SOUTH DAKOTA GEOLOGICAL SURVEY

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STATE OF SOUTH DAKOTA

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GEOLOGY of the CEDAR CANYON QUADRANGLE SOUTH DAKOTA

EXPLANATION

Sedimentary Rocks

RECENT

Qal — Alluvium
(Floodplain and recent valley-bottom deposits of gravel, sand and silt)

PLEISTOCENE

Qt — Terrace deposits
(Rounded quartz sand and mainly gravel, composed mostly of ironstone pebbles, 0-12 feet thick)

OLIGOCENE

Tow — White River Group
Chadron Formation
(Light-greenish to purplish bentonitic clay with 2 layers of calcareous-cemented fine-grained sandstone or limestone about 55 feet apart forming the cap rock for Fox Ridge. Basal white to rusty poorly cemented massive to cross-bedded quartz-feldspar grit. About 120 feet thick)

PALEOCENE

Tpl — Ludlow Formation
(Layers of clay-shale in colors of red, brown and purple. Lenses of carbonaceous shale of the Shadehill coal facies at base. Gypsum associated with the carbonaceous shale. About 90 feet thick)

UPPER CRETACEOUS

Kh — Hell Creek Formation
(Inter-bedded massive to cross-bedded interlaminated bentonitic sand, silt, and clay. Locally the sand has calcareous cement forming ledges and caprock. Weathers to badlands topography with popcorn and fluted surfaces. Angular to rounded fragments of ironstone scattered on the surface. Lenses of carbonaceous shale throughout the unit. About 450 feet thick)

Kf — Fox Hills Formation
Bullhead Member
(Alternating beds of dark-gray fine-grained sand and silt. Near the top is a gray to buff fine- to medium-grained graywacke. About 20 feet exposed)

Geologic contact
(dashed where approximately located)

Gravel Pit

BM 3017
Bench Mark
(monument showing exact altitude above sea level)

2703
Spot Altitude

▲ MAURINE
Triangulation Station
(monument marking exact geographic location)

House, School, and Church

Geology by Alan U. Lange, 1961
Assisted by Charles J. Mickel

Vertical and horizontal control surveyed from U.S. Geological Survey topographic maps and triangulation and level lines of Federal Surveys.
Drafted by Bruno C. Petsch, 1962

APPROXIMATE MEAN DECLINATION, 1962

Scale 1:62500

Vermillion South Dakota
1962

Tertiary Sediments

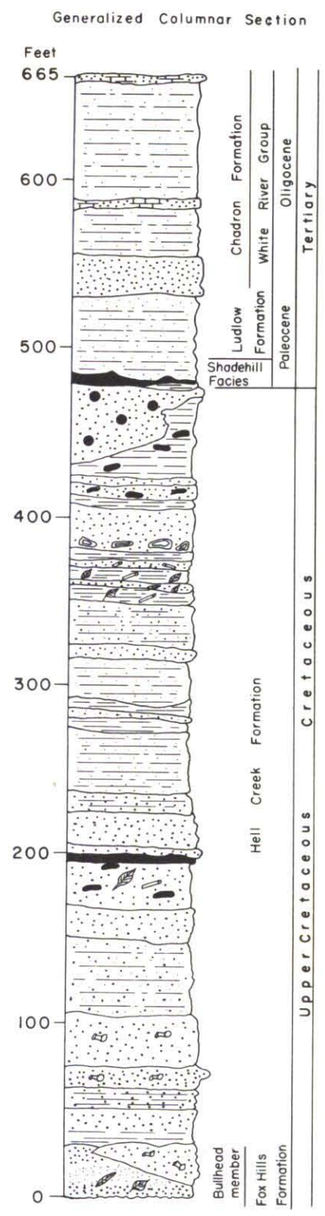
Quadrangle Location

CEDAR CANYON QUADRANGLE

GEOLOGY OF THE CEDAR CANYON QUADRANGLE

by

ALAN U. LANGE



INTRODUCTION

The Cedar Canyon quadrangle contains about 214 square miles in southwestern Perkins County and northwestern Meade County. The quadrangle is in the Cretaceous Tableland subdivision of the Great Plains physiographic province, and is located 125 miles northwest of Pierre. Topographically the area is gently rolling prairie grassland with a deeply incised upland and buttes to the south, and terrace remnants along the Moreau River and its larger tributaries. The major part of the area drains into the Moreau River system; however, the area south of the Fox Ridge divide at the southern boundary drains toward the south into the Cheyenne River.

