Geotectonics of the Pacific: Geotectonics of the Ryukiu Arcuate Is. and its influence upon the western part of Southwestern Japan

by

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1) Introduction

An existence of lattice structure in Eastern Kyushu with reference to the Ryukiu Arcuate Is., once advanced by F. v. Richthofen is not only important for the tectonic study of Kyushu but also for both western Shikoku and Chugoku. In the geotectonic study of the Ryukiu Arcuate Is. linked up with Kyushu the writer noticed an existence of the key localities in the Bungo channel which greatly serves to the tectonic study of Southwestern Japan. The Arcuate Is. extending between Taiwan and Kyushu not only intimately shows the influence of the Asiatic continent on the Japanese Is. but also the mechanics of the origin of the Ryukiu trench and the tectonic characters of the Shikoku sea. Moreover, it would be useful to the revelation of the connection, of the principal Pacific to both the Shikoku and Philippine Sea.

This paper reveals chiefly the submarine tectonics of the Shikoku Sea and the Bungo Channel with reference to the Ryukiu arcuate Is. founded on the geologic study of Taiwan, Ryukiu Is., Southern Kyushu and Shikoku which is not yet accomplished enough. Nevertheless, a general tectonic view of the Shikoku sea would be necessary for the study of Southwestern Japan which has the closest connection to the same Sea and the Ryukiu arcuate Is.

2) The Ryukiu Arcuate Is.

The Ryukiu Arcuate Is. whose arc is unique with that of the Marianas Is.,
bounds the outer side of the Tunghai (Eastern Sea of China) facing the convex side toward southeast. It extends between N. lat. 24° to 31° and E. mer. 122°～131°, linking up with many islands the south end of Kyushu and the north point of Taiwan, and delineating a beautiful festoon. F. v. Richthofen has divided the Is. into 3 groups from north to south; Osumi, Oshima-Okinawa and Sakishima; and from the geologic point of view into 3 zones longitudinally, from outer to inner Tertiary, Paleozoic and Volcanic. The 3 zones are limited by the 4 imaginary tectonic lines running parallel to the arcs, whose north extension forms the lattice with the original structure of Kyushu and Taiwan, wherein the longitudinal tectonic lines are more active than the original ones in Kyushu, but become opposite in Taiwan.

The idea was excellent, because the pulling forces of the 4 imaginary lines may be working even now upon Southwestern Japan. F. v. Richthofen limited the tectonic lines which confine the Paleozoic zone to the south of Kyushu range, and those of the Volcanoes to the just position of Kirishima volcano; but the former may be extended to Chugoku beyond the Kyushu range and the latter to the north passing Aso volcano. Moreover, to the west of the Volcanic zone an existence of the northsouth tectonic line, Tagawa-Kokura-Yoshimo may be considered extending from northern Kyushu to the western end of Chugoku, by which the latter might have been pulled away from the former.

The outthrusting of Tunghai was pointed in the direction of the southeast, and both the groups, Sakishima and Okinawa bear the brunt of the attack. The Ryukiu arc, particularly the Sakishima and Okinawa groups delineating an arc, and both the trenches lying parallel to and in front of the above arc represent the brunt of the tremendous outthrusting of the Tunghai. Indeed, the Ryukiu arc which has concentrated the Tunghai thrusting upon the Sakishima and the Okinawa groups has pulled Kyushu with the left wing of the arc, and separated Kyushu from Shikoku and Chugoku. By the southward horizontal shifting of Kyushu a flexure fault running northsouth might have happened along the Bungo channel between Kyushu and Shikoku, the north extension of which might have reached the Chugoku range passing Hiroshima Bay, as formerly has been probed by the gravity survey made by M. Matsuyama and N. Kumagai of Kyoto University and lately by C. Tsuboi of Tokyo University. The occurrence of negative anomaly in Iyonada may be due to the flexure fault.

3) Detachment of Kyushu from Western Shikoku

a) Southward displacement of those series in Western Shikoku with reference to Eastern Kyushu; Izumi sandstone, Crystalline schist, Mikabu and Paleozoic series

The outline of Shikoku is not a normal bilateral symmetry but oblique to eastwest. Osuminohana, the northernmost cape of Western Shikoku lies not in the direction of the west, but of the southwest from Osakinohana, northernmost of Eastern Shikoku; while the Ashizurisaki the southern Peninsula of the former lies strikingly more southward than the Murotosaki, the southern of the latter. This may be due to the influence of the Ryukiu Arcuate Is. and Kyushu which pulled Western Shikoku near at the end, which was in its turn displaced to the south.

