Celebrating 175 yrs

Groundwater Information Network

Groundwater Geoscience Program

Geological Survey of Canada

Boyan Brodaric

boyan.brodaric@canada.ca

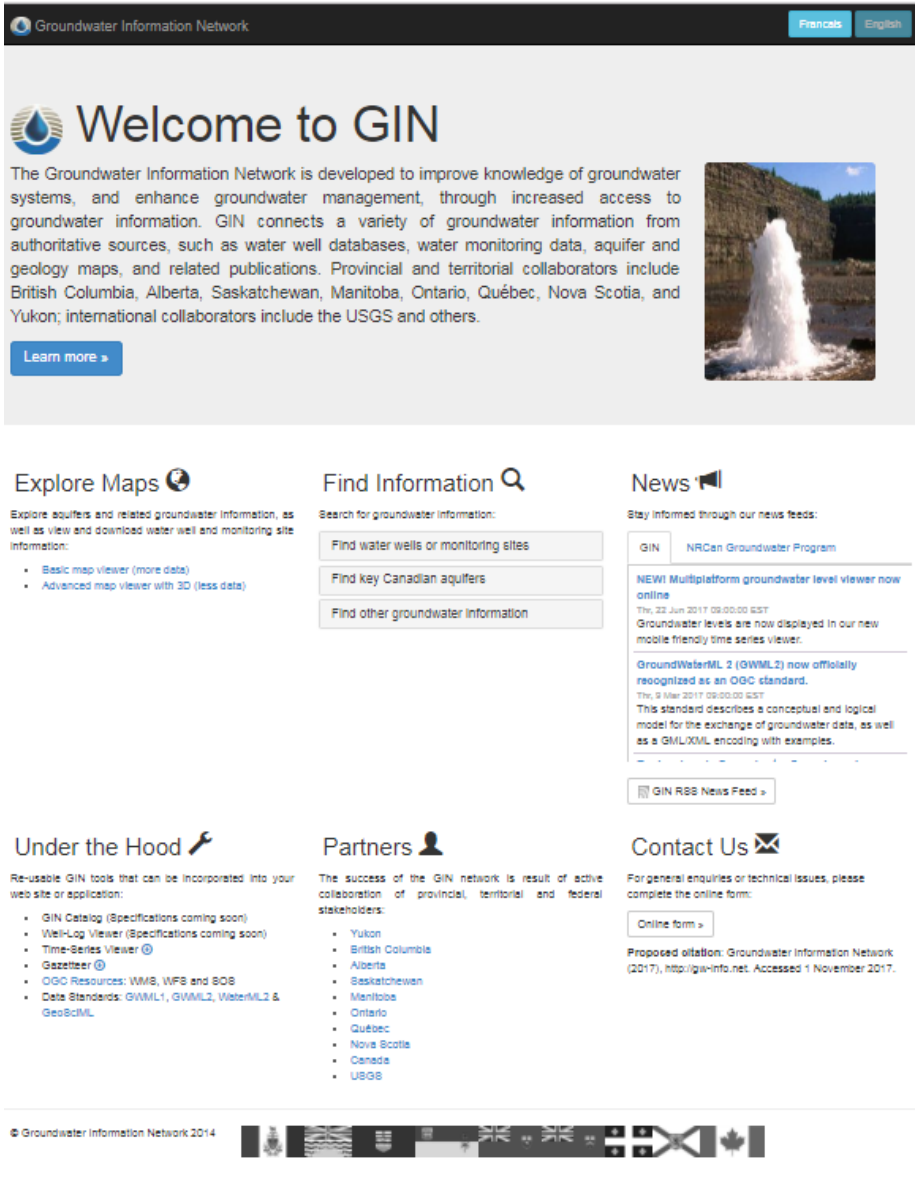
06 Dec 2017

NATURAL RESOURCES CANADA - INVENTIVE BY NATURE

Abstract

- **Groundwater Information Network**

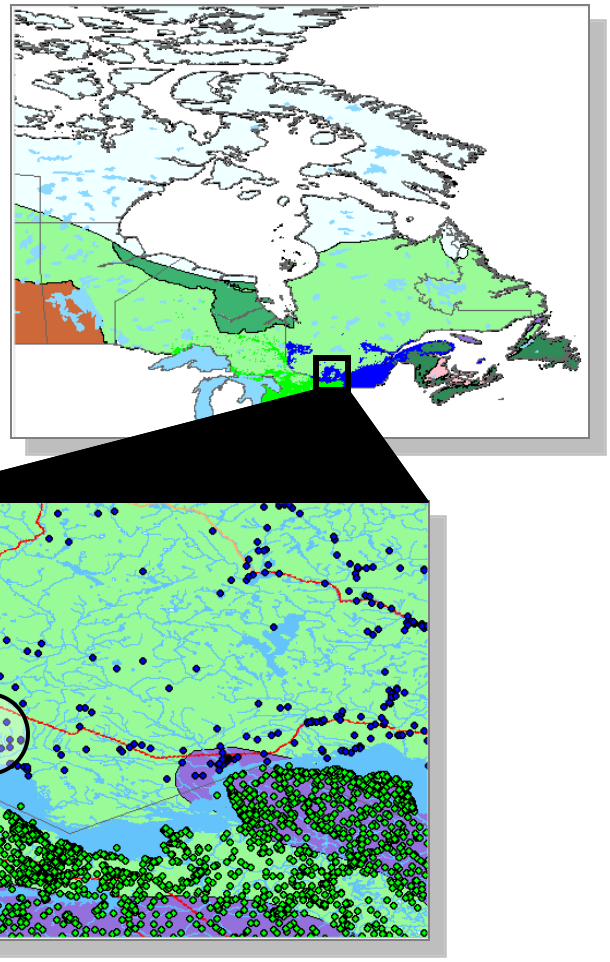
  Fed-prov-terr-int'l collaboration to disseminate groundwater data online, through the use of international standards and leading geospatial methods.



