37. The Japanese Islands in the Palaeozoic Age

By Teiichi KOBAYASHI, M. J. A.

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The Chichibu Geosyncline is the progenitor of the Japanese Islands. Its oldest fossiliferous formation is the Yoshiki formation near Fukuji, Gifu Prefecture, in the Hida Plateau, Southwest Japan. It is composed of shale, sandstone and siliceous shale in alternation, about 50 m thick, with intercalations of fossiliferous layers of green siliceous tuff and thin cherty layers. Its middle or late Ordovician age is dated with radiolarians, scolecodonts and ostracodes (Igo *et al.*, 1980). It is overlain unconformably by the Fukuji formation on one side and intruded by serpentine on the other side.

The Fukuji formation has long been referred to the Silurian system in Japan, but its Emsio-Eifelian age was pointed out in describing *Cheirurus* (*Crotalocephalus*) *japonicus* (Kobayashi and Hamada, 1956). It is composed of clastic, pyroclastic and calcereous rocks besides the basal conglomerate and its age must be within the range from Gedinnian to Eifelian or probably lower Eifelian (Kobayashi and Hamada, 1974). This chronology is accepted in subsequent studies on brachiopods (Ohno, 1977), Conularia (Murata, 1977), a gastropod (Kase, Nishida and Niko, 1985), a hyolith (Kase, Nishida and Niko, 1985), conodonts and ostracodes (Kuwano, 1987). The trilobites attain 21 species including *Crotalocephalites sorayamensis*. The Sorayama faunule shows its connection to the Pragian faunas of Sardinia and Germany through Tethys (Kobayashi, 1988c, d).

Enerinurus fimbriatus and other Ludlovian trilobites occur at Hitoegane adjacently to the north of Fukuji (Kobayashi, 1980). The Silurian and Devonian fossils are known from a few places to the southwest of Fukuji and further west in Fukui Prefecture in the Upper Kuzuryu tributaries, but unknown in the inner zone outside the Hida plateau.

In the outer zone of Southwest Japan the Yokokura formation on the northwest side of the Sakawa basin, Southern Shikoku islands is chiefly composed of limestones, yielding various fossils in different horizons. It contains about 50 species of trilobites, richest in Japan. The principal faunule at Gomi quarry is early Ludlovian, if not latest Wenlockian (Kobayashi, 1988a, b). *Enerinurus nodai* from the summit of Mt. Yokokura is probably late Wenlockian. The Palaeosciniidae, early and middle Devonian radiolarians are found in siliceous shales (Furutani, 1983). *Dictyonema* aff. *delcathus* Lapworth collected from a limestone to the north of Shiroishi is a species primarily described from the Llandovery of Wales. Thus the formation ranges from Silurian to Devonian. Some conodonts restricted to middle to late Ordovician in age were found in limestone boulders (Kuwano, 1980). Therefore the Yokokurayama formation may be underlain by the Ordovician formation, though unexposed. In the outer zone the middle Palaeozoic formations are known from Central Kyushu to the Kii peninsula through Southern Shikoku all within the Chichibu terrain. Recently a new locality of *Heliolites* was added from Mikame town, Ehime Prefecture (Makisaka and Kato, 1983).

No Ordovician fossil has as yet been discovered from Northeast Japan, but the later Palaeozoic sequence can be seen better in the Kitakami mountains than in Southwest Japan. In the Hikoroichi district it starts from the Silurian Kawauchi formation in which four fossiliferous limestones and the *Encrinurus* bed are distinguished. It is overlain by the Takainari siliceous clayslate containing radiolarians. This is succeeded upward by the lower Devonian Ono formation with coralline limestone or the so-called *Thamnopora* zone. The fossiliferous Middle Devonian Nakazato formation is composed of black clayslate and tuff. The Upper Devonian Omori formation is not so fossiliferous, but an upper Devonian phacopid is reported from the Hayachine tectonic belt near Kamaishi.

In the Nagasaka district to the east of Morioka there is the very thick Tobigamori formation which yields land plants together with neritic shells (Tachibana, 1952, 1981). Likewise land plants are found in Shikoku Island in the Ochi formation containing orbiculids. It is separated from the Yokokurayama formation by strike faults on the north side (Hirata, 1966). *Leptophloem rhobicum* Dawson and "*Lepidodendron*" occur both of them. It is quite probable that these plants were derived from islands nearby. This means that the appearance of islands within the Chichibu sea near the end of the Devonian period. This land area and its upheaval are called here "Archae-Japan" and "Nagasaka movement" respectively. In this district the Carboniferous sediments begin with the basal conglomerate of the Karaumedate formation on the Tobigamori formation, but the discordance looks not very strong at their boundary.

While the Devonian and older Palaeozoic formations occupy small areas, they are mostly marine sediments. The Ichinotani formation in the Hida plateau is an exception in the inclusion of the limno-paralic sediments. It consists of upper Visean to Uralian fossiliferous limestones with some intercalations of chert and dark coloured shales. Overlying this marine lower part disconformably, the higher part of the formation begins with flint sharp conglomerate. This in turn is followed upward by variegated shales with intercalations of chert breccia and silicified limestone which are limnic sediments of lateritic residual soil. This formation is considered the correlative of the Koten series in Korea and the upper Carboniferous formations in North and Northeast China (Igo, 1960). At that time the Hida plateau was located in the oscillation zone of shore line along a land on its Japan sea side.

