Technical Communication

Regulation of Mine Waters in the European Union: The Contribution of Scientific Research to Policy Development

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Abstract. A review of existing legislation in the light of recent major dam failures (Aznalcóllar, Spain, 1998; Baia Mare, 2000, Romania) highlights the need to develop appropriate regulations at the regional, national, and European Union (EU) levels. Although mining incidents as a result of dam failures are very conspicuous, chronic problems related to waters from mining voids and tailings are also very significant. In that sense, though mine waters are an integral part of the water cycle, they are rarely regulated as such. Ongoing discussions with Member States and stakeholders are focusing on mining wastes rather than mine water. Regulating only mine waste handling facilities and ignoring the mine voids would in many cases miss the main long-term pollutant source. Planned changes in EU environmental legislation with regard to mining cannot be properly understood outside of worldwide developments in this area. Adequate management of applied scientific research initiatives and policy formulation is crucial to satisfactory outcomes at EU and global levels. At the EU level, this interface is exemplified by the nature and anticipated outcomes of two EU-funded research projects (ERMITE and PIRAMID). Ways in which policy-focused deliverables are being developed by these projects, which interface science, engineering, and policy, are highlighted. This review of EU legislation not only highlights the difficulty of clearly assigning liability for mining contamination, but also the dilemma between the promotion of sustainable development (through the EU environmental legislation) and the irreversible nature of the exploitation of mineral deposits.

Key words: ERMITE; European Union; environment; mine water; policy

Introduction and Context

Several well-publicised instances of aquatic pollution due to mining accidents have prompted re-evaluation of environmental policies relative to mining in Europe, North America, and Australasia. While the protection of ground- and surface waters from most forms of industrial pollution has long been subject to legislative protection, mine water pollution has thus been regulated far less coherently. Mine water pollution differs sufficiently from other forms of industrial pollution, particularly in its ability to persist at gross levels long after production ends (Younger 1997). A better interaction amongst scientists, mining engineers, and policy makers is therefore necessary to take this into account while drafting new European Union (EU) legislation. Due to such differences, mine water arguably has regulatory requirements quite distinct from that of most other industrial processes. Not recognising the true nature of mine water problems has led to a wide variation in approaches to their regulation from one country to another. But is it desirable (and if so, feasible) to legally treat all mine waters with a single regulatory code? In this paper, we address this question, drawing upon ongoing debates and policy development initiatives in the EU. We hope that the EU experience might contribute to similar debates and initiatives elsewhere in the world since they exemplify how scientists, politicians, economists, and lawyers can work together in a truly interdisciplinary endeavour.

In the following sections, we first set the context of mine water pollution and associated issues from the EU perspective, then review existing EU legislative instruments, before highlighting current initiatives in the further development of relevant European legislation. Central to the success of these initiatives is the interface between research initiatives and policy actions at the EU level. Brief examples of ongoing research are drawn from two ongoing EU-funded research projects (ERMITE and PIRAMID), in which the authors are partners.

ERMITE has adopted the following definition of the term mine water: “Mine water is water which is in mined ground (including waste rock/tailings depositories) and/or which is now flowing from mined ground into adjoining water bodies (such as streams, wetlands, lakes, aquifers, and oceans)”. We use this definition throughout this paper. As the definition makes clear, mine waters are an intimate part of the total hydrological cycle. Nevertheless, they are rarely regarded as such in regulatory frameworks, despite the fact that short- and long-term pollution from active and abandoned mines is still one of the most serious threats to water resources in many countries. Mining can impact water resources at various stages of the mining cycle: during mining and mineral processing; during dewatering undertaken to make mining possible; by seepage of contaminated leachate from waste rock piles and tailings dams; during flooding of workings after extraction has ceased; and by discharge of untreated waters after inundation.

