Water Means Life

"OH, IT'S JUST WATER!" You have probably heard people say something like that. But does this wet substance really deserve to be put down in that way? After all, life itself started in water more than 3 billion years ago. More than 400 million years ago, the first living creatures left the water to live on land.

Even though those creatures no longer lived in the water, they still could not live without it. Water has left its mark on all living beings for all time. It takes part in the biochemical processes that occur in living cells. It serves us by dissolving our food and carrying off the waste products from our bodies. Water makes up forty percent of the human body.

How Much of the Earth is Earth

Some time ago our planet was given the name "Earth" and similar names in other languages. Those names were based upon a world view that was prevalent at that time. Today as we move our finger around the globe or our

planes around the world, we can get a more accurate picture of reality. We know that what we call the "Earth" is, for the most part, water. Three fourths of the globe is covered with water. Water is one of the most common substances found on our planet.

No other planet in our solar system has even nearly as much water in liquid form. There are two main reasons for this. The first is because it has "just the right amount" of sunlight. The second is because it has gravitational forces. The sunlight keeps most of the water on the earth in its liquid state. The gravity prevents the water vapor from escaping into outer space.

Six Percent Fresh Water

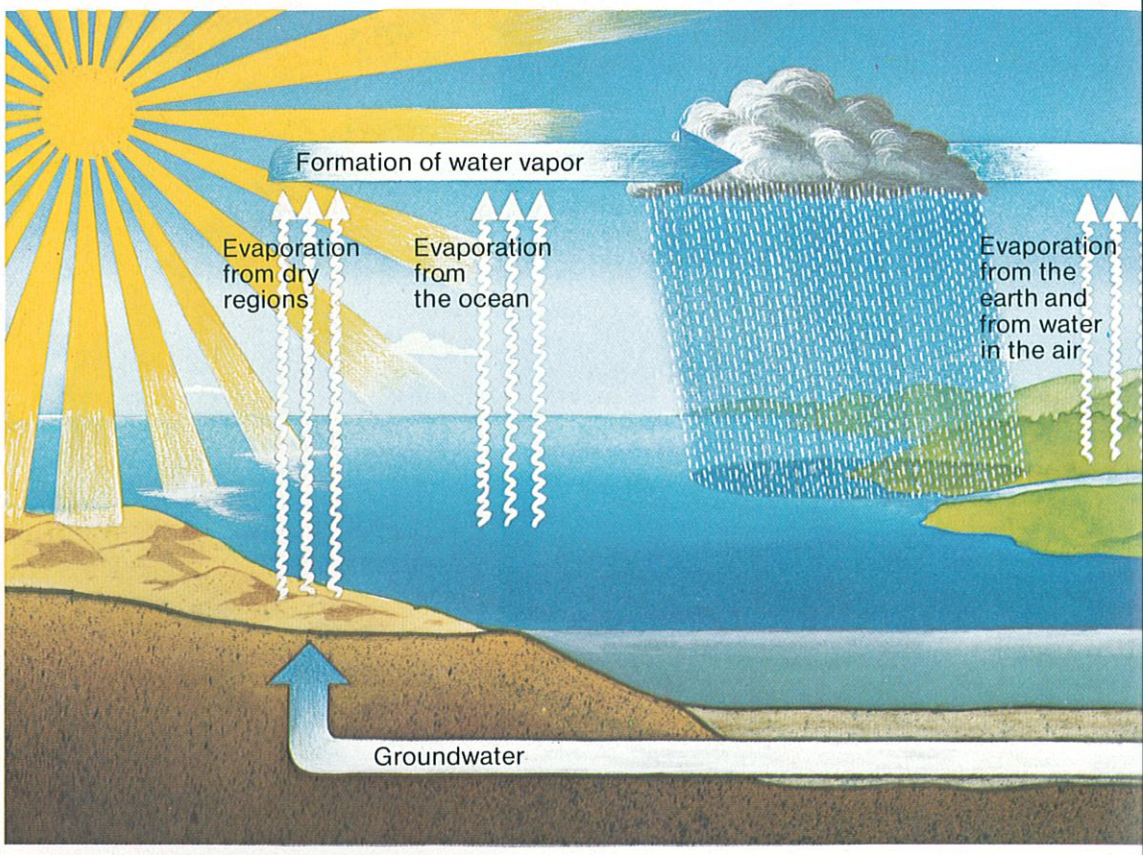
An estimated 94 percent of the water found on the earth is contained in the oceans of the world. The other six percent is fresh water and, of that, one third is located around the polar regions.

