Abandonment of Kincses Bauxite Mine connected to a water supply plant - professional and public acceptance aspects

Zsolt Kesserü [1], Ida Farkas [2], Árpád Kovacsics [2]

[1] *Faculty of Earth Sciences & Engineering, University of Miskolc, Hungary. e-mail: kzscons@mail.matav.hu*
[2] *Bakony Bauxite Mines Ltd. Tapolca, Hungary, e-mail: bauxit.muszaki@matavnet.hu*

Abstract: Kincses bauxite mine was protected against inflows from the bottom karst aquifer by a drainage system partly connected to the extraction cavities. This drainage also serves the municiapal water supply. The mining and the water supply has been divided, and the mine privatised. The closure of the mines require special measures for preserving the water supply as well as for long-term-protection of the vulnerable karst aquifer including thermal waters. The difficult problems and some insufficiencies of the new legal environment has created disputes between the mining company and the legally accepted participants of the public inquiry. An independent expert's opinion supported the agreement between the disputing participants. Site specific and non site specific conclusions are derived and presented.

1 BACKGROUND

All bauxite deposits of Kincses region are situated on the fissured/karstified Triassic dolomite bedrock. The extraction was protected by preventive water drainage (1.5-1.2 m³/s), consisting of drifts/holes inside and at the near-surface zone of the dolomite. This drainage system has provided 1.0-0.4 m³/s of drinking water for a town and several villages as well as industrial-quality water for several other users. (Bárdos, et al. 1982, Bárdos, and Machata 1982). Figure 1 presents the scheme on the location of the bauxite extractions and the drainage/water supply plant.

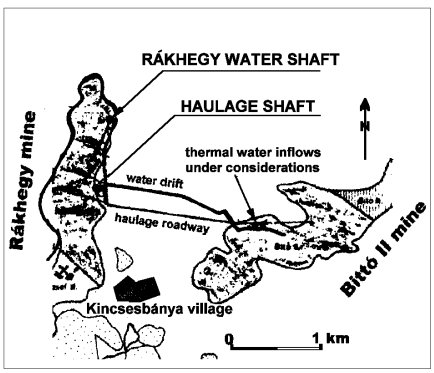

Figure 1 Situation scheme

For the purpose of minimising the yield of drained water, supplementary in-mine drainage holes were also applied for fitting the depression cone of the central drainage/water supply plant to the location of the extraction cavities. This supplementary drainage system was applied in mine fields situated at longer distance from the central drainage system, e.g. in Bitto II mine (Figure 2). The in-mine supplementary drainage subsystem produced non-drinking quality water: (this was utilised for irrigation etc.).

