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On Nepheline-basalt from Yingé-mên, Manchuria

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With 2 Plates

The present short paper deals with the first genuine occurrence, so far as I am aware, of nepheline-basalt in the Koreo-Japanese and Chinese regions. For this reason it may be of some interest to petrologists, who seem at present to attach special importance to any new find of feldspathoid rocks in the subalkaline circum-Pacific region.

It is the current opinion that the "Pacific region" is characterized by the predominance of subalkaline igneous rocks in contrast to the alkaline rocks of the "Atlantic region"[1]; but as there are many exceptions in the latter, so we find alkaline rocks also in the former; and these apparently aberrant forms seem to be increasing in number, as our petrological knowledge of their distribution in the "Pacific region" by degrees accumulates.

1) W. Cross in his recent paper seems to discredit broad generalizations concerning the genetic relations and regional distribution of igneous rocks, termed the Atlantic and Pacific kindred. After closely examining the existing analyses of the Hawaiian lavas, he was forced to the conclusion that "the Hawaiian magmas tend to show that the generalizations as to geographic distribution or the genetic relations of the *alkali* and *subalkali* groups included in current definitions of the *Atlantic* and *Pacific branches* or *Sippen* are far from correct. Hence in their present form they can have no place in a petrographic system." Whitman Cross, "The Lavas of Hawaii and Their Relations." *Jour. Washington Acad. Sci.*, vol. 1, No. 3, August, 1911. How far Becke's view on the *Sippe*, endorsed by Harker, can withstand the criticism of age, I cannot tell now. (*Added while in press.*)

Referring mainly to the western Pacific, WICHMANN[1] long ago made known a melilite-nepheline basalt from Oahu in the Hawaiian Islands, and CROSS[2] has acquainted us with the occurrences of a trachyte (acid phonolite) and a nepheline-basalt from one of the same island group. Alkaline rocks are said to occur in Tahiti, in the Viti Archipelago, and also in Timor[3]; while leucite-basalts are found in Java[4], in the southern Celebes[5], and also in Masbate, one of the Philippine islands[6]. A limburgite is known in the Samoa group, and a nepheline-basalt in the Caroline islands[7].

As to the alkaline rocks of Japan, I noticed some fifteen years ago[8] an allied rock from the Nemuro headland at the east end of Hokkaidô, where it is said to occur in the terrane of the Cretaceous. In 1907, I found the same kind of rock occurring in the Shirétoko promontory in Japanese Sakhalin, making a sheet or dyke in the coal-bearing Tertiary. Lately I have received dioritic-looking specimens, sent by DÉGUCHI, from Tendai-san, in the islet of Hattaku-tô, in the Pescadores, and from Reisuikô near Taihoku, Formosa. They all proved to be the same kind of rock as that above mentioned. These are doleritic both in mineralogical

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1) *Neues Jahrbuch f. Min.* etc., 1875, p. 172.

2) *Jour. Geol.*, vol. xii., 1904, p. 510.

3) R. Daly, "Origin of the Alkaline Rocks." *Bull. Geol. Soc. Amer.*, vol. xxi., 1910, p. 105.

4) Verbeek et Fennema, "Description géologique de Java et Madoura," 1896.

5) Harker, "Natural History of Igneous Rocks," p. 98. Details are given in W. Bücking, "Leucitbasalt aus der Gegend von Pangkadjene in Süd-Celebes." *Berichte d. Naturforsch. Gesel. z. Freiburg i. Br.* Bd. XI. Heft 2, 1899.

6) Iddings, "The Petrography of Some Igneous Rocks of the Philippines." *Philippine Jour. Sci.*, section A. (1910) 5, p. 164.

7) Harker, *loc. cit.*, p. 98. M. Weber recently acquainted us with the occurrences in the Samoa group, of an alkali-trachyte, phonolite, trachydolerite, nepheline-basalt and nepheline-basanite besides the usual plagioclase-basalt and andesite. *Abh. k. Bayr. Akad. d. Wiss.* II. Kl. 24. II. Abt. 1909, S. 290–310.

8) "Notes on the Geology of the Dependent Islands of Taiwan." *Jour. Coll. Sci. Imp. Univ.* Tokyo, vol. xxii., p. 44.

composition and texture, the cuneiform spaces left by fresh, polysynthetic tabular plagioclase being filled up with analcime. They may be analcime-diabase (basalt) or teschenite, and seem to be akin to those of California, described by FAIRBANKS[1], and many others. Since I could not examine the mode of their occurrence, and also as I was unable to find a sure trace of either nepheline or leucite, I have simply left them undescribed. A short description has, however, already been given of the *analcime-basalt* of the Pescadore group (Hôko-tô) in Taiwan[2].

