

PHASE CONTRAST SYNCHROTRON X-RAY MICROTOMOGRAPHY: THE BEST NONDESTRUCTIVE IMAGING FOR PRECAMBRIAN EMBRYO FOSSILS

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Abundant embryo fossils from the Precambrian Weng'an biota (about 580 million years ago) in Guizhou, southwest China, have attracted great attention as the earliest fossil record of metazoans in the world. These phosphatized spherical microfossils have provided significant insights into the origin and evolution of multicellular animals, and even given birth to the "palaeoembryology" which is a new interdisciplinary subject and hot spot in the field of palaeobiology.

Imaging is essential for investigating these embryo fossils. However, external morphological studies with Scanning Electronic Microscope cannot extract sufficient biological information of them. Internal structures of embryo fossils can be observed by examining thin sections with the help of transmitted polarization microscope and traditional digital imaging. But this method is invasive. When precious specimens are cut into sections, plenty of important morphological information is lost. So, an imaging technique which can reveal external and internal structures of embryo fossils without destroying them is necessary for figuring out their affinities.

Although nondestructive imaging using X-ray was applied in palaeontology over a hundred years ago, at the same time of the discovery of X-ray. Its only form was radiography until tomography was developed. In order to get enough spatial resolution, microtomography is the first choice for embryo fossils, because their sizes are only several hundred microns. Nevertheless, absorption microtomography based on industrial X-ray machine can't obtain good images due to weak absorption contrast of embryo fossils (weak absorption contrast is caused by diagenesis which can modify fossil's chemical features). So, phase contrast synchrotron X-ray microtomography is the unique candidate for three dimensional noninvasive studies of embryo fossils. As X-ray produced by the third generation synchrotron facility has high degree of coherence, phase contrast imaging can be used to improve the image contrast of embryo fossils. Besides, high beam intensity provided by synchrotron radiation source allows using monochromatic beams to avoid beam hardening of images, and makes the rapid data acquisition at very high spatial resolutions reality. In a word, utilizing phase contrast synchrotron X-ray microtomography to study embryo fossils, the experiment time is much shorter and image quality is much better.

References:

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