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News & Views

Discovery of Triassic coal-bearing strata in the Daxing'anling Region, Northeast China

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During the late Paleozoic to early Mesozoic, a tectonic transition occurred in Northeast China, marking a shift from the Paleo-Asian Ocean to the Mongolian Okhotsk and Paleo-Pacific tectonic domains [1]. As a result of regional compression induced by oceanic closure and continental collision, stratigraphic records from this period are scarce, but such records are essential for elucidating the tectonic and paleographic evolution of the region during the transition. Owing to the progress of isotope chronology [2], Triassic strata dominated by volcanic and volcaniclastic rocks were recently discovered in the Songliao and Hailar basins and the Yanji and Duobaoshan areas (Fig. 1a) [3–6], which have shed new light on the paleographic evolution of Northeast China during this period.

In this study, Middle Triassic coal-bearing volcaniclastic strata in the Daxing'anling area are described for the first time. The stratigraphic section (located at 49°27′51.88″N, 118°23′18.37″E, with a height of 576 m) is exposed in Xiwuzhuer village of northern Inner Mongolia, which is situated within the Erguna Block and adjacent to the Hailar Basin. The Triassic strata include coal seams, mudstone, carbonaceous shale, siltstone, pebbly sandstone, and conglomerate. The strata transition from conglomerate and pebbly coarse sandstone at the base to pebbly fine sandstone and mudstone at the top of the section (Fig. 1b). The Triassic strata were deposited in a fan-delta setting and can be subdivided into three units (Fig. 1c). The lower unit consists of interbedded greyish-black sandy conglomerate, carbonaceous mudstone, and coal seams with horizontal and wavy bedding, which were formed in swamp deposits and have a minimum preserved thickness of 15 m (base not exposed). The middle unit is mainly composed of thick layers of conglomerate and sandstone, with thin layers of carbonaceous shale in the middle (Fig. 1d) and a total thickness of 57 m. The rock assemblages are mainly greyish-black and greyish-white, with local yellowish weathered surfaces (Fig. 1e). The conglomerate is poorly sorted (Fig. 1f), sub-angular to sub-rounded, polymict, and clast-supported, and clast types include siltstone, mudstone, quartzite, and granite in a sandy matrix. The overall stratigraphy exhibits several fining-upward sequences. During petrographic observation, palimpsest texture were observed in some of the sandstone and conglomerate, which are assumed to have been caused by metamorphic processes related to volcanic activities. The middle unit exhibits normal grading and trough cross-bedding, indicating alternated distributary channel and swamp settings. The upper unit comprises interbedded layers of horizontally bedded coal seams (Fig. 1g, Fig. S1 online), carbonaceous mudstone, sandstone, and tuffaceous sandy conglomerate, with intercalated rhyolitic tuff beds in the middle, which represent swamp and explosive deposits and reach a thickness of 36 m. Two samples (HJ41 and HJ42) were collected from the upper unit of the Triassic strata for zircon U-Pb dating (Fig. 1c). Sample HJ41 (Fig. 1h) is greyish-black rhyolitic tuff and contains 40 % quartz, and 10 % feldspar, with a volcanic ash matrix and minor biotite. Quartz grains are angular to subangular, with partly rounded and embayed outlines due to magmatic partial resorption, which indicates a volcanic origin rather than long-term transportation and re-sedimentation (Figs. S2 and S3 online). Sample HJ42 (Fig. 1i) is greyish-black tuffite and contains mainly quartz, feldspar, and lithic fragments, cemented by clays, and with minor volcanic ash in the matrix. Approximately 20 % of the lithic fragments are metamorphic, and these are interpreted as having formed owing to fragmentation of basement rocks caused by explosive volcanism (Figs. S4 and S5 online). All 30 zircon analyzed grains from the tuff (Sample HJ41) yielded concordant ages, 26 of which defined an age peak at 249–229 Ma (Table S1 online). The weighted mean $^{206}Pb/^{238}U$ age was 237.7 ± 1.2 Ma (MSWD = 1.08). The remaining four zircons yielded ages of 520, 382, 288, and 260 Ma, which are interpreted to reflect the ages of captured zircons (Fig. S6 online). All 30 analyzed grains from the tuffite (Sample HJ42) were concordant and defined a normal age distribution. The resultant age peak ranges from 258 to 219 Ma (Table S1 online), and the weighted mean $^{206}Pb/^{238}U$ age of 240.0 ± 3.1 Ma (MSWD = 1.7) obtained from the analyses is interpreted as the eruption age of the tuff (Fig. S7 online). The dated samples were obtained from intercalated volcaniclastic layers in coal-bearing sedimentary strata; therefore, their ages provide constraints on the age of the surrounding strata. According to the zircon dating results of the two samples, the coal-bearing volcaniclastic deposits were formed between 240.0 and 237.7 Ma, corresponding to the Carnian stage of the Late Triassic.

