地質学論集　第37号　117-124ページ，1992年3月
Mem. Geol. Soc. Japan, 37, 117-124

Paleoenvironmental change of the Tertiary Yangnam and Pohang basins of the southern Korean Peninsula

Sun Yoon*

Abstract The Yangnam and Pohang basins are the largest Tertiary basins in the southern Korean Peninsula. The geologic events, such as paleoenvironmental change in chronologic order, of these basins are closely related to the origin of the Japan Sea, for these basins bound the southwestern border of the Japan Sea. In the Early-Middle Eocene time, dacitic volcanic activity occurred heavily all over the two basins. The dacitic volcanic activity occurred on land, and a large amount of welded tuffs and volcanic breccias were erupted. The rocks of the Late Eocene through the Oligocene are not found yet, and the area of the Yangnam and Pohang basins seems to have been in a state of quiet and weathering condition. In the Early Miocene time, heavy volcanic activity occurred only in the Yangnam Basin, and the Pohang Basin was in a state of quiet upland condition. The volcanic activity in the Yangnam Basin was bimodal in composition, that is, dacitic and andesitic-basaltic. The dacitic volcanic activity preceded the andesitic-basaltic activity and occurred on land. The andesitic-basaltic volcanic activity occurred mainly under water, and this suggests that the Yangnam Basin underwent fresh water invasion and existed as a large lake during the Early Miocene time. In the Middle Miocene time, marine water transgressed into the whole of the Pohang Basin and several collapsed basins in the Yangnam Basin. The Middle Miocene marine transgression brought warm water molluscan elements, such as *Hataiarca*, *Vicarya*, into the basins.

Key words : paleoenvionmental change, Yangnam and Pohang basins

Introduction

Four Tertiary basins are distributed along east coast of the southern Korean Peninsula, named Bugpyeong, Yeonghae, Pohang and Yangnam basins (Kim, 1970 ; Yoon, 1986) . Among these four basins, the Yangnam and Pohang basins are the largest ones and their stratigraphy is adapted as standard sequence in the Korean Tertiary stratigraphy. The geologic events, such as paleoenvironmental change in chronologic order, of these basins are closely related to the origin of the Japan Sea, for these basins bound the southwestern border of the Japan Sea. The present article deals with the paleoenvironments of the Yangnam and Pohang basins and their change in time.

The present article is a contribution of Basic Science Research Institute of Pusan National University, Korea, finished by the FY-89 financial support of Basic Science Research Fund of the Ministry of Education, Korea, and the writer would like to express his sincere thanks to the Ministry of Education, Korea.

Tertiary Stratigraphy of the Yangnam and Pohang Basins

The Yangnam and Pohang basins are adjacent to each other and underlain uniformly by Cretaceous sedimentary and igneous rocks, Gyeongsang Supergroup, as basement. The two basins, however, are quite different from each other in the Tertiary sequences. The Yangnam Basin comprises Early Miocene dacitic and andesitic-basaltic volcanic rocks and terrestrial sediments with

* Department of Geology, Pusan National University, Pusan, 609-735, Korea.

