



Celebrating **175** yrs



Groundwater Information Network

Groundwater Geoscience Program
Geological Survey of Canada

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06 Dec 2017

NATURAL RESOURCES CANADA - INVENTIVE BY NATURE



Natural Resources
Canada

Ressources naturelles
Canada

Canada



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.

Groundwater Information Network

French English

Welcome to GIN

The Groundwater Information Network is developed to improve knowledge of groundwater systems, and enhance groundwater management, through increased access to groundwater information. GIN connects a variety of groundwater information from authoritative sources, such as water well databases, water monitoring data, aquifer and geology maps, and related publications. Provincial and territorial collaborators include British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Québec, Nova Scotia, and Yukon; international collaborators include the USGS and others.



[Learn more >](#)

Explore Maps

Explore aquifers and related groundwater information, as well as view and download water well and monitoring site information:

- Basic map viewer (more data)
- Advanced map viewer with 3D (less data)

Find Information

Search for groundwater information:

- Find water wells or monitoring sites
- Find key Canadian aquifers
- Find other groundwater information

News

Stay informed through our news feeds:

GIN NRCan Groundwater Program

NEW! Multipatform groundwater level viewer now online

Thu, 22 Jun 2017 09:00:00 EST
Groundwater levels are now displayed in our new mobile friendly time series viewer.

GroundWaterML 2 (GWML2) now officially recognized as an OGC standard.

Thu, 9 Mar 2017 09:00:00 EST
This standard describes a conceptual and logical model for the exchange of groundwater data, as well as a GML/XML encoding with examples.

[GIN RSS News Feed >](#)

Under the Hood

Re-usable GIN tools that can be incorporated into your web site or application:

- GIN Catalog (Specifications coming soon)
- Well-Log Viewer (Specifications coming soon)
- Time-Series Viewer
- Gazetteer
- OGC Resources: WMS, WFS and SOS
- Data Standards: GWML1, GWML2, WaterML2 & GeoBdML

Partners

The success of the GIN network is result of active collaboration of provincial, territorial and federal stakeholders:

- Yukon
- British Columbia
- Alberta
- Saskatchewan
- Manitoba
- Ontario
- Québec
- Nova Scotia
- Canada
- USGS

Contact Us

For general enquiries or technical issues, please complete the online form:

[Online form >](#)

Proposed citation: Groundwater Information Network (2017), <http://gin-info.net>. Accessed 1 November 2017.





Data heterogeneity in Canada

▪ Distributed and heterogeneous data

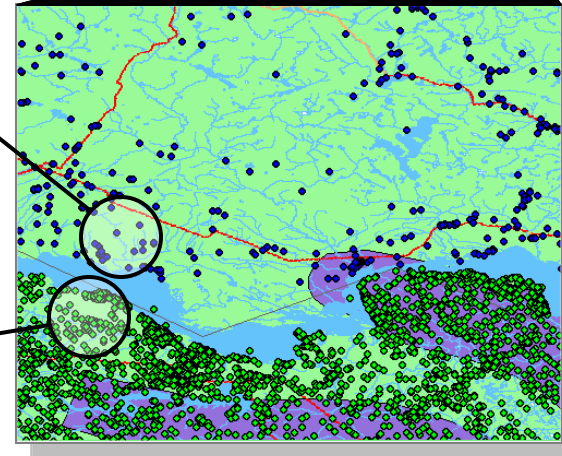
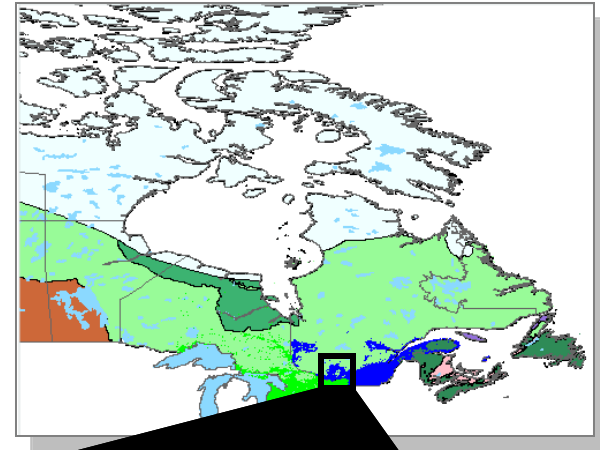
syntactic, schematic, semantic heterogeneity in ON-QC wells

Quebec rock type

	cle_noseq integer	epaisseur double precis	matprim character 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

