

BALKANMINE 2009

3rd BALKAN MINING CONGRESS
3. BALKAN MADENCİLİK KONGRESİ

October 1-3, 2009

İzmir-TURKEY

This Congress is supported by TÜBİTAK (The Scientific and Technological Research Council of Turkey)

BALKANMINE 2009

3rd BALKAN MINING CONGRESS 3. BALKAN MADENCİLİK KONGRESİ

**October 1-3, 2009
İzmir-TURKEY**



**UCTEA
The Chamber of Mining Engineers of Turkey**

All rights reserved © 2009

No parts of this book may be reproduced in any form or any means, without written permission of the Chamber of Mining Engineers of Turkey

Published by Gurup Matbaacılık, Ankara, Turkey

Phone: +90 (312) 384 73 44 Fax: +90 (312) 384 73 46

Puplication No. : 160

ISBN : 978-9944-89-782-2

© The Chamber of Mining Engineers of Turkey

Address: Selanik Cad. 19/3 06650 - Kızılay, Ankara - TURKEY

Phone : +90 (312) 425 10 80 Faks: +90 (312) 417 52 90

Web : www.maden.org.tr

E-mail : maden@maden.org.tr

EXECUTIVE COMMITTEE OF THE CHAMBER OF MINING ENGINEERS
MADEN MÜHENDİSLERİ ODASI YÖNETİM KURULU

President/ *Başkan* : Mehmet TORUN
Co-President/ *II.Başkan* : Berna Fatma VATAN
Secretary/ *Sekreter* : Nahit ARI
Treasurer/*Sayman* : Cemalettin SAĞTEKİN
Members/ *Üyeler* : Niyazi KARADENİZ
: İbrahim YILMAZOĞLU
: Mehmet GÜLER

BALKAN MINING CONGRESS COORDINATION COMMITTEE
BALKAN MADENCİLİK KONGRESİ KOORDİNASYON KURULU

Prof. Dr. Tevfik GÜYAGÜLER Turkey/*Türkiye*
Prof. Dr. Jani BAKALLBASHI Albania/*Arnavutluk*
Grad. Eng. Tomo BENOVIĆ Bosnia and Herzegovina/*Bosna Hersek*
Dr. Eng. Tzolo VOUTOV Bulgaria/*Bulgaristan*
Grad. Eng. Emmanouel FROGOUDAKIS Greece/*Yunanistan*
Prof. Dr. Stojan ZDRAVEV Macedonia/*Makendonya*
Dr. Miodrag GOMILANOVIĆ Montenegro/*Karadağ*
Dr. Eng. Doru CIOCLEA Romania/*Romanya*
Prof. Dr. Slobodan VUJIC Serbia/*Sırbistan*
Mag. Eng. Marjan HUDEJ Slovenia/*Slovenya*

EXECUTIVE COMMITTEE
YÜRÜTME KURULU

President/ *Başkan* : Dr. Bahtiyar ÜNVER
Co-President/ *II.Başkan* : Dr. Özcan Y. GÜLSOY
Secretary/ *Sekreter* : Dr. Elif AKCAN
Treasurer/*Sayman* : Cemalettin SAĞTEKİN
Members/ *Üyeler* : Nahit ARI
: Dr. Mehmet Ali HİNDİSTAN
: Dr. Şebnem DÜZGÜN
: Dr. Nuray DEMİREL
: Dr. A.Hakan ONUR
: Dr. Ercüment YALÇIN
: Cemil SEÇKİN
: L. Yaşar TOMSUK
: Muhammet YILDIZ
: Necati YILDIZ
: Güneş ERTUNÇ
: M.Suphi ÜNAL
: Fırat ATALAY

SUNUŞ

Odamız, gerek bilimsel ve teknik bilginin paylaşılması, gerekse ulusal ve evrensel meslek ilkeleri ve sorumlulukları temelinde uluslararası dayanışma amacıyla, diğer ülkelerin meslek örgütleriyle ve üniversiteleriyle iletişim içerisinde bulunmayı önemsemektedir.

Bu çerçevede söz konusu örgütlenmeler ile iletişime geçilmesi hususunda çalışmalar başlatılmıştır. Bu doğrultuda birincisi 2005 yılında Sofya’da, ikincisi 2007 yılında Belgrat’ta düzenlenen Balkan Madencilik Kongresi’nin üçüncüsü Odamızın ev sahipliğiyle ülkemizde düzenlenmektedir.

Dünyada bilim ve teknoloji alanında çok hızlı bir gelişim ve değişim süreci yaşanmaktadır. Üretilen bilginin her 2-3 yılda ikiye katlandığı ileri sürülmektedir. Bilime ve teknolojiye hakim olan güçler dünyayı da egemenlikleri altına almaktadır. Bu nedenle gelişmiş ülkeler bütçelerinden mühendislik- bilim teknoloji ve eğitim alt yapısına ayırdıkları payı gün geçtikçe arttırmaktadır.

