The Sinian System of Kuan-Tung Province

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Of all areas where the Sinian system is found (China proper, Mongolia, the eastern part of Tien-shan Mountains, South Manchuria and the northern half of Korea), it is most predominant (more than 7,000 m) in Kuan-tung Province*, South Manchuria, with an abundance of strata, apart from the basal part.

1. Distribution

In Kuan-tung Province, the Sinian System is widely distributed, except in the gneiss zone northeast of Chin-chou. It is distributed (a) on the northwest side of the gneiss zone (mainly on the northwest side of the railroad between Chin-chou and Pu-lan-tien), (b) on the south side of the gneiss zone in an area from Chin-chou via Ta-ho-shang-shan, Tung-chia-kou, mouth of the Ching-yun Ho (river) to the mouth of the Teng-sha Ho, and (c) at the tip of the Liao-tung Peninsula southwest of Chin-chou. The area where Dairen and Port Arthur are located consists almost entirely of the Sinian system. It is also distributed on many islets which are scattered along the shores of Po Hai (Pechili Bay) and the Yellow Sea.

2. Stratigraphy

Von RICHTHOFEN was the first geologist to investigate the Sinian System in Kuan-tung Province. While on a survey of South Manchuria in 1869, he viewed from a distance on a boat, from Chi-fu to Ying-kou, Sinian rocks exposed on the coast of Po Hai of the province. Then, BLACKWELDER observed briefly the northern part of Kuan-tung Province in 1903 when he traversed the Fu-chou district. After the Sino-Japanese War and during the Russo-Japanese War, the province was surveyed by several Japanese geologists. After the establishment of the South Manchuria Railway Co., geologists of the company surveyed the province. In 1915 a report on the geological survey in Kuan-tung Province accompanied by a

* Kuan-tung Province consists of the southwestern tip of the Liao-tung peninsula, South Manchuria, which was formerly territory held by Japan.

geological map was made public by Hanzō MURAKAMI,[1] geologist of the South Manchuria Railway Co. (SMR). Thanks to his work, the distribution and stratigraphy of the Sinian system in the province were made fairly clear. Then, in 1924, the geological sheet map "Dairen" on a scale of 1:400,000 and its explanatory text by Otoji AOJI[2], geologist of SMR, were published. Though the name "Sinian System" was not used in this report, the stratigraphy of the system was farther clarified. Riuji ENDŌ's preliminary report[3] on the Ordovician, Cambrian and Sinian Systems was published in 1928, in which he mentioned the Sinian System of Kuan-tung Province.

In the same year, Otoji AOJI[4] summarized and published his studies on the Sinian System in South Manchuria. The present author carried out a field survey of the Sinian System in Kuan-tung Province during his tenure of office at Ryojun College of Engineering at Port Arthur from 1926 to 1931, and published the results. The Geological Institute of SMR began the geologic mapping of Kuan-tung Province on a scale of 1:25,000, in 1931. In this project, the Sinian System was investigated in detail, although the results have not been published. Since that time, however, the stratigraphy, fossils, ripple marks, etc., of the Sinian System in Kuan-tung have been reported by several researchers in succession as follows: stratigraphy[5] by Riuji ENDŌ, Hisao ŌTANI, and Rinji SAITŌ, separately; ripple marks[6] by Tsutomu OGURA, and Shigeyuki MONDEN, separately; cross-bedding[7] by Hiroshi OZAKI; suncracks[8] by Rinji SAITŌ. *Manchuriophycus*[9] and *Collenia*[9] were formally described by Hisakatsu YABE and Riuji ENDŌ.

At first the author in 1930 divided the Sinian System into two series, the Kuan-tung Series and the Ta-ho-shang-shan Series. Then in 1932,[10] he subdivided each series into stages, giving them alphabetical symbols. Next, in 1934,[11] he named each stage, and transferred the Nan-shan Stage from the base of the Cambrian System to the uppermost part of the Kuan-tung Series.

In 1940[12], the author separated the Nan-shan Stage from the Kuan-tung Series and established the Nan-shan Series. After that, Rinji SAITŌ carried out a detailed survey of the relationship between the Nan-shan Series and the Kuan-tung Series, assuming an unconformable relation between them. As a result, he found an unconformity in the uppermost part of the Ying-cheng-tzu Stage of the Kuan-tung Series, and considered that the Shih-san-li-tai, Ma-chia-tun Stages and the uppermost parts of the Ying-cheng-tzu Stage should be removed from the Kuan-tung Series and be placed in the Nan-shan Series.

