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Geological Structure and Tectonics of the Ogcheon Zone in the Chungju-Jangseonri Area, South Korea

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with 15 Text-figures

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Abstract: The Ogcheon Zone of the Chungju-Jangseonri area consists of some nappes, in descending order of structural level Kyemeongsan nappe and Chungju nappe which overlie the Busan nappe I composed of the Precambrian Busan gneiss complex with its cover rocks (A′-unit), Busan nappe II whose basal part contains a small-scale slice of Precambrian gneiss complex, and Sanjeoteo nappe which overlies the Precambrian Bakdalryeong gneiss complex with its cover rocks (A-unit). The Kyemyeongsan nappe, Chungju nappe, Busan nappe II and Sanjeoteo nappe consist of two units, upper unit in which acidic rocks are predominant among original igneous constituents of metamorphic rocks with subordinate amount of basic rocks and lower unit in which basic rocks are predominant, showing that the magmatism was of bimodal type but that the predominant magmatism was of basic type during the earlier phase of the development of the Ogcheon sedimentary basin and of acidic type during the later phase. The acidic rocks of the Kyemeongsan nappe are plutonic rocks with volcanic rocks, but these of the Chungju nappe, Busan nappe II and Sanjeoteo nappe are only of volcanic type, showing that the Kyemeongsan nappe appears to have been derived from an activity center of acidic volcano-plutonism in the Ogcheon sedimentary basin as an intracontinental rift zone. The metamorphic rocks of the Ogcheon Zone of the Chungju-Jangseonri area were produced by a medium pressure type metamorphism during the first phase and by an andalusite type metamorphism during the second phase. The first phase metamorphism occurred in the metamorphic field which showed a downward increase of temperature from the upper unit to the lower unit, giving rise to kyanite, staurolite and garnet in the lower unit, though in the Kyemeongsan nappe such metamorphic minerals crystallized also in its upper unit. The exhumation of the medium pressure type metamorphic rocks occurred forming the above-mentioned nappes. It was followed by the folding with westward vergence throughout the nappes. The andalusite type metamorphism occurred throughout the nappes after this folding.

CONTENTS

I. Introduction

The Chungju-Jangseonri area between Chungju city and Jecheon city is placed in the Ogcheon Zone of South Korea (Fig. 1) and corresponds to the SW part of the Jecheon Sheet of geological map (Kim *et al.*, 1967), SE part of the Moggye sheet (Park & Um, 1971), NE part of the Chungju sheet (Kim & Lee, 1965) and NW part of the Hwanggangri sheet (Lee & Park, 1965) (Fig. 1). This area is considered to be a key area for understanding the tectonic evolution of the Ogcheon Zone. This is because the geological relationship between the metamorphic rocks and the Precambrian rocks and that between the former and the Joseon Supergroup can directly be examined in this area.

The tectonic unit division of the Ogcheon Zone of this area has been so far tried by many authors to understand its tectonic setting (e.g. Kobayashi, 1966; Kim, 1970; Kim & Kim, 1974; Reedman & Um, 1975; Kim & Yu, 1977; Choi & Kim, 1981; Kim *et al.*, 1986; Cluzel *et al.*, 1990, 1991). While petrologic study of the metamorphic rocks of this area has also been performed by Na *et al.* (1982), Hong (1984) and Na (1987). However, these studies of this area do not appear to have been based on the geological map drawn as the distribution of lithologic layering and on the analysis of time-relationship between the development of geological and rock structures and the growth of metamorphic minerals, though shown important information. In this paper, therefore, the present author will show the geological structures of two subareas of this area, Chungju subarea and Sanjeoteo subarea, clarifying lithofacies of the constituent rocks, detailed geological structures and their formation history, and further time-relationship between the metamorphism and the development of geological and rock structures.

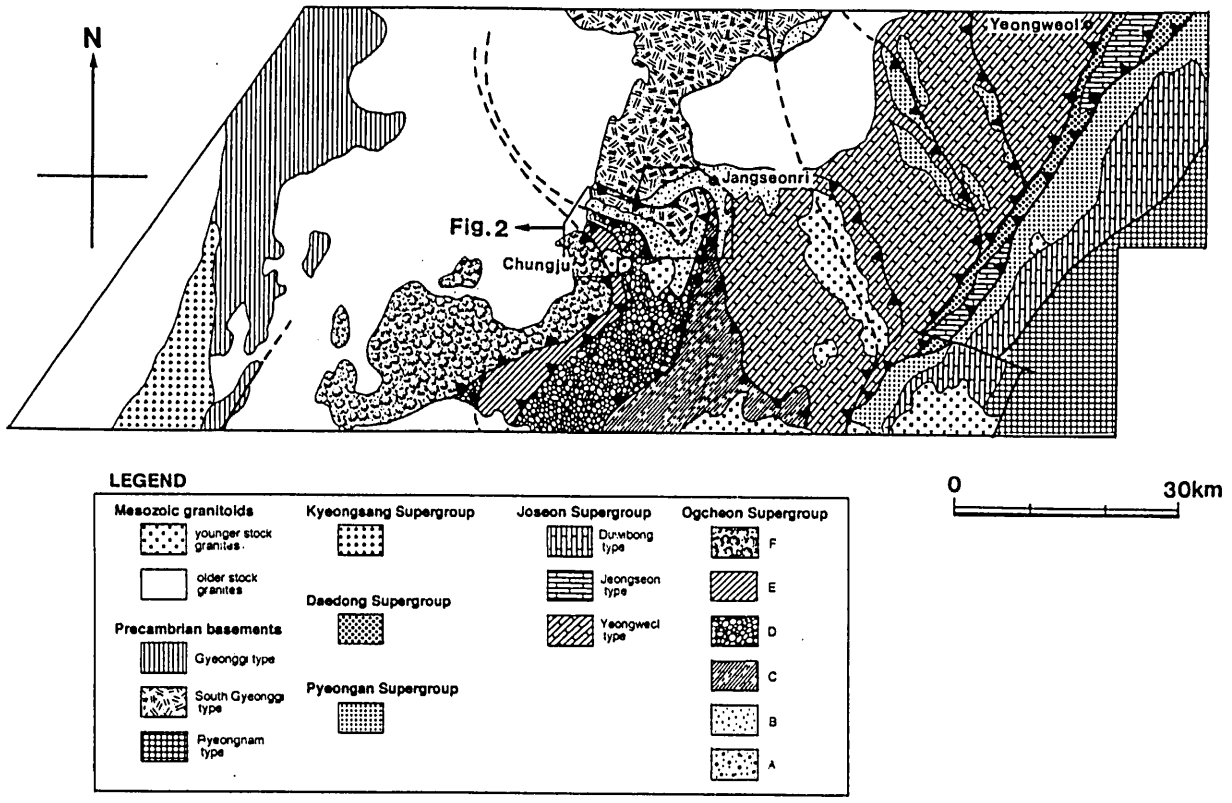

Fig. 1 Geological map showing the locality of the Ogcheon Zone of the Chungju-Jangseonri area.
A: cover rocks (A′-unit) of the Busan gneiss complex (South Gyeonggi type Precambrian basement), B: cover rocks (A-unit) of the Bakdalryeong gneiss complex (South Gyeonggi type Precambrian basement), C: Sanjeoteo nappe, D; Jori subnappe, E: Jideungsan subnappe, F: Kyemeongsan nappe.

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II. Outline of Geology

The Chungju-Jangseonri area consists of Precambrian gneiss complexes, their cover rocks and the Ogcheon Supergroup (Fig. 2). Precambrian gneiss complexes are the Busan gneiss complex and the Bakdalryeong gneiss complex placed in the northeastern part of this area. The cover rocks (A-unit) of the Bakdalryeong gneiss complex, which is developed as the geological body of the lowest structural level of this area, are overlain by a nappe (Sanjeoteo nappe) of the Ogcheon Supergroup. The Busan gneiss complex and its cover rocks (A′-unit) overlie as a nappe (Busan nappe I) on the Sanjeoteo nappe. Strictly speaking, however, the eastern part of the Busan nappe I is directly underlain by the Sanjeoteo nappe, but its northern part is underlain by the Busan nappe II which consists of two subnappes, upper subnappe comparable with the Jori subnappe in lithofacies and lower subnappe which is comparable with the A -unit in lithofacies and contains a small-scale slice of Precambrian gneiss complex in its basal part. The Busan nappe I is overlain by two nappes of the Ogcheon Supergroup, Chungju nappe and Kyemeongsan nappe in ascending order of structural level. The Chungju nappe forms an overturned fold (Gwanmo I fold) with WNW-ESE trending axis and northward closure. It consists of two subnappes, Jideungsan subnappe in the fold core and Jori subnappe in the fold mantle.

