

The chemical composition of groundwater in the ore fields of hydro geological arrays Middle Urals (experimental)

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Abstract. The chemical composition of groundwater produced during the exploration of ores to depths of 1200m. Installed vertical hydrochemical zoning. In ore - skarn zones opened brackish water with a salinity of up to 9 g / l. Groundwater subject to the forward and reverse metamorphism : the reverse - the influence of precipitation and surface waters of rivers, ponds, direct - the influence of adsorption - diffusion processes with formation sedimentogene waters.

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Introduction

Hydrogeological investigations revealed that the mineralization of ground water in crystalline arrays increases gradually and depth appearance of brackish water in the hundreds and thousands of meters. Arrays of Paleozoic underground fresh water were prepared to a depth of 700-1000 m or more, rarely opened brackish and salt fluids of different chemical composition. On the ancient crystal lichen fields - the Baltic, Ukrainian, Canadian and others discovered salt water positively and pickles, the origin of which is explained by metamorphism of buried water penetration brines along faults [1,2, 3, 4, 5, 6]. Hydrochemical zoning of groundwater installed in drilling wells Kola super-deepborehole.

Research methods

Exploration work to depths of 1,500 m were accompanied by hydrogeological studies, in particular, the study of the chemical composition of ground water. The main task was to take samples from these deep horizons. For this purpose the formation tester design VSEGINGEO. With it, the samples were taken from the test project after 8 – 16 hours of the inflow. This allowed us to obtain a water sample after passing through the test 2 – 4 volume spacker zone. Of reservoir water meet showing, not mud.

Results

Multilevel position of the Urals and the presence of water table horizon only in the upper region of the earth's crust causes intensification and significant exchange of water from the washed its soluble salts. In the highlands common ultrafresh with salinity 0,02 ÷ 0,1 g/l. Middle and Northern Urals, the most humid, mineralization present 0,1

÷ 0,35 g/l, rarely 0.5 g/l, in the southern Urals - up to 1 g/l or more. In deep horizons arrays are waterless and aquitard. By A. Veretennikova [7] chemical composition of groundwater is influenced by Urals relief, climate, lithology and water-bearing rocks of tectonic structure. Meridional ridge causes meridional zonal particular, and the difference in landscape and climatic conditions - latitudinal zonal st. First conclusion of deep groundwater hydrogeochemical zoning of the Middle Urals was made by A. Kovalchuk, S. O. Yushkova [8, 9]. According to them, it is expressed in the change of freshwater chloride ion increased mineralization. The basis for such conclusions were the 16 analyzed water samples throughout the Urals. The authors note that the deep water exchange infiltrating zone causes an increase in chloride water in large quantities. The chemical composition is due to leaching of the sedimentary strata of the relic of the pore solutions. Water allocated to the continent because of the low (less than 1) bromine - chlorine relations. The most complete work on Hydrogeochemistry of the Urals made by A.Y. Gaev and other researchers [10]. They are based on the analysis of the vast factual material the characteristic chemical composition of groundwater in different landscape and climatic zones, altitudinal zones and hydrodynamic this zone. The authors proceed from the common provisions on the altitude (top) and latitudinal landscape and climate) zoning of groundwater. According to the data of regime observations identified three hydrodynamic zones : I - aeration zone, II - seasonal and long-term fluctuations in groundwater levels, III - postoyannogo horizontal flow; six and ten macrobasins of hydroquinone nomic areas. It is shown that the chemical composition and mineralization of underground waters vary with latitudinal and altitudinal zones of landscape- climatic zoning of

manifested in connection with zoning runoff. The fundamental law - increasing salinity in the southern and southeastern eg detecting and changing composition of groundwater from bicarbonate to hydrocarbylbonate - sulfate, chloride and bicarbonate- chloride. In Tagil - Turin area are two directions for the formation of the chemical composition - hydrocarbon - and sulphate, and widely developed azonal water positively sulfate composition. Conclusions on Hydrogeochemistry groundwater Ural mountains noskladchatogo are the result of deep scientific analysis provdenno A.Y.Gaev. However, they only apply to a very active water zone, located in the area of influence of local erosion bases and, consequently, characterize the most part washed zone regional cracks Novato

