# 2017-2020

## EARTH'S OLDEST WATER

A record for the oldest water found on Earth was set in 2013 as researchers found several kilometers deep in a Canadian mine that produces copper, zinc and silver. The water was found bubbling up from a shaft, rather than trapped in solid rock (as is usually the case), and estimated to be between 1.5 and 2.0 billion years old. Considering that scientists place the planetary age at about 4.5 billion years, this water was probably produce and trapped in the Earth's crust as it cooled and could support life. Traces of sulfate and other simple ions in the freshwater suggest that ancient microbes were present and producing fluids over geologic timescales. By comparison, perhaps the world's oldest fossils (tube worms) may have been formed almost 4.3 billion years ago near thermal vents on the ocean floor, where seawater (comprising the entire planet's surface) and nutrient-rich magma were mixed.

## DEUTERIUM

Water is composed of two atoms, hydrogen and oxygen, that exist in several varieties depending on the number of neutrons in their nucleus. These "isotopes" are present in water at ratios that reflect its source, its planetary journey and its interactions with earthly life forms. Deuterium is a stable (non-radioactive) isotope that represents only 0.02% of the hydrogen in water and was likely formed early in the universe's history. Because the lighter and more common isotope of hydrogen is preferentially utilized by biological systems, low-deuterium drinking water has been used to treat specific health issues in humans. By contrast, deuterium-rich water is preferred in nuclear fission reactors because it more effectively slows down the reactions. Recently, an ultra-dense form of deuterium has been created that can serve as fuel for the safer nuclear fusion reactors, which produce only helium and hydrogen as byproducts.

## NUISANCE FLOODS

The term "nuisance flooding" is being used to describe that caused by high tides and routine rainfall events with the accompanying waves along coastal areas of the southeastern USA and elsewhere in the world. The causes of this flooding have been attributed to the combination of land subsidence and sea level rise. Whereas global climate change and sea level rise are now well correlated, it turns out that over-pumping groundwater aquifers and storing water behind dams results in a slight subsidence of the surrounding land. The land only subsides a few millimeters per year, but the cumulative effect on regions with elevations just above sea level is enough to cause chronic flooding (exclusive of major storm events). Since the beginning of the industrial age, humans have engaged in activities that redistribute water on the surface of the planet, affecting everything from watershed dynamics to the spin of the earth.

## WATER COMPUTER

The digital age is dependent on a variety of otherwise inert materials such as silicon dioxide (quartz) and may soon turn to black phosphorus or carbon nanotubes to design computers of the future. Water is a substance one rarely associates with computing, although bioengineers have now designed a computer that utilizes synchronized droplets of water as bits of information within a magnetic field that determines the direction of movement and interactions of the droplets. A water computer typically takes advantage of so-called microfluidics, whereby nitrogen bubbles or magnetics direct the flow of water through tiny tubes. The direction of flow then transmits information. Although water computers cannot compete with their conventional counterparts in terms of speed, the former have an advantage of controlling matter so they can be used in the laboratory to control and automate experiments.

## PLASTIC RIVERS

When one thinks of plastic trash, images of used water bottles, fishing nets and packaging are likely the most common images; however, large plastics are eventually broken up into much smaller fragments, or microplastics, that are the most dangerous to aquatic and marine organisms because they are mistaken for food and ingested. Surprisingly, most ocean plastics are introduced by ten of the major rivers in Asia and Africa (e.g., Nile, Yangtze, Ganges), which can deliver up to 3 million tons of plastic per year. In an effort to remediate the infamous Pacific Garbage Patch, an almost 700-meter long boom was towed offshore from San Francisco. The tube has a 3-meter skirt that allows it to be propelled by the wind in corralling surface plastics, which are then collected by a vessel and returned for recycling. While questions remain about the boom's efficacy, so do concerns about plastics that are too dense to float.

## MARTIAN WATER

That liquid water may have been a surface feature of Mars in the distant past is a hypothesis that has been around for a long time. It is based on water-related minerals present in soils and on large-scale geological structures observed in various regions of the planet. Data collected from low-frequency radar now suggest that there may be actual liquid water underlying Mars' south pole; however, the results can be interpreted in a number of ways. For instance, the water may be solid (as ice) instead of liquid and the data could also indicate a solid form of carbon dioxide (i.e., dry ice) rather than water. Even if liquid water exists beneath the pole, it may not be present as an earth-type groundwater aquifer because of its depth (almost two kilometers beneath the surface) and bottom temperatures (as low as -70° C). Of course, possible liquid water on Mars energizes the search for earth-like life forms.

## DEAD ZONES

News that extensive plots of bottom sediments in the Gulf of Mexico were essentially devoid of any marine life brought the topic of dead zones to the public's attention; however, this is a worldwide issue. Nutrients delivered by the Mississippi River from agricultural runoff along its course initiated massive blooms of marine algae that eventually died and sank to the bottom of the Gulf, where microbes then exhausted the available dissolved oxygen in decomposing algae. While periods of so-called hypoxia have apparently occurred sporadically in the geologic past, the mass of fertilizers and sewage reaching today's oceans has drastically increased the areal extent of dead zones. The prevalence of dead zones in semi-enclosed water bodies such as the Baltic Sea are even greater, affecting commercial fisheries and driving key species into suboptimal habitats or to local extinction.

## CAPTURING WATER

In a previous insight, the topics of rainwater harvesting and runoff capturing were briefly discussed in terms of an alternative to augmenting freshwater supplies via desalination and other energy-intensive practices. Both rainwater harvesting and rainfall capturing that use catchment or green roofs, respectively, can reduce the volume of runoff diverted into stormwater drainage systems. Whereas the fraction of precipitation diverted from surface water runoff by harvesting varies (<10% to almost 60%) depending on weather and site conditions, total and peak flows are reduced. Green roofs can cut surface runoff by as much as 90% and delay peak flow times and volumes, with the resulting water quality (as nitrogen and phosphorus only) dependent upon substrate composition, geotextile type and plant species. By comparison, pathogens and organic pollutants are ubiquitous constituents of conventional urban runoff.