SASKATCHEWAN INSTITUTE OF PEDOLOGY

GEOLGY OF THE SHAUNAVON PROJECT
SASKATCHEWAN

Report 0083-001-02 December 1, 1985
December 1, 1982

Saskatchewan Institute of Pedology  
University of Saskatchewan  
Saskatoon, Saskatchewan

Attention: Dr. J.L. Henry

Dear Dr. Henry:

Enclosed are six copies of:
(a) information sheet (Drawing 0083-001-01),
(b) cross sections AA', BB', and CC' (Drawings 0083-001-02-04),
(c) results of carbonate (p. 2-7) and grain size analyses (p. 9) on
   bedrock and till,
(d) x-ray diffraction patterns of bedrock and till (p. 11-15),
(e) geologic logs (p. 17-21), and
(f) five history of deglaciation phases (Figs. 1-5).

The regional cross sections (Drawings 0083-001-02, 03) show three bedrock
aquifers: namely; the Judith River Formation; the Eastend, Whitemud,
Battle, and Frenchman Formations unit; and the Ravenscrag Formation.
The salinity project areas are underlain by the Eastend, Whitemud, Battle,
and Frenchman Formations unit.

A detailed cross section (Drawing 0083-001-04) was drawn from a Ravenscrag
upland through project 82-2 to Rock Creek. The Eastend, Whitemud, Battle,
and Frenchman Formations unit occurs throughout the cross section and
represents the most permeable path for groundwater movement.
Three tills were encountered in testhole 82-2-104. The presence of weathering zones on the top of these tills indicate they were deposited by separate glaciations. Although sands and gravels of possible intertill origin were encountered in testhole 82-2-104, these deposits were not encountered in any of the other testholes suggesting intertill aquifers have a limited extent in the project area.

Although the finer-grained sediments in both the Eastend, Whitemud, Battle, and Frenchman Formations unit and the Bearpaw Formation have a high silt and clay content (p. 9), they differ in clay mineral content (p. 11, 12). The Bearpaw Formation has a much higher montmorillonite content than the Eastend, Whitemud, Battle, and Frenchman Formations unit. This difference would account for the rapid thickening of the drilling fluid when the Bearpaw Formation was encountered during test drilling.

The history of deglaciation of the Shaunavon area and surrounding region is shown in five sketches (Figs. 1-5). This interpretation is based on Christiansen (1979, enclosed). For more detailed location of the features shown within the Shaunavon area, the reader is referred to Drawing 0083-001-01. Attention is drawn in the following to the deglaciation of this area.

During Phase 1 (Fig. 1), meltwater drained from the Conglomerate Channel into the Frenchman Channel which in turn drained into the Missouri River. During Phase 2 (Fig. 2), meltwater drained through the "sidehill" Jones Channel into the Frenchman Channel.

To explain the upper part of the Swift Current Channel, it is postulated the lobe of ice south of the Frenchman Channel re-advanced northward diverting the Frenchman Channel into the Swift Current Channel (Fig. 3). During this phase, the Bone Channel drained into the Swift Current Channel which in turn drained into the Pelletier Channel, Lake Kincaid, the Big Muddy Spillway, and the Missouri River.
During Phase 4 (Fig. 4), the glacier retreated south of the Frenchman Channel, and the Channel returned to its previous course abandoning the upper part of the Swift Current Channel. The Bone, Swift Current, and Pelletier Channels drained into Lake Kincaid which in turn drained through the Big Muddy Spillway into the Missouri River.

During Phase 5 (Fig. 5), the lobe of ice south of the Frenchman Channel retreated into Alberta, and the Milk River Spillway came into existence. A glacial lake in the vicinity of Gull Lake drained through the Reid, Swift Current, and Pelletier Spillways into Lake Kincaid which in turn drained through the Big Muddy Spillway into the Missouri River.

When you have had an opportunity to study these results, we can discuss them further at your convenience.