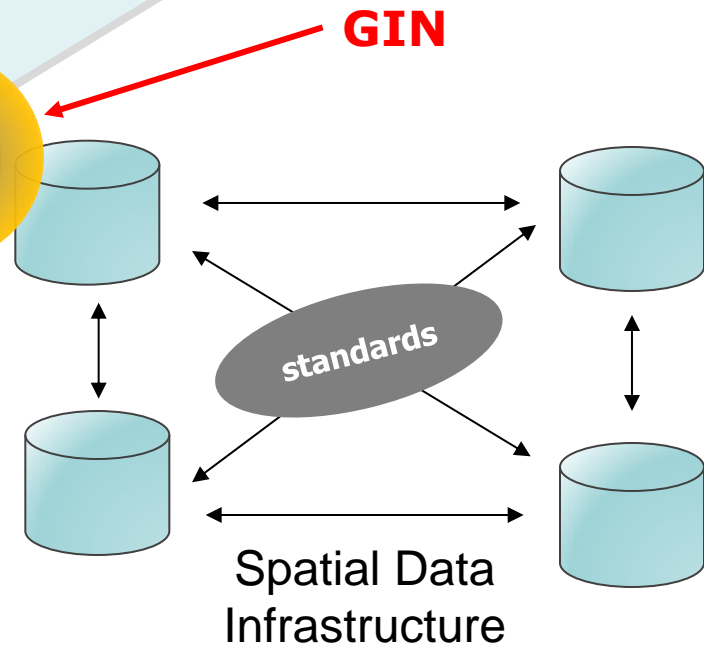
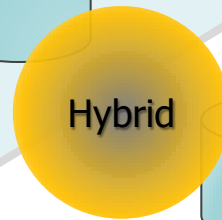
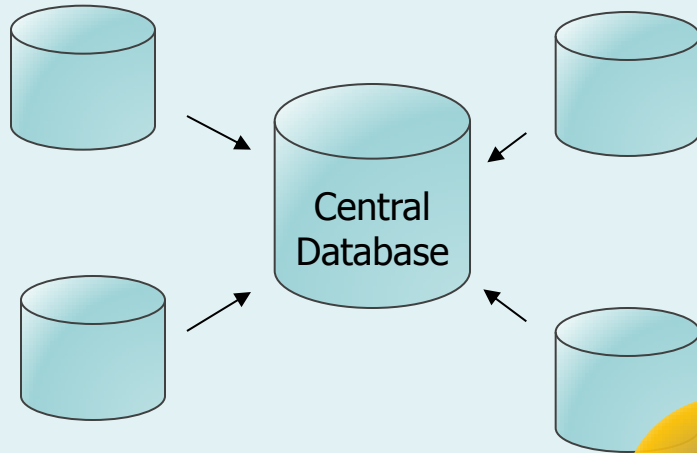
Ontario rock type

