

Introduction

The purpose of this map is to inform landowners, developers and municipal planners about the geological hazard of acid rock drainage (ARD) and to identify where the bedrock in southwestern Nova Scotia is potentially sulphide-bearing and may develop ARD if physically disturbed or exposed. Disturbing the bedrock refers to activities that physically alter and/or expose the bedrock, such as drilling, blasting and excavation. This map is intended to be used as a tool for making land-use and environmental planning decisions by indicating where precaution is needed, or further lithochemical analysis is likely required, before engaging in activities that disturb or expose bedrock.



Figure 1. Small, bronze-colored, cubic, pyrite crystals are visibly embedded in this slate. The rusty-colored iron staining indicates ongoing sulphide oxidation and ARD. Photo by G. Payne, NSERN.

Overview of Acid Rock Drainage
ARD is a phenomenon that occurs when naturally occurring sulphide minerals in rocks are exposed to air and water, and react in a chemical weathering process called sulphide mineral oxidation. During sulphide mineral oxidation, pyrite (and other sulphide-bearing minerals) react with oxygen and water to produce iron-oxides and sulphuric acid, which discharge into groundwater and streams, rivers or lakes. Waterbodies impacted by ARD typically have higher acidity (pH levels between 2 and 4), making them corrosive and unable to support many forms of aquatic life. Acidic waterbodies can negatively impact potable and industrial water supplies and can cause excessive corrosion in metal and concrete infrastructure (White and Goodwin, 2011; Fox et al., 1997). Furthermore, through a process called metal leaching, the acidic waters may break down other metal-bearing minerals in the rock, causing the release of dissolved metals (e.g., iron, aluminum, manganese, copper, zinc, cadmium, lead and other heavy metals), which can have adverse effects on human health. ARD can render municipal or domestic water supplies unusable and unpalatable, or aesthetically unpleasant. The oxidation of sulphide-bearing rocks tends to produce elevated iron concentrations, leaving an orange discoloration on rocks (Fig. 1), in stream beds (Fig. 2), and when in water supplies, discoloring laundry and porcelain fixtures.



Figure 2. Sulphide mineral oxidation of the surrounding pyrite-bearing bedrock discharges iron oxides into this stream, discoloring it red (photo by G. Payne, NSERN).

ARD occurs naturally at slow rates; exposing or breaking up sulphide-bearing bedrock, however, can accelerate the sulphide mineral oxidation process. Human activity such as highway construction, quarrying, excavating, as well as natural events (e.g., washouts) are activities that can physically disturb and expose sulphide-bearing bedrock.

Acid Rock Drainage Potential in Nova Scotia

Recent bedrock mapping in the Goldenville and Halifax groups in southern Nova Scotia (White and Goodwin, 2011; White et al., 2012) has shown that some bedrock formations have the potential to generate ARD. Sulphide-bearing slate from the Cunard and Acadia Brook formations have the highest potential of generating acidic runoff because these formations contain abundant pyrite, pyrrhotite and other sulphide-bearing minerals. Pieces of the weathered sulphide-bearing bedrock may be incorporated into the overlying loose surface material. Exposing this type of fill or soil can also initiate the process of ARD.

If disturbance is unavoidable, then potentially acid-generating bedrock (and other sulphide-bearing materials) must be managed in accordance with the Sulphide Bearing Material Disposal regulations (made under Section 66 of the Nova Scotia Environment Act 1995; Province of Nova Scotia 1995).

Classification of Acid Rock Drainage Potential

Recently published digital data and geological maps of southwestern Nova Scotia (White et al., 2012), combined with unpublished lithochemical data, were used as the base for ARD prediction. Rock formations were assigned to one of the following three acid-generating potential categories:

- High potential that bedrock will generate ARD
- Moderate potential that bedrock will generate ARD
- Low potential that bedrock will generate ARD

The ARD potential categories were established on legislative standards for identifying sulphide-bearing material using a similar lithochemical method (White and Goodwin, 2011) as the British Columbia Research Initial Test (BC-RIT).

The overall potential of a rock to generate acid is determined by the ratio of minerals that produce acid, such as sulphides, known as the acid-producing potential (APP), to the minerals that are able to neutralize it, such as carbonates, known as the acid-consuming ability (ACA) (White and Goodwin, 2011). Samples from the Bridgewater area (NTS 21A/07) were analyzed to determine their overall potential to generate acid by calculating the APP/ACA ratio. These results were extrapolated to the geological units in southwestern Nova Scotia. Rock samples above the 1:1 ratio were classified as acid-producers or high potential to generate ARD; samples within the 1:1 and 1:2 ratios have moderate potential to generate ARD; samples below the 1:2 ratio are considered as non-acid producers or low potential to generate ARD. Whole-rock data were used to classify the bedrock units into acid-generating potential categories on the map based on the method outlined in White and Goodwin (2011).

Summary

The intention of this map is to provide information about the geological hazard of ARD and its associated risks, and to identify where sulphide-bearing, potentially acid-generating bedrock is located in southwestern Nova Scotia.

Physically disturbing and exposing sulphide-bearing rocks can accelerate ARD. Determining if sulphide-bearing bedrock is present should be to be considered during the planning stage of development and construction in order to avoid negative environmental and human health effects as well as to reduce costly remediation. The best way to prevent ARD is knowing where sulphide-bearing bedrock is located and to avoid disturbing and/or exposing it.

