
SOUTH DAKOTA

STATE GEOLOGICAL SURVEY

E. P. Rothrock, State Geologist

REPORT OF INVESTIGATIONS

No. 20

THE GEOLOGY

OF

GRANT COUNTY, SOUTH DAKOTA

By

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University of South Dakota
Vermillion, S. Dak.

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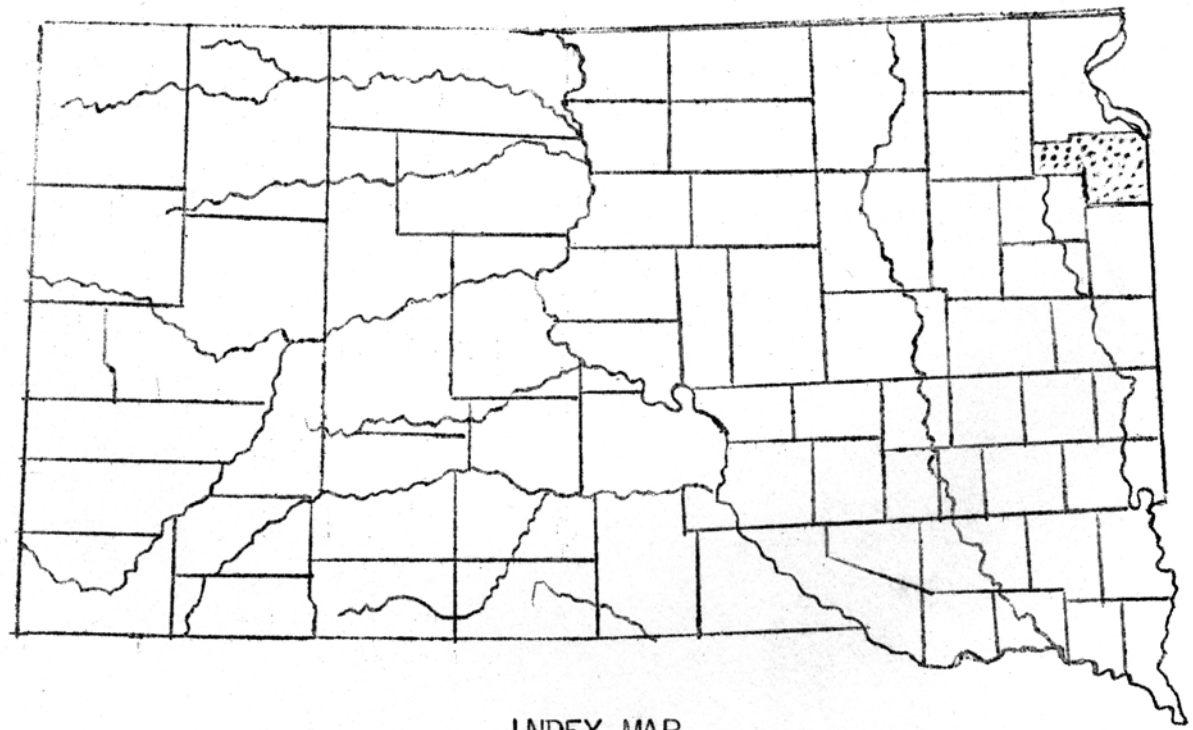
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THE GEOLOGY OF GRANT COUNTY,

SOUTH DAKOTA

BY

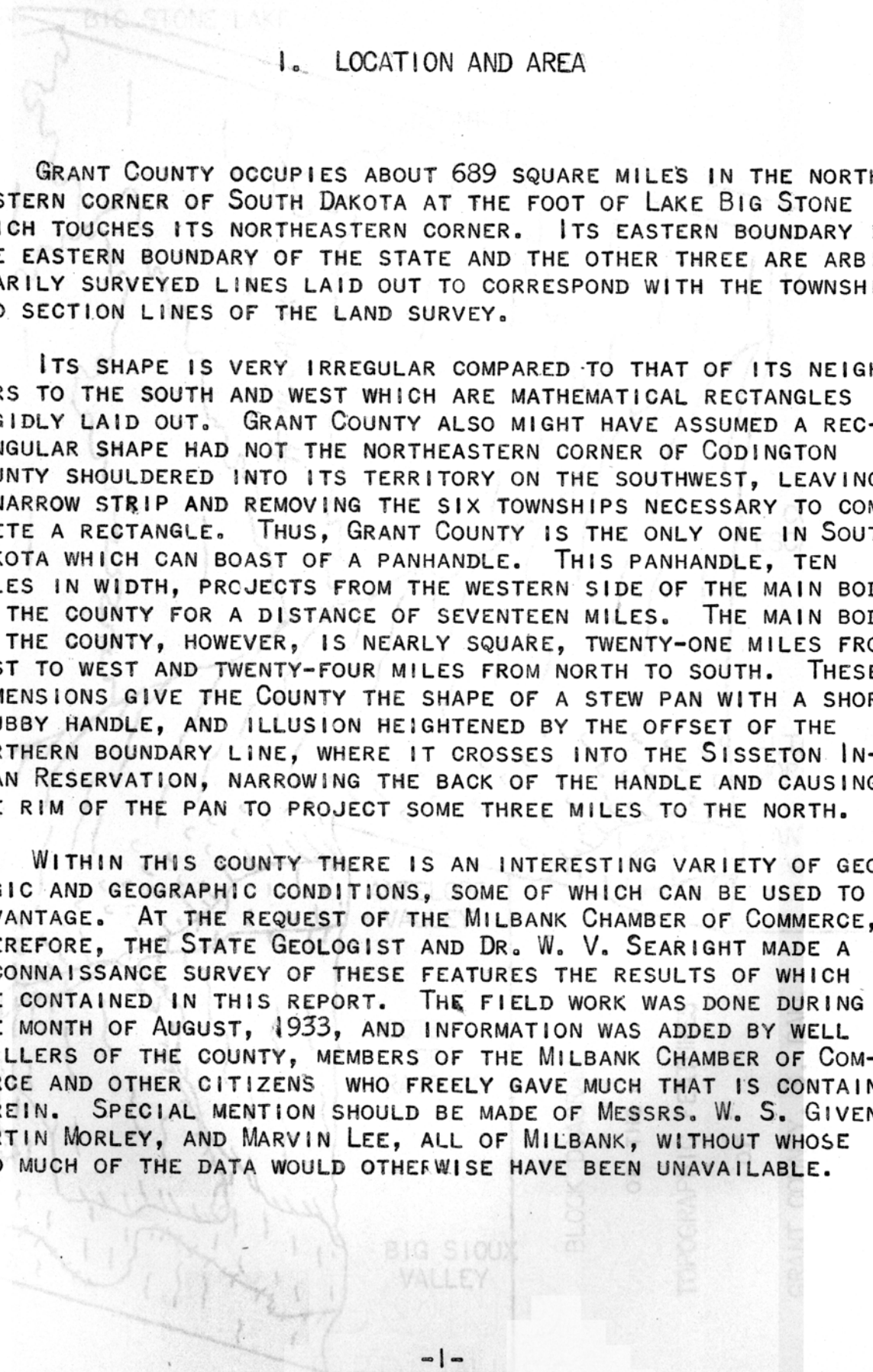
E. P. ROTHROCK



INDEX MAP



SHADED AREA INDICATES LOCATION OF GRANT COUNTY.

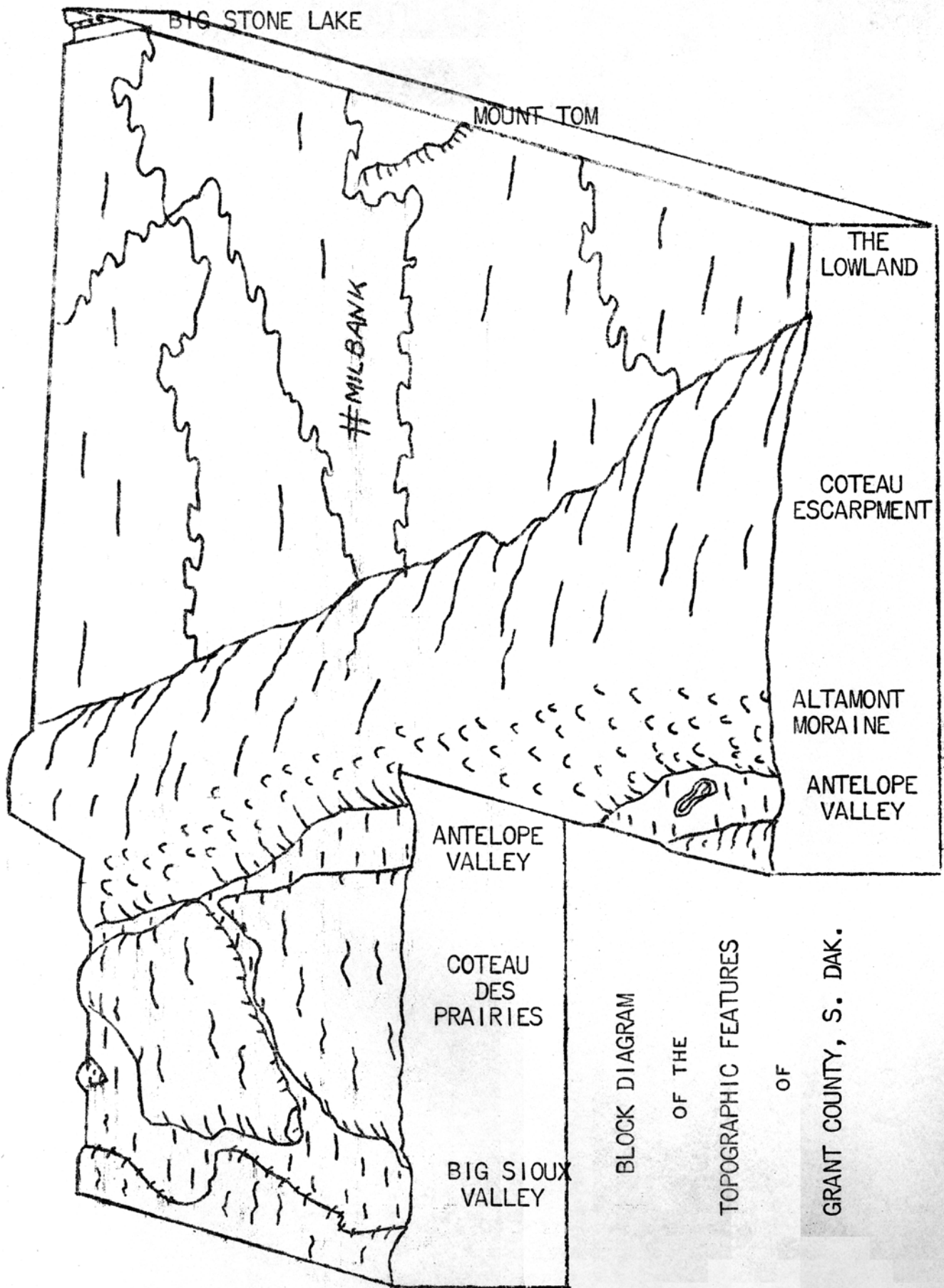


I. LOCATION AND AREA

GRANT COUNTY OCCUPIES ABOUT 689 SQUARE MILES IN THE NORTH-EASTERN CORNER OF SOUTH DAKOTA AT THE FOOT OF LAKE BIG STONE WHICH TOUCHES ITS NORTHEASTERN CORNER. ITS EASTERN BOUNDARY IS THE EASTERN BOUNDARY OF THE STATE AND THE OTHER THREE ARE ARBITRARILY SURVEYED LINES LAID OUT TO CORRESPOND WITH THE TOWNSHIP AND SECTION LINES OF THE LAND SURVEY.

ITS SHAPE IS VERY IRREGULAR COMPARED TO THAT OF ITS NEIGHBORS TO THE SOUTH AND WEST WHICH ARE MATHEMATICAL RECTANGLES RIGIDLY LAID OUT. GRANT COUNTY ALSO MIGHT HAVE ASSUMED A RECTANGULAR SHAPE HAD NOT THE NORTHEASTERN CORNER OF CODINGTON COUNTY SHOULDERED INTO ITS TERRITORY ON THE SOUTHWEST, LEAVING A NARROW STRIP AND REMOVING THE SIX TOWNSHIPS NECESSARY TO COMPLETE A RECTANGLE. THUS, GRANT COUNTY IS THE ONLY ONE IN SOUTH DAKOTA WHICH CAN BOAST OF A PANHANDLE. THIS PANHANDLE, TEN MILES IN WIDTH, PROJECTS FROM THE WESTERN SIDE OF THE MAIN BODY OF THE COUNTY FOR A DISTANCE OF SEVENTEEN MILES. THE MAIN BODY OF THE COUNTY, HOWEVER, IS NEARLY SQUARE, TWENTY-ONE MILES FROM EAST TO WEST AND TWENTY-FOUR MILES FROM NORTH TO SOUTH. THESE DIMENSIONS GIVE THE COUNTY THE SHAPE OF A STEW PAN WITH A SHORT STUBBY HANDLE, AND ILLUSION HEIGHTENED BY THE OFFSET OF THE NORTHERN BOUNDARY LINE, WHERE IT CROSSES INTO THE SISSETON INDIAN RESERVATION, NARROWING THE BACK OF THE HANDLE AND CAUSING THE RIM OF THE PAN TO PROJECT SOME THREE MILES TO THE NORTH.

WITHIN THIS COUNTY THERE IS AN INTERESTING VARIETY OF GEOLOGIC AND GEOGRAPHIC CONDITIONS, SOME OF WHICH CAN BE USED TO ADVANTAGE. AT THE REQUEST OF THE MILBANK CHAMBER OF COMMERCE, THEREFORE, THE STATE GEOLOGIST AND DR. W. V. SEARIGHT MADE A RECONNAISSANCE SURVEY OF THESE FEATURES THE RESULTS OF WHICH ARE CONTAINED IN THIS REPORT. THE FIELD WORK WAS DONE DURING THE MONTH OF AUGUST, 1933, AND INFORMATION WAS ADDED BY WELL DRILLERS OF THE COUNTY, MEMBERS OF THE MILBANK CHAMBER OF COMMERCE AND OTHER CITIZENS WHO FREELY GAVE MUCH THAT IS CONTAINED HEREIN. SPECIAL MENTION SHOULD BE MADE OF MESSRS. W. S. GIVEN, MARTIN MORLEY, AND MARVIN LEE, ALL OF MILBANK, WITHOUT WHOSE AID MUCH OF THE DATA WOULD OTHERWISE HAVE BEEN UNAVAILABLE.



BLOCK DIAGRAM
 OF THE
 TOPOGRAPHIC FEATURES
 OF
 GRANT COUNTY, S. DAK.

II. THE SURFACE

LIKE THE PEOPLE OF SCOTLAND, THE CITIZENS OF GRANT COUNTY MIGHT BE DIVIDED INTO TWO CLASSES, THE LOWLANDERS AND THE HIGHLANDERS, FOR THE COUNTY CAN BE DIVIDED INTO TWO VERY DISTINCT PARTS: AN EASTERN LOWLAND PLAIN WITH A SURFACE AS FLAT AS THE PROVERBIAL FLOOR, AND A WESTERN HIGHLAND WHOSE UNDULATING AND HILLY SURFACE LIES NEARLY A THOUSAND FEET ABOVE THIS PLAIN. THESE TWO SECTIONS, SO DIFFERENT IN ELEVATION AND TOPOGRAPHY, MEET AT THE BASE OF A GREAT SCARP WHICH TRENDS DIAGONALLY ACROSS THE COUNTY FROM NORTHWEST TO SOUTHEAST, DIVIDING IT INTO TWO NEARLY EQUAL PARTS.

THE LOWLAND

SURFACE:

THE MOST STRIKING CHARACTERISTIC OF THE LOWLAND IS ITS FLATNESS. HOUSES, TREES, HAYSTACKS AND TELEPHONE POLES STAND OUT PROMINENTLY ABOVE THE HORIZON AND CAN BE SEEN FOR DISTANCES OF SEVERAL MILES. HIGHWAYS STRETCH AWAY TO A VANISHING POINT IN THE FAR DISTANCE. THE SLIGHT UNDULATIONS ARE RARELY MORE THAN A FEW FEET IN HEIGHT. ALONG THIS PLAIN A FEW LOW MORAINIC RIDGES RISE ABOVE THE GENERAL SURFACE AND THE EASTERN PARTS OF THE VALLEYS OF WHETSTONE AND YELLOW BANK CREEKS AND BIG STONE VALLEY FORM THE ONLY DEPRESSIONS OF NOTE.

THE WESTERN EDGE OF THE PLAIN IS SHARPLY MARKED BY THE BASE OF THE GREAT ESCARPMENT (CALLED LOCALLY THE DAKOTA HILLS) WHICH PASSES ABOUT A MILE WEST OF REVILLO, TRENDS NORTHWESTWARD PASSING TWO MILES TO THE WEST OF TWIN BROOKS, AND CROSSES THE NORTH LINE OF THE COUNTY ABOUT FOUR MILES EAST OF THE SISSETON INDIAN RESERVATION LINE. FROM THIS LINE THE PLAIN STRETCHES EASTWARD INTO MINNESOTA AND NORTHWARD INTO ROBERTS COUNTY. IT SLOPES TO THE NORTHEAST AT THE RATE OF ABOUT FOURTEEN FEET PER MILE, A SLOPE TOO GENTLE TO BE READILY DETECTED BY THE NAKED EYE. IN FACT, IT APPEARS TO BE REVERSED WHEN TRAVELING WESTWARD DUE TO AN OPTICAL ILLUSION CAUSED BY THE GREAT ESCARPMENT OF THE DAKOTA HILLS.

ELEVATIONS FURNISHED BY THE ENGINEERING DEPARTMENTS OF THE RAILROADS, WHICH CROSS THIS COUNTY, AND COMPUTED FROM THE PROFILES FROM THE STATE HIGHWAY ENGINEER'S OFFICE BRING OUT THIS

SLOPE VERY PLAINLY. AT THE WESTERN EDGE OF THE PLAIN IN BOTH THE NORTHERN AND SOUTHERN PARTS OF THE COUNTY AN ELEVATION OF 1300 FEET IS REACHED. THE UPLAND IN THE VICINITY OF BIG STONE LAKE HAS AN APPROXIMATE ELEVATION OF 1050 FEET OR A TOTAL DROP OF 250 FEET IN A DISTANCE OF APPROXIMATELY SIXTEEN MILES. THE FOLLOWING ELEVATIONS ARE GIVEN BY THE RAILROAD ENGINEERS AND REPRESENT THE ELEVATION OF THE TRACK IN FRONT OF THE STATION IN THE CITIES MENTIONED:

TWIN BROOKS	1266 FEET
REVILLO	1208 FEET
ALBEE	1180 FEET
MILBANK	1142 FEET
BIG STONE CITY	1000 FEET

THE LOWEST POINT IN THE STATE IS THE WATER LEVEL OF BIG STONE LAKE. THIS LAKE LIES IN A DEEP TROUGH CUT IN NEARLY A HUNDRED FEET BELOW THE SURFACE OF THE PLAIN. THE SEA LEVEL ELEVATION OF THE WATER IN NORMAL SEASONS AVERAGES 967 FEET.

DRAINAGE:

MOST OF THE PLAIN IS UNDRAINED AND SHOWS THE CHARACTERISTIC SWELLS AND SWALES OF A RECENTLY GLACIATED SURFACE. THE FEW STREAMS WHICH CROSS THE SURFACE WANDER AIMLESSLY EASTWARD AND FINALLY ENTER THE MISSISSIPPI DRAINAGE BY WAY OF THE MINNESOTA RIVER. THE CHANNELS OF MOST OF THESE STREAMS DO NOT AVERAGE TEN FEET IN DEPTH AND FROM A SHORT DISTANCE ARE USUALLY DISTINGUISHED FROM THE PLAIN ONLY BY THE LINE OF TREES WHICH FOLLOWS THE CHANNEL. THE EXCEPTIONS TO THIS RULE ARE THE LOWER PARTS OF THE WHETSTONE AND YELLOW BANK CREEKS, WHICH LIE IN DEEPLY CUT VALLEYS. MOST OF THE RAIN WHICH FALLS ON THE PLAIN IS HELD IN THE SWAMPS AND SMALL PONDS WHICH DOT THIS LOWLAND. ONLY TWO NATURAL WATER BODIES ARE LARGE ENOUGH TO BE DESIGNATED AS LAKES. THE LARGEST IS BIG STONE LAKE, THE TIP END OF WHICH BORDERS THE NORTHEASTERN CORNER OF THE PLAIN FOR TWO MILES. THE SECOND IS LAKE ALBERT, A SHALLOW GLACIAL LAKE SIX MILES EAST OF MILBANK, WHICH WAS DRY AT THE TIME OF THIS INVESTIGATION (1933). A LAKE COVERING APPROXIMATELY ONE-HALF SQUARE MILE HAS BEEN FORMED AT MILBANK BY PLACING A DAM IN THE SOUTH FORK OF WHETSTONE CREEK.

MILBANK MORaine:

THIS NAME IS USED TO DESIGNATE FIVE SHORT, NARROW RIDGES, WHICH RISE SHARPLY OUT OF THE PLAINS TO HEIGHTS OF TWENTY TO

THIRTY FEET. MOST OF THEM AVERAGE ABOUT A QUARTER OF A MILE IN WIDTH. THE NAME MILBANK WAS USED HERE TO DISTINGUISH THESE MORAINIC RIDGES FROM THOSE THAT WILL BE DESCRIBED LATER BECAUSE THE NORTHERNMOST RIDGE LIES A MILE NORTHWEST OF THE CITY OF MILBANK. ALL THE RIDGES ARE FORMED OF BOULDER CLAY DUMPED AT THE EDGE OF AN ICE SHEET WHICH WAS HALTED TEMPORARILY ALONG THE LINE THEY NOW OCCUPY. THEY TREND IN A NORTHWEST-SOUTHEAST DIRECTION FORMING A LINE THAT IS NEARLY STRAIGHT. THE NORTHERNMOST RIDGE AT MILBANK IS ABOUT TWO MILES LONG AND LIES IN THE POSITION JUST INDICATED, NORTHWEST OF MILBANK. THE SECOND RIDGE IS ABOUT A MILE LONG AND LIES THREE MILES SOUTH AND ONE MILE EAST OF MILBANK, WHILE THE THIRD STARTS FOUR AND A QUARTER MILES SOUTH AND ONE MILE EAST OF MILBANK AND IS NEARLY CONTINUOUS FOR FIVE MILES. THE LAST RIDGE RISES TWO MILES EAST OF ALBEE (THREE MILES SOUTH OF THE END OF THE ONE JUST MENTIONED), AND TRENDS SOUTHEASTWARD FOR NEARLY TWO MILES WHERE IT IS FINALLY LOST IN THE SURROUNDING PLAIN. THESE RIDGES ARE NOT LARGE OR CONSPICUOUS FEATURES OF THE TOPOGRAPHY BUT SERVE TO BREAK THE UNIFORMITY OF THE PLAIN.

ANTELOPE AND BIG STONE MORAINES:

THE MOST STRIKING FEATURE OF THE ENTIRE LOWLAND IS BIG TOM, MOUNT TOM, OR THE MOUNT TOM RANGE, AS IT IS VARIOUSLY CALLED. AS SEEN FROM THE HIGHWAY, BETWEEN MILBANK AND BIG STONE, BIG TOM APPEARS TO BE A GREAT ROUND TOP MOUNTAIN RISING BOLDLY ABOVE THE SURROUNDING PLAINS. THE LACK OF ALL VEGETATION EXCEPT SHORT GRASS AND LOW BRUSH GIVES IT A BALD APPEARANCE, WHICH IS ESPECIALLY NOTICEABLE DURING THE DRYER PARTS OF THE YEAR. IN REALITY BIG TOM IS A RIDGE ENDING ABRUPTLY IN THE BALD KNOB TO WHICH THE NAME IS USUALLY APPLIED. IT LIES IN THE GREAT BEND OF THE YELLOW BANK RIVER, FOUR MILES SOUTH OF LAKE ALBERT. FROM THIS POINT IT TRENDS ABOUT THIRTY DEGREES EAST OF SOUTH, CROSSING THE STATE LINE INTO MINNESOTA IN THE NORTHEAST CORNER OF VERNON TOWNSHIP THREE MILES FROM ITS NORTHERN EXTREMITY. THE RANGE IS VERY STEEP SIDED AND IS COMPOSED LARGELY OF MEDIUM TO COARSE GRAVEL. IN GRANT COUNTY IT CONSISTS OF THREE LARGE PEAKS OR BOSSES SEPARATED BY SADDLES SIXTY-FIVE FEET DEEP. THE ENTIRE RIDGE, INCLUDING THE SADDLES, IS COVERED WITH SMALLER GRAVEL KNOLLS. ITS WIDTH IS NOT MORE THAN HALF A MILE AND THIS MAKES ITS HUNDRED OR MORE FEET OF HEIGHT APPEAR MORE CONSPICUOUS THAN IT WOULD IF THE SAME DIMENSIONS SPREAD OVER A WIDER TERRITORY.

