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Research Advances

Discovery of Large Bubble-Like Caves in the Laoshan Granites and Its Significance

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Objective

In recent years, the dispute regarding the Quaternary glacier of eastern China has become a research focus again, and one of the important focuses is the “glacial pothole”. In fact, the micro-topographic genesis of the rocky surface mortar may be interpreted differently in different places, including pothole, weathering pit, sea cave and wind-eroding pot. It is very controversial to determine this “glacial pothole”.

There have been many documents regarding the “glacial pothole” in Laoshan of Qingdao, but the fact that Laoshan is composed of “miarolitic granite” has been neglected. In this region, miarolitic caves with diameters of several centimeters are very highly developed with influences on the formation of mortar, which is clearly an unnegligible factor. Through multiyear investigations, it has been found that there are a large number of Laoshan granitic miarolitic caves with general diameters of 1–2 m and a maximum diameter of 3.1 m (bubble-like caves). These caves are nested in the cliff bedrock, and are characterized by spheroid shape, round and smooth cave walls, and are fresh without weathering. Such large granitic native caves have not been documented before in classic geology. They have the same genesis with granitic miarolitic caves, but mostly have no crystals. Thus, we call them “bubble-like caves”.

The purpose of this project is to reveal the existence of large granitic bubble-like caves，identify their main characteristics, causes and their genetic relationship with natural mortar. It also involves research on the native environment of magmatic rocks, types of granitic caves and the tourism value.

Methods

The approaches of this project include: (1) more precise measurement of bubble-like caves (miarolitic caves) and mortar shape for statistical analysis to determine the differences from other types of caves; (2) appraisal analysis on bubble-like caves (miarolitic caves) and mortar wall samples by scanning electron microscopy (SEM) and 3D profile to illuminate the micro morphological differences between bubble-like caves and external agent caves; (3) chemical analysis on rock samples and mortar detrital materials to determine the degree of weathering and the role in the formation of mortar.

Results

(1) Granite bubble-like caves are the native caves left from the magmatic condensation

As recorded in previous studies, miarolitic caves have general diameters of 1–3 cm and a maximum diameter of several dozen centimeters, and cairngorm or amethyst crystals tend to occur in them. However, in some miarolitic caves, crystals are not well developed, or with no crystals. The Laoshan miarolitic caves are distributed unevenly, e.g., miarolitic caves with diameters of 6–8 cm are arranged in a beaded shape in Hexi Vilage, Beijiushui (Fig. 1a), and those with diameters of 40 cm are found isolated adjacent to Xiaqinggong.

At present, 11 large oval caves with diameters of 1–3 m have also been discovered during the Laoshan investigation (Fig. 1b). They are large, with no crystals, and are known as bubble-like caves, to be distinguished from small miarolitic caves. Among them, the largest cave is the Yuhuang Cave in the Hualou scenic area, which is developed in the lower part of a precipice, fully embedded in bedrocks, characterized by smaller entry, larger cavity and elliptic-shaped cave like a bird egg with respective ellipsoid diameters of 3.1 m, 2.6 m and 2.4 m, also with round and smooth cave walls (Fig. 1c); it has fresh rocks

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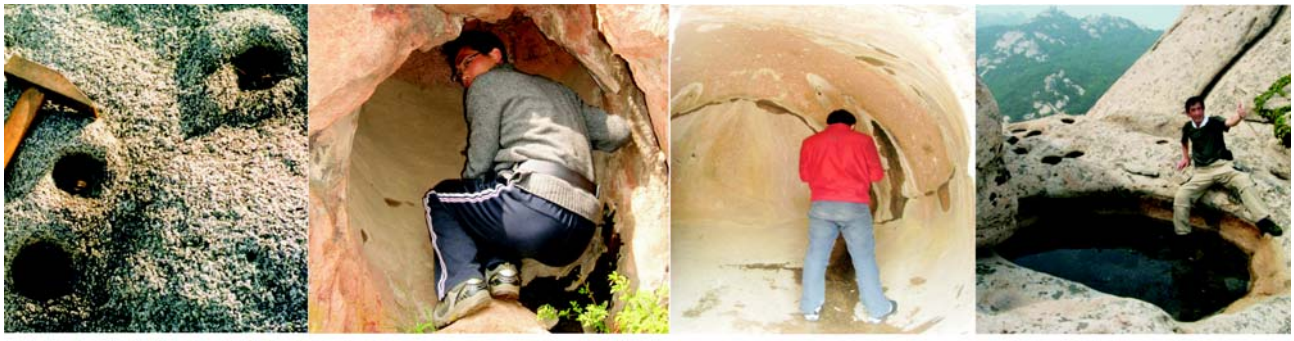

Fig. 1. Miarolitic caves, bubble-like caves and mortar in Laoshan granites.
(a), miarolitic caves in Beijiushui; (b), nameless bubble-like cave in the north of Laoshan Reservoir; (c), largest bubble-like caves—Yuhuang cave; (d), beidading mortar near Taiqinggong.

and well-preserved mineral crystals. Through analysis and comparison with a variety of external-force caves, the external geneses of marine erosion, wind erosion, corrosion, water erosion and weathering can be excluded. They may be residual native caves formed during magmatic condensation.

It is generally considered that miarolitic granites are formed under craton rift extensional setting in non-orogenic belts, and that they are the product under the environment with a faster condensation rate. The bubbles formed by H_2O, CO_2, F, and other volatile matters of gas phase and liquid phase in the magma, are unable to escape to form miarolitic caves or bubble-like caves, of which the presence of crystals depends on the late hydrothermal activity.

The large bubble-like caves in Laoshan will provide new information for geology. The discovery of giant bubble-like caves in Laoshan may provide new evidence for the research on the native environment of miarolitic granites. In general, miarolitic granite is positioned at depth shallower than 3 km. Estimated by Zhao (1998), Laoshan miarolitic granites may be located closer to the surface, and such knowledge is yet to be further studied.

(2) Close relationship between mortar and bubble-like caves in Laoshan

Three sets of mutually-perpendicular joints are developed in Laoshan granites with severe mechanical weathering. When bubble-like caves are exposed to the level, a mortar is formed with upward opening (Fig.1d). Research shows that a lot of mortars are not the so-called "glacial pothole" with flat bottom, but completely hemispherical shaped. The mortar with flat bottom is associated with the late weathering transformation. Under the weathering, especially for seasonal frost weathering conditions, small bubble-like caves (miarolitic caves) are enlarged constantly, and some small adjacent caves are connected together to form mortar. In recent years, the reports on so-called "glacial pothole" appear continuously in eastern China. It is worth noting that most "glacial potholes" are developed in miarolitic granites, which is the next emphasis of our task.

Conclusion

Large bubble-like caves are found in Laoshan Type-A granites with different macroscopic and microscopic morphologies from various external agent caves, of which the geneses are the same to small granitic miarolitic caves, i.e., the native caves formed during granite condensation. Laoshan mortar is formed on the basis of granitic bubble-like caves and miarolitic caves, of which some are the direct products of bubble-like cave exposure or formed due to the weathering and expansion of miarolitic caves. This discovery also affirms a new genetic type in speleology, the "granitic bubble-like cave". Granitic bubble-like caves are rare geological relics with high ornamental, popular science and tourism value.

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