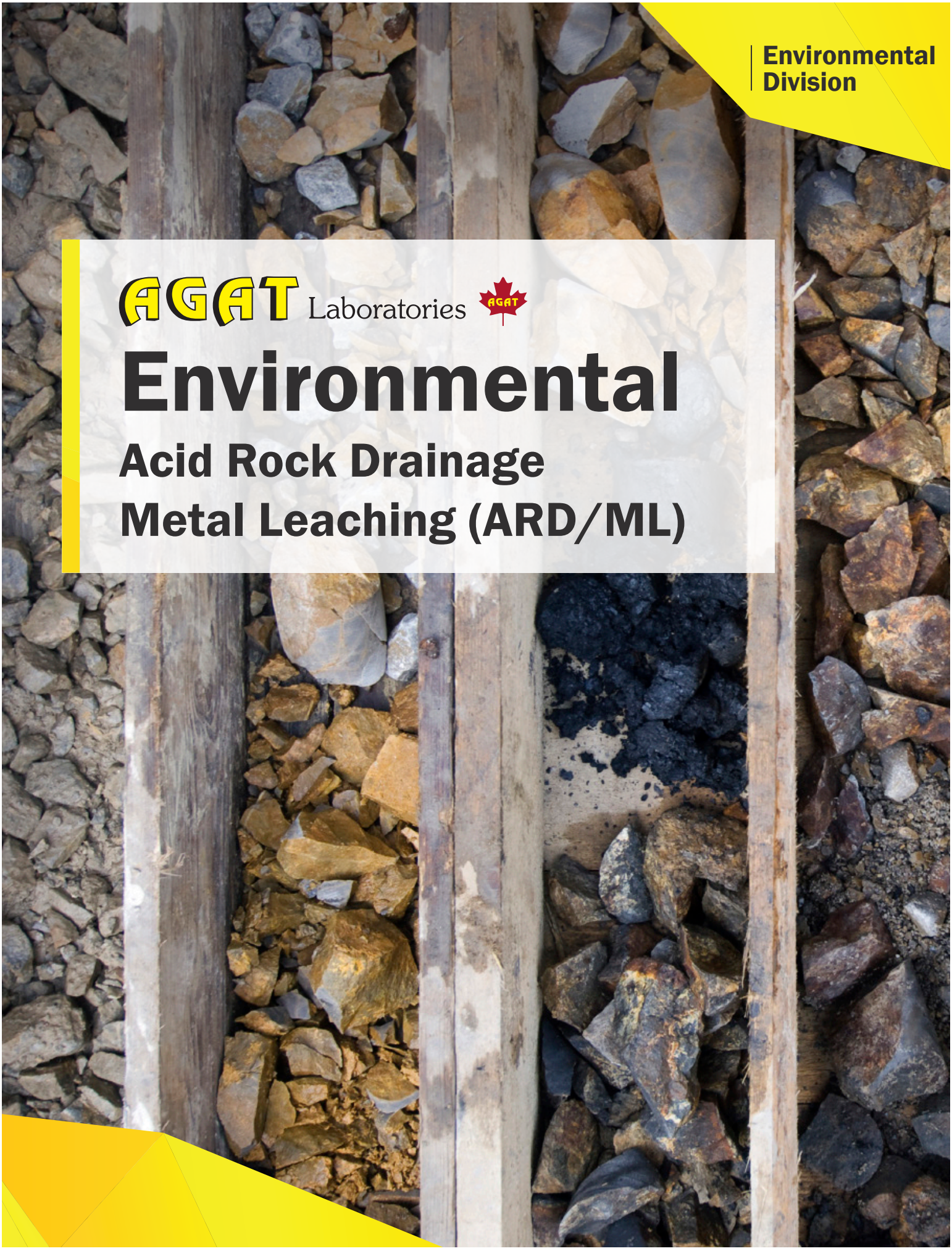
Environmental Division

AGAT Laboratories

Environmental

Acid Rock Drainage Metal Leaching (ARD/ML)



Acid Rock Drainage

Acid Rock Drainage (ARD) occurs when sulphide minerals from overburden, waste rock, and tailings deposits are exposed to naturally occurring oxidizing conditions. The oxidation of sulphides in the presence of water can generate acidic drainage. This drainage raises two problems: the generation of acidity which is also known as acid rock drainage (ARD) and the subsequent release of dissolved metals (metal leaching) into the surrounding environment. As the drainage becomes more acidic, its capacity to leach out elements from the rock, such as heavy metals, increases and can result in the water bearing a number of harmful constituents.

As a result of these interactions, polluted water can drain away from the exposed rock and have a significant impact at the operating site and the surrounding areas including bodies of water (river, lakes, and groundwater), wildlife and/or inhabitants if the appropriate prevention and management strategies have not been adopted.

