Températures dans les puits dans les Basses-Terres du Saint-Laurent : différentes méthodes de correction

St. Lawrence Lowlands well temperatures: various correction methods

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Objectives

- Correct temperature data from wells
- Compare correction methods
- Try to derive a correction method for the St. Lawrence Lowlands (SSL)
- Identify thermal anomalies
Geological context
Geological context

[Diagram showing geological context with stratigraphic columns and a map highlighting Quebec, Montreal, and Logan's Line.]
**Geological context**

### Formation Porosity and Permeability

<table>
<thead>
<tr>
<th>Formation</th>
<th>Porosité moyenne</th>
<th>Perméabilité médiane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cairnside</td>
<td>3.77 %</td>
<td>0.12 mD</td>
</tr>
<tr>
<td>Covey Hill</td>
<td>6.09 %</td>
<td>0.24 mD</td>
</tr>
</tbody>
</table>
Geothermal context

- Other studies in southern Quebec
Data

- 94 wells with temperature data
- 125 bottom hole temperature (BHT) and log measures (in 82 wells)
  - Depth: 250 - 4300 m
  - Raw temperature: 12 - 99 °C
  - 107 measurements in reservoir rocks
  - 18 measurements in caprocks
- 172 DST temperature data (in 49 wells)
Temperature corrections

Why?

- Mud circulation cools the surrounding rocks (*mud cooling effect*)
- Temperature recorded in wells after drilling is less than formation temperature
- With time, temperature comes back to equilibrium
Temperature corrections

- 27 measures (in 23 wells) corrected with Horner plot method
  - Analytical method
  - Based on difference of temperatures logged at different times
  - Needs
    - Mud circulation time
    - Different temperatures at different times
    - Time of the measures

- Harder to apply
  - Many mandatory data
    - Often handwritten and/or incomplete in paper/scanned well reports
Horner plot correction method (example)

**A162**

- **Graph 1:**
  - Log temperature (°F) vs. Time since circulation stopped (h)
  - Points and a linear trend line

- **Graph 2:**
  - Log temperature (°F) vs. \((t+T)/T\)
  - Points and a linear trend line

- **Equation:**
  - \(y = -3.5223x + 47.144\)
  - \(R^2 = 0.9822\)
Horner plot correction method (example)

**A162**

- **Log temperature (°F)**
- **Time since circulation stopped (h)**
- **End of mud circulation**

**Equation**

\[ y = -3.5223x + 47.144 \]

- **R² = 0.9822**
- **43.6° C at equilibrium**

- **4 hours 41.7° C**
- **11 hours 42.8° C**
- **20.5 hours 43.3° C**
Temperature corrections

- 125 measures (in 82 wells) corrected with Harrison method
  - Empirical method
  - Correlation between depth and temperature
  - Based on comparison with reliable temperature data

**Harrison Equation (3000 to 12,900 feet, 914 to 3932 meters)**
\[
\Delta^\circ C = -16.51 + 1.827 \times 10^{-2}z - 2.345 \times 10^{-6}z^2
\]
where \( z \) = depth in meters

- > 12,900 feet
  - 34.3\(^\circ\)F + 0.05\(^\circ\)F every 500 feet
Temperature corrections by Majorowicz and Minea (2012)

Hydro-Québec database - uncorrected vs. corrected temperature-at-depth ($T-z$)

- Uncorrected temperatures
- After Harrison correction
- After Harrison + SMU correction

~36°C/km
~14°C/km
3D geological model
Raw temperature data
Next steps

- Evaluate available static temperature data in order to perform SMU correction with TVD data
- Rock thermal properties (Maher Nasr, master’s student)
- Use of 3D model to evaluate geothermal potential
- Input DST temperature measures in evaluation (172)
Questions ?