6. *Petrographic Notes on the Sedimentary Rocks of Southwest Sagami Province. (Part I.)*

By Hiromichi TSUYA,

Earthquake Research Institute.

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Introduction.

The Cainozoic formations so widely distributed in the Kwantô district include various sedimentary rocks formed by accumulations of detritus and of fragmental material of volcanic origin. They exhibit great variety of composition and lithic characters, and are divided stratigraphically into various groups. Although no less important; contrasted with the igneous rocks, they have not received the attention they deserve from petrologists. Microscopic study of these sedimentary rocks may reveal many subdivisions, each exhibiting characteristics due to the physiographic conditions under which they were deposited, as well as to the sources whence they were derived. By recognizing these two conditions it should be possible to determine what physiographic changes, if any, have occurred, and what kind of volcanic products were ejected in the Kwantô district in geologically recent time, a determination important for detecting recent crustal movements and volcanic activities that have played their part in the district.

From the petrogenic standpoint a detailed determination of the rock-minerals composing the volcanic sediments is particularly desirable, in that it may furnish a clue to the genetic relation of these sediments to the materials that went to form the volcanoes, and from which material these sediments are derived.

This paper is a preliminary contribution to the petrography of the sedimentary rocks of the Kwantô district, particularly those of the southwestern part of Sagami Province.

Petrography of the Sedimentary Rocks of Enosima, Sagami.

Enosima is an island, about 0·25 sq. km. in area, lying near Kamakura on the northern shore of Sagami Bay, and well-known for its beautiful scenery. Geologically, the island is of Cainozoic formation which, according to the late Y. Ozawa, may be divided as follows:

Pliocene....Miura series { Lower group: Massive tufaceous sandstone and tuff-breccia. / Upper group: Tufaceous sandstone and agglomerate-tuff.

Pleistocene....Loam bed with gravel bed at its base.

Holocene....Valley gravels.

The more important petrographical types in these formations will be described below.

1. Tufaceous sandstone and tuff-breccia. (The lower group of the Miura series of Enosima.)

Except in the northeastern part of the island, these rocks are well exposed on the sea-cliffs. The bedding plane strikes N.W.–S.E. and dips 30–40° N.E. The bedding is generally due to alternation of coarse and fine material. The lower beds exposed in the western part of the island are characterised by distinct stratification of alternated layers of tufaceous sandstone and tuff-breccia; while in the eastern part of the island, where the higher beds are unstratified, the tufaceous sandstone presents a massive appearance.

Megascopic Characters.- The tufaceous sandstone is generally light gray. The sand-grains in it are subangular, but often well rounded, and show considerable variation in color, and include a variety of isolated crystals and rock-fragments. There is more or less of a gradation between the fine and coarse tufaceous sandstone and between the coarse tufaceous sandstone and tuff-breccia, some few fragments in which exceed 1 cm. in diameter. The tuff-breccia contains lenticular rock-fragments of various texture—porphyritic, scoriaceous, pumiceous, and glassy—cemented with sandy material.

Microscopic Characters.—Microscopically, the tufaceous sandstone is characterized by its numerous angular constituents (Fig. 1), of which the following are most abundant:—

(1) Numerous fractured and euhedral plagioclase-crystals. They are not zonally built, being identified as andesine $Ab_{60}An_{40}$—$Ab_{65}An_{35}$, with $n_{1D} = 1{\cdot}547\ (3) - 1{\cdot}544\ (7)$.
(2) Isolated crystals of augite ($n_{1D} = 1{\cdot}698$) and hypersthene.
(3) Rock-fragments of pyroxene-andesite exhibiting various crystallinity and textures.
(4) Glass-pieces.

In addition to the foregoing, the tufaceous sandstone contains a few fragments of a granitic rock and a silicified rock, besides orthoclase, quartz, and hornblende.

