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Редакційна колегія:

О.О. Сдвижкова, д-р техн. наук, проф.

О.Г. Вагонова, д-р екон. наук, проф.

А.В. Павліченко, д-р техн. наук, проф.

С.Я. Касян, канд. екон. наук, доц.

Radosław Dziuba, PhD, Managing Director of Łukasiewicz Research Network - Institute of Biopolymers and Chemical Fibres (IBWCh), Poland

Taras Bondarenko, PhD, Admissions Office International students coordinator, Faculty of Economics, Maria Curie-Skłodowska University in Lublin (UMCS), Lublin, Poland

Irena Jędrzejczyk, PhD, D.Sc., professor of Management Department, Faculty of Management and Transport University of Bielsko-Biala, Poland

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TABLE OF CONTENTS

	TABLE OF CONTENTS	3
	<u>Section 01. Actual Problems of Sustainability of Economic Development and Innovative Management</u>	
1.	Yeva Altukhova SMM in modern business	11
2.	Svitlana Andreeva Introduction of innovative technologies for food industry enterprises	15
3.	Nikita Anisimov Obsolescence management	18
4.	Kateryna Antishova Time management: the mistakes employees make every day	22
5.	Tetiana Arkhopenko Assessment methods of enterprise international competitiveness	25
6.	Iryna Barannyk E-economy: myth or future reality	29
7.	Anastasia Bilenko Strategic directions for sustainable development of Ukraine	32
8.	Yelyzaveta Boryskina How sustainable development can help business prosper	36
9.	Daria Borysova The problems of modern Ukrainian management	38
10.	Yulia Bovsunovska 4Ps of green marketing	41
11.	Kateryna Derkach Influence of the OCEAN model on the company's performance	44
12.	Olena Drobetska HR management in remote work era	47
13.	Maryna Hudym Development of financial technology in the banking sector	51
14.	Sofiia Kasian Neuromarketing and branding	54
15.	Iryna Katorska Value- added tax and its peculiarities in Ukraine	57
16.	Viola Khaustova Features of advertising as the basic tool of marketing communications	59
17.	Anastasiia Khudozhnyk The impact of the pandemic on the film industry and piracy in Ukraine	61
18.	Anastasia Krasnytska Problems of employment of first-year students in Ukraine	64
19.	Vera Kravtsova Information technologies in foreign economic activity of the enterprise	67
20.	Alina Kirilenko Authentic leaders in business environment	70
21.	Yulia Levchenko Development of the policy of management of fixed assets of an enterprise	73
22.	Alisa Lyman Japanese HRM model	75
23.	Yelizaveta Makarova PrivatBank vs Monobank banking strategies	79

24.	Mariia Mishchenko The impact of information technologies on business transformation in the context of globalization	84
25.	Nihar Musaieva TechFin vs FinTech	87
26.	Ivanna Myronenko Ways to increase the level of financial security of the banking system of Ukraine	91
27.	Yelyzaveta Nesen Comparative characteristics of the Japanese and Ukrainian model of HR management	95
28.	Regina Nykytiuk The impact of the pandemic on operations management in metallurgical industry	98
29.	Kseniia Panina, Andrii Shylov Assessment of the competitive situation in the banking market. Does it contribute to the improvement and implementation of banking services?	101
30.	Alisa Pankova Inventory accounting: integration of information technology for inventory optimization	105
31.	Victoriia Ponomariova Social networks as a communication tool in the B2B market	109
32.	Arina Prokopenko Trends and prospects for the development of the «green» economy	112
33.	Maria Rudenko Management of an enterprise based on information technologies	115
34.	Sabina Shcheglova The importance of self-management during distance learning	119
35.	Daria Sheyko Gender roles in management	122
36.	Victoria Stankevych Feminism in the labor market: why we need a feminist economics	124
37.	Daryna Starchova Effectiveness of advertising in Ukraine	127
38.	Kristina Sulimchuk What Ukrainian businesses boosted during the COVID-19 pandemic	130
39.	Oleksandr Svitenko Structure of digital marketing	133
40.	Viktorija Sypalo Implementation of investment projects at agricultural enterprises in Ukraine	135
41.	Viktorija Tkachenko Motivation and Incentives as Management Functions	137
42.	Veronika Tretyak Visual merchandising	141
43.	Maria Vashkovskaya Ways to deal with the emotional burnout of staff during the quarantine period	145
44.	Oleksandr Vytvytskyi Aging population of Ukraine and its economic consequences	148
45.	Oleksandr Yerak Agricultural sector of Ukraine: development prospects	152
46.	Alisa Zakaras Direct support in Ukraine: problems and prospects for development	156
47.	A. V. Zhmai Regular management as a method of overcoming the crisis	160

