Role of regional faults in the formation and placement of gold ore objects in western Uzbekistan

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Abstract. The results of the study, the relationship of regional faults with the processes of formation and mixing of gold ore occurrences in Western Uzbekistan are presented. According to researchers, the gold deposits of the region were formed under the influence of regional northwestern and transverse northeastern faults. So that the results of their research could serve as search signs and predictive criteria, they have not been studied enough to date. It is shown that the analysis of data on the location of gold ore occurrences in the network of regional faults in the region showed that 32% of gold ore objects were formed in the zones of northwestern faults. It is noted that the inter-fault space plays an important role in the placement of gold ore manifestations. Another important feature of the relationship between gold manifestations and regional faults has been revealed - this is the morphological feature (curvature area) of the faults, which determines the saturation of the inter-fault zone with manifestations of gold mineralization. The identified features of the relationship between regional faults and ring structures with gold occurrences are recommended to be used in forecasting and prospecting for gold.

1 Introduction

The main actual problem of the geological service of many states of the world, including Uzbekistan, is to ensure that the growth rate of mineral reserves is ahead of production in order to ensure that the degree of provision of production with them is always at a sufficiently high level [1-3]. To solve this problem of expanding and strengthening the mineral raw materials of gold, especially mining areas, it is first of all necessary to expand the area of exploration work on the flanks and deep horizons of known and developed deposits [4-6]. No less important is the revision and analytical work to study the patterns of formation and distribution of endogenous mineralization, ore-controlling factors, geological and structural conditions for the localization of mineralization, etc., which will reveal new facets of the genesis, patterns of formation, conditions for location and factors controlling

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mineralization [1-7]. In this regard, the study of ore-controlling structures of both regional and local manifestation scales in order to determine their role in the formation and placement of ore deposits will make it possible to determine search features and develop new predictive search criteria [8-10]. As part of the above, the studies were aimed at studying the relationship of regional faults with gold occurrences in Western Uzbekistan.

The draft Decree of the President of Uzbekistan No. UP-60, "Strategy for the Development of New Uzbekistan, provided for 2022-2026", provides for a radical increase in the volume of geological exploration to expand the mineral resource base in accordance with the needs of the economy of Uzbekistan, which today is the actual task of the republic's geology [1-3, 8-10].

Solution of this geological task, as defined in the Decree, is carried out by "cardinal increase of volumes of geological prospecting works". The objects where it is possible to increase the volume of geological exploration work are: the developed deposits, their flanks and deep horizons; deposits which should be involved in the exploitation; promising areas of endogenous mineralization; areas of geochemical halos; favorable structural positions; area of prospecting works [1-4, 7-9]. Among them, the most important is the area of prospecting works, where the increase in the volume of geological exploration will allow to carry out a set of geological studies aimed at solving a wide range of geological problems [1-4, 9]. These include, first of all, the task on the geological structure of the area, then comes the ore content, mineralogical and geochemical and geophysical features, then cosmogeological and prognostic tasks with the allocation of specific areas for further geological prospecting works.

2 Material and Methods

Allocation and justification of promising areas for this or that type of endogenous mineralization is currently one of the most important tasks of geology. First of all, it is related to gold, which is one of the main levers of the economy of many countries, including Uzbekistan [1-4]. This problem is also faced by the main gold ore province of the republic - Western Uzbekistan.

As it is known, Western Uzbekistan is a gold ore province with large gold deposits (Muruntau, Kokpatas, Daugyztau, Amantaytau, Charmitan and others), which, according to researchers, were formed under the influence of north-western regional and north-eastern local faults. According to I.H.Khamrabayev, M.M.Mansurov, R.A.Usmanov, Y.S.Savchuk, M.K.Turapov, R.H.Mirkamalov, B.O.Zhonibekov and others, the zones of their conjugations and intersections are the most favorable for formation of gold deposits.

However, these regional and local ore-controlling faults, in particular the zones of their conjunctions and intersections have not been studied enough for today so that the research results could serve as search structural-tectonic signs and criteria for determining the prospectivity of the region with allocation of specific areas for geological prospecting works.