Madencilik sektöründe aramadan uç ürüne kadar her aşamada ileri teknoloji kullanılmalıdır. Üretim ve kaynak performansının iyileştirilmesine ve yeni ürünlerin elde edilmesine yönelik olarak yeni gelişen teknolojilerin kullanımı, bu sektörün ülke kalkınmasına katkısı bakımından son derece önemlidir. Bu nedenle sektörde yüksek teknoloji kullanımı ve üretilmesine yönelik araştırma-geliştirme çalışmalarına öncelik verilmelidir. İleri üretim teknolojilerinin geliştirilmesi ve kullanımı, daha temiz ve daha etkin madencilik süreç ve ürünlerinin temini bakımından önkoşuldur.

Bu Kongre’de sektördeki teknolojik gelişmeler paylaşılırken, ülkemizin madencilik sektörünün tanıtımı da yapılacaktır. Balkan ülkelerindeki maden mühendislerinin ve yerbilimcilerin bir araya geleceği toplantılar da deneyimlerin ve teknik bilginin paylaşımı amaçlanmıştır.

Kongre’nin gerçekleşmesine katkı koyan Yürütme Kurulu Başkanı Bahtiyar ÜNVER başta olmak üzere tüm Yürütme Kurulu üyelerine, Balkan Madencilik Kongresi Koordinasyon Kurulu Üyesi Tevfik GÜYAGÜLER’e ve emeği geçen herkese teşekkür ederiz.

Saygılarımızla

YÖNETİM KURULU

FOREWORD

The 3rd Balkan Mining Congress (BALKANMINE 2009) organized by Balkan Mining Association, BALKANMINE and The Chamber of Mining Engineers of Turkey is held between October 1-3 in İzmir, Turkey. The primary objective of the Congress is to promote operational, economical and scientific information pertaining to all aspects of mining technology, energy and sustainable development.

In conjunction with the Congress, 3rd Mining, Natural Resources and Technology Fair of Turkey, MINEX 2009 is organized at the same location for the exhibition of mining products together with companies offering machinery, equipment, instruments, software and services to mining, processing and energy industries.

The papers included in the proceedings volume have been grouped under ten specific themes including, Balkan Mining Industry; Mineral Resources and Mine Geology; Exploitation; Process Engineering; Rock Engineering and Design; Computer Applications in Mining and Processing; Management and Mining Economics; Ventilation and Safety; Mining and Environment; History and Mine Education. The 98 papers included in this volume have been prepared by authors from 14 countries. I am confident to state that papers included in this proceedings volume are testimonials to the vibrant role that mining technology plays in the identification and establishment of routes to sustainable resource development, environmental protection and globalization.

Every successful congress stems from a teamwork approach. We owe gratitude to the members of the Organizing Committee, Balkan Mining Association Coordination Committee, Executive Board of the Chamber of Mining Engineers of Turkey and Chairpersons of the technical sessions. There is no need to mention that this proceedings volume and the BALKANMINE 2009 would not come to reality without contributions of the speakers and authors. Our most genuine appreciation also goes to the delegates for their interest and contributions to the success of the Congress.

We acknowledge with gratitude the financial support provided by TÜBİTAK, The Scientific and Technological Research Council of Turkey. We also owe gratitude to İZFAŞ, İzmir Fair Services Culture and Art Affairs Trade Inc., for their professional effort in the preparation of the Congress venue.

Once again, I thank all of the participants of the BALKANMINE 2009 for their contributions which will become instrumental in the enhancement of our scientific and professional development. I am delighted to reiterate that it is a great pleasure for me to welcome all friends and colleagues to İzmir, to a congress that you will find technically stimulating and socially enjoyable.

