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RECENT DATA ON THE STRUCTURE OF THE OIROT MERCURY DEPOSITS

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/Figures are appended./

The well-known Oirot mercury deposits are connected with the Kuray zone of mercury mineralization referred to as the depression between the Kuray-Teletsk and Borotal' ledges. The zone now under consideration is about 70 kilometers long and is situated in the Kosh-Agach region of the Southeast Altai.

Surveys of the Kuray mercury zone (Figure 1) between Ak-Tash and Chagan-Uzun were made by V. A. Kuznetsov in 1934 and by A. S. Mukhin in 1936. A great deal of the material in this article is derived from the latter survey.

The three chief structural elements of this zone are: a horst of crystallized shales on the southeast, forming the central part of the Kuray ridge; the Borotal' horst on the southwest, composed of Algonquin-Cambrian limestone and porphyrite, forming branches of the Severo-Chuy chalk mountains; and a graben between the two horsts, depressed by a complex of Paleozoic rocks.

In addition to great anticlines formed by dislocations forcing masses of Devonian and Silurian rock several kilometers apart, small tectonic blocks of carbonaceous rock and Mesozoic effusions are sometimes found in the central part of the anticlines.

The Chagan-Uzun district of the Kuray mercury zone, with a total width in the tectonic bands of not over 600 meters, is very complex, probably as the result of overthrust faults connected with the cleavage of the Kuray zone.

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A. Chagan-Uzun Deposit (Figure 2)

The following old formations were involved in the structure of this deposit:

1. A Cambrian limestone porphyrite formation with small, dark grey lenses of bituminous limestone

2. Cambrian serpentine rocks

3. Sedimentary Silurian rocks, chiefly: (a) green feldspar and graywacke sandstone; (b) white and grayish finely laminated limestones with Radiolaria; (c) three types of conglomerates -- broken, brecciated conglomerates with archaeocyathic limestone debris, intraformational broken Silurian conglomerates with limestone debris, and fine gravelly conglomerates with almost no limestone detritus

4. Devonian sedimentary rock, represented by green sandstones and shales with layers of rose-red effusive rocks.

The alternation of tectonic block formations suggests that the deposit district formed part of a complex lamellar overthrust folding, the chief branch of which shows mineralization (location No 1). The ore zone appears as a wavy system of or beds, and the tectonic rock areas, which show cinnabar mineralization, are considered ore beds.

A survey in 1944 showed that the district is a huge anticlinal fold of Silurian rock and that its axial surface dips northward at an angle of about 70 degrees.

In the central section, anticlines of old rock, bounded by the tectonic lines of reverse fault No 1 and normal faults No 2 and 3 along the axis of the folding, are assumed to have developed during the formation of plicated structure. The southeastern part of the anticline is cut by a more recent overthrust, No 4, at an angle of about 45 degrees to the axis of the anticline. The mechanism of this process is shown in Figure 3.

Later phases changed the tectonic zone, brecciating the dike formations of effusive rock. Hydrothermal solutions, from which cinnabar was precipitated, made changes in the circumjacent rocks, cementing them and skinning over the crushed parts, chiefly with carbonates containing magnesium calcite.

The rocks of the ore-bearing zone were formed as a result the contact action of effusive rocks and of the consequent metasomatic change.

The most intensive mineralization and carbonization took place at the points of contact, by injection, between mineralized serpentines and finely crystallized effusive rock. The number of mineral types connected with this period of mineralization is not great: chief among them are magnesium calcites and ferrous carbonates, pyrites and cinnabar, and small amounts of antimony, realgar, orpiment and fahlerz (tetrahedrites).

According to available material, mineralization in this area is chiefly related to four directions of zonal crushing:

1. Ore zones with a strike of 290 to 310 degrees and a steep dip to the Northeast, the eastern part of the main zone being the steepest

2. Ore zones with a strike of 320 to 350 degrees and a northeasterly dip; the western continuation of the main ore zone forms the largest part of this series.

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3. Ore zones with a strike of about 70 degrees and a northwesterly dip; ore veins discovered here in 1944 are not very large but sometimes contain considerable cinnabar concentrations

4. Veins with a strike of 310 to 340 degrees and a northeasterly dip, found only in sandstone on the under side of the ore zone and as yet not sufficiently investigated.

The following pattern in the distribution of mineralization should be noted:

a. The great ore bodies in the chief ore-bearing zone are related, for the most part, to washed out sections in the dip of the fracture

b. Both cinnabar and carbonate mineralizations are greater along pre-ore fissures with a strike of 10 to 30 degrees and a northeasterly dip of from 70 to 80 degrees; the columnar ore bodies enriched with cinnabar in the central part of the deposit belong to these structures

c. In the eastern district there is a rich ore concentration within the ore zone in the form of ladder veins and veins explained as fillings of fissures by hydrothermal minerals (Figure 4).

