

An update on the international network for acid prevention

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Abstract

Mining activities include the extraction and processing of economic minerals as well as the movement and storage of the waste rock and tailings, some of which may be reactive producing Acid and Metalliferous Drainage (AMD). This can impact operations and lead to a high level of residual risk/liability at the cessation of mining which may delay or prevent effective closure and lease relinquishment. Responsible management of these reactive materials throughout the operational phase of mining and for the entirety of mine's life cycle inclusive of post-closure is therefore critical for the mining industry's current and future success.

The International Network for Acid Prevention (INAP) is an international network of mining companies that was proactively formed by mine operators in 1998. Twenty-five years later, INAP continues to drive globally recognized leading practice in AMD risk management so that all mining companies can operate sustainably in their respective environments across the asset life cycle. This is achieved through mining industry-led collaboration, knowledge development, and sharing of outcomes.

INAP programs and activities are focussed on the reduction and management of AMD and, as such, can greatly assist in minimising the issues around residual risk which may present as a major barrier to operational performance and achieving successful mine closure. As INAP enters its next 25-year period, a review of the Strategic Plan is currently underway to ensure that INAP continues to add value and deliver in emerging and strategic areas, particularly given the pace of change which the industry needs to embrace to remain viable and relevant.

In addition to management of AMD, INAP has recently expanded its focus to thoroughly embrace prevention of AMD. In this presentation, examples of leading practices including source control work targeting the prevention and reduction of AMD, through better mine rock stockpile construction techniques will be presented. The paper will also consider how INAP is working to make the global ARD guide (GARD Guide) more effective and useful to all stakeholders worldwide, along with an update on current and future projects. INAP's key role in bringing the global technical and regional ARD alliance together will also be briefly discussed.

1 Introduction

One of the more significant issues facing the mining industry globally is mine closure. More specifically, the ability for companies to achieve either full relinquishment of mining leases or having work completed on such leases to be in "relinquishable" form, even if jurisdictional statutes do not allow for actual full release of the holdings. The models used in the industry for the vast majority of mine closures does not fully reflect societal expectations and, as such, is largely broken resulting in an increasing inability to achieve effective mine closure and lease relinquishment. Left unchecked, this trend will continue to negatively impact the industry's social partnerships that allow companies to operate and will drive uncertainty in new resource investment. The impact will be most notable for long-lived mining companies where their viability will be eroded from a lack of partner support – particularly from communities and First Nations partners.

The major part of the closure challenge is centred around the issue of residual risk. Companies, regulators, communities and impacted First Nations are all struggling with what constitutes an acceptable level of residual risk from the mining process. Closure and relinquishment will never be achieved unless residual risk

can be reduced to levels that are both scientifically and societally acceptable and that can be accommodated through sensible assurance.

Traditional industry thinking around what constitutes the mining life cycle also needs re-thinking, including the transition from mining to post mining. This will require early consideration of what happens beyond traditional closure and considers the post mining landscape and post mining business and societal opportunities. Areas such as water quality, repurposing of land and assets, new business opportunities all become important. Traditional values of, and opportunities for, Indigenous partners need to be far better integrated into closure planning and what eventually becomes the post mining world former mines.

In many instances, Acid and Metalliferous Drainage (AMD) is a major contributor to residual risk. Geochemical uncertainty not only diminishes the ability to close mines but is often a long term and expensive issue that can impact land use options and environmental impacts in perpetuity. AMD (also known as Acid Mine Drainage or Metal Leaching and Acid Rock Drainage (ML/ARD)) encompasses contaminant mobility under acidic or neutral/alkaline pH conditions (if there is excess alkalinity). While AMD occurs naturally where sulphide mineralization is present, the mining process almost always accelerates sulphide mineral oxidation, thereby exposing environmental receivers to elevated levels of metals and acidity compared to natural processes. AMD can be generated in waste rock piles, tailings facilities, pit wall rocks, heap leach pads, ore stockpiles and underground mine voids.

2 Who is INAP?

INAP represents a coalition of mining companies with knowledge, internal expertise, and experience in dealing with AMD. Since its formation in 1998, INAP and the Global Alliance of AMD experts have evolved to become a unique and effective industry led network, focussed on an area of specific business risk. It is a formally registered entity with a constitution and follows governance policies aligned with being an Australian registered company. Member companies provide both a Board member and an Operations Committee member to represent their organization at coordination/sharing sessions. A Chair and Vice-Chair of each governance entity (Board and "Ops Comm") are selected on a rotating basis from the member companies. Given the low cost of entry and on-going participation, INAP offers the opportunity for companies to significantly leverage their investment in INAP, provided they are prepared to actively participate and disseminate the information gained from that participation back to their respective organizations.