In order to study the geologic force acting on Ryukiu arc it may be necessary
to compare the geologic structure of both the sides of the Bungo Channel, built up by Western Shikoku and Eastern Kyushu, both of which formerly might have been continuous.

In Western Shikoku the Median line is cut by the north-south fault parallel to the Nakayamagawa R., where the Izumi sandstone lying western side of Crystalline schist series might have been displaced by 10 km. to the south along the fault. To the west of the fault the Median line is cut again by a smaller north-south fault of Ominami, where the Izumi sandstone lying on the western side of Crystalline schist is shifted a little to the south. Thenceforth the Median line extends far away into the Iyonada Sea, whose detail is unknown but runs south-southwest all the way parallel to the Satasaki Peninsula beyond the Bungo Channel and passing Saganoseki of Kyushu, where runs along the north side of
the Crystalline schist series but bends abruptly and acutely south-southwest at the Onogawa R., cutting the terminal apex of the same series.

In Western Shikoku the boundary between Crystalline schist and Mikabu series runs strikingly southwest, and to the north of Yahatahama is cut by the so-called “Senjo fault” running northwest to southeast, along whose western side a remarkable southward displacement of the Crystalline schist series may be recognized. In the same region of Western Shikoku the boundary between Mikabu and Paleozoic series runs westsouth passing the town of Ozu, while to the east of Yahatahama, it is cut by the north-south fault, on the western side of which the southward displacement of Mikabu series reaches above 10 km. in distance, and cuts partly the trend of the Paleozoic series. In 1943 the fault was called as “Futatsuiwa fault” after the name of this locality by S. Sawata who discovered at the same time Mikabu series, locally attached to the Crystalline schist series at Misaki lying near the apex and on the southern side of the Satachari Peninsula. The southern terminal of the fault is curved slightly to southwest, and intersecting obliquely the “Mikame fault” running northsouth, on whose western side southward displacement of the Paleozoic series may be recognized.

In Western Shikoku the boundary between the Paleozoic and the Shimantogawa series lies on the north side close to Hoketsu Bay, while in Kyushu lies at the Kamiura Peninsula which limits the north of Saei Bay, from where the boundary runs within Kyushu, south-southwest all the way along the south side of the Kyushu range and reaches the town of Minamata lying on Yatsushiro Bay.

In Eastern Kyushu there is no regular sequence of geologic series as seen in Western Shikoku, mentioned above. To the south of the Crystalline schist series of Saganoseki there are found some of the Mikabu series in close contact with the former; then Izumi sandstone series of Usuki, succeeded to the south by the Paleozoic of Kyushu range running south-southwest, wherein some faults running parallel to the range may be recognized. The occurrence of the Median line running parallel to the Kyushu range may be conjectured at Usuki between the Izumi sandstone and the Paleozoic.

After all, on both sides of Bungo Channel, the northsouth crossing of the boundary between the Paleozoic and the Shimantogawa series of Shikoku and Kyushu reaches about 30 km. in distance, which may be due to the ultimate effect of the southward displacement of the 4 series of Western Shikoku and the more speedy southward shifting of Eastern Kyushu, which pulled the former making probably a flexuated fault in the Bungo Channel running north-south. It might have happened close to Western Shikoku penetrating the town of Igata to the northwest of Yahatahama, and near the base of the Satachari Peninsula. The process of making of the flexuated fault may be continuing also in the Bungo Channel by the Shimantogawa series between Shikoku and Kyushu which is to be stated below.

b) Southward Shifting of the Shimantogawa series of the Uwajima district concerning Eastern Kyushu

In the river system of the Shimantogawa of Western Shikoku there is the Uwajima district which consists of the Shimantogawa series overlaid locally by the Izumi sandstone of Uwajima, lying between Hoketsu Bay and the Nakasuji ditch. The trend of the former series is eastwest, extremely disturbed and cut by numerous northsouth faults; projecting some of twisted, winding and slender
Peninsulas from the land toward the sea of the Bungo Channel. In Eastern Kyushu, there is the Shimantogawa series between the Kyushu range and the Shimizudake horst range, which corresponds to the same series of Uwajima. The trend of the series is northeast to southwest, extremely disturbed as in the case of Uwajima; projecting some of twisted, winding and slender Peninsulas from the land toward the sea, against Shikoku. The Mimikawa R. runs parallel to the Shimizudake horst range, on the north; it traverses the range at Aratani, running southeast and pours into the Sea of Hiuganada.