Data heterogeneity in Canada

- **Distributed and heterogeneous data**

  syntactic, schematic, semantic heterogeneity in ON-QC wells



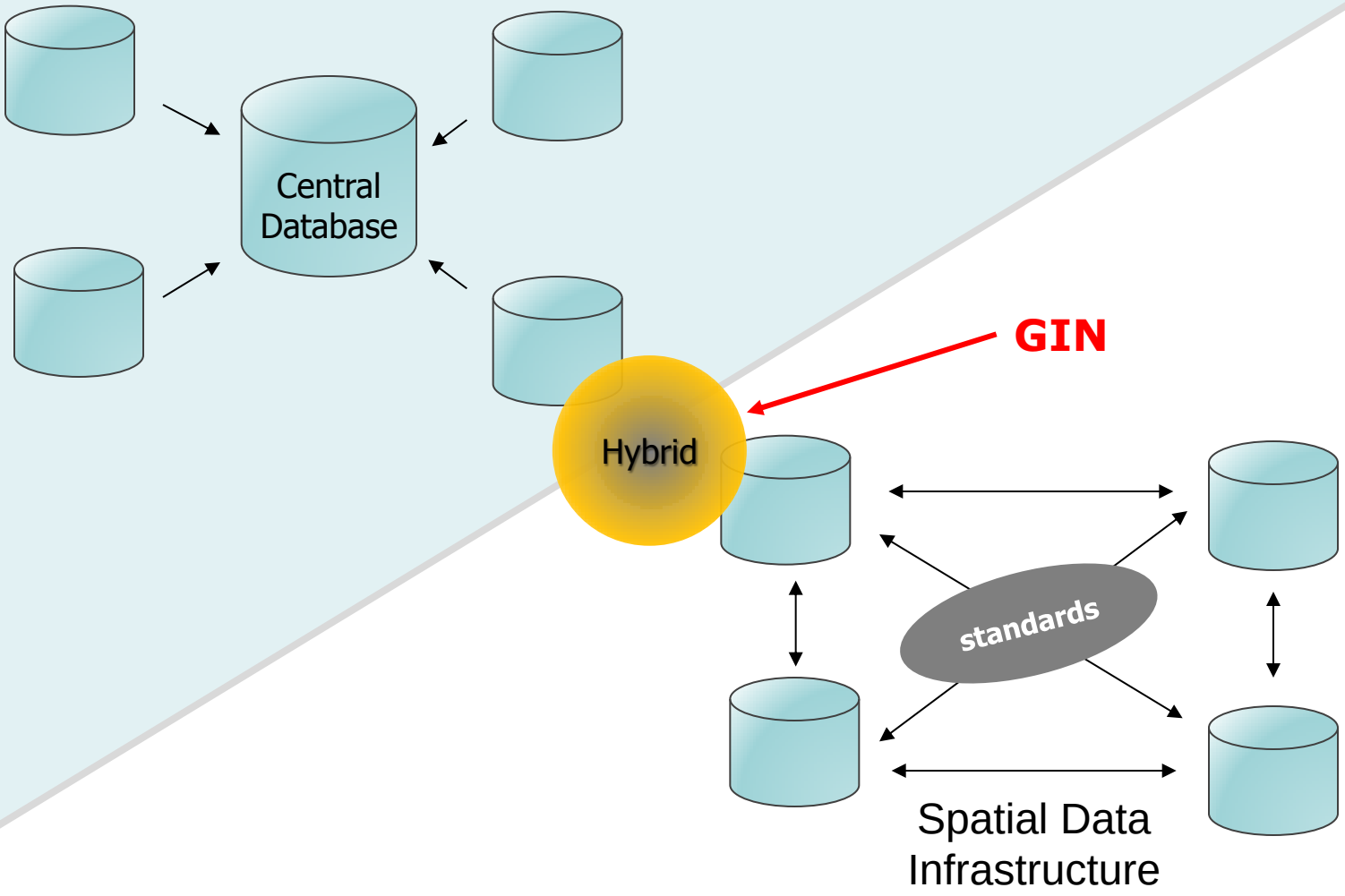
Quebec rock type

	cle_noseq integer	epaisseur double precis	matprim character var	fiss_prim character var	mat_sec character var	fiss_sec character var
1	1	1.5	SABL/BLO	INCO		INCO
2	1	3.4	SABL/BLO	INCO		INCO
3	1	3.4	ARGL/GRA	INCO		INCO
4	1	2.7	SABL/GRA	INCO		INCO
5	1	0.3	TERR	INCO		INCO

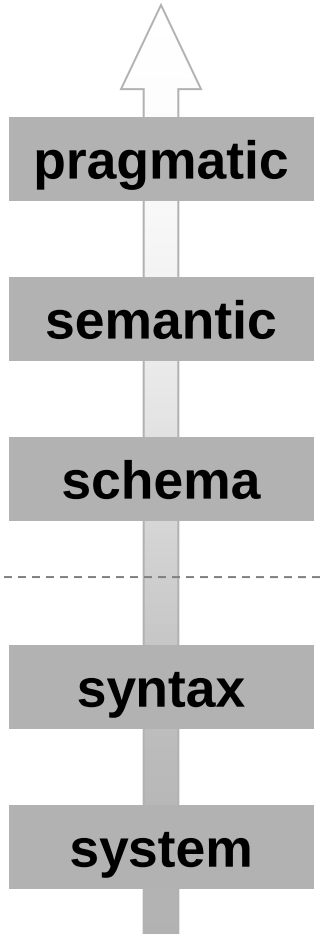
Ontario rock type

	materialcolor character var	material_1 character var	material_2 character var	material_3 character var	topdepth real	bottomdepth real
1		Topsoil			0	0.3048
2	Black	Muck			0.3048	0.9144
3		Medium Sand			0.9144	1.524
4		Fine Sand	Silt	Clay	1.524	7.3152

Solutions: central vs distributed



Levels of Interoperability



GW Practices (data usage)

GW Ontology (data content)

GWML, WaterML (data structure)