Plate 1:1

Water vapor escapes into the atmosphere after it evaporates from oceans, inland waters and plants. The amount that escapes in this way, however, is relatively small. Only one part in 100,000 of the total amount of water on the earth can be found in the earth's atmosphere. What is more, the length of time that the molecules remain there is very short. On the average, about ten days pass from the time they evaporate until they return again to the surface of the earth.

A Never-ending Cycle

How does water get to the land masses? What path does it follow to get there? This seemingly simple question concerning the earth's own water management system was not always so easy to answer as it is now. It was not until the last century that anyone was able to completely account for the total influx of water to a certain region through precipitation alone. Precipitation, runoff and evapora-



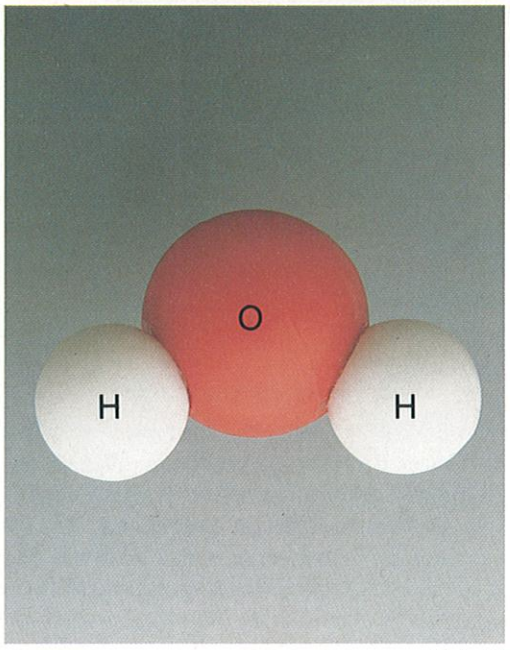


Plate 1:3

Hydrogen (H) *Oxygen (O)*

tion make up the elements of a continuous natural cycle. The formula that summarizes the water cycle mathematically is represented by the equation:

$$P = R + E + C$$

Where:
P = Precipitation
R = Runoff
E = Evaporation
C = Change in water storage (Storage in inland waters, glaciers, groundwater etc.)

An Amazing Substance

H_2O is the formula for the chemical compound we call "water". Two "small" hydrogen atoms and one "big" oxygen atom make up each water molecule.

What is important in this regard is the fact that the oxygen atom has two negative charges and that the hydrogen atoms are both positively charged. Because the centers of the