Sincerely yours,

E.A. Christiansen
CARBONATE ANALYSES
<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>CALCIUM (wt%)</th>
<th>MAGNESIUM (wt%)</th>
<th>DOLOMITE (wt%)</th>
<th>CALCITE (wt%)</th>
<th>CO2 EQUIVALENTS @ S.T.P. (ML/S/GM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-5</td>
<td>2.05</td>
<td>0.94</td>
<td>7.13</td>
<td>1.25</td>
<td>20.12</td>
</tr>
<tr>
<td>5-10</td>
<td>2.21</td>
<td>1.02</td>
<td>7.74</td>
<td>1.32</td>
<td>21.75</td>
</tr>
<tr>
<td>10-15</td>
<td>2.51</td>
<td>0.97</td>
<td>7.36</td>
<td>2.27</td>
<td>22.87</td>
</tr>
<tr>
<td>15-20</td>
<td>2.31</td>
<td>0.91</td>
<td>6.90</td>
<td>2.02</td>
<td>21.29</td>
</tr>
<tr>
<td>20-25</td>
<td>2.33</td>
<td>0.90</td>
<td>6.83</td>
<td>2.14</td>
<td>21.43</td>
</tr>
<tr>
<td>25-30</td>
<td>2.41</td>
<td>0.94</td>
<td>7.13</td>
<td>2.15</td>
<td>22.13</td>
</tr>
<tr>
<td>30-35</td>
<td>2.74</td>
<td>1.06</td>
<td>5.64</td>
<td>2.53</td>
<td>25.19</td>
</tr>
<tr>
<td>Sample</td>
<td>Calcium (wt%)</td>
<td>Magnesium (wt%)</td>
<td>Dolomite (wt%)</td>
<td>Calcite (wt%)</td>
<td>CO2 Equivalents</td>
</tr>
<tr>
<td>--------</td>
<td>---------------</td>
<td>----------------</td>
<td>---------------</td>
<td>--------------</td>
<td>----------------</td>
</tr>
<tr>
<td>0-5</td>
<td>2.72</td>
<td>1.01</td>
<td>7.66</td>
<td>2.63</td>
<td></td>
</tr>
<tr>
<td>5-10</td>
<td>2.04</td>
<td>0.92</td>
<td>6.98</td>
<td>1.31</td>
<td></td>
</tr>
<tr>
<td>10-15</td>
<td>2.08</td>
<td>0.96</td>
<td>7.28</td>
<td>1.24</td>
<td></td>
</tr>
<tr>
<td>15-20</td>
<td>2.07</td>
<td>0.87</td>
<td>6.60</td>
<td>1.59</td>
<td></td>
</tr>
<tr>
<td>25-30</td>
<td>2.49</td>
<td>1.16</td>
<td>8.30</td>
<td>1.44</td>
<td></td>
</tr>
<tr>
<td>35-40</td>
<td>2.47</td>
<td>1.11</td>
<td>8.42</td>
<td>1.60</td>
<td></td>
</tr>
<tr>
<td>45-50</td>
<td>2.91</td>
<td>1.25</td>
<td>9.48</td>
<td>2.12</td>
<td></td>
</tr>
<tr>
<td>55-60</td>
<td>2.17</td>
<td>0.98</td>
<td>7.45</td>
<td>1.38</td>
<td></td>
</tr>
<tr>
<td>Sample</td>
<td>CaO (wt%)</td>
<td>MgO (wt%)</td>
<td>Dolomite (wt%)</td>
<td>Calcite (wt%)</td>
<td>CO₂ Equivalents</td>
</tr>
<tr>
<td>--------</td>
<td>-----------</td>
<td>-----------</td>
<td>----------------</td>
<td>--------------</td>
<td>----------------</td>
</tr>
<tr>
<td>65-70</td>
<td>1.64</td>
<td>0.77</td>
<td>5.84</td>
<td>0.93</td>
<td>16.26</td>
</tr>
<tr>
<td>70-75</td>
<td>2.43</td>
<td>0.95</td>
<td>7.21</td>
<td>2.16</td>
<td>22.33</td>
</tr>
<tr>
<td>80-85</td>
<td>1.82</td>
<td>0.95</td>
<td>7.21</td>
<td>0.51</td>
<td>19.32</td>
</tr>
<tr>
<td>85-90</td>
<td>1.61</td>
<td>0.85</td>
<td>7.43</td>
<td>0.56</td>
<td>16.83</td>
</tr>
<tr>
<td>95-100</td>
<td>1.84</td>
<td>0.98</td>
<td>7.43</td>
<td>0.56</td>
<td>19.31</td>
</tr>
<tr>
<td>100-110</td>
<td>1.77</td>
<td>1.03</td>
<td>7.81</td>
<td>0.18</td>
<td>19.38</td>
</tr>
<tr>
<td>110-115</td>
<td>2.26</td>
<td>1.30</td>
<td>5.36</td>
<td>0.29</td>
<td>24.61</td>
</tr>
<tr>
<td>115-120</td>
<td>1.45</td>
<td>0.38</td>
<td>6.67</td>
<td>0.00</td>
<td>16.21</td>
</tr>
<tr>
<td>Sample</td>
<td>Calcium (wt%)</td>
<td>Magnesium (wt%)</td>
<td>Dolomite (wt%)</td>
<td>Calcite (wt%)</td>
<td>CO₂ Equivalents S.T.P. (ML/SM)</td>
</tr>