The north-south crossing between the Nakasuji ditch of Western Shikoku and the Shimizudake horst range of Eastern Kyushu is almost equal to the former case, which may be due to the southward shifting of the Uwajima district, and more speedy southward shifting of Eastern Kyushu, while the latter pulled the former making probably a flexuated fault in the Bungo Channel, which might have happened close to Western Shikoku and continued to the north flexuated fault stated above.

Outside the Bungo Channel, in the Hiuganada the flexuated zone may become a fault line running far parallel to the Ryukiu arc and penetrates into the Ryukiu Trench. According to H. Hond, the fault plane may dip acutely to northwest, but underneath of the Inner Trough of the arc, and thereabout a plane of intermediate earthquake is dispatched upon the Inner Trough from the depth of 250 km, while occasionally there may be found a deep earthquake.

1) The Nakasuji Ditch of Western Shikoku, and the Shimizudake Horst range of Eastern Kyushu

The Nakasuji ditch is a narrow graben running east-west connecting the town of Nakamura and Sukumo, filled up by the Izumi sandstone and the Paleogene series. They lie between the Shimantogawa terrain and the Ashizuri block, pressed toward the former by the latter. The Nakasuji ditch has the closest connection to the Shimizudake horst range of Nobeoka in Kyushu, though in origin they are opposite.

The Shimizudake horst range lies to the southwest of the town of Nobeoka, running a distance of 22 km. from northeast to southwest. It consists of many peaks from east to west, Shimizudake (1,205 m), Sasanotoge (1,340), Nakayamatoge (1,175), Ishinidayama (1,061), and Eshiroyma (1,607). The southwestern extension of the range passes Shimoishiro where the Kuma R. joins to a tributary and coincides with the trend of the Kumagawa graben in the Hitoyoshi basin, while the northeastern trend passes the town of Nobeoka.

According to Y. Nozawa and Y. Kino of the Geological Survey the Shimantogawa series lying near the south of the Shimizudake horst range is well rearranged in the trend of north-northeast to south-southwest and acutely dipping west as in the case of the Ashizuri block in Shikoku, which coincides with the trend of the Ryukiu Arcuate Is. The writer considers that the Shimantogawa series on the south of the Shimizudake horst range of Kyushu may have extended the Ryukiu Arcuate Is. passing Ōsumi, Ōshima, Okinawa and a part of Sakishima, and have formed chiefly a submarine ground of the oceanic side of the Ryukiu arc.

a) Stable Ashizuri

On the south of the Nakasuji ditch there lies the Ashizuri block, consisting
of the Shimantogawa series whose trend is northsouth, but turning to eastwest from northeast close by the ditch, facing convex side toward north-west, showing the direction of the lateral thrust coming from the south-east Pacific side. In the Nankaido earthquake of 1951, all the triangulation points set up all through Shikoku have moved toward southeast in the direction of the seismic center lying under the sea about Shionomisaki in Kii, while the two same points established on Ashizuri block have always continued the movement toward northwest from southeast according to its geologic structure. The Ashizuri block may be distinguished as the stable mass which supports the north end of the Ryukiu arc from the oceanic side.

b) Mechanics of the Arcuate Mountain

According to Y. Nozawa and Y. Kinô of the Geological Survey the granitic rocks exposed at Tomitaka lying on the eastern coast of the Higuganda are subjected to the lateral thrust from the Pacific. T. Suto of the Geological Institute of Kyushu University reported the foldings of the Miocene strata, at Uto lying on the same coast, subjected to the lateral thrust from the Pacific. These, together with the stable Ashizuri, indicate the existence of lateral thrust on the outside of the Ryukiu arc, supporting the northern end of the arc; but the southern is supported at Taiwan by the lateral thrust from the Pacific, while it is pushed out from the inner by the Tunghai movement. In the Mechanics of the Arcuate Mountain B. Willis has shown the necessity of 3 forces acting on the echelon structure of T. Tokuda, two of which are applied to both the ends from outside of the arc, while the other pushes out from inside.