Three years ago, I found in a Geological Survey specimen from the islet of Matsushima, Kyûshû, a rock resembling an aegirine-trachyte on which KÔZU[3] has very recently given a preliminary note. It is a grayish, trachytic-looking laurvikose soda-trachyte with calcium-bearing anorthoclase. The alkali-feldspar-bearing basalts from northern parts of Kyû-shû are also brought to our notice by the same writer[4]. What seem to be barkevikite-bearing rhyolites or andesites, I have several times observed from Kôdzu-shima, one of the Idzu islands, and also from the islet of Kôtô-sho (Botel-Tobago), Taiwan. From the above brief account, which might be multiplied if careful search were made, we see that even alkaline effusives of basic and acid natures are by no means rare in Japanese islands.

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1) "On Analcite-diabase from San Luis Obispo County, California." *Bull. Geol. Depart. Univ. Cal.*, vol. I., p. 273. I am always watching with keen interest the progress on the knowledge of the Miocene analcite-diabase (augite-teschenite or basalt) of California by American writers. If there is any thing which may be called a petrographical province, it is this very rock-group which unites both sides of the North Pacific. There are, as it is already stated, many localities in Japan where the so-called analcime-diabase occurs in dykes or sheets, and one of the allied rocks is the "don" which produced natural cokes by its contact action in many collieries in northern Kyûshû. The most interesting point in the studies of these rocks centers in the presence of analcime which was at one time supposed to be derived from *nepheline*, and at other times from decomposition of labradorite. The latter view is, I think, still entertained by L. Haehl and R. Arnold. (*Proc. Philos. Soc.* vol. XLIII. No. 175.)

2) Kotô, *loc. cit.*, p. 42.

3) Preliminary Notes on Some Igneous Rocks of Japan." I. *Jour. Geol.*, vol. xix. 1911, p. 535.

4) "Preliminary Notes etc." III. *Loc. cit.*, p. 566.

We have as yet scarcely any information respecting the alkaline rocks in China and the lands adjoining that part of the continent. But so far as the writer's knowledge of them goes, the granitic rocks on the southern border of the Mongolian plateau, extending from In-shan to Manchuria (*Iwulü-shan*), are mainly of a reddish, coarse-aplitic, *microcline*-rich variety†). The same group which is often mylonitized, forms the foundation of the Koreo-Manchurian highland in contrast to the granodiorites which are prevalent in Japan. A nepheline-syenite is said to occur in southern China[1]. I have a specimen of riebeckite-granite from a quarry near the city of *Foo-chou*, in the province of *Fokien*.

As to *effusives*, lack of knowledge is also deeply felt here. It is well known since the explorations of R. PUMPELLY[2] and the late VON RICHTHOFEN[3] that basalt is widely distributed over the southern Mongolian plateau as the counterpoise of the vast basaltic mesa of the east Koreo-Manchurian landmass. P. Vénukoff[4] gave a description of Mongolian basalts[5] collected at several widely separated localities by the celebrated travellers, M. POTANIN, and General PREJEVALSKY. They all proved to be plagioclase-basalts, and no mention was made of any feldspathoid variety. However, in this connection it may be of special interest to cite from the paper referred to, the occurrences of tachylite and limburgite, with the chemical analyses made of them:

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†) The so-called gneiss that built up the core of the Tsin-ling Shan range, lying to the south of the city Si-nan Fu (西安府), the well-known ancient capital, is found, on microscopic examination, to be a sheared modification of this variety.

1) R. Daly, *loc. cit.*, p. 103.

2) "Geological Researches in China, Mongolia, and Japan." *Smithsonian Contribution Publication*, 1886.

3) "China."

4) "Les roches basaltiques de la Mongolie." *Bulletin de la société Belge de géologie de paléontologie et d'hydrologie*, Bruxelles, tome II., 1888, p. 441.

5) According to V. A. Obrutschew ("Central Asia," I.), there is a large basaltic field, 500 *m* thick near Kalgan. resting on a great thickness of loose conglomerates and sandstones, belonging to the Gobi series—the fresh-water Tertiary with *Rhinoceros*—with trachyte at its base. There is another large basaltic area in Mergen in northern Manchuria.

