

**Stratigraphical Studies
on the Kumaishi Area, Southwestern Hokkaido**

By

Mitsuo HATA & Konroku TSUSHIMA

Abstract

The basement of the area studied is mainly made of granodiorite. The Tertiary System is divided into, in ascending order, the Fukuyama Group, Sekinai Formation, Kunnui Group, Esashi Formation, Tate Formation and Nagaiso Formation. The Fukuyama and Kunnui Groups are characterized by the "green tuff". The Sekinai Formation consists of sandstone and mudstone, the Esashi Formation chiefly of "hard shale" and the Tate Formation of tuff and tuffaceous siltstone. The Nagaiso Formation is mainly made of hornblende andesite.

The Daijima flora was found in the Sekinai Formation, and Kadonosawa fauna and Nishikurosawa-type foraminifera in the Kunnui Group. Judging from the fossils and lithofacies, the Fukuyama, Sekinai, Kunnui, Esashi, Tate and Nagaiso Formations are correlated respectively with the Fukuyama, Yoshioka, Kunnui, Yakumo, Kuromatsunai and Nigorikawa Formations in the standard stratigraphy of southwestern Hokkaido.

The difference of the amounts of sediment accumulation between the east and west sides of the dome of granodiorite is remarkable.

1. Introduction

The area under consideration belongs to the so-called "green tuff region". On the geology of the area, T. SHIMOTOMAI and K. FUKUDATE surveyed in 1936.

Several students (K. MAKINO (1953), F. KONNO (1958) and T. KOSHINO (1953)) investigated the same area for their graduation and promotion theses of the Faculty of Science, Hokkaido University. Their results are as follows : the sequence of the Neogene rocks begins with the Kunnui stage, lacking the Fukuyama stage.

Since 1965 the writers have investigated the area to clarify the stratigraphy and geological structure. After this, they have clarified that all of the formations, including the Fukuyama Group, of the standard sequence of the southwestern Hokkaido existed in the area.

2. Stratigraphy

In the western half of the Oshima peninsula, the "Paleozoic formation" and the granitic intrusive bodies form the basement of the Cenozoic sediments. In the north of the Shiramizu-dake, the Paleozoic strata, consisting of clayslate, sandstone and chert, are found. In the Kumaishi area, the basement rock is granodiorite exposing in the center of the area.

The Neogene strata run around the basement and make a dome. These are

subdivided into the Fukuyama Group, Sekinai Formation, Kunnui Group, Esashi Formation, Tate Formation and Nagaiso Formation in ascending order, occasionally intruded by the intrusives of diorite-porphyrite, rhyolite, andesite and basalt. Covering the above-mentioned rocks, the Pleistocene terrace deposits and Alluvial deposits develop along the coast and the rivers.

The stratigraphical succession is shown in the following table.

Table 1 Geological column of the Kumaishi area

Age	Stratigraphy	Thickness (m)	Column	Lithology	Fossil	Volcanic activity		
Quaternary	Holocene			Sand, gravel and clay				
	Pleistocene			Sand, gravel and clay		Rhyolite-Dacite		
			2-6		Sand, gravel and clay		Andesite	
			2-5		Gravel, sand and clay		Basalt-dolerite Diorite-Porphyrite	
	2-4		Gravel, sand and clay					
Neogene Tertiary	Nagaiso Formation	300		Hornblende andesite lava, tuff-breccia				
		+350		Massive siltstone with dacitic tuff and calcareous nodules				
	Tate Formation	250		Alternation of hard shale and silty mudstone, with siliceous nodules and tuff. Glauconitic, tuffaceous siltstone in basal part	Diatom			
		500						
	Miocene	Sandstone bed	350		Alternation of green sandstone and tuff-breccia with mudstone in the upper part	Makiyama chitani		
			400					
		Kunnui Group	Tuff-breccia bed	200		Andesitic tuff-breccia and volcanic conglomerate with lava		
				350				
	Mudstone bed	10-60		Black mudstone	Foraminifera (Nishikurosawa type) Kadonosawa fauna			
		100-150		Conglomerate and sandstone				
Sekinai Formation	200-250		Alternation of sandstone and mudstone conglomeratic sandstone	Dajima flora				
Fukuyama Formation	+600		Pyroxene andesite and propylite with tuff-breccia and welded tuff. Tuff and conglomeratic sandstone in basal part					
Pre-Tertiary	Granodiorite			Biotite-hornblende granodiorite				