The quantification of specific mine water impacts demands risk assessment, which is normally undertaken using the logical source-pathway-receptor framework. The sources tend to vary in importance during the life cycle of a mining operation, with waste rock (spoil) and tailings being more potent sources during active mining (when they are most disturbed) than after abandonment. In contrast, flooded mine voids (as pit lakes or as decanting deep mine workings) frequently continue to function as major pollutant sources long after mining has ceased (Younger 1997; Shevenell et al. 1999). For instance, a study of all mining districts in Scotland (nearly all abandoned now) found that flooded mine voids account for 98% of all mine water pollution, as compared to only 2% for old tailings dams and waste rock piles (Younger 2001). This imbalance is due to the difference in scale of the two source types; even the largest waste rock piles and tailings dams are shallow, and restricted in areal extent to a few tens or (at most) hundreds of hectares. This places an upper limit on the amount of rainfall they receive and means that they are physically amenable to remedial action and/or natural revegetation. By contrast, abandoned flooded voids are usually of great depth (e.g., Shevenell et al. 1999; Younger 2001), and are often vast in areal extent, with subsurface interconnections in excess of 50 km (Younger 2001); since they intercept large drainage areas, they cannot easily be comprehensively remediated in situ.

Many mines, especially old, abandoned mines, impact water resources heavily. Many entire rivers (and substantial reaches of others) have effectively been removed from the inventory of fresh water resources due to mine water pollution (about 1,000 km in the UK alone). Even if the metals were removed, such waters frequently remain too saline for potable use. In dry areas, such as the Mediterranean Basin, where water resources are already scarce, this problem is particularly serious, and it will grow in importance elsewhere in Europe as the climate changes. Ecological impacts are at least as important. Many mines abandoned 100 years ago still kill virtually all invertebrates in receiving waters (e.g., Nuttall and Younger 1999). The range of impacts spans physical smothering of benthos to acute toxicity. This, in turn, affects birds and mammalian predators of fish. The net result from this is long-term loss of habitat. The outlook in the EU is not encouraging, with a trend to increasing, long-term water pollution as active mining activity contracts.

What are the implications for regulation? Regulating only the mine waste facilities and not the mine voids misses the main pollutant source. If the full life-cycle of mining operations is considered, the post-closure phase is temporally dominant, but in practice, this phase is poorly regulated. Nevertheless, it has been accidental pollution from active mining sites (recent tailings dam failures) that have driven legislative development in Europe. Two recent tailings dam failures in Europe (Aznalcóllar and Baia Mare) revealed serious inadequacies in the regulatory framework, which were unfortunately not compensated sufficiently by the voluntary codes of practice of the companies concerned. Accordingly, these two cases have triggered a critical re-evaluation of policies in Europe relative to mining accidents in general and mine water pollution in particular. It is apposite to ask whether these two dam failures are so exceptional as to evoke the proverb that “hard cases make bad law”. The compilation given in Table 1 strongly suggests that these two cases are neither unique nor (notwithstanding their major impacts) especially extreme examples of the genre, since they at least stopped short of taking human life.

In the wake of the Aznalcóllar and Baia Mare dam failures, the EU launched a number of initiatives, most notably the Baia Mare Task Force, which was charged with learning lessons from the events to guide future policy and practice. The findings of this Task Force highlighted the need for a critical review of the current status and future requirements of EU legislation related to mining activities. As will be discussed later, although a variety of EU legal instruments address environmental issues arguably relevant to mining activities, there is no European legislation specific to mining today.

The April 1998 Aznalcóllar Tailings Dam Failure

The Los Frailes Mine, adjoining the village of Aznalcóllar (SW Spain), was most recently worked by a Swedish-Canadian company, which acquired the site after it had already been exploited for many years. The mine produced Ag, Cu, Pb, and Zn concentrates from a pyritic ore body. The pyrite-rich gangue contained arsenic, cadmium, thallium, and other metals in lower concentrations. After milling,

Table 1. Examples of recent mining accidents involving tailings dam failures in Europe and the rest of the world. (Source: adapted from EC COM (2000) 664 final and from Maimon, 2000)

Date	Location	Mined Product	Impact
1992	Summitville, Colorado, USA	Au	Complete loss of aquatic life along 25km stretch of the Alamosa River
1993	Ecuador	Au	24 people killed when sludge buried a gold miner's settlement
1994	Harmony Gold mine, South Africa	Au	17 people killed, 80 houses were destroyed
1995	Omai Mine, Guyana	Au	2.5 Mm^3 of cyanide solution from the mine contaminated the river Essequibo, with massive loss of aquatic life
1996	Marinduque Phillippines	Cu	3 Mt of toxic sludge from a copper mine flowed into the Boac River, flooding 20 villages
1998	Aznalcóllar, Spain	Zn, Ag, Pb, Cu	7 Mm^3 spill from a breached tailings dam containing pyritic sludge (see text for a more complete description).
2000	Baia Mare, Romania (re-processing of old Au mine wastes)	Au	An estimated 100,000 m^3 of mud and cyanide-rich ($\leq$ 126 mg/L total CN) supernatant spilled due to erosion of a tailings dam berm, causing major fish kills in tributaries of the Danube River in Romania, Hungary, and Serbia. Seriously disrupted water supply and other economic activities.
2000	Martin County, Kentucky, USA	Coal	Collapse of old underground workings in the vicinity of a coal washery slurry pond caused it to breach, allowing some 950,000 m^3 of waste material to flow into adjoining streams.