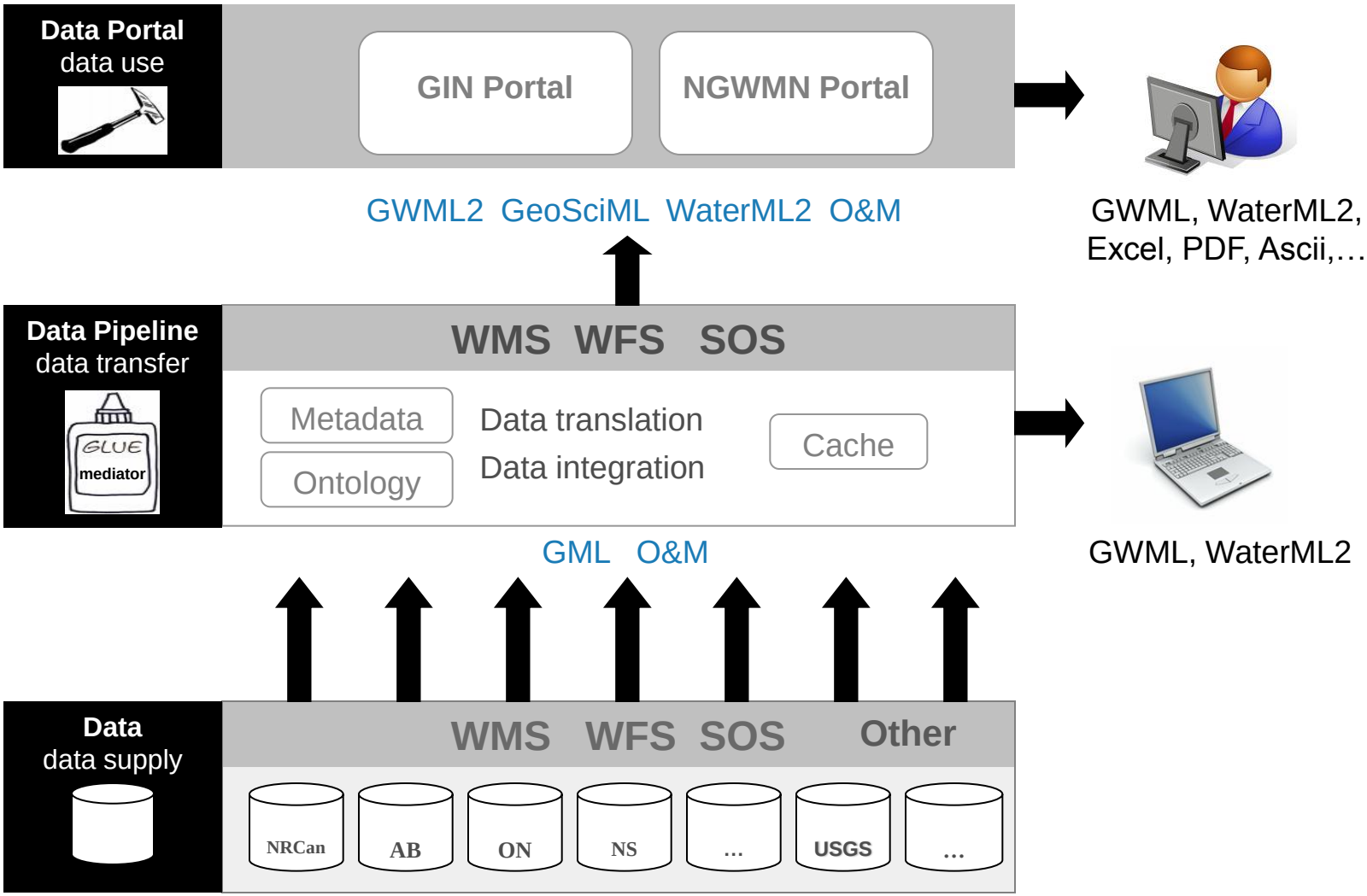
Hydrology

OGC

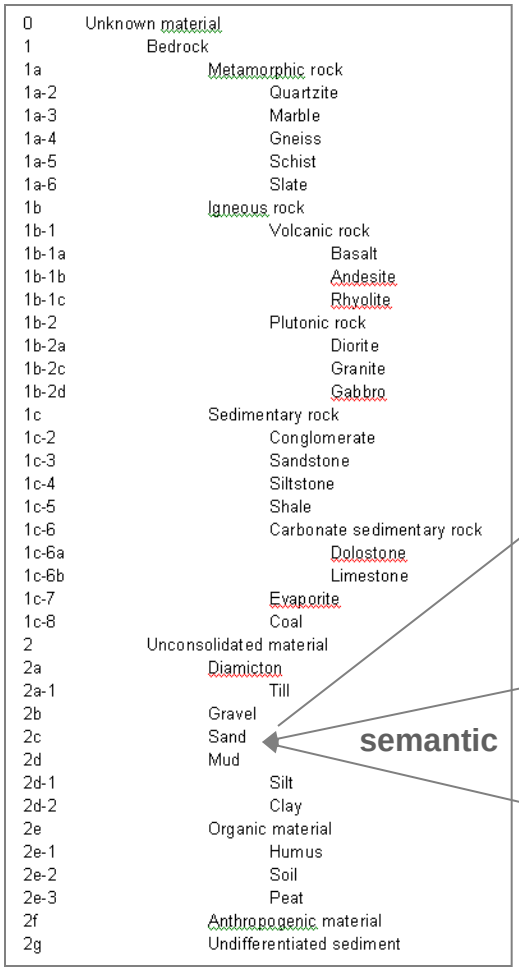
GML (data language)

WFS, WMS,… (data systems)

Architecture



Interoperability levels in action



GIN simple lithology ontology

		Lithology
	ON	Sand
	QC	Sand

syntactic

GWML

```
<lithology>
    …
    <name…>Sand</name>
</lithoogy>
```

schematic

	cle_noseq integer	epaisseur double precis	matprim character vai	fiss_prim character vai	mat_sec character vai	fiss_sec character vai
1	1	1.5	SABL/BLO	INCO		INCO
2	1	3.4	SABL/BLO	INCO		INCO
3	1	3.4	ARGL/GRA	INCO		INCO
4	1	2.7	SABL/GRA	INCO		INCO
5	1	0.3	TERR	INCO		INCO

semantic

	materialcolor character vai	material_1 character vai	material_2 character vai	material_3 character vai	topdepth real	bottomdepth real
1		Topsoil			0	0.3048
2	Black	Muck			0.3048	0.9144
3		Medium Sand			0.9144	1.524
4		Fine Sand	Silt	Clay	1.524	7.3152

Interoperability levels in action: GWML2

standard structure

standard content

standard syntax

```
<gwml2:GW_AquiferSystem
    [... snip ...]
    <gml:name codeSpace="http://gw-info.net">Appalachian External Zone</gml:name>
    [... snip ...]
  - <gsml:composition>
    - <gsml:CompositionPart>
        <gsml:role nilReason="unknown"/>
        <gsml:material xlink:title="Shale"
            xlink:href="http://resource.geosciml.org/classifier/cgi/lithology/shale"/>
      </gsml:CompositionPart>
    </gsml:composition>
  + <gsml:composition>
  + <gsml:composition>
    [... snip ...]
    <gwml2:gwUnitMedia xlink:title="granular" xlink:href="http://gw-info.net/media/granular"/>
    <gwml2:gwUnitWaterBudget xsi:nil="true"/>
  + <gwml2:gwUnitRecharge>
  + <gwml2:gwUnitRecharge>
    [... snip ...]
  + <gwml2:gwUnitDischarge>
  + <gwml2:gwUnitDischarge>
    [... snip ...]
    - <gwml2:gwHydraulicConductivity>
      - <om:OM_Observation gml:id="gu.fprop.1.1">
          <gml:description>Hydraulic conductivity for the hydrogeological unit. The median value for
            hydraulic conductivity is 10^-6 0.2 m/s, but it ranges from 10^-7 0.8 to 10^-4 0.8 m/s.
            Hydraulic regional conductivity The decreasing trend of transmissivity with depth in the
            rock is observed in all contexts. The average hydraulic conductivity is 10^-3 0.9 m/s near
            the top of bedrock (z = 1 m) which gradually loses an order of magnitude at a depth of 10
            m (10^-4 0.9 m/s), 25 m (10^-5 0.9 m/s), 60 m (10^-6 0.9 m/s) and 200 m (10^-7 0.9
            m/s).</gml:description>
          <om:phenomenonTime xlink:href="http://www.opengis.net/def/uom/nil" nilReason="missing"/>
          <om:resultTime xlink:href="http://www.opengis.net/def/uom/nil" nilReason="missing"/>
          <om:procedure xlink:href="http://www.opengis.net/def/uom/nil" nilReason="missing"/>
          <om:observedProperty xlink:title="Hydraulic Conductivity - Median" xlink:href="http://ngwd-
            bdnes.cits.nrcan.gc.ca/Reference/uri-
            cgi/classifier/ca.gin/NRCanGroundWaterTopics/1404"/>
          <om:featureOfInterest xlink:href="#gin.1"/>
          <om:result uom="http://sweet.jpl.nasa.gov/2.3/reprSciUnits.owl#meterPerSecond"
            xsi:type="gml:MeasureType">0.2E-6</om:result>
        </om:OM_Observation>
      </gwml2:gwHydraulicConductivity>
</gwml2:GW_AquiferSystem>
```

Schematic interoperability: standards

info@opengeospatial.org

OGC®
Making location count.

