Cretaceous Research 75 (2017) 125–140

Contents lists available at ScienceDirect

Cretaceous Research

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

Late Cretaceous volcanic arc system in southwest Korea: Distribution, lithology, age, and tectonic implications

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ARTICLE INFO

Article history:
Received 13 September 2016
Accepted in revised form 9 March 2017
Available online 18 March 2017

Keywords:
Late Cretaceous volcanism
SHRIMP zircon U–Pb age
Volcanics
Pyroclastic rock
Korean Peninsula

ABSTRACT

In the southwestern part of the Korean Peninsula, Cretaceous volcanic rocks occur along a NE–SW-trending, sinistral strike-slip fault (Hamyeol Fault). Based on their spatial distribution, the volcanic rocks are classified into three lithostratigraphic units: the Buan, the Seonunsan, and the Beopseongpo Volcanics. These volcanics are composed of various types of pyroclastic, sedimentary, and lavas/intrusive rocks. SHRIMP U–Pb ages of zircon crystals were isolated from each unit. For the Buan Volcanics, Cheonmasan Tuff = 87.23 ± 0.92 Ma; Udongje Tuff = 86.79 ± 0.71 Ma; Seokpo Tuff = 87.30 ± 0.99 Ma; and Yujeongje Tuff = 86.66 ± 0.93 Ma. For the Seonunsan Volcanics, Gyeongsusan Tuff = 84.9 ± 1.1 Ma and Yeongije Tuff = 86.61 ± 0.67 Ma. For the Beopseongpo Volcanics, Seongsan Tuff = 87.73 ± 0.89 Ma and Gyema Rhyolite = 86.2 ± 1.7 Ma. The ages correspond well to recent mapping results of volcanic rocks in the southwest and south parts of the Korean Peninsula. In addition, the age data are comparable to those of the Aioi and Arima volcanic rock groups in southwestern Japan. This suggests that regional volcanic activity in the Japanese Islands and the southwestern part of the Korean Peninsula is related, and results from magmatism together with crustal deformation due to slab rollback of the Izanagi Oceanic Plate underneath the Eurasian Plate.

1. Introduction

During the Cretaceous, the northeastern margin of the Eurasian Plate was subjected to sinistral crustal deformation and continental arc volcanism by oblique subduction of the Izanagi Oceanic Plate beneath the Eurasian Plate (Klimetz, 1983; Engebretson et al., 1984; Watson et al., 1987; Kim et al., 1997a,b; Taira, 2001; Chough and Sohn, 2010; Liu et al., 2014) (Fig. 1). As a result, non-marine volcanic and sedimentary successions and plutonic rocks formed on the Korean Peninsula along NE–SW- and NNE–SSW-trending fault systems (Kim et al., 2012; Chough, 2013, and references therein). A number of detailed studies have been conducted on the crustal evolution and tectonic history of the Cretaceous Korean Peninsula and nearby areas (Chun and Chough, 1992; Rhee et al., 1993; Rhee and Chough, 1993a,b; Chun and Kim, 1995; Kim et al., 1995, 2003; Jo et al., 1997; Kim et al., 1997a,b; Ryang and Chough, 1997, 1999; Rhee et al., 1998; Lee and Chough, 1999; Jo and Chough, 2001; Paik et al., 2001; Jo, 2003; Ryang, 2003; Kim et al., 2009; Chough and Sohn, 2010; Kwon et al., 2013; Gihm and Hwang, 2014).

Recently, Kim et al. (2012) carried out geochemical analysis and SHRIMP U–Pb zircon age dating on volcanic rocks in the mid-western Korean Peninsula. They reported that basin-forming crustal extension and magmatic processes in the northeastern Eurasian Plate began in the Early Cretaceous (130–110 Ma), and Mesozoic granitoids showed a general spatiotemporal trend of becoming younger in the NW to SE direction (approximately 150–110 Ma in northeastern China, 110 Ma in the northern and central Korean Peninsula, and 100–70 Ma in the southeastern Korean Peninsula). They attributed this spatiotemporal trend to rollback of the Izanagi Plate (Kim et al., 2012).

