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Short Communications (Research Advances)

LA-ICP-MS zircon U-Pb dating of tuffites in the Sachakou Pb-Zn mining area, Karakorum, Xinjiang and its establishment of Early Triassic strata

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1. Objective

In the past decade, a group of medium to giant lead-zinc deposits, represented by Huoshaoyun, Sachakou, and Yuanbaoling, have been discovered in the Aksai Chin region of Karakoram, Xinjiang. They are all located in the Mesozoic carbonate and clastic rock formations. The Sachakou lead-zinc mining area is adjacent to the northwest of the Huoshaoyun lead-zinc mining area and is in the same stratigraphic layer as Huoshaoyun. Although many scholars have been arguing about the type and age of Huoshaoyun lead-zinc mineralization, few scholars have paid attention to the classification of the ore-bearing strata in the area. The stratigraphy of the Lower Permian Shenxianwan Group to the Upper Cretaceous Tielongtan Group is exposed in the Sachakou area of Karakorum, Xinjiang, however, the Late Permian-Early Triassic stratigraphy is missing (Fig. 1a). Due to the harsh natural conditions in the area and the low level of work, the stratigraphic delineation is not exhaustive, and the regional lithology is dominated by carbonates and clastic rocks, which makes it difficult to identify the age of the regional lithology and causes problems for the exploration and research of lead-zinc in the area. In this paper, petrographic and zircon chronological studies are conducted on the newly discovered tuffites in the Sachakou Pb-Zn mining area to accurately determine the age of tuffites formation, with the aim of enriching the basic geological data and serving the lead-zinc prospecting.

2. Methods

Based on the 1∶2000 geological mapping of the Sachakou Pb-Zn mining area, sampling, microscopic observation and LA-ICP-MS zircon U-Pb isotope dating of the newly discovered tuffites outcrop in the mining area were carried out (Fig. 1b). The collected samples (No. S2, 34°40′19″N, 78°58′05″E, H5468 m) were crushed, selected and target made, and then the sample targets were cathodoluminescence irradiated by scanning electron microscopy, and zircons with good oscillatory rings and no internal fractures were selected for LA-ICP-MS testing. The off-line processing of the test data was performed by Glitter 4.4 software, and the zircon U-Pb age harmonics plotting and age weight averaging were done by Isoplot/Ex_ver 3 software. The whole testing and analysis process was completed at the Key Laboratory of Magma to genesis and Mineral Exploration, Ministry of Natural Resources.

3. Results

Sachakou tuffites is light yellow to dark brown, massive structure, mainly tuff structure (Fig. 1c). Under microscope, the rocks are mainly composed of volcanic debris (about 53%), terrigenous debris (about 46%) and a small amount of interstitial material (about 1%) (Fig. 1d). Among them, the size of volcanic debris is about 0.08–0.75 mm, and the composition is mainly rock debris, some crystal debris, and

