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SSF 多様化事件と環境変動：南中国澄江地域における最下部カンブリア系層序
The SSF diversification and environmental changes: The lowermost Cambrian stratigraphy in Chengjiang, South China

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As a prelude to the Cambrian Explosion, the diversity of small shelly fossils (SSFs) increased dramatically ca. 534-530 Ma in the earliest Cambrian. In the same interval, a large-scale phosphorite deposition and $d^{13}C$ excursions occurred, suggesting global environmental changes. Nonetheless, detailed conditions for the SSF diversification are unknown. In order to clarify the causal relationship between these events, this study examined the detailed lithostratigraphy, SSF biostratigraphy, and isotope ($d^{13}C$ and $^{87}Sr/^{86}Sr$) stratigraphy of the uppermost Ediacaran-lowermost Cambrian in Chengjiang, Yunnan, S. China.

The uppermost Ediacaran-lowermost Cambrian in Chengjiang is composed of Daibu Mb (50 m, dolomite), Zhongyicun Mb (40 m, phosphorite), and Dahai Mb (1 m, dolomite) in Zhujiaqing Fm. On the basis of the observation of outcrops, polished rock slabs, and thin sections, we classified the Zhongyicun phosphorite into 5 units; Unit A (18 m, bedded ph.), Unit B (5 m, ph/dol alt.), Unit C (5 m, ph/dol alt.), Unit D (8 m, bedded ph.), and Unit E (5 m, phosphate-rich bedded ph.). Basically, all phosphorites are composed of phosphate clastic grains in dolomite matrix. Phosphate content is higher in high-energy deposited phosphorites with coarse clastics. These observations suggest that phosphorites were primarily formed in shallower depositional settings, then eroded and delivered as clastics into relatively deeper carbonate depositional settings to form bedded phosphorite or alternation of phosphorite and dolomite. Moreover, as the SSFs occur in the same manner as phosphate clastic grains, they likely lived in extremely shallow settings along the basin margins.

By identifying 15 genera of SSFs from 10 horizons in the Zhongyicun Mb, we recognized two distinct assemblages; one with *Anabarites* sp. and *Protohertzina* sp. from the bottom of Unit A, and the other with *Paracarinachites* sp. and *Ocruranus-Eohalobia* group from the base of Unit C and Unit E. The faunal shift between the two corresponds to the major diversification of SSFs. We renewed the first appearance of the second assemblage at the horizon at least 5 m below the previous record in Chengjiang, suggesting that SSFs diversified much earlier (2 m.y., at a rough estimate) than previously recognized.

The data of $d^{13}C$ for 55 samples identified two negative $d^{13}C$ shifts (N1 and N2) and one positive shift (P1); i.e. N1 from -1 to -5 permil in the upper Daibu Mb, N2 from -3 to -6 permil in the middle-upper Zhongyicun Mb, and P1 from -6 to -2 permil in the uppermost Zhongyicun Mb. The $d^{13}C$ profile at Hongjiachong confirmed that the major SSF diversification likely occurred not during the positive $d^{13}C$ shift as previously regarded, but during the negative $d^{13}C$ shift (N2) at least in Yunnan. Here we named this negative shift 'the Fuxian Excursion'. This may be the key to clarify the mechanism of the biological and environmental changes.

The data of $^{87}Sr/^{86}Sr$ for 10 samples showed values around 0.709 with a positive excursion up to 0.711 across the Daibu-Zhongyicun boundary. These values are similar to those reported from Three Gorges, Hubei; however, clearly higher than the values from other regions. It may represent local signatures unique in S. China.

On the basis of the above new findings, we speculate the following processes for the earliest Cambrian phosphorite deposition with the SSF diversification. Some inner-shelf basins in the Yangtze platform became isolated from open-ocean probably during regression. In extremely shallow parts of such local basins, phosphorites were primarily precipitated from phosphate-enriched sea-water due to the high detrital flux from continental crust. The SSF diversification occurred also in such extremely shallow settings with unique seawater compositions. The isotopic excursions of $d^{13}C$ and $^{87}Sr/^{86}Sr$ apparently agree with such isolated basin model.

Keywords: small shelly fossils, phosphorite, Cambrian, Chengjiang, South China