III. Geological Structure and Stratigraphy

The Bakdalryeong gneiss complex is of Precambrian age [Kim *et al.*, 1967; Cliff, 1979 unpub. (2100Ma); Choi & Kim, 1981; Na, 1987]. It is covered by metamorphic rocks (A-unit), which were mainly derived from pelitic, carbonate and basic rocks and quartzite (Figs. 3 and 4). The relationship between the former and the latter is in general considered to be an unconformity (Kim *et al.*, 1967; Na, 1987), and the A-unit is regarded as to be transitional with the Joseon Supergroup in Husanri which is mainly composed of carbonate rocks (Reedman & Um, 1975).

The Busan gneiss complex is also of Precambrian age [Cliff, 1979 unpub. (1810Ma); Choi & Kim, 1981; Na,

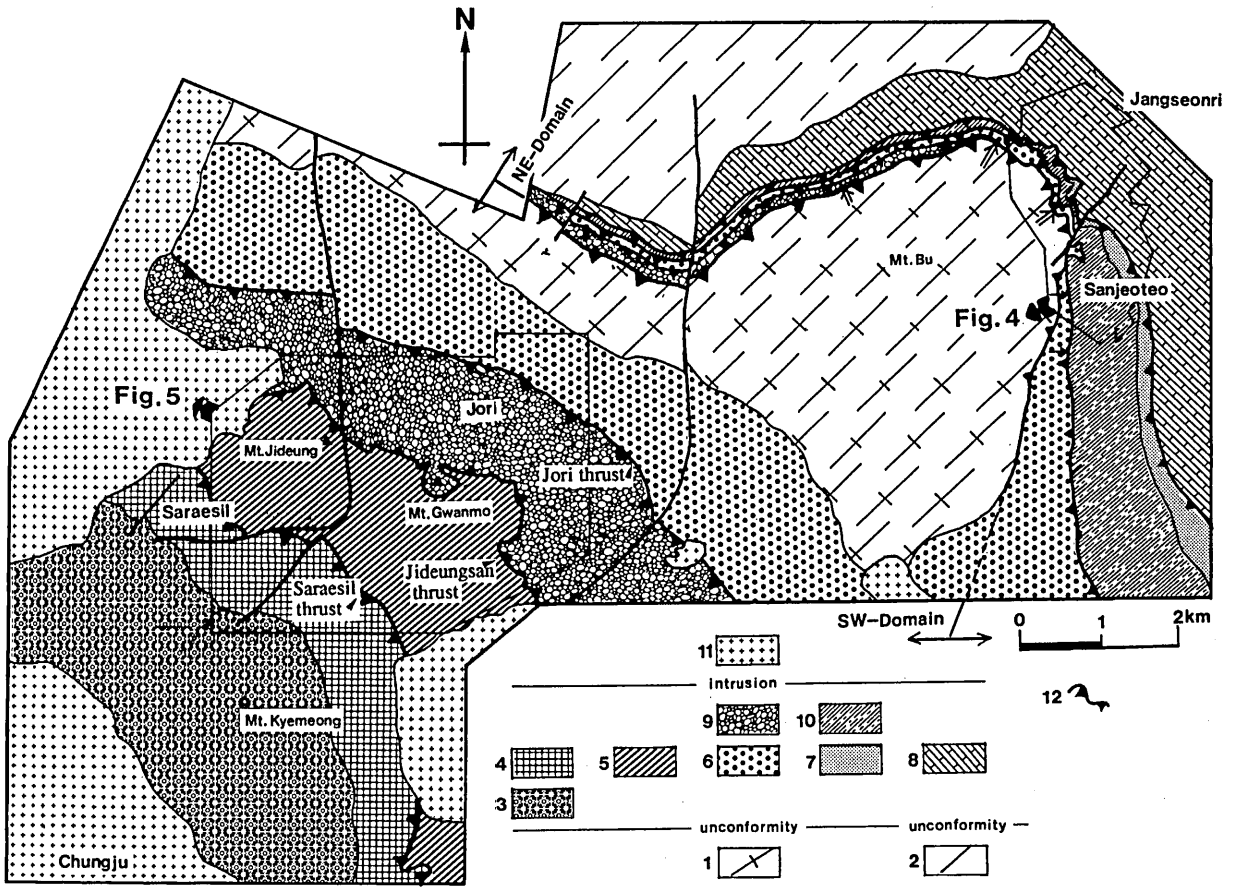

Fig. 2 Geological unit division of the Ogcheon Zone of the Chungju-Jangseonri area.
1: Busan gneiss complex, 2: Bakdalryeong gneiss complex, 3: upper unit of the Kyemeongsan nappe, 4: lower unit of the Kyemeongsan nappe, 5: Jideungsan subnappe, 6: cover rocks (A′-unit and its equivalent) of the Busan gneiss complex, 7: lower unit of the Sanjeoteo nappe, 8: cover rocks (A-unit) of the Bakdalryeon gneiss complex, 9: Jori subnappe and its equivalent, 10: upper unit of the Sanjeoteo nappe, 11: Mesozoic granites, Mt.Bu: Mt. Busan, 12: nappe boundary.

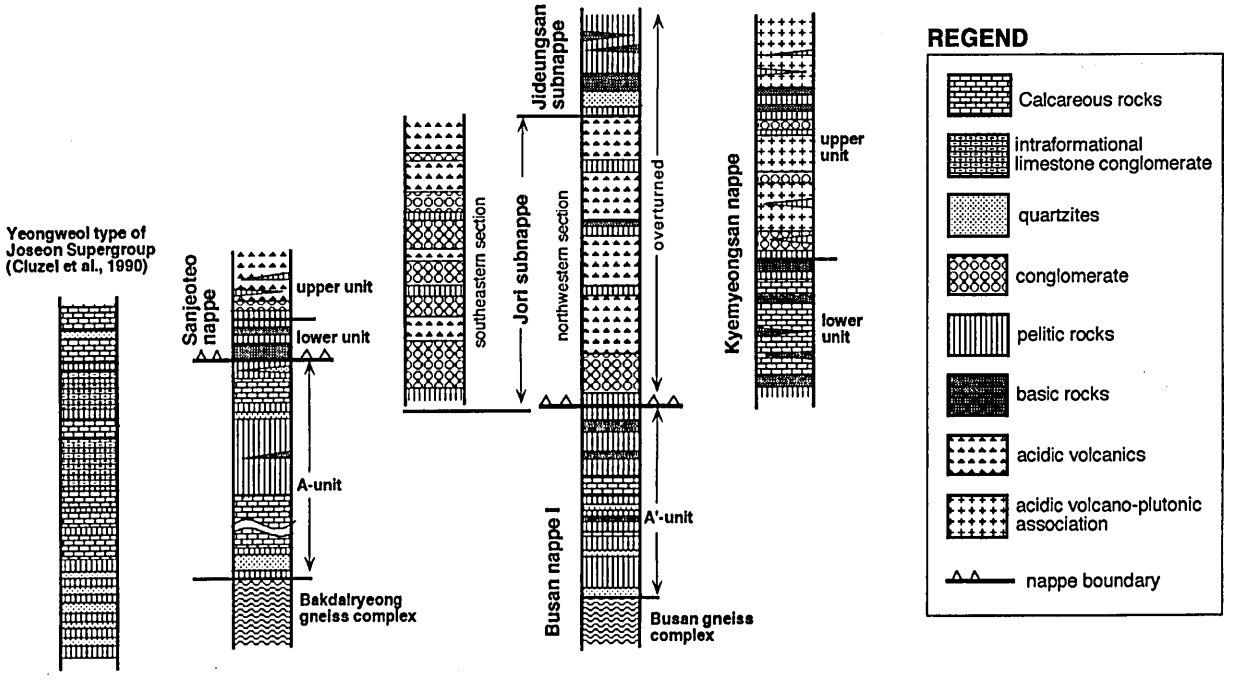

Fig. 3 Stratigraphical columnar sections illustrating lithological characteristics of the nappes of the Chungju-Jangseonri area.