Hydrogeological studies were carried out within the boundaries of the mine fields of existing enterprises. Mining operations at the mines deepened nor same local base erosion and groundwater levels in the centers of depression dropped to 300 ÷ 800 m Under these conditions, a depression formed funnel area which reach 10 ÷ 20 km², the quantities of water inflow 150 ÷ 850 m³/h Within the boundaries of depression and beyond to create conditions for groundwater flow through cracks and their movement to the artificial nucleus us (mines, quarries). Water infiltration in origin meteogienction washed cracks, reducing salinity groundwater. The same effect is surface water, filtered within the boundaries Dept. Ressay, the sphere of influence that got water. Exceptions are cases of technogenic pollution of aquifers, wearing local character, but lead to increased salinity and respectively to a change in water chemistry. Nevertheless vertical hydro geochemical zoning of groundwater in the region is clearly evident. Concentration of the chemical composition of the following components [11].

Chlorineion (Cl⁻). In surface water courses chloride ion content measurement varies from 4.3 to 11.0 mg/l. The same ratios maintained for ground water zone regional jointing - 4,9-14mg / l. Backgroundchloride ion contentis taken equal to 8.6mg / l. Exceeding this figure in town and villages rows indicates the domestic and industrial pollution chloride, which is typical for non-sewered settlements. Therefore proposed for this type of pollution along with other species, and count it as a dependency:

$$K_{\text{charged.Cl}^-} = \frac{C_{\text{obs}} - C_{\text{background}}}{C_{\text{background}}} > \sigma_1$$

Where C_{obs} — the observed value of the chloride ion, mEq; C_{lf-background} value of chloride ion, mg/l. Suppliers chloride ion in such cases are animal waste, household and industrial waste, and

then the concentration of this element is 32—44 mg/l. In deep well schloro-mounted ion in amounts of from 10.6 to 413.1 mg liter. However, most of the contents of this macronutrient is confined to theore-skarn zone NovoEstyuninskogolevel where it reaches 921,8 — 4715,8 mg/l or 61—89 wt. %.

Sulfateion (SO₄²⁻) enters the groundwater mineralization of organic residues and oxidation of sulfide minerals from the bedrock. Background of the sulfate ion concentration is 20 mg / l. In the brackish waters of the deep horizons sulfate ion reaches values 678,7 — 826,3 mg/l or 11 — 37 wt. %.

Bicarbonate ion (HCO₃⁻). Source of hydrogen ion in the area Regional fractures are weathering aluminosilicates Hydroxyl group reacts with carbon dioxide to form a hydrocarbyl carbonate ion OH⁻ + HCO₃⁻ - CO₂. Described process is particularly intensively on the surface where there is a significant Mortality plant residues Cove, and hence carbon dioxide is produced constantly. In the zone of active water exchange, despite the removal hydrogen ion concentration maintaining it occurs at a relatively high level, which cerned background concentration is 110 mg / l. In the area of local groundwater cracks tion concentration hydrogen ion concentration is 44 ÷ 155 mg / l, and in brackish waters somewhat less to 42,7 ÷ 76,3 mg / l.

Nitrates (NO₃⁻) in the water present in an amount not exceeding background values - 0,2 ÷ 1,0 mg/l. However, the content of mine water snits Ratov reaches 133 ÷ 150 mg / l due to the massive explosions at the breaking of rocks and ores.

Nitrites (NO₂⁻) in deep wells is not more than 0.02-0.1 mg / l. They testify to the fresh pollution associated with drilling fluids.

Sodium (Na⁺) enters into groundwater during weathering of feldspar. In extreme freshwater zone regional jointing its content reaches 4,1 ÷ 19,9 mg / l, with an average of 7.6 mg / l. In areas local groundwater cracks sodium concentration is 71.4 mg / l.