The author followed SAITŌ's suggestion and placed the boundary line between the Nan-shan Series and the Kuan-tung Series at the zone of contact between the Shih-san-li-tai and Ying-cheng-tzu Stages. An improved stratigraphic division of the Sinian System was published after the war[13] (1947), which is given in Table 1.

The Ta-ho-shang-shan Series composes Mt. Ta-ho-shang (664 m), the highest peak in Kuan-tung Province, east of Chin-chou, and the author named the series after that mountain. The series is developed extensively in an area between

Table 1. Stratigraphical Succession of the Sinian System in Kuan-tung Province.
(MATSUSHITA, 1932, 1934, 1940, 1947)

Nan-shan Series	14. Nan-shan Stage	Consists essentially of grayish-green clay slate with quartzite, siliceous sandstone and limestone	400–800 m
	13. Ma-chia-tun Stage	Pale-colored, thin-bedded siliceous limestone	50–200 m
	12. Shih-san-li-tai Stage	*Collenia* limestone	50–150 m
Kuan-tung Series	11. Ying-cheng-tzu Stage	Black, thick-bedded limestone	370–400 m
	10. Onoda Stage	Black, blue-black or blue-grayish thin-bedded limestone (intercalated with *Collenia* beds)	270–700 m
	9. Kan-ching-tzu Stage	Dolomite and limestone (intercalated with *Collenia* beds)	450–700 m
	8. Nan-kuan-ling Stage	Limestone; the lower part consists of impure limestone	800–1,000 m
	7. Chang-ling-tzu Stage	Grayish-green or greenish-gray phyllitic clay slate intercalated with siliceous limestone in the upper part	? 700 m
Ta-ho-shang Shan Series	6. Lung-tou Stage	White quartzite	450 m
	5. Ying-ke-shih Stage	Phyllitic limestone and calcareous phyllite	30–200 m
	4. Cha-kou Stage	Quartzite (with clay slate)	1,000 m
	3. Lung-wang-tang Stage	Siliceous slate and quartzite	800 m
	2. Wai-tou-shan Stage	Quartzite (with siliceous slate)	500 m
	1. Huang-ni-chuan Stage	Calcareous phyllitic clay slate	330 m †
	(Base unknown)		

Dairen and Port Arthur. In addition, the same series constitutes more than half of the hilly land along the seashore, eastward from Chin-chou to the mouth of the Teng-sha-ho River. It is also distributed in an area between San-shih-li-pu and Wa-fang-tien.

The Kuan-tung Series is developed extensively in the district stretching from Chin-chou through Chou-shui-tzu and Ying-cheng-tzu to Chang-ling-tzu. It is also found in the vicinities of Erh-shih-li-tai, San-shih-li-pu and Tung-chia-kou, at the eastern foot of Mt. Ta-ho-shang and south of the Ching-yun-ho River.

The name Nan-shan Series came from Nan-shan Hill south of Chin-chou. It is distributed in the district between the southern foot of Mt. Ta-ho-shang and Tung-chia-kou, in the neighborhood of Erh-shih-li-tai, in an area between San-shih-li-pu and Chi-ting-shan and on the islets of Hsi-ma-i Tao and Miao Tao.

3. Fossils

Fossils of the Sinian System in Kuan-tung Province are *Collenia* found in the limestone and dolomite of the Kuan-tung Series as well as in the limestone of the Nan-shan Series, and *Manchuriophycus* in the quartzite of the Ta-ho-shang-shan Series. Both of them are regarded as algal remains.

Fossils of *Collenia* are contained in the dolomite of the Kan-ching-tzu Stage and limestones of the Onoda and Shih-san-li-tai Stages. *Collenia* of the Shih-san-li-tai Stage forms a *Collenia* limestone with the characteristic color of reddish-purple or bluish-gray. For many years, *Collenia* limestone was called "Uzumaki" (whirl) limestone by Japanese geologists in Manchuria, and some geologists thought its origin to be organic, while others presumed inorganic and mechanical.

In 1937, ENDŌ[5] described it as a kind of fossil. *Collenia* in the Shih-san-li-tai Stage are described as *C. cylindrica* (Grabau) and *C. grabaui* (Resser and Endo). Those in the Kan-ching-tzu and Onoda Stages have not yet been studied. However, they may be *C. fuchouensis* and *C. tahoensis*, which were established by ENDŌ in the Fu-chou and Tai-tzu-ho Districts.