2.1 Granodiorite

The granodiorite is the basement rock of the area. It is exposed in the Futamata-gawa area in the eastern part of the surveyed area and in the Reisuidake and its environs in the central part of the area.

Lithologically the rock is divided into two types. One is medium-grained, greyish black in color, rich in hornblende and poor in biotite. Another is coarse-grained, greyish white, rich in biotite and dotted with large hornblende.

Under the microscope, plagioclase, hornblende and biotite are idiomorphic or hypidiomorphic, less than 3 mm across. A small amount of quartz and microcline fill interstices among the phenocrystic minerals. Quartz attains sometimes to 3 mm across.

Biotite and hornblende generally suffer chloritization. The granodiorite mass is intruded by small dykes of fine-grained pegmatite and aplite.

2.2 Fukuyama Group

The Fukuyama Group, covering the granodiorite unconformably, is distributed

from the upper stream of the Sekinai-gawa in the northern part to the Hiyamizu-gawa in the southern part of the area.

The basal part consists of tuff and thin conglomeratic sandstone, and the unconformity is well observed along the Futamata-gawa. The lower part of the Fukuyama Group is mainly composed of lava and sheet of basaltic andesite or augite hypersthene andesite. The middle part is composed of alteration products from lava and tuff-breccia. The upper part is composed of lava and tuff breccia of pyroxene andesite, intercalated with tuffaceous sandstone.

To the west of the Ken'ichi-gawa, lava flows are predominant, and to the east, tuff-breccia, respectively. Besides, a small amount of rhyolite and welded tuff are found.

Basaltic andesite or pyroxene andesite

There are two kinds of rocks, that is, one is rich in phenocrysts, and the other barren in them. The phenocrysts are plagioclase, augite and altered olivine, and the finer-grained phenocrysts are hypersthene and brown hornblende with opaque borders.

The groundmass shows pilotaxitic texture, and consists of plagioclase, hypersthene, iron ore, glass, with rare occurrence of augite and cristobalite. The rock generally shows green color by alteration. Epidote is found in the rocks intensively altered.

The thickness of the Fukuyama Group ranges from 400 to 500 m in the eastern part, and exceeds 600 m in the northwestern part where the lava flows are predominant.

Although the Fukuyama Group rarely contains coaly matters, age-determinable fossils have never been found. However, the authors consider that this group can be correlated with the Fukuyama Group, because this group is covered unconformably by the Sekinai Formation which yields the Daijima flora.

2.3 Sekinai Formation

The Sekinai Formation rests unconformably upon the Fukuyama Group, and is distributed only to the north of the Ken'ichi-gawa. The formation is mainly composed of the alternation products of sandstone and mudstone, intercalated with thin layers of coaly shale. The basal part of the formation is composed of coarse-grained arkose sandstone containing the small pebbles of granodiorite and altered andesite.

The sandstone which alternates with mudstone is medium- or coarse-grained arkose sandstone, and is made mainly of weathered clastic material of granodiorite. A stratum of the alternating sandstone of 1 or 2 m in thickness is found and contains sometimes carbonized woods.

The mudstone, colored from dark grey to black, shows distinct banded lamination and yields plant fossils. The thickness of stratum of the mudstone ranges from 0.1 m to 1 m. The formation which is 200 m to 250 m thick lies only

at the western part of the area.

Though the sedimentary gap shown by the unconformity beneath the Kunnui Group is not negligible, the amount of erosion might not be so large the Sekinai Formation were wholly eroded out. It is probable that there were few deposition.