Taking this into account, the work was carried out to study the positions of gold ore occurrences of Western Uzbekistan in the network of regional faults, cosmogeological structures (ring structures) in the fields of tectonic stresses and deformation.
3 Results and Discussion

The basis of the conducted works are: map of regional faults of Central Asia by M.A. Akhmedjanov and others; materials of decoding of space images; data on study of stress and strain state of the Earth's crust in Western Uzbekistan; more than 170 objects of gold occurrences.

According to M.A.Akhmedjanov, O.M.Borisov (1972) and D.Yakubov a number of regional north-western faults are allocated in western Uzbekistan (table №1). According to their opinion and representation, as well as I.H.Khamrabayev, F.A.Usmanov, Y.S.Savchuk, R.H.Mirkamalov, D.T.Khon, V.S.Korsakov, N.Y.Dulabova, M.Mansurov and others are ore-controlling structures of the region. In determining the relationship of these faults with gold mineralization, the fact of deposit location in the zones of these structures, as well as according to E.M. Nekrasov et al. (2019) in their satellite faults.

Table 1. Interrelation of gold ore objects and regional faults in Western Uzbekistan.

<table>
<thead>
<tr>
<th>#</th>
<th>Name of the regional structure (numbers according to the map &quot;Regional faults of Central Asia&quot;)</th>
<th>Genetic type (by M.A. Akhmadjanovich, O.M. Borisov, J. Yakubov, A.K. Bukharin et al.)</th>
<th>Distribution of gold occurrences in fault zones in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>North Kyzylkum 42</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Bukantau 46</td>
<td>uplift</td>
<td>0.6</td>
</tr>
<tr>
<td>3</td>
<td>Central Kyzylkum 47</td>
<td>uplift</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>Tamdy-Karachatyr 66</td>
<td>uplift</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>Besapano-Yuzhno-Fergana 67</td>
<td>uplift</td>
<td>3.4</td>
</tr>
<tr>
<td>6</td>
<td>South Tamdynsko-Katran 68</td>
<td>uplift</td>
<td>5.1</td>
</tr>
<tr>
<td>7</td>
<td>Aristantau-Taldyk 69</td>
<td>uplift</td>
<td>2.3</td>
</tr>
<tr>
<td>8</td>
<td>Auminzatau-Surmetashskiy 70</td>
<td>uplift</td>
<td>≈8</td>
</tr>
<tr>
<td>9</td>
<td>Aktau-Turkestan 71</td>
<td>uplift</td>
<td>0.6</td>
</tr>
<tr>
<td>10</td>
<td>Karatau-Zarafshan 72</td>
<td>uplift</td>
<td>4.5</td>
</tr>
<tr>
<td>11</td>
<td>Kulzhuktau-Zarafshan 73</td>
<td>uplift</td>
<td>0</td>
</tr>
<tr>
<td>12</td>
<td>Zirabulak-Dukdan 74</td>
<td>uplift</td>
<td>1.7</td>
</tr>
<tr>
<td>13</td>
<td>Zirabulak-Maghian 75</td>
<td>uplift</td>
<td>34</td>
</tr>
<tr>
<td>14</td>
<td>South Tianshan 76</td>
<td>uplift</td>
<td>≈3.0</td>
</tr>
<tr>
<td>15</td>
<td>Utemergensky 112</td>
<td></td>
<td>≈33%</td>
</tr>
</tbody>
</table>

Number of objects 176
Analysis of data on the location of gold occurrences in the network of regional faults showed that more than 32% of all deposits are located in the zones of north-western structures. The highest figure - 8%, in this case is characteristic of Auminzatau-Surmetash fault zone. Then follow South Tamdin-Khatran and Karatau-Zaravshan faults, which account for 5.1% and 4.5% of gold deposits in Western Uzbekistan, respectively. Besapano-South Fergana, Zirabulak-Maghian, South Tianshan and Aristantau-Taldyn faults, which respectively controlled 3.4%, 3.0% and 2.5% of gold occurrences, are also noted.