	Tachylite du lac *Kyry-nor*[1], 41° lat., 83° long.	Limburgite du lac *Doloy-nor*[2], 43° 25′ lat., 86° 30′ long.
SiO_2	49.37	41.69
Al_2O_3	17.67	14.85
Fe_2O_3	6.28	10.39
FeO	4.81	5.43
FeO_2	0.28	—
CaO	9.12	11.20
MgO	5.02	9.84
Na_2O	3.27	3.71
K_2O	1.41	1.05
H_2O	2.15	1.06
	99.38	99.32
Sp. Gr.	2.522	2.851

To mention the only remaining locality, an occurrence of a nepheline-basalt was cited by A. LANICK[3] from *Yang-shan*, which lies to the west of the town of *Wei-hsiën* in *Kiau-chau*. It is an amygdaloidal rock in which nepheline is present not in the form of crystals, but as a leptomorphic mesostasis. So much for our present knowledge of the alkaline rocks within the western Pacific territory.

Localities of the Manchurian Nepheline-basalt.—It may not be out of place here to remark briefly on the region in which the present nephline-basalt is found. So far as I know, it is the first occurrence in Manchuria of this kind of rock ever recorded in petrographical literature. As the region is entirely unknown to the

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1) *Kir-nor?* (lake), 2 degrees west of *Kalgan*. The longitude is probably referred to a Russian meridian.

2) *Dalai-nor?* lying to the N.N.E. of *Dolon-nor* (Lama-miau).

3) "Beitrage zur Petrographie von West-Schantung." Inaugural-Dissertation, Leipzig, 1908, S. 32.

outside world, a few lines may be proper to serve as an orientation of the localities of my find.

During my seven months' journey last winter through Manchuria and Korea, I happened to pass over a water-shed (Pl. I. *fig.* 1) of the *Sungari* and the *Hun-ho*, the latter being a tribuary of the well-known *Liau-ho*. I struck the road[1] leading southwestwards from the city of Kirin[2] to *Mopan-shan*[3], and then to the intermontane plain of *Shan-chêng-tzu*[4], a fertile and populous flat on one of the upper courses of the *Sungari*, drained by a large tributary, the *Hui-fa*[5]. Following the river course upstream in flat land and diviating from the high road (Pl. II.) to *Kai-yuan*[6], I rode directly south to a very low and lonely snow-clad water-shed, and at the end of December last, came down to the source of the *Hun-ho*[7], which I followed downstream southwestwards as far as *Mukden*.

On the south of the above-mentioned granitic water-divide on the low spur of a hill, called the *Nien-yü-ling*[8] pass, is located the noted ancient *Gate of Yingé-mên*[9] in the long palisade, now ruined, which runs through the heart of the Manchurian hinterland. It is 200 kilometers from *Kirin*, and 140 from *Mukden*.

The "*Yingé-mên area*" with all the surrounding districts is an elevated granite peneplain of 490 *m.*, flanked on the east by the overlying volcanic mesa of common basalt 150 *m.* thick, and limited on the west by *hills* of *nepheline-basalt* (Pl. I. *fig.* 1) which poured out probably at the junction of the microcline-granite and the Lower

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1) In Stieler's Hand-Atlas, No. 65, and Debes' Hand-Atlas, No. 44, the region is very imperfectly represented. The best maps ever published in Europe and accessible to general readers are *Karte von Ost-China*, scale 1 : 1,000,000, Berlin, Sheet Mukden, and Paul Langhan's *Neuere Tageskarte von Ost-Asien*, scale 1 : 5,000,000, Gotha.

2) Properly speaking the name is *Chi-lin*, and the people call it *Chuang-chang*. Kirin is the anglicized name, just as Mukden stands for *Fêng-tien*.

3) 磨盤山 4) 山城子 5) 輝發 6) 開原 7) 渾河
8) 牟魚嶺 9) 英額門

Cambrian and Tertiary terranes. *The present paper deals with this nepheline-basalt.* It was impossible for me to ascertain exactly the mode of occurrence of the basalt in my hasty journey through the snow-covered region in the cold Manchurian winter with the mercury at −36°C; and moreover the presence of nepheline in the basalt was discovered only after I had reached home and was able to examine slides of the rocks collected during my trip. The age-relation between the more basic, sodic nepheline-basalt on the west and the calcic plagioclase-basalt on the east was not ascertained, but the former is probably older than the latter. This may be conjectured from the incised character of the topography resulting from denudation; while the common basalt on the east builds up a long monotonous mesa (*Chang-kang*[1]) with sharp escarpment. (Pl. I. *fig.* 1.)

One specimen was struck at *Tsao-shih-err*[2] (Pl. II.) in the upper *Shan-shêng-tzu* plain, at the forking of the road to *Kai-yuan* and *Yingé-mên*, and another specimen was picked up quite by chance by H. Murakami in the gravelly bed of the *Hun-ho* river near the already-mentioned *Yingé-mên* gate. The geology of the "*Yingé-mên area*" is roughly indicated in the annexed sketch map (Pl. II.).

