

PRE-NEOGENE TECTONIC DIVISIONS AND MIDDLE PERMIAN BRACHIOPOD FAUNAL PROVINCES OF JAPAN

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Middle Permian brachiopod faunas of Japan are classified into two types, the Boreal–Tethyan mixed fauna of the Inner Mongolian–Japanese Transition Zone and the Tethyan–North American mixed fauna of the Tropical Panthalassan Zone. The former occurs from pre-Triassic accretionary terranes, the South Kitakami Terrane and the Akiyoshi Terrane, which were probably a continental shelf and a trench along the eastern margin of the Sino-Korean block, respectively, in the Middle Permian time. The latter occurs from exotic limestone blocks in the Mino Terrane, an Early Jurassic to Early Cretaceous accretionary terrane. These limestone blocks were probably parts of reef–seamount complexes situated at the mid-equatorial region of the Panthalassa in the Middle Permian time.

DURING the last decade the Permian biogeography of the world has been discussed by many authors (Chaloner & Creber 1988; Xu & Yang 1988, 1994; Bambach 1990; Ross & Ross 1990; Ziegler 1990; Grunt 1995; Shi et al. 1995; Grunt & Shi 1997; Shang & Jin 1997; Jin & Shang 1997). The Permian brachiopod faunas of Japan are important for geographical and biogeographical reconstruction of the Northern Hemisphere in that time. In this paper the generic composition and character of the Japanese Middle Permian brachiopod faunas are summarised, and their faunal provincialism is discussed in connection with pre-Neogene tectonic divisions of the Japanese Islands.

PRE-NEOGENE TECTONIC DIVISIONS OF THE JAPANESE ISLANDS

The pre-Neogene rocks of the Japanese Islands are classified into the following nine terranes (Tazawa 1993): Hida Terrane (the oldest terrane containing Precambrian rocks but lacking the Permian), South Kitakami Terrane (Middle Ordovician to Early Devonian accretionary terrane with Permian continental shelf deposits), Akiyoshi, Suo, Maizuru and Ultra-Tanba Terranes (Middle to Late Permian accretionary terranes with trench-fill deposits of the same age; only the Akiyoshi Terrane contains exclusively Early Carboniferous to Middle Permian exotic limestone blocks), Mino and Sanbagawa Terranes (Early Jurassic to Early Cretaceous accretionary terranes with Permian exotic limestone

blocks) and Shimanto Terrane (Late Cretaceous to the earliest Neogene accretionary terrane without the Permian). These terranes are arranged in the NE–SW direction, subparallel to the extension of the Japanese Islands, and younging towards SE, from the Japan Sea side to the Pacific side (Fig. 1).

The geotectonic framework of the Japanese Islands was formed through long-term subduction along the Sino-Korean block since Middle Ordovician (Tazawa 1993). The east- or southward thrust movement occurred and formed several nappes and klippes, such as the Hida Nappe (Komatsu et al. 1985), South Kitakami Nappe (Tazawa 1988) and Kurosegawa Klippe (Isozaki & Itaya 1991) in the latest Jurassic to earliest Cretaceous time. The large scale left-lateral strike-slip motion occurred along the Tanakura Tectonic Line (TTL) and the Median Tectonic Line (MTL) in the Early Cretaceous to Palaeogene time (Taira et al. 1989; Tazawa 1993). And finally, the opening of the Japan Sea caused clockwise rotation of Southwest Japan and counterclockwise rotation of Northeast Japan in the Early Neogene time (Otofuji & Matsuda 1983; Otofuji et al. 1985).

MIDDLE PERMIAN BRACHIOPOD FAUNAS OF JAPAN

The Middle Permian (Artinskian–Capitanian) brachiopod faunas of Japan are divided into two types, the Boreal–Tethyan mixed fauna and the Tethyan–

North American mixed fauna. As shown on Fig. 1 and Table 1, the Boreal-Tethyan mixed fauna is represented by those of the South Kitakami Terrane (South Kitakami Belt and Hida Gaien Belt) and the Akiyoshi Terrane (Akiyoshi Belt), and it contains both the Boreal and Tethyan elements. The Tethyan-North American mixed fauna is

represented by those of the Mino Terrane (Ashio Belt and Mino Belt), and it contains both the Tethyan and North American elements.

