

化石の三次元像解析と微量元素・同位体分析：化学古生物学に向けて Chemopaleontology: 3D images and trace element and isotope analyses of fossils

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Earth is a unique planet, which is filled with a large variety and number of life. Recent active planetary expeditions and telescopic observations of extrasolar planets allow us to expect possibility of life in other planets. But, presence of metazoan distinguishes biosphere of the earth from others. Conventional paleontology is based on morphological comparison of fossils with modern biota. The methods are very useful to investigate ancient animals and plants with the same body forms and tissues of modern biota, and allow to successfully decoding biological evolution based on some fossils with well-preserved tissues since the Cambrian (e.g. Shu, 2008 Gondwana Research). However, it is well known that body forms of *trilobite* animals at the dawn of the Metazoa are very strange and are often out of our insight even for the Cambrian fauna (e.g. Gould, 1989) as well as for many biota in the Ediacaran (e.g. Hultgren et al., 2011, Science; Schiffbauer et al., 2011, GSA meeting). We need another tool to investigate fossils: 3D observations and chemical compositions of microfossils.

Recent X-ray micro-CT analyses of the microfossils provide 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. We started to observe three-dimensional structures of the Early Cambrian microfossils including embryo and larvae stage fossils and SSF, and Chengjiang fossils including an echinoderm, a fish, arthropods with/without eggs, a mollusk, and a brachiopod, South China with a Synchrotron X-ray micro-CT at SPring-8. The observations of microfossils reveal the internal structures of animal embryo fossils, which are partly covered with envelopes and contain, often shriveled, globules, larvae of cnidarians, which comprise an umbrella-like top and relatively small column at bottom, often with pentaradial symmetry, and a polyp or a sea anemone. Although preliminary, the three dimensional observation of an echinoderm, which possesses gill-like structures, shows a relict of an internal cavity. The synchrotron micro-CT technique provides convenient and effective observations of internal structures for microfossils with complicated, small internal structures and even for completely compressed fossils. In addition, the reconstructed 3D images are very helpful to determine the most effective crosscutting planes for geochemical analyses.

Recent drastic progress of paleontology of the earliest metazoan fossils provides many candidates for arthropods with their eggs, chordates with notochords, the oldest fishes with spines and gills, and putative animal embryos, calcite, aragonite and Ca-phosphate biomineralizing fauna, earliest animals with sexuality, quite high trophic levels and others. However, only morphological comparison with the modern equivalents is still insufficient to provide the evidence for the above. Another tools to obtain the evidence for evolution of biological functions are required. We would like to propose some geochemical possibilities such as Ca, Fe, Mo, N, C and Cu isotopes, and trace element accumulation in specific tissues.

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