CLIMATE CHANGER: TURNING CARBON INTO ROCK

Sometimes I just shake my head when politicians just don't get it. Things like U.S. Energy Secretary Rick Perry's recent denial that carbon emissions have a significant role in climate warming, and Donald Trump's recent decision to pull out of the Paris climate agreement.

As a proud American, I'm doubly ashamed that our nation is the highest per-capita carbon polluter, and that our present federal government refuses to cooperate with other countries on this critical problem.

And then there are those times when I nod my head up and down because others do get it. I'm referring to two very encouraging carbon sequestration experiments reported in "Burying the Sky," in this month's Earth magazine. Author Kate S. Zalzal describes the CarbFix project at the Hellisheidi geothermal power plant in Iceland and the Wallula Basalt Pilot Project in central Washington state.

Carbon sequestration is the natural geological transfer of carbon from the atmosphere to the Earth's crust. Carbon capture and control is the engineered acceleration of that transfer, the pulling of carbon from the atmosphere and permanently storing it on land.

The Paris agreement came from the 2015 United Nations Climate Conference. The conference followed a guiding principle that humans should limit the rise in planetary temperature to about 2 degrees Celsius. This principle came from the fifth report of the Intergovernmental Panel on Climate Change and is based on the best scientific and economic analyses.

To stay within this range of plus 2 degrees, humanity can dump only about 1 trillion more tons of carbon to the air. Thus far, staying below that threshold has been mostly about reducing emissions by shifting to renewable energy sources such as wind, solar and hydropower. Other approaches involve fuel switching from coal to gas, improving energy efficiency and exploring the next generation of nuclear plants. Unfortunately, it's been exceedingly difficult to decarbonize our energy-rich lifestyles and industries.

Carbon capture and control focuses on the opposite side of the carbon budget equation, the post-emission, permanent removal of CO2 from the atmosphere. "Everything that comes out of the economic analysis," writes Peter McGrail, principal investigator of the Wallula carbon sequestration experiment, "indicates that having [carbon capture and control] in the technology mix is the lowest-cost route."

Carbon sequestration is hard-wired into our planet's biogeochemical cycling. This natural form of carbon capture and control has been responsible for keeping the planet livable for billions of years. The chemistry is straightforward. Raindrops begin as distilled water. They become drops of weak carbonic acid as they fall through the atmosphere. When this carbonized water drizzles over a rock like basalt (crystallized lava), the surface minerals dissolve, releasing calcium, magnesium and iron. These ions then combine with dissolved carbon to create carbonate minerals, most importantly calcium carbonate. The end result is limestone, one of Earth's most common near-surface rocks. In short, natural atmosphere has become the natural crust.

This three-step chemical reaction (acidification-weathering-precipitation) transformed Earth's hellish, Venus-like early atmosphere into one that could support life. During the last 40 million years, the same process was responsible for cooling the planet enough to bring on the recent ice ages.
A wide variety of experimental carbon capture and control projects are underway. Most involve the injection of compressed, liquefied carbon dioxide into deep geological formations. The Icelandic and Wallula projects are turning gas into rock. They inject a mix of water and extracted carbon dioxide underground, guide it to seep through billions of fractures and voids, and let the change to rock take place. Every speck of carbonate rock left underground is a mass of carbon pollution pulled from the air.

At this point, the main issues are the economics of scale. The good news is that there's no shortage of the three ingredients - water, basalt and carbon dioxide.

What I find most hopeful about this story is the seamless cascade of knowledge flowing from geology to chemistry, to engineering and to economics. With luck, the politicians will jump on the same band wagon.