Boreal-Tethyan mixed fauna

South Kitakami Terrane. In the South Kitakami

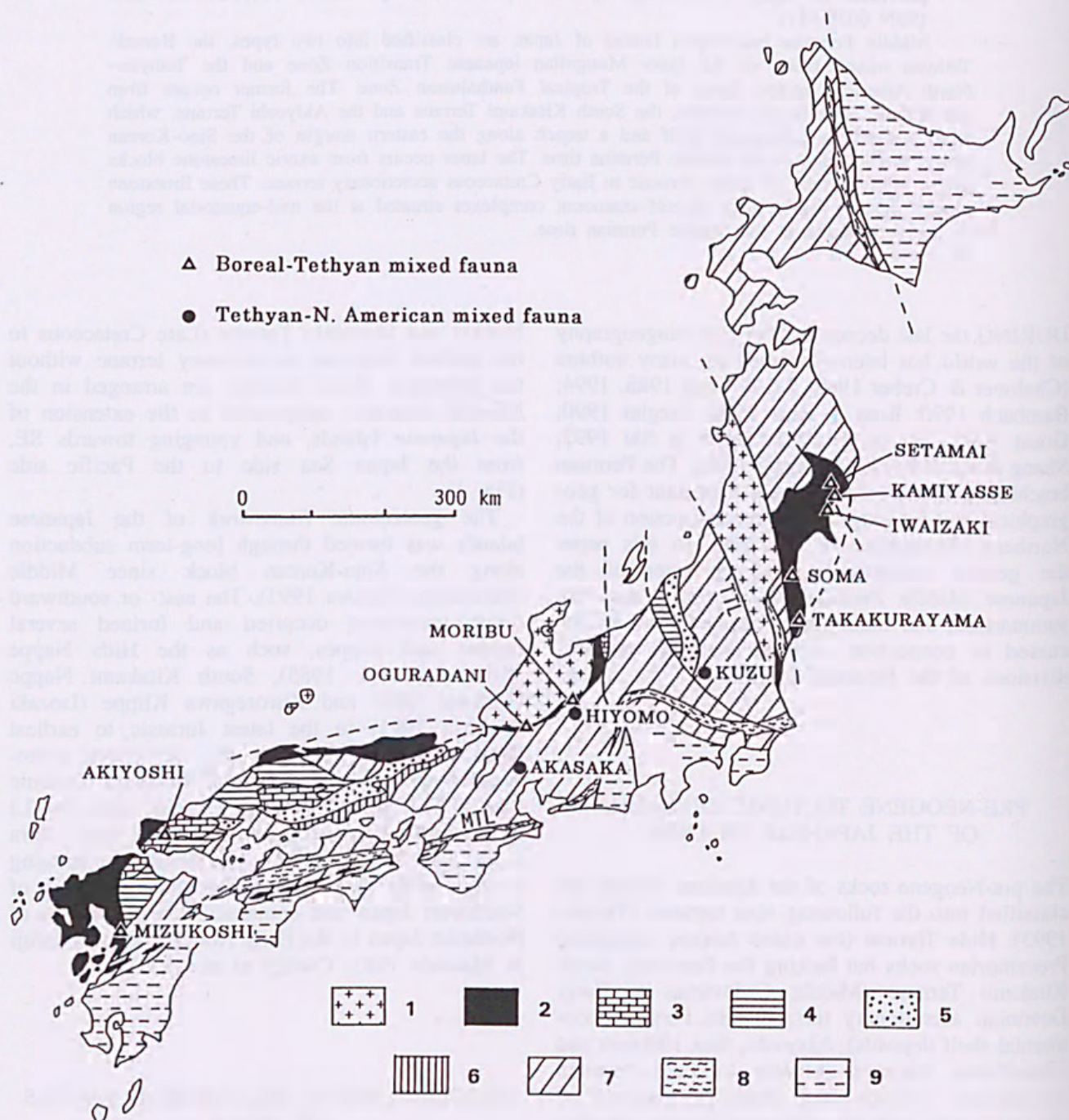


Fig. 1. Distribution of Middle Permian brachiopod faunas and pre-Neogene terranes in Japan (adapted from Tazawa 1993). TTL, Tanakura Tectonic Line; MTL, Median Tectonic Line; 1, Hida Terrane; 2, South Kitakami Terrane; 3, Akiyoshi Terrane; 4, Suo Terrane; 5, Maizuru Terrane; 6, Ultra-Tanba Terrane; 7, Mino Terrane; 8, Sanbagawa Terrane; 9, Shimanto Terrane.

Brachiopoda fauna [Faunal province]	Terrane [Belt]	Middle Permian reconstruction
I Boreal-Tethyan mixed fauna [Inner Mongolian-Japanese Transition Zone]	Middle Ordovician-Early Devonian accretionary terrane South Kitakami Terrane [South Kitakami Belt] [Hida Gaien Belt] Middle-Late Permian accretionary terrane Akiyoshi Terrane [Akiyoshi Belt]	Continental shelf on the eastern margin of the Sino-Korea Trench along the eastern margin of the Sino-Korea
II Tethyan-North American mixed fauna [Tropical Panthalassan Zone]	Early Jurassic-Early Cretaceous accretionary terrane Mino Terrane [Mino Belt] [Ashio Belt]	Reef-seamount complex on the mid-equatorial region of the Panthalassa

Table 1. The characters, faunal provinces, localities and their reconstruction of the Japanese Middle Permian brachiopod faunas.

Belt, Northeast Japan, the Middle Permian brachiopod faunas have been known from the Kanokura Formation of Setamai, Kamiyasse and Iwaizaki districts in the southern Kitakami Mountains (Hayasaka 1922, 1925, 1960; Hayasaka & Minato 1956; Mabuti 1935; Nakamura 1959, 1960, 1970, 1972a, 1979; Tazawa 1974, 1976, 1979, 1987b; Tazawa & Araki 1984; Minato et