The fossil plant and pollen are found in the Hiratanai-gawa. They belong to the Daijima flora and indicate the middle Miocene age. The plant fossils found in the upper course of the Hiratanai-gawa were reported by T. TANAI as follows (1963) :

Keleleeria ezoana TANAI

Pinus miocenica TANAI

Pseudolarix japonica TANAI and ONOE

Comptonia naumannii (NATHORST) HUZIOKA

Carya miocathayensis HU and CHANEY

Fagus antipofi HEER

Quercus elliptica TANAI and N. SUZUKI

Ulmus longifolia UNGER

Zelkova ungerri KOVATS

Parrotia fagifolia (GOEPPERT) HEER

Comptonia naumannii occupies nearly 90 per cent of the total specimens collected.

The formation may be correlated stratigraphically with the Yoshioka Formation, because this formation has not marine fossils and is evidently fresh water deposits.

2.4 Kunnui Group

The Kunnui Group is characterized by marine "green tuff". These pyroclastic sediments decrease their thickness rapidly toward the south and are eroded out by the unconformity beneath the Esashi Formation.

It is divided lithologically into Conglomerate bed, Mudstone bed, Tuff-breccia bed and Sandstone bed, in ascending order.

a) Conglomerate bed

The Conglomerate bed covers the underlying Sekinai Formation with clear unconformity. The lower half of the bed consists almost of conglomerate, which contains a large amount of huge boulders of granodiorite of the basement and a small amount of boulders of altered andesite derived from the Fukuyama Group.

Some huge boulders of granodiorite, occurring most abundantly to the east of the Ken'ichi-gawa, attain to 2 m in diameter.

In the area to the west of the Hiratanai-gawa, the conglomerate includes the round pebbles, 1 ~ 5 cm in size, of chert and clayslate in addition to the above-cited boulders of granodiorite.

The upper half of the bed is composed of the alternation of conglomerate and medium-grained sandstone containing coaly matters. The boulders of the conglomerate are smaller than in the lower half. The sandstone is ill-sorted and shows

cross-lamination.

The thickness varies remarkably in different localities, that is, it measures 100~150 m to the west of the Ken'ichi-gawa, and less than 20 m in the tributary of the Futamata-gawa.

In the sandstone distributed along the Hiratanai-gawa, following marine shells are found.

Siphonaria cf. *s-nomurai* HATAI

Clinocardium cf. *shinjiense* (YOKOYAMA)

Dosinia tugaruana NOMURA

Tapes siratoriensis OTUKA

Macoma optiva (YOKOYAMA)

Mya sp.

Ostrea gravitesta YOKOYAMA

(Determined by A. MIZUNO)

They contain species in common with those of the Kadonosawa fauna in northeastern Honshu.

b) Mudstone bed

The Mudstone bed, resting conformably on the Conglomerate bed, is made of massive black mudstone. It is exposed best along the Ken'ichi-gawa and decreases its thickness gradually toward the west. This bed was accumulated under fairly stable environment.

At the lowermost part (transitional zone from the underlying Conglomerate bed) of this bed along Ken'ichi-gawa, shell fossils such as *Portlandia*, *Yoldia*, *Macoma*, *Periploma*, *Dentalium*, *Natica*, *Neptunea* are found. Foraminifera found in the bed along the main stream of the Hiratanai-gawa are listed as follows :

Anomalinoidea cf. *globulosa* CUSHMAN and PARR

Burizarina aff. *robusta* BRADY

Praeglobobulimina pupoides D'ORBIGNY

Praeglobobulimina cf. *ezoensis* YOKOYAMA

Cibicides cf. *pseudoungerianus* CUSHMAN

Stilostomella sp.

Fissulina etigoense ASANO and MURATA

Eponides umbonatus (REUSS)

Eponides sp.

Globigerina sp. ind.

Guttulina yabei CUSHMAN and OZAWA

Gyroidina orbicularis D'ORBIGNY

Hanzawaia sp.

