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Editorial

Continent and life evolution: an international platform for earth system science

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Among the planets currently known, Earth is unique not only because it harbors life, but also because its continents, oceans, atmosphere, climate, and biosphere have co-evolved as an integrated and self-transforming system over billions of years. The emergence and long-term persistence of habitable environments have not resulted from any single process, but from sustained interactions among deep Earth dynamics, surface processes, environmental change, and biological evolution. Since the formation of Earth approximately 4.6 billion years ago, continental growth and reworking, plate tectonics, ocean–atmosphere evolution, climatic transitions, biological innovation, mass extinctions, and Earth surface processes have been coupled within a dynamic Earth system (Wilde *et al.* 2001; Santosh 2010; Zerkle 2018; Zhai and Peng 2020; Zhu *et al.* 2021; Young *et al.* 2023; Zhao *et al.* 2023; Stern and Gerya 2024). Continents have not merely provided a passive physical substrate for weathering, sedimentation, nutrient cycling, ecological diversification, and human civilization; they have also actively regulated the environmental conditions under which life originated, diversified, and repeatedly reorganized. Conversely, life has profoundly reshaped Earth's surface environments through the ecological engineering of reef structures and shell beds, modifying atmospheric composition, mediating biogeochemical cycles, influencing mineral formation, and transforming sedimentary and ecological systems (Peccerillo 2021; Hamidi 2022). Comparative studies of other terrestrial planets further broaden this perspective, particularly for reconstructing early Earth conditions where the geological record remains fragmentary. Understanding these long-term feedbacks among solid Earth processes, surface environments, and biological evolution is essential not only for reconstructing the history of our planet, but also for evaluating its future trajectory under climate change, biodiversity loss, resource exploitation, environmental degradation, and increasing human disturbance (Costanza *et al.* 2007; Bonan and Doney 2018; Folke *et al.* 2021). At the same time, Earth science is being rapidly transformed by the convergence of artificial intelligence and big-data analytics, cloud computing, human–machine interaction, quantum technologies, genomics and genome editing, nanoscience, polymer nanomaterial, and clean-energy technologies (Melnikov *et al.* 2018; Nayfach *et al.* 2021; Hultman *et al.* 2024). These technological breakthroughs provide opportunities and challenges for continent and life evolution under extreme conditions, spanning scales from microscopic mechanisms to planetary-scale processes and integrating insights across multiple scientific disciplines.

Responding to this expanding scientific frontier, Continent and Life Evolution (CLE) was established as an international, multidisciplinary journal devoted to earth and planetary system science (Steffen *et al.* 2020). CLE focuses on novel geoscience-related research concerning the past and future evolution of continents and life on Earth, as well as comparable planetary systems. In the era of Earth planetary genomic science, the journal seeks to promote studies that transcend the traditional boundaries of the lithosphere, hydrosphere, atmosphere, and biosphere, with particular emphasis on the interconnections among multiple Earth spheres.

The launch of the CLE initiative is spearheaded by the former Director of the Department of Geology at Northwest University (2019–2025) and is underpinned by the university's longstanding academic tradition and distinguished disciplinary expertise in geology. Established in 1939, the geology program at Northwest University ranks among the earliest such programs founded within comprehensive universities in China. Over more than eight decades, it has trained more than 10,000 graduates in Earth sciences and has made important contributions to geological education, petroleum geology, and basic geoscience research in China. Building on distinctive strengths in structural geology, palaeontology and stratigraphy, geochemistry, continental dynamics, early life evolution, Precambrian geology, orogenic belts and sedimentary basins, Cenozoic environments, oil and gas basin geology, geological engineering, and loess research, and with growing involvement in planetary geology, the university provides a solid academic foundation for the development of CLE. Supported by platforms such as the State Key Laboratory of Continental Evolution and Early Life, the journal is positioned to serve as an international forum for major questions linking continental evolution, biological history, environmental change, human activities, and the future Earth.

