

Surficial Geology of the Lynch 7.5 Minute Quadrangle, Nebraska

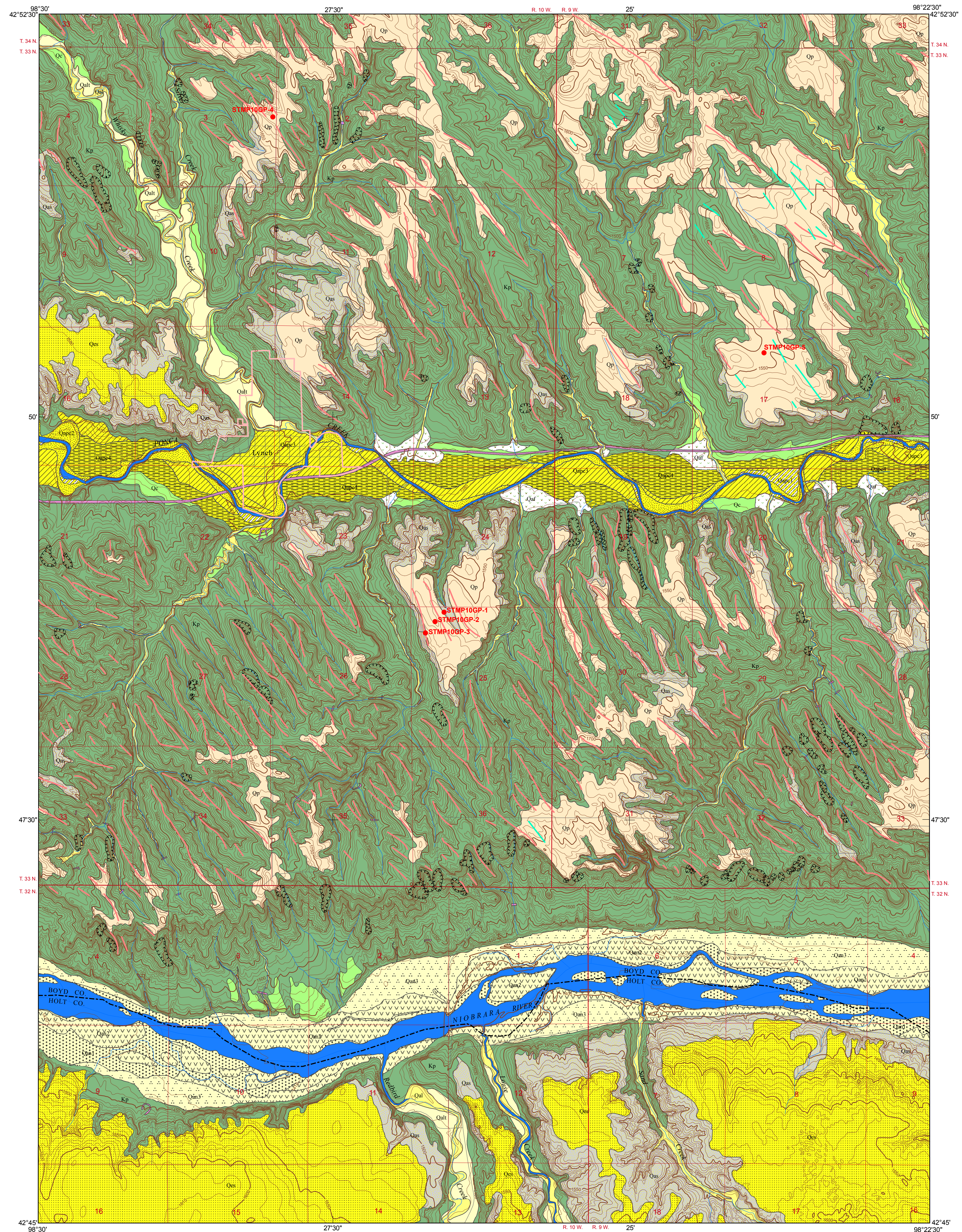
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Description of Mapping Units:

Kp Pierre Shale (Upper Cretaceous)

Gray to dark gray (weathering light gray, olive gray, olive brown, grayish brown, pale brown, and pale yellow) silt shale to clay shale, with rare, very thin to thin beds of siltstone, very fine sandstone, and bentonite, as well as some beds of chalky limestone.

According to Souders (1976), three members of the Pierre Shale crop out in Boyd County, Nebraska: (1) an unnamed lower member overlying the Niobrara Formation, (2) the Moberge Member, and (3) the Elk Butte Member, in ascending order.

