THE GEOLOGICAL SURVEY OF WYOMING
S.H. Knight, State Geologist
University of Wyoming
Laramie, Wyoming

GEOLOGY OF THE LA PRELE DAM SITE, CONVERSE COUNTY, WYOMING

INTRODUCTION

The La Prele Dam is located on La Prele Creek in the south half of Section 21, Township 32 N., Range 73 W., about 18 miles by road southwest of Douglas, Converse County, Wyoming.

The geology of the dam site was examined and mapped by Horace D. Thomas and Joseph Neely on August 26 and 27, 1936, in an attempt to correlate water losses from the reservoir with the geologic setting of the dam. Mr. Oliver Roush, of Douglas, spent both days at the dam and his assistance greatly facilitated the field work.

GEOLOGY OF THE GENERAL REGION

Stratigraphy.- The Paleozoic, Mesozoic and Cenozoic rocks which are known to be present in the general region about the dam site are shown in Table I.

Geologic Structure.- The region southward from the Platte River to a point about a mile north of the dam site is covered by a mantle of horizontal Oligocene rocks (White River) which rests unconformably upon the beveled edges of the folded Mesozoic rocks (Fig. 1). Several miles north of the dam site, sandstones of the Dakota group dip north and form an east-west trending ridge of low relief which protrudes from the surrounding Oligocene rocks. At the Natural Bridge, about a mile north of the dam site,

TABLE I

	SYSTEM	FORMATION	CHARACTER
CENOZOIC	TERTIARY (Oligocene)	White River	Sandstones, clays and volcanic ash beds.
MESOZOIC	CRETACEOUS		Many thousand feet of sandstones and shales, comprising many formations, with the sandstones and shales of the Dakota group at the base.
	JURASSIC		Morrison shale underlain by Sundance shales and sandstones.
	TRIASSIC	Chugwater	Red shales and sandstones.
PALEOZOIC	PERMIAN		Basal Chugwater, including Forelle limestone, Minnekahta (?) limestone, and red Opeche (?) shale.
	PENNSYLVANIAN	Casper	Upper part mainly sandstone, lower part sandstone and red shale. Some limestones throughout. Upper massive sandstone is Tensleep sandstone, lower part is Amsden formation.
	MISSISSIPPIAN	Madison	Massive grey and pink limestone of unmeasured thickness. Probably rests on granite, although some Cambrian rocks may intervene.
	PRE-CAMBRIAN		Igneous and metamorphic rocks.

Paleozoic rocks are exposed, and the sandstones in the upper part of the Casper formation, the red Opeche (?) shale, and the Minnekahta (?) limestone, are involved in a small, sharp anticline. Between the Natural Bridge and the dam site, the Paleozoic rocks rise to the south to form a high ridge whose structure is highly complicated, but which is essentially an asymmetric syncline in the Casper and the Madison formations which is broken by faults. Between the dam site and the upper part of the reservoir, the Casper formation and the underlying Madison limestone are arched into an anticline which plunges to the west and which is also complicated by faulting.

Geomorphologic history.- After the deposition of the many thousands of feet of Paleozoic and Mesozoic limestones, sandstones, and shales over the region, these rocks were involved in the Laramide folding at the end of Cretaceous time and were extensively warped and fractured. Erosion during early Tertiary time reduced the region to a topographic expression much as it has today. This mature topography was later completely buried by Oligocene sediments in part made up of volcanic ash and in part of stream deposited material derived from higher adjacent regions. La Prele Creek now heads in the Laramie Mountains and flows northwestward to join the North Platte