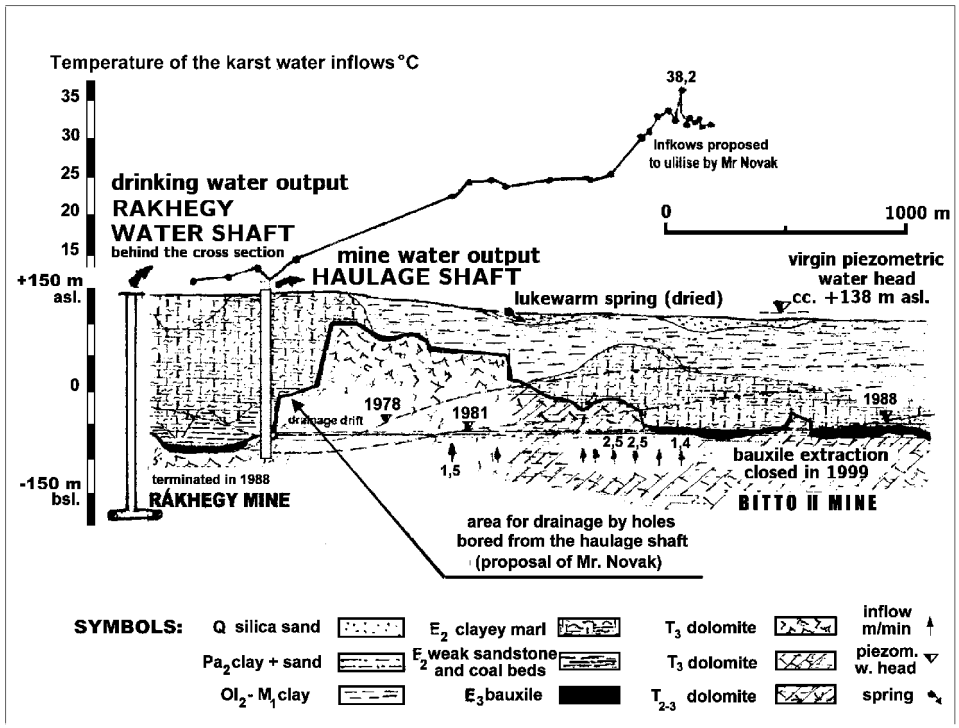

Figure 2 Cross section at Rákhegy and Bitto II mines

Thermal water (30-38 °C, cc. 0.1-.0.2 m³/s) originating from deeper streams has also been drained by the in-mine drainage system. These warm water inflows have occurred in a rather small area of Bittó II mine field, however, the transition between areas of the cold and warm water inflows was quite smooth (Figure 2).
Occurrence of these in-mine thermal water inflows and other thermal springs of this region are connected with a regional NW-SE fault system between the shallow and deeply buried part of the karst aquifer. The temperature of the in-mine inflows, and springs on the surface depends on the ratio of the cold and warm water recharge.
Prior to the mining activity several warm water springs (22-28°C) existed in the close vicinity of the mining area. In the late fifties these springs were dried out by the mine drainage.

The two types of water output were managed separately.

-- The water of the central drainage plant was managed as drinking water according to the related standards/prescriptions. The production of the central drainage plant

continuously exceeded the drinking water demand.

-- The water drained in the mining cavities was managed by a subsidiary water delivery system (Figure 2). A settling/cooling pond was applied on the surface, because the rate of warm water was higher in the industrial water, than in the drinking water, and the fine grained solid content needs settling.

This situation was working successfully for decades. The COMECOM provided long term market for the bauxite and the non-market governed system allowed non-cost effective solutions for water supply.

Extraction of the ore at the deeper fields (called: Rákhegy Mine) was completed in 1988. To preserve the quality of drinking water output, the depression cone was retained below the abandoned cavities of Rákhegy Mine (Figure 2) however, this position of the depression cone required more water output from the drinking water plant, than the drinking water demand. The excess water was utilised for excess recharge of Velence resort-lake.

2 PRE-CLOSURE SITUATION

Before privatisation, the mining and water supply were managed by a mining company. Its owner was a powerful holding called: Hungarian Aluminium Trust (HUNGALU). However, each of the mining companies were responsible for their own financial balance, the umbrella of the state-owned Trust allowed non-cost effective solutions e.g. non-market prices of drinking water etc. This powerful Trust was able to manage the closure/remediation problems originating from a half-century of bauxite extraction with an enormous amount of water (Böcker and Höriszt 1988).

New situation after privatisation

In 1994 the Rákhegy water-shaft and associated drainage drifts/holes were separared from the operating mine fields. It operates as one of plants belonging to the regional municipal water-supply company.

Kincses Bauxite Mining Company (Bitto II mine) was privatised in 1996. The new owner is the Bakony Bauxite Ltd.

Bauxite extraction of the Bitto II Mine was protected by the interaction of the in-mine drainage and by the drainage of the Rákhegy water supply plant continuously maintaining the depression cone below the abandoned cavities of Rákhegy mine.

The privatisation has caused a new situation in managing the mines' closure and remediation.

- Despite the strong interactions between the operation of the water supply plant and the bauxite mining (including environmental aspects), the interactions have to be managed by the two independent companies.

The water supply enterprise and the privatised mining company have to manage several environmental problems of a large region caused by a half century the mining and mine drainage. The state budget can not provide any support.

