I am delighted to invite you with this issue of Elements on a stunning and fascinating expedition to one of Earth’s most extreme, remarkable, and puzzling environments: its alkaline lakes (Fig. 1), which find themselves at a multi-disciplinary interface between geology, geochemistry, mineralogy, biology, hydrology, and geomorphology. I thought I knew what alkaline lakes were all about—until I read the articles in this issue. Now, I know! I also now know not to confuse alkaline lakes with saline lakes, the former being a subset of the latter; a subtle distinction I had not quite appreciated before when using the two expressions interchangeably as if they were synonyms.

The outstanding collection of articles in this issue features all of the different facets of alkaline lakes, each more captivating than the other, from their unique geological settings to their truly bizarre geochemistry and even more bizarre life forms and sprawling ecosystems (how counterintuitive is that?!). Their rare, beautiful, strange, and often ephemeral minerals (Fig. 2)—some existing for only a few hours, then going as quickly and quietly as they came—are a testament to the remarkably delicate chemical balance reigning in alkaline lakes. The role of alkaline lakes as societally important economic resources is also laid out, as is the part they may have played in the cradle of life, not only on Earth but also on Mars where the presence of numerous ancient brine (not freshwater) lakes has been inferred. The astrobiological potential of ancient Martian lakes, preserved because of the absence of plate tectonics on Mars contrary to our dynamic Earth where lacustrine paleoenvironments rarely survive in deep time, is likely to become clearer with upcoming Mars sample return missions. Perhaps the answers to some of the long-standing and still outstanding questions posed in this issue will be provided one day by our younger readership.

Because the notion of alkalinity underpins and controls every aspect of the chemical, mineralogical, and biological dynamics of alkaline lakes, a Toolkit is provided by this issue’s Guest Editors to clearly and logically introduce the basics of alkalinity, an often misunderstood, or simply not understood, concept in the geochemistry community at large. We (the Guest and Principal Editors) hope that this Toolkit will become a valuable resource in the classroom for students and teachers alike and help the general, non-specialist reader, as well as others who wish to educate themselves in the Earth and planetary sciences, to enter the enchanting universe of alkaline lakes on a solid theoretical foundation.

The fact that life exists so unexpectedly plentifully and productively under such extreme and challenging environmental and biogeochemical conditions as offered by alkaline lakes cannot help but make me wonder whether this could be taken as hope for Earth’s seemingly ominous future as we head at breakneck speed, at least compared with the geological timescale, toward far more extreme climatic and hence, environmental conditions than we have ever known before. Might humankind (which just clicked past 8 billion on November 15, 2022), so far accustomed to relatively less challenging conditions than those likely looming ahead for all we can tell, be able to adapt to this unprecedented exigent habitat-to-come in the same way life clearly adapted to the apparently hostile conditions of alkaline lakes? Well, it just might. As my colleague and Guest Editor, Becky Lange, told me in an attempt to defuse the pessimism that has settled over me during the last decade, “Society is just now beginning to stir—at a global level—on adjusting how we use energy, and who knows what might be accomplished in terms of...
ABOUT THIS ISSUE
Alkaline lakes are incredibly dynamic, unique, and fascinating biogeochemical environments. In this issue, a multidisciplinary group of authors uses their diverse insights to portray alkaline lakes’ biogeochemical, mineralogical, and geological importance for both science and society. Across all articles, the approachable discussions of the geochemical, biological, and societal aspects of alkaline lake science seek to portray the characteristics of alkaline lakes that make them unique and stimulate continued explorations of these systems.

The issue begins with a standalone Toolkit, designed to explain the fundamental but often misunderstood concept of alkalinity. From there, the individual articles explore the unique conditions leading to the formation of alkaline lakes, the distinctively productive and unique microbial ecosystems that inhabit them, their distinguishing chemistry and mineralogy, and their potential to have originated life on Earth as well as Mars. Together, the articles in this issue offer a well-rounded introduction to alkaline lakes. While such a collection could never encompass the breadth of knowledge associated with this field, each reader will undoubtedly find something to like and something that they hope to learn more about.

CELEBRATING 2023 WITH A GIFT
Each issue of Elements embarks on an exciting tour of the highlights, depths, and most fascinating facets of a current and well-defined topic within the geosciences. Whether you are a long-time subscriber or a first-time reader, we hope that you will find Elements issues like this one to serve as a valuable teaching tool for both you and future generations of readers to come.

Alkaline Lakes is the first issue of our 19th annual volume—and our 108th issue since the first publication in January 2005. As a celebration and special gift, we are pleased to offer you a double-sided complimentary poster on the centerfold of this issue. One side of the poster features the cover images of Elements issues published between 2005 and February 2023 (Fig. 1), and the second side is a Periodic Table of Elements (Fig. 2) for use in the classroom or office.

To remove the poster, please bend each leg of the staple binding by 90° using a dull knife. Carefully lift the poster out of the binding and then bend the staple legs back to their original positions.

We sincerely thank the Guest Editors, Benjamin Tutolo and Nicolas Tosca, and all of the issue’s authors for allowing us to include this poster gift for readers within their special thematic issue.

Richard Harrison, Becky Lange, Janne Blichert-Toft, and Esther Posner

EDITORIAL Cont’d from page 3

starting breakthroughs in clean energy solutions, geo-engineering feats to pull CO₂ out of the atmosphere, etc. once we begin to make changes?” Indeed, how about the huge potential for clean energy offered by fusion, the Holy Grail of energy, which was finally, after decades of failing, just accomplished for the first time in December 2022 in a breakthrough experiment at Lawrence Livermore National Laboratory using a large laser-based device called the National Ignition Facility? This experiment produced energy via thermonuclear fusion (as in stars such as our Sun) to create more (clean) energy than the laser energy used to initiate production of CFCs, which had created a life-threatening hole in the Earth’s ozone layer. As a result, the Earth’s ozone layer is now on track to fully recover. To end on a positive note and to loop all this back to the overarching topic of alkaline lakes, these distinctive natural features—alkaline lakes—have shown us, in all probability throughout most of our planet’s history, that everything is possible, even that which seems impossible!

Meanwhile, despite humankind’s destructive behavior, which if unchanged will put us in the express lane to total ecosystem collapse, alkaline lakes, like the rest of Nature has always done, continue to give generously to society. You will read about how microbial inhabitants of alkaline lakes are utilized in biotechnological applications that we take for granted in everyday life and which probably only few of us, myself included, knew to be derived in one way or another from alkaline lakes. Some examples, remarkable in their diversity, include detergent enzymes, purification of biogas, animal hide, paper processing, and, as implausible as it may sound, even the production of protein-rich foods. In other words, there is far more to alkaline lakes than just salt production!

Please enjoy this tour through the wonderland of alkaline lakes—and don’t forget to pack your Toolkit!

Janne Blichert-Toft