the gangue was separated from the ore by an aqueous flotation process that used sulphur dioxide, hydrated lime, copper sulphate pentahydrate, and proprietary surfactants. Some of the acidic water arising from this process was discharged to the tributary Río Agrio, but most was recycled before disposal with the gangue sludge to a 1.5 km^2 tailings pond (which held about 31 million t of sludge by April 1998). This tailings dam had been extended several times to contain the ever-growing volume of sludge, with conventional use of coarse discard for dyke construction.

During the night of 24-25 April 1998, some 3 Mm^3 of pyrite-rich sludge and 4 Mm^3 of acidic waters flowed in a torrent through a 50m-wide breach that developed in the dam following slippage of the dyke toe. The sludge and water engulfed the Río Agrio and the Río Guadiamar into which the Agrio drains. The Guadiamar is one of the principal freshwater sources of the Coto de Doñana, a Biosphere Reserve of exceptional importance for migratory birds and other wildlife (including the Emperor Eagle and the Iberian Lynx). The Doñana ecosystem is administered as two contiguous nature reserves, the Doñana National Park (at the centre of the system) and the Doñana Natural Park (an outer 'ring'). The subdivision is not natural; rather it represents a distinction between legal protection regimes (Santamaría and Amézaga 1999). Activities such as agriculture, irrigation, cattle raising, industrial development and hunting are allowed (under strict control) in the Doñana Natural Park, while most of them are prohibited in the Doñana National Park. The Aznalcóllar spill polluted an estimated 4500 ha of land that night, much of this in the Natural Park. The spill would certainly have impacted the National Park downstream had it not been for the prompt action of local residents and officers of the Natural Park, who rapidly constructed a series of earthen embankments across the course of the Guadiamar. This eventually stopped the progress of the spill and contained the acid water long enough to allow some treatment before eventual discharge to the Guadalquivír estuary. The subsequent clean-up work continued through most of 1998, as a joint effort by regional and national governmental agencies and the mining company. Sludge and contaminated soils were excavated throughout the path of the spill and transported back to the mine site, where they were placed in a recently-abandoned open pit.

As legal investigations began, it soon became evident that no legislation at the EU or local level could be used to specifically handle this type of mining contamination. As scientific research into the impacts of the spill and the restoration effort began to be implemented, two research projects were funded by the EU that could help develop an integrated scientific/legal appreciation of the issues raised by mining spills. Both projects involve fieldwork and policy evaluation studies. PIRAMID (*Passive In-situ Remediation of Acid Mine/Industrial Drainage)* (www.piramid.org) and ERMITE (*Environmental Regulation of Mine Waters in the European Union*) (www.minewater.net/ermite) are living examples of a dialogue between the scientific research and policy communities. Drawing upon early results of ERMITE, we present a review of the relevant EU policies, commenting where appropriate on how these were interpreted in the Aznalcóllar case.

Existing EU Policies and Mining Activities

1. The Waste Framework Directive 75/442 (as amended by Directive 91/156): Views differ as to whether this directive applies to residues from mining waste (Krämer 1999). Annex I specifies that "residues from raw material extraction and processing (e.g. mining residues)" are considered wastes. However, Article 2 states that "waste resulting from prospecting, extraction, treatment and storage of mineral resources and quarries shall be excluded from the scope of Directive 75/442 where they are already covered by other legislation". The issue is whether the other legislation referred to is national legislation (i.e., at the level of individual Member States) or whether it refers to EU legislation (which, as we will see below, is lacking). This ambiguity means that mining wastes are not being regulated by this directive. Two recent cases from the European Court of Justice (ECJ), cases C-9/00 and C-6/00 should be noted since their outcomes should influence the forthcoming initiative on new EU rules for mining wastes. For case C-9/00, a Finnish court requested, under Art. 234 of the EC Treaty, that the ECJ clarify the definition of wastes for unused quarry stones, and in particular for leftover granite blocks from a Finnish quarry. At the time of writing, this case has not yet been decided by the ECJ. However, the opinion of the ECJ Advocate General was that leftover quarry granite blocks was "waste" within the meaning of the relevant legislation, and therefore subject to EU waste handling rules (Opinion, 17 January 2002 in Case C-9/00 *Palin Granit*; http://www.curia.eu.int).

