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CHARACTERISTICS AND DYNAMICS OF MERCURY-RELATED OCCURRENCES IN GAS, OIL AND GROUNDWATER DEPOSITS OUTSIDE THE FERGANA REGION

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Abstract

This article analyses the occurrence, distribution characteristics and quantitative dynamics of mercury in gas, oil and groundwater deposits located outside the Fergana region, with particular emphasis on the Bukhara region. The migration of mercury through underground fractures, reservoir rocks and hydrocarbon-bearing formations is considered from the perspective of geochemical processes. In addition, the presence of mercury in gas and oil fields is evaluated as an important factor associated with industrial safety, environmental monitoring, corrosion and degradation of technological equipment, and the potential risk of groundwater contamination. The study highlights the regional variation in mercury content and its relationship with geological structure, fracture systems

and groundwater movement. The findings of the article have scientific and practical significance for assessing mercury-related risks during the exploitation of oil and gas deposits, improving monitoring systems and developing environmental safety measures.

Keywords: Mining, oil, gas, groundwater, mercury, mercury content, fracture, Bukhara region, geochemical processes, environmental safety.

1. Introduction

Mercury is a chemical element with the symbol Hg and atomic number 80. It belongs to the group of heavy metals and is distinguished by its unique physical and chemical properties. Under normal conditions, mercury is a silvery liquid metal with a high density and relatively low melting point. In nature, mercury may occur in native form, but it is more commonly found in mineral compounds, the most important of which is cinnabar, HgS.

Mercury and its compounds are of considerable scientific and practical interest because they are widely distributed in different geological environments and may be associated with ore deposits, hydrothermal systems, oil and gas fields, and underground water systems. At the same time, mercury is a toxic element that poses serious risks to human health, technological equipment and the environment. In oil and gas production, the presence of mercury in natural gas and associated fluids may lead to corrosion, contamination of technological systems and additional environmental hazards.

In hydrocarbon-bearing regions, mercury may migrate through underground fractures and deep fault zones together with gases, hydrothermal fluids or other volatile components. Therefore, mercury can be regarded not only as a hazardous

impurity, but also as a geochemical indicator reflecting the relationship between hydrocarbon deposits, tectonic structures and deep geological processes.

The main purpose of this article is to analyze the occurrence and distribution dynamics of mercury in gas, oil and groundwater deposits outside the Fergana region, particularly in the Bukhara region, and to identify the possible connection between mercury concentrations and deep fault systems.

2. Materials and Methods

The article is based on the analysis and generalization of geological, geochemical and structural data related to mercury-bearing gas fields in the Bukhara region and other hydrocarbon-bearing areas. Particular attention is paid to the Uchkir gas field, which is located within a complex tectonic zone associated with fault systems and regional lineaments.

The methodological approach includes:

1. analysis of mercury occurrence in natural gas, oil and groundwater systems;
2. comparison of mercury concentrations in different gas fields;
3. assessment of the relationship between mercury content and geological structures;
4. interpretation of mercury migration through deep fractures and tectonic fault zones;
5. evaluation of environmental and industrial risks associated with mercury in hydrocarbon deposits.

The study also considers published data reported by N.A. Ozerova and other researchers, including S.A. Bakiyev, I.M. Nurmatov and O.V. Polezhaev, who investigated mercury concentrations in gases from several gas fields.

3. Geological and Geochemical Characteristics of Mercury

Mercury is known to occur in more than thirty minerals. The main mercury mineral is cinnabar, HgS, which contains a high proportion of mercury and sulfur. Other mercury-bearing minerals include livingstonite, opofrite and several sulfide compounds containing zinc, cadmium, selenium, antimony, copper and tellurium.

The geochemical mobility of mercury depends on temperature, pressure, oxidation-reduction conditions, the presence of sulfur, halogens and organic matter, as well as the permeability of geological formations. In fractured zones, mercury may migrate in gaseous or dissolved form. This feature is especially important for oil and gas regions where deep faults provide pathways for the movement of fluids and gases from deeper parts of the Earth's crust.

In natural gas deposits, mercury may occur in very small concentrations, but even trace amounts can be significant from the viewpoints of technological safety and environmental protection. Mercury-containing gases may affect pipelines, processing equipment and separation systems. Moreover, mercury may enter groundwater systems and create long-term environmental risks.

