

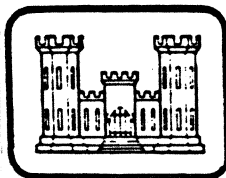
ANALYSIS OF GROUNDWATER AND STREAMFLOW DATA
WESTERN DAKOTAS REGION OF SOUTH DAKOTA

TASKS 3A.B.C. AND 4A.B. : GROUNDWATER RESOURCE INVENTORY

FINAL REPORT

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by

Johnette C. Allen, Derric L. Iles, and Anthony K. Petres

Department of Water and Natural Resources
Division of Geological Survey
Vermillion, South Dakota 57069

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1. Generalized stratigraphic column of central
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PLATES SHOWING AQUIFER UNITS *

2. Alluvium: Areal extent
3. Ogallala Group: Structure contour
4. Ogallala Group: Potentionmetric surface
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6. Arikaree Group: Potentiometric surface
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8. Fort Union Group: Isopach
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10. Fox Hills Formation: Structure contour
11. Dakota Formation - Newcastle Sandstone: Structure contour
12. Dakota Formation - Newcastle Sandstone: Isopach
13. Inyan Kara Group: Structure contours
14. Inyan Kara Group: Isopach

15. Sundance Formation: Isopach
16. Minnekahta Limestone: Isopach
17. Minnelusa Group: Structure contour
18. Minnelusa Group: Isopach
19. Madison Group: Structure contour
20. Madison Group: Isopach
21. Red River Formation: Structure contour
22. Red River Formation: Isopach
23. Deadwood Formation: Structure contour
24. Deadwood Formation: Isopach
25. Precambrian: Structure contour

PLATES SHOWING NON-AQUIFER UNITS

26. Pierre Shale: Areal extent
27. Niobrara Formation: Areal extent
28. Carlile Shale: Areal extent
29. Greenhorn Limestone: Structure contour
30. Belle Fourche and Mowry Shale: Areal extent
31. Skull Creek Shale: Isopach
32. Unkpapa Sandstone and Morrison Formation: Isopach
33. Spearfish Formation: Isopach
34. Opeche Shale: Isopach

* Plates 2-25 are available at a 1:500,000 scale from the
Division of Geological Survey upon request.

INTRODUCTION

This report is part of a series of studies being conducted by the U.S. Army Corps of Engineers to evaluate water resources in western South Dakota. The output contained in this report is restricted to portions of South Dakota west of the Missouri River. The following listed TASKS are the output for this study.

TASK III - Conduct a ground-water resource inventory in the Black Hills area including bedrock and alluvial deposits.

- A. Compile a geologic map of the Black Hills area using the mylar base map prepared in TASK I.
- B. Prepare maps showing distribution and thickness of subsurface aquifer units. (Structure contour maps were added as an output task through amendment of the original contract).
- C. Prepare maps and/or tables showing ground-water storage for aquifer units.

TASK IV - Update, expand, and detail the "Reconnaissance Elements of Western Dakota Region of South Dakota, Part 2" (Rahn, 1981).

- A. Prepare maps showing distribution, thickness, and structure.
- B. Prepare maps and/or tables showing ground-water storage for identified aquifer units.

The output in this phase of the study is intended to provide a comprehensive ground-water resource inventory and to provide framework maps to serve as a basis for more detailed technical studies. It will also serve as a tool for development and management of the ground-water resources based on data available at the present time.

This report is an update of a previously published report "Reconnaissance Elements of Western South Dakota, Part 2" (Rahn, 1981). This report differs from Rahn's report in that it makes a distinction between aquifer and non-aquifer units. An aquifer unit is defined for the purposes of this report as any water bearing strata with a potential for regional development. Non-aquifer units are units with limited or no aquifer potential. Non-aquifer units may locally be capable of maintaining low capacity wells. A general stratigraphic section of western South Dakota showing both aquifer and non-aquifer units is presented on plate 1.

In TASK III of the study for eastern South Dakota, management unit boundaries were designated for non-bedrock aquifers. Management unit boundaries were not determined in western South Dakota because of the regional extent and the lack of significant

hydrologic data on aquifers present.

AQUIFERS

Bedrock Aquifers

Bedrock aquifers include all sedimentary, igneous, and metamorphic rocks which underlie alluvial deposits. A detailed discussion of igneous and metamorphic aquifer units will be presented below. Table 1, appendix B, lists total recoverable water and areal extent for all of the known bedrock units which have regional aquifer potential in western South Dakota. Where adequate data are available, aquifer maps have been prepared showing the distribution, structure contours, and thickness of aquifer units (see pls. 2-25). In addition, potentiometric surface maps were constructed for both the Ogallala Group and Arikaree Group (pls. 4 and 6). Plates 26 through 34 show distribution, structure contours, and thickness of non-aquifer bedrock units where adequate data are available.

Precambrian Aquifer Units

All tertiary igneous, Precambrian igneous and metamorphic rocks are represented on plate 25 as one aquifer unit. These rocks were classified as one unit because of their similar hydrologic properties. Ground water is derived from bedding planes, joints, and fractures that occur in igneous and metamorphic rocks. The hydrologic properties of igneous and metamorphic rocks make the potential as a water source very difficult to assess. Estimates of storage values for this report are listed in appendix B, tables 1-4. Only the upper 500 feet of the Precambrian unit was used to determine amounts of recoverable water. Below this depth lithostatic pressure keeps most of the water-transmitting voids closed (Rahn, 1981). The Precambrian does supply small amounts of water to domestic, stock-watering and a few municipal wells in the Black Hills region. Water is obtained from the Precambrian in the municipalities of Custer, Rockerville, Deadwood, Lead, and at the Mt. Rushmore Memorial.

Alluvial Aquifers

Alluvial aquifers are randomly distributed throughout western South Dakota (pl. 2). They are commonly at the surface and are primarily water table although artesian segments may exist. Many alluvial aquifers are associated with or limited to present surficial drainage systems such as the White River. Others may occur as a "closed systems" with no apparent relationships to current surface drainages. An example of the latter occurs in southern Gregory County and is shown on plate 2.

NON-AQUIFER UNITS

Table 1 lists formations in western South Dakota which lack regional aquifer potential. These units are represented as "non-aquifer units" because they are too thin, too impermeable, unsaturated, or lack significant areal extent. Also included are stratigraphic units in western South Dakota where data are limited or not available to determine their use as potential aquifers. Locally, these non-aquifer units may be capable of producing enough water to maintain low capacity wells. Distribution and/or isopachs of non-aquifer units are presented in plates 26 through 34.

TABLE 1

List of non-aquifer units present
in western South Dakota

Pierre Shale
Niobrara Formation *
Carlile Shale
Greenhorn Limestone
Belle Fourche Shale
Mowry Shale
Skull Creek Shale
Unkpapa Sandstone *
Morrison Formation
Spearfish Formation
Opeche Shale

* The Niobrara Formation and Unkpapa Sandstone are capable of supplying modest amounts of water in western South Dakota. These stratigraphic units were included in table 1 because of the lack of available data to assess their potential for use as aquifers in western South Dakota.

GROUND-WATER INVENTORY

Quantities of recoverable ground water in western South Dakota were calculated for each aquifer by the following method. Initially, the estimated area of known aquifer occurrence was

determined by planimetering from maps constructed at 1:500,000 scale. Total miles were then converted to obtain the total number of acres in each aquifer unit. The average saturated thickness for each aquifer unit was obtained by one of three methods:

1. Using a previously published average saturated thickness.
2. Estimating average saturated thickness by county using isopach maps constructed for this report.
3. Planimetering areas of saturated thickness intervals within a county from constructed isopach maps.

Once the values for total acres and average saturated thickness were known for each aquifer, the estimated total of ground-water storage by aquifer unit was calculated. The total ground-water storage was calculated by multiplying the porosity times the volume (product of thickness times total acres of areal extent) for each aquifer unit. The total ground-water storage was then multiplied by a specific yield value unique to each aquifer unit to determine recoverable ground water in acre feet. Porosity and specific yield values used to calculate recoverable ground water remained constant within each aquifer unit. Porosity, specific yield and saturated thickness values for each aquifer unit are presented by county in appendix C. Values for recoverable water represent an approximate estimate of available water in storage. Amounts of recoverable water by county and by basin were calculated independently. Therefore, the values may not represent an exact match for total recoverable water by aquifer.

SUMMARY

Ground-water resources in western South Dakota are abundant. Much of the water is highly mineralized and at depths which presently make its utilization uneconomical (Rahn, 1981). Figure 1 and table 1 in appendix B present a summary of the total recoverable ground water in western South Dakota.

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APPENDIX A

TABLE 1. BASINS AND CORRESPONDING
NUMBER REPRESENTATIONS

BLACK HILLS REGION NOS. 1 - 32

1 - Alkali Creek	18 - Lame Johnny Creek
2 - Battle Creek	19 - Maloney Creek
3 - Bear Butte Creek	20 - Nine Mile Creek
4 - Beaver Creek	21 - Oyster Mountain
5 - Bennett Canyon	22 - Pass Creek
6 - Boxelder Creek	23 - Rapid Creek
7 - Cascade Creek	24 - Red Canyon-Pleasant Valley Fourmile Creek
8 - Chilson Canyon	25 - Redwater River
9 - Cottonwood Creek	26 - Sand Creek
10 - Crow Creek	27 - Spearfish Creek
11 - Driftwood Creek	28 - Spring Creek
12 - Elk Creek	29 - Stinking Water Creek
13 - Fall River	30 - Stockade-Beaver Creek
14 - False Bottom Creek	31 - Whitewood Creek
15 - French Creek	32 - Willow Creek
16 - Hay Creek	
17 - Inyan Kara Creek	

CHEYENNE RIVER REGION

33 - Lower Cheyenne	35 - Upper Cheyenne, Above Angostura (UCAA)
34 - Middle Cheyenne	

NIOBRARA RIVER REGION

36 - Bear Creek	38 - Minnechaduza Creek
37 - Keya Paha River	

39 - Bad River	44 - Missouri River (West)
40 - Belle Fource River	45 - Moreau River
41 - Cedar Creek-Cannonball	46 - Ponca Creek-Missouri
42 - Grand River	47 - White River
43 - Little Missouri River	

Figure 1 App A goes here (following P. A1)

Drainage Basin map of western South Dakota

This figure located in separate folder with plates 1-25.

APPENDIX A

TABLE 2. AREAS OF DRAINAGE BASINS
in Western South Dakota

* * * * *	
DRAINAGE BASIN	SQUARE MILES
* * * * *	
BAD RIVER -----	3,184
BELLE FOURCHE -----	2,075
BLACK HILLS REGION	
Alkali Creek -----	187
Battle Creek -----	300
Bear Butte Creek -----	148
Beaver Creek -----	132
Bennett Canyon -----	17
Boxelder Creek -----	374
Cascade Creek -----	25
Chilson Canyon -----	30
Cottonwood Creek -----	33
Crow Creek -----	42
Driftwood Creek -----	17
Elk Creek -----	599
Fall River -----	161
False Bottom Creek -----	102
French Creek -----	273
Hay Creek -----	39
Inyan Kara Creek -----	1
Lame Johnny Creek -----	100
Maloney Creek -----	15
Nine Mile Creek -----	35
Oyster Mountain -----	73
Pass Creek -----	227
Rapid Creek -----	714
Red Canyon - Pleasant Valley-	
Fourmile Creek -----	212
Redwater River -----	68
Sand Creek -----	49
Spearfish Creek -----	206
Spring Creek -----	385
Stinking Water Creek -----	31
Stockade-Beaver Creek -----	254
Whitewood Creek -----	101
Willow Creek -----	10
TOTAL BLACK HILLS MILES -----	4,960
CEDAR CREEK-CANNONBALL -----	93

CHEYENNE RIVER REGION	
Lower Cheyenne -----	3,529
Middle Cheyenne -----	1,352
Upper Cheyenne Above Angostura (UCA) -----	1,036
TOTAL CHEYENNE MILES -----	5,917
GRAND RIVER -----	4,580
LITTLE MISSOURI -----	574
MISSOURI RIVER WEST	
The area was planimetered using the median line in the Missouri River.	
Missouri (West River) -----	5,317
MOREAU RIVER -----	4,921
NIOBRARA RIVER REGION	
Bear Creek -----	133
Keya Paha -----	1,068
Bull Creek -----	160
TOTAL NIOBRARA -----	1,361
PONCA - MISSOURI -----	405
WHITE RIVER -----	8,151
TOTAL WEST RIVER AREA -----	41,538

Beaver Creek -----	127
Bennett Canyon -----	6
Fall River -----	86
French Creek -----	267
Lame Johnny Creek -----	100
Middle Cheyenne -----	182
Pass Creek -----	210
Red Canyon - Pleasant Valley - Fourmile Creek -----	149
Spring Creek -----	106
Stockade - Beaver Creek -----	114
TOTAL -----	1,555

DEWEY

Grand River -----	83
Missouri River -----	1,321
Moreau River -----	1,061
TOTAL -----	2,465

FALL RIVER

Beaver Creek -----	6
Bennett Canyon -----	11
Cascade Creek -----	25
Chilson Canyon -----	30
Driftwood Creek -----	17
Fall River -----	73
Lame Johnny Creek -----	2
Middle Cheyenne -----	259
Pass Creek -----	5
Red Canyon - Pleasant Valley - Fourmile Creek -----	64
Stockade - Beaver Creek -----	9
Upper Cheyenne -----	1,036
White River -----	213
TOTAL -----	1,750

GREGORY

Niobrara Keya Paha -----	31
Missouri River -----	703
Ponca - Missouri -----	321
TOTAL -----	1,055

HAAKON

Bad River -----	952
Lower Cheyenne -----	762
Missouri River -----	117
TOTAL -----	1,831

HARDING

Grand River -----	1,362
Little Missouri -----	576
Missouri River -----	732
TOTAL -----	2,670

JACKSON

Bad River -----	571
White River -----	1,371
TOTAL -----	1,942

JONES

Bad River -----	557
Missouri River -----	101
White River -----	320
TOTAL -----	978

LAWRENCE

Bear Butte Creek -----	51
Boxelder Creek -----	94
Crow Creek -----	42
Elk Creek -----	40
False Bottom Creek -----	98
Maloney Creek -----	6
Oyster Mountain -----	13
Rapid Creek -----	67
Redwater River -----	39
Sand Creek -----	44
Spearfish Creek -----	206

Stinking Water Creek -----	17
Whitewood Creek -----	82
TOTAL -----	799

LYMAN

Bad River -----	9
Missouri River -----	1,310
White River -----	404
TOTAL -----	1,723

MEADE

Alkali Creek -----	187
Bear Butte Creek -----	97
Belle Fourche -----	878
Boxelder Creek -----	76
Cottonwood Creek -----	27
Elk Creek -----	550
Lower Cheyenne -----	1,421
Middle Cheyenne -----	72
Moreau River -----	71
Nine Mile Creek -----	34
Oyster Mountain -----	61
Stinking Water Creek -----	3
Whitewood Creek -----	12
TOTAL -----	3,489

MELLETTTE

White River -----	1,320
TOTAL -----	1,320

PENNINGTON

Bad River -----	261
Battle Creek -----	95
Boxelder Creek -----	230
French Creek -----	2
Inyan Kara Creek -----	2
Lower Cheyenne -----	256
Middle Cheyenne -----	652

Pass Creek -----	11
Rapid Creek -----	651
Sand Creek -----	7
Spring Creek -----	284
Stockade-Beaver Creek -----	137
White River -----	204
TOTAL -----	2,799

PERKINS

Cedar Creek - Cannonball -----	12
Grand River -----	1,345
Lower Cheyenne -----	3
Moreau River -----	1,561
TOTAL -----	2,921

SHANNON

Niobrara - Bear Creek -----	5
Middle Cheyenne -----	208
White River -----	1,881
TOTAL -----	2,094

STANLEY

Bad River -----	852
Missouri River -----	676
TOTAL -----	1,528

TODD

Niobrara - Bull Creek -----	166
Niobrara - Keya Paha -----	538
White River -----	691
TOTAL -----	1,395

TRIPP

Niobrara - Keya Paha -----	506
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Missour River -----	143
Ponca - Missouri -----	89
White River -----	884
TOTAL -----	1,622

ZIEBACH

Grand River -----	69
Lower Cheyenne -----	871
Missouri River -----	243
Moreau River -----	812
TOTAL -----	1,995

APPENDIX B

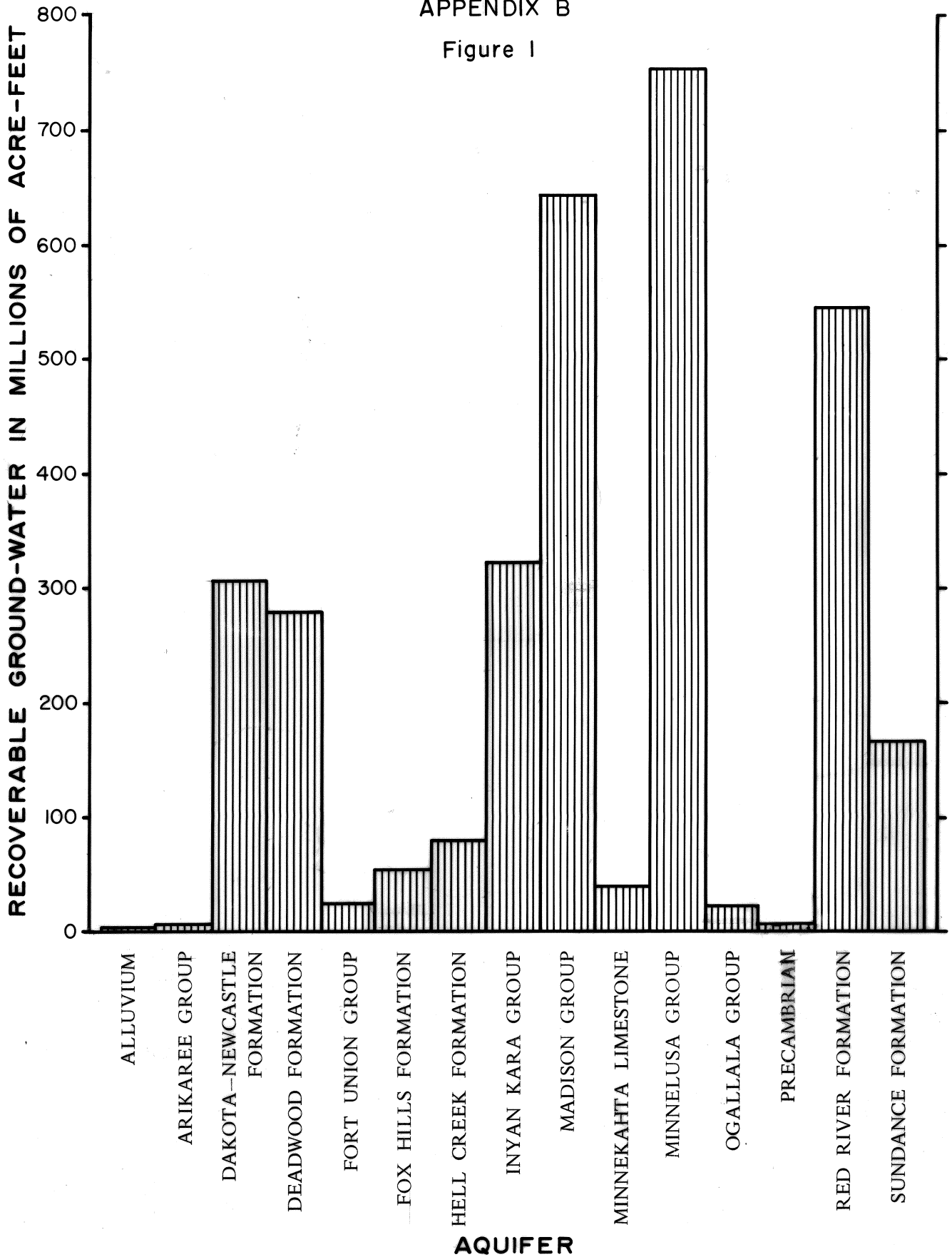
TABLE 1.

List of aquifers showing total recoverable
ground water in western South Dakota

Aquifer	Area of Aquifer (acres)	Recoverable water (acre-feet)
Alluvium	2,823,040	2,823,040
Arikaree Group	2,541,440	7,624,320
Dakota-Newcastle Formation	22,158,720	308,442,000
Deadwood Formation	19,159,040	280,475,200
Fort Union Group	1,443,840	23,037,600
Fox Hills Formation	7,441,920	55,814,400
Hell Creek Formation	5,390,720	82,190,400
Inyan Kara Group	23,239,040	324,169,440
Madison Group	19,116,160	644,827,200
Minnekahta Limestone	15,960,320	39,900,800
Minnelusa Group	23,114,880	755,555,520
Ogallala Group	1,140,360	19,929,600
Precambrian	533,120	2,665,600
Red River Formation	14,881,280	545,386,240
Sundance Formation	19,102,080	165,838,080

APPENDIX B

Figure 1



Sum total of Recoverable ground-water by Aquifer in western South Dakota.

APPENDIX B

TABLE 2.

List of aquifers showing total recoverable ground water by county in western South Dakota

County Aquifer	Area of aquifer (acres)	Recoverable water (acre-feet)
ALLUVIUM		
Bennett -----	89,600	89,600
Butte -----	89,600	89,600
Corson -----	102,400	102,400
Custer -----	128,000	128,000
Dewey -----	64,000	64,000
Fall River -----	51,200	51,200
Gregory -----	96,000	96,000
Haakon -----	182,400	182,400
Harding -----	128,000	128,000
Jackson -----	135,040	135,040
Jones -----	38,400	38,400
Lawrence -----	51,200	51,200
Lyman -----	32,000	32,000
Meade -----	480,000	480,000
Mellette -----	256,000	256,000
Pennington -----	352,000	352,000
Perkins -----	192,000	192,000
Shannon -----	128,000	128,000
Stanley -----	32,000	32,000
Todd -----	9,600	9,600
Tripp -----	102,400	102,400
Ziebach -----	83,200	83,200
ARIKAREE GROUP		
Bennett -----	755,840	2,267,520
Jackson -----	364,160	1,092,480
Mellette -----	75,520	226,560
Shannon -----	607,360	1,822,080
Todd -----	738,560	2,215,680
DAKOTA FORMATION - NEWCASTLE SANDSTONE		
Bennett -----	755,840	19,840,800
Butte -----	731,520	1,371,600

Corson -----	1, 224, 960	4, 593, 600
Custer -----	316, 160	1, 185, 600
Dewey -----	1, 470, 720	11, 030, 400
Fall River -----	729, 600	1, 368, 000
Gregory -----	638, 080	15, 553, 200
Haakon -----	1, 162, 240	21, 792, 000
Harding -----	1, 716, 480	9, 655, 200
Jackson -----	1, 196, 160	31, 399, 200
Jones -----	622, 720	15, 178, 800
Lyman -----	1, 077, 120	28, 274, 400
Meade -----	1, 217, 600	8, 316, 000
Mellette -----	835, 840	21, 940, 800
Pennington -----	1, 196, 160	8, 971, 200
Perkins -----	979, 200	3, 672, 000
Shannon -----	1, 344, 000	13, 104, 000
Stanley -----	979, 200	22, 032, 000
Todd -----	888, 320	28, 315, 200
Tripp -----	1, 036, 800	33, 048, 000
Ziebach -----	1, 040, 000	7, 800, 000

DEADWOOD FORMATION

Butte -----	1, 440, 000	39, 600, 000
Corson -----	1, 580, 800	27, 664, 000
Custer -----	801, 920	3, 007, 200
Dewey -----	1, 504, 640	15, 046, 400
Fall River -----	80, 000	100, 000
Gregory -----	49, 280	62, 600
Haakon -----	1, 622, 240	4, 358, 400
Harding -----	1, 716, 480	51, 494, 400
Jackson -----	552, 960	2, 764, 800
Jones -----	618, 880	1, 547, 200
Lawrence -----	428, 800	7, 504, 000
Lyman -----	142, 080	177, 600
Meade -----	2, 217, 600	44, 352, 000
Mellette -----	158, 080	197, 600
Pennington -----	1, 492, 480	14, 924, 800
Perkins -----	1, 830, 400	45, 760, 000
Shannon -----	624, 640	2, 342, 400
Stanley -----	831, 360	2, 078, 400
Tripp -----	658, 560	1, 646, 400
Ziebach -----	1, 267, 840	15, 848, 000

FORT UNION GROUP

Corson -----	92, 160	1, 152, 000
Harding -----	429, 440	8, 052, 000
Perkins -----	922, 240	13, 833, 600

FOX HILLS FORMATION

Butte -----	434,560	3,259,200
Corson -----	1,326,770	9,950,400
Dewey -----	402,560	3,019,200
Haakon -----	55,680	417,600
Harding -----	1,640,960	12,307,200
Jackson -----	2,560	19,200
Meade -----	864,000	6,480,000
Pennington -----	131,840	988,800
Perkins -----	1,830,400	13,728,000
Ziebach -----	752,640	564,480

HELL CREEK FORMATION

Butte -----	208,000	3,640,000
Corson -----	881,920	11,024,000
Dewey -----	87,680	219,200
Harding -----	1,629,440	28,515,200
Meade -----	280,320	3,323,680
Perkins -----	1,776,640	31,091,200
Ziebach -----	526,720	4,447,120

INYAN KARA GROUP

Bennett -----	755,840	9,920,400
Butte -----	1,431,040	21,465,600
Corson -----	1,580,800	15,412,800
Custer -----	360,960	8,121,600
Dewey -----	1,368,320	5,131,200
Fall River -----	917,760	22,370,400
Gregory -----	150,400	1,128,000
Haakon -----	1,162,240	10,460,160
Harding -----	1,716,480	22,528,800
Jackson -----	1,196,160	15,699,600
Jones -----	622,720	9,340,800
Lawrence -----	36,480	601,920
Lyman -----	721,920	13,536,000
Meade -----	2,107,520	36,354,720
Mellette -----	835,840	12,537,600
Pennington -----	1,245,440	23,352,000
Perkins -----	1,830,400	31,574,400
Shannon -----	1,344,000	21,168,000
Stanley -----	973,440	13,141,440
Todd -----	888,320	13,324,800
Tripp -----	1,029,120	11,577,600
Ziebach -----	963,840	5,421,600

MADISON GROUP

Butte -----	1,440,000	57,600,000
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Corson -----	1,396,480	69,824,000
Custer -----	736,640	9,208,000
Dewey -----	1,619,840	56,694,400
Fall River -----	981,120	9,811,200
Haakon -----	1,162,240	29,056,000
Harding -----	1,716,480	94,406,400
Jackson -----	649,000	8,120,000
Jones -----	567,680	7,096,000
Lawrence -----	314,880	9,446,400
Lyman -----	211,200	1,056,000
Meade -----	2,214,400	83,040,000
Mellette -----	355,840	2,668,800
Pennington -----	1,489,920	29,798,400
Perkins -----	1,830,400	109,824,000
Shannon -----	272,000	4,080,000
Stanley -----	793,600	11,904,000
Tripp -----	96,000	480,000
Ziebach -----	1,267,840	50,713,600

MINNEKAHTA LIMESTONE

Bennett -----	212,480	531,200
Butte -----	1,440,000	3,600,000
Corson -----	480,000	1,200,000
Custer -----	481,280	1,203,200
Dewey -----	826,240	2,065,600
Fall River -----	1,093,120	2,732,800
Haakon -----	1,013,760	2,534,400
Harding -----	1,716,480	4,291,200
Jackson -----	495,360	1,238,400
Lawrence -----	126,080	315,200
Meade -----	2,149,120	5,372,800
Pennington -----	1,283,200	3,208,000
Perkins -----	1,830,400	4,576,000
Shannon -----	1,344,000	3,360,000
Stanley -----	200,960	502,400
Ziebach -----	1,267,840	3,169,600

MINNELUSA GROUP

Bennett -----	755,840	24,564,800
Butte -----	1,440,000	43,200,000
Corson -----	1,580,800	43,472,000
Custer -----	740,480	25,916,800
Dewey -----	1,504,640	37,616,000
Fall River -----	1,115,520	52,987,200
Haakon -----	1,162,240	45,327,360
Harding -----	1,716,480	48,919,680
Jackson -----	1,196,160	46,650,240
Jones -----	500,480	8,758,400
Lawrence -----	199,680	5,591,040
Lyman -----	48,000	360,000

Meade -----	2,172,800	81,480,000
Mellette -----	835,840	20,896,000
Pennington -----	1,371,520	51,432,000
Perkins -----	1,830,400	65,894,400
Shannon -----	1,344,000	57,120,000
Stanley -----	796,800	17,529,600
Todd -----	888,320	22,208,000
Tripp -----	647,040	8,088,000
Ziebach -----	1,267,840	47,544,000

OGALLALA GROUP

Bennett -----	280,960	280,960
Gregory -----	193,280	1,932,800
Shannon -----	49,920	49,420
Todd -----	412,800	12,384,000
Tripp -----	203,400	230,400

PRECAMBRIAN

Custer -----	174,720	873,600
Lawrence -----	89,600	448,000
Pennington -----	268,800	1,344,000

RED RIVER FORMATION

Butte -----	1,440,000	57,600,000
Corson -----	1,580,800	79,040,000
Dewey -----	1,504,640	60,185,600
Gregory -----	152,960	764,800
Haakon -----	1,162,240	34,867,200
Harding -----	1,716,480	84,107,520
Jones -----	396,160	3,961,600
Lawrence -----	262,400	5,248,000
Lyman -----	140,800	1,408,000
Mellette -----	691,840	6,918,400
Pennington -----	1,139,840	28,496,000
Perkins -----	1,830,400	104,332,800
Stanley -----	540,160	12,153,600
Todd -----	188,160	1,128,960
Tripp -----	1,010,560	10,105,600
Ziebach -----	1,123,840	55,068,160

SUNDANCE FORMATION

Bennett -----	357,760	1,609,920
Butte -----	1,436,160	19,388,160
Corson -----	1,580,800	13,041,600
Custer -----	451,200	4,060,800
Dewey -----	1,504,640	9,027,840

Fall River -----	1,068,800	11,222,400
Haakon -----	1,162,240	5,230,080
Harding -----	1,716,480	23,172,480
Jackson -----	896,000	2,688,000
Jones -----	174,720	262,080
Lawrence -----	76,800	864,000
Meade -----	21,433,360	22,505,280
Pennington -----	1,272,960	9,547,200
Perkins -----	1,830,400	21,964,800
Shannon -----	1,344,000	8,064,000
Stanley -----	817,920	3,680,640
Ziebach -----	1,267,840	9,508,800

APPENDIX B

TABLE 3.

