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GEOGRAPHIC INTELLIGENCE MEMORANDUM

THE PHYSICAL GEOGRAPHY OF A SPECIFIC AREA NEAR SEMIPALATINSK

CIA/RR-G/I-239
November 1957

CENTRAL INTELLIGENCE AGENCY
OFFICE OF RESEARCH AND REPORTS

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PHYSICAL GEOGRAPHY OF A SELECTED AREA NEAR SEMIPALATINSK

The area of interest is located in northeastern Kazakhstan about 105 miles west of Semipalatinsk. It includes the territory within a radius of 25 nautical miles from 50°23'N - 77°53'E. Administratively the area is divided among Pavlodarskaya, Semipalatinskaya, and Karagandinskaya Oblasts.

I. Relief

The area is located on the northern fringe of the Kazakhstanskiy Melkosopochnik.* It is a gently rolling upland interrupted by numerous fairly long, isolated ridges and dotted with a few groups of hills and highlands. The area slopes gradually downward to the northeast, with average elevations ranging from about 200 meters (650 feet) in the north and northeast to more than 400 meters (1,300 feet) in the south and southwest. Extreme elevations vary from slightly less than 200 meters (650 feet) in the north and northeast to 629 meters (2,064 feet) at Gory Shaypak in the south. Northeast of the area, the landscape merges into the West Siberian Lowland. To the southwest, elevations increase in a series of steps to the elevated central part of the Melkosopochnik.

The highlands within the study area generally have steep slopes, the northern slopes commonly being the steepest. The form of the hills varies according to their composition. The quartzitic and sedimentary hills are sharp and jagged, whereas the granitic and porphoritic uplands have softer outlines and are cupola shaped. Although the orientation of the hills varies widely, the great majority trend in a northwest-southeast direction. These highlands generally rise about 50 meters (165 feet) above the surrounding terrain; a few, however, are over 200 meters (650 feet) high. In size, they range from small rounded hummocks to low ridges with numerous spurs. Generally the ridges are only a few kilometers (1 or 2 miles) in width, but they may be over 20 kilometers (12 miles) in length.

Surrounding the highlands are broad, flat valleys with many arms and branches that penetrate into the highlands. Scattered throughout the valleys are numerous basins up to 40 meters (130 feet) deep and ranging

* A highly eroded, hilly upland characterized by an irregular assortment of hills with elevations generally between 300 and 500 meters (1,000 to 1,650 feet).

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from less than 20 meters (65 feet) to many kilometers in width. Some are occupied by saline lakes.

II. Hydrography and Ground Water

The drainage pattern of the area is sparse, and is characterized by intermittent flow and interior drainage. There are no major streams in the area; but numerous, small ephemeral streams form during the spring thaw and after summer showers. They flow from the highlands onto the valley floor, where they either disappear or drain into small, shallow salt lakes. In the basins scattered over the valley floors are occasional salt lakes. Most of them are small; but the larger lakes, such as Sary-Kaska and Shabarsor, are more than 5 kilometers (3 miles) in length. Generally these lakes have a depth of from 0.5 to 2.5 meters (1.6 to 8.2 feet), although their level fluctuates greatly with the seasons.

Ground water in the area lies relatively near the surface and is generally fresh to slightly mineralized. Because the base rocks are primarily igneous and metamorphic with highly fractured upper strata, ground water does not flow between the strata but percolates through fissures and fractures in the rocks at depths of generally less than 10 meters (33 feet). Depth and flow vary considerably with the terrain, but they do not fluctuate greatly with the seasons. Occasionally, ground water from igneous and metamorphic strata emerges in the form of springs on the sides of hills and hummocks. Although some of these springs have an average flow up to 4 cubic meters per hour; many dry up during the winter. The ground-water level along the littorals of lakes varies greatly, but it generally lies from 5 to 6 meters (16 to 20 feet) below the surface; and the flow fluctuates between 0.04 and 3.5 cubic meters per hour. In some instances, fresh ground water has been obtained along the shores of salt lakes. Areas of gully alluvium are rich in ground water, which lies at a depth of 3 to 5 meters (10 to 16 feet) and has an average flow of 0.5 cubic meters per hour. In diluvial and alluvial deposits, ground water is found at depths from 4 to 6 meters (13 to 20 feet) and has a flow of 0.6 to 0.8 cubic meters per hour. Artesian basins may also occur within the area.

