



Short Communications (Research Advances)

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

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1. Objective

The Songliao Basin is a superposed basin filled with two layers. The lower layer is characterized by a fault-bounded volcanogenic succession comprising of intercalated volcanic, pyroclastic and epiclastic rocks. The upper layer is composed of normal sedimentary rocks. The Huoshiling Formation is the earliest volcanic stratum in the Songliao Basin. The report of geological age of it was rare, because of the lack of credible dating samples. It has seriously restricted the division and correlation of rift epoch strata, and the understanding of basin evolution. In this paper, the volcanic rocks of Huoshiling Formation whose lithostratigraphic characteristics are credible was found in LS101 Core, Yingtai Fault Depression, western Songliao Basin, China and the zircon U-Pb geochronology research was carried out. The result provides new data for understanding the formation time of Huoshiling Formation. At the same time, it's the first report of isotope age of volcanic rocks in Yingtai Fault Depression, Songliao Basin.

The LS101 core is located in Yingtai Fault Depression (Fig. 1a), western Songliao Basin, China, the lithostratigraphic classification mark of rift epoch strata that is clear. The rift epoch strata can be divided into Huoshiling Formation, Shahezi Formation, and Yingcheng Formation (Fig. 1b). The Huoshiling Formation is composed of grey-green dacitic ignimbrite. Its distribution is from 3810 m to 3722 m in depth. The Shahezi Formation is composed of two parts. The lower part of the formation was composed of grey-green tuff sandstone intercalated with variegated conglomerate, mudstone and sandstone, and upper part consisted of thick mudstone intercalated with thin sandstone. Its distribution is

from 3722 m to 3103 m in depth. The Yingcheng Formation is composed of two parts. The lower part of the formation was composed of andesite, basalt, rhyolite and rhyolitic volcanic breccia, and upper part consisted of dark grey silty mudstone. Its distribution is from 3103 m to 2705 m in depth. The volcanic sample of Huoshiling Formation in this paper is grey-green dacitic ignimbrite that from 3797 m in depth of LS101 core. The sample of grey-green dacitic ignimbrite has a welded tuffaceous texture, with crystal fragment of quartz, plagioclase, amphibole, and plastic hyaline fragment, and with pseudo fluxion structure (Fig. 1c).

2. Methods

Sample crushing, zircon separation, target fabrication, and cathodoluminescence were conducted at the Yuneng Rock and Mineral Separation Service Company, Langfang. LA-ICP-MS zircon U-Pb analysis was carried out at the Key Laboratory of Mineral Resources Evaluation in Northeast Asia, Ministry of Land and Resources of China. The instrument couples a quadrupole ICP-MS (Agilent 7500a) and 193 nm ArF Excimer laser (COMPexPro 102, Coherent, DE) with the automatic positioning system. The detailed experimental process, analysis steps and data analysis method followed the reference (Yuan HL et al., 2004).

3. Results

The zircon grains are euhedral to subhedral, long columnar in shape, with obvious concussion band. The Th/U ratios of zircons from the sample LS101 range from 0.42 to 2.26, showing that they are magmatic in origin (Supplementary Table S1). Twenty-five zircon grains yield six groups of concordant ages, The first group yielded a weighted mean $^{206}\text{Pb}/^{238}\text{U}$ age of 124.2 ± 2.0 Ma ($n=9$) (Fig. 1d), another five groups yielded a weighted mean $^{206}\text{Pb}/^{238}\text{U}$ age of 163.8 ± 4.5 Ma ($n=6$), 185.8 ± 7.7 Ma ($n=5$),