Qal Quaternary alluvium of smaller streams and the active channels of larger streams (Late Holocene, including modern times)

Silty clay, clayey to sandy silt, and fine sand.

Late Holocene to modern alluvium along small tributary streams in the general region of the Lynch Quadrangle varies according to its source area. Alluvium in small streams draining catchments dominated by Pierre Shale at the land surface is generally finer-grained than is the alluvium of streams whose drainage basins include older Quaternary alluvial terrace sands and eolian sands. This mapping unit also includes sediment that has accumulated in channelized streams and in other engineered drainageways. Some first-order and ephemeral streams in higher-relief areas where Pierre Shale is at the surface do not appear to have accumulated significant amounts of alluvium.

Qalt Quaternary alluvium of in terraces of smaller streams (Holocene)

Silty clay, clayey to sandy silt, and fine sand.

Sediments included in this mapping unit underlie terrace surfaces, which generally result from the incision, entrenchment, and headward erosion of smaller streams. Alluvial sediments physically separated from the active channel belt of their source drainage are included in Qalt. These sediments are mostly of late Holocene age and locally merge with slopewash under toeslopes at the margins of valleys.

Qm Youngest Quaternary alluvium of the Niobrara River (Late Holocene [modern])

Pale brown and light brownish gray silty sand and fine to coarse sand.

Sediments included in this mapping unit are stratified sediments deposited in late since ca. 1950 in flood channels and on bars of the Niobrara River. They are dominated by fine to medium sand, and silty sand is a lesser component. Flood channels are visible in some areas mapped as Qm1, in which case Qm1 may overlie Qm2 or older Holocene sediments of the Niobrara River. Areas mapped as Qm1 are subject to frequent flooding.

Qm2 Young Quaternary alluvium of the Niobrara River (Late Holocene [historic])

Pale brown and light brownish gray silty sand and fine to coarse sand.

This mapping unit includes some areas in which deposition occurred between 1890, the date of the earliest General Land Office (GLO) survey, and ca. 1950. This mapping unit also includes areas that were not within the 1890 channel of the Niobrara River, but nonetheless have characteristics similar to the latter category, namely the presence of riparian woodland contrasting with both mapping units Qm1 and Qm3. Sediments of this mapping unit are dominated by fine to medium sand. Areas mapped as Qm2 are subject to infrequent flooding.

Qm3 Older Quaternary alluvium of the Niobrara River (Late Holocene)

Pale brown and light brownish gray silty sand and fine to coarse sand.

All areas mapped as Qm3 are frequently separated from the modern course of the Niobrara River by mapping units Qm1 and Qm2. All areas mapped as Qm3 were parts of the stable floodplain in 1890, the date of the earliest General Land Office (GLO) survey, and they lack active channels of the Niobrara River. Qm3 is underlain by older Holocene and Late Pleistocene alluvium. Areas mapped as Qm3 are unlikely to experience flooding.

Qm4 Youngest Quaternary alluvium of Ponca Creek (Late Holocene [modern])

Light brownish gray fine to coarse sand.

Areas mapped as Qm4 can be identified as the results of very recent (post-1950) in-channel, point bar, and splay deposition in Ponca Creek. A recent splay is present inside a meander loop on the north side of Ponca Creek in the NW¼ NE¼ of section 20, T. 33 N., R. 9 W. Examination of General Land Office (GLO) surveys dating to 1890 indicate that the meanders of Ponca Creek have migrated very little in the area of the Lynch Quadrangle since that time. Nonetheless, where the lateral migration of point bars and channels has occurred in recent decades, or where flooding has deposited splays extending from the channel, Qm4 has been mapped. Splays are underlain by Qm2; point bar and channel deposits are underlain by older Holocene alluvium. The activity of Ponca Creek in areas mapped as Qm4 renders these areas hazardous.

Qm5 Young Quaternary alluvium of Ponca Creek (Late Holocene [historic])

Light brownish gray silty sand and fine to coarse sand.

Most of the areas mapped as Qm5 can be identified as the results of post-1890 deposition through the examination of the mapped position of Ponca Creek in General Land Office (GLO) surveys dating to that year. These areas typically are covered with riparian woodland, probably because they were unsuitable for farming when intensive agricultural land use began. Some areas mapped as Qm5 indicate deposition that pre-dates 1890, but their similarity in vegetation cover and/or surface features suggests that they are also similar in age and that they probably date to historic, but pre-European-settlement, times. Sediments included in this mapping unit are thin to medium-bedded silty sands and sands. These strata contain multiple, comparatively weakly-developed buried soils. Areas mapped as Qm5 are mostly wooded and occasionally experience overbank flooding.