<tr>
<td>--------</td>
<td>---------------</td>
<td>-----------------</td>
<td>----------------</td>
<td>---------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>125-130</td>
<td>1.31</td>
<td>0.76</td>
<td>5.76</td>
<td>0.14</td>
<td>14.32</td>
</tr>
<tr>
<td>135-140</td>
<td>1.88</td>
<td>0.82</td>
<td>6.75</td>
<td>1.03</td>
<td>18.71</td>
</tr>
<tr>
<td>145-150</td>
<td>2.62</td>
<td>0.86</td>
<td>6.52</td>
<td>3.00</td>
<td>22.57</td>
</tr>
<tr>
<td>SAMPLE 104: 0-5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>-------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CALCIUM (wt%)</td>
<td>4.21</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAGNESIUM (wt%)</td>
<td>1.33</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DOLOMITE (wt%)</td>
<td>10.24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CALCITE (wt%)</td>
<td>4.96</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2 EQUIVALENTS</td>
<td>35.97</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SAMPLE 5-10</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CALCIUM (wt%)</td>
<td>3.20</td>
</tr>
<tr>
<td>MAGNESIUM (wt%)</td>
<td>1.10</td>
</tr>
<tr>
<td>DOLOMITE (wt%)</td>
<td>9.34</td>
</tr>
<tr>
<td>CALCITE (wt%)</td>
<td>3.34</td>
</tr>
<tr>
<td>CO2 EQUIVALENTS</td>
<td>28.02</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SAMPLE 10-15</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CALCIUM (wt%)</td>
<td>2.58</td>
</tr>
<tr>
<td>MAGNESIUM (wt%)</td>
<td>1.13</td>
</tr>
<tr>
<td>DOLOMITE (wt%)</td>
<td>8.95</td>
</tr>
<tr>
<td>CALCITE (wt%)</td>
<td>1.53</td>
</tr>
<tr>
<td>CO2 EQUIVALENTS</td>
<td>25.29</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SAMPLE 15-20</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CALCIUM (wt%)</td>
<td>2.52</td>
</tr>
<tr>
<td>MAGNESIUM (wt%)</td>
<td>1.07</td>
</tr>
<tr>
<td>DOLOMITE (wt%)</td>
<td>8.27</td>
</tr>
<tr>
<td>CALCITE (wt%)</td>
<td>1.62</td>
</tr>
<tr>
<td>CO2 EQUIVALENTS</td>
<td>26.57</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SAMPLE 20-25</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CALCIUM (wt%)</td>
<td>2.68</td>
</tr>
<tr>
<td>MAGNESIUM (wt%)</td>
<td>1.09</td>
</tr>
<tr>
<td>DOLOMITE (wt%)</td>
<td>8.27</td>
</tr>
<tr>
<td>CALCITE (wt%)</td>
<td>2.21</td>
</tr>
<tr>
<td>CO2 EQUIVALENTS</td>
<td>25.02</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SAMPLE 50-55</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CALCIUM (wt%)</td>
<td>3.62</td>
</tr>
<tr>
<td>MAGNESIUM (wt%)</td>
<td>0.89</td>
</tr>
<tr>
<td>DOLOMITE (wt%)</td>
<td>6.75</td>
</tr>
<tr>
<td>CALCITE (wt%)</td>
<td>5.36</td>
</tr>
<tr>
<td>CO2 EQUIVALENTS</td>
<td>28.43</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SAMPLE 55-60</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CALCIUM (wt%)</td>
<td>3.79</td>
</tr>
<tr>
<td>MAGNESIUM (wt%)</td>
<td>1.03</td>
</tr>
<tr>
<td>DOLOMITE (wt%)</td>
<td>7.81</td>
</tr>
<tr>
<td>CALCITE (wt%)</td>
<td>5.22</td>
</tr>
<tr>
<td>CO2 EQUIVALENTS</td>
<td>30.67</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SAMPLE 60-65</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CALCIUM (wt%)</td>
<td>2.19</td>
</tr>
<tr>
<td>MAGNESIUM (wt%)</td>
