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Nature of Late Mesoproterozoic to Early Neoproterozoic magmatism in the western Gyeonggi massif, Korean Peninsula and its tectonic significance

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ABSTRACT

The western margin of the Gyeonggi massif, southern Korean Peninsula, has preserved N–S trending Neoproterozoic and sporadic Late Mesoproterozoic metaigneous rocks. Here we present the results from systematic field mapping, sensitive high-resolution ion microprobe (SHRIMP) zircon U–Pb dating, and whole-rock geochemical analyses of the Mesoproterozoic and Early Neoproterozoic metaplutonic rocks in the Hongseong area, together with previously published data from the western Gyeonggi massif. The SHRIMP ages of these rocks are categorized into three groups: (1) Late Mesoproterozoic (ca. 1.25–1.15 Ga), (2) Early Neoproterozoic (ca. 900–770 Ma), and (3) late Early Neoproterozoic (ca. 762–730 Ma). The geochronological and geochemical features of the Late Mesoproterozoic rocks suggest that they were possibly formed in association with convergent plate motion. The Early and late Early Neoproterozoic rocks are interpreted to arc-related orogenic and rift-related post-orogenic environments, respectively. These age results and the tectonic signatures provide insight into the convergence process along the margins of the Rodinia supercontinent.

1. Introduction

The Gyeonggi massif in the Korean Peninsula led to diverse collision tectonic models, illustrating the architecture of the eastern extension of the Triassic Dabie-Sulu collision belt in China (e.g., Ernst et al., 2007; Oh and Kusky, 2007; Zhai et al., 2007; Kwon et al., 2009). This is because of the absence of precise evidence of collision-related products such as eclogites and high-pressure rocks that can be used to define suture zones (e.g. Kwon et al., 2009). Although the suture zone itself may not be preserved within the Korean Peninsula, these collision models can be tested indirectly by comparing evolutionary histories of two different continents before the collision. In this context, recently reported Neoproterozoic igneous rocks from the Gyeonggi massif are considered important evidence of tectonic affinity (e.g., Lee et al., 2003; Song, 2010; Kim et al., 2008, 2013). However, a lack of understanding of the distribution and nature of the Neoproterozoic magmatic rocks makes it difficult to present a realistic tectonic scenario for the Proterozoic crustal evolution in the Korean Peninsula.

The western margin of the Gyeonggi massif in the Korean Peninsula has recently been interpreted as being located in active continental margins during the Neoproterozoic, Paleozoic, and Early Mesozoic, preserving evidence of subduction-collision tectonics (e.g., Oh et al., 2005, 2009, 2010, 2012, 2014; Kim et al., 2006b, 2008, 2011a,b,c, 2013, 2015, 2016; Seo et al., 2010, 2013; Kwon et al., 2009, 2013; Park et al., 2014a, b). It is notable that Neoproterozoic arc-related magmatism, Paleozoic arc-related magmatism and granulite-facies metamorphism, and Mesozoic near eclogite-facies metamorphism appear only on the western side of the Gyeonggi massif. Thus, it is worth considering this area part of an orogenic belt preserving various tectonic events related to the evolution of the Asian continent, like the Central Asian Orogenic Belt (CAOB) between the Tarim-North China and Siberian blocks (Safonova et al., 2011; Wilhem et al., 2012; Kröner et al., 2014) and the Central China Orogenic Belt (CCOB) bounded by the North and South China blocks (Fig. 1; Ratschbacher et al., 2006; Zhai et al., 2007; Dong et al., 2011; Wu and Zheng, 2013; Dong and Santosh, 2016).

The Neoproterozoic metaigneous rocks recognized along the southwestern and northwestern margin of the Gyeonggi massif (Lee et al., 2003; Kwon et al., 2013; Kim et al., 2008, 2013; Kim and Kee, 2015) have been considered important evidence, indicating its tectonic affinity to the South China block (SCB). This interpretation is based on the suggestion that the Neoproterozoic magmatic activities may be related to the amalgamation and disruption of the Rodinia supercontinent (e.g., Li and Powell, 2001; Ling et al., 2003; Rogers and Santosh, 2004; Li et al., 2005; X.-H. Li et al., 2008; Z.X. Li et al., 2008), and are seldom reported from the North China block (NCB) (Lu et al., 2008; Zhai et al., 2015).

