SURFICIAL GEOLOGY OF THE READLYN 7.5' QUADRANGLE BREMER COUNTY, IOWA

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ABSTRACT

Our objective for developing the surficial geologic map of the Readlyn Quadrangle is to obtain geologic data that can be used for county-specific land use planning tools for the city of Readlyn, IA, the Natural Resources Conservation Service (NRCS), and the local farmers. The geologic findings will also assist the development of groundwater permeability maps that will be used in the planning of potential sites for urban and agricultural developments. The city of Readlyn and the surrounding Cedar Falls/Waterloo metro area need this data to improve their water resources management plans, wetland protection programs, aggregate resource management programs, and the pollution potential from Iowa's growing confined animal farming operations (CAFOs). Sufficient data for our local natural resources is scarce for the production and interpretation of county specific land use planning tools. UNI's EDMAP program collaborated with Federal (NRCS, EPA), State (Iowa Geological and Water Survey), and local to address the need for sufficient geologic mapping data.

Introduction

The purpose for developing the surficial geologic map of the Readlyn Quadrangle is to obtain geologic data that can be used for county-specific land use planning tools for the city of Readlyn, IA, the Natural Resources Conservation Service (NRCS), and the local farmers. The study area was located in northeastern Iowa, in Bremer County (Fig. 1). The Readlyn 7.5' Quadrangle covered an area from 42^{o}37'30'' N to 42^{o}45' latitude and 92^{o}15' W to 92^{o} 07'30" longitude. The Readlyn Quadrangle lies in a terrain of dissected Pre-Illinoian glacial deposits that blanket a bedrock surface with significant relief. The study area also represents a portion of the Iowan Erosion Surface and exhibits Wisconsinan and Holocene alluvial surfaces, eolian landforms, and discontinuous outcrops of Paleozoic bedrock. Geologic units within the project area include Devonian carbonate bedrock, Pre-Illinoian glacial sediment and alluvium, Wisconsin outwash, loess, Holocene alluvium, and eolian sand.

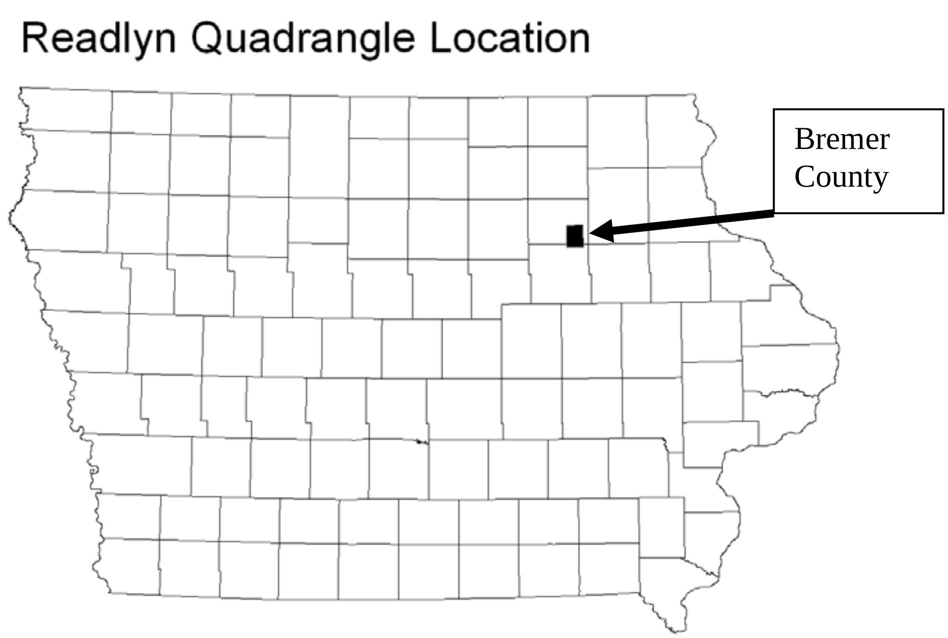

Figure. 1 Locality Map of Readlyn Quadrangle (highlighted in black)

