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The use of data on the material composition of sediments during forecasting works of titanium root and placer deposits

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SUMMARY

This work is devoted to using the coefficients of granulometric and material composition of sediments that contain productive bodies from 16 placer and promising areas of the Irshansky placer field the Ukrainian sub-province of titanium and titanium-zirconium placer deposits (USTTCPD). There are show the efficiency of using these methods to solve various problems that arise during forecasting and exploration of titanium deposits of the Irshansky placer field on 3 tables. These are: stratigraphical (age) correlations (regional, local); genetic diagnosis of continental and marine sediments; reconstruction of facial conditions and paleogeographic elements; assessment of the intensity of hypergenic processes. To solve these problems, various quantitative coefficients were used: mineralogical, granulometric, granulometric monofractions of ilmenite and chemical composition of ilmenite. There weare used of their groups: mineralogical petrofond, tectonic, sedimentation, paleogeographic coefficients; granulometric and statistical coefficients of the empirical distribution polygon (UPR) of sediments, calculated by weight and quantitative presentation systems and their efficiency (measuers: location - average size, trend, average; scattering - sorting, standard deviation, variations; deviations from the normal law of distribution - asymmetry, excess.

Introduction. *The Ukrainian sub-province of titanium and titanium-zirconium placer deposits* (USTTCPD) covers the Ukrainian shield (US), the Voronezh anteclisis (VA) and their slopes to the Dnieper-Donetsk depression (DDD). Within the USTTCPD there are 4 placer zones, 13 placer areas, 34 placer fields, groups and individual deposits (Atlas..., 2001). The most promising is the Dnieper zone, which includes 7 placers and 20 placers. The studied deposits of the Dnieper zone belong to the ancient buried - residual, continental and coastal. Exploration, study and development of deposits is accompanied by the selection of a large number of analyzes of their material composition, mainly to determine their technological characteristics. They can be used to perform other tasks - stratigraphy, genetic, facial, paleogeographic, paleogeomorphological reconstructions. According to the analysis of the material composition of sediments, various coefficients are calculated, which are used in a complex of geological, geophysical, paleogeographic, paleogeomorphological and other methods.

Method and Theory. In performing this work were used next theories and methods: *general systems theory* as a methodological basis of research; *geomorphosystem analysis* examines the geomorphosystem of the territory of USTTCPD; *morpholithogenetic approach* investigates the combined development of relief and sediments; *paleogeomorphological analysis* examines the history of the geomorphosystem of the territory of the USTTCPD; *analysis of the mineral composition* of placer deposits - the use of their coefficients; *analysis granulometric composition* of placers - the use of their coefficients; *analysis granulometric composition* of ilmenite monofraction - use of their coefficients; *analysis of the chemical composition* of ilmenite from placer deposits - use of their coefficients; *cartographic method* - the use of general maps and the compilation of new special ones.

Examples. The works of Yu. Burmin, M. Vadimov, M. Veklych, E. Dudrovych, M. Dyadchenko, P. Zamoriya, V. Kondrachuk, O. Komliev, Y. Koshyk, Y. Mukhin V. Ovcharenko, Y. Polkanov, G. Proskurin, O. Remezova, I. Romanov, V. Tarasenko, V. Timofeev, M. Ruban, A. Khatuntseva, S. Tsymbal, S. Shvaiberov are devoted to various issues of studying the conditions of formation and material composition of USSTCRR. Now the direction of geoinformation modeling of placer deposits, and titanium and titanium-zirconium USSTCRR A. Lalomov, O. Remezova, D. Khrushchev, S. Vasylenko, O. Kravchenko, O. Komliev, O. Kovalevich, O. Yaremenko O. various formalized data on the results of the study of the USSTCRR, in particular the material composition of placers and sediments that contain them.