The water-bearing capacity of the strata varies, depending on the extent of fracturing and the type of rock. Shale, tuffs, quartzites,

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and porphyrites generally have a low water-bearing capacity; limestone, loose sandstone, conglomerates, and granite have a high water-bearing capacity. Precipitation is the primary source of ground water.

A low mineral content is characteristic of most ground water within the area, much of it being classified as fresh. Ground water with the lowest mineral content is associated with massive crystalline rocks and deep rock strata. Ground water associated with other igneous and metamorphic rocks has a higher salt content. The relatively steep dip of many of the strata of the area results in relatively rapid filtration, which lowers the mineral content of the water. The temperature of the water probably averages about 50°F.

III. Climate

The climate of the area is extremely continental, with wide annual and diurnal ranges of temperature; hot, dry summers; severe winters; short, transitional springs and autumns; and light precipitation. The annual precipitation is about 11 inches, with a maximum in summer and a secondary maximum in autumn.

Winter begins in November, when average daily temperatures fall below freezing and a snow cover is established. This season lasts about 5 months, until the end of March or the beginning of April. Persistently cold weather prevails throughout the winter, and periods of thaw are rare. Normally, temperatures are below freezing from November through March, but below-freezing temperatures occur occasionally in October and April. January is the coldest month. Surface waters are frozen throughout the winter. The snow cover is light but stable, the ground being covered with snow from 100 to 160 days a year. From January through March, the snow cover is the deepest, ranging between 2 and 12 inches. Relative humidity is highest in winter, averaging between 70 and 80 percent. Wind velocities are high, and winds of gale force (in excess of 32 m.p.h.) from the northeast occur frequently. The predominant winds, however, are from the south and southeast. The strong winds make the cold more penetrating.

Spring sets in at the beginning of April and lasts less than a month. An abrupt upswing of temperature and variable weather are characteristic. Cold spells and freezes occur fairly often, and clear skies prevail most of the time. Wind velocities in spring are slightly greater than in

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CLIMATIC DATA FOR SEMIPALATINSK*

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Monthly Temperature**	3	4	14	37	58	68	71	67	56	38	21	9	37
Mean Daily Maximum Temperatures**	10	7	21	47	68	76	80	79	66	46	23	18	
Mean Daily Minimum Temperatures**	-6	-9	3	28	45	54	57	55	44	30	8	6	
Absolute Maximum Temperatures**	36	34	50	74	92	96	99	96	95	79	54	39	
Absolute Minimum Temperatures**	-42	-29	-29	-1	21	37	42	36	28	2	-55	-29	
Mean Relative Humidity (in %)	80	78	81	67	51	51	51	53	60	68	78	79	
Mean Monthly Precipitation (in inches)	0.8	0.5	0.5	0.6	1.0	1.7	1.2	1.0	0.6	1.1	1.1	0.9	11
Mean Number of Days with Precipitation	14	9	11	7	9	10	10	8	5	12	11	13	119
Mean Number of Days with Snowfall	14	9	11	6	1	0	0	0	0	7	9	12	69
Mean Number of Days with 6 Inches or More of Snow on the Ground at 0700	10	17	17	1	0	0	0	0	0	0	0	9	54

* The station closest to the area at roughly the same altitude
** Temperatures Measured in °F.

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winter, but the prevailing winds are from the west.

Summer is long, hot, and dry. Clear skies, intense sunshine, high evaporation, and rather low relative humidity predominate. Summer begins in May and lasts until the end of September. July is the hottest month, with a mean monthly average of 71°F. In summer the diurnal range is great, with temperatures at night often falling to 32°F. Toward the end of summer, temperatures and the diurnal range decrease noticeably. Summer is the season of maximum precipitation, particularly during June and July; but the rainfall is unpredictable and droughts frequently occur. Most of the rain falls in thunderstorms. Weak, dry winds blow from the west and northwest.

Autumn arrives suddenly in early October and lasts about a month. Temperatures decrease rapidly, and variable weather sets in. Snowfall becomes more frequent toward the latter part of fall, but intermittent thaws are likely. Morning frosts become progressively more frequent. Wind velocities increase, and the wind regime grades into that of winter.

