106°10'E

106°20'E

43° 20'N

43° 10'N

43° 00'N

N

No.25A Area

No.25B Area

No.24 Area

30

30

60

15

15

0 5 10km

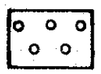
Fig. II — 3 — 1 2 Geological Map around Nos. 24 & 25 Areas

Fig. Ⅱ－3－12 (Contd.)

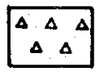
Legend

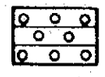
Sedimentary rocks and volcanic rocks

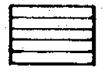

; Upper Quaternary:Gravel, sandstone, pebble, loam, mudstone, rock debris, aeolian sand.

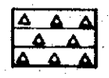

; Upper Quaternary system(Deluvium～Proluvium):Rock debris, sandstone, loam, clay.


; Upper Cretaceous system:Red and gray claystone, loam, sandstone, grit, rock debris, conglomerate, rubble, marl, limestone.

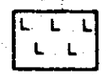

; Upper Carboniferous～lower Permian system:Andesitic basalt, andesite, andesitic dacite, rhyolite, acidic～intermediate tuff, tuff breccia, siliceous tuff.


; Middle Carboniferous system:Andesite, andesitic basalt, basalt, basic～intermediate tuff, grit, sandstone, siltstone, tuffaceous conglomerate, tuffaceous sandstone.

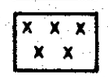

; Lower～middle Carboniferous system:Conglomerate, sandstone, grit, siltstone, andesite, dacite, acidic～intermediate tuff.

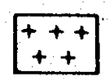

; Lower Carboniferous system:Basalt, andesitic basalt, andesite, basic ～acidic tuff, sandstone, siltstone, tuffaceous grit,conglomerate, dacitic ignimbrite.

Intrusive rocks


; Late Jurassic～early Cretaceous intrusion:Liparite stock


; Late Jurassic～early Cretaceous intrusin:Liparite dike


; Middle～late Carboniferous intrusion:Gabbro


; Middle～late Carboniferous intrusion:Gabbroic diorite

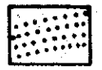

; Middle～late Carboniferous intrusion:Biotite hornblende granite


; Early Carboniferous intrusion:Granosyenite

Geological events

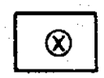

; Bedding plane


; Quartz vein


; Hornfels


; Fault


; Fault plane


; Survey points by MMAJ, 94 and area number

(after Mongolian data)

be mentioned was not given. Sample numbers of this area are MOF01 & 02.

(23) No.26 area

This area is situated around 35 km south-east by east from Bayan Ovoo village. Intrusive body of Carboniferous granitic rock appeared like a circle of its diameter around 2 km which was probably selected by satellite image. In the circle of granitic intrusive body, silicified part (sample No.; MOD15), quartz veins (sample No.; MOD14), silexite like stock (sample No.; MOD16) and part rich in oxidized iron minerals were seen in variety. Metal analysis did not give any special result, but X-ray diffraction analysis revealed existence of chlorite and sericite in silicified zone.

(24) No.27 area

This area is located around 20～25 km north-west by west from Bayan Ovoo village.

No.27-A area is comprised of silicified and weakly argillized Carboniferous andesite which extends several tens meters in width and around 1 km in length. The altered rock received oxidation due to weathering and shows brown on its surface. Existence of sericite was confirmed (sample No.; MOD12).

No.27-B is geologically almost same as No.27-A area, but its extension is a little larger than No.27-A. Existence of sericite was also confirmed (sample No.; MOD13).

(25) No.28 area

No.28-A area is located around 28 km south-west by south from Luus. Geology of this area is composed of pre Cambrian～Cambrian crystalline limestone, and Permian granite and granitic dikes which intruded into limestone. The selected area by satellite image seems to correspond to distribution of limestone. Remarkable mineralization and alteration were not seen, and here was nothing except several small quartz veins. Sample number of this area are LUF06 & 07.

No.28-B area is located around 40 km south-east by south from Luus village. On the way, quartz-fluorite vein in pre Cambrian limestone was found in this area and then it was surveyed. Only existence of kaoline and fluorite was confirmed

by X-ray diffraction (sample No.; HUF01).

No.28-C area is located around 60 km south-east by south from Luus village and MMAJ's Uudamtal report presented at March in 1994 considered this area (No.71 in Solongoi area) as siliceous sinter. Therefore sample was taken to check if it was actually siliceous sinter or not (sample No.; HUF02). A small hill which was wholly occupied by silicified granite and quartz veins in it extends in steppe for around 100m (in N40 ° W direction) with width of around 30 m. The age of intrusion of granite is thought to be Permian. Neither any special result was given by metal analysis, nor any evidence for siliceous sinter was given by X-ray diffraction. Therefore, silicified zone in this area should be considered as simple silicified zone around granite.

(26) No.29 area

This area is situated around 80 km south-west from Luus village.

Geology of No.29-A area is mainly composed of Triassic~Jurassic syenite body rich in oxidized iron minerals. Neither any special result was obtained from metal analysis, nor any evidence for argillization and silicification was confirmed by naked eye. Sample number of this area is LUD06.

No.29-B area is also occupied by silicified zone of Triassic~Jurassic granitic body which is partially rich in oxidized iron minerals. Metal analysis did not reveal any result to be mentioned, but existence of sericite was confirmed by X-ray diffraction.

(27) No.30 area

No.30-A area is located around 100 km south from Luus village. This area is occupied by early Permian granodiorite which shows ring structure. A part of granite which is rich in oxidized iron minerals seemed to be detected by satellite image. Yellow color on satellite image may be concluded to correspond to existence of oxidized iron minerals.

No.30-B area is located around 20 km south-east by south from No.30-A area was reported as No.79 in Unduruda area by MMAJ Uudamtal area report presented at March in 1994. According to that report, silicified rock here was concluded to

be siliceous sinter. Limestone of pre Cambrian～Cambrian distribute here widely and is partially silicified and somewhere quartz veins can be seen. This time, calcite, dolomite and a little amount of quartz were recognized from silicified zone, but evidence suggesting the hot spring and igneous activities could not be obtained.

(28) No.31 area

This area is located around 30 km south-west from Luus village, and 6 exposures of silicified andesitic volcanic rock which are circular hills of diameter around 150～200 m respectively are scattered in 2 km quadrangle. This volcanic rock seemed to be formed in Carboniferous～Permian. Each exposures shows weak argillization and partial existence of sericite, alunite, pyrophyllite and oxidized iron minerals (sample Nos.; LUD01～05, LUF01～05). The geological map around this area is shown in Fig. II-3-13.

(29) Nos.32 & 33 areas

These area are situated 40～50 km east from Olon-ovoot mine.

No.32 area is in limestone and No.33 area is in sandy sedimentary rocks. These areas seemed to be selected by satellite image because of these rock facies, therefore any mineralization and any alteration could not be observed.

(30) No.34 area

This area is located around 15 km south-east from Nomgon village. Geology of this area is rather complex and is composed of hornfelsized slate, rhyolite, intermediate～basic volcanic rock (or hypabysal rock) and white altered schist. These rocks seemed to be formed in Carboniferous. In rhyolite, small quartz veins are seen and silicification occurred wholly. But main alteration is seen in white altered schist and it developes in range of diameter around 1 km. This white altered part was chosen as alteration area by satellite image. X-ray diffraction analysis revealed common existence of sericite and partial existence of pyrophyllite in altered part. Chemical analysis showed Zn 348 ppm as maximum value in 7 samples of this area, but any other high values about other elements could not be obtained (sample Nos.; NOD01～04, NOF01～03).

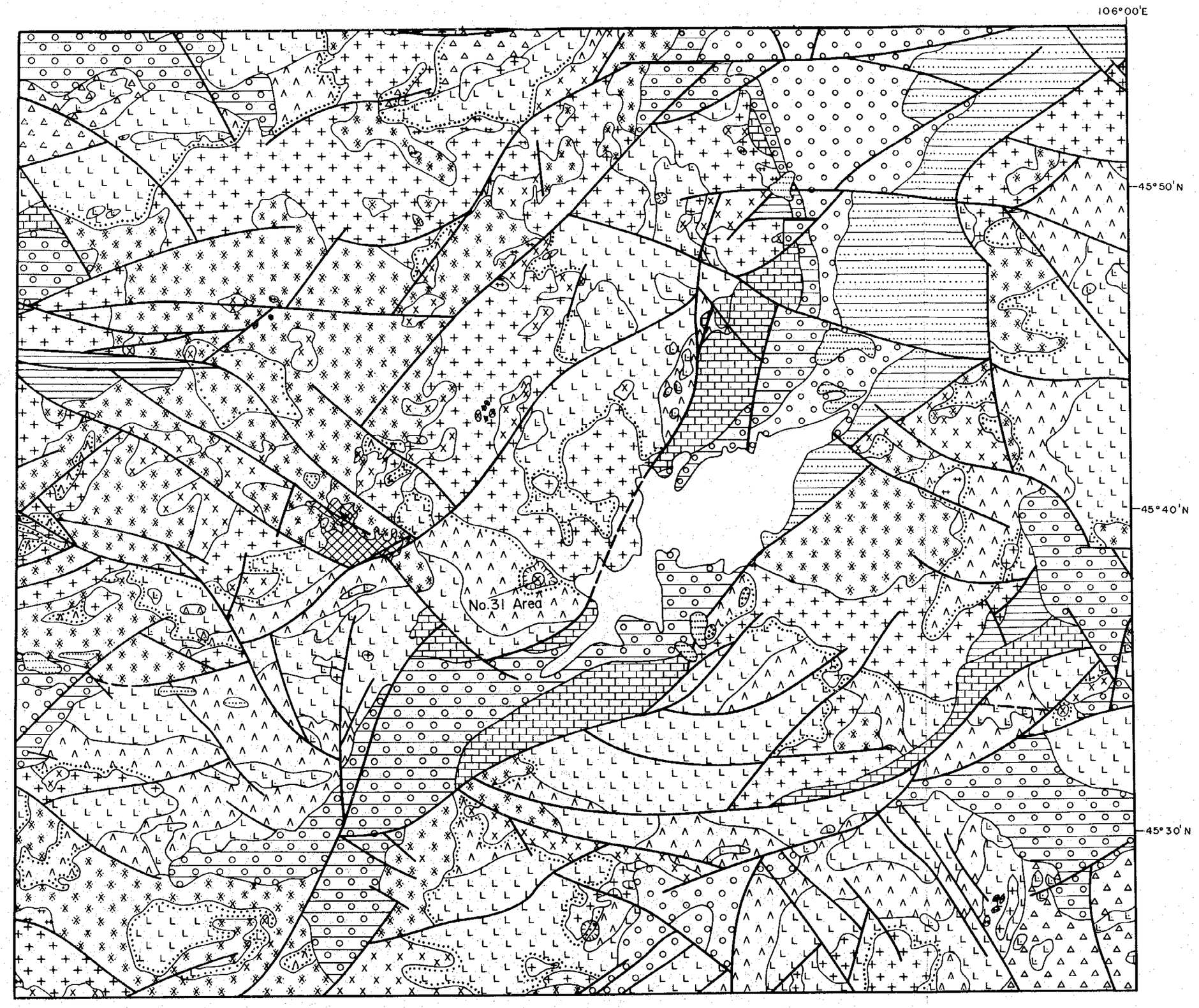


Fig. II－3－13 Geological Map around No. 31 Area

Fig. Ⅱ－3－13 (Contd.)

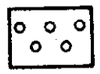
Legend

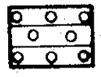
Sedimentary rocks and extrusive rocks


; Quaternary system(Upper～middle Quaternary):Diluvial-Proluvialic rock debris, sand, loam, grit, shingle, rubble, conglomerate.