CLE welcomes high-quality original research articles, reviews, perspectives, and commentaries that clearly demonstrate how continents, environments, and life have evolved since the formation of Earth. Priority is given to studies that reveal interactions among multiple Earth spheres, provide new theoretical insights, develop innovative methods, present robust datasets, or address broad scientific questions beyond local or purely descriptive observations. Descriptive, repetitive, incremental, or narrowly regional studies with limited novelty will not be considered.

The scope of CLE is organized around four closely related areas.

Continent Evolution: this section focuses on the general science of how continents evolve and interact with life, including deep Earth and tectonic processes, the assembly and breakup of palaeocontinents, the formation and evolution of the continental crust, tectonic uplift and climate change, geological processes of tectonics-magmatism-metamorphism, crustal weathering and deposition.

Earth Life History: this section explores planetary evolution from its origin 4.6 billion years ago to the present day, with an emphasis on the critical geological lives and environments. Topics include macro- and micro-palaeontology, evolution and critical history of life, sedimentary basins and stratigraphy, palaeogeography, palaeoclimatology, palaeoecology, human evolution and geoarchaeology, Earth surface processes and geomorphology.

Earth Future: this section focuses on Big-Data-based geoscience research on global change and macro-evolution of Planetary Earth. Themes include: the Changing Earth in past and future, climate modelling and feedback, planetary boundaries and habitability, extinction and mitigation, global ecological and climatic change, and remote sensing of changes in the Green Earth.

Human Activities and Global Change: This section focuses on the impacts of engineering activities on the Earth system, including mining, tunneling, urban construction, dam building, irrigation and water diversion, land reclamation, groundwater extraction, and oil and gas development. It highlights emerging interdisciplinary advances and technologies in geological engineering.

Special issues are an important part of CLE's academic strategy. They are designed to focus international attention on frontier questions, organize scholarly communities around emerging topics, and build thematic clusters that reflect the journal's integrative vision. Current and planned special issues cover several representative directions, including Precambrian continent evolution and plate tectonics, Konservat-Lagerstätten and early animal evolution, coupled solid Earth–surface processes in the Tethys region, the Cambrian Explosion of metazoans from a multi-spheric perspective, the onset of the Great Ordovician Biodiversification Event, and the impacts of human activities on global change. Together, these themes demonstrate CLE's commitment to linking deep-time continental processes, critical biological events, Earth surface evolution, and contemporary environmental challenges within a unified Earth system framework.

As an open access journal, CLE is committed to making scientific knowledge widely available to the international community. Articles are published online immediately after acceptance, and all submissions undergo rigorous peer review. The journal adheres to internationally recognized standards of publication ethics, including responsible authorship, avoidance of duplicate or redundant publication, proper citation, data integrity, and prevention of plagiarism or citation manipulation. The challenges facing Earth science today cannot be addressed within narrow disciplinary boundaries. Climate change, biodiversity loss, land degradation, resource security, geological hazards, carbon neutrality, planetary habitability, and sustainable development all require long-term Earth system perspectives. Geological records preserved in continents, rocks, sediments, fossils, landscapes, and ecosystems provide essential evidence for understanding how Earth has changed and how it may continue to change. Meanwhile, new technologies such as high-resolution dating, multi-proxy geochemical analysis, remote sensing, numerical simulation, artificial intelligence, and global databases are creating new opportunities to integrate deep-time records with modern observations and future projections. By linking continent

evolution, Earth life history, Earth future, and human activities (Cracraft 1975), CLE seeks to become an influential international platform for the next stage of Earth system research. We warmly invite researchers from around the world to submit their best work to the journal and to propose special issues that can help shape future directions in earth and planetary sciences. The evolution of continents and life is the history of our planet. Understanding this history is essential for interpreting the past, responding to the present, and safeguarding the future Earth. Continent and Life Evolution is committed to advancing this mission.

