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Precambrian Geology and Structure of the Central Region of South Korea

Ok Joon Kim*

Abstract

The central region of South Korea is composed of Precambrian formations and Jurassic Daebo granites and is divided tectonically into three provinces, that is, the Okchon geosynclinal zone in the middle, the Kyonggi massif on the north and northwest side, and the Ryongnam massif on the south and southeast side. The general trend of the Okchon geosynclinal zone and the distribution of Daebo granites is northeast, the Sinian direction.

The Kyonggi massif is composed of Precambrian Yonchon system, Sangwon system, gneisses, and Daebo granites, and the Ryongnam massif also Precambrian Ryongnam and Yulri systems, gneisses, and Daebo granites. Precambrian formations in both areas are of flysch type sediments and may be roughly correlated with each other. These formations except Sangwon and Yulri systems are thought to be early to middle Precambrian age and have acted as basement for the Okchon geosyncline where late Precambrian Okchon system was deposited.

The Okchon geosynclinal zone is divided into paleogeosynclinal zone to southwestern parts where the Okchon system is distributed, and neogeosynclinal zone to northeastern parts where nonmetamorphosed Paleozoic sediments are dominantly cropped out. Both zones are separated by upthrust created by Daebo orogeny of Jurassic period, which continues southwesterly to bind the Okchon geosynclinal zone and the Ryongnam massif at southwestern parts bisecting Korea peninsula diagonally.

Three periods of structural development are recognized in the area. Folds and faults of pre-Triassic age prevail in the Kyonggi massif. Many isoclinal folds and thrusts originated by Jurassic Daebo orogeny are aligned in the Okchon paleogeosynclinal zone paralleling to the geosynclinal axis so that same formation appears repeatedly in narrow strips, whereas fold axis in neogeosynclinal zone trend west-northwesterly which might be of Triassic in age and modified by later Daebo orogeny. Discontinuity of geology and structure of Okchon geosynclinal zone is attributed to shifting of the geosyncline through geologic time.

1. Tectonics and Geological Provinces of South Korea

The tectonics of South Korea have been elaborated by T. Kobayashi (1953) and later revised by the present writer (1970). South Korea is geolocically bound to North Korea by Chugaryong rift valley of N-NE trend.

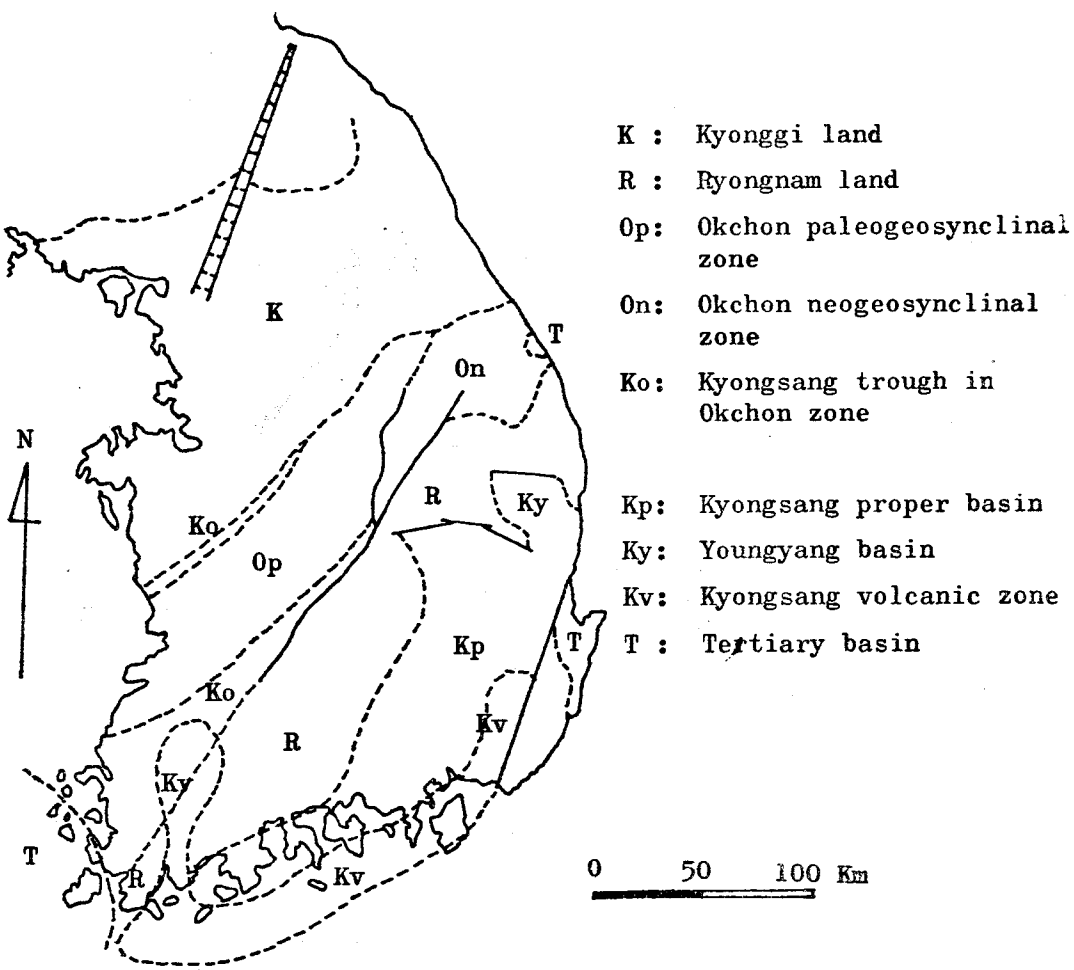
The Okchon geosynclinal zone (orogenic zone)