Dr. Bahtiyar ÜNVER

for the Organizing Committee

CONTENT

İÇİNDEKİLER

BALKAN MINING INDUSTRY

BALKANLARDA MADENCİLİK ENDÜSTRİSİ

Border Area Deposits and the Possibilities for Joint Projects	1
<i>N. Vulkanov, S. Topalov, I. Nishkov, G. Mihaylov, T. Tzvetkov, K. Boev</i>	
Some Aspects of the Development Possibilities of Coal Industry in Bosnia and Herzegovina	9
<i>I. Ibreljić, R. Husagić, Š. Suljić</i>	
Systems for Monitoring of Electrical Energy Consumption in Mining Industry of Bulgaria	17
<i>I. Stoilov</i>	
Metalogenetic Characteristics of the Groot Fe-Ni Deposit Republic of Macedonia	23
<i>O. Spasovski, B. Doneva</i>	
Nickel, World Production and Demand	29
<i>A. Apostolikasi, E. Frogoudakis, J. Bakallbashi</i>	
Gypsum in Albania and its Near Future Development Perspective	35
<i>J. Bakallbashi</i>	
Gemstone Mining History and its Importance for Environmental Economics of the Şaphane Mountain Fire Opal Deposit (Yeni Karamanca-Şaphane-Kütahya)	41
<i>M. Hatipoğlu, N. Türk, H.B. Buzlu</i>	
Economic Productivity in Turkish Boron Mining	47
<i>A. Konuk , S. Cubukcu, S. Onder, H. Ankara</i>	
Sedimentation Problems at Main Measure Regulation Stations	55
<i>D. Danilovic, S. Eric, V.K. Maricic, B. Lekovic</i>	
Industrial Mineral Resources in Bulgaria	59
<i>P. Daskalov, K. Dedelyanova, I. Kozhuharov</i>	

MINERAL RESOURCES AND MINE GEOLOGY

MİNERAL KAYNAKLARI VE MADEN JEOLJİSİ

Petrography and Geochemistry of Lignite, Kostolac Basin, Serbia: Importance to Mining	67
<i>A. Dangić, B. Simonović, D. Dimitrijević, N. Vasić, M. Babović</i>	
Valorisation of Raw Material Resources of the Western Part of Kostolac Mining Basin	77
<i>M. Babović, B. Babić, V. Popović, J. Milošević</i>	
Reserve Estimation of Dereköy Copper Deposit Considering Feasibility of the Project	83
<i>Ö. Erdem, T. Güyagüler</i>	
New Product Development via Application of Ceramic Glaze and Decorative Techniques to Andesites of Afyon-Iscehisar	91
<i>A. Saruışık , B. Ersoy , G. Saruışık</i>	
Geochemical Study of Effects of Lignite Firing in Power Stations: Kostolac, Serbia	101
<i>A. Dangić, B. Simonović, L. Cvetković, J. Milošević</i>	

EXPLOITATION

ÜRETİM FAALİYETLERİ

Velenje Coal Mine (VCM) Mining Method and Modern Mechanized Faces <i>M. Medved, L. Golob, A. Kotnik</i>	109
Ellatzite Mine - The Biggest Open Pit Mine for Copper and Gold Production in Bulgaria and in the Balkan Peninsula <i>T. Voutov, V. Tsatsov</i>	119
Characteristics of the Open Caste Mine “South Field” <i>Z. Ilic, Z. Belacevic</i>	125
Alternative Technological Solutions in Underground Ore Mining <i>G. A. Mihaylov</i>	131
Prospects for Development of Geo-Technological Production of Copper In Situ in Bulgaria <i>V. Danov, G. Zahariev</i>	139
Underground Workings Over 13 km Total Length Serve for Ellatzite Open Pit Mine Operation <i>V. Tsatsov</i>	147
New Crushing Transport System at Copper Mine Ellazite-Med AD <i>I. Antonov, I. Vladov, K. Chobanov, A. Tomov, V. Ketipov, Y. Bozhurski</i>	151
Geo-Technological Production of Uranium In Situ – Prospects for Development in Bulgaria up to the Year 2040-50 <i>V. Danov</i>	157
The Correlation of the Technical and Technological Parameters During the Operation of the Bucket Wheel Excavator S_{ch,r_s} 650 <i>A. Bytyçi, E. Goskolli</i>	163
Payload Estimation of a Walking Dragline - A Case Study <i>M. Özdoğan, A. Özgenoğlu</i>	171

PROCESS ENGINEERING

CEVHER HAZIRLAMA

Modernization of the Process “Flotation of Molybdenum” in “ELLATZITE–MED” AD, Bulgaria While Incorporating a System for Management Using Information <i>K. Yonchev, T. Makedonski</i>	177
The Evaluation of the Inyoite Mineral as a Neutron Shielding Material <i>A. S. Kıpçak, E. M. Derun, M. B. Pişkin, N. Tuğrul</i>	181
The Investigation of Comminution Properties of Different Coals on Impact Crusher and Numerical Analysis <i>Y. Umucu, V. Deniz, S. Çayırılı</i>	189
Investigation by Simple and Multivariable Linear Analysis Methods of the Interrelationships between the Bond Grindability with Physicomechanical and Chemical Properties of Coals <i>V. Deniz, Y. Umucu</i>	195

