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Synchrotron X-ray micro-CT analyses of The Early Cambrian microfossils

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Cambrian Explosion, the most drastic event in history of life on Earth, which is characterized by the rapid appearance of almost all of modern phyla, happened in early Cambrian (around 530 Ma). Therefore, paleontological and geochemical studies around the event are very important to reveal features and origin of the Cambrian explosion in the biological history.

Many microfossils are found mainly in phosphorites around Precambrian-Cambrian boundary. Especially in South China, we can find many well-preserved phosphatic microfossils. Globular-shaped microfossils are generally interpreted as embryos or larvae because of their forms (e.g. Bengtson & Yue, 1997; Steiner eta l., 2004). Skeletal microfossils, named as SSF (Small Shelly Fossils), are also reported and have various shapes, interpreted as Cnidaria, Chaetognatha, Gastropoda, Mollusca and others (e.g. Chen & Huang, 2001; Bengtson et al., 1990; Steiner et al., 2007). Because the SSF are distributed over the world, the biostratigraphy is often used for comparison among the sections in the world (literatures listed in Steiner et al., 2007). In addition, taxonomy of SSF is a key to investigate origin of biomineralization, diversification of hard structure-forming life and linkage to modern Metazoa, (e.g. Porter, 2007), thus the SSF highly attracts paleontological and biological interests. However, because most of SSF has simple and extraordinary shapes, the taxonomy is still unclear. On the other hand, globular microfossils have simple external forms so that it is often difficult to identify their affinity in detail. In addition, because some embryo- and larvae-stage fossils with complex forms are relatively large, the internal structures cannot be observed with SEM. We need new criteria for classification as well as their external morphology.

Recent X-ray micro-CT analyses of the microfossils yielded new methods to observe the internal structures (e.g. Donoghue et al., 2006). Compared with microscopic and SEM observations of cutting planes of the microfossils, this technique has two advantages of nondestructive analyses on any cross-sections of internal structures. This work presents preliminary observations of three-dimensional structures of the Early Cambrian microfossils including embryo and larvae stage fossils and SSF, South China with the Synchrotron X-ray micro-CT at SPring-8 (beam line: BL47XU). The spatial resolution is about 1 micrometer, and it takes only 10 minutes to take a CT image of a sample.

We classified the specimen into some groups based on the SEM images. One is composed of animal embryo fossils, which are partly covered with envelopes and contain, often shriveled, globules, or which are divided into two or more cells. Second consists of larvae of cnidarian. The fossils, which comprise an umbrella-like top and relatively small column at bottom, often with pentaradial symmetry, resemble forms of larvae of cnidarian and of small jellyfish. Some fossils are similar to a polyp or a sea anemone in form. Some horn-shaped fossils, so-called Anabarites are also found.

We analyzed these samples with the Synchrotron X-ray micro-CT and reconstructed their three-dimensional structures. The preliminary data allows us to observe the internal structures as well as the morphologies, and to identify their affinities.

Keywords: Synchrotron X-ray micro-CT, Spring-8, Early Cambrian, Small Shelly Fossils(SSFs), Embryo fossils