List of counties showing total recoverable ground water by aquifer in western South Dakota

Aquifer	Area of aquifer (acres)	Recoverable water (acre-feet)
BENNETT		
Alluvium	89,600	89,600
Arikaree Group	755,840	2,267,520
Dakota-Newcastle Formation	755,840	19,840,800
Inyan Kara Group	755,840	9,920,400
Minnekahta Limestone	212,480	531,200
Minnelusa Group	755,840	24,564,800
Ogallala Group	280,960	2,809,600
Sundance Formation	357,760	1,609,920
TOTAL	3,964,160	61,633,840
BUTTE		
Alluvium	98,600	89,600
Dakota-Newcastle Formation	731,520	1,371,600
Deadwood Formation	1,440,000	39,600,000
Fox Hills Formation	434,560	3,259,200
Hell Creek Formation	208,000	,640,000
Inyan Kara Group	1,431,040	21,465,600
Madison Group	1,440,000	57,600,000
Minnekahta Limestone	1,440,000	3,600,000
Minnelusa Group	1,440,000	43,200,000
Red River Formation	1,440,000	576,000,000
TOTAL	11,530,880	250,814,160
CORSON		
Alluvium	102,400	102,400
Dakota Formation	1,224,960	4,593,600
Deadwood Formation	1,580,800	27,664,000
Fort Union Group	92,160	1,152,000
Fox Hills Formation	1,326,720	9,950,400
Hell Creek Formation	881,920	11,024,000
Inyan Kara Group	1,580,800	15,412,800
Madison Group	1,396,480	69,824,000
Minnekahta Limestone	480,000	1,200,000

Minnelusa Group	1,580,800	43,472,000
Red River Formation	1,580,000	79,040,000
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TOTAL	13,408,640	276,476,800

CUSTER

Alluvium	128,000	128,000
Dakota-Newcastle Formation	316,160	1,185,600
Deadwood Formation	801,920	3,007,200
Inyan Kara Group	360,960	8,121,600
Madison Group	736,640	9,208,000
Minnekahta Limestone	481,280	1,203,200
Minnelusa Group	740,480	25,916,800
Precambrian	174,720	873,600
Sundance Formation	451,200	4,060,800
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TOTAL	4,371,360	58,235,040

DEWEY

Alluvium	64,000	64,000
Dakota-Newcastle Formation	1,470,720	11,030,400
Deadwood Formation	1,504,640	15,046,400
Fox Hills Formation	402,560	3,019,200
Hell Creek Formation	87,680	219,200
Inyan Kara Group	1,368,420	5,131,200
Madison Group	1,619,840	56,694,400
Minnekahta Limestone	822,240	2,065,600
Minnelusa Group	1,504,640	37,616,000
Red River Formation	1,504,640	60,185,600
Sundance Formation	1,504,640	9,027,840
	<hr/>	<hr/>
TOTAL	11,857,920	200,099,840

FALL RIVER

Alluvium	51,200	51,200
Dakota-Newcastle Formation	729,600	1,368,000
Deadwood Formation	80,000	100,000
Inyan Kara Group	917,760	22,370,400
Madison Group	981,120	9,811,200
Minnekahta Limestone	1,093,120	2,732,800
Minnelusa Group	1,115,520	52,987,200
Sundance Formation	1,068,800	11,222,400
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TOTAL	6,037,120	100,643,200

GREGORY

Alluvium	96,000	96,000
Dakota-Newcastle Formation	638,080	15,553,200
Deadwood Formation	49,280	61,600
Inyan Kara Group	150,400	1,128,000
Ogallala Group	193,280	1,932,800
Red River Formation	152,960	764,800
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TOTAL	1,280,000	19,536,400

HAAKON

Alluvium	182,400	182,400
Dakota-Newcastle Formation	1,162,240	21,792,000
Deadwood Formation	1,162,240	4,358,400
Fox Hills Formation	55,680	417,600
Inyan Kara Group	1,162,240	10,460,160
Madison Group	1,162,240	29,056,000
Minnekahta Limestone	1,013,760	2,534,400
Minnelusa Group	1,162,240	45,327,360
Red River Formation	1,162,240	34,867,200
Sundance Formation	1,162,240	5,230,080
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TOTAL	9,387,520	154,225,600

HARDING

Alluvium	128,000	128,000
Dakota-Newcastle Formation	1,716,480	9,655,200
Deadwood Formation	1,716,480	51,494,400
Fox Hills Formation	1,640,960	12,307,200
Fort Union Group	429,440	8,052,000
Hell Creek Formation	1,629,440	28,515,200
Inyan Kara Group	1,716,480	22,528,800
Madison Group	1,716,480	94,406,400
Minnekahta Limestone	1,716,480	4,291,200
Minnelusa Group	1,716,480	48,919,680
Red River Formation	1,716,480	84,107,520
Sundance Formation	1,716,480	23,172,480
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TOTAL	17,559,680	387,578,080

JACKSON

Alluvium	135,040	16,880
Arikaree Group	364,160	3,823,680
Dakota-Newcastle Formation	1,196,160	8,373,120
Deadwood Formation	552,960	5,529,600
Fox Hills Formation	2,560	76,800
Inyan Kara Group	1,196,160	15,699,600

Madison Group	649,600	17,864,000
Minnekahta Limestone	495,360	1,981,440
Minnelusa Group	1,196,160	93,300,480
Sundance Formation	896,000	13,440,000
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TOTAL	6,684,160	109,806,960

JONES

Alluvium	38,400	38,400
Dakota-Newcastle Formation	622,720	15,178,800
Deadwood Formation	618,880	1,547,200
Inyan Kara Group	622,720	9,340,800
Madison Group	567,680	7,096,000
Minnelusa Group	500,480	8,758,400
Red River Formation	296,160	3,961,600
Sundance Formation	174,720	262,080
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TOTAL	3,541,760	46,183,280

LAWRENCE

Deadwood Formation	428,800	7,504,000
Inyan Kara Group	36,480	601,920
Madison Group	314,880	9,446,400
Minnekahta Limestone	126,080	315,200
Minnelusa Group	199,680	5,591,040
Precambrian	89,600	448,000
Red River Formation	262,400	5,248,000
Sundance Formation	76,800	864,000
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TOTAL	1,585,920	30,069,760

LYMAN

Alluvium	32,000	32,000
Dakota-Newcastle Formation	1,077,120	28,274,400
Deadwood Formation	142,080	177,600
Inyan Kara Group	721,920	13,536,000
Madison Group	211,200	1,056,000
Minnelusa Group	48,000	360,000
Red River Formation	140,800	1,408,000
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TOTAL	2,006,400	44,844,000

MEADE

Alluvium	480,000	480,000
Dakota-Newcastle Formation	2,217,600	8,316,000
Deadwood Formation	2,217,600	44,352,000

Fox Hills Formation	864,000	6,480,000
Hell Creek Formation	280,320	3,323,680
Inyan Kara Group	2,107,520	36,354,720
Madison Group	2,214,400	83,040,000
Minnekahta Limestone	2,149,120	5,372,800
Minnelusa Group	2,172,800	81,480,000
Sundance Formation	2,143,360	22,505,280
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TOTAL	16,846,720	291,604,480

MELLETTTE

Alluvium	256,000	256,000
Arikaree Group	75,520	226,560
Dakota-Newcastle Formation	835,840	21,940,800
Deadwood Formation	158,080	197,600
Inyan Kara Group	835,840	12,537,600
Madison Group	355,840	2,668,800
Minnelusa Group	835,840	20,896,000
Red River Formation	691,840	6,918,400
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TOTAL	4,044,800	64,641,760

PENNINGTON

Alluvium	352,000	352,000
Dakota-Newcastle Formation	1,196,160	8,971,200
Deadwood Formation	1,492,480	14,924,800
Fox Hills Formation	131,840	988,800
Inyan Kara Group	1,245,440	23,352,000
Madison Group	1,489,920	29,798,400
Minnekahta Limestone	1,283,200	3,208,000
Minnelusa Group	1,372,520	51,432,000
Precambrian	268,800	1,344,000
Red River Formation	1,139,840	28,496,000
Sundance Formation	1,272,960	9,547,200
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TOTAL	11,244,160	172,414,400

PERKINS

Alluvium	192,000	192,000
Dakota-Newcastle Formation	979,200	3,672,000
Deadwood Formation	1,830,400	45,760,000
Fort Union Group	922,240	13,833,600
Fox Hills Formation	1,830,400	13,728,000
Hell Creek Formation	1,776,640	31,091,200
Inyan Kara Group	1,830,400	31,574,400
Madison Group	1,830,400	109,824,000
Minnekahta Limestone	1,830,400	4,576,000
Minnelusa Group	1,830,400	65,894,400

Red River Formation	1,830,400	104,332,800
Sundance Formation	1,830,400	21,964,800
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TOTAL	18,513,280	446,443,200

SHANNON

Alluvium	128,000	128,000
Arikaree Group	607,360	1,822,080
Dakota-Newcastle Formation	1,344,000	13,104,000
Deadwood Formation	624,640	2,342,400
Inyan Kara Group	1,344,000	21,680,000
Madison Group	272,000	4,080,000
Minnekahta Limestone	1,344,000	3,336,000
Minnelusa Group	1,344,000	57,120,000
Ogallala Group	49,920	499,200
Sundance Formation	1,344,000	8,064,000
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TOTAL	8,401,920	116,687,680

STANLEY

Alluvium	32,000	32,000
Dakota-Newcastle Formation	979,200	22,032,000
Deadwood Formation	831,360	2,078,400
Inyan Kara Group	973,440	13,141,440
Madison Group	793,600	11,904,000
Minnekahta Limestone	200,960	502,400
Minnelusa Group	796,800	17,529,600
Red River Formation	540,160	12,153,600
Sundance Formation	817,920	3,680,640
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TOTAL	5,965,440	83,054,080

TODD

Alluvium	9,600	9,600
Arikaree Group	738,560	2,215,680
Dakota-Newcastle Formation	888,320	28,315,200
Inyan Kara Group	888,320	13,324,800
Minnelusa Group	888,320	22,208,000
Ogallala Group	412,800	12,384,000
Red River Formation	188,160	1,128,960
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TOTAL	4,014,080	79,586,240

TRIPP

Alluvium	102,400	102,400
Dakota-Newcastle Formation	1,036,800	33,048,000

Deadwood Formation	658,560	1,646,400
Inyan Kara Group	1,029,120	11,577,600
Madison Group	96,000	480,000
Minnelusa Group	647,040	8,088,000
Ogallala Group	230,400	3,304,000
Red River Formation	1,010,560	10,105,600
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TOTAL	4,810,880	67,352,000

ZIEBACH

Alluvium	83,200	83,200
Dakota-Newcastle Formation	1,040,000	7,800,000
Deadwood Formation	1,267,840	15,848,000
Fox Hills Formation	752,640	5,644,800
Hell Creek Formation	526,720	4,477,120
Inyan Kara Group	963,840	5,421,600
Madison Group	1,267,840	50,713,600
Minnekahta Limestone	1,267,840	3,169,600
Minnelusa Group	1,267,840	47,544,000
Red River Formation	1,123,840	55,068,160
Sundance Formation	1,267,840	9,508,800
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TOTAL	10,829,440	205,278,880

APPENDIX B

TABLE 4.

List of basins showing total recoverable ground water by aquifer in western South Dakota

Basin Aquifer	Area of aquifer (acres)	Recoverable water (acre-feet)
BAD RIVER		
Alluvium	172,800	172,800
Dakota-Newcastle Formation	2,037,760	45,849,600
Deadwood Formation	1,973,120	9,865,600
Fox Hills Formation	76,160	571,200
Inyan Kara Group	2,037,760	22,924,800
Madison Group	1,951,360	34,148,800
Minnekahta Limestone	869,760	1,087,200
Minnelusa Group	1,982,720	59,481,600
Red River Formation	1,591,680	27,854,400
Sundance Formation	1,849,600	8,323,200
TOTAL	14,542,720	210,279,200
BELLE FOURCHE		
Dakota-Newcastle Formation	782,080	1,759,680
Deadwood Formation	1,328,000	29,880,000
Fox Hills Formation	81,280	609,600
Inyan Kara Group	1,328,000	19,920,000
Madison Group	1,328,000	49,800,000
Minnekahta Limestone	1,328,000	46,480,000
Minnelusa Group	1,328,000	46,480,000
Red River Formation	1,328,000	53,120,000
Sundance Formation	1,328,000	15,936,000
TOTAL	10,360,960	46,480,000
BLACK HILLS REGION		
ALKALI CREEK		
Dakota-Newcastle Formation	106,880	160,320
Inyan Kara Group	115,840	1,954,800
Minnekahta Limestone	115,840	289,600

Minnelusa Group	117,120	4,392,000
Sundance Formation	115,220	1,209,600
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TOTAL	570,880	8,006,320

BATTLE CREEK

Alluvium	32,000	32,000
Dakota-Newcastle Formation	74,240	167,040
Deadwood Formation	124,160	931,200
Inyan Kara Group	84,480	1,900,800
Madison Group	118,400	1,776,000
Minnekahta Limestone	96,640	241,600
Minnelusa Group	109,440	3,283,200
Precambrian	65,280	326,400
Sundance Formation	86,400	349,920
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TOTAL	706,560	9,008,160

BEAR BUTTE CREEK

Dakota-Newcastle Formation	39,680	74,400
Deadwood Formation	90,240	2,030,400
Inyan Kara Group	46,720	700,800
Madison Group	76,800	1,920,000
Minnekahta Limestone	53,760	134,400
Minnelusa Group	62,080	2,017,600
Precambrian	13,440	67,200
Red River Formation	79,360	1,587,200
Sundance Formation	50,560	530,880
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TOTAL	552,960	9,103,200

BEAVER CREEK

Deadwood Formation	43,520	54,400
Inyan Kara Group	12,800	432,000
Madison Group	65,920	824,000
Minnekahta Limestone	29,440	73,600
Minnelusa Group	36,480	1,459,200
Precambrian	37,760	188,800
Sundance Formation	13,440	120,960
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TOTAL	239,360	3,152,960

BENNETT CANYON

Deadwood Formation	10,240	12,800
Madison Group	10,880	163,200
Minnekahta Limestone	10,880	27,200

Minnelusa Group	10,880	544,000
Sundance Formation	10,880	97,920
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TOTAL	53,760	845,120

BOX ELDER CREEK

Dakota-Newcastle Formation	147,200	55,200
Deadwood Formation	167,680	209,600
Inyan Kara Group	128,640	2,894,400
Madison Group	155,520	3,499,200
Minnekahta Limestone	138,880	347,200
Minnelusa Group	147,200	5,152,000
Precambrian	49,920	249,600
Red River Formation	167,040	2,505,600
Sundance Formation	131,200	1,180,800
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TOTAL	1,233,280	16,590,400

CASCADE CREEK

Inyan Kara Group	14,080	528,000
Madison Group	16,640	208,000
Minnekahta Limestone	16,640	41,600
Minnelusa Group	16,640	707,200
Sundance Formation	13,440	120,960
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TOTAL	77,440	1,605,760

CHILSON CANYON

Dakota-Newcastle Formation	640	240
Inyan Kara Group	13,440	478,800
Madison Group	19,840	272,800
Minnekahta Limestone	19,840	49,600
Minnelusa Group	19,840	86,800
Sundance Formation	17,280	155,520
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TOTAL	90,880	1,824,960

COTTONWOOD CREEK

Alluvium	3,200	3,200
Dakota-Newcastle Formation	2,560	2,880
Deadwood Formation	20,480	512,000
Inyan Kara Group	20,480	307,200
Madison Group	20,480	614,400
Minnekahta Limestone	20,608	51,520
Minnelusa Group	20,480	768,000

Red River Formation	20,480	614,400
Sundance Formation	20,480	215,040
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TOTAL	149,248	3,088,640

CROW CREEK

Deadwood Formation	26,880	537,600
Madison Group	26,880	840,000
Minnekahta Limestone	11,520	28,800
Minnelusa Group	17,920	448,000
Red River Formation	26,880	403,200
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TOTAL	110,080	2,257,600

DRIFTWOOD CREEK

Deadwood Formation	5,760	7,200
Inyan Kara Group	11,520	302,400
Madison Group	11,520	172,800
Minnekahta Limestone	11,520	28,800
Minnelusa Group	11,520	576,000
Sundance Formation	11,520	103,680
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TOTAL	63,360	1,190,880

ELK CREEK

Alluvium	117,760	117,760
Dakota-Newcastle Formation	272,640	1,022,400
Deadwood Formation	380,160	6,652,800
Inyan Kara Group	312,960	7,041,600
Madison Group	362,880	9,072,000
Minnekahta Limestone	325,760	814,400
Minnelusa Group	337,280	11,804,800
Precambrian	7,680	38,400
Red River Formation	358,400	7,168,000
Sundance Formation	320,640	2,885,760
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TOTAL	2,796,160	46,617,920

FALL RIVER

Deadwood Formation	47,360	59,200
Inyan Kara Group	14,080	528,000
Madison Group	99,840	1,497,600
Minnekahta Limestone	50,560	126,400
Minnelusa Group	85,120	3,617,600

Precambrian	1,280	6,400
Sundance Formation	12,160	109,440
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TOTAL	310,400	5,944,640

FALSE BOTTOM CREEK

Deadwood Formation	64,000	1,600,000
Inyan Kara Group	24,320	456,000
Madison Group	52,480	1,246,400
Minnekahta Limestone	45,440	113,600
Minnelusa Group	49,920	1,248,000
Red River Formation	62,080	1,086,400
Sundance Formation	26,240	275,520
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TOTAL	324,480	6,025,920

FRENCH CREEK

Alluvium	23,680	23,680
Dakota-Newcastle Formation	65,920	247,200
Deadwood Formation	112,000	420,000
Inyan Kara Group	92,160	2,073,600
Madison Group	109,440	1,641,600
Minnekahta Limestone	99,200	248,000
Minnelusa Group	104,960	3,673,600
Precambrian	64,000	320,000
Sundance Formation	93,440	840,960
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TOTAL	764,800	9,488,640

HAY CREEK

Deadwood Formation	24,960	655,200
Inyan Kara Group	16,640	249,600
Madison Group	24,960	811,200
Minnekahta Limestone	24,960	62,400
Minnelusa Group	24,960	624,000
Red River Formation	24,960	499,200
Sundance Formation	24,960	299,520
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TOTAL	166,400	3,201,120

INYAN KARA CREEK

Deadwood Formation	640	5,600
Madison Group	640	12,800
Minnelusa Group	640	11,200
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TOTAL	1,925	29,600

LAME JOHNNY CREEK

Alluvium	10,880	10,880
Dakota-Newcastle Formation	21,760	16,320
Deadwood Formation	51,840	129,600
Inyan Kara Group	37,760	1,274,400
Madison Group	49,920	624,000
Minnekahta Limestone	42,880	107,200
Minnelusa Group	49,920	1,872,000
Precambrian	39,680	357,120
Sundance Formation	39,680	357,120
	-----	-----
TOTAL	315,520	4,445,920

MALONEY CREEK

Deadwood Formation	9,600	264,000
Inyan Kara Group	9,600	180,000
Madison Group	9,600	288,000
Minnekahta Limestone	9,600	24,000
Minnelusa Group	9,600	312,000
Red River Formation	9,728	243,200
Sundance Formation	9,600	100,800
	-----	-----
TOTAL	67,328	1,412,000

NINEMILE CREEK

Alluvium	12,800	12,800
Dakota-Newcastle Formation	22,400	16,800
Deadwood Formation	22,400	560,000
Inyan Kara Group	22,400	336,000
Madison Group	22,400	784,000
Minnekahta Limestone	22,400	56,000
Minnelusa Group	22,400	784,000
Red River Formation	22,400	728,000
Sundance Formation	22,400	235,200
	-----	-----
TOTAL	192,000	3,521,800

OYSTER MOUNTAIN

Alluvium	6,400	6,400
Dakota-Newcastle Formation	12,160	9,120
Deadwood Formation	46,720	1,191,360
Inyan Kara Group	40,320	604,800
Madison Group	46,720	1,168,000
Minnekahta Limestone	46,080	115,200
Minnelusa Group	46,720	1,401,600

Red River Formation	46,720	1,168,000
Sundance Formation	46,720	463,680
	<hr/>	<hr/>
TOTAL	336,000	6,128,160

PASS CREEK

Deadwood Formation	145,920	729,600
Inyan Kara Group	11,520	259,200
Madison Group	145,920	2,188,800
Minnekahta Limestone	71,680	179,200
Minnelusa Group	115,200	5,760,000
Sundance Formation	17,920	161,280
	<hr/>	<hr/>
TOTAL	508,160	9,278,080

RAPID CREEK

Alluvium	87,040	87,040
Dakota-Newcastle Formation	163,200	428,400
Deadwood Formation	294,400	2,944,000
Inyan Kara Group	190,720	3,576,000
Madison Group	270,720	5,414,400
Minnekahta Limestone	200,960	502,400
Minnelusa Group	213,760	6,947,200
Precambrian	158,080	790,400
Red River Formation	106,240	1,062,400
Sundance Formation	191,360	1,722,240
	<hr/>	<hr/>
TOTAL	1,876,480	23,474,480

**RED CANYON - PLEASANT VALLEY -
FOURMILE CREEK**

Deadwood Formation	92,800	23,200
Inyan Kara Group	23,040	648,000
Madison Group	122,240	1,833,600
Minnekahta Limestone	72,320	180,800
Minnelusa Group	103,680	4,665,600
Precambrian	13,440	67,200
Sundance Formation	41,600	374,400
	<hr/>	<hr/>
TOTAL	469,120	8,001,600

REDWATER RIVER

Deadwood Formation	44,800	1,120,000
Inyan Kara Group	8,960	134,400
Madison Group	44,800	1,400,000
Minnekahta Limestone	44,800	112,000

Minnelusa Group	44,800	1,120,000
Red River Formation	44,800	896,000
Sundance Formation	28,160	337,920
	-----	-----
TOTAL	261,120	5,120,320

SAND CREEK

Deadwood Formation	30,080	451,200
Madison Group	30,080	451,200
Minnelusa Group	14,720	368,000
Red River Formation	10,880	163,200
	-----	-----
TOTAL	85,760	1,433,600

SPEARFISH CREEK

Deadwood Formation	131,840	2,307,200
Madison Group	106,880	2,672,000
Minnelusa Group	40,960	1,024,000
Red River Formation	72,320	1,084,800
Sundance Formation	1,280	11,520
	-----	-----
TOTAL	353,280	7,099,520

SPRING CREEK

Alluvium	19,840	19,840
Dakota-Newcastle Formation	99,840	187,200
Deadwood Formation	137,600	1,032,000
Inyan Kara Group	117,760	2,649,600
Madison Group	136,320	2,044,800
Minnekahta Limestone	124,160	310,400
Minnelusa Group	129,920	3,897,600
Precambrian	104,320	521,600
Red River Formation	5,120	51,200
Sundance Formation	118,400	1,065,600
	-----	-----
TOTAL	993,280	11,779,840

STINKING WATER CREEK

Deadwood Formation	19,840	545,600
Inyan Kara Group	19,840	334,800
Madison Group	19,840	595,200
Minnekahta Limestone	19,840	49,600
Minnelusa Group	19,840	694,400

Red River Formation	19,840	496,000
Sundance Formation	19,840	208,320
	-----	-----
TOTAL	138,880	2,923,920

STOCKADE - BEAVER CREEK

Deadwood Formation	158,720	793,600
Madison Group	158,720	2,777,600
Minnekahta Limestone	34,560	86,400
Minnelusa Group	121,600	5,472,000
Sundance Formation	24,320	218,880
	-----	-----
TOTAL	497,920	9,348,480

WHITEWOOD CREEK

Alluvium	640	640
Deadwood Formation	65,280	1,713,600
Inyan Kara Group	24,320	410,400
Madison Group	34,560	864,000
Minnekahta Limestone	29,440	73,600
Minnelusa Group	30,720	921,600
Red River Formation	37,120	742,400
Sundance Formation	27,520	247,680
	-----	-----
TOTAL	249,600	4,073,920

WILLOW CREEK

Deadwood Formation	6,400	176,000
Inyan Kara Group	5,760	97,200
Madison Group	6,400	208,000
Minnekahta Limestone	6,400	16,000
Red River Formation	6,400	160,000
Sundance Formation	6,400	67,200
	-----	-----
TOTAL	37,760	724,400

CEDAR CREEK - CANNONBALL

Dakota-Newcastle Formation	1,920	2,880
Deadwood Formation	59,520	1,488,000
Fort Union Group	59,520	74,400
Fox Hills Formation	59,520	446,400
Hell Creek Formation	59,520	744,400
Inyan Kara Group	59,520	669,600
Madison Group	59,520	3,571,200
Minnekahta Limestone	32,640	81,600
Minnelusa Group	59,520	2,083,200

Red River Formation	59,520	3,571,200
Sundance Formation	59,520	714,240
	-----	-----
TOTAL	570,240	14,116,320

CHEYENNE RIVER REGION

Lower Cheyenne

Alluvium	267,520	267,520
Dakota-Newcastle Formation	2,221,440	20,826,000
Deadwood Formation	2,260,480	42,384,000
Hell Creek Formation	248,320	2,483,200
Fox Hills Formation	977,280	7,329,600
Inyan Kara Group	2,260,280	25,430,400
Madison Group	2,260,480	79,116,800
Minnekahta Limestone	2,260,480	5,651,200
Minnelusa Group	2,260,480	84,768,000
Red River Formation	2,260,480	96,070,400
Sundance Formation	2,260,480	16,953,600
	-----	-----
TOTAL	19,537,920	381,280,720

MIDDLE CHEYENNE

Alluvium	284,160	284,160
Dakota-Newcastle Formation	784,640	5,884,800
Deadwood Formation	851,200	6,384,000
Fox Hills Formation	52,480	393,600
Inyan Kara Group	851,200	12,768,000
Madison Group	851,200	12,768,000
Minnekahta Limestone	851,200	2,128,000
Minnelusa Group	851,200	34,048,000
Red River Formation	353,920	8,848,000
Sundance Formation	851,200	5,107,200
	-----	-----
TOTAL	6,582,400	88,613,760

UPPER CHEYENNE ABOVE ANGOSTURA (UCAA)

Dakota-Newcastle Formation	427,520	1,603,200
Deadwood Formation	23,680	23,680
Inyan Kara Group	618,880	16,245,600
Madison Group	602,880	7,536,000
Minnekahta Limestone	625,920	1,564,800
Minnelusa Group	625,920	31,296,000
Sundance Formation	622,080	6,531,840
	-----	-----
TOTAL	3,562,240	64,816,480