INAP presently provides access to an industry-only network where discussions can be held openly with other companies subject to the provisions of antitrust. INAP provides an excellent sounding board for industry members to test thinking, discuss and share common challenges, avoid duplication of effort, consolidate ideas and shape industry directions. There is also broader mentoring and succession potential for talent entering into, or early within, the industry so that career potentials are enhanced and can find a home within the breadth of the overall INAP network and industry.

3 So, what role does INAP have to play?

AMD from extracted wastes and/or ore is a global environmental issue and remains a costly economic and social challenge for the international mining sector. Left unchecked, it can result in long-term water quality impacts. Dealing effectively with poor water quality drainage associated with sulfide oxidation and acidic drainage is a formidable challenge for which no 'one size fit's all' solution currently exists, but it offers the opportunity to better manage mine closure and relinquishment issues, as outlined above.

Though recent attention in the industry has been on tailings facility management, the largest single residual risk and legacy from mining remains potential pollution from AMD.

To address the issues related to AMD, INAP programs and activities are focussed on the reduction and management of AMD and, as such, can greatly assist in minimising the geochemical issues around residual risk. A fundamental example is the current focus on source control work which targets the reduction of AMD through better material characterisation and handling, including early intervention in the mining,

comminution, and metallurgical circuits. This extends to new designs for waste rock dumps and tailings facilities with a view to AMD prevention/minimisation. In addition, INAP is focussed on the management of existing AMD, through better operational practice, technology development and transfer, and education and upskilling of company personnel and communities etc.

4 Current risks and emerging challenges

While INAP has operated for 25 years and, therefore, been through a number of the inevitable cycles that the mining industry endures, the past few years has seen rapid and transformational changes in the industry. This change has been fueled by a variety of factors inclusive of global focus on large energy use industries, unprecedented attention to ESG (Environmental, Social and Governance) performance in major industries, the tragic tailings incidents in Brazil and the dramatic shift in workforce practices brought about by the global pandemic. Societally driven initiatives such as the Global Tailings Review (GISTM 2019) have elevated geochemical contamination from mine waste to a comparable “catastrophic” level as chronic issues become of equal focus to the acute physical failures. These catalysts all landed at a time when the mining industry was already having a noticeable shortage of trained professionals and was not attracting talent to the industry commensurate with the losses through retirements.

Specifically, the challenges and risks to a viable industry and, by extension, the ability for INAP to remain relevant in support of that strive for viability were summed up during a strategic review by the INAP members as:

- Investor Forcing – the increased focus on Environmental, Social and Governance (ESG) compliance and the competition for investment, seeking more societally acceptable options in areas like decarbonisation than some in industry may be willing or able to change with sufficient pace and measure
- Regulator Forcing – rapid changes in expectations for both existing and new mining projects where previously acceptable performance is being replaced with ever increasing stringency on geochemical criteria
- Society – more awareness of the direct and indirect impacts that major industries like mining have on the environment and access to clean water. More focus on the relationship between the mining industry and Indigenous rights and land stewardship values. Equality and inclusion, as increasingly demanded by current and almost certainly future generations, is driving decisions on where to start and stay for career development.
- Water – sufficient quantity and quality for an increasing population and an ever-stressed environment
- Mine Closure – a need to move beyond “gates, fences and locks” to relinquished and/or relinquishable land with land use meeting community requirements
- Awareness – thinking outside of the industry norms and established practices
- Cumulative Impacts – shifting focus from a single mine or single watershed into bigger thinking

The overarching issue of climate change/decarbonisation is driving increased societal awareness on ESG matters and the focus on many of the risks as outlined above.

Revisiting these current risks and emerging challenges has led to an updated Vision Statement and an, in turn, an updated Strategic Plan to guide INAP into its next 25 years and well beyond.

5 Vision statement and strategic plan

The updated INAP Vision statement developed by INAP members to embrace the changing world reads as follows:

The International Network for Acid Prevention (INAP) drives leading practice in acid and metalliferous drainage risk management so that mining companies can operate sustainably in their respective environments across the life of asset cycle. This is achieved through mining industry-led collaboration, knowledge development and sharing.

