Static Water Levels and Completion Details of Nested Piezometers in the Quaternary-Tertiary(?) Succession, Athabasca Oil Sands (In Situ) Area, Alberta
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Alberta Geological Survey

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Test hole drilling and piezometer installation were funded jointly by the Government of Alberta, through the Energy and Utilities Board, and by the Government of Canada, through the Ministry of Western Economic Diversification under the Western Economic Partnership Agreement. This Geo-Note is one in a series of Geo-Notes detailing the results of the work completed as part of this project.

The stratigraphic test holes were drilled by the Layne Christiansen Company and by McAuley Drilling Ltd. The piezometer installations were completed by Elk Point Drilling Corp.
Abstract

The Alberta Geological Survey (AGS) completed the installation of nine piezometers in 2000. The piezometers were completed within both Quaternary drift aquifers and a Quaternary-Tertiary buried channel aquifer. Water levels were measured within these piezometers. The results of these measurements indicate that, at all three sites, vertical hydraulic gradients are downwards. At one of the sites (WEPA 00-1), the calculated vertical gradients between three of the nested piezometers are small. This may indicate that the three stratigraphically distinct aquifers monitored by these piezometers may be part of a larger, vertically connected aquifer system, even though they are separated by intervening till packages.
1 Introduction

Between 1999 and 2001, the Alberta Geological Survey conducted a groundwater-sampling program in northeastern Alberta. The purpose was to document baseline groundwater conditions in advance of oil sands development in the area. This project was jointly funded by the Government of Alberta, through the Energy and Utilities Board, and by the Government of Canada, through the Ministry of Western Economic Diversification under the Western Economic Partnership Agreement. This Geo-Note is one in a series of Geo-Notes detailing the results of the work completed as part of this project.

Much of the area of investigation is sparsely populated and, as such, water well and stratigraphic information is difficult to obtain for these areas. To fully understand and characterize the Quaternary and Quaternary-Tertiary hydrogeological systems in northeastern Alberta, several stratigraphic test holes were drilled by the AGS. Detailed stratigraphic and chemical analyses were performed on the collected core material. These analyses are reported in other Geo-Notes of this series. Subsequently, nine piezometers were installed to various depths at three of these sites to characterize water chemistry and capture water-level information from selected aquifers. The purpose of this document is to provide piezometer completion details and document water levels measured in each piezometer at various times between November 2000 and November 2001. Official driller’s reports for each piezometer are on file with Alberta Environment.

2 Study Area

The study area is located in the northeastern portion of Alberta. It is bounded on the west by the Athabasca River, to the north by the Athabasca and Clearwater rivers, to the east by the Alberta-Saskatchewan provincial border and to the south by the Mostoos Uplands (Figure 1). This area encompasses the southeast portion of the EUB-designated Athabasca Oil Sands Area.

3 Test Hole Details, Piezometer Completion and Water-Level Information

Latitude, longitude and elevation values were determined using the Locus GPS instrument system by Ashtech Precision Products Limited. One receiver was located over a point of known coordinates, such as an Alberta Survey Control Marker (ASCM), and a second receiver was located at the top of the piezometer’s casing. GPS positions are referenced to the WGS84 ellipsoid and modelled against the earth-fixed X, Y, Z Cartesian coordinate system. Ground elevation was established using a steel tape to measure from the top of the casing to ground level.

Water levels were measured using an electric water level tape. For each piezometer, the depth of water from the top of the casing is recorded. The elevation of the water level is determined by subtracting the measured depth to water value, and the height of the casing above ground surface from the top of casing elevation determined during surveying.

3.1 Site WR 99-1

Stratigraphic test hole WR 99-1 was drilled in December 1999 to a depth of 253.7 m. The test hole site is located approximately 45 km north of Wandering River, Alberta (Figure 2). In November 2000, two piezometers were installed at this site, WR 99-1-8(WT) and WR 99-1-230. WR 99-1-8(WT) was completed within the Quaternary drift. WR 99-1-230 was completed within a Quaternary-Tertiary buried channel aquifer of the Wiau Channel. Completion diagrams for the two piezometers are presented in
Figure 1. Study area location map.
3.2 Site WEPA 00-1

Stratigraphic test hole WEPA 00-1 was drilled in October 2000 to a depth of 173.5 m. The test hole site is located approximately 20 km southwest of Conklin, Alberta (Figure 2). In November 2000, four piezometers were completed at this site, all within Quaternary drift aquifers. The piezometers are designated WEPA 00-1-15(WT), WEPA 00-1-41, WEPA 00-1-76 and WEPA 00-1-120. Completion details are presented in Figure 5, Figure 6, Figure 7 and Figure 8. Water level data are presented in Table 1.

