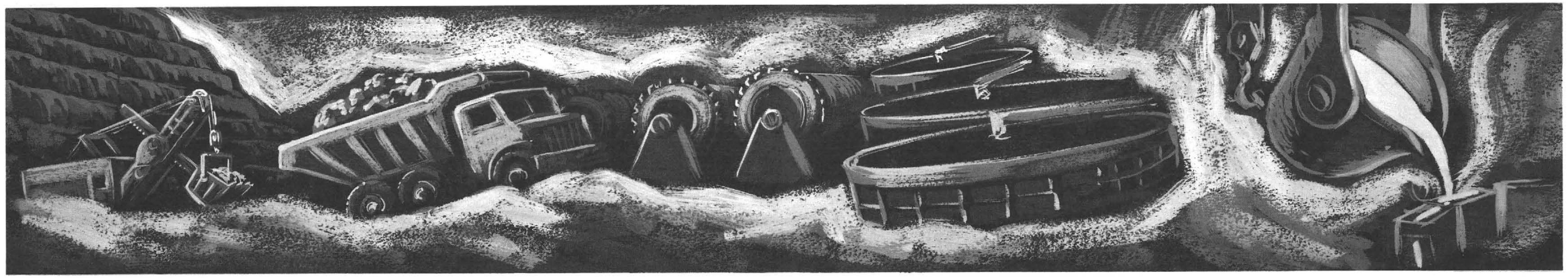

found ways of digging into the earth to take out the rocks containing high percentages of copper. Then these "bonanza" deposits were used up too, and man was forced to find ways of extracting copper from low grade ores.

Today, the average copper mine in Arizona is working ores that contain an average of only 12 or 13 *ounces* of copper for every 100 *pounds* of rock mined. A penny weighs only 11/100ths of an ounce; so it would take just about a whole pound of ore to gather enough copper to make a single penny.

Today copper mining is a mass production operation which depends on huge volume and absolute efficiency to make a reasonable profit for the thousands and thousands of people all across the country who have invested their money in it. It works on a very narrow margin of profit, and therefore it cannot afford to take any chances or make major mistakes.

After the geologists and geophysicists find an orebody and the engineers decide there is convincing evidence that there is copper-bearing rock of sufficiently high grade and quantity to justify further expense, the tremendous task of development is begun. In one Arizona mine, the company began excavating in 1964 to remove 200,000,000 (two hundred million!) tons of worthless earth in order to get down to the copper bearing rock by late 1969. The cost of removing this much barren overburden was expected to be more than $50 million!

When at last the ore is uncovered, copper mining then consists of a series of massive operations carried out with the precision of a well drilled army. Tons of explosives are placed in holes drilled in the rock. When they are detonated, hundreds of thousands of tons of rock are broken into pieces. These pieces are loaded into tremendous trucks that carry as much as 120 tons in a single load, by giant electric shovels that scoop up more than 12 cubic yards in one bite.

The trucks dump the ore into a primary crusher, where it is crushed so that the pieces are not more than perhaps 4 or 5 inches in any dimension. An endless conveyor belt carries it to a secondary crusher, where it is reduced to pieces with a maximum dimension of not more than a half-inch. From there it is conveyed to grinding machines, huge steel cylinders in which are loose, tough steel rods or balls. As the cylinder revolves, the rods or balls and the ore tumble free, and the steel smashes the ore to powder fineness. While it is being ground, the ore is mixed with water. It is ground so fine that it will pass through a screen with 10,000 or more openings in a single square inch. It is nearly as fine as flour or face powder and forms a thin mud with the water.

This "slurry" is piped to a flotation section, where it is mixed with certain chemicals called reagents. These reagents will coat certain of the metallic minerals but will not cling to anything else. When compressed air is blown up through the slurry, bubbles are formed, carrying to the surface the tiny particles of coated metallic minerals, which adhere to them, but leaving the rest of the particles in the bottom of the tank. The coated particles then are floated over the edge of the tank into a trough from which they are piped to a filter which separates the solid material from the water. The residue in the bottom of the tank is retreated until all of the convertible metallics are gathered and the worthless ground rock is piped out to a tailings pond.

The thick paste is called a concentrate, which may contain as much as 30% copper. This is taken to a smelter, where in a series of fiery operations in huge furnaces (twice the size of an ordinary house) the concentrate is reduced to almost pure copper. The heavy copper slabs which the smelter produces are about 99% pure copper, which is pure enough for some uses. But not for the principal uses of copper in the electrical and electronics industries. They must have copper of even higher purity. So most copper slabs are taken from the smelter to a refinery, where, by electrolysis, the copper is made 99.95% pure and the small amounts of gold and silver which were in the ore are recovered. Now the copper is ready to go to work in the Space Age.