1987]. It is covered by metamorphic rocks (A′-unit), which consist of pelitic, carbonate and basic rocks and quartzite (Figs. 3 and 5). The lithofacies of the A′-unit is essentially the same as that of the A-unit. The Busan gneiss complex has also been assumed to be transitional with the Bakdalryeong gneiss complex (Na, 1987). However, the former is placed as nappes on the latter (Figs. 2 and 4).

In the area to the north of Mt. Busan there are two nappes, Busan nappe II and Sanjeoteo nappe between the nappe (Busan nappe I) of the Busan gneiss complex and the A-unit. The Busan nappe II is divided into two subnappes, upper subnappe consisting of metamorphic rocks derived from acidic and pelitic rocks and lower subnappe which consists of metamorphic rocks equivalent to the A′-unit and a small-scale slice of Precambrian granite-gneiss complex in its basal part (Fig. 2). The metamorphic rocks of the Sanjeoteo nappe are divided into two units, upper unit and lower unit, with reference to original lithofacies (Fig. 2). The lower unit consists of pelitic and basic rocks with reference to original lithofacies, and the upper unit of acidic, conglomerate and pelitic rocks. In the area to the east of the Busan gneiss complex there is no Busan nappe II, showing the direct contact of the Busan nappe I with the Sanjeoteo nappe.

Fig. 5 clearly illustrates the structural discontinuity between the metamorphic rocks of the Jori subnappe, which corresponds to the upper unit of the Chungju nappe and constructs the mantle of the Gwanmo-I fold, and these of the Jideungsan subnappe, which corresponds to the lower unit of the Chungju nappe and constructs the core of Gwanmo-I fold, i.e. the lithologic layering of the Jideungsan subnappe is cut across by the subnappe boundary. In the Jori subnappe acidic and pelitic rocks are predominant with reference to original lithofacies, accompanying conglomerate, psammitic and basic rocks in subordinate amount (Figs. 2 and 5). Conglomerate and pelitic rocks appear to gradually increase toward the southeast, showing an interfinger-like mode of occurrence (Fig. 3). While the metamorphic rocks of the Jideungsan subnappe were derived from pelitic and basic rocks and quartzite (Figs. 2 and 5).

The metamorphic rocks of the Kyemeongsan nappe are also divided into two units, upper unit and lower unit, with

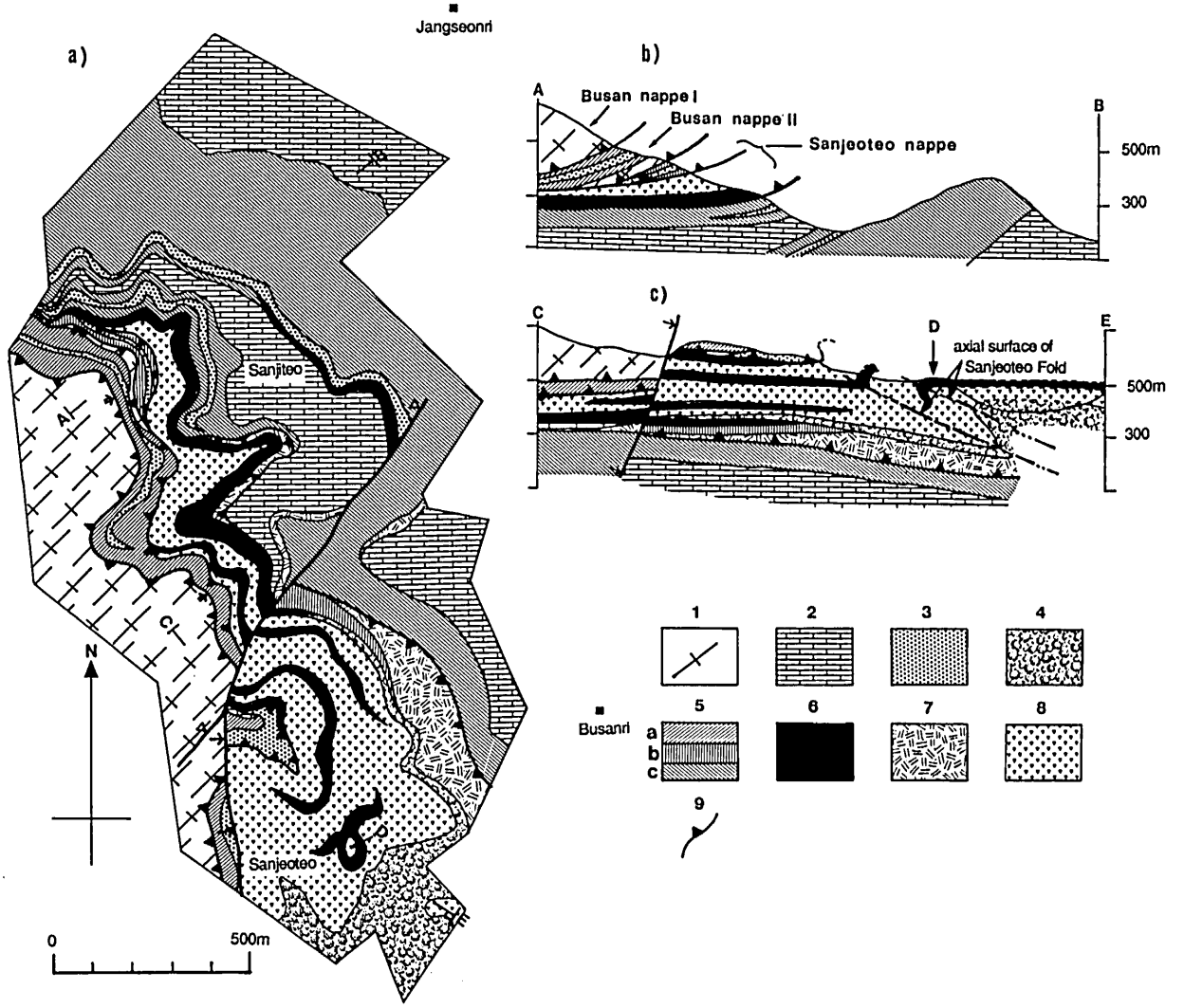

Fig. 4 Geological map (a) and profiles (b and c) of the Ogcheon Zone of the Sanjeoteo subarea.
1: Busan geniss complex (Busan nappe I), 2: calcareous rocks, 3: quartzites, 4: conglomerate rocks, 5: pelitic rocks (a: Busan nappe II, b: Sanjeoteo nappe, c: A-unit), 6: black pelitic rocks, 7: basic rocks, 8: acidic rocks, 9: nappe boundary. The Sanjeoteo fold is of the same generation as the Gwanmo II fold in the Chungju area.

