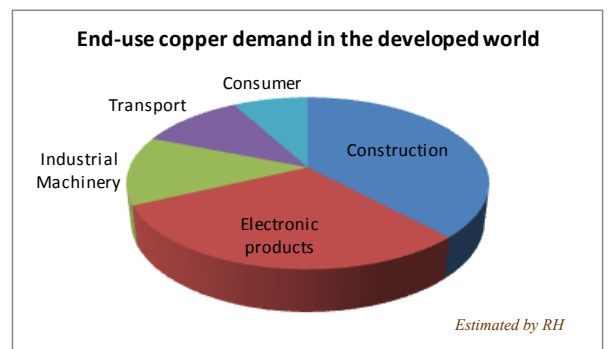
倫敦金屬交易所未平倉合約數量仍然遠低於最近的峰值，顯示出信心水平較低。而且儘管美國商品期貨交易委員會(CFTC)數據顯示，美國銅期貨市場投資者的頭寸在兩個月中首次呈現總體看多，但與2011年初時相比，仍然不夠熱情。

Copper Forecast in China

- ◆ It is expected that copper price to rise back up and recover its strength during 2012
- ◆ Forecast China copper demand to increase slightly for 2012, as supply availability remains low
- ◆ China copper demand growth is expected to slow down
- ◆ Refined copper imports have continued to increase
- ◆ China accounts for about 40% of global demand



Estimated by RH



Estimated by RH

Rockhound is a HK based company set up to serve the minerals industry in the Region. The company offers technical valuations and services in the natural resources sector.

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