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Improving the Ediacaran geological time scale for the study of oceanic redox history and early animal evolution

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The Ediacaran Period represents a critical transition is Earth history: global refrigeration gave way to a more habitable planet, oceanic redox conditions fluctuated but crossed a threshold to support animal metabolism, and a complex ecosystem was in the making as animals and other multicellular eukaryotes played increasingly important ecological roles. However, many nuances of Ediacaran environmental and evolutionary history remain unresolved, and their resolution crucially depends on reliable stratigraphic correlations and a useful Ediacaran geological time scale. Because of taphonomic biases, the Phanerozoic approach of defining stratigraphic boundaries using the first appearance datum of widely distributed, rapidly evolving, easily recognizable, and readily preservable species would have limited success in the Ediacaran System, save for the terminal Ediacaran stage. Thus, the subdivision and correlation of the Ediacaran System must be founded on a holistic approach integrating biostratigraphic, chemostratigraphic, and geochronometric data. An Ediacaran subdivision may be defined by the best available stratigraphic marker at the boundary, but its characteristic stratigraphic content is equally important for global correlation. With available data, a prospect is emerging for the recognition and definition of the second Ediacaran stage (SES) and the terminal Ediacaran stage (TES) where stratigraphic information is relatively rich. Terminal Ediacaran strata are well dated and host several taxa of skeletal and tubular fossils that postdate the Shuram negative $\delta^{13}C$ excursion where their stratigraphic relationship can be determined. Potential stratigraphic markers for the definition of the second Ediacaran stage (SES) include the post-glacial radiation of eukaryotes as represented by the first appearance of acanthomorph acritarchs, the termination of the cap carbonate series, or the end of the basal Ediacaran negative $\delta^{13}C$ excursion associated with the cap carbonate. Series-level subdivision of the Ediacaran System is a more challenging task. The Ediacaran System could be alternatively divided into two or three series. Resolving these alternatives requires more biostratigraphic, chemostratigraphic, and geochronological data to constrain the age, duration, and global extent of the Shuram excursion, to calibrate and correlate Ediacaran acanthomorph biozones, and to determine the temporal relationship among the Shuram excursion, the Gaskiers glaciation, and Ediacaran acanthomorph biozones. Despite these challenges, an improved Ediacaran geological time scale is on the horizon to facilitate a better understanding of the geobiological aftermath of snowball Earth

glaciations, the redox history of global oceans, the early evolution of multicellular life, and the evolutionary fuse of the Cambrian explosion.