In several European countries, wastes not produced on site are used to infill mining cavities. In the second case, C-6/00, an Austrian court requested that the ECJ clarify the difference between waste for recovery and waste for disposal. The context was a transfrontier shipment of slag and ashes for deposition into a former salt mine to secure hollow spaces (mine sealing). The ECJ view is that the deposition of wastes in a mine may be either disposal or recovery depending on whether they replace non-waste materials that would otherwise be used (C-6/00 *ASA Abfall Service*, 27 Feb 2002; available at http://www.curia.eu.int). The practise of emplacing wastes in mining voids in this way may lead to contamination of water. It is not yet clear if this practice falls within the remit of the Landfill Directive 99/31.

2. The Landfill of Waste Directive 99/31: This directive covers the deposition of wastes in dry hollows or ponds, and has clearly been written with municipal waste disposal operations in mind. It is explicitly stated not to apply to the disposal of "inert, non-hazardous waste from prospecting, extraction, treatment, and storage of mineral resources (including operation of quarries)". Since sulphidic wastes are not inert, it could be argued that the directive will apply to them. However, as it explicitly excludes the disposal of liquid waste streams, it is not compatible with tailings dam technology. (Underwater disposal of sulphide tailings is environmental good practice as well as physically convenient).

3. The IPPC Directive 96/61 concerning integrated pollution prevention and control This directive requires that specified industrial activities (see Annex 1 to the Directive) be subject to operating permits from the competent authorities in the Member States. These permits shall contain conditions based on Best Available Technologies (BAT) but also taking account of the technical characteristics of the installation concerned, its geographical location, and the local environmental conditions. According to Article 16(2) of the Directive, BAT reference documents (BREFs) are produced by the EC (http://eippcb.jrc.es). The focus of BREFs is on prevention techniques as well as 'end-of-pipe' treatment techniques. Mineral extraction is not mentioned in Annex 1 of the IPPC Directive. Mineral processing is included insofar as it fits the description of "production of non-ferrous crude metals from ore, concentrates or secondary raw materials by metallurgical, chemical, or electrolytic processes. It is not clear whether tailings ponds are landfills within the ambit of the directive. New installations have to comply with the directive since Oct 1999, but pre-existing installations do not have to be brought into compliance with the Directive until 2007.

Although the IPPC Directive does not include mining per se, a special BAT document is being prepared on management of tailings and waste-rocks in mining activities. This document is being prepared in response to a specific proposal in the abovementioned Commission's communication of safe operation of mining activities and will inform what environmental measures can be taken to reduce pollution and pollution risks. The mining sector has expressed its willingness to discuss the framing of BAT guidance. This BAT document is being compiled using an expert group comprising authorities and industries.

4. Preventing industrial accidents: The Seveso I and II Directives and UNECE Convention on the Transboundary Effects of Industrial Accidents: The EU adopted the Seveso Directive 82/501 on the hazards of certain industrial activities following a large-scale contamination event in Seveso (Italy).

Subsequently, this directive was replaced by Directive 96/82. Both directives imposed certain measures to prevent industrial accidents (e.g., emergency plants on and off-site, information for the adjacent population, monitoring requirements for public authorities). However, Article 2 (4) of Directive 82/501 excludes from its field of application "extraction and mining activities". Notwithstanding this exclusion, the directive might be deemed to relate to some mineral processing activities, insofar as mining, mineral processing, and the disposal of mining wastes can be deemed to be distinct activities (Krämer 1999). However, in practice, this is likely to prove difficult. In the case of Aznalcóllar, for instance, Directive 82/501 did not come into force with respect to the waste disposed in the tailings pond before 1993, and thereafter it seems that it still did not apply, since the quantities of chemicals mentioned in the annexes of the directive were not reached. Finally, the UNECE Convention mentioned above does not apply to dam failures, though it might apply to other industrial accidents provoked by such failures.

