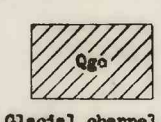
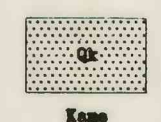


EXPLANATION



Glacial channel

Valley where glacial meltwater flowed and accumulated. Most valleys cut in ground moraine and in most places partially filled with deposits of unconsolidated glacial outwash. Silt and sand are most common materials in flat floors of wide channels; deposits of gravel, marl, and clay, and minor amounts of boulders also present. Sloping sides of channels are locally covered with trace to 6 feet of silt.



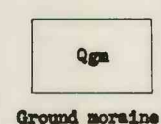
Kame

Miscellaneous kame, undifferentiated as to origin; knobs, low mounds, and irregularly shaped hills of unconsolidated glacial outwash. Silt and sand most abundant, but clay, gravel, and boulders also present. Coarse sand and gravel poorly sorted and rudely stratified. Fine sand and silt sorted in steeply dipping to horizontal lenses and discontinuous layers; cross-bedding common. Deposits locally contain till. Most common rock types present; granite and limestone abundant; platy shale, ironstone nodules, and some of lignite fragments common; caliche some near top and locally at depth. (See analyses of samples from kames on facing page.)



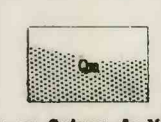
Esker

Long, narrow, sinuous ridge composed essentially of interbedded sand, gravel, and silt; lithologically similar to kames but less clay and silt present. Sorting poor. Stratification good to absent; bedding horizontal to near 45 degrees. Boulders as large as 1 cubic yard in size present. Glacial till (pebbly clay) present locally.



Ground moraine

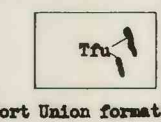
Glacial till; chiefly unstratified calcareous, plastic clay containing scattered stones of all kinds ranging in size from pebbles to boulders. Locally contains lenses and irregular masses of unconsolidated silt, sand, and gravel. Color buff (oxidized) at and near surface; gray to blue-gray at depth. Caliche some near surface common. Ground moraine covered in places by thin mantle of fine sand and silt, particularly adjacent to meltwater channels. Cobbles and boulders scattered over surface. Sand-size gypsum crystals abundant near surface.



Moraine on Coteau du Missouri  
Late Wisconsin?

Similar to ground moraine, but surface consists of abundant knobs, irregular ridges, kettles, and undrained depressions; boulders abundant.

UNCONFORMITY



Fort Union formation

Interstratified beds of clay, silt, fine sandstone, and lignite; silt and clay predominate. The clay (silty to fatty) and silt (clayey to sandy) are compacted to soft clay shale and soft silty shale in places. Some cementation by calcareous carbonate in most beds. Sandstone is mostly buff or yellowish buff; silt, buff or gray; clays, gray (blue-gray when wet). Some uniform silt have a distinctive "salt-and-pepper" appearance. Clays mostly plastic. Lignite seams common and material slakes easily on exposure. Also contains lenses and irregular masses of hard clay siltstone, thin layers and nodules of ironstone, fossil plants and fossilized wood. Stratification excellent, but beds not continuous over wide areas.

RELIABILITY OF MAP UNIT BOUNDARIES

(All boundaries except Ft. Union formation based on combined interpretation of topography and lithology.)

SHARPLY DEFINED GEOLOGIC CONTACT

(Conspicuous topographic change or marked lithologic gradation)

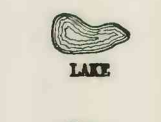
GRADATIONAL GEOLOGIC CONTACT

INFERRED AND GRADATIONAL GEOLOGIC CONTACT  
(Generalized in places)

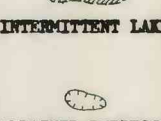
175

DEPTH TO LIGNITE BED IN FORT UNION FORMATION

Top of Fort Union formation at shallower depth than figures shown in symbols because clay, shale and sandstone beds are usually present above lignite beds.



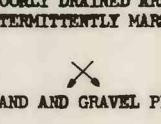
Lake



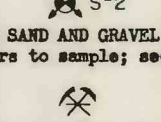
Intermittent lake



Undrained depression



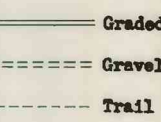
Intermittent stream



Poorly drained area  
Intermittently marshy



Sand and gravel pit



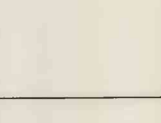
Sample from sand and gravel pit analyzed  
(Number refers to sample; see facing page)



Abandoned coal mine



Roads



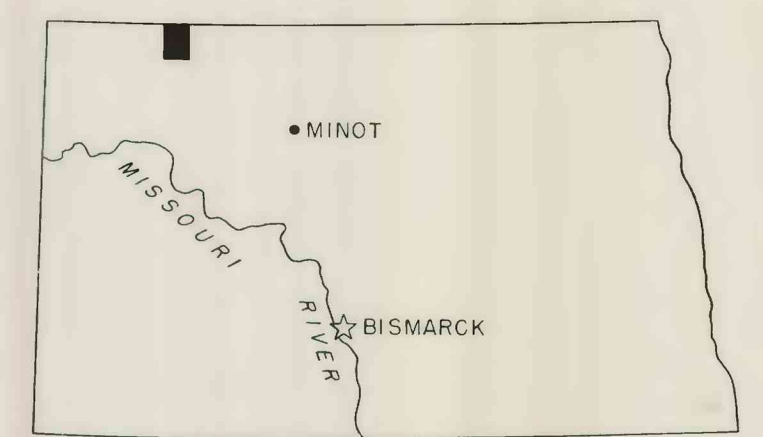
Buildings



Benchmark



International boundary commission monument



Key map of North Dakota showing location of Rival No. 2 Quadrangle

Base compiled by Topographic  
Branch, U.S. Geological Survey

PRELIMINARY

GEOLOGIC MAP OF RIVAL NO. 1 QUADRANGLE, NORTH DAKOTA

Geology mapped in 1947 and 1948 by  
R.C. Townsend, assisted by Arthur L. Jenke  
and Leonard S. Rolnick.

Drafting by Frank F. Mooney