The *geologic formations*, cartographically represented, are as follows:

1) The flesh-red, coarse-aplitic, microcline-rich orthogneiss (γ), greatly mylonitized, forming the basement of the overlying complex.

2) Diorite (δ), probably a differentiation-product of an alkaline granitic magma, No. 1. It is a grayish, medium-grained quartz-diorite, composed of short prismoids of deep greenish-brown hornblende, and bent lamellæ of oil-brown biotite, besides plagioclase with the characteristic zonal structure. Quartz fills

(1 長崗 2) 草市兒 In Plate II. it is erroneously spelled *Tsaoshiêr*.

up angular spaces, or forms myrmekitic bodies with the plagioclase. Locality: Nien-yü-ling.

3) The Middle Cambrian limestone (Ca) and the Lower Cambrian red breccia (C). The latter is a rather fine, grayish and reddish variegated breccia, consisting of subangular fragments of microcline and quartz, plagioclase and orthoclase, and lastly, melaphyre, cemented with reddish granitic sand and calcareous matter. The breccia contains slightly pinkish, flattened marly nodules of the size of 4 to 8 *cm.* with a thickness of $1^1/_2$ *cm.*, with no trace of organic structure. Locality: Hsiao-mai-pu-tzu.

4) The Miocene Tertiary (t) of the type of the Mu-shun colliery, composed of shales and medium-grained gray sandstone with a poor seam of coal.

5) Plagioclase-basalt (β_1).

6) Nepheline-basalt (β_2). Locality: Yingé-mên and Tsaoshiherr.

7) Alluvium (a).

Nepheline-basalt

Composition: Essential: Augite, nepheline, olivine.
Accessory: Magnetite, titanomagnetite, picotite.
Accessory part: Base.

Macrotexture: Compact with minute phenocryst (less than 1 *mm.*) of olivine.

Microtexture: Holocrystalline with a few patches of brown base, microporphyritic.

Macroscopically, the rock appears uniformly grayish-black, and is heavy and aphanitic, though, strictly speaking, finely granular. It is sometimes crumbly, falling into dull, polygonal, incoherent coccolitic clods on a slightly weathered portion, which

character seems to be a special feature of this rock. There occur in the general mass glittering flecks (0.9 by 0.3 *mm.*) of olivine with conchoidal fracture and vitreous luster, seen only by reflected light. The rock weathers into an ash-gray earthy mass with brown limonitic spots of decomposed olivine projecting from the general ground.

Macroscopically, the rock is hypocrystalline, varying in degree from percrystalline to docrystalline; and microcrystalline in crystallinity and ranging in size from decimillimeter to micron in granularity; it has inequigranular, prismoid (augite) and equant (nepheline), diverse and seriate (augite, nepheline) fabric. As in all basaltic rocks, the olivine is of a relatively large size as compared with the other constituents of the groundmass. So the fabric may properly be called seriate-porphyritic. On account of the isometric habitus of the microphenocrysts of both the augite[1] and the olivine, the texture of the rock is orthophyric, showing no signs of fluidal arrangement of components. The rock probably crystallized out from an undisturbed magma. (Pl. I. *figs.* 1 and 2.)

Titanaugite is a dominant ingredient occurring in the form of microlite of variable size, the largest being 0.17 *mm.* long and 0.037 broad. The larger ones, rarely seen in slides, are anhedral and tabular with the cleavage-plane toward (011); the smaller ones, on the other hand, are microlitic and euhedral. The extinction of the former on (010) is 43°41′ toward the obtuse angle. The color is yellowish-brown with a tinge of violet-green, and then zonally colored, the interior being of a violet shade; non-pleochroic, the polarization-color being a grayish-yellow of a low order. The crystals are often transversely cracked, and are full of air-pores

1) The larger anhedra are *not* seen in the photomicrographs, Pl. I. *figs.* 2 and 3.

and granules of magnetite. Next in abundance is *iron-ore*, which occurs in octahedra or clumps, peripherally changing into leucoxene (titano-magnetite).

Nepheline is the characteristic ingredient occurring in short prisms, the basal section of which is hexagonal and the longitudinal section rectangular. These colorless crystals (the largest being 0.13 by 0.11 *mm.*) occur in large quantities (30% of the volume) and are fresh with a vitreous lustre; they enclose rounded augite-microlites arranged parallel to the contour of the host—a characteristic habitus by which the presence of nepheline can be easily recognized. Through atmospheric decomposition the mineral substance becomes parallel-fibrous by zeolitization along the vertical axis, and in basal section the change is seen advancing from the periphery. Low polarization-colors and other optical behaviors are normal. With HCl and methylviolet the mineral is easily ascertained by the staining method.