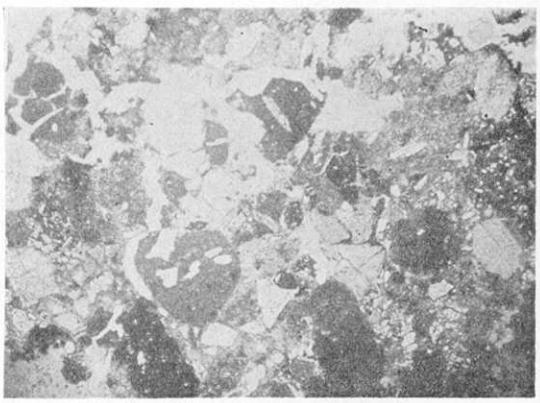

Fig. 1. Microphotograph of tufaceous sandstone. ×10.

Except in its coarser grain and brecciated structure, the tuff-breccia (Fig. 2) is practically similar, microscopically, to the tufaceous sandstone already described.

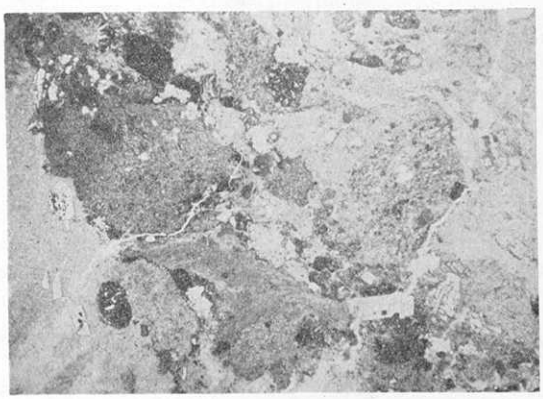

Fig. 2. Microphotograph of tuff-breccia. ×10.

2. Agglomerate-tuff. (The upper group of the Miura series of Enosima.)

This rests unconformably on the massive tufaceous sandstone described in the preceeding section. At the northeastern coast of the island, the unconformable relation of the two groups—lower and upper—is clearly apparent on the wave-cut platform that rises about one meter above sea level, and which was pushed up at the time of the great Kwantô earthquake in 1923. Here there is a decided difference in the physical characters of the two groups; the lower is massive, while the basal breccia of the upper group contains angular fragments of the tufaceous sandstone of the lower group, being overlain by well-bedded agglomerate-tuff. The bedding plane of the upper group strikes N. 60°W. on the western, and E.-W. on the eastern part of the northeastern section of the island. Passing close to the boundary of the two groups, is a distinct strike-fault. Near the boundary, the lower beds of the upper group dip steeply, 70–80° to the north; while higher up the dip becomes gentler, it being 20–30° about 100 m. from the base.

Megascopic Characters.—The tuff is dark gray. It consists of angular rock-fragments which rarely exceed 3 cm. in diameter, besides well-defined crystals of plagioclase (5–1 mm. in diameter) and pyroxene (1 mm. in length), together with a fine tufaceous matrix. Occasionally, the agglomerate-tuff grades into fine tuff showing distinct bedding.

Microscopic Characters.—Microscopically, the agglomerate-tuff contains numerous angular rock-fragments, of which the following are most abundant:—

(1) Andesite scoriae.
(2) Fragments of basaltic rock.
(3) Fragments of propylitic rock.

A few fragments of quartz-gabbro are also seen.

In thin section the andesite scoria (Fig. 3) shows a few phenocrysts

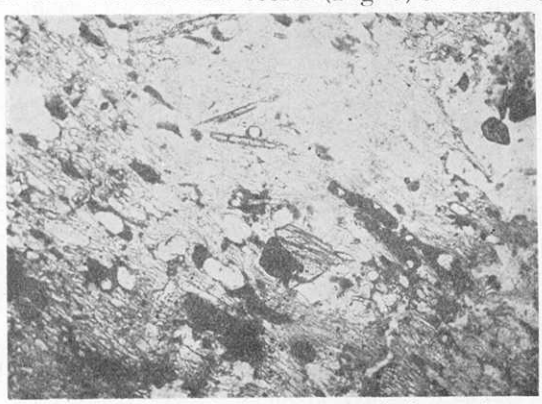

Fig. 3. Microphotograph of pyroxene-andesite scoria ×40.

of plagioclase, augite, and hypersthene. The plagioclase-phenocryst is 0·5 mm. by 0·1 mm. Faint zoning of less and more calcic plagioclases is exhibited. $n_{1D} = 1{\cdot}565$. Accordingly, the plagioclase-phenocryst was identified as labradorite $Ab_{30}An_{70}$. The augite-phenocryst, $n_{1D} = 1{\cdot}694$, and hypersthene are about 0·2 mm. in length. The groundmass is brown glass with $n_D = 1{\cdot}542$.

