# Water in Extreme Environments: Science Background for Educators

If learners complete the *Engineering a Water Reuse Process* pathway, they learn that water is important for many life systems and can have variable quality depending on different contaminants. This Science pathway, *Water in the Solar System*, explores how scientists investigate water on Earth and in the solar system, and that organisms need water to survive. In planetary science, scientists use the concept “follow the water” to search for traces of life—or of past life—because of how interconnected water is with life.

Earth isn’t the only ocean world in our solar system. Water exists in many forms (ice, water vapor, and even liquid) on moons, dwarf planets, and asteroids throughout our solar system. The Science pathway focuses on where water exists throughout the solar system, making distinctions among four “reservoirs” —surface, subsurface, atmosphere, and planetary rings. Learners explore the importance of water in their lives and in the greater context of supporting life in the solar system and universe.

Planetary scientists try to answer big questions such as

- Where is there water or signs of past water, in our solar system?
- How much water is out there, and can we get to it?
- Can life survive in the water, or could life have been sustained in the water?

Learners discover that although we have access to vast liquid water sources on Earth, there is more water locked in frozen sources in the outer reaches of our solar system. This is not by coincidence, as scientific evidence suggests that during the formation of a planetary system like our solar system, water, as water vapor, and other materials that readily evaporate are pushed out to the outer part of the solar system. These materials become more stable in the colder reaches away from our Sun, as solid ice. Astronomers see this distribution in exoplanetary systems too. In planetary systems that orbit different stars, water and other readily-evaporated materials get distributed away from the central star and condense into their solid forms, as ices, in the outer planetary reaches. This is why most planetary systems like ours have rocky planets near the central star and gas giants and ice giants at the outer reaches: the gases and ices have been pushed to the outer parts, where they are more stable.

## Habitability

In the Science pathway, learners use a variety of investigations to understand how water is distributed by volume, distance from the Sun, and location (surface, subsurface, etc.) on different planetary bodies (planets, dwarf planets, moons, and asteroids). They also learn about the concept of habitability, or how suitable an environment is to live in. There are many factors that make an environment inhabitable or uninhabitable, like temperature, salinity, radiation, toxicity, phase (that is, solid, liquid, gas), or the availability of nutrients. Although popular culture often portrays aliens as "little green men," bacteria, bacterial colonies, and other types of microbes are the life-forms most likely to have existed in other environments in our solar system.

Scientists search for water and signs of past water throughout our solar system using a variety of techniques. Spacecraft orbit and fly by planetary bodies, sending back data about their surfaces, including the likelihood that water is present. For example, the Europa Clipper mission is designed to study Jupiter's moon Europa. On some planets, like Mars, rovers and landers can send back data and images from the surface, showing us features up-close, and giving us information about whether water or signs of past life could be present. Future missions like the Mars Sample Return could send samples back for detailed analysis in the laboratory.