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GEOLOGICAL SURVEY OF CANADA
OPEN FILE 8896

Water level data from the Bells Corners borehole calibration facility (2019-2021), Ottawa, Ontario

K.D. Brewer

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Canada

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1.0 Introduction

In the early 1980's, the Geological Survey of Canada (GSC) established a borehole test site in Ottawa, Ontario for the development and calibration of borehole geophysical instruments and techniques (Bernius, 1996; Mwenifumbo et al., 2005). The facility is located near the Canada Centre for Mineral and Energy Technology (CANMET) research laboratories in Bells Corners (Figure 1). The site contains six deep bedrock calibration boreholes (73m – 300m) that intersect carbonate, sandstone, and igneous bedrock (Figure 2).

The need for monitored deep borehole sites in Canada is increasingly important for long-term research into groundwater flow through fractured bedrock, and surface to groundwater interaction. To support ongoing bedrock aquifer research initiatives, the GSC collected high-resolution optical and acoustic televiewer imagery in the boreholes to provide context for studying hydrogeological conditions at the site. Repeat groundwater temperature, conductivity and flow measurements were also acquired in the boreholes. Core testing was conducted to provide an expanded set of physical, mechanical, and hydrological calibration data (Crow et al., 2021).

As part of this work, the GSC has instrumented three of the boreholes with water level loggers to monitor fluctuations in groundwater levels and temperatures across the site (Table 1). A small weather station was also installed to record precipitation and air temperatures (Figure 2). This report provides a digital compilation of these new data (March 7, 2019 – October 26, 2021) in three tables provided in Appendix A. Additional information on the site, geological setting, and borehole geophysical logs can be found in Crow et al. (2021).

Figure 1. Location of GSC calibration facilities (map background: Google, n.d.).