; Pliocene-lower Quaternary:Rock debris, sandstone, grit, loam, clay with consolidated marl, rubble.


; Lower Cretaceous system(TAVSHIINGOBISRAJA suite, Upper member): Variegated grey red claystone, grit, sandstone, siltstone, rock debris, conglomerate, claystone, loam, rubble.

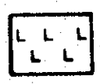

; Lower Cretaceos system(TAVSIINGOBISRAJA suite, Lower member): Grey green claystone, argillite, siltstone, sandstone, limestone, peat sandstone, loam, brown coal, bituminous claystone, conglomerate, gravelstone and debris of loam.


; Lower Cretaceous system(MANLAISKAJA suite):Red, sometimes green rubble, rock debris, rubble, claystone, sandstone, grit, conglomerate, siltstone, marl.


; Upper Jurassic～lower Cretaceous system(MOGOITINSKAJA suite):Grey, green, sometimes red conglomerate, sandstone, grit, argillite, siltstone, claystone, bituminous claystone, rubblic loam, rubble, marl, limestone, trachybasalt, basalt, andesitic basalt, liparite, bituminous schist.

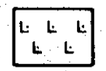

; Lower-middle Jurassic system(SAIHANOBOOSKAJA suite):Conglomerate, sandstone, siltstone, coal.


; Loer Permian system(SAHALAINGOLSKAJA suite, upper member)(Middle GOBI series):Liparitic tuff, liparite, liparitic dacite, trachy-liparitic dacite, dacite, trachydacite and tuff, liparitic ignimbrite, andesite and tuff, tuffaceous grit, conglomerate, sandstone, siltstone, argillite, basalt, obsidian.

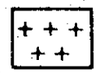

; Lower Permian system(SAHALAINGOLSKAJA suite, lower member)(Middle GOBI series):Ignimbrite, dacitic, trachydacitic, liparitic-dacitic tuff, dacite, trachydacite, trachyliparitic dacite, andesitic dacite and andesite, ignimbrite, trachyandesite, trachyandesitic dacite, tuffaceous sandstone, siltstone, conglomerate, basalt, andesitic basalt.


; Lower Permian system(Ihehadskaja suite)(middle GOBI series):Andesite, trachyandesite, andesitic basalt, trachyandesitic basalt, basic and intermediate tuff, andesitic dacite, tuffaceous conglomerate, sandstone, grit, conglomerate, dacite and andesitic dacite, ignimbrite and tuff, liparitic dacite, trachyliparitic dacite and tuff.

Intrusive rocks


; Early Permian subvolcanic rocks:Liparite, automagmatic liparitic breccia, liparitic dacite, trachyliparite, trachyliparitic dacite, trachydacite.

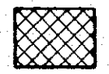

; Early Permian subvolcanic rocks:Trachyandesite.


; Early Permian igneous rocks:Granite, granite porphyry, low alkalic biotite-ampibole graite, syeite, graosyeite, granosyenite porphyry, aplite, pegmatite, graodiorite, diorite, qartz diorite, monzonite, diorite porphyry, gabbro.


; Early Permian igneous rocks:Leucocratic, porphyrytic, pegmatitic, equigranular granite.


; Early Permian igneous rocks:Porphyrytic, equigranular, biotite, hornblende granite.


; Early Permian igneous rocks:Amphibole, biotite-amphibole gabbro, gabbroic diorite.


; Rifeian igneous rock:Olivine and pyroxene gabbro, gabbroic anorthosite.

Geologic events


; Hornfels of contact zone.


; Secondary quartzite.


; Hydrothermal alteration rock:Silicification, argillization, pyritization, epidotization, tourmalinization, sericitization.


; Fault.


; Survey points by MMAJ, 94 and area number.

(after Zobotkin, 1983)

(31) No.35 area

This area is located around 15 km south-west from Nomgon village, and Carboniferous mudstone developes here and andesite~trachyandesite intruded into it in the almost same period or a little later. Silicification took place mainly on andesite body and silicified zone which is rich in oxidized iron minerals occupies range of several hundreds meters × around 2 km. Sample numbers of this area are NOD05 and NOF04.

(32) No.36 area

This area is located around 28 km south-west from Nomgon village and exists at the east end of small scaled mountains which extends in EW direction. In this area, metamorphic rocks such as green schist and siliceous schist which were formed in Devonian? are predominant. Just point that was selected by satellite image was revealed to be occupied by siliceous schist which include sericite and muscovite.

(33) No.37 area

This area is situated around 20 km west from No.36 area and is on southern slope of a mountain. The mountain is occupied by Carboniferous unaltered acidic volcanic rock showing remarkable flow-banding structure. In this volcanic rock, white argillized zone whose width is around several hundreds meters and which is partially silicified is seen like as a headband around the mountain. Altered zone shows schistosity that seemed to be originated in metamorphic rock. Fractural structures that are seen somewhere suggest the existence of certain structure line. This argillized zone is thought to be selected by satellite image. Analized silicified rocks, it was indicated that contents of Au and Hg were 11 ppb and 80 ppb respectively (sample No.; NOF05).

(34) Nos.38 & 39 areas

No.38 area is located around 60 km south from Dalanzadgad city and lies on northern slope of mountains which extends in EW directions. Acidic volcanic rock and conglomeratic sedimentary rock which seemed to be formed in Carboniferous develope here widely.

No.39 area is located around 20 km east from No.38 area and in this area rhyolite including muscovite distributes here. In both areas, mineralization could not be recognized, therefore satellite image seemed to choose the rock facies of these areas.

(35) No.40 area

No.40-A area is located around 25 km south-east from Hurmen village which is around 110 km south-west by south from Dalanzadgad. Rhyolite with flow banded structure and rhyolitic pyroclastic rock whose age seem to be Devonian develop in the area that was selected by satellite image. Any mineralization and any alteration could not be observed here.

No.40-B area is located around 5 km south-west from No.40-A area. A quartz vein that is along boundary zone between granitic rock and andesitic volcanic rock (age of both rocks seems Devonian) was found on the way of survey. The quartz vein whose width is 5～10 m extends around 150 m in N50° W direction and is composed of gray and fine quartz grains, but without sulfide minerals. In granitic rock, weak argillization was observed. Low contents of Au and Ag were confirmed by chemical analysis (sample Nos.; ATF01 & 02).

No.40-C is situated around 30 km south-west by south from No.40-B area, and Carboniferous andesite～dacite (probably intrusive body) which shows weak argillization and strong weathering extends several km long in EW direction with width of several tens meters. Sample number of this area is ALD01.

No.40-D area is around 10 km south-east from No.40-C area. In this area, a narrow quartz vein whose width is 15 cm was found in pre Cambrian sandstone, on the course of survey. Any special result to be mentioned was not given by chemical analysis (sample No.; ALD02).

(36) No.41 area

No.41-A area is located around 60 km south-west by south from Nomgon village, and late Carboniferous～early Permian rhyolite whose surface shows brown color because of abundance of limonite and hematite distributes in this area. It was selected due to abundance of oxidized iron minerals by satellite image.

No.41-B area is situated around 10 km south from No.41-A area, and pre Cambrian limeatone which shows brown color partially because of oxidized iron minerals developes here. This brown part should be selected by satellite image.

(37) No.42 area

This area is located around 80 km south-east from Hurmen village. Granitic intrusive body which shows weak silicification and strong weathering developes in unknown aged dark blue mudstone. This granitic body is exposured like a circle of diameter around 1 km and partially contains much Hg (140 ppb). Sample number of this area is NOD06.

(38) No.43 area

This area is located around 18 km south from Syhan-ovoo village. Outcrops of silicified acidic volcanic rock formed in Permian are scattered in the area around 3 km long and 200～300 m wide. Around silicified zone, white argillized zone which contains kaoline was observed. Metal analysis did not give any special result to be mentioned. Sample numbers here are OND01～03, ONF01 and 02. Fig. II-3-14 shows the geology around Nos.43～45 areas.

(39) No.44 area

This area is located south-west from No.43 and exists at north-west end of Ahar mountains. Devonian acidic volcanic rock which received strong silicification and weak argillization is exposured on NEE line in area of around 1 km long and 150 m wide. In silicified zone, brecciated texture was observed partially. Metal analysis did not give any special result to be mentioned, but by X-ray diffraction analysis kaoline and alunite were confirmed to occur commonly, and pyrophyllite to occur partially. Sample numbers of this area are OND04 and ONF03～05.

(40) No.45 area

This area is situated around 10 km west from No.44 area. Outcrop of Permian acidic～intermediate volcanic rock (dacite～andesite) shows complicated variety, such as fresh parts, strongly silicified parts and strongly argillized parts in a circular area of diameter around 700 m. In strongly silicified part,

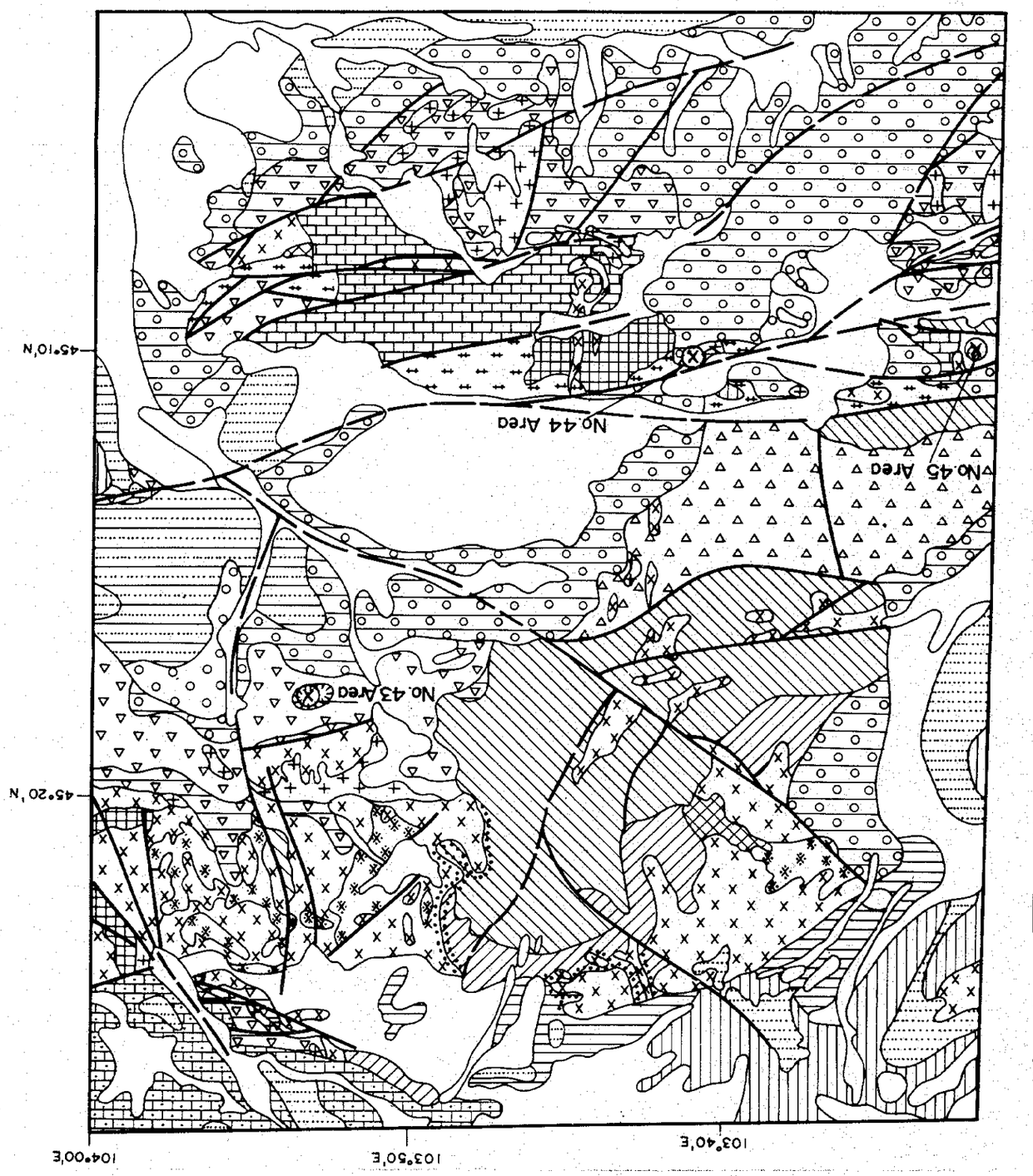


Fig. II－3－14 Geological Map around Nos. 43～45 Areas

Fig. Ⅱ－3－14 (Contd.)