Potassium (K⁺) in the groundwater zone regional fracture is present in small quantities 0,7 ÷ 1,5 mg / l, averaging -0.95 mg / l. Several more polluted waters in its 1,8 ÷ 3,1 mg / l on average 2.4 mg / l. Low potassium concentrations in groundwater due to high sorption power parity and its living matter digestibility (Kiryuhin et al, 1993). In the waters of the deep burn umbrellas potassium content equal to 3,0 ÷ 4,5 mg / l.

Sodium + Potassium (Na⁺ + K⁺) in the ground water zone of regional jointis contained in the first tens of milligrams per liter. In the area of local cracks observed slow increase of a few tens of milligrams per liter. In the relative amount they take second place after calcium (23÷42 wt.%). In the

brackish waters of the skarn zone total content of these components reaches $223,2 \div 491,3 \text{ mg/l}$, and in terms of NaCl to 5.21 g/l .

Calcium (Ca^{2+}) is fed into groundwater during weathering aluminosilicates. Cations of calcium has the highest prevalence ($36 \div 76$ weight %). In the freshwater zone of regional joint calcium contains 16 to 28 mg/l on average - 20 mg/l . In the waters of the deep horizons of the amount it increases from 33.9 to 433.0 mg/l . The highest calcium content marked in the brackish waters of ore skarn zone ($561,1 - 2592,2 \text{ mg/l}$). Carbonate rocks in the field have local development, not a lot of power, opened at great depths and significant effect on the chemical composition of groundwater does not have.

Magnesium (Mg^{2+}) contained in the groundwater of fracture zones in quantity $3,6 \div 14,5 \text{ mg/l}$. The average content of 9.4 mg/l , in the brackish waters of the skarn ore zone - 6.0 mg/l . In chlorine-calcium waters deeper horizons magnesium missing. On increasing groundwater salinity is strongly influenced by the ions Ca^{2+} , with the exception of magnesium and sodium ions (Fig. 1). This is due to the dissociation of magnesium chloride: $\text{MgCl}_2 \rightarrow \text{Mg}^{2+} + 2\text{Cl}^-$ and the formation of this component more stable compounds such as dolomite and its loss in the sediment.

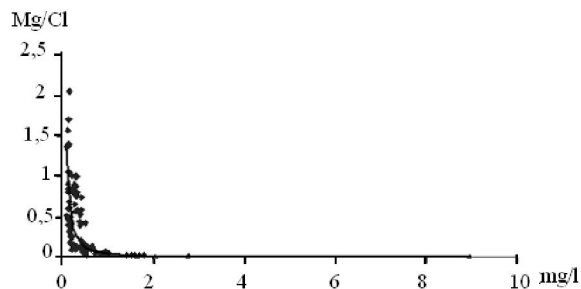
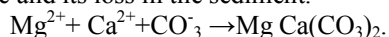


Fig. 1. Estyuninskoe ore field. Change magnesium chlorine relations. With the increasing salinity: $\text{Mg/Cl} = 0,047M^{-1,5}$, $r = 0,78$.

Carbon monoxide (CO) is installed only in are as of deep wells bottom hole from 26.6 to 196.4 mg/l . Piped gas between the cracks of the deeper parts of the Earth's crust, and rising up, reacts with hydroxyl ions to form bicarbonate ion.

Mineralization of groundwater increases with depth (Fig. 2) and highest values (8948 mg/l) reaches in ore-skarn zone Novo Estyuninskogo level. Effect of salinity on the growth of groundwater have chlorine ions and sulfate, and of lesser importance are hydrogen ions, which are

characteristic mainly for the surface part of the cuts. In the ore fields opened brackish water. Analysis of well logs 8215 showed that their intake comes from cracks, resistivity is equal to 11 thousand $\text{ohm} \cdot \text{m}$ on a background of 30 thousand $\text{ohm} \cdot \text{m}$. Below saline cracks salinity gradually decreases as a consequence of opening more permeable cracks. Groundwater composition in these cracks sulphate. At the same time opening water with high content of chlorine ion in Estyuninskoe ore field phenomenon is not so rare and fixed deviation charts COP IEP.

