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Research Advances

Latest Zircon U-Pb Geochronology of the Huoshiling Formation Volcanic Rocks in the Southeastern Margin of the Songliao Basin

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Objective

The Huoshiling Formation is the earliest volcanic stratum in the Songliao Basin, composed mainly of intermediate-basic volcanic rocks, with rare fossils. The geological age of this formation has been controversial for long. The accurate dating is not only the basis of stratigraphic division and correlation in the Songliao Basin, but also is significant for understanding the Late Mesozoic volcanic activities in Northeast Asia. In the past few decades, a lot of ages ranging from 169 Ma to 131 Ma were achieved by K-Ar and $^{40}Ar/^{39}Ar$ method from drilling cores and outcrops, showed a large discreteness. Few high-precision zircon U-Pb ages were reported only in drilling cores (133–124.9Ma), but related research was lack at the margin of the Songliao Basin. Three zircon U-Pb ages of volcanic rocks from the outcrops in the southeastern margin of the Songliao Basin were first reported in this paper, providing new evidence for the discussion of geological age.

Methods

Three fresh andesite samples were collected from the southeastern margin of the Songliao Basin (Fig. 1). The samples YG05 (43°57′0.6″N, 125°34′21.0″E) and YG08 (43°56′46.9″N, 125°36′38.8″E) were collected from the outcrops near the Yangcaogou coal mine, and the sample JY01 (43°50′37.3″N, 125°27′58.8″E) was collected from the outcrop near the Shibeiling coal mine.

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 (Agilient 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 some references.

Results

The zircon grains are euhedral to subhedral, columnar to long columnar in shape, with obvious concussion band, show that they are magmatic in origin.

The Th/U ratios of zircons from the sample YG05 range from 0.22 to 0.87. Twenty-three zircon grains yield two groups of concordant ages (Fig. 1), a weighted mean $^{206}Pb/^{238}U$ age of 130.6±1.8 Ma (n=10) and the other weighted mean $^{206}Pb/^{238}U$ age of 163.1±1.9 Ma (n=13). The former represents the formation time of the sample YG05.

The Th/U ratios of zircons from the Sample YG08 range from 0.17 to 1.09. Twenty-four zircon grains yield five groups of concordant ages (Fig. 1). The first group yielded a weighted mean $^{206}Pb/^{238}U$ age of 130.9±1.9 Ma (n=12), another four groups yielded a weighted mean $^{206}Pb/^{238}U$ age of 162.8±2.3 Ma (n=9), 179.0±2.1 Ma (n=1), 203.8±2.8 Ma (n=1) and 287.4±3.1 Ma (n=1), respectively. The $^{206}Pb/^{238}U$ age of 130.9±1.9 Ma represents the formation time of the sample YG08.

The Th/U ratios of zircons from the sample JY01 range from 0.18 to 1.03. Twenty-nine zircon grains yield four groups of concordant ages (Fig. 1); the first group gave a weighted mean $^{206}Pb/^{238}U$ age of 130.5±1.3 Ma (n=15), and another three groups gave a weighted mean $^{206}Pb/^{238}U$ age of 160.9±1.9 Ma (n=6), 181.9±1.9 Ma (n=7) and 221.7±15.2 Ma (n=1), respectively. The $^{206}Pb/^{238}U$ age of 130.5±1.3 Ma represents the formation time of the sample JY01.

As a result, 130.9–130.5 Ma, the youngest group of zircon U-Pb age is the formation age of the Huoshiling

