Good Riddance!

Where Carbon Dioxide Went, and Why We Don't Want it Back

> "Okay, so we're accumulating more carbon dioxide in the atmosphere than ever before in human history. So what? There was a time in the history of earth when the atmosphere was rich with carbon dioxide, so what's the big deal about the tiny increase we've seen in the last few hundred years?"

Yes, carbon dioxide was once the most abundant gas in the atmosphere, but you wouldn't want to have lived then. And you couldn't have, anyhow.

Our sun came into existence about five billion years ago, and a half billion years later, the globe that became the earth had formed from smashed-together junk left over from the sun's formation. For another few hundred million years, more junk continued to smash into the globe, including one piece big enough to tear off a chunk that became the moon. Geologists call this period of earth's history the Hadean because it was, well, as hot as Hades. It took another few hundred million years for this hellish globe to settle into something more stable, but by about 3.8 billion years ago, the earth had indeed settled down to a world of hot, churning oceans under a thick atmosphere of unbreathable methane, ammonia, and carbon dioxide.

Yet somehow this early earth supported a little bit of life: a really tough, really tiny scrap of life called cyanobacteria. It might have evolved on earth, but some people speculate it's tough enough that it could have survived the space environment and come from somewhere far beyond our solar system. On the hellish earth, it could do one thing well: it could use the chemicals around it and the energy of the sun to reproduce itself. It feasted on carbon dioxide then excreted water and exhaled oxygen. When a cell died, there was no other life around to break it down, so its tough, little corpse settled into the earth, taking with it the carbon it had extracted from the atmosphere, with some of the sun's energy locked into its chemical bonds. These energy-rich corpses eventually became petroleum.

The oxygen exhaled by cyanobacteria reacted strongly with just about everything. It reacted with the methane and ammonia in the atmosphere to make water, nitrogen, and more carbon dioxide. But mostly it reacted with iron to form iron oxide – rust. The earth at that time had lots and lots of raw iron that was particularly hungry for oxygen. So even after the methane and ammonia in the atmosphere had all been oxidized, the iron kept binding up the oxygen. Iron oxide formed beds of material that became the iron ore we mine today.

Earth had so much iron that for billions of years it could capture all the oxygen the cyanobacteria produced. And all that time the cynaobacteria then kept dying and settling into pools of energy-rich petroleum.

Then tragedy struck. About 2.2 billion years ago, the earth ran out of raw iron, and oxygen started to build up in the atmosphere. Geologists call this the "oxygen catastrophe." The world had been stable under its comfortable carbon dioxide atmosphere, but then oxygen came flooding into the air. The cyanobacteria didn't like having to wallow in their own waste; they died in great quantities. But thanks to this oxygen catastrophe, the story of the earth took a turn that allowed us to exist.

Nature evolved creatures that figured out how to use oxygen to pull the energy out of the organic materials the cyanobacteria made. When they did so, they made carbon dioxide. And what did the cyanobacteria do? Well, they burrowed inside these new life forms and established a comfortable home where they could get all the carbon dioxide they needed and be protected from that poisonous oxygen. They became the chloroblasts for algae, the cell organelle that does the work of photosynthesis. This arrangement worked so well that algae throve even while the atmosphere became rife with oxygen. And when the algae cells died, they added their own little corpses to the accumulating pools of petroleum. Over the next billion years or so, they enjoyed a free lunch of carbon dioxide and sunshine while the oxygen content of the atmosphere grew and grew. All the while, the carbon dioxide from the atmosphere got bound up into energy-rich organic compounds and sank into the earth.

When carbon dioxide finally started to grow a little scarce, nature evolved another type of creature that didn't need it at all. Instead of taking in sunlight and carbon dioxide, these creatures ate the algae. They recycled the algae's organic matter into structures that helped them thrive. Then other new life forms evolved, ones that could eat the things that ate the algae. That's how the animal kingdom came to be. Once this first "consumer society" got rolling, there weren't nearly as many tiny corpses to sink into petroleum pools. On the contrary, the game of life was to keep as many carbon molecules as possible circulating in the ecosphere. Anything that sunk out of sight represented a missed meal for some creature.

About 800 million years ago, the variety of life forms suddenly exploded. All the major categories of life, the phyla, came into existence. Life became a hurly-burly competition of plants and animals doing whatever they could to capture the molecules of life for their own use.

Some fossil fuels still did form in this time. Plants could grow in shallow, stagnant pools of water. Once they used up all the oxygen in the water, animals couldn't live there, so there was nothing to consume them. When these plants died, their organic molecules didn't get recycled. Instead they got compacted over the eons and became coal.

And that's the way it was with carbon until about three hundred years ago. All the carbon dioxide that had filled the early earth's atmosphere was either imprisoned under ground in rocks and oil beds or being endlessly recycled by the ecosystem. When cells oxidized carbon compounds for energy, any carbon dioxide they produced was quickly scarped up again by plants. Over these last 800 million years, our ecosystem has evolved

a diverse variety of life tailored to survive in an oxygen-rich, carbon dioxide-poor atmosphere.

Then, about three hundred years ago, the industrial revolution dawned. The industrial revolution wasn't so much about machines as it was about energy. Before that time, humanity had some clever machines, but except for some few windmills and waterwheels, all the energy humanity used came from plants and animals, which kept the carbon cycling between the atmosphere and the ecosphere. With the industrial revolution, people started drawing on the energy stored in billions of years of the accumulated corpses of cyanobacteria, algae, and wetland plants – petroleum and coal. But getting that energy out means putting carbon dioxide back into the atmosphere.

This is the story of the earth. For most of four billion years, carbon dioxide from the atmosphere was being locked into high-energy material and buried in the earth. In the last three hundred years, people have been unlocking energy from the earth and sending the carbon dioxide back into the atmosphere. In these three hundred years, we have been reversing the work of those four billion years. Humanity is smart enough to have figured out how to do this. But are we wise enough to do it without leaving our planet as hot as Hades?

— Doris Hamill