5. Environmental Impact Assessment (EIA) Directive 85/337 (as amended by Directive 97/11) and the UNECE Espoo Convention on Transboundary Assessment: This directive requires that an EIA be carried out for all economic activities (including mining and dam construction) that might have a significant impact on the environment. The EIA Directive emphasises a preventative approach; assessment is required before authorisation is given. In the case of Aznalcóllar, the mine began to operate before this directive entered into effect, so it did not apply to the mining activities or discharge of wastes into the ponds. However, the post-spill disposal of sludge and contaminated soil in the old mine void should have been subject to the directive (Krämer 1999), though it is not clear whether any EIA was undertaken despite the risks to groundwater and the close proximity to the Doñana Natural Park.

6. Discharges into Water: Directive 76/464 and daughter Directives on discharges of dangerous substances: The Dangerous Substances Directives address intentional, deliberate discharges to water, rather than accidental spills. They establish emission limits for a list of 18 substances. For some substances, all emissions are banned (e.g., Cd and Hg and their compounds) while for others (which includes Zn), limited emissions are permitted, but EU Member States must establish national emission reduction programmes. Mine sources are included in these programmes. At present, these directives are in the process of being subsumed into and replaced by the new Water Framework Directive (see below), and an expansion of the current list of substances (and revision of limit values) is being undertaken as part of this process. Insofar as this will impose substantial duties on Member States relative to certain abandoned mine discharges that contain Cd and Zn, it is unlikely to address non-listed substances (e.g., Al and Fe), which cause much of the damage associated with mine waters.

7. Groundwater Protection: Directive 80/68: This directive is intended to protect groundwater against pollution by certain dangerous substances, including As, Cd, Cr, Cu, Hg, Pb, and Zn. Articles 5 and 7 request Member States to undertake prior investigations concerning the disposal or tipping of wastes containing these dangerous substances which may lead to indirect or direct discharges to groundwater. In the Aznalcóllar case, it is unclear whether the Spanish authorities ever made such an investigation before approving tipping of the tailings sludge into the old open pit (see Krämer 1999). As with the Dangerous Substances Directives, this directive is destined to be subsumed into the new Water Framework Directive by 2014.

8. Water Framework Directive (WFD, COM (2000) 60 final): The WFD recently adopted by the Council of Ministers and the European Parliament is an innovative piece of legislation which seeks to manage water quantity, quality, and ecology at the catchment scale. On the face of it, the WFD ought to improve the regulation of mining activities, since it specifies "measures required to prevent significant leakage of pollutants from technical installations, and reduce the impact of accidental pollution incidents" and "systems to detect or give warning of such events". However, as observed earlier, the current practice is to regulate mining as a waste issue rather than as a water issue, so that specific guidance on mine water regulation is not forthcoming in the extensive WFD annexes. Indeed, the only specific reference to mine water is found in Article 11 (j), which allows re-injection of mine-derived water into the same aquifer. Thus, despite being theoretically applicable to mine water management, emergent practices relative to implementation of the WFD require clarification.

9. Habitat protection Directive 92/4: This Directive has the objective of creating a network of Special Areas of Conservation (SACs) in need of special protection. This Directive was not in force at the time of the Aznalcóllar spill, although there is no doubt that the Doñana reserve will be a major SAC. Although the Habitat Directive requires careful consideration of new developments in the vicinity of SACs, as with many other directives, the provisions apply only to new projects and not to existing ones.

10. Other measures: Cohesion Fund, Liability and Compensation issues: The EU Community Cohesion Fund (CCF) aims to address initial imbalances between Member State economies to ease the transition to integration. In view of the future EU enlargement and the extent of water and soil contamination by mining activities in many pre-accession countries, it is timely to consider whether CCF can be applied to clean-up after a mining-related pollution incident. Because of the pre-eminence of the 'polluter-pays principle' (as enshrined in Article 6 of the EC Treaty), there is no straightforward answer. Article 3 provides for the CCF to contribute to environmental projects, but the wording is unclear and allows for many exceptions. Case law is likely to be needed to establish this point. At present, there is no EU legislation on liability for damage caused to the environment. A White Paper on Environmental Liability introduced by the EC in 2000 contains a number of proposals to improve the implementation of existing EU laws to ensure adequate environmental restoration (Council of Ministers of 30/03/2000). The EC should issue a proposal to establish a framework directive for environmental liability soon, though it is as yet unclear whether the White Paper will cover mining accidents. This point will be analysed within the ERMITE project during the course of 2002. Nevertheless, assuming that the causes of dam failure were precisely known so that the responsibility of the mine operator could be established, the polluter-pays principle would apply, since accidents due to dam failures (dams being human constructions) are "foreseeable" (Krämer 1999).