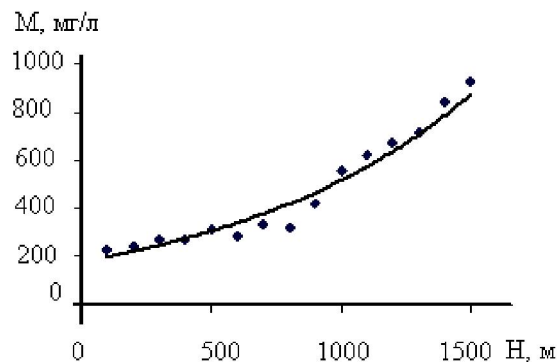


Fig. 2. Estyuninskoe ore field. Graph of increasing alinity of groundwater depth. $M = 182,7e^{0,001H}$, $r = 0,95$

According to the views Gaeva A.Y. (1986, 1989), developing ideas A. E. Fersman, G.A. Maksimovic allocated hydrogeochemical zone: A - bicarbonate; —B sulfate, B - sulphate -chloride, sulfate, chloride-tion; T-gidrogenzachloride. Zone A -gidrogenzibicarbonate.

Sodium bicarbonate water wells opened 7834, 8007, respectively, in the depth range $304 - 652 \text{ m}$, $810 - 1166 \text{ m}$. Their mineralization was $0,28 \div 0,59 \text{ g/l}$. This continental water, replaced by modern, but metamorphosed (technogenic metamorphism).

Zone B - sulfategidrogenza. Distributed this type of water from the surface to depths of 1311 m studied the prevailing component of water hydro-calcium-magnesium sulfate. Mineralization $0,11 \div 0,40 \text{ g/l}$. In the formation of such treatment a significant role played by the processes of decomposition of organic residues (Vostroknutov, 1964 Guys, 1989), as a result they are enriched with sulfate ion. Simultaneously, the formation of hydro-carbonate ion.

Zone C - sulfate-chloride gidrogenzis. By dominant components groundwater sulphate - chloride calcium-sodium composition with salinity from 0.38 to 2.06 g/l . The presence of sulfates in water due to the direct origin of marine waters, and changes in their

concentration by diluting fresh meteorogenic waters (reverse metamorphism) and desulphurization processes (direct metamorphism). Depending on the rock fracturing underground fresh water may occur at depths of up to 1500 m, brackish, on the contrary, at depths up to 270 m.

Zone D-gidrogenezischloride. In the interval of development – skarn deposits and slightly fractured rock blocks opened sulfate-chloride and chlorine-calcium water from fresh water with a salinity of $0,47 \div 0,98 \text{ g/l}$ to brackish- $1,02 \div 8,95 \text{ g/l}$. Leaching of salts, oxidation of sulfides in waste rock leaching leads to the formation a zonal sulphate - magnesium-calcium bicarbonate water with a salinity of $0,45 \text{ g/l}$ (Table. 1)

In the ore fields groundwater susceptible to reverse metamorphism, caused by man-made factors: first, household pollution in built up areas, and secondly, mining. Modern continental water, widely developed to mining, filtering through fissures in the areas of depression funnel metamorphosed, displace and replace unmetamorphosed water. Factor of safety of soda waters was weak rocks fracture and the corresponding water exchange.

On genetic grounds allocated water:

Table 1. Chemical composition and Hydrochemical types of ground water Estyuninskogoore field