GRAND RIVER

Alluvium	207,360	207,360
Dakota-Newcastle Formation	1,303,680	6,844,320
Deadwood Formation	2,194,560	72,864,000
Fort Union Group	1,186,560	16,315,200
Fox Hills Formation	2,863,360	21,475,200
Hell Creek Formation	2,462,720	40,019,200
Inyan Kara Group	2,914,560	43,718,400
Madison Group	2,914,560	160,300,800
Minnekahta Limestone	2,211,840	5,529,600
Minnelusa Group	2,914,560	102,009,600
Red River Formation	2,914,560	174,873,600
Sundance Formation	2,914,560	3,497,420
	-----	-----
TOTAL	27,722,880	679,132,000

LITTLE MISSOURI

Alluvium	36,480	36,480
Dakota-Newcastle Formation	341,760	1,537,920
Deadwood Formation	357,760	10,732,800
Fox Hills Formation	341,760	2,563,200
Hell Creek Formation	323,200	5,656,000
Inyan Kara Group	357,200	6,708,000
Madison Group	357,760	21,465,600
Minnekahta Limestone	357,760	894,400
Minnelusa Group	357,760	8,944,000
Red River Formation	357,760	17,888,000
Sundance Formation	357,760	6,439,680
	-----	-----
TOTAL	3,547,520	82,866,080

MISSOURI RIVER

Dakota-Newcastle Formation	3,389,440	76,262,400
Deadwood Formation	2,445,440	12,227,200
Fox Hills Formation	309,120	2,318,400
Hell Creek Formation	51,840	648,000
Inyan Kara Group	2,809,600	42,144,000
Madison Group	1,971,200	49,280,000
Minnekahta Limestone	606,720	1,516,800
Minnelusa Group	1,857,280	37,145,600
Ogallala Group	112,640	1,126,400
Red River Formation	2,021,120	75,792,000
Sundance Formation	1,866,240	8,298,080
	-----	-----
TOTAL	17,469,440	306,887,680

MOREAU RIVER

Alluvium	234,880	234,880
Dakota-Newcastle Formation	2,565,120	9,619,200
Deadwood Formation	3,128,320	62,566,400
Fort Union Group	284,160	4,262,400
Fox Hills Formation	2,451,200	18,384,000
Hell Creek Formation	1,926,400	31,304,000
Madison Group	3,128,320	156,416,000
Minnekahta Limestone	2,885,760	7,214,400
Minnelusa Group	3,128,320	109,491,200
Red River Formation	3,128,320	172,057,600
Sundance Formation	3,128,320	28,154,880
	-----	-----
TOTAL	28,840,320	603,268,960

NIOBRARA RIVER REGION**BEAR CREEK**

Arikaree Group	83,200	24,960
Dakota-Newcastle Formation	83,200	2,340,000
Inyan Kara Group	83,200	1,404,000
Minnekahta Limestone	35,840	89,600
Minnelusa Group	83,200	3,120,000
Ogallala Group	66,560	665,600
Sundance Formation	55,680	83,520
	-----	-----
TOTAL	490,880	7,727,680

KEYA PAHA

Arikaree Group	27,200	81,600
Ogallala	658,920	3,818,240
Dakota-Newcastle Formation	679,040	20,371,200
Deadwood Formation	13,400	14,112
Inyan Kara Group	668,800	7,524,000
Minnelusa Group	569,600	9,968,000
Red River Formation	453,760	4,537,600
	-----	-----
TOTAL	3,070,720	46,314,752

BULL CREEK

Arikaree Group	98,560	29,568
Dakota-Newcastle Formation	98,560	3,326,400
Inyan Kara Group	98,560	1,478,400
Minnelusa Group	98,560	2,464,000
Ogallala Group	98,560	985,600
	-----	-----
TOTAL	492,800	8,283,968

PONCA - MISSOURI

Dakota-Newcastle Formation	255,360	5,745,600
Inyan Kara Group	97,920	734,400
Minnelusa Group	5,120	12,800
Ogallala Group	124,800	1,248,000
Red River Formation	136,320	1,363,200
	-----	-----
TOTAL	619,520	9,104,000

WHITE RIVER

Arikaree Group	2,024,960	607,488
Dakota-Newcastle Formation	5,187,840	155,635,200
Deadwood Formation	1,676,160	2,095,200
Madison Group	1,408,000	7,040,000
Minnekahta Limestone	1,857,920	4,644,800
Minnelusa Group	4,836,840	187,413,600
Ogallala Group	501,120	5,011,200
Red River Formation	1,834,880	18,348,800
Sundance Formation	1,672,320	5,016,960
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TOTAL	21,397,120	386,210,688

APPENDIX C

TABLE 1.

List of porosity and aquifer thickness values
in determining water storage values for western South Dakota

Aquifer	Specific Yield (percent)*	Porosity (percent)	Estimated Thickness (feet)
ALLUVIUM			
Bennett	20	25	5
Butte	20	25	5
Corson	20	25	5
Custer	20	25	5
Dewey	20	25	5
Fall River	20	25	5
Gregory	20	25	5
Haakson	20	25	5
Harding	20	25	5
Jackson	20	25	5
Jones	20	25	5
Lawrence	20	25	5
Lyman	20	25	5
Meade	20	25	5
Mellette	20	25	5
Pennington	20	25	5
Perkins	20	25	5
Shannon	20	25	5
Stanley	20	25	5
Todd	20	25	5
Tripp	20	25	5
Ziebach	20	25	5
ARIKAREE GROUP			
Bennett	10	35	30
Jackson	10	35	30
Mellette	10	35	30
Shannon	10	35	30
Todd	10	35	30

DAKOTA-NEWCASTLE FORMATION

Bennett	7.5	20	350
Butte	7.5	20	25
Corson	7.5	20	50
Custer	7.5	20	50
Dewey	7.5	20	100
Fall River	7.5	20	25
Gregory	7.5	20	325
Haakon	7.5	20	250
Harding	7.5	20	75
Jackson	7.5	20	350
Jones	7.5	20	325
Lyman	7.5	20	350
Meade	7.5	20	50
Mellette	7.5	20	350
Pennington	7.5	20	100
Perkins	7.5	20	50
Shannon	7.5	20	130
Stanley	7.5	20	300
Todd	7.5	20	425
Tripp	7.5	20	425
Ziebach	7.5	20	100

DEADWOOD FORMATION

Butte	5	10	550
Corson	5	10	350
Custer	5	10	75
Dewey	5	10	200
Fall River	5	10	25
Gregory	5	10	25
Haakon	5	10	75
Harding	5	10	600
Jackson	5	10	100
Jones	5	10	50
Lawrence	5	10	350
Lyman	5	10	25
Meade	5	10	400
Mellette	5	10	25
Pennington	5	10	200
Perkins	5	10	500
Shannon	5	10	75
Stanley	5	10	50
Tripp	5	10	50
Ziebach	5	10	250

FORT UNION GROUP

Corson	5	30	250
Harding	5	30	300
Perkins	5	30	375

FOX HILLS FORMATION

Butte	5	20	150
Corson	5	20	150
Dewey	5	20	150
Haakon	5	20	150
Harding	5	20	150
Jackson	5	20	150
Meade	5	20	150
Pennington	5	20	150
Perkins	5	20	150
Ziebach	5	20	150

HELL CREEK FORMATION

Butte	5	30	350
Corson	5	30	250
Dewey	5	30	50
Harding	5	30	350
Meade	5	30	230
Perkins	5	30	350
Ziebach	5	30	170

INYAN KARA GROUP

Bennett	7.5	12	175
Butte	7.5	12	200
Corson	7.5	12	130
Custer	7.5	12	300
Dewey	7.5	12	50
Fall River	7.5	12	325
Gregory	7.5	12	100
Haakon	7.5	12	120
Harding	7.5	12	175
Jackson	7.5	12	175
Jones	7.5	12	200
Lawrence	7.5	12	220
Lyman	7.5	12	250
Meade	7.5	12	230
Mellette	7.5	12	200
Pennington	7.5	12	250
Perkins	7.5	12	230
Shannon	7.5	12	210
Stanley	7.5	12	180
Todd	7.5	12	200

Tripp	7.5	12	150
Ziebach	7.5	12	75

MADISON GROUP

Butte	5	11	800
Corson	5	11	1,000
Custer	5	11	250
Dewey	5	11	700
Fall River	5	11	200
Haakon	5	11	500
Harding	5	11	1,100
Jackson	5	11	250
Jones	5	11	250
Lawrence	5	11	600
Lyman	5	11	100
Meade	5	11	750
Mellette	5	11	150
Pennington	5	11	400
Perkins	5	11	1,200
Shannon	5	11	300
Stanley	5	11	300
Tripp	5	11	100
Ziebach	5	11	800

MINNEKAHTA LIMESTONE

Bennett	5	8	50
Butte	5	8	50
Corson	5	8	50
Custer	5	8	50
Dewey	5	8	50
Fall River	5	8	50
Haakon	5	8	50
Harding	5	8	50
Jackson	5	8	50
Lawrence	5	8	50
Meade	5	8	50
Pennington	5	8	50
Perkins	5	8	50
Shannon	5	8	50
Stanley	5	8	50
Ziebach	5	8	50

MINNELUSA GROUP

Bennett	5	10	650
Butte	5	10	600

Corson	5	10	550
Custer	5	10	700
Dewey	5	10	500
Fall River	5	10	950
Haakon	5	10	780
Harding	5	10	570
Jackson	5	10	780
Jones	5	10	350
Lawrence	5	10	560
Lyman	5	10	150
Meade	5	10	750
Mellette	5	10	500
Pennington	5	10	750
Perkins	5	10	720
Shannon	5	10	850
Stanley	5	10	440
Todd	5	10	500
Tripp	5	10	250
Ziebach	5	10	750

OGALLALA GROUP

Bennett	25	35	40
Gregory	25	35	40
Shannon	25	35	120
Todd	25	35	40
Tripp	25	35	40

PRECAMBRIAN

Custer	1	3	500
Lawrence	1	3	500
Pennington	1	3	500

RED RIVER FORMATION

Butte	10	20	400
Corson	10	20	500
Dewey	10	20	400
Gregory	10	20	50
Haakon	10	20	300
Harding	10	20	490
Jones	10	20	100
Lawrence	10	20	200
Lyman	10	20	100
Mellette	10	20	100
Pennington	10	20	250
Perkins	10	20	570

Stanley	10	20	225
Todd	10	20	60
Tripp	10	20	100
Ziebach	10	20	490

SUNDANCE FORMATION

Bennett	3	15	150
Butte	3	15	450
Corson	3	15	275
Custer	3	15	300
Dewey	3	15	250
Fall River	3	15	350
Haakon	3	15	150
Harding	3	15	450
Jackson	3	15	100
Jones	3	15	50
Lawrence	3	15	375
Meade	3	15	350
Pennington	3	15	250
Perkins	3	15	400
Shannon	3	15	200
Stanley	3	15	150
Ziebach	3	15	250

* All specific yield and porosity values were taken from Rahn, 1981, with the exception of Dakota-Newcastle Formation and Inyan Kara Group, which were taken from Hedges, et al., 1982.

Plates 1-25 (stored in separate folder)
(fold out size - follow page
C-6.)

These maps (Pl. 1-25 also available in
1:500,000 scale)

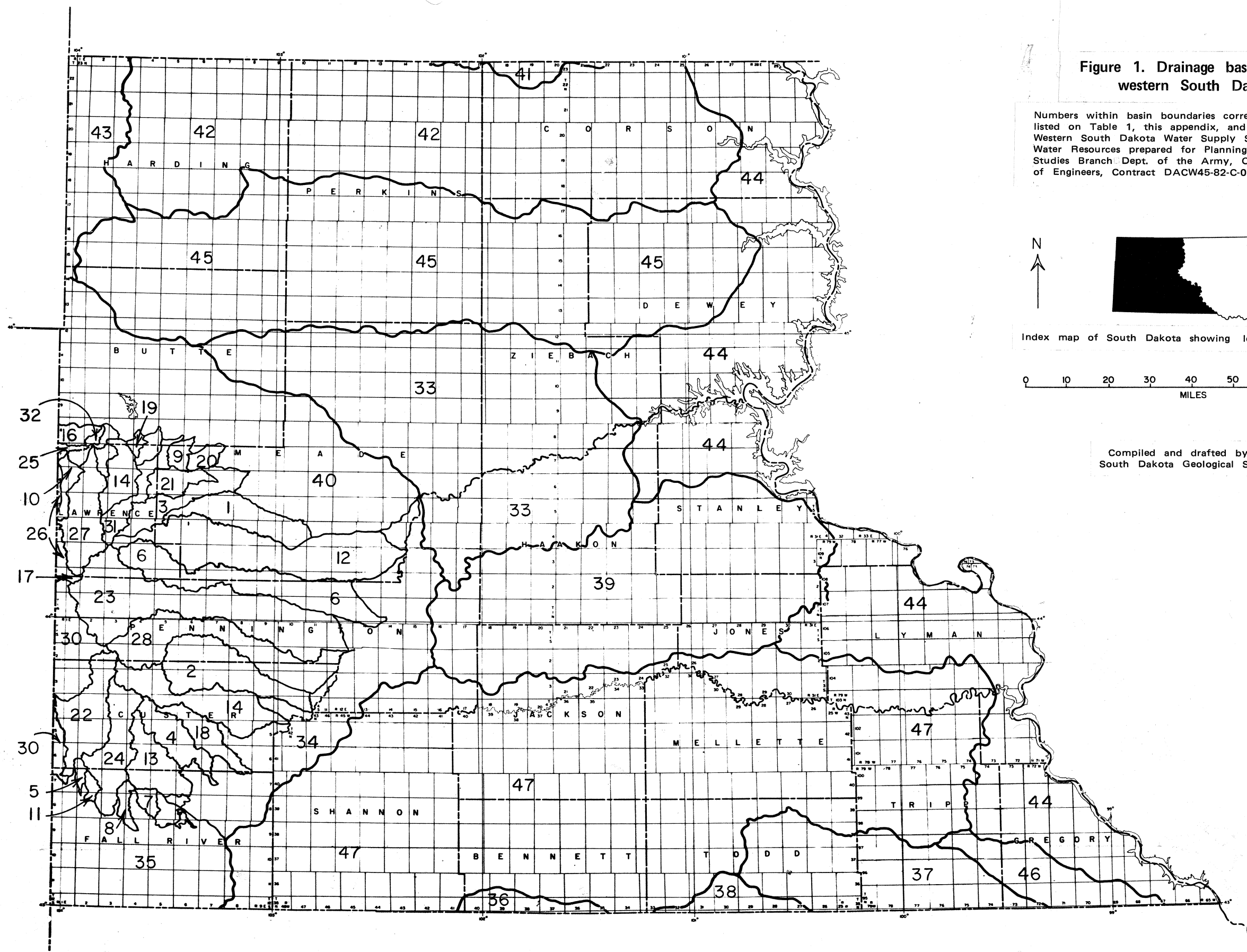
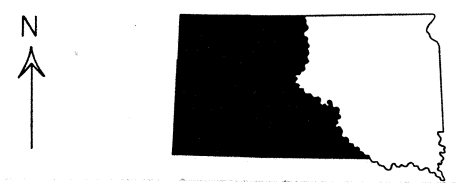
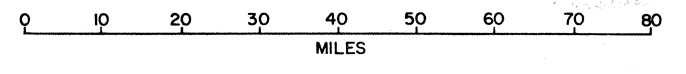


Figure 1. Drainage basin map of western South Dakota.

Numbers within basin boundaries correspond to basin names listed on Table 1, this appendix, and in text of Task 1, Western South Dakota Water Supply Study, Evaluation of Water Resources prepared for Planning Division, Special Studies Branch Dept. of the Army, Omaha District Corps of Engineers, Contract DACW45-82-C-0151.



Index map of South Dakota showing location of this map.



Compiled and drafted by the South Dakota Geological Survey.

PLATE 1

PERIOD	GROUP	FORMATION	DESCRIPTION	THICKNESS	STRATIGRAPHIC SECTION	DESCRIPTION	GROUP	PERIOD		
QUATERNARY	FORMATION	FORMATION	DESCRIPTION	THICKNESS	NORTHWESTERN SOUTH DAKOTA	DESCRIPTION	FORMATION	EPOCH		
TERTIARY	PALEOCENE	FORT UNION	TONGUE RIVER	Clay and sand, light colored, minor thin coal beds	0-400		Clay, sand, pebble and boulder mixture	PLEISTOCENE	QUATERNARY	
			CANNONBALL	Shale, greenish gray, sandstone, yellow to buff, as concretions and channel filling	0-225					PIERRE SHALE
			LUDLOW	Clay and sandstone, amber gray with some thin lignite beds. Shadepill (?) coal at base	0-350					
CRETACEOUS	CRETACEOUS	HELL CREEK FORMATION	Shale, drab, soft brown (samber beds) and sandstone gray. Sandstone increases toward base. Thin lenses of lignite in upper part.	0-325		Shale, dark gray, carbonaceous. Bentonite at base.	PIERRE SHALE	PIERRE SHALE	CRETACEOUS	
		FOX HILLS FORMATION	Sandstone, grayish white to carbonaceous gray shale. Ironstone concretions at top.	0-200						NOBARRA FORMATION
		PIERRE SHALE								
		NIORARA FORMATION	Chalk, light to dark gray, white speckled, microfossiliferous.	270						CARLILE SHALE
		CARLILE SHALE	Shale, medium to dark gray plastic to fissile - scattered ironstone concretions	320						
		GREENHORN LIMESTONE	Limestone, white to light gray, stobby, very fossiliferous with dark gray, white speckled shale at top and at base	70						BELLE FOURCHE SHALE
		BELLE FOURCHE SHALE	Shale, dark gray, dolomite and ironstone concretions	275						
		NOBARRA FORMATION	Shale, medium gray, siliceous, bentonite marker at top	275						SKULL CREEK SHALE
		SKULL CREEK SHALE	Sandstone, white to light gray, fine-grained in part, very stobby.	0-100						
		INNYAN KARA GROUP	Shale, dark gray with thin glauconitic siltstone near middle of interval.	200-250						MORRISON FORMATION
MORRISON FORMATION	Shale, medium gray, interbedded with sandstone, white, fine grained, glauconitic	180	SUNDANCE FORMATION							
SUNDANCE FORMATION	Sandstone, white, fine to medium grained, glauconitic, interbedded with shale, gray, green and brown	320		PIER LIMESTONE						
PIER LIMESTONE	Limestone, white to brown, fine grained, interbedded with shale, green, red and brown	30	SPEARFISH FORMATION							
SPEARFISH FORMATION	Shale, silty, orange, brick red, green and minor gray interbedded with anhydrite, gypsum and soil.	0-600		PERMIAN						
PENNSYLVANIAN	PERMIAN	MINNELUSA	MINNEKAHTA SANDSTONE		Limestone, white to lavender, fine, dense	0-50		SIOUX QUARTZITE	PRECAMBRIAN	
			OPPELT SHALE	Shale, brick red, silty	0-80	SIOUX QUARTZITE				
			CASSA	Anhydrite, white to light brown, limestone and dolomite, white to light gray, silty	80-300					SIOUX QUARTZITE
			BROOM CREEK	Limestone, dolomite, light gray, fine, silty	175-200	SIOUX QUARTZITE				
			WENDOVER-MEEK	Limestone, light gray to brown, dolomite, interbedded with blocks of calcareous shale	140-170					SIOUX QUARTZITE
			HAYDEN	Limestone, light gray to brown, dolomite, interbedded with minor red, plastic, sands	100-160	SIOUX QUARTZITE				
			ROUNDTOP	Shale, white to red, in part shaly.	0-80					SIOUX QUARTZITE
			RECLAMATION	Sandstone, white to red, in part shaly.	0-100	SIOUX QUARTZITE				
			KAIBAB	Sandstone, white to gray, medium to coarse grained	0-120					SIOUX QUARTZITE
			KIBBEV SANDSTONE	Limestone, white to light tan, lithographic, interbedded with anhydrite, white to light blue and light brown	0-400	SIOUX QUARTZITE				
CHARLES FORMATION	Limestone, light to medium brown, gray, fine to medium grained, in part surcitic	120-550	SIOUX QUARTZITE							
MISSION CANYON FORMATION	Limestone, light to medium brown, gray, fine to medium grained, in part surcitic	120-550		SIOUX QUARTZITE						
LODGEPOLE FORMATION	Dolomitic siltstone and varicolored shale	0-60	SIOUX QUARTZITE							
ENGLEWOOD	Light brown, fine grained limestone and dolomite, interbedded with thin gray shale	0-240		SIOUX QUARTZITE						
DUPEROW	Varicolored shale and red dolomitic siltstone	0-250	SIOUX QUARTZITE							
SOURIS RIVER	Light tan to brown dolomite, fine grained	0-30		SIOUX QUARTZITE						
INTERLAKE	Light tan to pale dolomite, locally sandy	0-75	SIOUX QUARTZITE							
STONEWALL	Brownish gray fine grained dolomite at top with green, waxy shale and siltstone at base	0-155		SIOUX QUARTZITE						
STONY MOUNTAIN	Light brown to pale red	0-115	SIOUX QUARTZITE							
RED RIVER (UNIT A)	Limestone, in part dolomitized, and light colored chert. Threefold subdivision is mainly based on E-log characteristics	0-100		SIOUX QUARTZITE						
RED RIVER (UNIT B)	Fine grained quartz sandstone at base, green, silty to subgray shale with small, waxy block phosphatic nodules interbedded with siltstone at top.	0-150	SIOUX QUARTZITE							
RED RIVER (UNIT C)	White to reddish-orange, fine to medium grained quartz sandstone and dolomite, contains green shale partings and locally abundant glauconite	0-630		SIOUX QUARTZITE						
WINNIPEG	Igneous and metamorphic rock		SIOUX QUARTZITE							
DEADWOOD	Igneous and metamorphic rock			SIOUX QUARTZITE						

1. As defined by Horton, D. E., 1965. Stratigraphy of the Central and Southwestern Geological Survey, Bull. 178, 83 pp.

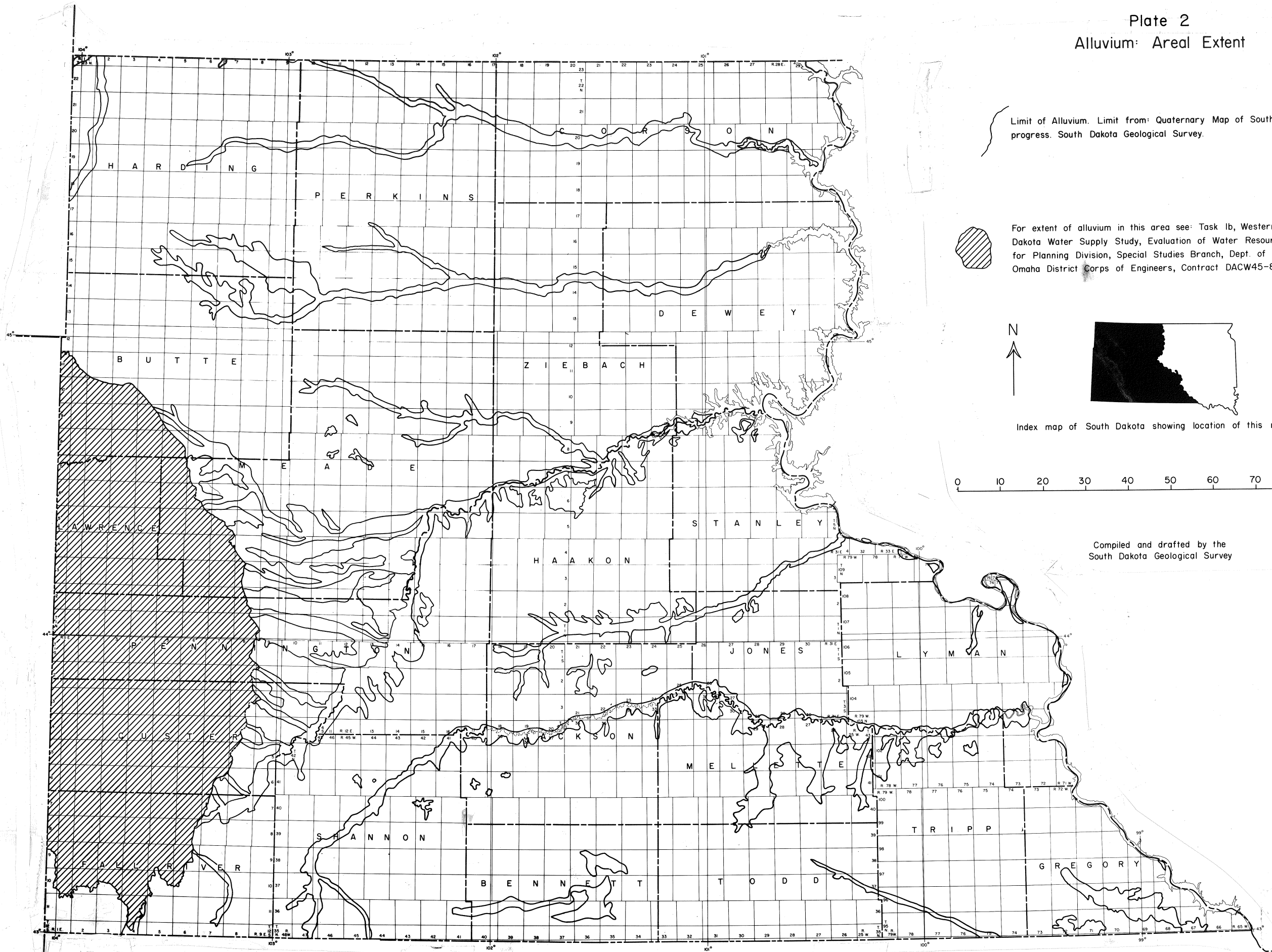
2. As described by Meek, F. B., and Hayden, F. V., 1961. Philadelphia Academy of Natural Resources Proceedings, v. 13, p. 419-20

3. Conrad, G. E., Reed, E. C., and Scherer, O. S., 1940. Correlations of the Formations of the Laramie Range, Horville Uplift, Black Hills and western Nebraska. Nebraska Geological Survey Bull. 13, 52 pp.

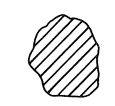
In view of the equivalency of the Horville sandstone and the Minnelusa sandstone, the Horville sandstone is employed in the Minnelusa in South Dakota.

SOUTH DAKOTA GEOLOGICAL SURVEY

Plate 2
Alluvium: Areal Extent



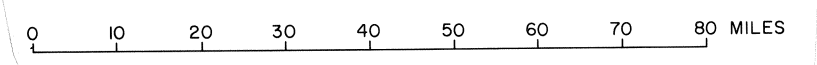
Limit of Alluvium. Limit from: Quaternary Map of South Dakota, in progress. South Dakota Geological Survey.



For extent of alluvium in this area see: Task 1b, Western South Dakota Water Supply Study, Evaluation of Water Resources, prepared for Planning Division, Special Studies Branch, Dept. of the Army, Omaha District Corps of Engineers, Contract DACW45-82-C-0151.

