

# MINING INFORMATIONAL AND ANALYTICAL BULLETIN

(SCIENTIFIC AND TECHNICAL JOURNAL)

With assistance of the Publishing house «Mining book», Investment support Fund mining publishing

## CHIEF EDITOR

V.N. ZAKHAROV – Corresp. Member of the RAS,  
Dr. Sci. (Eng.), Prof., Institute of Comprehensive Exploitation  
of Mineral Resources RAS, Moscow, Russia

## DEPUTY CHIEF EDITOR

N.A. GOLUBTSOV – Publishing house «Mining book»,  
Moscow, Russia

## EDITORIAL BOARD

A.A. ABRAMOV – Dr. Sci. (Eng.), Prof., National University of  
Science and Technology «MISiS», Mining Institute, Moscow, Russia

P.B. AVDEEV – Dr. Sci. (Eng.), Prof.,  
Transbaikal State University, Chita, Russia

V.N. AMINOV – Dr. Sci. (Eng.), Prof.,  
Petrozavodsk State University, Petrozavodsk, Russia

S.I. ARBUZOV – Dr. of Geology and Mineralogy, Prof.,  
Tomsk Polytechnic University, Tomsk, Russia

V.A. ATRUSHKEVICH – Dr. Sci. (Eng.), Prof., National University of  
Science and Technology «MISiS», Mining Institute, Moscow, Russia

A.A. BARYAKH – Academician of the RAS, Dr. Sci. (Eng.), Prof.,  
Mining Institute, Ural Branch, RAS, Perm, Russia

S.P. BAKHAeva – Dr. Sci. (Eng.), Prof.,  
Kuzbass State Technical University, Kemerovo, Russia

S.A. EPSHTEIN – Dr. Sci. (Eng.), Prof., National University of  
Science and Technology «MISiS», Mining Institute, Moscow, Russia

V.A. GALKIN – Dr. Sci. (Eng.), Prof., Research and Design  
Institute for Open Pit Mining, Chelyabinsk, Russia

V.I. GALKIN – Dr. Sci. (Eng.), Prof., National University of  
Science and Technology «MISiS», Mining Institute, Moscow, Russia

N.M. KACHURIN – Dr. Sci. (Eng.), Prof., Tula State University,  
Tula, Russia

N.O. KALEDINA – Dr. Sci. (Eng.), Prof., National University of  
Science and Technology «MISiS», Mining Institute, Moscow, Russia

D.R. KAPLUNOV – Corresp. Member of the RAS,

Institute of Comprehensive Exploitation of Mineral Resources RAS,

Moscow, Russia

I.L. KRAVCHUK – Dr. Sci. (Eng.), Chelyabinsk branch  
Mining Institute, Ural Branch, RAS, Chelyabinsk, Russia

S.S. KUBRIN – Dr. Sci. (Eng.), Prof., Institute of Comprehensive  
Exploitation of Mineral Resources RAS, Moscow, Russia

M.V. KURLENYA – Academician of the RAS, N.A. Chinakal  
Institute of Mining, Siberian Branch, RAS, Novosibirsk, Russia

A.A. LAVRINENKO – Dr. Sci. (Eng.), Prof., Institute of  
Comprehensive Exploitation of Mineral Resources RAS,

Moscow, Russia

A.V. LYAKHOMSKY – Dr. Sci. (Eng.), Prof., National University of  
Science and Technology «MISiS», Mining Institute, Moscow, Russia

A.V. NASTAVKIN – Cand. of Geology and Mineralogy,

Associate Prof., Head of Department, Southern Federal University,  
Rostov-on-Don, Russia

L.A. NAZAROVA – Dr. of Physics and Mathematics, N.A. Chinakal  
Institute of Mining, Siberian Branch, RAS, Novosibirsk, Russia

V.N. OPARIN – Corresp. Member of the RAS,  
Siberian Branch, RAS, Novosibirsk, Russia

S.N. PODOBRAZHIN – Dr. Sci. (Eng.), Russia Federal Service for  
Ecological, Technological and Nuclear Supervision, Moscow, Russia

I.Yu. RASSKAZOV – Corresp. Member of the RAS,  
Dr. Sci. (Eng.), Prof., Institute of Mining, Far East Branch, RAS,  
Khabarovsk, Russia

V.V. RUDENKO – Dr. Sci. (Eng.), Prof., National University of  
Science and Technology «MISiS», Mining Institute, Moscow, Russia

G.P. SIDOROVA – Dr. Sci. (Eng.), Prof.,  
Transbaikal State University, Chita, Russia

S.A. SILYUTIN – Cand. Sci. (Eng.), SUEK, Moscow, Russia

I.O. TEMKIN – Dr. Sci. (Eng.), Prof., National University of  
Science and Technology «MISiS», Moscow, Russia

A.P. VERZHANSKIY – Dr. Sci. (Eng.), Prof.,  
Chief Executive Officer, Noncommercial Partnership  
«Miners of Russia», Moscow, Russia

S.D. VIKTOROV – Dr. of Physics and Mathematics, Prof.,  
Institute of Comprehensive Exploitation of Mineral Resources RAS,  
Moscow, Russia

V.A. VINKOV – Dr. of Physics and Mathematics, Prof.,  
National University of Science and Technology «MISiS»,  
Mining Institute, Moscow, Russia

A.B. ZHABIN – Dr. Sci. (Eng.), Prof., Tula State University, Tula, Russia

N.V. ZHURAVLEVA – Dr. Sci. (Eng.), West-Siberian  
Test Operations Center, Novokuznetsk, Russia

## INTERNATIONAL EDITORIAL BOARD

A. ANTSIFEROV – Ukrainian State Research and Design Institute  
of Mining, Geology, Rock Mechanics and Mine Surveying, Ukraine

F. BORODICH – University of Cardiff, United Kingdom

C. DREBENSTEDT – Technical University Bergakademie Freiberg,  
Germany

J. DUBINSKY – Central Mining Institute, Poland

V. SAVATOROVA – University of Nevada, Las Vegas, USA

P. TSYBULENKO – Belarus National Technical University, Belarus

PAN YISHAN – Liaoning University, China

S. VUJIC – Rudarski institut, Belgrade, Serbia

M. DOBROKA – University of Miskolc, Miskolc, Hungary

P. KONICEK – The Czech Academy of Sciences,  
Institute of Geonics Studentska, Ostrava, Czech Republic

S. PRUSEK – Central mining institute, Katowice, Poland

José A. SANCHIDRIÁN – Universidad Politécnica de Madrid,  
Madrid, Spain

M. CAŁA – Akademia Górnictwa-Hutnicza im. Stanisława Staszica  
w Krakowie, Krakow, Poland

L. TOTEV – University of Mining and Geology St Ivan Rilski, Sofia

P. PAVLOV – University of Mining and Geology St Ivan Rilski, Sofia

Publishing house «Mining book»

Actual address: Russia, Moscow, Leninskiy prospect, 6, build. 7 of 3

Phone: +7 (499) 236-15-01, +7 (495) 737-32-64

E-mail: info@gornaya-kniga.ru, Internet: www.GIAB-online.ru

Printed in JSC «First Exemplary printing house» Branch

«Chekhov Printing House»



PUBLISHING HOUSE  
«MINING BOOK»

No 10-1 • 2021