B. Ak-Tash Deposit

This deposit is located on the eastern slope of an old glacial trough filled with morainic formations washed by the Ak-Tash springs.

The ore field is referred to as a tectonic block of limestone pressed down on the overthrust surface between rocks of dynamic metamorphic strata on the subaerial side and Silurian sandstone on the under side (Figure 5).

The upper dislocation on the northwestern border of the district has a very small zone of crumbling with low-grade tectonic clay. The lower overthrust (southeastern border) of ore-bearing limestone on Silurian sandstone is characterized by a wide zone of fracture (about 5 meters), with tectonic clay and immense rock fragments on both sides of the fault.

The northeastern flange of the ore deposit field is bounded by a system of intersecting dislocations.

All the limestone in the ore field is more or less mineralized. Exploitable mineralizations are related to ancient zones of crumbling in limestone with a strike of 310 to 330 degrees and a northeasterly dip of 70 to 80 degrees. Its width varies from 2 to 6 meters. Deposition is still continuing. In the central part of the ore bodies 0.2- to 0.4-meter strips of limestone breccias are found to contain almost no cinnabar or other hydrothermal minerals. Ice is often found here.

The ore zones are fairly close together; ore does not completely disappear in the crumbled limestone between zones, but merely becomes poorer. The ore bodies have no definite boundaries and the exploitable portions are found only by prospecting.

Inside the ore zones mineralization is unequally distributed in pockets. Transition from pockets of rich brecciated ores to poor ores occurs within a distance of a few centimeters.

Mineralization decreases gradually on the under side of the ore-bearing limestones. This indicates a screening of ore-bearing solutions by shales on the subaerial side of the ore zones. A similar screening occurred under blocks of "alien" rocks intruded in the limestone. If these structures determine the formation of rich ore pockets with a mercury content 50 to 80 times that of the average content of the deposit, then the small pre-ore dislocation, with tectonic clay extending about 0.5 to 1 centimeter, contributed to increasing

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the mercury content about ten times on the under side. The coefficient of variation for the average mercury content in individual ore zones fluctuates from 135 to 261 percent.

The mineralogical composition of the ore bodies in this district is simple and homogeneous.

C. West Deposit

This deposit is located 1 to 1.5 kilometers west of the Ak-Tash deposit on the steep southern slope of the Kuray ridge. It is divided by a small "log" 200 meters wide into West I, near the Ak-Tash deposit, and West II, farther east of it.

In West II, surface prospecting uncovered rich brecciated ores in one zone and poor or average mineralization of others. Mining operations below the surface in these zones showed only poor and scattered impregnations of cinnabar.

West I has been more thoroughly prospected, but so little mining has been done that the morphology of the ore bodies here cannot be adequately explained.

The fold with its intruded diorites is intersected by a system of zones of crumbled rocks, diagonal to the axis of the fold. They were probably ore-bearing channels and still play the role of ore-bearing zones with poor or average mineralization.

Crumbling layers of limestone collected ore-bearing solutions and also carried the richer ores. The dimensions of such strata or peculiar saddle-shaped veins have not yet been determined, but judged by the scale of the anticline they may be of importance.

D. Kuray Deposit

This deposit lies on the southern slope of the Kuray ridge, northeast of the Kuray settlement.

According to A. S. Mukhin and V. I. Kuznetsov, who prospected here, the ore field of this deposit forms part of an anticlinal fold, compounded of Silurian limestone and "tufogenic" effusive rocks, broken by granite blocks. The fold has a strike of 300 degrees. Its northern wall was broken by an overthrust of shale belonging to a dynamic metamorphic stratum with a northwesterly strike and a dip of 30 degrees. The overthrust outcrop on the old surface has a complex, calcareous character.

The ore bodies are, in general, steeply sloping veins and zones of crumbling rock. According to V. I. Kuznetsov, cinnabar is usually related to fissures around effusive rocks or in direct proximity to them -- most frequently at their points of contact with other rocks. Such selective mineralization is explained by their more regular structure and steeper angles of dip and possibly by their greater depth.

The old mineralization connected with diorite intrusion is shown by veins of epidote and quartz hematite. In general, the younger ore-bearing mineralization had two phases: (1) quartz, chlorite, antimony and cinnabar, and (2) brown carbonates and cinnabar.

Because of the poor quality of the ore beds, this deposit was not considered commercially profitable.

Comparison with other deposits in the Kuray zone shows that this deposit combines features of the Ak-Tash and West deposits.

We agree with L. D. Staroverov that this region is on a higher denudation horizon than the Ak-Tash anticline.