Cedar Canyon, after which this quadrangle is named, is the most striking physiographic feature in the mapped area. The relief in the canyon ranges up to 200 feet. The canyon walls are composed of Hell Creek (Kh) sand, silt and clay, which weather to gray grass-free badlands. The canyon was formed by the incision of the headwaters of Big Cedar Creek into a highland of Hell Creek sediments that are capped with sand and sandstone. The drainage system shows small well-defined flood plains. Grass-covered remnants of pre-existing surfaces are also present at different levels above the flood plain. Terrace remnants along the Moreau River decrease in altitude from the west where they are about 2570 feet above sea level, to the east where they are about 2500 feet. Small colluvial surfaces, developed on the Hell Creek capping sandstone, slope both toward and away from the present drainage system.

The Moreau River meanders eastward across the northern half of the quadrangle, with a gradient of eight feet per mile. In the western part of the quadrangle the slopes to the River are gentle, whereas to the east the gentle slopes end in vertical cuts which are caused by the undermining of terrace remnants by the Moreau River. The flood plain of the Moreau River attains a width of nearly two miles.

The largest tributary of the Moreau River in the Cedar Canyon Quadrangle is Deep Creek. The eastward course of Deep Creek is three to four miles south of the Moreau River and roughly parallel to it. The two waterways join about 13 miles east of the mapped area. The gradient of Deep Creek is about 20 feet per mile and the terraces decrease in altitude from 2610 feet near the center of the quadrangle to 2660 feet in the east. Geomorphologically, the smaller, lesser entrenched Deep Creek is being captured by the larger, more entrenched Moreau River. Evidence of capture is present in Sections 15, 16, and 18, T. 13 N., R. 12 E., where the headwaters of the Big and Little Cedar Creeks have been captured from Deep Creek by short tributaries of the Moreau River. These short tributaries have the characteristic nearly right-angle stream bends normally associated with stream capture. A probable site of future capture is in Section 12, T. 13 N., R. 12 E., where a tributary of the Moreau River has been artificially connected to Deep Creek by a diverson ditch.

In the past, Deep Creek extended westward probably past the Cedar Canyon area. The numerous meanders developed in Deep Creek indicates a mature stream possibly the same age as the Moreau River. The lithology of the upper Hell Creek (lenses of very coarse sand and sandstone) in the higher elevations of Cedar Canyon, coupled with the fact that the Moreau's position appears to have been down dip from that of Deep Creek, is probably the reason that Deep Creek was left stranded or perched 250 feet above the Moreau River. As the perching of Deep Creek was taking place, the tributaries of the Moreau gradually undermined the divide north of the Deep Creek Valley, until at least two tributaries of the Moreau cut through and captured the headwaters of Deep Creek.

Other tributaries of the Moreau River in the mapped area are Starve Out, Cabin, Brushy, Cottonwood, Mud, Ash, Big Cedar and Little Cedar Creeks, and Dillon Draw; these and Deep Creek are intermittent streams that meander over narrow well-defined flood plain alluvium (Qal). The Moreau River, Maurine Lake, and stock dams are the only permanent bodies of water, but springs issue intermittently from sands in the Hell Creek (Kh) and White River (Tow).

Near the southeastern corner of the quadrangle, the western part of Fox Ridge rises 300 feet above the surrounding upland. This flat-topped ridge and adjoining buttes are composed of Hell Creek (Kh), Ludlow (Tpl), and capped by White River (Tow). The cap is composed of calcareous-cemented fine-grained white sandstone and limestone. Fox Ridge has a minor degree of slumping, as small blocks of Ludlow and White River material have moved short distances downslope.

Maximim topographic relief in the Cedar Canyon quadrangle is about 760 feet, between altitudes of 3170 feet on Fox Ridge and 2410 feet on the Moreau River flood plain at the eastern edge of the quadrangle.

