EDITORIAL

CELEBRATION OF THE PERIODIC TABLE

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The periodic table of chemical elements is one of the most significant achievements in science because it arranges the 118 known elements in a deceptively simple pattern that reveals their properties. So how did this “Rosetta Stone of Nature” originate? Most likely, you will answer Dmitri Mendeleev, the Russian chemist who in 1869 published a version of the periodic table that we recognize today. His table expresses the periodic law: elements arranged according to the size of their atomic weights show periodic properties. To celebrate the 150th-anniversary of this great achievement, the United Nations and UNESCO declared 2019 to be the International Year of the Periodic Table of Elements. But does Mendeleev deserve all the credit? Scientific discoveries rarely arise in isolation; rather contributions from researchers over many years lead to a general picture that eventually emerges. But, sometimes, scientific discoveries are made simultaneously by different researchers. Such is the story of the periodic table.

Among the critical events that led to the discovery of the periodic table was the emergence of atomic theory that had been initially proposed in 1808 by John Dalton, a British tutor and schoolteacher. A key advance was Dalton’s assignment of relative weights to the atoms of elements. But how does one obtain an absolute weight of an atom? In 1811, Italian physicist and mathematician Amedeo Avogadro proposed an idea to calculate atomic weights from gases, but his hypothesis was not widely accepted. It was 50 years later that Italian chemist Stanislao Cannizzaro resurrected Avogadro’s ideas and showed how atomic weights could be calculated unambiguously. Cannizzaro’s paper, published in a local Pisa (Italy) journal, did not attract many readers and was republished as a pamphlet in 1859. Cannizzaro then attended a conference that would change the course of history of the periodic table. In 1860, the first international chemical congress was held in Karlsruhe (Germany) and 140 of the world’s leading chemists attended. The sole purpose of the meeting was to sort out the basic units of chemical interaction and the proper methods for determining unequivocal atomic weights. Cannizzaro’s defense of Avogadro’s ideas attracted great interest and copies of his pamphlet were distributed. Cannizzaro’s action provided the catalyst for the development of the modern periodic table. Chemists Lothar Meyer, William Odling, and Dmitri Mendeleev all attended the conference and were inspired by Cannizzaro’s work.

It was a French geologist and mineralogist Alexandre-Émile Béguyer de Chancourtois who was the first to arrange the chemical elements in order of their atomic weights. He devised a 3-D spiral graph and plotted the atomic weights on the surface of a cylinder that brought similar elements onto corresponding points above or below one another on the cylinder (Fig. 1). He presented his ideas to the French Academy of Sciences and published his work in 1862. Unfortunately, an original diagram was left out of the publication, making the paper hard to comprehend. Although de Chancourtois republished his work with the diagram later, it was largely ignored by chemists. After this, he appeared to lose interest in his idea and returned to other scientific endeavors.

More discoveries of the periodic system of elements quickly followed. John Newlands, a British sugar chemist and private chemistry tutor, noticed trends between elements and their weights, and published his “law of octaves” in 1865. Similar to de Chancourtois, Newlands’ work attracted little attention and his pattern did not hold up very well. Four years after Karlsruhe, British chemist William Odling published a table that included 57 elements. However, Odling’s system also failed to have much impact, and he did not pursue it further. Gustavus Hinrichs, a Dane who immigrated to the United States, published a unique periodic system with the elements in a “bicycle wheel” form, with groups of elements displayed as spokes. Lothar Meyer, an influential German chemist, produced several versions of the periodic table from 1864 onwards. Unfortunately, Meyer’s work wasn’t published until 1870, a year after Mendeleev’s 1869 periodic table, so his contributions are overshadowed by Mendeleev.

The history of the periodic table is a remarkable tale, involving discoveries by six diverse individuals over a seven-year period. There were key discoveries and events such as the 1860 congress that accelerated its development. Mendeleev may not have been the first to develop a periodic system of the elements, but he was a master at exploiting it. The discovery of the periodic table, as we currently know it, in 1869 was transformative, because it freed chemical science from associations with the medieval mysticism of alchemy. The periodic table even provided hints of the existence of subatomic structure that would be discovered in the next century.

There are many lessons to be learned from the history of the periodic table. The discoveries of four of the six discoverers of the table were not recognized until many years after they were published.

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Model of de Chancourtois’ vis tellurique, showing the periodic arrangement of elements.
As we go to press, the Intergovernmental Panel on Climate Change (IPCC) has just released its 2019 “Special Report on the Ocean and Cryosphere in a Changing Climate” (https://www.ipcc.ch/srocc/home/). When the topic is climate change, our reaction is usually “Uh-Oh!” Calls for clean energy, reduced emissions, and consumer activism are a regular part of news broadcasts or casual conversations. Unlike many of the political storms that currently rage in national forums, climate change is truly an international and global problem.

Our last issue of Elements (August 2019 v15n4) focused on the topic of weathering, clearly demonstrating how climate (and CO₂) links to weathering. The articles in “Catastrophic Perturbations to the Deep Carbon Cycle” take the focus on carbon even further by exploring the passage of carbon among the nonliving and living reservoirs from core to surface. The movement of carbon between the deep Earth and the surface plays a critical role in maintaining the surficial conditions that are necessary for life to exist and thrive. Yet, as demonstrated in this issue, there are ample examples of perturbations to Earth’s steady-state condition. What is learned from the study of natural perturbations to the carbon cycle can be used to help frame and understand the impacts of the human-induced perturbation on Earth’s global system that is currently underway.

Anthropogenic sources of greenhouse gases are the centerpiece of most conversations on the topic, yet, in reality, they are just one part of a very complex system of interdependent parts. The Deep Carbon Observatory (https://deepcarbon.net/) has made it possible for the articles in this issue to be Gold Open Access and they will be readily accessible from the Elements website. So, share the articles and help broaden the climate change conversation with your colleagues, students, and policy makers.

Meyer and Mendeleev were both active in promoting their versions of the periodic table, but Mendeleev is the name we recognize because his more complete version was published before Meyer’s version. And there are lessons to be learned for today’s scientists, young and old: read the literature broadly in fields beyond your immediate specialty; there are lessons to be learned for today’s scientists, young and old: read the literature broadly in fields beyond your immediate specialty; publish broadly and wisely; and be active in promoting your ideas once they have the backing of scientific evidence.

How will the periodic table stand up over the next 150 years? How many new elements will be discovered? Will these elements behave the way the periodic table predicts? Can superheavy nuclei be produced in space? Stay tuned … the fascinating story of the periodic table continues.

Nancy L. Ross, Principal Editor

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