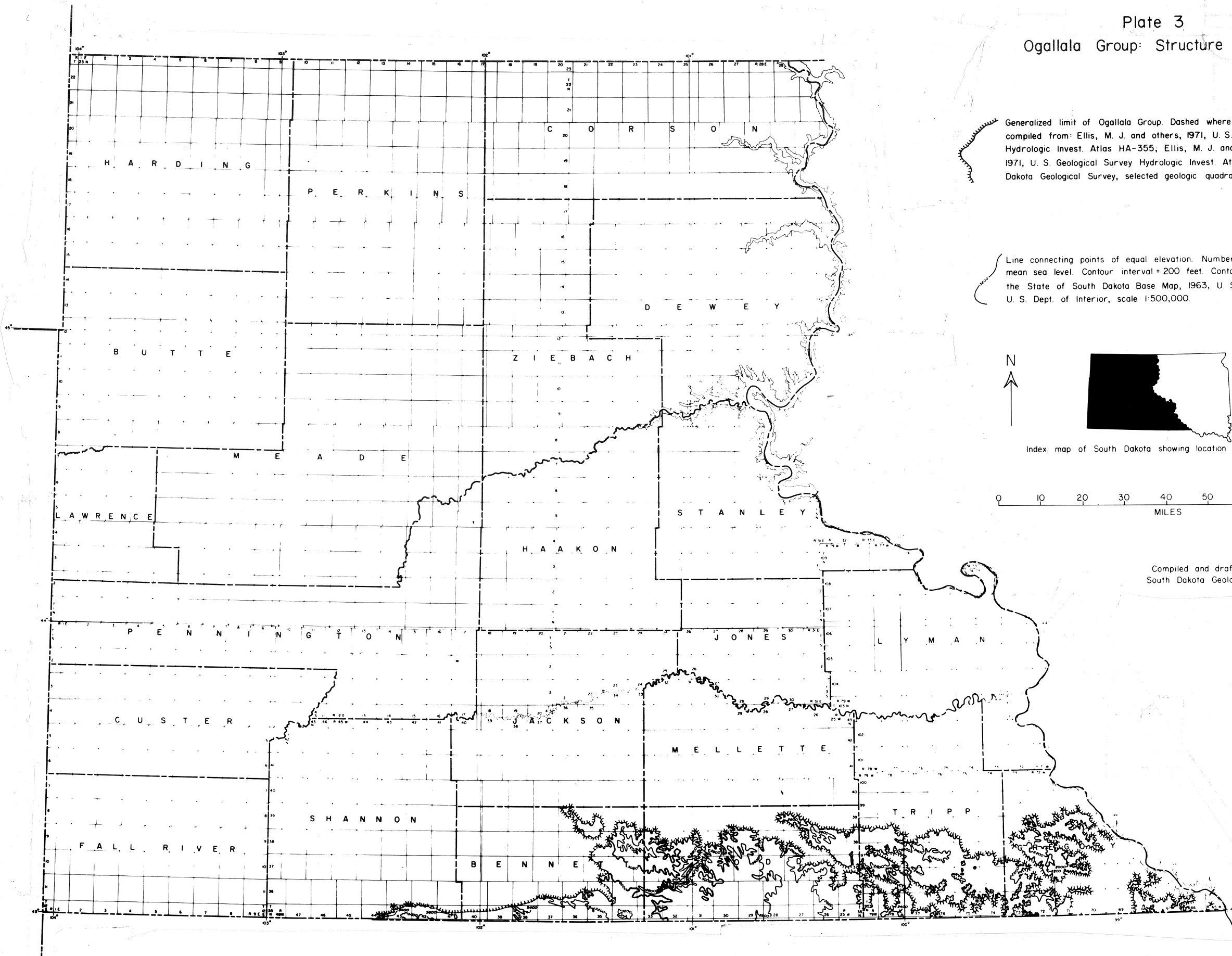


Index map of South Dakota showing location of this map.



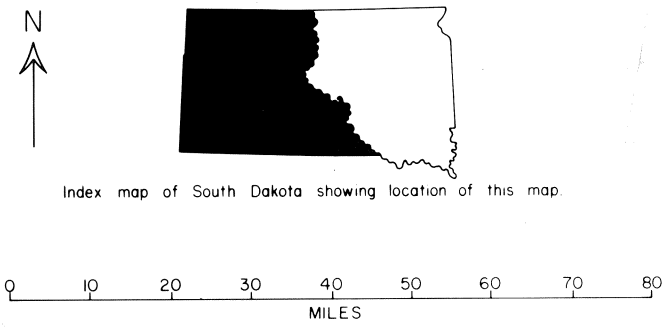
Compiled and drafted by the
South Dakota Geological Survey

Plate 3
Ogallala Group: Structure Contour



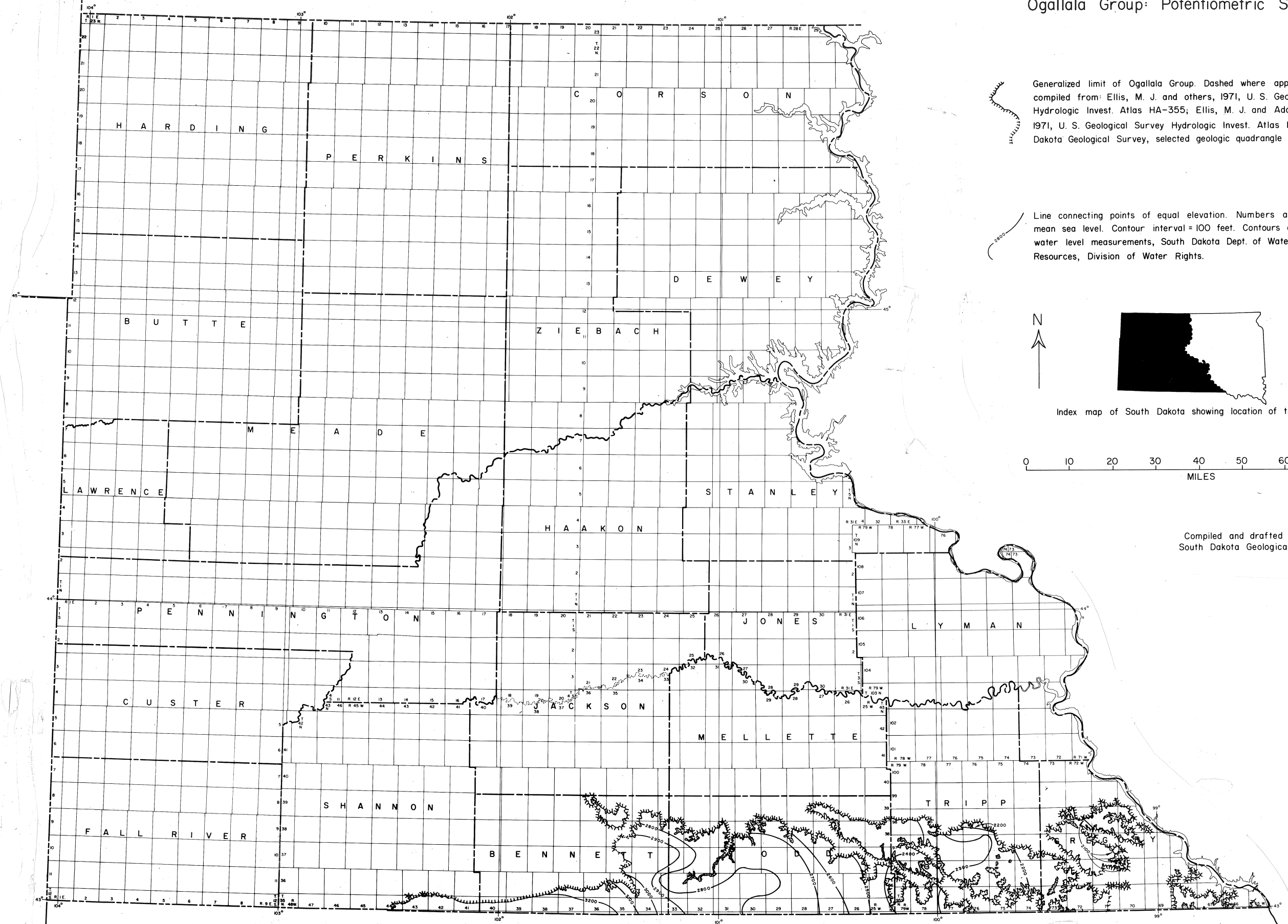
Generalized limit of Ogallala Group. Dashed where approximate. Limit compiled from: Ellis, M. J. and others, 1971, U. S. Geological Survey Hydrologic Invest. Atlas HA-355; Ellis, M. J. and Adolphson, D. G., 1971, U. S. Geological Survey Hydrologic Invest. Atlas HA-357, South Dakota Geological Survey, selected geologic quadrangle maps.

Line connecting points of equal elevation. Numbers are in feet above mean sea level. Contour interval = 200 feet. Contours generalized from the State of South Dakota Base Map, 1963, U. S. Geological Survey, U. S. Dept. of Interior, scale 1:500,000.



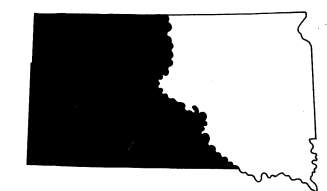
Compiled and drafted by the
South Dakota Geological Survey

Plate 4
Ogallala Group: Potentiometric Surface

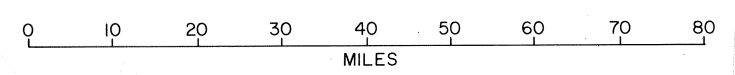


Generalized limit of Ogallala Group. Dashed where approximate. Limit compiled from: Ellis, M. J. and others, 1971, U. S. Geological Survey Hydrologic Invest. Atlas HA-355; Ellis, M. J. and Adolphson, D. G., 1971, U. S. Geological Survey Hydrologic Invest. Atlas HA-357; South Dakota Geological Survey, selected geologic quadrangle maps.

Line connecting points of equal elevation. Numbers are in feet above mean sea level. Contour interval = 100 feet. Contours generalized from water level measurements, South Dakota Dept. of Water and Natural Resources, Division of Water Rights.

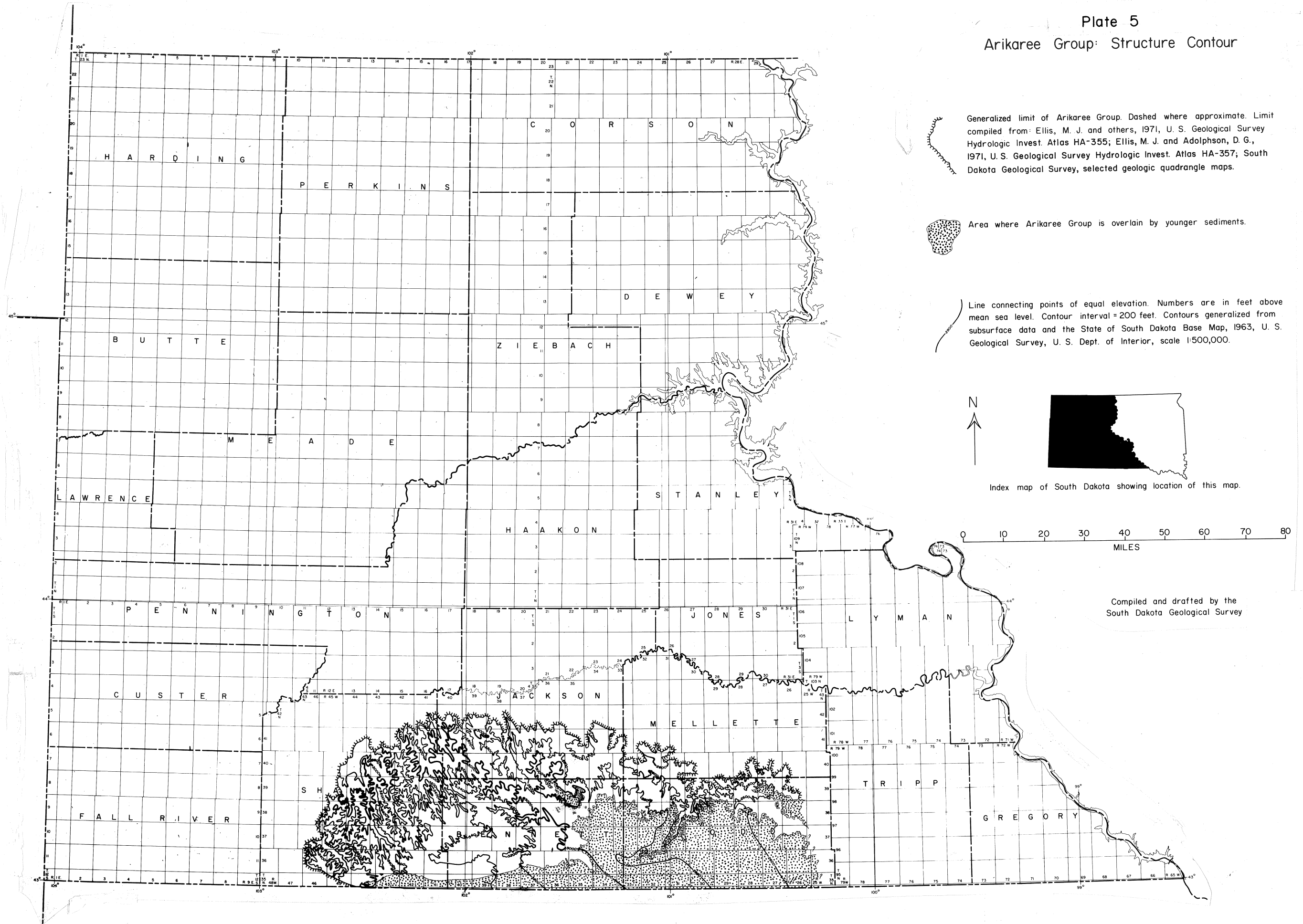


Index map of South Dakota showing location of this map.



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South Dakota Geological Survey

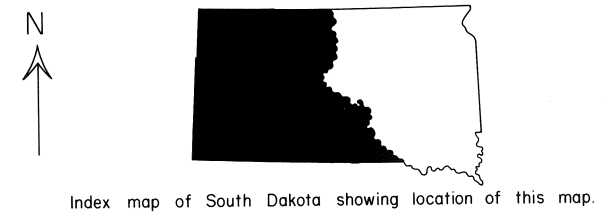
Plate 5
Arikaree Group: Structure Contour



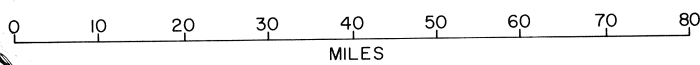
Generalized limit of Arikaree Group. Dashed where approximate. Limit compiled from: Ellis, M. J. and others, 1971, U. S. Geological Survey Hydrologic Invest. Atlas HA-355; Ellis, M. J. and Adolphson, D. G., 1971, U. S. Geological Survey Hydrologic Invest. Atlas HA-357; South Dakota Geological Survey, selected geologic quadrangle maps.

Area where Arikaree Group is overlain by younger sediments.

Line connecting points of equal elevation. Numbers are in feet above mean sea level. Contour interval = 200 feet. Contours generalized from subsurface data and the State of South Dakota Base Map, 1963, U. S. Geological Survey, U. S. Dept. of Interior, scale 1:500,000.

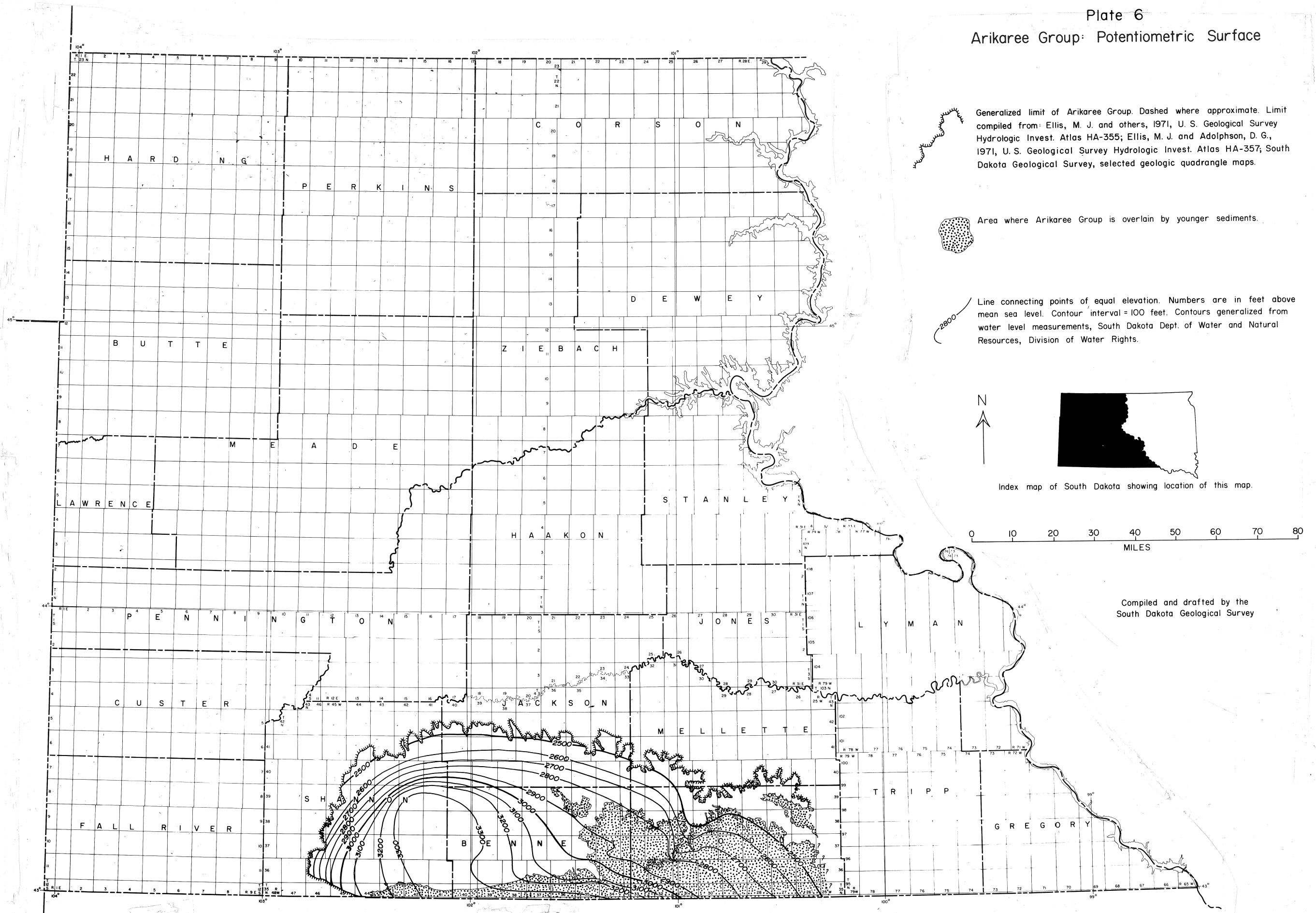


Index map of South Dakota showing location of this map.



Compiled and drafted by the South Dakota Geological Survey

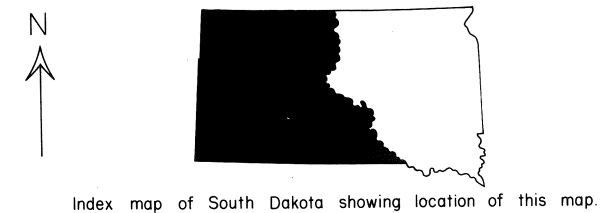
Plate 6
Arikaree Group: Potentiometric Surface



Generalized limit of Arikaree Group. Dashed where approximate. Limit compiled from: Ellis, M. J. and others, 1971, U. S. Geological Survey Hydrologic Invest. Atlas HA-355; Ellis, M. J. and Adolphson, D. G., 1971, U. S. Geological Survey Hydrologic Invest. Atlas HA-357; South Dakota Geological Survey, selected geologic quadrangle maps.

Area where Arikaree Group is overlain by younger sediments.

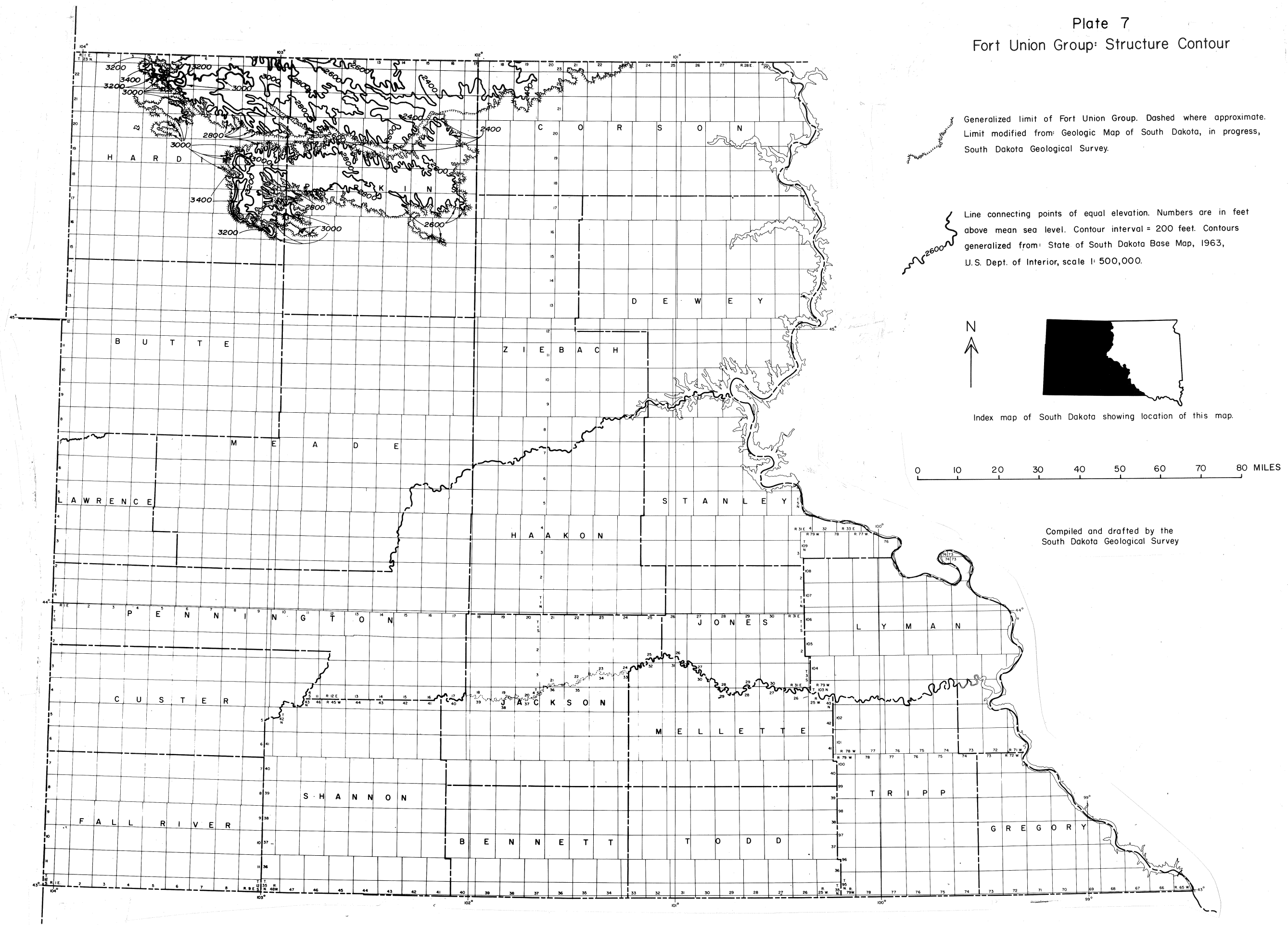
Line connecting points of equal elevation. Numbers are in feet above mean sea level. Contour interval = 100 feet. Contours generalized from water level measurements, South Dakota Dept. of Water and Natural Resources, Division of Water Rights.



0 10 20 30 40 50 60 70 80
MILES

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South Dakota Geological Survey

Plate 7
Fort Union Group: Structure Contour

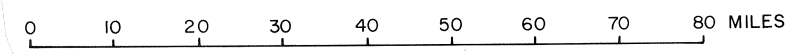


Generalized limit of Fort Union Group. Dashed where approximate. Limit modified from: Geologic Map of South Dakota, in progress, South Dakota Geological Survey.

Line connecting points of equal elevation. Numbers are in feet above mean sea level. Contour interval = 200 feet. Contours generalized from: State of South Dakota Base Map, 1963, U.S. Dept. of Interior, scale 1: 500,000.

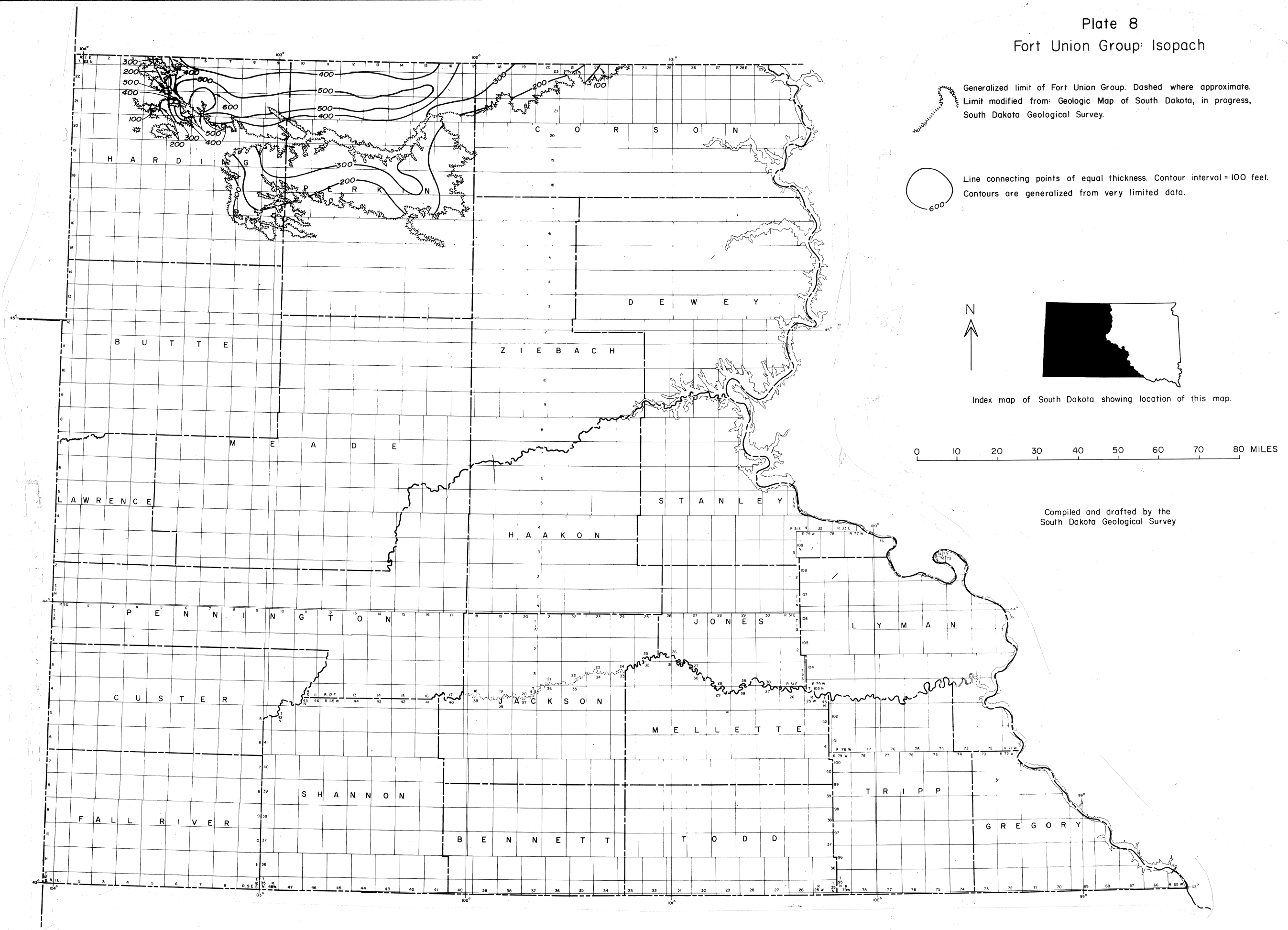


Index map of South Dakota showing location of this map.



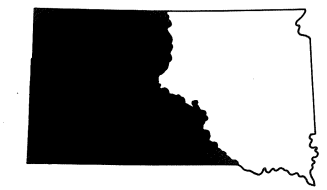
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Plate 8
Fort Union Group: Isopach

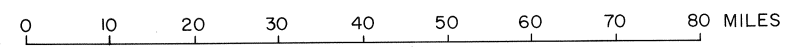


Generalized limit of Fort Union Group. Dashed where approximate.
Limit modified from: Geologic Map of South Dakota, in progress,
South Dakota Geological Survey.

Line connecting points of equal thickness. Contour interval = 100 feet.
Contours are generalized from very limited data.