THE SOUTHERN END OF THE RIDGE, IN LAC QUI PARLE COUNTY, MINNESOTA, IS KNOWN LOCALLY AS THE ANTELOPE HILLS AND, THEREFORE, THE NAME ANTELOPE MORAINE WAS GIVEN TO THE ENTIRE RIDGE YEARS AGO BY DR. T. C. CHAMBERLAIN.¹

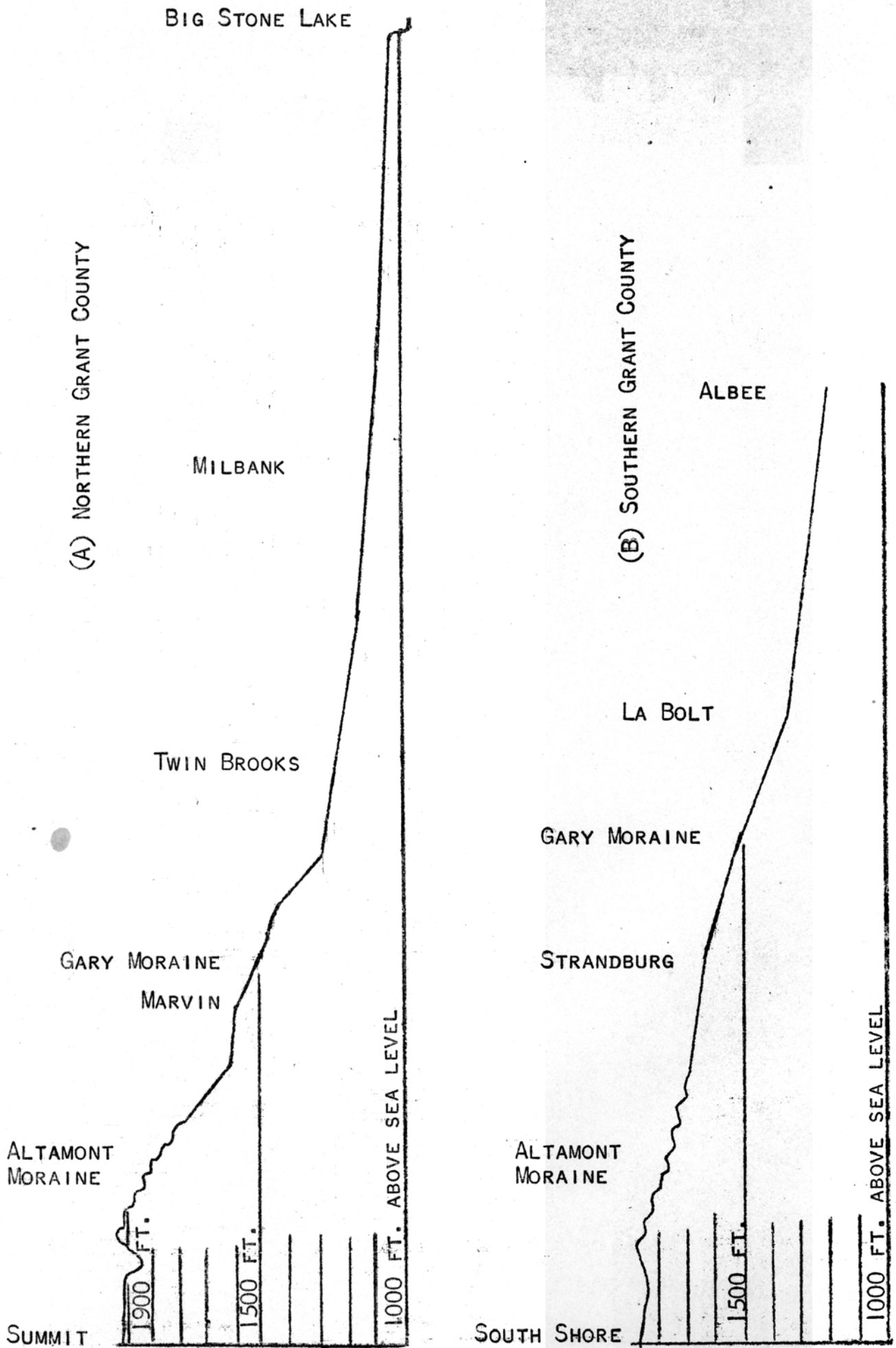
THE BIG STONE MORAINE IS THE NAME GIVEN TO SOME ROUGH TOPOGRAPHY WHICH BREAKS THE UPLANDS ABOUT HALF WAY BETWEEN BIG STONE LAKE AND THE NORTH FORK OF WHETSTONE RIVER. IT CONTINUES SOUTHEASTWARD ON THE EAST SIDE OF LAKE ALBERT TO THE MINNESOTA BOUNDARY. NORTH OF THE MAIN WHETSTONE RIVER IT IS A NARROW BELT SCARCELY HALF A MILE WIDE, COMPOSED OF HUMMOCKY TOPOGRAPHY WITH A RELIEF OF FIFTEEN TO TWENTY FEET. THIS PART OF THE MORAINE DOES NOT MAKE A CONSPICUOUS FEATURE ON THE LANDSCAPE. SOUTH OF THE WHETSTONE RIVER THE MORAINE WIDENS TO ABOUT TWO MILES AND IS CHARACTERIZED BY A HUMMOCKY SURFACE WITH A RELIEF OF FIFTEEN TO TWENTY-FIVE FEET. THE TOTAL AREA COVERED BY THIS SORT OF TOPOGRAPHY DOES NOT EXCEED EIGHT OR TEN SQUARE MILES. DR. FRANK LEVERETT INCLUDES THIS TOPOGRAPHY WITH THE BIG STONE MORAINE, WHICH HE TRACED AROUND THE SOUTHERN END OF LAKE BIG STONE FROM FARTHER EAST IN MINNESOTA.²

THE COTEAU DES PRAIRIES

THE HIGHLANDS IN THE WESTERN HALF OF GRANT COUNTY ARE PART OF THE DIVIDE BETWEEN THE VALLEYS OF THE JAMES AND RED RIVERS. THIS DIVIDE HAS LONG BEEN KNOWN AS THE COTEAU DES PRAIRIES. THE NAME WAS FIRST USED FOR THIS REGION BY PROFESSOR WILLIAM H. KEATING, WHO SAW THE HIGHLANDS WHILE TRAVELING WITH AN EXPLORING PARTY THROUGH MINNESOTA IN 1883.³ THE FIRST DESCRIPTION OF THEM WAS PUBLISHED BY AN ENGLISH GEOLOGIST, G. W. FEATHERSTONHAUGH, WHO SAYS, "THE COTEAU DES PRAIRIES . . . IS A VERY BROAD RIDGE OF LAND, DIVIDING THE WATERS TRIBUTARY TO THE MISSOURI FROM THOSE WHICH DISCHARGE THEMSELVES INTO THE ST. PETERS AND INTO THE RED RIVER OF LAKE WINNEPEG".⁴ DR. T. C. CHAMBERLIN DESCRIBES IT AS FOLLOWS: "THE COTEAU DES PRAIRIES . . . CONSISTS OF AN A SHAPED PLATEAU, THE APEX OF WHICH LIES ABOUT FORTY MILES WEST OF LAKE TRAVERSE AND ATTAINS A MAXIMUM ELEVATION OF A LITTLE OVER 2000 FEET ABOVE SEA LEVEL. THIS PROMONTORY STANDS BOLDLY FORTH 600 TO 800 FEET ABOVE THE PLAINS WHICH SKIRT IT ON THE EAST, NORTH AND WEST. . . . THE SIOUX VALLEY LIES BETWEEN THE

-
1. CHAMBERLIN, T. C., U.S. GEOLOGICAL SURVEY THIRD ANNUAL REPORT, PP. 388, 393. 1883.
 2. LEVERETT, FRANK, U.S. GEOLOGICAL SURVEY PROFESSIONAL PAPER 161, P. 105. 1932.
 3. SEE VOL. I OF THE GEOLOGICAL SURVEY OF MINNESOTA, P. 6. 1880.
 4. SEE VOL. I OF THE GEOLOGICAL SURVEY OF MINNESOTA, P. 62. 1880.

TOPOGRAPHIC PROFILES ACROSS COTEAU ESCARPMENT



ARMS OF THIS TOPOGRAPHICAL A THOUGH ITS DEPRESSION IS NOT EQUAL TO THAT OF THE GREATER VALLEYS ON THE EXTERIOR."¹

THE SURFACE OF THE COTEAU IN GRANT COUNTY LIES AT AN ELEVATION OF APPROXIMATELY 1900 FEET ABOVE SEA LEVEL, 600 FEET HIGHER THAN THE LOWLAND PLAIN. CERTAIN POINTS ON IT RISE 100 FEET ABOVE THIS AVERAGE, THE HIGHEST POINT MEASURED BEING ALONG THE HIGHWAY NEAR THE CITY OF SUMMIT WHERE AN ELEVATION OF 2008 FEET WAS RECORDED. THE HILLS THROUGH WHICH THE HIGHWAY PASSES RISE TWENTY OR THIRTY FEET HIGHER MAKING THIS SECTION OF GRANT COUNTY AS HIGH AS ANY PART IN THE STATE EAST OF THE MISSOURI RIVER. THE MEASURED DIFFERENCE IN ELEVATION BETWEEN THIS HIGH REGION AND BIG STONE LAKE IS 1041 FEET, GIVING GRANT COUNTY THE DISTINCTION OF HAVING NOT ONLY THE LOWEST POINT IN THE STATE, BUT ALSO OF HAVING THE GREATEST RELIEF OF THE PLAINS COUNTIES OF SOUTH DAKOTA.

THE FACE OF THE COTEAU IS A BOLD EAST FACING ESCARPMENT, KNOWN LOCALLY AS THE DAKOTA HILLS. AT THE NORTHERN END IT RISES FROM THE PLAIN AT THE AVERAGE RATE OF ONE HUNDRED FEET PER MILE, BUT FLATTENS OUT TO A SLOPE OF ABOUT FORTY FEET PER MILE IN THE SOUTHERN PART OF THE COUNTY. VIEWED FROM THE THE LOWLAND IT APPEARS TO BE AN ENORMOUS HILL EXTENDING BOTH NORTH AND SOUTH AS FAR AS THE EYE CAN SEE. LOOKING EASTWARD FROM ITS SUMMIT, THE LOWLAND STRETCHES AWAY FAR BENEATH INTO THE MISTY DISTANCE AS THOUGH VIEWED FROM AN AEROPLANE. THIS ESCARPMENT CAN BE FOLLOWED SOUTHWARD THROUGH DEUEL COUNTY WHERE IT LEAVES THE STATE AT GARY AND FINALLY ENDS IN COTTONWOOD AND WATONWAN COUNTIES, MINNESOTA. IT CAN BE FOLLOWED NORTHWARD THROUGH ROBERTS COUNTY AND INTO NORTH DAKOTA WHERE IT JOINS THE PEMBINA ESCARPMENT WHICH CROSSES THAT STATE. THIS ESCARPMENT, THEREFORE, IS ONLY A SMALL PART OF A TOPOGRAPHIC FEATURE WHICH IS SEVERAL HUNDRED MILES LONG. IT STARTS IN SOUTHWESTERN MINNESOTA AND ENDS IN SOUTHERN CANADA.

THE CHARACTERISTIC SURFACE OF THE COTEAU IS ROUGH, BUT THERE ARE CONSIDERABLE AREAS WHERE GENTLE SLOPES AND SMOOTH FIELDS OCCUR. PART OF THIS TOPOGRAPHY IS DUE TO STREAM EROSION AND PART TO GLACIAL DEPOSITION.

THE LOWER HALF OF THE SLOPE IS DEEPLY TRENCHED BY STREAM VALLEYS WHICH FORM THE HEADWATERS OF THE STREAMS CROSSING THE LOWLAND. A MULTITUDE OF SMALL STREAMS WHICH FINGER BACK INTO THE ESCARPMENT, FORMING FAN-LIKE PATTERNS THAT CONVERGE AT THE BASE OF THE SLOPE, MAKE THE HEADWATERS OF WHETSTONE AND THE

1. CHAMBERLIN, T. C., U.S.G.S. 3RD ANN. REP., P. 390, 1883.

NORTH AND SOUTH FORKS OF YELLOW BANK RIVERS. MOST OF THESE VALLEYS ARE CUT TO A DEPTH OF THIRTY TO SIXTY FEET AND THEIR BLUFFS ARE SO ABRUPT THAT TRAVEL IS DIFFICULT. MANY SECTION LINE ROADS ARE NOT OPEN IN THIS PART OF THE SLOPE, AND IT IS OFTEN NECESSARY TO FOLLOW VERY ROUND ABOUT ROUTES IN ORDER TO AVOID IMPASSABLE VALLEYS.

ALTAMONT MORaine:

ALONG THE CREST OF THIS ESCARPMENT LIES A GREAT TERMINAL MORaine KNOWN AS THE ALTAMONT MORaine. IT IS SIMILAR TO THE MORaines DESCRIBED ON THE LOWLAND IN THAT IT IS A BELT OF HILLY COUNTRY, BUT ITS SURFACE IS MUCH MORE ROUGH AND IT IS MUCH LARGER. IT EXTENDS THE ENTIRE LENGTH OF THE RIDGE IN GRANT COUNTY AND VARIES FROM TWO TO FOUR MILES IN WIDTH.

THE STONY HILLS, TWENTY TO FIFTY FEET HIGH, SURROUND KETTLE-LIKE HOLLOWs, MANY OF THEM CONTAINING SWAMPS AND PONDS. BOATING LAKE AND TWIN LAKES, NEAR THE NORTHERN BOUNDARY OF THE COUNTY, ARE THE LARGEST OF THESE KETTLE LAKES. THEY CAN BE SEEN FROM U. S. HIGHWAY No. 12, ABOUT HALF A MILE EAST OF THE WESTERN EDGE OF THE MORaine.

ANOTHER KETTLE LAKE LARGE ENOUGH TO RECEIVE A NAME IS KNOWN AS MYERS LAKE AND LIES FIVE MILES SOUTH AND ONE MILE WEST OF MARVIN. SO ROUGH IS THE SURFACE OF THIS MORaine THAT FEW ROADS TRAVERSE IT AND LITTLE CROP FARMING IS CARRIED ON. THIS IS BY FAR THE LARGEST MORainIC SURFACE IN THE COUNTY, AND, IN FACT, IN THIS PART OF THE STATE.

GARY MORaine:

ABOUT HALF WAY DOWN THE ESCARPMENT A SECOND BELT OF MORainIC TOPOGRAPHY OCCURS. FROM MARVIN NORTHWARD IT IS VERY CONSPICUOUS AND COVERS A STRIP OF COUNTRY ONE-HALF TO ONE MILE IN WIDTH. THE KNOBS ARE NOT SO HIGH NOR THE KETTLES AS DEEP AS ARE THOSE OF THE ALTAMONT MORaine, BUT THE HILLS ARE SUFFICIENTLY ROUGH TO MAKE IT A DIFFICULT COUNTRY IN WHICH TO TRAVEL, AND SUFFICIENTLY STONY TO PREVENT CROP FARMING ON A LARGE SCALE. SOUTHEAST OF MARVIN THE MORaine DISAPPEARS AS A TOPOGRAPHIC BELT, BUT HERE AND THERE SMALL KNOBBY HILLS AND PATCHES OF VERY STONY MOUNDS OCCUR WHICH TRACE THE CONTINUATION OF THIS BELT INTO DEUEL COUNTY WHERE IT JOINS THE MORE CONSPICUOUS MORaine AT GARY.

THE UPLAND:

THIS PART OF THE COTEAU OCCUPIES THE PANHANDLE OF GRANT COUNTY AND ABOUT A THIRD OF THE SOUTHWEST CORNER OF TROY TOWNSHIP IN THE SOUTHWEST CORNER OF THE COUNTY. ITS SURFACE IS THE PRODUCT OF ICE AND TORRENTS OF WATER WHICH CAN BEST BE CHARACTERIZED AS A GENTLY ROLLING TOPOGRAPHY CUT BY GREAT FLAT-BOTTOMED, GRAVEL FILLED VALLEYS. THIS CONTRASTS SHARPLY WITH THE SURFACE OF THE ESCARPMENT FOR THE ROUGH TOPOGRAPHY HAS GIVEN WAY TO LONG GENTLE SLOPES, LOW SMOOTH HILLS AND WIDE OPEN, GENTLE VALLEYS. SWAMPS AND LAKES ARE UNKNOWN EXCEPT IN GRAVEL CHANNELS. THE CHANNELS, THEREFORE, FORM THE MOST CONSPICUOUS FEATURES OF THIS UPLAND.

THE LARGEST OF THESE CHANNELS IS THE ANTELOPE VALLEY WHICH HAS BEEN TRACED FROM CLEAR LAKE, IN DEUEL COUNTY, THROUGH GRANT COUNTY TO A POINT NORTH OF SUMMIT ON THE NORTHERN BOUNDARY OF GRANT COUNTY. IT IS A GREAT OPEN VALLEY ONE TO THREE MILES WIDE, WHICH LIES IMMEDIATELY IN FRONT OF THE ALTAMONT MORAINE. IN FACT, ITS SURFACE IS DUE TO WASHING OF GRAVEL FROM GLACIAL ICE WHOSE FRONT STOOD AT THE SITE OF THE ALTAMONT MORAINE. THE VALLEY CONTAINS SEVERAL LAKES, BUT ONLY ONE LARGE ONE, CROOKED LAKE, LIES IN GRANT COUNTY. THE SOUTHERN END OF THE VALLEY IN THE VICINITY OF TROY HAS AN ELEVATION OF 1885 FEET ABOVE SEA LEVEL, WHILE THE NORTHERN END, IN THE VICINITY OF SUMMIT, HAS AN ELEVATION OF 1923 FEET.

THE ANTELOPE VALLEY HAS TWO CHANNELS LEADING FROM IT TO THE GREAT CHANNEL OF THE BIG SIOUX VALLEY; ONE AT SUMMIT, WHICH FLOWS NORTH AND WEST TO THE BIG SIOUX CHANNEL SOUTH OF ORTLEY, IN ROBERTS COUNTY, AND A SECOND WHICH HEADS WEST OF TWIN LAKES AND FLOWS DIAGONALLY ACROSS THE CENTER OF THE PANHANDLE. THE BIG SIOUX CHANNEL WAS THE MASTER DRAINAGE DURING GLACIAL TIMES AS IT IS TODAY, AND IS THE LONGEST OF THE GRAVEL CHANNELS. IN THE GRANT COUNTY PORTION OF THE COTEAU THIS CHANNEL VARIES IN WIDTH, BEING WIDEST AT THE POINT WHERE THE TRIBUTARY CHANNELS ENTER IT AND NARROW BETWEEN TRIBUTARIES. THE MAXIMUM WIDTH IS ABOUT THREE MILES AND THE MINIMUM ABOUT A HALF MILE.

THE FLOOD PLAINS AND SWAMPY LANDS OF THESE CHANNELS OCCUPY THIRTY-EIGHT SQUARE MILES OR ABOUT THIRTY PER CENT OF THE TOTAL AREA OF THE COTEAU UPLAND.

ORTLEY
1858

SUMMIT
1998#

X
1898

X
2009

MARVIN
#1651

X
1240

X
1030

BIG STONE
1000

TWIN BROOKS

1256

MILBANK
1142

1095

X
1880

SOUTH SHORE
1863
#

STOCKHOLM

1654

X
1773

X
1200

IN AND NEAR

GRANT COUNTY, SOUTH DAKOTA

ELEVATIONS TAKEN FROM RAIL-
ROAD AND HIGHWAY PROFILES.

TROY STRANDBURG
#1885

1686

#LABOLT
1358

ALBEE

1180

REVILLO

1208

X
1584

III. SOME GEOGRAPHICAL FACTORS

A DETAILED DESCRIPTION OF THE GEOGRAPHY OF GRANT COUNTY IS NOT WITHIN THE SCOPE OF THIS INVESTIGATION, BUT A FEW PERTINENT FACTS WHICH BEAR ON THE USABILITY OF THE REGION WILL BE MENTIONED.

ACCESS

GRANT COUNTY HAS READY ACCESS TO ALL POINTS IN ITS IMMEDIATE NEIGHBORHOOD. THERE IS NO NATURAL BARRIER TO HIGHWAY OR RAILWAY CONSTRUCTION EITHER WITHIN THE COUNTY OR TO THOSE LEADING INTO IT FROM WITHOUT. BIG STONE LAKE LIES IN THE EXTREME NORTHEASTERN CORNER OF THE COUNTY AND, THEREFORE, DOES NOT PREVENT TRAVEL. IN FACT, IT HAS BEEN A BENEFIT IN THAT IT HAS FORCED A TRANSCONTINENTAL RAILROAD AND A NATIONAL HIGHWAY TO CROSS THE COUNTY. THE GREAT ESCARPMENT OF THE DAKOTA HILLS IS ONLY A SMALL BARRIER TO TRUCKS AND PASSENGER TRAFFIC, WHICH CROSS IT READILY ON HIGHWAYS RUNNING BOTH NORTH AND SOUTH AND EAST AND WEST. MOST OF THE RAILROAD TRAINS CROSS IT WITHOUT EXTRA POWER. SOME OF THE LONGEST TRAINS ON THE CHICAGO, MILWAUKEE, ST. PAUL AND PACIFIC RAILROAD, HOWEVER, USE TWO ENGINES BETWEEN MILBANK AND SUMMIT.

GRANT COUNTY IS A PART OF THE HINTERLAND OF MINNEAPOLIS AND ST. PAUL TO WHICH CITIES THE THREE RAILROADS SERVING THE COUNTY LEAD. THE CHICAGO, MILWAUKEE, ST. PAUL AND PACIFIC RAILROAD TRAVELS THROUGH THE NORTHERN HALF OF THE COUNTY, PASSING THROUGH SUMMIT, MARVIN, TWIN BROOKS, MILBANK AND BIG STONE CITY AND OFFERING TRANSPORTATION BETWEEN THE TWIN CITIES AND ABERDEEN.

THE SOUTHERN END OF THE COUNTY IS SERVED BY THE GREAT NORTHERN RAILROAD WITH STATIONS AT ALBEE, LA BOLT AND STOCKHOLM. IT CONNECTS THIS PART OF THE COUNTY WITH THE TWIN CITIES ON THE EAST AND WATERTOWN, SOUTH DAKOTA ON THE WEST. THE GREAT NORTHERN RAILROAD IS PARALLELED, A FEW MILES TO THE SOUTH, BY THE MINNEAPOLIS AND ST. LOUIS RAILROAD WITH STATIONS AT TROY, STRANDBURG AND REVILLO. IT GIVES THE SAME OUTLETS AS THE GREAT NORTHERN. THE PANHANDLE IS THE ONLY PART OF THE COUNTY WHICH IS NOT CROSSED BY A RAILROAD, BUT AN EXCELLENT HIGHWAY AND WELL GRADED SIDE ROADS GIVE EXCELLENT ACCESS TO THE CHICAGO, MILWAUKEE, ST. PAUL AND PACIFIC RAILROAD AT ORTLEY AND SUMMIT TO THE NORTH, AND ALSO TO THE RAILROADS AT WATERTOWN TO THE SOUTH.

HIGHWAYS AND GOOD ROADS ABOUND, COVERING ALL PARTS OF THE COUNTY. THE ONLY EXCEPTIONS BEING THE BELT OF ROUGH COUNTRY IN THE ALTAMONT MORaine AND SMALL AREAS IN THE LOWER HALF OF THE ESCARPMENT WHERE THE HILLS OF THE GARY MORaine AND THE SHARPLY CUT VALLEYS MAKE NORTH-SOUTH TRAFFIC DIFFICULT.