Cribrostomoides renzi ASANO

Lagena sulcata spicata CUSHMAN and McCULLOCH

Lagena laevis (MONTAGU)

Amphycorina fukushimaensis ASANO

"*Marginulina*"? sp.

Martinottiella communis (D'ORBIGNY)

Nodosaria sp.

Nonionella miocenica stella (CUSHMAN and MOYEA)

Lenticulina cf. *nicobarensis* (SCHWAGER)

Ammonia cf. *japonica* HADA

Ammonia sp.

Sigmomorphina notoensis ASANO

Sphaeroidina austriaca D'ORBIGNY

(Determined by T. OKURA)

The fauna consists almost of calcareous foraminifera, and includes many species in common with those from the Nishikurosawa Formation in northeastern Honshu. Beside the above-cited foraminifera, fossils of shell (*Portlandia* sp.), *Makiyama* sp., fish scale and teeth of sharks are also found in the bed. The thickness of the bed ranges from 10 m to 40 m.

c) Tuff-breccia bed

The Tuff-breccia bed is generally green-colored. The bed is composed mainly of tuff-breccia and volcanic conglomerate of pyroxene andesite, and rests on the Mudstone bed. It is exposed typically along the stream of the Hiratanai-gawa.

The layers of rhyolitic tuff-breccia form the lowermost part, and hornblende andesitic lava and volcanic conglomerate the middle part. The pebbles of the tuff-breccia tend to be larger towards the lower part. The pebbles of volcanic conglomerate also tend to increase the diameter toward the lower part, and the boulders occasionally exceeds 30 cm across.

Beside these, thin andesitic lava and light-green coarse sandstone layer are rarely interbedded.

Pyroxene andesite

The phenocrysts are plagioclase and augite. The fine-grained phenocrysts are composed of hypersthene, rarely hornblende and biotite. The groundmass is hyalopilitic, and consists of plagioclase, pyroxene, iron ore and glass.

The thickness of the Tuff-breccia bed is 300 ~ 350 m in the west area. In the east area, it attains to nearly 200 m along the road between Kumaishi and Yakumo, however, decreases abruptly toward the south, and finally thins out in the Reisui-gawa.

d) Sandstone bed

The Sandstone bed covering the Tuff-breccia bed conformably, is mainly composed of light-green sandstone, intercalated with the many layers of green-colored tuff-breccia. The sandstone is medium- or coarse-grained and of volcanic origin, and includes plagioclase and biotite markedly.

The tuff-breccia is composed mainly of the debris, 2 ~ 5 cm in diameter, of pyroxene andesite and hornblende andesite, and resembles that of the underlying

Tuff-breccia bed.

In the upper and middle parts of the Sandstone bed, is found dark grey mudstone. The thickness of the bed is 350 ~ 500 m in the west area, while 100 m in maximum in the east area.

The mudstone includes *Makiyama* sp. In the upper stream of the Kaitori-ma-gawa, *Patinopecten kimurai* (YOKOYAMA) is found.

2.5 Esashi Formation

The lithofacies of the Esashi Formation differs between the west and the east areas. In the west area, Kumaishi district, the formation consists of mudstone or siltstone intercalated with thin layers of "hard shale". Its thickness is about 200 m. This lithofacies well resembles that of the Esashi Formation in the type locality, Esashi-machi.

In the east area, the formation occupies the southern extension of the typical Yakumo "hard shale" Formation, and it shows the obvious "hard shale" facies. The formation consists of thin alternations of dark grey hard mudstone and soft mudstone, occasionally interbedded with siliceous hard mudstone.

At places, siliceous or calcareous nodules are contained, and thin layers of glassy tuff and tuffaceous sandstone are intercalated. The thickness of the formation extends 700 m.

Except for the sporadical occurrence of *Cyclammmina japonica* ASANO and *Makiyama chitanii* MAKIYAMA, shell fossils are scarcely found.

The basal part of the formation is composed of thin glauconitic sandstone or tuffaceous sandstone. It rests unconformably on the Kunnui Group. The Esashi Formation is correlated with the Yakumo Formation of the typical "hard shale" facies.