- The new legal system has introduced new players namely the local authorities, the environmental protection organisations (non government organisations) and residents of the impacted region as legally accepted participants of the licensing procedures:

Controlled partial water rebuilding

The protection of karst water resources and cutting costs of excess water drainage required minimising the excess water drainage. This was at mutual financial interest for the twoenterprises, and it was a requirement of the Water Authority. After sophisticated studies (e.g. VITUKI 1996, Farkas 1995), a partial water level rebuilding was realised in 1998. The special built-in construction of the submergible pumps in the water shafts (see in Bárdos and Machata 1992) gives free hands in regulating the water level, although the efficiency of the in mine settlers strongly decreases due to flooding.

-- The selected intermediate position of the depression cone has provided adequate protection for the bauxite extraction in Bittó II Mine however, this intermediate position also requires a smaller amount of excess water output and excess payment. Under this conditions the majority of the abandoned extraction cavities of Rákhegy mine were flooded.
-- The adequate drinking water quality from the Rákhegy Water Shaft was based on a newly commissioned water treatment plant. The fast flooding of the abandoned cavities caused strong temporary changes of the solids and chemicals in the water lifted by the pumps. This temporary situation was managed by the water treatment plant. After a short transition period, the measured parameters of the water quality meet the standards.

3 PLANNING AND LICENSING THE CLOSURE OF BITTO II MINE

After having extracted all minable ores from the Bittó II mine which was the last bauxite extraction in the depression cone of Rákhegy water supply plant, it was planned to close in September 1999. The drained thermal streams are situated in this last mine (Figure 2).

Unique features of the closure and useful experience for planning

The Bakony Bauxite Mining Company has already successfully managed mines' abandonment at Nyirad region by preserving the aequate operation of the

drinking water supply provided by karst water wells (previously serving as double-purpose drainage and water supply system). (See in Farkas 2000). As one of the prevention measures all potentially toxic materials have been extracted from the operating openings prior to controlled flooding. Samples from the flooded opening did not contain any dangerous components. This experiment gives a good basis for planning and managing the closure of Bitto II, however this situation differs in some respects from the Nyirad case. The legal environment has also changed.

The main differences between the two situations are as follows.

- The water supply holes at Nyirád region are not connected with the mine extraction cavities. At the Rákhegy water supply plant the cavities of the supply plant are connected to the extraction cavities however the bulkheads in the connection-roads increases the hydraulic resistance of this connection. Fissures of the dolomite serve as short bypasses between the two sides of the bulkheads. The partial water head rebuilding at the abandoned Rákhegy mine field has given better analogous experience for planning the flooding of Bittó, than any other case examples.
- At the Nyirád region water-well availability was higher than the drinking water demand. A water treatment plant is not available. The water quality management is based on monitoring the water quality of the wells and on changing the operating wells if required. This is an operative gradient manipulation. The Rákhegy water supply plant is equipped with a powerful water supply plant.
- During the closure of Nyírád mine public-participation was not stipulated in the Acts, only the requirements of the authorities had to be met.

Plan for the mine's closure

The Mining Company has prepared an upgraded plan for the abandonment. This plan has utilised the controlled flooding experience at Nyirád and Rákhegy Mine, as well as the experience of continuous water supply at Nyírád and Rákhegy during mine-abandonment and depression cone rebuilding.

This plan focuses on the cleaning of the mine openings (roadways) in compilance with upgraded requirements. Even the asphalt cover at the bottom of the haulage roads was also extracted as a potential source of pollution. However this cleaning cannot extract any polluting materials inside collapsed cavities.

Two new bulkheads were also installed in the main drainage drifts situated in the dolomite for sealing the two fast pathways between the extraction cavities and the water supply plant. (Figure 2).

According to the experience on flooding the Rákhegy mine special attention was paid to analysing the acid generation potential in Rákhegy mine already flooded, and Bittó II field, being flooded. The condition in Bittó II seems to be less dangerous in this respect, because the small coalbeds, with pirite are not present in the near overburden of Bittó extractions (Figure 2) (Farkas 1995).

This plan did not include any measures for utilising the thermal inflows in the post closure period. The environmental assessment study on the mine's closure (Kovacsics, Egerszegi et al 1999) includes some paragraphs on considering the protection of the thermal water resources. It was concluded that the mine closure does not block its further utilisation through surface-based holes.