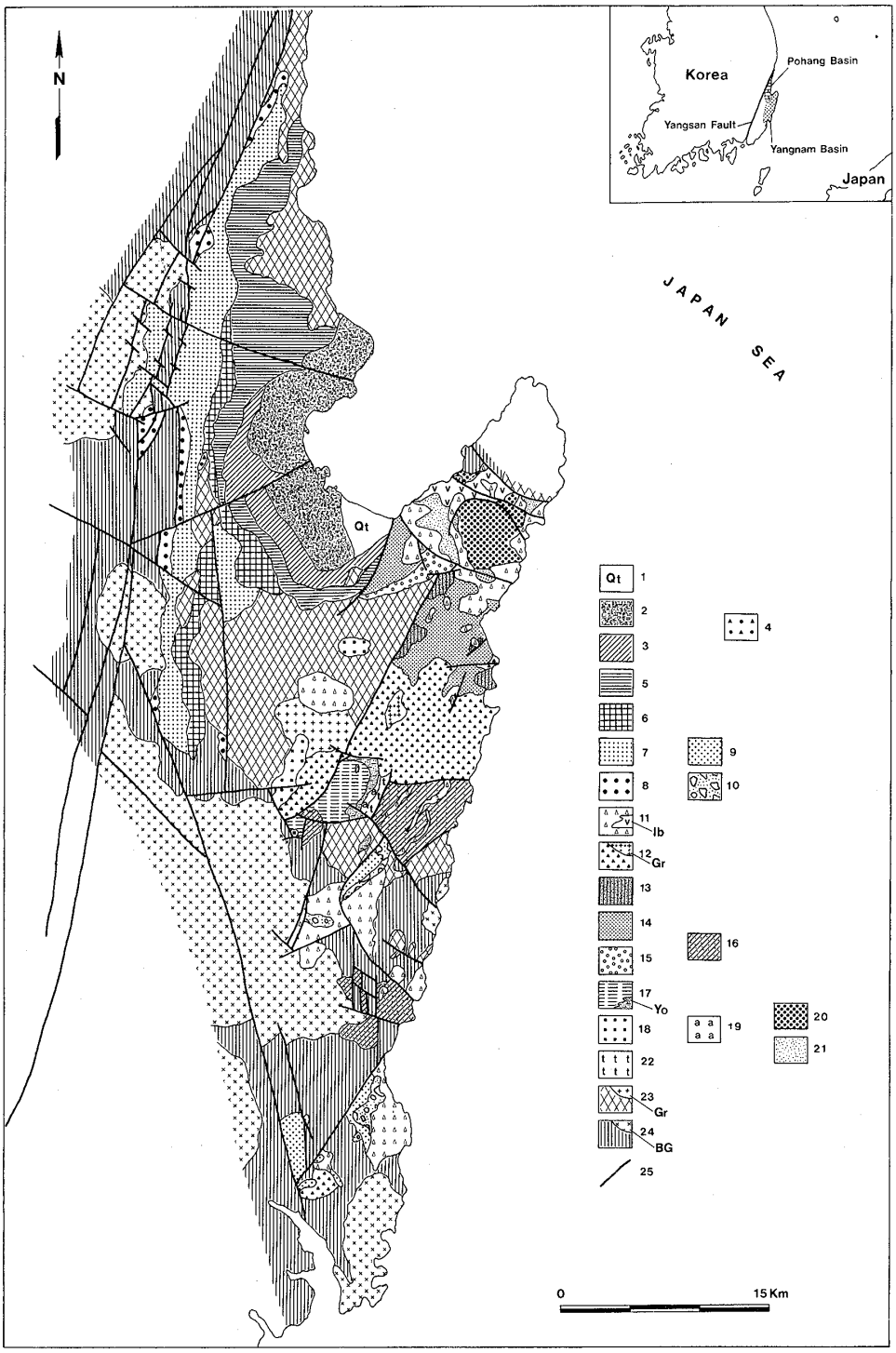
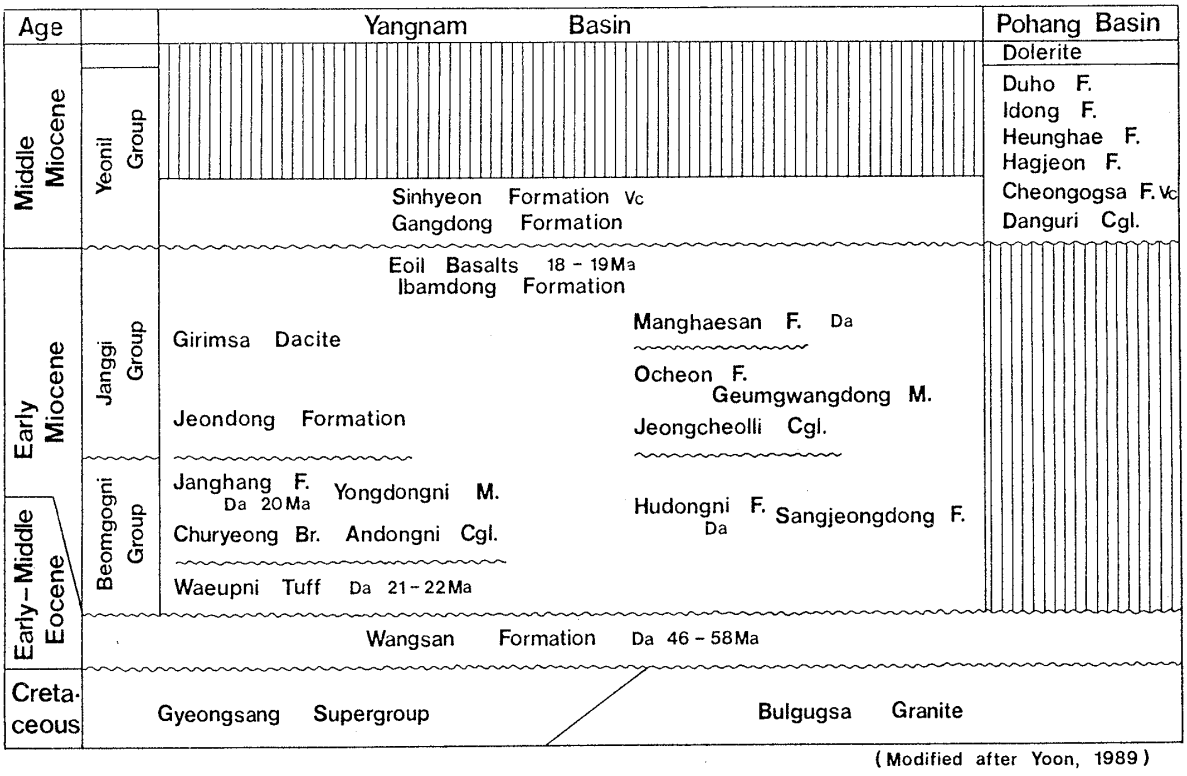


