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SHRIMP U-Pb ages of detrital zircons in metasedimentary rocks of the central Ogcheon fold-thrust belt, Korea: Evidence for tectonic assembly of Paleozoic sedimentary protoliths

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ABSTRACT

We analyzed detrital zircons in four metasandstones and two metadiamictites of the central Ogcheon Metamorphic Belt (OMB) in order to provide geochronologic constraints on the time of deposition and protolith age distributions. SHRIMP U-Pb ages of the newly analyzed zircons range from Archean to Early Paleozoic, and their age patterns permit the definition of four lithotectonic slices: upper and lower Pibanryeong units consisting primarily of quartzite and metasandstone; an upper Poeun unit of black slate containing Early Permian plant fossils; and a lower Poeun unit made up of metasandstone and metadiamictite. A quartzite of the upper Pibanryeong unit yielded two major zircon age populations at 965 ± 11 Ma and 447 ± 5 Ma, whereas two lower Pibanryeong metasandstones show major age concentrations at ~2.5 Ga, 1.0–0.9 Ga, and 545–535 Ma. The youngest components of these units suggest maximum ages of sedimentation as Late Ordovician and Early Cambrian, respectively. These upper and lower Pibanryeong zircon age distribution patterns are consistent with those of Ordovician and Devonian sedimentary strata, respectively from the South China Craton (SCC). On the other hand, three samples of the lower Poeun unit yielded two distinct age populations at ~1.87 Ga and 755 ± 7 Ma. In addition, a metadiamictite contains abundant Mesoproterozoic zircons with two broad peaks centered at ~1.3 and 1.6 Ga. Protolith ages and distribution patterns are profoundly different between the Pibanryeong and Poeun lithotectonic packages, suggesting the presence of a major thrust fault juxtaposing allochthons that are also characterized by large P–T contrasts. Our detrital zircon results for the Pibanryeong unit are compatible with derivation from the SCC, in apparent contrast with the Poeun occurrence of Early Permian plant fossils most likely correlative with the North China Craton (NCC). Taken together, the suturing of Paleozoic metasedimentary terranes in the OMB is a product of Permo–Triassic orogeny reflecting collision of the North and South China cratons.

1. Introduction

Detrital zircon geochronology using ion probes or laser ablation techniques has rapidly evolved during the past two decades, emerging as a nearly indispensible method for investigating sedimentary rocks and their source regions (Gehrels, 2012). Similarly, the U-Pb age determination of detrital zircons is useful not only for deciphering the provenance of metasedimentary rocks but also for investigating their tectonic affinity and even palaeogeography in a specific metamorphic complex (e.g., Hietpas et al., 2011). In this study, we have utilized detrital zircon ages to provide constraints regarding the source terranes of metasedimentary allochthons in the Ogcheon fold-thrust belt, central Korea (Fig. 1). The evolution and correlation of this belt with nearby Eurasian cratons are still problematic (e.g., Yin and Nie, 1993; Li, 1994; Ree et al., 1996; Chough et al., 2000; Lim et al., 2005, 2007; Cho and Kim, 2005; Oh et al., 2005; Ernst et al., 2007; Jeon et al., 2007; Zhai et al., 2007; Kwon et al., 2009; Kim et al., 2011a; Chang and Zhao, 2012).

The northeast-trending Ogcheon Belt is a broad Phanerozoic fold-thrust belt transecting the southern half of the Korean Peninsula. It consists of the fossiliferous Paleozoic Taebaeksan Basin (TB) and the fossil-deficient Ogcheon Metamorphic Belt (OMB) (Fig. 1a). The latter is often considered as a major suture zone continuing from the Qinling–Dabie–Sulu Belt sited between North and South China cratons through the Korean Peninsula and into southwestern Japan (Yin and Nie, 1993; Chough et al., 2000; Cheong et al., 2003; Cho and Kim, 2005; Ernst et al., 2007). For example, Chough et al. (2000) adopted the tectonic model of Yin and Nie (1993) and suggested that the indentor, comprising not only the OMB but also