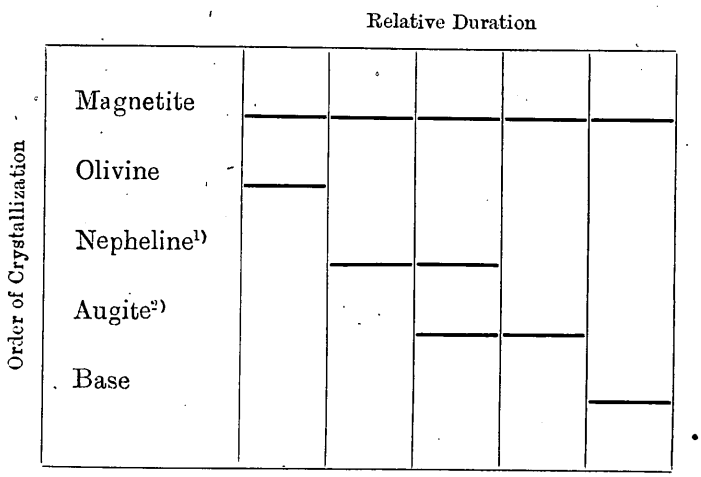
Olivine.—The minutely porphyritic or minophyric phenocrysts of olivine of variable size (usually less than 0.8 *mm.* by 0.5) occur abundantly in euhedral or corroded subhedral shape, and occasionally in glomeratic clusters. It often changes into a yellowish or greenish fibrous substance, from which it may be inferred that it is of a variety rich in magnesia. The olivine is colorless in section, and encloses copious octahedra of *brown spinel.* Polarization-colors are indigo-blue, purple, brown, and gray according to the thickness and orientation of given sections.

No sanidine or any other feldspars are present. *Apatite* is also absent. Sporadic patches of a brownish *basaltic base*, granulated and sometimes fibrous, fill up the interspaces left between the idiomorphic nepheline[1], and the overcrowded augite-microlites

1) For example, around the hexagonal section of nepheline, Pl. I. *fig.* 2.

swim in this scanty base, being rudely arranged tangentially around the nearly isometric crystals (see Pl. I. *fig.* 3) of nepheline, thereby producing the appearance of a leucite-melilite rock.

The rock is nearly holocrystalline, a variety typically rich in nepheline and simple in mineralogical composition. If the nepheline were absent, the mineralogical composition of the rock would correspond to a limburgite, to which the texture has a close resemblance, as may be seen in the photomicrographs, Pl. I. *figs.* 2 and 3. The order of crystallization of the rock-components is shown in the following scheme:



The chemical analysis of the rock from *Tsao-shih-err* was undertaken by Messrs. S. SHIMIDZU and T. OHASHI, of our Geological Survey, to whom I would acknowledge my indebtedness. The result is given below:

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1) Two generations.

2) Two generations (not seen in the photomicrograph). In the older and larger ones crystals of nepheline are poikilitically enclosed in the substance of augite (0.6 *mm* long) which sometimes suffers magmatic corrosion. The augite is so fully stuffed with octahedra of magnetite that the whole presents the appearance of some rhönite crystals, though the substance of the host is here pyroxenic.

		Norms.	
SiO_2	44.98%		
Al_2O_3	15.56	Orthoclase ($K_2OAl_2O_36SiO_2$) ...	7.8
Fe_2O_3	5.15	Albite ($Na_2OAl_2O_36SiO_2$).....	23.1
FeO	7.30	Anorthite ($CaOAl_2O_32SiO_2$)....	14.6
MgO	3.31	Nepheline ($Na_2OAl_2O_32SiO_2$)...	11.9
CaO	9.20	Diopside $\left\{\begin{matrix}CaOSiO_2\\MgOSiO_2\\FeOSiO_2\end{matrix}\right\}$	23.0
Na_2O	5.34	Olivine $\left\{\begin{matrix}2MgOSiO_2\\2FeOSiO_2\end{matrix}\right\}$	1.4
K_2O	1.29	Magnetite ($FeOFe_2O_3$).....	7.4
H_2O	3.77	Ilmenite ($FeOTiO_2$).....	5.5
TiO_2	2.89	Apatite ($3CaOP_2O_5$).....	1.0
P_2O_5	0.43		
MnO	0.23		
S	0.04		
Total	99.49	Sp. Gr. 2.947—2.950.	