	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



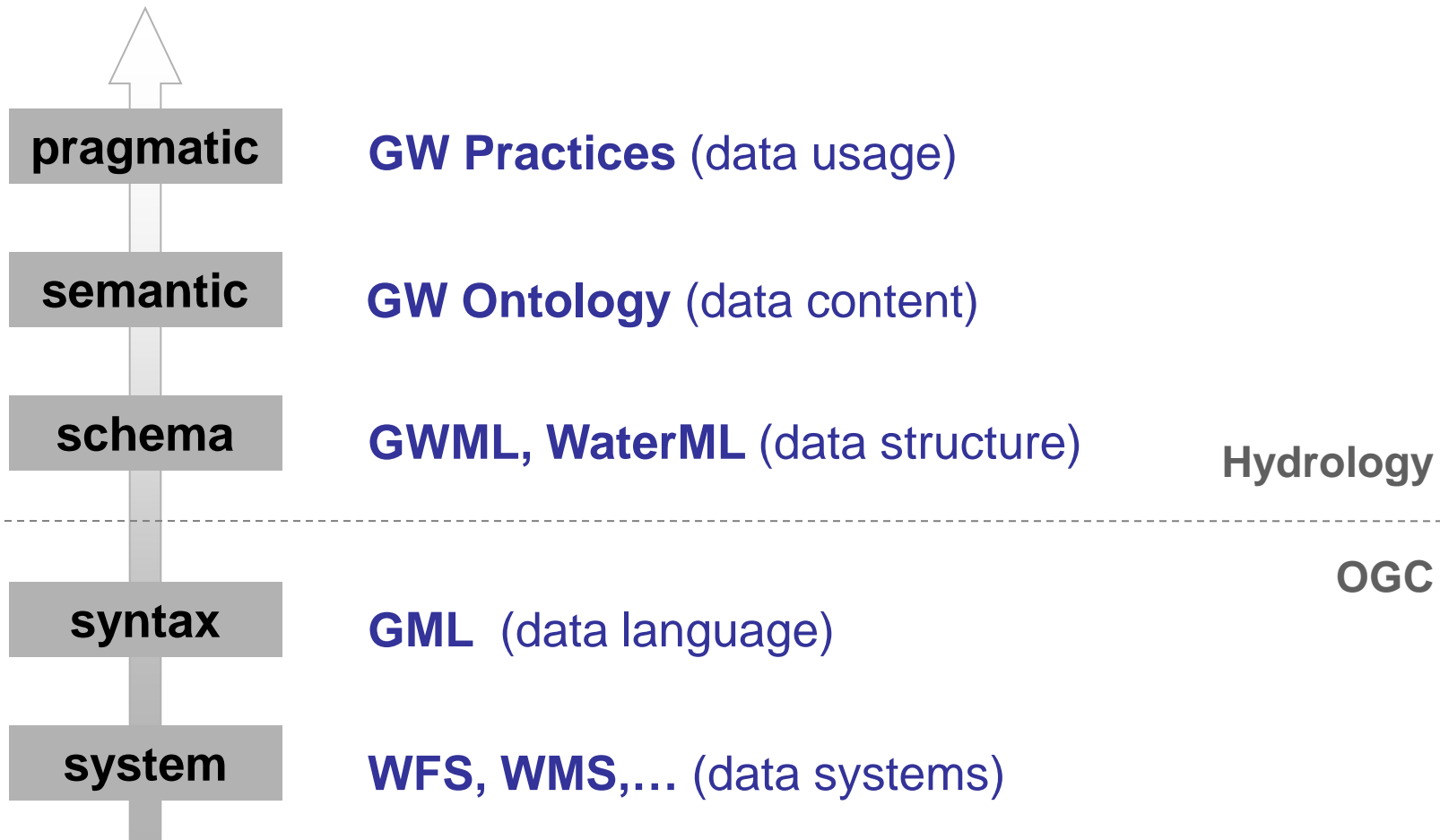


Solutions: central vs distributed



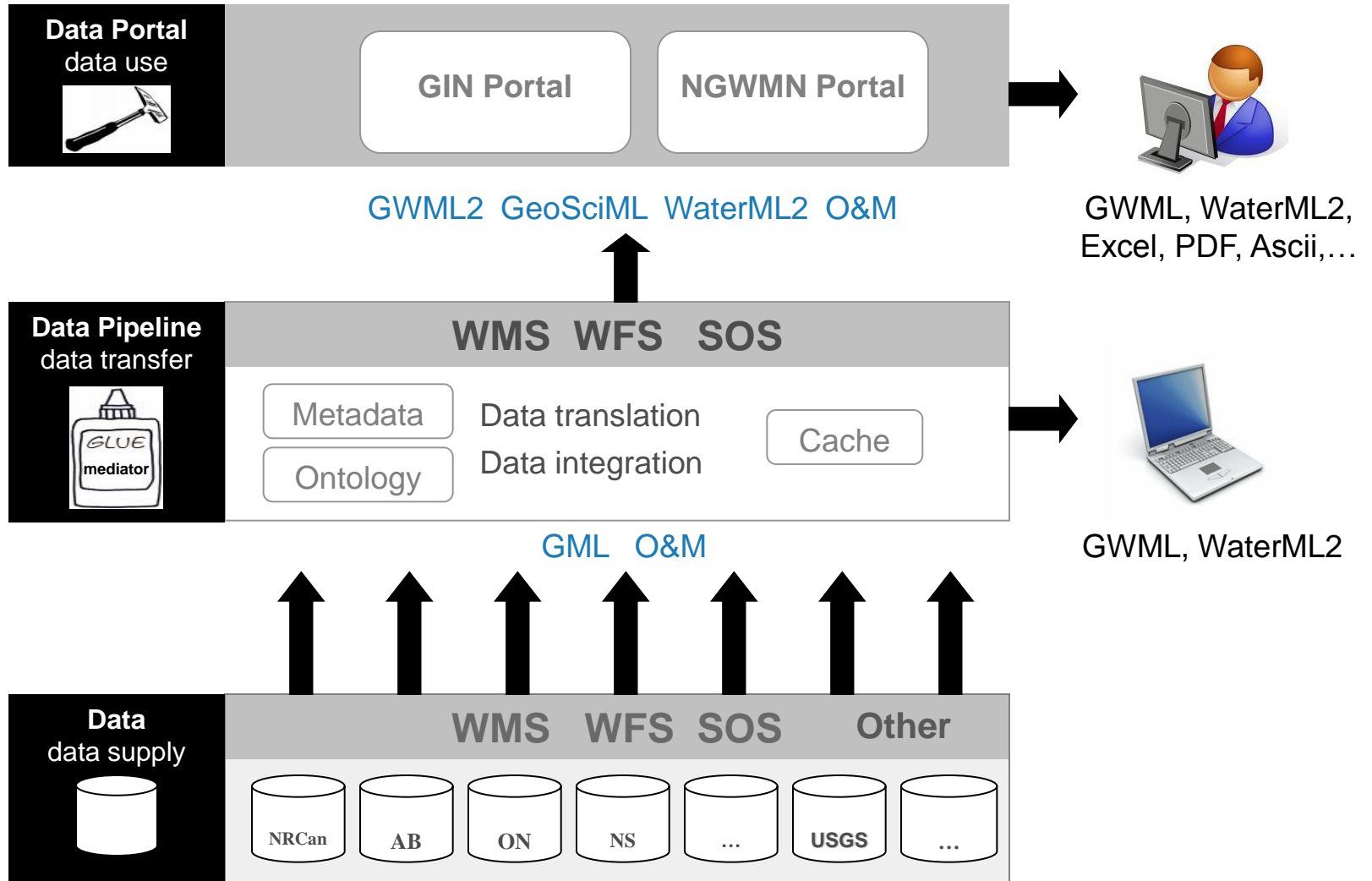


Levels of Interoperability





Architecture





Interoperability levels in action

0	Unknown material
1	Bedrock
1a	Metamorphic rock
1a-2	Quartzite
1a-3	Marble
1a-4	Gneiss
1a-5	Schist
1a-6	Slate
1b	Igneous rock
1b-1	Volcanic rock
1b-1a	Basalt
1b-1b	Andesite
1b-1c	Rhyolite
1b-2	Plutonic rock
1b-2a	Diorite
1b-2c	Granite
1b-2d	Gabbro
1c	Sedimentary rock
1c-2	Conglomerate
1c-3	Sandstone
1c-4	Siltstone
1c-5	Shale
1c-6	Carbonate sedimentary rock
1c-6a	Dolostone
1c-6b	Limestone
1c-7	Evaporite
1c-8	Coal
2	Unconsolidated material
2a	Diamicton
2a-1	Till
2b	Gravel
2c	Sand
2d	Mud
2d-1	Silt
2d-2	Clay
2e	Organic material
2e-1	Humus
2e-2	Soil
2e-3	Peat
2f	Anthropogenic material
2g	Undifferentiated sediment

		Lithology
	ON	Sand
	QC	Sand

syntactic

```

GWML
<lithology>
  ...
  <name...>Sand</name>
</lithology>
  
```

