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SAFETY ASPECTS OF SMALL UNDERGROUND MINES IN HUNGARY

ABSTRACT

Output of Hungarian underground coal mining has been continuously decreasing for the past four-five decades. Some events, e.g. reducing number of mines and especially longwalls, etc. were not really obvious, as they were real steps of modernizing mining technology. By the end of the 1980ies evident economic problems changed the perspective of the mines. Many of them joined to the neighboring power plants and others operated as independent enterprises mostly for extracting household coal. The last coal mine, part of joint venture with a coal-fired power plant was shut down at the end of 2014. Only small underground mines of low output and simple machinery are still in operation, sometimes having some difficulties from financial and environmental aspects. On the other hand a new safety regulation was issued some years ago for underground mining in Hungary. Questions of ability of small mines to meet requirements of this regulation are discussed in the paper.

Keywords: small-scale mining, artisanal mining, mine safety

Decrease of mining output of Hungary

Trends of coal, natural gas, crude oil and bauxite production of Hungary since 1960 are shown by Figure 1, according to the long-term data series of Hungarian Central Statistical Office. Mass of 1000 m³ of natural gas was estimated 1 t by the authors.

A new period began in Hungary after World War II, as there was no significant fuel source of the country but coal, so coal mining output increased continuously. Then numerous mines were shut down in the second half of the 1960ies. Only those ones were kept in operation which were suitable for operating mechanized longwalls. The sudden decrease of the production was avoided only by opening the first lignite opencast mine of approximately 7 million tons annual output. A slight increase could be found in the surface mining output during the past four decades, but production level of the underground mines has been decreased since the 1980ies. The last coal mine operating mechanized longwalls was shut down at the end of 2014.

Similar trends could be found in the ore mining and to a less extent in the petroleum extraction as it is shown on Figure 1.

Periods of increase of the output, modernization and fall of the production can be observed in the Borsod coal basin northwest of Miskolc in the northeastern part of the country. This basin was the mined out the most household coal for heating. Summarized

output of the mines and total (reduced) length of the coal faces, taking into account the periods when the longwalls were not in continuous operation can be seen on Figures 2 and 3.

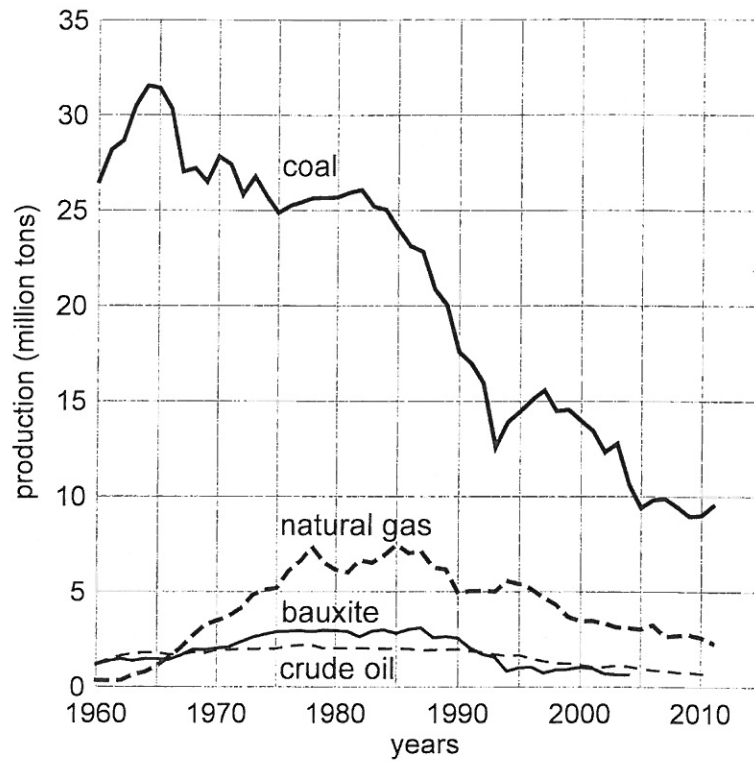


Fig. 1. Coal, natural gas, crude oil and bauxite production of Hungary since 1960 [16]