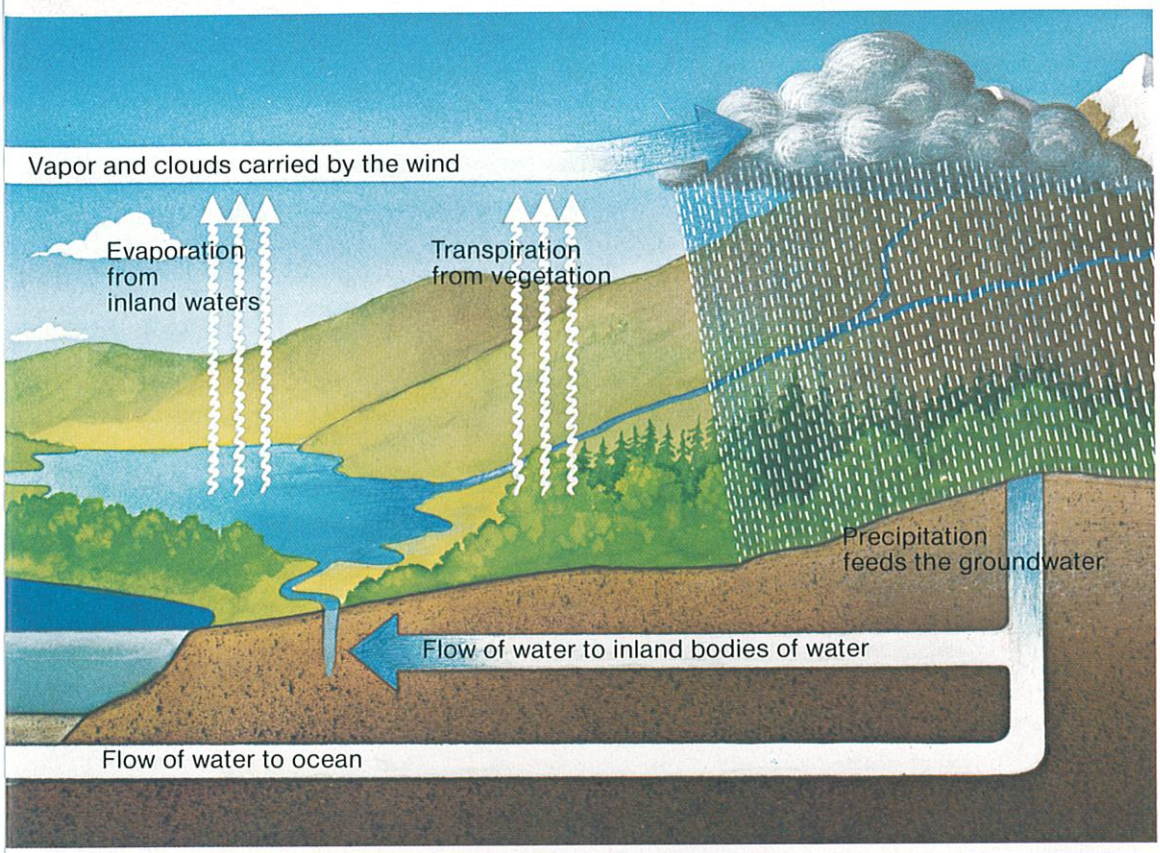
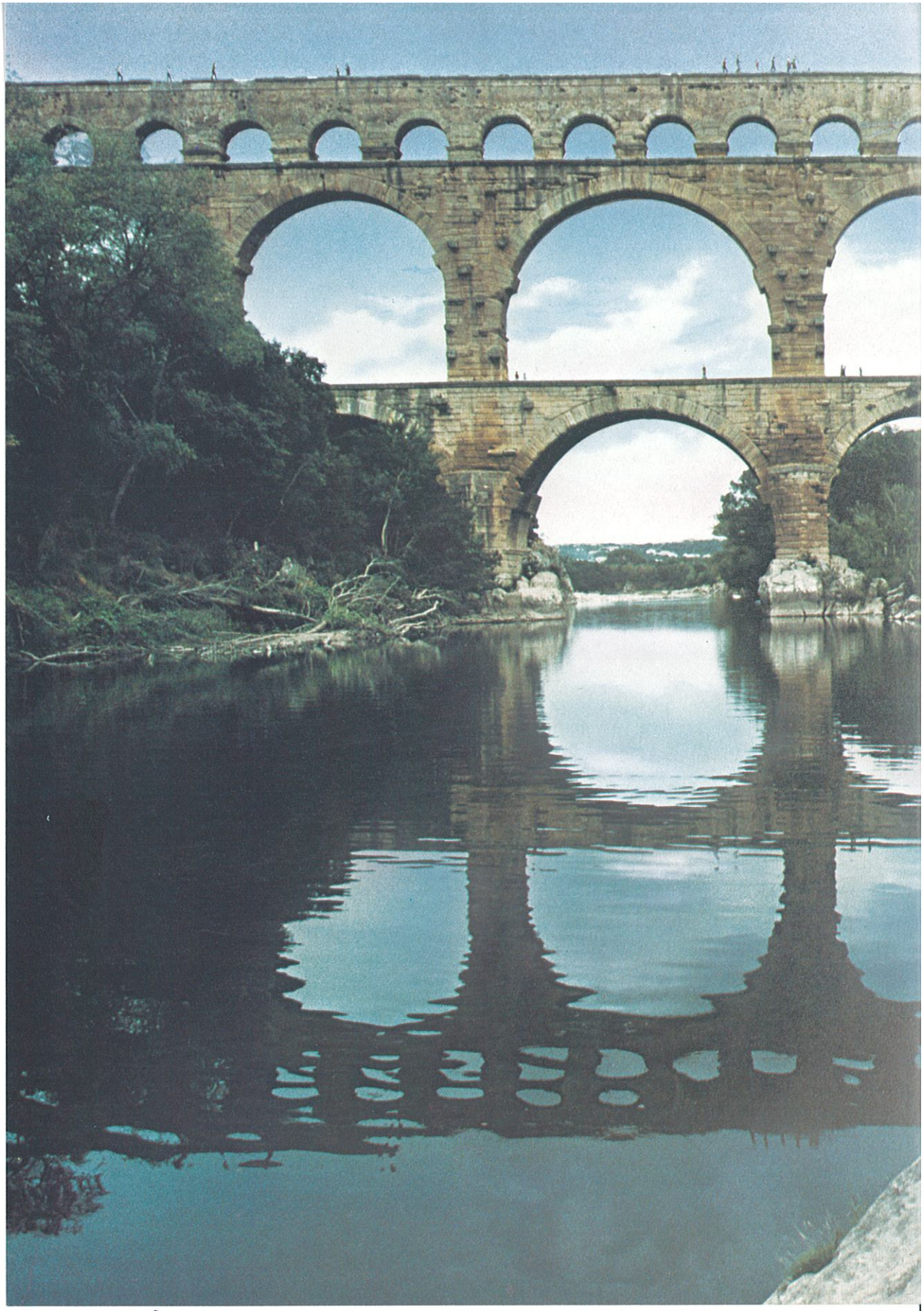
