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Geology of the Proposed Skunk River Dam

LEE B. BACKSEN[1] AND LYLE V. A. SENDLEIN[2]

Abstract. The Corps of Engineers plan to construct an earth-fill dam approximately three miles north of Ames, Iowa on the Skunk River. The proposed dam site is on a reach of the Skunk River which has been displaced approximately two miles to the southeast. The old channel has been filled and covered by glacial drift and is not detectable at the surface. Compilation of data obtained from geological investigations provides evidence for the existence of a buried valley. It is believed that the sands and gravels in this valley are hydraulically connected to the aquifer from which the City of Ames obtains its water supply. Furthermore, the valley underlies a portion of the area of the proposed reservoir. It is quite possible that construction of the dam will have a significant effect on the water supply of the City of Ames, and the buried valley an equally important effect on the proposed reservoir. Further study is indicated.

The Corps of Engineers recently announced plans for the proposed construction of an earth dam on the Skunk River north of Ames, Iowa. The location, NW¼, SE¼, SW¼, sec. 13, T. 84 N., R. 24 W., places the site approximately 2 miles north and 1 mile east of the northernmost city limits of Ames (fig. 1).

The Iowa State University Department of Earth Science has conducted investigations into various aspects of the geology of Story County for many years. These investigations have produced supporting data for Masters theses. In this paper, the authors have compiled the geological data available from these sources for the proposed dam site, and discuss some of the effects the dam may have on the proposed reservoir and the Ames city water supply.

PROPOSED DAM

The dam will be an earth-fill structure with an approximate axial length of 1,250 feet at the crest and 700 feet at the base. If the small saddle separating the spillway from the dam and the spillway width are added, the total crestal length will be 2,050 feet. The base of the dam in cross-section will measure 570 feet, and it will be 95 feet from the floodplain to the crest. The original plans as shown in the 10 December 1964 "Itinerum Review of Report for Flood Control and Other Purposes on the Skunk River, Iowa, Ames Reservoir" have been modified to include a cut-off trench to bedrock along the axis and an increase in the height to enlarge the capacity of the reservoir.

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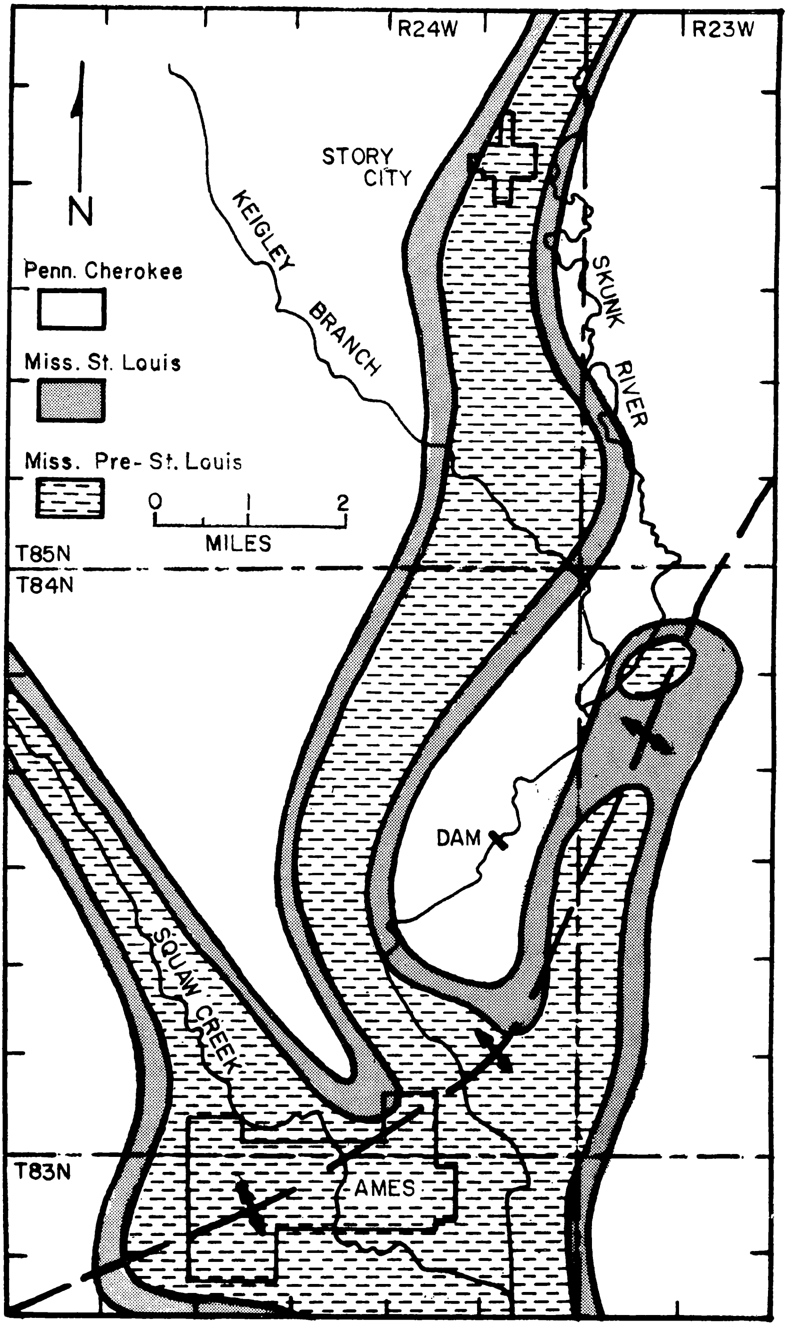

