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# Whereabouts of the collision belt between the Sino-Korean and South China blocks in the northeast Asian margin

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**ABSTRACT: This study delineates the collision belt (late Permian-Triassic) between the Sino-Korean and South China blocks in the northeast Asian margin, based on correlation of endemic fossil components (corals) in shallow marine deposits of the Silurian and Devonian, identified in both south China and southwest and northeast Japan. The Qinling-Dabie Belt in China was offset by the left-lateral Tanlu Fault and contiguous to the Sulu Belt. The Imjingang Belt in the Korean peninsula was, in turn, offset by the right-lateral South Korean Tectonic Line, and extended eastward to the Namhae Belt (newly named). Further east, it extended to the Higo Belt and the Kitakami Terrane in Japan, prior to the opening of the East Sea in the Miocene. The collision in the northeastern Asian margin in the Triassic was superposed by contemporaneous subduction of the paleo-Pacific Plate.**

**Key words:** collision belt, Sino-Korean Block, South China Block, Namhae Belt

## 1. INTRODUCTION

The collision between the Sino-Korean and South China blocks in the late Permian-Triassic caused closure of the paleo-Tethys Sea, as manifested in the Qinling-Dabie Belt and its eastern extension of the Sulu and Imjingang belts, offset by the Tanlu Fault (Liou et al., 1996; Ree et al., 1996) (Fig. 1). In the Korean peninsula, the South Korean Tectonic Line represents right-lateral offset boundary, counterpart of the Tanlu Fault, between the two blocks (Chough et al., 2000; Chough, 2013). Further east, however, the whereabouts of the collision belt is still unknown. The sole purpose of this study is to delineate the collision boundary of the Sino-Korean and South China blocks in the east of the South Korean Tectonic Line, based on comparison of characteristic components of corals in the Silurian and Devonian shallow marine deposits of the South China Block, including the southwest and northeast Japanese islands. The newly defined collision belt helps understand the superposed tectonic elements of contemporaneous subduction of the paleo-Pacific Plate under the fused continental margin in the Triassic.

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## 2. TECTONIC SETTING

Both the Sino-Korean and South China blocks were located at the eastern margin of the supercontinent, Pangea, in the late Permian (Scotese and Langford, 1995). The Sino-Korean Block comprises both the lower Paleozoic succession (Cambrian-Ordovician), which unconformably overlies the Precambrian basement rocks of high-grade gneiss and schist of the Archean and Proterozoic (Jahn, 1990; Zhou, 1994; Lee and Cho, 2012). The lower Paleozoic succession formed during the greenhouse period in the North China Platform and the Taebaeksan Basin, and is, in turn, unconformably overlain by the upper Paleozoic (Carboniferous-Permian) succession (Chough et al., 2000; Kwon et al., 2006; Chough et al., 2010; Lee and Chough, 2011). There is a distinct break in records of the Silurian and Devonian periods.

On the other hand, the South China Block comprises the Yangtze and Cathaysia blocks, which formed in the Neoproterozoic with a rifted basin (Nanhua Basin) (Chen et al., 1991; Li et al., 2009). The block comprises Paleozoic succession with a break during the mid-Paleozoic orogeny. On the contrary, the proto-Japanese islands are devoid of Cambrian-Ordovician succession and start with the Silurian succession, overlying the Precambrian basement rocks.

The Qinling-Dabie Belt represents collision of the two blocks initiated in the late Permian-Triassic (Liou et al., 1996), and recent geochronologic data suggest that the main continent-continent collision was preceded by a Silurian-Early Devonian collision between the Qinling microcontinent and Sino-Korean block (e.g., Liu et al., 2013; Dong et al., 2013). The occurrence of exhumed ultra-high pressure minerals is indicative of subduction of oceanic crust followed by collision. Offset by the Tanlu Fault, the belt is contiguous to the Sulu and Imjingang belts (Cho et al., 1995; Ree et al., 1996). High-pressure minerals are, however, absent in the Imjingang Belt. Further east, it is, in turn, offset by the South Korean Tectonic Line, demarcating the Gyeonggi Massif overlain by the late Proterozoic metasedimentary succession from the Yeongnam Massif, overlain by the Paleozoic succession (Reedman and Um, 1975; Chough et al., 2000; Chough, 2013).