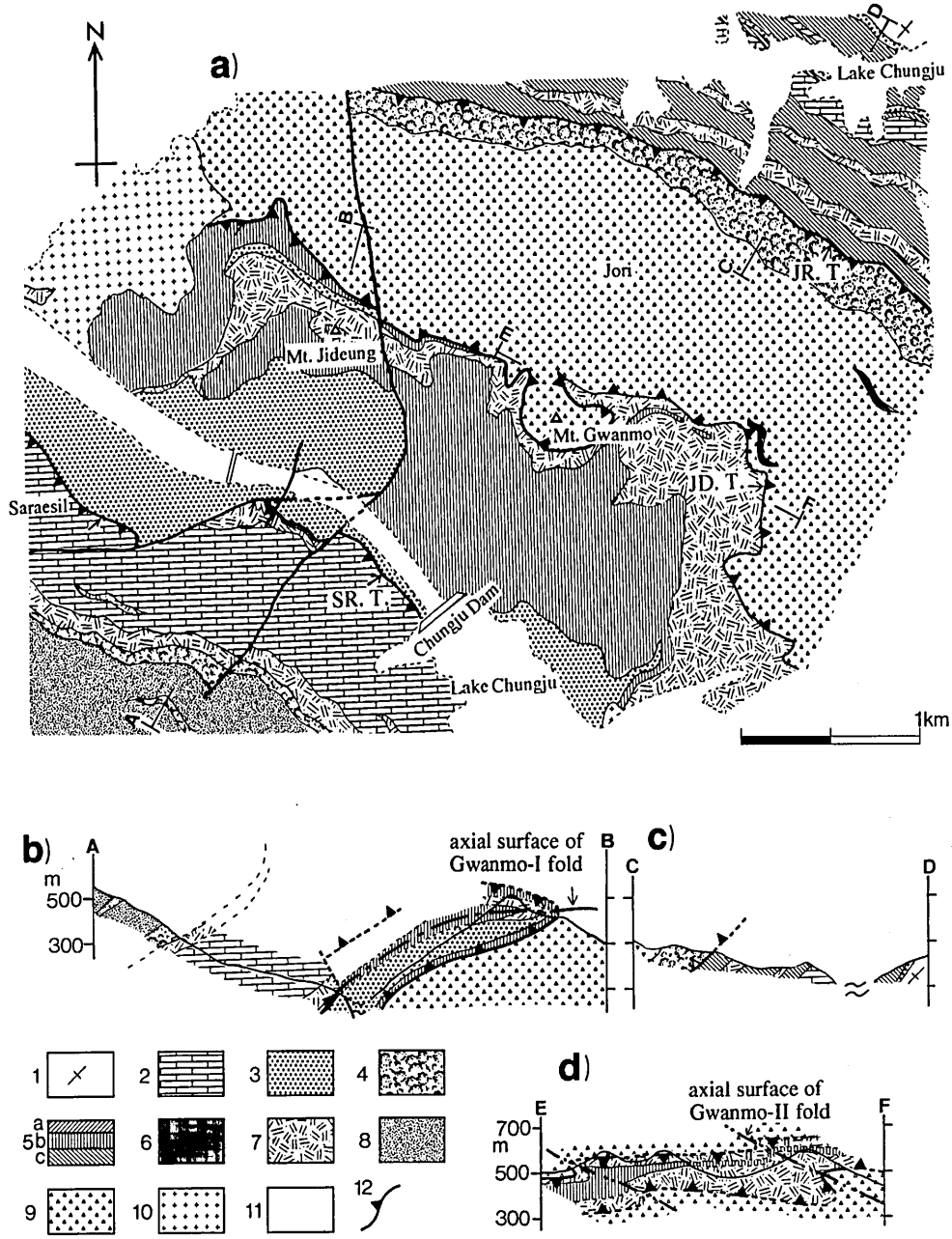

Fig. 5 Geological map (a) and profiles (b, c and d) of the Chungju subarea.
1: Busan gneiss complex, 2: calcareous rocks, 3: quartzites, 4: conglomerate rocks, 5: pelitic rocks (a: Kyemeongsan nappe, b: Jideungsan subnappe, c: A′-unit), 6: black pelitic rocks, 7: basic rocks, 8: acidic rocks of the Kyemeongsan nappe, 9: acidic rocks of the Jori subnappe, 10: Mesozoic granites, 11: Cenozoic rocks, 12: nappe boundary. SR.T: Saraesil thrust, JD.T: Jideungsan thrust, JR.T: Jori thrust.

reference to original lithofacies (Figs. 2 and 5). The lower unit consists of carbonate, basic and pelitic rocks, while the upper unit mainly of acidic and pelitic rocks, accompanying conglomerate and basic rocks in subordinate amount. Thus, it can be summarized that the Ogcheon Supergroup of the Chungju-Jangseonri area consists commonly of the upper unit with acidic rocks as predominant original lithofacies and of the lower unit with basic rocks as predominant original lithofacies (Fig. 3): The upper unit contains the upper unit of the Sanjeoteo nappe, the upper subnappe of Busan nappe II, the Jori subnappe and the upper unit of the Kyemeongsan nappe. The lower unit contains the lower unit of the Sanjeoteo nappe, the lower subnappe of Busan nappe II, the Jideungsan subnappe and the lower unit of the Kyemeongsan nappe. The lower unit and the upper unit must show a sedimentary sequence in the same sedimentary basin, i.e. the former is of the earlier phase and the latter is of the later phase of the Ogcheon sedimentary basin. Though magmatism found in the Ogcheon Supergroup is of bimodal type as pointed out by Cluzel *et al.* (1990, 1991), therefore, it would be said that basic magmatism and acidic magmatism were predominant in the earlier stage and in the

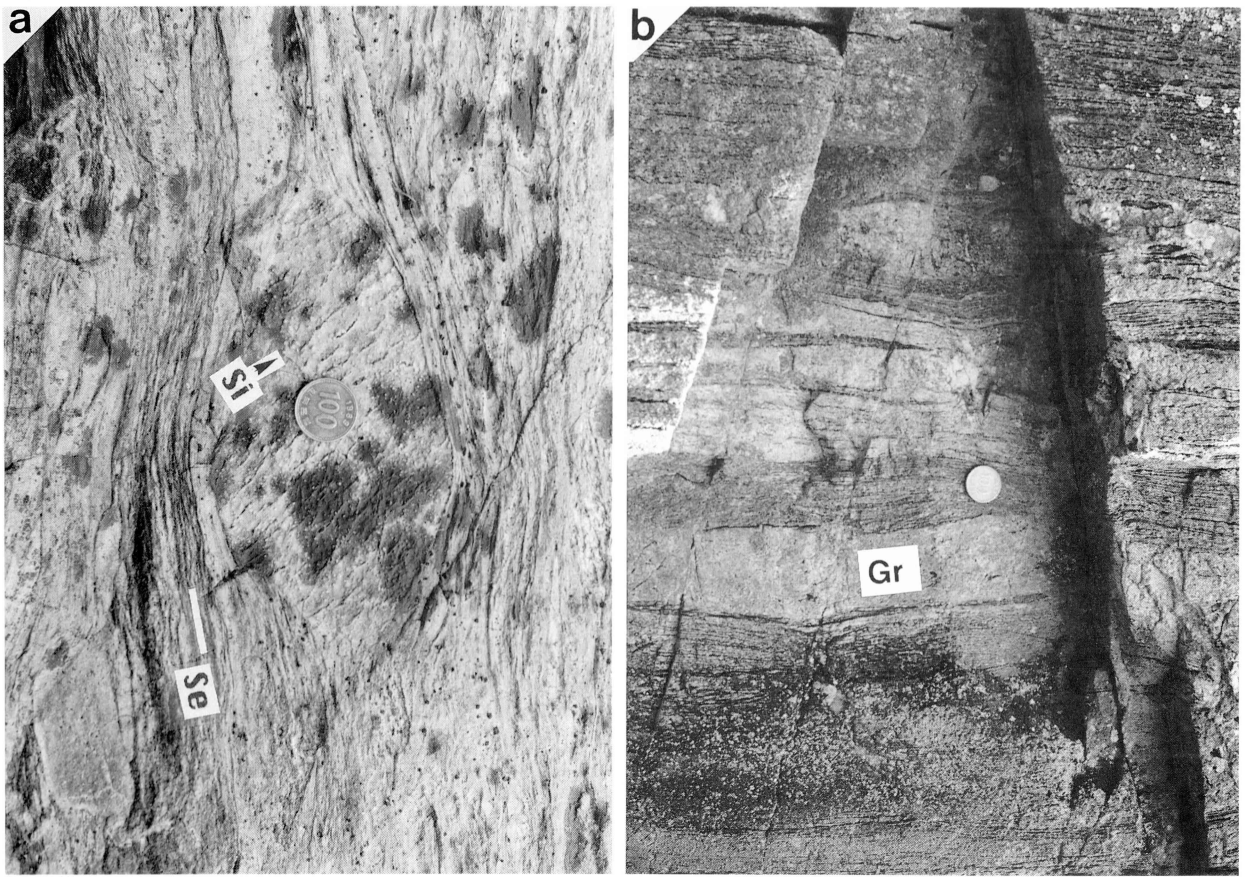

Fig. 6 Acidic rocks of the upper unit of the Kyemeongsan nappe.
a: shear lenses of mylonitized volcanic rocks. Si: schistosity in shear lense, Se: schistosity in matrix. b: mylonitized plutonic rocks (Gr) with distinct schistosity.

Fig. 7 Conglomerate of the Kyemeongsan nappe which contains pebbles of acidic rocks (white).