Questions, criticism and alternative options prior to and during the licensing

According to the Envirionmental Act the public inquiry is a required step of the abandonment-licensing procedure. The preliminary environment impact assessment study has been published and the legally accepted participants of the public inquiry, namely: local residents, municipalities and registered Environmental Protection organisations of the local residents have the opportunity to express criticism, questions, proposals, within a 30 day period. The act allows the legally accepted participants to appeal to the higher EPA Authority. As a last step, a submitting appeal to the court against the decision of the higher EPA Authority is also possible.

In the frame of this public inquiry, new options were introduced for preserving the thermal water stream for further utilisation and better control of the drinking water quality.

The proposal of Mr. Novák (retired ventilation engineer of Kincses Mining Co.) updated his proposal published in 1994 (Novak 1994). This updated proposal drafted a plant for producing warm water and a new drinking water supply plant to substitute the Rákhegy water shaft.

-- The plan on warm water supply proposed separating the area of the largest warm water inflows by bulkheads before closing the mine (as marked in Figure 3). The warm water was to be to lifted by a new hole equipped with submersible pumps (Novák, 1999). This proposal has not provided any hydrogeological & hydrodynamic estimation on the exploitable thermal water resources.
-- The proposal on forming a new water supply plant without direct connections to the abandoned and flooded workings was based on the Haulage Shaft of Bitto II. mine, as well as on new drainage holes to be bored from this shaft into the dolomite (Figure 2). It was pointed out, that this new water shaft would surely produce better water quality than the Rákhegy water supply plant does, wich is connected to the flooded goafs (Novak 1999). The cost estimation of this proposal seems to be quite optimistic.

The local E.P. organisation, called: GAJA and the municipal council of Kincesbánya supported this proposal during the public inquiry. GAJA has also expressed its worry and criticism on the potential efficiency of cleaning the mine before flooding, with special regard to hydrocarbons (asphalt, and relicts from the operation of the diesel LHD machinery) (GAJA 1999).

The proposals on alternative options, criticism and worries originated from several sources:

- First of all this is a new, and difficult task. There are no similar examples on closure of a mine that is connected by fast pathways to a water supply plant operating during and after the closure.
- The legally accepted participants of the public inquiry have a weaker information and professional basis than the Authority and mining Company.
- Some insufficiencies of the new regulations on public inquiry procedure have also caused certain difficulties and mistrust. E.g.: instead of continuous public involvement The act stipulates a public inquiry prior to passing final decision on licensing the closure. This legal solution is risky for the Applicant, because the appeals of the legally accepted participants can cause long delays and excessive costs. This is also bad for the legally accepted participants, because the last-minute critics and appeals are usually submitted too late for finding the best compromise.

Finally the mine and GAJA have agreed upon questions to be addressed to an independent, licensed expert. Thereafter the expert (one of the authors) was selected and agreed upon by the Mine and GAJA. This agreement was realised under the auspices of the licensing authority (EPA). The Applicant (Bakony Bauxite Mining Company) covered the costs of the independent expert's study.
The independent expert has revised the concept of the abandonment plan under licensing, as well as the proposals of the legally accepted participants.

4 THE INDEPENDENT EXPERT'S STUDY

Questions

The "last minute" study has focused on two main questions:
1. Which option of water supply can provide better long-term prevention against pollution for the karst water resources, including the thermal water?
2. Which measures are reasonable and feasible for protecting the water resources, including thermal water in "the last minutes" before closing?

Principles

1. However this "last minute study" should take into account the "last minute conditions" as the hard limits of the actual decision field, *the "last minute compromises" must not form irrevocable decision routes for the future*.
2. The limited economic power of all players namely: the privatised mining company, the water supply company, the municipalities and the state budget does not allow an optimal solution this time. *The best compromise would give free hands for finding better solution in the future.*
3. *The exceptional importance of the drinking water resources and the vulnerability of the karstic aquifers does not allow any compromise in long-term protection of the karst water resources.*

4. The harmonisation of the national water quality standards to EU norms does not allow long term compromises in the water quality requirements.