Legend

Sedimentary rocks and extrusive rocks

; Middle Quaternary～recent system:Rock debris, clump, sand, loam, sandy loam, clay, rounded and subrounded shingle.

; Miocene-Alluvial series:Shingle, conglomerate, grit, calcic sandstone, sand, yellow, yellow-grey coal.

; Palaeogene system(Middle～upper Oligocene):Loose and little cementing pink-yellow, pink, light grey, grey sandstone, claystone(green, white & red in color), shingle, olivine basalt(black & grey in color), eruptive breccia.

; Palaeogene system(Lower Oligocene):Claystone debris, sandstone, weathered sandstone, meratic conglo breccia, conglomerate, brownish red sandstone, dark red and light green sandstone.

; Upper Cretaceous system(BOMBOHOISKAJA suite):Conglomerate, meratic conglomerate, a little cemented grit, weathered sandstone, shingle, sandstone, claystone with gypsum, argillite, siltstone(red and pink in color), variegated rarely with interlayer and lens of coal, olivine basalt.

; Lower Cretaceous system(HOHSHIIRSKAJA suite):Siltstone, calcic argillite, cabonaceous schist, polymictic and inequigranular sandstone, pelitomorphic limestone, marl, coal, grit, green and grey conglomerate, basalt,andesite-basalt, pyroxene andesite-basalt.

; Lower Cretaceous system(MANLAI suite):Boulder block, conglomerate, meratic conglo breccia, sandstone, red claystone, rarely basalt, pyroxene andesite-basalt, tuff, tuff breccia, aglomerate.

; Upper Jurassic～lower Cretaceous system(TSAGAANTSAVSKAJA suite,Upper member):Rhyolite, trachyrhyolite, perlite, tuff, rarely andesite, tuffaceous sandstone, tuffaceous conglomerate, grey siltstone.

; Upper Jurassic～lower Cretaceous system(TSAGAANTSAVSKAJA suite,Lower member):Pyroxene, olivine basalt, andesitic basalt, andesite, andesitic dacite, tuff, rarely interlayer rhyolite, tuffaceous sandstone, basalt, conglomerate, grit, sandstone, tuffaceous sandstone, rarely siltstone.

; Upper Jurassic～lower Cretaceous system(AHARIINSKAJA suite):conglomerate,grit, arkosic and polymictic inequigranular sandstone, siltstone-sandstone, siltstone, argillite with carbonaceous inclusion, dolomitic limestone, rarely carbonaceous siltstone, andesitic basalt, andesite, dacite, tuff, tuff breccia.

; Middle～lower Jurassic system(SAIHANOVOOSKAJA suite):Polymictic sandstone, wearthered sandstone, sandstone, siltstone, polymictic argillite, carbonaceous argillite, grey argillite, argillite, meratic conglomerate,conglomerate, rarely with lens of coal, grit, limestone.

; Upper Permian system(HARUZUURSKAJA suite):Andesite, andesitic basalt, dacite, rhyolite, tuff, lava breccia, rarely sandstone polimictic volcanomictic tuffite, grit, conglomerate, siltstone.

; Upper Permian system(HAROVOOSKAJA suite, Upper member):Polimictic sandstone, siltstone, argillite, grit, conglomerate, rarely with interlayer and lens of andesite, dacite, rhyolite, tuff, ash tuff.

; Upper Permian system(HAROVOOSKAJA suite)(Lower member):Siltstone, argillite, sandstone, grit, conglomerate, boulders, weathered sandstone.

; Lower Permian system:Rhyolite, trachyrhyolite, felsite, dacite, andesite, andesitic basalt, basalt, tuff, tuff breccia, lava breccia, tuffaceous conglomerate, tuffaceous sandstone.

; Lower Ripheian system(UIZENUULSKAJA suite):Arkose sandstone, grit, metamorphosed argillite, schist, sandstone, quartz sericite schist, feldspar quartz schist, epidote feldspar amphibolite, sericite feldspar quartz schist, feldspar chlorite biotite epidote zoisite schist, tourmaline biotite quartz plagioclase schist, metamorphic rhyolite with interlayer of marblized limestone and quartzite.

Intrusive rocks

; Late Jurassic～early Cretaceous intrusion;Subvolcanic trachyrhyolite, rhyolitic porphyry, alkalic trachyte, syenite porphyry, rarely granite porphyry.

; Late Permian intrusion:Granite, Leucogranite, biotite granite, subalkalic granite, granite-porphyry, microgranite, rarely syenogranite with biotite & hornblende, granodiorite porphyry, diorite porphyry, quartz syenite porphyry, rhyodacite porphyry, rhyolite porphyry, adamellite.

; Late Permian intrusion:Gabbro, gabbroic diorite, biotite amphibole gabbroic diorite, microgabbroic diorite.

; Early Permianintrusion:Leucogranite, subalkalic biotite granite, biotite hornblende granite, granite porphyry, microgranite, aplitic granite. adamellite, alkalic syenite, quartz syenite, microgranite.

Geologic events

; Hornfels of contact zone.

; Silicified zone.

; Fault.

; Survey points by MMAJ, 94 and area number.

(after Togtox, 1986)

kaoline and alunite were confirmed to exist (sample No.; OND05), and in strongly argillized part copper and arsenic were confirmed to be contained rather abundantly as 236 ppm and 130 ppm respectively (sample No.; OND06). Therefore further geological survey and sampling seems necessary to be performed in details.

(41) No.46 area

This area is located around 50 km from Hurmen village and located around 70 km south-west from Dalanzadgad city. Carboniferous andesite which shows brown color received weak silicification, weak argillization and strong weathering. Metal analysis did not indicate any result to be mentioned (sample No.; ALD03).

(42) No.47 area

This area is situated around 10 km west from No.46 area. Carboniferous andesite developes widely here and brown alkali granite intruded into andesite in the almost same period as andesite. Brown color in granite should be due to strong weathering, but any silicification, any argillization and any mineralization could not be observed.

CAPTER 4 CONSIDERATION

4-1 Collection and Analysis of the Existing Data

The study of existing geoscientific information was done primarily on reports stored at the Geological Information Center (GIC) of the GSM. The work whose results are contained in these reports was commissioned to the Soviet international geology research institute by the Mongolian Government and the field work was carried out by teams comprising both Mongolian and Soviet members. The said reports were prepared at the above Soviet institution and is written in Russian language.

Geoscientific survey of the area in question began in the 1930s and there are reports on 62 geological investigations ranging from 1:1,000,000 to 1:50,000 in scale, also reports on nine geophysical work including airborne geophysics were studied in the course of this project. Only airborne magnetic survey at 1:200,000 covers the entire area. The geological work mostly covers the area to the north of 43 and thus the Gobi Desert and the vicinity of Altai Mountains have not been surveyed. Particularly areas studied by survey at 1:50,000 or larger scale, ore deposit assessment, and surface geophysics are concentrated in the zones to the east of 43 tigated were considered to be of low prospectivity and abandoned or promising zones have not been found because of insufficient investigation. There fore, satellite image analysis of the western parts may indicate the necessity of further survey of these areas.

There are mineral distribution maps covering the entire country at 1:500,000 showing the deposits and showings of known minerals together with geochemical anomalies. They have explanatory texts describing the grade, geology and occurrences.

In the present project, gold and silver deposits and showings were extracted for the whole area and copper, lead and zinc deposits and showings were extracted mainly for the western half of the area and were plotted on 1:1,000,000 map (PL.II-1). Most of the deposits and showings were discovered by the above surveys, but the grade is listed on the basis of relatively small number of analysis. In some cases only one sample has been analyzed and this should be taken into account in considering future prospectivity.

The following 10 areas where many gold showings swarm were selected through the

study of these available documents (PL.II-3).

(1) Tsagaan Ovoo Area (Au)
(2) Ulziit-Gulvansaihan Area (polymetal)
(3) Narangin Huduk-Tsagansubraga Area (Cu, Au)
(4) Ih Shanhai Area (Cu,Au)
(5) Harmagtai Area (Cu, Au)
(6) Olon Ovoot Area (Au)
(7) Bayan Hongor Area (Au)
(8) Bogd Area (Cu, Au)
(9) Bayan Govi Area (Cu, Au)
(10) Mt.Nemegt Area (placer gold)

Of the above areas six areas from (1) to (6) are located in the ground truth survey area which was surveyed in 1994, and (7) ~ (10) areas are situated in the western half part area to the west of longitude 103° E where ground truth survey is to be conducted in 1995.

4-2 Satellite Image Analysis

Thirty-three scenes of satellite images in Altantal region of Mongolia were analyzed and consequently 47 areas were selected as altered areas, because these areas show same colors on analized satellite images as those of Shuten area or Ih-shanhai area. Forty-five areas out of 47 areas were surveyed as 1994's ground truth survey. It is concluded to be possible that silicified zone and argillized zone around ore showings whose extension is more than 300 meters in diameter can be selected from analized satellite images. On the other hand, rock bodies which show characteristic structure (for example, ring structure etc) and have brown surface on account of much oxidized iron minerals were selected by analized satellite images. After try and error, it will be possible to select only argillized zones and silicified zones more precisely.

Geological relation between linear structure and ore showings is not clear, but main ore showings such as Shuten and Ih-shanhai seem to be arranged on a line directed for ENE or EW.

4-3 Ground Truth Survey

From the analized satellite images in eastern half of Altantal region, 47 areas were selected as altered zones. Actually 64 areas subdivided from 45 areas out of 47 areas were surveyed in 1994 (regarding locations of these areas, please refer to Fig. II-3-1). The areas which were reported in Uudamtal area's MMAJ report (presented at March in 1994) as siliceous sediments from hot spring were included in some of these 64 areas and were checked this time. And also the areas which seemed to be attractive on the way of survey were numbered as subdivided number and surveyed. In 24 areas in these 64 areas, any silicification and any argillization could not been observed (in the column of mineralization type in Table II-3-1, "NON" was written). These areas without argillization and silicification showed sometimes a little amount of clay minerals, but they might be selected by satellite images because of their special structure or brown surface having much oxidized iron minerals.

To choose the areas which are necessary to be surveyed in details, four criteria were considered. First one is to have wide silicified zone. Second one is to have strongly argillized zone. Third one is to show rather high contents of As, Sb and Hg, even though content of Au is small. Fourth one is to be volcanic rock or pyroclastic rock as host rock. On choosing the areas to be surveyed more, ore showings of vein type which show only small quartz veins, and ore showings of porphyry copper type which do not show Au content were excluded. Consequently No.5 (Shuten), Nos.10' & 11', Nos.23～25, No.31, Nos.43～45 were chosen as areas to be surveyed in more details. Nos.34 & 35, No. 37 areas provide some of four criteria, therefore these areas seem to be next to first selection. Regarding other areas, it is too early to conclude, but any data to promote further survey or exploration works can not be obtained.