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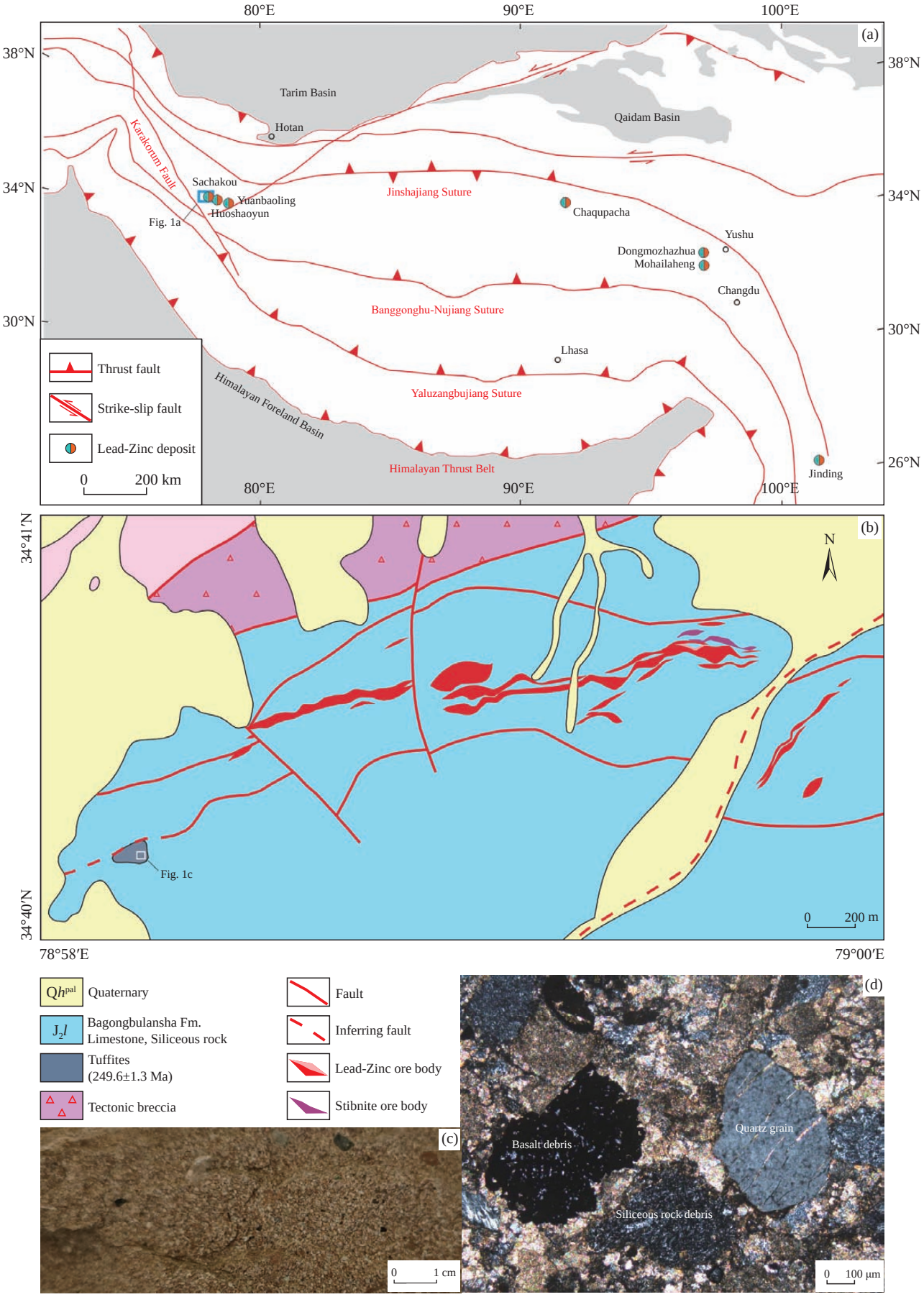

Fig. 1. a–Geotectonic position of the Sachakou area in the Karakorum, Xinjiang; b–geological sketch map of the Sachakou mine area; c–photograph of the Sachakou tuffites; d–representative photograph of the Sachakou tuffites.