Improvement of the Scheme of Flotation of Molybdenum Factory “ELLATZITE” <i>B. Dikinov, I. Kunchev, V. Mehandijski</i>	203
Application of Belt Filter Press LAROX PF 50 in the Conditions of Enrichment Factory “ELLATZITE” <i>V. Mehandijski, B. Dikinov, I. Kunchev, G. Strelkov</i>	207
Use of the Waste During the Grinding of Copper Ore in the Conditions of the Company “Ellatzite–Med”, AD <i>T. Makedonski</i>	211
Installation for Crushing and Sorting to Get Crushed Fractions for Rail and Road Construction and for the Production of Concrete <i>Y. V. Bozhurski, I. S. Antonov, A. L. Andreev</i>	217
A New Approach in the Wet Separation of Quartz-Kaolin Raw Material <i>M. Marinov, A. Valchev, I. Nishkov, I. Grigorova</i>	225
Determination of the Optimum Conditions of Roasting and Dissolution of Chalcopyrite in SO ₂ Saturated Water <i>M. Çopur, M. Kocakerim, M. Kızılca</i>	231
An Overview of the Rheological Behavior of Drilling Fluids <i>A. Ş. Deliormanlı</i>	243
<i>Genleşmiş Kil Agregası Üretiminde Katkı Kullanımının Önemi</i>	255
Importance of Additives Use in Production of Expanded Clay Aggregates <i>A. Özgüven, E. Oral, H. Bayrakdar, Z.Y.Açıkğöz, L.Gündüz</i>	

ROCK ENGINEERING AND DESIGN

KAYA MÜHENDİSLİĞİ VE TASARIM

Stability Analysis of Excavations in Jointed Rocks - the Computer Program RESOBLOK <i>T.Korini, V. M. Soukatchoff</i>	259
Some Aspects of the Elementary Ore Pieces Statics and Kinematics in the Draw Process <i>D. Anastasov</i>	269
Rock Mass Properties and Evaluation of Stability of Underground Openings - Case of Rreshen-Kalimash Tunnels <i>T. Korini, V. Jorgji, G. Muka, H. Sauku, S. Ristani</i>	273
Stability Aspects of Excavations in Landslide Zone for a Coal mine “Suvodol” - R.Macedonia <i>M. Jovanovski, J. Papic, R. Dambov, I. Peshevski</i>	283
Project for Observation of the Deformations of the Massif in Mine Ellatzite <i>I. Ivanov, G. Royalski</i>	291
Evaluation of Underground High Pressure Gas Storage Plants in Granite Rock <i>A. Özarlan, O. Taşçakmak</i>	299
Application of the Umbrella Arch Method in İstanbul (Turkey) Metro Project <i>H. Denek, Y. Özçelik</i>	311
Examination of Drilling Rate Index (DRI) of Rocks <i>H. Yenice, M. K. Özfirat, B. Kahraman, M. V. Özdoğan</i>	321

<i>Türkiye’deki Bazı Doğaltaş Ocaklarında Zincirli Kollu Kesici Uygulamaları ve Ocak Üretimine Etkileri</i>	329
Chain Saw Machine Applications at Some Natural Stone Quarries in Turkey and its Effects on Quarry Productivity	
<i>İ. C. Engin, E. Özkan</i>	
Smooth Blasting an Effective Method for Rocks Blasting with Explosives	339
<i>I. Nako, V. Jorgji, T. Korini, A. Bakiu</i>	
Controlled Blasting with Demolition Agent	345
<i>R. Dambov, R. K. Stefanovska, I. Dambov</i>	
New Ecological Technologies for Hole Blasting in Opencast Mines and Quarries	349
<i>G. Georgiev, G. Kamburova</i>	
Mining Solution for Works on a Pressure Penstock in the Pumped Storage Hydropower Plant Avče – Slovenia	355
<i>M. Hudej, M. Ranzinger, I. Pecovnik</i>	
Estimating the Los Angeles Abrasion Loss of the Aggregates from Bedrock Properties	361
<i>I. Ugur, S. Demirdag, H. Yavuz</i>	
Numerical Modeling for the Determination of Umbrella Arch and Face Bolt Effects on the Ground Settlement Induced by Urban Shallow Tunneling	371
<i>C.O. Aksoy, T. Onargan, A. Güney</i>	
<i>İzmir Metrosu 2. Aşama İnşaatındaki Kayaların Özelliklerinin İncelenmesi ve Karşılaşılan Kısıtlamalar</i>	379
Investigation of Rock Properties in 2nd Stage of Izmir Metro Construction and Restrictions	
<i>V. Özacar, C. O. Aksoy</i>	
The Prediction of Coal Bond Work Index Values by Using Point Load Index and Shore Hardness	385
<i>Y. Umucu, N. Sengun, R. Altindag, S. Sarac</i>	
<i>Zayıf Kaya Kütlelerinde Oluşturulan Dairesel Açıklık Aynası Etrafındaki Deformasyonların Tahmini</i>	391
Prediction of the Deformations Around the Face of an Circular Opening in Weak Rock Mass	
<i>H. Basarir</i>	
<i>Üç Eksenli Sünme Test Aparatı Tasarımı</i>	401
Design of the Triaxial Creep Test Apparatus	
<i>D. Arıkan, M.G. Şenyur</i>	
Technology of Benches Cutting at Final Slopes of High Waste Dumps at Cerovo 1	407
<i>R. Lekovski, L. Obradovic, A. Kostov</i>	

