

Research Advances

The Firstly Discovered Cosmic Spherules in Carbonaceous Siltstone from the Taizi Formation of the Mesoproterozoic Shennongjia Group, Central China

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Objective

Spherical micro-particles are often preserved in Precambrian sedimentary rocks. Finnish and Chinese scholars have previously discovered carbonaceous, siliceous or ferruginous spherules of out-space origin in the 1.6 Ga and 1.4 Ga sequence, respectively. The presence of spherules can record possible cosmic impact events. Also, cosmic spherules provide important information on the evolution of planets from outer space. This work firstly discovered cosmic spherules in thin layer of carbonaceous siltstone from the Taizi Fm. (1.2–1.3 Ga) of the Shennongjia group in the Shennongjia area, Hubei Province, central China (Fig. 1), and focused on the characteristics and implication of these spherules.

Methods

A series of lithological and geochemical samples from the spherule-bearing sequence were respectively collected from the spherule-bearing sequence (Fig. 1d) and were crushed to 50 meshes. Different types of heavy mineral grains are separated from the crushed sediments through jigging and elutriation. The spherules morphology and texture were determined with SEM. The laser-Raman spectrum and electronic microprobe tests gave the data of mineral and chemical compositions. Moreover, major oxides, trace elements, and REE were measured through in-situ ICP-MS methods.

Results

It is referred that the spherule-bearing sequence was developed at the upper Taizi Fm.. The overlying Yemahe Fm. have already obtained the whole-rock Pb-Pb isochron age with 1307±100 Ma from the dolomites and the LA-

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ICP-MS zircon U-Pb age with 1215.8±2.4 Ma from the tuff, respectively. In addition, the silty shale of the Taizi Fm. gave the zircon U-Pb isochron age of 1332±67 Ma. These data from other researchers restrict the deposition period of the Taizi Fm. to about 1.3 Ga (Fig. 1c). The Taizi Fm. is mainly composed of grey medium-fine grained sandstone and dark black or grey siltstone, which indicates a coastal beach to tidal flat environment and experienced high-frequency cyclic sedimentations from coastal beach to platform margin shoal, restricted platform and shelf sand barrier, then from platform margin shoal to restricted platform during deposition of Taizi Fm..

Preliminary research shows that the firstly discovered cosmic spherules from the Mesoproterozoic Taizi Fm. siltstone in the Shennongjia area are characterized as follows (Fig. 1d): (1) Extremely high content of cosmic spherules in rocks. As much as 24 cosmic spherules were obtained from 36 g of sample, equivalent to 670 cosmic spherules per kilogram. This is exceptionally rare in sedimentary rocks. For example, only 18 cosmic spherule grains were separated from 5 kg sandstone in Mesoproterozoic Satakunta Fm. of Finland, and 0–32 cosmic spherule grains per kilogram in the Mesoproterozoic Changzhougou Fm., and 8–100 cosmic spherule grains per kilogram in the Mesoproterozoic Dahongyu Fm. in the Ming Dynasty Tombs area, Beijing. (2) Trapped particles appearing on the surface of the spherules, which is the most unique characteristics of these cosmic spherules and has never been reported before. This phenomenon implies that the cosmic spherules have ever been in high temperature and the surface might in molten state, or the cosmic spherules ever captured the silicic particles from the molten host rock due to strong impact (Figs. 1e–g). (3) Many micro-pits observed on the surface of zircons associated with the cosmic spherules (Fig. 1h). Zircon (Mohs' hardness=8) is too hard to be depressed unless it was suffered from high energy impact under extremely high

