The progress of airburst impact origin hypothesis of Taihu lake basin in Southeast of China in around 7000 years ago. Zhidong Xie, Shuhao Zuo, Yujie Dong. State Key laboratory for Mineral Deposits Research, School of Earth Sciences and Engineering, Nanjing University, Nanjing, P. R. China, zhidongx@nju.edu.cn.

The hypothesis of impact origin of Taihu lake basin were proposed in twenty years ago based on deformation features of quartz grains (He et al., 1990; Wang, et al., 1993). The discovery of siderite concretions in Tai Lake area revived the hypothesis of Tai Lake impact origin (Wang, et al., 2009). The goals of this paper are to check the similar previous work done in twenty years ago about the deformation features in quartz grains based on our recent work, and report the progress of the investigation on the unique siderite concretions; finally to discuss the airburst impact origin hypothesis of Taihu lake basin in ~7000 years ago.

Introduction

Taihu lake is a big lake, about 65 km in diameter; the water is very shallow and its deepest part is only 3 meters. The lake is very flat with a very gentle slope. The bottom of the lake is very young with a hard loess layer which extended to vicinity area, dated to only 11k to 12k years ago. Taihu lake is the third largest freshwater lake with a 65-km diameter in Southeast of China, and located in the center of the three big cities: Shanghai, Hangzou and Nanjing. The formation and evolution of Taihu Lake has always been the concern of scholars. Several origin hypothesizes of the Taihu lake formation were proposed in recent 60 years, including tectonic, lagoon, volcano, impact etc., but no one were seriously studied in detail and in depth. The southwest arc of the lake leads some scientists the doubt that it was created by a meteorite impact.

In the early 90s of the 20th century, an impact origin was proposed on the basis of fractured quartz, wavy extinction of quartz grains, and even claimed shatter cones in the sandstone of Devonia Wutong formation in the islands of Taihu lake (He et al., 1990; Wang, et al., 1993). However, deformation of quartz and the circular structure can have multiple interpretations. There are no clue when the impact were happened in these proposals. The impact origin hypothesis is very difficult to explain the unique features of Taihu lake, such as shallow, flat, new bottom, huge. Therefore, in the absence of additional evidence, the impact origin hypothesis has fallen into disfavor, and gradually died out.

In recent years, the dredging work in a small lake Shihu, 10 km to east of Taihu lake, revealed some unique shaped rod and irregular shaped sediments in specific mud layer. They actually were siderite concretions containing abundant angular quartz and minor clay minerals. The discovery of unique siderite concretions combining with previous claimed impact evidences revived the impact hypothesis in 2009 (Wang et al., 2009). The irregular shaped siderite concretions were regarded as an ejecta materials of impact, which are the terrestrial materials were smashed by impact projectile and then splashed into air and felled down in the impact crater and its surrounding areas. However, many questions still remain, such as how siderite forms, and what kind of impact mechanism involved.

Results

We collected Devonian sandstone from Taihu lake area to see if any confirmed impact evidence from these sandstone. Various deformation features of quartz grains in Devonian sandstone of Taihu lake area, including uneven extinction, fractures, and deformed lamella, are observed under optical microscopy. The preferred orientations of quartz deformed lamella were measured by using the universal stage. The well developed braided micro-fractures and artificial network fractures in the sandstone samples were observed. We also compare the quartz deformation features from sandstone of Tai Lake area to that from similar formation sandstone from JiuJiang area 300 km away from Tai Lake. The results show that the quartz deformed lamella of sandstone of Tai Lake area are not typical impact-induced planar deformation features (PDF). Most of the deformation features are caused by relatively lower pressure, the origin of these deformation features can be explained by multiple forces.

The siderite concretions occur in four morphologies: micro-sphere dust, bean-sized lapilli (Fig. 1), elongated rods, and irregular-shapes (Fig. 2). The irregular shapes include massive, sheet, and tear shaped concretions. Dust, lapilli, Rod and irregular concretions were found dispersed in a specific mud layer in several locations in the vicinity of Tai lake, while rod concretions were found vertically in a mud layer in Shi Lake. Recent work reveals that the distribution of these strange siderite concretions were widely dispersed in a specific layer, almost every where in bottom of Taihu lake. They are not only found in lake bottom, even sporadically found higher place, such as piedmont, hills top or slope. The occurrence and distribution suggest they either grow from bottom or come down from air.

The concretions consist of aggregates of μm-sized siderite spheroids or siderite crystals as concretion matrix, and μms-sized angular quartz grains and minor

clay residues as concretion debris. The ratio of the debris to siderite varied from ~10 % to 80 %. The sizes of concretion range from μm to cm. The surface of rod and irregular-shaped concretions show irregular ripples and furrows. Quartz grains are very angular with sharp edges and corners. They also show deformation features with parallel fractures and undulate extinction under cross polarized light. Siderites can show euhedral crystal habit with rhombic shape. The siderite crystals commonly occur as radial aggregates in micro-sized spheroids.

The age of mud layer contained siderite concretions were constrained by peat woods and shell by using C14 dating, indicating a non-calibrated age of ~ 7000 years ago, indicating the concretions formed later than 7000 years ago.

Discussion:

The work on deformation features of quartz grain of sandstone of Taihu lake area does not provide strong and confirmed evidence of impact origin. These work suggest the previous work of twenty years ago need to be re-evaluated and the strong support evidences for the 2009 paper (Wang, et al., 2009) are negative, and the conclusion of confirmation of impact crater of Taihu lake needed be caution.

Based on the observation and preliminary results of siderite concretions, the origin of the siderite concretions could be explained by three distinct mechanisms: aqueous deposition within the mud, volcanic lapilli formation and lapilli formed in the ejecta plum of an impact. The round shape of Tai lake has been use as evidence of an impact, but the large size and shallow depth of the lake are inconsistent with a young impact structure.

An alternative impact model that could produce a shallow crater without major crustal disruption is an aerial burst of an impact. The airburst impact hypothesis may explain the features of huge, shallow, flat, young of Tai Lake basin, and the deformation features caused by relatively lower pressure. The strange and unique siderite concretions containing abundant angular quartz debris may provides evidences for the airburst impact hypothesis. In addition, it is rewarded and valuable to intensively study the formation origin of Tai Lake by multiple approaches.

References: [1] Y. He, D. Xu, D. Lu et al., 1990. *Chinese Science Bulletin*, 36 (10): 847-850. (in Chinese). [2] E. Wang, Y. Wan, Y. Shi, et al. 1993. *Chinese Science Bulletin*, 39 (5): 149-423 (in Chinese). [3] H. Wang, Z. Xie, and H. Qian, 2009. *Geological Journal of China Universities*: 15: 437-444. (in Chinese).

Fig.1 Bean sized siderite spheroids, similar as lapilli.

Fig. 2 Irregular shaped siderite concretions