Fig. 1 Index and geologic map of the Yangnam and Pohang basins.
1 : Alluvium, 2 : Duho Formation. 3 : Idong Formation, 4 : dolerite, 5 : Heunghae Formation, 6 : Hagjeon Formation, 7 : Cheongogsa Formation, 8 : Danguri Conglomerate, 9 : Gangdong Formaton, 10 : Sinhyeon Formation, 11 : Eoli Basalts, 12 : Girimsa Formation, 13 : Manghaesan Formation, 14 : Ocheon Formation, 15 : Jeongcheolli Conglomerate, 16 : Jeondong Formation, 17 : Janghang Formation, 18 : Churyeong Breccia, 19 : Andongni Conglomerate, 20 : Hudongni Formation, 21 : Sangjeongdong Formation, 22 : Waeupni Tuff, 23 : Wangsan Formation, 24 : Gyeongsang Supergroup, 25 : Fault, BG : Bulgugsa Granite, Gr : granite, Ib : Ibamdong Formation, Yo : Yongdongti Member

Table. 1 Tertiary stratigraphy of the Yangnam and Pohang basins.
Br : breccia, Cgl : conglomerate, Vc : *Vicarya*



thin Middle Miocene marine sediments, whereas the Neogene rocks of the Pohang Basin lack Early Miocene volcanic rocks and consists mainly of Middle Miocene marine strata. Stratigraphically, the Tertiary rocks of the Yangnam Basin are divided into the Early-Middle Eocene, Early Miocene and early Middle Miocene series, while the Pohang Basin comprises the Early-Middle Eocene and Middle Miocene series.

The early Middle Eocene series, called comprehensively the Wangsan Formation (Shimazu *et al.*, 1990 ; Wangsan Dacitic Volcanics, Yoon, 1989), is distributed along the marginal areas of the Yangnam and Pohang basins, and consists of dacites, dacitic welded tuffs and volcanic breccias. The volcanostratigraphic and petrological study of the formation has been scarcely carried out. The radiometric ages of the welded tuffs are from 46 Ma to 58 Ma (Jin *et al.*, 1988). The Wangsan Formation is unconformably overlain by the Miocene sequences of the Yangnam and Pohang basins. The Miocene stratigraphic summary of the Yangnam and Pohang basins is as follows.

