DEPARTMENT OF AGRICULTURE, CONSERVATION AND FORESTRY

Maine Geological Survey

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1. Introduction

Water that is naturally corrosive can be problematic for homeowners and, in some cases, can be a health hazard by dissolving lead and other metals into drinking water. New England has recently been identified as one region where there is a higher likelihood of finding groundwater that is naturally corrosive (Belitz et al., 2016). This publication describes why some water can be naturally corrosive and answers some common questions about corrosive water. It also discusses what homeowners and other water consumers can do to be aware of their drinking water quality, and to avoid problems associated with corrosive water.

2. What is corrosive water?

Corrosion is the chemical process in which metal is converted from a refined state to a more stable form, often by combining with oxygen. Rusting of iron (to form iron oxide) is the most well-known form of corrosion, but it can also occur with copper, lead, tin, aluminum, zinc, and many other common metals. Corrosivity is a property of water, which makes it likely to cause corrosion when it is in contact with metal. Most metals deteriorate with time when in contact with any water. However, corrosive water is more likely than non-corrosive water to corrode (destroy or "gnaw") metal. Corrosion happens because of chemical reactions that occur when the water and metal are in contact, such as in a pipe.

No single dissolved substance is responsible for making water corrosive, but several factors can increase the likelihood of corrosion, including softness (a lack of dissolved calcium and magnesium), conductivity (high concentrations of ions), dissolved oxygen, acidity (low pH), and high temperature, such as in water heaters and hot-water pipes.

Iron oxide on a steel baking pan. Iron oxide, commonly known as rust, is the most familiar example of corrosion. Photo credit: Roger McLassus.

3. Can corrosive water be a problem?

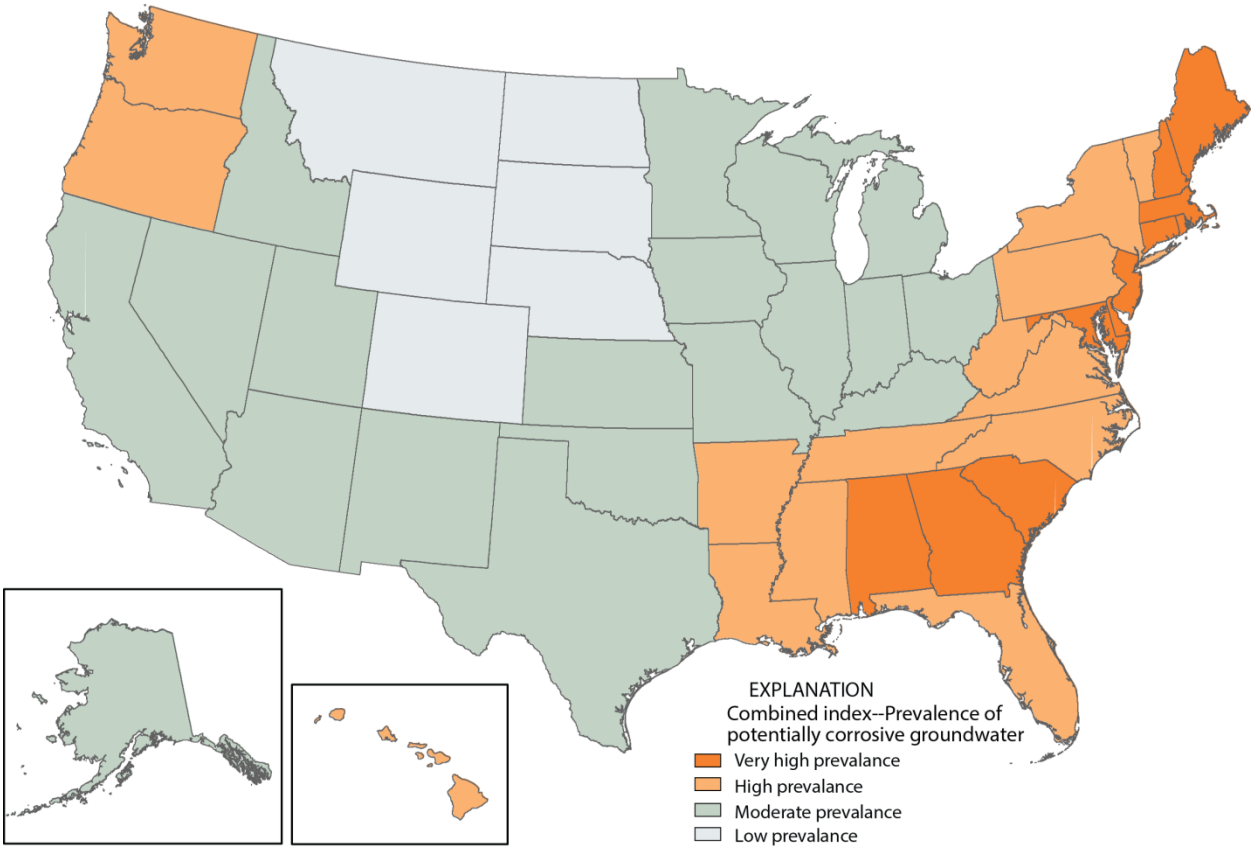
Despite sounding somewhat scary, corrosive water that is otherwise uncontaminated is not unhealthy to drink. The problems with corrosive water occur when it reacts with metal pipes, solder, valves, or fixtures in people's homes. The corrosion of household plumbing can leach toxic metals such as lead and copper from the plumbing into the drinking water. Lead exposure is especially hazardous for children and pregnant women, but can affect the health of all people (US EPA, 2016). Other problems can include leaking plumbing, greenish stains in fixtures, and unpleasant tastes.

