Journal of Asian Earth Sciences 96 (2014) 279–286

Contents lists available at ScienceDirect

Journal of Asian Earth Sciences

journal homepage: www.elsevier.com/locate/jseaes

Late Ordovician volcanism in Korea constrains the timing for breakup of Sino-Korean Craton from Gondwana

Deung-Lyong Cho [a], Seung Ryeol Lee [a], Hee Jae Koh [a], Jun-Beom Park [b], Richard Armstrong [c], Duck K. Choi [d,*]

[a] Geological Research Division, Korea Institute of Geoscience and Mineral Resources, Daejeon 305-350, Republic of Korea
[b] US Army Corps of Engineers Far East District, Geotechnical and Environmental Engineering Branch, Seoul 100-195, Republic of Korea
[c] Research School of Earth Sciences, Australian National University, Canberra, Australia
[d] School of Earth and Environmental Sciences, Seoul National University, Seoul 151-747, Republic of Korea

ARTICLE INFO

Article history:
Received 11 April 2014
Received in revised form 29 July 2014
Accepted 16 September 2014
Available online 28 September 2014

Keywords:
Tectonics
Paleogeography
Sino-Korean Craton
Gondwana
Ordovician
Geochronology

ABSTRACT

In the early Paleozoic the Sino-Korean Craton (SKC) and South China Craton (SCC) were situated along the margin of east Gondwana. The SKC was connected to core Gondwana by an epeiric sea which was the site for deposition of lower Paleozoic sequences of SKC. The SKC and SCC may have drifted away from core Gondwana sometime during the mid-Paleozoic and would have been outboard microcontinents in the late Paleozoic, until they collided to form the East Asian continent in the Triassic. The breakup of SCC from Gondwana was suggested to have taken place at ~380 Ma, while no reliable suggestions have hitherto been made for breakup of SKC from Gondwana. This study presents a convincing evidence for breakup of SKC from Gondwana, based on the recognition of Late Ordovician volcanism in Korea. New SHRIMP U–Pb zircon ages, 445.0 ± 3.7 Ma and 452.5 ± 3.2 Ma, are obtained from trachytic rocks of the Ongnyeobong Formation of Taebaeksan Basin in Korea which occupied the marginal part of the SKC in the early Paleozoic. This Late Ordovician volcanism along with previous records of Ordovician volcanic activities along the western margin of the SKC is interpreted indicating the development of an incipient oceanic ridge. The oceanic ridge uplifted the SKC including the epeiric sea, which subsequently resulted in terminating the early Paleozoic sedimentation of the epeiric sea. The paucity of lower Paleozoic volcanic rocks across much of the SKC however suggests that the oceanic ridge did not extend into the epeiric sea. Instead, spreading of oceanic ridge entailed dextral movement of associated transform faults, which may have played a major role in breakup of SKC from mainland Gondwana by the end of Ordovician.

1. Introduction

It has been well appreciated that East Asia was formed by amalgamation of two continental terranes derived from the Paleozoic Gondwana in the Triassic (McElhinny et al., 1981; Lin et al., 1985; Mattauer et al., 1985; Yin and Nie, 1996). These terranes are the Sino-Korean (or North China) and South China cratons. The Sino-Korean Craton (SKC) comprises most of North China and northern and southern parts of the Korean Peninsula, while the South China Craton (SCC) includes most of South China and middle part of the Korean Peninsula (Fig. 1a). The SKC and SCC were separated from each other during Paleozoic times, until they collided to form much of the current East Asian continent in the Triassic along an orogenic belt, Qinling–Dabie–Sulu–Imjingang Belt, which extends over 2000 km in a roughly E–W direction (Chough et al., 2000; Wu and Zheng, 2013).

Early Paleozoic paleogeographic positions of the SKC and SCC have been controversial over the years (cf. Burrett et al., 2014): Li and Powell (2001) and Cocks and Torsvik (2013) treated the SKC and SCC as outboard terranes away from Gondwana, whereas Veevers (2004) and Metcalfe (2006, 2013) placed the SKC and SCC to the marginal parts of Gondwana adjacent to Australia and India. The latter view is well accommodated and shown with a recent paleobiogeographic analysis by McKenzie et al. (2011), in which the SKC and SCC were placed contiguous to Australia and India along the margin of east Gondwana in the early Paleozoic. While accepting the latter view, the SKC and SCC may have drifted away from core Gondwana sometime during the mid-Paleozoic and would have been outboard microcontinents in the late Paleozoic,

* Corresponding author. Tel.: +82 2 880 6737; fax: +82 2 876 9798.
E-mail address: dkchoi@snu.ac.kr (D.K. Choi).

http://dx.doi.org/10.1016/j.jseaes.2014.09.022
1367-9120/

until they amalgamated to form the East Asian continent in the Triassic. The breakup of SCC from Gondwana was suggested to have taken place in the Late Devonian, ca. 380 Ma (Metcalfe, 1996, 2011; Yang et al., 2004). On the other hand, lower Cambrian Antrim Plateau Basalts in the Bonaparte Basin of northern Australia were proposed as possible evidence for breakup of SKC from Gondwana (Burrett and Stait, 1986, p. 75). However, volcanic-deficient lower Paleozoic sedimentary successions of the SKC (Meng et al., 1997; Choi and Chough, 2005) and trilobite faunal similarity between the SKC and northern Australia (Choi, 2009; McKenzie et al., 2011) negate the proposal of early Cambrian age for breakup of SKC from Gondwana. Therefore, to date no reliable age suggestions have been available for breakup of SKC from Gondwana.