A negligible number of gold deposits were established in the zones of Bukantau (0.6%), Zirabulak-Dukdan (1.7%) and Aktau-Turkenstan faults. In zones of North-Kyzylkum, Central-Kyzylkum, Tamdy-Karachatyr and Kulzhuktau-Zaravshan faults no gold ore deposits were noted (Fig. 1).

![Histogram of gold objects location in the regional fault zones in Western Uzbekistan.](image)

Thus, the metallogenic analysis of location of gold ore occurrences in Western Uzbekistan showed that about 33% of gold occurrences in the region are controlled by regional faults of north-west strike. 67% of them are located in the inter-fault space (Fig. 2), where a certain regularity in occurrence of gold mineralization in the geological space of the region is observed. This pattern is a decrease (reduction) of gold occurrences from the north to the south of the region.

Analyzing the data on location of gold occurrences in the inter-fault spaces, it should be noted that the gold objects in the geological space of the inter-fault zones are not placed evenly. The highest indicator is characteristic of the area between Besapano-Yuzhno-Fergana and Yuzhno-Tandynsko-Katran faults, where 30 gold deposits are located.

The second place is occupied by the inter-fault area between Bukantau and Tamdy-Karachatyr regional structures. There are 27 gold deposits in this space. The third place is occupied by the inter-fault space between South Tamdysko-Katran and Aristantau-Tamdyn faults, as well as between Aristantau-Tamdyn and Auminzatau-Surmetash faults,
where, respectively, 13 and 12 gold ore objects are located. In addition to these, we can
distinguish the inter-fault space between the Tamdy-Karachatyr, Besapan-Yuzhno-Fergana
faults, where the placement of 8 objects is observed.

<table>
<thead>
<tr>
<th>Name of regional faults</th>
<th>Number of ore objects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Bukantau 46</td>
<td></td>
</tr>
<tr>
<td>2 Tamdy-Karachatyr 66</td>
<td></td>
</tr>
<tr>
<td>3 Besapano-Yuzhno-Fergana 67</td>
<td></td>
</tr>
<tr>
<td>4 South Tamdinsky-Katran 68</td>
<td></td>
</tr>
<tr>
<td>5 Aristanau-Tal'dyk 69</td>
<td></td>
</tr>
<tr>
<td>6 Auminzatau-Surmetashskyi 70</td>
<td></td>
</tr>
<tr>
<td>7 Aktau-Turkestan 71</td>
<td></td>
</tr>
<tr>
<td>8 Karatau-Zaravshan 72</td>
<td></td>
</tr>
<tr>
<td>9 Kulzinktau-Zaravshan 73</td>
<td></td>
</tr>
<tr>
<td>10 Zirabulak-Dukdan 74</td>
<td></td>
</tr>
<tr>
<td>11 Zirabulak-Maghian 75</td>
<td></td>
</tr>
<tr>
<td>12 South Timshsan 76</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 2. Histogram of gold occurrences location in the regional interfracture zones.

Taking into account these data, as well as the location of 10 gold deposits in the inter-
fault zone between Aktau-Turkestan and Karatau-Zaravshan faults, we can note that these
facts confirm the above mentioned about the uneven manifestation of gold mineralization in
Western Uzbekistan. Uneven distribution of gold mineralization is determined by many
natural factors, among which the most important are: surfacing of the Paleozoic basement;
geological structure; tectonics; geodynamics and magmatism.

Among the inter-fault zones of the region are: geological space between Bukantau and
Tamdy-Karachatyr faults controlling 27 gold-ore objects; inter-fault space between
Besapano-South Fergana and Auminzatau-Surmetash faults, in which 60 gold-ore
occurrences are located.

Both interfracture zones contain more than 80 gold occurrences of the region. This
represents more than 45% of all surveyed gold occurrences in Western Uzbekistan. In all
interfracture zones taken together, placement of 64% of all registered gold ore occurrences
of Western Uzbekistan has been established.