The find of *Mediocaris* in the Ichinotani formation for example has enabled one to trace the Bashkirian horizon in the Fukuji area. Likewise the Upper Carboniferous-Lower Permian strata in the Kuzuryu lake district were plotted by means of fusulinids (Niko, 1985; Niko and Watanabe, 1987). There are some other fresh data, namely Carboniferous *Paladin* found in the Arakigawa formation in the Fukuji district (Kobayashi and Hamada, 1987), and Permian *Pseudophillipsia* in the Tamba plateau, in Kyoto Prefecture. *Ps. aff. middlemis* was also discovered in the late Permian Tsunemori series in the Akiyoshi district, Yamaguchi Prefecture.

In the inner zone of Southwest Japan there are limestone masses in various sizes and outlines which are patches of the so-called Akiyoshi facies scattered in the extensive terrain of the Yamaguchi facies composed mainly of non-calcareous rocks. The Hina limestone in Okayama Prefecture contains the Tournaisian trilobites in the basal part, but most others are Permian. The large masses of the Akiyoshi facies, the Akasaka, Akiyoshi and Omi limestones

for example, are thoroughly zoned and their structures analysed in details. On the contrary much remains to be solved in the Yamaguchi terrain. Nevertheless it is evident that the terrain was deformed by the Wealden Oga orogeny (Kobayashi, 1941). Recently micropalaeontology on radiolarians, conodonts and foraminifers is rectifying misdating of Palaeozoic part for the so-called Mesozoic area or vice versa. Similar confusions are recognized also in the outer zone.

In both zones there are the so-called Yasuba limestone conglomerates. They are mostly Permian and two or more ages and geneses are now distinguishable (Sakagami and Miyama, 1988). This kind of conglomerates is found also in the Kwanto mountains. The Yasuba conglomerate contains various kinds of fossils, like the Iwaizaki limestone in the Kitakami mountains mentioned later. In the Sakawa basin there are the Yamanba brachiopod limestone and the Shimoyama limestone containing corals, sponges and other fossils like the Iwaizaki limestone. Most of the other limestones in the outer zone are, however, fusulinid limestones. In the Sakawa basin the Permian sequence terminates with the brackish *Anadontophora* fauna. Incidentally *Calamites* (*Arthropteris*) sp. from Sasakura mine in Province of Iwami by Yabe and Hayasaka is a sole record of a drift wood-stem in the whole biota of West Japan.

No Ordovician fossil has as yet been uncovered from Northeast Japan. Nevertheless later Palaeozoic sequence can be seen better in the Kitakami mountains. In the Setamai-Hikoroichi district the Silurian Kawauchi formation with four fossiliferous limestones and *Encrinurus* bed is overlain by the Takainari siliceous claystone containing radiolarians. It is succeeded upward by the lower Devonian Ono formation which contains limestone or the so-called *Thamnopora* zone. The middle Devonian Nakazato formation is composed of black slate and tuff. Fossils are scarce in the Omori formation at the top, but an upper Devonian phacopid is reported from the Hayachine tectonic belt near Kamaishi.

The Omori formation is unconformably overlain by Lower Carboniferous formation, 2,500 m thick, which overlies also the older rocks clino-unconformably. The latter formation is overlain by the Onimaru formation disconformably and this in turn by the Nagaiwa formation unconformably. The Permian system in the southern Kitakami mountains consists of the fossiliferous Yukizawa formation in the lower and the Toyoma black slates barren of fossils in the upper part between which the Usuginu conglomerate wedges in. The Iwaizaki limestone intercalated in the black slates, however contains various middle Permian marine fossils. Granitic boulders are the leading member of this Usuginu conglomerate and its gigantic ones are too large to be transported for any long distance. The age of the granite in the Usuginu conglomerate is 425×10^6 by the K-A dating. The Toyoma slate was deposited in an embayment which opened its small mouth on the southeast side. The lower Permian Maiya flora contained in the Permian Rodai formation in the Nagasaka district is intimately related to the Cathysian flora in China.

In the south Kitakami sequence the Silurian, Devonian and Carboniferous systems are 200–250 m, 1,200 m and 3,000–3,500 m in average thickness respectively. The Permian is about 2,500 m excluding the Usuginu conglomerate, 850 m at the thickest. Combined with the discordances, the increase of the thickness suggesting the growth of the geanticline and its repeated unstabilities. The Toyoma slate is disconformably overlain by the Skytian-Ladinian Inai group, 2,500 m thick except the basal conglomerate which is composed also dark coloured

slate and sandy clayslate. Both of them belong to a kind of flysch before the Triassic Akiyoshi orogeny.

Since I had schematized the history of the Japanese Islands in 1941, our knowledge was greatly advanced as seen in Kimura's synthesis in this journal (1986–1987) particularly in the Mesozoic and later parts. In recent studies on the trilobites of Japan, I have paid much attention to her history, especially on the Palaeozoic Chichibu geosyncline. This is a supplement to this obscure part of her history.

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