



Short Communications (Research Advances)

First discovery of Cretaceous tuffs in the Zhenyuan area, southwestern Ordos Basin, China: Constraints from zircon U-Pb dating

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1. Objective

The Cretaceous succession is characteristic of the aeolian sedimentary system in the Ordos Basin, which is the major ore-bearing layer for the sandstone-type uranium deposits. Based on the research of paleontology and magnetostratigraphy, formers believed it belonged to the Early Cretaceous (Huang YB, 2010). However, the lack of intrusions or volcanic rocks for isotopic dating results in an unclear formation age for the Lower Cretaceous succession. Recently, tuffs were firstly discovered in the Luohandong Formation in the Zhenyuan area, Gansu Province, located in the southwestern Ordos Basin, China. The LA-ICP-MS zircon U-Pb dating of tuffs was carried out. The new ages can precisely constrain the depositional age of the Luohandong Formation and also provide significant indications for the study of regional volcanic activities, paleoclimate, basin evolution, and tectonic setting.

2. Methods

Three tuffs were sampled from the drill holes (Z3, Z5, and Z7 in Fig. 1). Sample crushing and zircon sorting were completed by the Hebei Langfang Yu-Neng Technology Service Limited Company. Microscopic analysis, zircon cathodoluminescence (CL) images, and zircon laser ablation-inductively coupled plasma-mass spectrometry (LA- ICP-MS, Agilent 7900) testing were performed at the Laboratory of the

Tianjin Center of the China Geological Survey. U-Pb dating, trace elements, and rare earth elements of zircon grains were measured by LA- ICP-MS. Data processing was completed by using ICPMSDataCal software. Age calculations and plot formation were mapped by IsoplotR.

3. Results

The gray-white tuffs are characteristics of the crystal pyroclasts with the sizes of quartz and biotite being < 0.5 mm (Figs. 2d, e, f). The detrital zircons from tuffs have a perfect crystal form. Grains are mostly euhedral and columnar, with obvious magmatic oscillatory zonings (Figs. 2h, i, j). Th/U values of zircons are >0.5, indicating magmatic origin. U-Pb dating can record the crystallization age and the time of volcanic activity. Z3 zircon dating analyses yield ²³⁸U/²⁰⁶Pb ages ranging from 117±2 Ma to 138±2 Ma. 73 of 74 grains have a weighted mean age of 125.32±0.22 Ma (Fig. 2). 68 grains of Z5 have ²³⁸U/²⁰⁶Pb ages ranging from 112±3 Ma to 134±5 Ma with a weighted mean age of 121.71±0.51 Ma. ²³⁸U/²⁰⁶Pb ages of Z7 ranged from 111±1 Ma to 131±3 Ma and their weighted mean age is 118.20±0.22 Ma (Supplementary Table S1).

Dating results present that the tuff beds in the Luohandong Formation have concordant ages of 126.12–118.36 Ma and weighted mean ages of 125.31–118.36 Ma (Fig. 2). Furthermore, the magnetostratigraphy in the Huanhe-Huachi Formation showed its paleomagnetic age was from 133.94 Ma to 129.73 Ma (Huang YB, 2010). The ages of the above two formations are consecutive, which further builds the time sequence of the Lower Cretaceous. As a result, it was the first time to precisely constrain the depositional age of the Lower Cretaceous Luohandong formation by the zircon U-Pb dating. These results will be meaningful to understand the metallogenic backgrounds, ore-forming process, and material sources of sandstone-type uranium deposits in the

