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Geochronological and geochemical implications of Early to Middle Jurassic continental adakitic arc magmatism in the Korean Peninsula

Sung Won Kim [a,*], Sanghoon Kwon [b], Kyoungtae Ko [a], Keewook Yi [c], Deung-Lyong Cho [a], Weon-Seo Kee [a], Bok Chul Kim [a]

[a] Geological Research Division, Korea Institute of Geoscience and Mineral Resources, Daejeon 305-350, Republic of Korea
[b] Department of Earth System Sciences, Yonsei University, Seoul 120-749, Republic of Korea
[c] Division of Earth and Environmental Science, Korea Basic Science Institute, Chungbuk 363-883, Republic of Korea

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ABSTRACT

Sensitive high-resolution ion microprobe (SHRIMP) zircon U–Pb ages and whole-rock chemical compositions of Early to Middle Jurassic plutons from the central to southern Korean Peninsula are reported to investigate the effect of paleo-Pacific plate subduction preserved along the continental margin. Twenty-one plutonic rocks from the Yeongnam massif (i.e., Sunchang and Namwon plutons), the Okcheon belt (Jeongup, Boeun, and Mungyeong plutons), the northeast (Gangreung pluton), and the Gyeonggi massif (Gonam, Anheung, and Ganghwa plutons) have age ranges from ca. 189–186 Ma to 177 Ma, 177–166 Ma, and 177–173 Ma, respectively. Most plutonic rocks have chemical compositions similar to adakites, showing high SiO_2 (45.62–74.96 wt.%), low MgO (0.01–2.84 wt.%), high Na_2O (2.65–4.83 wt.%), high Sr/Y and La/Yb, low Y and Yb, as well as low HFSEs (Nb and Ta), but initial Sr ratios (0.7048–0.7262), K_2O (0.50–5.88 wt.%), and K_2O/Na_2O (0.34–2.1) were unlikely to have been formed by melting of either a thickened and/or delaminated lower continental crust, or an altered oceanic crust. These suggest that the "adakitic" plutonic rocks in this region resulted from partial melting of an enriched mantle source metasomatized by dewatering from a delaminated flat-slab. The spatial distributions of this continental adakitic plutonic belt, based on the present study, together with previously reported geochronological results, indicate that magmatic pulses gradually migrated toward the continent across the Korean Peninsula as a result of slab shallowing caused by periodic slab buckling. The similar geochronological and geochemical characteristics, petrogenesis and tectonic setting of the plutonic belt spanning the Korean Peninsula, Japan, eastern China, and eastern Russia indicate a possible link to an active subduction system that existed during the Early to Middle Jurassic, although the products of the plate subduction might differ in different locations along the East Asian continental margin.

1. Introduction

The regional Mesozoic plutonic rocks along the East Asian marginal area are key for understanding the genesis of subduction-controlled magmatism in this region (Fig. 1a; e.g., Chen et al., 2003 and references therein; Kee et al., 2010b; Li and Li, 2007; Li et al., 2013; Sagong et al., 2005; Takahashi et al., 2010 and references therein; Wu et al., 2005; Wu et al., 2007a,b and references therein). A conspicuous NW–NNW-trending Early to Middle Jurassic adakite-equivalent plutonic belt in the Korean Peninsula reflects the response of the continental lithospheric margin of the Korean Peninsula to subduction of the paleo-Pacific (Izanagi) plate (Fig. 1b; e.g., Kee et al., 2010b; Kim et al., 2005, 2008, 2011a; Park et al., 2009; Sagong et al., 2005). Adakites and equivalent intrusions, with their high Sr and low Y, are widely believed to have originated by the interaction between partial melts from the eclogitic oceanic crust and the overlying mantle wedge, as a result of the subduction of young oceanic crust (<25 Ma), subduction initiation, or ridge subduction (Castillo, 2012; Castillo et al., 1999; Defant and Drummond, 1990 and references therein; Defant and Kepezhinskas, 2001; Gutscher et al., 2000a,b; Martin et al., 2005; Moyen, 2009; Peacock, 1993; Peacock et al., 1994 and references therein). However, a series of subsequent studies have shown that adakite-equivalent extrusive and intrusive rocks can be generated by diverse petrogenetic processes such as partial melting of the mantle wedge metasomatized by the slab melt (Kay, 1978; Li et al., 2013; Martin et al., 2005), partial melting of the overlying mafic lower crust (Wang et al., 2006; Xu et al., 2002), and cold plume (Castro et al., 2013; Gerya and Yuen, 2003). Recently, plume–slab interaction that occurred in the mantle wedge has been suggested as a possible genesis for the Abukuma adakite in northeast Japan (Lee and Lim, 2014). Therefore, caution should be taken to understand the petrogenetic process of adakitic rocks by conducting further geochemical analyses such as La/Yb and $^{143}Nd/^{144}Nd$ analyses (Castillo, 2012). Following the definition

* Corresponding author.
E-mail address: sungwon@kigam.re.kr (S.W. Kim).