The basaltic rock has numerous phenocrysts of plagioclase and hypersthene. The plagioclase-phenocryst varies in diameter from 7 mm. to 0·5 mm. It is euhedral, and twinned according to the Carlsbad and albite laws. Zoning of less and more calcic plagioclases is absent. The plagioclase-phenocryst was identified as anorthite Ab_5An_{95}, with $n_{1D} = 1{\cdot}578(4)$, $n_{2D} = 1{\cdot}585(6)$. The hypersthene is euhedral, and about 1 mm. in length, but it is completely altered to bastite. The groundmass is hypocrystalline, consisting of lath-shaped plagioclase-microlites, minute grains of augite, and isometric magnetite with more or less of a glass base.

The propylitic rock contains numerous spots of chlorite, up to 2 mm. in diameter. The plagioclase-phenocrysts have been replaced by chlorite and quartz. The groundmass is of pilotaxitic texture, consisting of plagioclase-prismoids (0·1 mm. in length), pyroxene, and iron ores. The plagioclase in the groundmass was identified as andesine $Ab_{70}An_{30}$, with $n_{1D} = 1{\cdot}546$. The pyroxene in the groundmass has altered to chlorite. A small amount of quartz, probably secondary, is observed in the groundmass.

The quartz-gabbro (Fig. 4) consists of plagioclase, augite, hornblende, biotite, and quartz. The accessory minerals are apatite and magnetite.

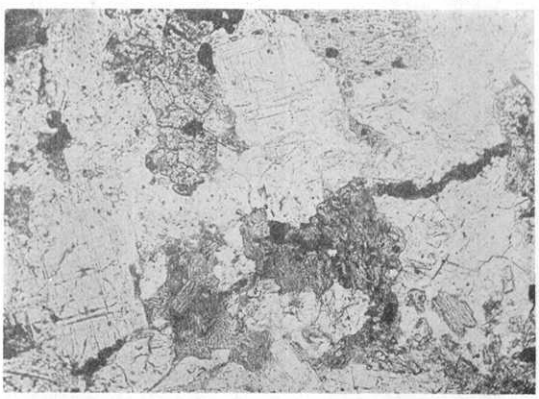

Fig. 4. Microphotograph of biotite-quartz-hornblende-gabbro. ×30.

Plagioclase is subhedral and twinned according to the Carlsbad, albite, and (rarely) pericline laws. Very faint zoning of less and more calcic plagioclases is exhibited. The plagioclase was identified as bytownite $Ab_{15}An_{85}$, with $n_{1D} = 1.573$. Biotite occurs in small quantity, filling the interstices of other minerals.

The agglomerate-tuff contains numerous isolated crystals, of which anorthite-crystals (Ab_5An_{95}) are most abundant. These isolated crystals are probably derived from the andesite or the basaltic rock, abundant fragments of which are found in the agglomerate-tuff.

3. Loam. (The Pleistocene deposit of Enosima.)

Resting on the erosion-surface of the foundation built up of rocks of the Miura series is the so-called loam bed, the total thickness of which is about 20 m.

Megascopic Characters.—Megascopically, the loam is light brown and somewhat tufaceous. In fineness of grain, the materials composing the loam are intermediate between sand and clay.

Upon close examination however the size of the grains in the loam, barring those in the basal gravels, is found to increase in coarseness with height; the individual grains being more angular in the coarser than in the finer part of the loam.