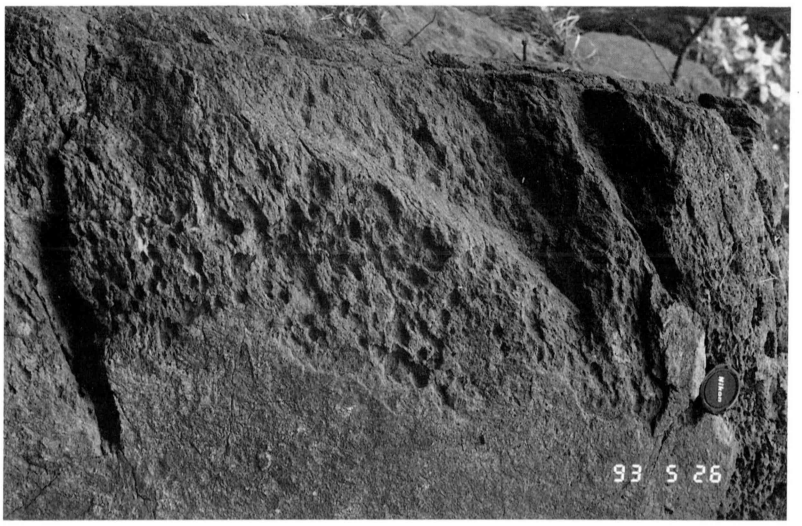

Fig. 8 Oblique relationship between the lithologic layering (horizontal) and the schistosity observed in metamorphic rocks the Jideungsan subnappe.

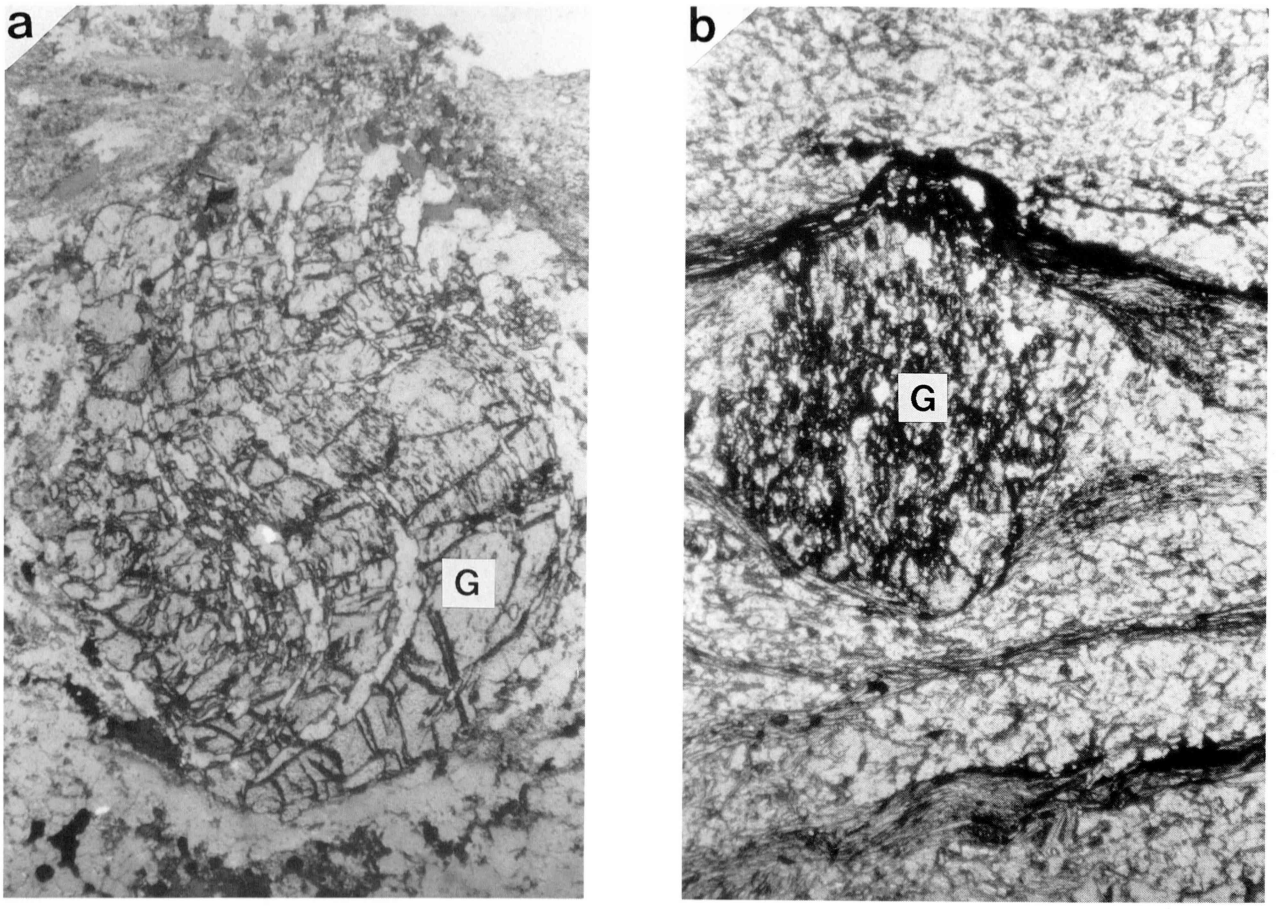

Fig. 9 Si-Se relation of garnet (G).
a: upper unit of the Kyemeongsan nappe, b: Jideungsan subnappe. Si is oblique to and discontinuous with Se.

later phase respectively.

The acidic rocks as original rocks appear to be much more predominant in the upper nappes, Kyemeongsan nappe and Chungju nappe, than in the lower nappes, Busan nappe II and Sanjeoteo nappe. The acidic rocks of the Chungju nappe and other underlying nappes are in general of volcanic types. While in these of the Kyemeongsan nappe there are plutonic (frequently syenitic and monzonitic) types as predominant constituents together with volcanic (frequently trachytic) types (Fig. 6). Conglomerate rocks of the upper unit of the Kyemeongsan nappe contain acidic rocks as main constituents of pebbles (Fig. 7), unlike the common facies of the Hwanggangri type conglomerate rocks, which is a characteristic constituent of the Ogcheon