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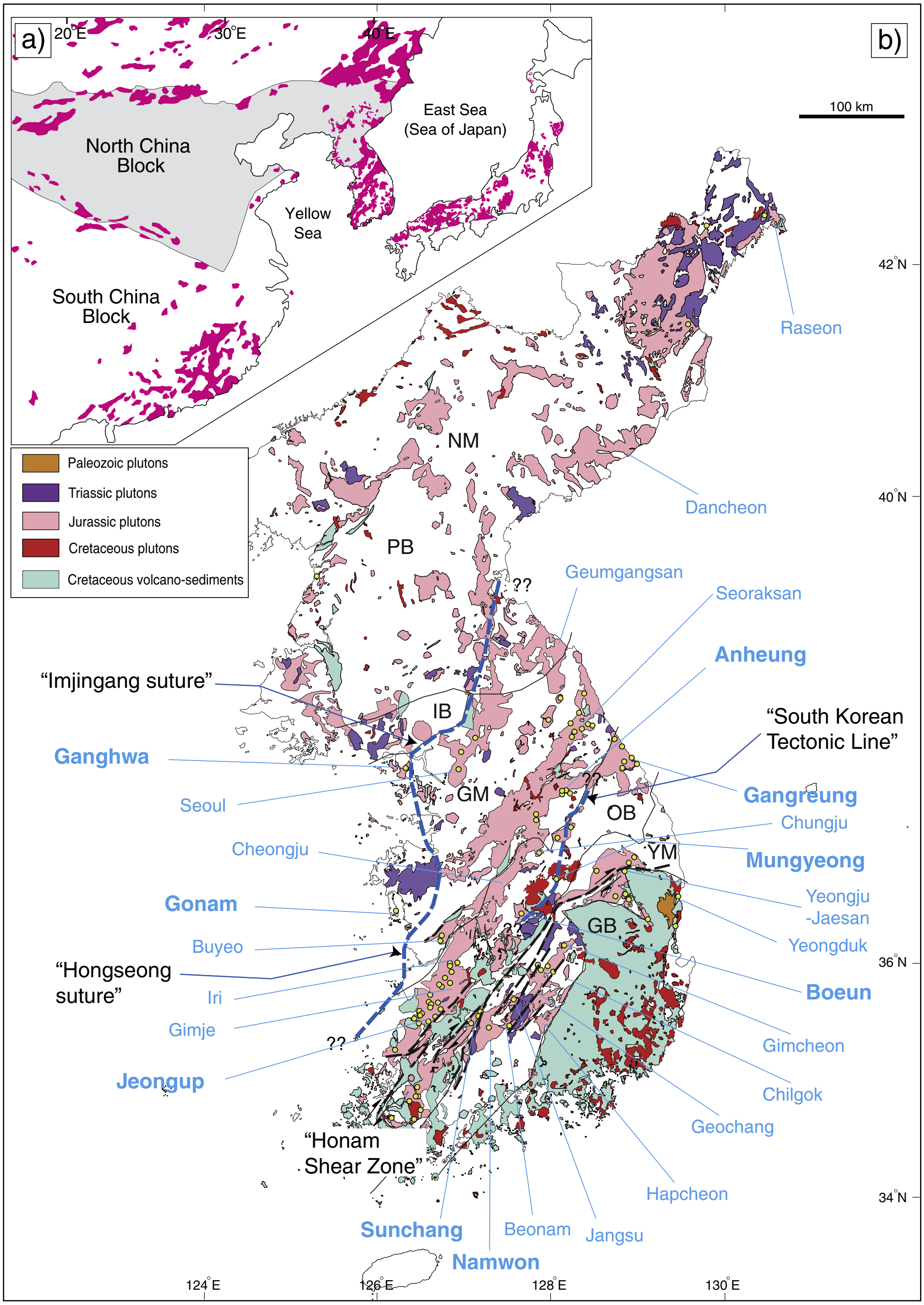

Fig. 1. (a) Tectonic map of Northeast Asia showing overall distribution of the Mesozoic granitoids. (b) Geologic map of the Korean Peninsula showing the distribution of Mesozoic granitoids. NM. Nangrim massif; IB, Imjingang belt; GM, Gyeonggi massif; OB, Okcheon belt; YM, Yeongnam massif; PB, Pyeongnam Basin; GB, Gyeongsang Basin.

suggested by Castillo (2012), we use the term adakite strictly for the extrusive and intrusive rocks that result from the partial melting of the eclogitic oceanic basalt in subduction zone and the term adakitic rocks for the rocks that result from other petrogenetic processes (e.g. Li et al., 2013 and references therein).

The Early to Middle Jurassic continental adakitic rocks are widely exposed in the Korean Peninsula (Kee et al., 2010b; Kim et al., 2011a). The tectonic environment leading to the formation of the adakitic arc magmatism in this region, however, is poorly understood. In this study, we present a systematic geological, geochronological, and geochemical investigation, combined with previously reported data, of the timing and petrogenesis of the adakitic plutonic belt in the Korean Peninsula to better constrain the arc tectonic setting related to paleo-Pacific plate subduction.