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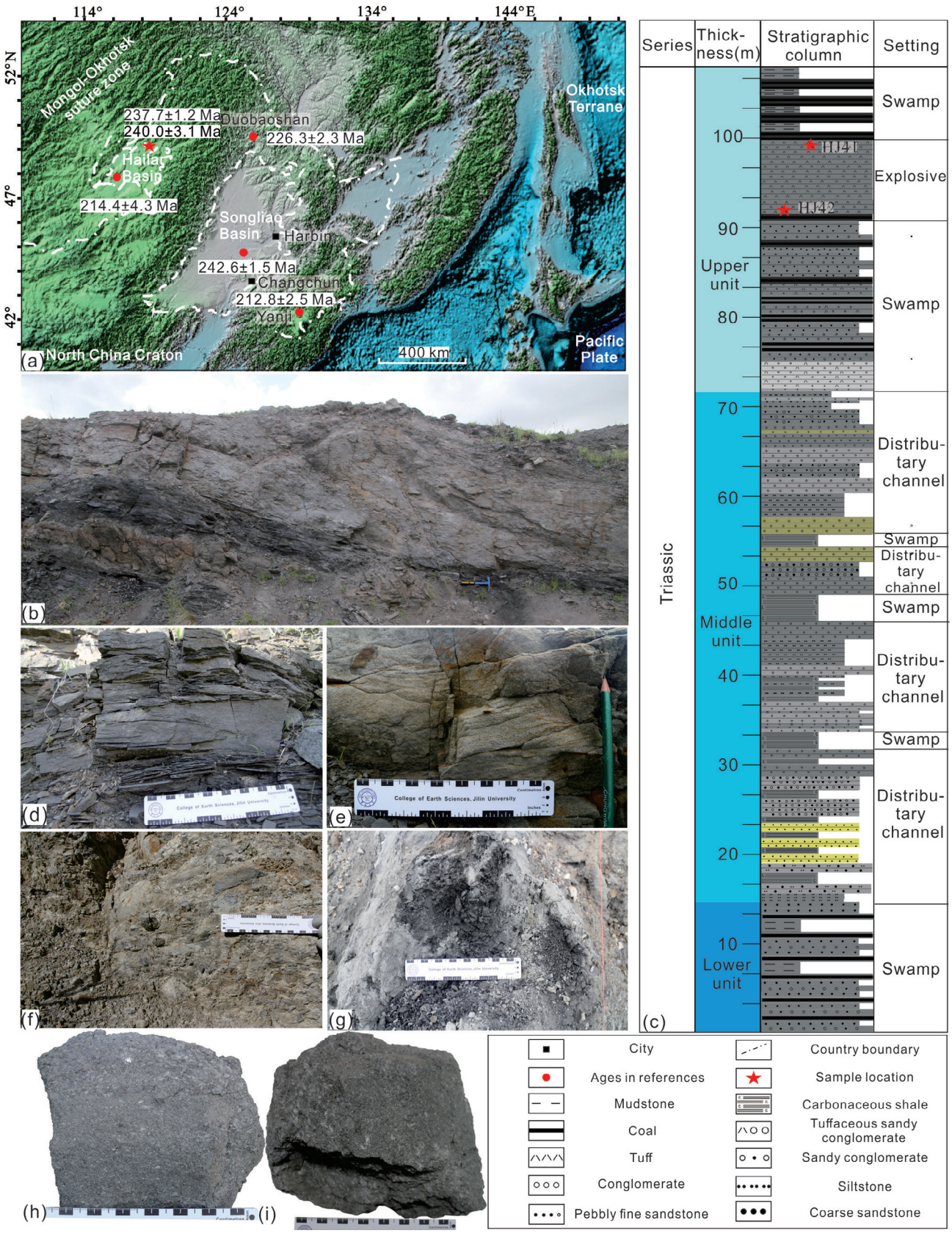

Fig. 1. Triassic coal-bearing sediments strata and age data of the Daxing'anling Region. (a) Zircon U-Pb samples data, revised according to reference. (b) The middle unit of the strata. (c) Stratigraphic sequence of the Triassic coal-bearing sediments strata. (d) Carbonaceous shale in the middle part. (e) Yellow weathered surface. (f) Conglomerate in the middle part. (g) Coal seam in the upper part. (h) Sample HJ41. (i) Sample HJ42.

Successive discoveries of Triassic strata in and around the study area have reaffirmed their presence in the northern NCC (North China Craton). The presence of Triassic strata in the Songliao and Hailar basins and the Yanji and Duobaoshan areas suggests that Triassic strata may have developed widely throughout Northeast China, which is inconsistent with previous reports. Middle Triassic (242 Ma) strata have been discovered at the base of the Songliao Basin and are overlain by Cretaceous (118 Ma) strata [3,7]. Late Triassic–Jurassic strata are absent, indicating that a tectonic transition occurred in the Songliao Basin during this period. Our new data provide chronological constraints for the Triassic strata in the Hailar Basin, thereby improving the understanding of the tectonic transition between the Songliao and Hailar basins during the Triassic. Our data also provide a means of comparing these two representative large petroliferous basins, which is useful for reconstructing the Paleozoic–Mesozoic tectonic evolution of Northeast China. Moreover, with the discovery of coal-bearing sedimentary strata in the Hailar Basin and determination of its formation age (242–237 Ma), it is inferred that there is substantial potential for hydrocarbon exploration in the deep part of the basin beneath previously explored strata, although further investigations are necessary to quantify its resource potential.

Conflict of interest

The authors declare that they have no conflict of interest.

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Appendix A. Supplementary materials

Supplementary materials to this news & views can be found online at https://doi.org/10.1016/j.scib.2024.06.023.

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