* Geology Department, Yonsei University, Seoul, Korea

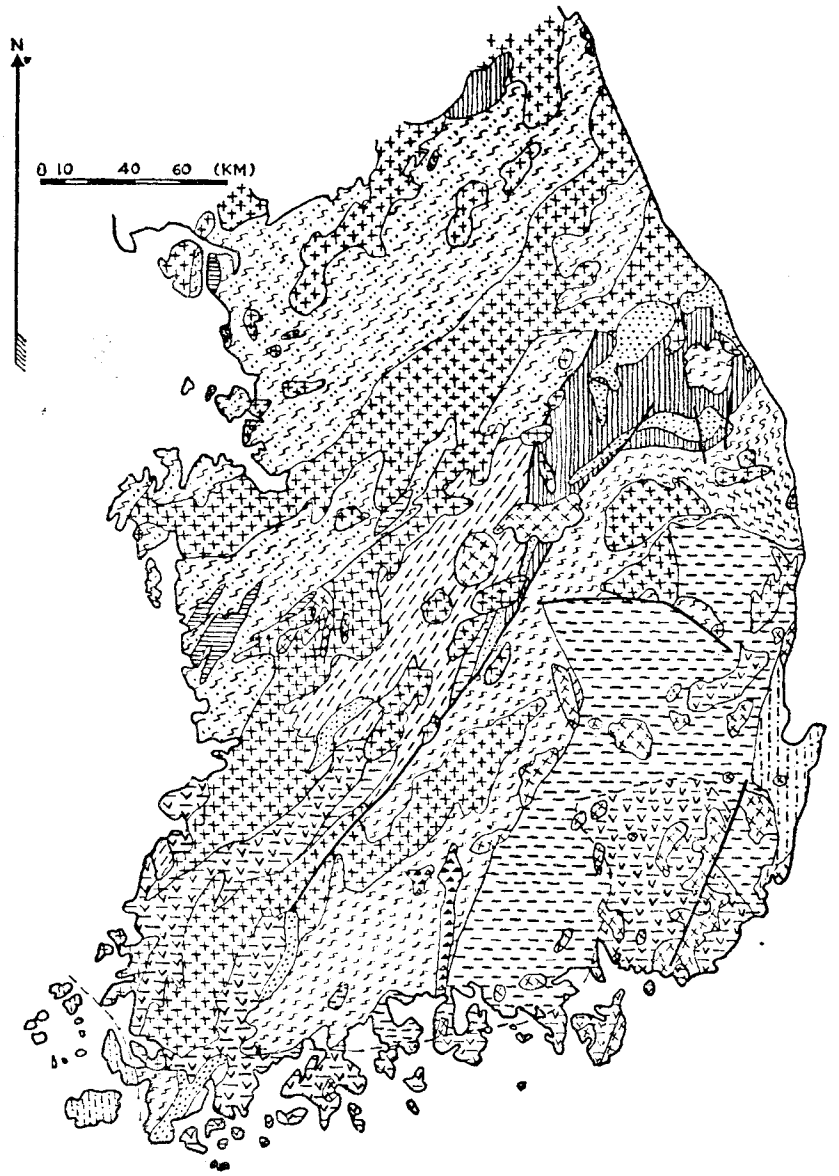
runs diagonally in NE-SW direction, the Sinian trend across South Korea, It is about 60-70 Km wide in the mid-central region. The Kyonggi massif is situated to the northwest side of and the Ryongnam massif to the southeast side of the Okchon zone. To the southeast of the Ryongnam massif is there the Kyongsang sedimentary basin which connects to the southwestern parts of the Okchon zone around the southwestern tip of Korea peninsula. Few Tertiary sediments crop out in few isolated area (see map 1).