Yangnam Basin

The Miocene sequence of the Yangnam Basin is divided into the Beomgogni, Janggi and Yeonil groups.

Beomgogni Group : Beomgogni (= Poumgongni, Tateiwa, 1924) Group is distributed in the Eoilli and Guryongpo areas, and consists of dacitic volcanic breccias, lapilli tuffs, welded tuffs, conglomerates, tuffaceous sandstones and mudstones. The Beomgogni Group in the Eoilli area is divided into the Waeupni (= Oaeumni, Tateiwa, 1924) Tuff, Andongni Conglomerate (Tateiwa, 1924), Churyeong Breccia (Yoon, 1982) and Janghang Formation (Yoon, 1982) in ascending order. The Beomgogni Group in the Guryongpo area is divided into the lower Sangjeongdong and the upper Hudongni formations (Yoon, 1989).

Janggi Group : The Janggi (= Choki, Tateiwa, 1924) Group is distributed in the Geumgwangdong, Mahyeolli, Eoilli and Haseori areas. The Janggi Group in the Geumgwangdong area is divided into the lower Jeongcheolli Conglomerate (Yoon, 1989) and the upper Ocheon

Formation (Yoon, 1980 ; Yoon, 1989), and intruded into and extruded by the Eoil Basalts (Shimazu *et al.*, 1990 ; Eoil Andesitic-Basaltic Volcanics, Yoon, 1989) . The Jeongcheolli Conglomerate is the basal conglomerate of the Janggi Group and consists of terrestrial poorly bedded boulder conglomerates intercalated with thin lenticular sandstone beds. The Ocheon Formation consists mainly of sandstones and mudstones with thin lignite beds and interbeds andesitic-basaltic hyaloclastites and hyalotuffs thinly in its upper part. Four dacitic volcaniclastic beds are interbedded. The Geumgwangdong (= Keumgoangdong, Tateiwa, 1924) Shale Member consisting of well laminated shales is intercalated in the lowermost part of the Ocheon Formation. The Geumgwangdong Shale Member yields abundant plant fossils (Changgi Flora, Huzioka, 1972) with rare insect and fish fossils.

In the Mahyeolli area, The Jeongcheolli Conglomerate is not distributed and the Janggi Group comprises the Ocheon and Manghaesan fomations and Eoil Basalts. The Manghaesan Formation (Yoon, 1989) overlies unconformably the Ocheon Formation and consists of dacitic volcanic breccias, lapilli tuffs and welded tuffs. The non-distribution of the Jeongcheolli Conglomerate in the Mahyeolli area seems to be due to the intrusion of Girimsa Dacite (Shimazu *et al.*, 1990 ; Girimsa Dacitic Body, Yoon, 1989) in the southern part of the area. The Janggi Group in the Eoilli and Haseori areas comprises the Jeondong Formation and Eoil Basalts. The Jeondong Formation (Yoon, 1982) consists chiefly of terrestrial poorly bedded boulder conglomerates intercalated with lenticular sandstones and mudstones. The formation interbeds several dacitic volcaniclastic beds in its lower part and andesitic-basaltic hyaloclastites and hyalotuffs in its upper part. On this point, the Jeondong Formation is similar to the Ocheon Formation, but the Jeondong Formation consists of boulder conglomerates all over the formation.

The Eoil (= Auil, Tateiwa, 1924) Basalts comprises the andesitic-basaltic rocks occurring as extrusives in the upper part of the Janggi Group and intrusives. The Eoil Basalts formed a large amount of hyaloclastites and hyalotuffs in the upper part of the Ocheon Formation, and also peperites at many places in the Ocheon Formation. The Eoil Basalt Volcanic Activity occurred mainly under water during the deposition of the upper part of the Ocheon Formation. The radiometric ages of the Eoil Basalts are 19.3 ± 1.0Ma (Tamanyu, 1985) in the Geumgwangdong area and 17.16 ± 5.96Ma, 19.57 ± 0.34Ma (Jin *et al.*, 1988) in the Eoilli area.