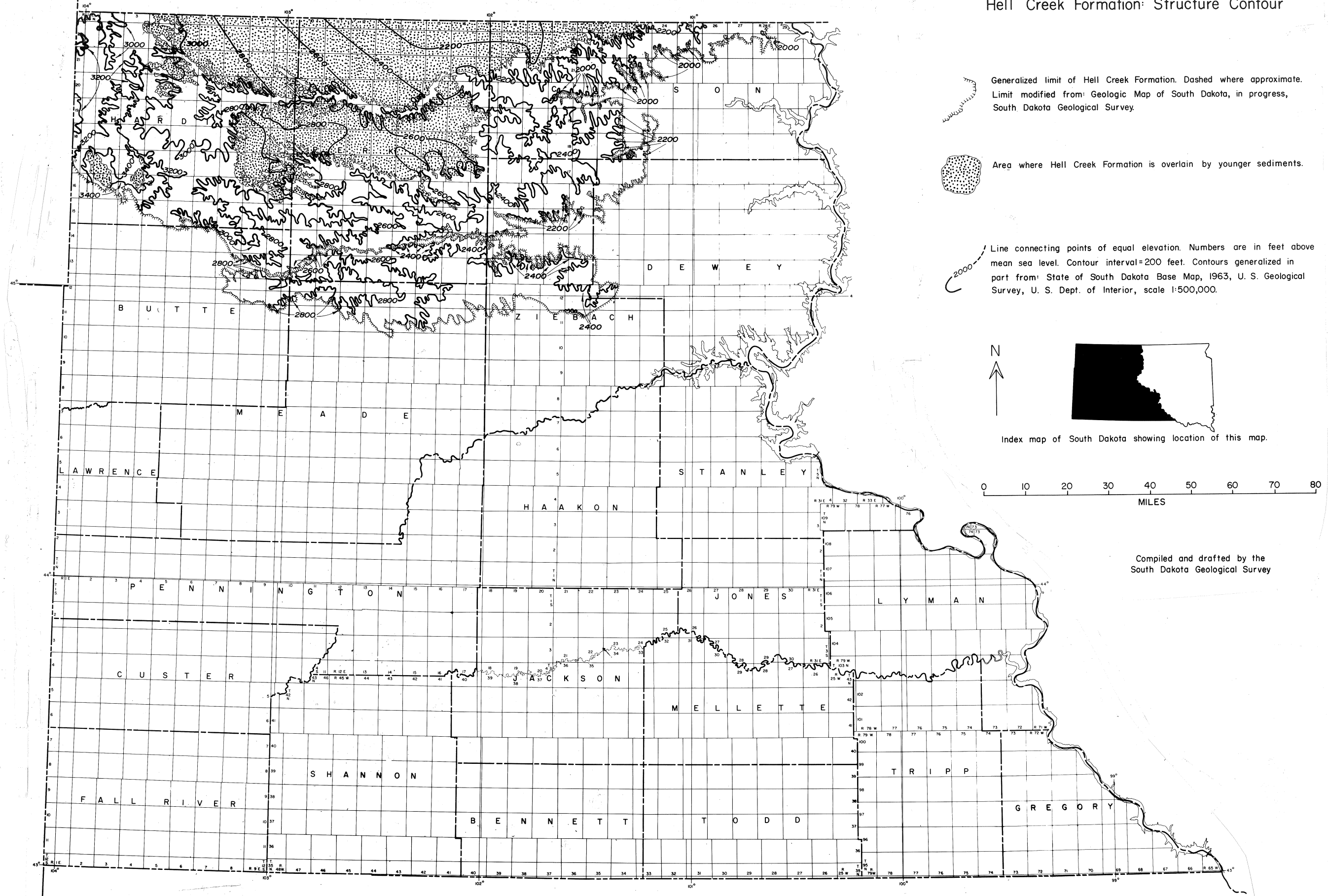


Index map of South Dakota showing location of this map.



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Plate 9
Hell Creek Formation: Structure Contour



Generalized limit of Hell Creek Formation. Dashed where approximate.
Limit modified from: Geologic Map of South Dakota, in progress,
South Dakota Geological Survey.

Area where Hell Creek Formation is overlain by younger sediments.

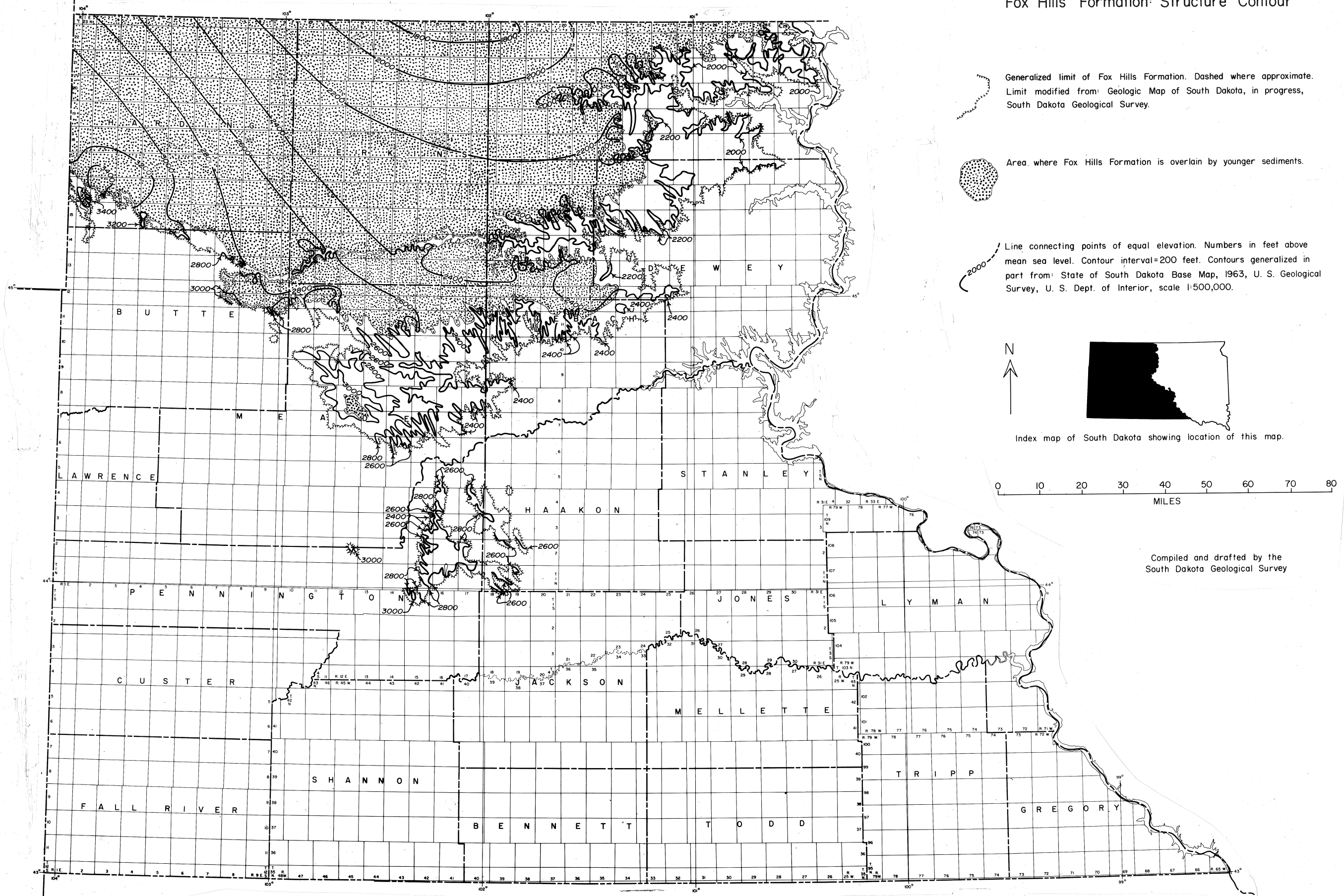
Line connecting points of equal elevation. Numbers are in feet above
mean sea level. Contour interval=200 feet. Contours generalized in
part from: State of South Dakota Base Map, 1963, U. S. Geological
Survey, U. S. Dept. of Interior, scale 1:500,000.

N
↑
Index map of South Dakota showing location of this map.

0 10 20 30 40 50 60 70 80
MILES

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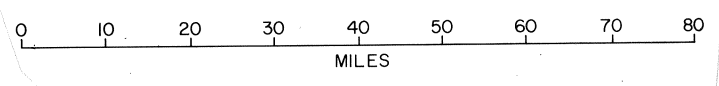
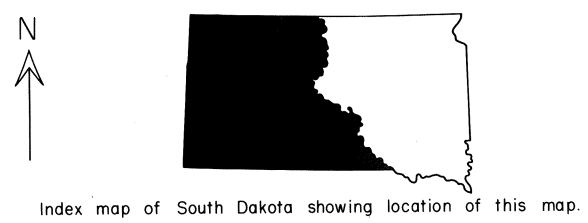
Plate 10
 Fox Hills Formation: Structure Contour



Generalized limit of Fox Hills Formation. Dashed where approximate.
 Limit modified from: Geologic Map of South Dakota, in progress,
 South Dakota Geological Survey.

Area where Fox Hills Formation is overlain by younger sediments.

Line connecting points of equal elevation. Numbers in feet above
 mean sea level. Contour interval=200 feet. Contours generalized in
 part from: State of South Dakota Base Map, 1963, U. S. Geological
 Survey, U. S. Dept. of Interior, scale 1:500,000.



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Plate II
Dakota Formation-Newcastle Sandstone: Structure Contour

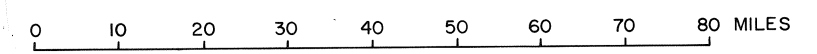
Formation boundary modified from: Schoon, Robert A., 1971, Geology and Hydrology of the Dakota Formation in South Dakota: South Dakota Geological Survey Report of Investigations No. 104, Fig. 1, p. 2.

—+700— Line connecting points of equal elevation. Numbers in feet above and below mean sea level. Contour interval = 100 feet except 500 foot interval along western limit.

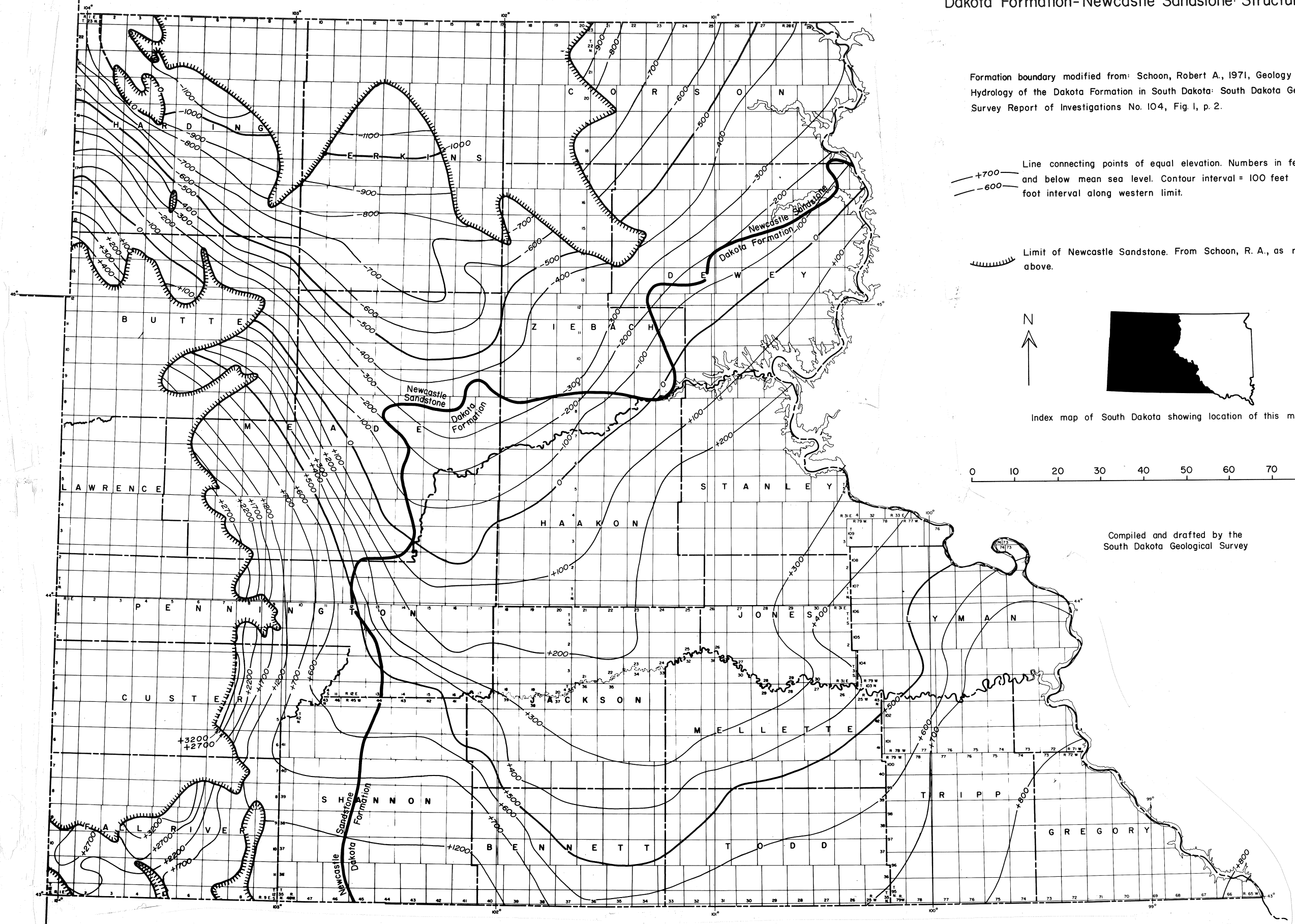
— Limit of Newcastle Sandstone. From Schoon, R. A., as referenced above.



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Dakota Formation-Newcastle Sandstone: Isopach

Contours and Formation boundary modified from: Schoon, Robert A., 1971, *Geology and Hydrology of the Dakota Formation in South Dakota*: South Dakota Geological Survey Report of Investigations No. 104, Fig. 1, p. 2.

Lines connecting points of equal thickness. Contour interval=25 feet for Newcastle Sandstone and 50 feet for Dakota Formation. Dashed where approximate.



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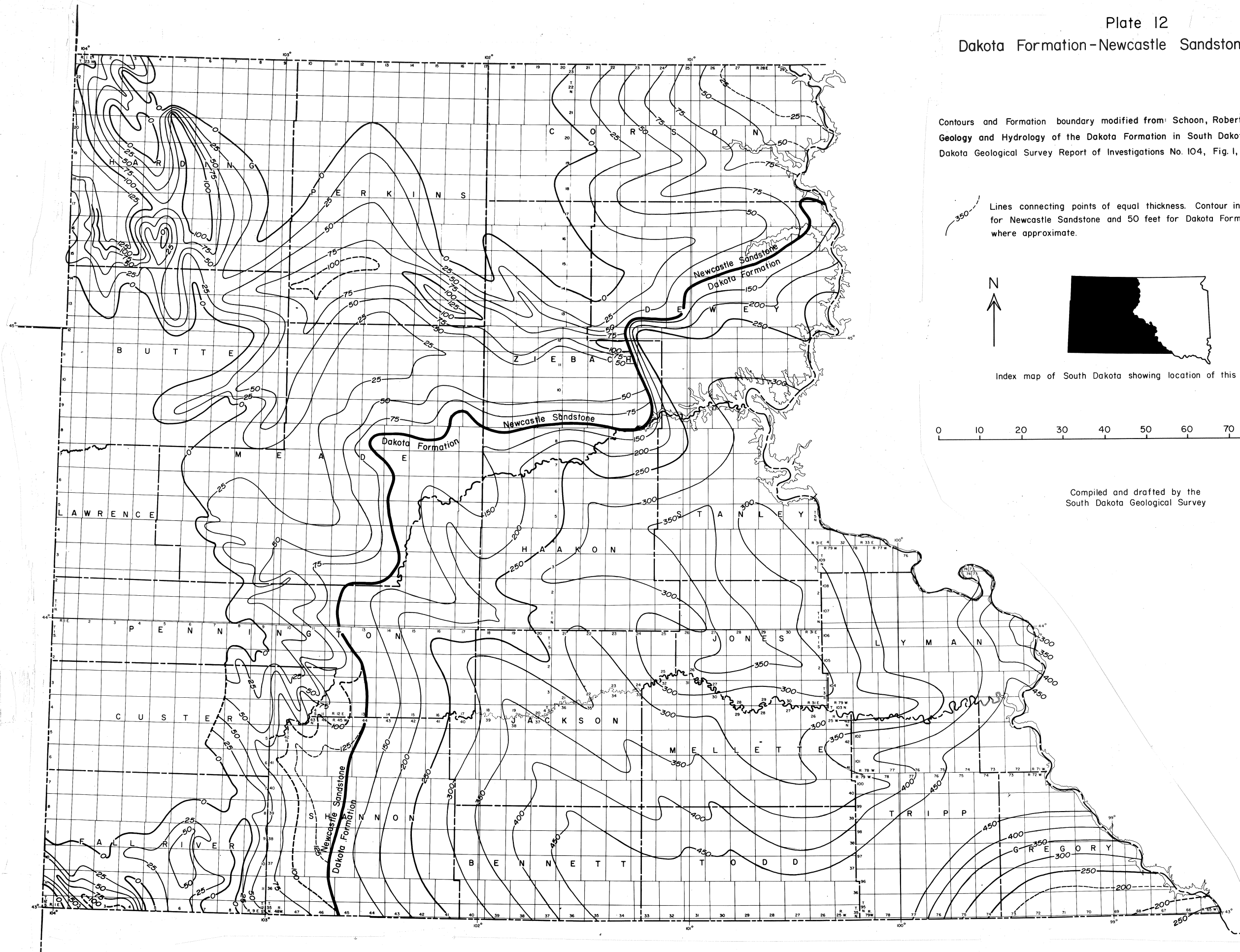
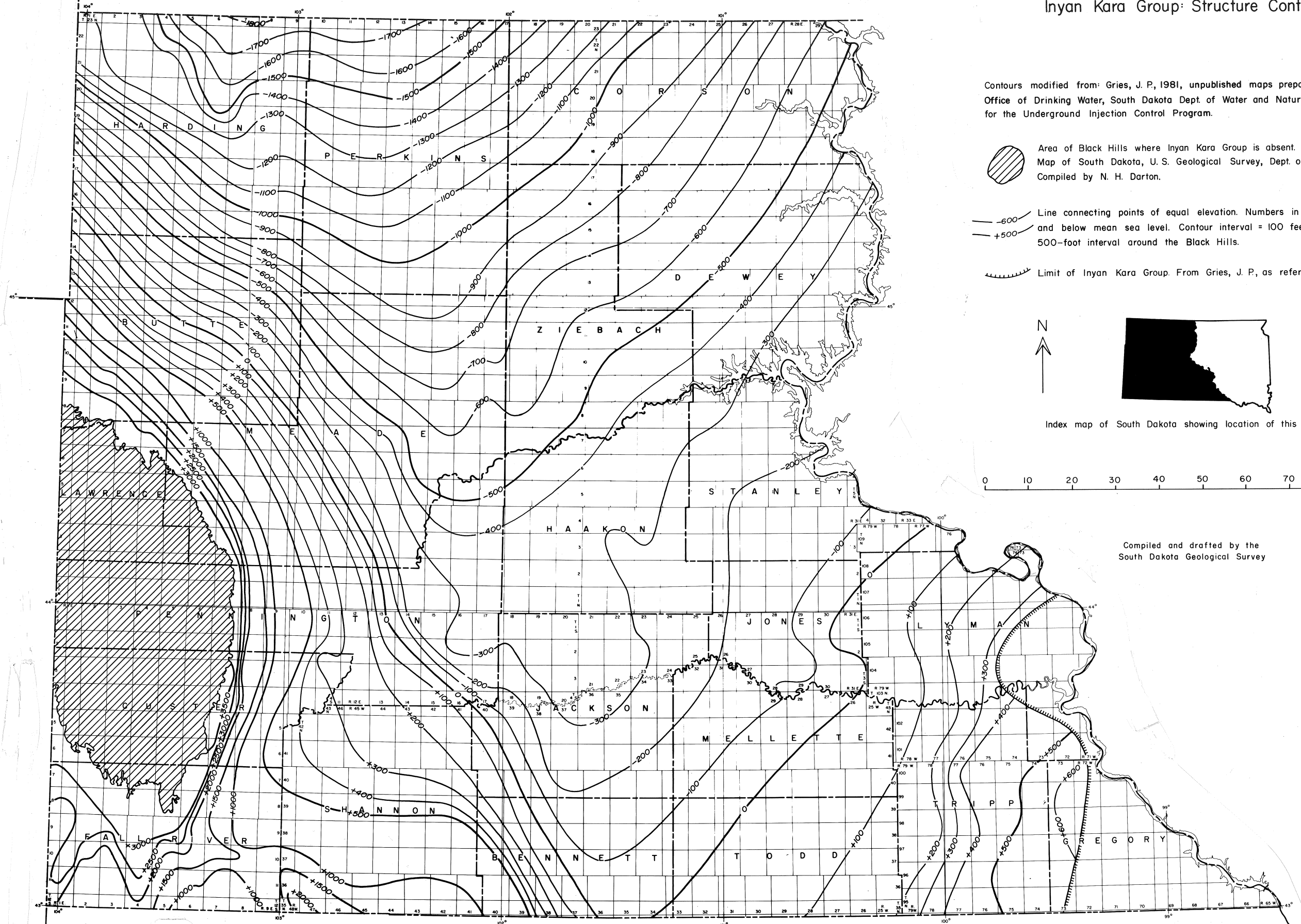

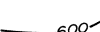
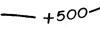



Plate 13
Inyan Kara Group: Structure Contour



Contours modified from: Gries, J. P., 1981, unpublished maps prepared for the Office of Drinking Water, South Dakota Dept. of Water and Natural Resources, for the Underground Injection Control Program.

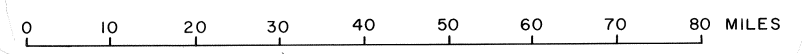
 Area of Black Hills where Inyan Kara Group is absent. From: Geologic Map of South Dakota, U. S. Geological Survey, Dept. of Interior, 1951. Compiled by N. H. Darton.

 -600
 +500
Line connecting points of equal elevation. Numbers in feet above and below mean sea level. Contour interval = 100 feet except for 500-foot interval around the Black Hills.

 Limit of Inyan Kara Group. From Gries, J. P., as referenced above.

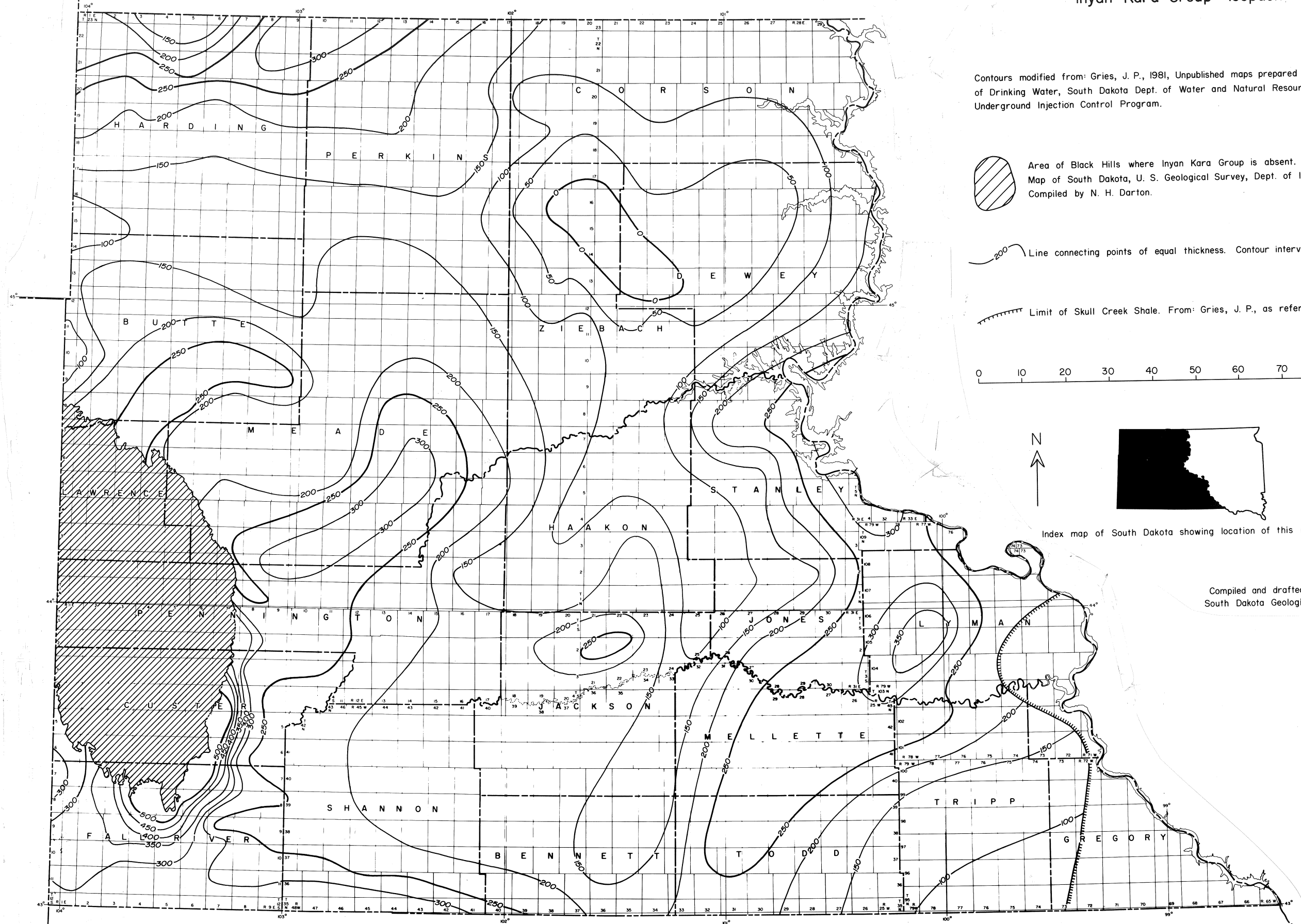


Index map of South Dakota showing location of this map.





Compiled and drafted by the
South Dakota Geological Survey


Plate 14
Inyan Kara Group: Isopach

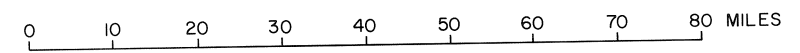


Contours modified from: Gries, J. P., 1981, Unpublished maps prepared for the Office of Drinking Water, South Dakota Dept. of Water and Natural Resources, for the Underground Injection Control Program.

 Area of Black Hills where Inyan Kara Group is absent. From: Geologic Map of South Dakota, U. S. Geological Survey, Dept. of Interior, 1951. Compiled by N. H. Darton.

 Line connecting points of equal thickness. Contour interval=50 feet.

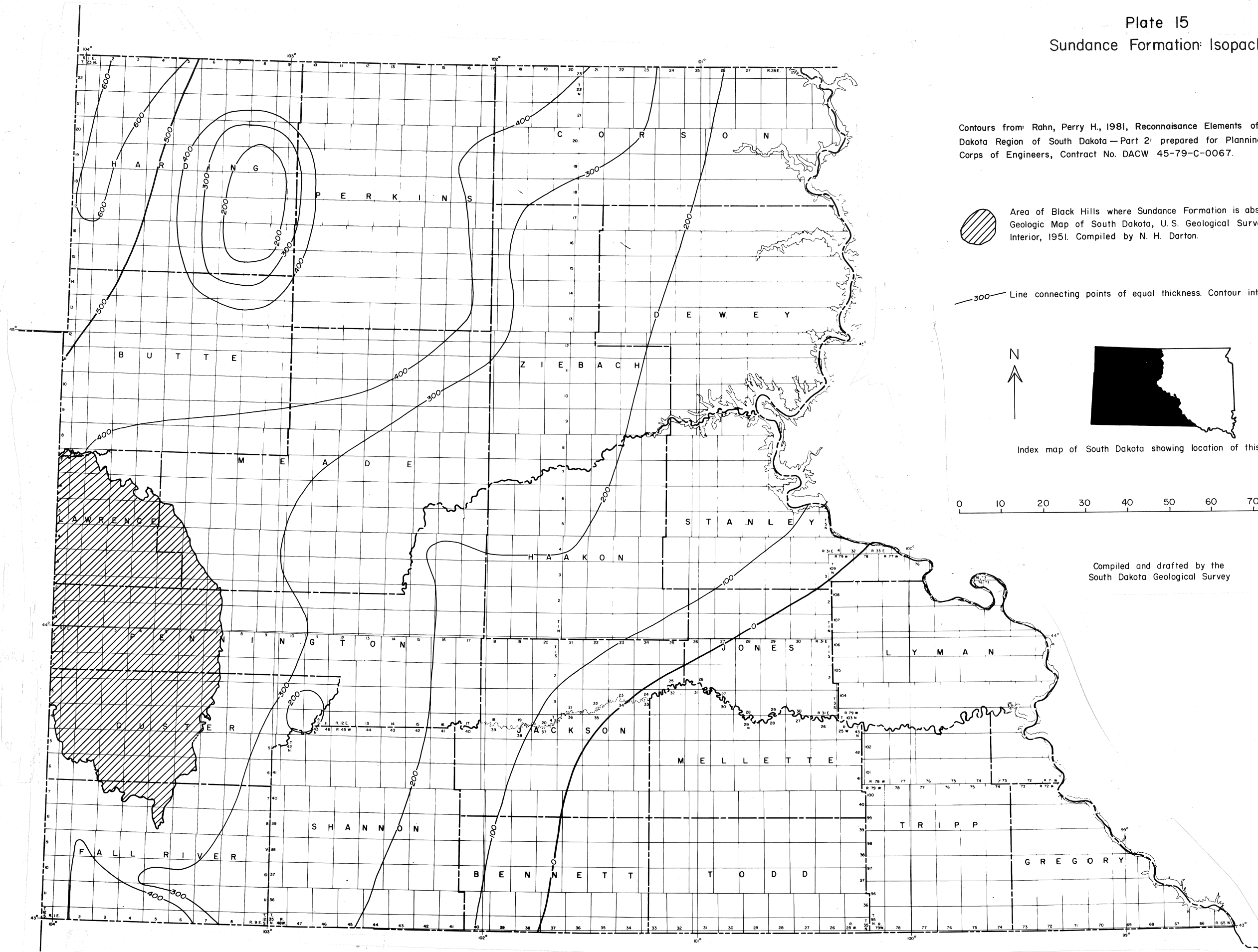
 Limit of Skull Creek Shale. From: Gries, J. P., as referenced above.