To logically follow the updated Vision Statement, an update of the Strategic Plan for INAP was initiated in 2023. In setting the context for the update the member companies noted these emerging trends of increased societal input into mining and enhanced engagement in terms of the potential impacts of the mining process. Mining exists for the benefit of society and commensurate societal demands, so if mining is going to improve in areas like environmental stewardship, a stronger societal understanding of how mining works is essential. Along with this enhanced societal understanding will also come with the understanding that the benefits of mining must not come at any cost – notably where environmental stewardship issues are involved. What this means in terms of the INAP Strategic Plan update is that there is a need for an approach that aligns with this Environmental, Social and Governance (ESG) trend, while keeping a focus on AMD which remains as one of the industry’s most enduring challenge. It became apparent that INAP must continue to add value and deliver in emerging and strategic areas which the industry needs to embrace not only in 2023, but for future years as well. Instilling a sense of adaptive management that allows adjustment in alignment with societal trends became a key driver for the update.

As a result of the direction from members to embrace the above noted trends, the updated Strategic Plan is embracing the following foundational elements:

- Networking and Information Sharing - Engagement
- Technology Transfer – Fostering Leading Practice / Continual Improvement
- Gap-Driven Research – Continual Improvement / Fostering Leading Practice
- Members and Partners – Engagement / Capacity Building
- Capacity and Capability – Capacity Building / Fostering Leading Practice

The first three are consistent with the formation of INAP 25 years ago. The latter two bullets are newly introduced and are seen as key to integrating more societally relevant issues into INAPs core functions and programs in a manner that allows INAP to remain relevant for its next 25 years and well beyond.

6 INAP’s flagship source control project

Preventing mine leaching through source control has been a major focus for INAP. “Source control” refers to any mine waste management approach that limits release of constituents from the mine waste itself as opposed to external removal approaches (e.g., water treatment). It has been shown that measurements of acidity load from various sites have revealed that sulfidic rock waste (mine rock stockpiles (MRS)) typically contributes the majority of the total acidity load from most mine sites. With this understanding of the importance of waste rock management to successful closure, INAP has been working on a multi-phase project towards improving rock placement strategies to lower water quality risks during operations and in closure for mine rock stockpiles.

The Phase I report identified opportunities for differing MRS construction methodologies to limit re-supply of oxygen into MRSs, reducing probability of internal MRS sulfide oxidation, and thus AMD risk arising from MRSs (INAP 2020). The changes in MRS construction, in comparison to conventional MRS construction methods, represents an opportunity for source control AMD risk reduction. Six fundamentally important, distinctive, established and/or emerging management strategies for MRSs to mitigate the effects of AMD were identified. Four of the methods are focused on geotechnical engineering approaches, and two are geochemically focused methods. They are:

- Lower lift heights – Geotechnical
- Engineered layers – Geotechnical

- Base-up, layered / compacted – Geotechnical
- Encapsulation – Geotechnical
- Oxygen consuming materials – Geochemical
- Sulphide passivation – Geochemical

The geotechnical approaches are principally focused on improved control of gas transport within MRSs, both during and post construction, which can be influenced by gas disruption layers / trafficked layers, encapsulation of high-risk materials, decreasing tip head heights, and paddock dumping in thin compacted layers from the base up. Strategic placement of oxygen consuming, and pyrite passivating materials can also lower acidity production. Each of these construction methods perform differently under different physical and chemical conditions (e.g., topography, climate, geochemistry) and can also be combined to achieve optimum outcomes. Numerical modelling of acidity generation from conventional and improved MRS construction methods demonstrate the ability for the improved methods to limit air-flow capacity thus decreased acidity-generation and lowering the severity of AMD-related risks (e.g., reducing the reliance on collect and treat systems).

The next phase of the project involves a high level and detailed technoeconomic evaluations of the efficacy of building MRSs based on two existing sites with a focus on source control. The work will support development and evaluation of a ‘decision tree’ type ‘tool’, which can be used as a first filter in evaluating the efficacy of applying differing MRS construction methodologies to specific site, while also evaluating conditions within existing MRSs when employing the same mechanisms, and site-specific controls on those mechanisms, as evaluated in Phase I. This work is planned for completion of the phase by the end of 2023.

7 INAP’s achievements and current/future activities

The development and maintenance of globally recognized, authoritative technical guides are one of INAP’s major achievements and, in the view of the membership, one of its ongoing responsibilities. The GARD Guide (INAP, 2014) intended as a state-of-practice summary of the leading practices and technology to assist mine operators and regulators to address issues related to sulphide mineral oxidation is a successful example. The GARD Guide is a living document and requires periodic updates. A detailed review was completed in 2017, gaps were identified and chapters prioritized requiring updating.