Yeonil Group : The Yeonil (= Ennichi, Tateiwa, 1924) Group is distributed in the Eoilli and Jeongjari areas, and divided into the lower Gangdong and the upper Sinhyeon formations. The Gangdong Formation (Yoon, 1976) consists of terrestrial poorly bedded boulder conglomerartes and unconformably overlies the Eoil Basalts. The Sinhyeon Formation consists of alternation of sandstones and mudstones interbedding lenticular conglomerate beds. The Sinhyeon Formation is an enbayment sediment yielding the *Vicarya-Anadara* assemblage (Yoon, 1979) and early Middle Miocene in age.

Pohang Basin

The Miocene sequence of the Pohang Basin comprises only the Yeonil Group. The Yeonil Group of the Pohang Basin is divided into the Danguri Conglomerate, Cheongogsa, Hagjeon, Heunghae, Idong and Duho formations.

Danguri Conglomerate : The Danguri Conglomerate (Yoon, 1975) is distributed discontinuously along the western margin of the Pohang Basin, and consists mainly of terrestrial poorly bedded boulder conglomerates intercalated with thin lenticular sandstone beds.

Cheongogsa Formation : The Cheongogsa Formation (Yoon, 1975) consists of conglomerates, sandstones and mudstones, and is subdivided into the Bomunji, Doeumsan and Daljeon Alternation members according to lithology, The Bomunji and Doeumsan Alternation members consist of alternation of conglomerates and sandstones, whereas the Daljeon Alternation Member consists of alternation of conglomerates and mudstones. The Cheongogsa Formation yields the *Vicarya-Anadara*, *Dosinia-Felaniella* and *Acesta-Conchocele* assemblages (Yoon, 1979 ; Yoon and Rhee, 1982), and is an embayment to shallow sea deposit and early Middle Miocene in age.

Hagjeon Formation : The Hagjeon Formation (Yoon, 1975) consists of alternation of sandstones and mudstones. The sandstones are commonly whitish grey in color, arkosic and fine-to medium-grained. The mudstones are very well-bedded and dark grey in color.

Heunghae Formation : The Heunghae (= Hunghae, Um *et al.*, 1964) Formation consists of siltstones which are