48.	Anastasiia Zueva Financial components of decentralization in Ukraine	163
	Section 02. <u>Environmental Problems and their Solutions</u>	
49.	M.Yu. Holub Research of the level of snow cover pollution in the zone of influence of motor transport	166
50.	Serhii Krasovskyi Phytoremediation of reclaimed coal dumps in Western Donbas	168
51.	V. Mulin Optimization of transport flow speed on the section of O. Polya av. in Dnipro	171
52.	Serhii Mytrofanov Prolonging life of underground Kryvbass - a myth or reality?	173
53.	Andrii Nechai Slime molds and urbanization	175
	Vadim Snisar Environmental impact of the motor transport	177
	Section 03. <u>Innovations in Engineering, Energy Efficiency and Alternative Sources of Energy</u>	
55.	Diana Baranchykova New horizons, perspectives and reality of Engineering	180
56.	Nazarii Koshevyi Solar energy - an alternative or a myth?	183
57.	Konstantin Kovtun Innovations in mechanical engineering	187
58.	Ruslan Kravchenko Engineering of the new millennium: the fourth industrial revolution and new world trends	189
59.	Stanislav Latishev Perspectives of renewable energy in Ukraine	192
60.	Kateryna Mankovska Simulation and investigation of the influence of constructive parameters of the bicycle frame on its ergonomic properties	195
61.	Anton Markov Analysis and Calculation of Technological Parameters of "Step Shaft" Forging in the Conditions of LLC "DNEPROPRESS STEEL". Analysis of the Range of Products of the Shop	198
62.	Igor Melnychenko Wind energy as an alternative source of electricity	202
63.	Nadezhda Morozova Features of modern drive systems use in the mining industry	204
64.	Yuliia Nikolenko Solar power as an alternative energy source in the modern world	206
65.	Yeva Norenko Electric vehicles: advantages, disadvantages, and prospects of use	208
66.	Taras Oleksiuk Simulation of turnover and calculation of the optimal stock of goods in the warehouse using the online service packer3d	212
67.	Illia Olishevskiy Automated heat pump heating system using non-traditional energy sources	215

68.	Vladyslav Parkhomenko Promising tendencies for open pit motor vehicles	217
69.	Anastasia Pisotska, Denis Kuznetsov Development of End-to-end Roll-bonding Technology for Reinforced Al-based Composites with Enhanced Ability to Impact Energy Absorption as well as the Fire Resistance	220
70.	Maria Romanenko The Ability to Manage Sales Activities as an Important Aspect of Existence of an Enterprise in the Labor Market	223
71.	Oleg Seredyuk Risk assessment and hazard identification at Ukrainian enterprises	226
72.	Faina Shinkevich Development of technology for obtaining three-layer joints by rolling	229
73.	Oksana Sokolovska Road traffic safety: best practices and challenges for Ukraine	233
74.	Ilanit Stashevskya Features of molybdenum disulfide friction	236
75.	Oleksandr Tararin Unconventional modern energy saving projects	240
76.	Evgeniy Tsivka Possibility of strengthening of arched fastening of mining through use of carbon fiber	244
77.	Eva Tsytko Catalyst of hydrogen peroxide decomposition	247
78.	Valentin Vlasyuk Raising energy efficiency of metallurgical production: challenges and perspectives	251
79.	Mykhailo Vorobiov Pipe Rolling Industry, General Analysis and Ways of Development	253
	Diana Zakharova Investigation of the drive mechanism of the sewing machine Bielefeld Nähmaschinen & Fahrrad Fabrik Hengstenberg	257
Section 04. <u>Computer Science and Solutions in IT</u>		
81.	Kateryna Ahashkova The application of blockchain technology	260
82.	Samir Akhmedov Cloud migration	262
83.	Aleksandra Atamanchuk, Mark Morochko Smart contracts: potential breakthroughs and application cases	265
84.	Alexandr Ayupov Directions in IT and Their Prospects	268
85.	Anastasiia Biletska Smart electronic planner with a variety of interfaces	270
86.	Ihor Bochin Why IT-specialists leave IT sphere	273
87.	Vladyslav Buriak Working from home versus working from office in a pandemic time	276
88.	Anastasia But The main fears of society about Artificial Intelligence	279
89.	Nikita Chekushkin Big Data technology problems	282
90.	Iryna Cherechecha Artificial Intelligence in University Educational Process	285