COMPUTER APPLICATIONS IN MINING AND PROCESSING

MADENCİLİK VE CEVHER HAZIRLAMADA BİLGİSAYAR UYGULAMALARI

Cluster Analysis of Copper Ore Types by Neural Networks in Aid of Mine Operations Planning	413
<i>V. Hristov, S. Topalov</i>	

Mathematical Model and Computer-Aided Optimization Strategy of the Methane Drainage Network	419
<i>G.B. Babut, R.I. Moraru</i>	
Data Collection, Visualization and Analysis in the Mining Factories	427
<i>S. Lyubenov</i>	
Introducing the Fuzzy Logic Control at the Information Management System of the “Rudnik” Mine Flotation Plant	437
<i>I. Miljanovic, S. Vujic, M.J. Pejović</i>	
NETPRO/Mine: An Integrated Resource Modelling, Mine Design and Automation Software	443
<i>A. E. Tercan, S. Anaç, S. Ak, B. Ünver, M. A. Hindistan, S. Gazel, H. Ulaş</i>	
Determination of Particle Size and Shape Characteristics of Quartz Sands	449
<i>I. Kursun</i>	
Robust Systems for Surveillance and Management at Open Pit Mines	459
<i>S. Vujić, I. Miljanović, S. Boševski, T. Benović, M. J. Pejović, A. Milutinović</i>	
MANAGEMENT AND MINING ECONOMICS	
<i>İŞLETME VE MADEN EKONOMİSİ</i>	
Economic Trends in Bulgarian Mining Industry Development	467
<i>V. Velev, I. Nishkov, I. Grigorova, B. Denev</i>	
Information System for Quality Monitoring and Management During Coal Mining	471
<i>Y. Anastasova, D. Anastasov, N. Yanev, K. Ivanov</i>	
Ore Reserves and Mineral Production in European Union	475
<i>Ş. Şafak, İ.H. Kırşan, E. Ertürk, M. Şahiner</i>	
Statistical Quality Control of Thicknesses of Plates Cutting from Diamond Circle Saw Block Cutter Machine	481
<i>H. Ankara, A. Değerli, S. Yerel</i>	
<i>Genleşmiş Kil Agregası Üretim Maliyetinin Hesaplanması</i>	487
Cost Evaluation of Expanded Clay Production	
<i>A. Özgüven, L. Gündüz</i>	
Application of Input-Output Analysis in Corporate Enterprises of EPIS Thermal Power Sector	491
<i>S. Maksimovic, Z. Milinovic, I. Miljanović, S. Boševski, M. Hudej, T. Benović</i>	
Efficiency Assessment of Cyclic Flow Conveyor System in the Assarel Mine, Bulgaria	499
<i>L. Tsotsorkov, D. Nikolov, M. Mihailov, N. Bekiarov</i>	
Evaluation and Actions that can Assure a Stable Management of the Open Pit Mine “ELLATZITE”-Main Elements, Measures of the Success	509
<i>G. Petrov</i>	
Developing Sustainability	513
<i>S. Göncüoğlu</i>	
Assessment of Quality of the Plates Using Single Linkage Cluster Method	519
<i>S. Yerel, H. Ankara</i>	

Availability Analysis of Mining Machines-A Case Study of a Dragline	525
<i>S. Eevli, N. Uzgören, Ö. Uysal</i>	
The World War Two Turkish Chrome Sales	531
<i>M. Önsoy</i>	