Manchuriophycus is the generic name of algae which was given by ENDŌ in 1933 to some marks on the bedding plane of quartzite of the Chiao-tou quartzite at Chiao-tou on the Mukden—An-tung Railroad. After that, in 1936, YABE[9] described a kind of *Manchuriophycus* which was found in the Sinian quartzite at Port Arthur, and named it *M. sawadai*.

4. Correlation of the Sinian System between Kuan-tung Province and Fu-chou District.

Even though these two districts stand side by side, only separated from each other by Pu-lan-tien (A-tang) Bay, there are no definite suggestions concerning correlation of the Sinian System between these two districts. The following three correlations have been previously proposed.

(1) In 1928 AOJI thought that the Wu-hsing-shan series is not restricted to the vicinity of Chin-chia-cheng-tzu in Fu-chou District, but is distributed in Kuan-tung Province also. That is, it seemed that the Wu-hsing-shan Series may be correlated with the present author's Kuan-tung Series (1930). Later, SAITŌ confirmed this correlation by field work (1938).

(2) ENDŌ insisted (1928 and later) that the Wu-hsing-shan Series in the neighborhood of Chin-chia-cheng-tzu is distinct from the limestone group of Kuan-tung Province (his Kuan-tung Group, or the present author's Kuan-tung series). He named the former the Pechili Group on the grounds that the *Collenia* species of the Pechili Group is different from that of the Kuan-tung Group. He described (1937) *Collenia fuchouensis* and *C. tahoensis* from the Pechili Group and identified *Collenia* from the Kuan-tung group as *C. cylindrica* (Grabau) and *C. grabaui* (Endo). In addition, ENDŌ thought that the Kao-chia-tun Shale and Sandstone Group

and the Chiao-tou Group may correspond to the Nan-shan Group in Kuan-tung Province. If this is true, the complete Sinian System in Kuan-tung may be equivalent to the Hsiho Series of AOJI. Teiichi KOBAYASHI was of the same opinion as ENDŌ, and the author also once believed that ENDŌ was correct (1935).

(3) In 1943, SAITŌ correlated the whole Hsi-ho Series with the Nan-shan Series and considered that the Kuan-tung and Ta-ho-shang-shan Series are much older. The author agreed with this opinion formerly (1947).

Recently, the author reconsidered the problem of correlation and arrived at the conclusion that the opinion stated in (1) is correct. Namely, the quartzite formation along the northern frontier of Kuan-tung Province is equivalent to the upper part of the Ta-ho-shang-shan Series, and at the same time to the Chiao-tou quartzite of the Hsi-ho Series; the overlying Kao-chia-tun shale and sandstone and the Chin-chia black limestone are nothing but the Kuan-tung Series. Consequently, SAITŌ's observations and interpretation in 1938 must be said to be correct.

It is noted that in Fu-chou District, the Nan-shan Series, (the upper part of the Sinian System) does not occur, and that furthermore at Feng-chia-tun, the Kb of the Kao-chia-tun shale and sandstone is overlain directly by the Cambrian System. Therefore the relation between the Cambrian and Sinian Systems in Fu-chou district is interpreted as a clino-unconformity, slight but distinct, the magnitude of the hiatus becoming larger northward.

As mentioned in the preceding paragraph, ENDŌ distinguished the species of *Collenia* in Fu-chou district from those of Kuan-tung Province. The formation containing *Collenia* in Fu-chou district may correspond to some horizon of the Onoda Stage in the province under consideration, while *Collenia* limestone of the province mentioned by ENDŌ is the Shih-san-li-tai Stage. Therefore, it seems quite probable that the species of *Collenia* are different between the two districts under consideration.

In 1938, SAITŌ insisted that the Ta-ho-shang-shan Series as a whole may be equivalent to the Chiao-tou quartzite, and that the Nanfen and Tiao-yu-tai Formations may not occur in Kuan-tung Province. The Huang-ni-chuan Stage, however, may be correlated with the upper part (Nb) of the Nan-fen shale-marl Formation, and the formations beneath the Huang-ni-chuan Stage are concealed underground.

Accordingly, it may be proper to consider that the formations corresponding to the Nan-fen and Tiao-yu-tai Formations may exist underground in Kuan-tung Province as well.