Qm6 Older Quaternary alluvium of Ponca Creek (Late Holocene)

Light brownish gray silty sand and fine to coarse sand.

Areas mapped as Qm6 are mostly in long-term agricultural use and rarely experience overbank flooding. In early aerial photographs (e.g., 1939, 1954), these areas show faint meander scrolls and channels, indicating the active lateral migration of Ponca Creek in geologically recent times. Sediments included in this mapping unit are thin to medium-bedded silty sands and sands. Areas mapped as Qm6 occasionally experience overbank flooding.

Qm7 Older Quaternary alluvium of Ponca Creek (Holocene)

Light brownish gray silty sand and fine to coarse sand.

Areas mapped as Qm7 are in long-term agricultural use and rarely experience overbank flooding. In the earliest series of aerial photographs (1939 and 1954), these areas appear smooth and comparatively uniform in tone, and they show no evidence for meander scrolls and channels, as does mapping unit Qm3. Therefore, these sediments are interpreted as being older than those of Qm3. Sediments included in mapping unit Qm7 are thin to medium-bedded silty sands and sands.

Qm8 Quaternary alluvial sediments, dominantly sands, on high terraces and eroded terrace remnants (Early-Middle Pleistocene?)

Dominantly pale brown fine to coarse sand and pebbly medium to very coarse sand, with some silt and shale-pebble sediment (derived from weathered Pierre Shale).

Areas mapped as Qm8 typically consist of fine to medium sand with few to common Rocky-Mountain-sourced crystalline pebbles or small cobbles of (quartz, granite, gneiss, anorthosite, etc.), chert or Jasper, limestone, shale, and siderite rhyolite (the latter two are clearly derived from the Pierre Shale). Rare pebbles to small cobbles of opaline sandstone and calcareous appear to be derived from the Miocene Ogallala Group, which crops out to the west. Surficial sands in areas mapped as Qm8 may have been reworked and resorted by eolian processes, because well-sorted fine to medium sands dominate locally, but definitive proof of eolian reworking is lacking.

Some large areas mapped as Qm8 (e.g., the large table at the western edge of the Lynch Quadrangle in sections 15 and 16 of T. 33 N., R. 10 W.) are clearly high terraces of a former large drainage, possibly the ancestral Niobrara River. Smaller tables and ridgetops areas mapped as Qm8 on the Ponca Creek-Niobrara River divide and north of Ponca Creek are the dissected remnants of such terraces. Loess mapped on these surfaces is thin (see mapping unit Qm9).

Discontinuous lags of crystalline pebbles may be found on oriented ridges eroded from the Pierre Shale on the Ponca Creek-Niobrara divide, suggesting that alluvial terrace sands and pebbly sands were formerly continuous across that divide.

The comparatively flat table (= terrace remnant) in section 17 of T. 33 N., R. 9 W. is covered mostly by silts and shale-pebble conglomerates, the latter being derived from the weathered Pierre Shale. Nearly 7.0 m of these materials underlie what we have interpreted as a thin cover of loess that is completely incorporated within the extant soil profile. The shale-pebble conglomerates are unlikely to be colluvial because of the low slope of the landscape position, and the clasts within them are too large to be wind-transported. Therefore, these sediments are interpreted as old alluvial deposits.

Qm9 Colluvium (Holocene, including modern times)

Silty clay to silt with fragments of Pierre Shale.

Colluvium appears on some toeslopes in the mapped area and merges downslope with alluvium, such as mapping unit Qal.

Qm10 Quaternary eolian sands reworked from local alluvial sands (Late Pleistocene)

Pale brown fine to medium sand.

Areas mapped as Qm10 overlie old terrace deposits of Qm8 high above modern drainages and are distinguished by subdued dune forms at the land surface and/or the preferential sorting of fine and medium sand without pebbles or cobbles (see mapping unit Qm8).

Qm11 Quaternary alluvial fan sediments (Holocene, including modern times)

Silty clay, silt, and sandy silt.

Multiple, small, low-angle alluvial fans lie along the northern and southern valley walls of Ponca Creek. They are identifiable at ground level by their slight elevation above toeslope and floodplain surfaces. They consist of thin increments of alluvium transported from the uplands by low-order streams.