This "last minute study" only allows considerations instead of additional studies. The above listed principles serve as guidelines for the considerations.

Considerations on the water supply

Despite the best cleaning of the roadways, some pollution would remain inside the collapsed goaf. The direct contact of the abandoned mines with the karst water reservoir forms a potential risk of karst water pollution. The risk of pollution is small during the water pressure rebuilding, because the general flow is directed from the karst to the abandoned, flooded goaf. The pollution-risk will be higher after rebuilding because under these conditions local water withdrawals and climatic changes of water recharge will govern the flow-direction. This statement relates to all former mining sites of the Transdanubian karst region (Kesserü 1997). The exceptional importance and vulnerability of the karst reservoir (COST 65) requires considering site-specific precautionary measures.

The optimal solution (disregarding the costs) would be a new karst water supply plant far away from the mining sites. Safe operation of a new plant requires an adequate gradient manipulation at the former mining sites for preventing the flow of polluted water from the flooded goafs to the karst aquifer. The most common solution of such gradient manipulation is the water-withdrawal from the flooded mine openings. This form of water withdrawal is already in application at the abandoned uranium mining sites of Hungary. *Without such gradient manipulation, the karst water supply plants, and thermal water wells will cause pollutant water flow from the abandoned mine openings into the karst aquifer.* (Kesserü 1997)

An acceptable compromise is already exists. The Rákhegy water supply plant with an adequate water treatment plant is already operating as a gradient manipulation and long-term cleaner of the abandoned mine. This compromise does not exclude an optimal solution. *In the future a new water supply plant can be commissioned at an adequate distance from the closed mines and the Rákhegy plant would be used for gradient manipulation.* The actual disinfecting-process of the water treatment plant, the chlorination may cause unpleasant odours even in very small concentration of hydrocarbon well below the permitted concentration of the drinking water standard. The risk of a small amount of hydrocarbon coming from the uncleaned collapsed cavities cannot be excluded. Disinfecting by peroxide is better, however, it is more expensive.

The alternative option *(a new water supply plant at the Bittó II haulage shaft)* is an expensive option with little advantages and a major disadvantage.

-- The drainage from an uplifted block of the bottom aquifer close the abandoned old workings cannot exclude the arrival of polluted water from the goaf, however the amount of pollution would be smaller in comparison to the Rákhegy water shaft.

-- The drainage from an uplifted block of the bottom aquifer cannot work effectively as a long term cleaner of the goaf which is important for the future.

It is more prudent to invest in upgrading the water treatment instead of commissioning a new plant at the Bittó II haulage shaft.

Considerations on the possibilities of thermal water production

The restoration of original mixed water springs on the surface takes very long time and the restoration of the channels crossing a weak rock medium is also questionable.

The alternative proposal on forming a barrier around the main in-mine thermal water inflows with bulkheads in the roadways at the uppermost part of the dolomite (Figure 3), cannot exclude fast pathways from the polluted goaf. The dolomite is a water-conducting medium, and the goaf near the barrier. The depression cone of the thermal water withdrawal from the openings surrounded by bulkheads would vitalise bypasses from the goaf. This solution surely would produce polluted thermal water. Regarding to the more rigorous EU standards on water quality this is not a reasonable option for the future.

A better option would be to explore thermal water at an adequate distance from the abandoned mine. The hydrogeological information from the bauxite exploration/exploitation can support the selection of the appropriate site.

