

Abstract

An extraordinary fossil record of multicellular life were found in phosphorites from the Precambrian Doushantuo Formation (550~600 Mya) , southern China. These fossils, which three-dimensional cellular structure details were perfectly preserved, have been classified as animal embryo, larva, and adult forms, as well as multicellular thallophytes, giant acritarch, and spheroidal chlorophyta. The well-preserved structural details indicates a rapid burial process, thus it is possible to simulate fossilization process in laboratory time. *Ulva fasciata*, a green algae, was selected as the major experimental material, and simplified control factors were apply to explore the most probable factors that influence fossilization and determine the possible roles they play during fossilization process.

In previous experimental approach, the replicated morphology of soft-bodied fossils has been attributed to adsorption of pre-existing mineral clays and correlated to bacteria activity. But the interior of the subjects was not mineralized in early experiments. We attempted to develop several phosphorite deposition systems based on conditions of ancient environment and fossils records. We induced the formation of calcium phosphate deposits by increasing the temperature and the following rise of pH value. The results showed that the interior of algal cells was mineralized and detail morphology was preliminarily replicated. The results also indicated that magnesium played an important role in the phoosphorite deposition systems. No deposition occurred within the cells in the absence of magnesium. We suggest that the formation of fossils in Doushantuo Formation may be the consequence of a catastrophic rapid burial and phosphorites deposition at an elevated temperature on the results mentioned above.

摘要

位於中國南方的陡山沱期地層屬於前寒武紀，沈積年齡距今約 6 億到 5 億 5 千萬年前，該時期的磷質岩層保存了大量的後生動物胚胎、幼體及成體，多細胞藻類、疑源類等微型化石，其 3 維立體結構也常被精細的複製下來。通常認為快速沈積掩埋的結果造成此大量生物群化石的細微構造被保存下來，據此可在實驗室中嘗試重現此一過程。我們選擇了多細胞藻類裂片石蓴 (*Ulva fasciata*) 作為重現磷質化石形成過程的實驗材料，並嘗試將實驗條件簡化以尋找影響磷質化石形成的因素，並了解其在化石形成過程扮演的角色。

在過去模擬軟組織化石形成過程的研究裡，傾向將其歸因於微生物引起礦物顆粒吸附於生物體的有機構造，但在模擬此機制的實驗系統始終未見生物體內部遭受礦化。在本篇論文中，我們從前寒武紀時期磷礦形成事件本身是否足以造成磷質化石形成的角度出發，根據陡山沱期地層環境及化石性質，嘗試以溫度及 pH 值的改變誘發磷酸鈣沈積使石蓴藻體磷酸礦化，實驗結果顯示我們成功的使藻體內部發生磷鈣礦物沈積並將其細胞構造初步的保留下來。另一方面，實驗結果亦顯示，若鎂不存在系統中，藻體內部的沈積便不會發生，鎂在磷質化石形成過程可能扮演重要的角色。據此，我們可以推測磷質化石形成過程可能肇因於環境變動的災難造成大量生物死亡，同時引起磷礦沈積將生物屍骸掩埋並使其磷酸礦化。