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
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	materialcolor character vai	material_1 character vai	material_2 character vai	material_3 character vai	topdepth real	bottomdepth real
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semantic

GIN simple lithology ontology



Interoperability levels in action: GWML2

standard structure

```
<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>
```

standard content

standard syntax



Schematic interoperability: standards

info@opengeospatial.org



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

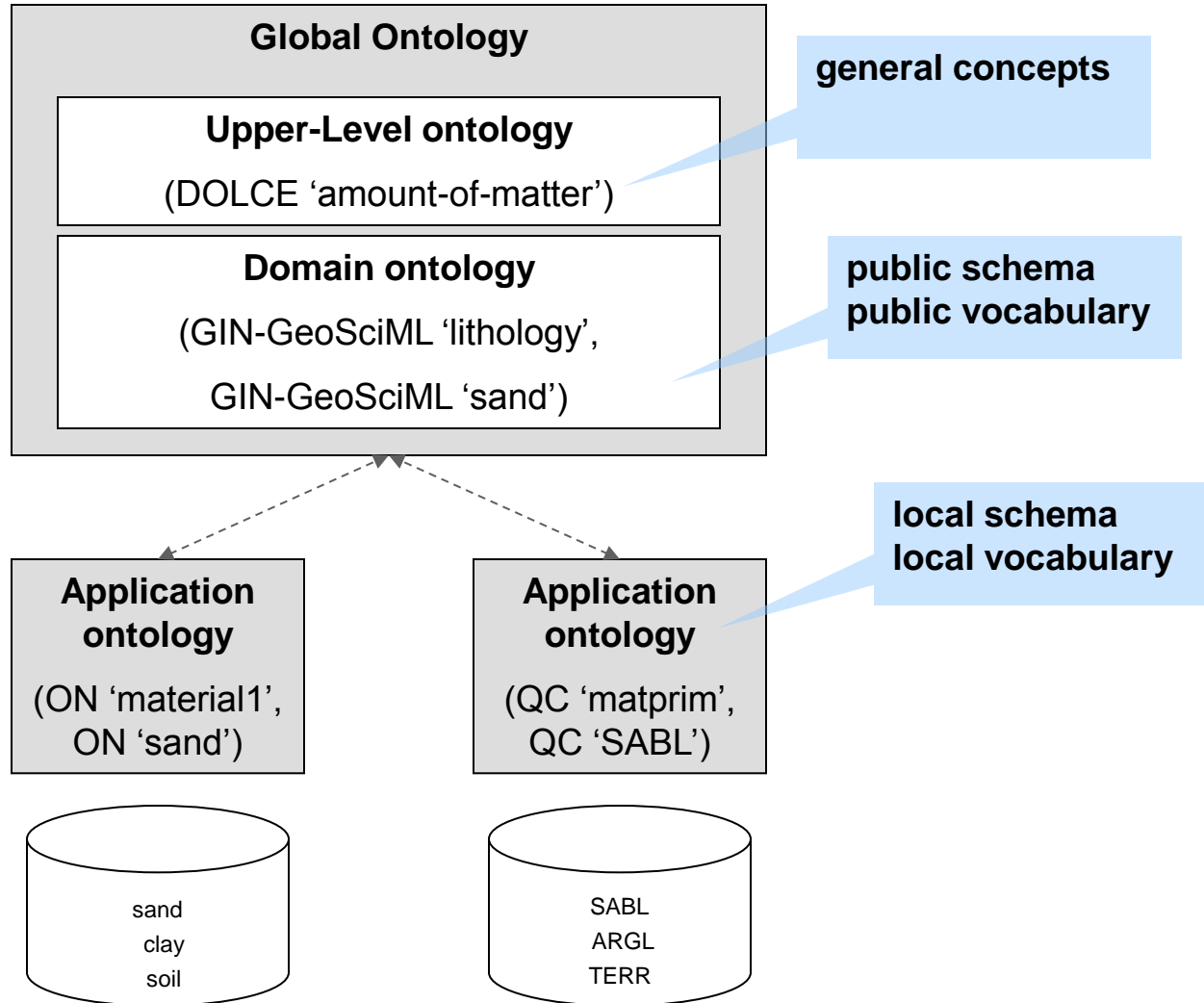
At its fourteenth session in 2012, the Commission for Hydrology requested its Advisory Working Group “to commence a process, including testing, that could potentially see WaterML 2.0 become a WMO standard for information exchange managed by WMO” (CHy-14, Res. 3). This request put in motion an effort 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