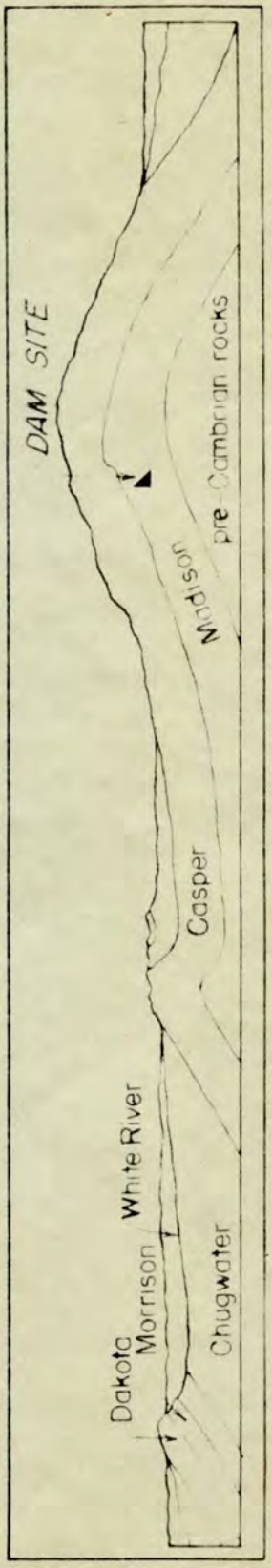

Fig 1 - Diagrammatic geologic cross-section along La Prele Creek showing the position of the La Prele dam

River a few miles upstream from Douglas. The course of La Prele Creek was established upon the surface of the Oligocene rocks, and a series of uplifts subsequently caused the stream to cut downward so that today its course falls indiscriminately across folded Paleozoic and Mesozoic rocks. It is, therefore, a typical superimposed stream, and at the dam site has cut a canyon, perhaps 800 feet deep, through an old pre-Oligocene ridge composed of folded and faulted Mississippian and Pennsylvanian sandstones and limestones.

GEOLOGY OF THE DAM SITE

The rock in which both abutments of the dam are located comprises beds of Madison limestone. A section of the rock exposed along the east abutment is as follows:

Sandy limestone member: Heavy-bedded gray limestone with intercalated sandy limestone beds. Continues upward above the top of the dam . . . . . 30 feet, plus.

Gray massive limestone member: Gray massive limestone, sandy at base and containing calcite vugs; grades upward into massive limestone which almost lacks bedding and which tends to be cavernous . about 57 feet.

Lavender limestone member: Thick-bedded, fine-grained lavender limestone; individual beds range from 1 foot to 2 feet in thickness in the upper part, but becomes more massive downward. Bedding planes well defined and accentuated by weathering. Contains fossil corals and brachiopods of Mississippian age. Base not exposed . . . . 20 feet, plus.

Structure.- The dam is located on the north flank of an anticline and the dip of the beds is to the north, downstream, at about 15 degrees. Above

high water line, in the east wall of the canyon, and a short distance upstream from the dam, these limestones are warped upward abruptly into an overturned minor anticline (Fig. 2). The fold is overturned to the north and appears to have broken, so that it is, in reality, an incipient thrust fault. However, the fold is not discernable in the west wall of the canyon.

The result of this sharp fold has been an intensive fracturing of the brittle limestones below it at the dam site. At point "C" on the accompanying map, the lavender limestone member and the gray massive limestone member of the Madison are cut by a set of fractures which trend N. 80° W., and which stand essentially vertical. That there has been actual horizontal movement along these fractures is shown by the slickensided nature of the chert nodules in the lavender member. Solution cavaties have formed along fracture planes. The fractures are sometimes open due to westhering, and the fractures are generally lined with vein deposits of crystalline calcite.

On the downstream side of the dam on the west side of the creek, near point "E", the lavender limestone member is strongly jointed by north-south and east-west fractures, and in places is irregularly broken. Certain beds show many slickensided surfaces which have an east-west trend and which dip from 10° to 30° to the south. The overlying gray massive limestone on this side of the canyon is highly brecciated and is cut by innumerable calcite-lined fractures.

Evidences of former water movements through the limestones.- The abundance of calcite-lined fractures in the limestones adjacent to the dam

indicates the deposition of lime along these openings by percolating water. At point "D" on the map is an open cavern, about 2 feet by 1 foot, in the gray massive limestone which connects downward with a calcite-lined fracture. At point "E" on the map is a large solution cavern located in a highly fractured area in the same limestone member. Solution by percolating water has opened cavities along many of the bedding planes in the lavender limestone member. The caverns, then, are features of solution and the calcite veins are features of deposition brought about through the agency of percolating water.