2.6 Tate Formation

The Tate Formation is mainly made up of homogeneous massive siltstone. It rests on the Esashi Formation with gradual change. Its boundary is marked by the tuff layers, 1 ~ 2 m in thickness, derived from the biotite-bearing dacite.

The siltstone is generally tuffaceous, and occasionally diatomaceous. Its color is generally dark grey, and light grey when weathered. Many tuff layers are intercalated, and the lithic character varies from glassy to biotite-bearing dacitic. Among them, dacitic pumice tuff layer, attaining to about 30 m thick, is remarkable.

Calcareous nodules are found, although the upper limit of the formation is unknown, its thickness extends 350 m near Kumaishi.

Except for *Coscinodiscus* sp., *Makiyama chitanii* MAK., fossils have not been found.

The Tate Formation equivalents stratigraphically to the main part of the Kuromatsunai Formation.

2.7 Nagaiso Formation

The Nagaiso Formation develops along the coastal region from Kumaishi to

Nagaiso. It includes tuff-breccia and lava of hornblende andesite and rests on the underlying strata unconformably. The tuff-breccia mainly occupies the lower part of the formation. The basal conglomerate including siltstone pebbles from the Tate Formation shows clear evidence of unconformity.

The lava interfingers with the tuff breccia in the upper part. The columnar joints are well developed. The hornblende andesite varies in granularity from coarse- to fine-grained, and also in color from dark grey to greyish white.

The phenocrysts are plagioclase, brown hornblende and rarely altered pyroxene. The groundmass is fine and rich in glass, spotted with plagioclase, hornblende and iron ore.

Though age-determinable fossils has not been found, this formation is considered to be products of Pliocene volcanic activity which corresponds to that of Nigorikawa stage in the Oshima peninsula. The thickness of the formation attains to 300 m in maximum.

3. Intrusive rocks

Diorite-porphyrite and rhyolite are intruded into the Kunnui Group, and dolerite into the Esashi Formation and pyroxene andesite dykes occur.

3.1 Diorite-porphyrite

The diorite-porphyrite occurs across a tributary of the upper course of the Sekinai-gawa, running with N-S trend, and the length attains to about 3.5 km.

The color of this rock is generally greenish, however, the hydrothermally altered one shows rather greyish white due to the presence of quartz and sericite.

This rock is characterized by the remarkable porphyritic texture with phenocrysts of plagioclase, hornblende and corrosive quartz. The groundmass is made of coarse-grained quartz and plagioclase. The rock is considered to have a close genetical relation with the hornblende andesite of the Nagaiso Formation.

3.2 Rhyolite

The rhyolite occurs mainly in the northeastern part of the area forming separated masses. Various lithology are observed in the outcrops. Some of them are strongly silicified. In general, flow structure and the columnar joint well develop. A small amount of phenocryst of quartz, plagioclase and hornblende, sometimes biotite is observed. These minerals mentioned above are frequently altered into clay minerals or carbonates. The groundmass is microcrystalline with association of minute chlorite.

3.3 Dolerite

Numerous sheets of dolerite are intruded into the Esashi Formation along the upper stream of the Futamata-gawa. The tint of this rock is greenish black. The rock appearance is generally massive but occasionally looks like sandstone when weathered.

Microscopically, typical intersertal texture made of plagioclase, iddingsitized

olivine and chloritized augite are observed. Some of them are often large, and they are easily distinguished as phenocryst from the groundmass.

3.4 Pyroxene andesite

The pyroxene andesite occurs as a small mass of dyke form in the area along the Ken'ichi-gawa. The rock is dark grey and is compact. It is composed of considerable amount of phenocryst and fine-grained groundmass.

The phenocrysts are plagioclase and augite, and the groundmass is mainly made of plagioclase, altered pyroxene and a small amount of iron ore and glass showing hyalopilitic texture.