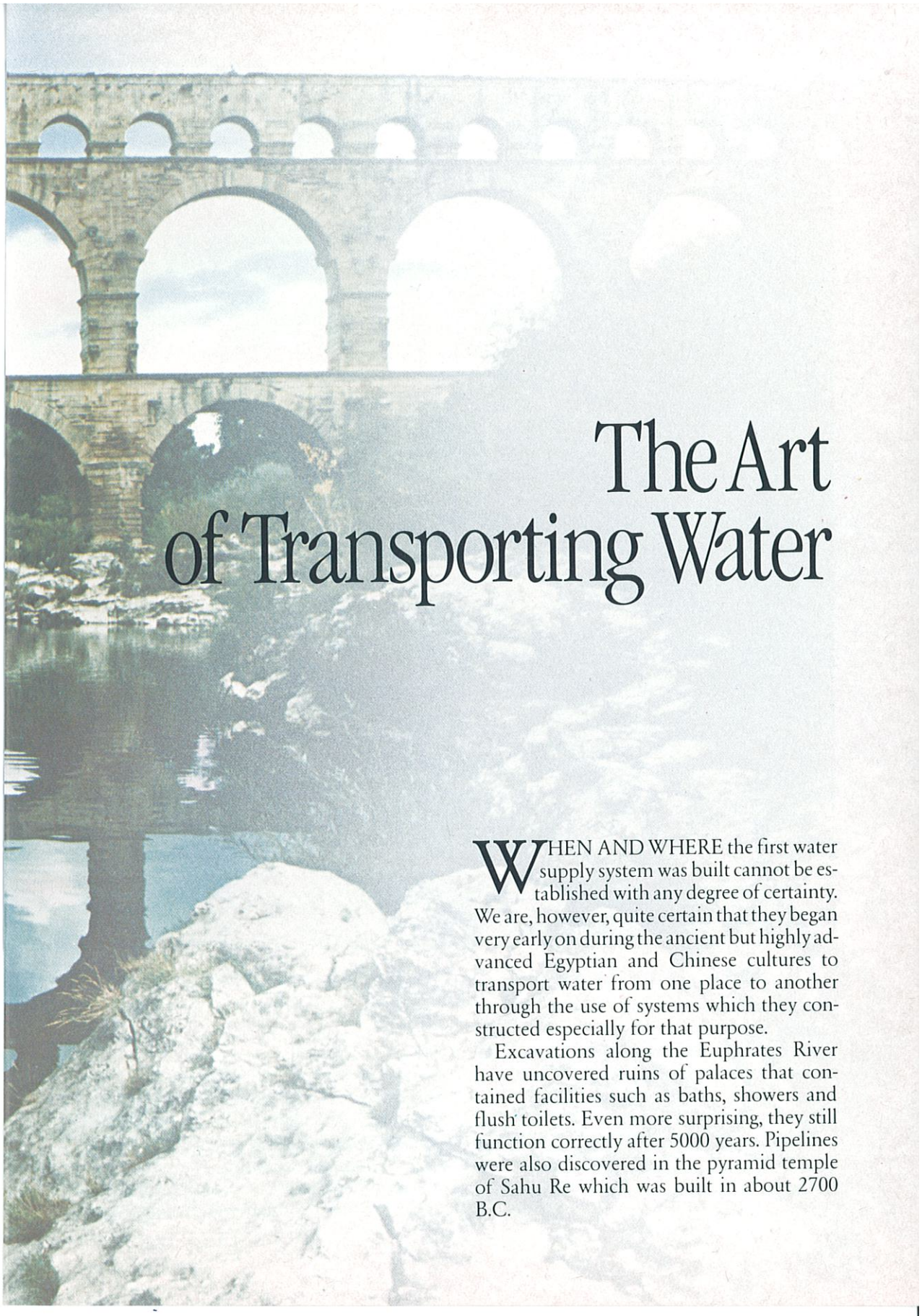