Submission Date: [2017-04-11](#)
Approval Date: [2017-04-11](#)
Publication Date: [2017-04-11](#)

External identifier of this OGC® document: <http://www.opengis.net/def/doc-type/standard/1.0/>
Internal reference number of this OGC® document: 14-0041
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 type:	OGC® Best Practice Paper
Document subtype:	if applicable
Document stage:	Draft
Document language:	English

1

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Spatial Data on the Web Best Practices

OGC® **W3C**
Making location count.

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/>

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Andreas Harth
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Chris Little



Problem: missing data links

SDI



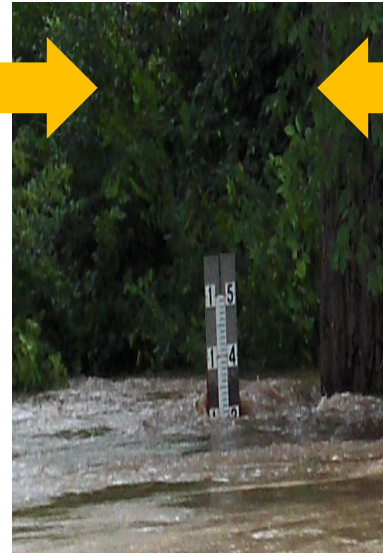
atmospheric water gauges, ...
Climate data
(<http://climate.weather.gc.ca>)

SDI



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

SDI



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

SDI



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**

- 📁 Aquifers and Regions
- 📁 Water wells and Boreholes
- 📁 Groundwater Level
- 📁 Hydrogeologic Properties
 - 💡 Hydraulic properties
 - 💡 Recharge rate
 - 💡 Groundwater flow
 - 💡 Aquifer Vulnerability
 - 💡 Aquifer Confinement
 - 💡 Groundwater Usage
- 📁 Samples and composition
- 📁 Surficial Geology
- 📁 Bedrock Geology
- 📁 3D Models