4. Geologic structure

The upper Tertiary deposits form a large domical structure, surrounding the granodiorite of the basement. There are two faults running parallel with each other in the Ken'ichi-gawa district. One is called Ken'ichi-gawa fault, of N-S trend, and the other is called Futamata-gawa fault, both of NNE-SSW trend. Being surrounded by the two faults, the Neogene Tertiary formation subsides, and the area to the east of Futamata-gawa fault relatively rises.

Generally, faults, in the east area of NNE-SSW trend, and in the west area of NNW-SSE trend are predominant. Next the tectonic movement during the Neogene Tertiary and the environment of accumulation in the east and west sedimentary basins are described below.

Fukuyama age

In this age violent volcanic activity of andesite took place on the basement of low relief. The volcanism was accompanied with faulting. The deposition occurred on the land, and the difference between the east and west areas was scarcely recognized.

Sekinai age

During the deposition of the Sekinai Formation, the west area had a tendency to subside, and the deposition occurred under the fresh water.

Kunnui age

In the Kunnui age simultaneously with the transgression the subsidence began. At first, thick deposits, varying in thickness at different localities, were accumulated. Next, the sea became stable and accumulated the black mudstone uniformly. About the middle of this age the submarine volcanic eruption violently commenced accompanied with faulting and folding, and brought the accumulation of the "green tuff" in large quantity. Since then, the contrast between the east and west areas became remarkable.

In the west area the thickness of the sediments measures 700 m to 900 m, while in the east less than 300 m and diminished rapidly toward the south.

Yakumo age

In contrast with the Kunnui stage in the west area the Yakumo Formation

showed transitional facies between "siltstone facies" and "hard shale facies". It is 200 m thick in maximum. In the east area the obvious "hard shale" developed more than 600 m thick.

The reason of the differential amounts of accumulation between west and east depositional basins is considered as follows: The migration of the center of accumulation took place at the time of the extensive transgression, which brought about the unconformity. And this is considered to be caused by the large-scale

