New insights into Mesoarchean photosynthesis from >2.8 Ga carbonate platforms of the Superior Craton

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One of the major consequences of photosynthesis is locally increased carbonate alkalinity and the precipitation of carbonate minerals in aqueous environments. On the modern Earth, reef–type ecosystems occupy the most productive end of the oxygen– and carbonate–producing spectrum. However, prior to about 700 million years ago, photosynthetic bacteria fulfilled this role, building reef–like microbialite (e.g., stromatolite) structures, and eventually whole carbonate platforms, out of the carbonate minerals they helped precipitate as a consequence of their alkalinizing effect. The most ancient examples of these systems, dating back to ca. 3.0 Ga, remain little explored. Here we present an overview of results from the EARTHBLOOM project, which over the past three years has examined in detail the stratigraphy, major and trace element as well as isotope geochemistry of multiple Meosarchean carbonate platforms preserved on the northwestern Superior Craton, Ontario, Canada. For all of these localities, carbonate C and O isotope compositions show a relatively tight range, consistent with precipitation from Archean seawater. However organic carbon isotopes show a significant range, with values spanning from -30 to as heavy as -12‰. The statistical distribution of organic carbon isotope data suggests different organic carbon sources in near-shore carbonate-dominated environments versus off-shore shaley environments. A diagenetic origin of this signal appears unlikely based on C- and O- isotope systematics and micro-scale isotopic analyses. The ensemble of data available to date indicates that a complex community of primitive phototrophs, including members fixing carbon via a pathway other than Calvin-Benson, constituted the primary producing community of these ancient carbonate platforms.