Plate 1:2

electrical charge are not symmetrically arranged in the molecule, a polarized union or a so-called "electrical dipol" is created. That fact has a strong influence on the consistency of the substance we know as water.

"By all rights", the boiling point of water should be −112°F. (−80°C.) rather than 212°F. (100°C.). Another effect of this lack of symmetry is the strongly pronounced ability of water to dissolve other substances. The fact that water attains its greatest density at 39°F. (14°C.), that is, at a temperature above the freezing point, is a characteristic for which we as humans can be quite "thankful" in retrospect. It allows the solid form of the substance to float on top of the liquid form. That is quite different than with most other substances. If this were not the case, the polar seas would freeze from the bottom up. The final result would be that few if any of the life forms we know today would have ever come into existence.





The Art of Transporting Water

WHEN AND WHERE the first water supply system was built cannot be established with any degree of certainty. We are, however, quite certain that they began very early on during the ancient but highly advanced Egyptian and Chinese cultures to transport water from one place to another through the use of systems which they constructed especially for that purpose.

Excavations along the Euphrates River have uncovered ruins of palaces that contained facilities such as baths, showers and flush toilets. Even more surprising, they still function correctly after 5000 years. Pipelines were also discovered in the pyramid temple of Sahu Re which was built in about 2700 B.C.

Clay Pipes Are Not New

The convenience of using a public bath was already available in Asia Minor over 4000 years ago. The water needed for those facilities was supplied by pipes made of fired clay which are very similar to those that are still produced today.

