



CHINA 中国地质(英文)
GEOLOGY



China Geological Survey conducted the first natural gas hydrates production test in the South China Sea

Zircon U–Pb ages of the volcanic rocks and their constraints on the ending of the Huoshiling Formation in the southeastern of Songliao Basin, NE China

Xue-jiao Qu, Ming-kai Zhang, Pu-jun Wang, Zhuo-long Yang, You-feng Gao, Kang-jun Wu, Jia Wang, Xian-feng Tan

Citation: Xue-jiao Qu, Ming-kai Zhang, Pu-jun Wang, Zhuo-long Yang, You-feng Gao, Kang-jun Wu, Jia Wang, Xian-feng Tan, 2026. Zircon U–Pb ages of the volcanic rocks and their constraints on the ending of the Huoshiling Formation in the southeastern of Songliao Basin, NE China, *China Geology*, 9, 214–216. doi: [10.31035/cg2024084](https://doi.org/10.31035/cg2024084).

View online: <https://doi.org/10.31035/cg2024084>

Related articles that may interest you

Zircon U–Pb age of the volcanic rock from the Huoshiling Formation in the Yingtai Fault Depression, Songliao Basin, China

China Geology. 2023, 6(4), 751 <https://doi.org/10.31035/cg2023002>

Baddeleyite and zircon U–Pb ages of the ultramafic rocks in Chigu Tso area, Southeastern Tibet and their constraints on the timing of Comei Large Igneous Province

China Geology. 2020, 3(2), 262 <https://doi.org/10.31035/cg2020017>

Zircon U–Pb ages and provenance characteristics of the Zhiluo Formation sandstones and the formation background of the uranium deposit in Huangling area, Ordos Basin, China

China Geology. 2021, 4(4), 600 <https://doi.org/10.31035/cg2021006>

Geological characteristics of unconventional tight oil reservoir (10^9 t): A case study of Upper Cretaceous Qingshankou Formation, northern Songliao Basin, NE China

China Geology. 2024, 7(1), 51 <https://doi.org/10.31035/cg2022072>

Determination of the early Paleozoic accretionary complex in Southwestern Yunnan, China: Implications for the tectonic evolution of the Proto–Tethys Ocean

China Geology. 2023, 6(2), 322 <https://doi.org/10.31035/cg2023019>

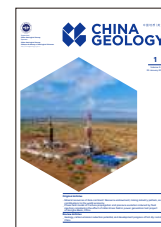
A new understanding of Demala Group complex in Chayu Area, southeastern Qinghai–Tibet Plateau: Evidence from zircon U–Pb and mica $^{40}\text{Ar}/^{39}\text{Ar}$ dating

China Geology. 2021, 4(1), 77 <https://doi.org/10.31035/cg2021021>



China Geology

Journal homepage: <http://chinageology.cgs.cn>
<https://www.sciencedirect.com/journal/china-geology>



Short Communications (Research Advances)

Zircon U-Pb ages of the volcanic rocks and their constraints on the ending of the Huoshiling Formation in the southeastern of Songliao Basin, NE China

Xue-jiao Qu^{a, b}, Ming-kai Zhang^a, Pu-jun Wang^c, Zhuo-long Yang^c, You-feng Gao^c, Kang-jun Wu^a, Jia Wang^a, Xian-feng Tan^{a, *}

^a School of Petroleum Engineering, Chongqing University of Science and Technology, Chongqing 401331, China

^b School of the Environment, the University of Queensland, Brisbane 4072, Australia

^c College of Earth Sciences, Jilin University, Changchun 130026, China

1. Objective

The Songliao Basin (SB) is situated on the eastern margin of Eurasia continent (Northeast Asia). During the Late Jurassic to Early Cretaceous, hundreds of rifting basins developed in this area, and the SB is a unique case among them as it evolved into the largest rift basin. The rift basin filling of SB includes Huoshiling Formation, Shahezi Formation, and Yingcheng Formation in ascending order. The mega-rifting was controlled by the Mongol-Okhotsk Collisional Belt to the north and northwest and the Pacific Subduction Zone to the east (Wang PJ et al., 2016). As the first rifting succession, the Huoshiling Formation contains key information about the formation of the rifting basins and records the evolution of the Mongol-Okhotsk Collisional Belt and the Pacific Subduction Zone. However, the geological period of the Huoshiling Formation has not been well constrained for two main reasons. First, it is easily confused with the Yingcheng Formation, as both are dominated by volcanogenic-sedimentary successions. Second, there is lack of reliable dating samples from the uppermost part of the Huoshiling Formation due to its considerable burial depth. In this paper, two credible volcanic rocks were identified at the uppermost part of the Huoshiling Formation in the Well CS607 and Well YS3 cores respectively, and one volcanic rock was identified in the middle of the Huoshiling Formation in the Well YS3 cuttings. Subsequently, Zircon U-Pb geochronology analyses were conducted. The results provide new data for constraining the timing of the Huoshiling

Formation in the context of the southeastern of SB.