It seems to us that the unfavorable estimate of the deposit is somewhat premature and needs revision. It would also be advisable to carry on vertical mining operations on the saddle-shaped veins.

E. Ryzh "Log" Deposit

This deposit is located on the left side of the Ryzh "Log" in the Kuray River system. The ore field is covered by diluvium, and the individual rock outcroppings do not give a clear idea of its structure.

Mineralization has been discovered in two adjacent zones, with a strike of 330 degrees and a southeasterly dip of 60 to 70 degrees, which intersect the anticlinal fold of limestone. Their character, direction and ore content are very like those of the Ak-Tash deposit, which definitely makes this deposit interesting.

A. S. Mukhin found an outcropping of brecciated limestone with an impregnation of zinc blende and zinc glance as well as masses of the same containing cinnabar. This has aroused interest in the deposit since it is possible to show an interrelation between mercury and polymetallic mineralization.

F. Chubek-Kul' Deposit

This deposit is located on the steep slope of the Aygulak ridge, 8 kilometers northwest of Ak-Tash. Here there are two known outcroppings of cinnabar rocks. Mineralization is connected with dark gray Cambrian limestones in contact on the north with metamorphic shales.

The rocks are related to a limestone block about 3 meters wide, squeezed between two dislocations. Cinnabar (except for various lithological compounds) is located mainly in horizontal veins or veins with a sloping dip, recalling the mineralization of the eastern part of the Chagan-Uzun deposit about 70 kilometers from the Chubek-Kul' deposit.

There are also many points where cinnabar mineralization is known in the original outcroppings between Ak-Tash and Chagan-Uzun.

G. Conclusions

Mercury mineralization is probably connected with the Laramie phase of Cambrian tectogenesis and, according to mineralogical analysis of the ores, owed its genesis to epitherms.

In prospecting for exploitable mercury concentrations in the mercury zone, it is necessary in my opinion to follow the anticline of the plicated zone dependent on dislocations, rather than the overthrust line on which mineralization is nowhere fixed.

The great development of cinnabar in slicks is evidence of the gr[illegible] prospects in this zone for mercury mineralization as a whole. The connection between mineralization and anticlines is a great aid to prospecting. It increases the opportunities for opening new deposits and parallel mineralization zones along anticlinal banks or walls.

Opening the saddle-shaped veins and blanket deposits without outcroppings on the surface requires the organization of careful prospecting and structural analysis of probable areas.

[Figures follow]

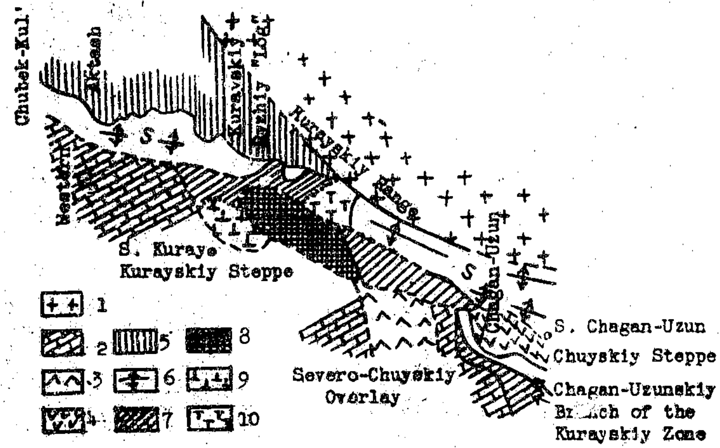

Figure 1. Structural Diagram of the Kuray Zone

1 - Horst of crystallized shales; 2 - Borotal' horst of limestones and porphyrites; 3 - Amphiboles; 4 - Hyperbasic rocks; 5 - Dynamic-metamorphic formation; 6 - Kuray formation and axes of great anticlines in it; 7 - Devonian formation; 8 - Carboniferous formation; 9 - Mesozoic effusions; 10 - Porphyrites.

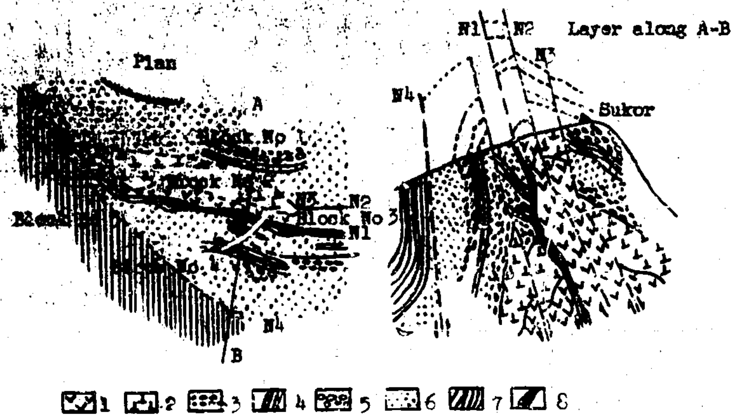

Figure 2. Structural Diagram of the Chagan-Uzun Deposit

1 - Serpentine hyperbasic rock; 2 - Limestone-porphyrite rock formation; 3 - Basal conglomerates; 4 - Limestones; 5 - Intraformational conglomerates; 6 - Sandstones; 7 - Sandstones and Devonian shales; 8 - Ore zone. Dislocations No 1 to 4: No 1 and 4, reverse and overthrust fault; No 2 and 3, normal faults.

