Let's Talk Water – Water Quality

By Dr. Mike Strobel

The quality of water is dependent upon the types and concentrations of dissolved constituents. All natural waters have some dissolved components. Rain and snow form in the atmosphere and absorb gases found in the air. In addition, rain and snow form as condensation on dust particles, so the composition of the dust also can affect the precipitation. Once the rain or snow reach the earth's surface and either runoff as surface water or infiltrate as ground water, they begin to interact with the soils, rocks, plants, and other natural and manmade items they encounter. The longer water stays in contact with something, the more probable that the chemistry of the water will be affected by the interaction.

Just because water contains other chemicals and compounds certainly doesn't mean the water is contaminated or harmful. In fact, many of the chemicals dissolved in water are important for human health, such as calcium, magnesium and iron. As many have pointed out in the past, often the only difference between a healthy supplement and a poison is the dose. In small quantities, many things have beneficial qualities. In large quantities, the same things can be harmful or deadly.

Scientists typically evaluate natural water quality based on major ions, minor ions, and trace elements. Major ions include calcium, magnesium, potassium, sodium, carbonate, bicarbonate, chloride, and sulfate. We often will refer to water by these major ions, such as a calcium-bicarbonate-type water or a sodium-chloride-type water. These constituents usually are dissolved by the water as in interacts with soils and rocks. As one would expect, water in a limestone aquifer (limestone is made up of calcium carbonate) typically is a calcium-bicarbonate-type water. Water in shale might be a sodium-sulfate-type water. The soils and geology can strongly influence the chemistry of the water. And the longer water is in contact with a rock type, the more it can dissolve the rocks and concentrations will increase. Therefore, not only do scientists look at what is dissolved in water, but also how much is in solution (often described in concentrations of milligrams per liter or micrograms per liter).

Minor ions include such things as iron, manganese, fluoride, nitrate, strontium, and boron. Many of these minor ions, although typically in lower concentrations than the major ions, can be important for human health but also can be undesirable or harmful in high concentrations. For example, iron is a necessary mineral for humans, but in high concentrations, iron can cause discoloration in water and mineral deposits in pipes, sinks, bathtubs, and toilets. Nitrate in high concentrations can have harmful health effects on humans, especially in babies. Fluoride is an additive to water in many locations because of its benefit to healthy teeth, but in high concentrations, it can be harmful.

Trace elements usually are present in natural waters in very low concentrations; a few micrograms per liter (parts per billion) or less. Trace elements consist of a wide range of chemicals, including arsenic, lead, selenium, cadmium, and chromium. Typically, trace

elements can be harmful at high concentrations. In Nevada, arsenic occurs in most natural waters because of the geology. The U.S. EPA has recently lowered its maximum contaminant level (MCL) for arsenic in public water supplies from 50 micrograms per liter to 10 micrograms per liter. Many Nevada communities will have a difficult time finding ways to meet this new standard. Selenium is another element that benefits human health in low concentrations, but at higher concentrations, it can be toxic.

Other ways scientists describe water quality includes characteristics, such as hardness, pH, and dissolved solids. Hardness is a measure of the amount of calcium and magnesium in water and it affects the ability of the water to lather with soap and to cause scaling on pipes. The hardness of water is classified in milligrams per liter of calcium carbonate as 0-60 (soft), 61-120 (moderately hard), 121-180 (hard), and more than 180 (very hard). The pH of water indicates its reactive characteristics. Low values of pH (below 4) indicate acidic water that can corrode metals. High values of pH (above 8.5) indicate alkaline water that can result in scaling when heated. Dissolved solids are the total amount of minerals dissolved in the water. This is measured in milligrams per liter (roughly parts per million) and water below 500 milligrams per liter is considered good. The classification for dissolved solids (in milligrams per liter) is less than 1,000 (fresh), 1,000-3,000 (slightly saline), 3,000-10,000 (moderately saline), 10,000-35,000 (very saline), and more than 35,000 (briny). Seawater is about 35,000 milligrams per liter dissolved solids.

So, evaluating the composition of water can tell us a lot about its water quality. Of course, there are many other constituents that can affect the quality of water, such as bacteria and pollution, but these will be discussed next week when we talk about contamination. If you have any questions, please send them to me in care of the Ely Times or email me at mstrobel@usgs.gov.