Corrosion of a copper water pipe. Photo credit: Bill Warner.

By law, public water systems monitor their water for corrosivity and other quality concerns and correct them with treatment before sending water through the distribution system. As a result, most problems due to corrosive water occur in houses that supply their own water, usually from a private drilled or dug well. However, even homes that use public water can have dissolved lead in the water if the plumbing includes lead pipes, lead solder, or leaded brass fixtures (more common in homes built before 1991).

4. Where is corrosive water found?

Water that is naturally corrosive can be found in all fifty states of the US, in surface water as well as groundwater. Because most households that supply their own water get it from groundwater wells, corrosive groundwater has received the most attention. In some states and regions, including Maine, there is a higher likelihood of finding corrosive groundwater than in others (Belitz et al., 2016), but that does not mean that all groundwater in Maine is corrosive.



Prevalence of potentially corrosive groundwater. Maine is one of 25 states where the US Geological Survey found a high prevalence of potentially corrosive groundwater. This finding does not indicate that any particular source of groundwater in Maine is necessarily corrosive, only that groundwater is more likely to be corrosive in Maine than in other states. Figure from Belitz et al., 2016.

Much of the groundwater in Maine is soft, which means that it is low in dissolved calcium and magnesium. If present in significant amounts, these minerals can prevent corrosion by coating the inside of pipes with a physical scale of solid material (primarily the mineral calcite, $CaCO_3$). Water in Maine is typically soft because of the relative lack of easily dissolved calcium and magnesium in the bedrock in most of the state, with the exception of a few areas that are underlain by limestone in northeastern Maine and a few other locations (Osberg et al., 1985). It must be pointed out that groundwater has the potential to be corrosive at any location in the State of Maine, so testing well water is the only way to be sure.

5. Why should I test my water?

It is impossible to tell if water is corrosive by taste, smell, or sight. The appearance of water also cannot tell you if it is contaminated with lead. On the other hand, it is possible, and relatively easy, to test your water for corrosivity factors, as well as dissolved lead and copper that could be in the drinking water due to corrosion of plumbing or fixtures. If you get your water

from a private well, the Maine Center for Disease Control and Prevention (ME CDC) recommends that you test your water once per year for bacteria and nitrates and every 3 to 5 years for arsenic, fluoride, uranium, radon, lead, and manganese. Any of these contaminants can be found in drinking water in any part of Maine. Tests may also be done for copper and for several simple measures of corrosivity, such as the Langelier Saturation Index (LSI).

The LSI is related to the formation of protective calcite scale inside of pipes. A positive value for the LSI indicates conditions that are favorable for forming a protective scale. A value of greater than 0.5 is considered protective against corrosion, while a value of less than −0.5 indicates that the water could be corrosive (Belitz et al., 2016). More information about testing methods and a list of laboratories can be found at the following website: http://wellwater.maine.gov (ME CDC, 2017a).

6. What can I do about corrosive water?

If you get your water from a private well, then you should test your water for lead and corrosivity, as well as the other tests recommended by the ME CDC, and determine if your home could have lead in the pipes, solder, or fixtures (more likely if built before 1991). The longer that water sits in your home plumbing, the more likely it is to contain dissolved metals. It is therefore recommended to flush the plumbing by running the water for several minutes before using it for drinking, making food, or mixing baby formula. Never use hot or warm tap water for human consumption, because heat can increase the corrosion of metal. It may also be necessary to treat or filter the water to reduce corrosion or unsafe levels of metals, but any treatment system should be designed by a professional based on the results of an appropriate water test. More information about treatment options and methods to reduce lead in drinking water can be found through the ME CDC and US EPA websites below.

7. Other Resources

More information about corrosive water from The Pennsylvania State University Extension (Penn State Extension, 2017): http://extension.psu.edu/natural-resources/water/drinking-water/water-testing/pollutants/corrosive-water-problems

Maine Center for Disease Control and Prevention (ME CDC, 2017b): http://www.maine.gov/dhhs/mecdc/environmental-health/eohp/wells/index.htm

US Environmental Protection Agency (US EPA, 2016): https://www.epa.gov/ground-water-and-drinking-water/basic-information-about-lead-drinking-water

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