4. Mercury Occurrence in Gas Fields of the Bukhara Region

The Uchkir gas field in the Bukhara region is of particular interest due to its structural position. According to geological interpretations, this field is located in an area where longitudinal and transverse fault systems intersect. The field is associated with the Bukhara fault zone and with transverse tectonic disturbances that limit the Gazli uplift.

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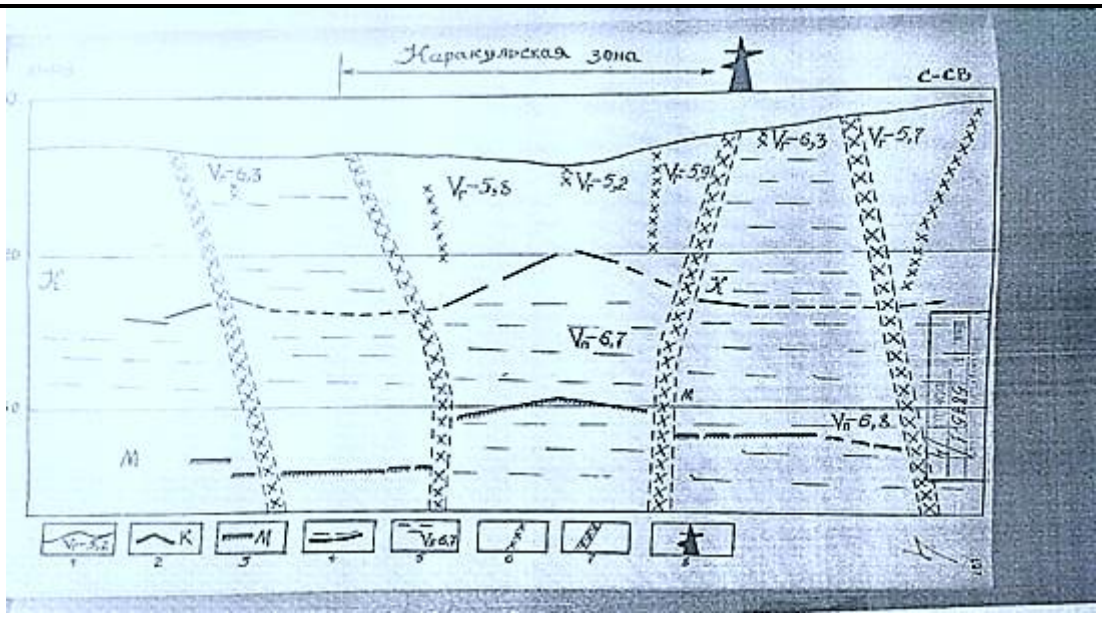

1 – domezazoy fundamenti yuzasi; 2- K qatlami yuzasi; 3- M qatlami yuzasi; 4 – taklif qilingan chegaralar (yoki shartli chegaralar) ; 5 – qatlam tezliklarini aks ettiruvchi maydon; 6- yer qobig'ining faqat yuqori qismi darzliklari; 7- er qobig'ining chuqur qismi darzliklari; 8-Uchqir gaz koni.

1-rasm. Amudaryo yotqizigi orqali seysmologik qirqimi (Farob-Tamdibuloq chuqur seysmik zonasi profilining bir qismi).

These transverse fault systems are considered part of a broader regional tectonic structure connected with the Ural–Oman lineament and the Julsari–Takhtabazar fault system. Many gas fields of the Turan Plate are located near such linear structures. This indicates that deep tectonic zones may have played an important role in the formation, migration and accumulation of hydrocarbons, as well as in the distribution of mercury within natural gas systems.

According to the available data, mercury was detected in gas samples from the Uchkir field at a concentration of approximately 0.5×10^{-6} g/m³. This value was

higher than those reported for some other gas fields, such as Gugurtli and Naip. A similar mercury concentration was also detected in gas from the Shadlik field, even when samples were taken from a gas pipeline located about 400 km away from the deposit. This suggests that mercury may remain present in transported gas and may therefore represent not only a local geological issue, but also a technological and environmental concern along gas transportation systems.