Although this is a natural process, any rock relocation cause by industry activities and excavation can trigger this phenomenon by exposing large surface areas of rock to water and oxygen. The additional rock surface exposure, increasing the reaction rate compared to natural conditions. Not all industrial operations that expose sulphide bearing rocks result in ARD.

In some situations the sulphide minerals may be non-reactive or they may even have a buffering capacity to neutralize any acid released from sulphide oxidation which consequently results in a metal leaching problem without an ARD problem. ARD potential is often initially estimated using rapid, accurate determinations on the likelihood of a sample to exhibit characteristics of generating acid.

AGAT Laboratories offers full-service analysis capabilities for ARD testing. We offer a complete range of solid phase geochemical analysis, static testing, leaching procedures (Shake Flask Extraction (SFE), Synthetic Precipitation Leaching Procedure (SPLP), and Toxicity Characteristic Leaching Procedure (TCLP)), Net-Acid Generation (NAG), and Kinetic Testing.

We offer these services nationally to a varieties of industries including mining, construction and infrastructure sectors.

AGAT Laboratories' Burnaby laboratory is accredited to ISO/IEC 17025 for specific tests as listed on our current scope of accreditation from the Canadian Association for Laboratory Accreditation (CALA). Our Acid-Base Accounting Procedures are accredited for Paste pH, Sulphate Sulphur, Total Sulphur, and Neutralization Potential.

Solid Phase Geochemical Analysis

AGAT offers a complete suite of solid phase geochemical analysis including sulphur speciation, carbon speciation, solid phase elemental analysis using various methods of sample digestion, and whole-rock analysis.

Mineralogical Analysis

AGAT offers mineralogical analysis including X-ray diffraction (XRD) by reitveld method, optical microscopy on polished thin section, scanning electron microscope SEM analysis, and Quantitative Evaluation of Minerals by Scanning Electron Microscopy (QEMSCAN).

Metals Packages and Mineralogy

Parameter
Metals Package by Aqua Regia Digest, ICP-OES Finish
Metals Package by Aqua Regia Digest, ICP/ICP-MS Finish
Metals Package by 4 Acid Digest, ICP-OES Finish
Metals Package by 4 Acid Digest ICP/ICP-MS Finish
Metals Package by 4 Acid Digest ICP/ICP-MS Finish with Hg-CVAA
Whole Rock Analysis (ICP-OES)
Whole Rock Analysis (XRF)
Mineralogy: Optical Microscopy on Polished Thin Sections
Mineralogy: Quantitative Evaluation of Minerals by Scanning Electron Microscopy (QEMSCAN)
Mineralogy: Rietveld XRD

Static Testing

Static tests are used to quickly predict the potential of a sample to generate acid. Acid-Base Accounting (ABA) is the analytical cornerstone for static test predictions of ARD potential.

In addition to Acid-Base Accounting (ABA), AGAT Laboratories offers a complete range of static tests including: sulphur speciation, carbon speciation, net acid generation (NAG), and leaching procedure (SFE, TCLP, SPLP). These methods are based upon the procedures outlined by the MEND, ASTM, and EPA methods.

Parameter
Dry <1kg, crush to 80% passing ¼ inch, split 250g and pulverize to 85% passing 200 mesh (85% passing 200 mesh (75 µm))
Pulverizing only (pulverize 250g to 85% passing 200 mesh (75µm))
Compositing (in addition to prep)

With world-class facilities and state-of–the-art instrumentation, our qualified personnel adhere to AGAT Laboratories' mission statement, delivering "Service Beyond Analysis".

Acid-Base Accounting (ABA)

ABA methods estimate the amount of acid-bearing material by measuring either total sulphur or sulphide-sulphur. Based on this information, AGAT Laboratories reports Neutralization Potential (NP), Maximum Potential Acidity (MPA), and Net Neutralization Potential (NNP).