al. 1979; Shen & Tazawa 1997), the Oashi Formation of the Soma district (Tazawa & Gunji 1982) and the Takakurayama Formation of the Takakurayama district (Yanagisawa 1967; Nakamura 1972b; Koizumi 1979) in the Abukuma Mountains. These faunas are characterised by the presence of both the Boreal and Tethyan elements. The Boreal-type representatives are *Yakovlevia*, *Cancrinella*, *Waagenoconcha*, *Megousia*, *Stenosisma*, *Spiriferella* and *Neospirifer*, and the Tethyan-type representatives are *Leptodus*, *Spinomarginifera*, *Richthofenia*, *Meekella*, *Rhipidomella*, *Geyerella*, *Transennatia*, *Orthothetina*, *Tyloplecta*, *Permudaria*, *Urushtenoidea* and *Permianella*.

In the Hida Gaien Belt, Central Japan, a brachiopod fauna of early Middle Permian age was revealed by Horikoshi et al. (1987) from the lower part of the Moribu Formation in the Moribu district. The Moribu fauna contains the Boreal elements, *Alispiriferella*, *Yakovlevia*, *Waagenoconcha*, *Rhomboispirifer*, *Stenosisma*, *Cancrinella*, *Megousia* and *Neospirifer*, and the Tethyan elements, *Urushtenoidea*, *Transennatia*, *Leptodus*, *Permudaria* and *Enteleles*. Recently a Middle Permian brachiopod fauna was described by Tazawa & Matsumoto (1998) from the lower part of the Oguradani

Formation in the Oguradani district, about 70 km SW of Moribu. The Oguradani fauna contains the Boreal elements *Stenosisma* and some Tethyan elements, *Leptodus*, *Transennatia* and *Meekella*. The Moribu and Oguradani faunas are closely related to those of the South Kitakami Belt, South Primorye, Northeast China and Inner Mongolia in generic and specific levels.