Recent mapping results showed that Cretaceous volcanic rocks are distributed throughout the southwest of the Korean Peninsula (Fig. 2). These volcanic rocks are intermediate to silicic in composition and are composed of a variety of extrusive and intrusive rocks as well as sedimentary rocks (Koh et al., 2013; Kwon et al., 2015). This study describes the characteristics (distribution, lithology, and stratigraphy) of volcanic rocks in the southwest Korean Peninsula and analyzes their tectonic significance using SHRIMP (Sensitive High Resolution Ion Microprobe) zircon U–Pb age dating and a

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http://dx.doi.org/10.1016/j.cretres.2017.03.010
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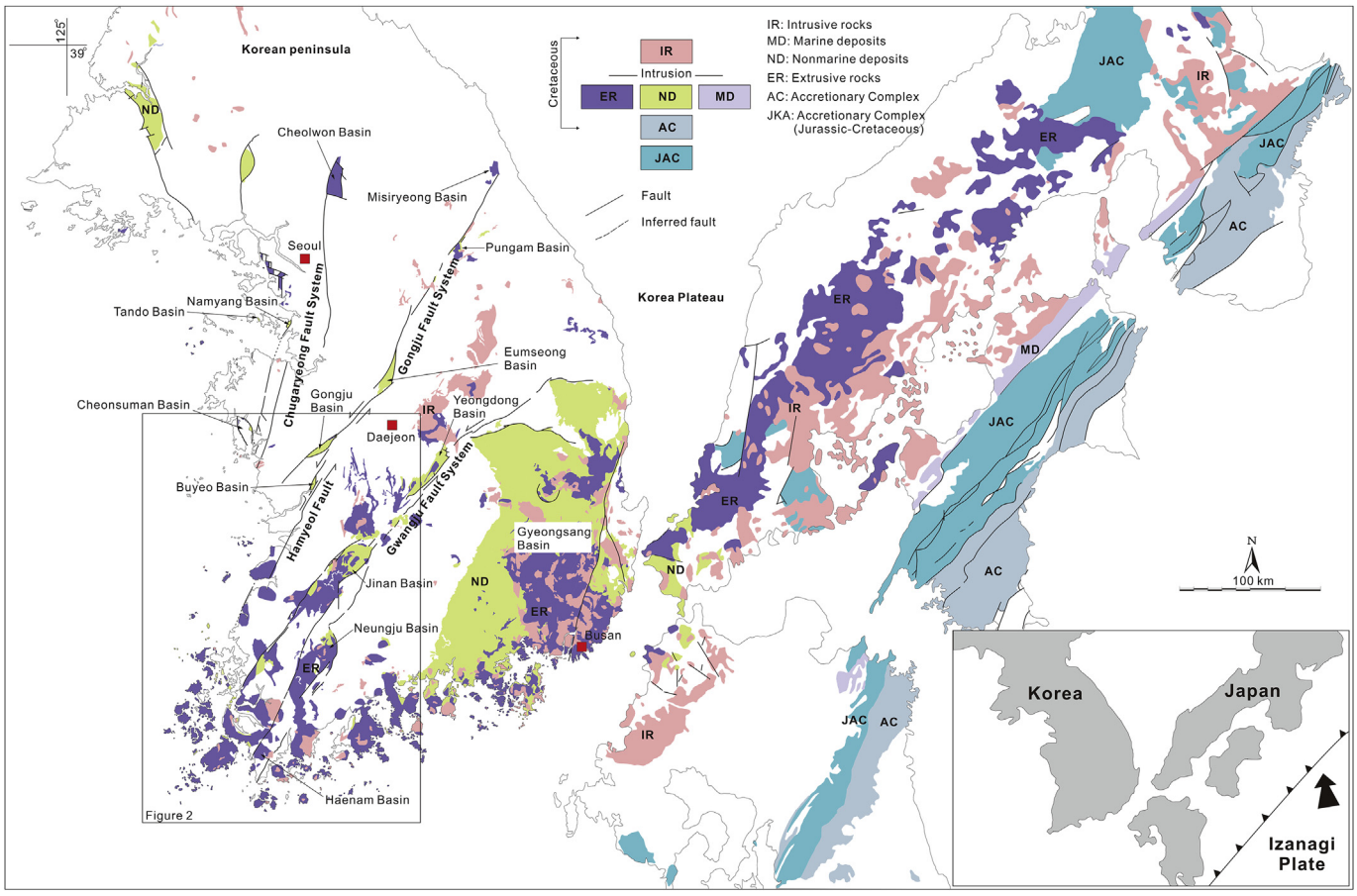