It is shipped to factories which make thousands of products, everything from extremely precise instruments for missiles and space vehicles, parts for nuclear submarines, and delicate components for a myriad of machines, to tubing for refrigerators, pipes for plumbing and highly decorative products for home furnishings. Copper is by far the most versatile and widely used nonferrous metal in the world.

And, yes, some of the copper goes to the United States Mint. In fact, a very large amount of it does, for today not only pennies but dimes, quarters and half dollars contain large percentages of copper. There the mint stamps out the coins of the various denominations and ships them to Federal Reserve Banks, from which they are distributed to other banks across the land. The banks supply them to merchants and other individuals, and eventually, after a long, long journey that started billions of years ago, that little bit of copper comes to rest in someone's pocket.

How little and neat it is for having been through all it has!

THE PENNY IN YOUR POCKET

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The penny in your pocket can be just the smallest coin the United States mints, good only to buy a few minutes on a parking meter or to pay part of the sales tax on something you buy.

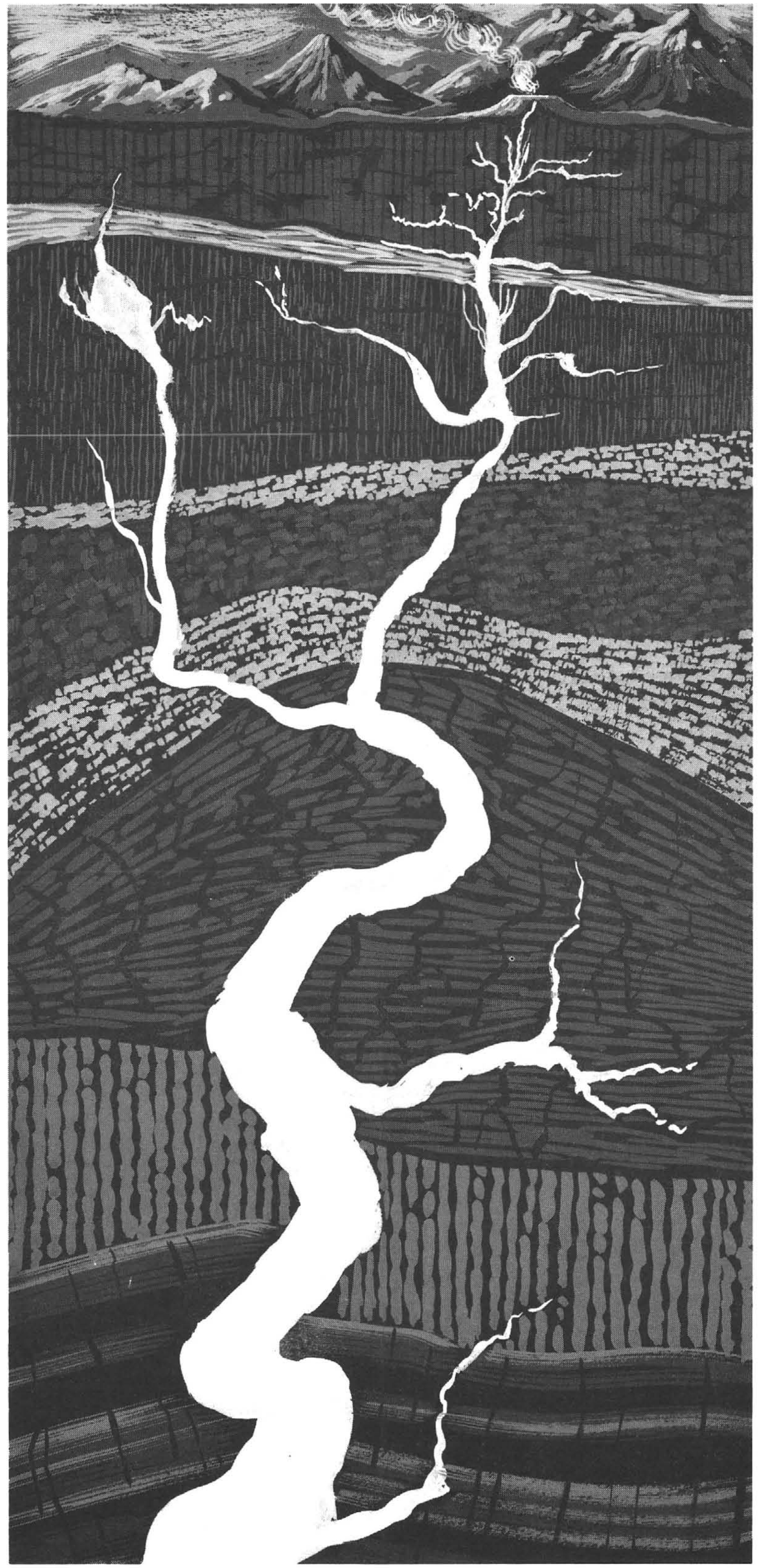
Or it can be a fascinating pocket museum piece. The story behind the penny in your pocket is one too few people know. Ask the average person where his penny came from, and he will say he got in change at a store, he got it from the bank, or something of that kind. Press him further, and he might say it came from the U. S. Mint. He might even say, if you really press him, that it came originally from a copper mine.

