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Periodic Table

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Did you know scientists constantly rethink old tools for new times?

Scientists constantly reinvent classic tools to fit the demands of modern science.

Bruce Railsback is one of those scientists. Railsback recently retooled the standard periodic table of the elements for easier interpretation of Earth processes after he realized that his geology students at the University of Georgia in Athens had difficulty grasping geochemical concepts with the conventional version. Chemical and biochemical reactions constantly form new minerals and reform old minerals, through processes like dissolution, crystallization, and even weathering. So geologists rely heavily on chemistry and the properties of elements in order to understand how naturally-occurring elements move around on and in Earth.

Dmitry Mendeleyev created the original periodic table of the elements in 1869, after he discovered that the then-known elements could be organized into groups based on their measured properties. About 70 years later, scientists determined that they could arrange elements in the table based on increasing atomic weight. As new elements were discovered, they fit perfectly into the holes in Mendeleyev's original layout.

The layout of the periodic table has remained virtually the same for the last 60 years. But the demands of science change with the times, and according to Railsback, standard tools often need reshaping. "We've had the periodic table as long as the light bulb. We've improved the light bulb; it seems reasonable to think about using the periodic table in a more sophisticated way," he says.

Railsback is ultimately concerned with visualizing processes and properties. He's also created a diagram illustrating the scale of things ranging in size from a proton to planet Earth. So too, he hopes his new periodic table will tune people's eyes to the natural order of Earth processes. The table is arranged according to elemental charges, rather than their atomic weights. This pinpoints one of the most apparent differences in Railsback's version: One element can appear multiple times, carrying the different charges that it does in nature. If you are like many geoscientists, this is a welcome change. It is often difficult to determine the charge on an element in the standard periodic table, causing us to rely on faulty memorization, guesswork, or more chemistry-inclined colleagues.

Rearranging the periodic table based on charge seems like a simple revision, but it is ultimately one that streamlines the table based on the dictates of natural processes. As Railsback discusses in his September, 2003 *Geology* paper accompanying the revised table, the "Earth Scientist's Periodic Table of the Elements" highlights reactions of elements with oxygen. The combination of oxygen with other elements based on their charges drives the most fundamental reactions on and inside Earth.

Basic geochemical concepts also fall out of the new table. For example, elements like aluminum and titanium, which form minerals in soil, group together. And elements that wash out of soils easily, like sodium and phosphorous, also group together. If you look at Inset 7 on Railsback's table, you will notice some red balls. Those are positively-charged ions, called cations. Oxygen is a negatively

charged ion, or an anion, and together the cations and oxygen form stable framework minerals. These are the minerals, like the aluminum-bearing gibbsite and iron-bearing goethite, that survive best in soils.

Railsback hopes that his revision will help earth scientists understand chemical processes. "I certainly have tried to incorporate concepts from across the earth sciences, to demonstrate that it has meaning to a lot of people," he says. Still, it will be difficult to gauge the success of his endeavor. "I've had a lot of people email me and say they think it's neat, and I've certainly given away a lot of copies," he says. Chemists probably won't flock to use the new version. For one thing, it looks a bit overwhelming. "That table looks way too complicated to me to be useful," says chemist Jyllian Kemsley.

But Railsback's fellow geologists give him mostly supportive or challenging feedback. Geochemists studying deep-Earth rocks, who found initial versions of the revised periodic table too limited to surface processes, prompted Railsback to revise again, this time including information pertinent to high-temperature processes. "Most of the comments have been of that sort - not that there was something wrong, but that there was either a gap or at least a sense that it wasn't useful to some folks," says Railsback. "I've tried then to expand its usefulness to meet their comments." As is the general rule in science, this is a work in progress.

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