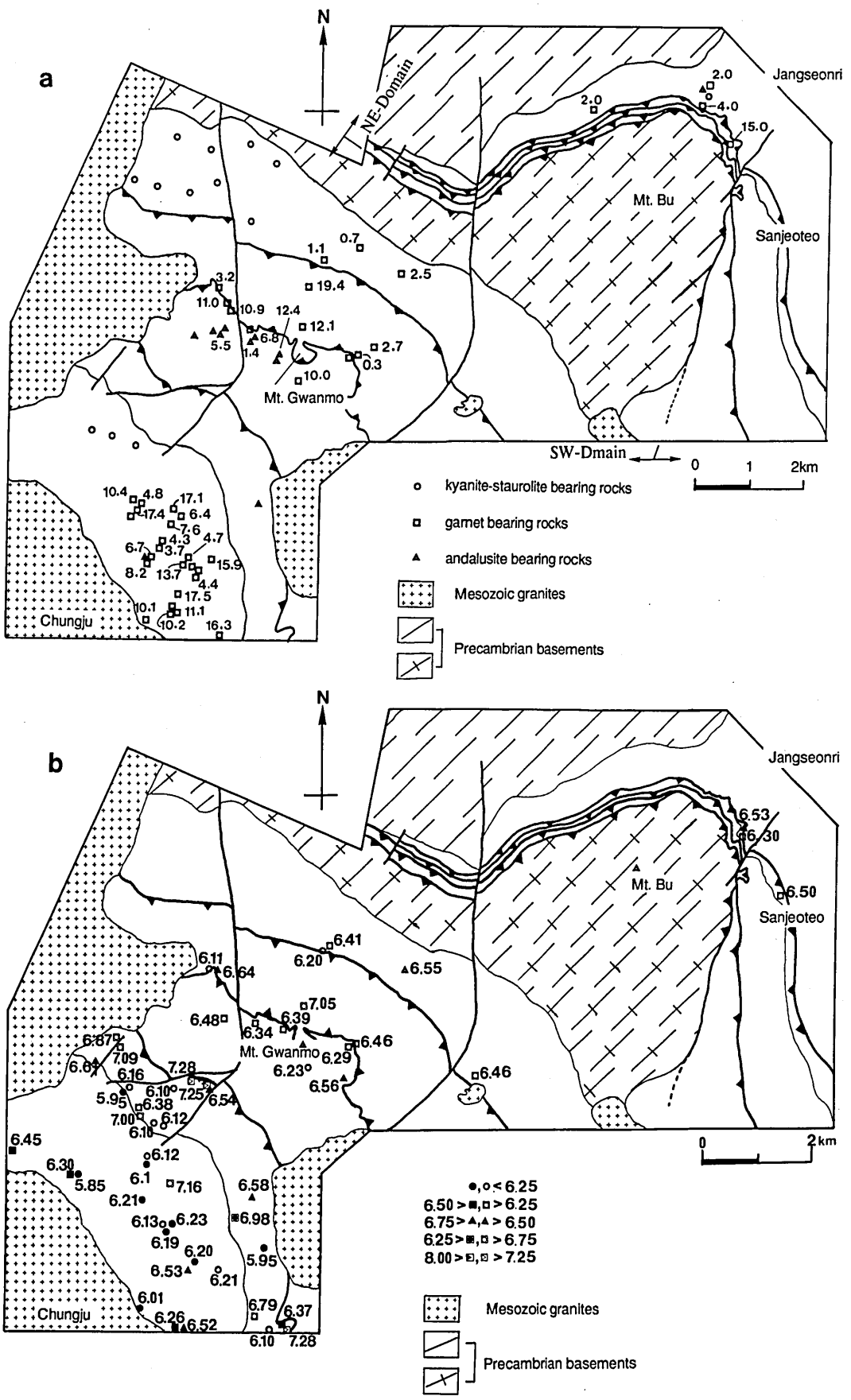

Fig. 10 a) Distribution of kyanite (and/or staurolite), garnet (minimum Mn content) and andalusite in pelitic metamorphics of the Chungju-Jangseonri area.
b) Minimum Si content of amphiboles in basic metamorphics of the Chungju-Jangseonri area.

Supergroup and characteristically contain carbonate pebbles. Thus, the Kyemeongsan nappe and its underlying nappes would be considered to have been derived from an activity center of acidic volcano-plutonism and from places away from such the activity center respectively.

IV. Time Relationship between Deformation and Metamorphism

The Gwanmo-I fold is formed by folding of a distinct schistosity of metamorphic rocks involved in the Chungju nappe. The schistosity appears to be the deformation structure of the first phase under naked eyes, frequently cutting across the lithologic layering (Fig. 8). However, detailed observation under the microscope indicates that the schistosity is frequently oblique to and discontinuous with Si schistosity of garnet (Fig. 9), like the case of the Ogcheon area reported by Kang *et al.* (1993). From this fact it can be said that in most of constituent rocks of the Chungju nappe the schistosity was reconstructed after the growth of garnet and before and during the Gwanmo-I folding. The deformation related to the formation of the Si schistosity of garnet is comparable with that of the Si phase in the Ogcheon area after Kang *et al.* (1993).

In the Jideungsan subnappe rims of garnet in pelitic rocks commonly are of low Mn content and amphibole in basic rocks is hornblende with low Si content (Fig. 10). While in the Jori subnappe rims of garnet commonly are of high Mn content, though from pelitic rocks just near the boundary between the Jideungsan subnappe and the Jori subnappe is rarely found garnet with rims of low Mn content, and amphibole in basic rocks is hornblende with high Si content (Fig. 10). The constituent rocks of the Jori subnappe are fine-grained, while these of the Jideungsan subnappe are distinctly coarse-grained frequently with garnet porphyroblasts of centimeter-size (Fig. 11), showing distinctly different feature under naked eyes between the former and the latter. The metamorphic grade appears to be discontinuous between the Jideungsan subnappe and the Jori subnappe. This is harmonic with the structural relation between them (Fig. 5). Fig. 12 illustrates parasitic folds of the Gwanmo-I fold in the Jori subnappe. This figure further indicates a pre-Gwanmo-I fold formed by the schistosity. Therefore, it would be assumed that the coupling of the Jori subnappe and the Jideungsan subnappe occurred before the Gwanmo-I folding accompanying the formation of the pre-Gwanmo-I fold. However, the deformation (D1) related to the coupling of these subnappes must have been continuous with the Gwanmo-I folding. The Gwanmo-I fold and the pre-Gwanmo-I fold appear to be coaxial through the Chungju nappe. The coupling of the Jideungsan subnappe and the Jori subnappe, which is related to the formation of the Chungju nappe and pre-Gwanmo-I fold, occurred accompanying the

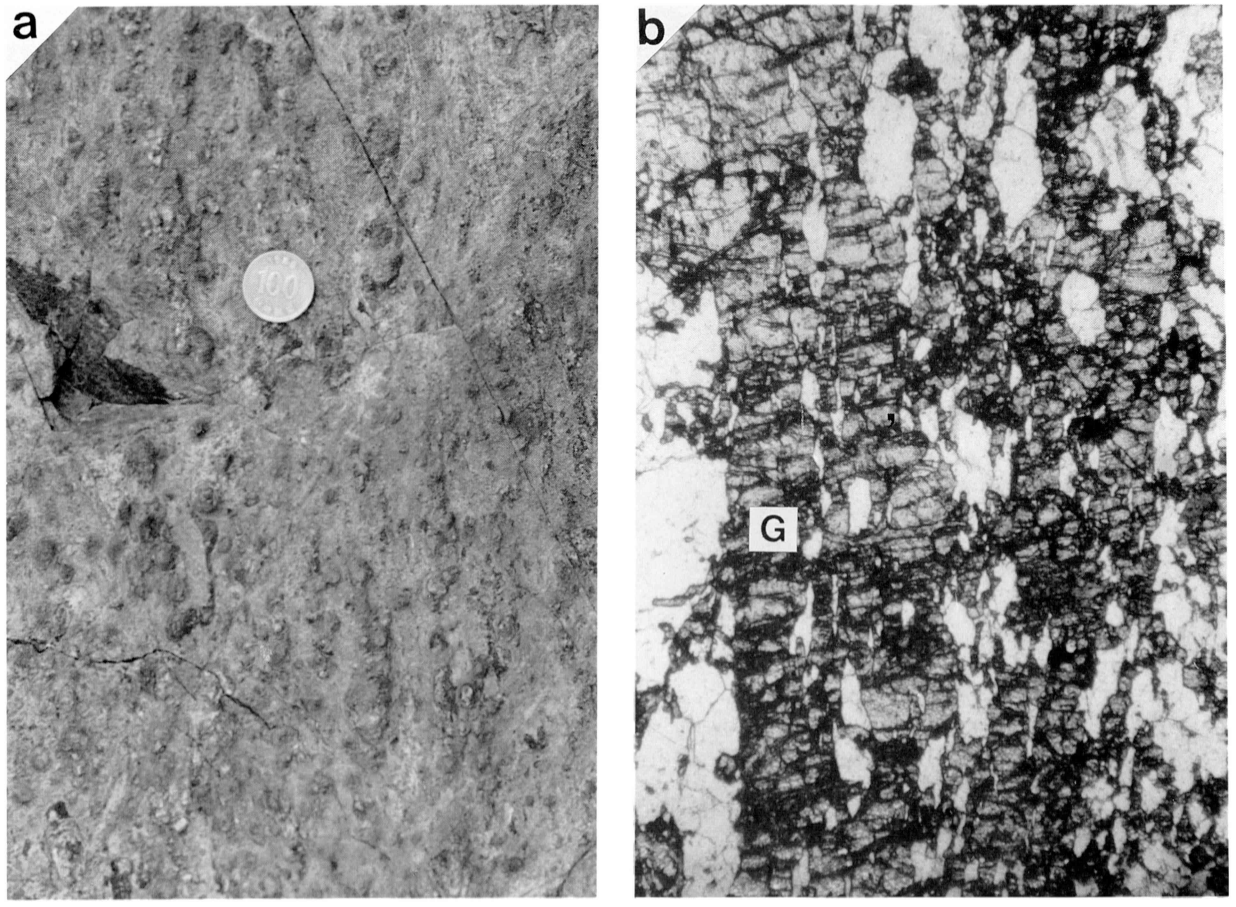

Fig. 11 a) Very coarse-grained garnet porphyroblasts of pelitic gneiss of the Jideungsan subnappe.
b) Microphotograph of the garnet porphyroblast (G). Si schistosity is straight through the porphyroblast.

ending of the metamorphism related to the growth of garnet, and the D1 deformation further gave rise to the Gwanmo-I fold. The formation of the Gwanmo-I fold is related to the coupling of the Chungju nappe with the Busan nappe I.

