Sponge-like grains and negative excursion of carbon isotopes in late Cryogenian

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Multicellular animals have evolved when the Earth experienced the Neoproterozoic Snowball Events. The oldest and currently well-accepted multicellular animals are the Ediacaran embryos, but biomarker and fossil records imply that sponges already evolved in Cryogenian. One of the examples is the sponge-like grains reported from South Australia, which have an internal channel system (Maloof et al. 2010). However, other researches considered that they are fragments of lithified microbial mat (Anticliff et al. 2014).

The Trezona Formation in Flinders Ranges, which yields the sponge-like grains, is 156 m thick sequence consisting of alternation of shallow-marine limestone and shale. Carbon isotopic values of limestone is in a range from −9 to −7‰ and correlated with the Trezona negative excursion just before the Marinoan glaciation. The grains of less than 2 cm in diameter exhibit various colors and textures. Among them, dark brown grains with an internal pore system and curved configuration are the sponge-like grains of Maloof et al. (2010). Internal pores are 0.1−0.2 mm thick and 1−2 mm wide, and complicated intersection forms a honeycomb structure.

EPMA and XRD analyses indicate hematite scattering within the sponge-like grains. This is similar with occurrence known from the Phanerozoic echinoderm grains, which were formed by iron oxide precipitation in a μm-sized pore system called steroem. Thus, the sponge-like grains has such smaller-sized pore system. A possible interpretation is that this corresponds to Ostia of sponges, and that the honeycomb structure is Osculum of sponges. This animal secreted platy skeletons like the Paleozoic stromatoporoids, and this could be the oldest biomineralization.
The Tresona excurtion in this time and the Shrum excursion during late Ediacaran were likely formed by re-mineralization of organic matter suspended in water column. There is a hypothesis that sponges were responsible for the re-mineralization of organic matter (Sperling et al. 2018). The animal of the oldest biomineralization had extinct by the Marinoan Snowball, and non-skeletal sponges became abundant in late Ediacaran. Biomineralization resumed 80 myr later by the latest Ediacaran *Cloudina* group.

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