Additional Information

For more information about ARD, please refer to Information Circular ME 067. Additional information includes the factors that influence ARD, the human activities that initiate ARD, and the effects of ARD that impact human health, the environmental and infrastructure.

Legend*

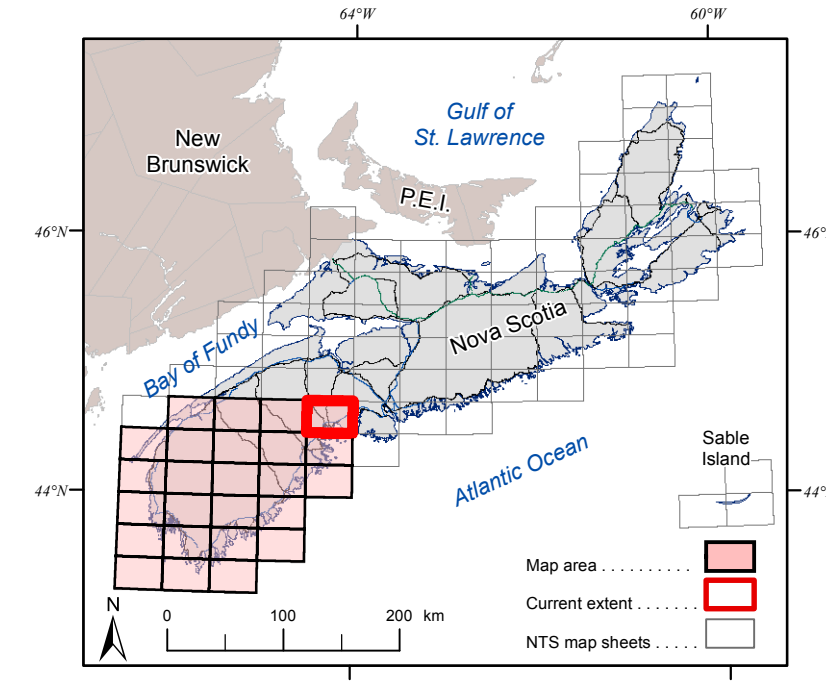
Potential for acid rock drainage (ARD) from bedrock that is exposed or physically disturbed

- High potential that bedrock will generate ARD (Dark brown)
- Moderate potential that bedrock will generate ARD (Medium brown)
- Low potential that bedrock will generate ARD (Light brown)

Symbols*

- Building (dotted line)
- Rock in water (dashed line)
- Municipal drilled well (circle with dot)
- Antarctic highway (dotted line with 'A')
- Trunk highway (dotted line with 'T')
- Collector highway (dotted line with 'C')
- Hard surface road (dotted line)
- Loose surface/resource access road (dotted line)
- Traffic, footpath, cart track (dotted line)
- Railway (active, inactive) (dotted line with cross-ticks)
- Coastline (dotted line)
- River, stream (solid line)
- Municipal boundary (dashed line)
- Watershed (primary, secondary) (dotted line)
- Transmission line (multi, single line) (dotted line with 'T')
- Municipal surface water supply area (dotted line)
- National Park (dotted line)
- Wetlands (dotted line)
- Lake/ocean (dotted line)

* Note: Compiled legend and symbols list for Open File Maps ME 2013-003 to 2013-027. All symbols may not appear on each map.



Descriptive Text
This map represents the fourth in a series of 25, 1:50,000 scale maps highlighting the acid-generating potential of bedrock in southwestern Nova Scotia if exposed and/or physically disturbed. A corresponding digital product (DP ME 484) and an information circular (IC ME 067) are available on the DNR website.
This map is part of an undergraduate Honours thesis project with Dalhousie University School of Planning, examining how to make geologic information accessible to an audience of planners and non-geologists.
Disclaimer
The information on this map may have come from a variety of government and non-government sources. The Nova Scotia Department of Natural Resources does not assume any liability for errors that may occur. Site specific lithochemical analyses are necessary to confirm the occurrence of acid-generating bedrock.

Map Notes
GIS databases, cartography and reproduction by Laura Trudell, Ange Ehler, Brian Fisher and Jeff McKinnon of the Nova Scotia Department of Natural Resources, 2013. The GIS databases and map were developed using ArcGIS 10.
Universal Transverse Mercator Projection (UTM), Zone 20, Central Meridian 63°00' West, North American Datum (NAD) 1983 Canadian Spatial Reference System (CSRS) 08.
Base and digital data derived from the Nova Scotia Topographic Database (NSTDB). Copyright Her Majesty the Queen in Right of the Province of Nova Scotia. The NSTDB is available from Service Nova Scotia and Municipal Relations (SNMR), Land Information Services Division (LIS), Nova Scotia Geomatics Centre (NSGC), Amherst, Nova Scotia.
Shaded relief image derived from a 25 m Digital Elevation Model of the Province of Nova Scotia, DP ME 56, version 2, 2006. Azimuth of 0°, sun angle of 45° and a vertical exaggeration of 5.

Nova Scotia Department of Natural Resources
Mineral Resources Branch
Open File Map ME 2013-006
Bedrock Acid Rock Drainage Potential Map of the Chester Area, NTS Sheet 21A/09, Halifax and Lunenburg Counties, Nova Scotia
L. L. Trudell and C. E. White
Scale 1:50,000
Halifax, Nova Scotia
2013
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Selected References
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