No.13-B, No.28-C and No.30-B areas were reported as siliceous sinter or sediments from hot spring in MMAJ report presented at March in 1994 (Uudamtal area), but by check survey in this year they could not be confirmed as products of hot spring. They may be considered as simple silicified zones around plutonic rocks. As usual, it is rather difficult to distinguish simple silicification from silicious sediments of hot spring. But as far as this year's survey, clear evidence of siliceous sediments from hot spring could not be observed.

Though this year's survey was preliminary, provision of topographical maps whose scale is 1 to 50,000 would make survey easier and more efficient.

4-4 Geological Structure·Characteristic Mineralization·Structural Control

The surveyed area in this year lies in southern part of Mongolia which is now called Gobi plain. On the north and the south of surveyed area, sedimentary rocks, volcanic rocks, plutonic rocks and metamorphic rocks of pre Cambrian period distribute widely. In the surveyed area, that is, in Gobi plain, volcanicrocks, plutonic rocks and sedimentary rocks of Mesozoic distribute widely, and Palaeozoic volcanic and plutonic rocks forming low mountains are exposed among Mesozoic groups. These geologic features were built up by collision of two tecto-nic plate (northern one is Siberia plate composed of pre Cambrian groups, and southern one is Sinokorean plate also composed of pre Cambrian groups) during Palaeozoic and first half of Mesozoic periods. Consequently in Mesozoic era, continental sedimentary basin was formed at the place of present Gobi plain (Parker and Gealey; 1985). Therefore, igneous activities were mostly active at late Palaeozoic to early Mesozoic.

Most of mineralization, silicification and argillization seem to have had genetical relation with volcanic activities (andesite and dacite) or plutonic activities (granite and granodiorite) of late Palaeozoic (Carboniferous to Permian). Some of igneous rock samples were analized (see Table II-3-2(2)), and these result were plotted on rock classification diagram as shown in Fig. II-4-1. According to Fig. II-4-1, most of igneous rocks here should be andesite and granite, and big discrepancy between chemical analysis and naked eye was not seen.

At the central part in Shuten mineralized zone (No.5 area), here is silicified zone including alunite and kaoline, and the original rock of silicified zone is andesite and its pyroclastics of late Carboniferous~early Permian. In this silicified zone, brecciated structure was seen everywhere as shown in Fig. II-3-4 and it seemed to be generated by hydrothermal activities. Around silicified zone, slightly propylitized andesite developes and a quartz vein containing good amount of Au was observed. There are many genetical models about hydrothermal gold ore deposits, but here schematic cross section of Round Mountain ore deposits in Nevada (USA) that is considered as one of typical epithermal gold ore deposits is shown as Fig. II-4-2. Upper column of this figure shows schematic cross section of Round Mountain ore deposits at present time and lower column shows cross section of the ore deposits reconstructed as the time of formation. Both occurrence of upper column in this fegure and that of Shuten mineralized zone are very similar each other except host rock. Homogenization temperature of fluid inclusion measured from quartz vein

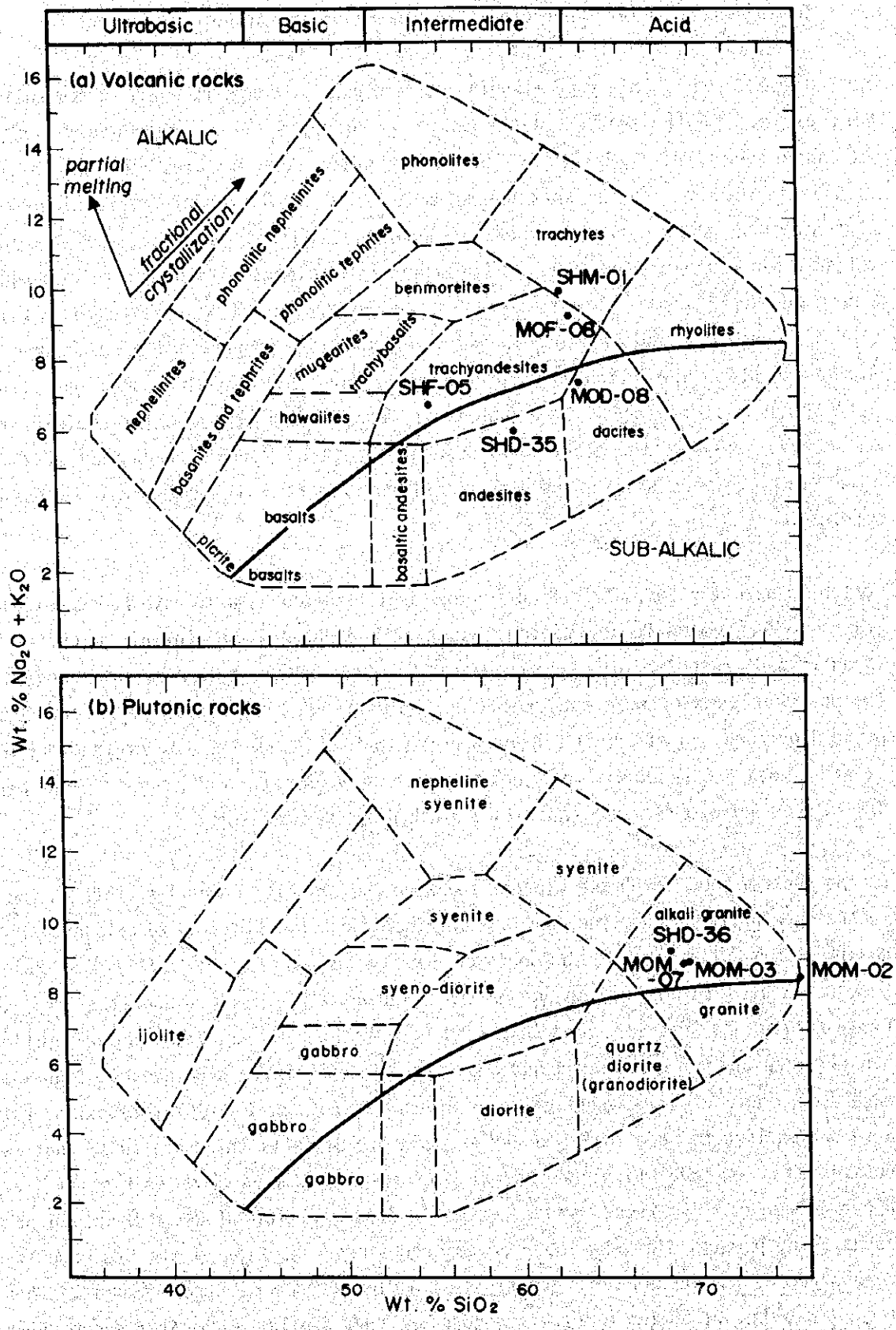
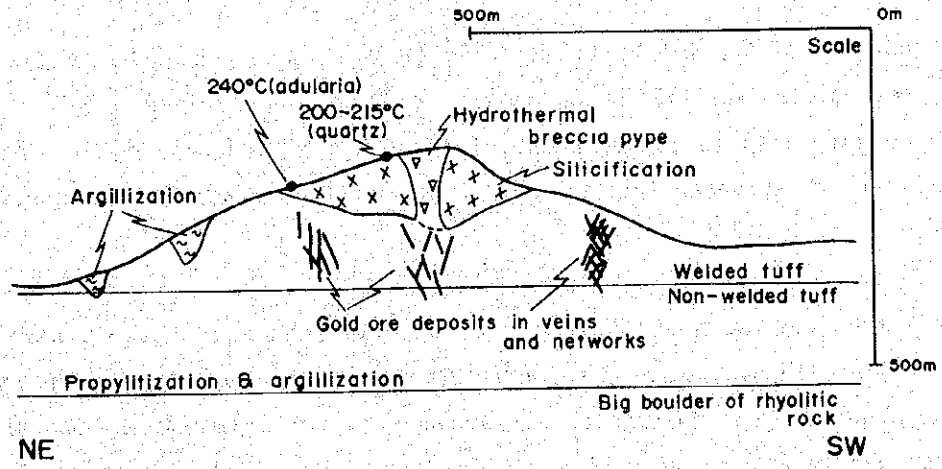
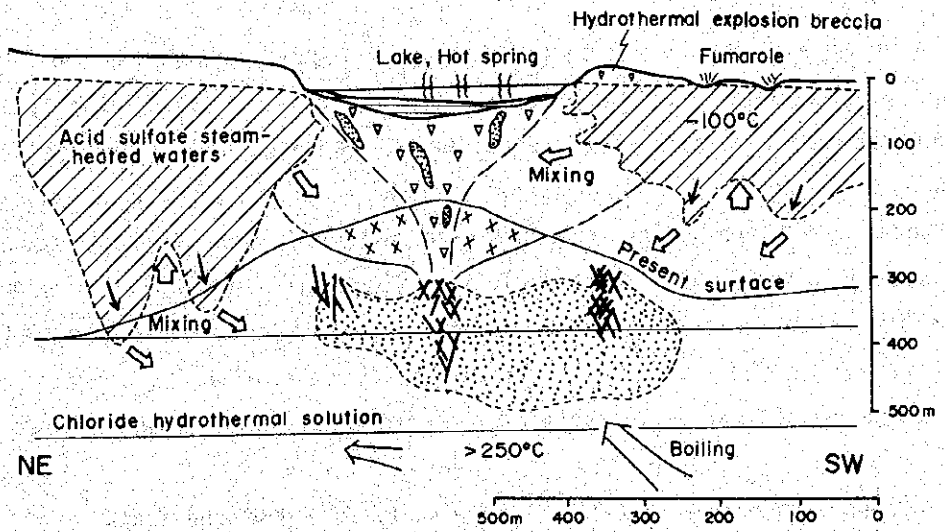


Fig.II-4-1 Rock Classification Diagram (after Cox et al. 1979)
The dividing line between alkalic and sub-alkalic magma series is from Miyashiro (1978).

(a) Schematic cross section at the present time.



(b) Schematic cross section at the time of formation.



; Deposition area of Gold

Fig. II — 4 — 2 Rock Classification Diagram

around silicified zone in Shuten area was 235.6° as shown in Table II-3-2(8) and it coincides well with that of Round Mountain ore deposits. The reason why adularia could not be seen in Shuten seems to have been low Ph compared with that of Round Mountain. It can be concluded that Shuten mineralized zone is epithermal gold ore deposits, and then it is expected to be explored for quartz veins and/or networks containing gold around and below silicified zone in Shuten mineralized zone area.

Ore showings of Nos.10' & 11', Nos.23～25, No.31 and Nos.43～45 areas seem to be very resemble to that of Shuten area, therefore more detailed survey is thought to be necessary also in these areas. That of Nos.34 & 35 and No.37 areas are also thought to be surveyed further. Locations of these areas are summarized in Fig. II-3-1.

Five areas such as No.2, No.6-A, No.16-B (Narinhudag), No.16-C and No.20 (Ih-shanhai) are thought to show porphyry copper type ore showings. Some samples from these areas showed some contents of copper, but maximum content was around 0.4%. Though quartz veins were observed everywhere, possibility to be economically good ore deposits could not be realized. Regarding most of silicified zones or rocks in other areas, geological type of ore showings could not be deduced.