From the ratios expressed by the above norms, our rock finds its final position in the C.I.P.W. quantitative system, as in the following[1]:

$$\frac{Sal}{Fem}=\frac{57.4}{38.3}<\frac{5}{3}>\frac{3}{5}$$ Class III. Salfemane.

$$\frac{L}{F}=\frac{11.9}{45.5}<\frac{3}{5}>\frac{1}{7}$$ Order 6. Portugare.

$$\frac{K_2O'+Na_2O'}{CaO'}=\frac{100}{53}<\frac{7}{1}>\frac{5}{3}$$ Rang 2. Monchiquase.

$$\frac{K_2O'}{Na_2O'}=\frac{14}{86}<\frac{3}{5}>\frac{1}{7},\text{ or }<\frac{5}{3}>\frac{3}{5}$$ Subrang 3-4. Shonkinose-Monchiquose.

In sampling the material for the chemical analysis, all the necessary precautions were taken by the writer. The analytical result shows near approach to that of the basalt from Franklin Island, Antarctic. The Manchurian rock has, however, a

1) Calculations made by Kôzu.

specific peculiarities worthy of note, showing exceptionally high percentages in CaO, and H_2O. Microscopic volumetric analysis made with J. Hirschwald's planimeter-ocular showed 30 per cent of nepheline and nearly 15 per cent of olivine, the latter value being only approximative, due to the phenocrystic habit and irregular distribution of the crystals in the microscopic field (Pl. I. *figs.* 2 and 3).

The presence of large amounts (45.5%) of feldspars, as they are expressed in the above norms, is to my mind a paradox, as basaltic glass is scantily present in the rock in which at least the feldspar molecules must be assumed to exist. Otherwise they must be looked for in the composition of nepheline.

The *chemical composition of nepheline* has long been a problem much discussed among mineralogists. Lately FOOTE and BRADLEY[1] have offered an explanation, namely, that a substance on crystallizing may form "a solid homogeneous solution with foreign matter," and that the mineral nepheline consists of a pure compound, probably $NaAlSiO_4$, with a varying amount of dissolved silica. Very recently, W.T. SCHALLER[2] has proposed still another explanation, *viz.*, that the mineral nepheline is an isomorphous mixture of the compounds crystallizing in the hexagonal modification, which are $AlNaSiO_4$ (essential component), $AlKSiO_4$ (kaliophilite), and $AlNaSi_3O_8$, the last being only in mixture in nepheline, and being best known in its triclinic form as albite. He says "the remarkable fact that the compound $KAlSiO_4$ is always present to the extent of about 20 per cent has as yet received no adequate explanation." The albite molecule in nepheline, however, varies from 5.6 to 10.6 per cent. At all

1) "On solid solution in minerals with special reference to nephelite." *Amer. Jour. Sci.*, 4th ser., 31.: 25. 1911.

2) "The chemical composition of nephelite." *Jour. Washington Acad. Sci.*, Vol. 1. No. 4, September, 1911, pp. 109–112.

events, the feldspars in the norms seem to enter largely into the composition of our nepheline. A portion of water may be present in combination with zeolitized products of the nepheline.

The present rock is a simple unique nepheline-basalt in regard to its mineralogical components. As it seems to me the present rock is neither a plutonic nor a dyke-rock, I cannot call it a shonkinite nor a monchiquite. Moreover, the essential attribute of alkali-feldspar is wanting in the Manchurian rock as to be classed among the former, and a brown biotite and barkevikitic amphibole is not present so as to be included among the latter. But I learn from petrological literatures that each of both rocks assumes various phases of crystallinity even within the same mass, extended researches of our Manchurian rock are necessary in regard to its geognostic relation and chemical composition in order to give the final decision as to what species it belongs. Since, however, in mineralogical composition and in appearance, it is most closely related to nepheline-basalts, it is here referred to that group. It is a noteworthy fact, especially in regard to the Sino-Japanese region, that up to the present time no leucite-rocks have ever been recorded from north of the Philippine islands.

My thanks are due to Mr. Swift, of our University, for reading through my English manuscript.

December, 1911.

B. KOTÔ:

NEPHELINE-BASALT FROM MANCHURIA.

PLATE I.

PLATE I.

Fig. 1.—View southwards from Tsaoshiêr (Pl. II.) toward the low granitic water-shed of the Nieu-yü-lying pass, which separates the waters of two mighty Asiatic rivers; the rivulet running toward us is the upper course of the Hui-fa river, a tributary of the Kirin-ula, which ultimately joins the great Amur; while the valley beyond the water-parting is the source of the Hun-ho, which runs southwestwards to meet the well-known Liao-ho. The plain in the foreground is an elevated granite peneplain of 490 *m*, flanked on the east (left) by an overlying mesa (*Chang-kang*) of common basalt, 150 *m* thick, and bounded on the west by denuded hills of the nepheline-basalt which is the subject of the present paper. (Page 6.)

