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Late Jurassic to Early Cretaceous sedimentary-tectonic development in the Chengde Basin, Yanshan fold-thrust belt, North China Craton

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ABSTRACT

The Chengde Basin is located in the central part of the Yanshan fold-thrust belt in the northern North China Craton. The sediments in the Upper Jurassic to Lower Cretaceous Tuchengzi Formation in the Chengde Basin provide a detrital record of basin dynamics and uplift of the basin margins during that time. We analyzed the sedimentary facies, paleocurrents, and provenance of the Tuchengzi Formation in the Chengde Basin for the period of the Late Jurassic and Early Cretaceous shortening in the Yanshan fold-thrust belt. Four sedimentary facies associations have been identified in the Tuchengzi Formation, corresponding to proximal fan, mid-fan, distal alluvial fan, and fluvial facies. The transport and distribution of the Upper Jurassic to Lower Cretaceous sediments in the Chengde Basin was controlled by the faults bounding the basin. Paleocurrent indicators and provenance data of conglomerate clasts reveal that the sediments of the Tuchengzi Formation in the northern part of the Chengde Basin were delivered from source regions to the north of the basin. The early sediments of the Tuchengzi Formation in the southern part of the basin comprise a suite of fluvial deposits, similar to the fluvial sediments in the northern part of the basin, and their paleocurrent data and the compositions of conglomerate clasts also suggest a northern source. However, the subsequent sedimentation in the Tuchengzi Formation in the southern part of the basin changed markedly to proximal fan facies, with sediments being derived from the south of the basin, according to the paleocurrent data and conglomerate clast lithology. The Sandaohe sheet, which is located in the southeast limb of the Chengde syncline, is not a klippe formed as a result of long-distance northward thrusting, but an autochthonous pop-up tectonic wedge generated by N–S shortening during the Early Cretaceous sedimentation of the Tuchengzi Formation. The sedimentation ended before the onset of the Early Cretaceous volcanic eruption recorded by the Zhangjiakou Formation, which unconformably overlies the Tuchengzi Formation.

1. Introduction

After the North China Craton (NCC) collided with the Mongolian arc terranes during the late Paleozoic, the northern edge of the NCC evolved from a plate margin to an intraplate environment (Davis et al., 2001). The Yanshan fold-thrust belt (YFTB) is located near the northern margin of the North China Craton (Fig. 1), and experienced at least two major episodes of compressional deformation during the Mesozoic. The first contraction occurred during the Late Triassic and Early Jurassic, and the second compression, also known as the "Yanshanian movement" or "Yanshanian event", occurred during the Late Jurassic and Early Cretaceous (Wong, 1927; Cope et al., 2007).

The Chengde Basin is located in the central segment of the YFTB, with its northern margin bounded by the Fengning-Longhua Fault and its southern margin by the Chengde County Fault (Figs. 1 and 2). A 20-km-wide asymmetric syncline, called the Chengde syncline, lies between the Shuangmiao Fault in the central part of the basin and the Jiyuqing Fault at the southern margin of the basin (Fig. 2). Although strongly deformed in the Jurassic Yanshanian movement, the Chengde Basin offers a crucial location for studying the context of the tectonic-sedimentary response, because of the relatively complete preservation and good outcrops of Mesozoic sedimentary rocks within the basin.

Basin-fill sediments are records of contemporaneous tectonic activities, and can provide constraints not only on paleogeographic conditions, but also on the timing and magnitude of shortening

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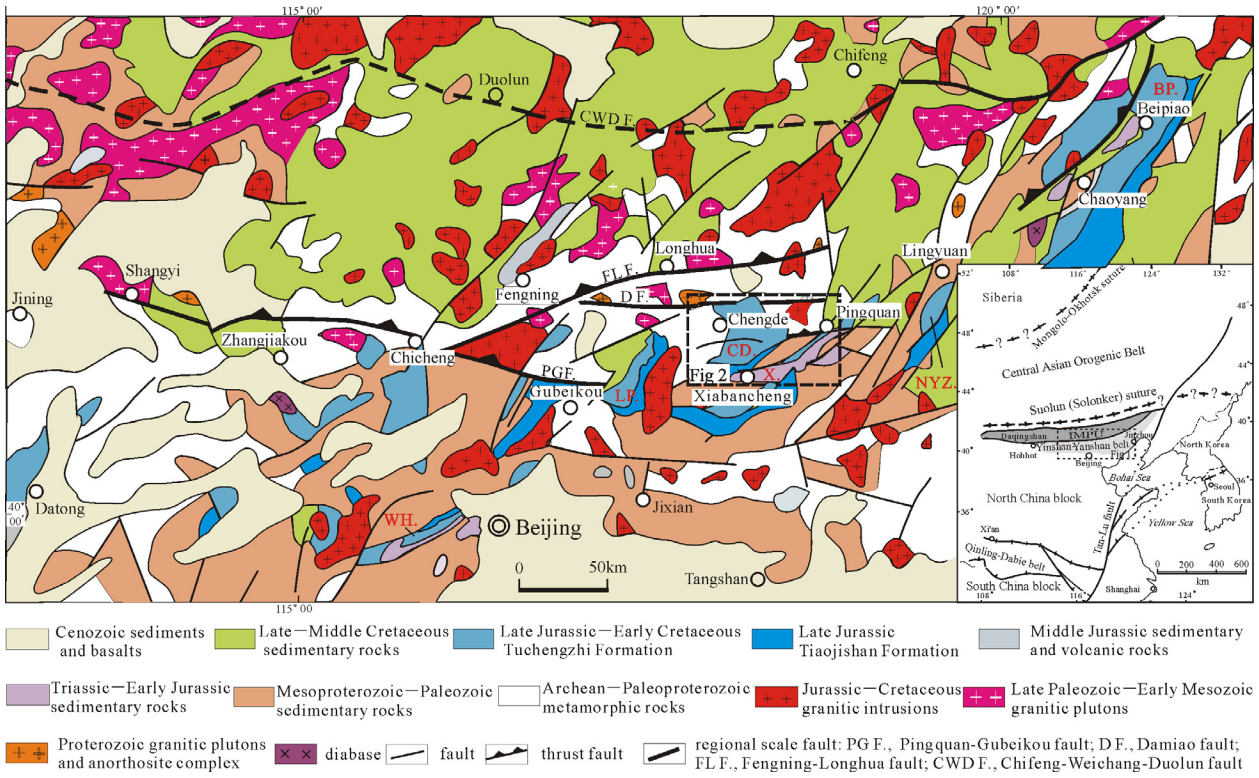