The climate of Cedar Canyon quadrangle is semiarid, with a mean average rainfall of 15.2 inches and an average temperature of 46.9 degrees Fahrenheit at the U. S. Weather Bureau Station at Faith, 25 miles east of the quadrangle. The area is sparsely populated, with one family per six square miles. The town of Maurine, in the southeastern part of the quadrangle, is composed of a store, garage, town hall and two houses. U. S. Highway 212 extends east and west across the southern part of the quadrangle. Three gravel roads lead northward from this Highway, but only one reaches the northern boundary of the quadrangle.

The Cedar Canyon quadrangle was mapped with the assistance of Charles J. Mickel during the summer of 1961 under the supervision of Earl J. Cox as part of the State Geological Survey's program of studying South Dakota's economic mineral resources, including ground water. The geology was mapped on topographic maps prepared by the U. S. Geological Survey for the Maurine, Cedar Canyon, Bixby, and Imogene 7½-minute quadrangles. Advice and assistance from Wayne A. Pettyjohn is acknowledged and greatly appreciated. The writer wishes to thank the people of the area for their help in providing valuable information.

EXPOSED SEDIMENTARY ROCKS

The exposed sedimentary rocks of the Cedar Canyon quadrangle are Fox Hills and Hell Creek Formations of Late Cretaceous age, the Ludlow Formation of Paleocene age, and the White River Group of Oligocene age. Also present are terrace deposits and alluvium, of Pleistocene and Recent age.

Fox Hills Formation Meek and Hayden, 1862

The Fox Hills Formation was named from exposures along Fox Hills between the Cheyenne and Moreau Rivers, about 70 miles east of the mapped area.

In the type area and to the north the Formation consists of four members, in ascending order: Trail City -- bluish-green coarse- to fine-grained sand and silt, and dark-gray to gray silty clay and clay; Timber Lake -- laminated greenish to light-gray to buff medium- to fine-grained graywacke sandstone with some glauconite; Bullhead -- thick alternating layers of brown to gray clay-shale containing streaks of silt; and Colgate -- calcareous and siliceous-cemented cross-bedded fine- to very coarse-grained graywacke sandstone.

The Bullhead Member of the Fox Hills Formation is recognizable in the Cedar Canyon quadrangle. Nearly 20 feet of this unit is exposed in two cut-banks along the Moreau River in Sec. 27, T. 14 N., R. 13 E. This member consists of alternating dark-gray fissile siltstone and light-gray fine-grained sand in bands less than six inches thick.

Near the top of the Bullhead Member is a gray to buff, fine- to medium-grained graywacke sand, three to four feet thick. The lower contact of the Bullhead Member is not exposed in the Cedar Canyon quadrangle. The upper contact of the Bullhead Member with the overlying Hell Creek Formation is well exposed in Sec. 27, T. 14 N., R. 13 E. The upper contact is drawn where the alternating dark fissile siltstone and light-gray fine-grained sand with massive graywacke lenses of the Bullhead Member, underlie a zone of alternating cross-bedded laminated graywacke sands and highly carbonaceous clays and silts of the Hell Creek Formation.

Impressions of plant leaves and blades of grass are present throughout the unit.

Hell Creek Formation Brown, 1907

The Hell Creek Formation was named from exposures along Hell Creek in eastern Montana, about 190 miles northwest of the mapped area.

The Hell Creek Formation is about 450 feet thick, and is exposed in 90 percent of the area. The unit is composed of interbedded and interlaminated bentonitic sand, silt and clay. The contact between the Hell Creek Formation and the Fox Hills Formation (Bullhead Member) is discussed above. The upper contact of the Hell Creek with the Ludlow Formation is drawn either at the base of a carbonaceous shale layer of the Shadehill (?) coal facies or where it is absent, at the red, purple, brown, and yellow clay-shales. The Hell Creek Formation immediately underlying the carbonaceous shale or varicolored clay-shale consists of either massive of cross-bedded buff poorly cemented coarse-grained graywacke ("somber beds").

The sand and silt fraction varies in shades of gray, brown, and yellow. The sands are fine- to coarse-grained graywacke, with cross-bedding and graded bedding. Fresh cuts along the Moreau River in the SW¼SE¼ sec. 24 and SW¼NE¼ sec. 25, T. 14 N., R. 12 E., show two graywacke sands, the lower one being about 40 feet thick. The clay occurs in layers as much as 17 feet thick.