Qm12 Peoria Loess (Late Pleistocene [Late Wisconsinan])

Light brownish gray, brown, pale brown, and light yellowish brown clayey silt, medium to coarse silt, and sandy silt.

The eolian silts of the Peoria Loess are thin (~0.8-3.0 m) and patchily distributed in the mapped area and it can be difficult to identify as a discrete increment on flat upland surfaces interpreted as the remnants of old terraces, particularly on the Ponca Creek-Niobrara River divide. In many of these cases, the evidence for loess coverage is simply the siltier texture within soil horizons overlying alluvial sands or pebbly sands, which are mapped downslope or in other places as Qm8. An example of this condition is the table (= terrace remnant) extending across the N½ section 25, to the western edge of section 23, and into section 24 of T. 33 N., R. 10 W. Loess is generally thicker and more distinct as a stratigraphic unit on summit surfaces north of Ponca Creek. In a borehole at a ridgetop in the NE corner of the NE¼ NE¼ SW¼ of section 3, T. 33 N., R. 10 W., 2.75 m of loess overlies sand equivalent to mapping unit Qm8, and weathered Pierre Shale was encountered at a depth of 4.17 m.

F Fill

Artificial fill, typically derived from local sources.

This mapping unit is intended to portray significant accumulations of artificial fill in dams, road embankments, and other manmade structures.

W Water

Low-relief oriented feature mapped from aerial photography and interpreted as a product of eolian processes

Prominent high-relief oriented ridge line interpreted as a product of eolian erosion

Landslide

Test hole location

City or town boundary.

Overview of the Lynch Quadrangle

Geographic Setting and Geomorphology

The Lynch 7.5-minute quadrangle lies in eastern Boyd County and northernmost Holt County in north-central Nebraska. The entire quadrangle lies west of the Laurentide glacial limit and on the Great Plains. The Lynch Quadrangle lies within the Level IV Southern River Breaks of the Northwestern Glaciated Plains Level III Ecoregion of Chapmann et al. (2001), although this part of Nebraska was not glaciated at any time during the Late Cenozoic. The Lynch Quadrangle overlaps United States Department of Agriculture Natural Resources Conservation Service (NRCS) Major Land Resource Areas (MLRAs) 63B Southern Rolling Pierre Shale Plains and 66 Dakota-Nebraska Eroded Tableland (United States Department of Agriculture, Natural Resources Conservation Service, 2006).

Glacial deposits are present within short distances to the north and east of the Lynch Quadrangle. In Wisconsinian times, the western limit of the Laurentide ice sheet stood approximately 5 km to the northeast of the northeast corner of the quadrangle and about 15 km north of the center of the northern border of the quadrangle on the eastern side of the present Missouri River in Charles Mix County, South Dakota. The glacial limit in Nebraska is approximately 30-35 km to the east of the eastern edge of the Lynch Quadrangle in Knox County, Nebraska.

Roughly northwest-to-southeast-oriented streamlined ridges and intervening narrow valleys eroded from the Pierre Shale appear throughout the Lynch Quadrangle, but they are particularly prominent on the Ponca Creek-Niobrara River divide in the mapped area and on adjacent quadrangles to the west and east (Figs. 1-3). Single-oriented ridgetops can be traced for ~0.2-2.5 km, and the intervening valleys range from ~0.12-0.45 km in width. The upper slope on the NE-facing side of a ridge is usually significantly steeper than the gentler, continuous slope of the SW-facing side. Terraces, slumps, and slides are prominent on Pierre Shale slopes throughout the map area (Figs. 4-5), but slides and slumps can be particularly prominent on the NE-facing slopes of oriented ridges (Fig. 1). Considering the similarity of these features to others described from Nebraska, and the predominant Late Pleistocene-Holocene wind directions interpreted from dunes in the Sand Hills, the oriented topography of Boyd County is attributed to Quaternary eolian erosion.

Bedrock and Regolith Geology

The single bedrock unit underlying all of the Lynch Quadrangle is the Pierre Shale (Upper Cretaceous), the youngest Cretaceous Formation under almost all of Nebraska and much of South Dakota. The Pierre Shale is unconformably overlain by outliers of the Upper Miocene Ogallala Group in the enclosing region, and the Ogallala Group is generally more continuous to the west in Boyd County and further west in Keya Paha and Cherry Counties. The Niobrara Formation, which underlies the Pierre Shale in the regional stratigraphic succession, crops out extensively in Knox County, Nebraska, the next county to the east of Boyd County.