Fig. 1. Geologic map of area surrounding the proposed dam

Physiography

The area is underlain by glacial drift of the Des Moines lobe, and, except along major drainages, the topography is the typical drift plain swell and swale pattern. Relief, on this topographically youthful surface, usually does not exceed 50 feet. However, along the major streams, it approaches 100 feet. Principle streams of the area are the Skunk River, Squaw Creek, and Keigley Branch. The Skunk River flows to the southwest into sec. 23; there it makes approximately a 90[b] bend to the southwest.

Geology

Stratigraphy

The stratigraphy as described by Zimmerman (1952) and Backsen (1963) is as follows:

Pleistocene	0 - 125 feet
Pennsylvanian	0 - 20 feet
Mississippian (St. Louis)	0 - 30 feet
Mississippian (Warsaw)	45 - 50 feet

A composite section of the Pleistocene deposits is presented below.

	Average thickness
Upper till — May be traced with relative ease over study area. Upper 5-25 feet oxidized	50 feet
Silt — Blue gray to gray, 50-60 feet in thickness northwest of Ames, but absent in vicinity of proposed dam site, the unit underlying the upper till is a mixture of silt, sand, gravel and till	30 feet
Intermediate till — composed of an oxidized zone up to 25 feet thick and an unoxidized zone of 50 to 60 feet thick	60 feet
Sands and gravels — These deposits are called the "aquifer" (Backsen, 1963) and are hydraulically connected to the sands and gravels from which the city of Ames obtains its water supply. They occur on top of bedrock in the vicinity of the proposed dam and on top of the lower till north of there	40 feet
Lower till — It does not have an upper oxidized zone and is found only in the bottom of the buried valleys. Very common in the valley underlying Squaw Creek	60 feet

In the vicinity of the proposed dam site, the glacial drift rests upon both Pennsylvanian and Mississippian rocks. The Pennsylvanian rocks are limited to the Cherokee group. The Mississippian rocks which underlie the drift are assigned to St. Louis and Warsaw formations.

Composite sections (Zimmerman, 1952) of each of the above groups are presented below.

Composite Section of the Lower Part of the Cherokee Group
Total thickness exposed 24.5 feet

		feet
6	Drift	
5	Limestone, gray, fine-grained, porous, massive; containing abundant pyrite crystals; bottom contact irregular and gradational with shale below	2.0
4	Shale, gray-green, blocky; very calcareous, calcite nodules becoming abundant near top; containing Pennsylvanian conodonts; upper contact irregular and gradational	2.25
3	Limestone, gray, dense, glauconitic; upper layer dense with a 3-inch band of dense, gray chert in center; lower layer sandy, grading laterally into calcareous sandstone	0.75
2	Sandstone, white to buff, fine-grained friable, well-sorted; grains rounded to subangular; cross-bedding locally prominent; locally containing lenses of "conglomerate" chert near top	18.0
1	Dolomite, buff to light gray, fine-grained with occasional calcite rhombs	1.5

Composite Section of the St. Louis Formation
Total Thickness Exposed – 28.0 to 29.0 Feet

6	Dolomite, buff, fine-grained, heavy-bedded, concretions common; a 1-foot bed 1.5 feet below top is resistant and locally cherty; upper surface irregular and weathered	7.5
5	Dolomite, light gray to buff, fine-grained, dense, conchoidal fracture, fossiliferous	0.75
4	Dolomite, buff to brown, fine-grained, massive, locally glauconitic; containing a few chert concretions	2.0
3	Dolomite and shale (interbedded); dolomite, gray-brown, medium-grained, containing calcite veinlets; shale, brown, calcareous, fissile	1.0
2	Dolomite, brown, fine to medium-grained, massive; containing a few chert concretions. Recrystallization along joints forms veins of dense, gray dolomite. These veins form dike-like ridges on weathered surface. Lower contact irregular	10.75
1	Sandstone, light green, fine-grained, friable, with dolomitic lenses becoming more prominent near top	6.0 to 7.0

