Fe-rich Concretions Bearing Angular Quartz Fragments from Taihu Lake, Southeast of China: Products of Airburst Eject Plumes ~7-8K Years Ago. Zhidong Xie, Shuhao Zuo, Henian Wang. State Key laboratory for Mineral Deposits Research, School of Earth Sciences and Engineering, Nanjing University, Nanjing, P. R. China, zhidongx@nju.edu.cn.

Here we report the occurrence of the Fe-rich concretions containing abundant angular quartz grains in the vicinity of Taihu Lake, Southeast of China. We propose that the Fe-rich concretions of Taihu lake were formed in the eject plumes by airbursts ~7-8 thousand years ago.

Background: 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 formed by a meteorite impact.In the early 90s of the last 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 [1,2]. 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 depth, flat and new bottom, huge area. 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. Most of them 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 [3]. 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.

Direct contact impact is difficult to explain the formation of Taihu lake basin. An alternative impact hypothesis is airburst impact model, which could produce a huge, shallow, flat, young basin without major crustal disruption under relatively low shock pressure ~7-8k years ago [4]. Unique siderite concretions likely formed in this airburst impact event, which is the key to the origin of Taihu lake.

Results

The term “concretion” is used in this paper to indicate the texture of these siderite-quartz rich materials, not to infer the sedimentary origin.

Morphology and occurrence: The siderite concretions occur in four morphologies: micro-sphere dust, bean-sized lapilli, elongated rods, and irregular-shapes. 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.

Mineralogy: The siderite 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 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 texture of the Fe-rich lapilli concretions are similar to volcanic accretionary lapilli, consisting of clay to sand sized angular quartz fragments and clay debris embedded in fine unknown materials, which can not be resolved under SEM. High resolution TEM is needed to confirm the mineral phases. Quartz grains are shattered fragments with angular edges.

Age: The age of the specific mud layer was constrained by C14 dating of charcoal wood and shell fragments in the same layer, suggests that the siderite concretions formed in about 7-8k years ago, or younger.

Discussion:

Based on observation and preliminary results, we think the origin of the siderite concretion, which might fit into three possibilities: aqueous deposition, volcanic lapilli formation and comet airburst impact origin. Volcanic lapilli is not in favor due to siderite formation. We mainly discuss other two possibilities.

The siderite concretions consist of micro-sized euhedral siderite crystals as matrix and angular quartz grains as debris. Angular quartz may origin from shattered sandstone. How siderite formed is more challenging. Siderite may formed in chaotic air vapor or in the mud layer. Spherules are the basic unit of dust, lapilli, Rod and irregular siderite concretions. The siderite crystals commonly occur in radial aggregates that make up micro-spheroids. Spherules indicate a high-energy environment, such as chaotic dynamic vapor or flood current .

Two origins of the siderite concretions are more-possible: precipitation of siderite around quartz fragments in the mud layer or aggregation of rock fragments and siderite in a plume of debris resulted by an airburst impact involving a base surge. If these features formed in the debris plume as lapilli, the angular quartz grains represent fragments of shocked rocks. The airburst hypothesis also requires a source of iron and carbonate to form euhedrual siderite in the debris plum, which can come from local geological units. More work is needed to identify a source of the iron.

The occurrence, age, morphology, and mineralogy of siderite concretions favor the lapilli formation model that they formed in the air and fall down to ground, other than aqueous deposition model that they growth from lake bottom mud. The vertical occurrence and wide distribution of the rod concretions suggest they either grow from bottom or come down from air. Higher-ground distribution is not easy to explain by aqueous deposition. The siderite concretions occurring in a specific Holocene mud layer indicate they formed in one young event, which favor the lapilli formation model of airburst impact. The link of basic unit of spherules in different shaped concretions favors the lapilli formation too.

Comet airburst hypothesis is possible to explain the whole story of Fe-rich concretions. However, the whole process how they formed is still in black box. Only the product of the events, such as these weird Fe-rich concretions reflects some dim lights. More samples and discussions will be presented in the coming meeting.

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). [4]Y. Dong, Z. Xie, S. Zuo, 2012. *Geological Journal of China Universities*: 18: 395-403. (in Chinese).

Acknowledge: Thanks to Laijing and Jiachao for providing samples for this study. Most samples discussed here were collected by them.