The Well CS607 and Well YS3 are located in the Wangfu and Yushu Fault Depression respectively, southeastern of SB (Figs. 1a, b). The Huoshiling Formation in these wells is conformably covered by the Shahezi Formation, characterized by thick lacustrine sedimentary rocks and marsh coal (Figs. 1c, d). Simultaneously, the thick volcanic rocks developed at the top of the Huoshiling Formation provide excellent material for zircon U-Pb dating. The lithostratigraphic characteristics and sample descriptions of Well CS607 and Well YS3 are as follows.

Well CS607: The Huoshiling Formation is mainly composed of rhyolitic tuff interbedded with volcanic breccia. Rhyolitic pyroclastic lava is drilled at the uppermost part, while andesite is drilled at the lowermost part. The Shahezi Formation can be divided into two parts: The lower part consists of grey-black mudstone interbedded with coal and sandstone, while the upper part mainly consists of grey glutenite interbedded with thin layers of mudstone. The Yingcheng Formation is characterized by interbedded thin layers of purple-red mudstone and sandstone (Fig. 1c). The dating sample from the Well CS607 core is grayish-white rhyolitic pyroclastic lava at a depth of 2728.2 m. The content of pyroclastics is about 15%, mainly consisting of quartz and feldspar, with rare occurrences of basalt breccia (Figs. 1e, f). The matrix shows aphanitic texture, rhyotaxitic texture, and elongated vesicles filled with multi-stage quartz (Figs. 1e, f).

Well YS3: The Huoshiling Formation can be divided into three parts: The lower part is characterized by mafic and intermediate volcanic rocks; the middle part consists of mudstone interbedded with trachyandesite and tuff; and the upper part primarily comprises tuff and rhyolitic pyroclastic lava interbedded with coal. The Shahezi Formation is characterized by grey-black mudstone interbedded with coal and sandstone. The lithological characteristics of the Yingcheng Formation are similar to the Shahezi Formation,

First author: E-mail address: quxuejiao2008@aliyun.com (Xue-jiao Qu).

* Corresponding author: E-mail address: xianfengtan8299@163.com (Xian-feng Tan).

Literary editor: Xi-jie Chen
 doi:10.31035/cg2024084

2096-5192/© 2026 China Geology Editorial Office.