Usage


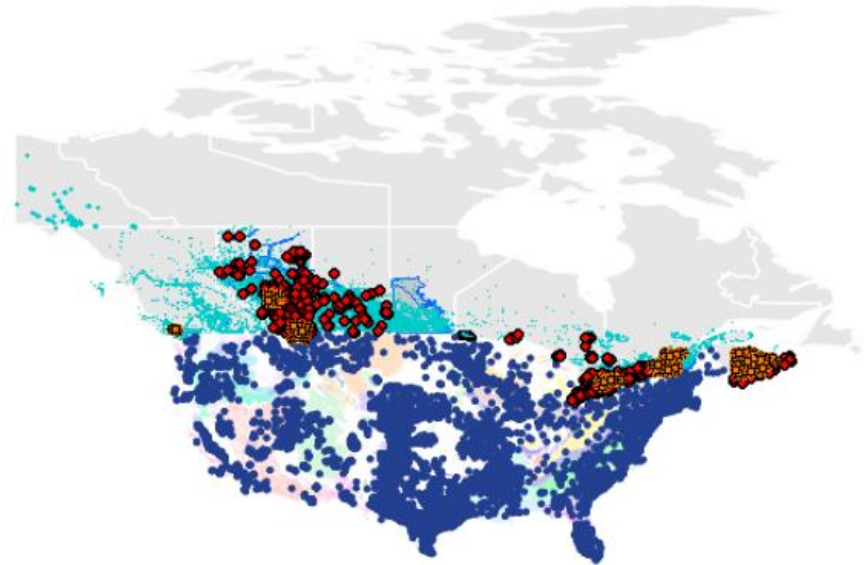
Usage Statistics 2016-17

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

Groundwater Information Network Français English

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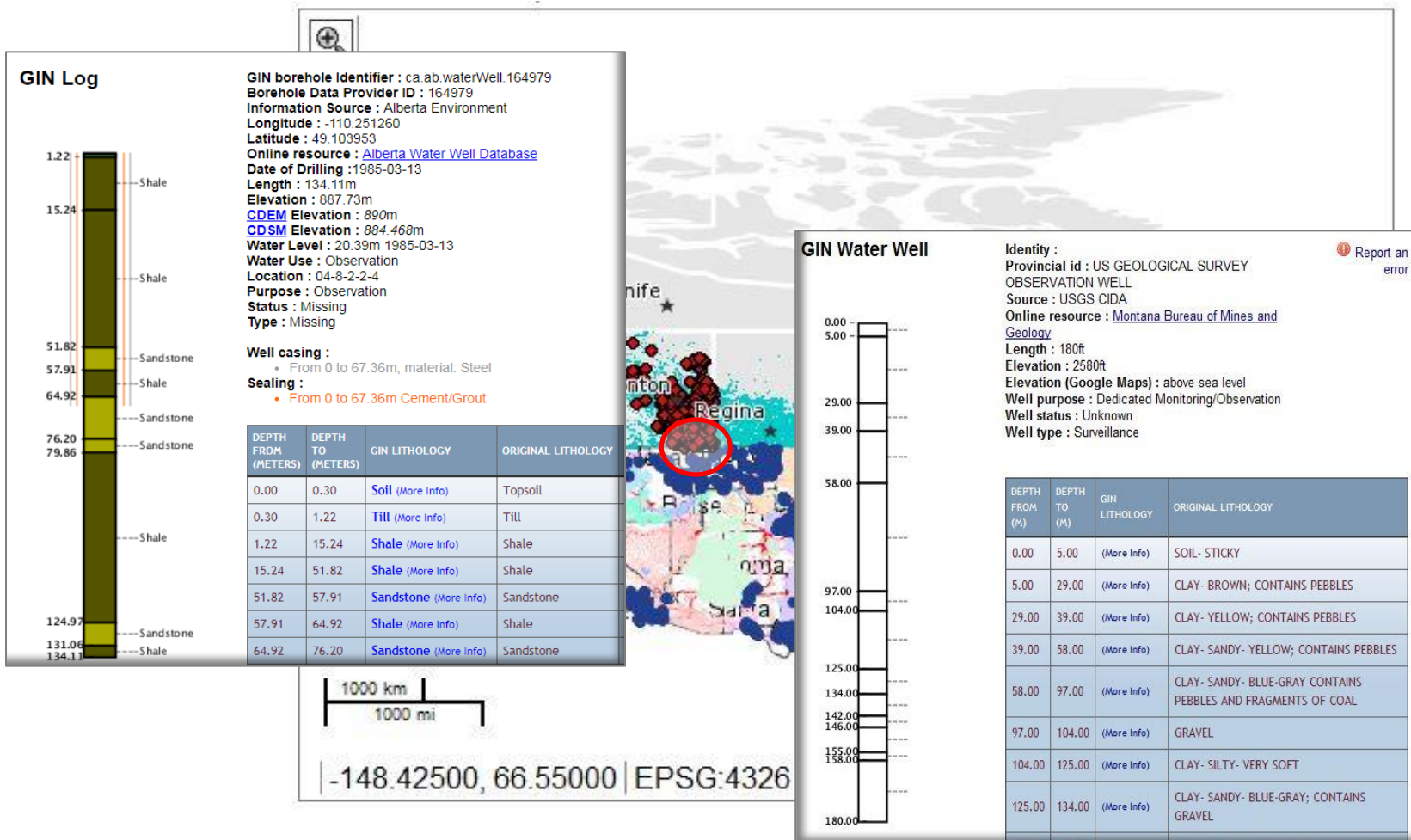
GIN [NRCan Groundwater Program](#)

NEW! Multiplatform groundwater level viewer now online
Thu, 22 Jun 2017 09:00:00 EST
Groundwater levels are now displayed in our new mobile friendly time series viewer.