5) Volcanic Zone

On the west of Ōsumi group, there lies the Volcanic zone coming from the inner side of the Ryukiu arc. According to Tad. Matsumoto on the way it passes the Tokara Is. and Kikai Caldera lies in the sea before it enters Kagoshima Bay wherein lie both the Calderas, Aira and Ibusuki; then advancing to the north rise Kirishima volcanoe and Aso Caldera. The Volcanic Zone might have been shorn, extremely pressed between the stresses that were brought about by the southward pulling forces. In the southeast and the north of Hitoyoshi basin where the volcanic zone passes, there lie two localities cut by the network of faults, which seem to be in the condition of just before the depression and the eruption of the volcanoes.

According to K. Sawamura of the Geological Survey an outcrop of the Shimantogawa series lies at Kokubu at the southern foot of Kirishima volcano. The trend of the series is north-northeast to south-southwest dipping moderately west. The series may extend the inner side of the Ryukiu arc, along the Inner Trough.

6) Inner Trough of the Ryukiu Arc

On the inner side of the Ryukiu arc there lies a depressed basin parallel to the arc, whose maximum depth reaches 2,000 m. The trough is deepest within of both the groups, Sakishima and Okinawa, while toward the north it becomes gradually shallower, and in the west of Kyushu the 500 m isobath incloses the terminal of the trough. The trough occupies the area between the depressed and outthrust Paleo-Cathaysia massif, represented by the wide continental shelf
and the Ryukiu arc.

The outer and the inner zone of Kyushu might have extended toward Taiwan along the trough, but the latter which consists of the Crystalline schist, Paleozoic, Sangun metamorphic series, Inkstone series, Upper Cretaceous and others, but its farther whereabouts are unknown, while the former may be traced somehow or other along the Ryukiu arc.

7) Paleozoic of the Ryukiu Arc

In Kyushu the trend of the Median line which runs from Usuki to Yatsushiro differs from that in Shikoku, where it runs from northeast to southwest. The Paleozoic of the Kyushu range running parallel to the Median line might have been extended toward Taiwan along the Inner Trough of the Ryukiu arc, but subjected to the outthrusting of the Paleo-Cathaysia massifs it has been brought about to the present position of the Ryukiu arc in Ōshima, Okinawa and Saki-shima, in the form of Klippe beyond the Shimantogawa series of the inner side of the arc, and is in contact with the series on the outer side. According to Tokunaga the Paleozoic of Okinawa dips north and consists of quartzite, sandstone and shale, the topmost overlaid by the limestone, from which Hanazawa obtained Neoschwagerina.

The Shimantogawa series which might have occupied the submarine ground in front of the Ryukiu arc is subjected to the lateral thrust from the Paleo-Cathaysia massifs and built syncline of accumulated foldings, the sunken down bottom of which made the trench. The wavy foldings might have been extended among the Shimantogawa series, occupying the submarine frontal triangular area. The North, the South and the Okino-Daitozima might have been the Neogene series overlaying the Shimantogawa series, from the former of which Hanazawa obtained Lepidocyclina.

8) Sakishima Is. Group

On the eastern coast of Taiwan there lies the fault cliff of enormous height extending northsouth from Karenko to the Jungara Bay of Luzon, subjected to the lateral thrust from the Pacific, while to the north-east of North Taiwan lies the Ryukiu Arcuate Is. pushed out from Tunghai by the lateral thrust coming from the continent at the Miocene epoch, while the abrupt eastward bending of the northern principal axis of Taiwan together with the Sakishima Is. group running westeast was built at the same time, by the same thrust, in connection with the Pacific movement mentioned above. By the abrupt eastward bending of the northern principal axis of Taiwan the Crystalline schist series and the slate formation might have been extended on the south side of the Sakishima block. Any occurrence of the same series and the formation is not remarked on the Is. at present. But it might be suspected that the same series and the formation had formerly surrounded the outer side of the Sakishima block parallel to the Sakishima Trench, though they are submerged now.

Lately the geologic age of the Crystalline schist series of Taiwan is assigned to the Permian, by Yen of the Geological Survey of Taiwan, while the geological horizon of the Slate formation, is not yet clear, but if it is possible for the formation to be correlated to the Shimantogawa series of Japan, the tectonic study
of the Ryukyu arc may be facilitated.