Weathered exposures form badlands topography with fluted (sandy) and popcorn (bentonitic) surfaces. Abundant fragments of ironstone locally cover the surface of the weathered Hell Creek Formation sufficiently to retard erosion, forming bed-rock terraces. Manganese-iron concretions, and marcasite or pyrite concretions are scattered throughout the unit.

A two-foot layer of sandy lignite was noted near the base of a cut on the east side of a terrace at NW¼NE¼ sec. 25, T. 14 N., R. 12 E. Numerous layers or lenses of peat, carbonaceous shale, and brown carbonaceous sand and silt are present throughout the unit, as are small black dull and shiny angular coal fragments averaging about ⅛-inch in diameter.

Near the upper contact of the Hell Creek Formation, and within the Formation, are cross-bedded brown to buff medium- to very coarse-grained graywacke sands and calcareous-cemented sandstones. These sands and sandstones cap the Hell Creek upland near Cedar Canyon. Small buttes in the SW¼ sec. 2, T. 12 N., R. 13 E., and SW¼ sec. 27, T. 13 N., R. 12 E., and a short ridge in the SW¼NW¼ sec. 23, T. 14 N., R. 12 E., are also capped with the upper Hell Creek graywacke sands and sandstones.

Dinosaur bones, plant impressions, and woody material resembling twigs are present in the unit.

Ludlow Formation Lloyd and Hares, 1915

The Ludlow Formation was named from exposures near the town of Ludlow, South Dakota, about 60 miles north of the mapped area.

The Ludlow Formation is exposed along the northern and southern boundaries of the area. In the northern area the Ludlow is exposed in the SE¼ sec. 23, T. 15 N., R. 11 E., and in the E½ sec. 20, R. 15 N., R. 12 E. The western exposure contains at its base four to five feet of brownish carbonaceous shale, whereas the eastern one contains only one to two inches of black coaly material. Above the carbonaceous shale and coal layers are layers of clay-shale in colors of red, brown, and purple.

In the southern part of the quadrangle the Ludlow is present on Fox Ridge and on the high areas to the west. In this part of the quadrangle the Shadehill coal facies is absent; however, the varicolored clay-shales are present. The varicolored basal clay-shale becomes sandy along Fox Ridge to the west.

The contact between the Ludlow Formation and the underlying Hell Creek Formation was discussed above. The upper contact of the Ludlow with the White River Group is drawn at the base of a zone of white angular to sub-rounded quartz-feldspar coarse-grained sand and grit.

The Ludlow Formation reaches a thickness of about 90 feet on Fox Ridge.

White River Group Meek and Hayden, 1856; Chadron Formation Darton, 1899

The Chadron Formation was named from exposures near Chadron, Nebraska, about 150 miles southwest of the Cedar Canyon quadrangle.

The Formation consists of light-greenish to purplish bentonitic clay, with ledges of calcareous-cemented fine white sandstone or limestone, and white to buff coarse-grained sand and grit. The unit is as thick as 120 feet. The sand and grit at the base of the Chadron Formation ranges from about three to more than 20 feet in thickness, the latter thickness being measured at a pit in the NE¼ sec. 8, T. 12 N., R. 13 E. Loose boulders composed of siliceous-cemented quartz-feldspar grit are present in the SW¼SE¼ sec. 10, T. 12 N., R. 13 E., where they reach a diameter of 15 feet.

Smaller buttes in the SW¼ sec. 2, T. 12 N., R. 13 E., and SW¼ sec. 27, T. 13 N., R. 12 E., have fragments of cemented fine-grained sandstone of the White River Group scattered as float over the surface. The fragments of float lie directly on the upper Hell Creek sands, which means that if the intervening Ludlow Formation had once been present, no evidence remains.

The Chadron Formation contains two conspicuous ledges of calcareous-cemented fine-grained sandstone or limestone with thicknesses up to one foot. The lower ledge forms a bench along the side of Fox Ridge.

Surficial Deposits

The Cedar Canyon quadrangle has two types of surficial deposits: terrace deposits and alluvium.

Terrace deposits (Qt), composed chiefly of sands and gravels, occur along the Moreau River and Deep Creek. The gravels are mainly rounded ironstone and quartz grains. A cut-bank on the west side of a terrace in the SW¼NE¼ sec. 27, T. 14 N., R. 13 E., exposes 12 feet of gravel. The gravel is cross-bedded and interbedded with thin lenses (one to two inches thick) of coarse- to very coarse-grained quartz sand.