Composite Section of the Warsaw Formation
Total Thickness Exposed – 48.82 to 50.82 Feet

22	Shale, blue-gray to green, silty, blocky, dolomitic; containing large irregular, granular, nodular masses of chert intermixed with calcite. In places it contains lenses of dolomite and locally the lower portion grades laterally into argillaceous dolomite. The shale is locally separated from overlying sandstone by a lens of brown to buff, medium-grained dolomite	5.0
21	Dolomite, buff to brown, fine to medium-grained, heavy-bedded; lens of gray shale 1.1 feet above base; upper 3 feet siliceous with nodular, irregular, granular masses of chert and calcite	5.5
20	Shale, blue-gray, blocky, silty, finely disseminated pyrite present. The bottom 1 foot grades laterally into gray to buff, earthly, pyritic dolomite. Dolomite lenses locally present in rest of shale	3.25

19	Dolomite, buff to gray, fine to medium-grained; argillaceous, locally cherty	2.0
18	Dolomite, brown, fine-grained; with masses of dark brown chert and calcite nodules; locally argillaceous; two beds of dark brown, brecciated-appearing, siliceous dolomite, one at base and the other 2.5 feet above base; dolomite grades laterally into shale	4.0
17	Shale, brown to dark gray, blocky, with siliceous dolomite concretions throughout; two 3-inch beds of brown, siliceous, dense dolomite, one near middle and the other near top	2.0
16	Dolomite, dark gray, fine to medium-grained; upper half firm and locally siliceous	2.15
15	Shale, blue-gray, blocky, pyritic; top 4 inches dolomitic and locally siliceous	1.75
14	Dolomite, buff to brown, medium to fine-grained; lower 2 feet argillaceous; top 1 foot resistant, saccharoidal dolomite containing crinoid stems, fish teeth and brachiopods; locally capped with lens of buff dolomitic chert	3.0 to 3.5
13	Chert, dark brown, very dense, upper surface irregular	4.5
12	Dolomite, brown, fine-grained, firm, with dark brown nodular chert	1.0
11	Chert, clear, granular nodules and irregular masses mixed with calcite; pyritic; bed-like but probably masses in brown, fine-grained dolomite. It pinches and swells	1.0 to 1.75
10	Dolomite, brown, fine-grained, firm; containing irregular nodules of granular, chalcedonic chert	0.75
9	Chert, dark brown, mottled, appearing brecciated in places. It has a 1 inch layer of brown, fine-grained dolomite on top and bottom	0.5 to 0.75
8	Dolomite, gray to brown, fine-grained, pyritic; with a few chert nodules	0.75
7	Shale, blue-gray to buff, blocky, silty, pyritic; dolomite lens 1 foot above base; a band of granular chert nodules 2 feet above base locally underlain by a lens of dolomite.	3.0 to 3.5
6	Dolomite, gray-brown, medium-grained; lower 5 inches resistant, upper 5 inches nodular, argillaceous; containing fish teeth and algae	0.82
5	Dolmite, buff, fine-grained, earthy; containing lenses of coarser-grained, more resistant dolomite; discontinuous chert bed 2 feet above base. The bottom 8 inches grades into shale laterally	3.0
4	Dolomite, brown, fine-grained, very shaly. On weathering it gives the appearance of shale. Upper and lower contacts irregular	1.0
3	Dolomite, buff, fine-grained, argillaceous, massive; discontinuous band of dense, chalcedonic chert 1.5 feet above base. Masses of calcite appear in and around chert zone	2.35
2	Shale, blue-gray, blocky, pyritic; with selenite along the the partings; containing brachiopods and algae (?)	5.0
1	Dolomite, blue-gray, medium-grained, pyritic	0.5

Structure

The structure present in the Ames area is an anticline that is

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probably a northern extension of the flexure pattern that extends to the southwest through the Redfield structure. The dam site is on the western edge of a flexure with dips of 55 feet and 100 feet per mile for the northwest and southwest limbs, respectively. The trend of this structure is shown in figure 1.

Bedrock Geology

Distribution of the bedrock is shown in figure 1. The outcrop pattern is controlled by the Ames anticline and stream dissection.