At any rate, the Crystalline schist and Slate Formation of Sakishima, coming from Taiwan might have collaborated with the Shimantogawa series of Okinawa which has come from Kyushu and occupied the outer side of the Ryukyu arc though there may be a fault line between them. On the one hand the Ryukyu arc is strengthened by the intrusion of granites, probably erupted in the Laramide epoch which are exposed at Ishigakijima, Ōshima, Tokunoshima, Okino-erabushima, Yakushima, the Peninsula of Ōsumi and many other places of Kyushu, while the Paleozoic of Ishigakijima, Okinawa and Ōshima which might have been the extension of the Kyushu range along the Inner Trough of the Ryukyu arc, have been pushed out from the northwest, occupying the present position of the Is. which determin the outline of the arc. Since then the Ryukyu arc might have been subjected several times to the lateral thrust of Tunghai.

In Ishigaki Is. of the Sakishima group, an occurrence of Eocene limestone is known while in Nishi-omote Is. of the same group there are the coal seams correlated to the Kaizan series (Miocene) of Taiwan. In Miyako Is. of the Sakishima group and in the principal Okinawa Is. of the Okinawa group, an occurrence of the Shimajiri series is known, which may be correlated to the Byoritsu series (Pliocene) of Taiwan. Furthermore, the occurrences of Ryukyu limestone are known which are developed in Southern Taiwan and almost all the Is. of the Ryukyu arc.

According to Ōtsuka, after the deposition of the Shimajiri series, there was an earth movement in Miyako Is. of the Sakishima group; which is succeeded by the deposition of Ryukiu limestone. Since then there has been a migration of *Paleoloxodon* and *Capreolus* from Taiwan and its neighbourhood which shows the existence of the Asiatic landbridge between the Is. and the continent. In the late Pleistocene the outline of the Ryukiu arc was performed and Miyako Is. separated from others. Two epochs of the Tunghai movement that pressed the Ryukiu arc may be distinguished in Miyako Is.; one of which occurred after the deposition of the Shimajiri series; the other, after Ryukiu limestone.

According to Hanzawa, in both the lower part of coal seams of Nishiomote Is. and the upper of the Shimajiri series, volcanic eruptions are contained, which show the two epochs of volcanic activities, that happened in Neogene of the Ryukiu arcuate Is.

9) The Shikoku Sea

Nankai Trough lies in the southern offing of Shikoku, extending between the continental slope and the deep ocean bottom, about which the writer has stated in another paper, where the term “Trench” used, had better be replaced as “Trough” after R. Tayama. The trough meets the so-called Kyushu-Palau submarine ridge running from southeast to northwest at about the point of N. lat. 31°, E. mer. 133°30′ which corresponds to the sea surface lying 131 km. east-south from Toimisaki of Ōsumi, and 180 km. south-southeast from Oki Is. to the west of Ashizurisaki. After running toward southeast the Kyushu-Palau ridge passes on its way Parece Vela Rf. whereabouts but from before the reef the ridge changes its course strikingly to the northsouth; inferring from the fact it would be convinient to divide the ridge into two parts and to call the
part up to this place as the Kyushu ridge and the remaining as the Parece Vela-Palau ridge.

The Kyushu ridge consists of the submarine swells lying in the depth of 496 m., 440 m., 328 m., and 268 m. and others, which stand in a line running from northwest to southeast. In the south the ridge meets the tectonic line which coincides with the N. lat. 23°, at the point lying north-northeast of the Parece Vela Rf. The Kyushu ridge and the N. lat. 23° tectonic line inclose a triangular area, the base of which is the Ryukiu arc. The submarine bottom of the area is strikingly uneven on its surface, and those islets of North and South Daitojima and Okino-Daitojima as well as the Okinawa Trench are contained in it.

In the Shikoku Sea, the ocean bottom of 4,000 m. depth is limited from submerged triangular area by the Kyushu ridge, the trend of which not only coincides with the direction of the lateral thrust that occurred in the ocean, which presses the Stable Ashizuri and the eastern coast of Kyushu, but also becomes perpendicular to the trend of the Nankai Trough.

a) The Boundary between the Shikoku and the Philippine Sea

The N. lat. 23° coincides with the east west axis of the Sakishima Trench, the eastward extension of the former not only meets the Kyushu Ridge but also passes the junction between the Fuji and the Pagan Volcanic zone lying to the south of Sulphur Is. According to Hosokawa the line seems also to coincide with the Neo-Wallace-Hosokawa Line which divides the fauna of Southern Is.