Regional setting

During the Pleistocene, continental glaciers advanced over Iowa, depositing sediments during and after ice contact. The main glacial stages from oldest to youngest were the Pre-Illinoian, Illinoian, and Wisconsinan (Fig. 2). The Readlyn Quadrangle lies on the Iowan Surface (Fig. 3). The Iowan Surface (Figure) displays sweeping, relaxed, open topography. The surface usually appears slightly inclined to gently rolling with long slopes, low relief, and open views to the horizon (Prior, 1991). This region of Iowa has no constructional features associated with glaciations. There are no moraines, eskers, kames, or outwash plains. The Iowan Erosion Surface was previously known as the Iowan Drift Region. A considerable amount of this region is covered by loess, but the major part of the region is covered by a thin loam sediment that overlies a stone line on the till (Ruhe, 1969). The Iowan Drift does not exist in northeastern Iowa. The Iowan Drift Region is actually an erosion surface (Ruhe, 1969).

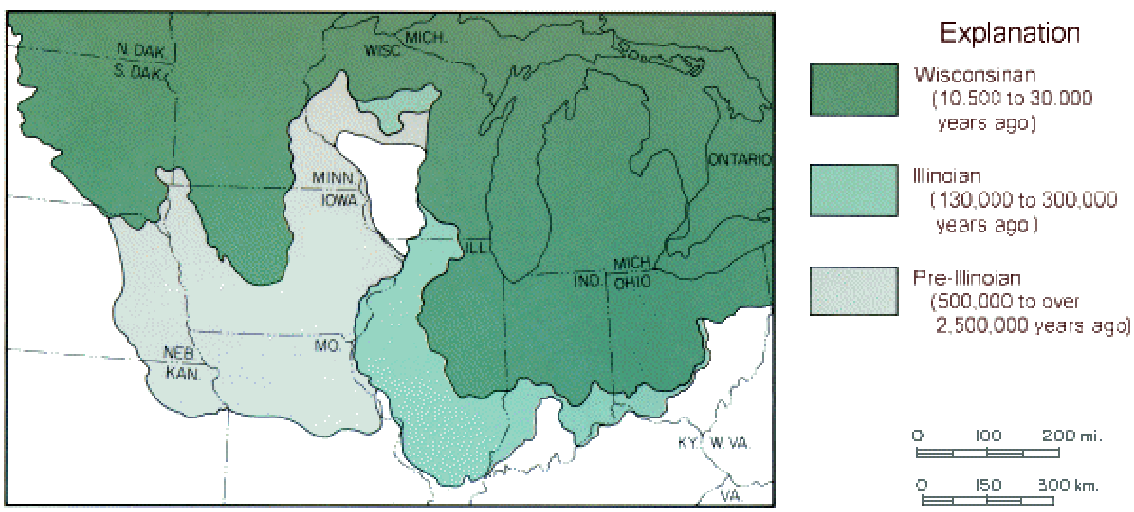

Figure 2 Limits of major Pleistocene glacial advances into the Midwest (Prior, 1991)

The edge of the erosion surface extends under the thick loess, so the erosion surface itself cannot be the primary source for the loess (Hallberg, 1979). It is postulated that much of the Iowan Erosion Surface must have been created before the loess began to be deposited. Radiocarbon ages indicated that loess deposition began on the erosion surface approximately 18,000-23,000 radiocarbon years ago and between 21,000-29,000 radiocarbon years ago on the areas with paleosols. This aging indicates that erosion and loess deposition were occurring simultaneously (Zanner, 1999). The Iowan Surface was last inhabited by glaciers in Pre-Illinoian time and since then has lain exposed to various episodes of weathering and soil development, erosion, and loess deposition (Prior, 1991).