91.	Yevheniy Chub Development of a web-application using the Vue.js framework	288
92.	Denis Chumichov The Internet of Things	290
93.	Oleh Danysh Windows clipboard text problem	294
94.	Oleksii Denysenko Overview of Wi-Fi 6	296
95.	Tatiana Drobot Ways to protect information from unauthorized access	299
96.	Daria Fedorenko Cyber hygiene	303
97.	Roman Gavrilov, Igor Yaroshenko Machine learning in game development	307
98.	Maxim Goncharov Computer virtual reality addiction	309
99.	Ihor Hladchenko AI in healthcare and medicine. Is there a need?	312
100.	Diana Hrechuk IT technologies in the field of industrial automation	315
101.	Kateryna Kanivets Development of an interactive web application for car rental optimization	317
102.	Viacheslav Kastierov Artificial intelligence: history and prospects	321
103.	Ilia Khaitul Cryptocurrency as one scenario of our future development	323
104.	Andrii Khukhrianskyi Mobile hacking	326
105.	Vladislav Klishevych How to choose the best software development tool for a beginning programmer?	329
106.	Yegor Kolodii Dealing with data breaches in business	332
107.	Oleksii Komisarov Neuralink: are people ready for this big technology breakthrough	335
108.	Victoria Kopach History of development of artificial intelligence	338
109.	Oleksandra Kotenko Face recognition technology on smartphones	340
110.	Dmytro Kuznetsov Common problems in starting IT business	342
111.	Olga Levitan Internet Piracy: Methods of Combating	345
112.	Kateryna Lib Load Testing: Causes of Application Failures and Solutions	349
113.	Valeriia Marchenko Social crimes: analysis, techniques and prevention	351
114.	Arsenii Miakenkyi Use of face recognition subsystem in security video surveillance systems	355
115.	Nikita Minchenko Machine Learning as one of the trends in cyber security	358
116.	Nikita Mishchenko Functors in modern C ++	361
117.	Alina Namestnykova, Denys Polishchuk Neural interfaces — the next step of human evolution	365
118.	Roman Nashyvanko 10 Best Kali Linux Tools for Penetration Testing	369

119.	Maxym Nuhumanov Public service automation	371
120.	Ivan Piven State in a smartphone: experience of Ukraine	375
121.	Ihor Plakhotnik Top 10 programming languages 2020-2021	378
122.	Artem Pohosian, Lievon Pohosian Protection of information in computer networks based on network level technologies	381
123.	Ivan Poliakov Machine learning – security aspects	384
124.	Egor Potebenko The use of Python for the development of artificial neural networks	386
125.	Danil Pristash 11 Important Differences between Windows 10 and Windows 8	389
126.	Kseniia Prylipko Information systems design: problems and solutions	391
127.	Dariya Raihorodska Modern distance learning platforms: goals, objectives, and development prospects	394
128.	V. Ryabchinska Analysis of hack attacks. History and perspective	396
129.	Artem Scherbatyuk Programming languages in game development	399
130.	Alexander Serhiienko The use of programming languages to create helpful bots	401
131.	Sonya Shnaiderman IT in Foreign Language Teaching in pandemic period	405
132.	Yulia Sida Virtual Reality opens the new era for museums	407
133.	Yuriy Titov Modern trends in the field of creating animation using information technology	410
134.	Maksym Tsedov Grover algorithm as an effective solution to SAT problem	413
135.	Ihor Velychko Technology and methods of automatic facial identification and recognition	417
136.	Nikita Voropinov Information War and Information Weapon	420
137.	Rostyslav Yashkin Development of a secure web-application using JWT	423
138.	Serhii Yermakov Transaction management using pattern Saga	425
139.	Polina Yerovenko Artificial intelligence and the arts	427
140.	Dmitry Zakharov Criticism of the Translation Results of Facebook’s “Transcoder” AI	429
	Daniil Zhmak Computer viruses and malware	433
	<u>Section 05. Earth Sciences (Geology, Geodesy, Land Management, Geography, Archeology)</u>	
142.	Viktoria Adamova Spectral analysis in open pit mining	437

