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3D models of probable animal body-fossils from pre-Marinoan limestones, South Australia

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In the Neoproterozoic of South Australia, two glacial successions are separated by a thick package of non-glacial sediments. The interglacial stratigraphy includes salt diapir-fringing stromatolite-oolite shoals, black shales, and an impressive 18‰ negative shift in the δ^{13}C of carbonate preceding the younger (Marinoan) glacial unit that was deposited at equatorial latitudes. Within pre-Marinoan stromatolitic limestones are bioclastic packstones containing distinctive weakly calcified fossils. These objects are the oldest cm-scale calcified body fossils ever reported by $\sim$90 Myr. The fossils cannot be physically released from the calcite matrix by conventional techniques, nor are the density contrasts between fossil and matrix significant enough to be imaged with traditional X-ray based CT-scanning methods. We construct 3D digital models of the fossils from automated tracing of individual specimen cross-sections obtained by serially grinding and scanning the sample 50.8 μm at a time. Through this process, we image a population of ellipsoidal organisms without symmetry and with a network of interior canals opening to circular apertures. We suggest that these reef-dwelling organisms share ecological and morphological similarities with sponge-grade animals.