Thus, the studies of relations between gold mineralization occurrences and regional
faults in Western Uzbekistan showed that about 33% of gold ore objects are controlled by
regional fault zones of northwest trending and 64% are located in the interfault zones,
which is an important fact that should be taken into account when forecasting and searching
for gold deposits in all areas of Western Uzbekistan.

Another important feature of interrelation of gold mineralization occurrences with
regional faults, which can be used as a structural feature in prospecting and as a reliable
criterion in prognostic works, has been revealed. This feature is that the morphological
features (curvature area) of regional faults determine the degree of saturation of inter-fault
zones with gold mineralization (Fig.3). In the area of interfault space curvature between
Bukantau and Tamdy-Karachatyr faults, nine gold ore objects are located, which is 33% of
the total number of objects in this interfault zone. A similar picture is characteristic of the interfault space curvature section between Besapan-Yuzhno-Fergana Yuzhno-Tamdy-Katran faults, where eight gold deposits are located.

![Histogram of distribution of gold occurrences depending on the morphology of faults in Western Uzbekistan.](image)

**Fig. 3.** Histogram of distribution of gold occurrences depending on the morphology of faults in Western Uzbekistan.

It is known that northwestern faults of the region are complicated by transverse structures, wedge-shaped structures occupy a special place in the processes of ore formation, controlling formation and placement of mineralization of noble, non-ferrous and other metals from this position the conducted analysis shows that 4 wedge structures of the region could control formation and placement of up to eight gold ore objects. This is a weighty structural factor, which requires special attention during prognostic and prospecting works.

As you know, in recent years, remote sensing materials are widely used in the search for mineral deposits, in the study of the geological and structural-tectonic structure of certain areas of the Earth's crust. When searching for endogenous deposits the priority is the interpretation of structural-material complexes, ring and linear structures.

What is the role of linear structures (regional and local faults) in formation and location of gold-ore objects in Western Uzbekistan is considered above.

Below we will consider the relationship between endogenous gold mineralization of the region and ring structures, as they are an important object in prognostic and prospecting works.
Analyzing several studies on decoding of aerospace images established that the endogenous mineralization is usually located: in the boundary zone of the ring structure; in its central part; between the center and boundary zone; in the zone of ring structure complication by fractures.

Based on these data the study of relationship of gold ore occurrences with ring structures of the Western Uzbekistan was carried out (Fig.4).

Fig.4. Cosmostructural position of gold objects of Western Uzbekistan in the ring structures.

It has been established that the majority of gold ore objects in the region are associated with ring structures, complicated by regional ore-controlling faults. The most favorable position for the location of gold deposits is the peripheral zones of the structure and the zone between the center and the boundary structure of the ring structure.

For many, especially small and medium-sized ring structures, a certain relationship with gold mineralization is established, among them favorable for the manifestation of gold mineralization are ring structures complicated by faults.

Application of research results as prospecting signs and prognostic criteria will increase the efficiency of geological exploration works and reliability of prognosis.

4 Conclusion
The vast majority of gold occurrences in Western Uzbekistan are located in the inter-fault zones between regional ore-controlling faults of northwest trending. Regional northwest-trending faults and their subparallel satellites in the form of lateral branches control the location of one-third (1/3) of all gold occurrences in the region.

Important in the formation of gold ore objects and their location in the geological space are areas of changes in the morphology of interfracture zones, in which up to 30% of gold deposits of their total number have been noted.

Joint development with regional, northwest trending faults of local ore-controlling structures of northeast trending (transverse, anti-Tianshan structures). The vast majority of gold, silver and tungsten deposits in the region are spatially associated with such local faults. Favourable structural position for ore formation are the zones of conjugations, their intersections with other systems of rupture tectonics.

Ring structures are promising for location of endogenous gold mineralization. The vast majority of gold occurrences are located in the ring structures, some of which are complicated by north-western, north-eastern and latitudinal faults. Peculiarities of relations between regional and local ore-controlling faults, as well as ring structures and gold ore occurrences revealed in the course of the study are recommended to be used as prediction criteria and structural attributes during prospecting for gold in Western Uzbekistan.

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