ARCHAEOLOGY

Reversing Corrosion

Chemical method for restoring copper after it has crumbled to dust makes it possible to unroll ancient documents and thus reveal the secrets of the past.

By MARJORIE VAN DE WATER

➤ A DEAD SEA SCROLL, embossed on copper, carried hidden in its rolls directions for finding a buried treasure that may not exist.

For more than 2,000 years this tight little roll of metal lay corroding in a cave near the Dead Sea. The désert's dry sandy winds blew into its hiding place. The metal crumbled to dust. Besides the dust, only a cement-like crust remained.

When it was discovered, scientists were searching for archaeological riches after the first sensational Dead Sea scroll had set off a wave of religious interest and speculation.

Instead of the sheepskin or papyrus of the first finds, this roll of ancient embossed letters was of the supposedly more lasting metal. Yet it seemed undecipherable because it was impossible to unroll the brittle crumbling metal.

Because scientists were so eager to read the hidden words in the scroll, a Baltimore chemist developed a new method to undo nature's destruction. He found a way to restore such corroded copper to its original condition so that it could be unrolled and handled and read.

Most of the large collection of Dead Sea scrolls discovered in their cave hiding places were written on leather in ancient Hebrew or Aramaic letters. Later, tightly rolled, they were hidden near an ancient monastery in Qumran.

One Scroll on Copper

However, this one scroll, of particular interest, was embossed on what had been originally a single strip of impure copper.

When found, it was in two parts so badly corroded the original metal had completely disappeared and was replaced with oxides and salts. The rolls were filled with dust. They were cracked and, in some places, they were broken. The lightest touch would cause them to crumble apart.

The problem that faced scientists was how to unroll this time-ruined roll and unlock for present generations its secrets of the distant past.

Archaeologists, paleographers, Old and New Testament scholars and language experts had combined forces on deciphering the leather scrolls. It was found that some were precious early editions of books of the Old Testament.

Some were records and rules of discipline of an ancient Hebrew monastic order called the Essenes, of whom extremely little was known. This was the order that had occupied the monastery near which the scrolls were found.

Dating by radiocarbon and other archaeological means showed that some, at least, dated back to the second century B.C. or possibly even as far back as the fourth century B.C. As they were deciphered, the scrolls proved to be of the utmost importance both to Bible scholars and archaeologists.

This information made the tightly wrapped copper scroll even more of a challenge.

Working with a grant from the American Philosophical Society, Dr. Alsoph H. Corwin, Johns Hopkins University chemist, undertook an attempt to find a way to treat the crumbling metallic dust of the scroll in order to restore the original copper so that it could be unrolled and manipulated without breaking up and without loss of the embossed letters.

Associated with Dr. Corwin in the work were R. Subramanian and Joseph A. Walter.

Dr. R. J. Gettens of the Freer Gallery of Art in Washington, formerly chief of technical research at the Fogg Art Museum at Harvard, had already developed a method for unrolling one of the leather scrolls so brittle it had defied inspection for years.

Dr. Gettens had some tiny fragments that had broken off the copper scroll. These bits he furnished to Dr. Corwin to serve as samples for his experiments.

Seeing how tiny were the samples, Dr. Corwin realized it would be necessary to make up models for his research that would duplicate in the laboratory the effects of thousands of years in the soil of a Qumran cave.