Fracture zone and the sampling interval, m	Chemical composition formula	Hydrochemical water type	Number of samples
River Barancha	$M_{0,11-0,17} \frac{\text{HCO}_3^+ \text{SO}_4^{2-} \text{Cl}^-}{\text{Ca}_{51} \text{Mg}_{30} \text{Na}_{19}} \text{pH} 6,7$	II ₁	10
Ground water alluvial-diluvial deposits	$M_{0,09-0,5} \frac{\text{HCO}_3^+ \text{SO}_4^{2-} \text{Cl}^-}{\text{Ca}_{36} \text{Mg}_{24} \text{Na}_{20}} \text{pH} 8,0$	II ₁	10
Ground water zone of regional joint	$M_{0,12-0,88} \frac{\text{HCO}_3^+ \text{SO}_4^{2-} \text{Cl}^-}{\text{Ca}_{51} \text{Na}_{23} \text{Mg}_{24}} \text{pH} 7,6$	II ₁	19
Local ground water zone cracks: 249—1248	$M_{0,14-0,4} \frac{\text{HCO}_3^+ \text{SO}_4^{2-} \text{Cl}^-}{\text{Ca}_{51} \text{Na}_{23} \text{Mg}_{23}} \text{pH} 7,6$	II ₁	87
1128—1500	$M_{2,77-8,95} \frac{\text{Cl}^- \text{SO}_4^{2-}}{\text{Ca}_{83} \text{Na}_{16}} \text{pH} 6,9$	III ₃	7
Mine waters	$M_{0,3-0,56} \frac{\text{HCO}_3^+ \text{SO}_4^{2-} \text{NO}_3^- \text{Cl}^-}{\text{Ca}_{57} \text{Mg}_{35} \text{Na}_6} \text{pH} 7,6$	II ₂	6

– sodium bicarbonate (soda), which are modern continental waters;

– sulphate-sodium modern waters formed in the upper part of the hydrosphere (water rivers meteorogenic water, shallow groundwater);

- magnesium chloride-water marine origin;
- chloride-water kaltsivye deeper parts of the ore fields.

In this meteorogenic fresh water penetrating into the deeper horizons, determine the flow of sea water reverse metamorphism and desulphurization processes - in a closed hydrogeological structure, which includes ore- skarn deposits, caused deep metamorphism degenerative direct sea water in reservoir characteristic even for deep parts of the

crust. Hydrogeochemical zoning groundwater deposits shown at different depths, which is a consequence of heterogeneity fractured aquifer filtration and capacitive properties. This leads to the presence of fresh water at depths greater than 1000 m, at the same time of brackish water in some areas in the surface of the cut. Yet the overall growth trend of mineralization with depth and changes in chemical composition are obvious. Regular variation of the parameters listed and indicators associated with chlorides of calcium, sodium, magnesium. Whatever the inhomogeneous Aquiferous Wednesday manifestation hydrogeochemical zoning of groundwater associated with the activity of water exchange (Table 2).

Table 2. Generalized hydrogeodynamic and hydrogeochemical indicators ground water Estyuninskogoore field

Data	Ground water fracture zones				
	Unconsolidated sediments	Regional joint intermediate zone	the intermediate zone local cracks	local cracks	ore-skarn zone
Hydrodynamic zone of active water exchange	a very active	active	delayed	Very delayed	Very delayed
Water conductivity, m ² /day	190	36,8	2,0	1,0	0,002
Hydrochemical zone	B	B	C	A; C	D
Salinity, g/l	0,11–0,17	0,11–0,88	0,14–0,50	1,0–2,0	2,77–8,95

As for the availability of fresh water at great depths this phenomenon is due to both man-made and natural causes. Desalination of groundwater may be due to overflows in their areamine depression. Natural causes are to rise Uralsarched - block character. Ceteris paribus neoplasm cracks primarily occurs most intensively in the river valleys and intermountain depressions, where there are the greatest depth development of fresh water. Cyclic development of the Urals (Popov B.A., Zoloyev K.K., 1990) resulted in periodic attenuation and enhanced education and open cracks in the modern view thus a so -called pulsating voids, leading to surface waters sucked.

Conclusions

- Hydrogeological arrays Ural saquifers throughout the depth of their opening, reaching in the ore fields of 1500 m

- Modern water make up the bulk of the pore water (intermountain depressions and river valleys), fissure type and presented infiltratgenymi waters of unconsolidated sediments and indigenous Paleozoic rocks ;

- In the ore fields are four hydro- chemical and hydrogeological zones and complete coincidence boundaries of their development is not, moreover, there is the opposite location of zones vertically when, for example, the zone of carbonate gidrogenezis A is at great depths that testifies the

penetration of water with surface changes with fluctuating voids ;

- The chemical composition of groundwater occurs by leaching components of the bedrock of their elution from the pores, micro - and large cracks, oxidation, carbon-dioxide hydrolytic oxidation, the influence of surface water Groundwater ore-bearing rocks exposed reverse metamorphism due to a higher degree of fracture and penetration of new meteoric waters at depths greater than 1000 m. Groundwater ore - skarn zones underwent metamorphism deep, straight, due to weak fractured metasomatic altered rocks and hence closed structure ;

- Groundwater composition is not due to deep levels of leach in go of their sedimentary strata (for Kovalchuk), and direct marine origin and converted to continental conditions in sedimentogenic water.