Chapter 7, Treatment, was the first to be addressed and was completed in 2020 (INAP, 2020). One of the key gaps identified was the need to integrate mine closure and sustainability in the guide. A dedicated chapter on “Mine Closure / Sustainability” is being prepared in addition to the update to Chapter 6 Prevention and Migration. Both should be available in 2023. A new GARD Guide website will be launched in 2023 to accommodate the updates.

The Global Cover System Design - Guidance Document (INAP 2017) is another example of a technical guide. It is a summary of leading practices addressing issues where cover systems can be employed. A holistic framework for management of reactive materials during operations and at closure is the pillar of the document. The information provided within the design tool is not a replacement for site-specific classification and engineering required for cover system design. However, the tool is a means of beginning early conceptualization to help focus further investigation at a site level and to begin to form realistic expectations for cover system performance at an early stage of a project.

Guidance is important but the industry needs a sufficient number of qualified people to utilize this guidance for INAP’s work to be effective. As such, a key element of INAP’s strategy is ensuring sufficient capacity and capability for our future industry. Partnering with various universities and other research organizations is key. In addition to the financial benefits (as demonstrated by the Diavik scale-up project that resulted in a \$15 M CDN bond reduction), more than 30 highly qualified students (HQS) are now working directly in the mining and minerals industry. The TERRE-NET (Toward Environmentally Responsible Resource Extraction Network) comprised of 15 co-investigators from 7 universities across Canada is ending in 2023 and to date,

67 of the 87 HQS involved in the 28 projects have graduated and many have joined the industry. Further, INAP recently partnered with the Cooperative Research Centre for Transformations in Mining Economies (CRC-TIME) initiative in Australia as an affiliate member and over the 10-year program life. More than 50 HQS are expected to graduate and be available for positions within the industry.

Training and education are the focus of two other INAP projects. The Queensland University of Technology (Brisbane, Australia) is developing an interactive game/education package that could be used in high schools and universities to teach people about the importance of AMD. The game is divided in different phases (e.g., finding the resources; operating the mine; and closing the mine) where each phase has a series of questions to answer and points are assigned. Key to the game will be to show that AMD is prevented or minimized. Discussions are also underway to develop a series of AMD training modules that are based on the various GARD Guide chapters with “An Introduction to AMD” being the first of six modules developed.

INAP also sponsors and is the home of ICARD, the International Conference for Acid Rock Drainage, which is held every 3 years. With COVID-19, the 12th ICARD was both virtual and delayed by one year being held in September 2022. The 13th ICARD, or ICARD 2024, will take place in Halifax, Nova Scotia (Canada) from September 16 to 20, 2024. The ICARD community can finally meet again at a face-to-face event to discuss real issues and find innovative solutions around AMD and its impact on the environment.

INAP continues to recognize leading practice in ARD management with an international award presented at ICARD events. The awards are for the implementation of leading practice in the identification, planning and management of potentially reactive geologic materials at the corporate level, and at a mining site. Past winners include a corporate award for Rio Tinto’s Iron Ore Pilbara operations and site awards for Kinross Brazil for their operation of their Paracatu site in Brazil and most recently Agnico Eagle Mines’ Detour Lake mine site in Ontario, Canada. The next set of awards is planned for ICARD 2024 in Halifax.

INAP works globally with world class consultants, including running technology transfer workshops with key global experts, an important element of collaborative partnerships. Support is provided for our Global Alliance partners for workshops such as the Annual British Columbia / MEND Workshop in Vancouver and the AMD Workshop in Australia hosted by the University of Queensland Sustainable Minerals Institute. INAP members regularly present at various national and international events. INAP information is made available through Newsletters, LinkedIn and the INAP Website at www.inap.com.au.

8 Conclusion

INAP was formed some 25 years ago as a result of the urgent need to combat a global and long-term environmental issue facing the mining industry. Through many industry cycles, it remains a powerful example of how companies can work collaboratively and collectively when faced with major challenges. INAP has also brought AMD practitioners across the world together through its Global Alliance, enabling enhanced connectivity between industry issues and those with the skills to address them. It has sought to drive a more efficient and collaborative approach to AMD management. Over recent years, many sites have successfully demonstrated that these issues can be successfully managed to avoid legacy environmental impacts. Importantly, INAP is industry led and its member companies continue to drive for leadership in addressing one of the most significant environmental issues facing the industry.

References

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