Fig. 1. A paleogeographic plate reconstruction of the Japanese Arc relative to the Korean Peninsula during the Cretaceous (modified from Chough and Sohn, 2010). The distribution of intrusive-extrusive-non-marine deposits represents a volcanic arc associated with subduction of the Izanagi Plate under the Asian continent.

comparison of these results with previous SHRIMP zircon U–Pb and K–Ar age results of Cretaceous volcanic rocks.

2. Geologic setting: characteristics of the Cretaceous volcano-sedimentary basin system in the Korean Peninsula

During the Cretaceous, the Korean Peninsula was situated on the northeastern edge of the Eurasian Plate and was subjected to broad sinistral deformation due to oblique subduction of the oceanic Izanagi Plate beneath the Eurasian Plate (Fig. 1). NE–SW- and NNE–SSW-trending sinistral strike-slip fault systems developed on the Korean Peninsula (from north to south, these were the Chugaryeong, Gongju, Hamyeol, and Gwangju Fault Systems; Fig. 1). Small-scale (<50 × 50 km^2), non-marine sedimentary basins formed along these fault systems along with the Gyeongsang Basin, which is the largest sedimentary basin (~20,000 km^2) in the Korean Peninsula (Fig. 1). The Chugaryeong Fault System comprised many N–S- and NNE–SSW-trending sinistral strike-slip faults, along which the Cheolwon, Namyang (or Sihwa), Tando, and Chunsuman Basins formed (Fig. 1). The basin-fill sediment is composed largely of siliciclastic deposits that accumulated in alluvial-fluvial-delta-to-lacustrine environments and is frequently intercalated with basaltic to rhyolitic volcanic rocks (Kee et al., 2006a,b; Kim et al., 2009; Kwon et al., 2013). SHRIMP zircon U–Pb age dating on the volcanic rocks has revealed ages of approximately 115–109 Ma (Kee et al., 2006b; Hwang et al., 2011; Kim et al., 2012), indicating that these sedimentary basins were formed during the Early Cretaceous.

In the south-central region of the Korean Peninsula, the Gongju, Gwangju, and Hamyeol Fault Systems trend in a NE–SW direction (Fig. 1). Non-marine sedimentary basins (Eumseong, Gongju, Buyeo, Pungam, Kyokpo, Yongdong, Jinan, Neungju, and Haenam Basins) developed along the fault systems, and the basin–fill sediments were deposited in alluvial fan and fluvio-lacustrine environments basaltic to rhyolitic volcanic rocks are also intercalated with the basin-fill sediments (Chough, 2013, and references therein). In the case of the Gongju Basin, K–Ar ages of basaltic andesites covering the basin-fill sediments were estimated at approximately 77 Ma (Cheong, 2002), while SHRIMP zircon U–Pb ages of the volcanic rocks in the northeast of the basin were dated at approximately 108 Ma (rhyolitic tuff) and 84 Ma (quartz feldspar porphyry) (Kim et al., 2010). These ages indicate that basin formation and volcanism in the Gongju Fault System was continuous from the Early to Late Cretaceous.

The Gyeongsang Basin, which is the largest non-marine sedimentary basin on the Korean Peninsula, contains deposits up to 9 km thick, non-marine sedimentary rocks (Sindong and Hayang Groups), volcanic rocks (Yucheon Group), and plutonic rocks (Bulguksa granites), which formed from the Early to Late Cretaceous (Chang et al., 1997). The Sindong and Hayang Groups are mostly comprised of conglomerates, pebbly sandstones, sandstones, mudstones, shales, and carbonate rocks, with intercalated layers (<100 m thick) of basaltic to rhyolitic volcanic rocks. Zircon from the Gusandong Tuff exposed in the upper part of the Hayang Group was LA-ICP-MS age dated to approximately 96–97 Ma (Jwa