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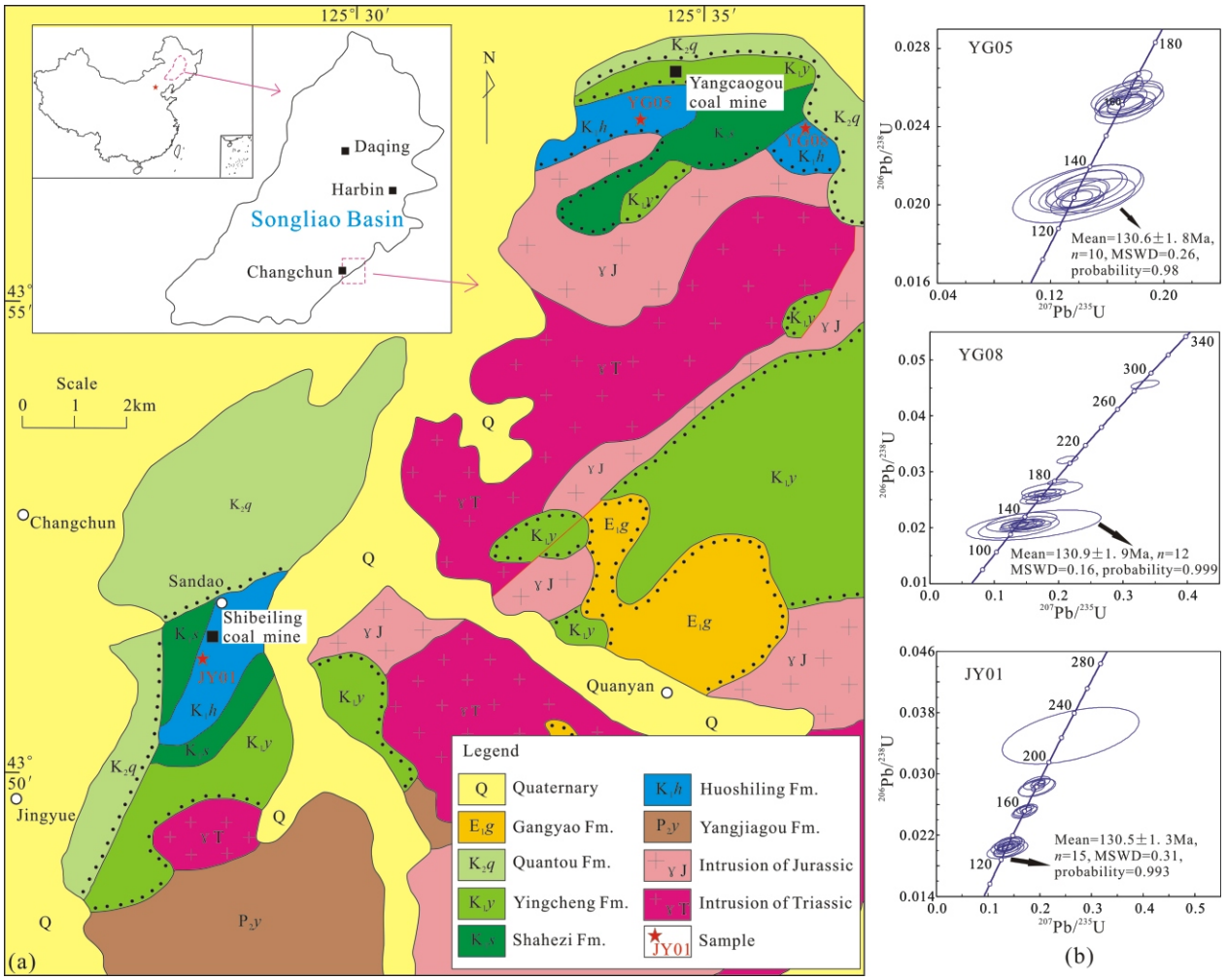

Fig. 1. Geological map (a) of the study area, showing the locality of samples, and concordia diagrams (b) of zircon U-Pb for the volcanic rocks from Huoshiling Formation.

Formation volcanic rocks in the southeastern margin of the Songliao Basin. There are four age groups for the captured zircons: 163.1–160.9 Ma, 181.9–179.0 Ma, 221.7 –203.8 Ma and 287.4 Ma. 163.1–160.9 Ma is consistent with the latest basement granites from the Songliao Basin, and the other three groups can be found in zircon U-Pb dating of basement from the Songliao Basin by previous researchers.

Conclusion

The weighted mean $^{206}Pb/^{238}U$ ages of the volcanic rocks from the Huoshiling Formation in the southeastern margin of the Songliao Basin range from 130.9 to 130.5 Ma, match with the reported zircon U-Pb age (133–124.9Ma) from drill cores in the Songliao Basin, suggesting that the Huoshiling Formation formed around Hauterivian-Barremian of the Early Cretaceous.

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