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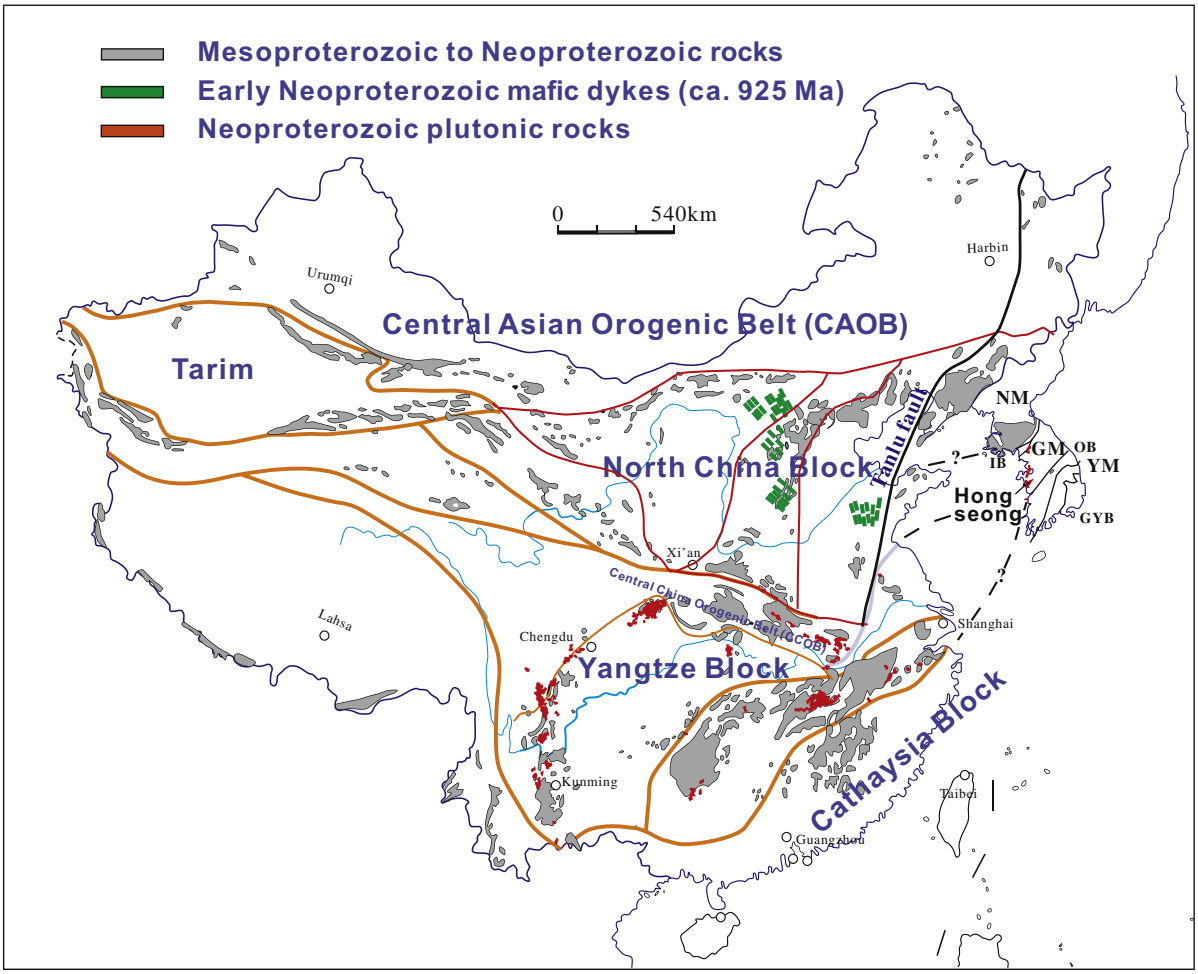

Fig. 1. Tectonic map of East Asia showing the distribution of Mesoproterozoic to Neoproterozoic rocks, Early Neoproterozoic mafic dykes, and Neoproterozoic plutonic rocks in China and the Korean Peninsula. NM, Nangnim massif; IB, Imjingang belt; GM, Gyeonggi massif; OB, Okcheon belt; YM, Yeongnam massif; PB, Pyeongnam basin; GB, Gyeongsang basin.