VENTILATION AND SAFETY

HAVALANDIRMA VE İŞ GÜVENLİĞİ

IT Application for the Occupational Health and Safety Integrated Management System	543
<i>G. D. Vasilescu, L. Popescu, T. A. Csaszar, D. Cioclea</i>	
The Effect of Atmospheric Pressure on Methane Release: A Case Study	549
<i>S. Demirovic, S. Gutic</i>	
Preventing Spontaneous Combustion Using Zinc Chloride Inhibitor at Lonea Mine Unit	555
<i>I. Toth, D. Cioclea, L. Toth</i>	
Optimizing the Location of Structures Used for Regulating and Driving Air	563
<i>I. Gherghe, L. Jurca, C. Lupu, D. Cioclea, C. Boantă</i>	
Numerical Prediction of Fan Parameters in Mine Air Controlled Recirculation Systems	567
<i>R.I. Moraru, G.B. Babut</i>	
Management of the Ventilation Network of Paroşeni Mine During Accidental Stoppage of the Main Ventilation Station	571
<i>D. Cioclea, C. Lupu, L. Jurca, I. Toth, I. Gherghe, C. Boantă</i>	
<i>Metan Drenajının İşletme Performansı Üzerindeki Etkilerinin Araştırılması</i>	575
Investigating the Effects of Methane Drainage on the Operating Performances of Mines	
<i>G. Aydın, İ. Karakurt, K. Aydın</i>	
<i>Maden Havasındaki Metanın Oksidasyonu ile Enerji Üretimi</i>	585
Energy Production by Oxidation of Mine Ventilation Air	
<i>İ. Karakurt, G. Aydın, K. Aydın</i>	

MINING AND ENVIRONMENT

MADENCİLİK VE ÇEVRE

Tailings Dam “Benkovski 2” – Perspectives for Development of the Equipment	593
<i>S. Dimitrov, G. Boyadjiev</i>	
Anthropogenic Influence of the Open Pit Mining and Land Reclamation in the National Park Environment	601
<i>I. Miljanović, T. Benović, M. Hudej, S. Maksimović, S. Boševski, M. J. Pejović</i>	
Technical and Biological Reclamation of the Topolnica Tailing Dump	609
<i>R. Dambov, O. Spasovski, Z. Gocev</i>	
Emergency Risk Situation and Risk Reduction at Four Albanian Tailing Dams	615
<i>B. Shushku, E. Goskollli</i>	
Improvement in the Explosives of ANFO Type with the Purpose of Decrease in the Toxic Emissions and Increase in the Energy Parameters	621
<i>G. Kamburova</i>	

Abandoning Production in the Kanižarica Mine and Restructuring the Exploitation Area– A Case of Good Practice <i>J. Šporin, Ž. Vukelić, S. Grdišič, J. Matekovič, Ž. Sternad</i>	627
On Cleaning of Mining Waste Waters <i>T. Lorand, L. Csaba, D. Ciprian</i>	635
<i>Kömür Açık İşletmelerinde Optimum Arazi Rehabilitasyon Yönteminin Belirlenmesi</i> Determination of Optimum Rehabilitation Method in Open Pit Coal Mines <i>M.S. Delibalta</i>	641
<i>CBS ve UA Kullanılarak Muğla Mermer Ocaklarının Çevresel Etkilerinin Belirlenmesi</i> Determining the Environmental Impacts of the Marble Quarries in Mugla by Using GIS and RS <i>K. Koruyan, A. H. Deliormanlı, E. Yalçın, V. Tecim, Z. Karaca</i>	653
Selection of the Method of Coal Exploitation According to the Environmental Protection Criteria <i>M. Grujic, P. Rybar, J. Engel</i>	661
Heavy Metals in the Water of The River Kalnistanska and the Vicinity <i>O. Spasovski, R. Dambov</i>	667
<i>Harşit (Giresun) Granitlerinin Mineralojik - Petrografik Analizi ve Granitlerin Bina Malzemesi Olarak Kullanımı için Doğal Radyoaktivite Seviyesinin İncelenmesi</i> Investigation of Harşit (Giresun) Granites Mineralogical- Petrography Analysis and the Level of Natural Radioactivity of Granites Used as Building Materials <i>M. Çapık, A.O. Yılmaz, M. Vıcıl</i>	671
HISTORY AND MINE EDUCATION	
TARİH VE MADENCİLİKTE EĞİTİM	
Urfa (Harran) Bazda Ancient Underground Marble Quarrying <i>S. Kulaksız, C. Ağan</i>	683
<i>Müzelerin Eğitime Katkısı: “Kütahya Jeoloji Müzesi”</i> Educational Contribution of Museums: “The Geological Museum of Kütahya” <i>A. Haşimoğlu, B. Yeşil</i>	689
Authors Index / Yazarlar Dizini	699

Heavy Metals in the Water of the River Kalnistanska and the Vicinity

O. Spasovski & R. Dambov
Faculty of Mining and Geology, Stip

ABSTRACT The paper presents the results and conclusions from the investigations carried out on the water contamination with heavy metals in the River Kalnistanska and its vicinity. For the increased content of heavy and toxic metals in the near vicinity of river Kalnistanska, especially in the water systems, large contribution have increased ore mineralization of the area, sewage waters from the feces of the town and neighboring villages, and industrial objects (battery factory etc.).