<td>0.98</td>
</tr>
<tr>
<td>DOLOMITE (wt%)</td>
<td>7.43</td>
</tr>
<tr>
<td>CALCITE (wt%)</td>
<td>1.43</td>
</tr>
<tr>
<td>CO2 EQUIVALENTS</td>
<td>21.27</td>
</tr>
<tr>
<td>SAMPLE</td>
<td>90-95</td>
</tr>
<tr>
<td>--------</td>
<td>-------</td>
</tr>
<tr>
<td>CALCIUM (WT%)</td>
<td>2.10</td>
</tr>
<tr>
<td>MAGNESIUM (WT%)</td>
<td>1.00</td>
</tr>
<tr>
<td>DOLOMITE (WT%)</td>
<td>7.59</td>
</tr>
<tr>
<td>CALCITE (WT%)</td>
<td>1.13</td>
</tr>
<tr>
<td>CO2 EQUIVALENTS S.T.P. (MLS/GM)</td>
<td>20.95</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>100-105</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CALCIUM (WT%)</td>
<td>1.63</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAGNESIUM (WT%)</td>
<td>0.81</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DOLOMITE (WT%)</td>
<td>6.14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CALCITE (WT%)</td>
<td>0.74</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2 EQUIVALENTS S.T.P. (MLS/GM)</td>
<td>16.57</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>110-115</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CALCIUM (WT%)</td>
<td>1.74</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAGNESIUM (WT%)</td>
<td>0.97</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DOLOMITE (WT%)</td>
<td>7.36</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CALCITE (WT%)</td>
<td>0.35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2 EQUIVALENTS S.T.P. (MLS/GM)</td>
<td>18.66</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>130-135</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CALCIUM (WT%)</td>
<td>3.11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAGNESIUM (WT%)</td>
<td>1.17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DOLOMITE (WT%)</td>
<td>8.87</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CALCITE (WT%)</td>
<td>2.95</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2 EQUIVALENTS S.T.P. (MLS/GM)</td>
<td>28.16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
GRAIN SIZE ANALYSES
<table>
<thead>
<tr>
<th>Sample</th>
<th>Depth Feet</th>
<th>Wt.% Sand 2.0-.05mm</th>
<th>Wt.% Silt .05-.002mm</th>
<th>Wt.% Clay &lt;.002mm</th>
<th>Geological Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>82-2-101</td>
<td>70-75</td>
<td>4.5</td>
<td>55.1</td>
<td>40.4</td>
<td>Eastend Fm. etc.</td>
</tr>
<tr>
<td>125-130</td>
<td>12.9</td>
<td></td>
<td>44.3</td>
<td>42.8</td>
<td>Bearpaw Fm.</td>
</tr>
<tr>
<td>82-2-103</td>
<td>190-200</td>
<td>15.5</td>
<td>46.9</td>
<td>37.5</td>
<td>Eastend Fm. etc.</td>
</tr>
<tr>
<td>250-255</td>
<td>25.0</td>
<td></td>
<td>42.6</td>
<td>32.4</td>
<td>Bearpaw Fm.</td>
</tr>
<tr>
<td>82-2-104</td>
<td>5-10</td>
<td>37.7</td>
<td>25.7</td>
<td>36.6</td>
<td>Upper Till</td>
</tr>
<tr>
<td>15-20</td>
<td>39.3</td>
<td></td>
<td>28.8</td>
<td>31.9</td>
<td>Middle Till</td>
</tr>
<tr>
<td>50-55</td>
<td>38.7</td>
<td></td>
<td>31.1</td>
<td>30.2</td>
<td>Lower Till</td>
</tr>
<tr>
<td>90-95</td>
<td>40.4</td>
<td></td>
<td>33.5</td>
<td>26.1</td>
<td>Lower Till</td>
</tr>
<tr>
<td>120-125</td>
<td>47.1</td>
<td></td>
<td>29.2</td>
<td>23.7</td>
<td>Lower Till</td>
</tr>
</tbody>
</table>
X-RAY DIFFRACTION PATTERNS