The loam is composed of a brown earthy substance, with isolated crystals of plagioclase, pyroxene, and magnetite. The brown earthy substance forms the bulk of the loam. The plagioclase-crystal is glassy, 0·3–1·0 mm. in diameter, and can be detected with the naked eye. There are also numerous plagioclase-crystals, 0·5 mm. in diameter, in the upper horizon of the loam bed, which are largely decomposed. Pyroxene-crystals occur as stout prismoids, 1 mm. in length, or as irregular fragments, 0·1–0·5 mm. in diameter. Magnetite occurs as round grains, 0·1 mm. in diameter, and is strongly magnetic.

Microscopic Characters.—Under the microscope, most of the grains composing the loam are subangular; but many are well-rounded, particularly those in the lower horizon of the loam bed. (Fig. 5) Minerals seen under the microscope are plagioclase, augite, hypersthene, and magnetite. There are two kinds of plagioclase. One was identified as anorthite Ab_5An_{95}, with $n_{1D} = 1.576\,(8)$, $n_{2D} = 1.584\,(6)$, and the other as labradorite $Ab_{30}An_{70}$, with $n_{1D} = 1.565\,(5)$, $n_{2D} = 1.569\,(4)$. The anorthite-crystals, which are quite fresh, are plentiful in the lower horizon of the

loam bed but scarce in the upper, where labradorite-crystals predominate, and which, megascopically, are found to have decomposed to a white earthy substance.

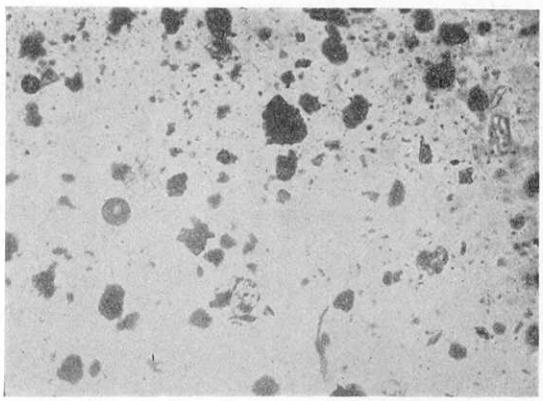

Fig. 5. Microphotograph of loam. × 40.

The augite-crystals are found throughout the loam bed. In the lower horizon they are microscopic while in the upper they occur as stout prismoids, about 1 mm. in length, and can be seen with the naked eye. The megascopic crystal of augite is: $n_{1D} = 1{\cdot}692$. The hypersthene-crystals are fewer.

The brown earthy substance of which the greater part of the loam is composed, is microscopically yellowish and flocculent. It becomes reddish by ignition, the reddening being probably due to oxidation of the iron ore contained in it. It does not effervesce in dilute hydrochloric acid, showing absence of carbonate of lime. Rarely, it contains small fragments of colorless or colored minerals, though none of them have been optically determined. Its refractive index is not uniform, varying from $n_D = 1{\cdot}535$ to $n_D = 1{\cdot}545$. In the refractive index the brown earthy substance resembles volcanic glass, but it does not show the vitroclastic structure characteristic of vitric tuff which consists practically of volcanic glass shards.

Summary.

In the foregoing pages are given the petrographic descriptions of the rocks of Enosima.

The rocks of the Miura series, which form the foundation of Enosima, are largely composed of fragmental volcanic material, probably

laid down under water, including agglomerate-tuff, tuff-breccia, and tufaceous sandstone, together with lithic tuff and crystal tuff. This volcanic material might have been derived from near-by sources as products of volcanic eruptions. The tufaceous sandstone may be detrital tuff, but its ingredients occur as angular fragments, showing that at no stage of their history have they been subjected to considerable attrition.

The two groups of the Miura series possess the respective petrographic characteristics of their ingredients. The lower group is represented by tuff-breccia and tufaceous sandstone, together with lithic tuff and crystal tuff. These rocks consist principally of isolated crystals of plagioclase and pyroxene, and rock-fragments of pyroxene-andesite containing plagioclase-phenocrysts, which have been identified as andesine $Ab_{60}An_{40}$—$Ab_{65}An_{35}$. The upper group is represented by agglomerate-tuff, consisting principally of isolated crystals of anorthite and pyroxene, and rock-fragments of pyroxene-andesite scoriae containing plagioclase-phenocrysts identified as labradorite $Ab_{30}An_{70}$. It is also remarkable that the rocks of the lower group contain subordinately not only isolated crystals of orthoclase, quartz, and hornblende, but also fragments of a granitic rock and a silicified rock; while the rocks of the upper contain fragments of basic rocks such as hypersthene-basalt, quartz-gabbro, and propylite.