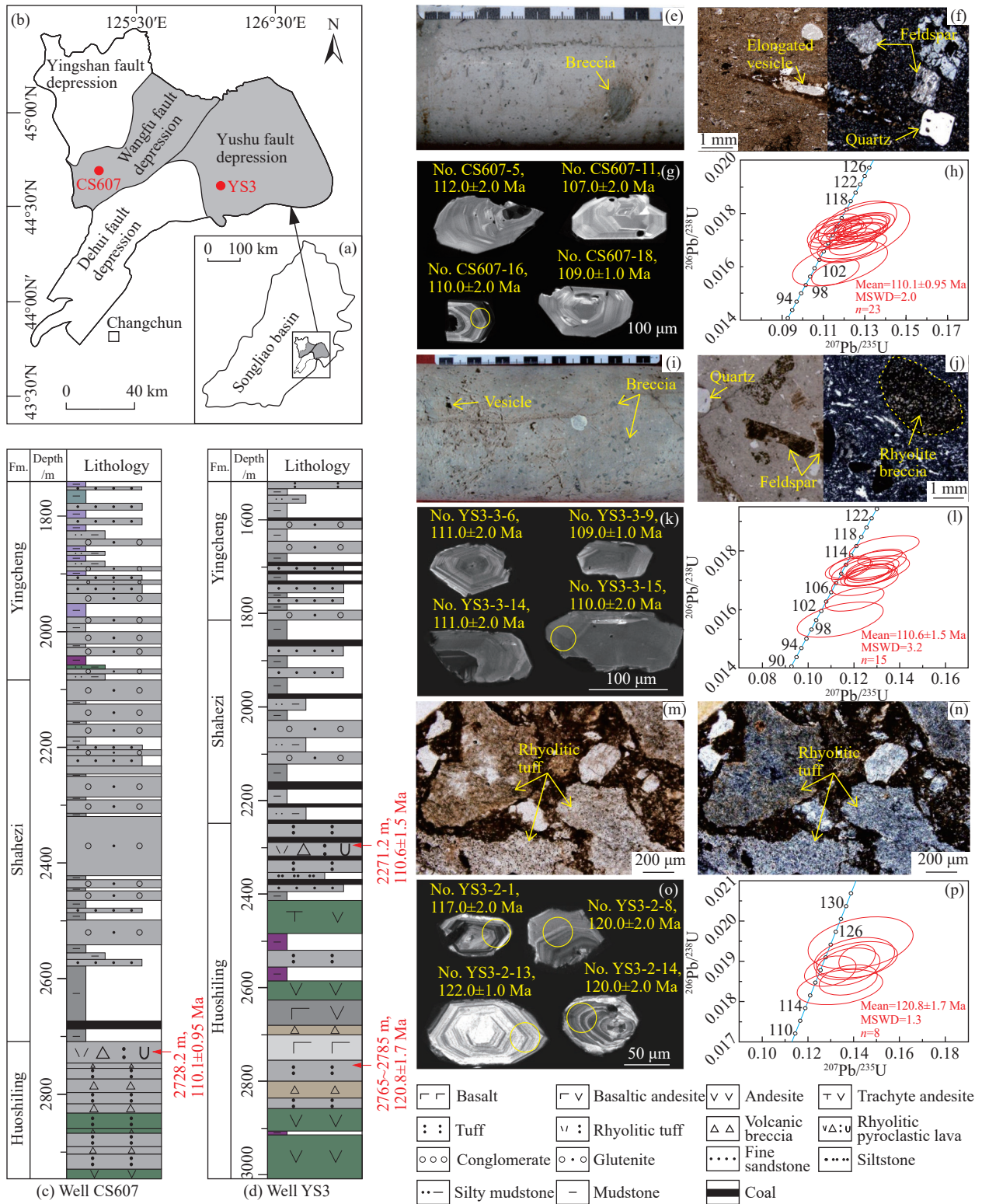


Fig. 1. a–Location of Wangfu and Yushu Fault Depression; b–sampling location; c, d–stratigraphic and lithological column of the rift stage for Well CS607 and YS3; e, f–core and thin section photos of zircon U-Pb dating sample, grayish-white rhyolitic pyroclastic lava, Well CS607-2728.2 m; i, j–core and thin section photos of zircon U-Pb dating sample, grayish-white rhyolitic pyroclastic lava, Well YS3-2271.2 m; m, n–Cutting thin section photos of zircon U-Pb dating sample, Well YS3-2773 m; g, k, o–representative cathodoluminescence images of analyzed zircons of Well CS607-2728.2 m, YS3-2271.2 m and YS3-2765–2785 m; h, l, p–U-Pb concordia age plot for zircons of Well CS607-2728.2 m, YS3-2271.2 m and YS3-2765–2785 m.

with tuff developed at the top (Fig. 1d). The dating sample from the Well YS3 core is grayish-white rhyolitic pyroclastic lava at a depth of 2271.2 m. The content of pyroclastics is about 20%, mainly consisting of feldspar and quartz, with

occurrences of rhyolite breccia (Figs. 1i, j). The matrix shows a felsic texture, rhyotaxitic texture, and unfilled vesicles (Figs. 1i, j). The dating sample from the Well YS3 cutting is rhyolitic tuff at a depth of 2765–2785 m within a stable rhyolitic tuff

section that ranges from 2761 m to 2800 m (Fig. 1d). The dating cuttings were carefully selected in stereomicroscope one by one before zircons separation. The rhyolitic tuff is mainly composed of volcanic ash and has been converted to felsic minerals through devitrification (Figs. 1m, n). A few angular quartz and feldspar crystals could be found in some tuff fragments.

2. Methods

Zircons sample crushing, separation, target fabrication, and cathodoluminescence were conducted at the Hebei Institute for Regional Geology and Mineral Investigation in Langfang. U-Pb isotopic dating of zircons was conducted at the State Key Laboratory of Geological Processes and Mineral Resources of China University of Geoscience (Wuhan). The instrument couples a quadrupole ICP-MS (Agilent 7500a) with the Geolas2005 Laser Ablation System. The laser has a spot size of 32 μm , and ablation depth ranges from 20 μm to 40 μm . The detailed experimental process, analysis steps and data analysis methods followed the reference. The data processing was completed with the software ICPMS Data-Cal 12.2 and Isoplot 3.75. Errors in individual analyses by LA-ICP-MS are given at the 1 σ level, whereas errors in pooled ages are given at the 95% (2 σ) confidence level.