References

Bonan GB, Doney SC. Climate, ecosystems, and planetary futures: the challenge to predict life in Earth system models. *Science* 2018, 359(6375):eaam8328. DOI: 10.1126/science.aam8328

Costanza R, Graumlich L, Steffen W, Crumley C, Dearing J, *et al*. Sustainability or collapse: what can we learn from integrating the history of humans and the rest of nature? *AMBIO* 2007, 36(7):522–527. DOI: 10.1579/0044-7447(2007)36%5B522:SOCWCW%5D2.0.CO;2

Cracraft J. Historical biogeography and earth history: perspectives for a future synthesis. *Ann. Mo. Bot. Gard.* 1975, 62(2):227–250. DOI: 10.2307/2395196

Folke C, Polasky S, Rockström J, Galaz V. Our future in the Anthropocene biosphere. *Ambio* 2021, 50:834–869. DOI: 10.1007/s13280-021-01544-8

Hamidi H. A Comprehensive exploration of earth's systems: geography, ecology, and environmental dynamics. *Soc. Sci. Chron.* 2022, 2(1):1–21. DOI: 10.56106/ssc.2022.008

Hultman L, Mazur S, Ankarcrona C, Palmqvist A. Advanced materials provide solutions towards a sustainable world. *Nature. Mat.* 2024, 23:160–161. DOI: 10.1038/s41563-023-01778-9

Melnikov AA, Poulsen Nautrup H, Krenn M, Dunjko V, Tiersch M, *et al*. Active learning machine learns to create new quantum experiments. *Proc. Natl. Acad. Sci. U.S.A.* 2018, 115(6):1221–1226. DOI: 10.1073/pnas.1714936115

Nayfach S, Roux S, Seshadri R. A genomic catalog of Earth's microbiomes. *Nat. Biotechnol.* 2021, 39(4):499–509. DOI: 10.1038/s41587-020-0718-6

Peccerillo A. Geochemical cycles—the circulatory system of planet Earth. *In Air, Water, Earth, Fire*. Cham: Springer International Publishing, 2021. pp. 129–152.

Santosh M. A synopsis of recent conceptual models on supercontinent tectonics in relation to mantle dynamics, life evolution and surface environment. *J. Geodyn.* 2010, 50(3–4):116–133. DOI: 10.1016/j.jog.2010.04.002

Steffen W, Richardson K, Rockström J, Schellnhuber HJ, Dube OP, *et al*. The emergence and evolution of Earth System Science. *Nat. Rev. Earth Environ.* 2020, 1(1):54–63. DOI: 10.1038/s43017-019-0005-6

Stern RJ, Gerya TV. The importance of continents, oceans and plate tectonics for the evolution of complex life: implications for finding extraterrestrial civilizations. *Sci. Rep.* 2024, 14(1):5470. DOI: 10.1038/s41598-024-54700-x

Wilde SA, Valley JW, Peck WH. Evidence from detrital zircons for the existence of continental crust and oceans on the Earth 4.4 Gyr ago. *Nature* 2001, 409(6817):175–178. DOI: 10.1038/35051550

Young ED, Shahar A, Schlichting HE. Earth shaped by primordial H2 atmospheres. *Nature* 2023, 616(7956):306–311. DOI: 10.1038/s41586-023-05823-0

Zerkle AL. Biogeodynamics: bridging the gap between surface and deep Earth processes. *Phil. Trans. R. Soc. A* 2018, 376(2132):20170401. DOI: 10.1098/rsta.2017.0401

Zhai M, Peng P. Origin of early continents and beginning of plate tectonics. *Sci. Bull.* 2020, 65(12):970–973. DOI: 10.1016/j.scib.2020.03.022

Zhao G, Zhang J, Yin C. Pre-plate tectonics and origin of continents. *Chin. Sci. Bull.* 2023, 68(18):2312–2323. DOI: 10.1360/TB-2022-0249

Zhu R, Zhao G, Xiao W. Origin, accretion, and reworking of continents. *Rev. Geophys.* 2021, 59(3): e2019RG000689. DOI: 10.1029/2019RG000689