GEOLOGY OF NINGAN DISTRICT (KIRIN), WITH
SPECIAL REFERENCE TO THE ORIGIN OF
CHINGPOHU AND TIAOSHUILLOU FALLS*

By T. H. Yen (尹贊誥)

(Geological Survey of China)

INTRODUCTION.

This paper was originally written as a chapter of the report of the
Scientific Expedition to the Ningan and Muleng Districts (寧安縣*與穆陵縣)
organized by the Research Institute of Harbin during the autumn of last year
(1931). The scientific staff of the Expedition was composed of eight members:
three geologists (Meun, Ahnert, Chisinoff and myself), two zoologists, one
botanist, one archaeologist and one economist. After ten days' work in the Mul-
eng District Mr. Ahnert left us for Harbin while Mr. Chisinoff and I went
to Ningan where we began immediately our field work. After having surveyed
the region of Ningan and that of Tongchingsheng (東京城), we arrived at Ssu-
ch'ing (四城) at the beginning of October. It had been agreed that Mr.
Chisinoff would go along eastern bank of the Lake Chingpo (鏡泊湖) while
I followed the opposite bank; we would return to Chichienfeng (七間 inflict
separately one from the East and the other from the West. At the end of
the third day, unfortunately, I was obliged to go back to Peiping, leaving Mr.
Chisinoff alone to do the remaining work. But owing to the undesirable con-
ditions, a final report of the Expedition cannot now be presented. This paper
must be considered as a preliminary one based only on the last pages of my own
field notes.

GEOGRAPHICAL SITUATION OF THE LAKE.

Chingpo (or Lake Bisten) lies about a hundred li SW of Ninganhsien
(formerly Ninguta) between 128° 48' and 129° 3' longitude E, 43° 47' and
1. The lake is called Nan Hu by Bartholomew (the Times Survey Atlas of the
World, 1922), but it is generally known in Europe under the name of Lake
Bisten.
44° 3' latitude N. It is long, narrow, irregular in shape, stretching its arms into the lateral valleys. The entire length, measured from the southern extremity near Nanhu'ou (南湖頭) to the Taoshuiou Falls (濤水頭) in the north, is no less than 40 kilometers while the width varies from one to four kilometers, with an average of one and a half kilometers. As no systematic sounding has been effected we do not know the bathymetric conditions of the Lake, but according to an unpublished report it seems that the maximum depth in the northern part is about 40 meters.¹

The Lake is surrounded by mountains the summits of which stand from 600 to 800 meters above sea level. The maximum is attained by Lashizhan (老蔣山) with an altitude of about 1000 meters. As the surface of the Lake rises to 410 meters above sea level, the mountains have only a relative height from 200 to 600 meters with regard to the Lake.

The river Mutankiang (牡丹江) which takes its origin at the southern slope of Mutanling (牡丹嶺) and S of Taoshuiou (數化頭) passes through the Lake and comes out by the Taoshuiou Falls. It runs first along the foot of the hill side and then wanders in a more widely open valley before it joins the Sungari River near Lashizhan (老蔣頭).

**STRATIGRAPHY.**

Five groups of formations were distinguished in the region studied, i.e., between Ningan and the Lake. The difficulty of a detailed study is fully understood by those geologists who have participated in an expedition composed of more than one group of specialists. The field work is often disturbed by the collective movement and much is left to be desired.

**Igneous Rocks:** These are chiefly represented by granite with large crystals in the central part and fine grained at the periphery of the massif. In some places it passes laterally into porphyry as exposed in the eastern part of Soochi'ung. Basic rocks of a very dull colour also occur accompanying the

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¹. According to a preliminary sounding near Hionoanjang (小水頭) by my brother T. S. Yin in 1930.
². All rock specimens are now kept at the Research Institute of Harbin; Mr. Ahnot proposed to study them.
granite, chiefly in the small peninsula called Luchuanpo (鹿闊頭子) and in the neighborhood of the Falls.

These rocks seem to form all the surrounding mountains of the Lake and a part of those on the other side of Shih-chien (石頭厳). They are also well developed in the hills west of Ningan, where they are associated with some pegmatite rocks rich in crystals of garnet and tourmaline.

Late Mesozoic or Early Tertiary sandstones and conglomerates: Reddish sandstones or arkoses are widely distributed in this region. They constitute the hills on both sides of Hualienkou (花蓮口), E. of Ningan, and the low mountains on the western side of Mutankiang, extending far southwestward to the neighborhood of Tungchingchung. SE of this ancient city, well known of archaeologists, sandstones also occur according to an oral communication of Mr. Chinseifelh, but we do not know their areal distribution. From exposures of sandstones in Pingtingshan (平頂山) to the section cut by Mutankiang in the region of Souchung the formation may be continuous.

