

ACID DRAINAGE TECHNOLOGY INITIATIVE: TEN YEARS OF MINING INDUSTRY, GOVERNMENT AGENCIES AND ACADEMIA COLLABORATION IN THE METAL AND COAL MINING SECTORS IN THE USA¹

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Abstract. The Acid Drainage Technology Initiative (ADTI) was initiated in 1995 by federal agencies, the National Mining Association and the Interstate Mining Compact Commission to identify, evaluate and develop cost-effective and practical acid drainage technologies. In 1999, ADTI was expanded through the addition of the metal mining sector, which is focused on drainage quality issues related to metal mines. ADTI addresses drainage quality issues from abandoned, active, and future coal and metal mines.

The guiding principle of ADTI is to build consensus among industry, federal and state regulatory agencies on acid drainage technology development and technology transfer issues. ADTI is focusing its efforts on mine drainage prediction, sampling/monitoring, modeling and avoidance/remediation. ADTI is not a regulatory or policy development program.

ADTI includes the Coal Mining Sector and the Metal Mining Sector under the overall guidance of the ADTI Operations Committee. The Operations Committee consists of representatives from industry, state and federal government and academia. The Coal Mining Sector recently formed a number of groups to address a wide range of topics. The following groups have been formed: Water Quality, Coal Combustion By-Products (CCBs), Underground Mining, Passive Treatment, Technology Transfer. White papers have been prepared on 18 topics that are currently being studied. The Metal Mining Sector includes a steering committee and work groups on prediction, sampling and monitoring, modeling, mitigation, and pit lakes. The Metal Mining Sector has a committee that works with the Questa mine of Molycorp in the review of the waste rock pile study.

Since 2003 ADTI is the US organizational partner of The International Network for Acid Prevention (INAP). The partnership is continuing and is strengthened through closer cooperation and communication. This paper will provide details of progress over the last four years.

Additional Key Words: proceedings, organization, federal agencies, state agencies

¹ Paper presented at the 7th International Conference on Acid Rock Drainage (ICARD), March 26-30, 2006, St. Louis MO. R.I. Barnhisel (ed.) Published by the American Society of Mining and Reclamation (ASMR), 3134 Montavesta Road, Lexington, KY 40502

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7th International Conference on Acid Rock Drainage, 2006 pp 2159-2169

DOI: 10.21000/JASMR06022159

<http://dx.doi.org/10.21000/JASMR06022159>

Introduction

Two previous ICARD papers presented background information and details of the Acid Drainage Technology Initiative (ADTI) (Hornberger, et al, 2000; Williams, 2003). The rest of this introductory section provides a summary of the formation and development of the ADTI as described by Williams (2003).

The ADTI was initiated in 1995 by federal agencies, the National Mining Association (NMA) and the Interstate Mining Compact Commission (IMCC) to identify, evaluate and develop cost-effective and practical acid drainage technologies. In 1999, ADTI was expanded through the addition of the metal mining sector, which is focused on drainage quality issues related to metal mines. ADTI addresses drainage quality issues from abandoned, active, and future coal and metal mines.

The guiding principle of ADTI is to build consensus among industry, federal and state regulatory agencies on acid drainage technology development and technology transfer issues. ADTI is focusing its efforts on mine drainage prediction, sampling/monitoring, modelling and avoidance/remediation. ADTI is not a regulatory or policy development program.

ADTI includes the Coal Mining Sector (CMS) and the Metal Mining Sector (MMS) under the overall guidance of the ADTI Operations Committee. The Operations Committee consists of representatives from industry, state and federal government and academia. The Coal Mining Sector includes a steering committee and five technical working groups: Water Quality Group, Underground Mining Group, Passive Treatment Group, Coal Combustion By-Products Group, and Technology Transfer Group. The Metal Mining Sector includes a steering committee and work groups on prediction, sampling and monitoring, modelling, mitigation, and pit lakes.

The Coal Mining Sector has produced two publications on the prediction and prevention of acid drainage (Skousen et al., 1998 and Kleinmann et al., 2000). The Metal Mining Sector has workbooks under preparation covering the work group topics.

ADTI has evolved in response to changing needs and technologies as evidenced by the addition of the Metal Mining Sector in 1999. The Operations Committee and the members of the Coal and Metal Mining Sectors will guide future direction in response to identified issues.

