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Super-orogens and modern like topography during Gondwana assembly triggered Ediacaran-Cambrian animal diversification

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Over geological times, plate tectonics and supercontinent cycles provide first order contributions to Earth environmental changes and life evolution. In particular, the middle Neoproterozoic to Cambrian period recorded dramatic transitions towards a habitable Earth, including the Neoproterozoic Oxidation Event (NOE) and Cambrian animal diversification. Key tectonic factors that contributed to changes of Earth surficial system during this period (670-500 Ma) include the assembly of Gondwana along collisional orogenic belts with mean crustal thickness of ~ 50 Km, similar to the Alpine-Himalayan system, a marked decrease in the global thermobaric ratio (T/P) to modern levels, and the large-scale occurrence of HP-UHP metamorphism reflecting global continental deep-subduction. Moreover, secular mantle cooling resulted in thinning of oceanic crust maximizing the continent-ocean hypsometric duality to values similar to the present day. The unprecedented topographic relief of Gondwanan orogenic systems, and their extensive low-latitude disposition resulted in intense weathering and erosion, supplying an unprecedented volume of sediments to the ocean and corresponding with the highest seawater Sr isotope value in Earth history. The high sediment and nutrients supply profoundly changed seawater compositions and enhanced ocean productivity, thereby triggering Neoproterozoic oxygenation events and providing environmental triggers for the Ediacaran-Cambrian explosion. Although mantle plume and magma degassing could also have contributed to surficial changes, orogens were likely the main tectonic drivers of environmental change. This research is funded by the NSFC grants (42322208), National Key R&D Program of China (grant 2022YFF0802700 and 2023YFF0803604), Project (JLFS/P-702/24) of Hong Kong RGC Co-funding Mechanism on Joint Laboratories with the Chinese Academy of Science, and Australian Research Council (grant FL160100168).