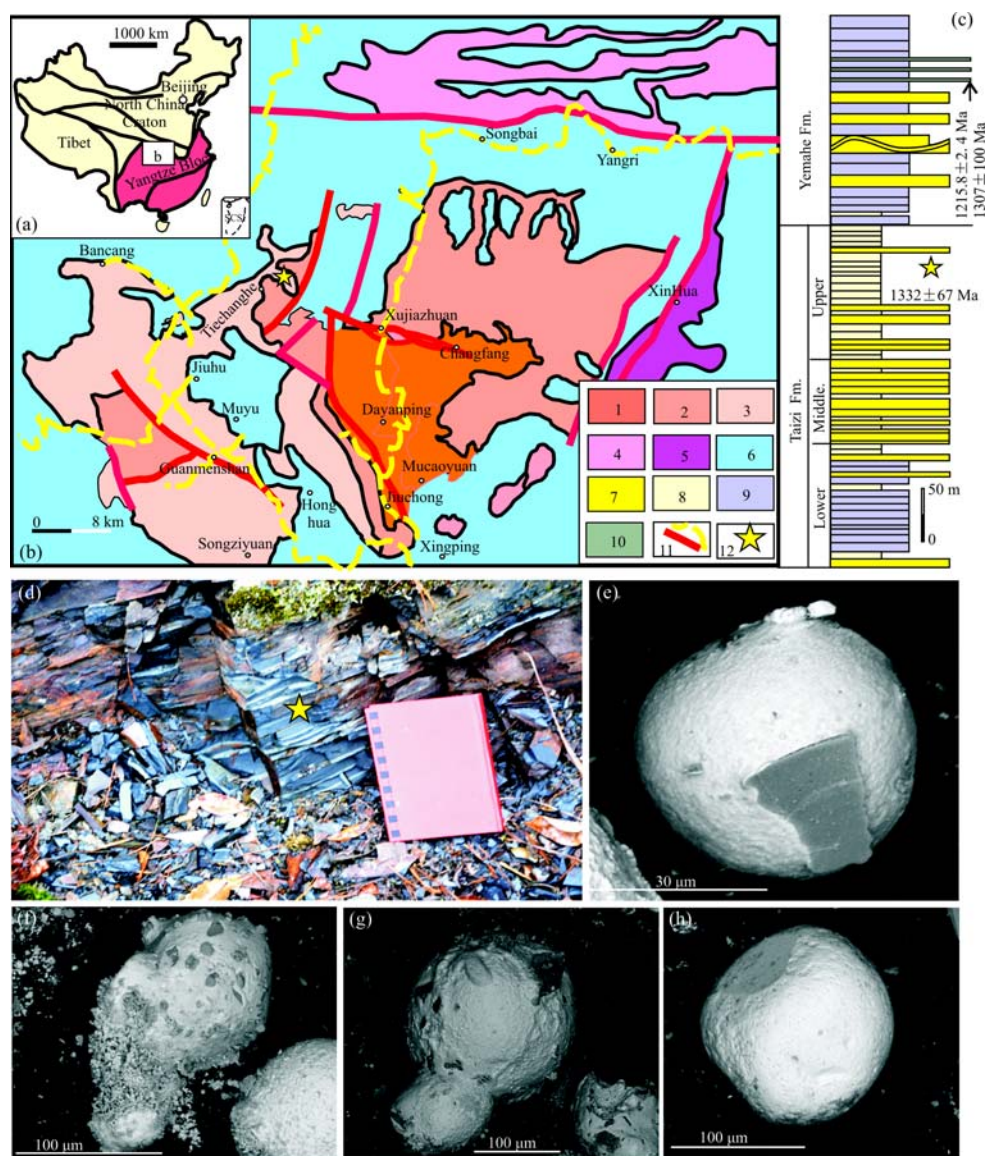


Fig. 1. Cosmic Micro-spherules from the Taizi Fm. of the Mesoproterozoic Shennongjia group (ca. 1.3Ga).

(a) and (b), Sketch map showing the Shennongjia group in northern Yangtze Block margin; (c), Lithological column of the Taizi Fm.; (d), Host rock: dark grey siltstones bearing cosmic spherules; (e), (f) and (g), Captured type of cosmic spherules; (h), A zircon grain with micro-pits on the surface. 1, Dayanping and Macaoyuan Fm.; 2, Luanshigou, Dawokeng and Kuangshishan Fm. of Lower subgroup of Shennongjia group; 3, Taizi, Yemahe, Wenshuihe, Shicaohe and Songziyuan Fm. of Mid-to Upper subgroup of Shennongjia group; 4, Undivided Upper and Middle Subgroup; 5, Undivided Lower Subgroup; 6, Neoproterozoic-Palaeozoic; 7, Glutinite or sandstone; 8, Siltstone or mudstone; 9, Dolomite; 10, Tuff; 11, Red solid lines are fault and yellow dotted lines show road; 12, Sample location.

temperature. (4) High contents of Ir or Au in zircon.

Conclusions

This work discovered abundant cosmic spherules from the Taizi Fm. siltstones (ca. 1.3 Ga) for the first time. Also, both the captive particles on the micro-particles surfaces of the host rock and the micro-pit structures on zircon surfaces associated with the spherules demonstrate a high temperature impacting and melting process on the spherules. Furthermore, the Ir contents in zircons are evidently high. All these jointly prove that the northern margin (Shennongjia area) of the Yangtze Platform was in

shallow sea setting and suffered meteorite impact in the period of 1.3 Ga.

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