Figure 1. Ridges oriented roughly northwest-southeast bounding an oriented valley in section 27, T. 33 N., R. 10 W. The steep side (sts) of the ridge to the left faces northeastward, and the shallow slope (shs) of the opposite ridge faces southwestward. Note the small landslides on the steeper slope (sts).

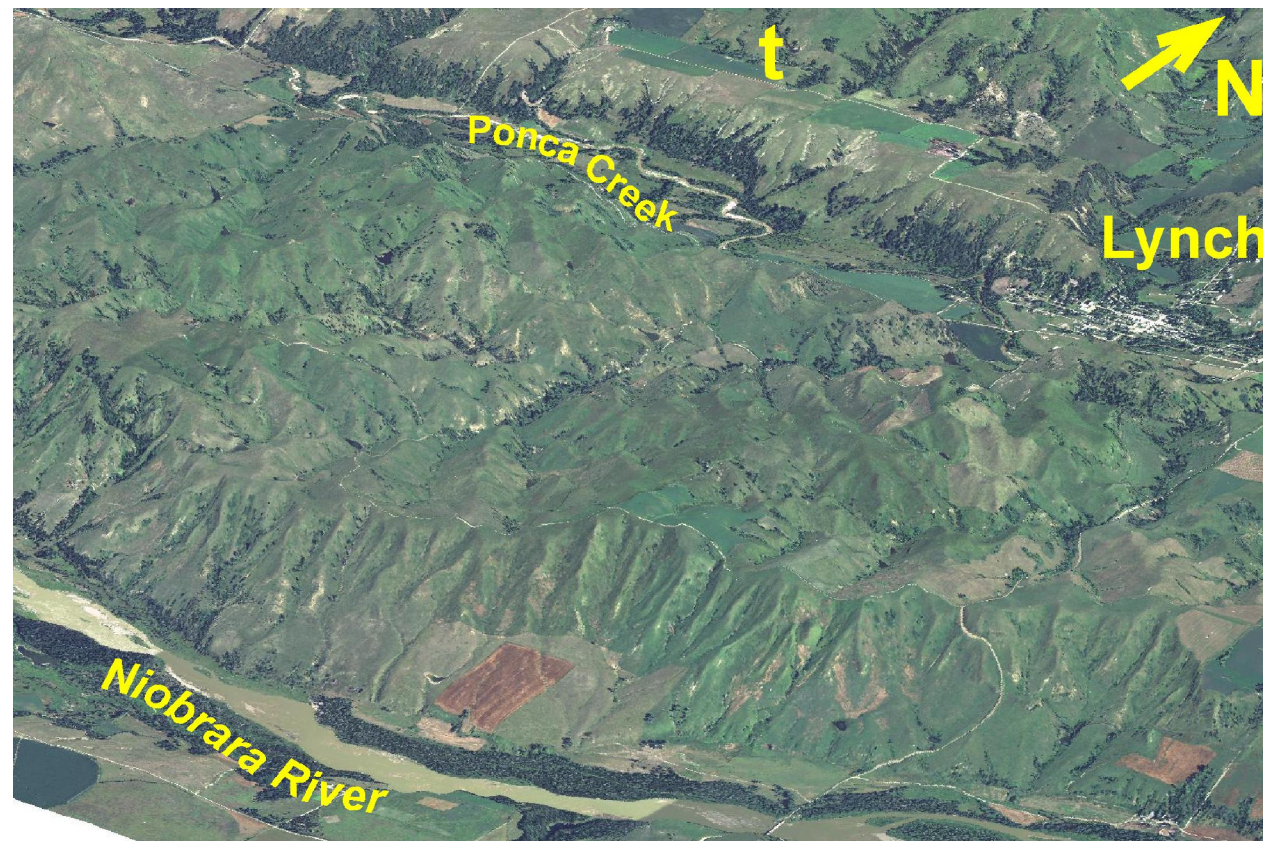


Figure 2. Simulated low-angle aerial view of the western part of the Ponca Creek-Niobrara River divide on the Lynch Quadrangle, produced by draping an aerial photograph over a digital elevation model (DEM) of the Lynch Quadrangle. View is roughly to the west-northwest. Note roughly northwest-to-southeast-trending ridges and valleys. Table (t) west of Lynch is a remnant of a high Pleistocene terrace represented by mapping unit Qm8 and covered with sands reworked by wind activity (mapping unit Qm9; Quaternary eolian sands).