The geological structure of the Chungju nappe is further characterized by the development of the Gwanmo-II folds with NNE-SSW trending axes, being overprinted on the Gwanmo-I fold (Figs. 5 and 13). The Gwanmo-II folds show overturned fashion with WNW ward vergence. Their micro-scale parasitic folds are masked by andalusite (Fig. 14), clearly showing that andalusite type metamorphism first occurred after the Gwanmo-II folding. Therefore it can be said that the deformation (D2) related to the formation of the Gwanmo-II folds is comparable with the S2 deformation in the Ogcheon area after Kang *et al.* (1993). The Gwanmo-II folds are uniformly found with a constant axial trend of NNE-SSW and WNW ward vergence through the whole nappes of the Chungju-Jangseonri area. This is clearly shown in the geological map of the Sanjeoteo area (Fig. 4). This figure indicates that the D2 phase folds are overprinted with the same axial planes through the Busan nappe I, Busan nappe II, Sanjeoteo nappe and cover rocks of the Bakdalryeong gneiss complex. Fig. 14-b also illustrates the D2 phase fold of the Kyemeongsan gneiss complex whose axial plane schistosity is masked by andalusite. The coupling of the whole nappes in the Chungju-Jangseonri area occurred before the D2 deformation.

The Kyemeongsan nappe and the cover rocks of the Busan and Bakdalryeong gneiss complexes contain metamorphic minerals such as kyanite, staurolite and garnet with low Mn content in pelitic rocks, as well as andalusite, and hornblende of low Si content in basic rocks (Figs. 10, and 14), showing that, before andalusite type metamorphism, they were metamorphosed under the higher temperature condition of medium-pressure type metamorphism. The upper subnappe of Busan nappe II is comparable with the Jori subnappe with reference to metamorphic grade as well as

Fig. 12 Parasitic folds of the Gwanmo I fold with flat-lying axial surfaces and pre-Gwanmo-I fold in acidic schist of the Jori subnappe.

Fig. 13 A parasitic fold of the Gwanmo-II fold with distinct axial plane cleavage in the pelitic gneiss of the Jideungsan nappe.

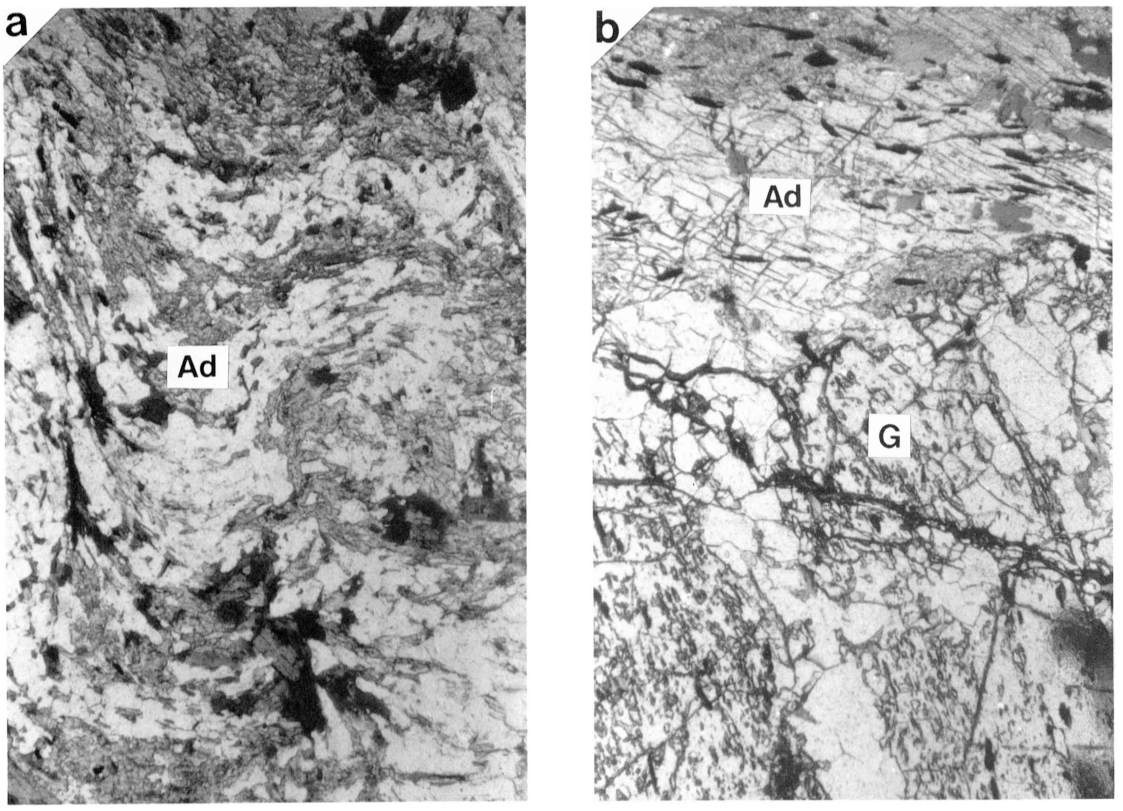

Fig. 14 Andalusite masking the axial plane cleavage of the Gwanmo II fold.
a) data from the Jideungsan subnappe, b) data from the Kyemeongsan nappe. Ad: andalusite, G: garnet.

lithofacies. Its metamorphic grade is lower than that of its surrounding nappes, as mentioned in the preceding page. Thus it can be said that the D1 deformation of the Chungju-Jangseonri area occurred giving rise to exhumation of the metamorphic rocks as nappes from the various parts of the field of medium-pressure type metamorphism and then the coupled nappe pile suffered the D2 deformation, being followed by andalusite type metamorphism. Such the sequence of the deformation and metamorphism of the Chungju-Jangseonri area is clearly comparable with that of the Ogcheon area, which has been clarified by Kang *et al.* (1993).

The metamorphic grade for the medium-pressure type metamorphism is lower in the Jori subnappe and the upper subnappe of Busan nappe II than in the Jideungsan subnappe, the lower subnappe of Busan nappe II, the Sanjeoteo nappe and the cover rocks (A-unit and A′-unit) of the Busan and Bakdalryeong gneiss complexes. This fact means that it is lower in the upper stratigraphic unit than in the lower stratigraphic unit, suggesting that the medium-pressure metamorphism occurred under the metamorphic field which showed a regular tendency for temperature to increase from the upper sedimentary sequence to the lower sedimentary sequence. Thus the tectonics for the phase of the medium-pressure type metamorphism appears to have occurred not giving rise to any great destruction of the initial sedimentary sequence.

Cluzel *et al.* (1990, 1991) clarified that the sedimentary basin for the Ogcheon Supergroup was an intracontinental rift zone developed during Cambro-ordovician age and that its metamorphism of the first phase is ascribed to the closing of the rift zone. The closing of the rift zone must be a collision of the Gyeonggi massif and the Busan-Bakdalryeong gneiss complexes, accompanying underthrusting of the latter and the Ogcheon Supergroup. The metamorphic field for the Jori subnappe/Jideungsan subnappe, the upper subnappe/the lower subnappe of the Busan nappe II and the upper unit/the lower unit of the Sanjeoteo nappe during the collision was of downward increase of temperature from the upper sequence to the lower sequence. However, the upper unit of the Kyemeongsan nappe is characterized by metamorphic minerals of the highest metamorphic grade in the Chungju-Jangseonri area. Acidic volcano-plutonic rocks of the upper unit of the Kyemeongsan nappe are highly mylonitized during the D1 deformation, clearly showing dynamic recrystallization of plagioclase and K-feldspar (Fig. 15). Such the deformation of feldspars is considered to have occurred under the temperature of higher than ca. 450°C (cf. Voll, 1976; Tullis, 1983). Pelitic and basic rocks intercalated in acidic rocks contain metamorphic minerals such as garnet with low Mn content and kyanite and hornblende with low Si content respectively (Figs 10). The upper unit of the Kyemeongsan nappe appears to have been initially an activity center of acidic volcano-plutonism, as mentioned in the preceding paragraph. These informations may suggest that thermal structure of the phase of such magmatism was inherited by that of the medium-pressure type metamorphism.