The difference in the ingredients of the lower and upper groups of the Miura series would seem to indicate changes in the physiographic condition of the terranes in which the Miura series is developed, and also changes in volcanic activities by which the pyroclastic rocks in the two groups of the Miura series were produced. This petrographic boundary corresponds with the structural unconformity between the lower and upper groups. But it may be said that, on the whole, the volcanic activity in the period of the Miura series is represented by extrusion of pyroxene-andesite.

The loam of Enosima consists of a brown earthy substance and isolated crystals of anorthite, augite, hypersthene, and magnetite. The brown earthy substance occurs as irregular particles containing minute grains of iron ore, but none are found to have been derived from pieces of volcanic glass. It is considered to be fine-grained material—clay—derived from the disintegration of pre-existing rocks.

Under the microscope, most of the crystal grains in the loam are subangular, but many, particularly those in the lower horizon of the loam bed, are distinctly rounded, indicating considerable attrition.

In considering the origin of the loam bed the prime requisite is to know whether aeolian or aqueous agencies have acted in the deposition of the loam. Although the grains composing the loam of Enosima are much rounded, there is no definite evidence on the condition of their deposition, whether aeolian or aqueous. Further study is needed to decide this question.

6. 相模國南西地域の堆積岩の岩石學的研究 (一)

地震研究所　津　屋　弘　達

關東地方には所謂關東ローム層を初めとして種々の新生代地層が廣く分布してゐる。かゝる地層を構成する岩石の岩石學的研究が關東地方全般に亘つて系統的に行はれると、その岩石の本源が推定され、最近地質時代に於ける關東地方の地理的輪廻が明かにされるのみならず、かゝる地層に多量に含まれてゐる火山噴出物と隣接地方に現存する火山の岩石或は火成岩體との成因的關係の有無が確められる。尙、岩石學的方法によつてこの地方の地層の對比が可能である。

昭和五年十一月二十六日の伊豆地震の震域地方特に箱根、熱海諸火山の地質構造と地質的位置とを明かにするにはこれらの火山の基底地層の地質を確かにしなければならぬのであるが、同地方に於ては普通の層序學的方法による地層の對比が可成り困難と考へられる。夫故に隣接する相模國南西地域の地層を構成する岩石 (特にその中の火山物質) がこの地方の既知の層序に從ひ如何に變移するかを知り、それを標準として伊豆地方の地層を岩石學的方法によつて對比しやうと企てゝゐる。

かゝる目的のために先づ相模江ノ島を構成する地層の岩石を檢べた。江ノ島は所謂三浦層及び關東ローム層より成る。江ノ島の三浦層は凝灰岩、凝灰角礫岩、凝灰質砂岩より成る下部層と集塊凝灰岩より成る上部層とに不整合及び斷層によつて區分されてゐる。この兩層は岩石學的に著しい相違を示してゐる。卽、その中に含まれてゐる斜長石の成分より見て、下部層の岩石が主として中性の安山岩の碎片を材料とするに反して、上部層の岩石は主として基性の安山岩のスコリアを材料としてゐる。且、前者は往々正長石、石英、角閃石及び花崗岩、珪化岩片等を含み、後者は灰長石及び玄武岩、變朽安山岩、石英斑糲岩片等を含む。江ノ島のローム層は上述の三浦層を不整合に蔽ひ、斜長石、輝石、磁鐵鑛等の結晶と淡褐色粘土狀物質とより成る。この中、斜長石と輝石との光學性質を檢べた結果、該層の下部と上部とに於て含まれてゐる結晶の分量のみならず光學性質が一樣でないことが判明した。

江ノ島の地層を構成する物質の本源、堆積條件等を確定するには尙廣範圍に亘る岩石學的研究を俟たねばならぬ。