In Central Kyushu, Southwest Japan, a Middle Permian brachiopod fauna was described by Yanagida (1963) from the upper part of the Mizukoshi Formation. The Mizukoshi fauna contains the Boreal elements, *Neospirifer* and *Spiriferella*, but no Tethyan elements. The lacking of the Tethyan-type brachiopods in this fauna may be owing to the incomplete material.

Akiyoshi Terrane. A brachiopod fauna of late Middle Permian age has been known from the Tsunemori Formation in the Akiyoshi district, Southwest Japan (Mabuti 1937; Yanagida 1996). The Tsunemori fauna contains *Spiriferella*, *Alispiriferella*, *Stenosisma* and *Megousia* as the Boreal elements, and *Gemmellaroia*, *Leptodus*, *Enteleles*, *Goniarina* and *Tyloplecta* as the Tethyan elements. In his report of the Tsunemori fauna, Yanagida (1996: 315) mentioned that this fauna is related to that of the Yangtze Platform (South China). However, the Tsunemori fauna is clearly a mixed fauna of the Boreal and Tethyan elements, and similar to the Middle Permian fauna of the South Kitakami Terrane and also to those of South Primorye and Northeast China in generic composition.

Tethyan–North American mixed fauna

Mino Terrane. Recently, a Middle Permian brachiopod fauna was described by Tazawa & Shen (1997) from Hiyomo in the Mino Belt, Central Japan. The brachiopods were collected from a limestone block in the Jurassic melange, widely distributed in the Hiyomo district. The Hiyomo fauna contains some Tethyan elements such as *Entelestes*, *Compressoproductus* and *Eolyttonia*, but lacks completely both the Boreal and Gondwanan elements. It is noteworthy that the Hiyomo fauna contains North American elements, *Glyptosteges*, *Cenorhynchia* and *Lepidospirifer*, and resembles the Middle Permian (Leonardian to lower Guadalupian) brachiopod fauna of West Texas in generic and specific levels. Moreover, the presence of a typical North American-type genus *Coscinophora* and a Tethyan-type genus *Peltichia* has been revealed by Tazawa (1997c) and Shen (pers. comm.), respectively, from the lower part (*Parafusulina* Zone) of the Akasaka Limestone in the Akasaka district, Mino Belt, Central Japan. Consequently, it is defined that the Middle Permian brachiopod fauna of the Mino Terrane is the Tethyan–North American mixed one without the Boreal and Gondwanan elements.

The Nabeyama fauna, described by Hayasaka (1933) from the lower part of the Nabeyama Limestone in the Kuzu district, Ashio Belt, Central Japan, contains some Tethyan type genera, *Entelestes*, *Meekella* and *Orthothetina*, but several of Boreal aspect are completely absent. This fauna requires re-study because the presence of the Northern American-type brachiopods is strongly expected.

MIDDLE PERMIAN BRACHIOPOD FAUNAL PROVINCES OF JAPAN

Based on brachiopods and other marine organisms the following four realms are recognised in the Middle Permian time: the Boreal, Tethyan, Gondwanan and Panthalassan Realms. Moreover, several transitional zones may be added in the boundary regions (see Shi et al. 1995: fig. 1). In this paper, however, only two faunal zones concerning the Japanese brachiopod faunas, the Inner Mongolian–Japanese Transition Zone and the Tropical Panthalassan Zone, are discussed and shown on Fig. 2.

The Inner Mongolian–Japanese Transition Zone (Tazawa 1991) occupies the area of eastern sea of the Sino-Korean block and the boundary region

of the Boreal–Tethyan–Panthalassan realms of the Northern Hemisphere in the Middle Permian time. This transitional zone is characterised by the presence of both Boreal and Tethyan elements, and is represented by the faunas of the South Kitakami and Akiyoshi Terranes in Japan, South Primorye, Northeast China and Inner Mongolia.