SOILS

A DETAILED SURVEY OF THE SOILS OF GRANT COUNTY HAS BEEN MADE BY THE U. S. BUREAU OF SOILS AND ITS RESULTS ARE AVAILABLE TO THE PUBLIC. NO REPETITION OF THIS INFORMATION WILL BE ATTEMPTED HERE, EXCEPT THE GENERALIZATION THAT ALL SOILS ARE OF GLACIAL ORIGIN, AND THEREFORE OF HIGH FERTILITY. SILT, LOAM AND CLAY SOILS ARE CHARACTERISTIC. "THE UPLAND SOILS ARE CHARACTERIZED BY THREE DISTINCT LAYERS, OR HORIZONS, WHICH, FOR CONVENIENCE, ARE GIVEN THE DESIGNATIONS A, B, AND C. THESE MAJOR LAYERS MAY BE SUBDIVIDED ACCORDING TO LOCAL VARIATIONS, BUT THE THREE GENERAL DIVISIONS ARE ALWAYS PRESENT. IN CULTIVATED AREAS, THE SURFACE LAYER, KNOWN AS THE A HORIZON, IS DARK COLORED TO A DEPTH VARYING FROM TEN TO FOURTEEN INCHES. IN THE VIRGIN SOIL THIS SURFACE HORIZON HAS TWO LAYERS WHICH HAVE THE SAME COLOR, BUT DIFFER SLIGHTLY IN STRUCTURE. THE UPPER LAYER IS VERY FINELY GRANULAR, SILTY, OR SINGLE-GRAINED. THE GRANULES ARE UNIFORM IN COLOR THROUGHOUT THE LAYER, AND THE MATERIAL DOES NOT CHANGE COLOR WHEN CRUSHED. THE UPPER TWO-INCH LAYER IS USUALLY SOD. THE LOWER PORTION OF THE A HORIZON, WHICH BEGINS AT A DEPTH OF SIX OR EIGHT INCHES, IS SLIGHTLY MORE COMPACT AND CRUMBLES INTO GRANULAR MASSES, THE GRANULES BEING LARGER THAN IN THE UPPER PART.

"THE NEXT LAYER IS THE UPPER PART OF THE B HORIZON. IT IS NEARLY ALWAYS HEAVIER IN TEXTURE THAN THE HORIZON ABOVE, BEING OFTEN A HEAVY CLAY. THIS MATERIAL IS RATHER COMPACT, BUT IT BREAKS INTO ANGULAR FRAGMENTS LARGER IN SIZE THAN THE GRANULES IN THE A HORIZON. THE TRUE COLOR OF THESE PARTICLES IS BROWN, BUT THE DARK COLORED ORGANIC MATTER HAS BEEN CARRIED DOWN FROM ABOVE AND DEPOSITED OVER THEM AS A COATING. THE DARK COLOR DECREASES DOWNWARD AS THE CONTENT OF ORGANIC MATTER BECOMES LESS. THIS LAYER IS USUALLY FROM TEN TO FIFTEEN INCHES THICK.

"THE LOWER PART OF THE B HORIZON IS COLORED GRAYISH BROWN OR GRAYISH YELLOW WITH A FAINT OLIVE TINGE, AND HAS SPOTS OF LIGHT GRAY OR WHITE LIME CARBONATE SCATTERED THROUGH IT. THE

LIME MAY ALSO BE PRESENT AS SMALL CONCRETIONS, AS COATINGS ALONG THE BREAKAGE PLANES, AND AS DEPOSITS IN SMALL ROOT CHANNELS, ANIMAL BURROWS AND WORMHOLES. THE MATERIAL CONSTITUTING THE LOWER LAYER OF THE B HORIZON BREAKS UP INTO SOFT CLODS. THIS LAYER VARIES FROM EIGHT TO SIXTEEN INCHES IN THICKNESS, AND IT IS APPARENTLY A ZONE OF LIME ACCUMULATION, SINCE IT CONTAINS A HIGHER PERCENTAGE OF CARBONATE THAN THE A HORIZON AND SEEMS TO CONTAIN MORE LIME CARBONATE THAN THE HORIZON BELOW IT.

"THE DEEPER UNDERLYING LAYER, THE C HORIZON, CONSISTS OF THE PARENT MATERIAL WHICH HAS BEEN BUT LITTLE ALTERED BY WEATHERING. ITS COLOR IS GRAYISH YELLOW WITH A SLIGHT OLIVE TINGE. USUALLY LIME CARBONATE IS PRESENT UNIFORMLY THROUGHOUT THE MASS. THE MATERIAL IS USUALLY SILTY IN CHARACTER, STRUCTURELESS, AND BREAKS INTO SOFT CLODS.

"UPLAND SOILS WHICH HAVE REACHED THE STAGE OF DEVELOPMENT JUST DESCRIBED ARE SHOWN . . . AS TYPES OF THE BARNES AND MOODY SERIES."

FOR MORE DETAILED INFORMATION ON GRANT COUNTY SOILS THE READER IS REFERRED TO THE PUBLICATION ON THE BUREAU OF SOILS.

CLIMATE

THE CLIMATE OF GRANT COUNTY IS BEST BROUGHT OUT BY A STUDY OF THE FOLLOWING TABLES WHICH ARE TAKEN FROM A RECORD KEPT AT MILBANK FOR THE U. S. WEATHER BUREAU. GRANT COUNTY IS A TYPICAL INLAND COUNTY AND SO SHARES WITH THE REST OF SOUTH DAKOTA AND WESTERN MINNESOTA A TYPICAL CONTINENTAL CLIMATE, CHARACTERIZED BY RAPID CHANGES AND EXTREMES. COLD WINTERS, HOT SUMMERS, CHANGES FROM A HOT OR WARM SPELL TO A COOL OR FRIGID SPELL WITHIN A DAY OR TWO ARE COMMON. THE FOLLOWING TABLES BRING OUT CERTAIN FACTS: THE AVERAGE ANNUAL TEMPERATURE SINCE 1890 HAS BEEN 42.8 DEGREES FAHRENHEIT. THE AVERAGE JANUARY TEMPERATURE HAS BEEN 11.9 DEGREES FAHRENHEIT AND THE AVERAGE TEMPERATURE DURING JULY HAS BEEN 70.8 DEGREES FAHRENHEIT. ON THE HOTTEST SUMMER DAY THE MERCURY REACHED 105 DEGREES FAHRENHEIT, AND ON THE COLDEST WINTER DAY RECORDED IT REACHED 35 DEGREES BELOW ZERO FAHRENHEIT. THE GROWING SEASON VARIES FROM 97 DAYS TO 169 DAYS, AVERAGING 138 DAYS OR APPROXIMATELY FOUR MONTHS AND A HALF.

I. WATKINS, W. I. AND PIERRE, W. H., SOIL SURVEY OF GRANT COUNTY, SOUTH DAKOTA, U.S. DEPARTMENT OF AGRICULTURE, BUREAU OF SOILS, 1927.

THE RAINFALL IS NOT HEAVY COMPARED WITH RAINFALL IN EASTERN STATES, BUT AVERAGES 23 INCHES A YEAR WHICH IS SUFFICIENT TO GROW CROPS, ESPECIALLY SINCE MORE THAN HALF OF IT FALLS DURING THE SUMMER MONTHS. DURING DRY SEASONS, HOWEVER, THE ANNUAL PRECIPITATION HAS FALLEN TO 12.71 INCHES, BUT THIS HAS OCCURRED ONLY ONCE IN THE FORTY-FOUR YEARS THE RECORD HAS BEEN KEPT, AND FOR SIX YEARS IT HAS SHOWN AN ANNUAL PRECIPITATION OF OVER THIRTY INCHES. THE MAXIMUM OF THIRTY-FIVE INCHES FELL IN 1905.

EXTREMES, HOWEVER, ARE THE EXCEPTION AND THE NORMAL CLIMATE HAS A BRACING TEMPERATURE, NEITHER OPPRESSIVELY HOT IN SUMMER NOR SEVERELY COLD IN WINTER. MOISTURE AND TEMPERATURE ARE SO WELL BALANCED THAT CROP FAILURES ARE RARE.

PRECIPITATION, ANNUAL AND AVERAGE AMOUNTS (IN INCHES AND HUNDREDTHS)

MILBANK, GRANT COUNTY, SOUTH DAKOTA

YEAR JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEP. OCT. NOV. DEC. ANNUAL

1890	0.00	0.60	1.00	0.27	1.54	10.53	0.86	1.53	1.45	1.35	0.30	0.45	19.88
1891	0.06	0.25	1.20	1.86	1.90	3.04	1.44	0.55	0.78	0.67	0.40	0.56	12.71
1892	0.07	1.41	0.52	3.99	8.09	2.91	3.80	6.33	0.13	0.27	0.55	0.73	28.80
1893	1.26	1.36	2.16	1.37	2.14	1.38	2.07	2.05	0.00	0.78	0.33	0.95	15.85
1894	0.65	T.	2.51	3.73	0.50	2.12	T.	0.76	1.70	2.28	0.10	T.	14.35
1895	0.20	0.60	0.30	2.50	1.93	3.56	2.63	0.40	1.50	0.00	1.20	0.00	14.82
1896	0.45	1.05	0.50	5.95	4.70	3.08	1.04	2.21	1.70	2.09	0.60	0.54	23.91
1897	1.10	1.30	1.40	2.15	2.05	4.60	3.92	0.63	1.68	0.82	0.25	0.15	20.05
1898	0.00	0.52	0.90	1.03	3.36	3.52	2.73	2.58	0.95	2.96	0.40	0.00	18.95
1899	0.13	0.27	0.67	1.59	3.97	4.22	2.28	7.00	0.42	1.77	0.53	0.17	23.02
1900	0.25	0.65	2.50	0.83	1.00	1.54	3.65	5.26	3.28	0.91	0.42	0.35	20.64
1901	0.30	0.30	2.27	2.28	1.03	3.73	1.59	0.99	6.68	1.37	0.40	0.55	21.49
1902	0.30	0.30	1.37	0.72	3.73	2.63	2.04	2.70	0.11	1.29	1.04	1.50	17.73
1903	0.55	0.30	1.23	1.84	4.09	2.30	7.50	3.66	5.04	2.10	0.16	0.49	29.76
1904	0.18	0.90	0.67	2.25	1.85	4.58	3.22	3.42	1.67	2.54	T.	0.82	22.10
1905	0.60	0.15	0.52	1.25	7.35	8.60	5.27	3.55	2.17	3.00	2.85	T.	35.31
1906	0.41	0.07	1.89	2.72	6.29	6.55	2.93	5.22	2.38	3.61	1.13	0.77	33.97
1907	2.50	0.70	1.15	0.73	3.83	6.06	1.76	1.63	1.58	0.91	0.14	1.01	22.00
1908	0.47	4.04	2.53	4.00	5.42	4.70	1.47	1.86	2.05	1.81	2.60	2.55	33.50
1909	0.71	1.34	0.15	0.53	4.80	1.46	2.18	3.45	1.55	2.96	0.74	2.80	22.67
1910	0.80	0.65	0.35	2.12	0.43	3.33	1.91	3.38	0.81	2.62	0.28	0.40	17.08
1911	1.42	0.45	0.37	2.12	1.52	3.84	3.18	3.08	3.19	3.70	1.28	0.65	24.08
1912	0.21	0.07	0.57	4.40	3.62	.94	5.58	3.09	1.87	0.38	0.28	0.52	22.53
1913	0.61	0.68	1.83	2.52	3.97	0.89	3.11	3.41	1.92	1.36	1.17	0.11	21.58
1914	1.32	0.41	1.37	3.01	3.20	8.24	2.39	3.87	2.45	2.15	T.	0.60	29.01
1915	0.60	1.76	3.06	4.12	5.13	5.78	3.27	1.33	2.16	2.64	0.25	0.49	30.59
1916	2.85	0.39	1.20	2.72	4.07	5.04	1.42	5.18	1.80	0.67	0.10	0.72	26.16
1917	1.64	1.25	3.09	1.81	1.16	3.06	2.09	1.70	3.78	1.56	0.16	0.89	22.19
1918	2.10	1.62	2.71	2.17	3.85	2.95	1.64	2.31	0.30	1.93	2.15	2.19	25.92
1919	0.16	1.51	0.88	3.49	2.63	7.23	2.05	0.81	1.08	1.49	2.74	0.86	24.93
1920	1.09	0.53	4.69	2.30	2.69	0.63	2.28	2.04	2.37	1.31	2.28	1.34	32.55
1921	0.22	0.20	2.65	2.21	1.21	2.64	3.30	2.48	4.80	0.44	3.89	0.26	24.30
1922	1.94	3.19	0.66	1.92	2.52	1.11	1.26	1.84	1.35	1.23	4.76	0.53	22.31
1923	2.59	1.29	1.12	2.79	2.52	2.68	1.54	1.21	2.08	0.49	0.52	0.41	19.24
1924	0.55	0.90	3.05	2.70	1.19	5.12	0.95	5.47	2.45	1.13	0.10	0.35	23.96
1925	0.85	0.25	0.31	1.92	0.89	7.40	1.91	1.79	2.20	0.80	0.72	T.	19.04
1926	1.20	0.10	0.70	0.58	3.07	1.73	4.94	5.97	3.15	1.28	1.21	1.42	25.35
1927	0.33	0.46	1.91	3.02	2.93	2.73	3.86	2.31	0.82	1.66	1.55	3.40	24.98
1928	0.50	0.33	0.15	1.37	0.62	3.01	3.81	4.30	1.43	2.43	0.89	0.10	18.94
1929	1.81	1.37	1.48	3.07	2.02	0.61	4.91	1.56	4.20	2.30	0.25	0.80	24.38
1930	0.65	1.08	0.12	0.90	2.65	2.81	4.64	1.66	1.14	1.48	2.45	T.	19.58
1931	0.10	0.75	1.01	1.06	5.42	1.76	1.40	2.47	1.21	1.87	1.55	0.57	19.17
1932	0.77	0.02	2.05	3.85	2.68	5.11	2.50	2.08	1.65	2.16	1.20	0.42	24.49
1933	0.68	0.68	0.73	1.43	2.62	2.22	2.29	2.17	2.03	0.02	0.23	0.53	15.63
Ave.	0.80	0.82	1.40	2.25	3.01	3.75	2.71	2.76	1.98	1.60	1.00	0.71	22.92

WEATHER STATION AT MILBANK, GRANT CO., S. DAK.

TEMPERATURE (DEGREES FAHRENHEIT)

FROST DATA

YEAR	HIGHEST	LOWEST	ANNUAL MEAN	YEAR	LAST KILL- ING FROST IN SPRING	FIRST KILL- ING FROST IN AUTUMN	LENGTH GROWING SEASON
1900	102	-25	46.8*	1890	MAY 5	OCT. 17	165
1901	107	-26	44.6	1891	MAY 4	OCT. 3	152
1902	100	-30	43.8	1892	MAY 22	OCT. 7	138
1903	96	-25	....	1893	.....	SEPT. 16	...
1904	101	...	44.3*	1894	MAY 19	.....	...
1905	95	-31	42.4	1895	MAY 20	SEPT. 28	131
1906	101	-26	42.8	1896	APR. 21	SEPT. 11	143
1907	96	-35	40.0	1897	JUNE 6	SEPT. 17	103
1908	99	-25	43.4	1898	MAY 2	OCT. 5	156
1909	97	-25	41.3	1899	MAY 13	SEPT. 29	139
1910	98	-20	43.6	1900	MAY 4	SEPT. 17	136
1911	102	-26	42.0	1901	JUNE 7	OCT. 3	118
1912	97	-34	41.2	1902	MAY 10	SEPT. 12	125
1913	100	-22	42.7	1903	JUNE 11	SEPT. 16	97
1914	98	-28	42.66	1904	MAY 15	SEPT. 21	129
1915	89	-29	42.4	1905	MAY 1	OCT. 16	168
1916	99	-32	40.0	1906	MAY 8	SEPT. 30	145
1917	105	-33	38.8	1907	MAY 27	SEPT. 25	121
1918	98	-28	45.7	1908	MAY 6	SEPT. 28	145
1919	101	-30	43.3	1909	MAY 10	OCT. 12	155
1920	97	-21	42.7*	1910	JUNE 2	SEPT. 12	102
1921	98	-22	46.6	1911	MAY 13	OCT. 19	159
1922	100	...	48.1*	1912	MAY 16	SEPT. 26	133
1923	96	-20	45.6	1913	MAY 6	SEPT. 19	136
1924	94	-30	42.9	1914	MAY 15	OCT. 14	152
1925	99	-22	44.8	1915	MAY 18	OCT. 5	140
1926	105	-22	43.6	1916	MAY 3	SEPT. 15	135
1927	94	-23	42.0	1917	MAY 6	OCT. 6	153
1928	99	-28	43.3	1918	MAY 14	SEPT. 17	126
1929	104	-37	41.0	1919	MAY 7	OCT. 10	156
1930	102	-30	43.7	1920	APR. 28	SEPT. 30	155
1931	108	-18	....	1921	MAY 15	OCT. 3	141
1932	99	...	46.61*	1922	APR. 26	OCT. 12	169
1933	104	-27	44.2	1923	MAY 12	OCT. 5	146
-----				1924	MAY 24	OCT. 6	135
Ave.			42.8	1925	MAY 25	SEPT. 21	119
				1926	MAY 22	SEPT. 24	125
				1927	APR. 23	SEPT. 23	153
				1928	.....	SEPT. 23	...
				1929	MAY 20	SEPT. 18	121
				1930	MAY 24	SEPT. 27	126
				1931	MAY 22	SEPT. 24	125
				1932	APR. 27	SEPT. 29	155
				1933	APR. 27	OCT. 8	163
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				Ave.	MAY 13	SEPT. 28	138

* ELEVEN MONTHS AVERAGE

LATEST DATE OF KILLING FROST IN SPRING - JUNE 11.
EARLIEST DATE OF KILLING FROST IN AUTUMN - SEPT. 11.

IV. GEOLOGY

THE BEDROCK

IF A GIANT KNIFE COULD CUT A VERTICAL SLICE OUT OF THE COUNTY THE BED ROCK WOULD APPEAR LIKE THE LAYERS OF A GREAT CAKE. AT THE BASE WOULD BE A FOUNDATION OF GRANITE AND ON THIS WOULD LIE A SERIES OF SANDSTONES, SHALES, AND LIMESTONES OF MARINE ORIGIN, PILED LAYER ON LAYER TO A THICKNESS OF SEVERAL HUNDRED FEET. OVER THE MARINE ROCK IS SPREAD A SHEET OF LOOSE BOULDER CLAY AND SAND, OF GLACIAL ORIGIN. IN DISCUSSING THE GEOLOGY, THEREFORE, THREE NATURAL DIVISIONS CAN BE MADE: THE ROCKS OF THE BASEMENT FOUNDATION, THOSE OF OCEANIC ORIGIN, AND THOSE OF THE GLACIAL DRIFTS. THIS THREEFOLD DIVISION HOLDS NOT ONLY FOR THE MANNER BUT FOR THE TIME OF THEIR FORMATION. THE FOUNDATION ROCK WAS FORMED AT AN EARLY DAY IN THE KNOWN HISTORY OF THE EARTH DURING WHAT IS CALLED THE ALGONKIAN ERA. AFTER A GREAT LAPSE OF TIME THE STRATIFIED MARINE ROCKS WERE FORMED. THIS TIME OF THEIR FORMATION IS KNOWN AS THE CRETACEOUS PERIOD. AFTER A SECOND GREAT LAPSE OF TIME, THE GLACIAL DRIFTS WERE SPREAD OVER THE ENTIRE COUNTY DURING THE PLEISTOCENE EPOCH. AN UNDERSTANDING OF THE RELATIONSHIPS OF THESE THREE GROUPS OF ROCKS WILL THROW CONSIDERABLE LIGHT ON THE ECONOMIC POSSIBILITIES OF THE COUNTY AND THEY WILL THEREFORE BE DESCRIBED IN SOME DETAIL.

THE GRANITE FOUNDATION:

ROCKS OF THIS FOUNDATION OUTCROP ONLY IN A SMALL AREA BETWEEN MILBANK AND BIG STONE, WHERE THEY APPEAR AS SMOOTH BOSSES OF ROCK IN THE SHALLOW VALLEYS OF THE CREEKS. THE WESTERNMOST OUTCROP LIES FIVE MILES EAST AND ONE AND ONE-HALF MILES SOUTH OF MILBANK, (SECTION 13, T. 120 N., R. 48 W.). FROM THIS POINT THE GRANITE CAN BE FOLLOWED EASTWARD FOR THREE MILES, (SECTION 17, T. 120 N., R. 47 W.). A HALF DOZEN QUARRIES HAVE OPENED IN THIS AREA. A SECOND OUTCROP LIES AT THE BOTTOM OF THE VALLEY OF WHETSTONE CREEK, A MILE SOUTHWEST OF BIG STONE CITY, (S. W. CORNER, SECTION 17, T. 121 N., R. 46 W.), AND IS REPORTED AS THE FOUNDATION FOR THE RAILROAD BRIDGE, ONE-QUARTER MILE WEST OF THE OUTCROP, TWENTY-SEVEN FEET BELOW THE BED OF THE CREEK.

IT ALSO OUTCROPS IN MINNESOTA, IN THE BOTTOM OF THE MINNESOTA RIVER VALLEY, A MILE EAST OF THE STATE LINE AND A MILE SOUTH OF

BIG STONE CITY. THIS OUTCROP EXTENDS OVER AT LEAST TWO SQUARE MILES OF THE VALLEY BOTTOM. SINCE THE ROCK IN ALL THESE OUTCROPS IS THE SAME, IT IS SAFE TO ASSUME THAT THIS GRANITE UNDERLIES AT LEAST THIRTY SQUARE MILES IN THE NORTHEASTERN PART OF GRANT COUNTY. IN DRILLING WELLS ON THE LOWLAND, GRANITE HAS BEEN STRUCK AS FAR EAST AS MILBANK AND AS FAR SOUTH AS ALBEE. AS NO SAMPLES WERE AVAILABLE FROM THESE WELLS, IT IS NOT POSSIBLE TO TELL WHETHER THE GRANITE OF THE DRILLERS IS THE SAME AS THAT OF THE OUTCROPPING AT THE QUARRIES, BUT IT IS CERTAIN THAT IT IS A SIMILAR ROCK AND A PART OF THE BASEMENT ON WHICH THE MARINE ROCK LIE. IT WILL BE POSSIBLE TO STRIKE A SIMILAR BASEMENT ROCK IN ALL PARTS OF THE COUNTY IF DRILLING IS CARRIED TO A SUFFICIENT DEPTH.

THE ROCK IS A GRANITE, BEING COMPOSED OF APPROXIMATELY 60% DARK RED FELDSPAR BELONGING TO THE ORTHOCLASE GROUP, 25% CLEAR QUARTZ, 15% BIOTITE MICA. THIS MINERAL COMPOSITION GIVES THE ROCK A RICH DARK COLOR WHICH IS WELL DESCRIBED BY ITS TRADE NAME, MAHOGANY GRANITE. THE ROCK IS MEDIUM TO COARSE IN TEXTURE, GRAINS AVERAGING ONE-HALF TO ONE INCH IN DIAMETER. PEGMATITE STRINGERS OR VEINS ARE COMMON IN WHICH CRYSTALS FROM THREE TO FOUR INCHES ACROSS HAVE BEEN MEASURED. MOST OF THESE VEINS ARE SMALL, HOWEVER, SELDOM EXCEEDING TEN INCHES IN WIDTH.

ON WEATHERED SURFACES A DISTINCT GRAIN CAN BE SEEN. THIS WAS NOTED BY THE EARLY EXPLORERS IN THE REGION WHO CALLED THE GRANITE IN THE MINNESOTA VALLEY, NEAR BIG STONE, GNEISSIC GRANITE.¹ THE SAME ROCK HAS BEEN CLASSIFIED AS A GNEISS.² IN THE GRANT COUNTY OUTCROPS THE GRAIN IS CAUSED IN PART BY A ROUGH ORIENTATION OF CRYSTALS AND IN PART BY THE SEGREGATION OF FELDSPAR AND BLACK MICA. IT IS NOT VISIBLE IN THE FRESH ROCK BUT IS BROUGHT OUT AS FINE LINES OR LAMINATIONS UPON PARTIAL WEATHERING. THE STRIKE OF THE GRAIN IS EAST-WEST AND IT DIPS TO THE NORTH AT AN ANGLE OF FIFTY DEGREES. THE ROCK TAKES A HIGH POLISH AND IS MUCH PRIZED AS AN ORNAMENTAL STONE.