The examinations are an attempt to determine the real and the physical state of heavy metals in the river water and its tributaries. Samples were analyzed with ICP-AES method. Earlier experiences indicated that the following elements should be expected: Mn, Fe, Al, Zn, As, Cd, Cu, Ni, Co, Ag, Cr, Ti with possible occurrence of increased concentrations of maximum allowable amounts.

Analysis and data interpretation yielded increased concentrations of Mn, Fe, Al, Pb, Zn, As, Cd and Cu. The entire drainage system in the Kalnistanska in the Municipality of Probistip has been polluted. It was found that the major pollutants are the Zletovo Mine and the discharge of waste waters containing heavy metals.

1 INTRODUCTION

Investigated area is located in the eastern part of the Republic of Macedonia near to town of Probistip. River Kalnistanska flow through mountain, lowland and canyon terrains. There are many hills above the Probistip where the river Kalnistanska is situated and it is lay down along the fault lines.

After the exit at village Kalniste, along the river Kalnistanska valley alluvium is wide spread with width of 300 to 1000 m. Left bank is flatland with characteristic little uplifts.

Hydrographic net of this area belongs to the river Bregalnica which has water through the whole year. Left affluent of river Bregalnica is river Zletovska in which river Kalnistanska influents. These rivers are with

permanent flow through the whole year. In the rainy days there are enough water, and in rainless summers water potential decreased. Only river Kalnistanska could dry up (rarely).

Over the past few decades environmental pollution was not given sufficient attention. However, the issue was given a priority over the few years. Heavy and toxic metals in drinking water has been of special concern. It is of note that the wells from which the population in several municipalities receive water for the water supply system are located in the River Kalnistanska alluvion. This has been a serious problem for the people in the Municipality of Probistip.

People in the area use the waters from several tributaries for drinking water and household needs. They also use the water for irrigation, agriculture particularly in the

production of many kinds of vegetables. Investigations carried out so far point out possible water pollution.

Another reason for the implementation of the project is the strict laws on the quality of the human environment.

The studied area included the Rivers Kalnistanska and Zletovska as far as its estuary to the Bregalnica (Figure 1). The area marked with an oblong is the place where water samples were collected.



Figure 1. Map of the Republic of Macedonia with location of investigated area.

2 METHODS OF WORK

Preliminary field activities were carried out in order to obtain data on the situation of the terrain.

Field sampling also defined measurement points and cross-section lines. Topography of sampling stations was defined including the cross section lines for sample collection. The initial phase consisted of collecting water samples in the middle of the river course in a 1-l. clean plastic vessel. Sample collection also included filtering through paper the openings being 45 μm . Before closing the vessel acidifying with 0.4 ml nitric acid (HNO_3) of 50 % was done to avoid possible metal settling on the wall and the bottom of the vessel. Laboratory examinations included ICP-AES method and their interpretation.

3 RESULTS AND DISCUSSION

The results obtained from flowing water samples are given in Table 1, with comparison between maximum allowable (MAC) concentration of heavy and toxic metals for III – IV classes.

Data shown in Table 1 make it possible to define the amount of heavy metals in the Kalnistanska River water and its tributaries and the reasons for their occurrence.

Based on the data presented in Tab. 1, certain constants can be given concerning the presence of particular heavy metals in the waters of the Kalnistanska River.

The data for the concentration of zinc (Table 1) indicate its increased presence in most of the samples which were analyzed. The greatest concentrations of zinc are found

in the sample Kr-9, which are 0.28 mg/l. The increased concentrations of zinc are also found in the samples: Kr-1, Kr-3 and Kr-5. In the remaining samples the concentration of zinc is present in amounts less than the

standard ones. Generally, it can be concluded that the entire research area is contaminated with zinc. The increased concentrations of zinc are a result of the active working of the Mine for lead and zinc Zletovo.

Table 1. Contents of heavy metals in flowing waters in the Kalnistanska River (mg/l).

Sample	Fe	Mn	Zn	Pb	Cu	Cd	As	Ag
Kr-1	0.290	0.016	0.1700	0.013	0.007	0.0120	0.014	0.0029
Kr-2	0.050	1.150	0.0130	0.011	0.005	0.0007	0.018	0.0041
Kr-3	0.043	0.210	0.2400	0.024	0.034	0.0008	0.028	0.0022
Kr-4	0.029	0.017	0.0580	0.019	0.019	0.0012	0.044	0.0040
Kr-5	0.072	1.310	0.1800	0.043	0.023	0.0010	0.026	0.0025
Kr-6	0.110	0.025	0.0072	0.010	0.005	0.0180	0.070	0.0015
Kr-7	0.180	0.120	0.0440	0.010	0.010	0.0010	0.055	0.0043
Kr-8	0.240	0.025	0.0310	0.029	0.016	0.0011	0.022	0.0015
Kr-9	0.280	0.218	0.2800	0.006	0.003	0.0110	0.016	0.0017
Standard	1.0	1.0	0.2	0.03	0.05	0.01	0.05	0.02