About Standards Innovation

OGC Geoscience Markup Language (GeoSciML)

OGC® WaterML

1) Overview
2) Documents and Downloads
3) Official Schemas
4) Related News

1) Overview

WaterML 2.0 is a standard information model for the representation of water observations data, with the intent of allowing the exchange of such data sets across information systems. Through the use of existing OGC standards, it aims at being an interoperable exchange format that may be re-used to address a range of exchange requirements, some of which are described later in this document.

2) Documents and Downloads

Version	Document Title	Document #	Type
2.0.1	OGC® WaterML 2.0: Part 1- Timeseries	10-126r4	IS
1.0	OGC® WaterML2.0: Part 2 - Ratings, Gaugings and Sections	15-018r2	IS
2.2	OGC WaterML 2: Part 4 – GroundWaterML2	16-032r2	IS
	WaterML-WQ – an O&M and WaterML 2.0 profile for water quality data (1.0)	14-003	BP

CHy-15 Pre-Session

Standardized Data Sharing in Hydrology

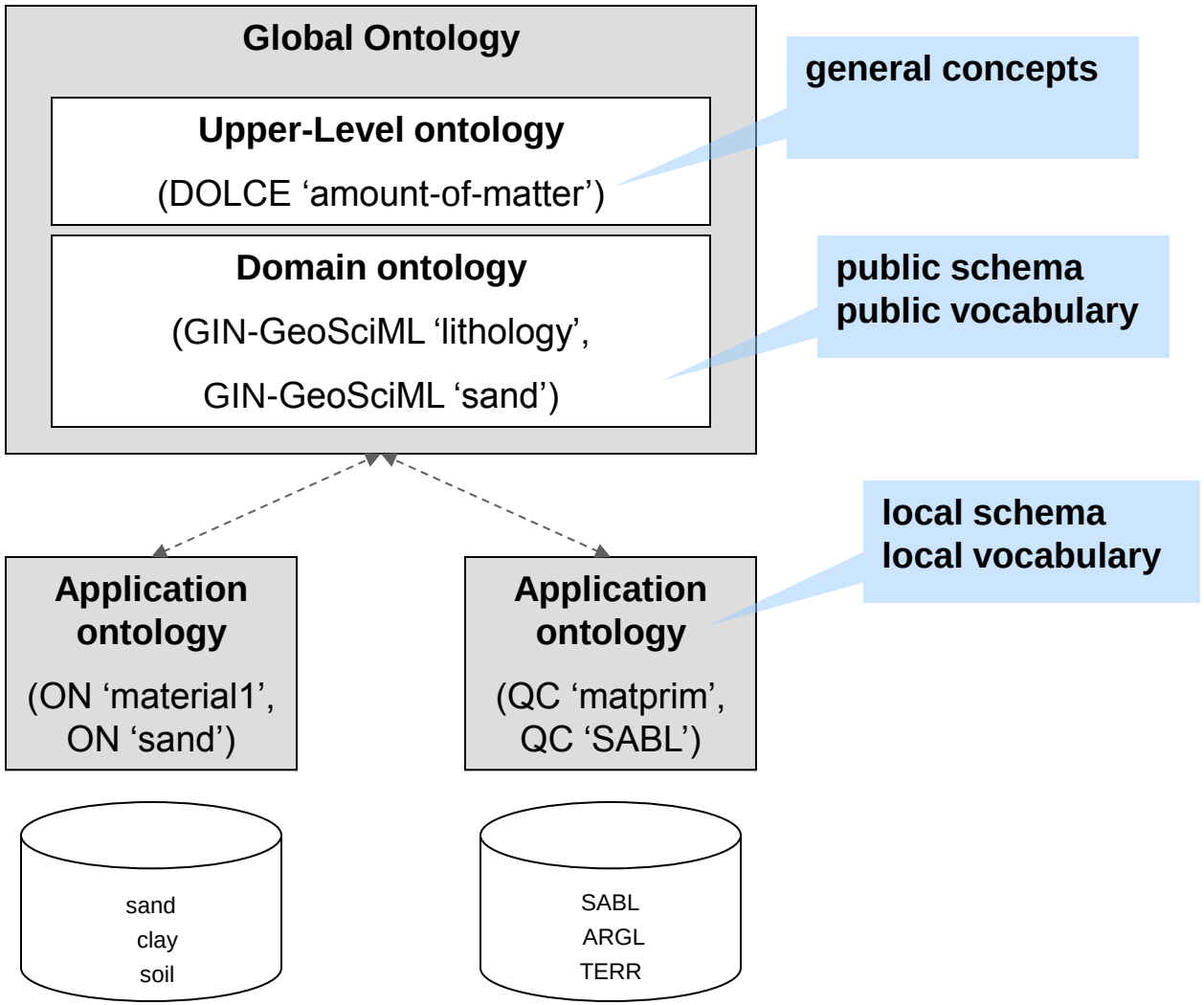
Introduction

At its fourteenth session in 2012, the Commission for Hydrology requested its Advisory Working Group "to commence a process, including testing, that could potentially see WaterML 2.0 become a WMO standard for information exchange managed by WMO" (CHy-14, Res. 3). This request put in motion an effort that precipitated several data and data-sharing activities that need to be addressed at CHy-15. Specifically, the Commission will need to make decisions on three items:

1. **Whether or not to endorse the WMO Hydrological Observing System;**
2. **Whether or not to recommend to the WMO Executive Council that WaterML 2.0: Part 1 and part 2 be adopted as WMO standards for information exchange for use by National Hydrological Services; and**
3. **Whether or not to support ongoing adoption by WMO of further WaterML 2.0 standards.**

WaterML 2: Part 4 – GroundWaterML 2 (GWML2) Data Exchange for Groundwater Features

