

Cosmic spherules from Carboniferous and Permian bedded chert of the Tamba Belt in the Sasayama area, Japan

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Cosmic spherules are subspherical to spherical particles of <1 mm diameter which are produced by melting of interplanetary dust and large objects during atmospheric entry. Although ancient cosmic spherules provide constraints on the past flux of extraterrestrial matter to the Earth, a few spherules have been found in the sedimentary rocks with depositional ages higher than Triassic. Here we report the discovery of ancient cosmic spherules from Upper Carboniferous to Middle Permian bedded chert successions (Hatayama and Fujioka-oku section) in the Tamba Belt, Sasayama area, central Japan. The Hatayama section is 2.6 m thick and comprises red bedded chert. The conodont *Mesogondolella clarki* representing Moscovian (Late Carboniferous) occurred from the middle part of the section. Fujioka-oku section (ca. 16 m) consists mainly of red bedded chert. Several grey thick chert beds are intercalated in the upper part of the section. Asserian (Early Permian) to Capitanian (Middle Permian) radiolarians, such as *Pseudoalbaillella simplex* and *Pseudoalbaillella sakumarensis*, were obtained from the upper part of the section.

We found 29 cosmic spherules from Fujioka-oku and Hatayama sections. Based on the texture and chemical compositions, these spherules were classified as iron-type (I-type) cosmic spherules. Various types of the textures are present in I-type spherules: smooth surface, interlocking, and polygonal textures. The size distribution of these spherules (mainly 10-30 μm in diameter) is consistent with that of I-type spherules reported from an Anisian (Middle Triassic) bedded chert succession in the Chichibu Belt, Japan. Energy dispersive spectra (EDS) analysis shows that all the I-type spherules are dominated by Fe with minor amounts of Al, Si, K, Cr, and Ni. Although the result suggests that the I-type spherules have been altered as indicated by the presence of Al, Si and K on the surface of the spherules, these spherules are much older than any previous collection in the bedded chert successions from Japan.

Keywords: cosmic spherule, bedded chert, Carboniferous, Permian, Tamba Belt, radiolarian