THIS GRANITE IS OF VOLCANIC ORIGIN; THAT IS, IT WAS FORMED BY THE FREEZING OF AN ENORMOUS MASS OF MOLTEN ROCK WHICH NEVER REACHED THE SURFACE OF THE EARTH. ITS COARSE CRYSTALS SHOW THAT IT COOLED VERY SLOWLY, PROBABLY DUE TO THE FACT THAT IT WAS A

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1. "IMMENSE MASSES OF GRANITE ALL QUASI-STRATIFIED, IN LAMINAE ABOUT AN INCH BROAD." FEATHERSTONHAUGH, G.W., A CANOE VOYAGE UP THE MINNAY SOTOR, VOL. 1, PAGE 35, LONDON, 1847.
 2. HALL, C. W., "THE GNEISSES, GABBRO SCHISTS, AND ASSOCIATED ROCKS OF SOUTHWESTERN MINNESOTA, "U.S. GEOL. SURV. BULLETIN 157, P. 41.

PART OF AN ENORMOUS MASS OF LIQUID ROCK. AT LEAST THIRTY SQUARE MILES, AND PROBABLY THREE TIMES THAT AREA, IS UNDERLAIN BY THE GRANITE IN GRANT COUNTY AND THE SAME ROCK CAN BE TRACED FOR MANY MILES DOWN THE MINNESOTA RIVER VALLEY IN MINNESOTA. SUCH ENORMOUS MASSES OF VOLCANIC ROCK ARE KNOWN IN A NUMBER OF PLACES AND ARE USUALLY ASSOCIATED WITH THE MOST ANCIENT ROCKS VISIBLE AT THE EARTH'S SURFACE. NO FIGURES CAN BE GIVEN FOR THE DEPTH OF THE GRANITE. ONE QUARRY HAS PENETRATED IT TO A DEPTH OF 100 FEET, BUT IF THE THICKNESS CORRESPONDS TO THE KNOWN THICKNESS OF OTHER GREAT BODIES OF GRANITE WITH SIMILAR HORIZONTAL EXTENT, IT SHOULD BE MEASURED IN HUNDREDS OR POSSIBLY EVEN THOUSANDS OF FEET.

IT IS NOT LIKELY THAT THE BASEMENT ROCK UNDER THE ENTIRE COUNTY IS EXACTLY LIKE THAT EXPOSED IN THE OUTCROP, BUT IT WOULD RESEMBLE IT IN BEING A VERY HARD, DENSE ROCK AND WOULD CONTAIN OTHER MASSES OF VOLCANIC MATERIAL. IT PROBABLY CONTAINS A GREAT DEAL OF BANDED OR LAMINATED ROCK SUCH AS GNEISSES, SCHISTS AND SLATES, AND MAY ALSO CONTAIN QUARTZITE.

THE AGE OF THE ROCK IN MINNESOTA RIVER VALLEY OF MINNESOTA IS GIVEN AS PRE-CAMBRIAN BECAUSE OF THEIR RESEMBLANCE TO KNOWN PRE-CAMBRIAN ROCK FARTHER NORTH IN MINNESOTA. SINCE THE OUTCROPS IN GRANT COUNTY ARE CONTINUOUS WITH THOSE IN THE MINNESOTA VALLEY, IT IS SAFE TO ASSIGN THEM ALSO TO THE PRE-CAMBRIAN GROUP.

THE OUTCROPS IN THE MINNESOTA VALLEY ARE LISTED UNDER THE HEADING OF PRE-CAMBRIAN ROCK IN THE DESCRIPTION GIVEN BY HALL.¹ NO EVIDENCE IS GIVEN FOR THE AGE ASSIGNED, HOWEVER. THE SAME ROCKS ARE ASSIGNED TO THE ARCHEAN GROUP BY THE EARLY WISCONSIN GEOLOGISTS. IN A REPORT ON THE GEOLOGY OF BIG STONE AND LAC QUI PARLE COUNTIES, WISCONSIN, DATED 1884 AND PUBLISHED IN 1901, WARREN UPHAM MAKES THE FOLLOWING STATEMENT. "THE ROCK THAT UNDERLIES THESE COUNTIES BELONGS TO THE ARCHEAN, COVERED MORE OR LESS BY A NONCONFORMABLE LATER COATING OF CRETACEOUS. THE FORMER ARE EXPOSED ALONG THE MINNESOTA VALLEY FROM ORTONVILLE SOUTHEASTWARDLY TO MARSH LAKE, AND ON TO THE SHORES OF LAC QUI PARLE."² IN LATER PUBLICATIONS THE AGE IS GIVEN AS ALGONKIAN.³ THIS MAKES THEM CONSIDERABLY YOUNGER THAN THE ARCHEAN, BUT STILL LEAVES THEM IN THE PRE-CAMBRIAN.

1. HALL, C. W., U.S. GEOLOGICAL SURVEY BULLETIN 157, P. 38, 1899.
2. UPHAM, WARREN, THE GEOLOGY OF MINNESOTA, MINNESOTA GEOLOGICAL AND NATURAL HISTORY SURVEY VOL. VI, PLATE 29.
3. DARTON, N. H., GEOLOGY AND UNDERGROUND WATERS OF SOUTH DAKOTA, U.S. GEOLOGICAL SURVEY WATER SUPPLY PAPER 227, PLATE 1, 1909.

AS THERE ARE NO BEDROCK EXPOSURES IN GRANT COUNTY EXCEPT THOSE OF THE GRANITE, IT IS IMPOSSIBLE TO DETERMINE ITS AGE BY ITS RELATION TO THE SURROUNDING BEDROCK, NOR WILL ITS EXTENT THROW LIGHT ON THE SUBJECT FOR LARGE GRANITIC MASSES ARE TO BE FOUND IN BOTH ARCHEAN AND ALGONKIAN ROCKS. THE TENDENCY HAS BEEN, HOWEVER, TO PLACE THE ROCKS FARTHER SOUTH IN THE YOUNGER GROUP, HENCE THE BIG STONE GRANITE IS HERE CLASSED AS ALGONKIAN.

THESE ROCKS ARE AMONG THE MOST ANCIENT EXPOSED IN THE ENTIRE STATE. THEY ARE ROUGHLY CONTEMPORANEOUS WITH THE QUARTZITE EXPOSED IN THE VICINITY OF SIOUX FALLS, AND THE SCHISTS, GNEISSES, AND GRANITES WHICH MAKE THE CORE OF THE BLACK HILLS.

THE SURFACE OF THE ALGONKIAN ROCKS:

THE GRANITE SURFACE SLOPES VERY GRADUALLY TOWARD THE WEST ACCORDING TO THE REPORTS OF WELL DRILLERS. IT HAS BEEN STRUCK SIX MILES WEST OF THE OUTCROP AT A DEPTH OF 456 FEET. IN MILBANK IT WAS STRUCK IN WELLS AT DEPTHS OF 280 TO 300 FEET. FIVE MILES SOUTH OF MILBANK IT IS REPORTED 220 FEET BELOW THE SURFACE. A WELL NINE MILES SOUTH OF MILBANK STRUCK IT AT A DEPTH OF 240 FEET. THE SOUTHERNMOST GRANITE IS REPORTED ONE AND ONE-HALF MILES EAST OF ALBEE, TEN MILES SOUTH OF THE QUARRIES, WHERE IT WAS STRUCK 125 FEET UNDERGROUND.

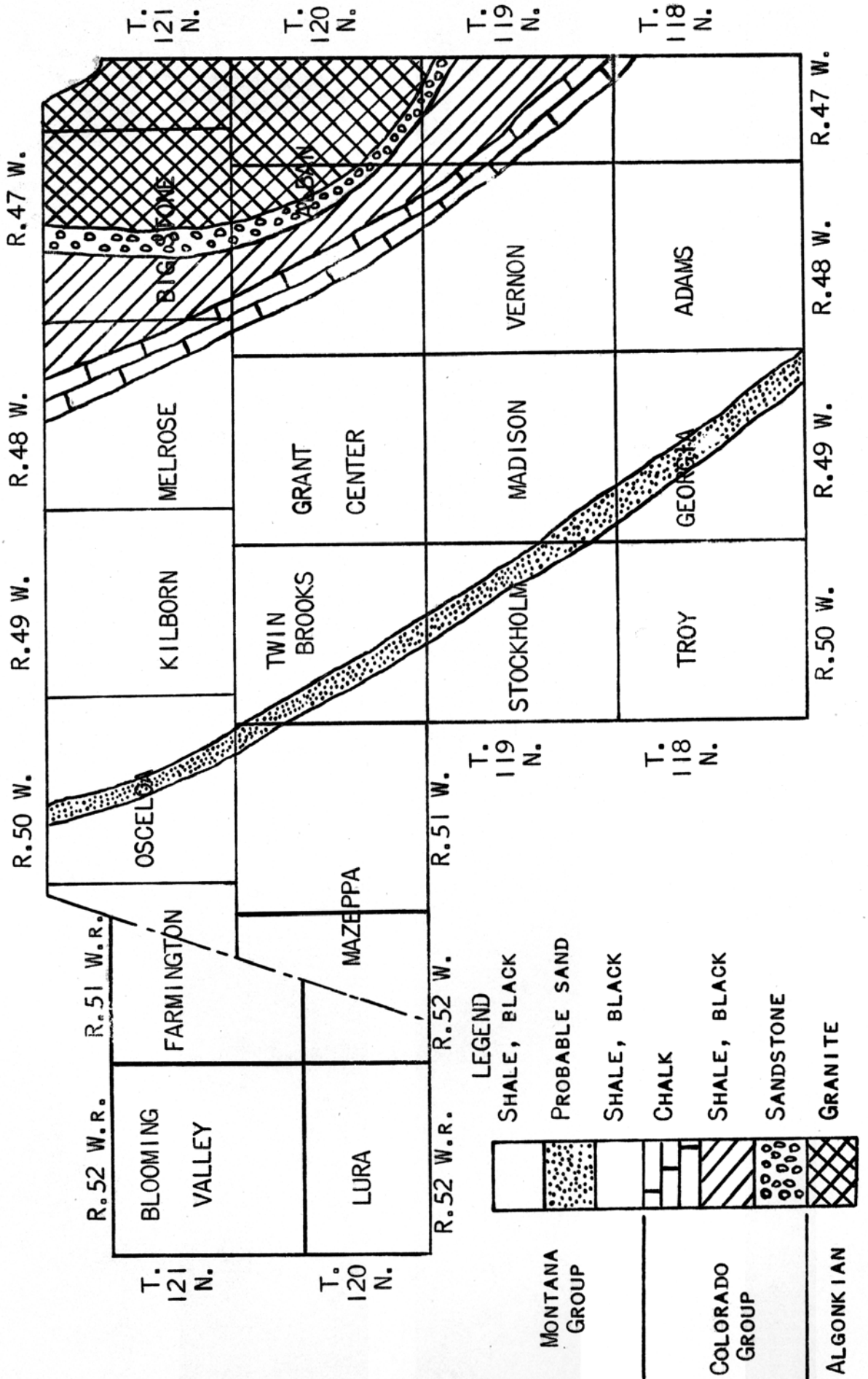
WHEN THESE DEPTHS ARE COMPUTED TO SEA LEVEL ELEVATIONS, THEY SHOW THAT THE SURFACE HAS AN APPROXIMATE ELEVATION OF 1000 FEET AT BIG STONE LAKE, 1100 FEET AT THE QUARRIES, 880 FEET AT MILBANK, 700 FEET ONE MILE WEST OF MILBANK, 800 FEET NINE MILES SOUTH OF MILBANK, AND 1100 FEET ONE AND ONE-HALF MILES EAST OF ALBEE. IN OTHER WORDS, THE SURFACE SLOPES WESTWARD AT A VERY LOW ANGLE, THE MAXIMUM SLOPE IN THIS REGION BEING 66 FEET PER MILE. ALTHOUGH THE GRANITE HAS NOT BEEN REACHED IN ANY WELLS DRILLED WEST OF THOSE MENTIONED, IT IS PROBABLE THAT THE SURFACE WILL BE ENCOUNTERED AT SEA LEVEL ELEVATIONS OF BETWEEN 500 AND 1000 FEET, UNDER THE ENTIRE COUNTY.

THE MARINE ROCKS

THE CHIEF CHARACTER OF MARINE ROCKS IS THEIR STRATIFICATION. THEY LIE LAYER UPON LAYER, LIKE HUGE BLANKETS OR RUGS PILED ONE UPON THE OTHER. THE LAYERS ARE MADE OF SAND, CLAY OR LIME DEPENDING UPON THE PART OF THE SEA IN WHICH THEY WERE FORMED, AND

GRANT COUNTY, SOUTH DAKOTA

APPROXIMATE DISTRIBUTION OF BEDROCK FORMATIONS UNDER THE GLACIAL DRIFTS



THE KINDS OF MATERIAL WHICH WERE SUPPLIED.

IN GRANT COUNTY MARINE ROCK HAS BEEN ENCOUNTERED IN WELLS ONLY. IN NO PLACE ARE THEY EXPOSED AT THE SURFACE. THAT THEY ARE OCEAN FORMED IS ATTESTED BY THE FACT THAT "SNAIL SHELLS" (CEPHALOPODS) ARE REPORTED FROM THEM IN THE VICINITY OF MILBANK. FISH TEETH WHICH CAME FROM "BLUE CLAY" IN A WELL TWO MILES EAST OF ALBEE WERE SHOWN BY THE DRILLER WHO SAVED THEM. SMALL BITS OF PYRITE (FOOL'S GOLD), WHICH WERE ENCOUNTERED IN THE BLUE CLAY OF THESE WELLS WERE ALSO SEEN, AND THE ROCK ITSELF WAS EXPOSED IN A DUG WELL NEAR MILBANK. THIS BLACK SHALE LOOKED VERY MUCH LIKE THE BLACK SHALE FOUND IN THE ROCKS OF THE CRETACEOUS SYSTEM IN OTHER PARTS OF THE STATE.

MANY WELLS HAVE BEEN DRILLED ON THE LOWLAND AND QUITE A NUMBER HAVE GONE DEEP ENOUGH TO AFFORD CONSIDERABLE VALUABLE INFORMATION ON THE CHARACTER OF THE BEDROCK. THE WELLS BETWEEN MILBANK AND TWIN BROOKS HAVE STRUCK WATER AT SEVERAL HORIZONS AND THE COMBINATIONS OF THEIR RECORDS SHOW THE FOLLOWING SUCCESSION OF STRATA:

30 TO 50 FEET	GLACIAL DRIFT. BOULDER CLAY.
75 TO 100 FEET	BLUE SHALE.
2 TO 5 FEET	CHALK ROCK. THESE THICKNESSES MENTIONED IN LOGS AS THOSE AT WHICH WATER FLOWS WERE OBTAINED; TOTAL THICKNESS NOT AVAILABLE.
200 TO 300 FEET	BLUE SHALE.
	SAND. ARTESIAN WATER SAND.

MR. MARTIN MORLEY, A WELL DRILLER OF MILBANK, DESCRIBES THE GENERAL SECTION BETWEEN THERE AND TWIN BROOKS AS FOLLOWS:

AT A DEPTH OF 125 TO 185	CHALK ROCK.
AT A DEPTH OF 330 FEET	SAND FOLLOWED BY BOX CLAY. (BLACK SHALE)
AT A DEPTH OF 350 FEET	SAND FOLLOWED BY BOX CLAY.
AT A DEPTH OF 385 FEET	SAND.

PYRITE CAP ROCKS OCCUR ON THE LOWER SAND, AT LEAST LOCALLY.

A WELL DUG ONE MILE EAST OF MILBANK, WHICH WAS BEING CLEANED AT THE TIME OF THIS INVESTIGATION (1933), GAVE THE ONLY CHANCE FOR THE INSPECTION OF THE BEDROCK IN THE COUNTY. THIS WELL DISPLAYS THE FOLLOWING SECTION:

42 FEET
8 FEET
PLEISTOCENE
CLAY; TYPICAL GLACIAL DRIFT.
SAND; FINE GRAINED, DARK COLORED,
HUMUS AND SPLINTERS OF WOOD FOUND
IN IT. COARSER PEBBLES AND SMALL
BOULDERS AT THE BASE. LARGEST
BOULDER ENCOUNTERED WAS A FOOT IN
DIAMETER. THIS IS A WATER SAND,
BUT THERE IS SUFFICIENT CLAY IN
IT TO MAKE IT MOLD SLIGHTLY IN
THE HAND. THE GLACIAL BOULDERS
(ONE GRANITE) AND THE UNMINERAL-
IZED WOOD SHOW THIS TO BE A GLACIAL
DEPOSIT.

5 TO 6 FEET
CRETACEOUS
BLACK GUMMY CLAY WITH LAMINATED BED-
DING MUCH LIKE PIERRE SHALES. IN
THIS SAME MATERIAL "SNAILS" (CEPH-
ALOPODS) WERE FOUND IN THE NORTH-
EASTERN PART OF MILBANK AT FORTY
ODD FEET BELOW THE SURFACE.

THE CHALK

THIS ROCK, A SOFT VARIETY OF LIMESTONE, IS WELL KNOWN TO THE LOCAL DRILLERS IN GRANT COUNTY AND IS DESCRIBED AS A WHITISH, CHALKY MATERIAL. IT IS REPORTED IN A NUMBER OF WELLS IN THE VICINITY OF MILBANK AND TWIN BROOKS WHERE IT FURNISHES A FLOW OF WATER. THOUGH NOT AN ARTESIAN WATER SUPPLY, IT FURNISHES VERY GOOD PUMP WELLS. CHALK ROCK IS ALSO ABUNDANT IN THE GLACIAL DRIFTS OF THE COUNTY, AND MAY HAVE COME FROM BEDROCK OF THIS SAME FORMATION NOT FAR AWAY. ONE CHALK PEBBLE FROM THE DRIFT CONTAINED A SPECIMEN OF OSTREA CONGESTA, THE TYPE FOSSIL OF THE NIOBRARA FORMATION.

THE CHALK LIES AT A DEPTH OF 125 TO 130 FEET BELOW THE SURFACE, WHICH IS AN ELEVATION OF ABOUT 1100 FEET ABOVE SEA LEVEL. THE RECORDS OF ARTESIAN WELLS WERE NOT SUFFICIENTLY DETAILED TO NOTE THE PENETRATION OF THE CHALK, PROBABLY BECAUSE THEY WERE DRILLED FOR FLOWING WATER AND LITTLE ATTENTION WAS PAID TO WATER HORIZONS WHICH WOULD NOT FLOW.

THE WELLS PRODUCING FROM THIS LEVEL LIE IN A BELT WHICH TRENDS NORTHWEST-SOUTHEAST AND PARALLELS THE BASE OF THE COTEAU A FEW MILES TO THE WEST. MOST OF THE COUNTRY EAST OF THE BELT

IS SERVED BY SHALLOW WELLS WHICH DO NOT ENTER THE BEDROCK. IT IS, THEREFORE, IMPOSSIBLE TO SAY HOW FAR THE CHALK MAY EXTEND IN THIS DIRECTION. IT IS ENTIRELY MISSING IN THE GRANITE AREA AND PROBABLY IS ERODED IN THE NORTHEASTERN CORNER OF THE COUNTY SINCE THE SURFACE HERE LIES AT A LOWER ELEVATION THAN THAT AT WHICH THE CHALK OCCURS IN THE WELLS. NO WELLS HAVE BEEN DRILLED ON THE COTEAU TO A SUFFICIENT DEPTH TO REACH THIS HORIZON, BUT CHALK ROCK SHOULD UNDERLIE ALL OF THE COUNTY WEST OF THE BELT IN WHICH THE WELLS OCCUR.

THE ARTESIAN SAND:

IN THE MILBANK-TWIN BROOKS AREA, AN ARTESIAN FLOW IS OBTAINED FROM A SANDSTONE WHICH LIES 200 TO 250 FEET BELOW THE CHALK. THESE WELLS ARE ABOUT 300 FEET DEEP IN THE VICINITY OF MILBANK, 500 FEET NEAR TWIN BROOKS AND 200 FEET NEAR THE NORTH COUNTY LINE, EIGHT MILES NORTH OF TWIN BROOKS. THE SAND LIES AT AN ELEVATION OF ABOUT 700 TO 800 FEET ABOVE SEA LEVEL NEAR TWIN BROOKS. SEVEN MILES TO THE NORTH, THE ARTESIAN SAND, WHICH IS PROBABLY THE SAME, LIES ABOUT 100 FEET HIGHER.

IT IS PROBABLE THAT THIS SAND UNDERLIES THE NORTHEASTERN AND THE SOUTHEASTERN PORTIONS OF THE COUNTY, BUT IS CUT OUT IN THE VICINITY OF THE GRANITE OUTCROPS. ITS FURTHEST EXTENSION SOUTH OCCURS AT REVILLO WHERE FLOWING WELLS ARE ENCOUNTERED IN A SAND LYING ABOUT 1000 FEET ABOVE SEA LEVEL. IT IS NOT POSSIBLE TO CORRELATE THIS SAND POSITIVELY WITH THE ARTESIAN SAND ABOUT TWIN BROOKS FOR THERE IS A GAP OF ABOUT EIGHT MILES IN WHICH NO DATA IS AVAILABLE, BUT THE ELEVATION OF THE SAND AND THE NEARNESS OF THE KNOWN GRANITE SURFACE SUGGESTS IT IS THE SAME. THE FOLLOWING LOG OF THE RAILROAD WELL DRILLED AT REVILLO WAS FURNISHED THROUGH THE COURTESY OF MR. G. E. LOVERING, ASSISTANT CHIEF ENGINEER FOR THE MINNEAPOLIS AND ST. LOUIS RAILROAD COMPANY.

LOG OF M. AND ST. L. RAILROAD, REVILLO, SOUTH DAKOTA.
 DRILLED JUNE, 1900. TESTED 7,500 GAL.
 PER HOUR. ELEVATION: 1208 FT.

POSSIBLE CORRELATION		
GLACIAL DRIFT	40 FEET	YELLOW CLAY
	25 FEET	SAND
<hr/>		
	115 FEET	BLUE CLAY
CRETACEOUS	15 FEET	FINE SAND
	31 FEET	COARSE SAND AND GRAVEL

A WELL, ONE MILE NORTH OF ALBEE, GAVE THE FOLLOWING LOG ACCORDING TO THE DRILLER. LOCATION: S. E. CORNER, SECTION 35, T. 119 N., R. 48 W.

30 FEET	GLACIAL DRIFT.
180 FEET	BLUE CLAY, NOT STICKY; CONTAINS FOOL'S GOLD.
5+ FEET	FINE SAND; GAVE GOOD WATER, BUT COULD NOT PUMP IT.

NOTE: A WELL ONE-HALF MILE NORTH MADE A GOOD PUMP WELL FROM THIS SAME SAND.

AT ALBEE A "FINE WHITE SAND" GIVES WATER AT A DEPTH OF 90 FEET OR A SEA LEVEL ELEVATION OF 1100 FEET. THE LOGS OF THE WELLS AS REPORTED GIVE:

GLACIAL DRIFT	40 FEET	CLAY
PROBABLY CRETACEOUS	----- 50 FEET -----	WATER SAND. WATER NOT GOOD, NOR IS SUPPLY DEPENDABLE. BLUE CLAY FINE WHITE SAND. PLENTY OF FRESH WATER; NOT SALINE TO TASTE, BUT DOES HAVE SLIGHT TASTE OF IRON.