Fig. 2.—Nepheline-basalt from Tsaoshiêr, magnified 260 diameters, set in with a large anhedron of olivine (on the left) and a basal hexagonal section of nepheline with zonally arranged prismoids of augite. The groundmass is a plexus of short prisms of nepheline, prismoids of augite, and minute speck-like crystals and clumps of titanomagnetite, floating on sporadic brown patches (on the left of the hexagonal section of nepheline) of basaltic base. (Pages 9–10.)

Fig. 3.—The same, magnified 130 diameters, showing the general appearance of the diverse, seriate fabric of the rock under weak powers. (Pages 9 and 11.)

Fig. 1.

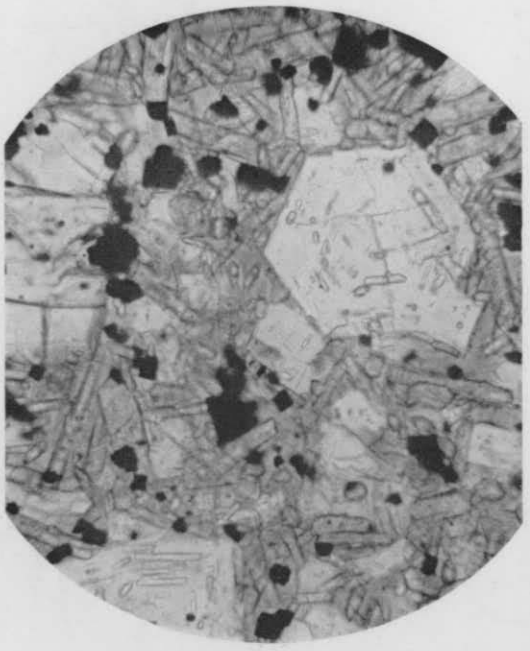


Fig. 2.

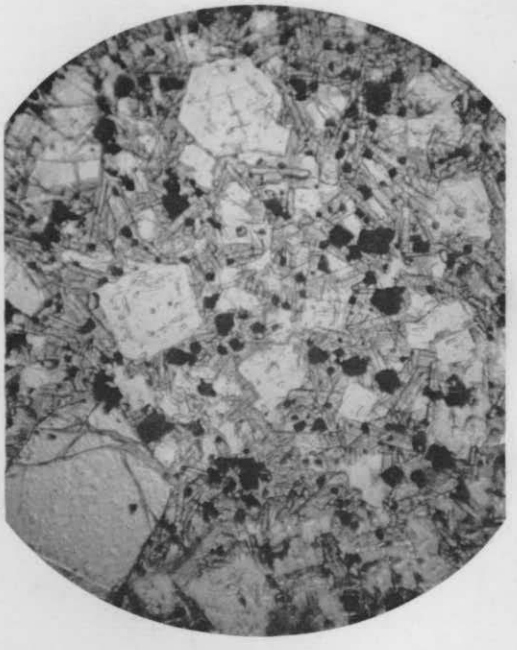


Fig. 3.

Author, Photo.

PLATE II.