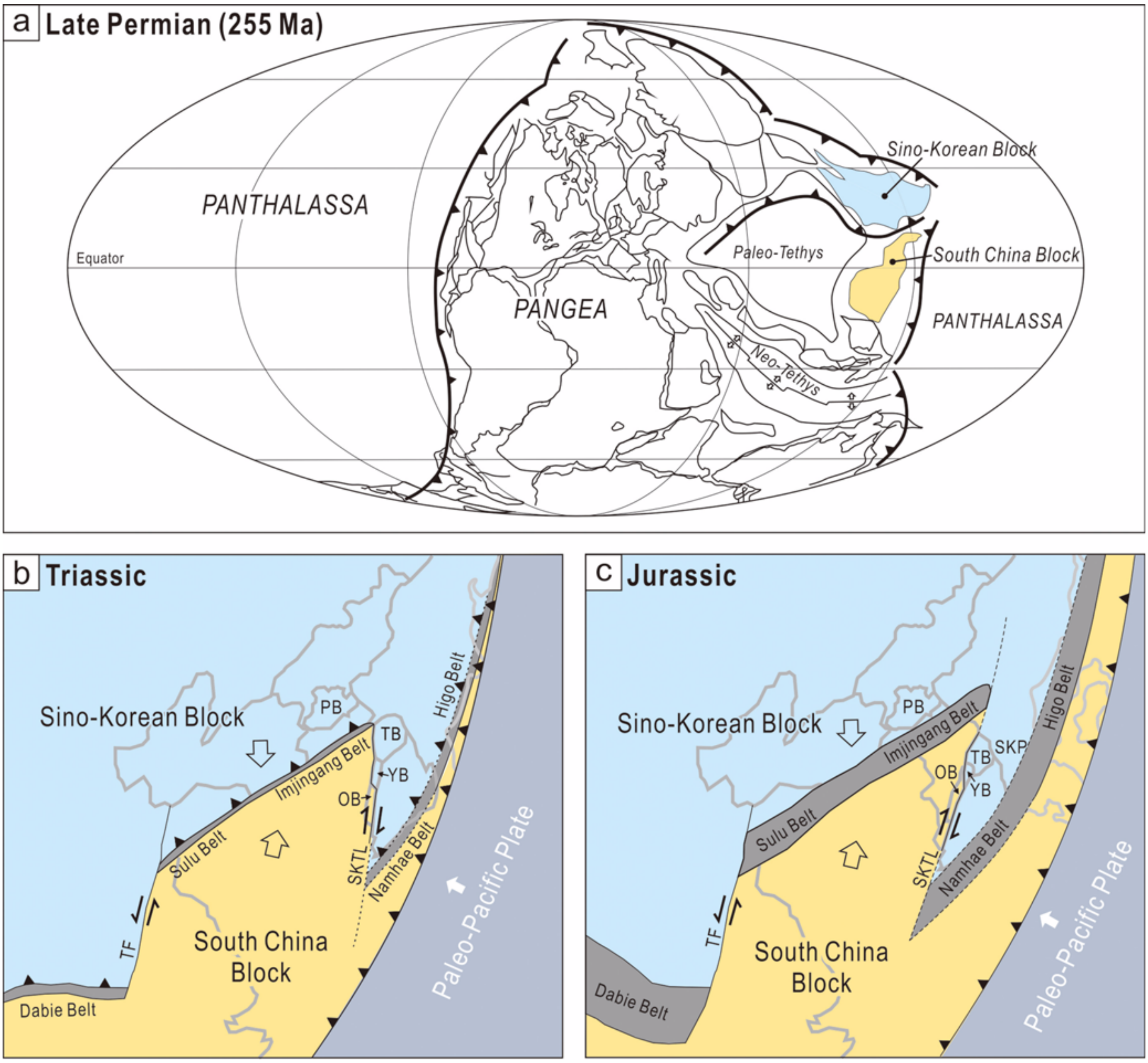


**Fig. 1.** (a) Paleogeography of the Late Permian (after Scotese and Langford, 1995). (b) Tectonic reconstruction of the Sino-Korean and South China blocks in the Triassic. (c) Tectonic reconstruction in the Jurassic. Note that the indented South China Block collided against the Sino-Korean Block along the Qinling-Dabie, Sulu, Imjingang, and Namhae-Higo belts, forming an offset along the Tanlu Fault and the South Korean Tectonic Line. Contemporaneous subduction of the paleo-Pacific Plate was superposed. PB, Pyeongnam Basin; YB, Yeongwol Block; TB, Taebaeksan Basin; OB, Okcheon Basin; TF, Tanlu Fault; SKTL, South Korean Tectonic Line; SKP, South Korea Plateau.

## 3. CLOSURE OF PALEO-TETHYS SEA

Evidence for the closure of the paleo-Tethys Sea and the collision of the Sino-Korean and South China blocks in the east of the South Korean Tectonic Line comes from a comparison of endemic corals in the Silurian and Devonian successions of the southwest and northeast Japanese islands with those of the South China Block (Fig. 2). The Middle-Late Paleozoic successions in these areas yield abundant fossils including corals, radiolarians, trilobites, conodonts, and brachiopods. In this study, corals are used for paleogeographic reconstruction based on their endemic characteristics. Rugose and tabulate corals were abundant in shallow marine environments during the Silurian and Devonian in many continental blocks. They are sessile animals, indicative of warm and shallow marine environments.

The Silurian-Devonian corals occur in the Kurosegawa Terrane (Higo Belt), the Kitakami Terrane, and the Hida Belt. In the Kurosegawa Terrane (Yokokurayama, Imose, Mitakiyama, and Gionyama areas), tabulate corals (*Mesosolenia*