As shown in Fig. II-3-1, areas of porphyry copper ore showings are arranged on almost EW line (along latitude 44° N) in central part of Gobi plain. This arrangement must be reflect the structure of basement and is parallel to boundary between 2 tectonic plates in Palaeozoic period. On the other hand, areas which are epithermal gold type and are thought to be epithermal type are scattered randomly in the surveyed area. All of these ore showings are considered to have genetical relation with igneous activities in Carboniferous～Permian, and time of silicification and alteration seem to be almost same as or slightly later than these igneous activities. Result of age determination is shown in Table II-3-2(6).

4-5 Comparison between Satellite Image Analysis and Ground Truth

As mentioned in the previous section (4-3), no silicification and no mineralization, but sometimes small amount of clay minerals could be observed in 24 areas of 64 surveyed areas. In these 24 areas, special geological structure (for example, ring structure etc) or brown surface covered with oxidized iron minerals are thought to have been selected by satellite image analysis. All other areas show more or less silicification and/or argillization, and some of them show hopeful mineralization

as mentioned above. Among 45 areas which were selected by satellite image analysis and surveyed actually, in 17 areas no silicification and no mineralization could be observed. It is rather difficult to select altered areas thoroughly and objectively, based on slight difference of colors allotted artificially. But rate of failure (it is 24/45 in this time) will be expected to decrease, after try and error. The rate in next year will be smaller than in this year. However, at this moment it is impossible to select only hopeful areas by satellite image analysis.

To avoid individual difference on selecting altered areas, it is necessary to develope a digital way. Such kind of way is not impossible on treating three dimensional digital data.

4-6 Possibility of Ore Deposits

As mentioned in previous section (4-3), Shuten mineralized zone of epithermal gold ore deposit type, silicified zones such as Nos.10' & 11', Nos.23 ~25, No.31 and Nos.43~45 areas which may be epithermal type gold ore showings, and weak hydrothermal alteration zone such as Nos.34 & 35 and No.37, porphyry copper type ore showings and quartz veins were found in the ground truth survey area. The target of this year's survey is to find out gold ore showings, therefore it is concluded to survey further in the areas which show possibility of epithermal type gold ore showings. Specially in Shuten area, further survey for around and below silicified zone is thought to be nacessary, and adjacent area northeast of Shuten is also necessary to be surveyed judging from existing data.

PART III CONCLUSION AND RECOMMENDATION

PART III CONCLUSION AND RECOMMENDATION

CHAPTER 1 CONCLUSION

1. Collection and analysis of the existing data

As the result of the collection, compilation, and analysis of the existing data on geological survey, geochemical exploration, geophysical exploration, drilling, and so on for ore deposit and ore showing of gold, silver, copper, lead, and zinc in the survey area, 10 areas, namely Tsagaan Ovoo, Ulziit-Gulvansaihan, Olon Ovoot, Narangin Hudak-Tsagaansubraga, Ih Shanhai, Harmagtai, Bayanhongor, Bayan Govi, Bogd, Mt.Nemegt, where many gold showings which contain gold swarm, have been selected.

Out of these 10 areas, Tsagaan Ovoo, Ulziit-Gulvansaihan, Olon Ovoot, Narangin Hudak-Tsagaansubraga, Ih Shanhai, and Harmagtai areas are situated in the ground truth survey area to the east of longitude 103° E and other four areas are situated in the western half part to the west of longitude 103° E.

2. Interpretation of satellite image

Thirty-three scenes of the Landsat TM images covering the whole survey area have been interpreted and the alteration zones and lineament in the satellite images have been selected.

The selected alteration zones which show same color in the analyzed satellite images as that of the Shuten area or Ih Shanhai area have numbered 96 areas in the whole survey area and 47 areas in the eastern half area investigated by the ground truth survey.

The alteration zones selected seem to have a tendency to swarm in some areas such as the Mandalgovi-Saihan Ovoo area in the northern part of the ground truth survey area, Shuten-Ih Shanhai area in the east, and Hanbogd-Nomgon area in the south and are arraged in a east-northeast to east and west direction.

It was difficult to detect the known porphyry copper type ore showings such as Serven-Suhait, Harmagtai, and Narim Hudak in the satellite images, because they are not accompanied by strongly argillized and highly silicified zones. It was also difficult to detect vein type gold ore deposits such as Olon Ovoot deposit because

of narrow alteration zone.

In the eastern half part of the survey area to the east of longitude 103° E, two linear structures, namely northeast to east-northeast and west-northwest directions, are predominant and extend for a long distance.

The curved to circular structures in the satellite images are clearly observed in the Shuten area, an area to the southeast of Shuten, the Hanbogd area, and an area to the south-southeast of Luus.

The lineament of the east and west direction is dominant in the Nos.43 and 44 areas, the east-northeast direction in the Shuten and Ih Shanhai areas, and the east and west direction in the Nos.23, 24, and 25 areas.

As the result of the ground truth survey for the selected alteration zones, it is concluded to be possible to select the ore showings accompanied by the silicified and argillized zones covering an area of more than 300 meters in diameter. Therefore, it seems to be useful to survey the selected alteration zone as a clue to search for epithermal gold deposit.

3. Ground truth survey

Forty-five areas out of 47 areas selected from the analyzed satellite images of the eastern half part of the survey area to the east of longitude 103° E were investigated in the field. In 24 areas out of these 45 areas, neither silicification nor argillization was observed. In these areas accompanied by no argillization and silicification, although a little amount of clay minerals were sometimes found, some rock bodies which have special structure or brown surface stained by oxidized iron minerals might be selected by analyzed satellite images. No.5 (Shuten), Nos.10' and 11', Nos.23～25, No.31, and Nos.43～45 areas out of the remaining 21 areas are considered to be ore showings of epithermal type gold deposits related to the volcanic activity in late Carboniferous to early Permian, judging from the fact that host rocks of these areas have been subjected to intensive silicification and argillization, mineral assemblages of hydrothermal alteration zones consist mainly of quartz, alunite, and kaolinite, host rocks are andesitic volconic and pyroclastic rocks of late Carboniferous to early Permian, silicified breccias which seem to be hydrothermal explosion breccias are found everywhere in the silicified zones, and the silicified zones are rich in arsenic,

antimony, and mercury. In particular, gold-bearing quartz vein containing 4.16 to 9.78 g/t of gold, 1.1 to 2.0 meters wide and 350 meters long, and large-scale silicified zone, 1.0 to 3.5 kilometers wide and about 7.0 kilometers long, are found in the Shuten mineralized zone. Therefore, It is expected that quartz veins and/or networks containing gold may be present around and below the silicified zone in the Shuten mineralized zone.

4. General commentary

The ground truth survey for 45 hydrothermal alteration zones which are situated in the eastern half part of the survey area to the east of longitude 103° E, out of 96 alteration zone selected from the whole survey area by the satellite image analysis, and 2 known silicified zone which were not detected on the analyzed satellite image was carried out. As a result, hydrotheral alteration zones were observed at 21 localities. Fifteen localities out of these 21 localities are newly found alteration zones by the satellite image analysis. Out of 23 localities where hydrothermal alteration zones were found, Shuten mineralized zone which seems to be of epithermal type gold deposit, 10 silicified zones, namely No.10, No.11, No.23, No.24, No.25, No.31, No.43, No.44, No.45, and the area adjacent to the northeast of Shuten, which may be epithermal type gold ore showing, and 3 weak hydrothermal alteration zones (No.34, No.35, and No.37) is thought to be surveyed further in detail. In spite of the vast survey area covering 330,000 aquare kilometers, hydrothermal alteration zones were effectively found. This fact indicates that the satellite image analysis is useful for search of epithermal type gold deposit.

CHAPTER 2 RECOMMENDATION FOR THE SECOND YEAR'S SURVEY

1. In the western half part of the survey area to the west of longitude 103° E, the ground truth survey for the alteration zones selected in the analyzed satellite images and known hopeful gold showings in the areas, where gold showings swarm, which have been selected from the analysis of the existing data is recommended to be conducted to find hopeful area of gold, because no ground truth survey was carried out in 1994.

2. In the eastern half part of the survey area to the east of longitude 103° E, is recommended to be conducted.

(1) Shuten mineralized zone area

a) Detailed geological survey and sampling for laboratory works
b) Geochemical prospecting by means of soil and rock samples

(2) Area adjacent to the northeast of Shuten, Nos.10' & 11', Nos.23～25, No.31, Nos.43～45, Nos.34 & 35, No.37 area