143.	Serhii Artiushenko Problems of using personal protective equipment at Ukrainian enterprises	440
144.	Yelyzaveta Bodriaho Spherical tomography and 3D modelling of mineral component distribution	443
145.	Nataliia Davidenko Use of 3D seismographs in the mining industry	447
146.	Vladislav Glyanko Using a risk matrix at Ukrainian enterprises	450
147.	Yevhen Kozii Chromium in the coal seams of the Chervonoarmiiskyi geological and industrial area of Donbas	453
148.	Yevhen Moldavanov Substantiation of the parameters of the experiment to predict the magnitude of convergence in the longwall in the area of the primary landing of the main roof	456
	Sg.Tikhliyets Metamorphism as the main geological process of genesis of ore and rocks: case of the Northern iron-ore district of Kryvyi Rih basin	460
Section 06. <u>French Language Section</u>		
150.	Anna Halizova Yoga, sport, alimentation consciente : trois aspects de la vie saine	462
151.	O. Krotov La culturologie et ses tâches en tant que science	464
152.	V. Magro L'importance de l'apprentissage des langues étrangères dans le domaine de relations économiques internationaux	465
153.	O. Mosseyko Phénomène de l'anarchisme	467
154.	S. Pokolodna Typologie de la personnalité dans le contexte du comportement monétaire	468
155.	V. Pustova Argo comme une particularité linguistique de la langue française	470
156.	A. Savitskaya Comment la psychologie de la gestion affecte l'efficacité de la gestion	472
157.	Anastasiia Tymofieieva Pourquoi devons-nous apprendre les langues ? L'aspect de la communication dans des études linguistiques	474
158.	N. Vodopyan Activités économiques dans l'arctique et le subarctique	477
	K. Yefimchuk La culture des débats et leur importance dans l'éducation	479
Section 07. <u>German Language Section</u>		
160.	Bohdan Chornyj Reverse Engineering Von Drehmaschinengetriebe	481
161.	Anna Miroschnitschenko Unternehmertum Ist Die Wichtigste Art Der Wirtschaftstätigkeit	483
162.	Matvey Schevchenko Schädliche Wirkung der Nutzung von sozialen Netzwerken	486

163.	Sergey Sinyatkin Unterschiedliche Arten der galvanischen Zelle und ihre Spezifik	488
	Natalia Zinenko Das Wort regiert die Welt, und der Philologe regiert das Wort!	490
	<u>Section 08. Humanities: Challenges and Issues (Social Studies, Philosophy, Pedagogics, Law, Applied Linguistics, Theory and Practice of Translation)</u>	
165.	Daria Khalabuda Mediation and legal prospects of its development in Ukraine	493
166.	Mikhailina Samoilenko The cultural distance and the peculiarities of the translation of cinema discourse	496
167.	Довлетова Багул Сопоставительная характеристика морфологических маркеров существительных в русском и украинском языках, связанных с процессами адаптации	498
168.	Чень Венсю Репрезентация категории рода существительных в русском и украинском языках	500
169.	Любов Датченко Специфіка назв художніх музеїв Польщі	502
170.	Сергій Муштат Особливості назв польських національних парків	504

Yevhen Kozii

V.V. Ishkov, scientific supervisor

M.L. Isakova, language adviser

Dnipro University of Technology, Dnipro (Ukraine)

Chromium in the coal seams of the Chervonoarmiiskyi geological and industrial area of Donbas

Chervonoarmiiskyi geological and industrial area is located on the monoclinic slope of the south-western wing of the Kalmius-Toretsk hollow.

The object of research is the main coal seams of the Chervonoarmiiskyi geological and industrial area of Donbas.

The purpose of research is to establish the regularities of chromium distribution in the coal of the main working seams of the Chervonoarmiiskyi geological and industrial area.

The collected material characterizes the content of chromium in 56 coal seams, which belong to the suite C_1^4 (seam d_4), C_2^1 (seams f_0^5 , f_0^7 , f_1), C_2^2 (seams g_1 , g_1^{2H} , g_1^2 , g_1^3 , g_1^4), C_2^3 (seams h_1^H , h_1 , h_4 , h_5 , h_6 , h_8 , h_{10} , h_{10}^1), C_2^5 (seams k_3 , k_5^H , k_5 , k_5^B , k_6 , k_7 , k_7^1 , k_7^{1+2} , k_7^2 , k_8^H , k_8), C_2^6 (seams l_1 , l_1^B , l_2^1 , l_3 , l_3^{B+H} , l_3^B , l_4 , l_4^B , l_5 , l_5^1 , l_6 , l_7^H , l_7 , l_7^{B+H} , l_7^B , l_8^H , l_8 , l_8^1) and C_2^7 (seams m_2 , m_3^H , m_3 , m_3^1 , m_4^0 , m_4^2 , m_4^{2+2B} , m_5^{1B} , m_6^1 and m_6^2) lower and middle parts of the coal period. 2814 occurrences of chromium in coal seams of the area were used in the research. The most representative (more than 33 analyzes satisfy the requirements of accuracy and reproducibility [1-2] and relatively evenly distributed over the area) results were obtained in 38 seams.

