

Bad news for birthday balloons: the global helium shortage, the war in Ukraine, and radioactive rocks

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On January 5th, Gazprom's Amur processing plant, located in far eastern Russia, went up in flames, causing global shortages of helium gas. After Russia's invasion of Ukraine and resultant sanctions, the plant has been left unrepaired by the European engineers qualified for the work. With this supply off the market, helium prices have spiked, kicking off an international race to identify new deposits from Tanzania to Saskatchewan.

Helium is useful for far more than just birthday balloons. Because it is such a light and unreactive gas, it has an incredibly low boiling point of -269 Centigrade. Temperatures that close to absolute zero are required for some of the most advanced industrial and scientific applications, such as magnetic resonance imaging (MRIs), microprocessor fabrication, and quantum computing. So it makes sense that the University of Nebraska, facing supply shortages, paused their fifty-year-old tradition of releasing red balloons at home football games, with medical uses taking priority.

Because it is so light, helium simply floats away into space. Thus, we must look into the earth to find deposits of this gas. Naturally occurring helium comes from one of two sources: primordial helium, trapped in the mantle dating back to the agglomeration of the earth; and radiogenic helium, which is released as the radioactive elements uranium and thorium decay.

Most of my (non-geologist) friends freak out when I tell them that the earth's crust is very slightly radioactive. But we should be very grateful that it is, because it keeps our planet warm and habitable. Uranium and thorium concentrate into granitic rocks, and as they decay, they release alpha particles. You may remember "alpha decay" from high school chemistry, but the particle itself, composed of two protons and two neutrons, is simply a helium nucleus.

Helium escapes these granitic rocks, often assisted by faults and fractures that act as superhighways for the gas. With its buoyancy, helium will rise until it hits a barrier. Crude oil and natural gas follow a similar path, though they come from ancient organic matter like algae, unlike helium's inorganic origins. (Note that "natural gas" is mostly methane, a small hydrocarbon molecule). But with a width of 0.49 angstroms, a helium atom is 26 times smaller than the hydrocarbon molecule octane, one of the principal components of gasoline (remember "high-octane" gas?). Just as sardines will pass harmlessly through a net for catching tuna, helium molecules will escape through rock perfectly adequate for trapping oil. This makes drilling for helium incredibly risky.

But let's take a step back and discuss helium exploration and how we found ourselves in this shortage in the first place. Helium is very rarely found in natural gas wells, but extracting trace amounts can be profitable at the biggest gas processing plants, like those in Qatar. Our current

shortage has geoscientists searching for helium deposits independent of natural gas systems. To find helium, you have to collect a lot of data. Gas samples from groundwater to identify areas where helium is percolating; seismic data collection to identify potential helium traps deep underground, securing permits, and, of course, drilling wells.

All of this can take years and cost millions of dollars before the first gas from a new helium deposit makes it to the balloon. And helium investments have been low over the past two decades as the US government has emptied the Federal Helium reserve. Sales from this reserve, which was built up during the cold war, have depressed helium prices and investments, contributing significantly to the current supply shortage.

Having fewer birthday balloons than normal this year is certainly something we can deal with, especially compared to energy hardships, fertilizer shortages, and the other human consequences of the Ukraine invasion. But we can't take our natural resources for granted. When a geologist watches a red balloon float away, they think of the millions of years it took that helium to form. They picture the confluence of rare conditions to seal and trap the gas. They contemplate the investments and efforts to produce the deposit. I hope that in writing this newsletter, I can help you, my readers, see like a geologist. Once you do, you'll appreciate that even something as seemingly light and trivial as helium has deep earth origins.