Similarly, although properties were affected by the recent dam failures in Europe, there appears to be no redress available in EU legislation (though there may well be in national legislation). This is because the only applicable directive (on compensation to individuals; Directive 85/374) focuses only on damages caused by defective products (for a detailed discussion on this point, see Krämer 1999).

Revising EU Environmental Policy

The previous analysis demonstrates that existing EU legislation does not adequately cover environmental aspects of mining activities. Indeed, many of the existing directives explicitly exclude extraction and mining activities. In this context, what type of legislation can we/should we expect? Recent developments have occurred in three stages.

1. The creation of the Baia Mare Task Force in reaction to Aznalcóllar and Baia Mare.

2. The formulation of recommendations for environmentally safe mine operations (COM (2000) 593 final), and an EC communication on the sustainable non-energy (i.e., excluding uranium and coal) extractive industry (COM (2000) 265 final).

3. Proposals for amendments to existing legislation and possible introduction of new legislation related to mining pollution. Four proposals, discussed below, will proceed in parallel.

The most favourable time for a dialogue between researchers and policy makers is when new directives are being prepared, which makes the ERMITE project especially timely (see below). The proposal for a new directive follows extensive consultations with industry and other stakeholders, from which the poor applicability of the Landfill Directive to mining wastes has become evident. Mining waste is known to be among the largest waste streams in the EU. Some waste streams generated by non-ferrous metal mining industry contain large quantities of ecologically dangerous, environmentally persistent metals (Cd, Zn, etc.). Since water is the major pathway for such contaminants, it is imperative that any new mining waste directive clearly considers mine water questions. To ensure that this occurs, institutional links are in place to facilitate the transfer of information from the ERMITE Consortium to the policy development process. The ERMITE partners will actively use their networks with researchers, industry, and regulators. The idea that mine voids and mine waters represent the main source of pollution compared to the mine residues was introduced to policy makers during the First European ERMITE Stakeholder Group Meeting (01/06/02, Brussels). This meeting illustrated the importance of a constant dialogue between researchers and policy makers.

As explained above, the Seveso II Directive covers industrial accidents. It obliges operators to implement safety management systems, including details on risk assessment with possible accident scenarios. In the wake of the Baia Mare and Aznalcóllar incidents, the Commission envisages amending the Seveso II Directive so that it unequivocally includes mineral processing, including the use of tailings ponds. However, the Seveso II Directive could only cover such activities if dangerous substances were present in quantities beyond the threshold levels set out in the Directive. Current proposals include significantly lower threshold levels for the inclusion of qualifying substances, and extending the list of carcinogens covered by Seveso II.

From Research to Policy

The EC has funded collaborative research on themes of common interest to Member States over many years, in a series of Framework R&D Programmes. Currently, in the 5th Framework (FP5), the EC has re-emphasised the need to orient research to serve the needs of EU policy. Linking the research and the policy communities is essential since scientific findings are expected to play a role in decision-making. Policy does not share objectives, methods, or time-scales with research. It is therefore necessary to set up a dialogue between research and policy making from the beginning.

History of EU-funded mining research

Before considering the future, we need to briefly consider the history of EU-funded research on mining and the environment. Research on mining has a long pedigree within the EU. However, most of this research has been focused on mining technology. Only recently have environmental concerns related to mining practices been included in the funding streams. In comparison with previous EU Research Framework Programmes, the appearance of interdisciplinary research projects with a policy orientation is a new development.

The research programmes of the European Coal and Steel Community (ECSC), managed by the former Directorates of Energy and Employment, Social Affairs and Education, formerly constituted the most important body of European research on mining issues. The Treaty that established the ECSC required that technical and economic research related to the production and increased use of coal and steel, and occupational safety in the coal and steel industries, be promoted. Soon after signing the Treaty, funding was allocated to support research projects on these topics. Within the ECSC umbrella, there have been several generations of mine safety, hygiene, and technology programmes, especially in the 1970s and 80s. Particularly relevant are the 7 five-year programmes on medium-term guidelines for technical coal research covering mining operations, mine infrastructure and management. ECSC-COALRES 7C (1994-99) introduced a section on environmental protection, including the abatement of water pollution, with projects such as "Environmental Problems of Water and Gas Emissions from Mines" (1996-99). However, in the context of the establishment of the EU, the ECSC Treaty will be phased out in 2002, and the ECSC research activities will be merged with the Directorate General (DG) Research framework programmes (such as the present FP5). The ECSC Coal RTD programme (1997-2002) is still active until then.