Current ADTI Organizational Structure

The organizational structure of the ADTI is shown in Fig. 1. The two sectors, MMS and CMS, have their own Steering Committees. Representatives from each of the Steering Committees form the Operations Committee. Dennis Turner with the Arizona Department of Environmental Quality acts as the Secretariat of the Operations Committee as well as the MMS Steering Committee. He maintains the minutes of the meetings, provide draft agendas, etc.

A list of the ADTI Operations Committee members is given in Table 1. Each of the sectors organizes their Steering Committees to reflect their activities. For example, the MMS Steering Committee is organized around specific representatives from various sectors plus the chairs of the work book and administrative committees.

The ADTI Operations Committee holds quarterly conference calls to provide updates of progress and to discuss issues of mutual concern. The participation is quite good and the calls

are typically completed in 1 hour. Coordination of committee work is another major purpose of these calls. The Operations Committee also seeks for opportunities to meet face-to-face. This is planned but does not always occur on an annual basis, and the biggest constraint is a lack of travel budget for the Operations Committee members

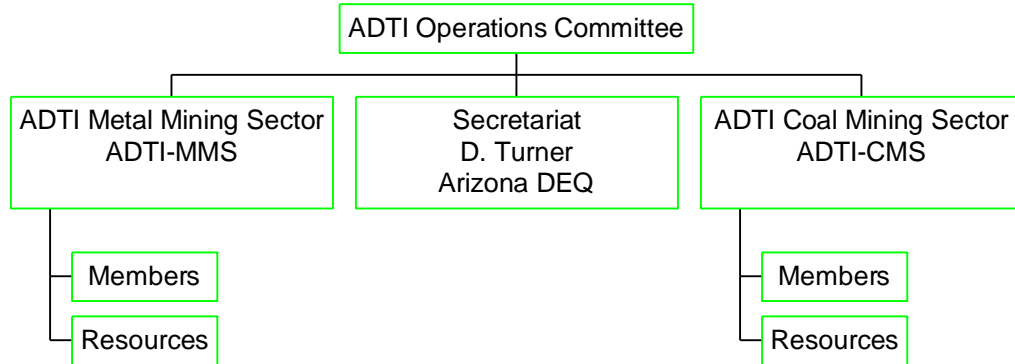


Figure 1, Organizational Structure of ADTI

ADTI-MMS Activities

The major activities of the ADTI–MMS are:

- Preparation of a series of Workbooks
- Molycorp waste rock stability project
- 7th ICARD coordination
- INAP participation
- Prediction method standardization and development of certified reference materials

A web site for the ADTI-MMS is being maintained at the University of Nevada, Reno, the web site address is: www.unr.edu/mines/adt.

Workbooks

The ADTI-MMS has worked on a series of Workbooks since its inception. These workbooks are meant to summarize the state-of-the-practice and provide guidance to all the ADTI stakeholders. Progress has been made on the workbooks as summarized below, however this progress has been associated with funding opportunities. While volunteer efforts keep the organization going, it is very difficult to make progress on the workbooks when relying completely on volunteer efforts.

Table 1. ADTI Operations Committee

Secretariat	Dennis Turner	Arizona Department of Environmental Quality
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Metal Mining Sector participants

Academia	Dirk van Zyl (Committee Chair)	University of Nevada Reno, Mine Life Cycle Center
Federal	Dave Williams	US Bureau of Land Management
Industry	Charles Bucknam	Newmont Mining Corporation
State	Harry Posey	Colorado Division of Minerals and Geology
MMS Chair	Virginia McLemore	New Mexico Bureau of Geology & Mineral Resources (New Mexico Tech)

Coal Mining Sector participants

Academia	Paul Ziemkiewicz	Director, National Mined Land Reclamation Center, West Virginia University
Federal, CMS Chair	Stephen Parsons	Office of Surface Mining, U.S. Department of the Interior
Industry	Ken Johnson	CONSOL Energy
State (IMCC)	Roger Hornberger	Pennsylvania Department of Environmental Protection
Ex-officio	Greg Conrad	Executive Director, Interstate Mining Compact Commission (IMCC)

Each of the workbooks is being prepared by a technical committee, the membership of which is listed on the ADTI-MMS web site. A consensus review process was developed to review the workbooks before their publication. A number of the workbooks are presently in this review process. The following summarizes the status of the workbooks:

- Introduction: consensus review underway.
- Sampling and monitoring: one paper was presented at the 2004 SME meeting (McLemore, et al, 2004) and one paper is in press in Reviews of Engineering Geology (McLemore, et al, 2004), draft of workbook is in progress.