Both Kyonggi and Ryongnam massifs are composed of Precambrian formations, and the Okchon zone of Precambrian and postcambrian formations. Thus South Korea can be divided into four geological provinces as below:

1. Kyonggi-Ryongnam massif province
2. Okchon geosynclinal zone
   Okchon paleogeosynclinal zone
   Okchon neogeosynclinal zone
3. Kyongsang basin province
   Kyongsang basin proper area
   Yongyang basinerea
   Volcanic zone
4. Tertiary basin area



Map 1. Geological Provinces of S. Korea



Map 2. Geologic map of South Korea

The Okchon geosynclinal zone runs in accordance with Sinian direction and so are the major four mountain ranges in Precambrian terrain although foliations of Precambrican formations in the Kyonggi-Ryongnam massif are diverse. Precambrian formations of various types are distributed in the Kyonggi-Ryongnam massif and the the Okchon paleogeosynclinal zone as shown in map 2.

2. Precambrian Geology

a) Kyonggi-Ryongnam province

The province was previously separated, but now grouped together because of the fact that (1) the kyonggi and Ryongnam massifs are located in opposits side of the Okchon zone, (2) geology and tectonics of both massifs are similar and may roughly be correlated, and (3) the massifs acted as basement for Okchon geosynclinal formations.

Prominant in the province are Precambrian schists and paragneisses which were intruded by Precambrican granite gneisses and Jurassic Daebo granites.

In the Kyonggi province, a northern half, Precambrian formation is designated as Yonchon system and overlain unconformably by Sangwon system as tabulated below.

	Sangwon system
Late Precambrian	Iam series
	Jangraksan series
	~~Granite gneiss~~~~~~~
	Yonchon system
Mid Precambrian	upper Yonchon series
	lower Yonchon series
	~~fault contact~~~~~~~
Early Precambrian	undifferentiated gneisses and schists

In the Ryongnam province, a southern half, Precabrian formations were differentiated as follows.

	Yulri system
Late Precambrian	Taebaeksan series
	~~ ? ~~~~~~
	Kosonri series
	Kakwhasa series
~~	~~~~~~~~~~~~~~
	Ryongnam system
Mid-Precamberian	Wonnam series
	~~
	Kisong series
	~~
Early Precambrian	Pyonghae series

Schistosity of Precambrian formations in the Kyonggi-Ryongnam massif is diverse, but predominant is north-northeast direction which is oblique to the trend of the Okchon geosynclinal zone and the distribution of Jurassic Daebo granites, and which is thought to be pre-Triassic in age.

b) Okchon geosynclinal zone.

The zone was previously divided into metamorphosed and nonmetamorphosed zones. It was thought that the Okchon system was distributed in the former zone and non-metamorphosed Paleozoic to Mesozoic sedimentary formations in the latter zone, and both zones were originally of the same formations, but showed difference in grade of metamorphism. However, both zones are bound by upthrut and shear fault, so that lithology and structure are discontinuous in both zones.

The Okchon system in erstwhile metamorphosed zone is definitely Precambrian in age although few geologists had thought it to be metamorphosed Paleozoic to early Mesozoic sediments. The difference in geology and tectonics in both zones is due to the fact that the Okchon geosyncline had been shifted or migrated and effected by different orogenies through geologic time. Thus the writer designated the so-called metamorphosed zone as "paleogeosynclinal zone" and non-metamorphosed zone as "neogeosynclinal zone". Paleogeosynclinal zone is consisted of

Okchon system of late Precambrian age and Jurassic Daebo granites, and neogeosynclinal zone of post-cambrian sediments. Only Okchon system is dealt in the present paper. The stratigraphy and ligthology of Okchon system are tabulated below:

Okchon system	major rock types
Kunjasan series	pebble-bearing silicic rock, in part slightly calcarious.
Hwanggangri series	pebble-bearing slaty to phyllitic rock.
Changri series	limestone black slate
Munjuri series	phyllite, limestone lenses
Hyangsanri series	dolomite quartzite
——— ? ———	
Kemyongsan series (undifferentiated)	schist, gneisses, hematite-quartz schist, amphibolite, limestone lenses

Two unconformities were recognized between the Changri and Hwanggangri series, and between the Hwanggangri and Kunjasan series. Pebbles in the Hwanggangri series are of various rock pebbles mainly of granite gneiss, quartzite, and phyllite, and in rare occasions limestone and granite. Scattering various sizes of pebbles in fine matrix is suggestive of tillite deposits. Pebbles of the Kunjasen series are also of many varieties, of which calcite pebbles or nodules are worthwhile to mention. Some of calcite pebbles are not metamorphosed whereas others are entirely altered to amphiboles leaving reaction rim like feature around their peripheries. This feature led some geologist to interpret that the amphibole pebbles were derived from hornblendite of Jurassic age which penetrates elsewhere into Cambro-Ordovician limestone series. Consequently it was thought by these geologists that the Kunjasan and Hwanggangri series were post-Ordovician in age. In general the Okchon system could be correlated in lithology and stratigraphy to the Sangwon aystem and might be equivalent to the Sinian system in China.

c) Precambrian granite gneisses

Precambrian granite gneiss was recognized to intrude into the Yonchon system in the Kyonggi massif and into the Yulri system in the Ryongnam massif, but no relationship has been detected in the Okchon system. No age determination has been carried out so that it has not been known whether these two granites are the same in age. From the geological viewpoint, however, two granite gneisses can be separated: post-Yonchon to pre-Sangwon and post-Yulri to pre-Chosun of Cambrian age. The former is perhaps older than the latter and they are correlated respectively to mid-precambrian and late-precambrian in age.

d) Correlation of Precambrian systems

Precambrian systems in central Korea so far described can be correlated as tabulated in table 1.

3. Geologic Structure

The periods in which metamorphism and deformation were taking place in the Precambrian formations of the Kyonggi-Ryongnam massif are uncertain because of lack of detailed study in the critical region. Some are older than the Sangwon (Sinian) period, but exact nature is still vague. Thus, the geologic structure of Precambrian regions is grouped as pre-Triassic in age, because a structural break in Korea is definitely known to have occurred in Triassic as well as in Jurassic-early Cretacrous periods in so far as the region under present study is concerned. The geologic structure is shown in map 3.

Table 1. Correlation chart of Precambrian system in S. Korea

area / age	Kyonggi massif		Okchon paleogeosynclinal zone		Ryongnam massif	
late Precambrian	Sangwon system	Iam series	Okchon system	Kunjasan	Yulri system	Taebaeksan granite gneiss
				Hwanggangri		
				Changri		Kosonri
		Jangraksan series		Munjuri		
				Hyangsanri		Kakhwasa
		Granite gneiss		?		
middle Precambrian	Yonchon system	Upper series		Kemyongsan	Ryongnam system	Wonnam
		Lower series				Kisong
early Precambrian		Undifferentiated schists & gneisses				Pyonghae

a) Pre-Triassic deformation

In the Kyonggi massif NNE to SSW foliation prevails in the Yonchon and Sangwon system although diversity exists. Paralleling this direction run one major rift valley and four fault valleys in the area which characterize physiography in north-central region of South Korea. They are from northwest to southeast Chugaryong rift ualley, Kyonggang fault, Inje fault, Hyonri fault and Changchon fault. These faults are prominent in the Precambrian terrain and brought older undifferentiated gneisses in contact with rocks of the younger Sangwon system, as well as Daebo granites. Pleistocence basalt flows extruded along Chugaryong rift valley, and along other faults Jurassic Daebo granites are bound Precambrian formations, or Cretaceous sediments and/or volcanics are cropped out. Conclu svely these faults are cut by Jurassic Daebo granites at south-western end and differ in direction from Triassic and Jurassic deformation trends.