3. Results

Zircons from the Huoshiling Formation are euhedral or subhedral crystals with diameters from 50 μm to 170 μm and axial ratios varying from 1 : 1 to 3 : 1. Generally, the crystals show an angular or sub-angular morphologies. Zircons exhibit clear internal structure and oscillating growth rings under cathodoluminescence (Figs. 1g, k, o). Based on the relatively high Th/U ratios of the zircon samples (Supplementary Table S1) and the above information, these zircons are of magmatic origin.

Twenty-four zircon grains from Well CS607-2728.2 m were analyzed. The age peak formed by twenty-three grains indicates an age range of 101 Ma to 113 Ma, with Th/U ratios ranging from 0.39 to 1.74. The weighted mean $^{206}\text{Pb}/^{238}\text{U}$ age of 110.1 ± 0.95 Ma (MSWD=2.0) (Fig. 1h) yielded by these twenty-three results provides a reference for the ending of the Huoshiling Formation. Seventeen zircon grains from Well YS3-2271.2 m were analyzed. The age peak formed by fifteen grains indicates an age range of 100 Ma to 116 Ma, with Th/U ratios ranging from 0.52 to 0.80. The weighted mean $^{206}\text{Pb}/^{238}\text{U}$ age of 110.6 ± 1.5 Ma (MSWD=3.2) (Fig. 1i) yielded by these fifteen results also provides a reference for the ending of the Huoshiling Formation. Fourteen zircon grains from Well YS3-2765–2785 m were analyzed. The age peak formed by eight grains indicates a range of 117 Ma to 124 Ma, with Th/U ratios ranging from 0.62 to 1.27. The weighted mean $^{206}\text{Pb}/^{238}\text{U}$ age of 120.8 ± 1.7 Ma (MSWD=1.3) (Fig. 1p) yielded by these eight results provides a reference for better approaching the initiation time of the Huoshiling

Formation. The $^{206}\text{Pb}/^{238}\text{U}$ age of 120.8 ± 1.7 Ma can be correlated with the zircon U-Pb age of volcanic rock LS101 in the Yingtai Fault Depression, western Songliao Basin (Wang CL et al., 2023).

4. Conclusion

The weighted mean $^{206}\text{Pb}/^{238}\text{U}$ ages of the rhyolitic pyroclastic lava from the top of the Huoshiling Formation are ca. 110 Ma, suggesting that the Huoshiling Formation in the southeastern of SB ended around the Albian. As the first rifting basin filling of the SB, the middle of the Huoshiling Formation is ca. 121 Ma, providing new evidence that the Huoshiling Formation in the southeastern of SB started earlier than the Aptian. The onset of rifting in Northeast Asia predates the Aptian, and the early stage of the rifting basin had been lasting for a considerable duration, exceeding 10 Ma.

CRedit authorship contribution statement

Xue-jiao Qu, Xian-feng Tan and You-feng Gao conceived of the presented idea and collected the samples. Pu-jun Wang and Xian-feng Tan developed the theory. Xue-jiao Qu, Ming-kai Zhang, Zhuo-long Yang and Jia Wang analyzed the samples and drew all the figures. Xue-jiao Qu, Kang-jun Wu and Ming-kai Zhang verified the analytical methods.

Declaration of competing interest

The authors declare no conflicts of interest.

Acknowledgment

This research was jointly supported by the National Natural Science Foundation of China (42102135, 42072140, 42202122 and 41790453), Science and Technology Research Program of Chongqing Municipal Education Commission (KJZD-M202101502, KJQN202201549 and KJQN2021 01535), Natural Science Foundation of Chongqing (CSTB 2022NSCQ-JQX0031 and CSTB2022NSCQMSX1586) and China Scholarship Council (202208505055).

Supplementary dataset

Supplementary data (Table S1) to this article can be found online at doi: [10.31035/cg2024083](https://doi.org/10.31035/cg2024083).

References

- Wang CL, Song LB, Yuan HQ. 2023. Zircon U-Pb age of the volcanic rock from the Huoshiling Formation in the Yingtai fault depression, Songliao basin, China. *China Geology*, 6(4), 751–752. doi: [10.31035/cg2023002](https://doi.org/10.31035/cg2023002).
- Wang PJ, Mattern F, Didenko NA, Zhu DF, Singer B, Sun XM. 2016. Tectonics and cycle system of the Cretaceous Songliao Basin: An inverted active continental margin basin. *Earth-Science Reviews*, (159), 82–102. doi: [10.1016/j.earscirev.2016.05.004](https://doi.org/10.1016/j.earscirev.2016.05.004).