- Prediction: a draft of this workbook is under development.
- Modeling: Kirk Nordstrom of the USGS is writing the section on geochemical models; this work is being funded by INAP and NMA (\$15,000). This work is being overseen by Drs. Rens Verburg and Andrew Nicholson.
- Mitigation: consensus review of workbook underway.
- Pit lakes: funding has been secured for this workbook and the MMS steering committee will work with this committee to undertake the project.

Molycorp Waste Rock Stability Project

A research program to evaluate the effects of weathering on the stability of waste rock dumps at the Questa Molycorp mine in New Mexico is being managed by the University of Utah. Researchers from the University Network of MMS, including New Mexico Tech, University of Nevada, Reno and the University of British Columbia are working on this project. A Technical Review Committee of the ADTI-MMS has been established to serve as an independent reviewer of the work and to provide input to Molycorp. This committee had a number of meetings and has provided input on the first draft report.

7th ICARD Coordination

Coordination of the 7th ICARD consisted of ADTI-MMS members participating in the organizing and technical committees.

INAP Participation

INAP participation includes regular attendance of INAP Operations Committee and Global Alliance meetings. These are typically limited to those meetings occurring in North America. In 2003 and 2005 INAP participated in the Annual Mine Closure Workshops organized by the Mining Life-Cycle Center at the University of Nevada, Reno.

Prediction method standardization and development of certified reference materials

Prediction method standardization and development of certified reference materials are also important activities of the ADTI-MMS Prediction Committee in conjunction with the ASTM International E01 and D34 Committees, USGS, NIST, and CANMET.

ADTI-CMS Activities

The Coal Mining Sector (CMS) of ADTI made a significant change in its organizational structure during the past two years, and the present structure of work groups/committees more closely resembles the structure of the MMS than the previous 2 working groups of the CMS: Prediction and Avoidance/Remediation. At an annual meeting of the CMS in 2004, sixteen critical technical issues were identified that are important to the ADTI mission and small groups of CMS members were assigned to develop white papers summarizing these issues and outlining approaches to resolve them. These white papers were reviewed at a subsequent meeting, and the technical issues were combined into four major technology development working groups, plus a technology transfer group.

The four major working groups are: the Water Quality Group, the Underground Mining Group, the Coal Combustion By-Products Group, and the Passive Treatment Group. The Technology Transfer Group is the fifth group in the CMS organizational structure and its role is to incorporate the work products of the four technical committees in user-friendly packages and

disseminate technological information to the user community. In addition, the CMS has a Steering Committee, composed of the chairpersons of the 5 working groups, plus an industry, university, Interstate Mining Compact Commission and federal agency representative. This CMS Steering Committee, like its MMS counterpart, reports to the ADTI Operations Committee to promote continuity, communications and consensus building in pursuing the mission of both sectors of ADTI. The Chairman of the CMS Steering Committee is Stephen Parsons of the Office of Surface Mining Reclamation and Enforcement in Washington, D.C.

The Chairman of the Water Quality Group is Keith Brady, Chief of the Surface Mine Permitting Section of the Pennsylvania Department of Environmental Protection. The issues that this group is investigating include: prediction of long-term acid mine drainage behavior of surface mine discharges; treatment for non-conventional constituents associated with mine drainage; selenium prediction, avoidance and remediation; re-evaluation of the validity of manganese toxicity and treatability criteria; and prediction of contaminant concentrations and loading in mine drainage through improved kinetic testing.

The Chairman of the Underground Mining Group is Andrew “Nick” Schaer, of the West Virginia Department of Environmental Protection. The issues that this group is investigating include: prediction of long-term acid mine drainage characteristics of discharges from flooded underground mines; prediction of long-term acid mine drainage behavior from above-drainage underground mines; prediction of contaminant loading through hydrologic budget analysis of underground mines; treatment methods for large-volume underground mine discharges; and in-situ or in-mine treatment of underground mine drainage waters (minepools). Much of the work of this group is founded in recent concerns and studies by federal and state agencies, universities and industry about major abandoned underground mine flooding and potential large volume discharges in the Monongahela River basin in West Virginia and Pennsylvania.