A topographic break between the terrace deposits and the Recent alluvium in the form of benches is evident. The benches number from three to five in any one slope, and clearly indicate stages in the downcutting of the Moreau River and Deep Creek.

The larger terraces are present on the southern side of the River and Creek, ranging up to about 100 acres in area. The alluvial benches along Deep Creek have as much as two feet of fine- to medium-grained sand; however, some have gravel like that of the terraces.

Locally, boulders of the Tongue River Formation are scattered over the surface; however, they are not concentrated enough to warrant separate mapping.

SUBSURFACE GEOLOGY

The lithology and thickness of the subsurface rocks are shown in Table 1. This table is a composite of well samples and electric logs of nearby oil tests. The wells are the Shell #22-7 Bastian (SE¼SW¼ sec. 7, T. 15 N., R. 16 E.), located about 25 miles northeast; the Phillips #1 Nelson (NW¼SE¼ sec. 18, T. 13 N., R. 18 E.), located about 30 miles east; and the Evans-Querbes #1 Capp (NW corner sec. 9, T. 13 N., R. 16 E.) which is located 20 miles northeast of Maurine.

Table 1--Lithology and Thickness of the Subsurface Rocks in the Cedar Canyon Quadrangle.

Age	Group or Formation	Thickness	Lithology
Cretaceous	Pierre	645+	Light- to dark-gray micaceous shale and white sandy marl, with calcareous and chert concretions.
	Niobrara	255	Dark-gray to black carbonaceous shale with white calcareous specks.
	Carlile	355	Light- to dark-gray somewhat micaceous shales with some clear quartz sand.
	Greenhorn	320	Light- to dark-brown to black shale with fragments of limestone. Abundant fossils.
	Belle Fourche - Mowry	123	Gray to dark-gray bentonitic shale, containing carbonaceous material and plant fossils.
	Newcastle	50	White to very light-gray fine-grained porous slightly bentonitic sand.
	Skull Creek - Fall River	100	Light- to dark-gray bentonitic shale with as much as 10 percent light-gray to tan very fine-grained sandstone; pyrite and siderite concretions.
Jurassic	Morrison	135	Varicolored gray shale, trace of glauconite, sandstone and fish scales.
	Sundance	395	Greenish gray glauconitic fine-grained sandstone, marl, micaceous clayey siltstone, and clay.
	Piper	10	White, pale-gray and pale-pink dense limestone with a trace of red shale.
Triassic	Gypsum Springs to Spearfish	215	Pale reddish-brown to dark-red shale with white anhydrite and brownish siltstone.
Permian-Pennsylvanian	Minnekahta	50	Moderate to redbrown siltstone, red orange clay, pink to cream-colored limestone, reddish shales, and some large rounded quartz grains.
	Opeche	150	Limestone, anhydrite, dolomite, and gray to black to brown non-calcareous splintery shale.
	Minnelusa	300	White, pink to red limestone, light-colored sandstone, and light- to dark-grayish and greenish shales.
Mississippian	Big Snowy	300	Dense limestone to hard grayish sandstone to grayish black shale; some of the limestone contains ostracods.
	Kibbey	70	Dark limestone to black shale, and clear medium to coarse unconsolidated quartz sand.
	Charles	55	White dense to translucent limestone and waxy varicolored shales in colors of tan, brown, green, red and black.
	Mission Canyon (Madison)	415	White, gray and yellow to translucent crystalline and granular limestone; some micaceous shales near lower contact.
	Lodgepole	255	Light-gray to yellowish-gray to gray oolitic granular limestone; contains greenish gray shales.
	Englewood	100	White to moderate yellowish-gray granular limestone, gray glauconitic soft sand, and bituminous shale.
Devonian		215	Hard gray, yellow-brown, grayish-red siltstones, to pale reddish-brown to red dolomite; red to gray hard splintery shale.
Silurian		155	Light olive-brown to light-gray to reddish dolomite with etched quartz grains; dark- and light-gray shales.
Ordovician	Stony Mt.	40	Grayish-red dolomitic shale, partly mottled with dark-gray papery micaceous shale.
	Red River	540	Greenish to olive-gray fractured dense limestone; traces of light to medium-gray shales.
	Winnipeg	205	Dark yellowish-brown sandy clay, greenish bentonitic clay, and limestone fragments; lower part contains fine to medium, rounded quartz grains.
Cambrian	Deadwood	300	White to reddish glauconitic sand and clay, with frosted rounded and angular quartz grains.
Precambrian	Granite	?	Biotite, quartz and feldspar.