But how did the copper get into the copper mine? And how did it get out of the mine to go to the Mint . . . and to the bank and the store and finally to a pocket? Therein lies a marvelous tale.

Millions and millions of years ago, when the earth was being formed into the shape and condition we know it today, the fiery, molten mass in the earth's center contained all of the chemical elements man needs to live in this environment; hydrogen and oxygen, nitrogen, helium and all the other gasses; sulfur, calcium, silica and all the other nonmetallics; and copper, gold, silver, iron, uranium and all the familiar and unfamiliar metals. But all of them were swirling around in one huge, blazing mass. Before they would be ready for man's use they had to be sorted out and made available in the forms we know them today.

Scientists recently have stated that the first lasting hard crust of the earth was formed some 2,800,000,000 (that two billion, eight hundred million) years ago. Then, for many millions of years the finishing touches were put on the earth for man's habitation. Various forms of life were created and inhabited the seas and the lands; some, like the shark and the scorpion, have survived right up until today; others, like the dinosaurs and the sabertooth tiger, have become extinct.

During the same eons great changes were taking place in the earth's surface. Tremendous



seas existed where there is dry land today; swamp forests existed where today we have high, dry plateaus; today's low areas were perhaps thousands of feet above sea level. Gradually this was all reshaped. Fantastic earthquakes broke huge portions of the earth's surface and raised mountains like the Rockies and the Sierra Nevadas out of the bottom of the sea; great volcanoes boomed up through weak spots in the earth's crust and built other mountains, like Arizona's San Francisco Peaks. Finally, relatively recently — only in the last 8 to 10 million years — the major features of Arizona's present topography has been established.

That is the major features only. The earth's surface is changing constantly. It is changing even as you read this. Most mountains are getting lower, most valleys are getting higher as erosion, by wind and water, carves off tiny bits of the mountain tops and sides and carries the bits of rock down into the valleys. Elsewhere, new mountains — like Paracutin in Mexico — are being created by volcanic action. Canyons, like Arizona's Grand Canyon, are getting deeper as the water rushing down them carries rock and sand to scrape away endlessly at the bottom and sides. And every day, somewhere around the world, the earth's crust shifts, now in a major earthquake, now in an almost imperceptible settling. Geologic action is taking place all around us, always; but it is so slow that the only times we notice it is when it occurs suddenly, on a large scale, such as the great Alaskan earthquake of 1964.

As long ago as more than 165 million years molten rock containing large quantities of copper, plus some gold and silver, was forced up through cracks in the earth's surface at a place we now call Jerome, Arizona. Thus was created an ore body, and in this particular one the copper is said to be the oldest in Arizona, probably the oldest in the United States and possibly the oldest in the world. In some parts of the orebody the copper constituted as much as 45% of the rock.

Elsewhere in Arizona — at Morenci, Ajo, Bisbee, Miami, Ray, Superior and the other great modern-day copper camps — copper minerals were formed as tiny particles scattered widely in masses of rock called porphyry. The concentration of the copper-bearing particles varied greatly, in some areas constituting perhaps as much as 10 percent of the total weight of the rock, in others as little as a small fraction of one percent.

Thousands of years ago man first learned to use copper, and it was this discovery, along with the discovery that plants grow from seeds, that led man out of the Stone Age and into more advanced stages of civilization. When at last, during the late 1800's, man learned to harness electricity and make it work for him, the demand for copper increased tremendously. Aside from terribly expensive gold and silver, copper is the world's best conductor of electricity. The demand has been growing ever since, so fast, indeed, that most of the rich deposits of copper ore, like those at Jerome, have long since been used up.

Today more and more uses of copper are being developed. It is used in all manner of electrical devices, including the guidance and other complex systems of Space Age missiles. It is used in making brass and bronze for thousands of industrial products; in plumbing for homes and great office buildings; in parts for automobiles; in ultra-modern decorations for homes; in telephones and clocks and pens and airplanes and pots and pans and bulldozers and thousands and thousands of other products. And, yes, in our coins too.

Not just our pennies. In 1965 the United States Mint started replacing a large part of the silver in our dimes, quarters and half dollars with copper because of the growing shortage of silver. In fact, most people today are familiar with the new "copper sandwich" coins.

All of this usage makes great demands on our copper mines in Arizona and in the rest of the country. Hundreds of years ago copper was found on the earth's surface in almost pure form, called native copper. This was used up, and man