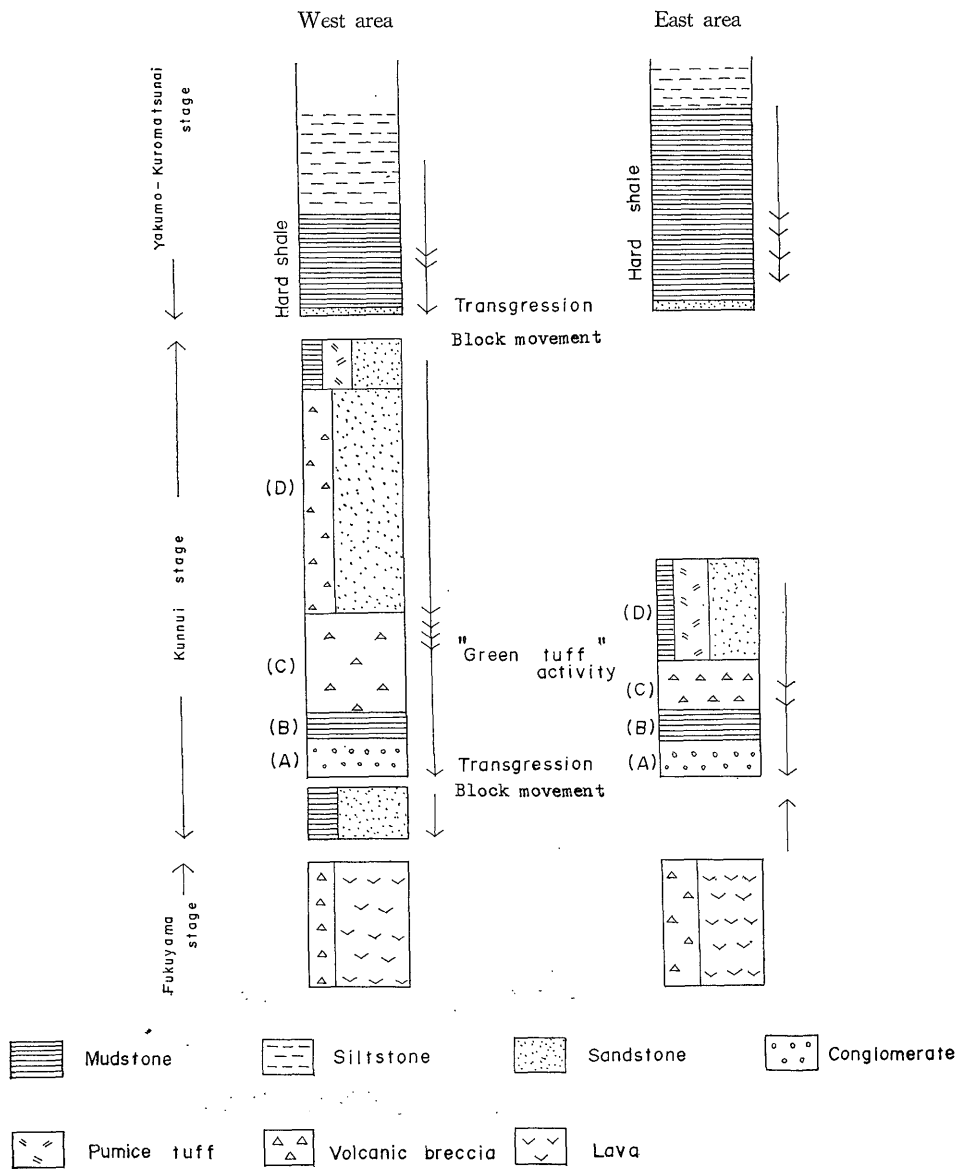


Fig. 2 Columnar sections of the east and west areas

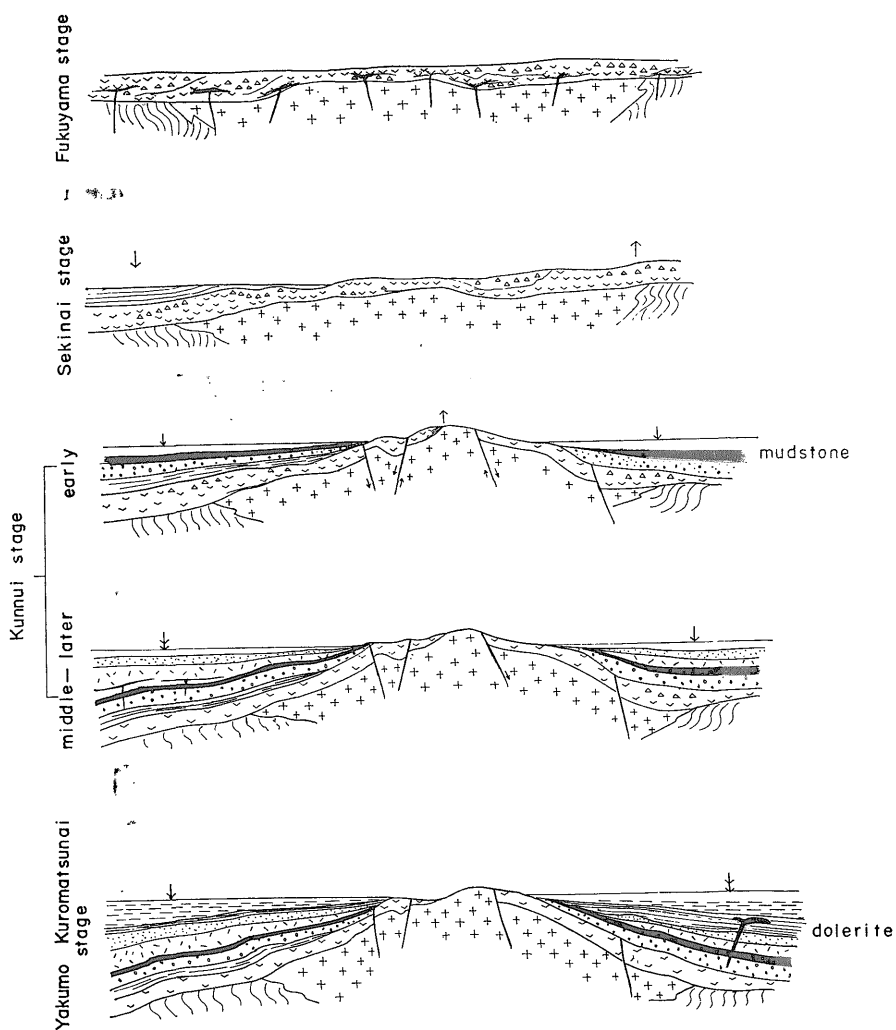


Fig. 3 Idealized E-W sections showing changes of the sedimentary basin

block movement and seesaw movement of the southern Hokkaido.

5. Conclusion

The area under consideration belongs to "green tuff region" of the southwestern Hokkaido. The Neogene Tertiary sediments is distributed, forming dome structure surrounding the basement granodiorite. The area comprises all formations equivalent to those of the standard stratigraphical sequence of the Miocene strata (Fukuyama, Yoshioka, Kunnui, Yakumo, Kuromatsunai, Nigorikawa Formations) and is one of the most suitable areas for the study of stratigraphy and mechanism of sedimentation in southern Hokkaido.

As fossil animals and plants to determine the geological age, the Daijima flora from the Sekinai Formation (the Yoshioka Formation equivalent), the shell

fossils of the Kadonosawa fauna and the foraminiferal fossils containing many common species with the Nishikurosawa Formation are mentioned. The unconformity at the time of the transgression of the Kunnui age is very remarkable.

The green tuff which forms the middle to upper part of the Kunnui Group has the thickness attaining to 700 m in the west wing of the dome, while shows marginal facies with the thickness of 0~300 m in the east wing. Contrary to the Yakumo stage, the thickness of the "hard shale" measures only 10~20 m in the west area, and in the east exceeds 600 m.