In 1913, A. R. Wallace who remarked the zoological boundary between Eastern Asia and Australia has drawn a line extending from the Lombok Strait to the Celebes Sea via the Makassar Strait, while in 1926, E. D. Merrill who studied the flora of the Philippine has prolonged the Wallace Line toward the north along the western coast of the Is. and named it as Neo-Wallace Line. In 1935, R. Hosokawa of Kyushu University who noticed the floral difference between the Ogasawara Is. and the Marianas Is. has drawn the boundary-Hosokawa Line running east-west, which passes the neighbourhood of the Volcano Is. In 1936 T. Kano has remarked that the north extension of Neo-Wallace Line may pass between Kotosho Is. and Kashoto Is. off Taiwan; thence after bending to the east, the elongation may be connected to the Hosokawa Line.

The Shimantogawa series which might have constituted the submarine ground of the outer side of the Ryukiu arc is subjected to the Tunghai movement, and the circumscribed syncline built by the accumulated foldings of the series might have been formed at the place of the Okinawa Trench, and the wavy foldings in the frontal triangular area.

Outside the triangular area the southern sea of Shikoku represents the deep sea bottom character of 4,000 m. depth which may be distinguished strikingly from the shallow depressed basin of the Japan Sea. The lateral thrust that occurred in the ocean bottom may have given an underthrust to the foot of continental slope at the position of the Nankai Trough, the east west bottom of which being penetrated by the fault plane dipping north. There is a tendency of the lateral thrust to increase strength as it approaches the east. The Kii Peninsula is more pressed from the bottom than Shikoku is, and reaches the uppermost in the Fossa Magna region.

By the N. lat 23° tectonic line the Shikoku Sea would be separated from the Philippine Sea whose physical character of the bottom is strikingly distinguished from the former geotectonically.
b) The Philippine Sea

The Philippine Sea may be divided longitudinally into 3 parts with the Parece Vela-Palau Ridge and the south extentsile submarine ridge of Shichito; the west, middle and east. The western part is the portion lying between Taiwan-Philippine, and the Parece Vela-Palau ridge, which is the widest and deepest. It may be the depressed portion of the Philippine Sea, 5,000 m. depth of which occupies almost the whole area. The middle belongs to the portion lying between the Parece Vela-Palau ridge and the south extentsile submarine ridge of Shichito, which manifests the deep sea bottom character of 4,000 m. depth, extending the bottom of the Shikoku Sea lying to the north. The east is the portion intercalated between the south extentsile submarine ridge of Shichito and the Marianas Is. which may be the depressed area whose depth reaches 3,000 m. The Yap, Palau and Halmahera Is. are the group of the Islands which form en echelon and occupy the south sea between the Philippine Sea and New Guinea, through which the western Pacific has pressed the eastern Malaysia and the Banda Sea as the writer stated in another paper.

c) Geotectonic History of the Shikoku Sea

The boundary between the Shikoku Sea and the Western Pacific is the Nippon Trench and the Shichito submarine ridge, the latter of which contains the Fuji Volcanic zone, which broke out at the beginning of the Miocene. The Fuji Volcanic zone extends far south beyond the Volcanic Is. where the North Mariana submarine ridge (Pagan Volcanic Zone) diverges out, thence the zone becomes thoroughly submerged, and reaches the Yap Is. Outside the Shichito submarine ridge there lies partly the Ogasawara ridge running northsouth bordered by the Nippon Trench on the east; it may be connected to the South Mariana Submarine Ridge, in containing the same Eocene fossils. Apparently, the Pagan Volcanic Zone and the South Mariana Submarine Ridge are united together and form the Mariana festoon Is., bordered by the Mariana Trench on the east, facing the convex side toward the Western Pacific.

If the Tertiary barriers of Shichito-Ogasawara submarine ridge are taken away with those of the Marianas Is., the sea of the Western Pacific would have spread into the Shikoku and the Philippine Sea and reached Tunghai, wherein the southwestern Japan might have extended along the Paleo-Cathaysia massif toward Taiwan; the Philippine Trench being the remains and boundary between the continent and the Pacific at that time; and if it may be allowed to say, the outer zone of Japan might have extended to Borneo where Danau formation is found, allied to the Shimantogawa series and to New Guinea where develop formations similar to the outer zone of Southwestern Japan.