Semantic interoperability: ontologies

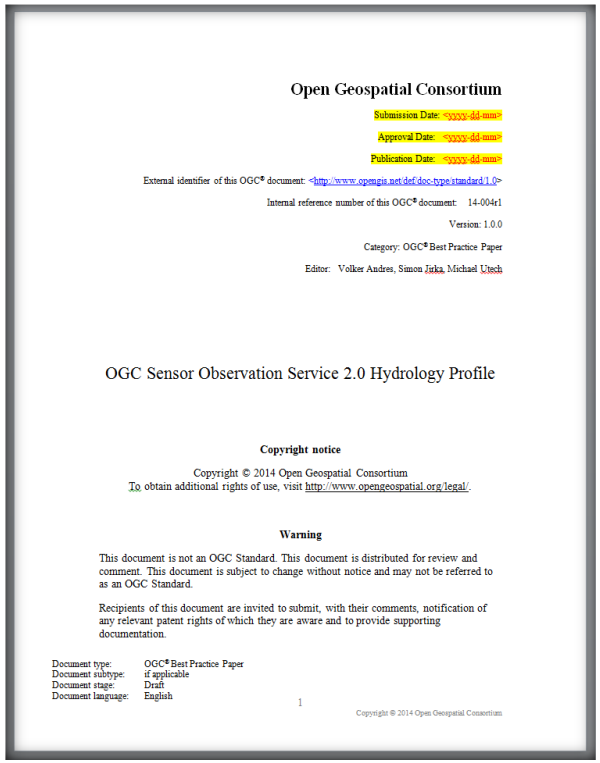


Pragmatic interoperability

- **Web service profiles, best practices**

  how to: use the services, serve data on the web

- **E.g. SOS Profile for Hydrology, SDWBP**



Open Geospatial Consortium

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Version: 1.0.0

Category: OGC® Best Practice Paper

Editor: Volker Andres, Simon Jirka, Michael Utech

OGC Sensor Observation Service 2.0 Hydrology Profile

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Document subtype: if applicable
Document stage: Draft
Document language: English

1

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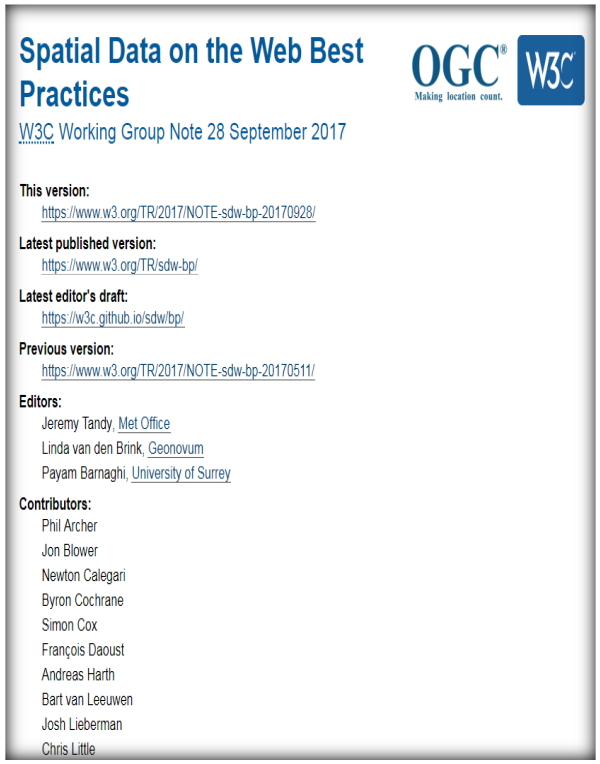


Spatial Data on the Web Best Practices

OGC® Making location count. W3C

W3C Working Group Note 28 September 2017

This version:
https://www.w3.org/TR/2017/NOTE-sdw-bp-20170928/

Latest published version:
https://www.w3.org/TR/sdw-bp/

Latest editor's draft:
https://w3c.github.io/sdw/bp/

Previous version:
https://www.w3.org/TR/2017/NOTE-sdw-bp-20170511/

Editors:
Jeremy Tandy, Met Office
Linda van den Brink, Geonovum
Payam Barnaghi, University of Surrey

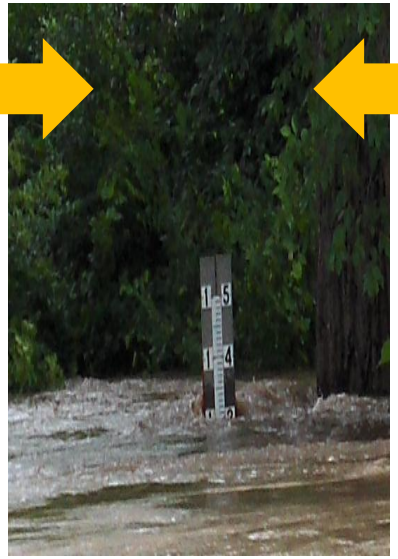
Contributors:
Phil Archer
Jon Blower
Newton Calegari
Byron Cochrane
Simon Cox
François Daoust
Andreas Harth
Bart van Leeuwen
Josh Lieberman
Chris Little

Problem: missing data links

SDI SDI SDI SDI

LD

LD



LD

atmospheric water
gauges,…
Climate data
(http://climate.weather.gc.ca)

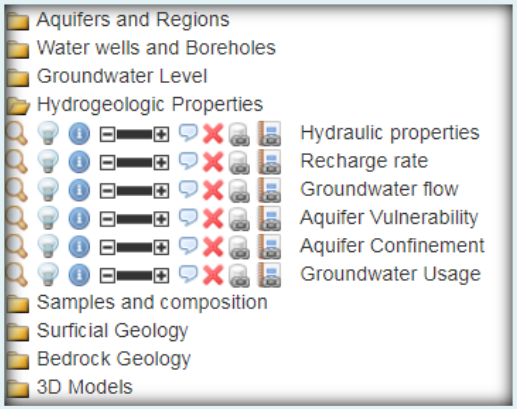
surface water
rivers, lakes, watersheds,…
Nat'l Hydro Network
(www.geobase.ca)

surface water
gauges,…
Nat'l Hydrometric Network
(www.wateroffice.ec.gc.ca)

groundwater
aquifers, wells, gauges…
GW Info Network
(www.gw-info.net)