The Chairman of the Coal Combustion By-Products (CCB's) Group is Kimery Vories of the OSMRE Mid-Continent Region. This group is focused on development of risk assessment methods to evaluate CCB placement in various mine placement scenarios, and documentation of the benefits and potential impacts of mine placement of CCB's through field validation studies. Much of the work of this group is correlated with the technical foundation provided by the series of interactive technical forums on CCB's that OSMRE has conducted throughout the US, and the long-term coal ash research programs conducted at the: (1) Materials Research Institute at the Pennsylvania State University; (2) Center for Applied Energy Research at the University of Kentucky; (3) Energy and Environment Research Center at the University of North Dakota; (5) Combustion By-Products Recycling Consortium of the U.S. Department of Energy; and (4) the National Mine Land Center at the West Virginia University.

The Chairman of the Passive Treatment Group is Dr. Arthur Rose, Professor Emeritus of Geochemistry at the Pennsylvania State University. The issues that this group is investigating include: long-term evaluation of performance of passive systems; development of metrics for passive treatment systems evaluation (e.g. capacity of media for sustained treatment); evaluation of reasons for success or failure of passive systems including a 4 phase study process; development of improved methods of passive treatment incorporating better engineering design elements; effectiveness of refuse caps and barriers; and assessment of in-situ treatment options including alkaline amendments, foundation drains and reactive barriers.

The Chairman of the Technology Transfer Group is Dr. Jeffrey Skousen of West Virginia University, who has extensive technology transfer experience and capabilities. This group is exploring several technology transfer methods including an extensive website containing policy and state-of-the-art summaries of the major issues, as well as pertinent publications and links to AMD literature; pamphlets and brochures stating the mission and goals of ADTI with contact information; seminars and workshops presented by ADTI members at national conferences and other symposia; publications in journals and proceedings of the accomplishments and results of research performed by ADTI members.

The new and improved organizational structure of the CMS is not dramatically different from the priorities and functions of the original two working groups. Prediction is still a central focus of the Water Quality Group, and prediction topics are also in the core of the Underground Mining Group issues, and are included in the risk assessment methods of the CCB's Group. Avoidance/remediation issues are the central focus of the Passive Treatment Group, as much of the work of the original Avoidance/Remediation Working Group was dealing with passive treatment systems. In addition, avoidance and remediation topics are scattered throughout the list of issues of the other three technology development work groups described above. The new organizational structure increases the diversity of the work group functions and provides a distinct and necessary focus on underground mining issues and CCB issues that were not prominently featured in the previous working group structure. Coal production from active underground mines is the major part of production statistics in several Appalachian states, and acid mine drainage problems from abandoned underground mines have been recognized to be the major portion of the AMD problem since the report of the Appalachian Regional Commission in 1969. Therefore, it made sense for the CMS to develop a specific Underground Mining Group, rather than leaving these issues as tasks to be addressed sometime in the future. Also, virtually all coal combustion processes produce coal ash from the inorganic mineral matter in the coal, and other coal combustion by-products are generated; hence it is important to investigate technologically and environmentally sound uses and mine placement practices for these residual waste products, as alternatives to landfilling them. For the above reasons and the fact that a national controversy exists over mine placement of CCB's it is important for the CMS to have a work group devoted to these issues.

Current projects and recent working group results

The CMS has several projects which have been completed since ICARD 6, or which have recently commenced or made significant continuing progress. These projects include the following:

1. Reprinting of the 2000 CMS workbook entitled "Prediction of Water Quality at Surface Coal Mines" by the National Mine Land Center at WVU.
2. Reprinting of the 1998 PA DEP book titled "Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania" in a CD format, by OSMRE members of ADTI.
3. Development of two standard kinetic test procedures, the ADTI-WP1 Humidity Cell Weathering Procedure, and the ADTI-WP2 Leaching Column method.
4. Ongoing monitoring and assessment of the performance of passive acid mine drainage treatment systems.