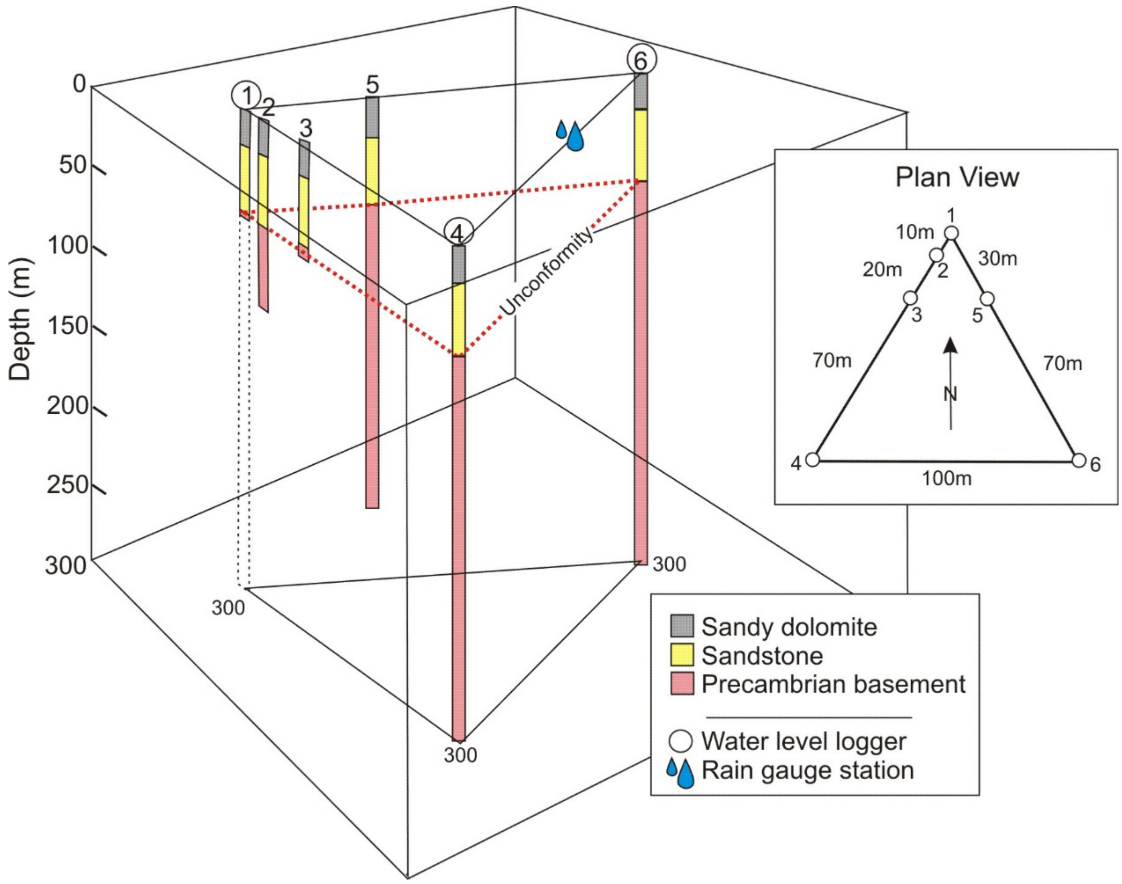

Figure 2. Positions and depths of boreholes in the Bells Corners deep borehole cluster (from Crow et al., 2021).

Table 1. Well co-ordinates and elevations based on differential GPS measurements recorded by the GSC between 2019 and 2021. GPS data was collected using a Novatel Smart6L receiver. Position information was further refined using a data post processing (CSRS-PPP) service provided by NRCan. The horizontal datum is NAD83 and the vertical datum for the elevations (orthometric height) is CGVD28(HTv2.0). bgs=below ground surface.

Name	Logger	Lat	Long	Elevation (Top of Casing) (m)	Open hole diameter (mm)	Drilling Depth (m bgs)	Depth Open (m bgs)	Casing Stick-up (m)
BC81-1	✓	45.318754	-75.861179	115.45 ± 0.04	76 (NQ)	299.20	64	0.23
BC81-2		45.318670	-75.861230	115.74 ± 0.04	76 (NQ)	120.12	115	0.87
BC81-3		45.318502	-75.861336	115.30 ± 0.05	96 (HQ)	119.50	73	0.54
BC84-4	✓	45.317933	-75.861694	114.77 ± 0.03	76 (NQ)	300.25	300	0.85
BC84-5		45.318536	-75.860965	114.71 ± 0.04	76 (NQ)	248.97	249	0.84
BC84-6	✓	45.318020	-75.860453	112.67 ± 0.03	76 (NQ)	298.74	290	0.53

2.0 Instrumentation

Water level loggers were deployed in spring 2019 in boreholes 1, 4, and 6 with a barometric sensor in borehole 1. A rain gauge and air temperature data logger were also installed in June 2019 between boreholes 4 and 6.

2.1 Water level loggers

The pressure transducers are industry-standard, standalone units made by Onset (www.onsetcomp.com). Three of the units are deployed as water level meters, suspended in the boreholes on 12.2 m of stainless steel cable. This length of cable was chosen to ensure the logger would always be submerged, based on estimations of seasonal water level variations. A fourth transducer was placed in the top of borehole 1 to record the ambient barometric pressure for the purpose of converting water pressure to water depth, using the Onset HOBOware software (v 3.7). All four units were bench tested by allowing them to equilibrate overnight to ambient conditions (in office). Results indicate near identical response among units within ± 0.1°C, and ± 0.2 kPa. (Table 2).

Table 2. Pressure transducer details and results of bench stabilization test.

				Bench test	
Model	Serial Number	Borehole	Sample rate	Temp (°C)	Pressure (kPa)
U20L-01	20270645	BC81-1	1/hr	22.142	100.155
U20L-01	20292275	BC81-4	1/hr	22.238	100.107
U20L-01	20270653	BC81-6	1/hr	22.046	100.149
U20L-04	20292431	BC81-1	1/hr	22.142	100.310

2.2 Weather station

A weather station was installed to record ambient air temperature and rainfall. The station is located between boreholes 4 and 6. The sensor is an Onset Pendant-Event Data logger with a HOBO RG3-M rain gauge, and the Pendant is in an RS-1 solar radiation shield (Table 3). The RG3 is a tipping-bucket rain gauge with a resolution of 0.2 mm that logs rainfall in mm/day.

Table 3. Weather station details.

Model	Serial Number	Sample rate – Temperature	Sample rate – Rain gauge
UA-003-64	20572078	1/30min	1/24hrs

3.0 Data Processing

Data from the HOBO sensors were processed using HOBOware (v 3.7). The software was primarily used to convert water pressure data to water depth (m). In some instances, where barometric pressure was not available, the pressure was converted using manual water tape measurements. All the manual measurements are included on the graphs, and provide a verification of the water level data where converted from pressure data. The data were then exported into a standard spreadsheet format to convert water depth to water elevation, based on GPS elevations measured on the well caps.