Groundwater Information Network

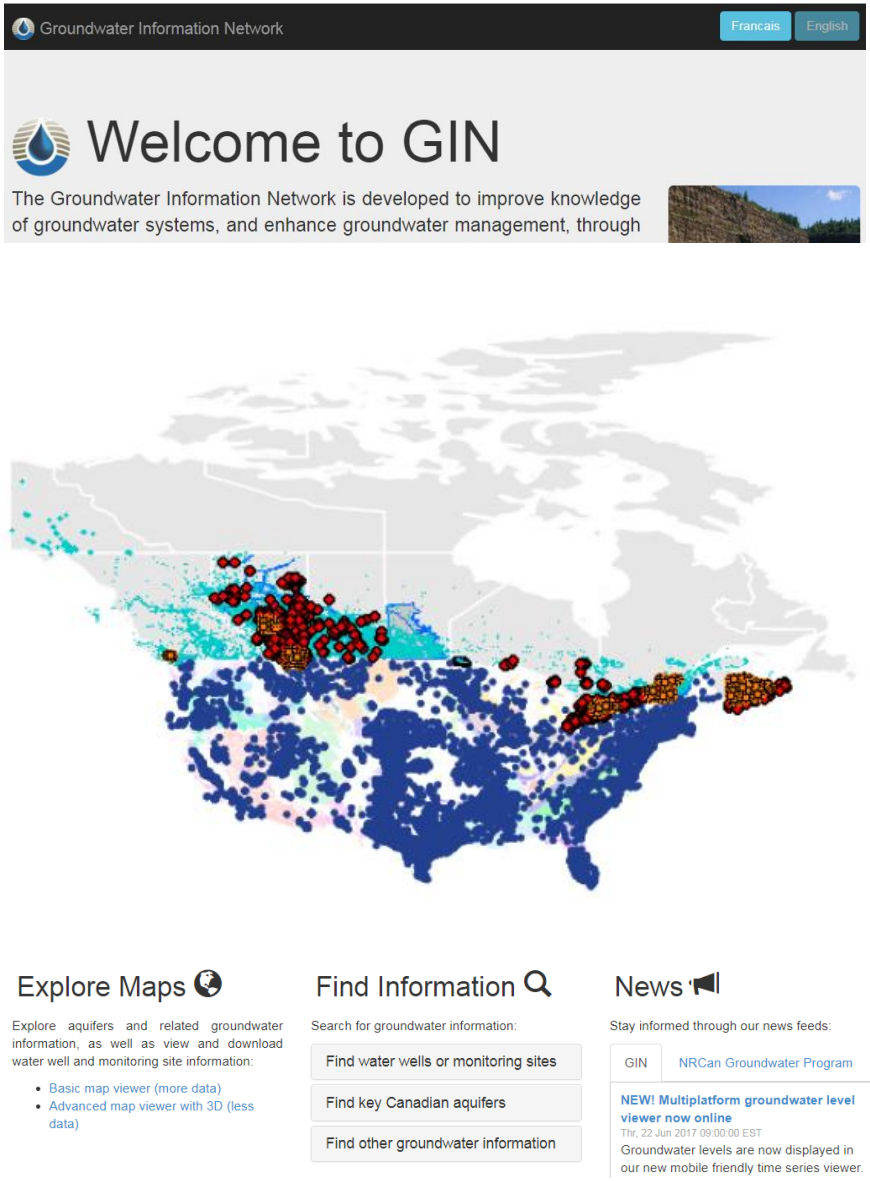
- **National**
  YK BC AB SK MB ON QC NS NL
- **International**
  USA, EU, AU
- **Data Layers**



- **Usage**

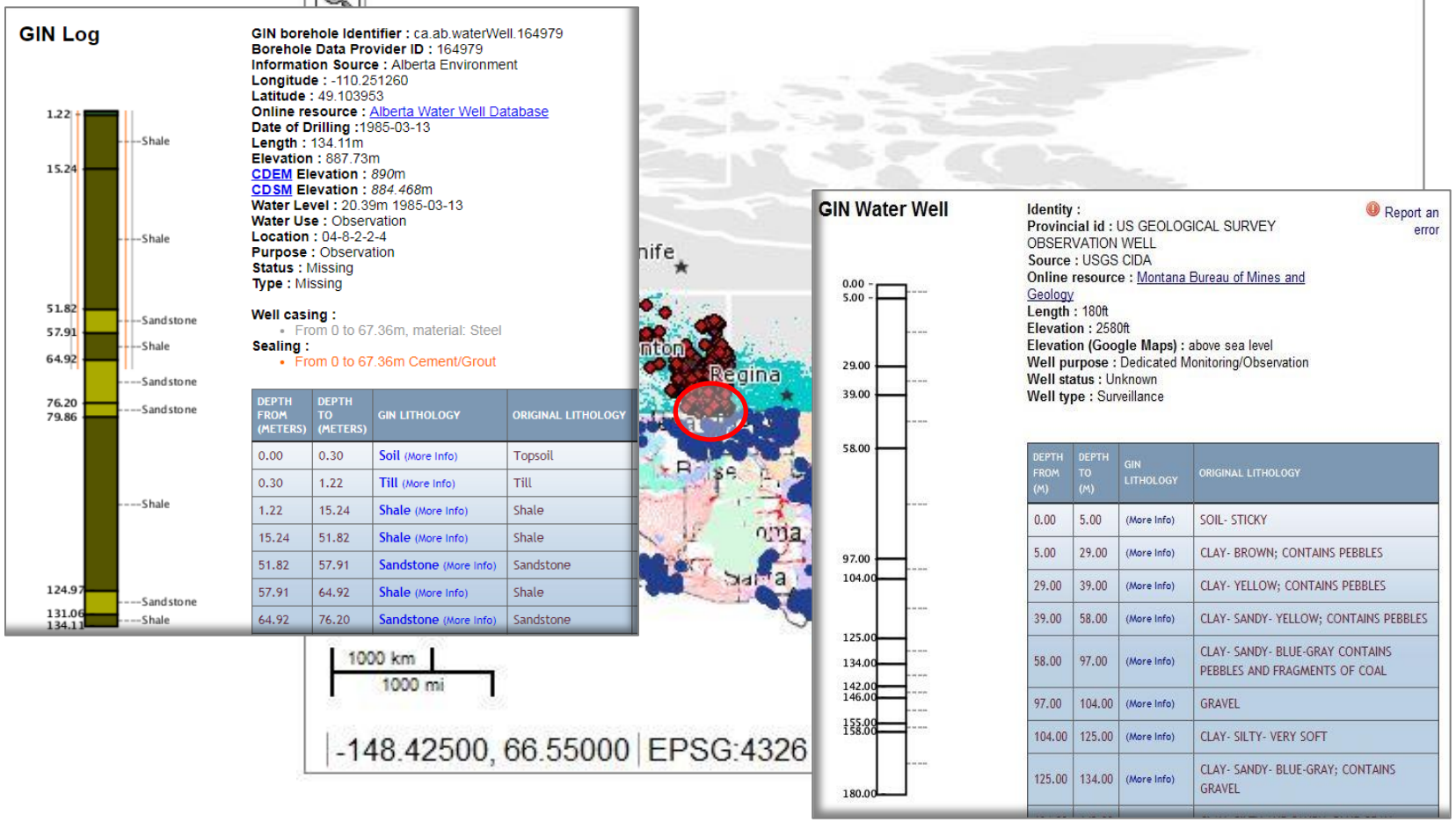
Usage Statistics 2016-17

sessions:	44,119
users:	15,391
Return visitors:	66%
GGP aquifer views:	**483**
GGP data downloads:	**2404**
P/T well views:	**9,974**
P/T well downloads:	**1049**
Other info requests:	**22,822**