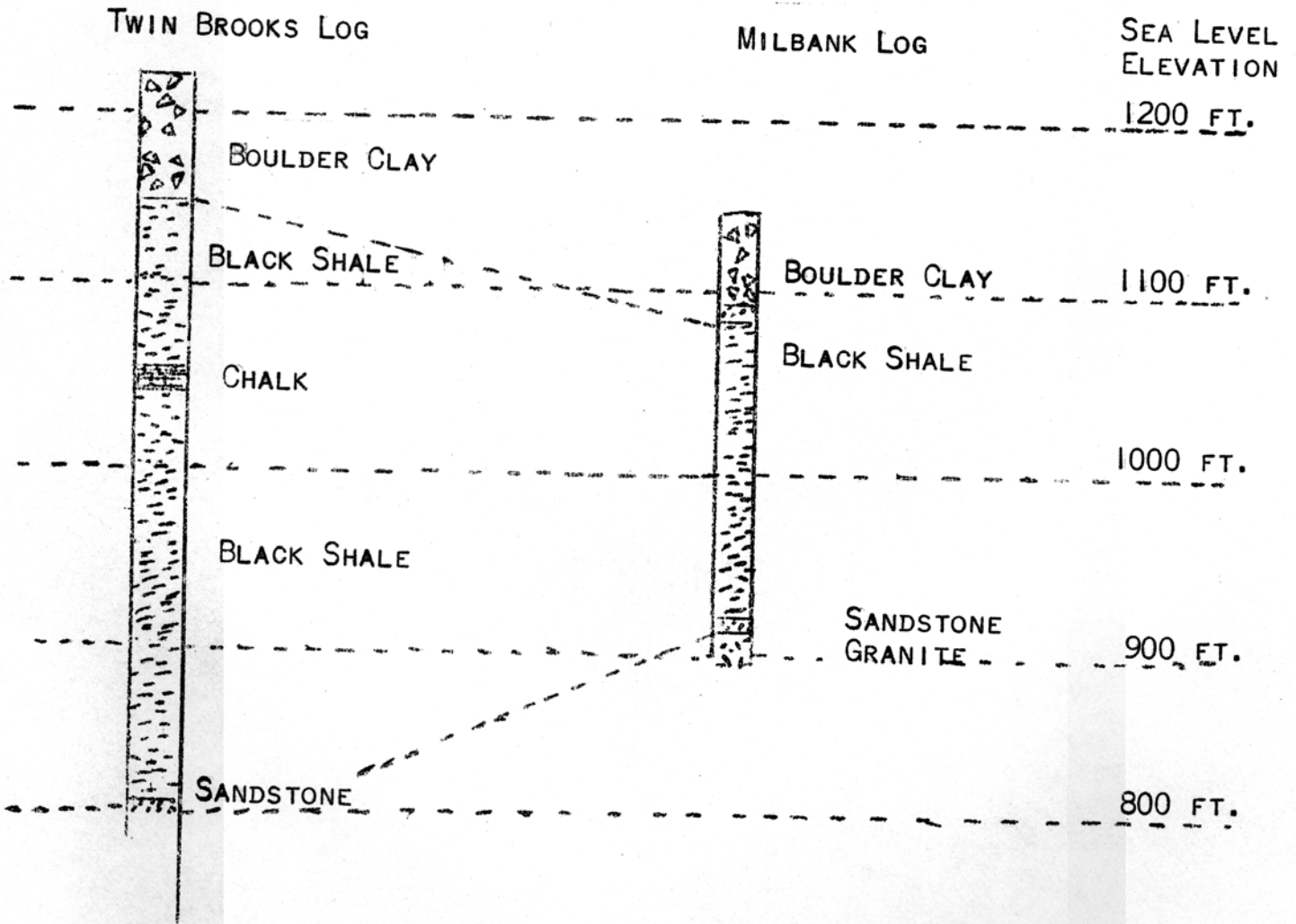
THE SEA LEVEL ELEVATION OF THIS SAND AND THE CHARACTER OF THE WATER CORRESPOND TO THAT OF THE CHALK NEAR TWIN BROOKS. THE MATERIAL, HOWEVER, IS REPORTED AS WHITE SAND, AND NO CUTTINGS WERE AVAILABLE FOR IDENTIFICATION. A MILE EAST OF ALBEE GRANITE IS REPORTED AT 125 FEET.

THE AGE OF MARINE ROCKS:

THE PRESENCE OF CHALK ROCK AND THE FISH TEETH INDICATE THAT THE BEDROCK OF THE LOWLAND IS OF CRETACEOUS AGE. BEYOND THIS LITTLE CAN BE SAID. THE CUSTOM OF CALLING ALL ARTESIAN SANDS NEAR THE BASE OF THE CRETACEOUS STRATA THE DAKOTA SANDSTONE WAS FOLLOWED BY DARTON. IN SPEAKING OF THE ARTESIAN HORIZONS IN GRANT COUNTY, HE SAYS, "IT HAS BEEN PROPOSED THAT THE BASAL BED IS THE DAKOTA SANDSTONE, BUT POSSIBLY IT IS THE BENTON." THE

I. DARTON, N. H., U.S. GEOL. SURV. WATER SUPPLY PAPER 227, P. 103, 1909.

GENERALIZED SECTIONS
FROM
WELL LOGS
BETWEEN
TWIN BROOKS AND MILBANK



CHALK SUGGESTS A CORRELATION WITH THE NIOBRARA, ESPECIALLY SINCE ONE DRIFT PEBBLE HELD A SPECIMEN OF THE INDEX FOSSIL, OSTREA CONGESTA. CHALK OCCURS IN THE PIERRE FORMATION, HOWEVER, ALONG THE MISSOURI RIVER AND ALSO IN THE GREENHORN FORMATION IN THE LOWER BIG SIOUX VALLEY. THE DETERMINATION OF THE EXACT AGE OF THESE BEDS MUST AWAIT A PALEONTOLOGICAL CORRELATION, BUT IT IS A SAFE ASSUMPTION THAT THE BEDROCK OF THE LOWLAND BELONGS IN THE LOWER PART OF THE CRETACEOUS SYSTEM.

THESE ROCKS OVERLAP THE OLD GRANITE SURFACE FROM THE WEST. THE CONTACT IS NOWHERE TO BE SEEN, BUT LIES BETWEEN MILBANK AND THE GRANITE OUTCROP FOUR MILES EAST OF THE CITY.

THE BEDROCK OF THE COTEAU:

NO BEDROCK IS EXPOSED ON THE COTEAU AND THE WATER SUPPLIES ARE FROM SHALLOW WELLS FOR THE MOST PART. FOR THIS REASON THERE IS VERY LITTLE SATISFACTORY INFORMATION AS TO THE CHARACTER OF THE ROCK UNDERLYING THIS PART OF THE COUNTY.

A LINE OF WELLS, WELL UP ON THE COTEAU SLOPE, AND TRENDING NORTHWEST-SOUTHEAST THROUGH STRANDBURG AND STOCKHOLM, GAVE NO SATISFACTORY INFORMATION, EXCEPT THAT THEY ALL DREW WATER FROM A HORIZON LYING BETWEEN 1400 AND 1500 FEET. IN SOME CASES THESE WERE FLOWING WELLS; IN OTHERS WATER HAD TO BE PUMPED. THE SOUTHERNMOST WELL IN THIS LINE IS A 315-FOOT WELL, THREE AND ONE-HALF MILES SOUTH OF STRANDBURG. SEVERAL WELLS OCCUR NEAR STOCKHOLM, DRAWING WATER FROM THE SAME ELEVATION. SEVERAL FLOWING WELLS PRODUCE FROM THIS HORIZON FOUR AND ONE-HALF MILES NORTHWEST OF STOCKHOLM. THE NORTHERNMOST WELL OF THIS LINE IS KNOWN AS THE BRENNEN WELL AND LIES ABOUT THREE MILES SOUTH OF MARVIN.

INFORMATION AVAILABLE ON THE SOUTHERNMOST WELL WAS THAT IT FURNISHED AN ABUNDANT SUPPLY OF WATER AND WAS DRILLED INTO A SAND VEIN.¹ A SEVENTY-FOOT FLOWING WELL, ONE MILE SOUTHEAST OF STRANDBURG, ORIGINATED IN THE SAND AT AN ELEVATION OF ABOUT 1570 FEET.

THE BEST WELL LOG ON THE COTEAU WAS OBTAINED FROM A WELL WHICH WAS BEING FINISHED AT THE TIME OF THE INVESTIGATION. IT WAS LOCATED ONE-HALF MILE EAST OF STOCKHOLM, AND AFFORDED A GOOD COMPARISON WITH TWO OTHER WELLS DRILLED SOUTH OF STOCKHOLM. THE DRILLER, MR. IVAN KORSBURG, GAVE THE FOLLOWING LOG:

1. THE NORBECK COMPANY. PERSONAL COMMUNICATION.

65 FEET	BLUE CLAY.
15 FEET	FINE WHITE SAND. A SAMPLE OF THIS SAND UNDER THE MICROSCOPE SHOWED IT TO BE COMPOSED ALMOST ENTIRELY OF ANGULAR FRESHLY BROKEN BITS OF QUARTZ, WELL SORTED IN SIZE.
70 FEET	BLUE CLAY. AN UNSATISFACTORY SAMPLE OF THIS MATERIAL FROM THE SLUDGE PIT DISPLAYED A GREAT DEAL OF SANDY MATERIALS STUCK TOGETHER WITH A HEAVY CLAY, BUT IT WAS IMPOSSIBLE TO ASCERTAIN WHETHER THIS WAS A MIXTURE OF CRETACEOUS SHALES AND THE WHITE SAND OR WAS GLACIAL MATERIAL.
4 FEET	COARSE GRAVEL. WATER BEARING HORIZON.

NEITHER OF THESE SAMPLES, FROM THE FIFTEEN-FOOT SAND OR THE SEVENTY-FOOT BLUE CLAY, COULD BE POSITIVELY IDENTIFIED AS BEDROCK. THE BLUE CLAY, AS IT WAS FOUND IN THE SLUDGE PIT, HAS MUCH THE CHARACTER OF SANDY GLACIAL CLAY. THIS WAS THE BEST DIRECT EVIDENCE AVAILABLE AT THE TIME OF THE EXAMINATION.

IT IS INTERESTING, HOWEVER, TO NOTE THAT THE WELLS ALONG THE FRONT OF THE COTEAU STRIKE THE WATER SAND AT A UNIFORM HORIZON WHICH DIPS SLOWLY TO THE NORTH. THREE MILES SOUTH OF STRANDBURG, THE 315-FOOT WELL PRODUCES WATER AT APPROXIMATELY 1600 FEET ABOVE SEA LEVEL, WHILE A 190-FOOT WELL ACROSS THE ROAD PRODUCES THE WATER FROM A SAND AT ABOUT 1470 FEET.

AT STOCKHOLM, SEVEN MILES NORTH OF THESE WELLS, THE UPPER SAND IS ENCOUNTERED AT AN ELEVATION OF APPROXIMATELY 1585 FEET AND THE LOWER SAND AT APPROXIMATELY 1500 FEET IN THREE WELLS NEAR THE TOWN. THREE MILES NORTHWEST OF STOCKHOLM FLOWING WELLS WERE PRODUCING FROM A SAND AT AN ELEVATION OF ABOUT 1450 FEET, WHILE ABOUT FOUR MILES NORTHWEST OF THESE, THE BRENNEN WELL DRAWS FROM A SAND AT AN ELEVATION OF 1372 FEET. THREE MILES EAST OF THE BRENNEN WELL THE LINE OF SPRINGS BREAKS OUT ON THE FACE OF THE COTEAU AT AN ELEVATION VARYING FROM 1360 TO 1425 FEET.

THE AVAILABLE DATA IS INCONCLUSIVE, BUT THERE IS A SUGGESTION IN THE CONCORDANCE OF THE LEVELS AT WHICH THESE WELLS PRODUCE. SUCH UNIFORMITY IS MOST COMMON IN MARINE SANDSTONES, WHICH IN THIS CASE WOULD BE IN THE BEDROCK. THERE IS, OF COURSE, A POSSIBILITY THAT THE CONCORDANCE IS DUE MERELY TO CHANCE AND THAT THE WELLS ARE PRODUCING FROM SEPARATE SANDS. THE REMARKABLY UNIFORM FLOW OF WATER, AND THE LACK OF ANY DECREASE DURING THE RECENT DRY SEASON, HOWEVER, STRENGTHEN THE SUGGESTION OF A BEDROCK WATER SAND.

THERE HAS BEEN SOME DIFFERENCE OF OPINION AS TO THE FORMATION OF THE COTEAUS; THE OLDER MINNESOTA GEOLOGISTS ASSERTING THAT THE COTEAUS WERE A ROCK ESCARPMENT AND THAT THE GLACIAL DRIFT COVERS IT AS A THIN VENEER. "THE ALTITUDE OF THE COTEAUS IS DOUBTLESS THUS CAUSED BY THE GREATER HEIGHT OF THE FORMATIONS, PROBABLY CRETACEOUS, UPON WHICH THESE DRIFT DEPOSITS LIE, RATHER THAN BY EXTRAORDINARY THICKNESS OF THE DRIFT BEYOND THAT WHICH IT COMMONLY HAS THROUGHOUT SOUTHWESTERN MINNESOTA. THE DEPTH THAT IS ADDED TO THE GENERAL DRIFT-SHEET BY THE ACCUMULATIONS OF THE TERMINAL MORAINES DOES NOT APPEAR TO AVERAGE MORE THAN 50 TO 75 FEET."¹ LATER GEOLOGISTS ESPECIALLY INTERESTED IN GLACIAL PHENOMENA HAVE TAKEN THE VIEW THAT THE COTEAUS WERE LARGELY DEPOSITS OF DRIFT AT LEAST IN MINNESOTA. "THE PROMINENT COTEAU DES PRAIRIES, IN THE SOUTHWESTERN PART OF MINNESOTA, WAS FOR SOME TIME INTERPRETED BY GEOLOGISTS AS OWING ITS GREAT PROMINENCE CHIEFLY TO CRETACEOUS STRATA, WHICH WERE THOUGHT TO FILL THE GAPS BETWEEN THE HIGH AREAS OF SIOUX QUARTZITE NOTED ABOVE. BUT STUDIES BY MEINZER ALONG THE COTEAU AND LATER STUDIES BY THE PRESENT WRITER HAVE SHOWN THAT THE FILLING BETWEEN THE QUARTZITE AREAS CONSISTS LARGELY OF GLACIAL MATERIAL, BORINGS HAVING BEEN PUT DOWN TO A DEPTH OF 400 TO 500 FEET WITHOUT ENCOUNTERING ROCK."²

THE STATEMENT BY MEINZER TO WHICH DR. LEVERETT REFERS READS IN PART AS FOLLOWS: "IT STILL SEEMS ALTOGETHER PROBABLE THAT THE ELEVATION OF THE COTEAU IS TO A LARGE EXTENT CAUSED BY OLDER FORMATIONS (THOUGH AS YET THERE IS NO PROOF OF THIS IN MINNESOTA); BUT THE WELL DATA AT HAND SHOW THAT THE AVERAGE THICKNESS OF THE DRIFT IS MUCH GREATER HERE THAN ON THE ADJACENT LOWLAND PLAIN, AND THAT SO FAR AS THIS COUNTY (LINCOLN COUNTY, MINNESOTA) IS CONCERNED A CONSIDERABLE PART OF THE HIGHER ELEVATION RESULTS FROM THIS GREATER THICKNESS. THE WELL RECORDS ALSO SEEM TO INDICATE THAT THE PRESENT MARGIN OF THE COTEAU IS DETERMINED BY THE DEPOSITS OF DRIFT, AND THAT LOCALLY THE UNDERLYING FORMATIONS ARE NO HIGHER ABOVE SEA LEVEL BENEATH THE COTEAU THAN BENEATH THE LOWLAND PLAIN."³

EVEN THOUGH THE DATA AT HAND DO NOT SOLVE THE PROBLEM FOR THE PORTION OF THE COTEAU IN GRANT COUNTY, IT IS OF INTEREST TO NOTE THAT THIS SECTION IS A SMALL PART OF THE ESCARPMENT WHICH HAS BEEN TRACED NORTHWARD THROUGH NORTH DAKOTA INTO SOUTHERN CANADA. THE NORTHERN END OF THE ESCARPMENT IS KNOWN TO BE ROCK

1. UPHAM, WARREN, THE GEOLOGY OF MINNESOTA, MINNESOTA GEOLOGICAL AND NATURAL HISTORY SURVEY VOL. 1, 1882, p. 601.
2. LEVERETT, FRANK, QUATERNARY GEOLOGY OF MINNESOTA AND PARTS OF ADJACENT STATES", U.S.G.S. PROF. PAPER 161, p. 11, 1932.
3. MEINZER, O. E., "GEOLOGY AND UNDERGROUND WATERS OF SOUTHERN MINNESOTA, U.S.G.S. WATER SUPPLY PAPER 256, p. 233, 1911.

CORED. THE MOST SOUTHERLY OUTCROP IS THE PEMBINA MOUNTAINS, WHICH IS THE NAME GIVEN THAT PART OF THE ESCARPMENT LYING IN NORTHERN NORTH DAKOTA, WHERE CRETACEOUS FORMATIONS OUTCROP. IT IS PROBABLY SAFE TO ASSUME, THEREFORE, THAT THE GRANT COUNTY SECTION OF THE COTEAU IS ROCK CORED, AND THAT BEDROCK WILL BE FOUND AT AN ELEVATION SEVERAL HUNDRED FEET ABOVE THAT AT WHICH IT OCCURS ON THE LOWLAND.

THE GLACIAL DRIFTS

GLACIAL DEPOSITS DOMINATE THE GEOLOGY OF GRANT COUNTY. THEY ARE SPREAD AS A MANTLE OVER THE ENTIRE COUNTY, ENTIRELY CONCEALING ALL OLDER ROCKS EXCEPT FOR THE VERY FEW SMALL OUTCROPS OF GRANITE WHICH HAVE BEEN DESCRIBED (PAGE 15). THESE DEPOSITS CONSIST OF DEBRIS LEFT BY MELTING ICE SHEETS WHICH COVERED THE COUNTY IN THE GEOLOGIC YESTERDAY, AT A TIME IN THE EARTH'S HISTORY KNOWN AS THE PLEISTOCENE EPOCH, SOMETIMES CALLED THE GREAT ICE AGE.

THESE DEPOSITS COLLECTIVELY ARE CALLED THE GLACIAL DRIFTS, AND UNDER THIS HEAD IS INCLUDED BOULDER CLAY (TILL), WHICH COMPOSES BY FAR THE BULK OF THE DEPOSITS, SANDS AND GRAVELS WASHED DOWN CHANNELS IN FRONT OF THE MELTING ICE, AND DEPOSITS OF WIND-BLOWN DUST WHICH ARE PROMINENT IN SOME OF THE SOILS OF THE COUNTY.

THREE SHEETS OF DRIFT WERE LAID OVER THE COUNTY BY THREE SUCCESSIVE ICE SHEETS, AND PARTS OF THEM STILL REMAIN, THOUGH THE LAST ICE DID MUCH TO OBLITERATE THE EARLY DRIFTS. TO GLACIAL GEOLOGISTS, THE OLDEST SHEET IS KNOWN AS THE KANSAN DRIFT SHEET, THE NEXT YOUNGER, THE IOWAN, AND THE YOUNGEST, THE WISCONSIN. THESE NAMES ARE BORROWED FROM NEIGHBORING STATES IN WHICH DRIFT SHEETS WERE BEING FORMED AT THE SAME TIME THAT THEY WERE IN GRANT COUNTY.

THE THICKNESS OF THE DRIFT VARIES IN DIFFERENT PARTS OF THE COUNTY, AND IT IS POSSIBLE ONLY TO GIVE A FEW GENERALIZATIONS HERE. ON THE LOWLAND THE DRIFT IS MUCH THINNER THAN ON THE FACE OF THE COTEAU. A STUDY OF THE WELL RECORDS GIVES AN AVERAGE OF ABOUT 50 FEET FOR THE DRIFT OF THE LOWLAND. THE FOLLOWING TABLE MAY SERVE AS A GUIDE:

MILBANK - - - - -	50 FEET
TWIN BROOKS - - - - -	71 FEET
MELROSE TOWNSHIP	
(T. 121 N., R. 48 W.) -	60 TO 65 FEET
ALBEE - - - - -	40 TO 60 FEET

ON THE COTEAU THE ONLY INFORMATION AVAILABLE WAS THAT FROM THE WELL NEAR STOCKHOLM WHERE THE DRIFT WAS AT LEAST 150 FEET IN DEPTH. NO INFORMATION AS TO THE THICKNESS OF THE DRIFT IS OBTAINABLE ON THE HIGH PARTS OF THE COTEAU.

THE KANSAN DRIFT SHEET

KANSAN DRIFT IS EXPOSED IN VERY FEW PLACES IN THE COUNTY, THE OUTCROPS ALL BEING ON THE EAST SIDE OF THE COTEAU. THREE OF THEM ARE WELL UP ON THE ESCARPMENT IN THE SOUTHERN PART OF THE COUNTY, AND ONE IS ON THE LOWLAND NORTH OF TWIN BROOKS. THIS SITUATION MAY BE DUE TO THE FACT THAT, SINCE ITS FORMATION, TWO GLACIERS HAVE OVERRIDDEN THE KANSAN DRIFT SHEET AND DOUBTLESSLY REMOVED MUCH OF IT. IT IS ALSO DUE TO THE FACT THAT THE KANSAN DRIFT SHEET IS WELL CONCEALED UNDER DRIFTS LEFT BY THE TWO YOUNGER GLACIERS.

THE BEST SECTION WAS OBTAINED FROM AN EXPOSURE FIVE MILES SOUTH OF LABOLT IN THE SOUTHWEST CORNER OF SECTION 35, T. 118 N., R. 49 W. AT THIS POINT HIGHWAY NO. 77 CROSSES A LARGE STREAM AND THE ROAD CUT ON BOTH THE NORTH AND SOUTH BLUFFS EXPOSE THE DRIFT.

SECTION OF KANSAN DRIFT

S.W. CORNER, SECTION 35, T. 118 N., R. 49 W.

2 FEET	PRAIRIE SOIL; BLACK TO BROWN; SCATTERED PEBBLES AND 6 TO 8 INCH BOULDERS.
1½ FEET	"FOREST SOIL"; ASHY GRAY; FLUFFY FEEL; WITH TYPICAL COLUMNAR JOINTING AND PSEUDO-LAMINATION. THIS IS SIMILAR IN COLOR, TEXTURE AND STRUCTURE TO THE SANGAMON FOREST SOIL OF ILLINOIS.
2 FEET	SAND, BUFF, MEDIUM GRAINED.
5 FEET	GUMBO TILL; VERY STICKY; DARK BROWN TO BLACK ON OUTCROP, BUT DRIES TO A LIGHT BROWN; GUMBO CHECKING ON SURFACE AND TYPICAL STARCHY FRACTURE ON FRESH MATERIAL. NO PEBBLES OR BOULDERS.
10+ FEET	DARK COLORED DRIFT.

ON THE COUNTY LINE TWO MILES EAST OF THE SECTION JUST DESCRIBED AND TWO AND ONE-HALF MILES SOUTHWEST OF REVILLO, ANOTHER GOOD EXPOSURE OCCURS. THE FOREST SOILS ARE WELL DISPLAYED AND A DARK, STICKY TILL UNDERLIES IT. THE TYPICAL GUMBO, HOWEVER, IS NOT PRESENT.

SECTION OF KANSAN DRIFT

S.W. CORNER, SECTION 32, T. 118 N., R. 48 W.
ROAD CUT AT THE NORTHEAST CORNER OF ROAD
INTERSECTION.

- | | |
|-------------|---|
| 2½ FEET | PRAIRIE SOIL. SILTY WITH SOME PEBBLES AND ONE GRAVEL PATCH ACROSS WHICH SOIL HAS BEEN FORMED; BLACK AT THE TOP, GRADING INTO BROWN BELOW; TYPICAL COLUMNAR JOINTING. |
| 1 FOOT | SAND AND FINE GRAVEL WITH PROMINENT STRATIFICATION. |
| 1 FT. 8 IN. | "FOREST SOIL". LIGHT, ASHY GRAY, SILTY MATERIAL; ONE COMPACTED WITH COLUMNAR JOINTING; TYPICAL OF SOILS AND FULL OF ABUNDANT ROOT MARKS AND LEAF IMPRESSIONS; PSEUDO-BEDDING. |
| 4 FEET | TILL. DARK BROWN AND STICKY; PEBBLES PRESENT, BUT NOT ABUNDANT; NO CHALK OBSERVED, BUT PROBABLY LOST BY LEACHING; DOLOMITES, IGNEOUS AND METAMORPHIC ROCK INCLUDED IN THE PEBBLES; BOTH FRESH AND ROTTEN IGNEOUS PEBBLES ARE PRESENT. |

ONE MILE NORTH OF TWIN BROOKS TWO DRIFTS ARE EXPOSED IN A ROAD CUT. THE LOWER OF THESE HAS ALL THE EARMARKS OF KANSAN TILL AND THE UPPER IS EVIDENTLY THE YOUNGER WISCONSIN SHEET. AN UNDULATING CONTACT, IN THE HOLLOW OF WHICH OCCUR SMALL PATCHES OF SAND AND GRAVEL, SEPARATES THE TWO. AT THIS POINT THE FOLLOWING SECTION WAS MEASURED.