Index map of South Dakota showing location of this map.


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South Dakota Geological Survey.

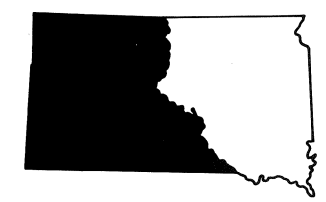
Plate 15
Sundance Formation: Isopach



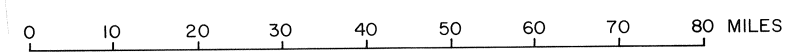
Contours from: Rahn, Perry H., 1981, Reconnaissance Elements of the Western Dakota Region of South Dakota—Part 2: prepared for Planning Division, Corps of Engineers, Contract No. DACW 45-79-C-0067.

 Area of Black Hills where Sundance Formation is absent. From: Geologic Map of South Dakota, U.S. Geological Survey, Dept. of Interior, 1951. Compiled by N. H. Darton.

 Line connecting points of equal thickness. Contour interval= 100 feet.




Index map of South Dakota showing location of this map.




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South Dakota Geological Survey

Plate 16
 Minnekahta Limestone: Isopach

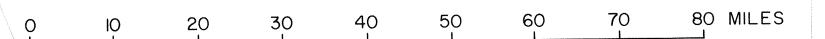
Contours from: Rahn, Perry H., 1981, Reconnaissance Elements of the Western Dakota Region of South Dakota—Part 2, Prepared for Planning Division, Corps of Engineers, Contract No. DACW 45-79-C-0067.

 Area of Black Hills where Minnekahta Limestone is absent. From: Geologic Map of South Dakota, U.S. Geological Survey, Dept. of Interior, 1951. Compiled by N. H. Darton.

 Line connecting points of equal thickness. Contour interval=50 feet.



Index map of South Dakota showing location of this map.



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 South Dakota Geological Survey

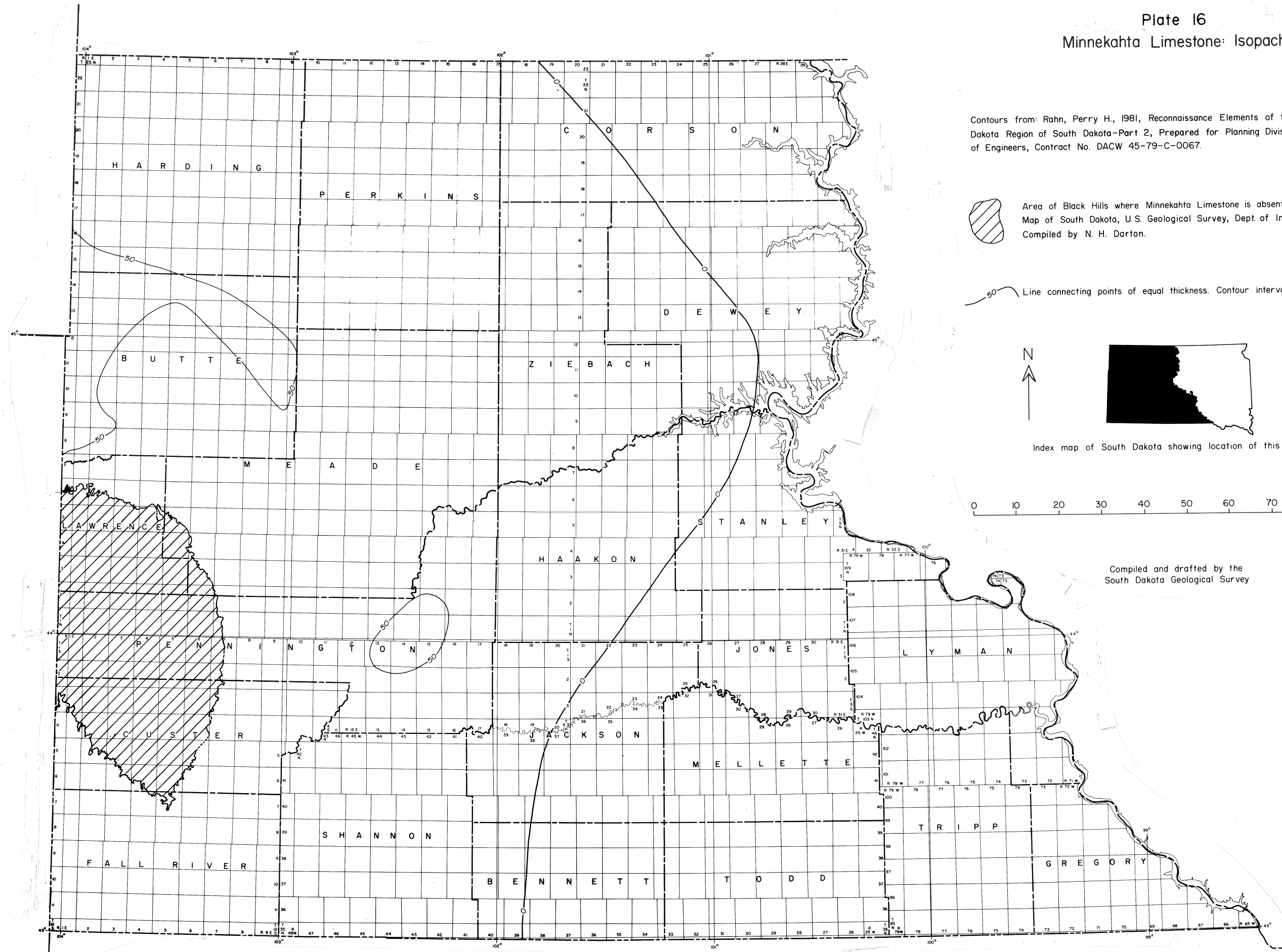

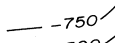



Plate 17
 Minnelusa Group: Structure Contour

Contours modified from: Gries, J. P., 1981, unpublished maps prepared for the Office of Drinking Water, South Dakota Dept. of Water and Natural Resources, for the Underground Injection Control Program.

 Area of Black Hills where Minnelusa Group is absent. From: Geologic Map of South Dakota, U.S. Geological Survey, Dept. of Interior, 1951. Compiled by N. H. Darton.

 Line connecting points of equal elevation. Numbers are in feet above and below mean sea level. Contour interval = 250 feet except for 1000-foot interval around the Black Hills.

 Eastern limit of Minnelusa Group. From Gries, J. P., as referenced above.



Index map of South Dakota showing location of this map.



Compiled and drafted by the
 South Dakota Geological Survey

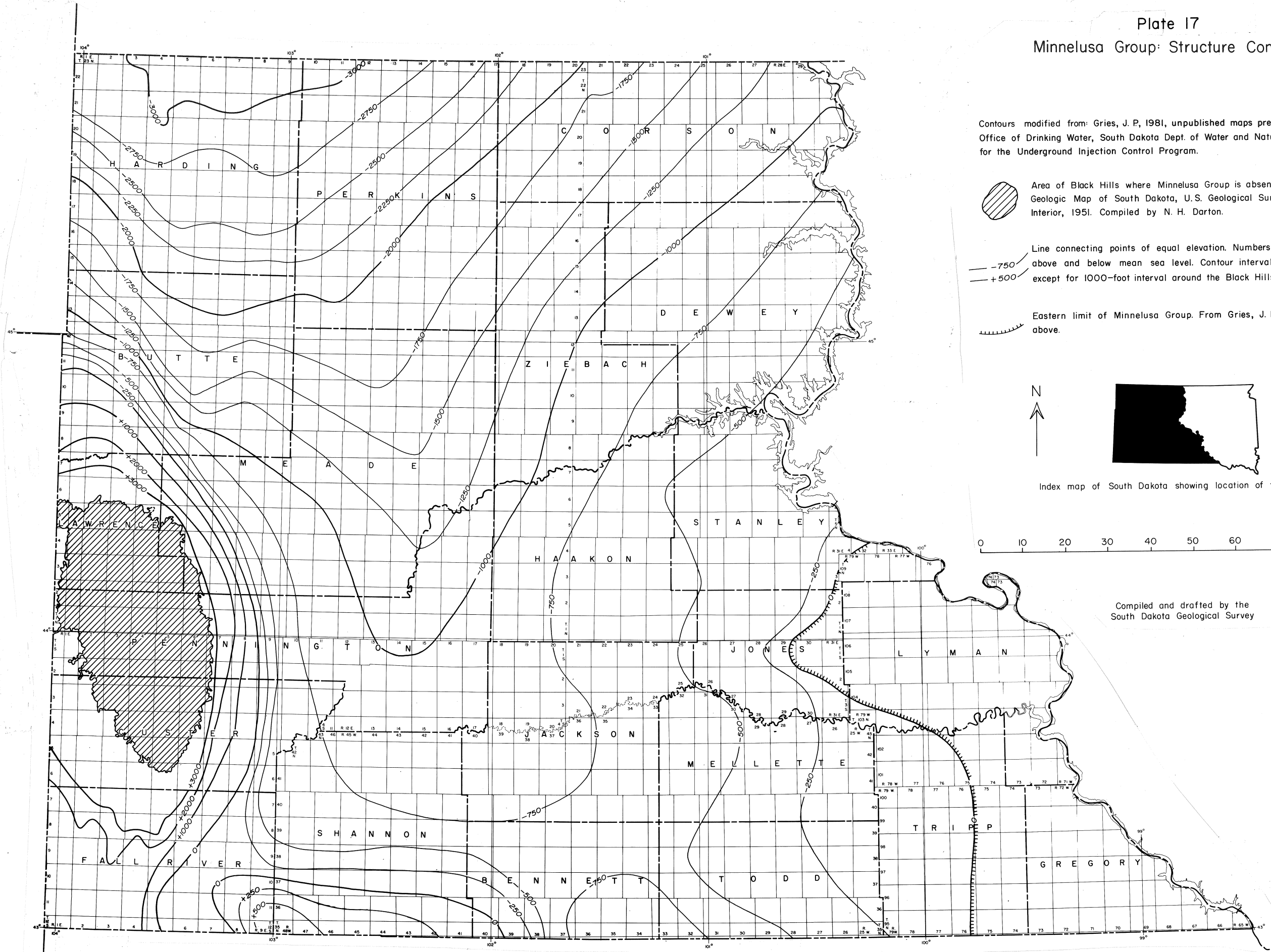





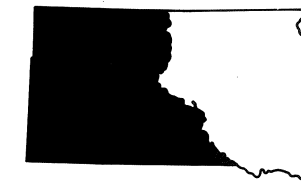
Plate 18
Minnelusa Group: Isopach

Contours from: Gries, J. P., 1981, unpublished maps prepared for the Office of Drinking Water, South Dakota Dept. of Water and Natural Resources, for the Underground Injection Control Program.

 Area of Black Hills where Minnelusa Group is absent. From: Geologic Map of South Dakota, U.S. Geological Survey, Dept. of Interior, 1951. Compiled by N. H. Darton.

 Line connecting points of equal thickness. Contour interval = 100 feet.

 Limit of Minnelusa Group. From Gries, J. P., as referenced above.



Index map of South Dakota showing location of this map.



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South Dakota Geological Survey

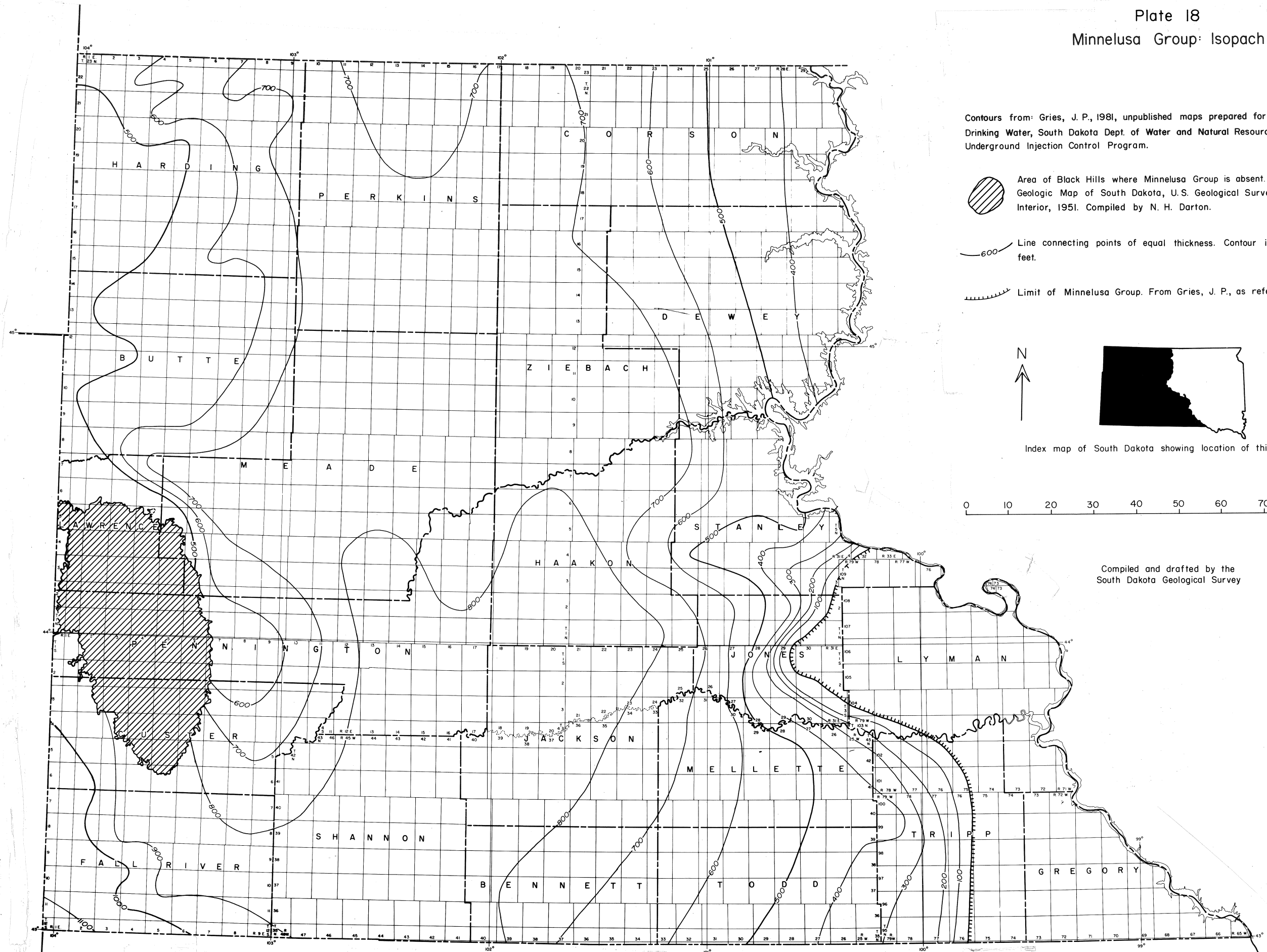


Plate 19
Madison Group Structure Contour

Contours modified from: Gries, J. P., 1981, unpublished maps prepared for the Office of Drinking Water, South Dakota Dept. of Water and Natural Resources, for the Underground Injection Control Program.



Area of Black Hills where Madison Formation is absent. From: Geologic Map of South Dakota, U.S. Geological Survey, Dept. of Interior, 1951. Compiled by N. H. Darton.

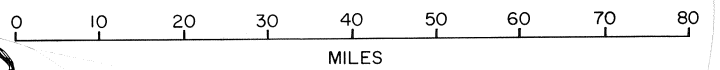
Line connecting points of equal elevation. Numbers in feet above and below mean sea level. Contour interval = 250 feet except 1000 foot interval around the Black Hills.



Limit of Madison Group. From Gries, J. P., as referenced above.



Index map of South Dakota showing location of this map.



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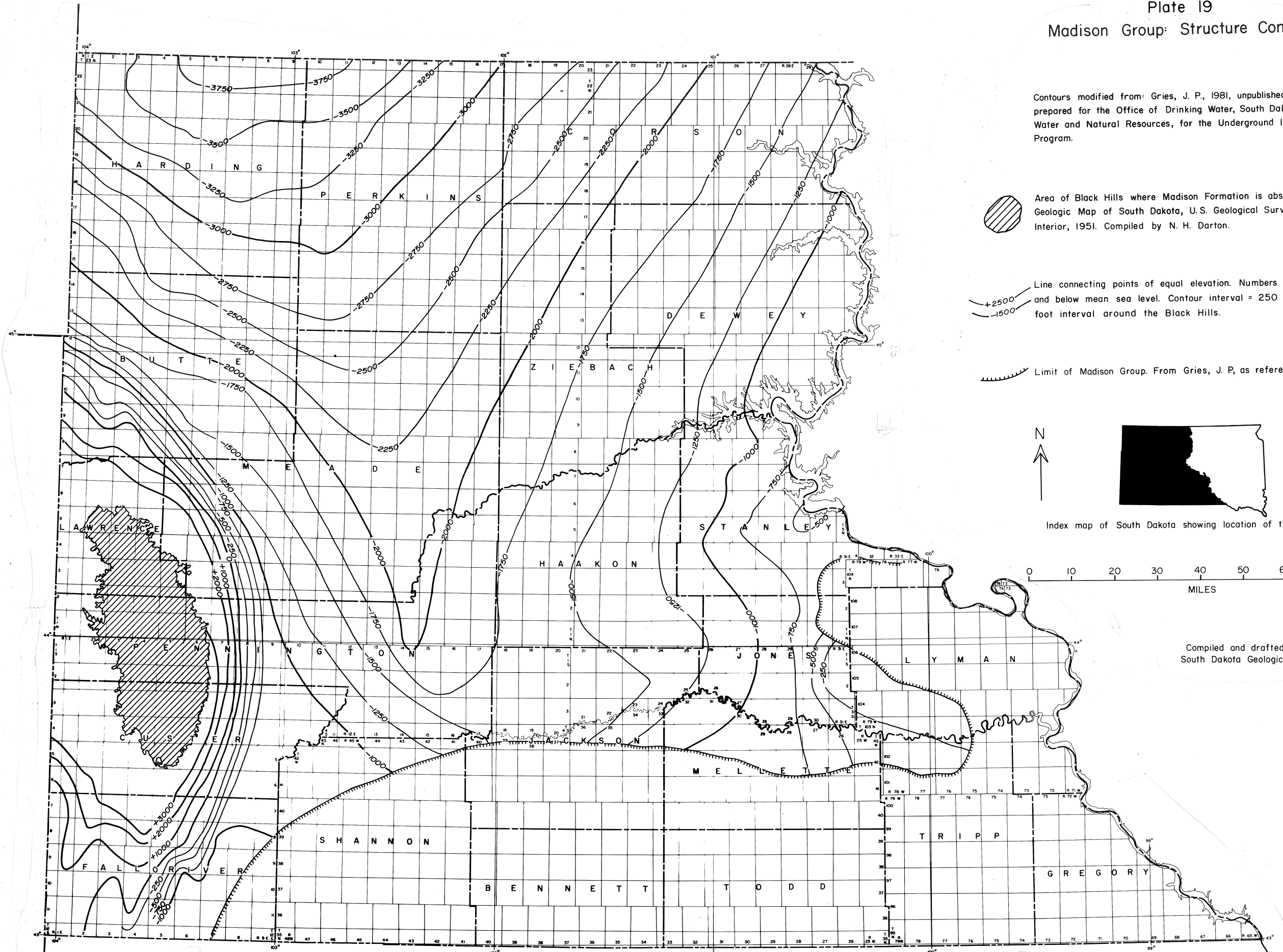




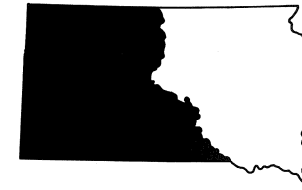
Plate 20
Madison Group: Isopach

Contours modified from: Gries, J. P., 1981, unpublished maps prepared for the Office of Drinking Water, South Dakota Dept. of Water and Natural Resources, for the Underground Injection Control Program.

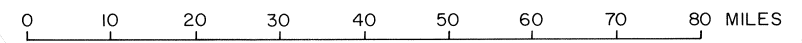
 Area of Black Hills where Madison Group is absent. From: Geologic Map of South Dakota, U.S. Geological Survey, Dept. of Interior, 1951. Compiled by N. H. Darton.

 Line connecting points of equal thickness. Dashed where approximate. Contour interval = 100 feet.

 Limit of Madison Group. From Gries, J. P., as referenced above.



Index map of South Dakota showing location of this map.



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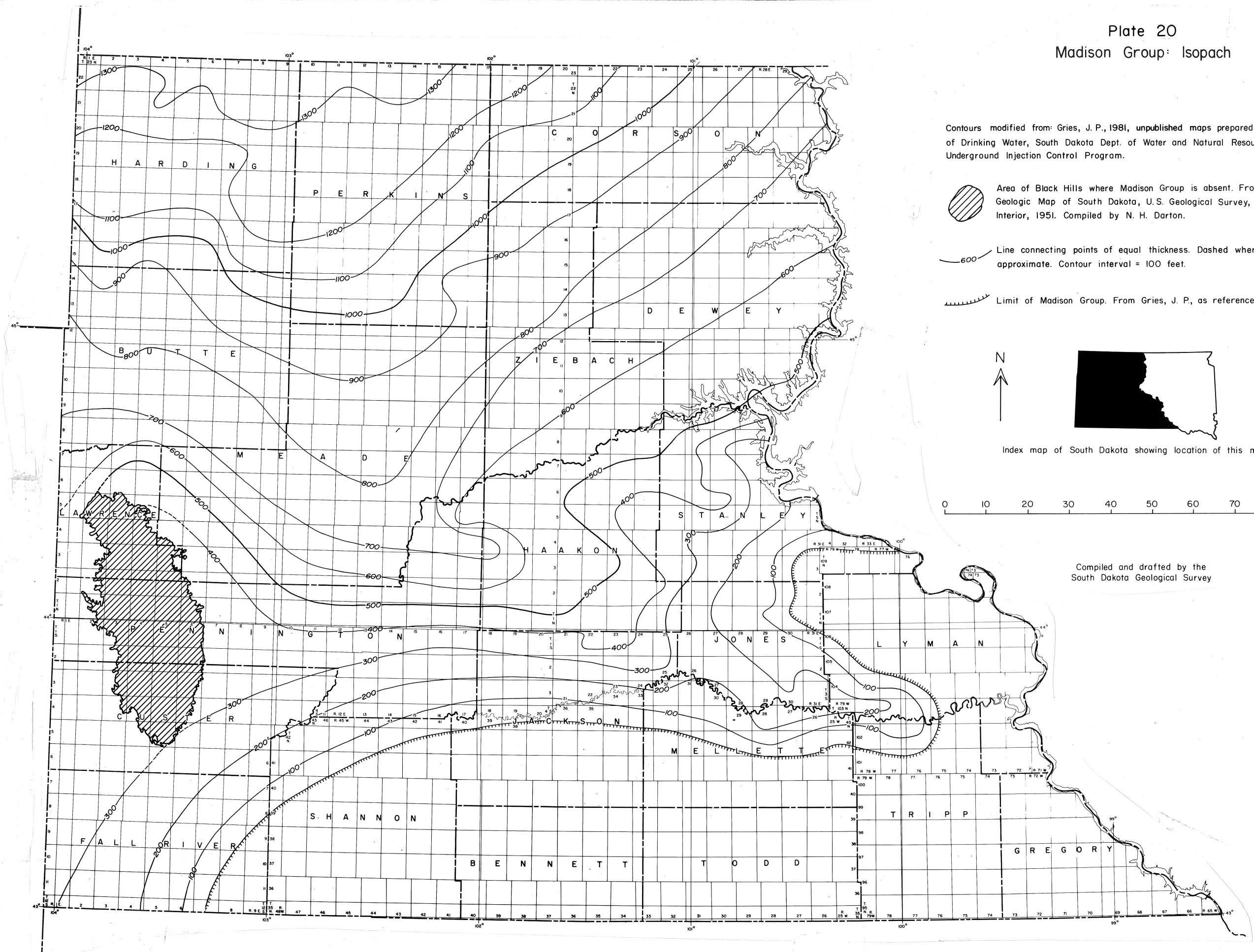


Plate 21
Red River Formation: Structure Contour

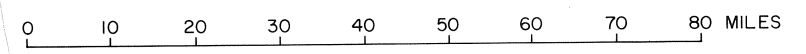
Contours modified from: Gries, J. P., 1981, unpublished maps prepared for the Office of Drinking Water, South Dakota Dept. of Water and Natural Resources, for the Underground Injection Control Program.

Line connecting points of equal elevation. Numbers are in feet above or below mean sea level. Contour interval = 500 feet except in extreme southeastern portion of map. Dashed where approximate.

Limit of Red River Formation. From Gries, J. P., as referenced above.



Index map of South Dakota showing location of this map.



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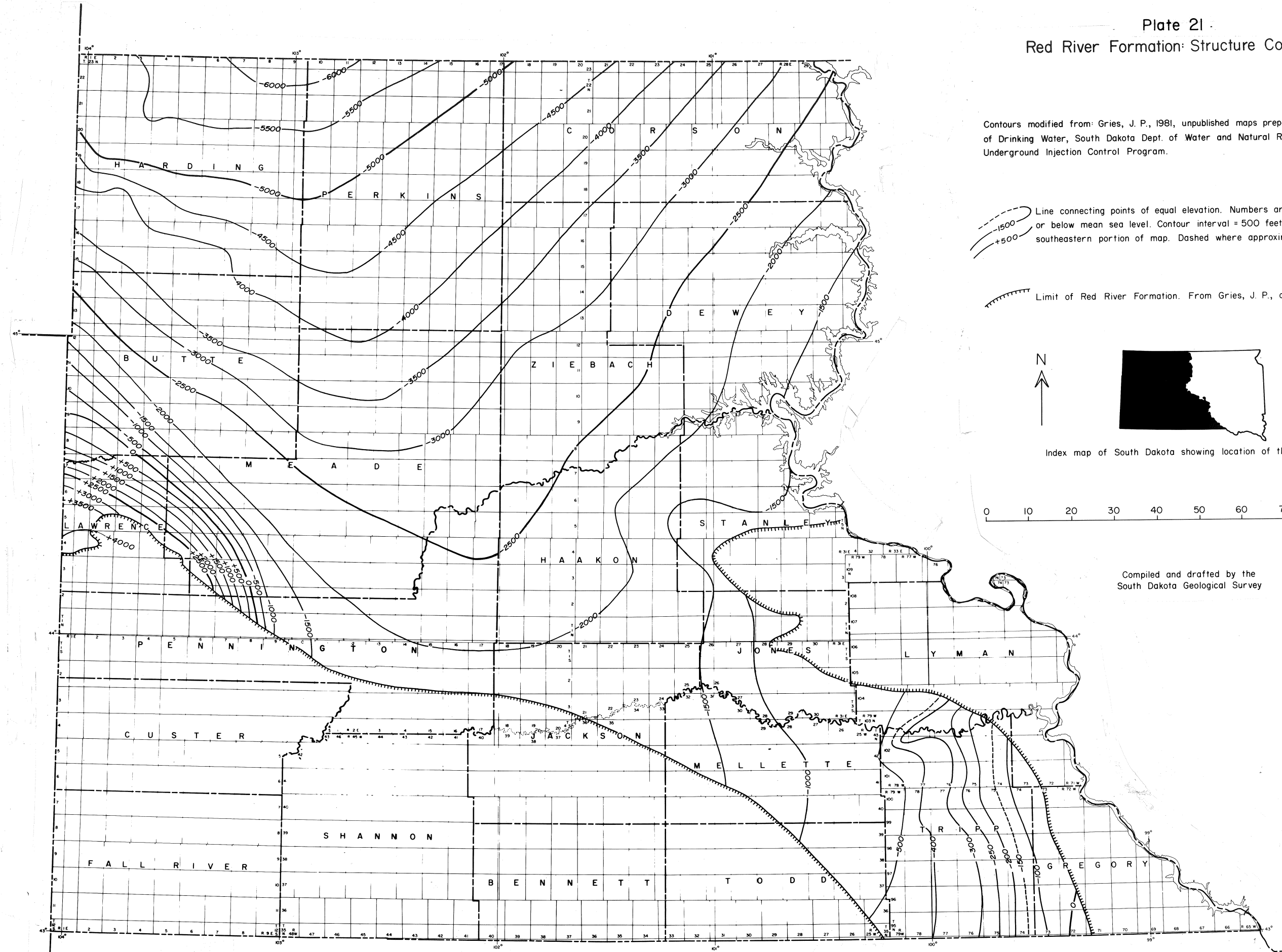
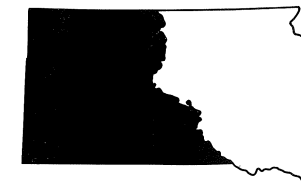


Plate 22
Red River Formation: Isopach

Contours from: Gries, J. P., 1981, unpublished maps prepared for the Office of Drinking Water, South Dakota Dept. of Water and Natural Resources, for the Underground Injection Control Program.