Semi-detailed geological survey and sampling for laboratory works

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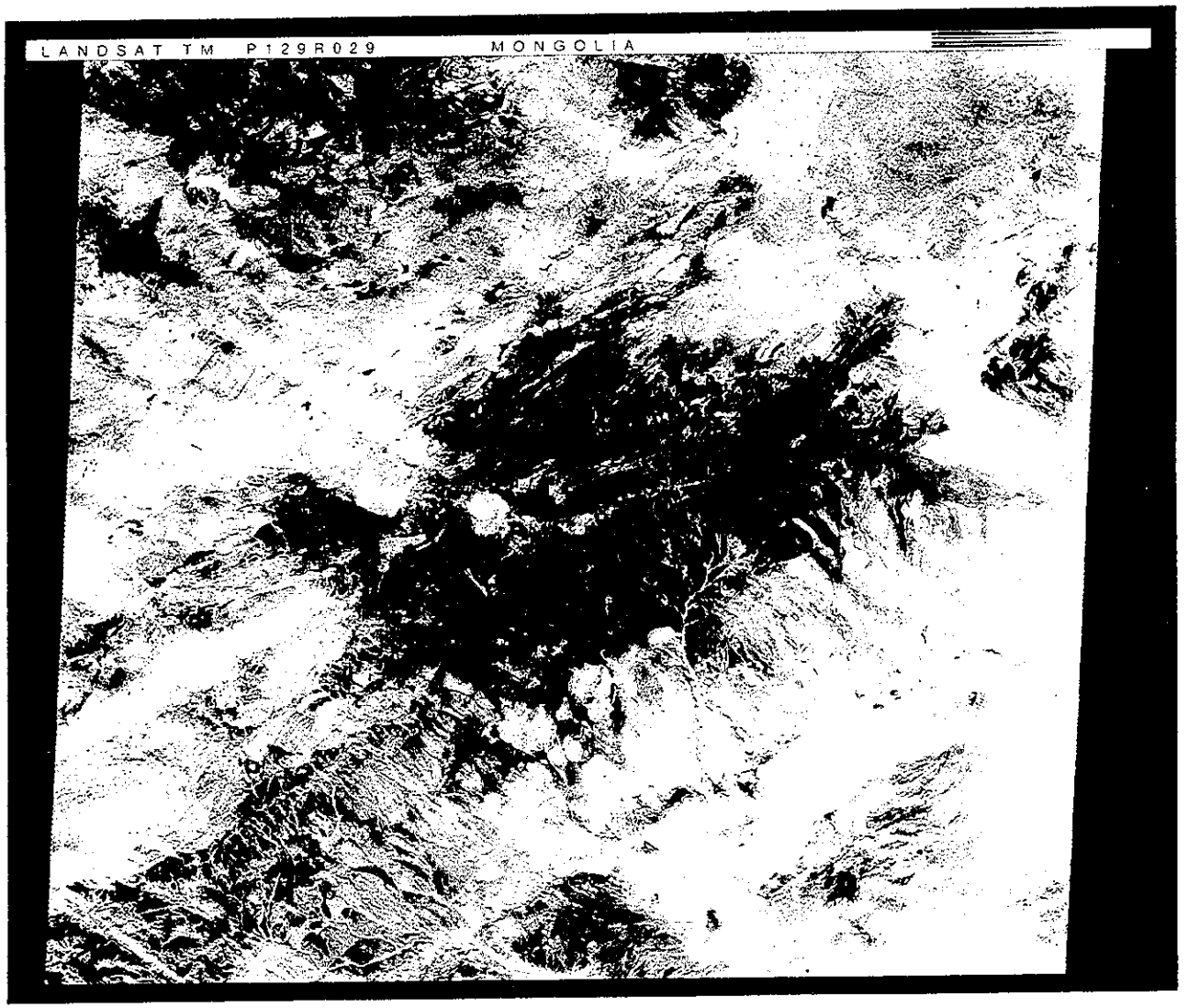
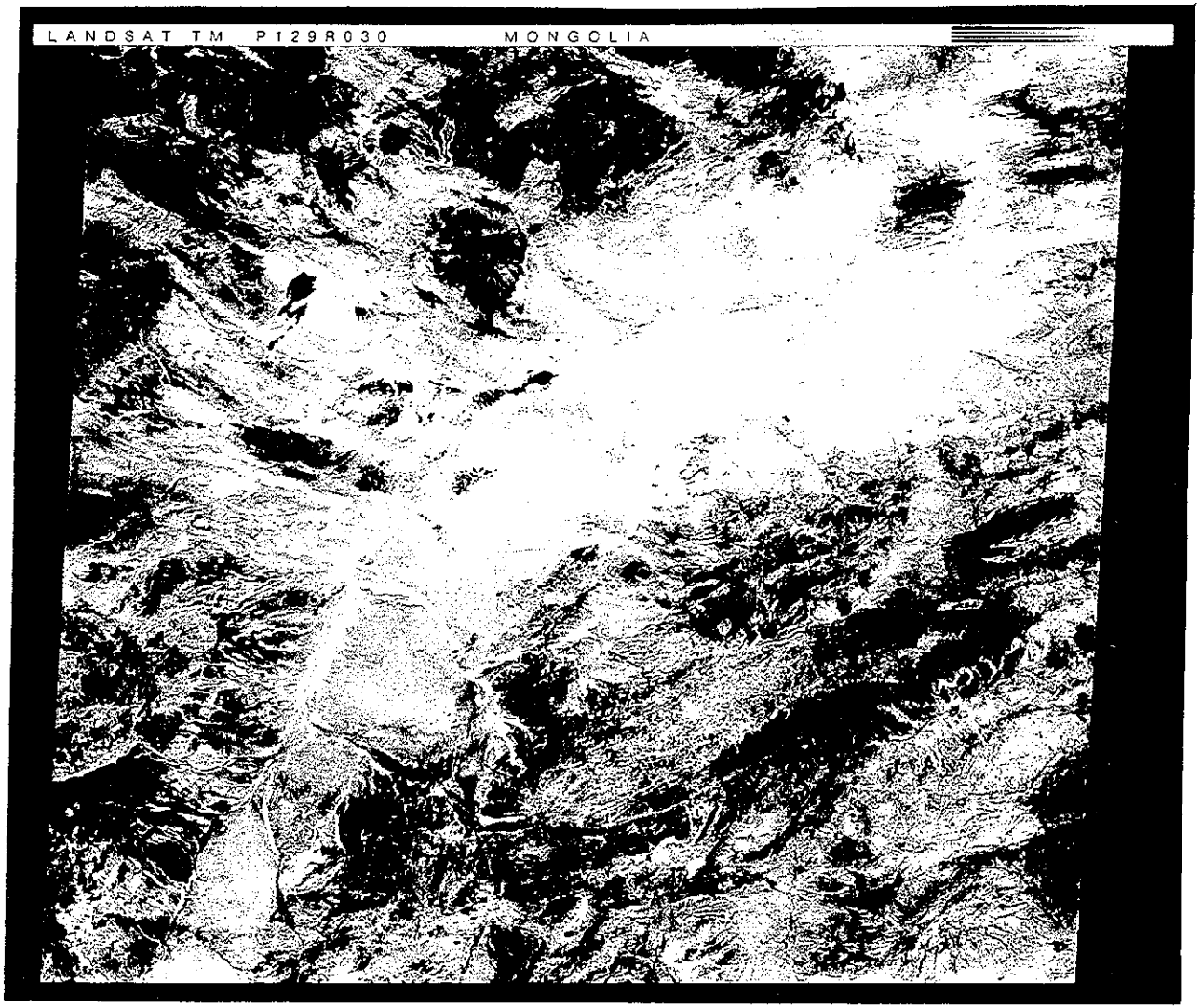
APPENDIX



Appendix 1:Analized Satellite Image



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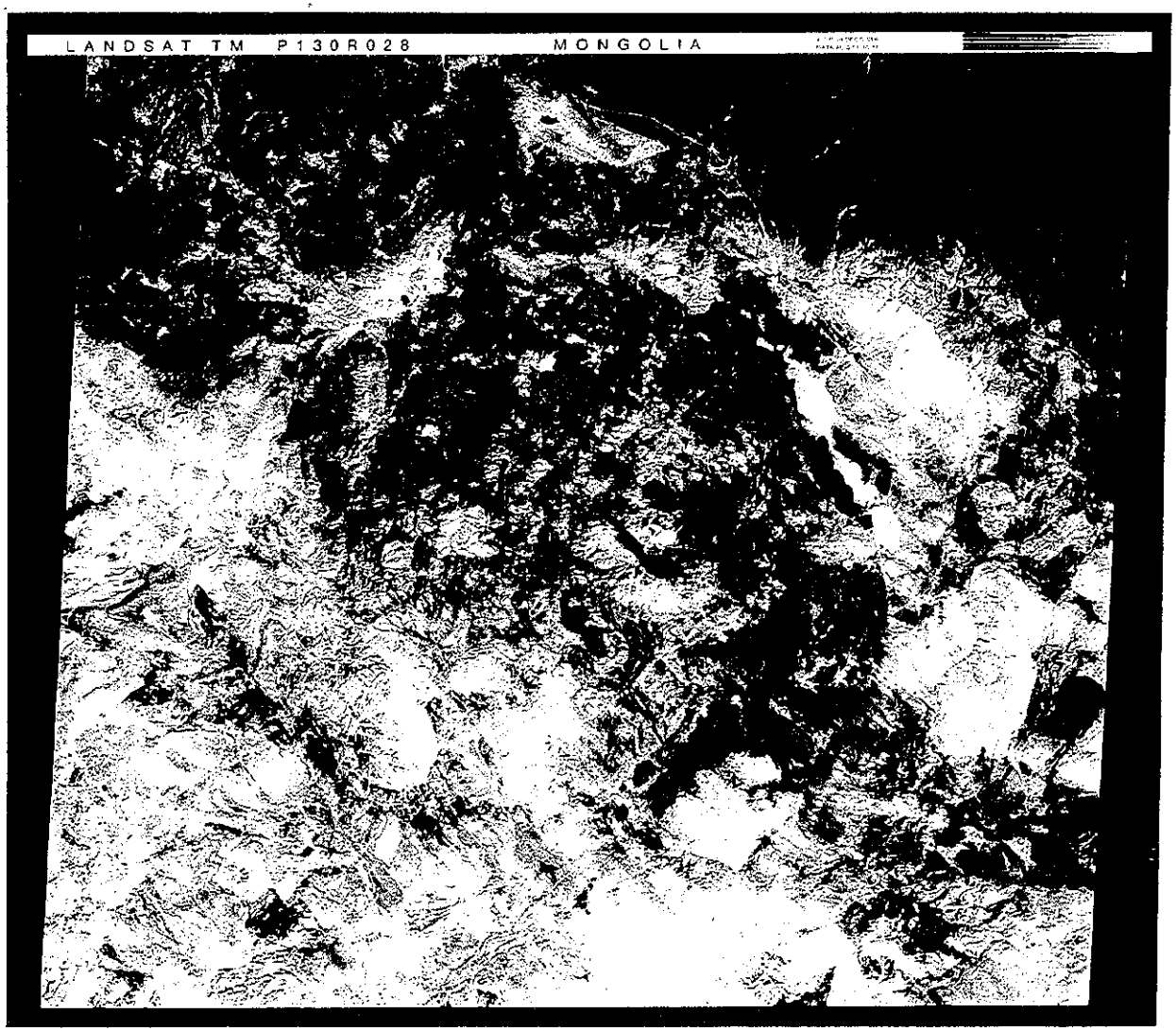

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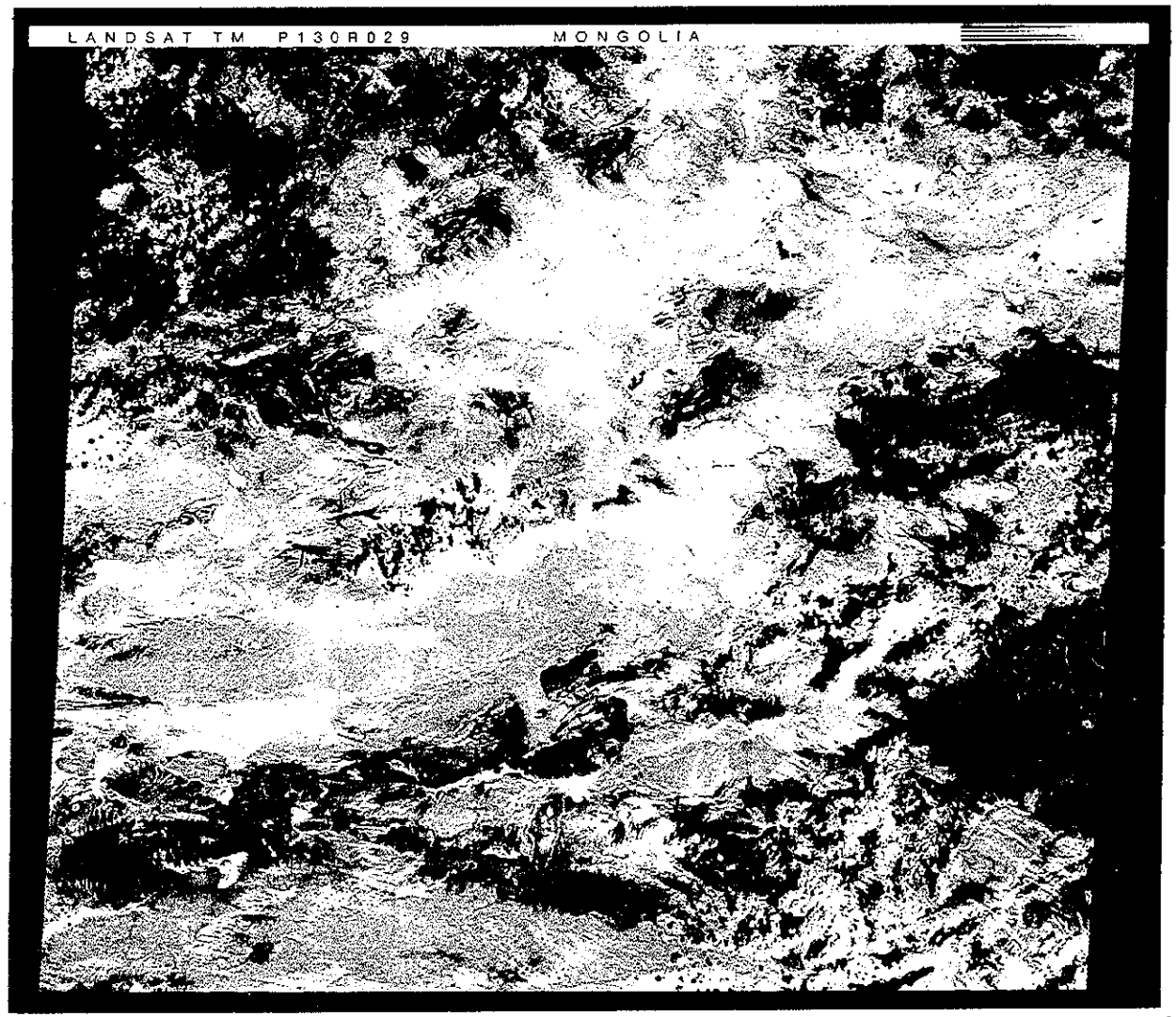