SECTION OF KANSAN DRIFT

N.W. CORNER, SECTION 120 N., R. 50 W.

- | | |
|-------------|--|
| 1 FT. 8 IN. | BLACK PRAIRIE SOIL. NON-CALCAREOUS;
GRADING INTO:- |
| 1 FT. 6 IN. | MORE CALCAREOUS BROWN SOIL, PARTLY LEACHED, BUT WITH SAME COLUMNAR JOINTING AS THE BLACK SOIL. |

2 FT.

YELLOW CALCAREOUS TILL; LIES ON WAVY SURFACE WITH STONY OR GRAVELLY SPOTS IN HOLLOW OF THE CONTACT.

4 FT.

TILL. DENSE, DARK BROWN, COLUMNAR JOINTING. STICKY BUT NOT GUMBO TILL. PARTLY LEACHED. ONE PEBBLE OF MUCH WEATHERED CHALK NOTED. VEINS AND STRINGERS OF SECONDARY CALCITE THROUGHOUT THE OUTCROP.

NOTE: THE DEGREE OF OXIDATION AND LEACHING OF THIS LOWER TILL INDICATES THAT IT IS NEAR THE TOP OF THE KANSAN DRIFT.

A FOURTH OUTCROP WAS NOTED A MILE SOUTH OF STOCKHOLM. THESE OUTCROPS ARE FAR ENOUGH APART TO SHOW THAT THE KANSAN ICE SHEET COVERED THE ENTIRE COUNTY AND ITS DEPOSITS MUST HAVE MANTLED THE ENTIRE TOPOGRAPHY BEFORE THE COMING OF THE LATER ICE SHEETS. THIS FACT IS FURTHER STRENGTHENED BY THE OCCURRENCE OF KANSAN DRIFT IN THE VICINITY OF LAKE KAMPESKA IN CODINGTON COUNTY, WEST OF GRANT COUNTY.!

THE IOWAN DRIFT SHEET:

THE IOWAN DRIFT IS EXPOSED ONLY IN THE PANHANDLE OF GRANT COUNTY, WEST OF THE ANTELOPE VALLEY, WHERE IT COVERS AN AREA OF LESS THAN FOUR TOWNSHIPS (BLOOMING VALLEY, FARMINGTON, LURA AND MAZEPPA). IT APPEARS AS A THIN SHEET OF TILL SPREAD OVER AN OLD, WELL-DRAINED TOPOGRAPHY. THE DRIFT DISPLAYS A SMOOTH UNDULATING SURFACE, CHARACTERIZED BY BROAD OPEN VALLEYS WITH GENTLE BLUFFS AND INDEFINITE CHANNELS. SWAMPS AND LAKES, SO ABUNDANT ON THE YOUNGER DRIFT TO THE EAST AND WEST OF THIS AREA, ARE CONSPICUOUS BY THEIR ABSENCE. THE TILL AT THE SURFACE IS NOT AS STONY AS IS THE TILL OF THE YOUNGER DRIFT. THERE ARE NO SHARP RIDGES OR HILLS OF DRIFT, SUCH AS CHARACTERIZE THE TERMINAL MORAINES OF THE YOUNGER DRIFT SHEET, AND NO GRAVEL HILLS (KAMES OR ESKERS) BREAK THE SMOOTH SURFACE OVER THE ENTIRE OUTCROP.

THESE FEATURES ARE CHARACTERISTIC OF THE IOWAN DRIFT WHERE IT OCCURS IN MINNESOTA AND IOWA.² THE ABUNDANT GRAVELS, CHARACTERISTIC OF IOWAN DRIFT IN OTHER PLACES, ARE NOT PRESENT IN GRANT COUNTY. LARGE DEPOSITS OF GRAVEL OCCUR IN THE BIG SIOUX VALLEY AND IN THE ANTELOPE VALLEY, BUT THESE ARE THE PRODUCTS OF THE WISCONSIN ICE SHEET.

1. LEVERETT, FRANK, U.S. GEOL. SURV. PROF. PAPER 161, MAP ON PAGE 58. 1932.
2. LEVERETT, FRANK, U.S. GEOL. SURV. PROF. PAPER 161, PAGE 23, 1932. CARMAN, ERNEST J., FURTHER STUDIES ON PLEISTOCENE GEOLOGY OF NORTHWESTERN IOWA, ANNUAL REPORT FOR 1929, IOWA GEOL. SURV. VOL. 35, PAGE 40.

THE WISCONSIN DRIFT SHEET:

THIS SHEET OF DRIFT FORMS THE SURFACE OF MOST OF THE COUNTY, THE VARIOUS DETAILS OF TOPOGRAPHY BEING LARGELY DUE TO IRREGULARITIES IN ITS DEPOSITION. THE SMOOTH AREAS OF THE LOWLAND AND ON THE FACE OF THE COTEAU ARE WISCONSIN TILL PLAINS, OFTEN CALLED GROUND MORAINES. THE ROUGH AREAS ARE IRREGULAR PILES THE WISCONSIN DRIFT FORMED AS THE ICE FRONT HALTED IN ITS EASTWARD RETREAT. THESE ARE THE TERMINAL MORAINES OF THE GEOLOGIST.

THE WISCONSIN GLACIER MOVED INTO THE COUNTY FROM THE EAST, CLIMBED THE COTEAU HIGHLANDS TO THE APPROXIMATE LOCATION OF THE ANTELOPE VALLEY. AFTER A LONG PAUSE HERE, THE INCREASING HEAT MELTED THE ICE SO RAPIDLY THAT THE FRONT RETREATED EASTWARD FASTER THAN THE NEW ICE WAS FURNISHED BY THE GLACIER. THE FRONT THUS RETREATED EASTWARD OFF THE COTEAU AND ACROSS THE LOWLAND, HALTING THREE TIMES, BEFORE IT LEFT THE COUNTY ALL TOGETHER.

AT THE SAME TIME A TONGUE OF ICE, WHICH WAS MOVING DOWN THE JAMES VALLEY, SPREAD EASTWARD ONTO THE COTEAU AND REACHED THE EXTREME SOUTHWEST CORNER OF THE PANHANDLE OF GRANT COUNTY, WHERE IT WAS HALTED AND FINALLY RETREATED DUE TO EXCESSIVE MELTING, AS THE ICE FROM THE EASTERN LOBE HAD DONE. ONLY FIVE SQUARE MILES OF GRANT COUNTY ARE COVERED WITH THE DRIFTS OF THIS JAMES VALLEY GLACIER.

WITH THIS GENERAL PICTURE IN MIND IT WILL BE POSSIBLE TO DESCRIBE BRIEFLY THE DETAILS OF THE WISCONSIN DRIFT SHEET. FOR CONVENIENCE THEY CAN BE DIVIDED INTO MORAINIC AND OUTWASH DEPOSITS. THE FORMER WILL INCLUDE THE GROUND AND TERMINAL MORAINES WHICH ARE LARGELY BOULDER CLAY (TILL), AND THE LATTER WILL INCLUDE THE SANDS AND GRAVELS WHICH WERE DEPOSITED AT THE ICE FRONTS AT VARIOUS STAGES DURING ITS RETREAT ACROSS THE COUNTY.

ALTAMONT MORaine:

THE EASTERN EXTENSION OF THE GLACIER IN THE JAMES VALLEY IS MARKED BY A SHARP RISE FROM THE GENTLE UNDULATIONS OF THE IOWAN DRIFT SURFACE TO A ROUGH TOPOGRAPHY WHICH COVERS SECTIONS 17, 18, 19, 20 OF TOWNSHIP 120 NORTH, RANGE 52 WEST (LURA TOWNSHIP). THIS IS A SMALL AREA BUT IS PART OF A VERY LARGE TERMINAL MORaine WHICH EXTENDS INTO CODINGTON AND DAY COUNTIES AND HAS BEEN CALLED THE ALTAMONT MORaine, BECAUSE IT IS THE OUTER MORaine OF THE WISCONSIN ICE SHEET.

1. CHAMBERLIN, T. C., U.S. GEOL. SURV. THIRD ANNUAL REPORT, PP. 378-386, 393; 1883.

MADE IN U.S.A.

THE DOMINANT FEATURE OF THE WISCONSIN DRIFT IN GRANT COUNTY IS THAT PART OF THE ALTAMONT TERMINAL MORaine WHICH WAS FORMED WHEN THE WISCONSIN ICE TONGUE, WHICH MOVED IN FROM MINNESOTA, REACHED THE TOP OF THE COTEAU ESCARPMENT. THIS GREAT MORaine IS CHARACTERIZED BY AN EXCEEDINGLY ROUGH SURFACE IN WHICH KETTLE-LIKE HOLLOWs, CARRYING LAKES AND SWAMPs, ABOUND. THEY ARE SURROUNDED BY A MASS OF KNOBBY, BOULDER-COVERED HILLS AVERAGING 50 FEET IN HEIGHT. THIS MORaine COVERS MOST OF TROY TOWNSHIP (T. 118 N., R. 50 W.), IN THE SOUTHWESTERN PART OF THE COUNTY, AND TRENDS NORTHWEST IN A BELT TWO TO FOUR MILES WIDE, LEAVING THE COUNTY AT THE CITY OF SUMMIT. THE MORaine FORMS THE CREST OF THE COTEAU ESCARPMENT AND RISES ABOVE THE TOPOGRAPHY BOTH EAST AND WEST OF IT. ITS ELEVATION AT SUMMIT IS APPROXIMATELY 2050 FEET WHICH IS 100 FEET ABOVE THE IOWAN DRIFT TO THE WEST. BOTH ITS SIZE AND THE LARGE AMOUNTS OF GRAVEL WHICH LINE ITS FRONT INDICATE THAT THE ICE STOOD AT THIS LOCATION FOR A LONG TIME. THIS STRONG MORaine CAN BE TRACED CONTINUOUSLY SOUTHWARD FROM GRANT COUNTY THROUGH THE TOWN OF ALTAMONT, SOUTH DAKOTA, FROM WHICH IT DERIVES ITS NAME.

THOUGH THE ALTAMONT MORaine REPRESENTS THE LONGEST STAND OF ICE, IT IS NOT THE EXTREME WESTWARD LIMIT OF ICE ADVANCE ALONG THE COTEAU ACCORDING TO DR. LEVERETT. AN INDEFINITE MORaine LIES IMMEDIATELY IN FRONT OF THE ANTELOPE VALLEY SOUTH OF GRANT COUNTY. THIS MORaine IS CALLED THE BEMIS MORaine AND REPRESENTS A STAND OF THE WISCONSIN ICE FRONT WHICH WAS OF SHORT DURATION. THE MAIN STAND WAS ALONG THE ALTAMONT MORaine. THE BEMIS MORaine IS DEVELOPED AS A WEAK BUT DISTINCT TOPOGRAPHIC FEATURE IN COD-INGTON COUNTY WHERE IT IS REPRESENTED BY STONY KNOBS AND RIDGES AND GRAVEL HILLS SOUTH OF PUNISHED WOMAN'S LAKE. THE LANDMARK, KNOWN AS PUNISHED WOMAN'S MOUND, IS ONE OF THESE HILLS.

IN GRANT COUNTY, HOWEVER, THESE FEATURES HAVE ENTIRELY DIS-APPEARED AND THE DIVISION BETWEEN THE WISCONSIN AND IOWAN DRIFT SHEETS IS VERY INDISTINCT. JUDGING FROM THE TOPOGRAPHY, THE LINE OF SEPARATION BETWEEN THESE DRIFTS IN THE PANHANDLE OF GRANT COUNTY, SHOULD BE PLACED AT THE WESTERN EDGE OF THE ANTELOPE VAL-LEY. A SMALL AREA OF ROUGH TOPOGRAPHY ON THE WESTERN SIDE OF THE ANTELOPE VALLEY IMMEDIATELY SOUTH OF CROOKED LAKE IS THE ONLY SUGGESTION OF THE BEMIS MORaine IN GRANT COUNTY.

GARY MORaine:

A SECOND MORaine PARALLELING THE ANTELOPE MORaine LIES TWO MILES EAST OF IT AND ABOUT 400 FEET LOWER ON THE COTEAU

I. LEVERETT, FRANK, U.S.G.S. PROFESSIONAL PAPER 161, P. 57.

ESCARPMENT. IT IS CALLED THE GARY MORaine BECAUSE A MORaine WITH A SIMILAR RELATION TO THE ALTAMONT MORaine PASSES THROUGH THE TOWN OF GARY, SOUTH DAKOTA. "THE GARY MORaine IS NAMED BY CHAMBERLIN FROM GARY, SOUTH DAKOTA. IT IS COMBINED WITH THE ALTAMONT MORaine IN ROBERTS AND GRANT COUNTIES, SOUTH DAKOTA, THE COMBINED BREADTH BEING SIX TO EIGHT MILES, ABOUT HALF OF WHICH PROBABLY PERTAINS TO THE GARY MORaine."¹ IN THE NORTHERN PART OF THE COUNTY THE GARY MORaine SHOWS AS A BELT OF DECIDEDLY ROUGH TOPOGRAPHY ALMOST A MILE IN WIDTH, AND IS EASILY TRACED THROUGH MARVIN, BUT IT BECOMES VERY INDEFINITE SOUTH OF TWIN BROOKS, AND ITS LOCATION IN THE SOUTHERN PART OF THE COUNTY CAN BE TRACED ONLY BY PATCHES OF LOW HILLS WHICH ARE COVERED BY AN UNUSUAL NUMBER OF BOULDERS.

MILBANK MORaine:

WERE IT NOT PERSISTENT FOR SUCH A LONG DISTANCE, THE PARTS OF THE MILBANK MORaine WOULD DOUBTLESS BE CONSIDERED AS DETAILS OF THE GROUND MORaine RATHER THAN A TERMINAL MORaine. THIS MORaine OCCURS AS A LOW RIDGE RISING TWENTY TO FIFTY FEET ABOVE THE SURROUNDING PLAINS. ITS SUMMIT IS HUMMOCKY. THE MORaine IS NOT CONTINUOUS BUT OCCURS IN RIDGES TWO TO FIVE MILES LONG AND ONE-QUARTER TO ONE-HALF MILE IN WIDTH, SINCE THESE RIDGES ALL TREND IN THE SAME DIRECTION AND LIE VERY NEARLY IN A LINE, IT IS EVIDENT THAT THEY REPRESENT A TEMPORARY HALT IN THE ICE FRONT AS IT RETREATED ACROSS THE COUNTY. THIS IS A MINOR MORaine AND PROBABLY CANNOT BE TRACED ANY DISTANCE OUTSIDE OF GRANT COUNTY.

ANTELOPE MORaine:

THE ANTELOPE MORaine IS THE EASTERNMOST TERMINAL MORaine IN GRANT COUNTY. ITS MOST CONSPICUOUS PORTION IS A HIGH RIDGE, SEVEN MILES EAST AND TWO MILES SOUTH OF MILBANK, KNOWN AS MOUNT TOM. FROM THIS BALD GRAVEL HILL, A RIDGE ONE-QUARTER OF A MILE IN WIDTH AND STANDING BOLDLY 50 TO 100 FEET ABOVE THE SURROUNDING TILL PLAIN, TRENDS SOUTHEASTWARD INTO MINNESOTA WHERE, IN THE SOUTHWESTERN PART OF LAC QUI PARLE COUNTY, IT IS GIVEN THE NAME OF THE ANTELOPE HILLS BY THE SETTLERS. FROM THIS SECTION CHAMBERLIN GAVE THE NAME ANTELOPE TO THE ENTIRE MORaine.²

DR. LEVERETT SAYS, "THE NORTHWEST END OF THE DISTINCT MORaine IS A RANGE OF GRAVELLY HILLS IN EASTERN GRANT COUNTY,

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1. LEVERETT, FRANK, OP. CIT., P. 75.
 2. CHAMBERLIN, T. C., U.S. GEOL. SURVEY THIRD ANNUAL REPORT, PP. 388-394, 1883.

SOUTH DAKOTA, KNOWN AS THE MOUNT TOM RANGE, WHICH RUNS FROM THE NORTH FORK OF THE YELLOW BANK RIVER TO THE SOUTH FORK, A DISTANCE OF TWO OR THREE MILES AND HAS A GENERAL WIDTH OF SCARCELY A HALF OF A MILE... IT IS A DISTINCT MORAINE FOR ONLY A SHORT DISTANCE INTO SOUTH DAKOTA, WHERE IT BECOMES MERGED WITH OTHER MORAINES."¹

BIG STONE MORAINE:

THIS NAME WAS GIVEN BY DR. LEVERETT TO A TERMINAL MORAINE WHICH HE FOLLOWED AROUND THE SOUTHERN END OF BIG STONE LAKE FROM MINNESOTA. "IT RUNS ALONG THE SOUTHWEST SIDE OF BIG STONE LAKE IN SOUTH DAKOTA."² IT DOES NOT TAKE A RIDGE-LIKE FORM IN THIS REGION, BUT IS REPRESENTED BY PATCHES OF ROUGH TOPOGRAPHY WHICH LIE ON THE HIGHLAND BETWEEN LAKE BIG STONE AND THE NORTH FORK OF THE WHETSTONE RIVER.

THOUGH MOUNT TOM IS CONSIDERED THE NORTHERN END OF THE ANTELOPE MORAINE, SMALL GRAVEL OUTWASHES, KAME-LIKE HILLS AND SMALL PATCHES OF MORAINIC TOPOGRAPHY EXTENDING NORTHWARD FROM IT PAST LAKE ALBERT, CONNECT IT WITH THE BIG STONE MORAINE AT THE JUNCTION OF THE MAIN AND NORTH FORKS OF THE WHETSTONE RIVER.

GROUND MORAINES:

BETWEEN THESE FOUR TERMINAL MORAINES LIE VERY GENTLY UNDULATING DRIFT PLAINS OF THE WISCONSIN GROUND MORAINE. THE UNDULATIONS ARE SO FLAT THAT THE PLAINS GIVE THE IMPRESSION OF BEING FLAT. THIS GROUND MORAINE OFFERS AN EXCELLENT SOIL AND EASILY TILLABLE FIELDS. TO IT, THEREFORE, IS LARGELY DUE THE EXCELLENT AGRICULTURAL POSSIBILITIES OF THE COUNTY.

WISCONSIN GRAVEL DEPOSITS:

ALONG THE ENTIRE FRONT OF THE ALTAMONT MORAINE IN GRANT COUNTY, LIES A SHEET OF GRAVEL ONE TO TWO MILES IN WIDTH WHICH OCCUPIES THE DEPRESSION KNOWN AS THE ANTELOPE VALLEY. THIS SHEET OF SAND AND GRAVEL WAS WASHED INTO THE VALLEY BY WATERS FROM THE MELTING ICE WHICH SORTED THE DEBRIS THE ICE CARRIED, ACCORDING TO SIZE OF GRAIN, CARRIED THE FINE SILT AND MUD FAR AWAY AND LEFT THE COARSE SANDS AND GRAVELS BEHIND IN THE ANTELOPE VALLEY. SUCH A SHEET OF GRAVEL IS CALLED AN OUTWASH PLAIN BECAUSE IT FORMS A GENTLY SLOPING FLAT IN FRONT OF THE MORAINE.

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1. LEVERETT, FRANK, U. S. GEOL. SURV. PROF. PAPER 161, P. 103.
 2. LEVERETT, FRANK, OP. CIT., P. 105.

BLOCKS OF ICE ARE SOMETIMES TRAPPED IN THESE OUTWASHES, AND SAND AND GRAVEL FILLED AROUND AND OVER THEM. AN ICE BLOCK MAY THUS BE KEPT IN COLD STORAGE UNTIL LONG AFTER THE FRONT OF THE GLACIER HAS LEFT THE REGION. WHEN THIS BLOCK MELTS, IT LEAVES A DEPRESSION IN THE GRAVELS WHICH FILLS WITH SPRING WATER FORMING A LAKE. CROOKED LAKE, SOUTH OF TROY, IS SUCH A LAKE. TWO OTHER SMALL, UNNAMED LAKES, HAVING A SIMILAR ORIGIN LIE IN THE PANHANDLE SECTION OF ANTELOPE VALLEY.

THE BIG SIOUX VALLEY, WHICH CROSSES THE EXTREME WESTERN PART OF THE PANHANDLE, LIES IN A BROAD GRAVEL-FILLED VALLEY WHICH SERVED AS A SPILLWAY FOR WATERS FROM THE WISCONSIN GLACIER. MUCH OF IT CAME FROM THE PART OF THE ICE FRONT WHICH LAY IN ROBERTS COUNTY THOUGH IT WAS ALSO FED BY WATERS FROM THE ICE FRONT IN THE VICINITY OF SUMMIT AND FROM THE NORTH END OF THE ANTELOPE VALLEY. ONE CHANNEL BORDERING THE ALTAMONT MORAINE AT SUMMIT, CARRIED WATER PAST THIS CITY AND EASTWARD INTO THE BIG SIOUX WHILE ANOTHER CHANNEL, BEGINNING AT THE NORTHERN END OF THE ANTELOPE VALLEY, FOUR MILES WEST OF MARVIN, CARRIED WATER DIRECTLY SOUTHWEST INTO THE SOUTHERN PORTION OF THE BIG SIOUX SPILLWAY. THE DEPOSITS OF GRAVEL FORMED IN SUCH SPILLWAYS ARE KNOWN AS VALLEY TRAINS. THE VALLEY TRAIN OF THE BIG SIOUX COVERS AN AREA OF ABOUT 25 SQUARE MILES IN GRANT COUNTY.

NEAR THE BASE OF THE COTEAU ESCARPMENT, SMALL GRAVEL PATCHES AND MINIATURE OUTWASHES ARE COMMON BUT NO GREAT VOLUME OF GRAVEL WAS DEVELOPED. SOME OF THE LARGER OF THESE DEPOSITS ARE INDICATED ON THE ACCOMPANYING MAP.

THE STAND WHICH THE ICE MADE AT THE ANTELOPE AND BIG STONE MORAINES FORMED SOME LARGE DEPOSITS IN THE EASTERN PART OF THE COUNTY. THE NORTHERN END OF THE ANTELOPE MORAINE, MOUNT TOM, IS COMPOSED OF ENORMOUS HILLS OF GRAVEL AND SMALLER HILLS CAN BE FOUND SPRINKLED OVER THE GRANITE AREA BETWEEN MOUNT TOM AND LAKE ALBERT. SOME DEPOSITS ARE ALSO TO BE FOUND ALONG THE WHETSTONE CREEK IN FRONT OF THE ANTELOPE MORAINE. THESE HILLS SHOULD BE CLASSED AS KAMES AS THEY ARE EVIDENTLY PILES OF GRAVEL FORMED BY STREAMS FLOWING OFF THE FRONT OF THE ICE.

THE GRAVEL OUTWASH FILLS THE VALLEY OF THE NORTH FORK OF WHETSTONE RIVER FROM THE NORTH COUNTY LINE TO LAKE ALBERT AND DOWN THE MAIN VALLEY OF THE WHETSTONE RIVER FROM ITS JUNCTION WITH THE NORTH FORK TO THE BIG STONE VALLEY. AT THE JUNCTION OF THE MAIN AND NORTH FORKS, THE OUTWASH COVERS A LARGER AREA THAN IT DOES FARTHER NORTH OR SOUTH, OCCUPYING NEARLY FOUR SQUARE MILES. THE OUTWASH CAN BE TRACED AROUND THE GRANITE AREA THROUGH THE BIG BEND OF THE YELLOW BANK RIVER, NORTH OF MOUNT TOM.

THE ONLY OTHER LARGE VOLUME OF GRAVEL OCCURS IN A LONG RIDGE OR ESKER TWO MILES SOUTHEAST OF REVILLO. THIS RIDGE CAN BE FOLLOWED FOR MORE THAN TWO MILES. IT IS ABOUT 500 FEET ACROSS AT THE BASE AND 30 TO 50 FEET HIGH. THIS IS THE ONLY LARGE ESKER IN GRANT COUNTY AND OWES ITS EXISTENCE TO A LARGE STREAM OF WATER WHICH FLOWED THROUGH A CREVASS IN THE GLACIER, FILLING IT WITH SAND AND GRAVEL WHICH WAS LEFT AS A RIDGE AFTER THE ICE MELTED.