300 — Line connecting points of equal thickness. Contour interval = 100 feet.

Limit of Red River Formation. From Gries, J. P., as referenced above.



Index map of South Dakota showing location of this map.

0 10 20 30 40 50 60 70 80 MILES

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South Dakota Geological Survey

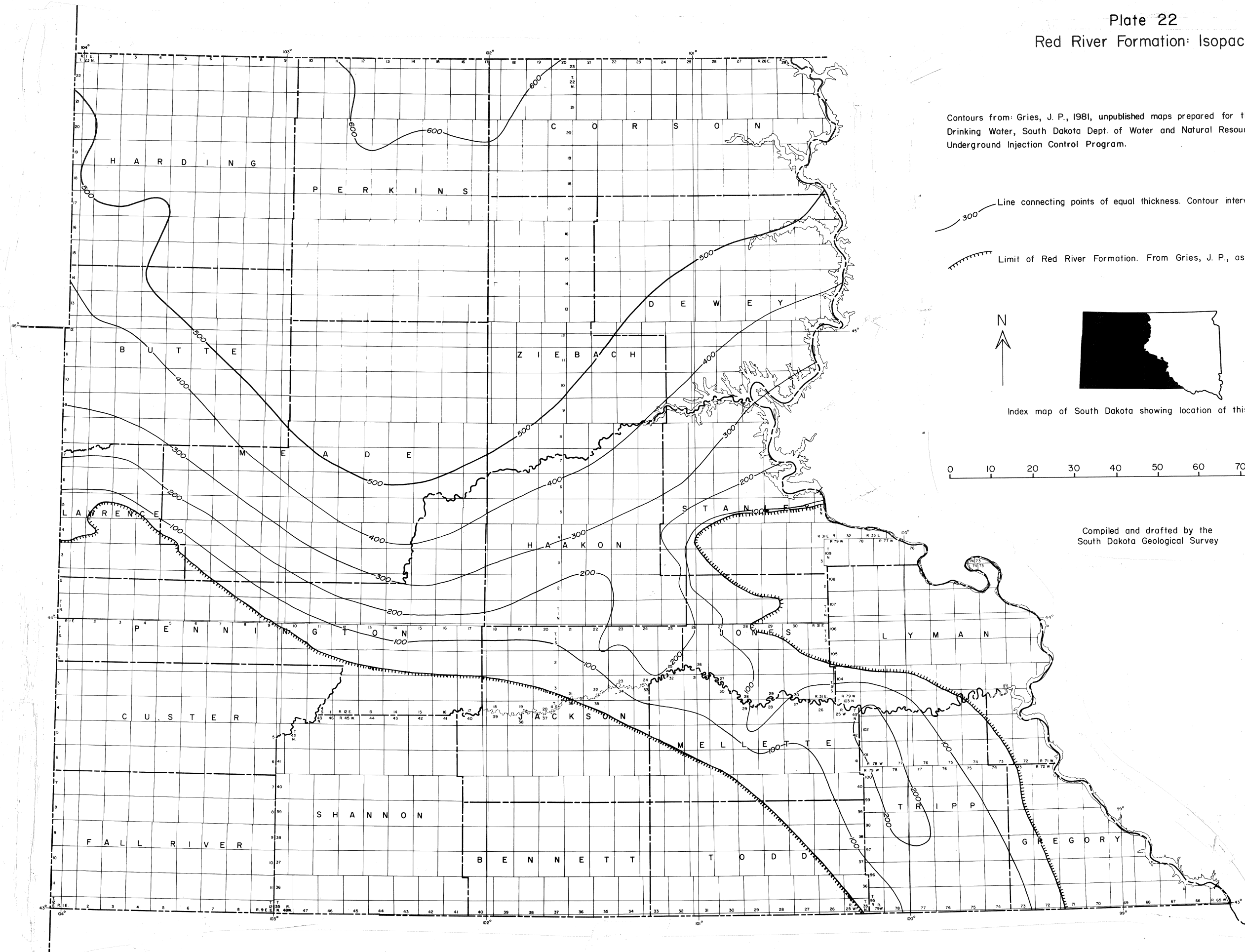
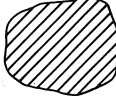




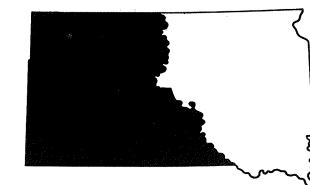
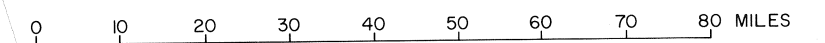
Plate 23
 Deadwood Formation: Structure Contour

Contours from: Steece, Fred V., 1978, Deadwood Formation in the Williston Basin, South Dakota: Williston Basin Symposium, Montana Geological Society, 24th Annual Conference, pp. 63-69.

 Area of Black Hills where Deadwood Formation is absent. From: Geologic Map of South Dakota, U.S. Geological Survey, Dept of Interior, 1951. Compiled by N. H. Darton.

 Line connecting points of equal elevation. Numbers in feet above and below mean sea level. Contour interval = 1000 feet except for one 500 foot contour in southeast portion of map.

 Limit of Deadwood Formation. From: Steece, Fred V., as referenced above.



Index map of South Dakota showing location of this map.

Compiled and drafted by the
 South Dakota Geological Survey

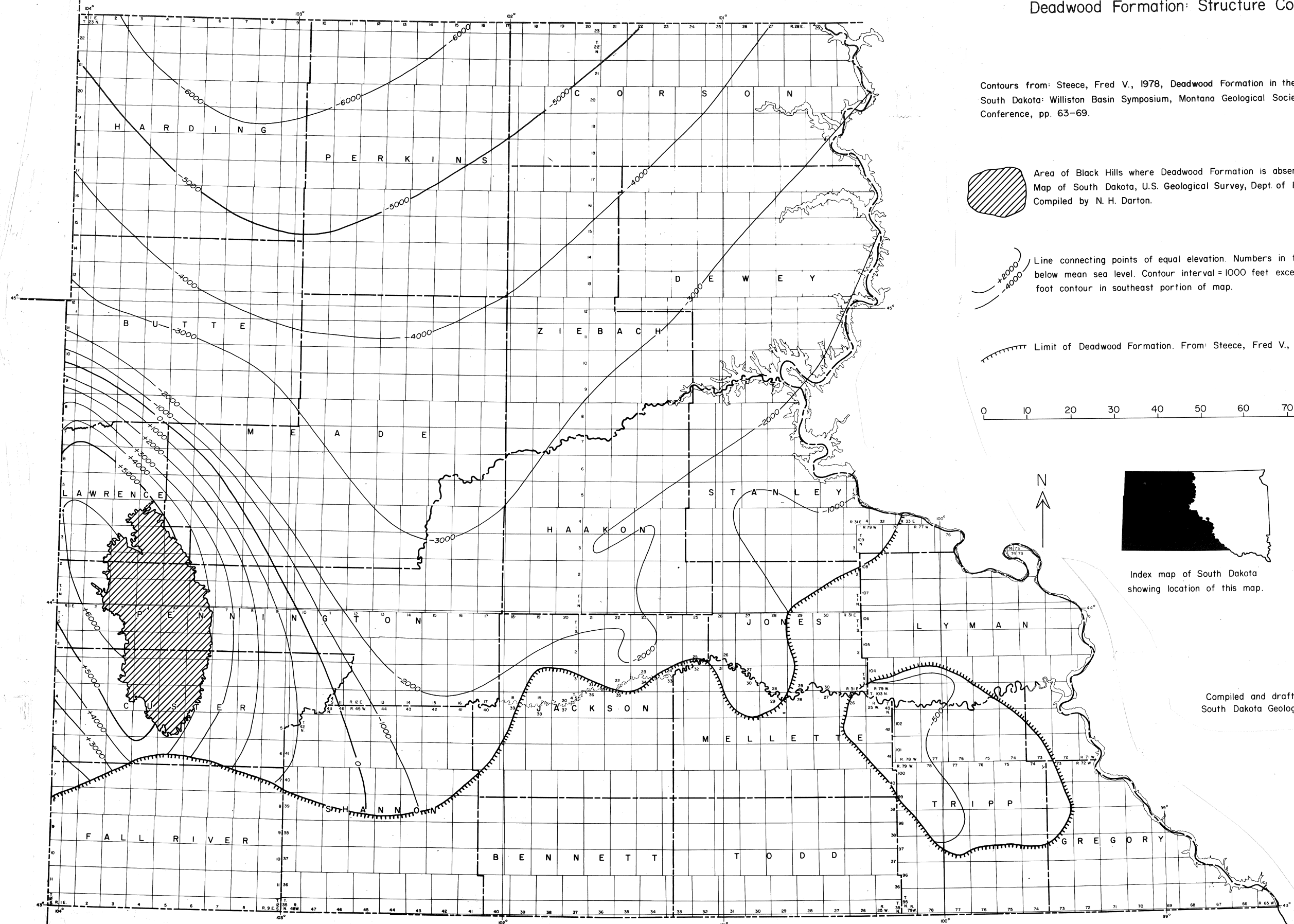

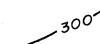
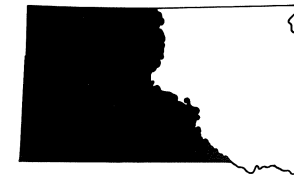


Plate 24
Deadwood Formation: Isopach

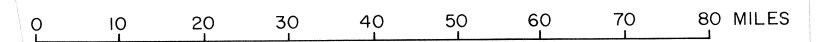
Contours from: Steece, Fred V., 1978, Deadwood Formation in the Williston Basin, South Dakota: Williston Basin Symposium, Montana Geological Society 24th Annual Conference, pp. 63-69.

 Area of Black Hills where Deadwood Formation is absent. From: Geologic Map of South Dakota, U. S. Geological Survey, Dept. of Interior, 1951. Compiled by N. H. Darton.

 Line connecting points of equal thickness. Contour interval = 100 feet except for supplemental 50 foot contour.



Index map of South Dakota showing location of this map.



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South Dakota Geological Survey

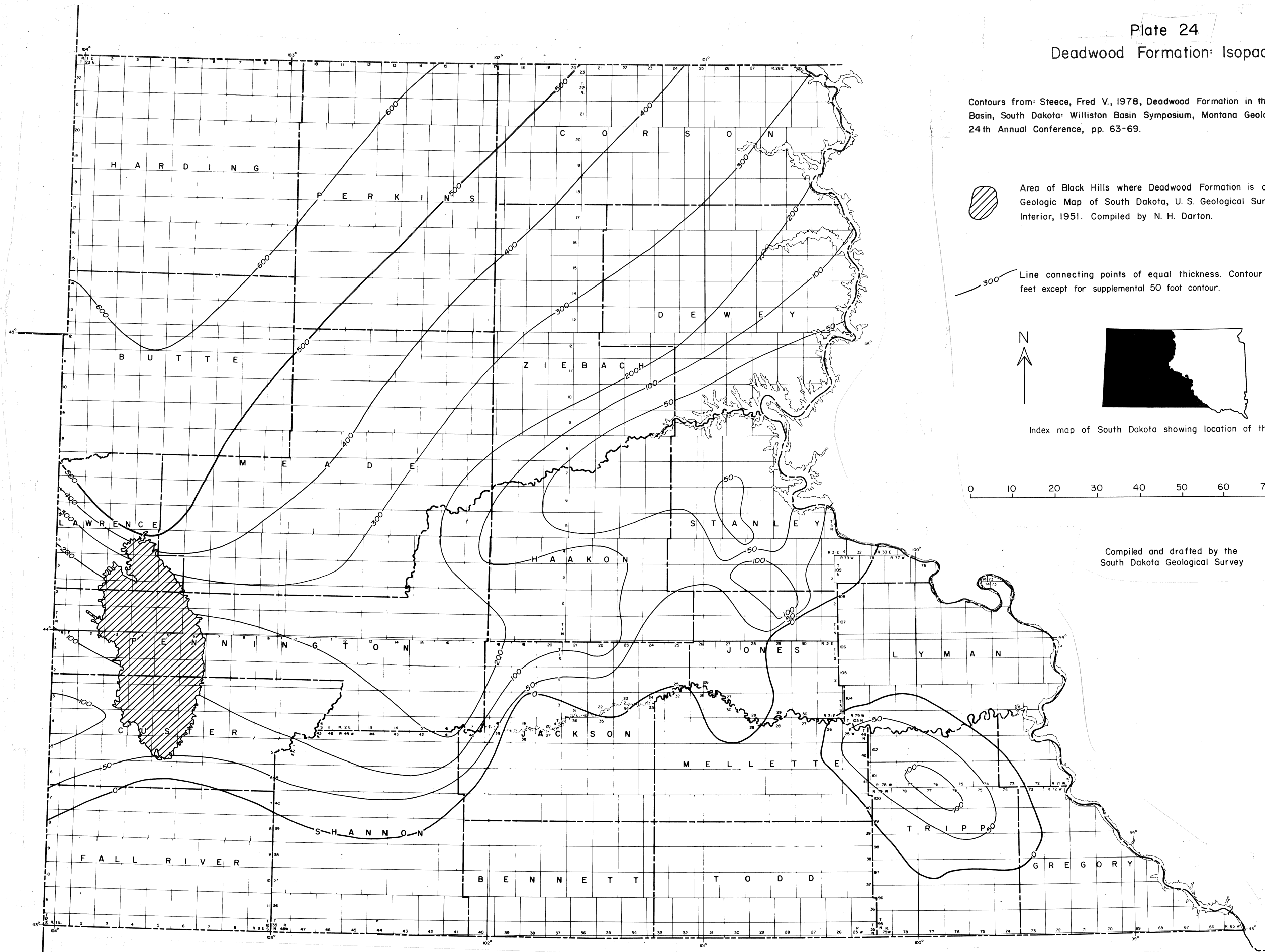


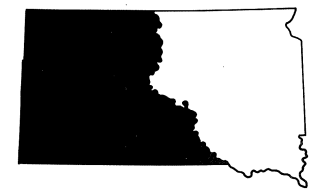


Plate 25
Precambrian: Structure Contour

Contours from: Stach, R. L., unpublished map of the precambrian surface in South Dakota, South Dakota Geological Survey.

 Area of Precambrian outcrop. From: Geologic map of South Dakota, U. S. Geological Survey, Dept. of Interior, 1951. Compiled by N. H. Darton.

 Line connecting points of equal elevation. Numbers are in feet above and below sea level. Contour interval=100 feet down to -2000 contour where interval = 500 feet. Southwest region not contoured.



Index map of South Dakota showing location of this map.



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South Dakota Geological Survey

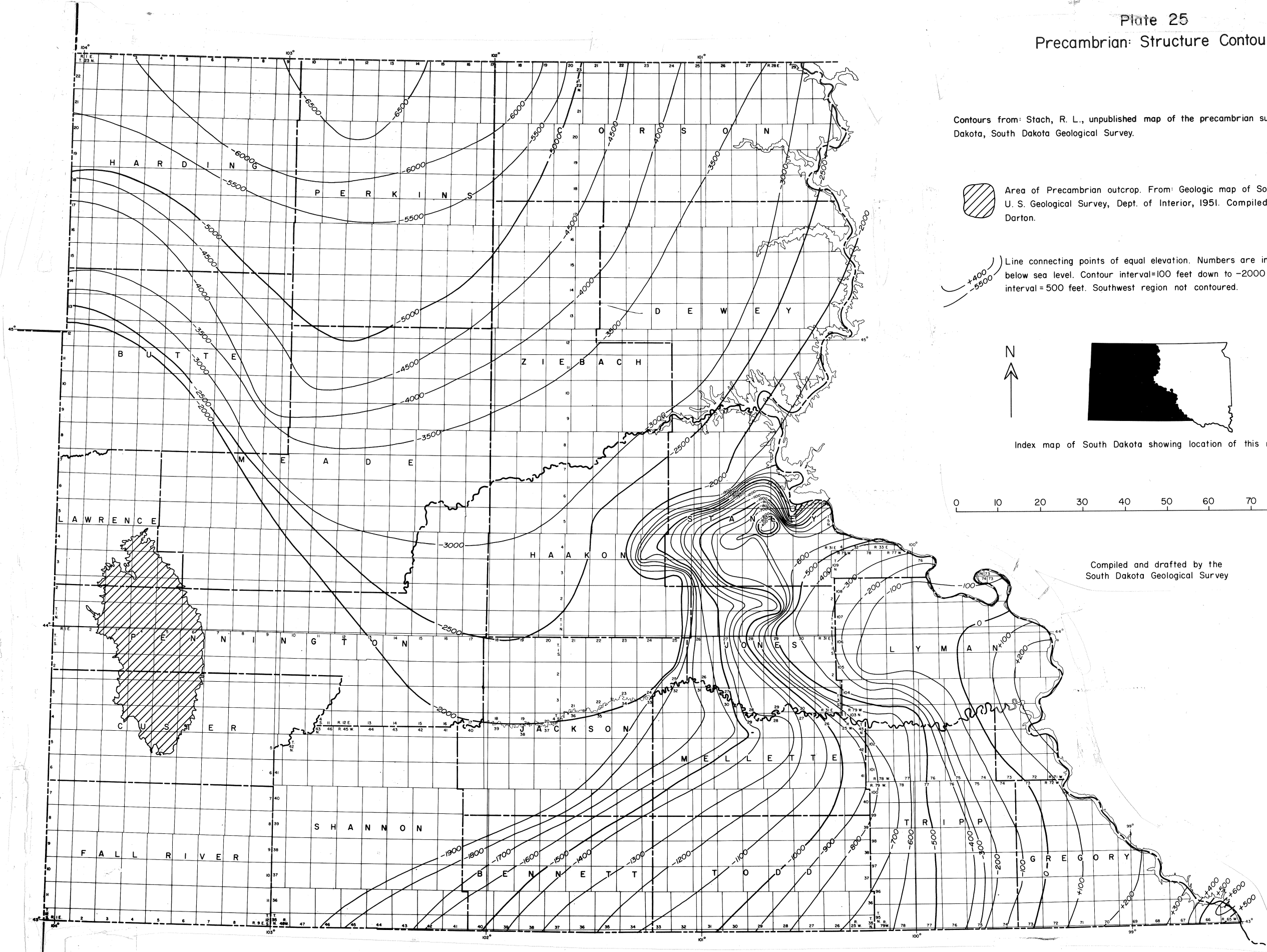


Plate 26
Pierre Shale: Areal Extent
WESTERN SOUTH DAKOTA

Areal extent of the Pierre Shale.

Area of Western South Dakota where the Pierre Shale is absent.

0 50 MILES

Compiled and drafted by the
South Dakota Geological Survey

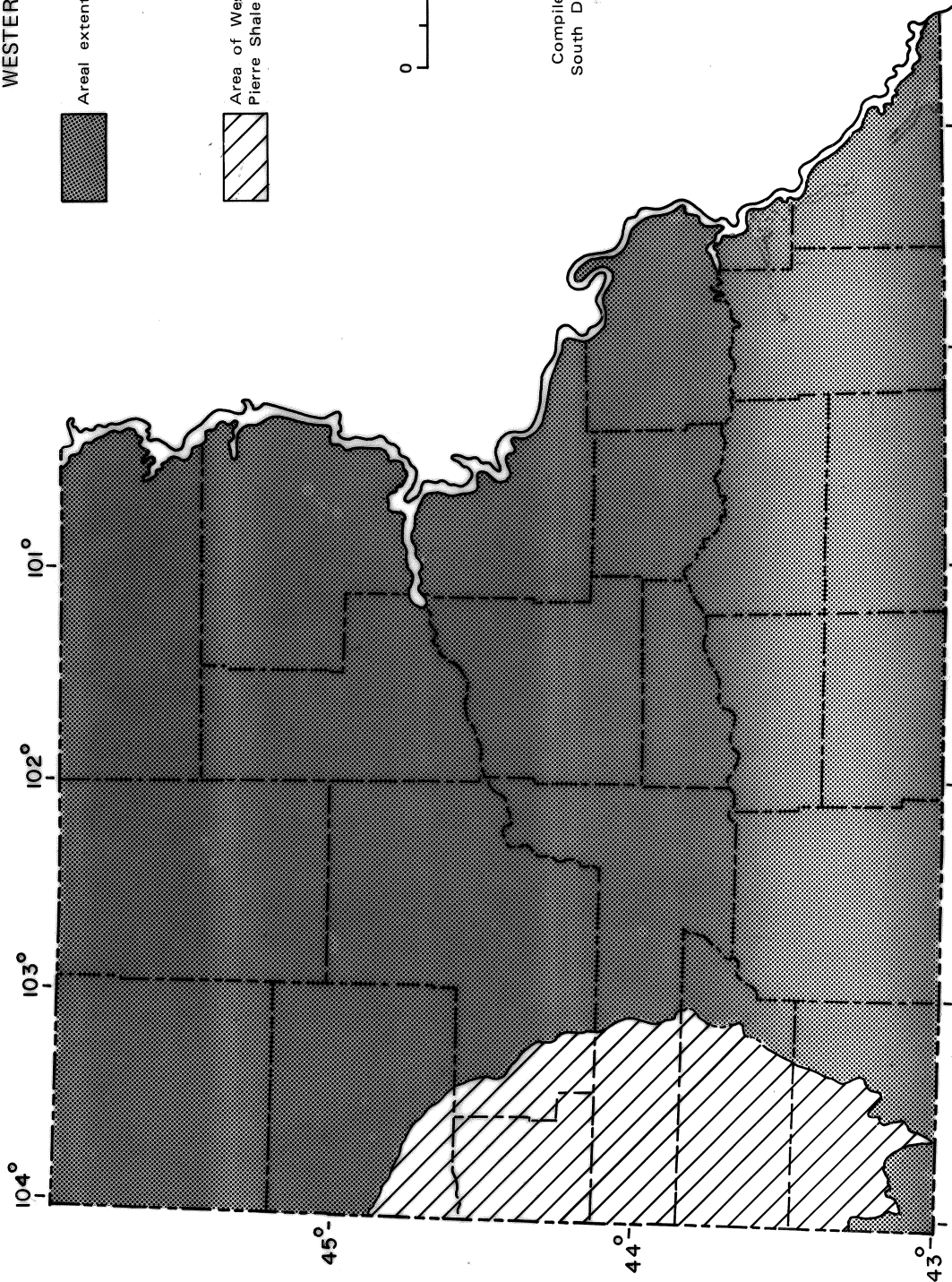


Plate 27
Niobrara Formation: Areal Extent
WESTERN SOUTH DAKOTA

Outcrop: from Petsch, Bruno C., 1972, Geologic Map of the Black Hills, South Dakota Geological Survey.

Areal extent of the Niobrara Formation.

Area of the Black Hills where the Niobrara Formation is absent.

0 50 MILES

Compiled and drafted by the South Dakota Geological Survey

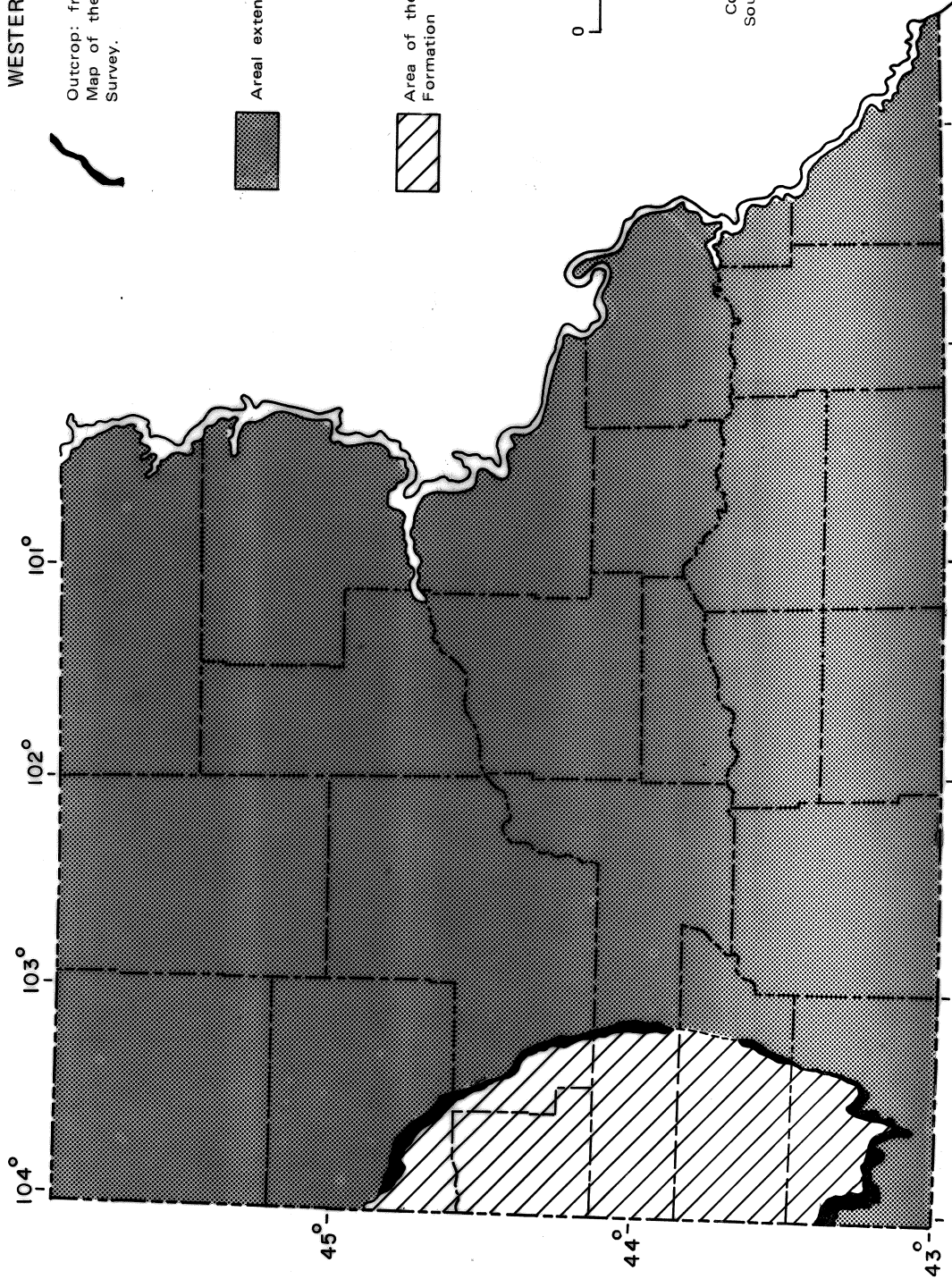




Plate 28
Carlile Shale: Areal Extent
WESTERN SOUTH DAKOTA

Outcrop: from Petsch, Bruno C., 1972, Geologic Map of the Black Hills, South Dakota Geological Survey.

 Areal extent of the Carlile Shale.

 Area of Black Hills where the Carlile Shale is absent.