Bedrock Configuration

The bedrock configuration (or topography) for this area has been studied by Zimmerman (1952) and Backsen (1963) in detail, and by Twenter and Coble (1965) in a more regional manner. A portion of Backsen's map is presented in figure 2.

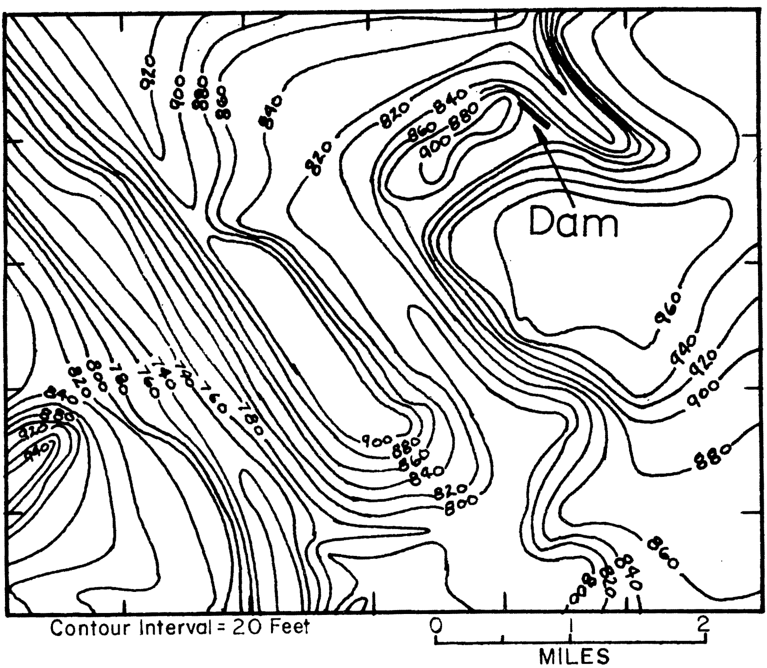

Fig. 2. Bedrock configuration map

Discussion

Buried Channel

There are several evidences of the existence of a buried channel present to the west of the reach of the modern Skunk River between a point where the Skunk River makes a sharp, near

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90° turn two miles north of Ames, to the northeast, to a point two miles of the confluence of the Keigley Branch. This valley is shown on Twenter and Coble's (1965) map as a small tributary which terminates just north of Story City. Figure 2 gives a detailed contour map of the lower end of this valley (Backsen, 1963).

The bedrock geology map, figure 1, of Zimmerman (1952), which is based on a limited amount of control, is an interpretation that was not influenced by any preconceived ideas of a buried channel. The outcrop pattern suggests that a bedrock valley exists. By comparing this pattern to the one paralleling Squaw Creek, it is obvious that it represents a valley configuration.

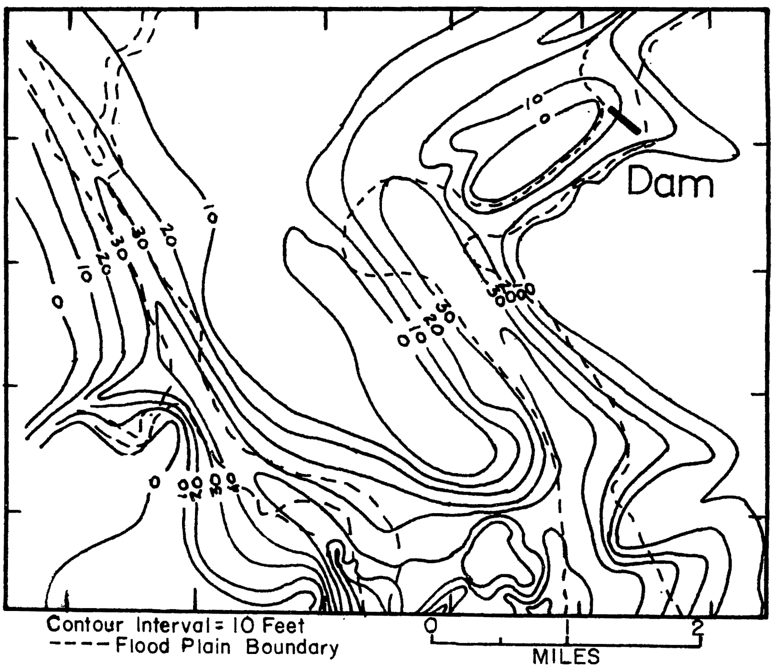

Fig. 3. Aquifer thickness map

Nature of the Valley Fill

Backsen (1963) pointed out that the sand and gravels present in the buried valley and in the aquifer become finer to the north, and it is possible that the materials in the valley are extremely fine-grained and not as good an aquifer as the deposit to the south. Figure 3 (Backsen, 1963) is an isopach of the aquifer. A minimum of 20 feet of sand and gravel is present to the northwest of the proposed dam site.