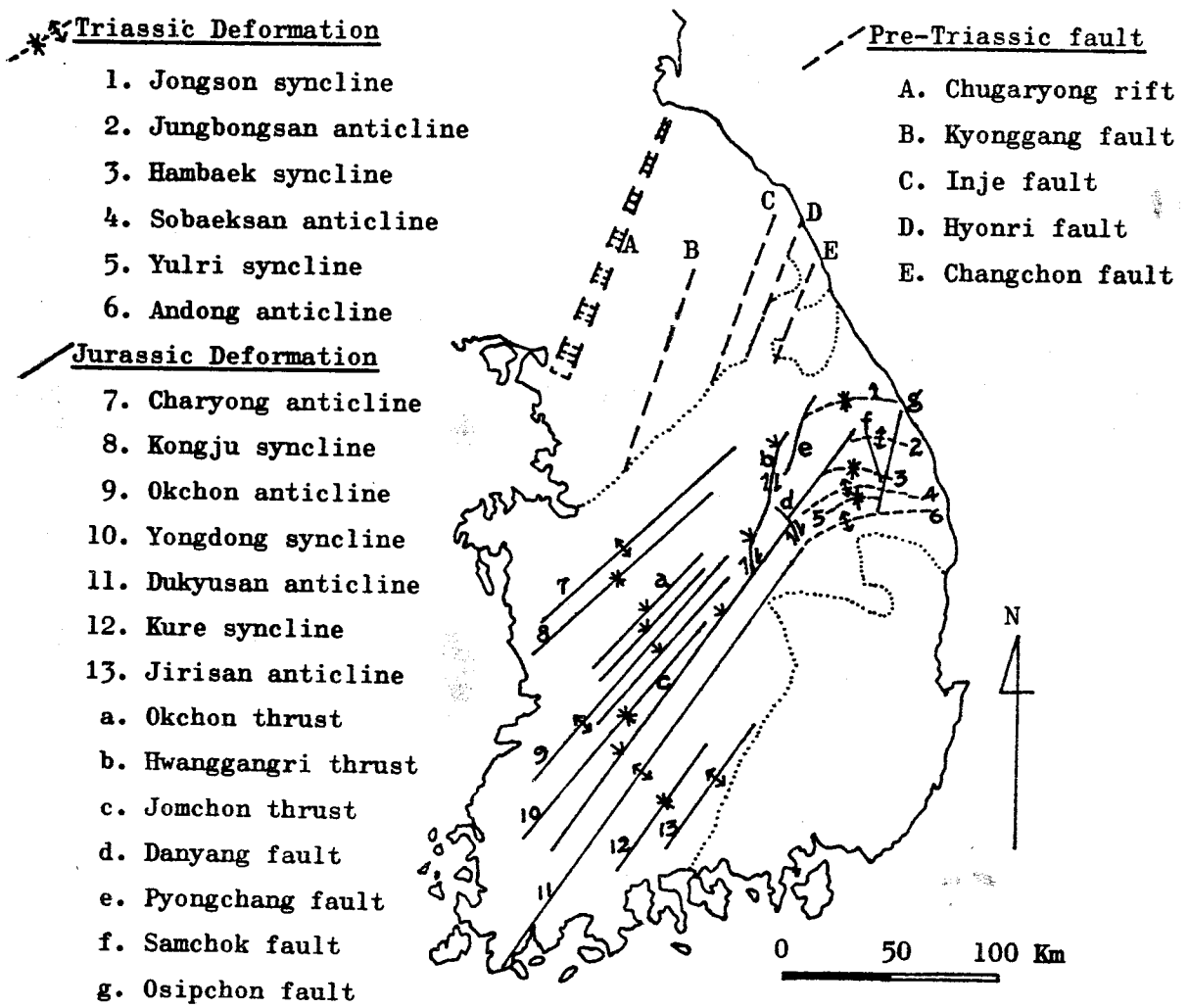
In the Ryongnam massif foliation of Precambrian systems is diverse, but mostly shows east-northeast direction which is cut by both Triassic and Jurassic deformational alignments.

b) Triassic deformation (Songrim Disturbance)

In the Okchon neogeosynclinal zone at east-central region of South Korea, Paleozoic and Triassic sedimentary formations are folded and the axis of folds trend west-northwesterly. This deformation was caused by Songrim disturbance at the end of Triassic period. Jurassic sediments have not, however, been affected by this deformational movement. Western end of those folds are bent to Sinian direction of Jurassic age. Northeastern portion of the Ryongnam massif also reveal W-NW trend in foliation, but it is uncertain whether they are contemporaneous although they were grouped as Triassic deformation in the map 3.

c) Jurassic deformation (Daebo orogeny)

Jurassic deformation known as Daebo orogeny was taken place and continued from early Jurassic to early Cretaceous (this was known from age dating of Daebo granites). This orogeny is the biggist one in Korea and all the previous



Map 3. Structural map of S. Koreaa

formations were severely folded and faulted. The nature of Daebo orogeny is manifested by two-fold facts, that is, distribution of Jurassic Daedong sedimentary formations and alignment of Daebo granites, and is well developed in Okchon geosynclinal zone and its adjacent precambrian terrains.