Previous studies on the Neoproterozoic metaigneous rocks along the western Gyeonggi massif revealed that the area preserves evidence of magmatism of ca. 900–700 Ma (e.g., Song, 2010; Kwon et al., 2013; Kim et al., 2008, 2013; Park et al., 2014b). Among them, ca. 900–770 Ma arc-related igneous rocks have been interpreted as possibly having been formed in association with the assembly of the Rodinia supercontinent (e.g., Kim et al., 2008, 2013; Kwon et al., 2013), while ca. 750–700 Ma rift-related rocks were formed during its disruption (e.g., Kim et al., 2013; Park et al., 2014b). The late stage of the Neoproterozoic magmatism is temporally correlated with the rift-related volcanic suite of ca. 760 Ma preserved within the Okcheon belt (Lee et al., 1998; Kim et al., 2006a).

Here, we present detailed SHRIMP zircon U–Pb ages and geochemical data for the Late Mesoproterozoic as well as the Middle Neoproterozoic metaplutonic rocks in the Hongseong area of the southwestern Gyeonggi massif (Figs. 2 and 3). Although the Late Mesoproterozoic and Early Neoproterozoic plutonisms have been reported from the area previously (e.g. Kim et al., 2008, 2013), we report new bodies defined based on detailed geological mapping and systematic age dating. The results, together with previously reported data from the area, will help elucidate the nature of the Late Mesoproterozoic to Early Neoproterozoic magmatic events along the western margin of the Gyeonggi massif, and the paleogeography of the western Gyeonggi massif in the Rodinia supercontinent.

2. Geological setting

The Korean Peninsula, located at the eastern margin of the Asian continent, is composed of three major Precambrian basement units: the Nangnim, Gyeonggi, and Yeongnam massifs (Fig. 1). These massifs are separated by two narrow orogenic belts, namely the Okcheon and Imjingang belts, which are predominantly composed of Neoproterozoic to Phanerozoic metasedimentary, metavolcanic, and sedimentary rocks (Cho and Kim, 2005; Cho et al., 2007). These tectonic provinces are considered to represent the assembly of continental terranes that amalgamated during the Permo-Triassic collision in East Asia, although the final configuration before the Jurassic and Cretaceous disruptions remains controversial (e.g., Yin and Nie, 1993; Ree et al., 1996; Chough et al., 2000; Kim et al., 2006b; Oh and Kusky, 2007; Kwon et al., 2009; Oh et al., 2015).

The major lithological units in the southwestern Korean Peninsula, including the western Gyeonggi massif and the Imjingang belt (Fig. 2), are Paleoproterozoic and Neoproterozoic orthogneisses, paragneisses, schists, amphibolites, and other metasedimentary rocks, as well as Early to Middle Paleozoic ortho- and paragneisses, schists, metasedimentary rocks, metavolcanic rocks, and Middle to Late Paleozoic metasedimentary rocks (Fig. 2: Cho et al., 2007; Kim et al., 2014a, b, 2015; Koh et al., 2015). These rocks have been affected in places by Triassic upper amphibolite- to near eclogite-facies metamorphism(s) (e.g., Cho et al., 2007; Oh et al., 2005; Kim et al., 2006b; Kwon et al., 2009, 2013; Sajeev et al., 2010). In addition, the Triassic post-collisional gabbro–monzonite–syenite–mangerite–granitoid series (ca. 245–226 Ma) are sparsely distributed in this region (e.g., Peng et al., 2008; Williams et al., 2009; Seo et al., 2010; Kim et al., 2011a). Several tectonic models that have recognized the Triassic tectonomagmatic/metamorphic events in the southwestern Korean Peninsula indicate that the