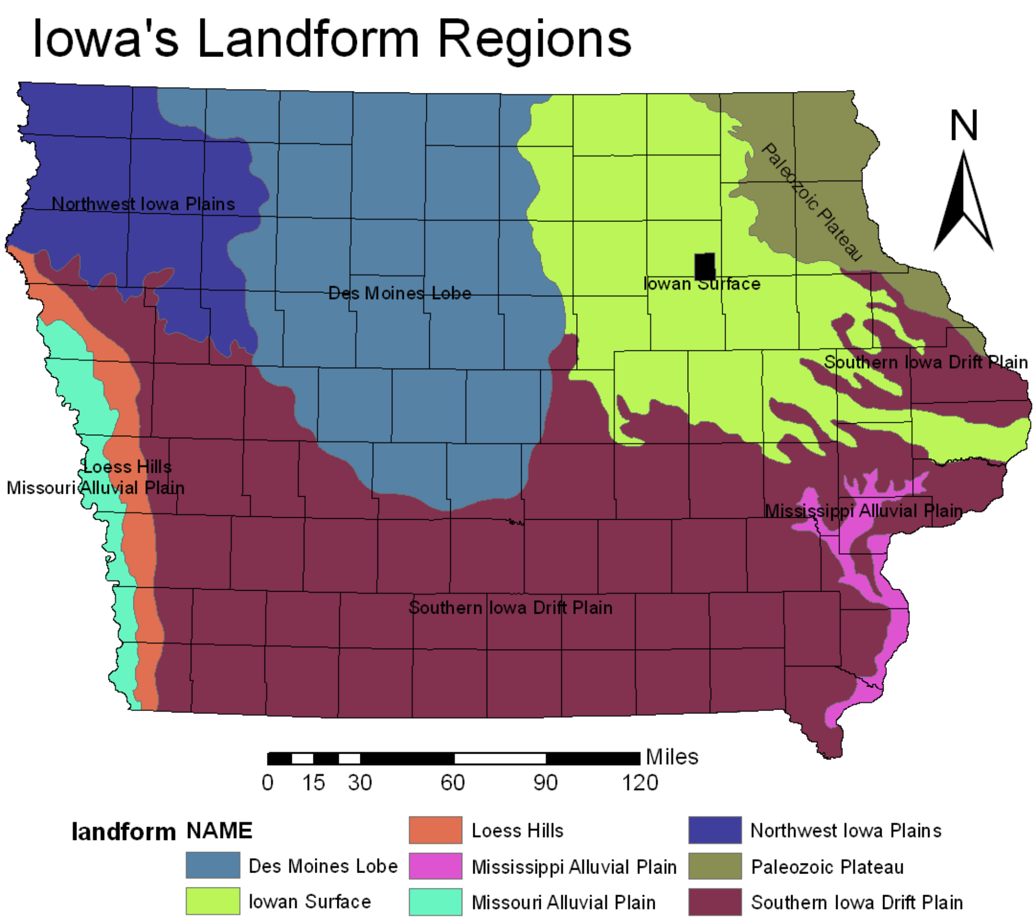

Figure. 3 Landform Regions of Iowa with the Readlyn Quadrangle (highlighted in black)

METHODS

Spatial data collection

Geographically referenced data were necessary for this mapping project. This project required obtaining geospatial data (digital raster – topography, aerial photography, depth to bedrock, and other shapefiles) from the Iowa Natural Resources Geographic Information Systems Library (http://www.igsb.uiowa.edu/nrgislibx/gishome.htm). Spatial data were also collected in the field using Trimble GeoXH units. This mobile mapping enables the collection of field data to lessen the possibility of error in identifying geologic sampling points and mapping units.

Field work

Samples were taken from the field using a bucket-auger (2" diameter) and shovel excavations of surficial outcrops (Fig. 4). Samples were described in the field notebook on the basis of sediment identification methods. In most cases the maximum range reached for mapable surface geologic units (soil parent material) was 3 to 12 feet. The hand auger was capable of reaching depths of 20 feet, but the UNI EDMAP team often encountered the seasonally high water tables and/or gravel to cobble sized glacial sediment. Each of these naturally occurring conditions made drilling by hand at depths greater than 4 feet difficult. The UNI EDMAP team hand drilled 47 cores. Working in collaboration with the Iowa Geologic and Water Survey on the surficial mapping of Bremer County the team participated in drilling five (35 to 45 feet) cores with a drilling rig. We also extensively used soil, vegetation features, and landscape positions to assist our mapping efforts. The soil samples were collected for lab analysis.