The drainage pipes that were already installed thousands of years ago in India and China were made of the same material.

Clean Water Means Healthy People

The ancient Greeks had already arrived at the insight that clean water serves to keep people healthy and so is an important element in securing the survival of a people or nation. Sport and bathing facilities had public restrooms with constantly running water. In their cities, the Greeks installed water lines made of stone, wood and fired clay.

Supply lines made of bronze or lead also began to be used. A high-pressure supply line

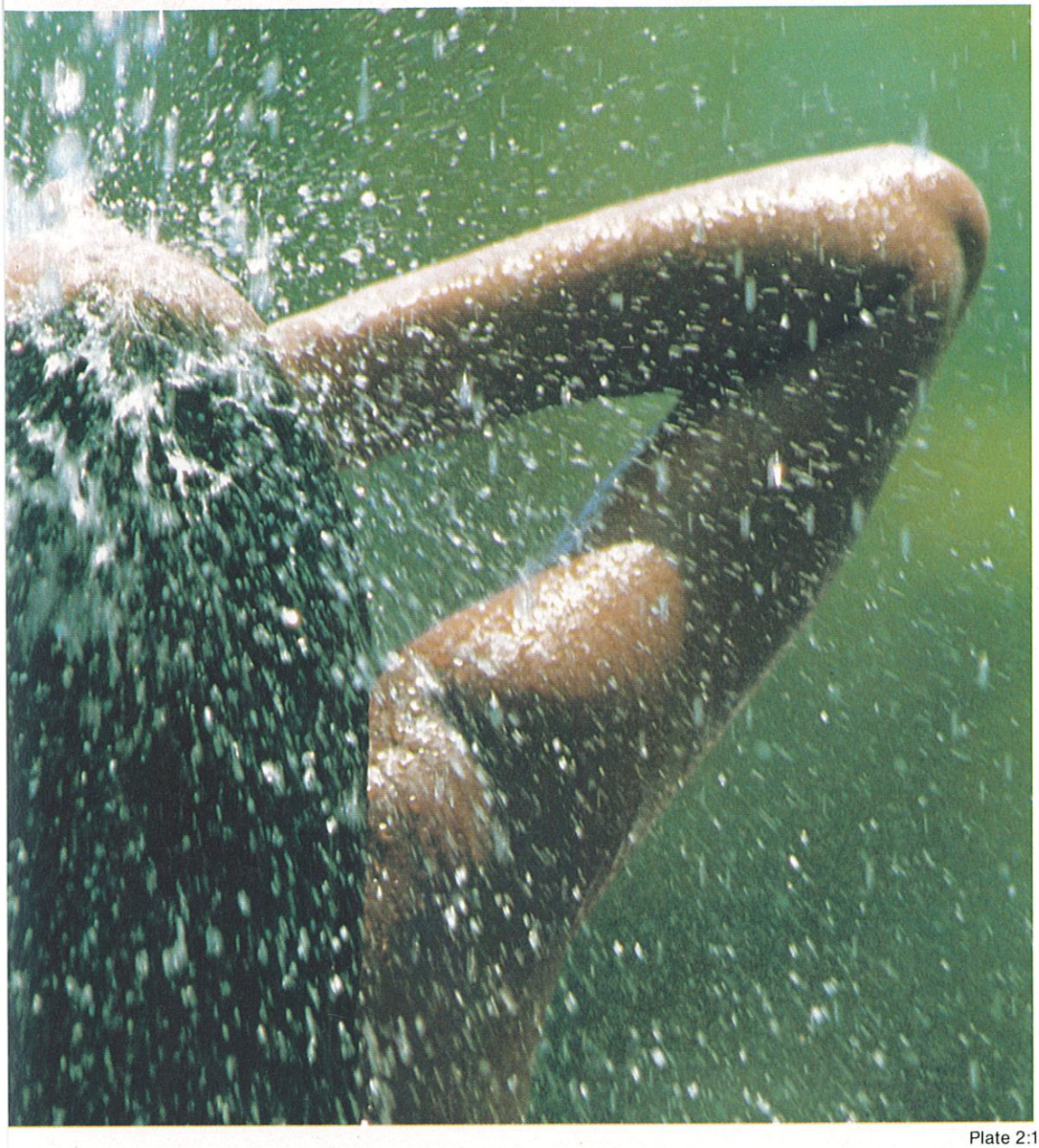


Plate 2:1

made of bronze can be dated back to the 13th century B.C. It was capable of withstanding a pressure of 300 pounds per square inch (20 bar) and was installed in stone tiles drilled for that purpose.

The Deeds of the Pioneers

If there are any people at all who can be considered pioneers in the art of transporting water, the ancient Romans qualify without doubt for the honor. The aquaducts that they constructed, which were truly architectural masterpieces, transported water into the city of Rome. It was a city of more than one million inhabitants who were almost addicted to bathing.

The same was also true of Pompeii as the excavations there have shown. Almost every block of houses was supplied with water by lead pipes. It is surely quite safe to assume that this piping material was detrimental to their health. Some scientists even look upon this as

a secondary cause for the downfall of the Roman Empire.

320 Gallons Per Person Per Day

The Roman aquaducts were fed from springs high in the hills and were then used to transport the water across the valleys. The soil filtered the water that came from the rain and the melting snow. Then the natural force of gravity carried the water in the direction of the city.

The eleven aquaducts that were in use during the age of the Caesars (from 14 to 96 A.D.) supplied the city with an average of 320 gallons (800 l) a day for every man, woman and child in the city. This is more than the per capita average in the modern city of Rome. After the popes saw to it that the structures were repaired and rebuilt following centuries of disrepair, averages of up to 440 gallons (1100 l) per person per day were not unknown.