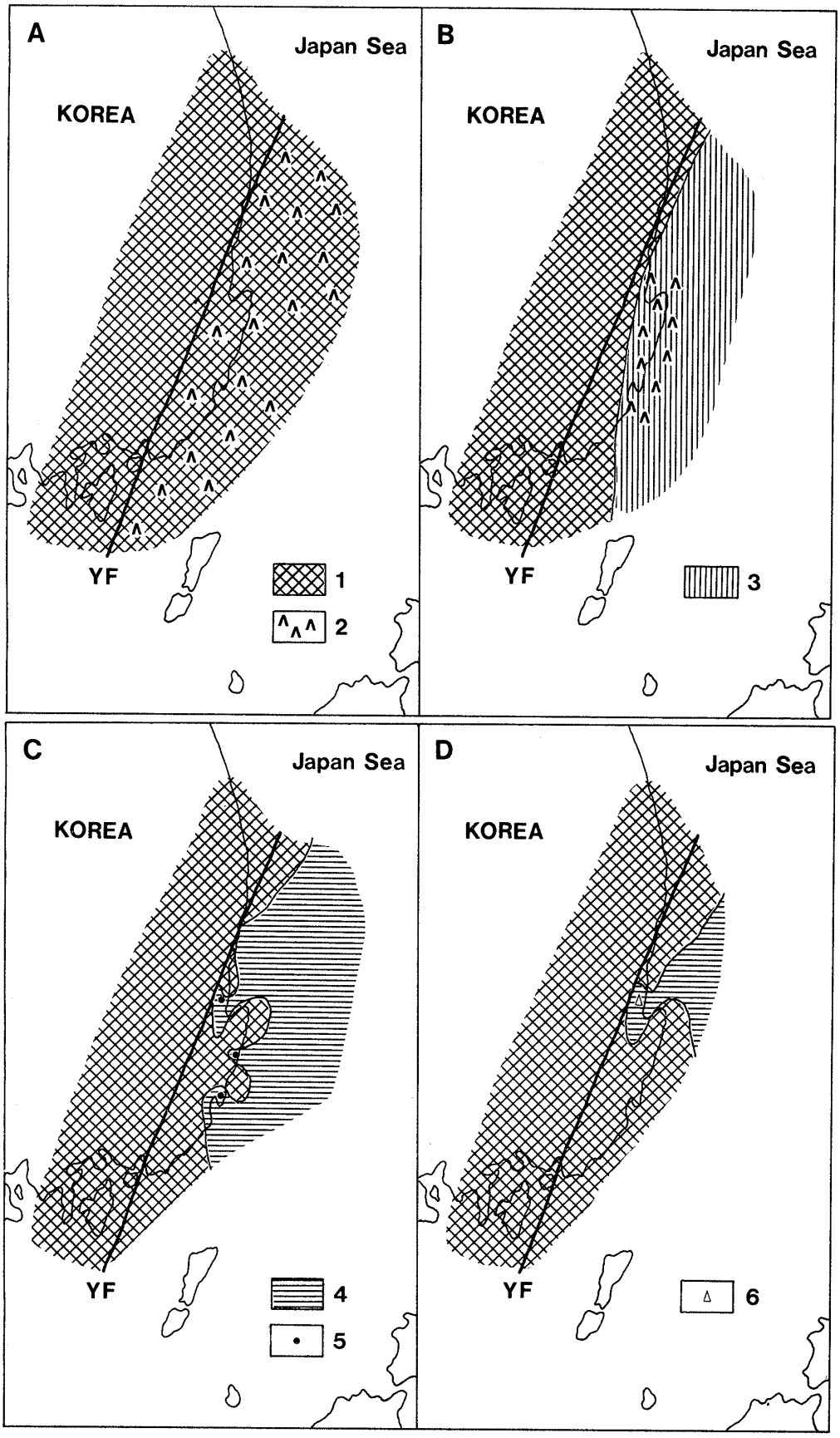


Fig. 2 Paleoenvironmental maps of the Yangnam and Pohang basins.
A : Early-Middle Eocene time, B : Early Miocene time, C : Early Middle Miocene time, D : Middle Miocene time, 1 : land, 2 : volcanic activity, 3 : lake, 4 : sea, 5 : *Vicarya-Anadara* assemblage, 6 : *Mizuhopecten-Modiolus* and *Conchocele-Yoldia* assemblages

dark grey in color and fairly well-bedded.

Idong Formation : The Idong formation (Um *et al.*, 1964) is almost equal in lithology to the Hagjeon Formation.

Duho Formation : The Duho Formation (Um *et al.*, 1964) is almost equal in lithology to the Heunghae Formation, and yields the *Mizuhopecten-Modiolus* and *Conchocele-Yoldia* assemblages (Yoon, 1979) and is Middle Miocene in age.

Paleoenvironmental change of the Yangnam and Pohang Basins

To interpret and compile the history of the paleoenvironmental change of the Yangnam and Pohang basins, the stratigraphic characteristics and geologic events of the two basins are discussed as following.

1. The Early-Middle Eocene dacitic volcanic rocks are distributed in both of the Yangnam and Pohang basins.

2. The Early Miocene volcanic rocks are thickly distributed in the Yangnam Basin, but not in the Pohang Basin.

3. The Early Miocene volcanic activity is bimodal in composition, that is, dacitic and andesitic-basaltic. The dacitic volcanic activity occurred during the period from the lower through the upper parts of the Early Miocene sequence, whereas the andesitic-basaltic volcanic activity occurred during the period from the middle through the upper parts of the Early Miocene sequence. It is characteristic that the andesitic-basaltic volcanism acted mainly under water.