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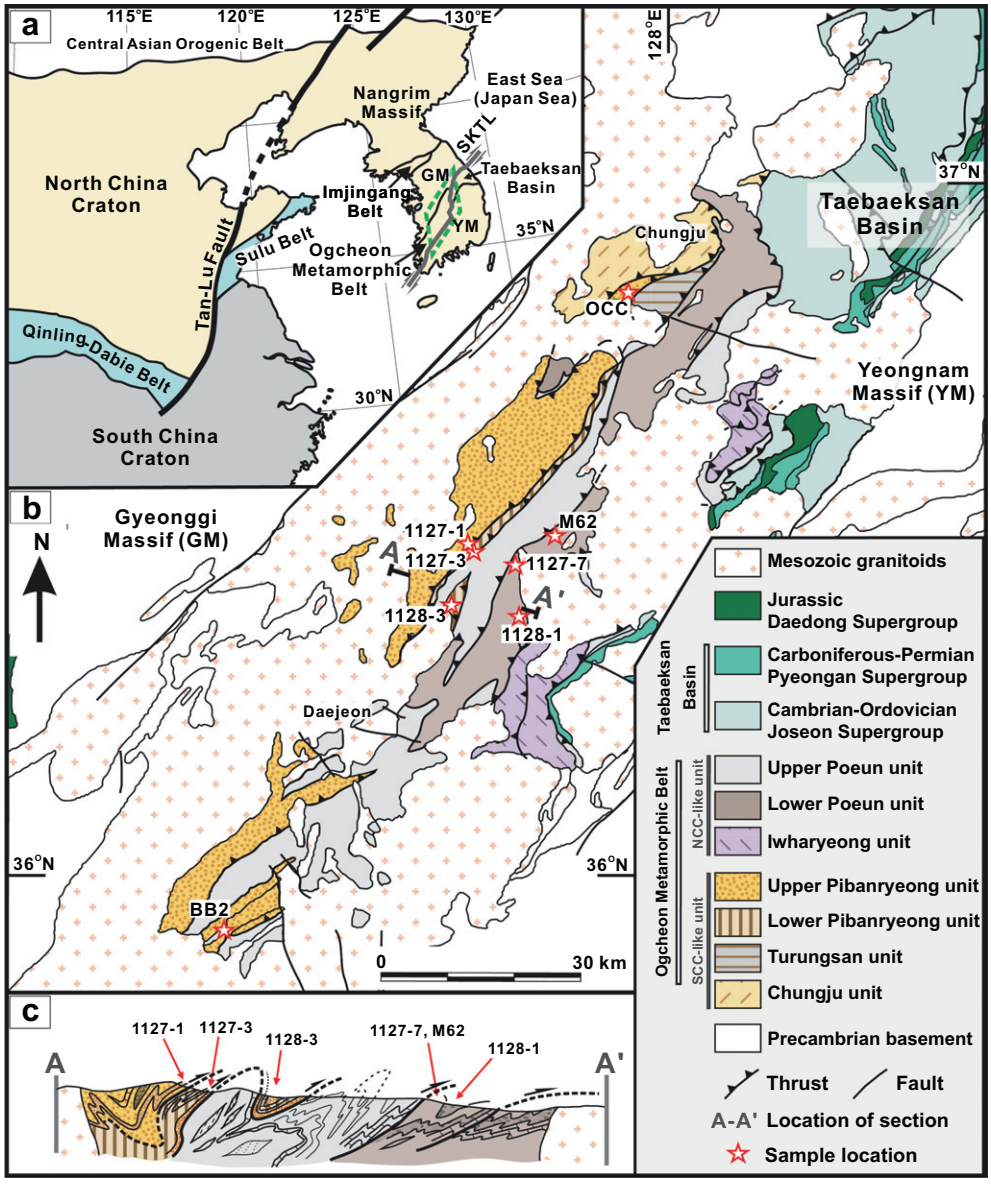

Fig. 1. (a) Schematic map showing various tectonic provinces of East Asia including the Korean Peninsula (adopted from Cho et al., 2007). Dashed box is enlarged in (b). (b) Geologic map showing sample locations and various stratigraphic/lithotectonic units of the Ogcheon Metamorphic Belt and Taebaeksan Basin (modified after Cluzel et al., 1991, and KIGAM, 1995). Stars denote the sample locations; two sample locations, BB2 and OCC, are from Lim et al. (2005) and Park et al. (2011), respectively. (c) Schematic cross-section across A–A′ in (b) (modified from Cluzel et al., 1991).

the Gyeonggi Massif and the Imjingang Belt, is bounded by the South Korean Tectonic Line (SKTL), which lies along the boundary between the TB and the OMB (Fig. 1). However, the tectonometamorphic evolution of the SKTL is poorly constrained primarily because of the lack of precise geochronologic and kinematic data. The absence of fossils in polymetamorphosed sedimentary units provides additional sources of uncertainty for unraveling the tectonostratigraphy in the OMB. Nevertheless, Neoproterozoic (~860 and 750 Ma) volcanism followed by Middle Permian (~270–265 Ma) medium-pressure metamorphism has been documented in the northwestern part of the OMB (Lee et al., 1998a; Cheong et al., 2003; Cho and Kim, 2005; Kim et al., 2007; Kim et al., 2011b; Kim and Park, 2012). In addition, Lim et al. (2005, 2006, 2007) reported the occurrence of plant fossils in black slates across the middle to southeastern OMB, and provided crucial evidence for the former presence of Late Carboniferous–Early Permian strata prior to the tectonic juxtaposition with other lithotectonic units.

In order to provide reliable age constraints for establishing the tectonometamorphic reconstruction, we used a sensitive high-resolution ion microprobe (SHRIMP) to analyze detrital zircon grains separated from four metasandstones and two metadiamictites of the central OMB. Major goals of our study are threefold: (1) to determine the maximum depositional age of each lithotectonic unit; (2) to provide geochronologic constraints for the source region; and finally (3) to delineate the tectonometamorphic evolution of the OMB. Our new detrital zircon geochronology should help establish the stratigraphy of sedimentary protoliths as well as the crustal architecture of the OMB.

2. Geological setting and specimen sampling

2.1. Geological outline and lithotectonic units

The Korean Peninsula consists of three major Precambrian massifs (the Nangrim, Gyeonggi and Yeongnam massifs) juxtaposed