Still in Use Today

Placed one after another, the aquaducts of Rome would stretch out to a distance of over 260 miles (420 km). Some of them carry water not only at one level but at two or three different levels. The structures are still regarded today as belonging to the technical and artistic wonders of the world.

The decline of these structures began in the fourth century A.D. They started to show signs of destruction and decay. A certain amount of restoration was undertaken in the 15th century. Of the aquaducts that remain standing today, there are a few that still carry water to Rome.

GERMAN INNOVATIONS. A new era in piping system technology began in the year 1455. The Dillenburg Castle in the Westerwald installed a water pipe made of cast iron. Almost 200 years later, the water fountains in the gardens at the Castle of Versailles received their supply of water through cast-iron pipes. During the 18th century, people were discovering more and more concerning the possibilities provided by this new technology. Only 100 years later, the use of cast-iron pipes had become the norm throughout most of Europe.

In the forests of Sweden, wood was the first piping material because it was so abundant in nature. The remains of such pipelines have reached the impressive age of almost 1000 years. In the year 1649, a water line almost 2000 feet (600 m) long was installed for the castle at Uppsala. For the first time, wooden pipes proved to be unsuitable. The water pressure was too high. According to old sources, these wooden pipes were replaced by discarded cannons.

Water Out of the Depths

Mankind has not only searched all around the world for water but also into its depths. Already in the year 150 B.C., wells were dug in China to a depth of up to 2000 feet (600 m). The Roman water workers also dug wells in addition to building aquaducts.

The current record for the deepest water well in the world is held by a well in the state of Montana in the U.S.A. It is 7,320 feet (2,231 m) deep. Today, with all the advances in deep-well drilling technology, we are digging deeper and deeper towards the center of the earth. In July of 1979 on the peninsula of Kola, the Russians set the all-time record for the deepest hole ever drilled: 31,909 feet (9,726 m). According to the latest information, they are still drilling.