Results of investigations. The Department of Earthlogy and Geomorphology of the Taras Shevchenko National University of Kyiv has been developing the *morphochronodynamic* direction of studying the Earth's morphosystem for many years, which has now acquired the status of a scientific concept of geomorphology (*morphochronodynamic*), which includes theory, methodology, method, techniques, applied use (Komliev, 1988). It is based on the experience and results of forecasting works of various minerals (titanium, diamonds, gold, amber, monazite sands, hydrocarbons (oil), peat, sapropel, phosphorites, building materials, groundwater), which contributed to the creation of its *own* method *of complex paleogeomorphological analysis*, which systematically combines various general and partial methods of geology, geophysics, paleogeography, hydrogeology, geomorphology, paleogeomorphology, cartography, mathematical and geoinformation modeling (Komliev, 1988; Koshik,1990). An important place in this methodological complex belongs to the study of granulometry and material composition of sediments. Tables 1-3 show the efficiency of using these methods to solve various problems that arise during forecasting and exploration of titanium deposits of the Irshansky placer field. These are: stratigraphical (age) correlations (regional, local); genetic diagnosis of continental and marine sediments; reconstruction of facial conditions and paleogeographic elements; assessment of the intensity of hypergenic processes. To solve these problems, various quantitative indicators (coefficients) were used: mineralogical, granulometric, granulometric monofractions of ilmenite and chemical composition of ilmenite. Table 1 shows the mineralogical coefficients and efficiency of their use: *petrofond* (zircon / rutile, zircon / garnet, zircon / tourmaline, tourmaline / rutile, zircon / distene + staurolite); *tectonic* (zircon / ilmenite leukoxenized, zircon / mica, ores / turmaline) ores / mica, quartz / mica); *sedimentation* (zircon / pyroxene + amphibole + epidote, quartz / feldspar), *paleogeographic* (leukoxen / ilmenite, leukoxen / ilmenite leukoxenized, total paleogeographic). The relations in the analyzes of minerals, which are stable, unstable and diagenetic under hypergenic

conditions, as well as the content (yield) in the analyzes (in %) of the *heavy fraction* of minerals were studied.

Table 1. *Efficiency of use of indicators of mineral composition of correlated deposits*

Task type	Mineralogical coefficients characterizing the deposits are correlated with the ancient relief					
	petrofund (zr/rut, zr/ gar, zr/tur, tur/rut, zr/ d+st)	**tectonic (zr/il, zr/ m, o/tur, o/m, q/m)**	**sedimentation (zr/p+ a+ e, q/f)**	**paleogeographic (l/ il, l/i+ il, Pc)**	**MC**	**EHF**
Stratigraphic (age) correlations						
1. regional						
2. local	**?**			**?**	**?**	**?**
	?			+	+	
Genetic reconstructions						
1. continental sediments	+	+	+	+	+	+
2. marine sediments					**?**	**?**
3. separation of continental and marine sediments	**?**			**?**	+	
Facial (morphodynamic) reconstructions	+	+	+	+	+	+
Paleogeographic reconstructions	+			+	+	
Estimation of intensity of the imposed processes				+	+	

Abbreviation: zr (zircon), rut (rutile), gar (garnet), tur (turmaline), d (disten), st (staurolite), i (ilmenite), il (ilmenite leukoxenized), m (mica), o (ores), q (uartz), p (pyroxen), a (amphibole), e (epidote),f (feldspar), Pc (paleogeographic coefficient), MC (content minerals: stable/ unstable/ diagenetic), EHF (entrance of the heavy fraction).

Table 2 shows the granulometric coefficients and statistical parameters of *the empirical distribution polygon* (EPD) of sediments, calculated by weight and quantitative presentation systems and their efficiency. They are divided according to the ***measuers*** adopted in lithology: *location* (average size, trend, average), *scattering* (sorting, standard deviation, variations), *deviations from the normal law of distribution* (asymmetry, excess).

Table 3 presents the granulometric coefficients of ilmenite and the chemical composition of ilmenite and their efficiency. Granulometry coefficients and statistical parameters of ilmenite monofraction were also calculated from the data of weight and quantitative presentation systems. They are divided by ***measures***: *location* (average size, trend, average), *scattering* (sorting, standard deviation, variation), *deviation from the normal distribution law* (asymmetry, excess). The chemical composition of ilmenite is reflected by the coefficients of *oxidation, preservation, leaching* and *thiorization.*

The tables show the effectiveness of the coefficients: + - satisfactory; - - unsatisfactory; ? - not defined.