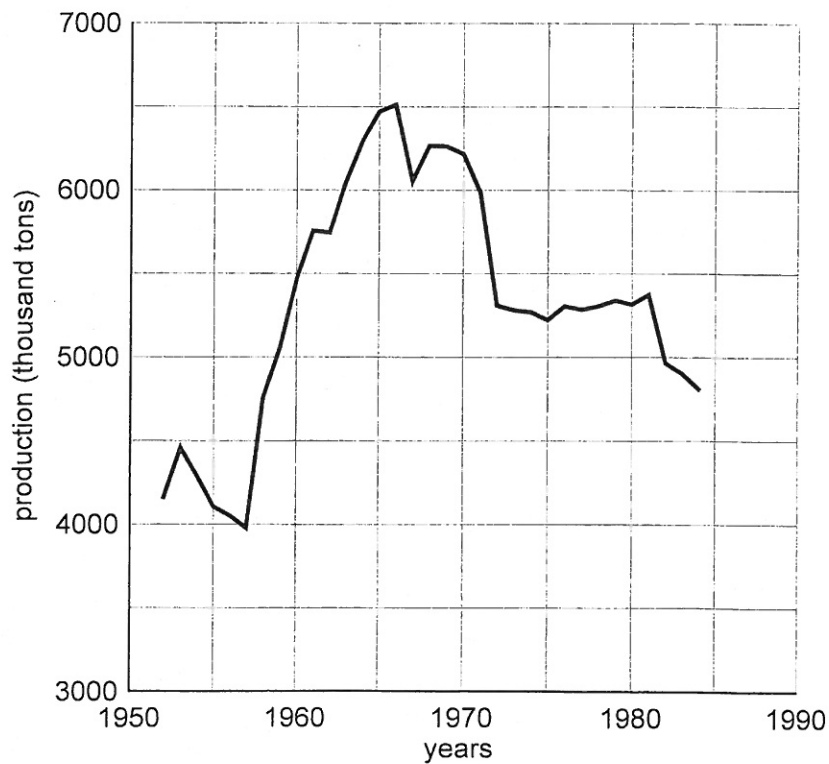


Fig. 2. Total mining output of the Borsod coal basin in North-Eastern Hungary [1]