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Topographic Features

A low ridge parallel to and southwest of the Keigley Branch, stands about 40 feet higher at its highest point than the surrounding area. The Skunk River valley narrows the reach where it cuts through this topographic ridge. A reach of the modern Skunk River, approximately equal in length to the width of this ridge, appears to be displaced to the southeast approximately 1 to 1½ miles. Bedrock is exposed along this reach in several places, indicating that it is very close to the surface.

The Story City Flat, the area which lies between the Keigley Branch and the Skunk River, is underlain by sands and gravels which appear to be the northward extension of the aquifer described by Backsen (1963). These sands thin to the southwest toward the Keigley Branch and the topographic ridge. The buried channel appears to underlie the southern end of the Story City Flat (figure 2).

Ames Water Supply

The City of Ames derives its water supply from the aquifer composed of sand and gravel in the buried valley complex and the modern alluvial system of the Skunk River and Squaw Creek. Backsen's aquifer thickness map is presented in figure 3. The contribution by each portion of the aquifer is presently unknown. The Story City Flat appears to be a possible recharge area and may play an important part in the aquifer system.

One of two problems may arise from construction of the dam on this site. If the buried channel does not exist, the segment of the aquifer upstream from the dam is lost because the positive cut-off beneath the dam will stop all underflow supplying the aquifer. Even though water will be allowed to flow past the dam through the outlet structure, the rate of recharge into the aquifer may not be sufficient and some water, which would have been in the aquifer-alluvial system, will move past Ames on the surface.

If the buried channel does exist and is hydraulically connected to the aquifer, the Ames water supply will not be affected; but the dam may not hold the required amount of water during low-flow conditions.

Further studies are needed before the problems posed above can be resolved. Additional data could also provide information that would lead to a better evaluation of the aquifer system so that prediction on the total capacity of this system could be made. Should the demand for water exceed the aquifer capacity, the reservoir could be extremely important as a source of municipal water.

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Literature Cited

Backsen, Lee Bower (1963) Geohydrology of the Aquifer Supplying Ames, Iowa. Unpublished Masters thesis, Iowa State University Library.

Itinerum Review of Reports for Flood Control and Other Purposes on the Skunk River, Iowa — Ames Reservoir; the U.S. Army Corps of Engineers, Rock Island District, Rock Island, Illinois, December 10, 1964.

Twenter, F. R. and Coble, R. W. (1965) The Water Story in Central Iowa, Iowa Geological Survey Water Atlas No. 1.

Zimmerman, Harold Lee (1952) Bedrock Geology of Western Story County, Iowa. Unpublished Masters thesis, Iowa State University Library.

Depth Studies of Wisconsin Loess in Southwestern Iowa: IV. Shear Strength[1]

N. S. Fox, R. A. Lohnes, and R. L. Handy[2]

Abstract: This report is the fourth in a series of papers dealing with depth variations in the engineering properties of Wisconsin-age loess in Iowa. Previous studies have included graduation and in-place density (Davidson, et. al. 1953), clay and carbonate contents (Handy and Davidson, 1956), and organic matter, manganese and iron contents (Daniels et. al. 1960).

This paper discusses the variation of the Coulomb shear strength parameters *c* (cohesive shear strength) and ϕ (angle of internal friction)in the loess in a cut located in N. W. ¼ Sec. 3, T77N, R44W, Harrison County, Iowa. This cut was described in detail and proposed as a new type section for the Loveland formation by Daniels and Handy (1959). In general, the hill and cut consist of approximately 130 feet of post-Farmdale loess, over 12 feet of Farmdale loess, over 20 feet of Loveland loess, over oxidized calcareous Kansan (?) till. The upper 30 feet of loess is not cut and was not included in the description by Daniels et. al (1959). Below this, the upper 40′ of the cut has a slope of 50 per cent, and the lower 90 feet is cut into three near-vertical benches.

Review of Previous Work

Previous studies of shear strength parameters of loess sampled from the Loveland section were made by Olson (1958) using direct-shear tests and Akiyama (1963) using triaxial testing. Because of difficulties in trimming test samples and maintaining the natural moisture content, and because of the relatively arduous nature of the tests, relatively little could be concluded

[1] Technical Report No. 3, Office of Naval Research, Geography Branch, Project No. NR-389-144. Project 580-S of the ISU Engineering Research Institute. Contribution No. 66-3 from the Soil Research Lab.

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