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EDITED AND REVIEWED BY
Georg Rümpker,
Goethe University Frankfurt, Germany

*CORRESPONDENCE
Derek Keir,
d.keir@soton.ac.uk

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Editorial: Horizons in Earth science 2022

Derek Keir[1,2]*, Bruce S. Lieberman[3], Valerio Acocella[4], Wouter Buytaert[5], Steven L. Forman[6], Michel Grégoire[7], Kenneth P. Kodama[8], David R. Lentz[9] and Carmen Sanchez-Valle[10]

[1]School of Ocean and Earth Science, University of Southampton, Southampton, United Kingdom, [2]Dipartimento di Scienze della Terra, Università degli studi Firenze, Florence, Italy, [3]Department of Ecology and Evolutionary Biology, Biodiversity Institute, University of Kansas, Lawrence, KS, United States, [4]Dipartimento di Scienze, Università Degli Studi Roma Tre, Roma, Italy, [5]Department of Civil and Environmental Engineering, Imperial College London, London, United Kingdom, [6]Department of Geosciences, Baylor University, Waco, TX, United States, [7]Geosciences Environnement Toulouse, CNRS-CNES-IRD-UPS, Toulouse, France, [8]Department of Earth and Environmental Sciences, Lehigh University, Bethlehem, PA, United States, [9]Department of Earth Science, University of New Brunswick, Fredericton, NB, Canada, [10]Institut für Mineralogie, Universität Münster, Münster, Germany

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Editorial on the Research Topic
Horizons in Earth science 2022

Earth science in the 21st century is becoming ever more relevant to societal development since it focuses on understanding the processes shaping the planet on which we live. Earth processes are complex, ever changing and include interactions between the oceans, atmosphere, solid Earth and life. Earth science is therefore central to addressing key challenges such as understanding the evolution of life on Earth, identifying and modeling the key interactions that control Earth's climate, and for developing strategies to mitigate against human-induced modification of the natural environment. To help bring the state-of-the-art science to the wider community in an open access Research Topic format, the team of Specialty Chief Editors at Frontiers in Earth Science are delighted to present the inaugural "*Horizons in Earth Science 2022*" article Research Topic. This Research Topic showcases high-impact, authoritative and reader-friendly review articles covering the most topical research at the forefront of the Earth sciences.

With the current rapid rate of global warming, a better understanding of interactions between the major components of the global climate system and how these potentially will change in the future is important. The paper by Ma and Chen reviews the recent advances in understanding the interactions between the East Asian winter monsoon (EAWM) and the periodic changes in sea-surface temperatures across the east-central equatorial Pacific (known as the El Niño-Southern Oscillation (ENSO)). The relationship between these systems is complex with a warm ENSO phase (i.e., El Niño) winter generally coinciding with a weaker-than-normal EAWM, but with no simple relationship observed during the cool ENSO phases (La Niña) (Geng et al., 2018). Interaction between the EAWM and ENSO with other major climate systems is likely required to better understand EAWM-ENSO relationships.

Two key research areas currently generating much excitement and interest both within and beyond the field of invertebrate paleontology are skillfully presented in the Research

Topic. In particular, two of those articles, by Cong and Potin and Daley respectively, explore in detail some of the fascinating Cambrian animals discovered, as well as consider their implications for understanding the nature of the Cambrian radiation interval from an evolutionary and ecological perspective. Indeed, research into the Cambrian radiation is not just a Research Topic of current interest to the field, but rather has been long standing and fundamental. The Research Topic was brought to the forefront of the field in the modern era by Gould (1989), who amplified the discoveries and documentation presented in Whittington (1985) on the Burgess Shale. Whittington (1985) had in turn described work given in numerous other publications by other authors too numerous to mention, but including especially the extensive work of Derek Briggs, Richard Fortey, and Simon Conway Morris (see roughly contemporaneous high profile accounts of these provided in Briggs and Fortey, 1989; Morris, 1989). Closely paralleling and following these in time were the phenomenal discoveries on the Chengjiang Biota, and other Cambrian soft-bodied deposits distributed throughout the world.

One key part of research into Cambrian life involves uncovering and describing new taxa, as well as establishing their phylogenetic affinities. Better documenting the animals of the Cambrian radiation, and subjecting these to phylogenetic and other types of analyses, makes it possible to evaluate hypotheses about the nature of evolutionary patterns and processes during the initial proliferation of bilaterian animals in the fossil record. Is there anything special about evolutionary processes during this time, including in terms of greater rapidity of speciation or greater morphological flexibility (Lieberman, 2003)? Without good knowledge of these fossils, their morphologies, and their evolutionary relationships, such a question is impossible to answer.

Potin and Daley expertly take us on a fascinating deep dive into arguably the most spectacular and distinctive of the animals spawned during the Cambrian radiation: the anomalocaridids, and more broadly, the Radiodonta. These animals, some massive by Cambrian standards, include predators and several other ecological types, and are skillfully discussed and evaluated by the authors. Daley is a world renown expert on the group, and she, along with Potin, illustrates a variety of beautiful specimens, and synthesizes anatomical, phylogenetic, ecological, and biogeographic information on Cambrian and later representatives to produce a truly integrative publication.

Cong focuses on the discoveries of the Chengjiang biota of China, which have dramatically expanded knowledge beyond what was first uncovered in the Burgess Shale. Cong is an internationally recognized expert on the study of the Chengjiang. With his contribution he skillfully interlays specimens with cladograms, and pays special attention to some of the key problematic fossils from the Chengjiang. He also evaluates potential homologies that connect these, often uncertainly, to known phyla, all in the context of information from anatomy and taphonomy. The problematic fossils considered are some of the most puzzling, yet also fascinating, and this paper brings a very useful and insightful perspective as to how to treat and interpret these. Importantly, even as our knowledge of the life of this time interval continues to grow, certain fundamental questions remain.

Just as paleontology has focused for quite some time on some of the early events in animal evolution, a highly dynamic and growing new area of research has emerged. This research centers on how we can better understand what is happening to life forms today, specifically, the prodigious die off of species referred to as the Biodiversity Crisis, by looking at the fossil record. Indeed, elucidating extinction may have been paleontology's first fundamental contribution to evolutionary theory, and now the analysis and understanding of extinction in the fossil record is given added meaning through the sub-discipline of conservation paleobiology. This Research Topic is skillfully outlined and illuminated in Walker, who is also one of the internationally recognized experts in the field. She usefully applies understanding of conservation of the modern biota to conservation paleobiology. This synthetic perspective includes a highly relevant timeline on the biotic effects of our own species, and some of our close relatives, while laying out a detailed framework for better placing the study of the present in the context of the past: notably upending and inverting the outdated Uniformitarian perspective. This valuable approach will help provide the context for developing predictive approaches for future species survival, using the lens of the past (Strotz et al., 2018).

Author contributions

DK: Writing–original draft, Writing–review and editing. BL: Writing–original draft, Writing–review and editing. VA: Conceptualization, Writing–review and editing. WB: Writing–review and editing. SF: Writing–review and editing. MG: Writing–review and editing. KK: Writing–review and editing. DL: Writing–review and editing. CS-V: Writing–review and editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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