Thus the differential sinking of the both sedimentary basins may have been related to the change of location of the accumulation center caused by the block movement of the basement rock.

References

- HATA, M. (1967) : The Neogene Tertiary of the Vicinity of Kumaishi-machi, Western Hokkaido, *Kōen Yōshiroku*, no. 18, Geol. Surv. Jap. Hokkaido Branch.
- HATA, M. (1967) : The Neogene Tertiary of Kumaishi District, Hokkaido, *Jour. Geol. Soc. Japan*, vol. 73, no. 2.
- KONNO, F. (1958) : The Geology of Kaitorima-Nagaïso of Taisei-mura, Kudo-gun, (Manuscript), *Promotion Thesis, Fac. Sci., Hokkaido Univ.*
- KOSHINO, T. (1953) : The Geology of North-Western Kumaishi-mura, Nishi-gun, (Manuscript), *Graduation Thesis, Fac. Sci., Hokkaido Univ.*
- MAKINO, K. (1953) : The Geology of South-Eastern Kumaishi-mura, Nishi-gun, Oshima Province, (Manuscript), *Graduation Thesis, Fac. Sci., Hokkaido Univ.*
- SHIMOTOMAI, T. and FURUDATE, K. (1936) : Report of Valuable Minerals in Hokkaido, *Hokkaido Ind. Res. Rep.*
- TANAI, T. (1963) : Tertiary Floras of Japan—Miocene Flora—The Collaborating Association to Commemorate the 80th Anniversary of the Geological Survey of Japan.

西 南 北 海 道 熊 石 付 近 の 第 三 系 の 層 位

秦 光 男 对 馬 坤 六

要 旨

本地域は西南北海道のグリンタフ地域にあたり、花崗閃緑岩を基盤として、新第三系がドーム状に分布する。特に道南標準層序となつている福山層から濁川層相当までの各層が発達していることが明らかになつた。

化石として関内層から台島植物群、訓縫層群下部から門の沢動物群に属する貝化石および西黒沢型の有孔虫を発見した。

さらにドームの東翼、西翼の堆積機構の差について論じた。