Relation of water loss from reservoir to geologic structure and rock type.- It has been reported that as much as 18 sec. ft. of water seeps through, or around, the dam. At the time of this examination, however, the reservoir was empty and the seeps no longer flowed. Seepage through the da m is not the concern of this report, but water lost in this manner must certainly be slight in comparison to the volume of water which drains through the limestones adjacent to the dam and arises as seeps or springs from the lavender limestone member of the Madison on both sides of the canyon on the downstream side of the dam.

The positions of these seeps are shown on the map, and all arise from the lavender limestone. The seeps on the west side of the creek, east of point "E", arise from vertical fractures which cut the limestone. The seeps on the east side of the canyon are not so well defined, but are located on the same limestone. The water probably seeps from both fractures and bedding planes. A seep under the dam also arises from this same limestone member.

Course of the water.- It is believed that water enters the lavender limestone on the upstream side of the dam (1) through fractures, (2) along

bedding planes, and (3) through caverns in the overlying gray massive limestones which connect downward with fractures which cut the lavender member. The water then follows down the dip of the lavender limestone by following bedding planes and fractures, passes around the abutments of the dam, and arises as seeps from the lavender limestone along the canyon walls on the downstream side of the dam. There is, therefore, no major point at which water enters the rock in the reservoir.

The fact that the seeps on the west side of the canyon flow less water than those on the east tends to substantiate this theory, inasmuch as there is but a small area of limestone exposed in the reservoir near the west abutment of the dam, due to a covering of silt.

The fact that the seeps dry up when the water level in the reservoir falls to about 105 feet below the spillway may be correlated in a general way with the fact that the lowermost exposure of the lavender limestone in the reservoir is about 90 feet below the spillway. However, the talus along the cluff formed by this limestone is pervious and would allow water to enter the limestone after the water level had fallen below the actual outcrop of the bed. The fact that the flow of the seeps decreases materially when the water level in the reservoir falls to about 72 feet below the spillway might indicate that the cavernous gray limestone overlying the lavender limestone is the main zone of ingress of the water, or, on the other hand, might simply mean that the hydrostatic head is no longer sufficient to force a large quantity of water through the ramifying fractures in the lavender bed.

SUMMARY OF GEOLOGIC CONDITIONS

1.- The dam site is located in a region where the rocks have been considerably deformed by folding and faulting.

2.- The limestones which crop out at the dam site have been highly fractured due to this deformation.

3.- The open nature of some of the fractures and the vein deposits in other fractures indicate that in the geologic past these openings were followed by percolating water.

4.- The beds in which the seeps occur on the downstream side of the dam dip gently upward through the dam site and crop out below the water level on the upstream side of the dam.

5.- From these facts it is concluded that water enters the outcrops of the limestones in the reservoir, follows down the dip of the beds through fractures and along bedding planes, passes around the dam through the canyon walls, and arises as seeps on the downstream side of the dam. Probably not all the water which enters the beds comes out in seeps, for some possibly continues down the dip.

6.- Silt deposited in the reservoir probably acts as an effective barrier to prevent water from passing under the dam. It is believed that little or no water follows this route, mainly because the seeps are located on the sides on the canyon from 20 to 30 feet above the base of the dam.

PROCEDURE TO STOP SEEPAGE

Inasmuch as the water enters the limestone through innumerable openings, the only means of stopping the seepage would be to cover the outcrops of the beds on the canyon walls upstream to a point where the dip brings them above water level. The method of blocking off these outcrops lies beyond the scope of this report.

STRENGTH AND STABILITY OF THE FOUNDATION OF THE DAM

The water seepage probably has little or no effect on the foundation of the dam. Although the rock is pervious, it still has strength. The deformed nature of the rock in the region indicates that extensive earth movements have taken place in the past. There is but little liklihood, however, of renewed movement along the old lines of weakness. The region is now apparently structurally stable.

EXPLANATION OF FIGURES

Fig. 2 - View of the east canyon wall a short distance upstream from the dam site showing the sharp flexure in which the limestones are warped into a vertical position.

Fig. 3 - Madison limestone in the east abutment of the dam. Vertical fractures and bedding planes are here opened by weathering.