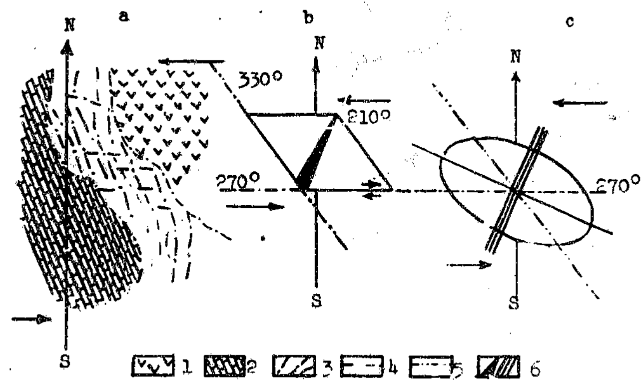

Figure 3. Diagram of the Chief Phase of Dislocations

a - General Geological Situation (Chagan-Uzun Deposit): 1 - Hyperbasic rocks; 2 - Borotal' horst; 3 - Tectonic complex of the Chagan-Uzun branch of the Kuray mercury zone and site an of the chief disjunctive dislocations. b and c, diagrams of dislocations: b- Rhomboid; c- Elliptical: 4 - Direction similar to that of zone of dispering and richest mineralization; 5 - Direction of overthrust fold; 6 - Direction of shearing similar to the direction of columnar mineralization and of certain veins in the mercury deposit area.

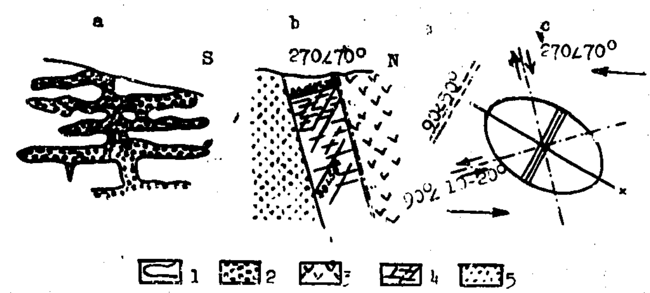

Figure 4. Diagram of the Site and Formation of "Horizon" Beds

a - Position in the Field of "Horizon" Beds Projected on a Plane of Average Strike: 1 - Connecting channels (columns of the northeastern strike); 2 - "Horizon" beds; b - Position (in Cross Section of Zone) of Ladder Veins, Series/of Which Create a "Horizon" Bed; 3 - Transformed serpentires; 4 - Ore zones and position of veins with cinnabar; 5 - Sandstones; c - Diagram of the Formation of Fissures During Compression.

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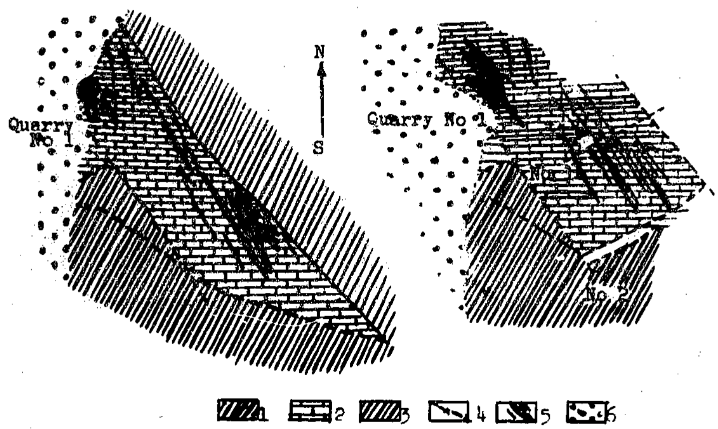

Figure 5. **Structural** Diagram of the Ak-Tash Deposit

1 - **Shales of dynamic metamorphic formation**-"supra-ore" layer; 2 - Ore-**containing limestones**; 3 - "Infra-ore" **sandstones** and limestones; 4 - Blocks of "alien" **rock**; 5 - **Ore-bearing** zones; 6 - Moraine.

- END -