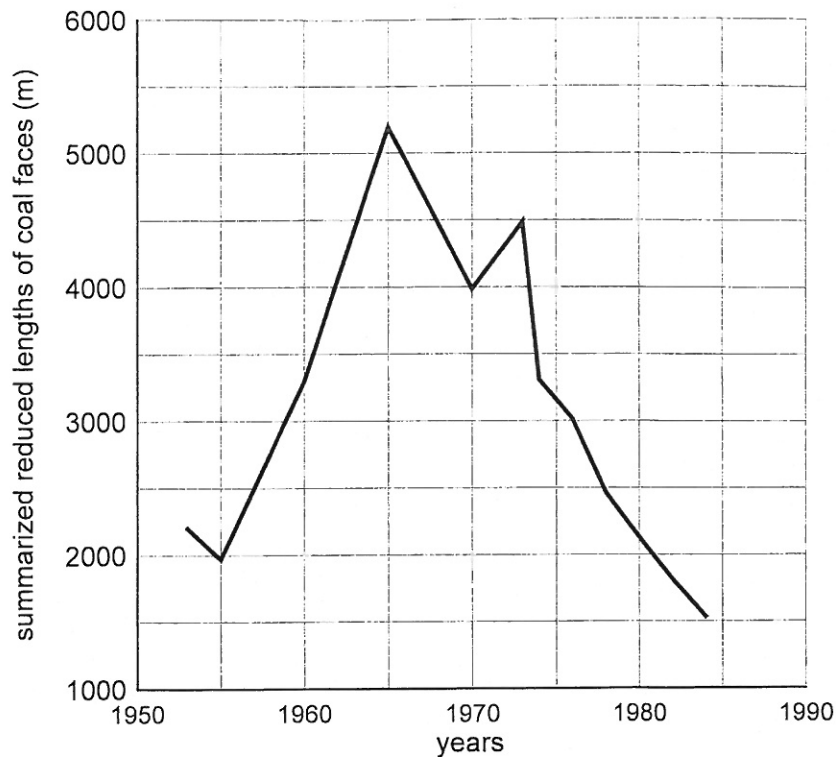


Fig. 3. Summarized reduced lengths of the coal faces in the Borsod coal basin in North-Eastern Hungary [1]

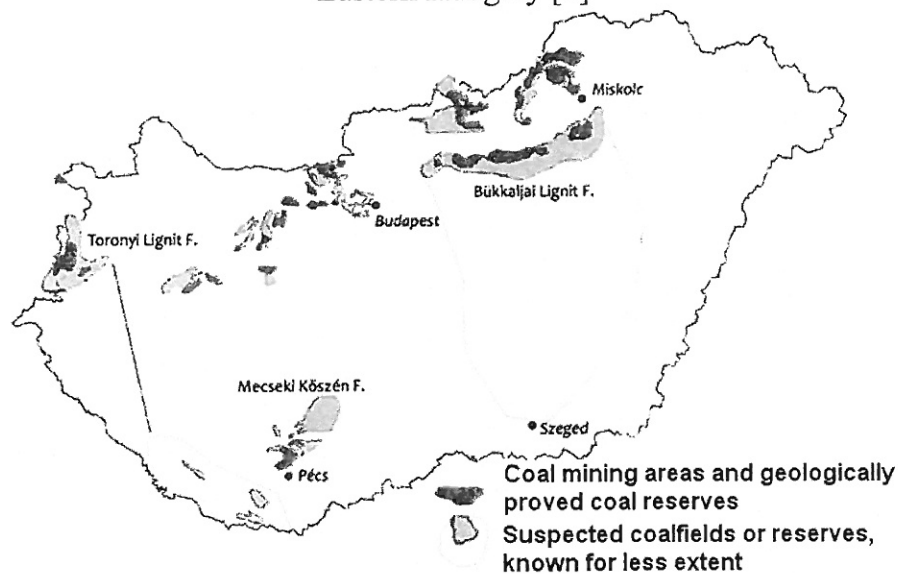


Fig. 4. Coal mining areas, geologically proved and suspected coalfields of Hungary [14]

Mineral reserve of some Hungarian coal basins which were mined during 100-200 years has really left. But there are some untouched areas which are explored, furthermore great areas which are suspected remarkable coal reserves (Figure 4). The main problem can be with these deposits that coal seams are geologically disturbed, deep and different mine hazards, such as methane and coal dust explosion, gas and rock outburst, karstic water inlet, etc. should be expected. This time opencast lignite mine can be considered profitable, but it is worth examining other ways of underground coal mining, e.g. underground coal gasification, shortwall mining, etc.

This time only two underground mines are in operation in Hungary. One of them mines manganese for the metallurgy and steel-making industry. It uses conventional room-and-pillar technology, but is making some remarkable technical innovations. The other one is extracting a bauxite orebody and a coal seam covering it using the same room-and-pillar technology based on blasting and LHD machinery as bauxite mining. The coal is sold mostly for household heating purposes. Beside heating smaller houses, use of coal could be profitable in e.g. asphalt mixing plants, greenhouses, fertilizing, methanol and coke production, heat and power generation, etc. to make less dependent the country from importing fuel.

Small mines of lower output

Mines operating with relatively few employees and simple equipment can be profitable in certain cases, both surface and underground ones. According to the recent concepts of small mines, actually old operations of the domestic mining industry some 50 years ago and even earlier can be considered small mines as well. Hungarian literature is available in most topics, e.g. mining methods [20, 29], mine safety [21], etc. beside some classic works [3, 26]. Furthermore it is proved by some classics of the international publications [7, 8, 9, 12] that even small mines be safe, mechanized and profitable.