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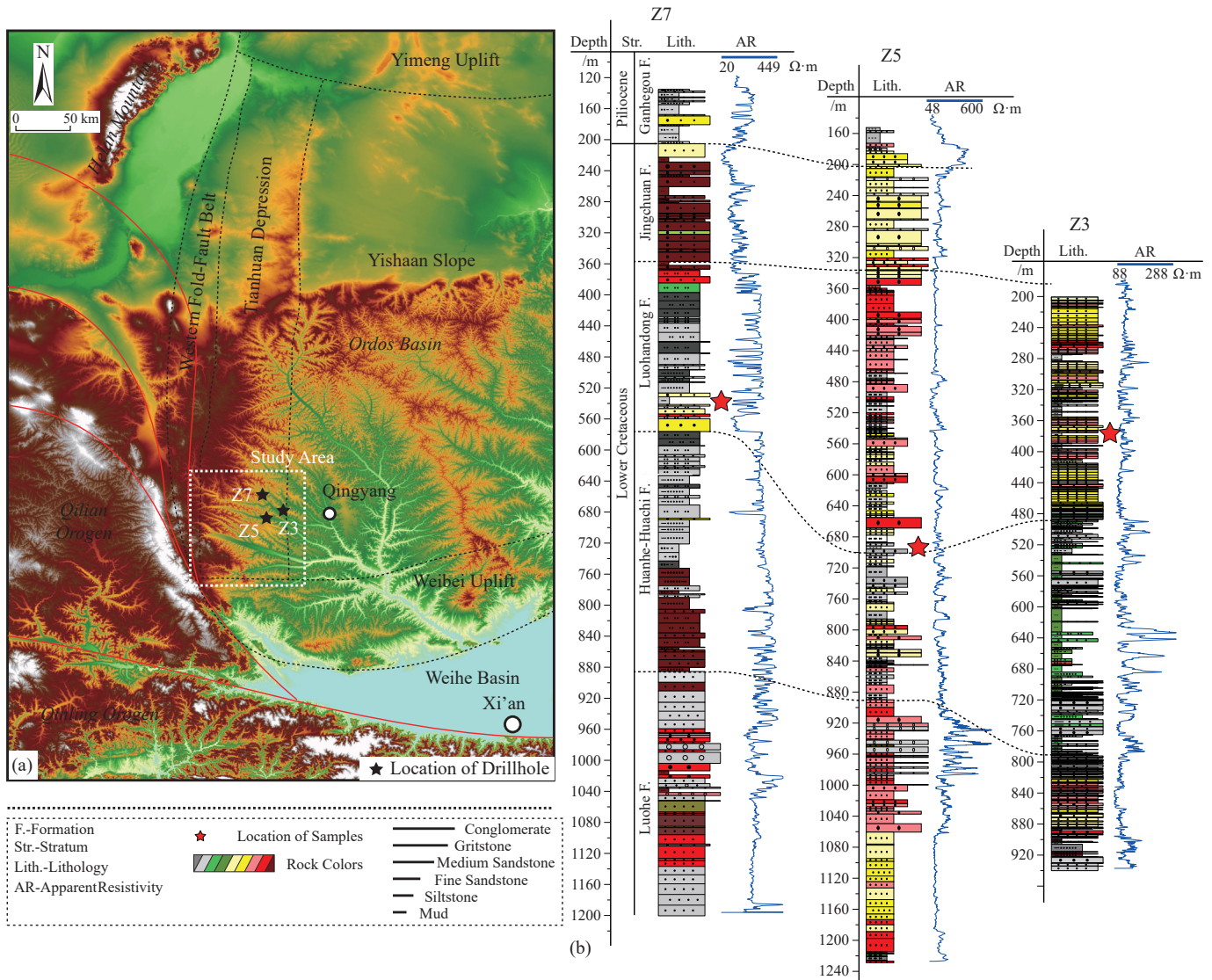


Fig. 1. Tectonic sketch map of the southwestern Ordos Basin (a) and profile of drill holes, sample locations (b).

southwestern Ordos Basin.

The development of tuffs commonly represents intensive volcanic activities. The occurrence of the tuffs has a great consistence with the global paleoclimate transfer and the oceanic anoxic events in the Early Cretaceous, at about 124 Ma (Grossman EL and Joachimski MM, 2012), which was marked by the oxygen isotopic analysis (Gerka K, 2008). It was hypothesized that the masses of tephros spread in the atmosphere and caused the temperature to decrease and result in the change on sedimentary environments in the Ordos Basin.

4. Conclusion

Gray-white crystal tuffs were firstly discovered in the Lower Cretaceous Luohandong Formation in the southwestern Ordos Basin. The zircon U-Pb dating exhibited their concordant ages to be 126.12–118.36 Ma and weighted mean ages to be 125.31–118.36 Ma. These results provide a much more precise time constraint for the Early Cretaceous deposition in the Ordos Basin, and also confirm the

metallogenic backgrounds for the sandstone-type uranium deposits. Meanwhile, these tuffs are believed to represent a widely spreading volcanic activity. It may have caused a global climate change, which resulted in the transition of sedimentary environments in the Ordos Basin.