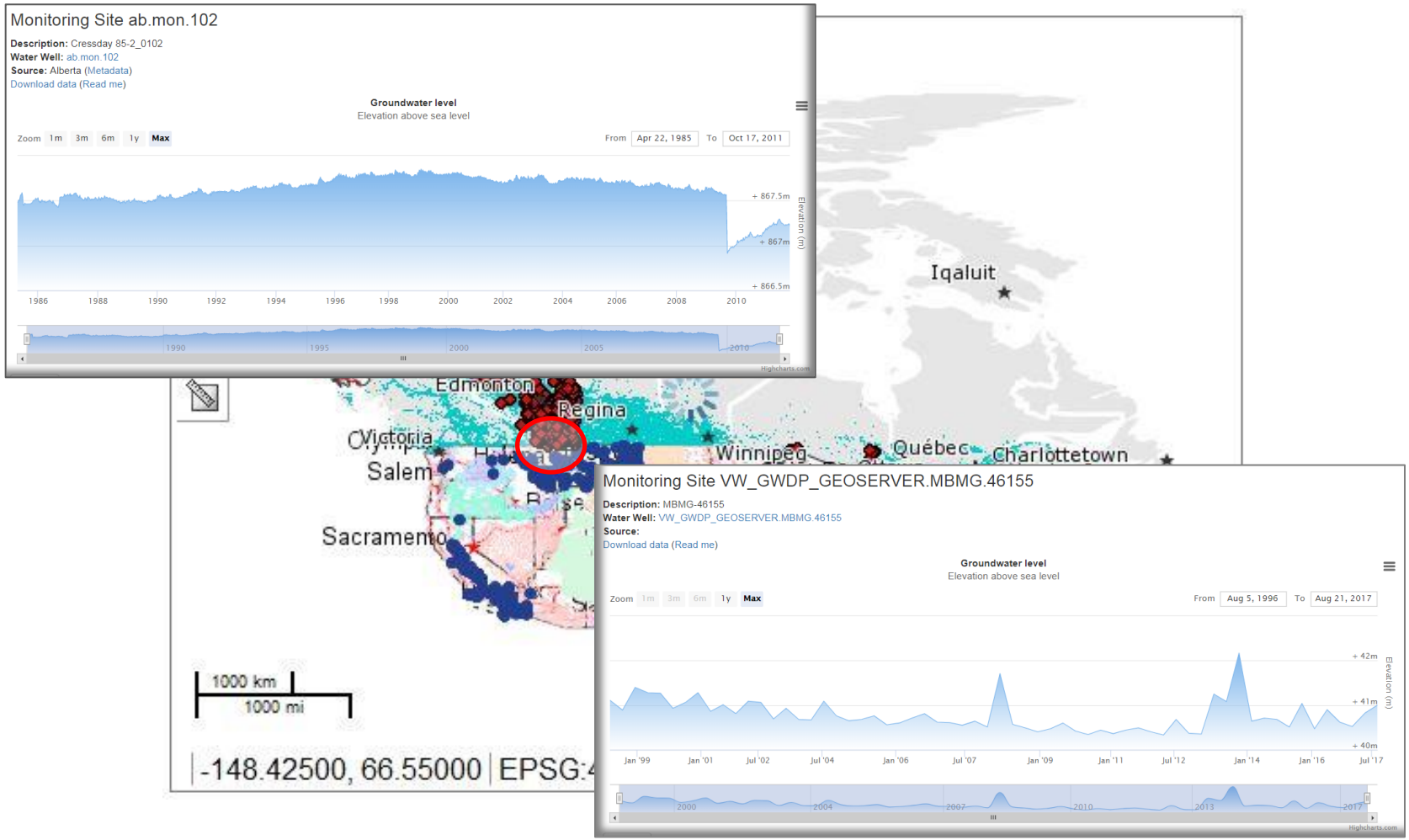
GW Interoperability: wells

- **CAN:** water wells (9 provinces)
- **USA:** water wells (USGS, 50+ states)



GW Interoperability: monitoring data

- **CAN:** groundwater level (5 provinces)
- **USA:** groundwater level & quality (USGS, 50+ states)



GW Interoperability: aquifers

- **CAN:** key aquifers (30)
- **USA:** principal aquifers (62)

Groundwater Information Network

USA National Aquifer

Aquifer name	Aquifer code	Lithology
Other rocks	N9999OTHER	
Information source	US National Groundwater Monitoring Network	
Online resource	US National Aquifer Code Reference List	
Metadata	Principal Aquifers of the 48 Conterminous United States, Hawaii, Puerto Rico, and the U	

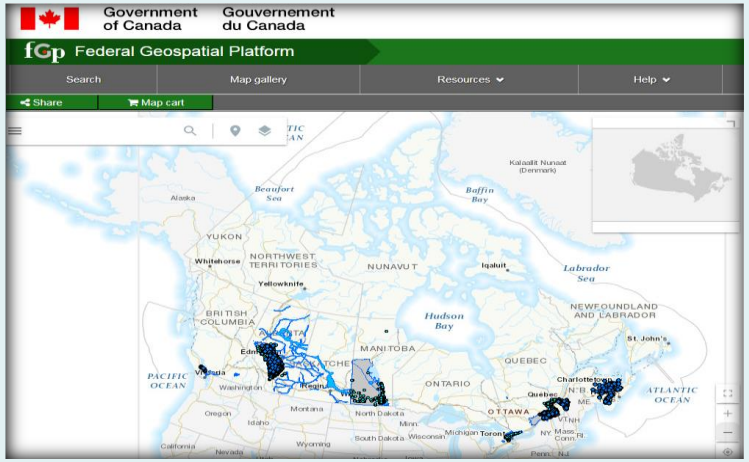
Milk River Transboundary Aquifer

Version	Metadata
	e3f4e9c8-04fc-4216-bb01-e3729a79b002
Project	
Milk River	

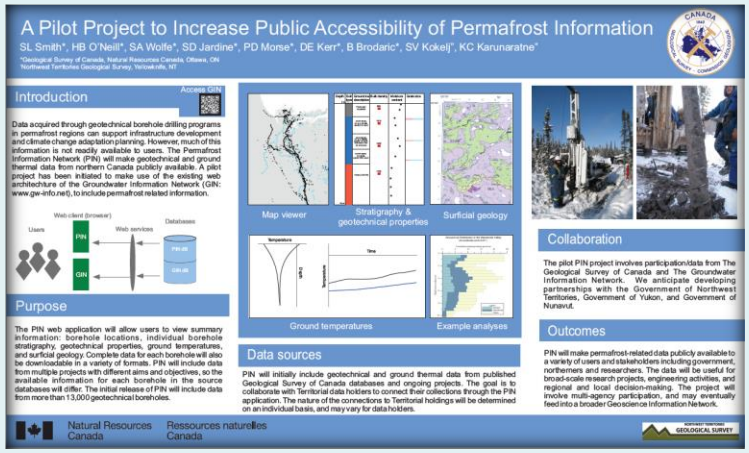
Bedrock aquifer media	
Typical value:	porous - fractured
Description	The area has two aquifers: Belly River aquifer (sandst
Source	Geology and groundwater resources of the Milk River
Confinement	
Description	The aquifers are confined by the shale and siltstone o conditions.
Source	Geology and groundwater resources of the Milk River
Surficial sediment thickness	
Range: [15 to 800] m	
Description	The surficial sediment for this study includes all sedim sediments thickness roughly follows the surface topog Sweet Grass Hills and the plains show the thinnest su study area: Disturbed Belt and Cypress Hills.
Source	Regional groundwater assessment of potable groundv
Hydrogeological unit thickness	
Description	Milk River Aquifer The thickness is up to 69 m in soutl The Belly River Group/Judith River Formation is 320 r Formation is about 70 m thick in the northwestern par Alberta and from 450 to 500 m in north central Montar Lethbridge and up to 130 m in the Sweetgrass Hills ar
Source	Regional groundwater assessment of potable groundv
Groundwater depth	
Description	In Milk River Aquifer, the Sweet Grass Hills and Cut B
Bedrock hydraulic conductivity	
Description	Milk River Aquifer The hydraulic conductivity of Virgell conductivity varies between 8.7*10^-4 and 9.2*10^-2 r Montana ranges from 9*10^-8 m/s to 8.8*10^-7 m/s. (
Source	Regional groundwater assessment of potable groundv