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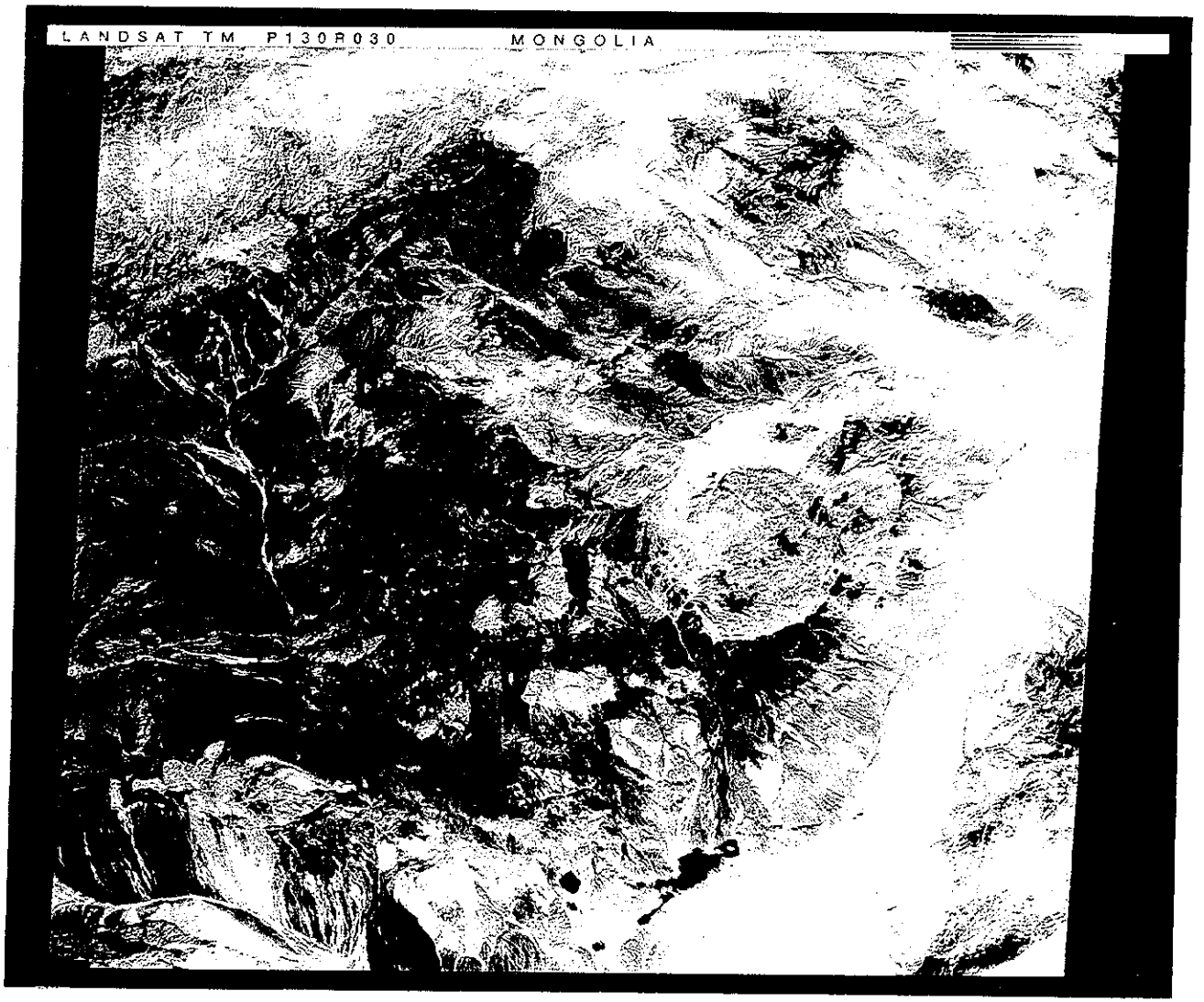

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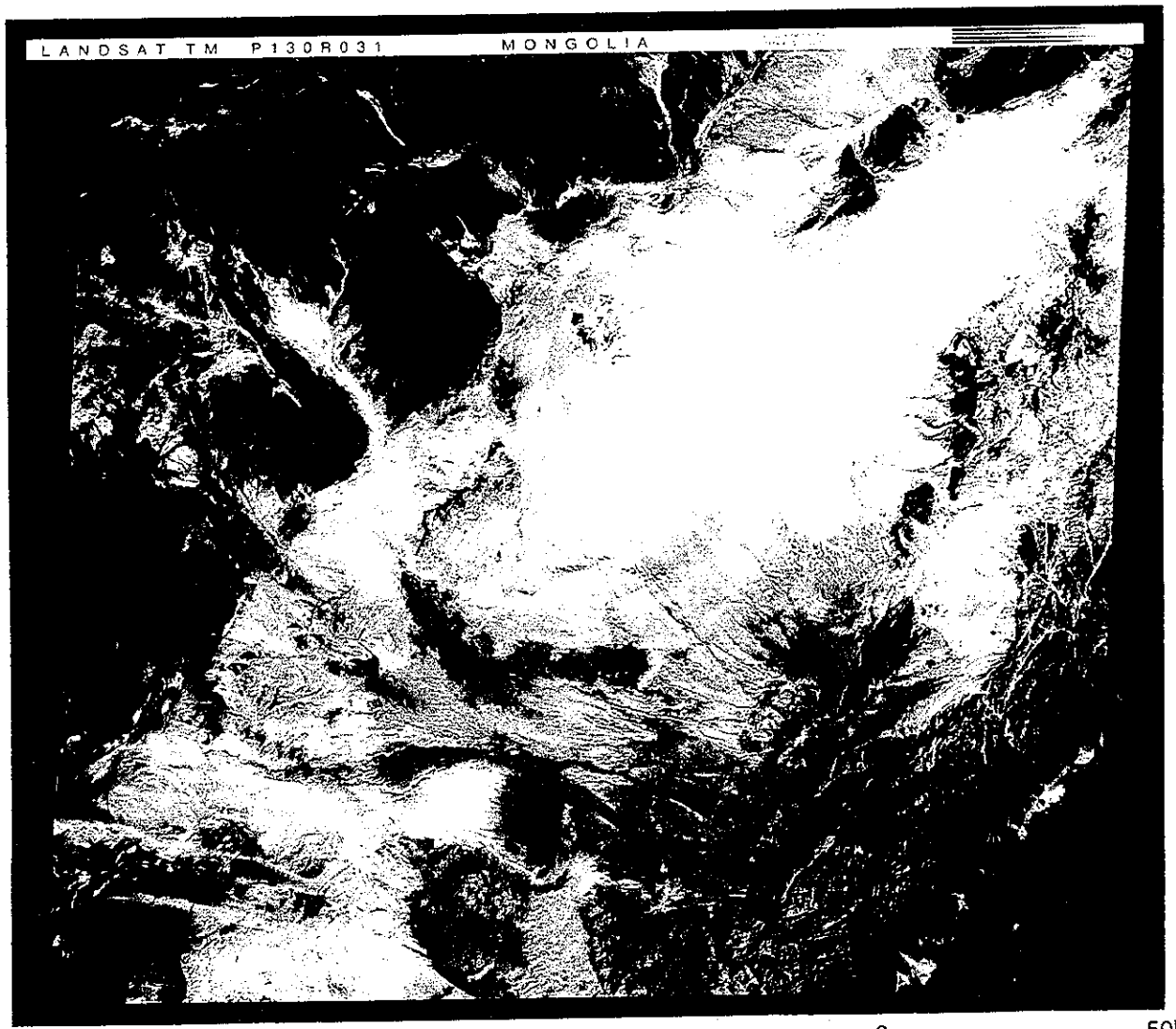

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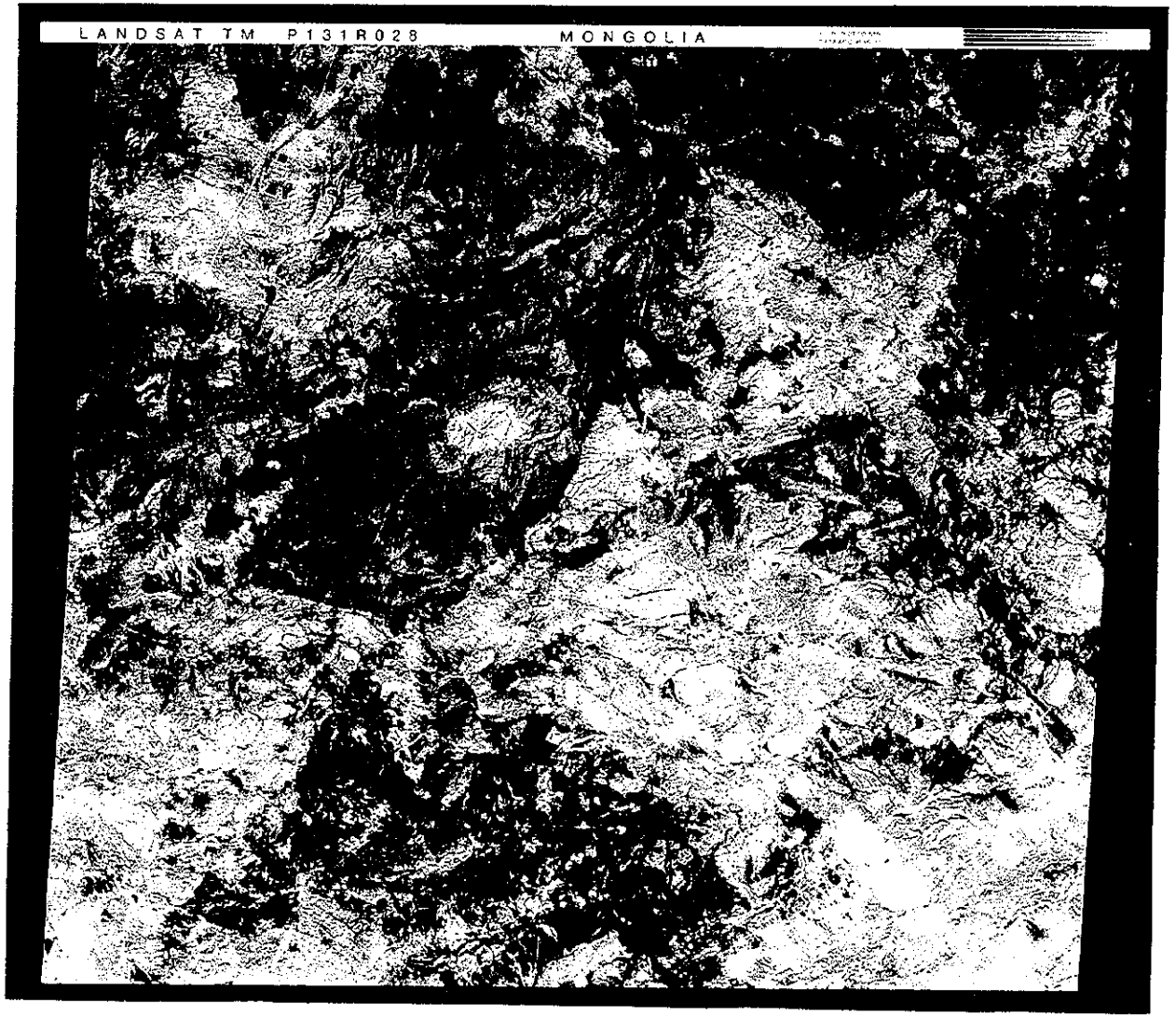

