

Large calcareous concretions from Miocene outer shelf deposits in Ibaraki Prefecture: Carbonate mineralization by cool-seep water

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Various-shaped, very large calcareous concretions occur from the Lower Miocene Kokozura Formation of the Takaku Group distributed in Isozaki coast and its nearby north, Kita-Ibaraki City, north Ibaraki Prefecture within the southern Joban basin. The formation is mainly composed of much bioturbated muddy fine sandstone, which may have been deposited on outer shelf. Calcareous concretions are well observed along a sea cliff of a few 100 m long and on a wave cut bench of 100m long and 150m wide. They are morphologically divided into six types on the basis of their shapes, size and mode of occurrence within the mother rocks. Several molluscan fossils represented by *Lucinoma acutilineatum* are associated with the concretions. From the stable isotope ratios of $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ in the concretions and shells of *L. acutilineatum*, the concretions seem to be of methane cool-seep water origin. Because this surface exposure bearing such the calcareous concretions would be the largest in Japan as far as we know, it will be very significant for investigating formative processes of calcareous concretions of cool-seep water origin.