GW Interoperability: wells

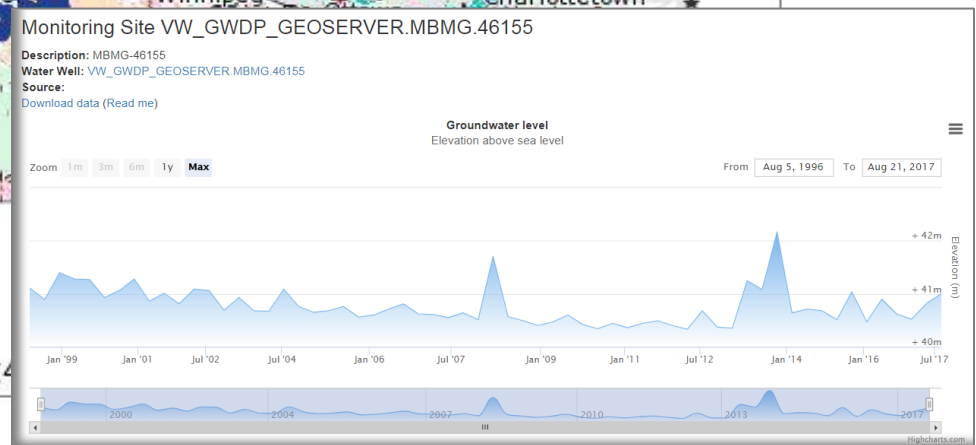
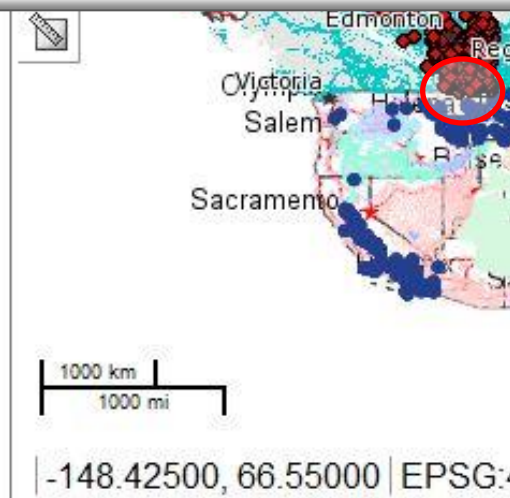
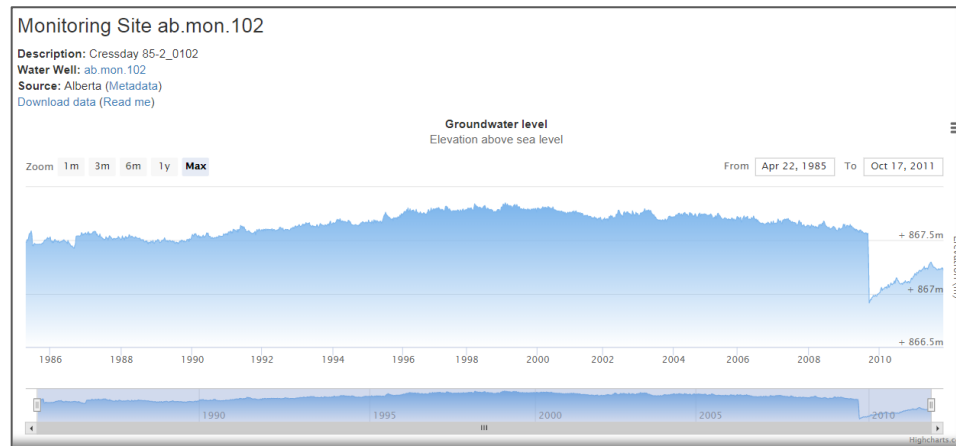
- **CAN:** water wells (9 provinces)
- **USA:** water wells (USGS, 50+ states)





GW Interoperability: monitoring data

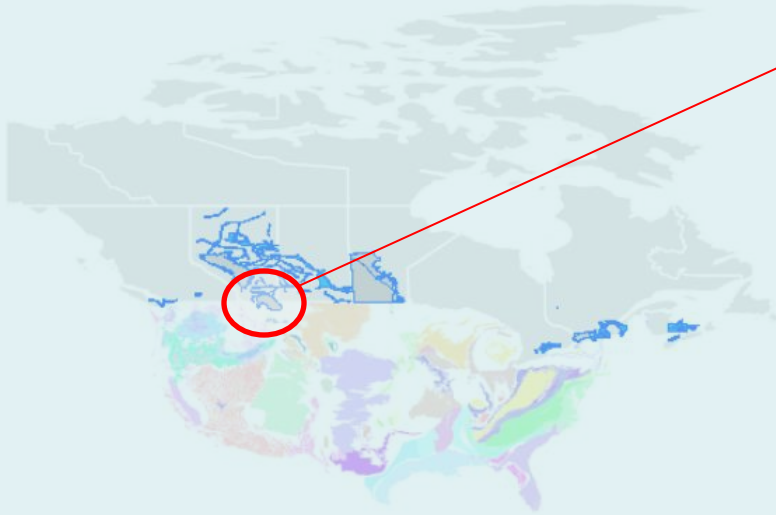
- **CAN:** groundwater level (5 provinces)
- **USA:** groundwater level & quality (USGS, 50+ states)





GW Interoperability: aquifers

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



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 (sandstone) and Milk River aquifer (sandstone).
Source	Geology and groundwater resources of the Milk River
Confinement	
Description	The aquifers are confined by the shale and siltstone or 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 sediment thickness roughly follows the surface topography. Sweet Grass Hills and the plains show the thinnest surficial sediment in the study area. Disturbed Belt and Cypress Hills.
Source	Regional groundwater assessment of potable groundwater
Hydrogeological unit thickness	
Description	Milk River Aquifer The thickness is up to 69 m in southern Alberta. The Belly River Group/Judith River Formation is 320 m thick in the northwestern part of Alberta and from 450 to 500 m in north central Montana. Lethbridge and up to 130 m in the Sweetgrass Hills area of Montana.
Source	Regional groundwater assessment of potable groundwater
Groundwater depth	
Description	In Milk River Aquifer, the Sweet Grass Hills and Cut Bank areas, groundwater depths are generally between 10 and 20 m.
Bedrock hydraulic conductivity	
Description	Milk River Aquifer The hydraulic conductivity of Virgell Formation varies between 8.7×10^{-4} and 9.2×10^{-2} m/s. In Montana, it ranges from 9×10^{-8} m/s to 8.8×10^{-7} m/s.
Source	Regional groundwater assessment of potable groundwater