Figure 4. Jessica Schmitz (UNI EDMAP) and a student assistant describing a section of Qal

GIS data processing

Geospatial data were obtained for both Bremer and Black Hawk counties from the Iowa Natural Resources Geographic Information Systems Library, because the Readlyn Quadrangle exists within each (approx ¾ in Bremer and ¼ in Black Hawk). While drawing the map features and contacts a combination of field, supporting geospatial data (aerial photos, topography, etc.), and ArcGIS 9.3 editing tools were used.

Laboratory methods

Particle size analysis was used to quantify the textural content and variability for unconsolidated sediment (fine-earth fraction) and soil samples from the Readlyn Quadrangle. Identifying textural variability between a series of depositional units or soil horizons is important because they are indicative of changing energy in depositional systems or changes in weathering environments for soils.

The initial coarse (>2mm) fraction including pebbles, cobbles, and boulders was visually estimated from each stratigraphic unit during field descriptions. Clay-rich units and samples were disaggregated to access homogenous samples. Forced air was used to clean the sieve and crusher between each use to avoid sample contamination of organics and sedimentary particles. The fine particle size (>2mm) distribution for each sample was determined using the pipette method of Gee and Bauder (1986). The procedure categorizes sediment from each depositional unit into the Wentworth Geometric Progression Scale (Table 1). In addition, the USDA textural classes were also determined from the Wentworth classes.

Table 1

Particle Size Analysis Distribution (Wentworth Scale) Categories

		(mm)			(μm)
Sand	VCS	2-1	Silt	VCSi	63-53
	CS	1-0.5		CSi	32-16
	MS	0.5-0.25		Msi	16-8
	FS	0.25-0.125		Fsi	8-4
	VFS	0.125-0.063		VFSi	4-2

*Abbreviations: V (very), C (coarse), M (medium), F (fine), S (sand), Si (silt).

Four pipetting sessions measured specific particle size fractions from each sample (16 μm, 8 μm, 4 μm, and 2 μm). The temperature was recorded from the salt factor (dispersion) bottle before each sampling period to achieve the proper sampling time. The sediment solutions were contained in crucibles and placed in an oven to evaporate the distilled water. The product (sediment and salt) was weighed to the 0.0000 decimal place after each crucible cooled in a dissector for no longer than fifteen minutes, again to lessen the possibility of gaining water.

The sand to coarse silt fraction (2 mm to 32 μm) of each sedimentation bottle was obtained by quantitatively washing the sediment through a 450 mesh (32 μm openings) sieve using tap water. The contents of the nineteen sedimentation bottles were rinsed in beakers and placed in an oven at 105 °C for 4 hours, completely evaporating the excess water. The sands and coarse silts were then carefully transferred into a sieve set (Table 2).

Table 2

Particle Size Analysis Sieve Series

Sieve #	Opening
18	1.0
35	0.5
60	0.25
120	0.125
230	0.063
270	0.053
pan	0.032

Each sediment fraction was placed into a Gilson three-inch sieve shaker for one and one-half minutes to complete particle separation. Each sieve and its contents were weighed individually on a top loading balance and measured to the nearest 0.01 g.

Results

From our field and laboratory work we have interpreted five map able units (1:24,000).

CENOZOIC

QUATERNARY SYSTEM

HUDSON EPISODE

Qal - Alluvium (DeForest Formation-Undifferentiated) Variable thickness of less than 1 to 5 m (3-16 ft) of very dark gray to brown, noncalcareous to calcareous, massive to stratified silty clay loam, clay loam, loam to sandy loam alluvium and colluvium in stream valleys, on hill slopes and in closed depressions. May overlie Noah Creek Formation, Wolf Creek or Alburnett formations or fractured Devonian carbonate bedrock. Associated with low-relief modern floodplain, closed depressions, modern drainageways or toeslope positions on the landscape. Seasonal high water table and potential for frequent flooding.