In connection with the question of certain coal, ore or non-metallic mineral deposits of Hungary from time to time arises that profitable mining operations of low investment costs and smaller capacity could be established. So we ought to review the most basic experiences of small-scale mining in the world.

It is rather complicated to define the concept of artisanal and small-scale mining or as it is usually abbreviated, ASM [6, 10, 11, 15, 17, 22, 23, 25]. It is mostly based on manual work, simple machinery is used and the output of these mines is usually low. But even the aspects of the definition is not quite clear. According to Hentschel, Hruschka and Priester [10] the most important factors can be described as

- invested capital,
- number of employees,
- output of the mine,
- quantity and value of the saleable products,
- productivity (output per number of employees),
- mineral reserve and the size of the mining site
- continuity of the production,
- reliability of the mining operation
- theoretical lifetime of the mining operation

None of the enlisted sources determine neither quantitative nor qualitative measures for these aspects. Consequently accurate definition do not exist. Only different experiences are described, which are remarkable but somewhat different for the studied countries:

- The extraction of the mineral deposits in question can hardly or cannot be mechanized economically.
- The loss of mineral reserve is high and usually not the proper mineral processing technology is used. Consequently the yield is generally poor.
- These operations are facing chronic capital shortages both in the development and operation as well.

- Working in such mines is rather exhaustive physically due to the absence of appropriate machinery. Consequently productivity is usually rather low.
- Salaries and wages are low.
- Mine safety and quality of safety equipment are usually poor. Social insurance often missing or not available for the workers.
- Environmental aspects are generally not taken into account for the satisfactory degree in these mining operations.
- Mine workers of these operations are often seasonally employed peasants who are not skilled and whose proper mining qualification is missing.

Finally it can be concluded, that these operations are face with the lack of capital and skilled personnel and not rarely even employees.

Such countries are discussed in publications [6, 10, 11, 15, 17, 22, 23, 25] as Ghana, Malawi, Mozambique, Republic of South Africa, Tanzania, Zambia and Zimbabwe in the southern part of Africa, China, India and the Philippines in Asia, Brazil, Bolivia, Ecuador and Peru in South America. And some minerals in question are diamond, clay, gemstones, gold, marble, ores and sand. Diverse mining methods are used, underground, surface and alluvial mines, quarries and narrow vein mines can be found among them. The number of employees is quite surprising, 3-15 million people work only in China in such mining operations. It is estimated that 15-20 % of the output of non-fuel mines is produced by small-scale mining.

Basic concept of mechanization small mines

Remarkable development could be observed during the past 2 or 3 decades in the underground production and haulage equipment. Automation of the machinery and computerized control of the most processes are significant. On the other hand selection of the equipment imperceptibly simplified [5, 9, 12, 28].

- Blasting method is dominantly used in underground ore mining, based on jumbos and LHDs. Belt conveyors and dumpers are used for mainline haulage and even railways in horizontal drifts. Powerful loaders of small cross section are available for narrow vein mining which can be used in 1.8-2 m wide and 2.3 m high openings.
- Fully mechanized longwalling became totally dominant in European underground coal mining, consequently coal seams slashed by faults are usually not mined out.
- Shallower seams are mined out using room-and-pillar technology, if lower rock pressure enables economically low loss of coal left in the pillars. Primary cutting is usually done by continuous miners, the coal is hauled with shuttle cars or ramcars, the hanging wall is supported by roofbolters if necessary.

Mining operations, not satisfying environmental, financial, social insurance and safety regulations cannot be allowed in Hungary. Furthermore workers without appropriate qualifications must not be employed in mines. Lower output can be resulted only by lower capital investment, simpler or second hand equipment and less staff.

Some questions of mine safety in Hungary

As it was demonstrated in the previous chapters, output of the mining sector of Hungary significantly decreased. Recently certain areas of surface mining, such as lignite and construction materials mining became dominant.