IV. Soils

Most of the study area is covered by a thin layer of gravelly chestnut soils interspersed with patches of solonets (alkali) and solonchak (saline) soils. The humus content is about 3 percent. On the summits and slopes of the highlands, the soil is characteristically thin, poorly developed, and gravelly. Small amounts of fine sand or sandy clay (sometimes as low as 10 to 15 percent) are intermixed with much larger quantities of pebbles and gravel. The soil mantle averages about 20 centimeters (8 inches) in thickness, below which is weathered parent material. On the lower slopes the soil cover reaches 40 centimeters (16 inches), but on the steeper slopes and on the summits of the highlands the thickness decreases to 10 centimeters (4 inches) or less, and in places a soil cover is completely absent. In these areas the surface layer consists of alluvial deposits of pebbles and rocks, with outcrops of parent rock.

In the basins and valleys between the hills, solonets and solonchak chestnut soils prevail. The humus content is about 3 percent. Although the depth of the soil cover in the basins varies with relief, it probably averages over 1 meter (40 inches). The upper horizon, a gravelly humus layer about 50 centimeters (20 inches) deep, is underlain by a clayey

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alkali horizon. Below this is a sulphate horizon about 50 centimeters (20 inches) deep, below which is a thin layer of weathered parent material.

Figure 1 gives the distribution of the soil types found in the area. Number 1 designates complexes consisting largely of solonets with some chestnut and brown soils interspersed. These soil varieties are generally gravelly, with frequent outcrops of rock. Number 2 indicates solonchak soils interspersed with patches of chestnut or brown soils. Gritty, loamy soils predominate; but gravelly soils occur. Number 3 indicates light chestnut and brown soils with patches of solonets. In small depressions, dark-colored dealkalized soils occur. Here gritty, loamy varieties alternate with gravelly soils. Number 4 includes complexes of solonets and solonchak. Number 5 refers to dark chestnut soils. These soils are primarily gravelly with frequent outcrops of rocks. Number 6 designates saline lakes.

The water content of the soils varies with the seasons. In spring, it constitutes about 5 percent of the weight of the soil mass, or 50 millimeters (2 inches) of water in the upper meter (40 inches) of soil. During the course of the summer the water content declines, and in late summer it is less than 1 percent. During the fall and winter the soil moisture gradually builds up to the spring level.

The consistency of the surface layer of soil (to a depth of 12 centimeters or 4.8 inches) also varies with the seasons. In spring, the average date for the occurrence of a slightly plastic condition in the surface layer of soil is about the middle of April. The following table shows by percentage the frequency of occurrence of various conditions in the surface layer of soil at selected periods during the year.

Soil Conditions During Selected Periods
(in percent of time)

Period	Sticky	Soft Plastic	Firm Plastic	Firm
10-20 May	0-5	20-25	25-30	40-50
10-20 Aug	0-5	10-25	20-30	40-70
10-20 Sep	5	10-20	35	40-50

During the late fall and winter, soils in the area are firm most of the time.

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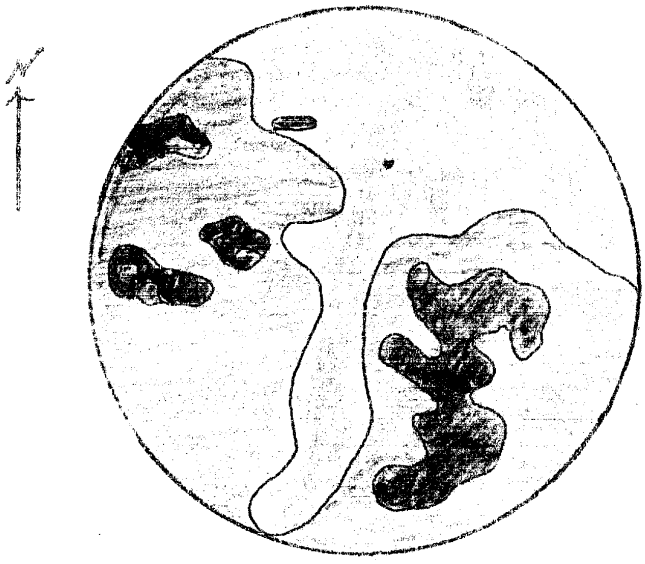
Figure 1.

