



No Paleozoic Helanshan Suture separating the Alxa Massif from the North China Craton

SUN Jiaopeng*

Department of Geology & State Key Laboratory of Continental Dynamics, Northwest University, Xi'an 710069, Shaanxi, China

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Abstract: The western extension of the North China Craton (NCC) in the west is a hot-debated topic surrounding various viewpoints on the collisional timing and plate boundary between the Ordos Block and the Alxa Massif (Sun et al., 2019a, b, c). Most models underlined that the amalgamation of the Alxa Massif and the Ordos Block as well as the final assemblage of the NCC terminated prior to Paleozoic. However, according to Precambrian tectono-thermal sequence comparison, detrital zircon age pattern correlation and paleomagnetic reconstruction, an increasing number of authors recently believed that the Alxa Massif and the NCC were individual blocks until Ordovician even Triassic. However, no convincing Phanerozoic structural, magmatic and metamorphic constraints that are associated with such a Paleozoic collision have been well demonstrated in the western NCC and its vicinity so far. Thereby, widespread Paleozoic sedimentary imprints in the HTB and its bilateral basins may prove important and also irreplaceable basis for investigating tectono-sedimentary processes in the western NCC and further evaluating these tectonic models surrounding the HTB. In this study, we combine regional stratigraphical and sedimentological data on the Paleozoic sequences within the HTB and its vicinity basins of the western NCC, incorporating detrital zircon isotopic dating and palaeoecoenosis correlation analyses. These data are used to model the tectono-sedimentary evolution of the western NCC during this important time interval, and shed light on the Cambrian tectonic relationship of the Alxa Massif to the NCC. The HTB locates between the Bayanhaote Basin of the Alxa Massif to the west and the western Ordos Basin of the Ordos Block to the east, and is featured by an NNE-SSW trending uplifted synclinorium. The Paleozoic tectono-stratigraphic successions in the Bayanhaote Basin, the HTB and the western Ordos Basin are rather comparable. The Cambrian and Ordovician successions are comprised mainly by carbonate rocks and separated by a parallel unconformity that distributes in all tectonic units. The absence of latest Ordovician to earliest Carboniferous deposits suggests a prolonged sedimentary hiatus in response to a regional tectonic uplift, likewise similar to that of the NCC. Above, Carboniferous shallow marine strata and Permian fluvio-lacustrine facies comprise long-term regression evolutionary trend. The comparable lithological assemblage and vertical sequence suggest that the Alxa Massif, the HTB and the Ordos Basin should be situated in linked paleogeographical system

throughout the Paleozoic, indicating these three units should be part of the NCC as the Ordos Basin. The Cambrian sedimentation around the HTB was dominated by shallow-water carbonate shelf successions, differing from deep-marine carbonate slope and turbidite lithological associations which were commonly deposited in abysmal sea setting. Tectono-stratigraphy of the HTB is consistent with time-equivalent sequences elsewhere in the northwestern Ordos, which are all in disconformity contact with the underlying Precambrian and the overlying Carboniferous successions. The Cambrian transgression-regression cycle of sequences in the HTB is roughly comparable with those in other tectonic units. Sedimentary circle of Ordovician successions throughout the northwestern Ordos are consistent, marking by an upward-deepening sequence, which comprises mainly of inner shelf facies in the basal section, the superposing outer shelf and slope facies, and abysmal sea successions in the top. In addition, lithofacies packages throughout the study area were deposited at a distance from plate boundary, considering rare volcanic and metamorphism records have been preserved. Facies relations for Ordovician sections across the HTB suggest successive sedimentary distribution and unified paleogeographical pattern. Basin-filling evolution of the northwestern Ordos was further ascribed as the offshore extensions of Cambro-Ordovician proto-Ordos carbonate platform. Carboniferous strata deposited in the HTB and its surrounding portions share similar facies associations and comparable sedimentary cycle, comprising the bottom littoral-neritic facies and the coal beds enriched deltaic deposits in the upper portion. Comparable Permian delta-fluvial facies are likewise preserved in the HTB and the Ordos Basin, but are absent west of the Bayanhaote Basin due to the subsequent uplift and erosion. The continuous sedimentary facies migration across the northwestern Ordos additionally leads to a unified basin system superposed by linked shallow marine paleogeography. The Bayanhao Basin, the HTB, the Ordos Basin as well as the other portion of the NCC should be situated in connected biogeography subregion. Fossils collected from Bayanhaote Basin reveal Ordovician palaeobios assemblages identical to those in the cotemporary successions of the HTB, and are also the most common conodont taxa in the NCC as well. Late Paleozoic fossils collected from well BC2 and Xi1 in the Bayanhaote Basin can be well corresponded to those from the HTB and the Ordos Basin. Fossils of the Jingyuan Formation are rather similar to fossils identified in the Wusitai of the northwest HTB. Sporopollen fossils authenticated from the Yanghugou

* Corresponding author. E-mail: sunjiaopeng@163.com

Formation of the Well B2 can be widely found in the Ordos Basin and are identical to coexistent sporopollen assemblage of the HTB. Cambrian fossil assemblages of the HTB match well those of the Ordos Basin as well as the eastern NCC. Although no contemporaneous fossil data of the Bayanhaote Basin are available for comparison, while linked and continuous Ordovician-Carboniferous paleobiospecies suggest that the entire northwestern Ordos situated in same palaeontological division. Thus, all stratigraphy and sedimentary clues listed in this paper, integrated with other tectonic observations, definitely object to the plate boundary tectonic setting for the HTB. The Bayanhaote Basin and the HTB should be the seaward-extension of sedimentary system covering the NCC throughout Paleozoic.

Key words: Helanshan tectonic belt, western North China Craton, Alxa massif, tectonic affinity

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About the corresponding author



SUN Jiaopeng Female, born in 1988 in Yantai City, Shandong Province; doctor; graduated from China University of petroleum; postdoctor of Department of Geology, Northwest University. He is now interested in the study on the tectonic geology. Email: sunjiaopeng@163.com; phone: 13186128177.