5. Ongoing study of sources, mobilization and transport, and treatment of selenium in coal mine overburden and surface and groundwater.
6. The development and posting of an ADTI CMS website at the following address:
<http://wwwri.nrcce.wvu.edu/adti/index.cfm#>

The project to develop standard kinetic test procedures (i.e. ADTI-WP1 Humidity Cell Method and ADTI-WP2 Leaching Column Method) is a good example of cooperation, technology development and consensus building among various ADTI stakeholders. The need for these standardized procedures was recognized since the inception of ADTI in 1995 as described in Geidel et. al., (2000) and Hornberger and Brady (1998). ADTI members in the MMS and the CMS had extensive experience in kinetic tests and the methods development process. Kinetic tests have historically been used more by industry and regulatory agencies in metal mining, and Charles Bucknam and Susan Sorini (1997) have extensive experience in the ASTM methods development process, while Kim Lapakko and Bill White (all 4 researchers from the MMS) have extensive experience in the use of kinetic tests and provided comments and suggestions in the peer review phase of the project (e.g. Lapakko, 1988, Lapakko et al.,1995, White et al., 1994). Specific ASTM methods that were developed or modified are:

- ASTM D5744 Standard Test Method for Accelerated Weathering of Solid Materials Using a Modified Humidity Cell
- ASTM E1915 Standard Test Methods for Analysis of Metal Bearing Ores and Related Materials by Combustion Infrared Absorption Spectrometry
- ASTM D6234 Test Method for Shake Extraction of Mining Waste by the Synthetic Precipitation Leaching Procedure
- E 2242 Test Method for Column Percolation Extraction of Mine Rock by the Meteoric Water Mobility Procedure

Within the CMS, William Telliard is the Director of Analytical Methods Development for the Office of Water of EPA, and his associate Joan Cuddeback is the Work Assignments Manager for Chemical Methods Development for CSC/Dyncorp as a consultant for EPA. A major logistical goal of the project team was to integrate the methods development expertise of Telliard and Cuddeback with the kinetic test experience of Dr. Barry Scheetz and Dr. Will White of the Materials Research Institute (MRI) of the Pennsylvania State University, Dr. Frank Caruccio and Dr. Gwen Geidel of the University of South Carolina, Dr. Chuck Cravotta of USGS, Eric Perry of OSMRE and Dr. Bob Kleinmann of DOE. Keith Brady and Roger Hornberger of PA DEP coordinated these efforts as principal investigators of the project team, but the technical insight and experience of the above named scientists in the control of carbon dioxide in the weathering test apparatus, the importance of particle size and surface area to volume ratios in the rock samples, and interpretation of the results was invaluable.

OSMRE funded 2 years of methods development work in 2002 and 2003 in commercial laboratories and the Materials Research Laboratory at Penn State, in cooperation with EPA, CSC/Dyncorp, PA DEP and the National Mine Land Reclamation Center at West Virginia University, plus a peer review study in 2004. The results of this work have been reported in Hornberger et. al., (2003, 2004, 2005) and Brady et al., (2004). The final step to completing the development of the final draft of the ADTI-WP2 Leaching Column Method and publishing it in the Federal Register as a standard EPA method is a full inter-laboratory validation study in

accordance with the ASTM D - 2777 protocol. That inter-laboratory study is in progress during 2005 and 2006 with joint funding by OSMRE and EPA. Seven laboratories are participating in the inter-laboratory study including USGS, MRI of Penn State, a coal industry lab (Consol Energy Research and Development) and four commercial laboratories (Mahaffey Laboratories, Geochemical Testing, Sturm Environmental Services, and Benchmark Analytical). The weathering tests of four shale samples (from PA, IN and WV) and a sandstone sample commence in January 2006 and will be completed in April 2006. The results of this study will be reported in future journal articles and conference proceedings.

Discussion

The ADTI has grown considerably during the last 10 years since it was formed. Two groups are actively involved in finding solutions to acid drainage problems in the coal and metal mining sectors. The organization is living up to the guiding principle of building consensus among industry, federal and state regulatory agencies on acid drainage technology development and technology transfer issues. Furthermore, ADTI is focusing its efforts on mine drainage prediction, sampling/monitoring, modeling and avoidance/remediation. ADTI is not a regulatory or policy development program.

ADTI has been very successful in contributing a better understanding and solutions to the acid drainage problems facing the mining industry in the USA. It is clear that much more work must be done in the future; however, ADTI can be successful as the organization is based on a strong foundation of cooperation between the major stakeholders.

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