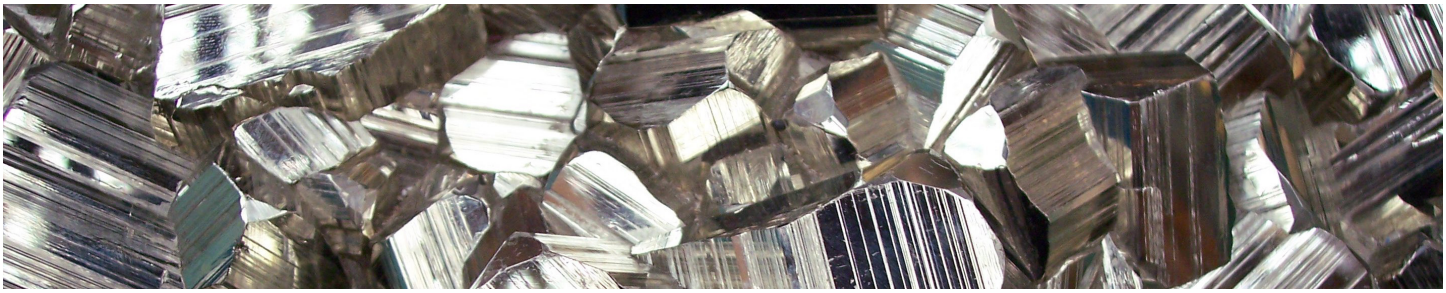
AGAT Laboratories offers several methods for the determination of NNP, including Modified ABA (Lawrence and Wang 1996- 1997), Modified ABA (Lawrence 1989-1991), Standard Sobek, and Siderite Corrected NP.

Minimum Sample Amount: 250g

Method
Mod ABA (96-97)/(89-91) /Standard Sobek
Mod ABA (96-97)/(89/91)/Standard Sobek + Siderite Corrected NP

Parameter
Carbon Options
Total Carbon
Total Organic Carbon
Total Inorganic Carbon (Direct Measurement) Residual Carbon

Parameter
Sulphur Species Options
Total Sulphur in Soil
Sulphate Sulphur- HCl Leach (sulphide sulphur by difference)
Sulphate Sulphur- Na_2CO_3 Leach
Sulphur Spec. (Sulphate-S, Sulphide-S & Insoluble-S; ASTM 2492-02 method)



Net-Acid Generation (NAG)

The main purpose of the Net Acid Generation or NAG test is to directly assess whether a sample is capable of neutralizing the potential acid produced by sulphide oxidation. This method uses hydrogen peroxide (H2O2), a strong oxidizing agent capable of rapidly oxidizing sulphide minerals.

The solid material is titrated with sodium hydroxide (NaOH) after complete oxidation with hydrogen peroxide. The amount of NaOH needed is equivalent to the Net Acid Generation of the material and it is expressed in kg H2SO4 per metric tonne.

AGAT Laboratories offers single addition NAG by both the EGI and MEND Method.

Minimum Sample Amount: 50g

Parameter
Single Addition NAG
Method
EGI
MEND
pH
EC
ORP
Sulphate
Acidity
Alkalinity
Fluoride
Chloride
Nitrate + Nitrite
Nitrite
ICP-MS

Shake Flask Extraction (SFE)

A Shake Flask test is the recommended solubility test procedure for determining the concentration of soluble constituents (mg/kg) at higher water to solids ratios.

SFE can be used as a rapid means for obtaining leached elements of interest in a sample.

This Acid Rock Drainage (ARD) test method uses distilled or deionized water as the leachate for soluble constituents. The extract from this test method is subjected to mineral solubility and other equilibrium determinations as requested by the client. Analysis on the extract may include pH, electric conductivity (EC), oxidation reduction potential (ORP), sulphate, acidity, alkalinity, anions, cations and metals.

Minimum Sample Amount: 500g

Parameter
Shakeflask Extraction (MEND)
pH
EC
ORP
Sulphate
Acidity
Alkalinity
Fluoride
Chloride
Nitrate + Nitrite
Nitrite
Dissolved metals by ICP-MS/OES

*Pricing for additional parameters available upon request

Synthetic Precipitation Leaching Procedure (SPLP) And Toxicity Characteristic Leaching Procedure (TCLP)

SPLP and TCLP are procedures that are designed to determine the mobility of both organic and inorganic analytes present in liquid, soil, and waste. Analysis on the extract may include pH, electric conductivity (EC), oxidation reduction potential (ORP), sulphate, acidity, alkalinity, anions, cations and metals.

Kinetic Testing

Kinetic cells, also known as humidity cells, involve a longer process after the initial determination of samples of interest using ABA and/or SFE analysis.

This kinetic test method covers a laboratory weathering procedure that accelerates the natural weathering rate of a solid material sample so that diagnostic-weathering products can be produced, collected, and quantified. Soluble weathering products are mobilized by a fixed-volume aqueous leach that is performed, collected, and analyzed weekly.

Routine kinetic tests include both MEND and ASTM humidity cell testing.

Minimum Sample Amount: 2kg

Parameter
Particle Size Analysis (Ro-TAP/Sieve)
Particle Size Analysis (2 point Hydrometer)
One time set up charge
Weekly Sampling
Weekly pH
Weekly EC
Weekly ORP
Weekly Sulphate
Weekly Acidity
Weekly Alkalinity
Fluoride
Chloride
Nitrate + Nitrite
Nitrite
Dissolved metals by ICP-MS/OES

*Pricing for additional parameters available upon request

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