Table 2. *Granulometric coefficients and statistical parameters) of sediments correlated with the ancient relief*

Task type	Granulometric coefficients and statistical parameters of the empirical distribution polygon (EDP) of sediments correlated with the ancient relief							
	Measures of EDP location (Md, Mo, X, X')		Measures of scattering (sorting) of sediments (S, So, V, H, S', V')		Measures of deviation from the normal distributionlaw (α, r, α', r')			
	weight data(Md, Mo, X)	quantitative data (X')	weight data (S, So)	quantitative data (V, H, S', V')	weight data (α,r,)	quantitative data (α',r')	ELF	SSF
Stratigraphic (age) correlations								
1. regional	-	-	-	-	-	-	-	
2. local	-	-	-	-	-	-	-	+
Genetic reconstructions								
1. continental sediments	+	+	+	+	+	+		
2. marine sediments	+	+	+	+	+	+		
3. separation of continental and marine sediments	-	-	-	-	-	-		
Facial (morphodynamic) reconstructions	+	+	+	+	?	?		
Estimation of intensity of the imposed processes								
Abbreviation: granulometric coefficients and statistical parameters: *calculated graphically:* Md (average size, So (sorting); *calculated computer:* X, X' (average); S, S' (standard deviation); V, V' (coefficients of variation); H (relative entropy); α, α' (coefficients of asymmetry); r, r' (coefficients of asymmetry). ***Others***: Mo (trend), ELF (the emergence of the largest fractions), SSF (the sum of sand fractions)								

Conclusions. The tables show the coefficients of granulometric and material composition of sediments that contain, lay and cover productive bodies from 16 placer and promising areas of the Irshansky placer field of the Dnieper zone USTTZPD. These quantitative indicators were used in compiling paleogeomorphological maps of 9 of these areas for the time of accumulation of placers containing deposits of the Poltava swita of the upper Oligocene-middle Miocene. For stratigraphic correlations at both regional and local levels, mineralogical coefficients in most cases do not give a clear result, except for a group of paleogeographic coefficients. Granulometric parameters, including monofraction of ilmenite, also do not give a positive result. Practically all mineralogical and granulometric coefficients (tables 1-3) can be used for genetic reconstructions of continental sediments, as well as facial (morphodynamic) reconstructions. For genetic reconstructions of marine sediments, reliable results of granulometry, including monofraction of ilmenite. To separate continental and marine sediments, you can use all the coefficients of the chemical composition of ilmenite, the ratio of stable, unstable and diagenetic minerals. The use of petrofond and paleogeographic mineralogical coefficients is in question here, and all granulometric coefficients do not give a positive result. Mineralogical petrofond and paleogeographic coefficients and ratios of stable, unstable and diagenetic minerals, as well as granulometric coefficients of monofraction of ilmenite and chemical composition of ilmenite are suitable for reconstructions of paleogeographic elements. The latter can also be used to study the intensity of hypergenesis, as well as, paleogeographic mineralogical.

Table 3. *Granulometry and chemical composition of ilmenite monofraction*

Task type	Coefficients and statistical parameters of granulometry and chemical composition of ilmenite monofraction of sediments correlated with the ancient relief									
	Measures of ELD location (Md, Mo, X, X')		Measures of scattering (sorting) of sediments (S, So, V, H, S', V')		Measures of deviation from the normal distributionlaw (α, r, α', r')		Chemical composition of ilmenite monofraction			
	weight data(Md, Mo, X)	quantitative data (X')	weight data (S, So)	quantitative data (V, H, S', V')	weight data (α,r,)	quantitative data (α',r')	ox	pr	l	t
Stratigraphic (age) correlations										
1. regional										
2. local	- -	- -	- -	- -	- -	- -	? +	? +	? +	? +
Genetic reconstructions										
1. continental sediments	+	+	+	+	+	+	+	+	+	+
2. marine sediments	+	+	+	+	+	+				
3. separation of continental and marine sediments	-	-	-	-	-	-	+	+	+	+
Facial (morphodynamic) reconstructions	+	+	+	+	?	?				
Estimation of intensity of the imposed processes							+	+	+	+

Abbreviation: granulometric coefficients and statistical parameters: *calculated graphically:* Md (average size, So (sorting); *calculated computer:* X, X' (average); S, S' (standard deviation); V, V' (coefficients of variation); H (relative entropy); α, α' (coefficients of asymmetry); r, r' (coefficients of asymmetry). ***Others*****:** Mo (trend); *coefficients of variability of the chemical composition of ilmenite:* ox (oxidation), pr (preservation), l (leaching), t (thiorization)

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