Daedong sediments of Jurassic age are scattered in both Okchon paleogeosynclinal and neogeosynclinal zones and aligned in NE to SW direction, whereas Cretaceous Kyongsang sedimentary formations in the zones are not aligned and deformed in the same direction. Granites in central region of South Korea exclusive of southeastern Kyongsang basin province crop out in the core of the four major mountain ranges which are mostly composed of Precambrian formations in the Kyonggi-Ryongnam massif as well as the Okchon geosynclinal zone. The trend of granites distribution is also of NE-SW and parallel to the axis of the Okchon geosynclinal zone. This granites are regarded synte-

ctonic and named Daebo granites, and their ages range from early Jurassic to early Cretaceous. Thus, age of tectonic development in the area is definitely of early Jurassic to early Cretaceous in age, and in connection with this it must be mentioned that Daebo granites were considered to be late Cretaceous in age and so described in all previous papers by all previous writers.

The stratigraphic sequence of the Okchon system was thought by all previous works to be reverse order in contrast to the sequence listed already, because they did not recognized overturned isoclinal structure. Thus previous works could not precisely interpret the geology and structure of the Okchon system. Foliation of the Okchon system strikes NE to SW Sinian direction in coincide with the axis of the Okchon geosynclinal zone and mostly dips to northwest. These are mostly overturned isoclinal folds in which at least three overthrusts are apparent. Consequently same formations appears repeatedly in narrow strip of the Okchon zone.

As shown in map 3, four anticlinoriums and three synclinoriums run alternately from the southern border of the Kyonggi massif to the Ryongnam massif through the Okchon zone. The Okchon thrusts are in the Okchon zone, the Hwanggangri thrust (combination of upthrusts and shear faults) bound between the Okchon paleogeosynclinal zone and neogeosynclinal zone, and the Jomchon thrust joined by the Hwanggangri thrust bound between the Okchon zone and the Ryongnam massif toward southwest. These anticlinoriums constitute major mountain ranges and younger sediments of Jurassic and Cretaceous periods scatter in few isolated locations in the synclinorium areas. As already mentioned, western ends of Triassic deformation change toward Sinian direction which means that Triassic deformation was modified by Jurassic Daebo orogeny. All major structures are shown in map 3 classifying ages and nature with which they were formed, so that detail explanation is deleted because of self-explanatory naiure of the figure.

4. Evolution of Okchon Geosyncline

As mentioned already the geology and structure of the Okchon paleogeosynclinal and neogeosynclinal zones are different and discontinuous although both zones constitute a continuous tectonic unit trending to Sinian direction. The discontinuity is attributed to migration of the geosyncline itself through geologic time, but not due to difference in metamorphism postulated by previous workers.

Geologic distribution outside of the present Okchon geosynclinal zone has revealed that original Okchon geosyncline was much wider than the present breath and boundary between paleogeosynclinal zone and neogeosynclinal zone is seemed to be rather persistant through geologic time, or intermittent in nature. The paleogeosyncline existed during late Precambrian time when the Okchon system was deposited, whereas the neogeosyncline was persisted during Paleozoic to early Mesozoic era in which time Chosun and Pyongan sedimentary systems were accumulated. During late Triassic to Jurassic period both zones were uplifted leaving scattered intermontain basins where Daedong system of Jurassic age was deposited. Present outline of the Okchon geosynclinal zone was defined dy the Daebo orogeny and it is of writer's opinion that the Hwanggangri thrust which bind the Okchon paleogeosyclinal andt neogeosynclinal zones is intermittent in nature.

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追　　記

本論文은 1971年에 筆者의 資料에 依하여 整理된 것이다. 1972年度에 春川隣近의 1/50, 000 地質調査가 이루어졌으므로 多少修正되리라고 보나 干先 筆者의 生覺을 피력하여 批評을 듣고자 게재하는 바이다.