3.3 Site WEPA 00-3

Stratigraphic test hole WEPA 00-3 was drilled in October 2000 to a depth of 182 m. The test hole site is located approximately 30 km east-northeast of Conklin, Alberta (Figure 2). In November 2000, three piezometers were completed at this site, all within Quaternary drift aquifers. The piezometers are designated WEPA 00-3-17(WT), WEPA 00-3-79 and WEPA 00-3-158. Completion details are presented in Figure 9, Figure 10 and Figure 11. Water level data are presented in Table 1.

4 Comment on Vertical Gradients at the Piezometer Sites

At all three piezometer sites, vertical gradients are downwards. Vertical gradients were calculated using the average hydraulic head elevations for each piezometer. Table 2 summarizes these calculated values.

The greatest vertical gradient, 0.30 m/m, is between WR 99-1-8(WT) and WR 99-1-230. The lowest vertical gradient is 0.03 m/m between WEPA 00-1-41 and WEPA 00-1-76. The average calculated vertical gradient is 0.16 m/m and the median value is 0.19 m/m.

At site WEPA 00-1, the vertical gradients between the three deepest piezometers are very similar and approach 0 m/m. This may indicate that the three stratigraphically distinct aquifers monitored by these piezometers may be part of a larger, vertically connected aquifer system, even though they are separated by intervening till packages.

5 Conclusions

Nine piezometers were installed as part of a recent Alberta Geological Survey groundwater characterization project. The piezometers were completed in both Quaternary drift aquifers and a Quaternary-Tertiary buried channel aquifer. Hydraulic head measurements were taken between November 2000 and November 2001. Vertical gradients vary between 0.30 m/m to 0.03 m/m and show that groundwater flow at the various locations is downwards. There are indications that the three deepest aquifers at WEPA 00-1 may be vertically connected, even though they are separated by till packages.
Well Name: WR99-1-8(WT)
Location (DLS): 07-36-77-15W4
Latitude: 55.7143976°N
Longitude: 112.1878725°W
Datum: NAD83
Surveyed Ground Level: 663.15 m

Figure 3. Piezometer-construction details: WR99-1-8(WT).
Figure 4. Piezometer-construction details: WR99-1-230.
Table 1. Monthly water level elevations in metres above sea level, November 2000 - November 2001.

<table>
<thead>
<tr>
<th>Date</th>
<th>WEPA 00-1-15(WT)</th>
<th>WEPA 00-1-41</th>
<th>WEPA 00-1-76</th>
<th>WEPA 00-1-120</th>
<th>WEPA 00-3-17(WT)</th>
<th>WEPA 00-3-79</th>
<th>WEPA 00-3-158</th>
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<th>WR 99-1-230</th>
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Well Name: WEPA 00-1-15(WT)
Location (DLS): 06-33-074-09W4M
Latitude: 55.4514162°N
Longitude: 111.3298313°W
Datum: NAD 83
Surveyed Ground Level: 666.83 m

Figure 5. Piezometer construction details: WEPA 00-1-15(WT).
Well Name: WEPA 00-1-41
Location (DLS): 06-33-074-09W4M
Latitude: 55.4513766°N
Longitude: 111.3298244°W
Datum: NAD 83
Surveyed Ground Level: 667.01 m

Figure 6. Piezometer construction details: WEPA 00-1-41.
Well Name: WEPA 00-1-76
Location (DLS): 06-33-074-09W4M
Latitude: 55.4513830°N
Longitude: 111.3299586°W
Datum: NAD 83
Surveyed Ground Level: 666.99 m

Figure 7. Piezometer construction details: WEPA 00-1-76.
Well Name: WEPA 00-1-120
Location (DLS): 06-33-074-09W4M
Latitude: 55.4513762°N
Longitude: 111.3298897°W
Datum: NAD 83
Surveyed Ground Level: 666.92 m

Lithology

WEPA 00-1-120

Top of casing elevation: 667.68 m
Drillhole diameter: 14 cm
Bentonite grout: 0 - 116.3 m
5.08 cm diameter Sch 80 PVC pipe

Sandpack: 116.3 - 121.9 m
PVC 5.08 cm, 3 row, 0.0508 cm slot size screen: 117.3 - 120.3 m
5.08 cm PVC washdown valve on screen bottom

Figure 8. Piezometer construction details: WEPA 00-1-120.
Figure 9. Piezometer-construction details: WEPA 00-3-17(WT).
Figure 10. Piezometer-construction details: WEPA 00-3-79.
Well Name: WEPA 00-3-158  
Location (DLS): 16-04-075-05W4M  
Latitude: 55.4729752°N  
Longitude: 110.7073340°W  
Datum: NAD83  
Surveyed Ground Level: 648.20 m

Figure 11. Piezometer-construction details: WEPA 00-3-158.
Table 2. Calculated vertical gradients.

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<th>Calculated Vertical Gradient (m/m)</th>
<th>Top Piezometer</th>
<th>Bottom Piezometer</th>
</tr>
</thead>
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<tr>
<td>0.30 WR 99-1-8</td>
<td>WR 99-1-230</td>
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<tr>
<td>0.20 WEPA 00-1-15</td>
<td>WEPA 00-1-14</td>
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