One of notable geologic features in the SKC is a regional disconformity between lower Paleozoic and upper Paleozoic sequences, spanning in age from ~460 Ma to ~320 Ma, known as the mid-Paleozoic great unconformity (Cheong, 1969; Kim et al., 2001; Wang et al., 2010). Choi (2009) proposed a scientific scenario for the tectonic history of SKC during the mid-Paleozoic hiatus: namely, the SKC drifted away from Gondwana sometime during the Late Ordovician and was a passively drifting microcontinent in the late Paleozoic, and then collided with the SCC at ~250 Ma. However, Choi (2009) failed to provide the precise timing and evidence that might explain the breakup of SKC from Gondwana.

This paper reports the recognition of an Upper Ordovician volcanic succession, Ongnyeobong Formation, in the Taebaeksan Basin, for the first time in Korea. The geochemical and geochronological analyses of volcanic rocks of the Ongnyeobong Formation provide convincing evidences for constraining the timing for breakup of SKC from Gondwana and enable us to discuss their paleogeographic and tectonic implications.

2. Geologic setting

The Korean Peninsula is tectonically divided into the northern, central, and southern blocks (Fig. 1a) and is further subdivided into eleven tectonic provinces: the northern block comprises the Kwanmo Massif, Machollyong Belt, Rangnim Massif, and Pyongnam Basin; the central block includes the Imjingang Belt, Gyeonggi Massif, and Chungcheong Basin; the southern block

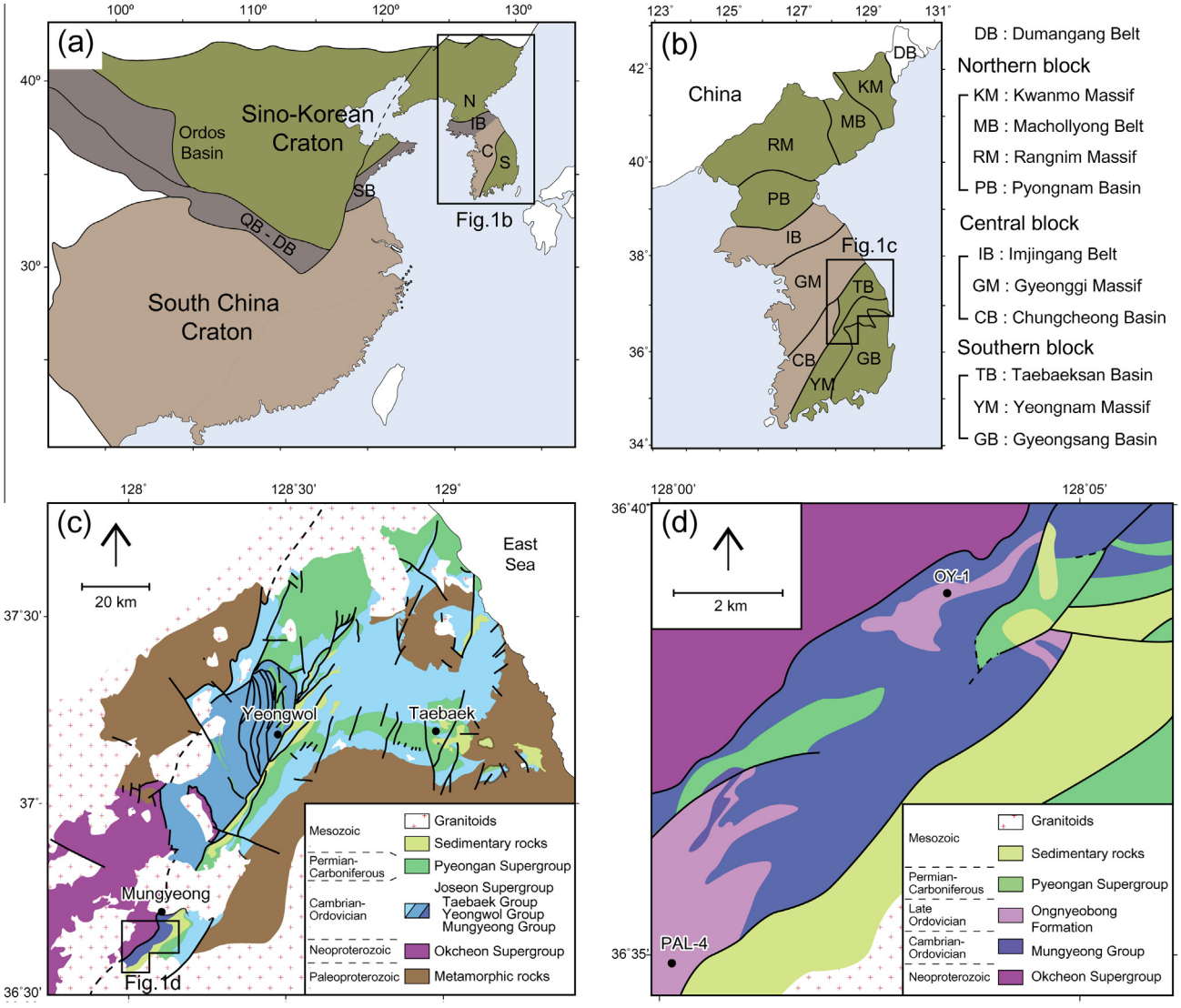

Fig. 1. (a) Simplified tectonic map of East Asia (modified from Wu and Zheng, 2013 and Choi, 2013). Abbreviations: C – central block, DB – Dabie Belt, IB – Imjingang Belt, N – northern block, QB – Qinling Belt, S – southern block, SB – Sulu Belt. (b) Tectonic provinces of the Korean Peninsula (Choi, 2013). (c) Simplified geologic map of the Taebaeksan Basin, Korea. (d) Geologic map of Mungyeong area, southernmost part of the Taebaeksan Basin. OY-1 and PAL-4 denote the sampling localities for SHRIMP U–Pb zircon age dating.