Before the Tertiary, the Shikoku and Philippine Sea might have been occupied by the Western Pacific, which has influenced greatly on the Southern China since the Caledonian time, as exemplified at present in the case of Halmahera Echelon, in which the Western Pacific has pressed the Eastern Malaysia with the Banda Sea. But for the energy which the Pacific has, it would be impossible to influence the Tibetan plateau beyond the vast Yangtze-kiang River system of Southern China.

The Pacific would have had the closest relation to Southwestern Japan whose Chichibu Geosyncline of T. Kobayashi has been cherished under the sea since the Gotlandian time along the Paleo-Cathaysia massif and its eastern extension.

Since the beginning of the Tertiary the Shikoku and Philippine Sea have
been limited by the Ogasawara and the South Mariana submarine ridge accompanying the Nippon and the Mariana Trenches, from the Western Pacific; while in the beginning of the Miocene the Shichito Submarine ridge and the Pagan Volcanic zone are moreover added to the former. Though the Nippon and the Mariana Trenches are modified tectonically they stand in a line running north-south, which manifests the tectonic line, the north extension of which passes the isthmus of Southern Hokkaido (Tomakomai-Sapporo line) and extends to the Mamiya Strait between the continent and Sachalin. The tectonic line might be called the Mariana-Nippon-Tartar Tectonic Line limiting the Western Pacific from the East Asiatic continental Is.

10) Summary and Conclusion

1) In 1908 B. Koto noticed that the Mariana Trench and the southern part of Nippon Trench might form the boundary of the old Asiatic continent which has been depressed away under the sea, wherein, however, the key locality which serves the tectonic study of Southwestern Japan might have been hidden, while the Ryukyu Trench and Philippine Trench are the present boundary of the Asiatic continent; and he called the same sea South Japan Sea. In 1948 H. H. Hess remarked the long north-south sea bottom between both the submarine ridges, the Kyushu-Palau and the Shichito; and with no regard to the N. lat. 23° tectonic line he called it 'the Shikoku Sea' which may be distinguished from the Philippine Sea.

    The Japan Sea may be a shallow depressed basin of the Asiatic continent while the Shikoku Sea has a deep oceanic character closely connected to the Western Pacific. In this sense the southern sea of Shikoku which is bounded from the Philippine Sea by the N. lat. 23° tectonic line would be called 'the Shikoku sea'.

2) Of the 4 series from inner to outer-Crystalline schist, Mikabu, Paleozoic and the Shimantogawa series-which constitute the outer zone of Southwestern Japan, the Shimantogawa series occupies the widest area and perhaps the thickest. During the trip, through the Shimantogawa terrain, on foot and by ship which took a few days, the writer was surprized at the long sequence of sandstone and shale of this series predominated in this district.

    The Shimantogawa series consists of the thick series of sandstone and shale with rare conglomerate. Sometimes limestone is found which contains the same fossil as is found in the Torinosu limestone of the Upper Jurassic. Particularly the series intercalates red and green Radiolarian cherts whose fauna may be compared with those of the Franciscan series of California and the Danau formation of Borneo. But except these there is little or no remarkable fossil found in this series. Accordingly in spite of its importance the stratigraphy of this series is not yet established. The outsiderside of the Sakishima Is. group might be occupied by the Crystalline schist series and the Slate formation of Taiwan; but lately the former is assigned to the Paleoozoic by T. P. Yen while if the latter is correlated to the Shimantogawa series the tectonic geology of the Ryukiu arc will be facilitated.

3) In Chikuho coalfield, the occurrences of north-northwest to south-southeast tectonic lines are known. But they may belong to another system of tectonic movement and be distinguished from the lattice of the Tunghai movement, about which as Tateiwa has already stated, they may be a manifestation of the Taipakushan movement of Eastern Korea.
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南西日本に及ばす琉球弧島の影響について

江原真伍

(摘要)

琉球弧島の先島, 沖縄諸島に集中された支那東海の押し出しは, 弧の左翼に連なる東九州を強引して, 六を西四国より分離させた。西四国の中山川に沿へる港谷口断面, 八幡浜の東にある千丈, 双ツ岩, 龟岩等の断層はその証左である。

琉球海溝は四万十川に起る縱斜軸に相当するものであり, 四国海とヒリッピン海の境界は北緯 32°構造線を以てするも適當なりと思われる。生物の境界 Neo-Wallace-Hosokawa 線も大体この方向にあることが考えられる。