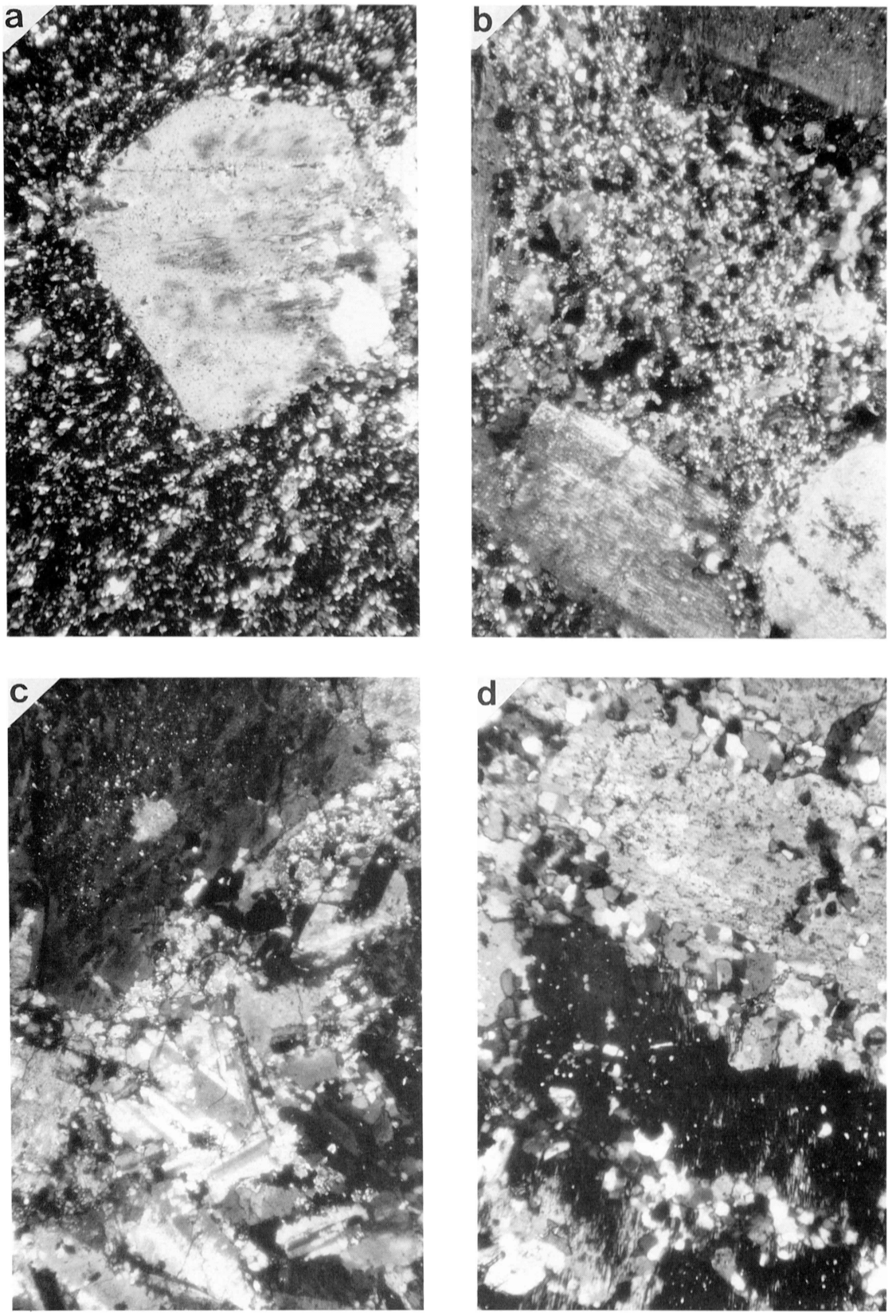

Fig. 15 Acidic rocks of the upper unit of the Kyemeongsan nappe.
a: vlocanic rock with very fine-grained matrix, b: volcanic rock with fine-grained matrix, c: hypabyssal rock with dynamically recrystallized plagioclase, d: plutonic rock with dynamically recrystallized K-feldspar.

References

Choi, W. C. and Kim, D. H., 1981: The study of Ogcheon geosynclinal belt (I). *Rept. Geosci. Min. Resour.*, **11**, 19–43, Korea Inst. Energy Resour.*

Cluzel, D., Cadet, J.P. and Lapierre, H., 1990: Geodynamics of Ogcheon Belt (South Korea). *Tectonophysics*, **183**, 41–56.

Cluzel, D., Jorivet, L. and Cadet, J. P., 1991a: Early middle Paleozoic intraplate orogeny in the Ogcheon Belt (S. Korea): a new insight on the Paleozoic buildup of east Asia. *Tectonics*, **10**, 1130–1151.

Cluzel, D., Lee, B. J. and Cadet, J. P., 1991b: Indosinian ductile dextral fault system and synkinematic plutonism in the southwest of Ogcheon Belt (S. Korea). *Tectonophysics*, **194**, 131–151.

Hong, Y. K., 1984: Geochemistry of garnet-biotite mineral pairs in the Hwanggangri area, Korea. *Jour. Geol. Soc. Korea*, **20**, 115–126.

Kang, J. H. Hara, I., Hayasaka, Y., Sakurai, Y., Shiota, T. and Umemura, H., 1993: Time-relationship between deformation and metamorphism of the Ogcheon Zone in the Ogcheon district, South Korea. *Mem. Geol. Soc. Japan*, **42**, 63–90.

Kim, K. W. and Lee, H. K., 1965: Geological map of Chungju sheet. Geol. Surv. Korea.*

Kim, N. J., Choi, S. O. and Kang, P. C., 1967: Geological map of Jecheon sheet. Geol. Surv. Korea.*

Kim, O. J., 1970: Geology and tectonics of mid-central region of South Korea. *Jour. Korean Inst. Mining Geol.*, **2**, 73–90.*

Kim, O. J. and Kim, K. H., 1974: The study of structure and Petrology of the area between Susanri and Hwanggangri. *J. Korean Inst. Mining Geol.* **7**, 101–122.

Kim, O. J., Min, K. D. and Kim, K. H., 1986: Geology and mineral resources of the Ogcheon Zone – the boundary between the Ogcheon and Choson Systems in the south of Jecheon, and the geology in its vicinity-. *Jour. Korean Inst. Mining Geol.*, **19**, 225–230.*

Kim, O. J. and Yu, K. M., 1977: The study of structure and petrology of the area between Hachonri and Weolgulri, Jecheon-gun. *Jour. Korean Inst. Mining Geol.*, **10**, 19–36.*

Kobayashi, T., 1966: Stratigraphy of the Chosen Group in Korea and South Manchuria and its relation to the Cambro-Ordovician formations of other areas, Sect. B. The Chosen Group of North Korea and Northeast China. *Jour. Fac. Sci. univ. Tokyo*, Sec. 2, **2**, 209–311

Lee, M. S. and Park, B. S., 1965: Geological map of Hwanggangri sheet. Geol. Surv. Korea.*

Na, K. C., 1987: Petrologic study on the Busan migmatitic gneiss in the northeastern margin of the Ogcheon Zone. *Jour. Korean Inst. Mining geol.*, **20**, 235–246.*

Na, K. C., Kim, H. S., Lee, D. J. and Lee, S. H., 1982: Comparative studies between Chungju and Seosan Groups. *Jour. Korean Inst. Mining Geol.*, **15**, 177–199.*

Park, P. S. and Um, S. H., 1971: Geological map of Moggye sheet. Geol. Surv. Korea.*Reedman, A. J. and Um, S. H., 1975: The geology of Korea. Geol. Min. Inst. Korea, 139pp.

Tullis, J. A., 1983: Deformation of feldspars. In: *Feldspar Mineralogy* (ed. by Ribbe, P. H.), Mineralogical Society of America short course notes, **2** (2nd. edn), 297–323.

Voll, G., 1976. Recrystallization of quartz, biotite, and feldspars from Erstfeld to the Leventina Nappe, Swiss Alps, and its geological significance. *Schweizerische Mineralogische und Petrographische Mitteilungen*, **56**, 641–647.

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