The increased concentration of lead are noticed in the samples Kr-5 (0.043 mg/l), Kr-8 (0.029 mg/l), Kr-3 (0.024 mg/l) and Kr-4 (0.019 mg/l). It is obvious that increased concentrations of lead are found in most of the samples, but the great sample concentrations of lead are found in those samples where increased concentrations of zinc were also found, which confirms the statement of the great influence of the hydro-waste dump and the active working of the Mines Sasa for the pollution of the environment with these metals.

In all the samples cadmium is found in extremely larger concentrations compared to maximum allowed concentration. The great sample concentrations of cadmium are noticed in the samples Kr-1 (0.12 mg/l) Kr-6 (0.018 mg/l) and Kr-9 (0.011 mg/l). This behaviour of the cadmium is due to its geochemical characteristics (easily soluble, low mobility). The increased concentrations of cadmium follow the parts which are contaminated with zinc because it geochemically follows the minerals in the zinc.

The increased concentrations of copper are found in most of the samples, but the great sample concentrations of copper found in the samples Kr-3 (0.034 mg/l), Kr-4 (0.019 mg/l), Kr-5 (0.023 mg/l) and Kr-8 (0.016 mg/l), while in the remaining samples the concentrations of copper are close or less than in maximum allowed concentration. The presence of the copper in the waters of river Kalnistanska is a result of the occurrence of chalcopyrite in an association with the minerals of the lead and zinc.

Iron is present in concentrations lower than maximum allowed concentration and is not a significant contaminant of the drainage system of the river Kalnistanska.

Attention should be paid for the high concentrations of the manganese in the samples: Kr-2 (1.15 mg/l) and Kr-5 (1,31mg/l). The reason for the occurrence of the manganese in high concentrations in the waters of the river Kalnistanska as a presence of the waste waters from the Mines Zletovo.

4 CONCLUSION

Data obtained with laboratory examinations on heavy metal contents in the waters of the Kalnistanska and its tributaries indicate that a number of heavy metals occur in increased amounts, some of them in amounts lower than the maximum allowable.

The most important contaminants are lead, zinc, cadmium, silver, arsenic and silver.

The increased concentrations of heavy metals are a consequence of the geological composition of the terrain, anthropologic activities such as early mining and stockpiling of waste material, the use of fertilizers in agriculture as well as the physical and chemical character of the water solutes.

It can be said in the end that the largest distribution and resulting contamination with heavy metals were found in the mine and flowing into the Kalnistanska. From ecological point of view this entails the need of rehabilitation of the area in order to prevent flora and fauna intoxication in the water medium and the surrounding and prevent the negative effect on the health of the population.

The metal concentration in flowing waters is also influenced by their geochemical characteristics and pH and Eh factors.

REFERENCES

- Fairall, K., 2002. *Chemistry of river water and sediments associated with mining in Macedonia*, MSc project, Royal Holloway, University of London, Unpublished
- Gill, R., 1997. *Modern Analytical Geochemistry*, Addison Wesley Longman Limited, Harlow, UK.
- Jonasson, I., 1997. *Geochemistry of sediment/water interactions of metals, including observations on availability*. In: Shear, H and Watson, A (eds.), *The Fluvial Transport of Sediment - associated Nutrients and Contaminants*, Windsor, Ontario, pg. 255-271.
- Levison, A. A., 1974. *Introduction to Exploration Geochemistry*, Applied Publishing Ltd, Calgary.
- Spasovski, O., Doneva, B., 2007. *Heavy metals in the water of the river Zletovska and the vicinity*. 2nd Balkan mining congress, Belgrade, Serbia.
- Spasovski, O., Doneva, B., 2007. *Heavy metals in sediments and soils along the river Bregalnica in the part of hydroaccumulation Kalimanci to Kocani*, Geologica Macedonica, pp 75-86.
- Spasovski, O., Mitev, T., 2009. *Heavy metals in waters along the river Bregalnica in the part of hydroaccumulation Kalimanci to Kocani*. XI YUCORR Conference with international participation "COOPERATION OF RESEARCHERS OF DIFFERENT BRANCHES IN THE FIELD OF CORROSION AND MATERIALS AND ENVIRONMENT PROTECTION", Tara, Serbia.
- Younger, P. L., 2002. *Mine water pollution from Kernow to Kwdrulu - Natal: geochemical remedial options and their selection in practice*, Geoscience in south - west England, 10, 255 – 266.