THE DEPOSITS OF THE WISCONSIN GLACIER ARE THE YOUNGEST ROCKS IN THE COUNTY AND ARE THE LEAST HARDENED OF THE THREE GREAT GROUPS MENTIONED AT THE BEGINNING OF THIS DESCRIPTION. THEY CONSIST OF LOOSE GRAVEL, SAND, SILT AND CLAY WHILE THE UNDERLYING CRETACEOUS MARINE STRATA ARE COMPOSED OF SHALES, LIMESTONES, AND SANDSTONES, AND THE OLDEST OR BASEMENT ROCKS ON WHICH THE TWO OTHERS LIE ARE COMPOSED OF THE TOUGHEST AND DENSEST ROCKS KNOWN.

V. ECONOMIC GEOLOGY

THE MINERAL RESOURCES OF GRANT COUNTY INCLUDE BUILDING AND STRUCTURAL MATERIALS, WATER SUPPLIES AND SOILS.

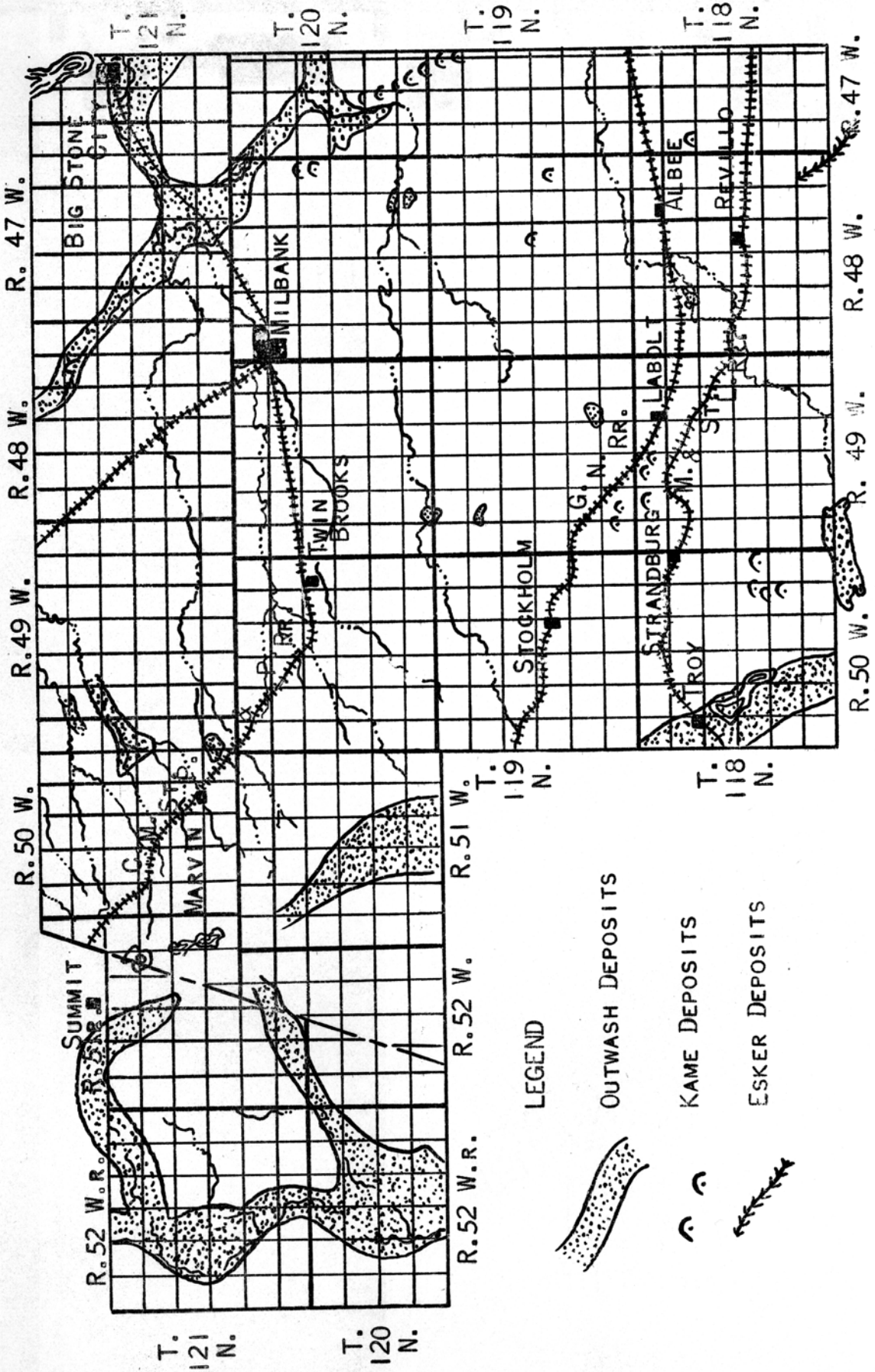
GRANITE

GLACIAL BOULDERS, OR FIELD STONES AS THEY ARE SOMETIMES CALLED, ARE ABUNDANT ESPECIALLY ON THE TERMINAL MORAINES. THEY CONTAIN A GREAT VARIETY OF ROCKS AND CAN BE DRESSED FOR BUILDING BLOCKS. THIS STONE HAS BEEN USED EFFECTIVELY IN WALLS AND SMALL BUILDINGS WHERE A VARIETY OF COLORS WAS DESIRED, BUT CAN NEVER SUPPLY MORE THAN A LOCAL MARKET BECAUSE OF THE EXPENSE INVOLVED IN COLLECTING SCATTERED BOULDERS.

THE STONE INDUSTRY IN GRANT COUNTY WILL DEPEND UPON THE DEVELOPMENT OF THE GRANITE WHICH OUTCROPS FOUR MILES EAST OF MILBANK AND HAS BEEN DESCRIBED ON PAGE 15 OF THIS REPORT. THIS GRANITE IS THE BASIS FOR ONE OF THE MOST IMPORTANT OF SOUTH DAKOTA'S MINERAL INDUSTRIES AND SHOULD CONTINUE TO HOLD THIS PLACE. THE STONE IS NOW QUARRIED FOR ORNAMENTAL STONE, BUT WILL SERVE EQUALLY WELL FOR BUILDING STONE, RIPRAP, OR CONCRETE AGGREGATE SHOULD OCCASION DEMAND. IT HAS A DARK MAHOGANY COLOR AND TAKES A POLISH WHICH MAKES IT ESPECIALLY VALUABLE AS AN ORNAMENTAL STONE. IT HAS SUFFICIENT JOINTING TO ASSIST IN THE QUARRYING, BUT THE CRACKS ARE FAR ENOUGH APART TO ALLOW THE REMOVAL OF LARGE BLOCKS. IT HAS BEEN USED EFFECTIVELY FOR SOME VERY DISTINCTIVE PUBLIC MEMORIALS, NOTABLY THE STATUTE OF PATRIOTISM BY PAUL BARTTLETT AT DULUTH, MINNESOTA AND THE LARGE COLUMNS IN THE NATIONAL CATHOLIC SHRINE AT WASHINGTON, D. C.

THE FIRST QUARRYING OF THIS STONE WAS DONE BY MR. GUST SWANSON, STONE MASON, WHO USED THE ROCK FOR TOP STONE FOR BUILDING FOUNDATIONS. REAL QUARRYING BEGAN ABOUT 1908 WHEN ROBERT HUNTER ERECTED THE FIRST LARGE DERRICK AND OPENED A COMMERCIAL QUARRY. THE FIRST DIMENSION STONE QUARRIED IN SOUTH DAKOTA WAS USED IN THE STATE CAPITOL BUILDING AT PIERRE. IN 1933 THE ORIGINAL HUNTER COMPANY WAS STILL IN EXISTENCE AND WAS OPERATING TWO QUARRIES AND A MODERN FINISHING PLANT. FOUR OTHER COMPANIES, MOST OF WHICH HAD STARTED SINCE 1920, WERE ALSO IN OPERATION. MILBANK GRANITE HAS BEEN SHIPPED TO NEARLY EVERY STATE IN THE UNION AND ALSO INTO CANADA.

SAND AND GRAVEL DEPOSITS
OF
GRANT COUNTY, SOUTH DAKOTA



THE VOLUME OF GRANITE IS SUFFICIENT FOR AS LARGE AN INDUSTRY AS MAY DEVELOP. THE DEEPEST QUARRY HAS PENETRATED THE ROCK TO A DEPTH OF ONE HUNDRED FEET WITH NO APPARENT CHANGE IN ITS CHARACTER. IT IS PROBABLE THAT THREE OR FOUR TIMES THIS DEPTH CAN BE REACHED IF NECESSARY. THE SMALL OUTCROPS WHERE THE QUARRIES HAVE BEEN OPENED COVER A VERY SMALL PART OF THE TOTAL AREA WHERE THE ROCK IS ACCESSIBLE. FOR APPROXIMATELY FIVE SQUARE MILES THE GRANITE IS OVERLAID BY A THIN MANTLE OF GLACIAL DRIFT WHICH CAN BE STRIPPED EASILY IF THE MARKET WARRANTS THE EXPENSE. THE OUTCROP IN THE WHETSTONE VALLEY, A MILE SOUTHWEST OF BIG STONE CITY, OFFERS ANOTHER POSSIBILITY, THOUGH THE AREA OF EXPOSED ROCK IS NOT VERY EXTENSIVE AND THE DRIFT COVER OUTSIDE OF THE VALLEY IS PROBABLY TOO THICK TO STRIP ECONOMICALLY. WITH THIS ENORMOUS VOLUME OF GRANITE AS A RESOURCE IT SHOULD BE POSSIBLE TO MAINTAIN A LARGE PRODUCTION FOR A GREAT MANY YEARS.

SAND AND GRAVEL

THE DEVELOPMENT OF THESE MATERIALS HAS NOT YET BEGUN IN GRANT COUNTY. THE GRAVELING OF HIGHWAYS HAS OPENED A FEW ROAD-SIDE PITS AT ADVANTAGEOUS PLACES, BUT THERE HAS BEEN NO ATTEMPT AT COMMERCIAL PRODUCTION. LARGE AMOUNTS OF GRAVEL COULD BE PRODUCED, HOWEVER, IF THE DEMAND WERE CREATED.

ALL GRAVEL IS OF GLACIAL ORIGIN, AND THE SORTING, THEREFORE, IS VERY IMPERFECT. SCREENING AND WASHING, HOWEVER, CAN OVERCOME THIS DIFFICULTY. THE PERCENTAGE OF SOFT MATERIALS, SUCH AS CHALK, SHALE, AND IRON IN THE GRAVEL IS NOT EXCESSIVELY HIGH IN MOST DEPOSITS. NEARLY ALL OF THE DEPOSITS LIE UNDER A COVER OF SILT, WHICH WILL HAVE TO BE REMOVED. THE DEPTH OF THE COVER VARIES SO MUCH THAT NO GENERALIZATION CAN BE MADE, BUT IT IS SAFE TO SAY THAT STRIPPING WILL BE NEEDED ON ALL DEPOSITS, AND MOST OF IT WILL BE THREE FEET OR MORE FOR DEPOSITS OF COMMERCIAL SIZE.

IN THE SHORT TIME AVAILABLE FOR THIS INVESTIGATION, IT WAS NOT POSSIBLE TO DETERMINE THE AMOUNTS OF GRAVEL IN THE VARIOUS DEPOSITS. A LITTLE INFORMATION WAS AVAILABLE ON THE DEPTH AND CHARACTER OF MATERIALS WHERE PITS HAD BEEN OPENED, BUT MOST OF THE DEPOSITS CONTAINED NO SUCH OPENING. THE INFORMATION AT HAND, HOWEVER, SHOWS THE YARDAGE IN SOME OF THESE DEPOSITS MUST BE RECKONED IN THE MILLIONS. THE GREAT VOLUMES AND VARIED CHARACTER OF THE DEPOSITS MAKE IT NECESSARY TO GIVE EACH A CAREFUL INVESTIGATION IF IT IS TO BE USED FOR COMMERCIAL PRODUCTION.

A SHORT DESCRIPTION OF THE LARGER DEPOSITS IS ALL THAT CAN BE ATTEMPTED IN THIS REPORT.

COTEAU GRAVELS:

THE LARGE DEPOSITS OF THE COTEAU OFFER AN ESPECIALLY GOOD OPPORTUNITY FOR GRAVEL PRODUCTION. THESE OCCUR IN THREE LOCATIONS, NAMELY: THE BIG SIOUX SPILLWAY, THE ANTELOPE VALLEY, AND AT THE BASE OF THE COTEAU ESCARPMENT.

THE BIG SIOUX SPILLWAY:

THE BIG SIOUX SPILLWAY PROBABLY CONTAINS THE LARGEST DEPOSITS OF GRAVEL IN THE COUNTY, FOR IT EXTENDS NORTH AND SOUTH ACROSS THE ENTIRE PANHANDLE, A DISTANCE OF ELEVEN MILES, AND HAS AN AVERAGE WIDTH OF ABOUT TWO MILES. THIS SPILLWAY WAS THE OUTLET FOR WATERS WHICH FLOWED FROM THE ICE FRONT WHILE IT STOOD OVER THE ALTAMONT MORAINE. THESE WATERS CARRIED ENORMOUS AMOUNTS OF SAND AND GRAVEL WHICH EVENTUALLY CHOKED THE SPILLWAY CHANNEL. TWO TRIBUTARY SPILLWAYS, WHICH ARE ALSO GRAVEL-FILLED, COME FROM THE ANTELOPE VALLEY, TREND IN A SOUTHWESTERLY DIRECTION AND JOIN THE BIG SPILLWAY. THE COMBINED AREA OF THESE SPILLWAYS IS ABOUT TWENTY-FOUR SQUARE MILES. IN THIS AREA GRAVELS AND SANDS ARE TO BE FOUND UNDER THE FLATS AND THE SWAMPY LOWLAND, BORDERING THE BIG SIOUX RIVER, AND ALSO ON TERRACES HIGHER UP ON THE BLUFF. THE GRAVEL IS COVERED BY SILT IN MOST PLACES TO A DEPTH OF SEVERAL FEET, BUT IS EXPOSED AT MANY PLACES BY ROAD CUTS WHERE THE HIGHWAYS ASCEND FROM THE LOWER FLATS ONTO THE TERRACES. A FEW PITS ARE OPENED AND THESE THROW SOME LIGHT ON THE THICKNESS OF THE GRAVELS.

SIX FEET OF GRAVEL WERE EXPOSED IN A PIT ON THE NORTH SIDE OF THE COUNTY LINE, FOUR MILES EAST OF SUMMIT (S. W. CORNER, SECTION 36, T. 122 N., R. 52 W., RES.). SEVEN MILES SOUTH OF THIS PIT A ROAD CUT SHOWED SIX TO TEN FEET OF GRAVEL UNDER TWO FEET OF SILT COVER (S.W. CORNER, SECTION 1, T. 120 N., R. 52 W., RES.). A CUT BANK ONE AND ONE-HALF MILES SOUTHWEST OF THIS LAST PIT, IN THE MIDDLE OF THE SPILLWAY, EXPOSED EIGHT FEET OF GRAVEL, COVERED BY FOUR FEET OF SILT. SIX FEET OF GRAVEL WERE ALSO EXPOSED ON THE WEST BANK OF BIG SIOUX CHANNEL AT THE SOUTH COUNTY LINE. IN NO CASE WAS THE BOTTOM OF THE GRAVEL EXPOSED, BUT IT IS PROBABLE THAT ITS THICKNESS EXCEEDS TEN OR FIFTEEN FEET.

ANTELOPE VALLEY GRAVELS:

THE ANTELOPE VALLEY, WHICH LIES IN FRONT OF THE ALTAMONT MORAINE, IS FILLED WITH OUTWASH. ONLY A SMALL PART OF THIS OUTWASH (11 SQUARE MILES) LIES IN GRANT COUNTY. THIS VALLEY OFFERS SOME EXCELLENT OPPORTUNITIES FOR GRAVEL PROSPECTING, HOWEVER, SINCE IT IS CROSSED AT ITS SOUTHERN END

BY THE MINNEAPOLIS AND ST. LOUIS RAILWAY WITH THE TOWN OF TROY LOCATED AT THE EASTERN EDGE OF THE OUTWASH. FEW PITS WERE OPENED AND NO OTHER OPPORTUNITIES WERE OFFERED FOR OBTAINING FIGURES FOR THE DEPTH OR CHARACTER OF THE GRAVEL. ONE EXPOSURE, TWO MILES SOUTH OF TROY, SHOWED MORE THAN SIX FEET OF GRAVEL UNDER A COVER OF ONE FOOT OF SILT.

ALONG THE SOUTH LINE OF THE COUNTY IS A LARGE GRAVEL-FILLED VALLEY, WHICH EMPTIES INTO THE ANTELOPE VALLEY AT ROUND LAKE. PART OF THIS VALLEY IS IN GRANT COUNTY, AND PART IN CODINGTON. IT IS, THEREFORE, INCLUDED WITH THE GRANT COUNTY GRAVELS. AT ITS EASTERN END A STREAM HAS CUT DEEPLY INTO THE VALLEY FILL, EXPOSING MORE THAN TWENTY FEET OF SAND AND GRAVEL.

THE NORTH END OF THE ANTELOPE VALLEY LIES IN THE PANHANDLE, AND WAS TRACED FOR ABOUT FIVE MILES FROM THE SOUTH COUNTY LINE. IT REACHES A WIDTH OF TWO MILES. GRAVEL APPEARS IN NUMEROUS ROAD CUTS, BUT NO PITS OR OTHER OPENINGS WERE DISCOVERED. IT IS SAFE TO ASSUME THAT THE GRAVEL IN THIS END WILL CORRESPOND IN DEPTH AND QUALITY TO THAT FOUND IN THE SOUTHERN SECTION, WHICH HAS JUST BEEN DESCRIBED.

GRAVELS OF THE COTEAU ESCARPMENT:

THE TERMINAL MORAINES (ALTA-MONT AND GARY) CONTAIN MANY SMALL POCKETS AND HILLS (KAMES) OF GRAVEL, BUT NO LARGE DEPOSITS SUFFICIENT FOR COMMERCIAL PRODUCTION.

LARGER DEPOSITS DO OCCUR ALONG THE LOWER SLOPE AND BASE OF THE ESCARPMENT, HOWEVER. SOME OF THE LARGEST OF THESE HAVE BEEN INDICATED ON THE ACCOMPANYING GRAVEL MAP. THOUGH THEY ARE TOO SMALL FOR COMMERCIAL PRODUCTION, THEY WILL SERVE WELL FOR LOCAL USE SUCH AS CONCRETE CONSTRUCTION ON NEIGHBORING FARMS AND FOR GRAVELING LOCAL HIGHWAYS. THE THREE FOLLOWING EXAMPLES WILL GIVE AN IDEA OF THE SIZE AND CHARACTER OF THESE DEPOSITS.

(1) A SMALL OUTWASH CONTAINING 50,000 TO 100,000 CUBIC YARDS OCCURS AT THE BASE OF THE COTEAU ESCARPMENT AT THE EAST QUARTER CORNER, SECTION 14, T. 121 N., R. 50 W. A PIT OPENED IN THIS DEPOSIT SHOWED:

1 FT. BROWN SOIL COVER
10 FT. MEDIUM TO COARSE GRAVEL; MOSTLY OF
HARD MATERIALS PERCENTAGE OF
OVERSIZE SMALL (5-10%); SOME
BOULDERS SCATTERED THROUGH THE
DEPOSIT; SAND MATRIX NOT OVER
40 OR 50%.

(2) A SECOND DEPOSIT WAS OPENED ON THE NORTH BLUFF OF A TRIBUTARY TO YELLOW BANK CREEK IN SECTION 8, T. 119 N., R. 49 W. THIS WAS APPARENTLY DEPOSITED BY WATER RUNNING OFF THE COTEAU ESCARPMENT. THE TOTAL DEPOSIT CONTAINS SOME 30,000 CUBIC YARDS OF PATCHY MATERIAL, BUT A PIT FROM WHICH 4,000 OR 5,000 YARDS HAD BEEN REMOVED SHOWED THE FOLLOWING SECTION:

½ TO 2 FT. BLACK SOIL AND SOD COVER
6 FT. MEDIUM GRAVEL, YELLOW AND POORLY SORTED; LARGE BOULDERS ONE TO TWO FEET IN DIAMETER, ABUNDANT.
10+ FT. YELLOW STONY TILL.

(3) ANOTHER LOCATION, TWO MILES WEST OF ALBEE IN THE NORTH-EAST ONE-QUARTER SECTION 8, T. 118 N., R. 48 W., CONTAINED A VOLUME OF 10,000 TO 20,000 YARDS. IT IS A SMALL OUTWASH JUST EAST OF THE BASE OF THE COTEAU ESCARPMENT AND A SMALL PIT SHOWS THE FOLLOWING SECTION:

2 FT. SOIL AND COVER.
6 TO 8 FT. SAND AND GRAVEL IN ALTERNATE LAYERS; FAIRLY WELL SORTED; LITTLE OVER-SIZED AND NO BOULDERS.

LOWLAND GRAVELS

WHETSTONE VALLEY GRAVELS:

THE LARGEST SAND AND GRAVEL DEPOSITS OF THE LOWLAND OCCUR IN THE EASTERN PART OF THE COUNTY AND MAY BE LOCATED ROUGHLY ALONG A LINE FOLLOWING THE NORTH FORK OF THE WHETSTONE RIVER AND PROCEEDING SOUTH ALONG THE ANTELOPE MORaine. FROM THE JUNCTION OF THE NORTH FORK WITH THE MAIN FORK OF WHETSTONE CREEK, OUTWASH CAN BE FOLLOWED DOWNSTREAM TO ITS JUNCTION WITH THE BIG STONE VALLEY. THIS DISTRIBUTION IS DUE TO THE FACT THAT THE ANTELOPE AND BIG STONE MORAINES JOIN IN THIS REGION, AND CONSEQUENTLY FORMED A GREATER AMOUNT OF OUTWASH THAN FARTHER WEST OF THE LOWLAND. IT IS POSSIBLE THAT THE PRESENCE OF THE GRANITE SOUTH OF LAKE ALBERT AND IN THE BIG STONE VALLEY ALSO HAS SOMETHING TO DO WITH HOLDING UP THE ICE AT THIS POINT.

THE OUTWASH WHICH FILLS THE VALLEY OF NORTH FORK IS SCARCELY ONE-HALF MILE WIDE AT THE NORTH COUNTY LINE. THIS WIDTH INCREASES, HOWEVER, NEAR THE JUNCTION WITH THE MAIN VALLEY TO A

MILE AND A HALF, THE LARGEST BODY OF OUTWASH COVERING AN AREA OF ABOUT 6 SQUARE MILES. SOUTH OF THIS JUNCTION THE OUTWASH NARROWS SHARPLY AGAIN TO LESS THAN A QUARTER OF A MILE AT LAKE ALBERT. FROM THE JUNCTION, OUTWASH CAN BE FOLLOWED DOWN THE MAIN WHETSTONE VALLEY INTO THE VALLEY OCCUPIED BY BIG STONE LAKE WHERE IT JOINS GRAVEL TERRACES ON THE BLUFFS OF THE LAKE DEPRESSION. IN THIS PART OF THE WHETSTONE VALLEY, HOWEVER, THE MATERIALS OCCUR IN TERRACES ON THE VALLEY BLUFFS, WHILE IN THE VALLEY OF THE NORTH FORK AND AT THE JUNCTION, MOST OF THE GRAVEL OCCUPIES THE BOTTOMS OF THE VALLEYS OR LOW TERRACES.

THE GRAVEL REACHES A DEPTH OF MORE THAN TEN FEET IN SEVERAL OUTCROPS. NEAR THE JUNCTION OF THE TWO FORKS MENTIONED (E $\frac{1}{4}$ CORNER, SEC. 20, T. 121 N., R. 47 W.) A PIT EXPOSED TEN FEET OF GRAVEL UNDER TWO FEET OF SILT COVER. A SECOND, THREE MILES DOWNSTREAM IN THE MAIN WHETSTONE VALLEY (N.E. $\frac{1}{4}$ CORNER, SEC. 23, T. 121 N., R. 47 W.) SHOWED FIVE FEET OF SILT COVER UNDERLAID BY MORE THAN TEN FEET OF GRAVEL. AT THE BRICK PLANT ONE-HALF MILE WEST OF BIG STONE CITY, THE FOLLOWING SECTION WAS EXPOSED.

