The first crown eukaryotic biomarkers emerge during the Bitter Springs carbon isotopic anomaly

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The diversity of eukaryotic shapes and forms experienced a massive increase in the Neoproterozoic, and several models have proposed links between these evolutionary events and the large carbon isotopic excursions of the Cryogenian and Ediacaran. The Bitter Springs Anomaly (BSA), dated to ~800 Ma, is the oldest of the large Neoproterozoic excursions. To investigate biotic and environmental changes across this event, we studied redox chemistry, sedimentology and molecular fossils of a particularly well preserved section in central Australia. Over ~200 meters of carbonate stratigraphy, the BSA records a negative carbon isotope shift from +5‰ to -4‰ and back to +5‰. The recovery is associated with a facies change from microbial carbonates deposited under (transitory) anoxic and ferrous waters, to very shallow carbonates and redbeds largely deposited under oxic conditions. Intriguingly, hydrocarbons recovered from the stratified ferrous section contain biomarkers best interpreted as the lipid remains of anaerobic predatory eukaryotes, possibly the oldest clearly indigenous biomarker signal of Eukarya in the geological record. The anaerobic eukaryotic signal diminishes at the end of the excursion and is replaced by the emergence of what we interpret as the oldest known signal of clearly indigenous crown group steranes. These steranes have a primitive homologue distribution and are best interpreted as the remains of aerobic heterotrophic eukaryotes rather than algae. We investigate causes and consequences of the emergence of these two first eukaryotic biomarkers in association with the Bitter Springs isotopic anomaly.