4. The Middle Miocene sequences of the Yangnam and Poahg basins commonly comprise a lower terrestrial boulder conglomerate deposit and an upper marine sequence, but the lithofacies of the two sequences is different each other. In the Yangnam Basin, the Middle Miocene strata are thin, consists of a lower terrestrial conglomerate deposit and an upper embayment sediment, and distributed separately, whereas the Middle Miocene strata of the Pohang Basin are thick and comprise a sequence from terrestrial through embayment to open sea deposits. The Pohang Basin has a marine transgression sequence.

5. The Middle Miocene or younger volcanic rocks are not distributed in the Yangnam Basin, while a dolerite intruded into the marine strata in the Pohang Basin.

The history of the paleoenvironmental change of the Yangnam and Pohang basins is compiled as following :

In the Early-Middle Eocene time, dacitic volcanic activity occurred heavily all over the area of the Yangnam and Pohang basins. This dacitic volcanic activity occurred on land, and a large amount of welded tuffs and volcanic breccias was erupted and formed the Wangsan Formation. The rocks of the Late Eocene through the Oligocene are not found yet, and it is assumed that the area of the Yangnam and Pohang basins was in a state of quiet and weathering condition during that time.

In the Early Miocene time, heavy volcanic activity occurred in the Yangnam Basin. The volcanic activity was bimodal in composition, that is, dacitic and andesitic-basaltic. The dacitic volcanic activity preceded the andesitic-basaltic activity and occurred discontinuously in the whole of the Early Miocene time.

The andesitic-basaltic volcanic activity started in the middle of the Early Miocene time and continued through the end of the time. The andesitic-basaltic activity occured mainly under water, and this suggests that the Yangnam Basin subsided continuously, underwent a fresh water invasion and existed as a large lake during the Early Miocene time. The Early Miocene volcanic activity and other sedimentation did not occurred in the Pohang Basin, and the Pohang Basin was in a state of quiet upland condition.

In the early Middle Miocene time, the Pohang Basin began to subside and the Yangnam Basin had been uplifted except for several collapsed basins. Marine water transgressed into the whole of the Pohang Basin and the collapsed basins of the Yangnam Basin. The marine transgression into the collapsed basins of the Yangnam Basin was short in time and deposited only embayment deposits, while the marine transgression into the Pohang Basin was steady and continuous in the Middle Miocene time. The Middle Miocene marine transgression, Euichangian Marine Transgression (Yoon, 1975) brought warm water molluscan elements, such as *Hataiarca*, *Vicarya*, into the basins.

References

Huzioka, K., 1972 : The Tertiary floras of Korea. *Min. Coll., Akita Univ., Jour., ser. A*, **5**, 1-83, pls. 1-14.

Jin, M. S., Kim, S. J. and Shin, S. C., 1988 : K/Ar and fission-track datings for volcanic rocks in the

Pohang-Kampo area. *Korea Inst. Energ. Resour., Res. Rep. KR*-87-27, 51-88.*

Kim, B. K., 1970 : A study on the Neogene Tertiary deposits in Korea. *Geol. Soc. Korea, Jour.*, **6**, 77-96.*

Shimazu, M., Yoon, S. and Tateishi, M., 1990 : Tectonics and volcanism in the Sado-Pohang Belt from 20 to 14 Ma and opening of the Yamato Basin of the Japan Sea. *Tectonophysics*, **181**, 321-330.

Tamanyu, S., 1985 : Geothermy of Korea. *Geol. Surv. Japan, Chishitsu News*, no.366, 50-57.** (original title translated).

Tateiwa, I., 1924 : Geological atlas of Chosen, no. 2, Ennichi, Kyuryuho and Choyo Sheet, *Geol. Surv. Gov. Gen. Chosen*, 6 p., 3 maps, 2 figs.**

Um, S. H., Lee, D. W. and Bak, B. S., 1964 : Explanatory text of the geological map of Pohang Sheet (1 : 50,000 scale), *Geol. Surv. Korea*, 1-21 + 1-10, 5 pls., 1 map.*

Yoon, S., 1975 : Geology and paleontology of the Tertiary Pohang Basin, Pohang District, Korea. Part 1. Geology. *Geol. Soc. Korea. Jour.*, **11**, 187-214.