5. Comparative Mercury Concentrations in Selected Gas Fields

According to data reported by S.A. Bakiyev, I.M. Nurmatov and O.V. Polezhaev, relatively high mercury concentrations were recorded in gases from several gas fields. The maximum values were reported as follows:

Table 1. Mercury concentrations in natural gas samples from selected gas fields

Gas field	Well or sampling point	Mercury concentration, μg/m³
Pamuk	Well 41	15.8
Zevardi	Well 49	16.8
Zevardi	Well 241	16.3
Dengizkul	Total field output	16.9
Gazli	Sampling point 1	17.4
Gazli	Sampling point 2	17.8

These values show that mercury distribution in natural gases is not uniform. Its concentration varies depending on the geological structure of the field, the depth and type of fault systems, the degree of tectonic activity and the presence of deep fluid migration pathways.

The relatively high mercury concentrations in Pamuk, Zevardi, Dengizkul and Gazli indicate that these fields may be connected with deep tectonic structures. In such areas, mercury-bearing fluids and gases may rise from deeper zones of the crust through fractures and fault systems.

6. Relationship Between Mercury and Deep Fault Systems

The structural-geological analysis of mercury-bearing gas fields shows that elevated mercury concentrations are often associated with areas where deep faults intersect with large planetary lineaments. Such zones are usually characterized by complex tectonic development and increased geodynamic activity.

The main geological features of these zones include:

- intersection of deep faults with major regional lineaments;
- connection with ancient rift-related structures;
- sharp changes in the depth of the crystalline basement and the Moho surface;
- increased modern tectonic activity;
- higher heat flow compared with surrounding areas;
- occurrence of hydrothermal mineralization, including mercury mineralization.

These features suggest that mercury enrichment in natural gas is not accidental. It may be related to deep geochemical processes and the upward migration of mercury-bearing fluids through activated fault zones.

Gas fields located only within a single fault system are not always characterized by high mercury content. Higher mercury concentrations are more typical of structurally complex zones where several fault systems intersect. This indicates that the intensity of mercury migration depends not only on the presence of fractures, but also on their depth, permeability, tectonic activity and connection with deeper geological sources.

7. Environmental and Industrial Significance

The presence of mercury in natural gas, oil and groundwater systems has important environmental and technological implications. Even at low concentrations, mercury can accumulate in industrial equipment, pipelines and gas-processing facilities. This may cause corrosion, contamination and additional costs for safe operation and maintenance.

From an environmental point of view, mercury is dangerous because it may enter groundwater systems and spread through natural water circulation. In areas where hydrocarbon deposits are connected with fractured geological structures, the possibility of mercury migration into groundwater should be considered during environmental monitoring.

Therefore, mercury monitoring should be included in the assessment of gas and oil fields, especially in regions located near deep faults and tectonically active zones. Regular monitoring of mercury concentrations in gas, condensate, oil and groundwater can help reduce environmental risks and improve industrial safety.

8. Conclusion

The analysis shows that mercury occurrence in gas, oil and groundwater deposits outside the Fergana region, particularly in the Bukhara region, is closely related to geological structure, deep fault systems and tectonic activity. The Uchkir gas field and several other gas fields of the Turan Plate demonstrate that mercury may migrate through underground fractures and become concentrated in hydrocarbon-bearing formations.

Elevated mercury concentrations recorded in the Pamuk, Zevardi, Dengizkul and Gazli gas fields indicate that mercury distribution is associated with deep tectonic zones and major regional lineaments. The highest mercury values are generally

observed in structurally complex areas where deep faults intersect with large planetary lineaments.

The results suggest that the mercury content of natural gases may be linked to the inflow of deep fluids from the Earth's interior during periods of tectonic activation. This confirms the importance of considering mercury as both a hazardous component and a geochemical indicator in the study of hydrocarbon deposits.

For practical purposes, the obtained conclusions emphasize the need for systematic mercury monitoring in gas, oil and groundwater systems. Such monitoring is necessary for industrial safety, environmental protection and the prevention of mercury-related risks during the exploitation and transportation of natural gas.

References

1. Ozerova, N.A. (1986). Data on mercury occurrence in gas fields and tectonic structures of Central Asia.
2. Bakiyev, S.A., Nurmatov, I.M., & Polezhaev, O.V. (1986). Mercury concentrations in natural gases of selected gas fields.
3. Additional geological and geochemical sources on mercury migration, hydrocarbon deposits and deep fault systems should be added according to journal requirements.