Number of employees decreased from approximately 80 000 to 10 000 during the past 25 years (including administrative staff). Consequently, scales of the mining operations are quite different from the ones that were usual formerly (Table 1). According to statistical statements, 328 of 428 Hungarian mining operations employ less than 20 persons [2].

Tab.1. Number of mining operations as a function of number of employees [2]

Number of employees	Number of mines, employing this staff
1-9	341
10-19	42
20-49	30
50-249	13
more than 250	2
total:	428

The first general mine safety regulation was issued in 1922 by the Budapest Royal Mining Authority. Originally it was valid only for the region of the Budapest authority, but the other authorities accepted and used it. It was replaced by a decree of the ministry of the interior in 1951 (625.625/1951. (VIII. 2.) BEM), which was obligatory as the first general mine safety and health preventing regulation. Chapters of this regulation changed from time to time and it was issued in book form in the 1980ies.

Remarkable changes could be observed in the legal regulation of the mining sector. The original version of the new mining law (XLVIII (1993)) entered into force in 1993 and was amended several times. Numerous decrees came out to complete the basic mining law serving Hungarian mine safety [13]. To be the most important ones are considered the following:

- minimal requirements providing safety and protecting health in mines (4/2001. (II. 23.) GM),
- regulation of surface mine safety (43/2011 (VIII. 18. NFM),
- regulation of underground mine safety (61/2012 (XI. 22.) NFM), and
- general safety regulation of blasting of civil purposes (13/2010 (III. 4.) KHEM).

Most mine hazards occur in underground mining as it is obvious if extent of the texts are considered although not only number of mines and miners reduced but size of regulations too. Recent regulation of underground mine safety can be considered framework statute as it is significantly simpler than the former regulation, containing basic concepts of health and life protection. It is a little bit surprising that while concrete limitations of the concentration of some important explosive and poisonous gases (CH_4 , CO_2 , CO) in the mine atmosphere are determined, others (H_2S , NO_x , NH_3) are not regulated by this new version.

Beside these facts a serious challenge can be the ageing and continuous decrease of the experienced mineworkers and technicians from mine safety point of view as well.

Certain simplification of the mine safety regulation can be advantageous for the small underground mines. Further assistance can be a safety management kit provided by the state. Such expert system was worked out by New South Wales (NSW) Department of Primary Industries – Mineral Resources and The Institute of Quarrying Australia [24], it can serve as an important and useful example. The basic aim of the Safety Management Kit for small-scale mines, quarries and extractive industry

operations is to prevent mine accidents and assist mines to meet requirement of safety regulations.

The structure of the safety and management kit enables training miners and technicians of small and middle-sized mines to satisfy basic safety regulations and preparing their safety management plans (Mine Safety Management Plan - MSMP) and documentation. The document consist of the following 4 parts:

1. Information chapter, enlisting the mine hazards that should be expected in each mine of the state, protection methods and examples, responsibilities, areas of communication and training in the firm, documentation models.
2. Checklists, flow sheets and questionnaires helping working up all these are included in the second part.
3. A sheet is contained in the third part for the valuation of the safety plan (MSMP). Assistance of fellows of the NSW Mine Safety Operation bureau make development easier and more perfect.
4. A general list of tasks for controlling the safety condition of the working area, containing e.g. checking buildings, mobile and fix equipment, loaders, cleaning up, handling hazardous materials, etc.

The package in question was contributed by the state authorities and mines to ensure practical usage for the purpose in question. According to the experiences it proved to be useful to make safer small mining operations.