Two sections of the sandstone formations have been personally examined. The vertical cliff cut by Mutankiang near the entrance of Hualienkou consists of sandstones with more or less coarse grains of quartz, mica and decomposed feldspath. This formation dipping 15° SE has an exposed thickness of about 40 meters; the entire thickness cannot be observed, for the base is not visible and the top is eroded. Four meters above the river there is a layer of conglomerates the pebbles of which have a diameter from one to five inches, and are derived from granite, porphyry and other acid rocks. Conglomerates with pebbles of the same rocks are to be found in higher parts of the cliff but none of the conglomerate layers exceed half a meter in thickness. Some six meters above the water occurs a thin layer of mud containing lignite; a small gallery was opened some years ago by local authorities to see whether it was workable. The layer of lignite is not of a uniform thickness (varying from 10 to 40 cm), the average being 20 cm. It contains badly preserved fossil plants. Tree trunks parallel to the strata are of rather common occurrence immediately above the lignite; one of them measures six meters in length. According to the country people thin beds of lignite exist also further east.
Another exposure examined is that of Sanshit'ung. The section shows more fine-grained sandstones with beds of small pebbles derived from various igneous rocks. So far as it is known no intercalations of lignite occur.

We had not the opportunity to go to see the excellent exposures of this formation on the western side of Mutanhuang, especially those north of Chichienfang where the reddish sandstones have at least a total thickness of 120 meters and probably more, the strata dipping gently WNW as can be seen at distance.

Tertiary basalt: As in the Mishan and Muleng districts, basalt occurs frequently at the top of low mountains in the region of Ningsan, forming flat plateaus. It is generally compact without phenocrysts of olivine. The lava flow is not horizontal but its angle of dip is not apparent so that one of the flat topped mountains is called Pingtingshan which shows in reality an angle of about 3 or more degrees. It overlies either igneous rocks or sandstones with lignite which is more probably of early Tertiary than of Cretaceous age.

Pleistocene basalt: While the Tertiary basalt flows covers the summits of mountains the Pleistocene basalt occupies the valleys eroded by pre-existing rivers. It descends from a volcano of the Hsinpoisan Range southeastward, dammed the valley now partly occupied by the Peihu (North Lake) and constituted the so called Shi't'etse. From the northern extremity of the great Lake the lava flow turns north-easterly and forms a more or less monotonous surface known as Shi't'okangte (石頭崗子) which extends northward to Shalanche (沙蘭鐵) and expands eastward to cover the entire plain of Tungchingsheng.

The petrological characters of the basalt cannot be stated now (the specimens not yet having been studied) but what seems to be certain, is that the basalt flow consists of two or three sheets if not more, as is indicated by the fact that there is, in vertical section of the lava, an alternation of compact zones with those having an amygdaloid structure. The columnar structure is also of com-

mon occurrence; In some places the columns are no less than 10 meters high. Theropy lava and rectangular obsidian masses are also frequent.

Alluvium: As the Pleistocene basalt flow which covers the valley is strongly dissected it is not strange to find alluvium under it. This formation which should be placed before the Pleistocene basalt has no good exposures, its thickness and extent remain unknown. Here we refer only to modern alluvium accumulated along the rivers.

FORMATION OF CHINGPOHU AND OTHER LAKES.

Before the outpouring of the Tertiary basalt flow the land surface assumed the character of a more or less undulating peneplain corresponding to the Peitai stage of North China. The lava came at a certain period of Tertiary Era to fill the low depressions of the peneplain, thus marking the end of the Peitai stage. During successive periods of erosion the rolling hills of the peneplain were gradually worn down, and the depressions protected by basalt flows came to form the high relief of the new land-feature. The inversion of relief can everywhere be noted in eastern Kirin and constitutes one of the leading features of the landscape.

Being short of time, we were not able to distinguish later physiographical stages in the region concerned. Moreover the lower part of the valleys cut by successive periods of erosion is covered partly at least, by the Pleistocene lava; this renders difficult the recognition of the later stages. But it seems certain that the sculpturing of the Peitai peneplain into the land feature immediately preceding the Pleistocene lava flow required a very long time embracing more than one period of erosion recognized in North China, while the post-lava erosion is of much less importance.

