The exploration depth of sandstone-type uranium deposits worldwide is mostly less than 700 m, and most of them occur in strata of fluvial facies (Adams et al., 1981; Jin et al., 2016; Hou et al., 2017). Only a few small uranium deposits have been reported in aeolian depositional environments (Isachsen et al., 1955; Li et al., 2001). In the Pengyang–Jingchuan region of the southwestern Ordos Basin, uranium ore bodies with large thickness and high grade in the aeolian sandstone of the Luohe Formation were newly found at depths from 700 to 1500 m, which have laid the foundation for increasing the uranium resources significantly in the Ordos Basin. Special research and development have been planned to explore the deep sandstone-type uranium deposits, with the implementation of a 2000 m deep scientific drilling program supported by the National Key Research and Development Project, based on investigation results of the “Northern China Sandstone Type Uranium Deposits Geological Survey” project.

The Pengyang uranium deposit is located at the southwestern margin of the Tianhuan depression zone of the Ordos Basin, adjacent to the Changqing oilfield to the northeast. The ore-bearing horizon is the Lower Cretaceous Luohe Formation (K1l) (Fig. 1), which consists of a set of very thick red sand bodies developed under an aeolian sedimentary environment (Jiang et al., 2001; Xing et al., 2018). The regional structures are characterized by faults that trend mainly in the NW and near NS directions. The uranium mineralized area lies within a NS-trending strip 60.9 km long and 33.5 km wide, covering an area of 2,049.4 km², at depths of 700–1500 m. The Luohe Formation ranges from 300 m to 400 m thick and contains 1 to 3 layers of uranium mineralization. The wall rocks adjacent to the mineralization are mainly gray, greenish-gray medium-grained sandstone and medium-grained sandstone (Fig. 2a). The mineralized layers in the Luohe Formation is distributed in the top, middle and bottom, with thicknesses of 3.2–31.3 m, 7.4–11.5 m and 50.5 m respectively. The depths of these uranium mineralization layers range from 790 m to 1415 m. The thicknesses of uranium orebodies revealed by the drilling range from 9.1 to 16.3 m, and the uranium grades are between 0.0105%–0.097%, which manifests a large uranium resource.

The uranium mineralization is associated with bleaching zones along or crosscutting the strata of the Luohe Formation, as seen in drill cores from the deep exploration borehole (SD01) (Fig. 2a). Distinct alteration zones are developed symmetrically along fractures, i.e., from green gray in the center, through yellow/light red in the transition zone, to red sandstone at the outmost. Typical vertical zonation of sandstone type uranium ores was observed in several drill holes (such as hole BUZK07), and reverse zonation (i.e., upper gray and lower red)
occurs in drill hole BUZK03 (Fig. 2b). For drill holes BUZK05 and BUZK08 on the southwestern edge of the mineralization zone, only reddish uranium mineralization was observed. The proportion of alteration and ore minerals is generally low (5%), mainly including pyrite, calcite, dolomite, anatase, pitchblende and collophosphate.

The mechanism for this special uranium mineralization is interpreted to be related to introduction of deeply derived reducing fluids into the red sandstone along structural cracks and bedding, causing alteration zoning and precipitating uranium minerals in the redox transitional zone. This mineralization process reveals the importance of coupling deep reducing (perhaps hydrocarbon-bearing) fluids and red sandstone-hosted oxygen-bearing uranium fluids. This model has great scientific significance for the study of sandstone-type uranium mineralization theory, as well as for expanding the exploration space of sandstone-type uranium deposits in the Ordos Basin and other sedimentary basins in northern China.

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