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References

1. Vostroknutov, G. A., 1964. To the geochemical characteristics of the Greenstone formations of the Western slope of the Middle Urals (on the example of Revdinsky district). Institute of Geology and Geochemistry of the USSR. Hydrogeology, Vol. 69: collection 3. Senior - 2336. Kiryukhin A. hydrogeochemistry of folded areas. C. A. Kiryukhin, N. B. Nikitin, S. M. Sudarikov Leningrad: Nedra, 1990. - 253 S.
2. Pelto, C. R., 1954. Mapping of multicomponent systems. Journal Geol., 62 (5), p. 501-512
3. Stone, W.E., Crocket, J.H. and M.E. Fleet, 1990. Partitioning of Pd, Ir, Pt, and Au between sulfide liquid and basalts melt at 1200°C. Geochim. Cosmochim. Acta, 54 (18), p. 2155-2341
4. Tuttle, O.F. and N.L. Bowen, 1958. Origin of granite in the light of experimental studies in the system NaAlSi₃O₈ - KAlSi₃O₈ - SiO₂ - H₂O. Mem. Geol. Soc. Amer., 74
5. Wilson, A.H. and M. Tredoux, 1990. Lateral and vertical distribution of PGE and petrogenetic controls on the sulfide mineralisation in the PI Pyroxenite Layer of the Darwendale subchamber of the Great Dyke, Zimbabwe. Econ. Geol., 85 (3), p.556-585
6. Hydrogeology of the USSR. Volume XIV/ the Urals. Ed. by V.F. Preis. Year: Nedra, 1971. Gg.648 Kovalchuk, A. I. The main features of the chemical composition of groundwater gornoslinskino Urals. A. I. Kovalchuk, Yu. P. Vdovin. Tr. Sverdovskiy mountain in - TA im. ARV. Hydrogeology and engineering Geology of Ural. Vol. 117. Sverdlovsk: Izd-vo in-TA, 1975. -S. 40-42.
7. Kovalchuk, A. I. Deep water orogen Urals. A. I. Koval'chuk, S. O. Yushkova. Yearbook of the Institute of Geology and Geochemistry of them. Acad. A. N. Zavaritsky. - Sverdlovsk, 1980. -S. 29-33
8. Gaev A. Ya. hydrogeochemistry of the Urals and the issues of protection of groundwater A. Ya. Gaev. / Sverdlovsk: Ural. University, 1989.- 368 S.
9. Mikhailov Yu Century Hydrogeochemical zoning of Estjuninskaja iron ore deposits in the Middle Urals. Yu Century Mikhailov M.: hands. Deptin VINITI, RR 30.
10. Pelto, C. R., 1954. Mapping of multicomponent systems. Journal Geol., 62 (5), p. 501-512
11. Stone, W.E., Crocket, J.H. and M.E. Fleet, 1990. Partitioning of Pd, Ir, Pt, and Au between sulfide liquid and basalts melt at 1200°C. Geochim. Cosmochim. Acta, 54 (18), p. 2155-2341
12. Tuttle, O.F. and N.L. Bowen, 1958. Origin of granite in the light of experimental studies in the system NaAlSi₃O₈ - KAlSi₃O₈ - SiO₂ - H₂O. Mem. Geol. Soc. Amer., 74
13. Wilson, A.H. and M. Tredoux, 1990. Lateral and vertical distribution of PGE and petrogenetic controls on the sulfide mineralisation in the PI Pyroxenite Layer of the Darwendale subchamber of the Great Dyke, Zimbabwe. Econ. Geol., 85 (3), p.556-585.

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