Mining and mine pollution has also been present in the main stream research programmes managed by DG Research within the larger Framework Programmes. The 2nd Framework Programme (FWP) included the MATREC C programme (1990-92) on raw materials and recycling, with a section on mining technology. This work was continued in the BRITE/EURAM 2 and 3 programme of the 3rd (1990-94) and 4th FWPs (1994-99), with projects such as "Novel methods for controlling zinc in mine effluents". The 3rd FWP also had the ENV1 programme, which supported some projects on acid mine drainage and removal of cadmium. The TOROS project, on the biogeochemistry of an acidic, metal-rich river-estuary system, was funded within ENV2 in the 4th FWP. The current FP5 has supported the appearance of an array of projects dealing with metal pollution and mining, such as PIRAMID, PEREBAR, METAL: BIOREDUCTION, DIMDESMOTOM and IMAGE-TRAIN. PIRAMID explicitly includes work with stakeholders, and counts a mining company and a mining consultancy amongst its research team. It is developing guidelines on passive mine water treatment for general diffusion and uptake in Europe. However, only the very latest FP5 research project, ERMITE, is focused explicitly on interfacing research with policy-making.

ERMITE

The goal of ERMITE is to provide integrated guidelines for developing European legislation and practice relative to water management in the mining sector. The project is centred on dialogue between various scientific disciplines, and across traditional research/policy boundaries. This dialogue was only made feasible by submitting the proposal a full year in advance of the anticipated (now realised) political decision of the EC to propose a mining waste directive, combining in-depth knowledge of both EU policy making and technical aspects of mine water management. ERMITE will concentrate on three types of deliverables: analysis of mine water problems in the EU and Eastern Europe as a framework for policy-making, development of technical guidelines and economic analysis methodologies for the management of mine waters at the catchment level, and evaluation and support of EU legislation. ERMITE calls for an integrated and interdisciplinary approach, combining both solid waste and water perspectives in a full life cycle approach. ERMITE considers it essential to manage mining wastes and water from the river basin management viewpoint proposed by the WFD. Guidelines to integrate water within the mining waste issue are currently being prepared and discussed with EC policy makers and will constitute the final deliverable of the ERMITE project. A series of interviews and workshops with European and national stakeholders groups will provide the necessary connections with the main policy actors and facilitate the dissemination of the project. A first step has been the co-organization with the DG Environment of an interservice meeting to exchange information and views on various initiatives from both the policy and the technical side. For the sake of real time information, ongoing results will be regularly published and posted on its web page (http://www.minewater.net/ermite). The ERMITE consortium is a multidisciplinary team, including mining schools, water resources groups, ecologists, economists, lawyers, and experts in European policy and institutional issues. The consortium has strong links with previous and current mine water research and established networks among industry, regulators, and other stakeholders. It includes groups in Spain, the UK, the Netherlands, Sweden, Germany, Poland, Slovenia, Bosnia-Herzegovina and Hungary. One of the partners (JRC-IPTS, Sevilla) is a unit of the EC.

Future Directions

A number of issues are being raised within the framework of the current review of the legislation on mine waters in the EU. These involve:

- applying the full life-cycle approach to the environmental regulation of mining activities without concentrating only on accidental pollution (e.g., dam breaks) and waste management;
- expanding the scope of the proposed BAT document to encompass key mine water issues as well as wastes;
- modifying the present policy initiatives, to take into account the scale of the river basin unit defined by the WFD, and the implementation plans of the WFD, to incorporate specific guidance on the management of mine water pollution;
- integrating the energy and non-energy mining activities, which up to now have been treated by the EC as independent despite their commonality.

Acknowledgements

ERMITE is funded by the EC FP5 under the Key Action Sustainable Management and Quality of Water (contract EVK-CT-2000-00078). A. Kroll wishes to thank her EC colleagues and ERMITE partners for their useful comments, patience and review. The views expressed by the authors do not express an official position of the EC.

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