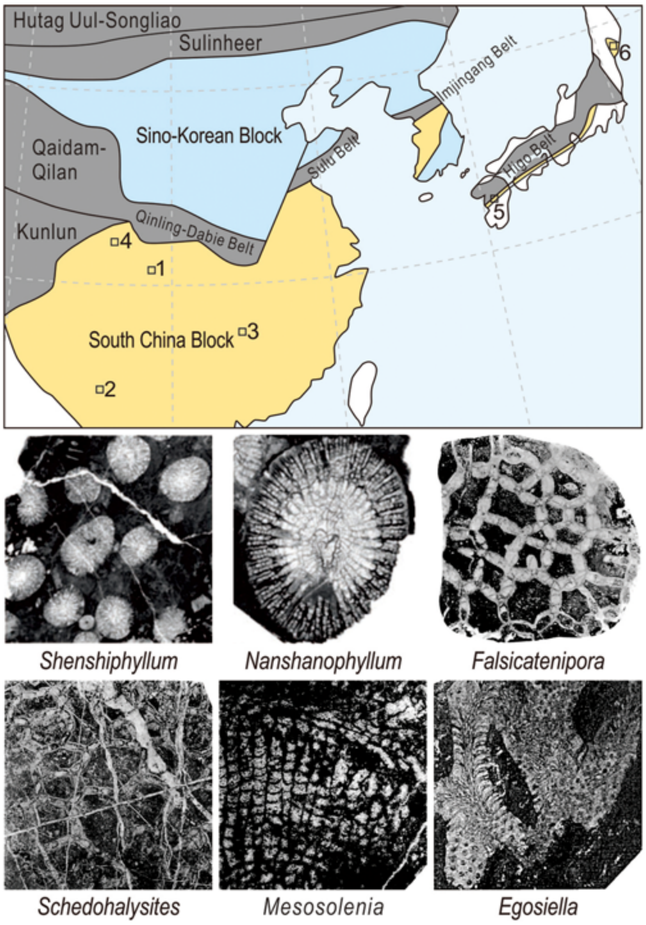


**Fig. 2.** Distribution of endemic rugose and tabulate corals in the Silurian-Devonian shallow marine deposits of the northeast Asian margin (south China and southwest and northeast Japan). 1. Ningqiang-Guangyuan (Shaanxi-Sichuan) (*Shenshiphyllum*, *Nanshanophyllum*, *Falsicatenipora*, *Schedohalysites*, *Mesosolenia*, *Egosiella*), 2. Daguan (NE Yunnan) (*Shenshiphyllum*, *Nanshanophyllum*), 3. Shimen (Hunan) (*Nanshanophyllum*), 4. Zhugqu (SE Gansu) (*Nanshanophyllum*), 5. Kurosegawa Terrane (*Shenshiphyllum*, *Nanshanophyllum*, *Falsicatenipora*, *Schedohalysites*, *Mesosolenia*, *Egosiella*), 6. Kitakami Terrane (*Falsicatenipora*, *Schedohalysites*). Data compiled after Nakai (1981), Niko and Adachi (2000, 2004) and Kido and Sugiyama (2011).

*decorasa and Egosiella sp. cf. E. ningqiangensis*) have an affinity of the South China Block, i.e., the paleo-Tethys Sea (Niko and Adachi, 2000, 2004). Rugosa corals (*Nanshanophyllum and Shensiphyllum*) also have a similar affinity (Kido and Sugiyama, 2011). In the Kitakami Terrane, tabulate corals (*Halysites and Schedohalysites*) of the Arisu and Hikoroichi areas are well correlated with those of the Kurosegawa Terrane (Kato et al., 1980). Rugosa corals (*Tryplasma and Cystiphyllum*) are also common in both areas (Kido and Sugiyama, 2011).

In the Hida Belt, tabulate corals (*Favosites, Squameopora, Squameofavosites,* and *Heliolites*) and rugose corals (*Aphyllum*, *Oborophyllum*, *Entelophyllum*, *Rhizophyllum*, *Cystiphyllum*, *Tryplasma*, *Cyathophyllum*? and *Pseudamplexus*) occur in the Fukuji Formation (probably Early Devonian). These corals are, however, largely of cosmopolitan in origin (Kato et al., 1980).

## 4. COLLISION BOUNDARY

Major crustal deformation in the Korean peninsula occurred in the late Permian-Triassic when the South China Block collided with the Sino-Korean Block along the Imjingang Belt (Ree et al., 1996). It was the most important event in the transformation of the stable platforms into a collision-related tectonic belt. Along the South Korean Tectonic Line, the Gyeonggi Massif (South China Block) was in right-lateral shear relative to the Yeongnam Massif (Sino-Korean Block) (Chough et al., 2000; Chough, 2013). This shear zone of major structural discontinuity was an eastern counterpart of the left-lateral Tanlu Fault (Fig. 1). At the southern tip of the South Korean Tectonic Line, the collision belt between the two blocks lies within the Namhae (South Sea) area. According to the correlation of endemic corals in southwest Japan and Qinling-Dabie Belt, it is most likely that the Namhae Belt is contiguous to the Higo Belt of southwest Japan (Fig. 1). The Higo Belt also comprises medium-pressure-type metamorphic rocks of 230 Ma (Osanai et al., 2006).