4.0 Summary

A plot of water elevations in the three boreholes alongside rainfall data is shown on Figure 3. Maximum water level variation within each of the three boreholes was found to range between 6.2 m and 6.5 m over the time period measured. The integration of precipitation data into this water level data set provides insight into the response times of this fractured bedrock system, and supports the ongoing study of hydrogeological conditions at the site.

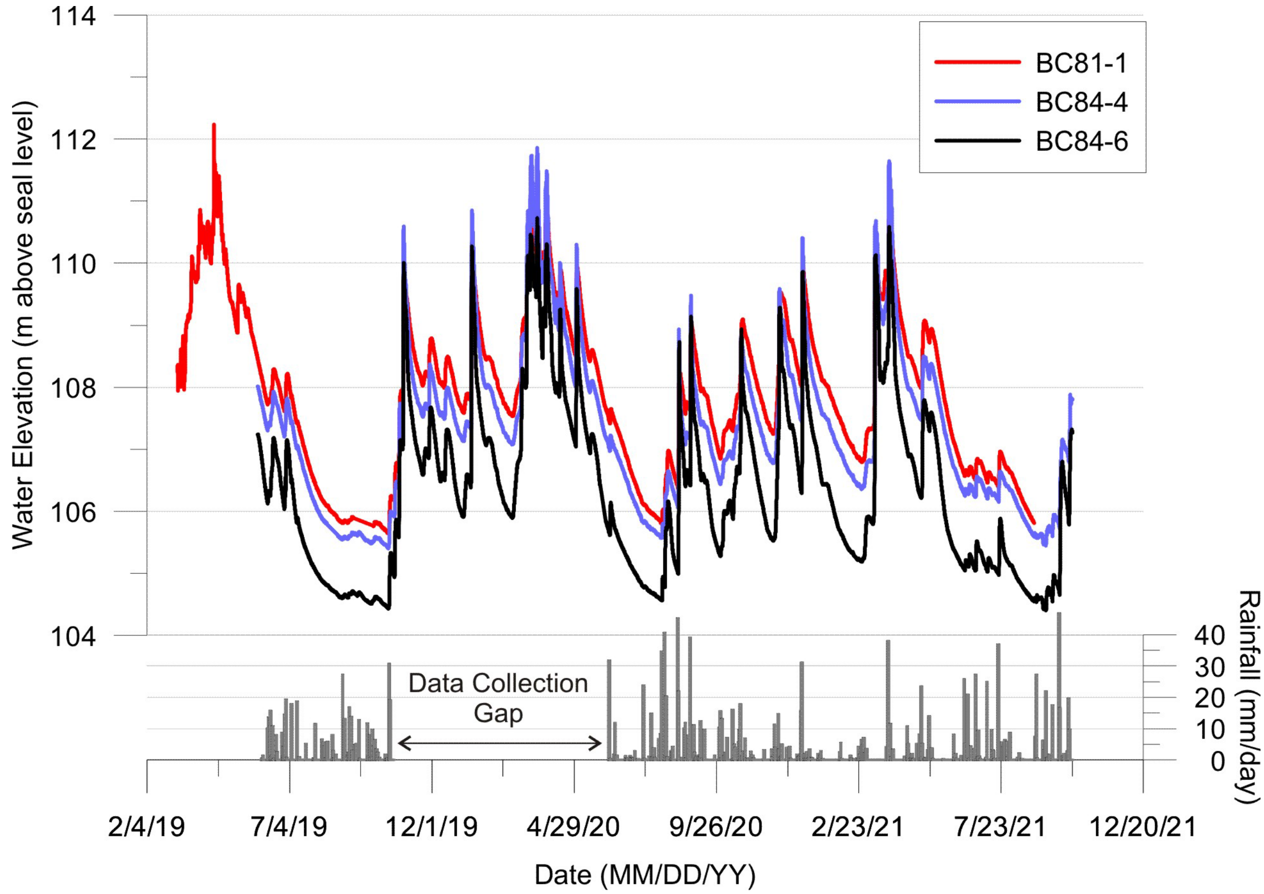

Figure 3. Water level and rainfall data measured between March 7, 2019 and October 26, 2021 at the GSC's Bells Corners Borehole Calibration Facility.

To discuss research opportunities or site access, please contact the GSC at:

< bellscornerscalibrationfacility@NRCan-RNCan.gc.ca>

5.0 Acknowledgements

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