AZURITE AND MALACHITE: INTO THE COPPER AGE

Mineralogical history and technological advancement have always gone hand in hand. The discovery of new minerals has led to the discovery of new elements, new sources of metals and other resources, and to the overall betterment of mankind. One of the great, early examples is the role that azurite and malachite played in the dawning of the Copper Age.

Azurite [basic copper carbonate $Cu(CO_3)_2(OH)_2$ and malachite [basic copper carbonate, $Cu_2(CO_3)(OH)_2$] are familiar to every mineral collector for their respective colors—azure blue and forest green. Both are oxidized copper minerals that occur worldwide in shallow deposits or outcrops. Many anthropologists believe that they were the critical materials that led mankind out of the Stone Age.

It is uncertain whether man first collected native gold or native copper. But archaeologists have recovered amulets of both metals in Asian and European cultural sites dating to more than 10,000 B.C. With its softness and great malleability, gold had no utilitarian value. But with its greater hardness, copper could be fashioned into tools and weapons. The rarity of native copper, however, delayed further advances in metalworking technology for thousands of years.

Copper mineralization is generally emplaced at depth in the form of such sulfide minerals as bornite [copper iron sulfide, Cu_5FeS_4], chalcocite [copper sulfide, Cu_2S], and chalcopyrite [copper iron sulfide, $CuFeS_2$]. When erosion exposes copper-sulfide deposits, the action of atmosphere and water alters the sulfide minerals into such oxidized minerals as cuprite [copper oxide, Cu_2O] and the brilliantly colored copper carbonates azurite and malachite. Further chemical action can sometimes reduce these carbonate minerals to native copper.

Azurite and malachite were far more abundant than native copper. Late Stone Age people collected most of their copper from outcrops and other occurrences in which the native metal was closely associated with azurite and malachite. They were also aware that azurite and malachite, with their eye-catching colors, were not common rocks or earth, and that they were possibly—somehow—related to native copper.

Around 5000 B.C., some Asian cultures were already melting native copper in drafted charcoal fires and using ceramic molds to cast the molten metal into various useful shapes. In one of the monumental turning points in the prehistory of technology, an early metallurgist, either by chance or by choice, heated not native copper, but the associated minerals azurite and malachite in a bed of drafted, glowing charcoal.

The combination of intense heat and direct contact with the carbon in the coals and the free oxygen of the atmosphere drove off the carbon and oxygen in the carbonate minerals, leaving behind a small pool of molten, metallic copper. Modern metallurgists describe this reaction as simple reduction smelting.

Few discoveries have ever had greater immediate and long-term significance. The realization that large quantities of metallic copper could be derived from certain colorful, easily identified “rocks” that had no metallic appearance whatsoever represented a quantum leap in man’s understanding of the natural world. The technology of crude smelting dramatically increased the supply of metallic copper which, in turn, lifted man out of the Stone Age and into the Copper Age.

Chronologically, the term “Copper Age,” which refers to the period when a culture’s tools and weapons were made primarily of copper, is of strictly regional value, since the metal came

into regular use at different times in different parts of the world. The same is true for the subsequent Bronze Age.

Bronze, which is copper alloyed with smaller amounts of tin, was first produced in Southeast Asia about 4500 B.C., possibly by an accidental mixing of copper and tin ores. Metalworkers found that bronze was harder than copper and had superior casting qualities—ideal attributes for fashioning improved tools and weapons.

The knowledge of copper smelting later proved invaluable in learning to smelt another metal from its ores—iron. Although iron (and steels) quickly became the world's most-used metal, science continued to develop an ever-growing number of uses for copper and bronze.

The "Age of Electricity" that began in the late 1800s was in effect a second Copper Age. No other affordable metal matched the electrical conductivity of copper or was available in the huge amounts needed for the countless millions of miles of cable and wire that electrified the world.

So azurite and malachite, those two colorful, copper-carbonate minerals so sought-after by collectors, occupy exalted positions in the history of minerals and metals. After all, our 7,000-year-long succession of metallurgical advancement began when an Asian metallurgist, for unknown reasons, heated those two copper carbonates in a drafted charcoal fire.

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