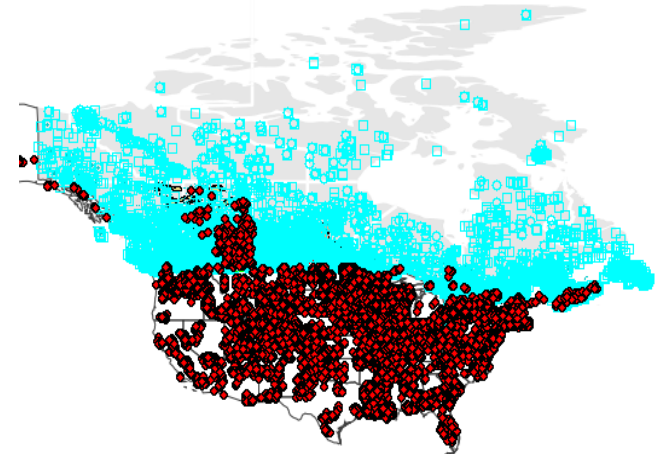
Interoperability: other, national

■ FGP (Federal Geospatial Platform)

■ Open GOC Portal

■ PIN (Permafrost Info Network - CCGP)

■ surface water: hydrometric network



...coming soon



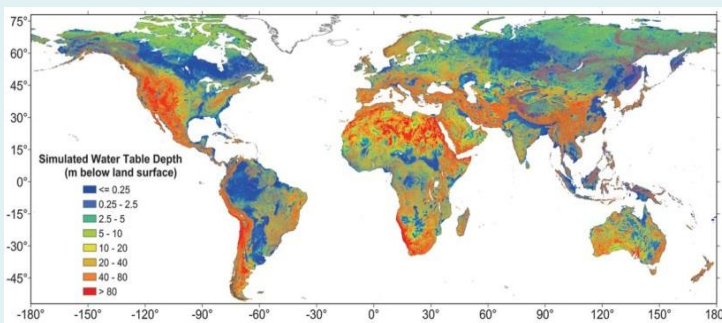
Applications: international

■ global groundwater modeling

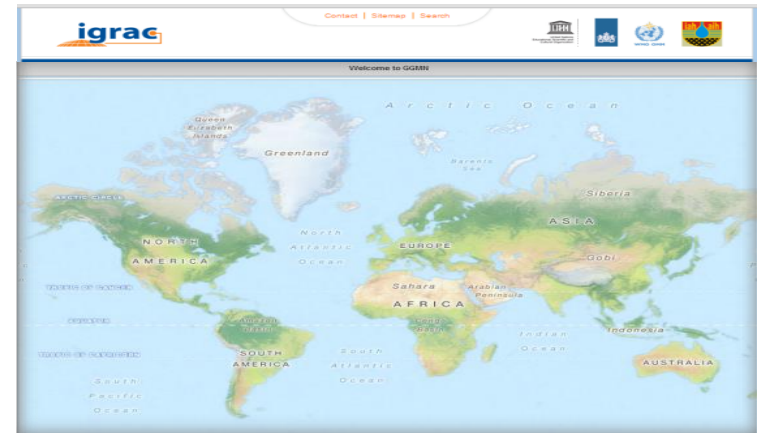


Global Patterns of Groundwater Table Depth

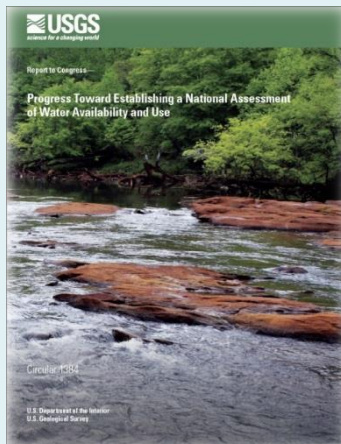
Y. Fan^{1,2}, H. Li¹, G. Miguez-Macho²



■ global groundwater monitoring

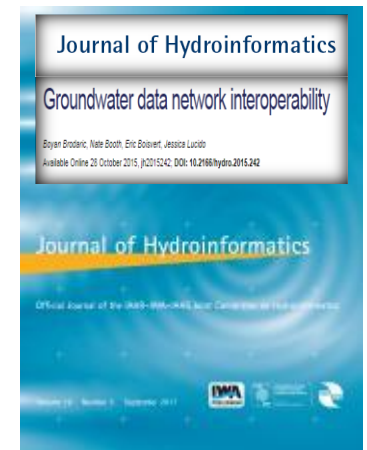
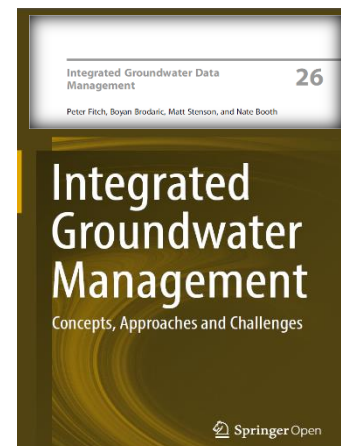


■ national water accounting



...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

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Heryk Julien
Francois Letourneau
Charles Logan
Alex Smirnoff

Notable Contributors

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Christine Rivard
Alfonso Rivera
Hazen Russell
David Sharpe
GGP project leaders (past, present)