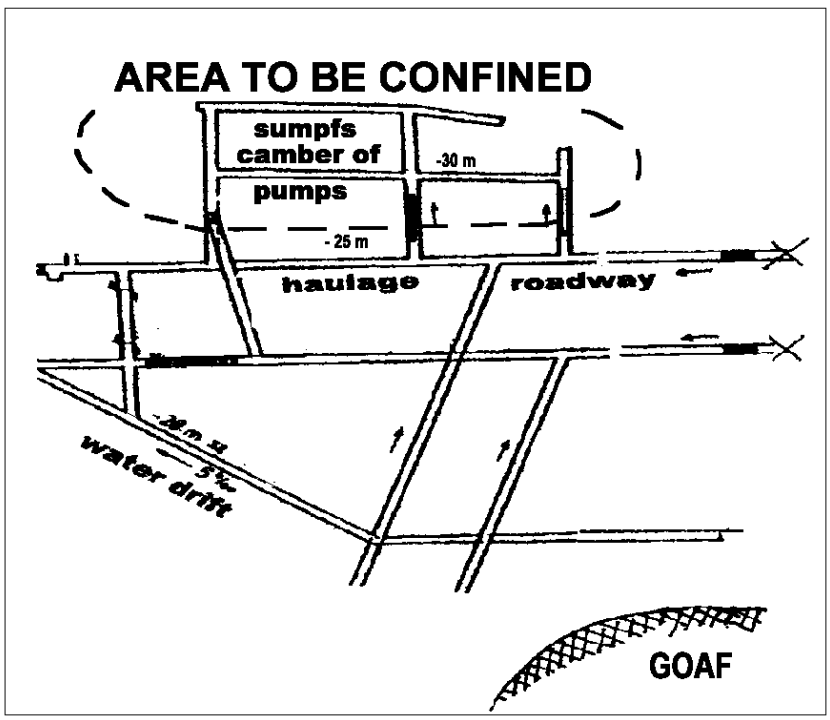

Figure 3 Thermal inflows to be confined by bulkheads (proposal of Mr Novak)

5 FIRST POST CLOSURE EXPERIENCE

The sampled quality of water from the Rákhegy plant remained below the standardised limits even in the first period of flooding. It seems that the experience on the flooding of Rákhegy was well utilised.

A former bauxite-exploration/piezometer well at an adequate distance from the closed mine is already selected as one of the potential sources for producing warm water. Obtaining a license for thermal water production is in progress.

6 CONCLUSIONS

Site specific conclusions:

Operation of the Rákhegy municipal water supply system protects the aquifer against the pollution by gradient manipulation and by long term cleaning of the polluted goaf. The existing water treatment plant should maintain the water quality for the users. This solution seems to be the best site-specific compromise.

The alternative water supply option (by Mr. Novák) cannot guarantee clean water howewer it may produce better water quality than Rákhegy. It cannot work as an effective cleaner of the goaf.

An in-mine system of bulkheads in the close vicinity of the thermal water inflows cannot form an appropriate barrier against pollutants. Further utilisation of the warm water resources should be based on boreholes, at an adequate distance from the abandoned openings.

Some non site specific messages:

The connection of mine drainage with mine water utilisation would be a prudent solution, however it requires studies on the post closure conditions particularly in a karst environment.

The privatisation policy should also consider the long-term responsibility for the drinking water and the environment, because a short operating period of privatised companies cannot produce adequate financial basis for restoring the environment damaged during a long period of the state owned mining. (The privatised mining company was capable of fulfilling all related paragraphs of the privatisation contract in the presented case example).

Involvement of the public even in the early period of forming the abandonment options would ensure a smooth licensing procedure instead of informing the society on the planned actions one-two month prior to final decision.

Independent experts can effectively support public involvement.

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Zamknięcie kopalni boksytu w Kincses połączonej z systemem wodociągowym – aspekty akceptacji społecznej i zawodowej

Zsolt Kesserü, Ida Farkas & Árpád Kovacsics

Streszczenie: Kopalnia boksytu w Kincses była chroniona przed wdarciem wody z położonego poniżej zbiornika krasowego za pomocą systemu drenażu częściowo połączonego z wyrobiskami. Drenaż ten zaopatruje również miejski system wodociągowy w wody pitne. Kopalnia i system wodociągowy zostały

rozdzielone, a kopalnia została sprywatyzowana. Zamknięcie kopalni wymaga podjęcia specjalnych kroków dla ochrony systemu zaopatrzenia w wodę, jak również długotrwałej ochrony podatnego na zanieczyszczenie zbiornika krasowego. Trudne kwestie oraz pewne niedociągnięcia prawne doprowadziły do dyskusji między zarządem kopalni a uprawnionymi uczestnikami referendum publicznego. Opinia niezależnego eksperta pomogła w porozumieniu pomiędzy uczestnikami dyskusji.