SOILS



1. Solonets, chestnut, and brown

2. Solonchak with patches of chestnut or brown

3. Light chestnut and brown soils with patches of solonets

4. Solonets and solonchak

5. Dark chestnut

6. Saline lakes

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V. Vegetation

The vegetative cover of the area consists of a sparse growth of xerophytic and halophytic plants. Feather grasses, sagebrush, and saltwort are the principal species. On the steep, gravelly slopes and summits is a sparse cover of feather grass and sagebrush. The vegetative cover is sparser on southern slopes than on northern, where fescue and feather grass predominate. In the depressions, a denser grass cover prevails, and copses of deciduous brush and stunted trees occur where moisture is more abundant. Feather grasses intermixed with sagebrush and saltwort predominate on the solonets, solonchak, and thin alluvial soils in the central parts of the valleys. Patches of wild barley are found on the moister, mildly saline soils along the peripheries of the valleys and are generally surrounded by halophytic brush growing on solonets soils.

VI. Geology

The geologic structure of the area is very complex. In past geological ages, the area was subjected to intense mountain building in the form of folding, faulting, and intrusions. Since the Mesozoic period, however, mountain building has been much less intense; and the area has been greatly eroded. This has resulted in the exposure of strata of various ages and types. The upper 100 to 200 meters (330 to 660 feet) of rock are severely fractured and displaced.

The most recent deposits are Quaternary and Tertiary (see Figure 2, Number 1), which rest on a Paleozoic foundation. Siliceous and quartzitic conglomerates probably comprise the lower strata. Above them are thick deposits of fine clay interspersed with layers of quartzitic sandstones. The upper strata consist of Quaternary alluvial sands, 2 to 5 meters (7 to 16 feet) in depth.

Sedimentary layers of the Upper Devonian (Figure 2, Number 2) lie on top of effusive formations along the northern fringe of the area. The lower strata are thick layers of conglomerate (up to 300 meters or 1,000 feet), interlayered with thin beds of limestone (30 to 40 meters or 100 to 130 feet). The upper layers consist of sandstone-shale deposits with a thickness of 300 to 400 meters (1,000 to 1,300 feet). Lenses of coal are also present.

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Figure 2.

GEOLOGY

1. Tertiary and Quaternary
2. Upper Devonian
3. Lower and Middle Devonian
4. Lower and Middle Devonian
5. Middle Paleozoic
6. Upper Silurian
7. Lower Silurian
8. Upper and Middle Cambrian
9. Lower Paleozoic

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Much of the area is underlain by effusives of Lower and Middle Devonian age. On Figure 2, Number 3 indicates the areas where quartz porphyry, porphyrites, and their tuffs are exposed; and Number 4 shows the areas in which porphyrites and their tuffs outcrop primarily. Lying on Cambrian rock, the lower strata of these series are probably composed of pyroxene-plagioclase porphyrites 70 to 150 meters (230 to 490 feet) thick. The middle layers probably consist of quartz porphyry about 100 meters (300 feet) thick. In order of occurrence, these strata are probably overlaid by (a) porphyrites 50 to 100 meters (165 to 330 feet) thick, (b) quartz porphyry 50 meters (165 feet) thick, (c) porphyry up to 120 meters (395 feet) thick, (d) a 250- to 300-meter (820 to 1,000 feet) layer of conglomerate and fragmented tuff containing quartz porphyry, (e) a layer of tuffaceous sandstone and tuff; and finally (f) an upper layer of quartz porphyry or porphyrite.

Number 5 indicates areas in which undissected effusives of Middle Paleozoic age outcrop. Porphyrites, quartz porphyry, and their tuffs are probably the chief types of rocks. Although the depth is unknown, it is probably great.

Number 6 indicates areas of Upper Silurian sedimentary deposits. These thick sedimentary deposits consist primarily of green tuffaceous sandstones and shales with bands and lenses of tuffite, conglomerates, and limestone. In the upper part of this formation, a cover of porphyrites and agglomerate tuff is present in many places.

Number 7 designates areas of Lower Silurian formations. The lower strata appear to consist of porphyrites and their tuffs interbedded with jasper and tuffaceous sandstone, which are overlaid by jasper alternating with layers of tuff. The upper strata probably consist of porphyrites and their tuffs and of tuffaceous sandstone containing bands and lenses of marl, limestone, and conglomerate. The thickness of the Lower Silurian strata is about 900 to 1,200 meters (2,950 to 3,950 feet).

Number 8 shows areas of greatly metamorphosed layers of Upper and Middle Cambrian age. The strata are composed of flaky shale, sandstone, and siliceous rock interspersed with marbleized limestone. The Cambrian strata are probably about 600 meters (2,000 feet) thick.

Number 9 indicates areas in which Lower Paleozoic granite and granodiorite outcrop. The thickness is presumably great.

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