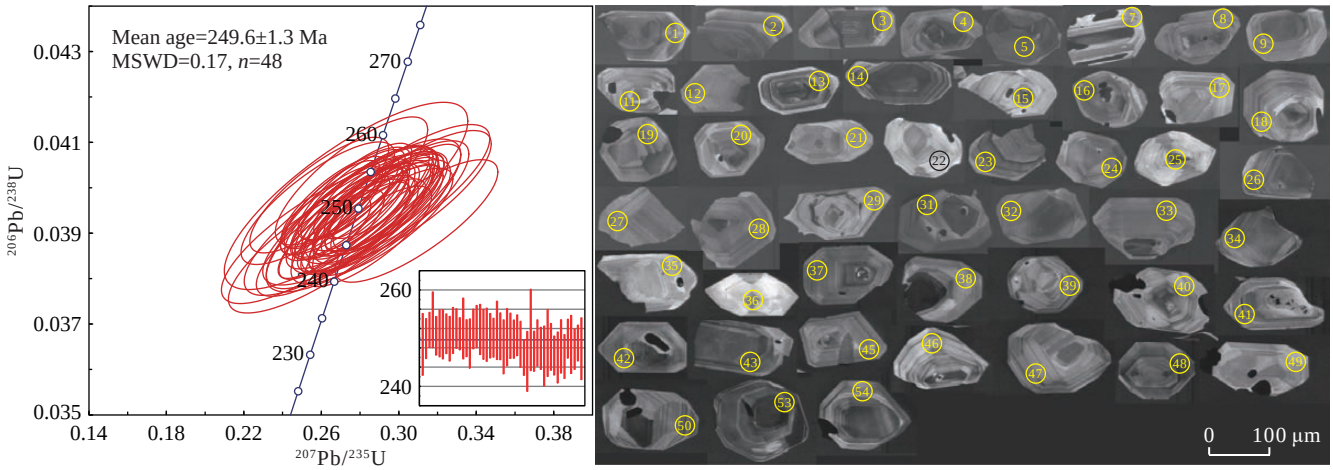

Fig. 2. Concordia diagram showing zircon U-Pb dating result of the Sachakou tuffites.

very small amount of glass debris. The rock debris are medium acidic magmatic rocks, such as andesitic, rhyolitic, etc., mostly prismatic; followed by crystal debris, mainly potassium feldspar and quartz, showing that the composition corresponds to rhyolitic tuff; the glass debris are mostly scimitar-shaped or other irregular forms, sporadically distributed in the rocks. The size of terrestrial debris is about 0.03–0.86 mm, mainly composed of rock debris, including rhyolitic and andesitic composition; very small amount of quartz and feldspar debris, mostly sub-angular, distinguished from the crystal debris in volcanic debris. The interstitial material is mainly volcanic glass, filling in the debris pore space. The tuffites as a whole exhibit the characteristics of a transitional type of medium-grained clastic sandstone and rhyolitic tuff.

The cathodoluminescence images show that most of the zircons are morphologically intact, with automorphic plates and short columns, single particles 100 μm to 150 μm long and 50 μm to 110 μm wide, developing clear oscillatory rings. The results of LA-ICP-MS U-Pb dating analysis show that the Th content of the 48 effective measurement points ranges from 37.51×10^{-6} to 371.14×10^{-6}, and the U content is 44.42×10^{-6} to 331.97×10^{-6}, the Th/U ratios are 0.53 to 1.44, indicating magmatic-genetic zircons (Supplementary Table 1). The $^{206}Pb/^{238}U$ age of the samples, ranging from 245.2±6.18 Ma to 253.8±5.77 Ma, with a weighted average age of 249.6±1.3 Ma (n=48, MSWD=0.17, 95%) (Fig. 2). The zircon age distribution of the tuffites is concentrated and basically consistent with the Tuanjiefeng volcanic rocks, suggesting that the tuffites formed in the Early Triassic.

4. Conclusion

The tuffites found in the Sachakou lead-zinc mine area is a transitional type of medium-grained clastic sandstone and rhyolitic tuff, with zircon U-Pb weighted age of 249.6±1.3 Ma (n=48, MSWD=0.17, 95%) , It is highly consistent with the age of the Tuanjiefeng volcanic rocks obtained by previous authors, which not only effectively constrains the depositional age, but also provides new age evidence for redefining the stratigraphic framework in the area, and further confirms the Tianshuihai Terrane was under the tectonic environment of northern subduction of the Paleao-Tethys Ocean in Early Triassic.

CRediT authorship contribution statement

Xiao-jian Zhao and Kai Weng contributed equally to this research. Xiao-jian Zhao and Kai Weng conceived of the presented idea, Nuo Li and Qing-lin Sui developed the theory. Ming Wang, Nuo Li, Deng-hui Chen, and Zhou-ping Guo participated in the field investigation, Meng-qi Jin verified the analytical methods. All authors discussed the results and contributed to the final manuscript.

Declaration of competing interest

The authors declare no conflict of interest.

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Supplementary data set

Supplementary data (Table 1) to this article can be found online at doi: 10.31035/cg2023048.