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References

1. 200 éves a borsodi szénbányászat, 1786-1986. Borsodi Szénbányák, Miskolc, 1986, <http://mek.oszk.hu/07500/07506/07506.pdf>. Downloaded: April 12th, 2015
2. A foglalkoztatottak száma nemzetgazdasági ágak, ágazatok szerint, nemenként. Központi Statisztikai Hivatal, STADAT táblák, https://www.ksh.hu/docs/hun/xstadat/xstadat_evkozi/e_qlf005a.html. Downloaded: June 30th, 2015.
3. Agricola, Georgius, 1985: De Re Metallica Libri XII. Tizenkét könyv a bányászatról és a kohászatról. Országos Magyar Bányászati és Kohászati Egyesület (OMBKE) Bányászati Szakosztálya, Budapest, 1985.
4. Assessing European Capacity for Geological Storage of Carbon Dioxide. EU GeoCapacity, project No. SES6-518318, priority name: Sustainable Energy Systems, <http://www.geology.cz/geocapacity/publications/D16%20WP2%20Report%20storage%20capacity-red.pdf>. Downloaded: June 30th, 2015.
5. Chadwick, John, 2011: Muckpile management. Underground Trucks and LHDs. *International Mining*, June, 2011, p 26-39, <http://www.infomine.com/library/publications/docs/InternationalMining/Chadwick2011r.pdf>. Downloaded: January 5th, 2015.
6. Clausen, Fabian – Barreto, Maria Laura - Attaran, Amir, 2011: Property Rights Theory and the Reform of Artisanal and Small-Scale Mining in Developing Countries. *Journal of Politics and Law* Vol. 4, No. 1; p 15-26. March, 2011. URL: <http://ccsenet.org/journal/index.php/jpl/article/viewFile/9589/6883>. Downloaded:

- January 5th, 2015.
7. Gentry, D. W. – O'Neill, 1984: Mine Investment Analysis. Society of Mining Engineers of the American Institute of Mining, Metallurgical and Petroleum Engineers Inc., New York, New York, 1984.
 8. Hartman, Howard L. – Mutmanský, Jan M., 2002: Introductory Mining Engineering. John Wiley and Sons, Inc.
 9. Hartman, Howard L. (Senior Editor), 1992: SME Mining Engineering Handbook I.-II. 2nd Edition. Society for Mining, Metallurgy and Exploration, Inc. Littleton, Colorado, 1992.
 10. Hentschel, Thomas – Hruschka, Felix – Priester, Michael, 2002: Global Report on Artisanal & Small-Scale Mining. Projekt-Consult GmbH. Mining, *Minerals and Sustainable Development*, No. 70, January, 2002,
https://www.commddev.org/userfiles/files/804_file_global_report_on_artisanal.pdf.
Downloaded: January 5th, 2015.
 11. Hinton, Jennifer J. – Veiga, Marcello M.– Veiga A. Tadeu C., 2003: Clean artisanal gold mining: a utopian approach? *Journal of Cleaner Production*, 11 (2003) p 99-115. URL: http://ac.els-cdn.com/S0959652602000318/1-s2.0-S0959652602000318-main.pdf?_tid=cf833862-ab8f-11e4-b225-00000aab0f6c&acdnat=1422959667_544423e6f11b04abbb245187d635ea30.
Downloaded: January 5th, 2015.
 12. Hustrulid, W. A. (editor), 1982: Underground Mining Methods Handbook. Society of Mining Engineers of the American institute of Mining, Metallurgical and Petroleum Engineers, Inc. New York, New York, 1982.
 13. Izsó István, 2004: Magyar bányajog, Miskolci Egyetem Kiadó, Miskolc, pp. 7-64.
 14. Juhász Árpád, 1987: Évmilliók emlékei. Gondolat Könyvkiadó, Budapest, ISBN 9632818555, p.560.
 15. Lima, Raquel Quaresma DE, 2013: How Effective are the Existing Regulations Towards the Formalization of Artisanal and Small-Scale Mining Activities in Brazil? What lessons can be learned from the Brazilian Experience? Published in CEPMLP Annual Review - CAR Volume 16 (2013) Editor-in-Chief: Wendy Treasure, January, 2012,
file:///D:/Users/User/Downloads/cepmlp_car16_76_602674380.pdf. Downloaded: January 5th, 2015.
 16. Long data series, Industry. Hungarian Central Statistical Office, STADAT sheets, http://www.ksh.hu/docs/hun/xstadat/xstadat_hosszu/h_oia001a.html. Downloaded: January 10th, 2015)
 17. Mallo, Stephen J., 2012: Mitigating the Activities of Artisanal and Small-Scale Miners in Africa: Challenges for Engineering and Technological Institutions. *International Journal of Modern Engineering Research (IJMER)*, Vol.2, Issue.6, Nov-Dec. 2012 pp-4714-4725. ISSN: 2249-6645,
http://www.ijmer.com/papers/Vol2_Issue6/FC2647144725.pdf,
downloaded January 5th, 2015.
 18. Molnár József: Kis kapacitású bányák működésének műszaki és gazdasági kérdései. Erdélyi Magyar Műszaki Tudományos Társaság (EMT), XVII. Bányászati, Kohászati és Földtani Konferencia. Déva, 2015. március, p 26-29.88-92.
 19. Működő vállalkozások száma létszám-kategória és gazdasági ág szerint, 2010. Központi Statisztikai Hivatal, STADAT táblák,
http://www.ksh.hu/docs/hun/xtabla/valldemog/tablvad10_14.html. Downloaded: June 30th, 2015.