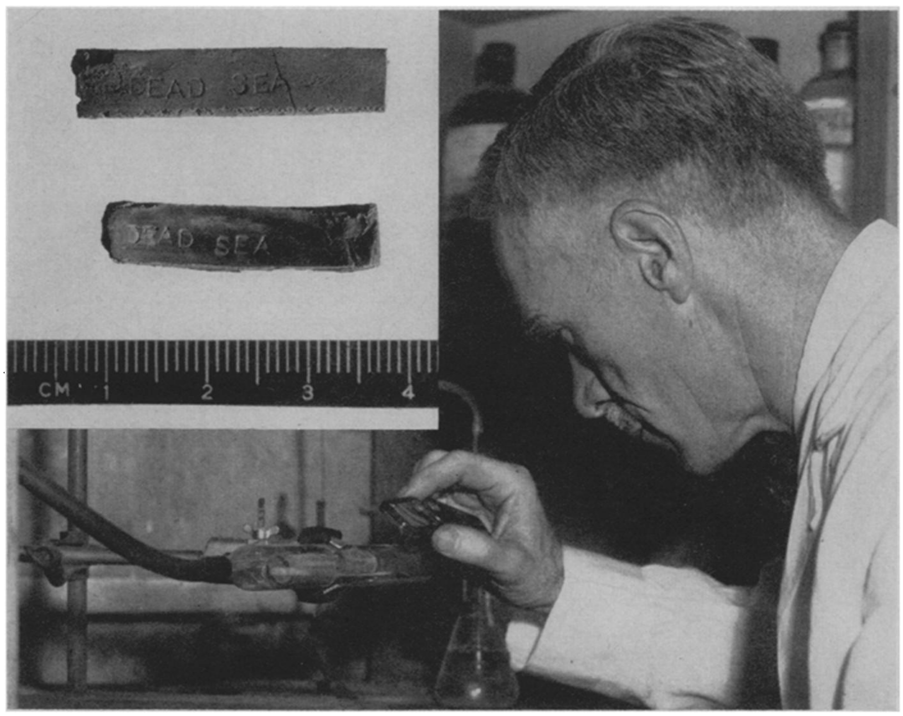
Three Methods Tried

He tried three methods for preparing such a model.

First he tried electrolytic corrosion. That did not work because the convection currents in the electrolyte made it difficult to preserve the embossed letters.

Next he tried gaseous corrosion. This appeared to be working, but it soon was evident that this method would be too slow. He had only a few months for the challenging job.

What he finally decided on was to make up a cuprous oxide paste containing im-



METAL RESTORED—Dr. Alsoph H. Corwin, Johns Hopkins University chemist, at work on a new method for restoring crumbling mass of copper oxide to the original copper with embossed letters intact. Insert shows strips of copper oxide paste, made by Dr. Corwin to duplicate condition of the scroll, on which he made his experiments.

purities similar to those of the original. He made his paste stiff enough so that he could form it. Then he dried it so that he could use it for his restoration studies.

Next step was to compare the actual chemical composition of the original scroll with that of his model. Dr. Corwin found the composition of the corroded scroll by microchemical analysis.

He found that he could duplicate it best by wetting his cuprous oxide paste strip with a solution of cupric chloride. This was found to act as an excellent cementing agent for the strip giving it a physical strength much more like the original scroll.

Now he was ready to try to restore his model strip to the original copper. After experimenting with various materials, Dr. Corwin found that the best way to restore the metal was to put the corroded model into an atmosphere of hydrogen. The strength of the restored metal, he found, could be improved by wetting again with the cupric chloride solution and repeating the exposure to hydrogen.

Now he would have been ready to try out the method on the scroll.

Scroll Not Available

Unfortunately, however, the scroll was not in this country. And, in the meantime, it had already been opened in England by sawing it into segments.

The scientist who did the work there was Dr. H. Wright Baker, professor of mechanical engineering at the college of technology at the University of Manchester. Dr. Baker's method was also, in part, a chemical process.

After a superficial cleaning of the outside of the roll with dental instruments and polishing brushes, Dr. Baker applied a resin coating and baked it in an electric oven for a few hours at 40 degrees Centigrade. Now it was tough and could be safely handled.

Then, using a special saw less than two inches in diameter and only 0.006 inch wide, Dr. Baker cut the scroll into small segments that could be lifted off.

In some cases, he found that a stony material had formed from the desert dust blown into the roll in the cave. This acted as a cement to fasten adjoining layers together. Where this occurred, the layers were cut or forced apart. Patches of corrosion products were cut away with dental drills.

No Letters Lost by Cutting

Of more than 3,000 letters on the scroll, only five percent were missing and an additional two percent were not clear. However, none of these were lost in the cutting, because it was possible in each case to make the cut in blank spaces between columns.

The message which was revealed, when all the segments had been transcribed and translated, proved to be the directions for finding buried treasure—the oldest such document ever found.

The treasure itself, if it really exists, has not yet been unearthed, however.

Another achievement by Dr. Corwin of more immediate practical interest to archaeologists and museum directors was development of an electrolytic method for restoring ancient corroded bronzes.

Sodium hydroxide, used previously as the electrolyte for such cleaning, left a residue of stannic oxide in the pores of the restored bronze object, Dr. Corwin found. This residue was not only dulling, but harmful, because it would later adsorb corrosive chemicals and so cause future corrosion.

Experiment showed Dr. Corwin that following the alkaline restoration with repeated electrolysis, using a sulfuric acid solution as electrolyte, did away with the residue and greatly improved the appearance of the object.

Then a final polishing treatment done in an electrolyte of phosphoric acid, dioxane and water left the bronzes bright and relatively resistant to future corrosion.

The cleaning time was only about 15 minutes. And no arduous hand cleaning at all was required.

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Pakistan and India together produced 97% of the total world supply of *jute* in 1956.

The cost of keeping one *rat* on farm premises starts at $10.