***The Archimedian screw** has stirred the imagination of technologists for ages. Here is a drawing of a three-tiered apparatus dating from the time of the Renaissance (Agostino Ramelli, 1588).*

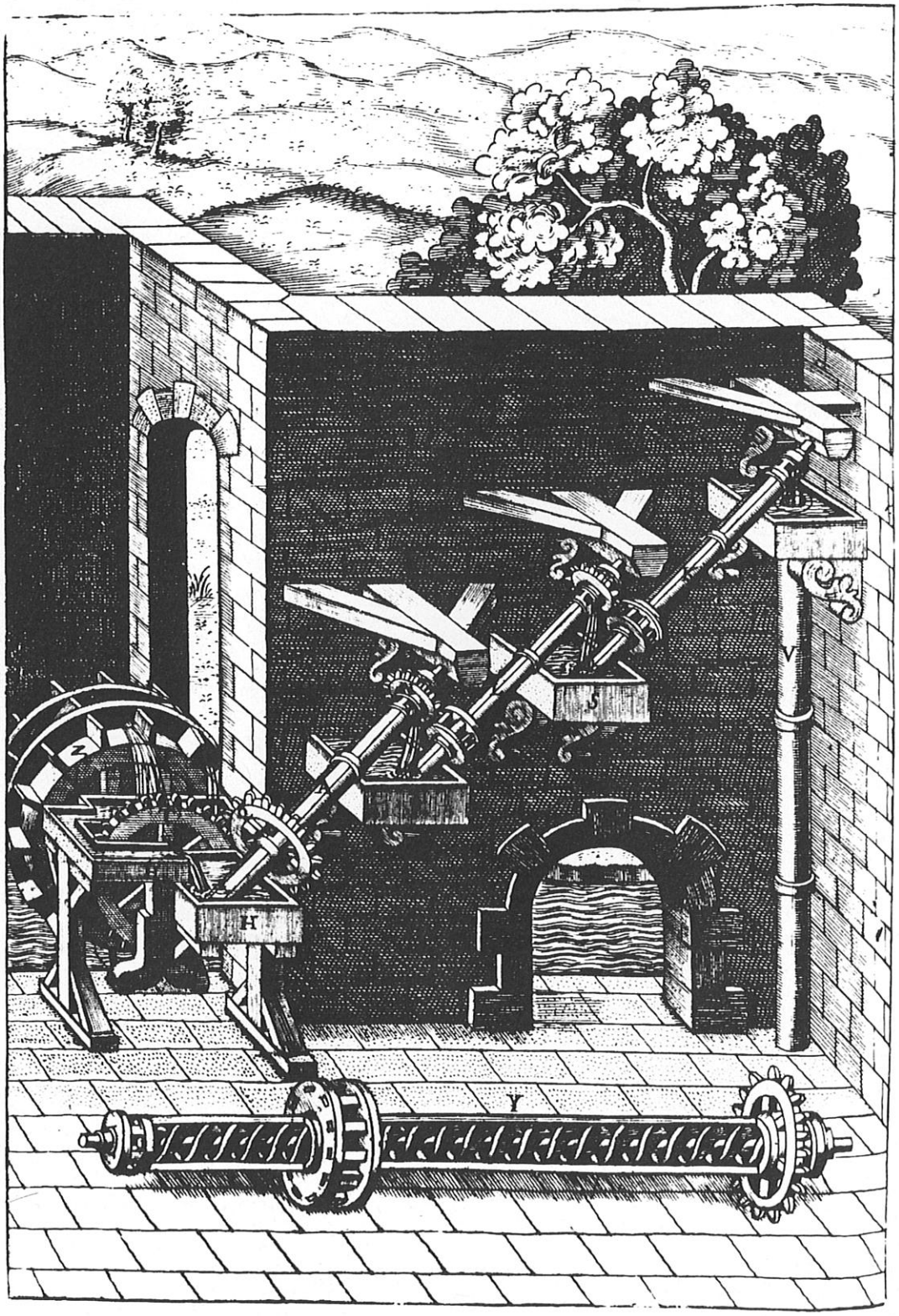


Plate 2:2