20. Németh László, 1971: Bányabiztosítás. Műszaki Könyvkiadó, Budapest, 1971.
21. Patvaros József, 1989: Elemi bányaveszélyek elleni védekezés. Tankönyvkiadó, Budapest, 1989.
22. Priester, Michael – Hentschel, Thomas – Benthin, Bernd, 1993: Tools for Mining Techniques and processes for Small Scale Mining A Publication of the Deutsches Zentrum für Entwicklungstechnologien - GATE A division of the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH – 1993, http://www.gate-international.org/documents/publications/webdocs/pdfs/g10toe_1.pdf. Downloaded: January 5th, 2015.
23. Siegel, Shefa – Veiga, Marcello M., 2009: Artisanal and small-scale mining as an extralegal economy: De Soto and the redefinition of “formalization” *Resources Policy*, Vol 34 (2009), p 51-56, <http://www.sciencedirect.com/science/article/pii/S0301420708000652>. Downloaded: January 5th, 2015.
24. Small Mines Safety Management Kit. NSW (New South Wales, Australia) Government. Department of the Industry, Resources and Energy, <http://www.resourcesandenergy.nsw.gov.au/miners-and-explorers/safety-and-health/publications/workbooks/small-mines-safety-management-kit>. Downloaded: June 30th, 2015.
25. Small-Scale Mining (Standard Format), 2006. Department of Water Affairs and Forestry, 2006. Best Practice Guideline A1: SmallScale Mining (Standard Format). ISBN 978-0-9814156-2-8, <https://commondatastorage.googleapis.com/comsa/MINING%20AND%20ENVIRONMENTAL%20IMPACT%20GUIDE-A1%20Small-Scale%20Mining%20%28Standard%20Format%29.pdf>. Downloaded: January 5th, 2015.
26. Traugott, Delius Kristóf, 1972: Bevezetés a bányatan elméletébe és gyakorlatába valamint a bányakincstári tudományok alaptételeinek ismertetésébe. Országos Magyar Bányászati és Kohászati Egyesület Bányászati Szakosztálya, Budapest, 1972.
27. Turai Endre: X. A geoinformációk jelentősége a bányászati termelésben és a környezetgazdálkodásban. In Herczeg Ádám – Turai Endre: Geoinformatika. URL: http://www.tankonyvtar.hu/hu/tartalom/tamop425/0033_SCORM_MFGFT6008T/sc_o_10_01.scorm. Downloaded: June 30th, 2015.
28. Walker, Simon, 2014: Machines for small mining spaces. *Narrow vein Mining. Engineering and Mining Journal*. March, 2014. p 28-35. URL: <http://emj.epubxp.com/i/271090>. Downloaded: January 5th, 2015.
29. Zambó János, 1972: Bányaművelés (Feltárás és fejtés). Műszaki Könyvkiadó, Budapest 1972.