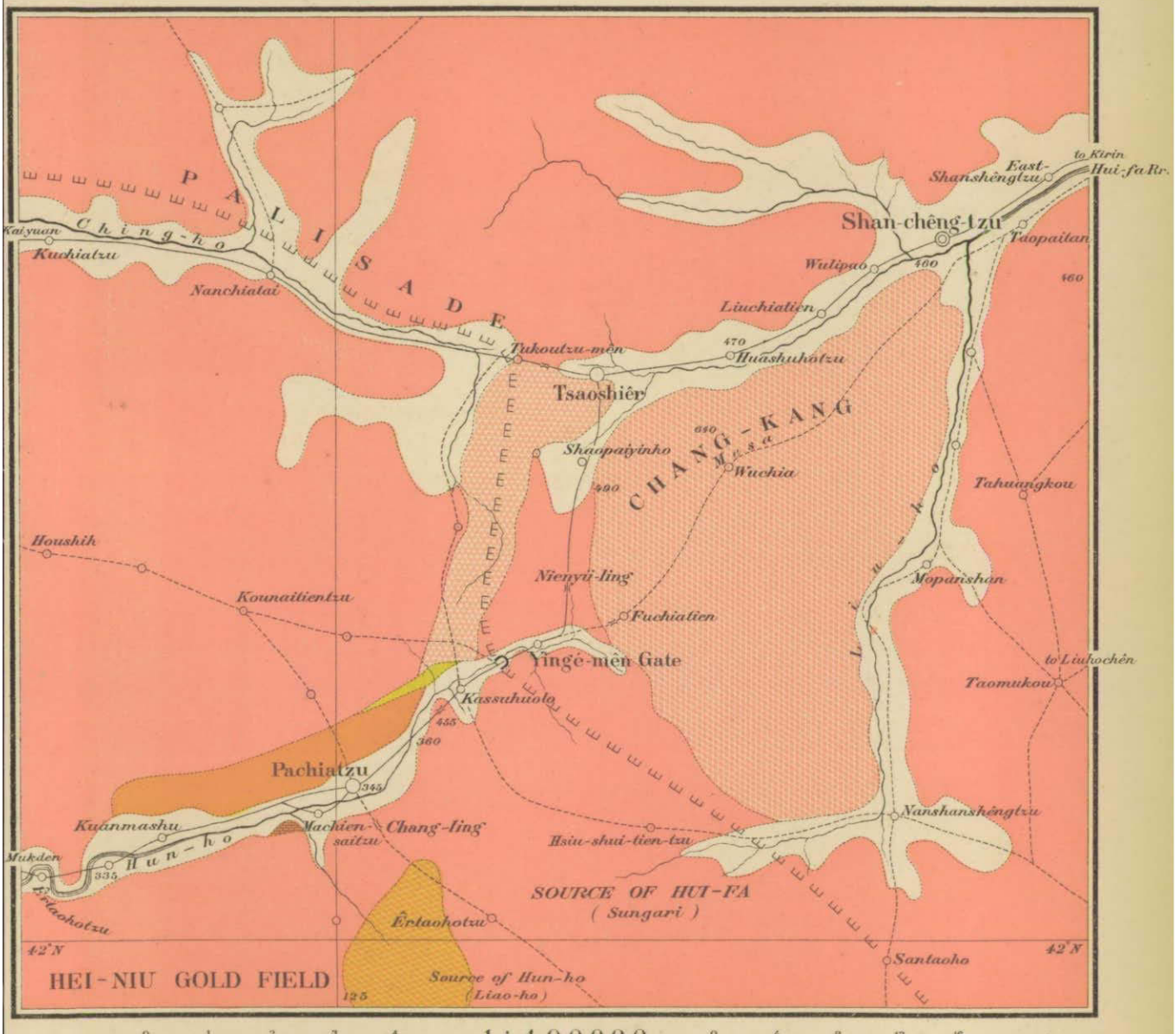
PLATE II.

Map showing the general distribution of the geologic formations represented in the Yingé-mên area (p. 7), the land-feature being seen in Pl. I., fig. 1. As to its petrographic elements the Koreo-Manchurian hinterland is, broadly speaking, built up of the two opposite poles—the pinkish granites and the black basalt; and this is typically exemplified in this small limited area.

The region is also of historical interest, as the Pohais, the Manchus and other ancient highlanders of eastern Manchuria took the road in the intermontane plain of Shan-chêng-tzu (see Map) for their expeditions into the Manchurian plain with bold intent of swallowing gigantic China. With this aim, these peoples marched along the high road from Tsaoshiêr (see Map) either westwards through the Tukoutzu-mên gate to Kai-yüan, or southwestwards through the Yingé-mên gate to Mukden. At these two gates the road was cut by the long mound of the ancient palisade (see Map), now ruined, which was built to keep back the swarms of "northern barbarians." The Russians did the very same thing, as the ancient highlanders did. They followed the same track in the Russo-Japanese war on their march from, and retreat to, the secluded and safe city of Kirin.

This region is geologically interesting as well; for besides the occurrence of nepheline-basalt there is a narrow band of the Cambrian with Tertiary beds folded in what is apparently old granite-gneiss in the N.E.-S.W. direction. The Tertiary here is the north end of the well-known coal seam series of Mushun. The above-mentioned trend is the guide-line of the geologic structure that governs the whole Manchurian hinterland. The diorite region marked on the south is probably a differentiation-product of an alkaline granitic magma. This region (the Hei-niu goldfield) is also one of the richest auriferous areas in Manchuria.

GEOLOGIC MAP OF THE YINGÉMÊN AREA



0 1 2 3 4 Ri — 1 : 400.000 — 0 4 8 12 16 K m.

γ	δ	β_1	β_2	ϵa	ϵ	t	a
Granite	Diorite	Plagioclase-basalt	Nepheline-basalt	Upper-Cambrian Limestone	Upper-Cambrian	Tertiary	Alluvium