On the clusterization dendrogram of seams by chromium content (Fig. 1), the first cluster is composed by seams with a low content (from 7 to 22 g / t, with a cluster average of 16 g / t), the second cluster – seams with the middle content (from 24 to 30 g / t, with a cluster average of 25 g / t), the third cluster – with abnormally high concentrations (from 37 to 73 g / t, with a cluster average of 46 g / t).

In the structure of the first cluster there are three nested clusters: 1.1 – formed by seams with abnormally low chromium concentrations in coal (from 7 to 12 g / t, with a weighted average of 9 g / t in the cluster); 1.2 – combines seams with chromium content from 14 to 17 g / t, with a cluster weighted average of 16 g / t; 1.3 – formed by seams with chromium concentrations in coal from 19 to 22 g / t, with a cluster weighted average of 21 g / t.

To identify the main factors controlling the chromium accumulation in the coal seams of the area, correlation and regression analyzes of its concentration with the main technological indicators and petrographic composition of coal were performed. In the area as a whole, there is a statistically significant relationship between the chromium content in the coal of the area and ash content.

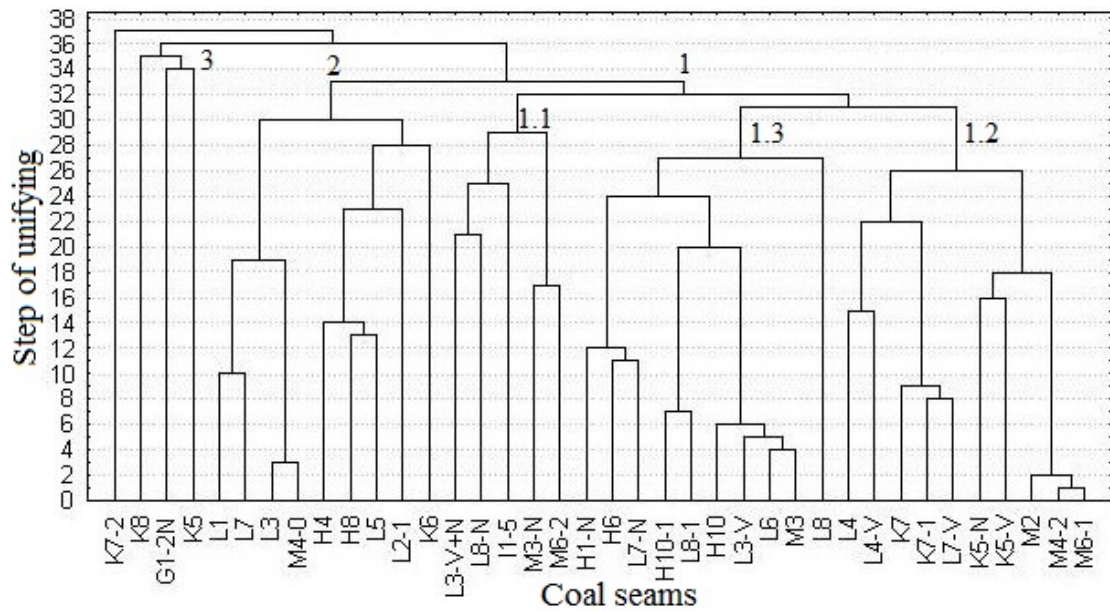


Fig. 1. Clusterization dendrogram by the weighted centroid method of coal seams of the Chervonoarmiyskyi geological and industrial area of Donbas by chromium content

Also in the whole area in all studied seams there is a slight increase in the concentration of this element with increasing degree of coal carbonization, complicating the structure of the seams and reducing their thickness, increasing the number of intraformational mineralized seams and the content of lipid components. There is no statistically significant association between chromium concentrations and total sulfur content and epigenetic mineralization, as well as roof and soil lithology.

For the purpose of visualizing the qualitative analysis of the general form of distribution of the values of chromium concentrations in the coal seams, histograms of the distribution of the normalized content of these elements were constructed (Fig. 2).