————, 1976 : The Tertiary statigraphy ofthe Ulsan Basin. No. 1. Tertiary deposits in the eastern block. *Coll. Lib. Arts and Sci., Busan Nat. Univ.*, **15** (*Nat. Sci. Ser.*), 67-71.

————,1979 : Neogene molluscan fauna of Korea. *Geol. Soc. China, Mem.*, 3, 125-130.

————, 1980 : The Tertiary stratigraphy of the southeast marginal area of the Pohang Basin. *Korea Sci. Engin. Found.*, 21 p., 1 map.*

————, 1982 : Tertiary stratigraphy of the Eoil Basin, Korea. *Geol. Soc. Korea, Jour.*, **18**, 173-180.

————, 1986 : Tectonic history of the Tertiary Pohang and Yangnam basins. In Nakagawa, H., Kotaka, T. and Takayanagi, Y. (eds.), *Kitamura Commem. Essays Geol.*, 637-644.

————, 1989 : Tertiary stratigraphy of the southern Korean Peninsula. *Proc. Internat. Symp. Pacific Neog. Conti. Mari. Events, IGCP* 146, Nanjing Univ. Press, 195-207.

———— and Rhee, S. H., 1982 : Discovery of *Vicarya* from the Tertiary Pohang Basin, Korea. *Geol. Soc. Korea, Jour.*, **18**, 49-52.

* in Korean with English abstract.
** in Japanese.

Geographic names

Andongni ..... 安洞里
Beomgogni ..... 凡谷里
Bugpyeong ..... 北坪
Bulgugsa ..... 佛國寺
Cheongogsa ..... 泉谷寺
Churyeong ..... 楸嶺
Danguri ..... 丹邱里
Duho ..... 斗湖
Eoil ..... 魚日
Eoilli ..... 魚日里
Euichang ..... 義昌
Geumgwangdong ..... 金光洞
Girimsa ..... 祇林寺
Guryongpo ..... 九龍浦
Gyeongsang ..... 慶尚
Hagjeon ..... 鶴田
Haseori ..... 下西里
Heunghae ..... 興海
Hudongni ..... 厚洞里
Ibamdong ..... 立岩洞
Idong ..... 梨洞
Janggi ..... 鬐
Janghang ..... 獐項
Jeondong ..... 典洞
Jeongcheolli ..... 井泉里
Jeongjari ..... 亭子里
Mahyeolli ..... 馬峴里
Manghaesan ..... 望海山
Ocheon ..... 烏川
Pohang ..... 浦項
Sangjeongdong ..... 上政洞
Waeupni ..... 臥邑里
Wangsan ..... 旺山
Yangnam ..... 陽南
Yeonghae ..... 寧海
Yeonil ..... 延日

（要　旨）

Yoon, S., 1992：Paleoenvironmental change of the Tertiary Yangnam and Pohang basins of the southern Korean Peninsula. ***Mem. Geol. Soc. Japan*, 37, 117-124.**（尹　銑，1992：**韓半島南部陽南および浦項盆地の古環境変遷．地質学論集，37, 117-124.**）

韓半島南部の陽南および浦項盆地は最大の第三紀堆積盆地である．日本海南東縁にあたるこれらの堆積盆地における，環境の変化のような地質事件は，日本海の起源の問題と密接な関係を持っている．前期～中期始新世には，激しいデイサイト質火山活動がこの２つの盆地において起こり，陸上で行われた活動は大量の溶結凝灰岩・火山角礫岩をもたらした．上部始新統～漸新統は発見されず，これら地域は静穏で，かつ侵食地域であったと考えられる．前期中新世には，激しい火山活動が陽南盆地に起こったが，浦項盆地は静穏な陸域であった．陽南盆地の火山活動はデイサイトと安山岩・玄武岩のバイモーダルな活動を示し，陸域でかつ大半は水中で行われた．当時陽南盆地には広大な湖が存在していたことがわかる．中期中新世には浦項盆地の全域にわたって海進が起こり，陽南盆地ではいくつかの陥没盆地が発生した．中期中新世の海進は，*Hataiarca*, *Vicarya* のような暖海生の軟体動物要素をもたらした．