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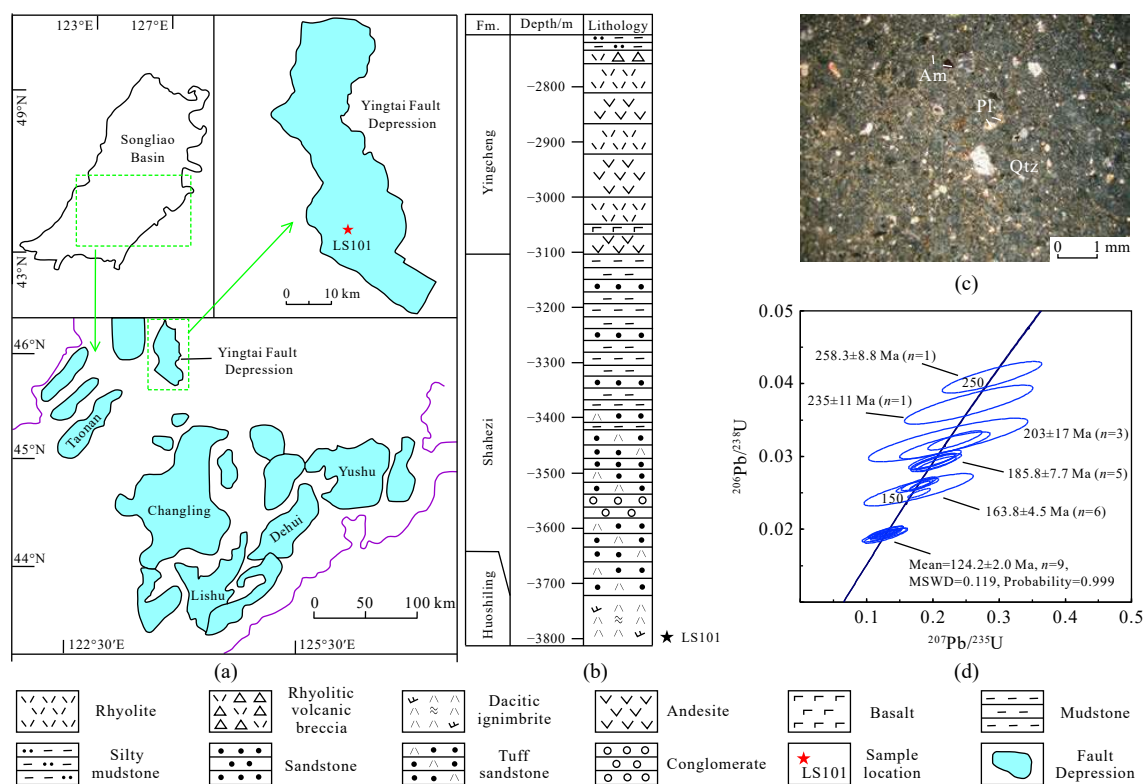


Fig. 1. Sampling location (a), strata sequence of the rift epoch (b), thin section of lithological identification (c), and zircon U-Pb concordia diagram (d) of the Huoshiling Formation.

203 ± 17 Ma ($n=3$), 235 ± 11 Ma ($n=1$) and 258.3 ± 8.8 Ma ($n=1$), respectively. The $^{206}\text{Pb}/^{238}\text{U}$ age of 124.2 ± 2.0 Ma represents the formation time of the sample LS101, which can be correlated with the volcanic rock zircon U-Pb ages of Fucan 1 core in Northern Songliao Basin (Huang QH et al., 2011) and YS3 core in Changling Fault Depression, later than the formation time of Huoshiling Formation in southeastern margin of Songliao Basin (Wang CL et al., 2017). The other zircons in this paper are thought to be captured zircons, the ages of them represent the magmatic events of basement in Yingtai Fault Depression.

4. Conclusions

(i) The weighted mean $^{206}\text{Pb}/^{238}\text{U}$ ages of the volcanic rocks from the Huoshiling Formation in this paper is 124 Ma, suggesting that the Huoshiling Formation in the Yingtai Fault Depression formed around Barremian of the Early Cretaceous.

(ii) The dating results of captured zircons show that the Late Permian (about 258.3 Ma), early Late Triassic (about 235 Ma), late Late Triassic (about 203 Ma), late Early Jurassic (about 185.8 Ma), and late Middle Jurassic (about 163.8 Ma) magmatic events had taken place in the basement of Yingtai Fault Depression.

CRedit authorship contribution statement

Cheng-long Wang conceived of the presented idea. Li-bin Song collected the samples and provided the core information. Cheng-long Wang and Hong-qi Yuan analyzed the samples and drew all the figures. All authors discussed the results and

contributed to the final manuscript.

Declaration of competing interest

The authors declare no conflicts of interest.

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Supplementary dataset

Supplementary data (Supplementary Table S1) to this article can be found online at doi: [10.31035/cg2023002](https://doi.org/10.31035/cg2023002).

References

- Huang QH, Wu HC, Wan XQ, He HY, Deng CL. 2011. New Progress of Integrated Chronostratigraphy of the Cretaceous in Songliao Basin. *Geological Bulletin of China*, 35(3), 250–257. doi: [10.19839/j.cnki.dcxz.2011.03.002](https://doi.org/10.19839/j.cnki.dcxz.2011.03.002).
- Wang CL, Zhang MS, Sun K, Wang YN, Li XB, Liu XS. 2017. Latest zircon U-Pb geochronology of the Huoshiling Formation volcanic rocks in the southeastern margin of the Songliao Basin. *Acta Geologica Sinica (English Edition)*, 91(5), 1924–1925. doi: [10.1111/1755-6724.13425](https://doi.org/10.1111/1755-6724.13425).
- Yuan HL, Gao S, Liu XM, Li HM, Gunther D, Wu FY. 2004. Accurate U-Pb age and trace element determinations of Zircon by Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry. *Geostandards and Geoanalytical Research*, 28(3), 353–370. doi: [10.1111/j.1751-908x.2004.tb00755.x](https://doi.org/10.1111/j.1751-908x.2004.tb00755.x).