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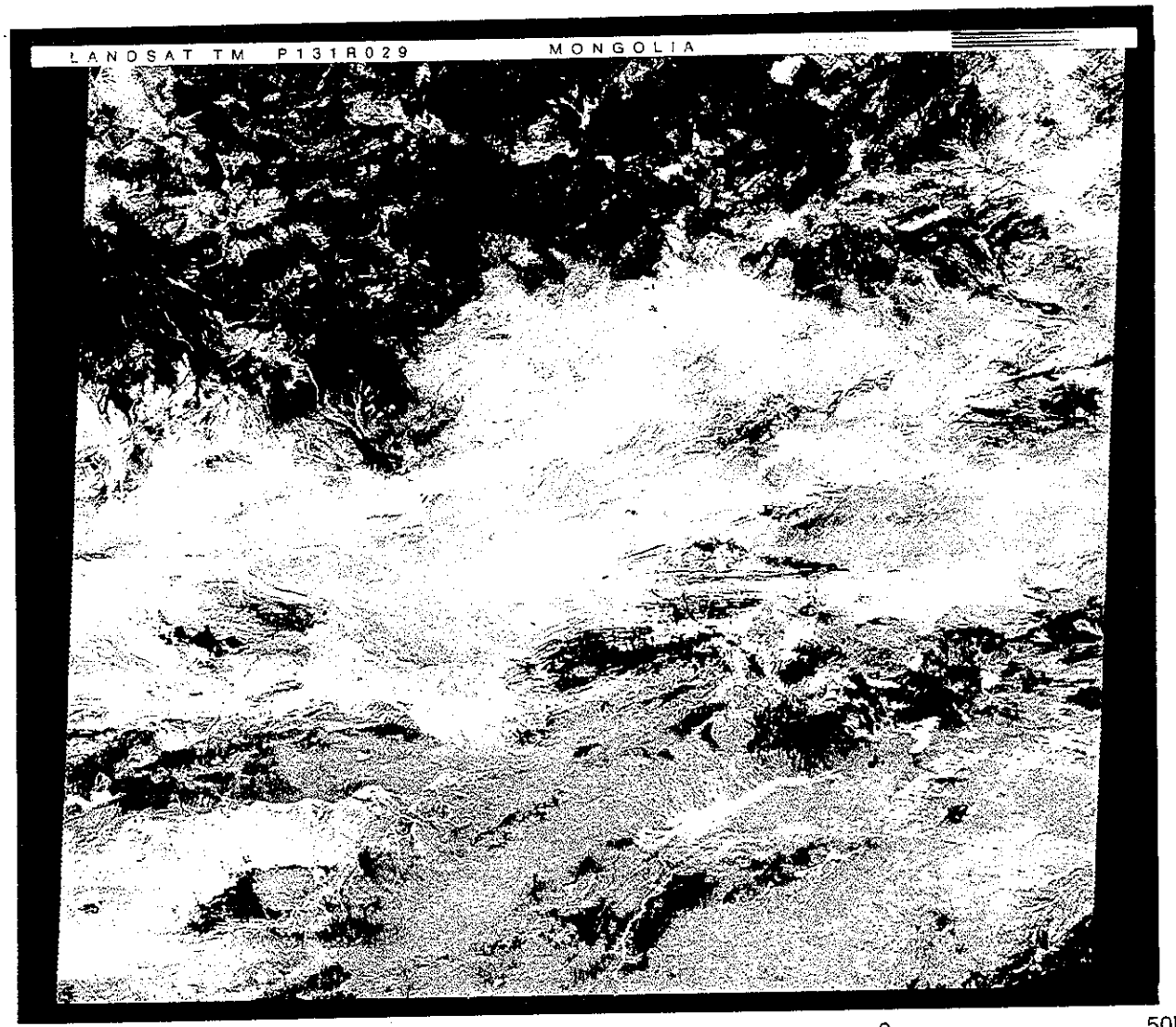

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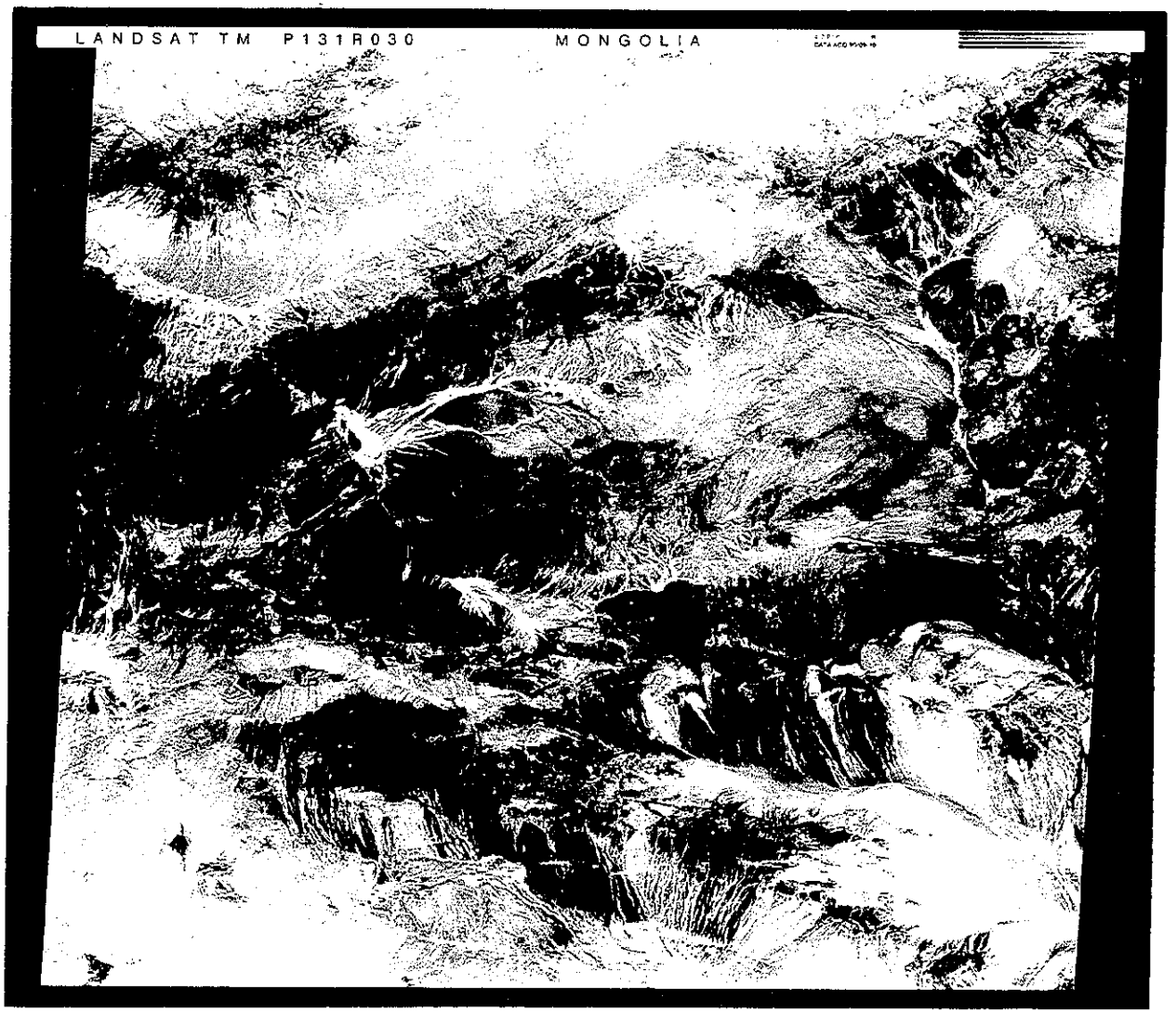
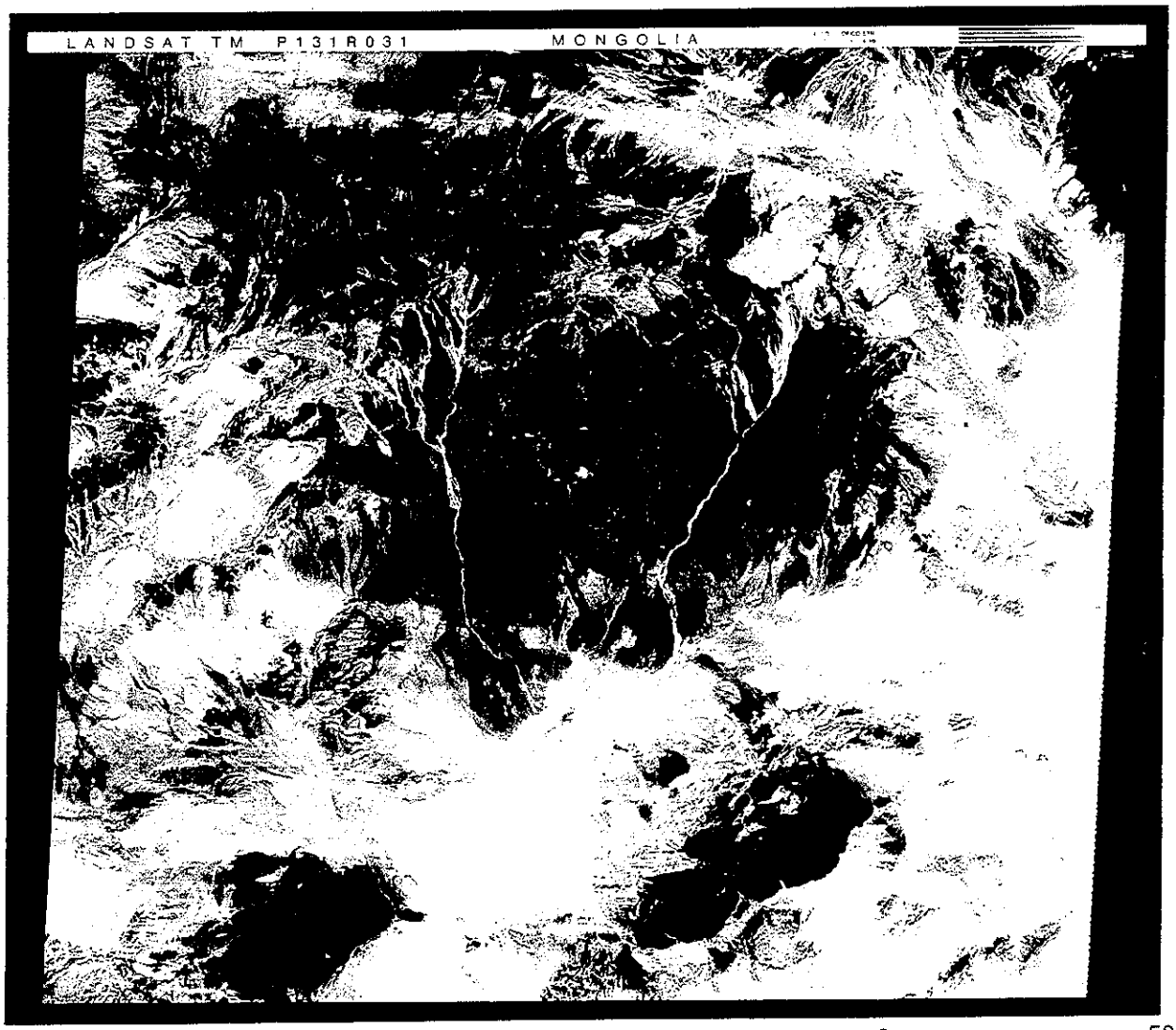


Appendix 9:Analized Satellite Image



Appendix 10:Analized Satellite Image