In these collision belts of the southwest and northeast Japanese islands, the meta-sedimentary successions co-occur with the accretionary prism of the paleo-Pacific Plate. The former shows medium-pressure metamorphic facies (amphibolite-granulite facies), whereas the latter are of high-pressure metamorphic assemblages (Isozaki, 1997). This superposition of the back-to-back events, i.e., the collision of the Sino-Korean and South China blocks and the subduction of the paleo-Pacific Plate affected the entire northeastern Asian margin since the Triassic, including the Korean peninsula and the proto-Japanese continental promontory.

## 5. DISCUSSION

The endemic rugose corals are representative of shallow marine environments in the continental margin and platform setting. The regional correlation of rugose corals in the collision belts is thus suggestive of continent-continent collision of the two blocks, most likely led by initial subduction of an oceanic crust under the continental crust. The endemic nature of the rugose corals negates the possibility of accretionary prism of the paleo-Pacific Plate. These corals flourished in shallow continental margin platforms of the South China Block, which collided later against the active margins of the Sino-Korean Block. This is evinced by the occurrence of ultra-high pressure rocks and metamorphic facies as well as the structural vergence of the exhumed masses in the Qinling-Dabie Belt (e.g., Hacker et al., 1995). Certain Upper Ordovician corals (*Agetolites sp. and Catenipora zhejiangensis*), an affinity of the South China Block, also occur in the nappe units across the Imjingang Belt (Chough, 2013).

The South Korean Tectonic Line is the major structural disconinuity, extending for about 400 km, representing a northeast-striking right-lateral shear zone. The Gyeonggi Massif (South China Block) and the overlying metasedimentary rocks of the Okcheon Group in the northwest are in thrust contact with the Yeongnam Massif (Sino-Korean Block) and the overlying sedimentary successions of the Joseon and Pyeongan groups in the southeast (Chough, 2013). In the middle part of the peninsula, the line divides the Okcheon Group from the Yeongwol Group. Earlier studies have placed the deformation zone of the two blocks across the Yeongwol and Taebaek groups (Cluzel et al., 1990, 1991) or the Honam shear zone further south (Yin and Nie, 1993; Otoh and Yanai, 1996; Yanai et al., 1985, 1993). The strike-slip fault, South Korean Tectonic Line, is representative of an offset of two continental blocks, which is a counterpart of the Tanlu Fault in the east of the Qinling-Dabie Belt (Chough, 2013). In the Namhae region, numerous large and small islands comprise mostly of Cretaceous volcanic rocks (Chough and Sohn, 2010). However, exhumed basement metamorphic rocks, an affinity of the South China Block, also occur locally, although mid-Paleozoic limestone and dolostone are yet to be found (Lim et al., 1999).

Prior to the opening of the East Sea, the Namhae-Higo Belt extended northeastward, close to the Asian continental margin (Fig. 1). However, it was demarcated by the South Korea Plateau, which was rifted and submerged during the opening of the East Sea in the Miocene (Chough and Barg, 1987; Yoon and Chough, 1995; Kim et al., 2011). The belt was superposed with the accretionary complex, caused by subduction of the paleo-Pacific Plate under the sutured continent. The dual events of collision and subduction are manifested by the co-occurrence of collisional orogen and accretionary complex whose metamorphic facies are different from each other (Isozaki et al., 2010).

## 6. CONCLUSIONS

The correlation of endemic corals in shallow marine deposits of the Silurian and Devonian in the South China Block is suggestive of an existence of the here-named Namhae Belt, an extension of the Imjingang Belt, offset by the South Korean Tectonic Line. Prior to the opening of the East Sea in the Miocene, it extended further northeast to the Higo Belt, Kyushu and the Kitakami Terrane, northeast Japanese promontory. The entire tectonic belt represents part of continental collision between the Sino-Korean and South China blocks in the northeast Asian margin, which activated in the Late Triassic (~220 Ma). The collision belt was superposed by contemporaneous subduction of the paleo-Pacific Plate and experienced contiguous deformation in the Jurassic and Cretaceous accompanied with magmatism and volcanism.

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