SECTION AT THE BRICK PLANT AT BIG STONE CITY

S.E. $\frac{1}{4}$, N.W. $\frac{1}{4}$, SEC. 17, T. 121 N., R. 46 W.

- 13 FT. SILT. YELLOW, BANDED SOME SANDY, EVIDENTLY WATER-LAID. THESE FURNISH MATERIAL OF WHICH THE YELLOW BRICKS WERE MADE.
- 17 FT. MEDIUM GRAVEL, (AVERAGING $\frac{1}{4}$ INCH) AND SAND; FAIRLY CLEAN AND COMPOSED MOSTLY OF HARD MATERIALS; NOT MUCH OVERSIZED, THOUGH ONE TO TWO-FOOT BOULDERS ARE SCATTERED THROUGH THE DEPOSITS. THE MATERIALS NOTED AS ABUNDANT AMONG THE PEBBLES WERE GRANITE-GRAY AND MAHOGANY, SCHISTS AND GNEISSES, DOLOMITES ABUNDANT, SHALE ABUNDANT IN WELL ROUNDED PEBBLES, PIPESTONE VERY SCARCE, CHALK VERY SCARCE, ONE PIECE NOTED.

NOTE: - TORRENTIAL CROSS-BEDDING INDICATES THAT THE WATER CURRENTS WHICH DEPOSITED THIS GRAVEL FLOWED EASTWARD.

KAME AND ESKER GRAVELS:

SMALL AMOUNTS OF GRAVEL CAN BE TRACED THROUGH LAKE ALBERT AND THE VALLEY WHICH CONNECTS IT WITH YELLOW BANK CREEK, BUT THESE ARE TOO SMALL FOR COMMERCIAL EXPLOITATION. THERE ARE, HOWEVER, CERTAIN HILLS OF GRAVEL WHICH ARE OF SUFFICIENT SIZE TO BE WORTH PROSPECTING. THESE HILLS ARE DOME OR BEEHIVE SHAPED. THEY VARY IN HEIGHT FROM A FEW FEET TO SEVENTY FEET, AND IN DIAMETER AT THE BASE FROM TWENTY FEET TO THREE HUNDRED FEET. THE MOST CONSPICUOUS OF THESE IS MOUNT TOM. NOT ONLY IS THIS BIG HILL MADE OF GRAVEL, BUT SAND AND GRAVEL HAVE ALSO BEEN SPREAD OUT ABOUT ITS BASE, ESPECIALLY TO THE NORTH AND WEST WHERE IT FORMS A SMALL OUTWASH SURROUNDING THE END OF THE RIDGE. GRAVEL KNOBS OCCUR OVER THE ENTIRE LENGTH OF THE ANTELOPE MORaine IN THE COUNTY BUT APPEAR TO BE LARGER AND MORE ABUNDANT AT THE NORTHERN END.

SIMILAR BUT SMALLER HILLS ARE SCATTERED OVER THE SURFACE OF THE GRANITE OUTCROPS NORTHWEST OF MOUNT TOM. THE LARGER OF THESE HAS BEEN INDICATED ON THE ACCOMPANYING GRAVEL MAP. GRAVEL KNOBS OF THIS SORT ARE CALLED KAMES AND THOSE WHICH HAVE BEEN DESCRIBED CAN SUPPLY LARGE QUANTITIES OF GRAVEL. IF THIS MATERIAL IS CHARACTERISTIC OF THAT IN KAMES FOUND IN OTHER PARTS OF THE STATE, THE GRAVEL MAY BE PATCHY AND POORLY SORTED. BALLS AND MASSES OF CLAY MAY OCCUR IN THE DEPOSITS, ESPECIALLY THOSE ON THE END OF THE RIDGE, WHERE THE SORTING ACTION WAS NOT SO VIGOROUS AS IT WAS TO THE NORTH.

THERE IS ONLY ONE ESKER OF SUFFICIENT SIZE TO WARRANT ATTENTION HERE. IT IS A CONSPICUOUS RIDGE, TWO MILES LONG AND A FEW HUNDRED FEET ACROSS AT THE BASE. THE NORTHERN HALF LIES IN GRANT COUNTY TWO MILES SOUTHEAST OF REVILLO, AND THREE MILES WEST OF THE SOUTHEAST CORNER OF GRANT COUNTY.

THIS ESKER SHOWS THE UNDULATING CREST CHARACTERISTIC OF SOUTH DAKOTA ESKERS AND WINDS SNAKE-LIKE OVER THE TOPOGRAPHY. IT IS BROKEN INTO SEVERAL PARTS AND HAS KNOBS ON ITS CREST WHICH ARE VERY KAME-LIKE IN APPEARANCE. IT ENDS AT THE SOUTHEAST IN A GROUP OF EIGHT OR TEN LITTLE KAMES.

WHERE THE MATERIALS ARE EXPOSED, POORLY SORTED SANDS AND GRAVELS OCCUR. CLAY PATCHES AND MANY BOULDERS, ONE TO THREE FEET IN DIAMETER ARE INCLUDED. THE ENTIRE MASS IS VERY CALCAREOUS AND THE GRAVELS ARE STAINED A DEEP YELLOW BROWN BY OXIDATION OF IRON WHICH IT CONTAINS.

ON THE WHOLE THIS ESKER LOOKS LIKE A BETTER GRAVEL PROSPECT THAN IT REALLY IS. THE PATCHY CONDITION OF THE GRAVELS MAKE

THEM DIFFICULT TO EXCAVATE. THE POOR SORTING, THE OVERSIZE AND THE ABUNDANCE OF SHALE AND OTHER SOFT MATERIALS IN THE GRAVELS DOES NOT RENDER THEM OF HIGH QUALITY FOR MOST PURPOSES.

THOUGH THE TOTAL YARDAGE OF GRAVEL CONTAINED IN THE ESKER IS HIGH, THE AVAILABLE YARDAGE WILL BE COMPARATIVELY SMALL. CAREFUL PROSPECTING WILL YIELD POCKETS WHERE 5,000 TO 10,000 YARDS CAN BE EXCAVATED. PRODUCTION FROM THIS ESKER WILL BE A MATTER OF PICKING OUT ENOUGH OF THESE SMALL POCKETS TO OBTAIN THE REQUIRED AMOUNT OF GRAVEL.

CLAYS

THE EASILY ACCESSIBLE CLAYS IN GRANT COUNTY ARE OF GLACIAL ORIGIN. ALL THE DRIFTS OF THE DIFFERENT ICE SHEETS CONTAIN CLAYS WHICH MIGHT BE USED FOR BRICK OR SIMILAR PURPOSES. THE LIME CONTENT, HOWEVER, IS RATHER HIGH AND HAS A TENDENCY TO MAKE BRICK SOFT.

THE SILT OVERLYING THE GRAVELS OF THE VARIOUS OUTWASHES OFFER A BETTER SOURCE OF MATERIAL. THEY ARE MUCH BETTER SORTED, AND DO NOT CONTAIN THE PEBBLES AND SANDY MATERIAL WHICH ARE PRESENT IN THE BOULDER CLAYS. THESE SILTS HAVE BEEN USED AT BIG STONE CITY BY THE MILLER BRICK COMPANY, WHICH PRODUCES A YELLOW BRICK OF VERY GOOD QUALITY. SIMILAR SILTS COVER ALL OTHER GRAVELS IN THE WHETSTONE CREEK. THEY ARE OF VARIOUS THICKNESSES, AND DOUBTLESS COULD BE USED AT MANY PLACES. NO EFFORT WAS MADE, HOWEVER, TO DETERMINE THEIR THICKNESS OR EXTENT. THE SILTS OF THE BIG SIOUX AND ANTELOPE VALLEYS ALSO OFFER POSSIBILITIES WORTH PROSPECTING.

THERE IS NO EVIDENCE THAT CLAY, SUITABLE FOR OTHER PURPOSES THAN BRICK AND TILE, WILL BE FOUND IN THE COUNTY. THOUGH THERE IS AN ABUNDANCE OF COMMON CLAYS, SPECIAL TYPES, SUCH AS FIRE CLAYS, BALL CLAY, CHINA CLAY, ETC, DO NOT OCCUR.

GOLD

GOLD HAS BEEN REPORTED FROM THE SANDS AND GRAVELS OF THIS REGION AS LONG AGO AS 1894.¹ MR. DOANE ROBINSON, FORMER STATE

1. TODD, J. E., SOUTH DAKOTA GEOLOGICAL SURVEY BULLETIN No. 1, "A PRELIMINARY REPORT OF THE GEOLOGY OF SOUTH DAKOTA", P. 147, 1894.

HISTORIAN, REPORTS ITS PRESENCE NEAR GARY IN THE LAC QUI PARLE RIVER, AND ATTEMPTS HAVE BEEN MADE TO MINE GOLD AT THE SOUTHERN END OF BIG STONE LAKE. IN ALL CASES THE GOLD OCCURRED IN GLACIAL GRAVELS, HAVING BEEN BROUGHT FROM VEINS OR LODES TO THE NORTHEAST. SUCH VEINS ARE KNOWN AS NEAR AS THE LAKE OF THE WOODS, AND NEAR REDWOOD FALLS, MINNESOTA.²

THE FINDING OF VALUABLE PLACER DEPOSITS, HOWEVER, IS VERY IMPROBABLE AS GLACIAL ICE HAS A TENDENCY TO SCATTER ITS MATERIALS TOO WIDELY. GOLD NUGGETS MAY BE FOUND FROM TIME TO TIME IN THE GRAVELS AND DRIFTS OF GRANT COUNTY, BUT SHOULD NOT AROUSE HOPE FOR AN IMPORTANT GOLD INDUSTRY.

WATER SUPPLIES

SURFACE WATER:

THE STREAMS WHICH CROSS GRANT COUNTY ARE NOT RELIABLE SOURCES OF SURFACE WATER. ALL ARE INTERMITTENT. DURING THE DRY SEASON OF 1933, EVEN THE BIG SIOUX WAS REDUCED TO POOLS AND SWAMPY PLACES IN ITS CHANNEL. WHETSTONE CREEK, THE NEXT LARGEST STREAM, WAS IN THE SAME CONDITION, AND THE SMALLER STREAMS WERE NOTHING BUT DRY CHANNELS. THIS, OF COURSE, WAS AN ABNORMAL CONDITION, BUT EVEN IN NORMAL YEARS THEY CARRY ONLY SMALL VOLUMES OF WATER. THE LARGER LAKES, HOWEVER, ARE PERMANENT. BIG STONE AND CROOKED LAKES STILL HELD WATER AT THE CLOSE OF THE HOT DRY SUMMER OF 1933, THOUGH MOST OF THE OTHERS HAD BEEN REDUCED TO MARSHES AND DRY FLATS. THESE LAKES, HOWEVER, SHOW A LOWERING OF THE SURFACE, AMOUNTING TO THREE OR FOUR FEET BELOW THE NORMAL LEVEL. THEIR WATERS ARE FRESH AND THEY WILL MAKE EXCELLENT SOURCES OF SUPPLY WHERE LAKE WATER IS NEEDED.

SPRING WATER:

SPRINGS ARE ABUNDANT ON THE FACE OF THE COTEAU AND IN THE GRAVELS AT THE BASE OF THE LARGER TERRACES IN THE LOWER END OF THE BIG STONE AND WHETSTONE VALLEYS. THE COTEAU SUPPLIES HAVE BEEN VERY STEADY, FLOWING A FAIR SUPPLY AT THE END OF THE DRY SUMMER OF 1933. SOME IDEA OF THE CHARACTER OF THE WATER MAY BE OBTAINED FROM AN ANALYSIS WHICH WAS MADE OF THE SPRING WATERS WHICH SUPPLY THE CITY OF MILBANK.

1. PERSONAL COMMUNICATION.
2. TODD, J. E., BULLETIN No. 1, S. DAK. GEOL. SURVEY., P. 148, 1894.

ANALYSIS OF MILBANK SPRING WATER

(FURNISHED BY C. M. ST. P. AND P. RAILROAD, 1923)

OXIDE	1.6	}	TOTAL IN-
CALCIUM			
CARBONATE	2.7	:-	CRUSTING
SULPHATE	25.3		
MAGNESIUM CARBONATE	11.0	}	SOLIDS
			40.6
ALKALI SULPHATE	1.1	}--	NON-INCRUSTING
CHLORIDE	0.8		
			SOLIDS 1.9
TOTAL	42.5		

AS RE-CALCULATED BY MR. GUY G. FRARY, STATE CHEMIST, THIS ANALYSIS SHOWS:

	PARTS PER MILLION
CALCIUM	152.5
MAGNESIUM	54.4
SO ₄	318.9
NA (SODIUM)	11.5
CO ₃	162.5
CL	<u>13.7</u>
TOTAL SOLIDS	713.5

THE SOURCE OF THESE SPRINGS HAS ALREADY BEEN DISCUSSED IN THIS REPORT (P. 25). THE UNIFORMITY OF THE FLOW AND THE APPROXIMATE UNIFORMITY IN THE ELEVATIONS AT WHICH THE SPRINGS APPEAR SUGGESTS A BEDROCK SOURCE, WHICH MAY CORRESPOND WITH THE WATER SANDS STRUCK IN SOME OF THE WELLS HIGHER UP ON THE COTEAU.

NO BEDROCK IS VISIBLE, HOWEVER, AND IF THIS IS THE SOURCE, THE WATERS WOULD HAVE TO PERCOLATE THROUGH A CONSIDERABLE THICKNESS OF GLACIAL DRIFT. SAND AND GRAVEL POCKETS, EXPOSED ON THE FACE OF THE COTEAU AT THAT ELEVATION ARE SCARCELY LARGE ENOUGH TO KEEP A STEADY FLOW UNDER THE DRY CONDITIONS. THESE SPRINGS MAKE AN EXCELLENT SOURCE OF SUPPLY, ESPECIALLY FOR FARM INSTALLATIONS AND SUPPLIES FOR SMALL TOWNS. BY COMBINING SEVERAL SPRINGS THE CITY OF MILBANK WAS AMPLY SUPPLIED THRU THE DRY SEASON OF 1933.

SHALLOW WELLS

MUCH OF THE WATER USED IN THE COUNTY COMES FROM WELLS LESS THAN 100 FEET IN DEPTH. THESE ARE LISTED AS SHALLOW WELLS BECAUSE THE SOURCE OF WATER IS LARGELY FROM SURFACE SUPPLIES. IN THE LARGE SAND AND GRAVEL-FILLED VALLEYS, SUCH AS THOSE OF THE BIG SIOUX, ANTELOPE, AND WHETSTONE VALLEYS AN ABUNDANCE OF GOOD WATER CAN BE FOUND IN WELLS LESS THAN TWENTY-FIVE FEET DEEP, WHICH PENETRATE THE SAND AND GRAVEL FILLS BENEATH THE SILT COVER. WATER IS ALSO OBTAINED FROM THE CONTACT OF THE DRIFT WITH THE UNDERLYING BEDROCK. IN THE NORTHEASTERN PART OF THE COUNTY, SUCH WELLS AVERAGE ABOUT SIXTY FEET IN DEPTH, AND ON THE LOWLAND SOUTH OF MILBANK FORTY TO FIFTY FEET IN DEPTH. A DIRTY SAND, WHICH IN MANY PLACES CARRIES PIECES OF WOOD AND OTHER ORGANIC MATTER, USUALLY SUPPLIES THE WATER. THESE WATERS ARE ALWAYS HARD. NO ANALYSIS OF THEM WAS AVAILABLE, BUT THE TESTIMONY OF MANY HOUSEWIVES WHO REPORT DIFFICULTY USING SOAP AMPLY ATTESTS TO ITS HARDNESS. THIS SOURCE SUPPLIES SUFFICIENT WATER FOR FARM USES IN MOST PLACES, BUT COULD NOT BE USED WHERE LARGE SUPPLIES OF WATER WERE NEEDED. MANY OF THESE WELLS FAILED DURING THE DRY SUMMER OF 1933.

BEDROCK SUPPLIES:

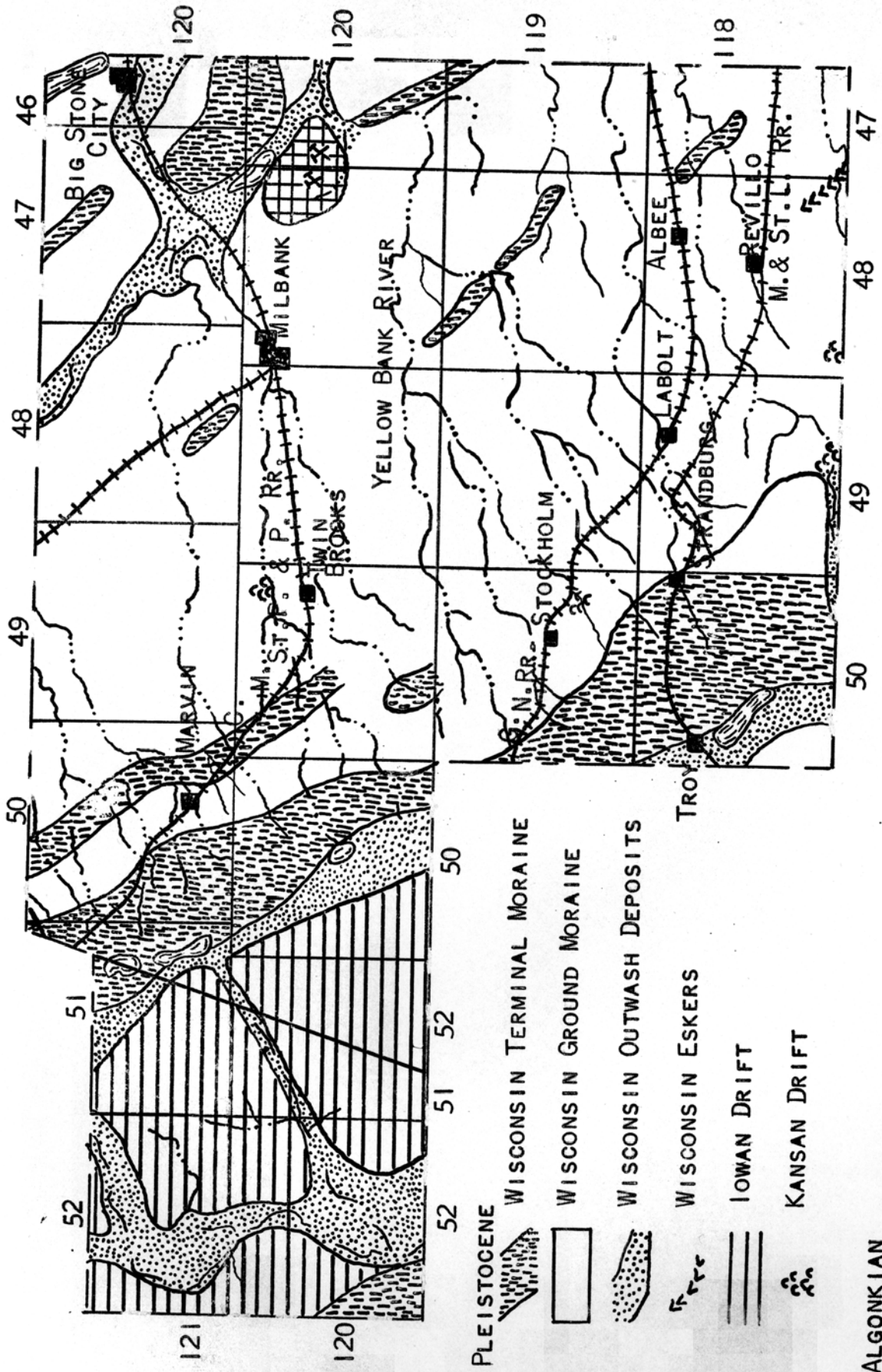
THE BEDROCK WATER SANDS, WHICH HAVE BEEN DISCUSSED EARLIER IN THIS REPORT (P.25) WILL BE REPEATED HERE FOR THE SAKE OF CLARITY. IN THE LOWLAND TWO WATER SANDS ARE AVAILABLE, THE CHALK ROCK AND THE ARTESIAN SANDSTONE. BOTH OF THESE SANDS CAN BE ENCOUNTERED BY DRILLING WEST OF THE OUTCROP SHOWN ON THE GEOLOGIC MAP. THE CHALK LIES AT AN APPROXIMATE ELEVATION OF 1150 FEET. THE ARTESIAN SAND LIES AT AN ELEVATION OF ABOUT 800 FEET. ON THE LOWLAND, THEREFORE, THE CHALK SHOULD BE ENCOUNTERED AT A DEPTH OF FROM 100 TO 150 FEET, AND THE ARTESIAN SAND FROM 200 TO 400 FEET. IN ORDER TO ENCOUNTER THESE FORMATIONS BENEATH THE COTEAUS IT WOULD BE NECESSARY TO ADD 800 TO 900 FEET TO THE FIGURES ALREADY GIVEN. NO ANALYSES OF THE WATER FROM THE CHALK IS AVAILABLE, BUT IT IS ORDINARILY DESCRIBED AS SOFT. THE WATER FROM THE ARTESIAN WELLS AT REVILLO AND ALBEE IS DESCRIBED AS SOFT AND "SWEET", BUT THAT FROM ALL THE DEEP WELLS AROUND MILBANK AND TWIN BROOKS IS SUFFICIENTLY CHARGED WITH SALTS TO GIVE IT A TASTE. SOME DESCRIBE THE TASTE AS SALTY AND OTHERS AS "PLUTY". AN ANALYSIS OF THE WATER FROM THE ARTESIAN WELL ON THE PETER HUBLOU FARM, ONE MILE NORTH AND ONE-HALF MILE WEST OF MILBANK, WAS MADE BY MR. GUY G. FRARY, STATE CHEMIST, IN THE STATE CHEMICAL LABORATORY, AND GIVES THE FOLLOWING RESULTS:

ELEMENTS	PARTS PER MILLION
TOTAL SOLIDS	2933.0
SILICA	12.0
IRON AND ALUMINUM	-----
CALCIUM	27.0
MAGNESIUM	4.36
SULPHATE	1160.97
CHLORIDES	132.0

THE LOW CALCIUM AND MAGNESIUM CONTENT SHOWS THAT THIS WATER IS NOT HARD. IN FACT IT IS USED AS LAUNDRY WATER WITHOUT BREAKING. THE SULPHATE CONTENT, HOWEVER, IS HIGH ENOUGH TO GIVE THE WATER CERTAIN MEDICINAL PROPERTIES. THIS IS PROBABLY A FAIR SAMPLE OF THE WATER TO BE ENCOUNTERED IN THE DEEP ARTESIAN SAND IN THIS PART OF THE BASIN.

THE WATER SUPPLIES OF THE COTEAUS COME ENTIRELY FROM GLACIAL SANDS, WITH A POSSIBLE EXCEPTION OF THE SPRINGS AND SHALLOW FLOWING WELLS WHICH OCCUR IN THE LOWER HALF OF THE COTEAU ESCARPMENT. FROM THE INFORMATION AT HAND IT IS IMPOSSIBLE TO TELL WHETHER A WATER BEARING SANDSTONE LIES ABOVE THE CHALK IN THE COTEAUS. THE ACCORDANCE OF THE WATER LEVEL IN THE SPRINGS AND CERTAIN COTEAU WELLS SUGGESTS THAT SUCH A SAND EXISTS AT AN ELEVATION OF ABOUT 1400 FEET. IF SO, A WELL ON THE SUMMIT OF THE COTEAU WOULD HAVE TO BE DRILLED TO A DEPTH OF APPROXIMATELY 500 OR 600 FEET TO REACH THE SAND. THE ABUNDANCE OF SHALLOW WATER SOURCES IN THE SANDS OF THE ANTELOPE AND BIG SIOUX VALLEYS, IN GRAVEL AND SAND POCKETS OF THE GLACIAL DRIFTS, MAKE IT UNNECESSARY TO DRILL DEEP WELLS IN THIS PART OF GRANT COUNTY.

SURFICIAL GEOLOGY
GRANT COUNTY SO. DAK.



- PLEISTOCENE
 - WISCONSIN TERMINAL MORaine
 - WISCONSIN GROUND MORaine
 - WISCONSIN OUTWASH DEPOSITS
 - WISCONSIN ESKERS
 - IOWAN DRIFT
 - KANSAN DRIFT
- ALGONKIAN
 - GRANITE
 - QUARRIES