The Tropical Panthalassan Zone, newly proposed in this paper, occupies the low latitude and mid regions between the Tethyan sea and North American continent. This zone is characterised by a very distinctive Tethyan–North American mixed fauna, and represented by some faunas from the exotic limestone blocks of the Mino Terrane, Japan.

MIDDLE PERMIAN RECONSTRUCTION OF JAPAN

The Middle Permian reconstruction of Japan is summarised as follows and shown on Fig. 2 and Table 1.

The Middle Permian of the South Kitakami Terrane, including the South Kitakami and Hida Gaien Belts, is composed of shallow-sea continental shelf deposits (Tazawa 1988, 1989), and can be correlated with those of South Primorye, Northeast China and Inner Mongolia in both lithostratigraphy and fossil contents (Tazawa 1996, 1997a). The Middle Permian brachiopod faunas of the South Kitakami Terrane are characterised by the mixed fauna of the Boreal and Tethyan elements (Tazawa 1987a, 1991, 1992; Nakamura & Tazawa 1990), and are closely related to those of South Primorye, Northeast China and Inner Mongolia. From the above data the Middle Permian reconstruction of these regions is considered to be the continental shelf bordering the eastern margin of the Sino-Korean block, which was present at a middle northern palaeolatitude and near the boundaries of the Boreal–Tethyan–Panthalassan realms.

The late Middle Permian Tsunemori Formation in the Akiyoshi Terrane is composed of deep-sea, trench-fill deposits (Kanmera 1983; Kanmera & Sano 1986), contrasting to those of the South Kitakami Terrane. But the brachiopod fauna from the Tsunemori Formation contains both the Boreal and Tethyan elements, similar to those of the South Kitakami Terrane and also to those of South Primorye, Northeast China and Inner Mongolia. These data suggest that the trench accumulating the sediments of the Tsunemori Formation was located at the front of eastern margin of the Sino-Korean block in the Middle Permian time.