Since each member of the Sinian system is more predominant in the southern part of Kuan-tung Province than in Fu-chou district, it may be inferred that Kuan-tung Province must have been situated closest to the most subsiding part of the geosyncline in which the Sinian System was deposited. Also, there may have existed formations of the horizon lower than the Tiao-yu-tai quartzite in Kuan-tung Province. This idea is presented diagramatically in Fig. 1.

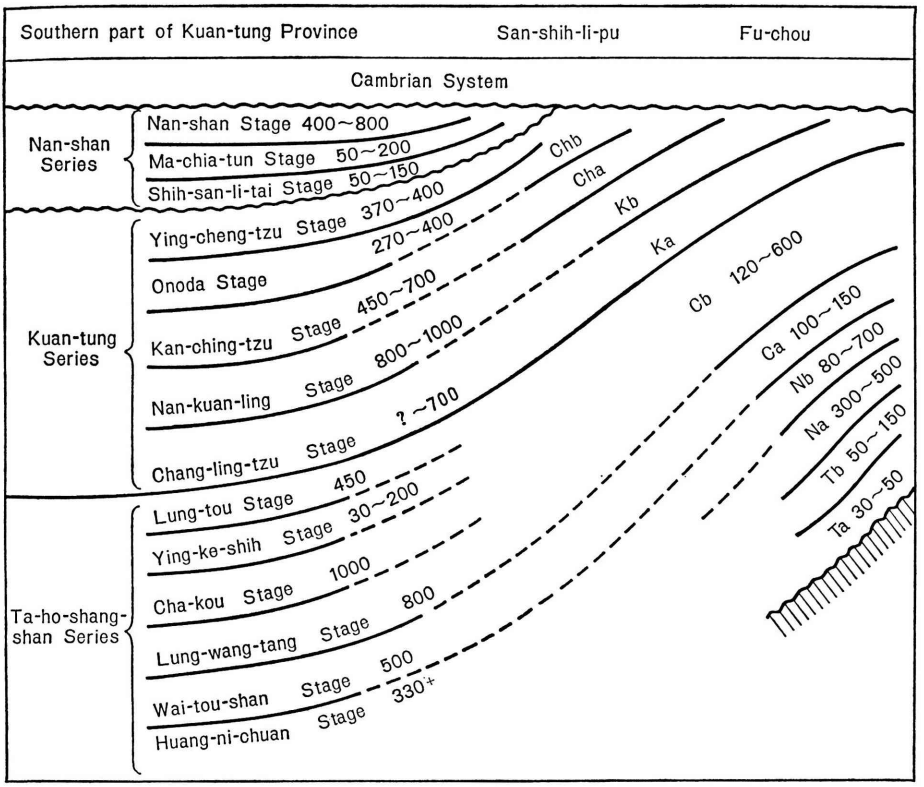

Fig. 1. Idealized Cross-section Showing the Correlation of the Sinian System between Kuan-tung Province and Fu-chou District (MATSUSHITA, 1952).

5. Lower limit of the Sinian system in Kuan-tung Province

As mentioned in the preceding paragraph, the basal part of the Sinian System is not found in the area between Dairen and Port Arthur where the Ta-ho-shang-shan Series, the lower part of the Sinian System, is best developed. Therefore, the lower limit of the Sinian System is unknown. The author previously stated (1930, 1934) that its basal part is found at Mt. Ta-ho-shang. From observation, the Ta-ho-shang-shan Series rests disconformably on the author's Hsiang-shui-ssu Series consisting of metamorphic rocks of sedimentary origin. Later, since Bunkichi BESSHO found gneiss injected into the Ta-ho-shang-shan Series, SAITŌ inferred that the Hsiang-shui-ssu Series may belong to the metamorphosed parts of Units 1 and 2 of the lower part of the Ta-ho-shang-shan Series. The author agrees with this opinion.

According to Michitaka SAWATARI's study, a low-angled overthrust divides the author's Hsiang-shui-ssu Formation from the underlying Liao-tung System of SAWATARI. If this is true, the lower limit of the Ta-ho-shang-shan Series remains unknown, even at Mt. Ta-ho-shang. To the east of San-shih-li-pu, the Ta-ho-

shang-shan Series becomes rather thin. This fact is inferred due to the low-angled overthrusting of the Ta-ho-shang-shan Series on the gneiss group.

In conclusion, the lower limit of the Sinian System in Kuan-tung Province is unknown.

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