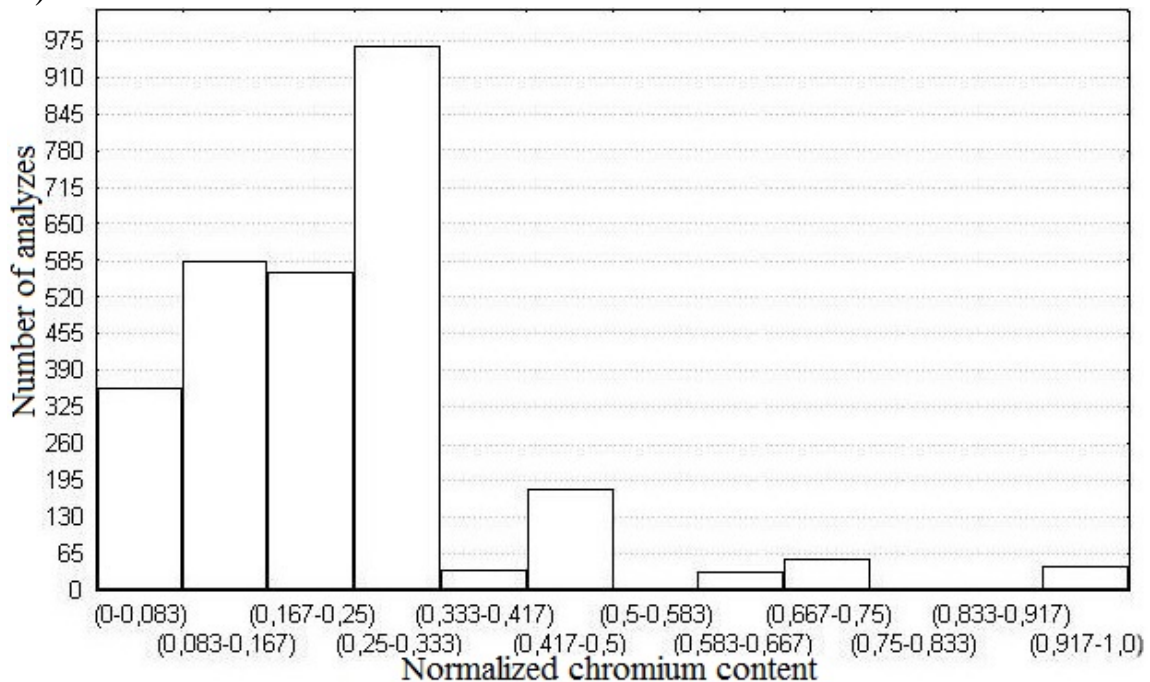


Fig. 2. Histograms of the distribution of the normalized chromium content in the coal seams of the Chervonoarmiiskyi geological and industrial area of Donbas

For convenience of their visual comparison with histograms of distributions of other toxic and potentially toxic elements, the basic technological parameters, petrographic structure and other characteristics of coal all values of concentrations are normalized.

Analysis of the constructed histogram of the distribution of normalized chromium content allows to establish: the distribution of the main part (87% of all results) of the sample is close to the lognormal distribution law and placed in the range of 0,0-0,417 with a mode in the range of 0,25-0,333, which corresponds to chromium content in coal seams: 23-28 g / t; there are two clearly expressed abnormally high intervals of values: 0.583-0.75 and 0.917-1.0, which correspond to the concentrations of chromium in the coal seams: 44-56; 67-73 g / t. 97% of their occurrence is due to the influence of the values of chromium content in the coal seams: g_1^{2H} , k_5 , k_7^2 i k_8 .

The significance of the differences between the sample's mean concentrations of chromium in the coal of the nearest stratigraphic sections of seams and suites was established using the program STATISTICA 7 [3] by calculating the t- criteria and U- criteria of Mann-Whitney (as the most powerful nonparametric alternative of t- criteria) with significance level $p \leq 0.05$.

As a result of the study, the following conclusions can be made:

– The accumulation of chromium in the coal seams of the area is polygenic and polychronic. The main form of these elements is sorbed (on clay minerals and fusened microcomponents).

– The distribution of the main part of 87% of the sampling population of chromium concentrations in the coal of the area is described by the lognormal law, with a mode in the range of 23-28 g / t. The entire sample size is characterized by an average value of 23 ± 1 , with a variance of 118, a standard deviation of 11, an asymmetry factor of 1.95 ± 0.05 and an excess coefficient of 6.31 ± 0.09 .

– The average values of chromium content in the main working coal seams of the area are significantly lower than the maximum concentration limit in coal.

– The calculated sample mean values of chromium content can be used to correlate the main coal seams of the area.

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