Interoperability: other, national

- **FGP** (Federal Geospatial Platform)

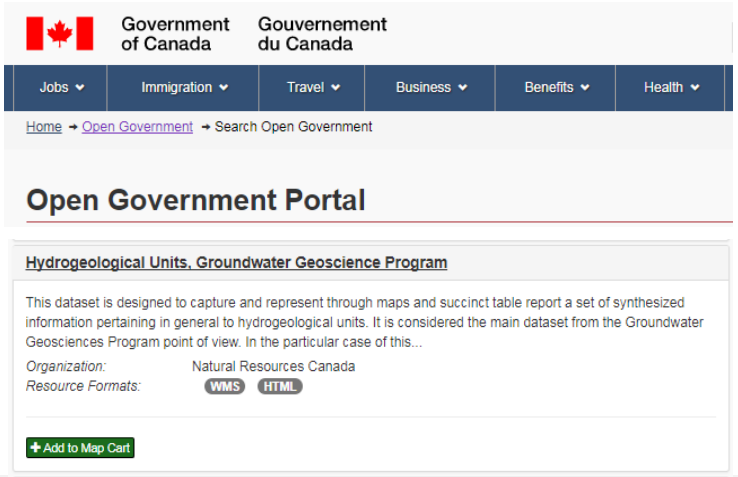


- **PIN** (Permafrost Info Network - CCGP)

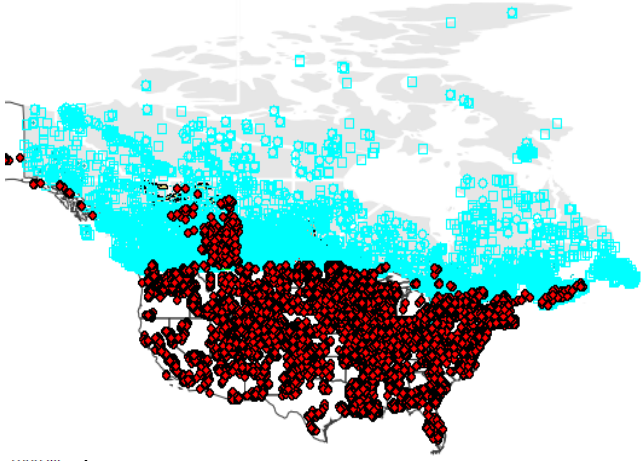


...coming soon

- **Open GOC Portal**

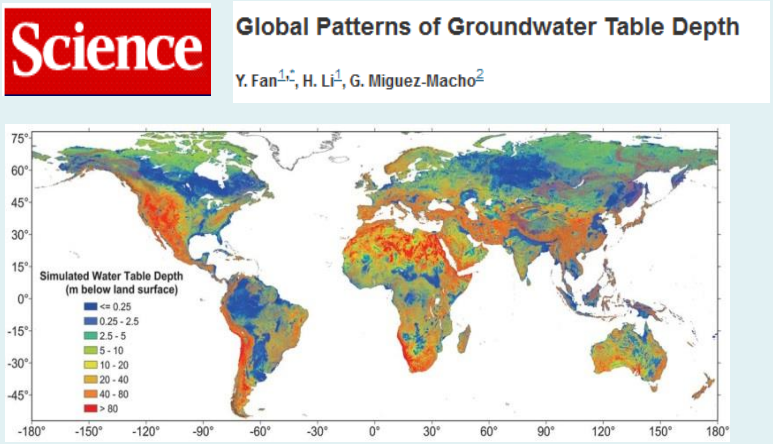


- **surface water: hydrometric network**

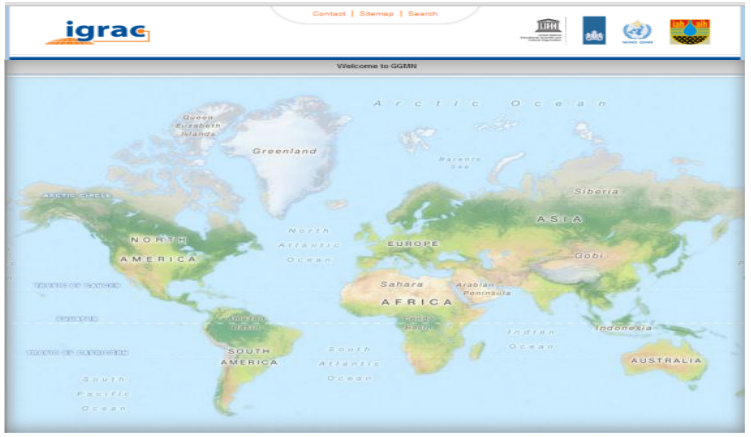


Applications: international

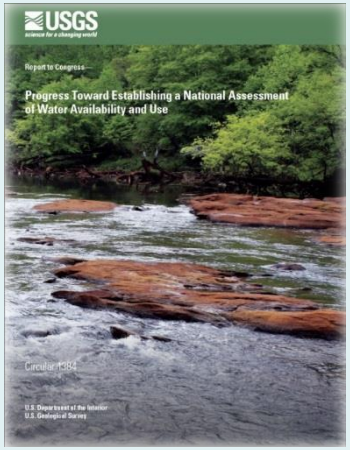
- **global groundwater modeling**



- **global groundwater monitoring**

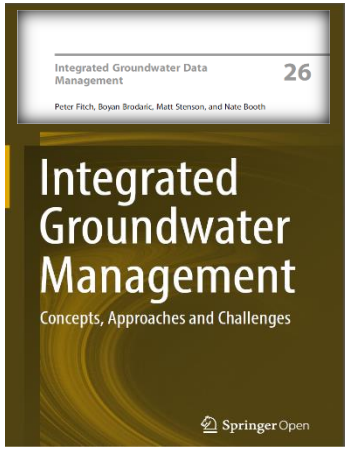


- **national water accounting**



...coming soon

- **interoperability: international**



Final Thoughts

- Canadian national Groundwater Info Network is operational and thriving
- Spatial Data Infrastructure + Linked Data technologies and standards
- Toward a North American groundwater data network

Thank you – Merci

GIN: CAN Groundwater Information Network
Groundwater Geoscience Program

- http://gw-info.net

Groundwater Information Network
Réseau d'Information sur les Eaux Souterraines

GIN Team	Notable Contributors
Eric Boisvert	Yves Michaud
Boyan Brodaric (Lead)	Christine Rivard
Heryk Julien	Alfonso Rivera
Francois Letourneau	Hazen Russell
Charles Logan	David Sharpe
Alex Smirnoff	GGP project leaders (past, present)