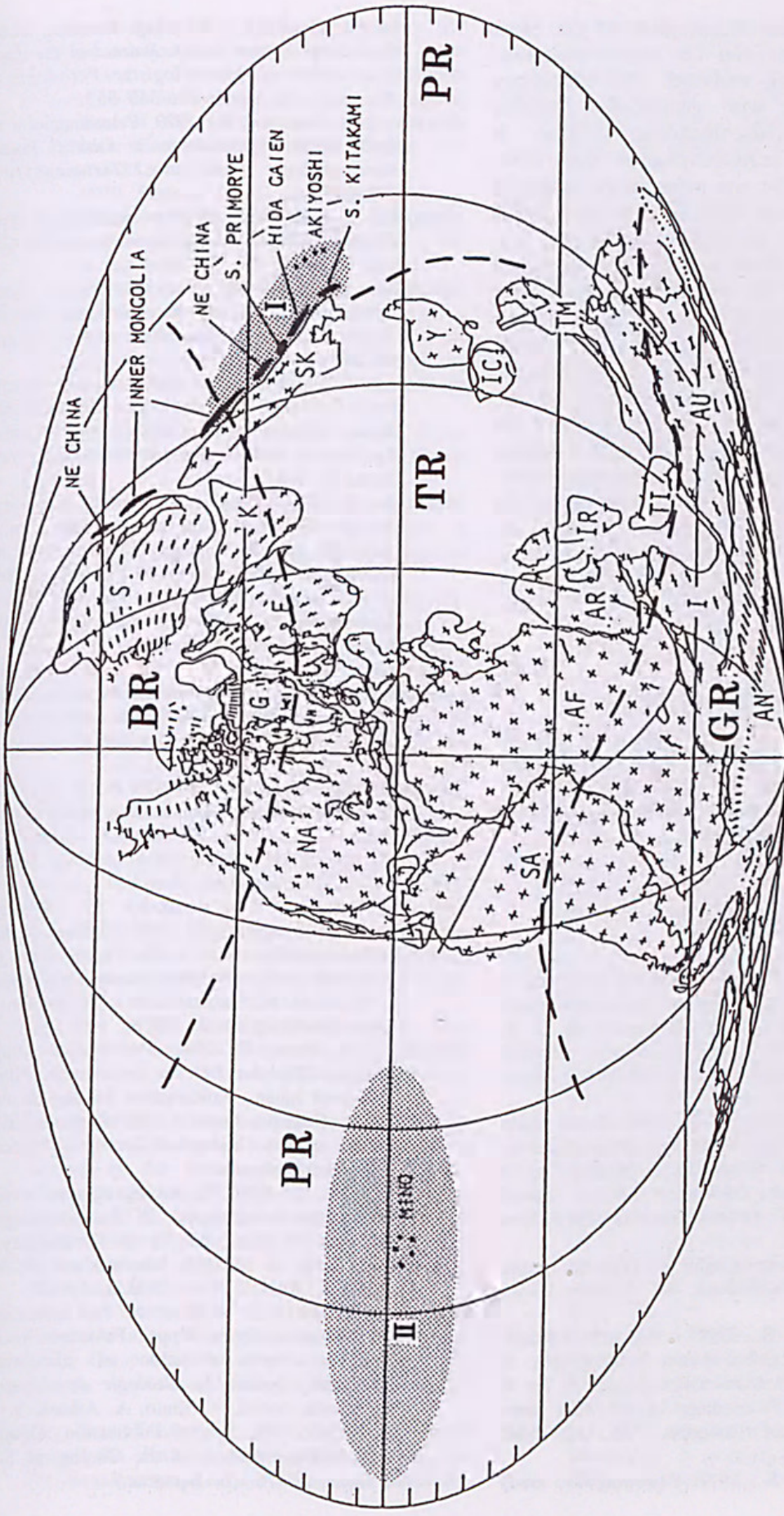


Fig. 2. Geographical and biogeographical reconstruction of Japan and its environs in the Middle Permian time (adapted and modified from Scotese & McKerrow 1990; Tazawa 1992). Black areas are continental shelf or reef-seamount complex. Faunal province: I, Inner Mongolian-Japanese Transition Zone; II, Tropical Panthalassan Zone; BR, Boreal Realm; GR, Gondwanan Realm; PR, Panthalassan Realm; TR, Tethyan Realm. Continent or block: AF, Africa; AN, Antarctica; AR, Arabia; AU, Australia; E, Europe; G, Greenland; I, India; IC, Indochina; IR, Iran; K, Kazakhstan; NA, North America; S, Siberia; SA, South America; SK, Sino-Korea; T, Tibet; TI, Tibet; TM, Thai-Malaya; Y, Yangtze.

The Middle Permian brachiopods of the Mino Terrane are collected from the exotic limestone blocks in the Jurassic melange. The limestones often occur together with greenstones (basaltic rocks). From the palaeomagnetic (Hattori & Hirooka 1977, 1979), sedimentological (Sano 1988; Sano & Kanmera 1996) and palaeobiogeographical (Ishii et al. 1985; Ozawa 1987; Tazawa 1991, 1992) studies, the limestone–greenstone blocks are considered to have originated from the reef–seamount complexes situated at the equatorial region of the Panthalassa in the Permian time. But there was no information about the palaeolongitude of the region. Now, I have some data based on the brachiopod faunas, which are of mixed composition of the Tethyan–North American elements and shows the mid region between the Tethys and North America. From the above data, the Middle Permian reconstruction of the limestone–greenstone blocks of the Mino Terrane can be explained as discussed by Tazawa (1997b), the reef–seamount complexes on the mid-equatorial region of the Panthalassa, i.e. the Tropical Panthalassan Zone.

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