Qe – eolian windblown sand ‘stringers’

Qallt - Low Terrace (DeForest Formation-Camp Creek Mbr. and Roberts Creek Mbr.). Variable thickness of less than 1 to 5 m (3-16 ft) of very dark gray to brown, noncalcareous, stratified silty clay loam, loam, or clay loam, associated with the modern channel belt of the Shell Rock and West Fork Cedar river valleys. Overlies the Noah Creek Formation. Occupies lowest position on the floodplain ie. modern channel belts. Seasonal high water table and frequent flooding potential.

HUDSON and WISCONSIN EPISODE

Qnw2 - Sand and Gravel (Noah Creek Formation) Generally 2 to 8 m (6-26 ft) of yellowish brown to gray, poorly to well sorted, massive to well stratified, coarse to fine feldspathic quartz sand, pebbly sand and gravel with few intervening layers of silty clay. A thin mantle of loess, reworked loess or fine-grained alluvium (Qal) may be present. This unit includes silty colluvial deposits derived from the adjacent map units. In places this unit is mantled with 1 to 3 m (3-10 ft) of fine to medium, well sorted medium to fine sand derived from wind reworking of the alluvium. This unit encompasses deposits that accumulated in low-relief stream valleys during the Wisconsin Episode and Hudson Episode. Seasonal high water table and some potential for flooding.

Qwa2 - Loamy and Sandy Sediment Shallow to Glacial Till (Unnamed erosion surface sediment) Generally 1 to 7 m (3-23 ft) of yellowish brown to gray, massive to weakly stratified, well to poorly sorted loamy, sandy and silty erosion surface sediment. Map unit includes some areas mantled with less than 2 m (7 ft) of Peoria Formation materials (loess and eolian sand). Overlies massive, fractured, firm glacial till of the Wolf Creek and Alburnett formations. Seasonally high water table may occur in this map unit.

Examples of hand coring descriptions

<u>Data</u>
8/12
42°38'22.971"N 92°8'35.667"W
0-30cm- 10YR21
30-40cm- 10YR32
40-103cm- 10YR32
103-140+cm- 10YR53
Sigglekov- Bremer County Park

10/8
42°40'48.223"N 92°08'56.660"W
0-70cm- 10YR21
70-97cm- 10YR31
97-165cm- 10YR21
Aldo Leopold Reserve- near Wetland

10/16
0-105cm- 10YR32
105-120cm- 10YR31
Seven Bridges County Park, cutbank of Wapsi

11/5
0-24cm- 10YR22
24-35cm- 10YR33
35-90cm- 10YR44
2641 250th

11/5
0-35cm- 10YR21
35-40cm- Transition zone
40-62cm- 2.5Y4/3
62-74cm- 2.5Y5/4
Hit glacial erratic or other debris
2261 Reed

11/5
0-45cm10YR22
45-68- 10YR34
68-73+- 10YR44
Hit glacial erratic or other debris
2085 Sable

11/12
0-75cm- 10YR21
75-91cm- 10YR31
91-115cm- transition
115-125cm- 10YR58
125-145cm- 2.5Y5/2 – Clay rich
2779 Marquis rd

11/12
0-36cm- 10YR21
36-57cm- 10YR31
Many rocks
57-72cm- black/brown stripping
2262 Viking Rd

4/1
42°40'19.900"N 92°08'29.229"W
7.5YR44
3’8’’ deep
Sand
Depth to water- 3’

4/1
42°40'51.542"N 92°09'3.445"W
2.5Y31
6’8’’ deep
Sand
Depth to water- 4’2’’

4/1
42°40'52.748"N 92°09'16.571"W
10YR32
4ft deep
Sand, coarse sand/gravel
Depth to water- 3’

4/9
42°41'19.963"N 92°13'50.676"W
10YR58
4.5ft deep
Clay/sand mix

4/9
42°41'19.229"N 92°13'57.518"W
7.5YR58
6ft deep
Sand (fine, well sorted)

4-9
42°40'49.074"N 92°08'06.750"W
7.5YR46
4ft deep
Sand/clay

Sources

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