0 50 MILES



Compiled and drafted by the
South Dakota Geological Survey

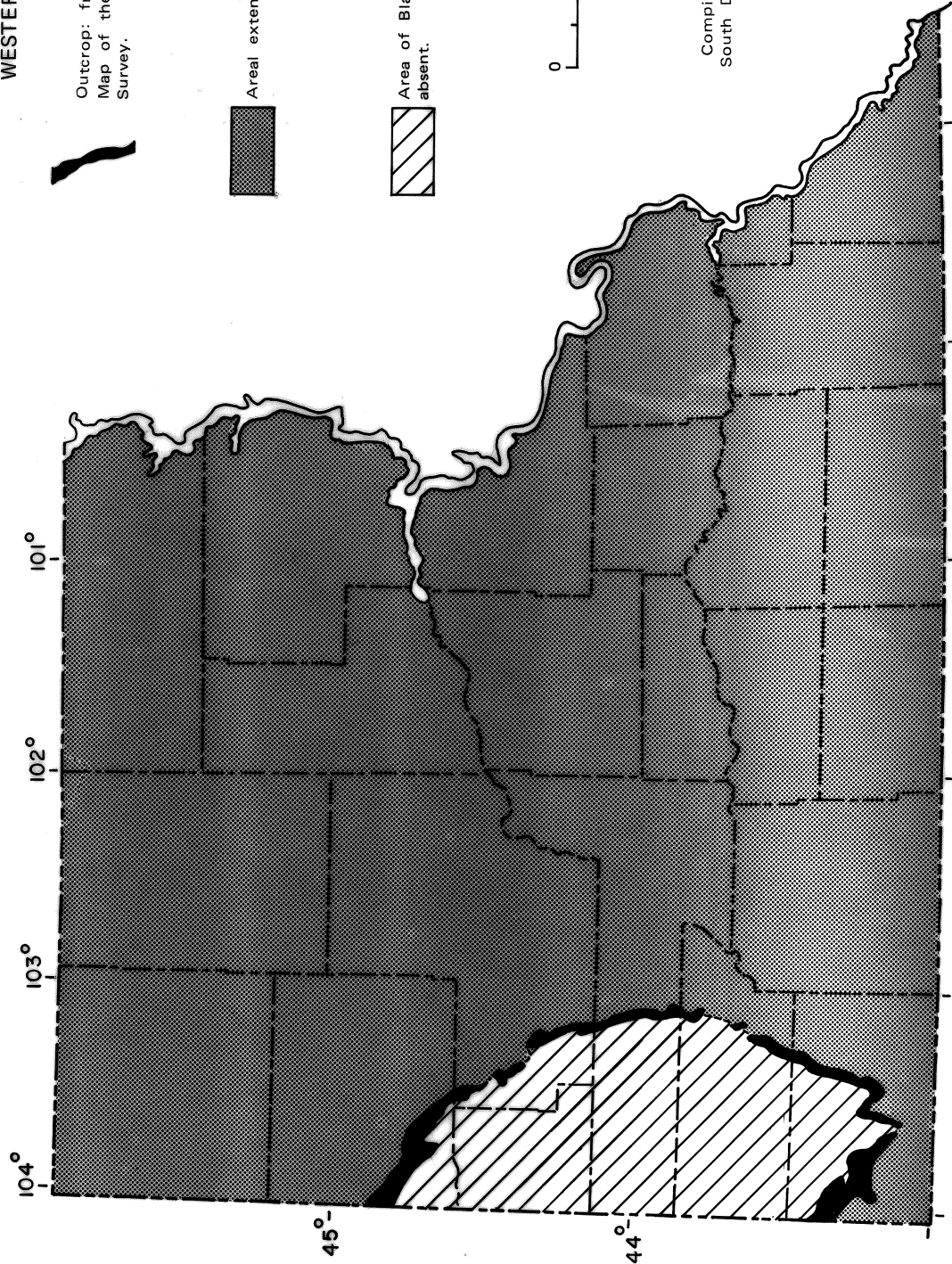


Plate 29
 Greenhorn Limestone: Structure Contour
 WESTERN SOUTH DAKOTA

Elevations drawn on surface of Greenhorn Limestone;
 Datum mean sea level.

Contours and Formation boundaries modified from: U. S.
 Geological Survey, Bureau of Reclamation, and South
 Dakota Geological Survey, 1964, Mineral and Water Resources
 of South Dakota, Fig. 3, p. 22.

Outcrop, Dashed where approximate.

Area of Black Hills where the Greenhorn Limestone
 is absent.

Line connecting points of equal elevation. Contour
 interval = 200 feet below 1000 foot elevation and
 interval = 1000 feet above 1000 foot elevation.

0 50 MILES

Compiled and drafted by the
 South Dakota Geological Survey

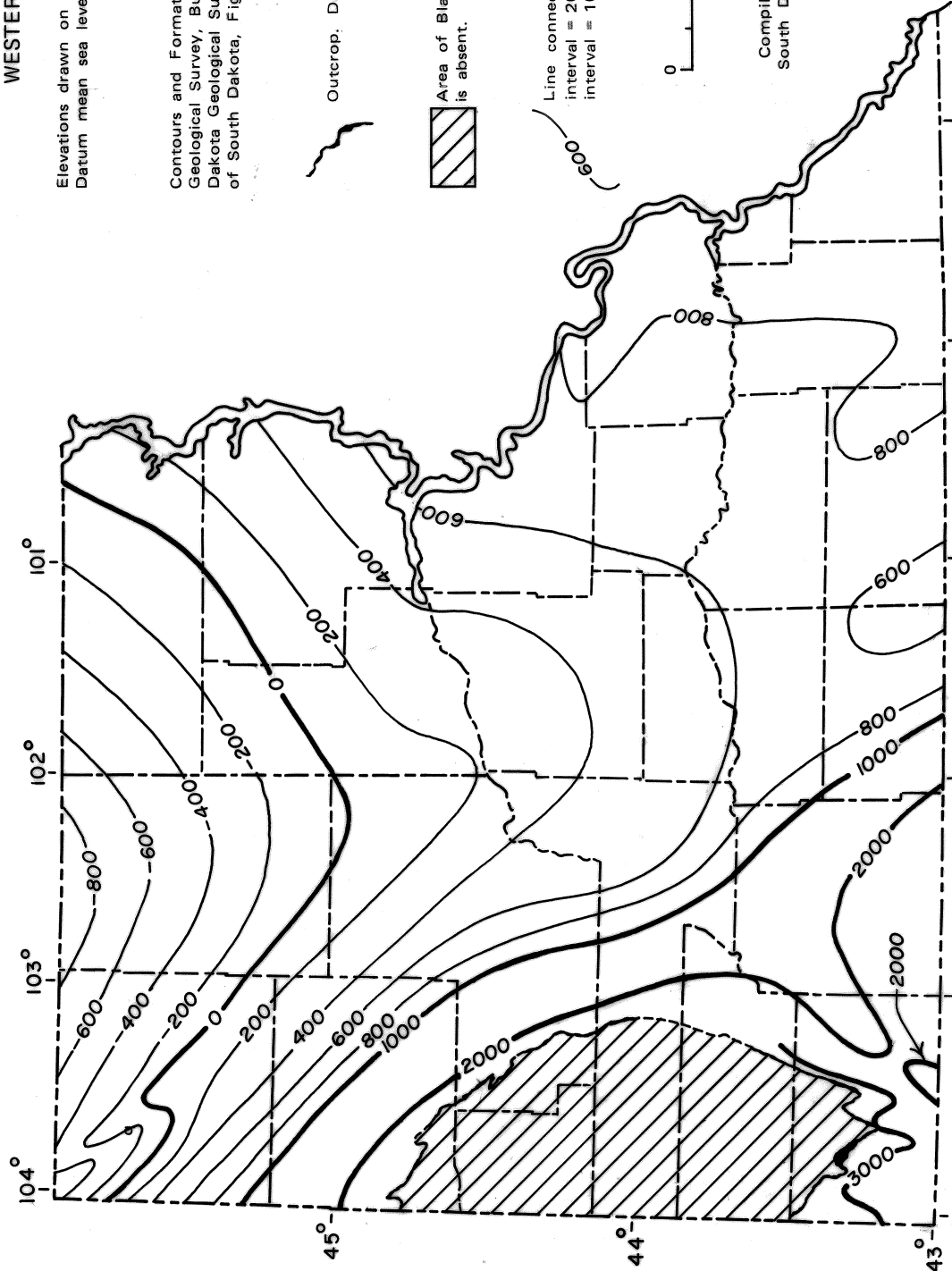




Plate 30
Belle Fourche and Mowry Shales: Areal Extent
WESTERN SOUTH DAKOTA

Outcrops from Petsch, Bruno C., 1972, Geologic Map of the Black Hills, South Dakota Geological Survey.



 Areal extent of the Belle Fourche and Mowry Shales.

 Area of the Black Hills where the Belle Fourche and Mowry Shales are absent.

0  50 MILES

Compiled and drafted by the
South Dakota Geological Survey

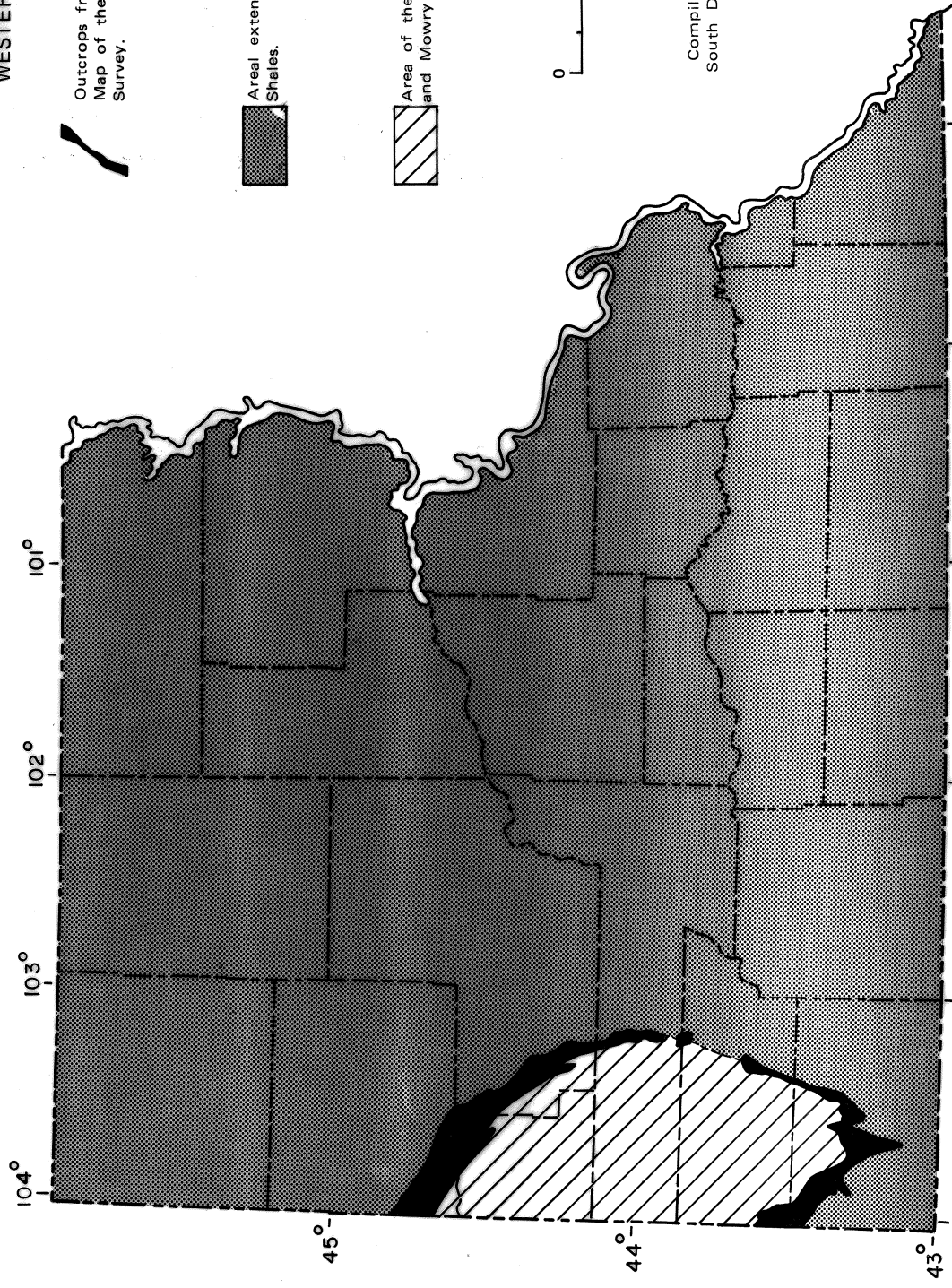


Plate 31
 Skull Creek Shale: Isopach
 WESTERN SOUTH DAKOTA

Contours and Formation boundaries modified from: Schoon, Robert A., 1971, Geology and Hydrology of the Dakota Formation in South Dakota. South Dakota Geological Survey, Report of Investigations No. 104, Fig. 10, p. 10.

Outcrop. Dashed where approximate.

Line connecting points of equal thickness. Dashed where approximate. Contour interval = 50 feet.

Area of Black Hills where the Skull Creek Shale is absent.

0 50 MILES

Compiled and drafted by the South Dakota Geological Survey

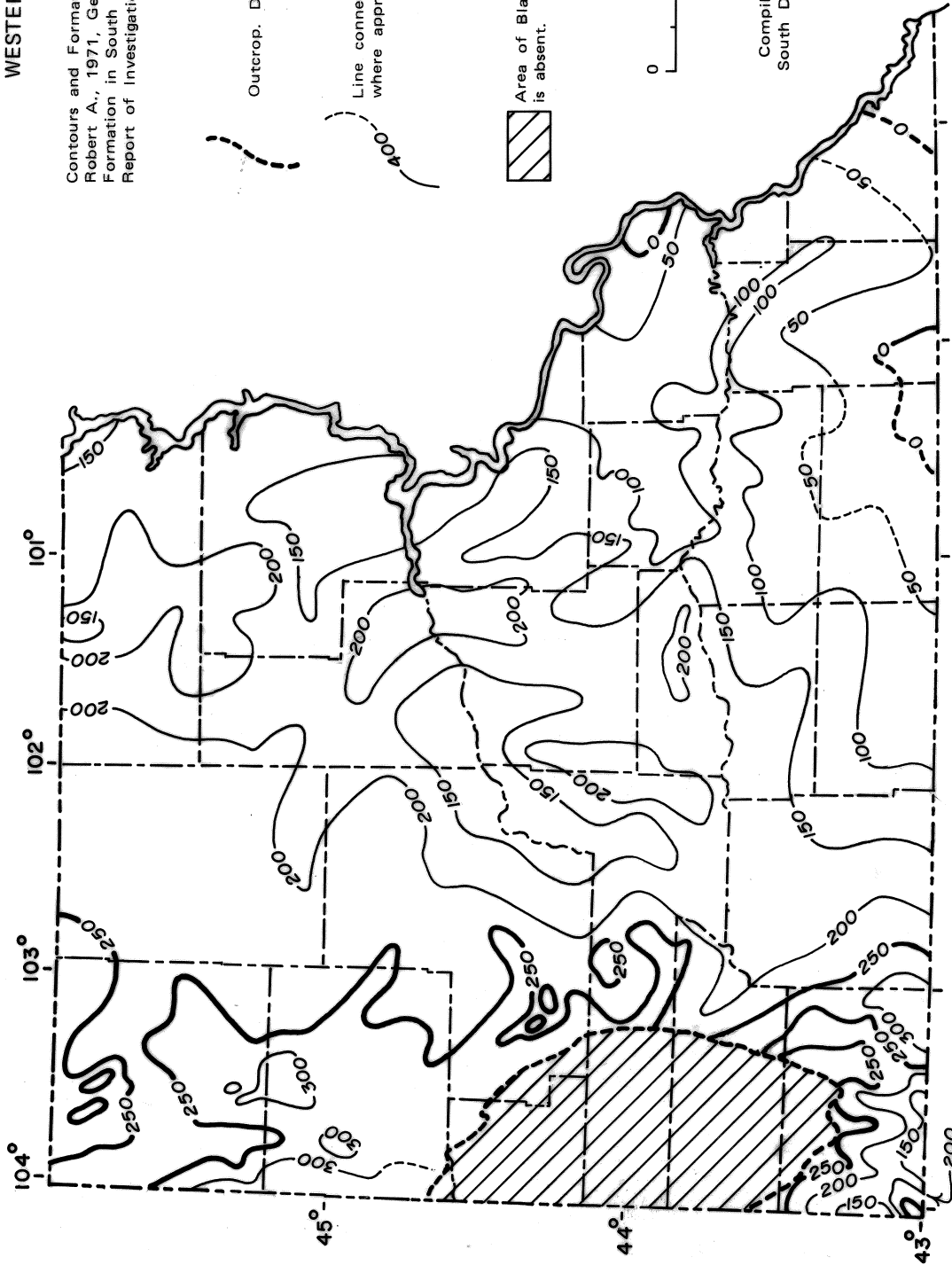


Plate 32

Unkapa Sandstone and Morrison Formation: Isopach

WESTERN SOUTH DAKOTA

Contours and Formation boundary from: Rahn, Perry H., 1981, Reconnaissance Elements of the Western Dakota Region of South Dakota, Part 2, Fig. 18.

Outcrop

Line connecting points of equal thickness.
Contour interval = 50 feet.

Area of Black Hills where the Unkapa and Morrison Formations are absent.

0 50 MILES

Compiled and drafted by the
South Dakota Geological Survey

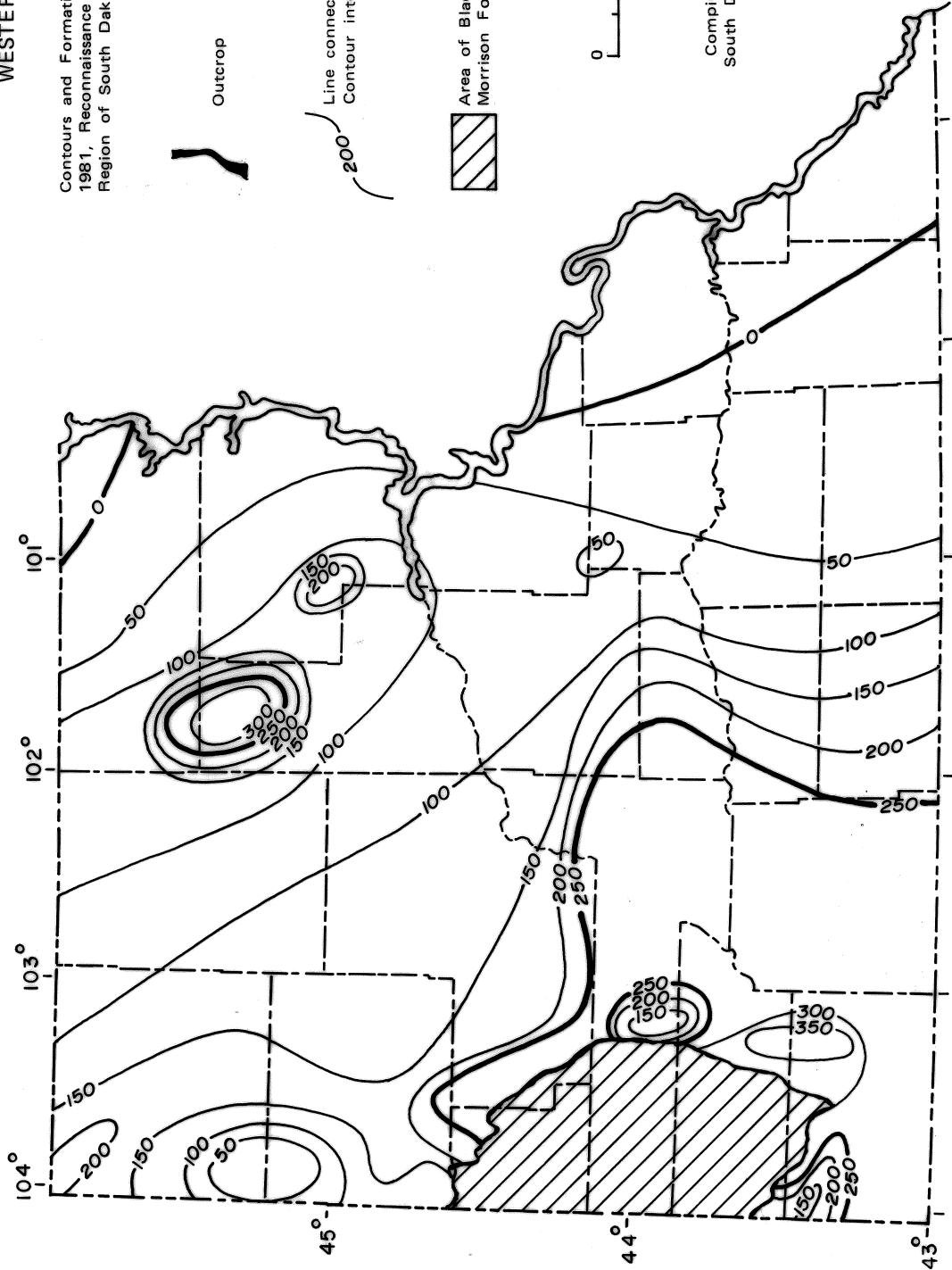
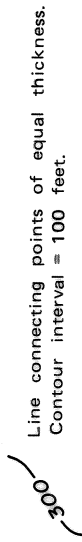


Plate 33
 Spearfish Formation: Isopach
 WESTERN SOUTH DAKOTA

Contours and Formation boundary from: Rahn, Perry H.,
 1981, Reconnaissance Elements of the Western Dakota
 Region of South Dakota, Part 2, Fig. 14.



Outcrop



Line connecting points of equal thickness.
 Contour interval = 100 feet.



Area of Black Hills where the Spearfish Formation
 is absent.



Compiled and drafted by the
 South Dakota Geological Survey

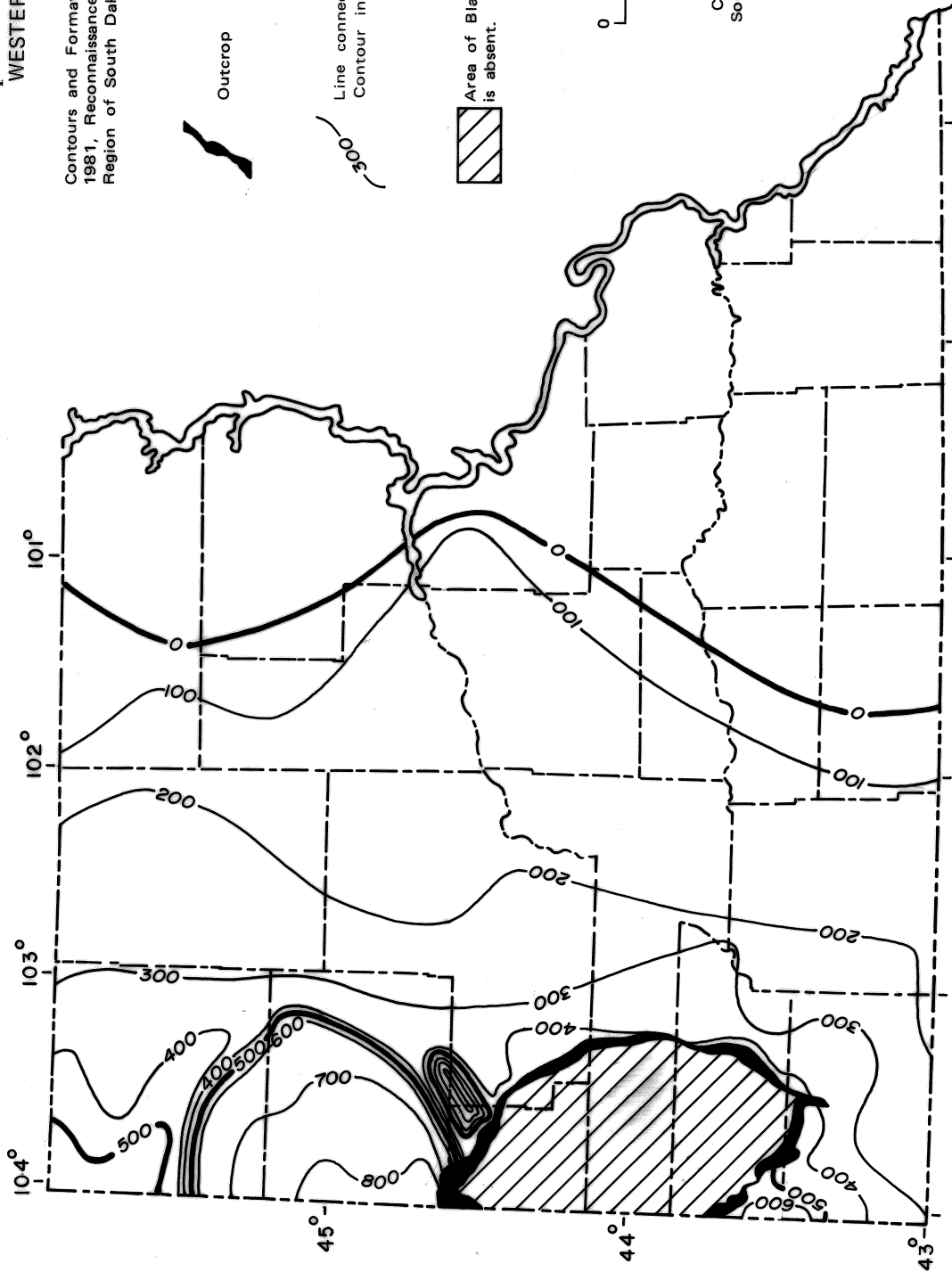
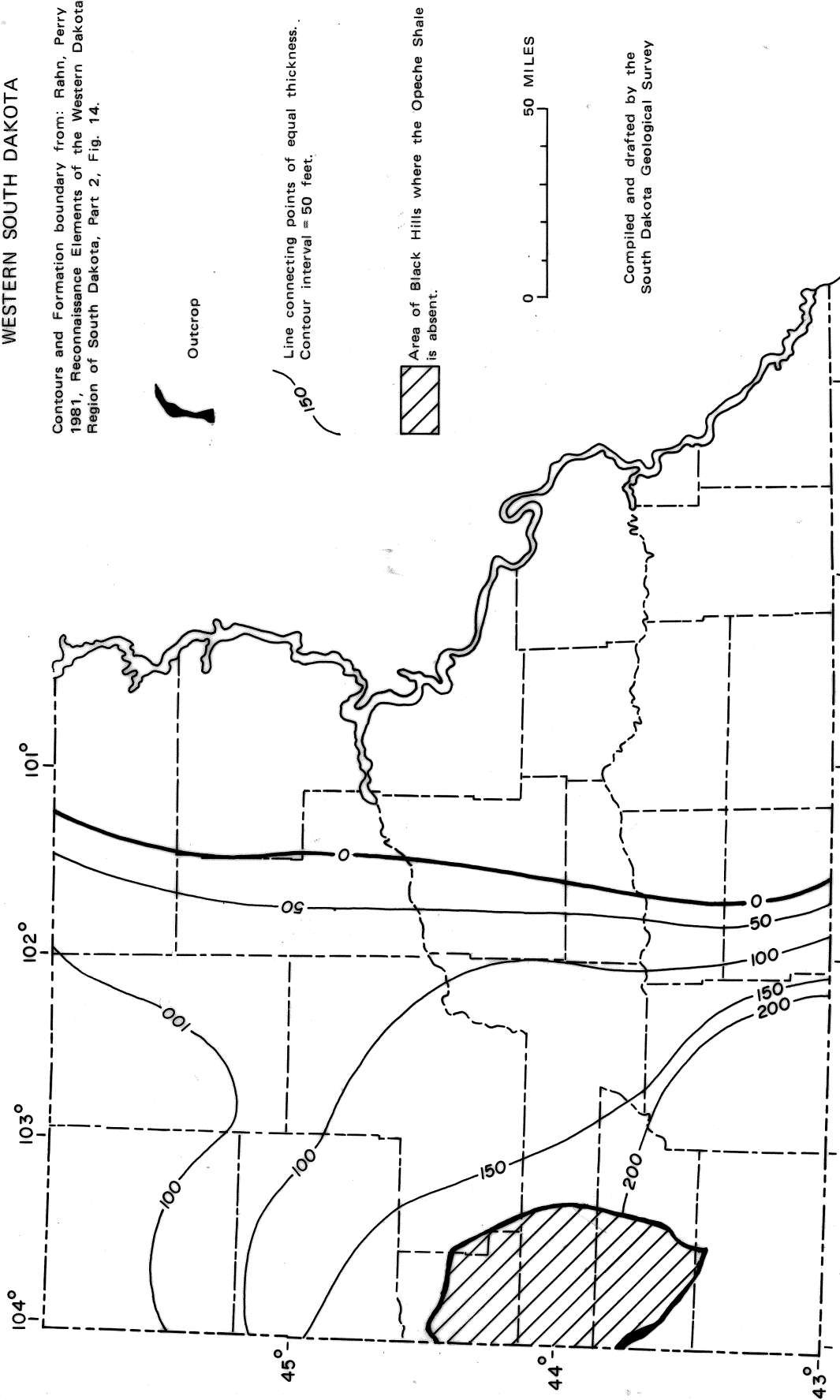


Plate 34
 Opeche Shale: Isopach
 WESTERN SOUTH DAKOTA

Contours and Formation boundary from: Rahn, Perry H.,
 1981, Reconnaissance Elements of the Western Dakota
 Region of South Dakota, Part 2, Fig. 14.



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