Mutankiang had done much erosive work before the eruption of Pleistocene lava and reached an advanced stage of activity. It run out from the Mutankiang, passed through the mountainous region south-west of Tungching-cheng; at various points it becomes entrenched in narrow gorges.

The Pleistocene volcano introduced a period of paroxisms, pouring out its fluid lava southeastward and northeastward, changing the sharp V-shaped valleys into widely open valley with more or less flat bottom. Since the thick-
ness of the lava is necessarily unequal in different parts of its extension, the task of estimating the average thickness is not an easy one. Along the northern bank of Mutanxian, North of Smu-ch'ung, the exposed height of the basalt flow does not exceed 10 meters but this can by no means be considered as the average thickness.

The lava formed a dam across the mouth of the lateral (secondary) valleys (into the principal one) west of Smu-ch'ung and came to occupy the widened part of the valley of Mutanxian south of Shalanchung. This gave rise to at least five barrier lakes, the Chiappohu being by far the greatest. Of the four remaining only two are preserved: Peshu (老埔) or North Lake and Hiaopchhu (小北湖). The latter was originally much greater than it is now; it extended as far southward as the basalt flow, but much of the former extension now presents only a marshy surface during the rainy season. The lakes marked Lake 4 and Lake 5 in the map once existed, but they are now filled with organic as well as alluvial deposits.

TIAOUSHUO FALLOWS.

The existence of a barrier lake does not imply the formation of water-falls. The well known barrier lakes of Europe have a tributary of a regular circulation without giving rise to any water-fall; such is the case of the Lac d’Ayeu, in central France. If waterfalls exist at the issue of Mutanxian from the great Lake there must be some local particularities in the arrangement of the geological formations.

The Mutanxian, after having traversed the Lake emerges by two branches: the northern branch about one kilometer above the junction appears to be cut entirely in the basalt lava; the southern one, three times as long as the former but with much less traffic, finds its way along the base of the hills, i.e. between the lava and the igneous rocks. The two branches are soon reunited again. Actually the Tiaoshuou Falls are situated about half

a kilometer above the point of reunion; the bed of Mutankiang is comparatively much wider from the Falls downward with here and there picturesque islets standing out from the water. These small monticles, instead of being formed of basalt as one would expect to find, are constituted entirely of granite. Mr. Chuishoff has seen one of them the top of which is at about the same level as the surface of the lava (i.e. more than 10 meters above the water). These monticles arose probably from 20 to 30 meters above the present water-level when the lava flows arrived; this branch of the river was at the beginning of its new régime still separated into two branches by the monticles. It is doubtful whether water falls of much less importance existed at that time, but by continuous erosion the granitic hillocks were worn down rapidly, causing a gradually increasing difference of level at the line of contact of granite and basalt. Large blocks of granite are frequently seen in the bed of Mutankiang near the point of junction of the two branches. It is therefore clearly shown that the rapid destruction of the granitic hillocks by the river and the greater resistance of the basalt has determined the origin of the falls.

INTAKE AND RESURGENCE OF RIVERS.

On glancing at the topographic map of this region, one will not fail to be struck by the peculiar facts that rivers southwest of Shalancheng and west of Suchit'ung suddenly disappear when they meet the basalt flow and that they reappear from under the lava sheet SE of Shalancheng and W of Tuchiat'uen (杜家屯). These reappearing rivers are united into one which enters the great river near Shalint'uen.

Not only do the rivers which descend from the lateral valleys disappear in swallow-holes, but the lake Peibo, has also an effluent outlet under the lava flow. This is probably also the case of Chingpohu although it has a superficial outlet in Mutankiang. The underground streams are seemingly anastomose more or less; each of the reappearing rivers finds its supply in the plexus of water rather than in one of the engulfed rivers. In this respect the

1. See the russian map, sheets XXX-56 and XXX-57, scale 1:84000, published in 1906.
intake and the point of resurgence here described are somewhat different from those of a single river which remains a unit throughout its entire course from the intake to the point of resurgence.
Explanation of Plate II.
EXPLANATION OF PLATE II.

GEOLOGY OF NINGAN DISTRICT.

Fig. 1. One of the flat-topped mountains E of Ninganhsien and N of Hualienkou. Basalt covers late Mesozoic or early Tertiary sandstone formations.

Fig. 2. Tiaoshuilou Falls. Right side (of the observer), the main fall which is permanent; left side, lateral falls which flow only during the rainy season.

Fig. 3. Northern bank of Mutankanjiang consisting of Pleistocene lava flows. N of Sauchitung.

Fig. 4. Granitic bocls in the bed of Mutankanjiang about one kilometer E of the junction of the two branches of the river.