Fig. 4 - View from top of dam, looking downstream, showing the dip of the beds in that direction. Numerous seeps arise from the lavender limestone member shown in the lower left-hand corner of the photograph.

Fig. 5 - View of the face of the dam and the east abutment. The lavender limestone from which seeps arise downstream from the dam is shown in the lower part of the canyon wall.

Fig. 2

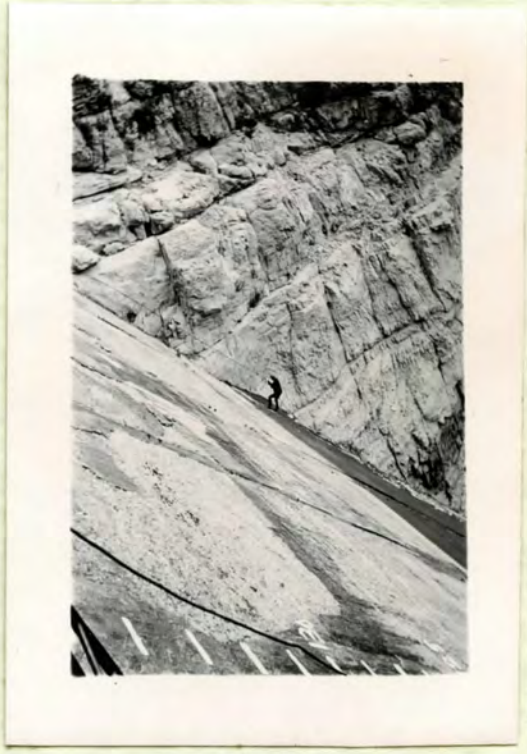

Fig. 3

Fig. 4

Fig. 5

GEOLOGIC MAP
of the
LA PRELE DAM SITE

The Geological Survey of Wyoming
S.H. Knight, State Geologist
by
H.D.THOMAS and JOSEPH NEELY

August 27, 1936

SCALE

0 10 20 30 40 50 100 feet

LEGEND

- Qal — SILTS AND GRAVELS
- Cmu — MADISON LIMESTONE–Undivided
- Cmg — MADISON–Gray Sandy Limestone Member
- Cml — MADISON–Fractured and Jointed Lavender Limestone Member
- FRACTURE ZONE
- SEEPS

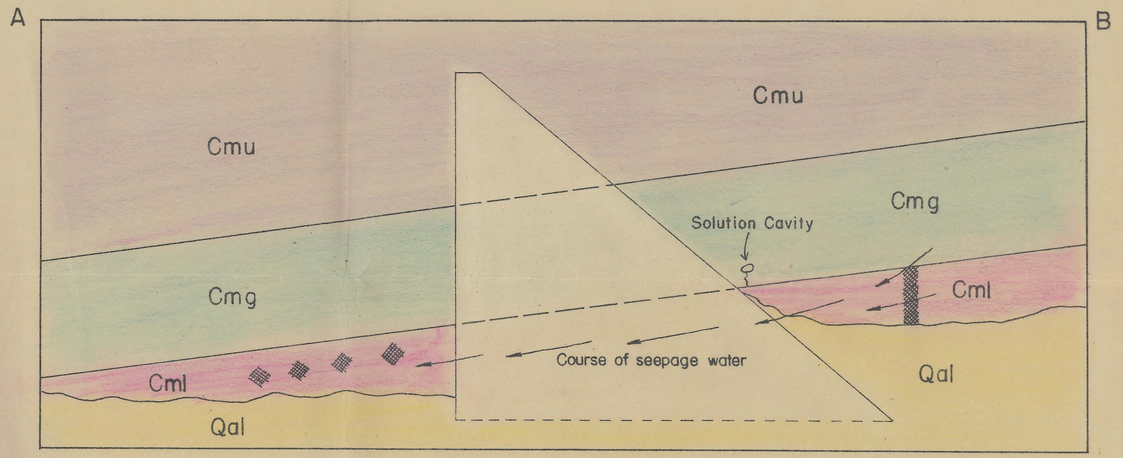

Diagram Showing Relationship of Dam to Bedrock Along Line A–B
Elevations of Contacts Projected