Fig. 1. Geological sketch map of the northern margin of the NCC (modified after Zhang et al., 2007; index figure modified after Davis et al., 2001). WH, Western Hills of Beijing; LP, Luanping Basin, northern Hebei; CD, Chengde Basin, northern Hebei; X, Xiabancheng Basin, northern Hebei; NYZ, Niuyingzi Basin, western Liaoning; BPL, Beipiao Basin, western Liaoning.

and associated thickening (e.g., Liu et al., 2004, 2012; He et al., 2007; Cope et al., 2007). Thus, in combination with structural relationships and geochronology, sediments can be used to address the depositional environments, provenance characteristics, and development and deformation of the sedimentary basins in the Yanshan belt during the Late Jurassic–Early Cretaceous shortening. Some previous structural and geochronologic studies have interpreted the Chengde syncline as representing a folded allochthon that resulted from long-distance north-vergent thrusting with a displacement of at least 40 km (Davis et al., 1998, 2001). In contrast, other studies have provided geometric, kinematic, stratigraphic, provenance, and geochronologic evidence that the faults bounding the northern and southern limbs of the Chengde syncline (i.e., the Shuangmiao and Jiyuqing faults) are two separate thrust faults with opposing north and south vergence rather than a single folded north-directed thrust, and that the sedimentary rocks within the syncline are not allochthonous (e.g., Zhao et al., 2004; Cope et al., 2007; He et al., 2007; Zhang et al., 2012). Although there is now a consensus that the Chengde syncline is not a nappe, the formation of the Sandaohe sheet, which is located in the southeast limb of the Chengde syncline, and its role in the development of the Chengde Basin are not well constrained. The Sandaohe sheet is dominated by Meso–Neoproterozoic carbonate rocks and is surrounded by Upper Jurassic Tiaojishan volcanic rocks. Knowledge of its method of formation is important for better understanding the scale of the compressional deformation in the Yanshan fold-thrust belt during the Late Jurassic and Early Cretaceous; that is, whether the Yanshan fold-thrust belt experienced long-distance northward thrusting during this interval, as suggested by Davis et al. (2001), or instead relatively limited N–S shortening.

In this study, we investigate the Upper Jurassic–Lower Cretaceous Tuchengzi Formation across the Chengde Basin from north to south, employing detailed sedimentary facies relationships and provenance analysis. Four sedimentary facies associations are identified, corresponding to proximal fan, mid-fan, distal alluvial fan, and fluvial environments. We demonstrate that the Tuchengzi sediments in the northern part of the Chengde basin and the early Tuchengzi sediments in the southern part of the basin were transported from source areas to the north of the basin, whereas the subsequent Tuchengzi sediments in the southern part of the basin were derived from the south. In particular, we highlight that rapid uplift and erosion of the Sandaohe sheet at the southern margin of the Chengde syncline provided substantial amounts of material for the Tuchengzi Formation in the southeastern Chengde basin.

2. Geological background

2.1. Geological setting

The northern margin of the NCC, which is located southeast of the Central Asian Orogenic Belt, is divided into two E–W-trending tectonic units by the Pingquan-Gubeikou Fault (also referred to as the Shangyi-Gubeikou-Pingquan Fault; HBGMR, 1989). The two units are named the Inner Mongolia Paleo-Uplift (IMPU) in the north and the Yanshan fold-thrust belt (YFTB) in the south (Fig. 1). The IMPU is characterized by extensive Archean–Proterozoic high-grade basement rocks that are unconformably overlain by Jurassic–Cretaceous volcanic and sedimentary rocks. The entire tectonic province was exhumed during the late Carboniferous to Early Jurassic (Zhao, 1990; Zhang et al., 2007).

The YFTB consists mainly of a Paleoproterozoic basement, Mesoproterozoic sediments, Cambrian to Ordovician marine clastic and carbonate platform sediments, middle Carboniferous to Triassic fluvial and deltaic sediments, and Jurassic to Cretaceous (and