Preface

Two… four… six… eight…

In the most humble opinion of we two typical biogeochemists, everyone should have a favorite element. Ours is silicon. Did you just leap to a conclusion? Computer chips? Solar cells? They're neat, but not why we appreciate… silicon!

We heart silicon because it's at the heart of silica.

Silica is a compound, nominally SiO_2. Silicon dioxide you could call it, if you felt like sounding technical, or silicic acid, when it is dissolved in water. In any event, as molecules go, silica has versatility and a habit of participating in feats of derring-do.

Yes, feats of derring-do, and we don't mean the sci-fi dreams of silica-based life forms. What silica does in real life is cooler than a Horta. If you knew, you'd heart silica, too. That's what the next ten chapters, each telling a scientific tale of silica, are designed to do- make you fall in love with silica.

Silica was there, for example, when life began on Earth. In fact, it wasn't just there, it was key. It was the basis of the silicate rocks that reacted with hydrothermally warmed seawater to produce the solutes (dissolved substances) that reacted with each other and with metals to become the metabolic reactions at the core of all Terran life.

Much later on in geologic time, in the guise of stone tools made and used, silica helped to steer the evolution of human hands, cleverness, and ability to create and comprehend technology, music, mathematics, and complex compound sentences. This enabled us to become what we are today—intelligent and dexterous enough to have, for example, discovered, understood, and put to ubiquitous use in modern technology the piezoelectric properties of silica in the form of quartz crystals (if you press on them the right way, they give off electricity). Sonar, ultrasound, radios, telecommunications, you name it, it probably depends on quartz's piezoelectric effect.

During the billions of years in between the origin of metabolism and the invention of the quartz oscillator, some rudimentary animals, unicellular critters, and land plants developed the ability to biomineralize silica, producing microscopic scales, shells, skeletons, and liths featuring shapes, pores, lattices, grooves, spikes, and processes too fantastic to be matched by any mere human glassmaker (not even the venerable Blaschkas famous for their glass flowers and other equally incredible botanical and zoological glass models). More impressive yet, silica biomineralizers need no flame or furnace. They make their glass at room temperature or cooler. Incidentally, silica biomineralization is so common and widespread that, despite our best (unintentional) agricultural efforts to distill silica out of soils and into sewage systems, the world in your immediate vicinity teems with tons of microscopic, biomineralized glass.

Part of the reason that silica biomineralization is so common is that silica is everywhere. You can't throw a stone without hitting a silicate rock except maybe in the middle of a city (and even there, they're lurking immediately below the pavement, as the granite of fancy countertops, and on the outer walls of grander buildings). The water is full of dissolved silica, too, making it unsurprising that even vertebrate animals like ourselves, who don't biomineralize silica, have a true nutritional need for it. Our skeletons would be weak and malformed, our hair and skin would be a wretched mess, our organs would be falling apart, and our wounds would not heal if we hadn't kept up an adequate daily intake of dietary silica so far throughout our lives. Thank not only our water, but our beer and the plants we eat (especially grains). They're all full of easily digestibly absorbable silica.

All this silica cycling through lakes, rivers, the ocean, and the biosphere came from the dissolution of the silicate minerals that constitute silicate rocks, new ones of which are continually being produced through volcanism. The craziest thing about this slow dissolution of silicate minerals, which is known as chemical weathering, is not that it wipes out mountain belts (although it does), but that it is key to maintaining the pleasant, temperate habitability of Earth. When silicate minerals dissolve, they convert carbon dioxide from the atmosphere into carbonate salts that eventually end up in the ocean. In the longer term, this compensates for the steady release of carbon dioxide out of the magmatic interior of the Earth via such things as volcanoes and hot springs. Without silicate weathering, the surface of the Earth would have long ago baked itself sterile through a runaway greenhouse effect.

Silicate weathering will also mop up all the carbon dioxide we've spewed out via the burning of fossil fuels and forests too. Unfortunately for us, this will take more than 200,000 years. On the other hand, human beings are inveterate tinkerers. We have already found a way to speed up the chemical weathering of silicate minerals that, if it were to be deployed across broad swathes of the warm, wet tropics, could put some brakes on the global warming and climate change we've unintentionally unleashed.

Read on, please, for all the siliceous details.

Lund, Sweden

Christina De La Rocha
Daniel J. Conley

http://www.springer.com/978-3-319-54053-5

Silica Stories
De La Rocha, C.; Conley, D.J.
2017, XI, 201 p. 39 illus., 1 illus. in color., Hardcover
ISBN: 978-3-319-54053-5