STRUCTRAL GEOLOGY

The Cedar Canyon quadrangle is located in the southeastern corner of the Williston Basin. The regional dip could not be determined because of the small area of outcrop of Fox Hills, and the fact that the Hell Creek, Ludlow and Chadron Formations are terrestrial in origin. In the area to the east, however, it was determined that the regional dip was four feet per mile to the north or northwest; thus the beds are nearly flat-lying.

ECONOMIC GEOLOGY

Ground water, boulders, gravel, and grit and sand are the chief mineral resources in the Cedar Canyon quadrangle, but the possibility of oil and gas cannot be disregarded.

Ground Water

Ground water can be readily obtained from the Hell Creek Formation throughout the area, in shallow wells ranging from 30 to 300 feet in depth. The chemical analyses of the water from these wells is shown in Table 2. According to the ranchers, some of the wells can be pumped dry whereas other wells can withstand endless pumping. The water level ranges from the surface to 240 feet below the surface. The wells supply both household and stock needs.

During years of greater rainfall, numerous springs issue from the Hell Creek sands, and from the Chadron sands just above the white calcareous sandstone and limestone ledges.

Table 2--Chemical Analyses of Water from the Cedar Canyon Quadrangle

Source of Water	Parts per million SO_4	Cl	Mg	Ca	Na	Total Solids	Hardness
1. Hell Creek	493	1	1	10	520	1546	520
2. Hell Creek	316	5	22	30	300	1064	165
3. Hell Creek (upper coarse sands)	33	1	14	57	40	340	200
4. Hell Creek	369	2	0.9	9	432	1232	25
5. Hell Creek	337	3	0.2	13	430	1256	33
6. Hell Creek	57	-	-	4	160	542	10
7. Standard	250	250	125			500	120

1. M. Fisher ranch, SW corner sec. 22, T. 15 N., R. 13 E.
2. B. Haines ranch, SW¼SE¼ sec. 10, T. 12 N., R. 13 E.
3. W. Packer ranch, NW¼NE¼ sec. 26, T. 13 N., R. 11 E.
4. E. Pullins ranch, NW¼ sec. 13, T. 13 N., R. 11 E.
5. E. Pullins ranch, SW¼SW¼ sec. 13, T. 13 N., R. 11 E.
6. H. Thingelstad ranch, N. center of sec. 33, T. 13 N., R. 12 E.

Boulders

Highly polished tan-colored quartzite boulders Tongue River (?) are scattered locally throughout the area. The boulders are most noticeable in the northern half of the area, with the greatest concentration in the northwest quarter. The boulders range up to four feet in diameter.

Gravel

Gravel deposits on the terrace remnants along the Moreau River and Deep Creek are used for road surfacing. The gravel deposits range from a few inches to 12 feet thick. The gravels are interbedded with lenses of fine- to coarse-grained sands, and contain a high percentage of ironstone, thus making them impractical for use as concrete.

A pit in the NW¼SW¼ sec. 16, T. 13 N., R. 13 E., was used during the summer of 1961 for road surfacing. The terrace deposit in the SW¼NE¼ sec. 27, T. 14 N., R. 13 E., is to be used in the rebuilding and reconditioning of U. S. Highway 212. Many of the smaller terrace deposits have small pits where gravel has been removed.

Grit and Sands

An abundance of massive and cross-bedded fine- to coarse-grained graywacke sand is present in the quadrangle, but the composition makes the sand unsuitable for concrete.

The cemented fine-grained white sandstone and limestone of the White River Group on Fox Ridge has been crushed and used for asphalt road surfacing. The material, however, is very difficult to crush.

The grit and sand which marks the base of the White River on Fox Ridge in the NE¼SE¼ sec. 8, T. 12 N., R. 13 E., has been used extensively for aggregate. The grit is composed of angular to sub-round very coarse-grained quartz and feldspar sand and grit. In the pit more than 20 feet of this material is exposed.