CRediT authorship contribution statement

Yin Chen conceived of the presented idea. Yin Chen and Jian-guo Li wrote the manuscript in consultation. Lu-lu Chen and Hua-lei Zhao participated in the preliminary work of sample collection and data analysis. 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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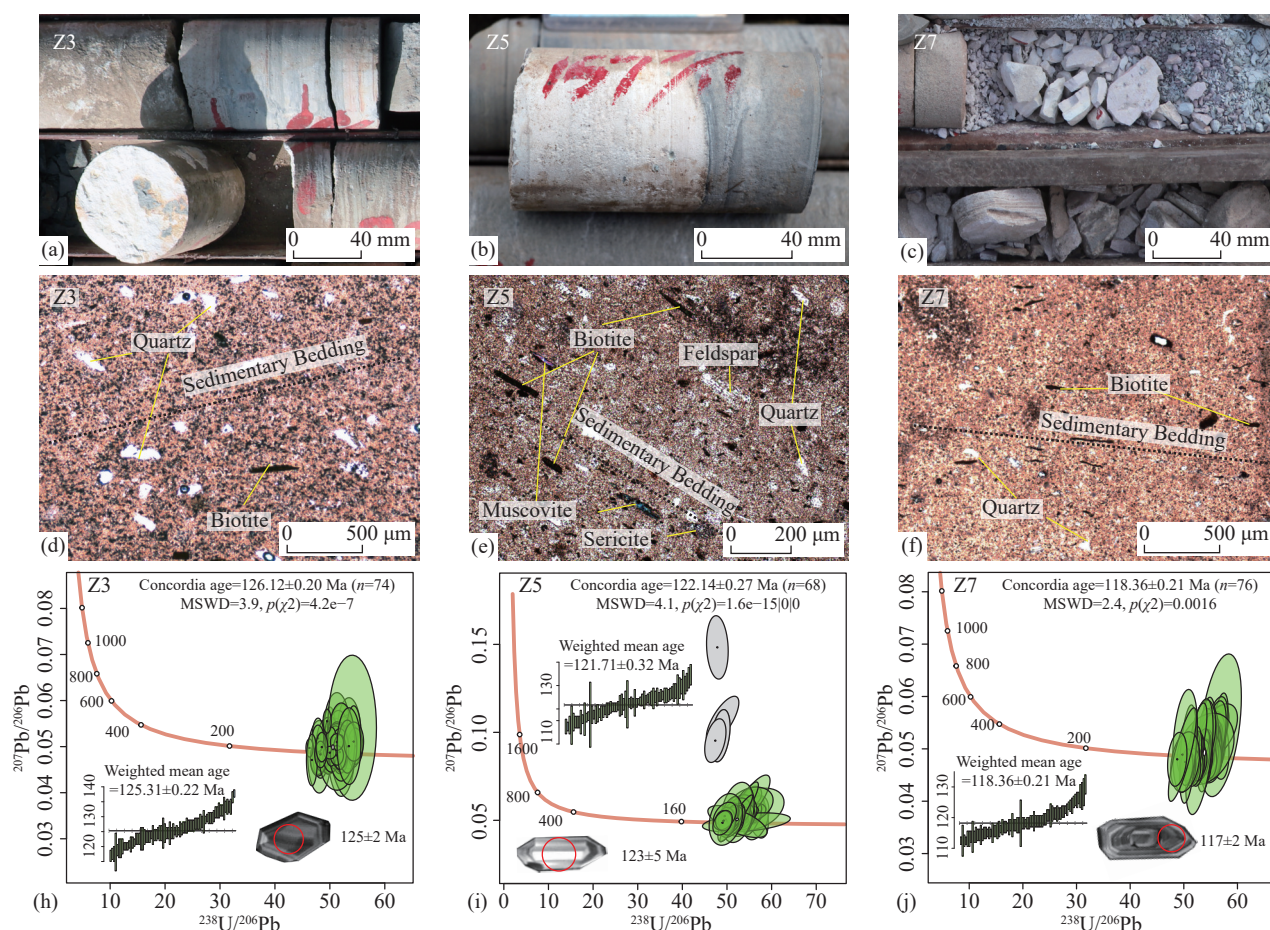


Fig. 2. Photos of samples and zircon U-Pb dating of the tuff beds in the Ordos Basin. a–c –photos of three samples; d–f–orthogonal polarization micrographs of three samples; h–j–zircon U-Pb dating concordia diagrams, weighted mean ages, and CL images.

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Supplementary dataset

Supplementary data (Supplementary Table S1) to this article can be found online at doi: [10.31035/cg2023109](https://doi.org/10.31035/cg2023109).

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