Figure 4. Terraces on a Pierre Shale slope in the NE¼ of section 3, T. 32 N., R. 10 W., viewed from the northeast. Niobrara River Valley (NRV) is visible in the background.

The Pierre Shale has been weathered by oxidation and local acid rock weathering to a depth of a few meters under upland areas.

Regolith in the Lynch Quadrangle consists of sandy alluvium in stream valleys, sands and pebbly sands covering old, dissected terraces, colluvium, the deposits of small alluvial fans, eolian sand reworked from alluvial terrace sands, and loess.

Groundwater and Mineral Resources

Potential and realized sources of groundwater in the Lynch Quadrangle are either: (1) the very shallow alluvial aquifers of Ponca Creek and the Niobrara River or (2) the very deep bedrock aquifers of the Late Cretaceous Codell Sandstone of the Carlile Shale and, more importantly, sandstones in the mid-Cretaceous Dakota Formation. Both formations lie below the Pierre Shale and the Niobrara Formation. According to Souders (1976), the Codell Sandstone lies at depths of 200-400 ft (60-120 m) under the valley of Ponca Creek and at depths of 400-600+ feet (120-180+ m) under the adjacent uplands. The Dakota Formation lies 600-800 ft (180-240 m) below the valley of Ponca Creek and 800-1000 ft (240-300 m) below the valley of the Niobrara River and the upland divides in Boyd County (Souders, 1976). Other than sand and gravel in the alluvial fills of Ponca Creek and the Niobrara River, there are no other known mineral resources of economic value within the Lynch Quadrangle.

References

Chapman, S.S., Oremik, J.M., Freouf, J.A., Higgins, D. G., McCauley, J.R., Freeman, C.C., Steinauer, G., Angelo, R.T., and Schlegel, R.L., 2001. Ecoregions of Nebraska and Kansas (color poster with map, descriptive text, summary tables, and photographs). Reston, Virginia, U.S. Geological Survey (map scale 1:1,950,000).

Souders, V.L., 1976. Physiography, Geology, and Water Resources of Boyd County, Nebraska. Nebraska Water Survey paper No. 42. Conservation and Survey Division, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln.

United States Department of Agriculture, Natural Resources Conservation Service, 2006. Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296.



Figure 3. End-on view of oriented ridge on the Ponca Creek-Niobrara River divide, showing steep northeast-facing slope (sts) and shallower southwest-facing slope (shs).

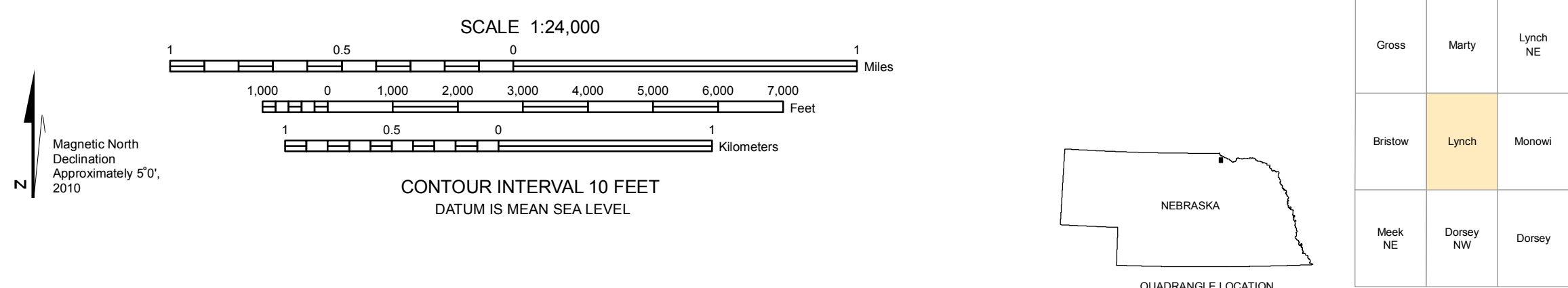


Figure 5. Exposure of weathered Pierre Shale on west valley wall of Redbird Creek near the hamlet of Redbird, Holt County, in the W¼ SW¼ of section 12, T. 32 N., R. 10 W. A small landslide (slide) has occurred recently at the site.

Projection: UTM zone 14 North, NAD83

Contours from the Nebraska Department of Natural Resources, compiled from USGS 7.5 minute topographic quadrangles

Additional base data derived from 2005 second edition TIGER/line files



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