Megaclasts in alluvial fills from the Ogallala Group (Miocene), Banner, Kimball, and Morrill counties, Nebraska

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Megaclasts in alluvial fills from the Ogallala Group (Miocene), Banner, Kimball, and Morrill counties, Nebraska

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ABSTRACT

Locally derived blocks and boulders (megaclasts) occur in conglomerate and in sand and gravel fills of channels in the Ogallala Group (Miocene) at localities in Banner, Kimball, and Morrill counties in western Nebraska. Some of the megaclasts are up to one or more orders of magnitude larger than the largest distantly derived grains in the sediments surrounding them. A number of these megaclasts probably moved downslope by mass wasting from outcrop sites on paleovalley sides and were later transported by running water. Other blocks and boulders were eroded by streams from bedrock along channel sides and then were transported by these bodies of water to their depositional sites.

The compositions and source formations of the blocks and boulders vary. Clasts of sandstone, caliche, and cemented volcanic ash were derived from erosion of older beds of the Ogallala Group. Interbedded sandstone and concretions were eroded from rocks of the Arikaree Group, and masses of siltstone were part of the Brule Formation.

INTRODUCTION

Megaclasts have been reported previously from Tertiary formations at four sites in western Nebraska ranging in age from Oligocene to Miocene. Work by the author since 1979 shows that megaclasts are relatively abundant in most upper Ogallala Group channel fills in the southern third of the Nebraska Panhandle.

The purposes of this report are: (1) to describe the megaclasts which can easily be mistaken for weathered outcrops; (2) to note positions of megaclasts in alluvial fills; and (3) to report the geometries of the paleochannels in which the fills (including megaclasts) were deposited.

PREVIOUS WORK

Crowell (1964, p. 86) defined megaclasts as 

"... large clasts (pebbles, cobbles, boulders, and blocks), mixed or dispersed in a matrix of finer material."

He said (ibid., p. 87) that these megaclasts may occur in bedded or unbedded sequences and listed nine possible modes of origin for megaclasts. The modes included ice rafting, glacial deposition, slumping, volcanic and other mud flows and turbidity currents, tectonic formation along the edges of thrusts, talus accumulation, and selective weathering. To these may be added fluvial erosion and collapse along cutbanks of channels incised into bedrock during normal stream flow as well as during major stream discharges.

In Nebraska, megaclasts have been reported previously from at least four formations of Tertiary age. Matthew (1924, p. 63) noted large slump blocks of Miocene rock in a younger channel sand. Lugn (1939, p. 1255) elaborated on Matthew's brief description of the slump blocks and reported their dimensions as "from 10 to 20 feet or larger." Skinner and others (1977, p. 309, 312-313 and Fig. 7) gave a more complete description of the same site. Their Figure 7 shows that the blocks are tabular and jumbled. Slump blocks up to 0.6 m in diameter have also been reported in a channel fill in the Box Butte Formation by Galusha (1975, p. 36). Swisher (1982, p. 65, and Pl. 6) describes "rip-up blocks" up to 0.9 m in diameter in a channel fill of the Gering Formation. Schultz and Stout (1955, p. 24) noted large boulders of Pierre Shale in a basal Chadron fill at one locality.

OGALLALA MEGACLASTS

Megaclasts occur in either sand and gravel or conglomerate-filled channels in the Ogallala Group in southwestern Morrill, southern Banner, and northern Kimball counties in Nebraska. Five sites containing megaclasts (Fig. 1) are described in this paper. The easternmost of these filled channels is partially exposed along the west side of the valley of Greenwood Creek in Morrill County. This site, principally on the Flamig Ranch (NW 1/4, sec. 33, T. 18 N., R. 50 W.), has many good exposures of unconsolidated sand, and sand and gravel in the Ogallala Group. The gravel contains quartzite, granite, rhyolite, and other types of stream-transported clasts derived from Rocky Mountain sources to the west and southwest. The largest of these clasts have intermediate diameters of over 10 cm. Scattered about on the surface of outcrops of the coarsest of these beds are a few locally derived older Ogallala sandstone boulders up to 60 cm in diameter.

Other Ogallala channels filled with sand and gravel occur to the west and southwest of Greenwood Creek. These beds contain large sandstone boulders like those at the Greenwood Creek site. A channel fill on the Singleton Ranch (NW 1/4, sec. 31, T. 17 N., R. 53 W.) in Banner County has a basal conglomerate containing older Ogallala sandstone and calcrite boulders (Fig. 2) up to 50 cm in intermediate diameter.

The boulder-sized megaclasts had to have originated close to their present positions because they are composed of poorly indurated sedimentary rocks. On the Beranek Ranch (NE 1/4, sec. 5, T. 16 N., R. 54 W.) in Kimball County, there is a channel fill where the distance between the source of the megaclast boulders and their depositional site can be estimated. At this locality a younger Ogallala valley has been produced by stream erosion of

Figure 1. Physiographic map of study area with locations of specific sites. Base after DeGraw (1971).

Figure 2. Sandstone megaclast in Ogallala granitic conglomerate, Singleton Ranch, Banner County, Nebraska. Hammer is 40.6 cm long.
Figure 3. Megaclasts in Ogallala sand and gravel in alluvial fill of channel that was eroded by stream into older Ogallala sandstone beds (left). Dashed line is approximate position of channel side. Arrow points to site of Figure 4.

Figure 4. Sandstone megaclasts (rounded) in Ogallala conglomerate along channel side. Rocks at left are older Ogallala sandstone ledges. Hammer is 40.6 cm long.
Figure 5. A, (left page) Megaclast boulders and blocks in Ogallala channel fill on Van Pelt Ranch. Arrow 1 points to location of boulders in Figure 5B. Arrow 2 points to location of blocks in Figure 5C; B, (right page) Megaclast sandstone boulders in conglomerate. Man is 1.9 m
C, (left page) Megaclast volcanic ash block in conglomerate. Hammer is 40.6 cm long; D, (right page) Megaclast volcanic ash blocks in conglomerate. Stick is about 1.2 m long; E, (left page) Megaclast volcanic ash block (9.1 x 3.0 x 2.4 m) in trough-crossbedded conglomerate; and F, (right page) Close-up of SE showing edge of block in Figure SE in side of trough in conglomerate.
older Ogallala Group sandstones, the underlying sandstones of which are probably part of the Gering Formation of the Arikaree Group, and the uppermost siltstones of the Brule Formation (White River Group). This younger Ogallala valley was subsequently filled with sand and gravel which later was cemented into conglomerate locally along the paleovalley side. Sandstone boulders averaging about 80 cm in intermediate diameter occur in this younger Ogallala fill (Fig. 3). Sandstone source ledges crop out as little as 30 cm from some of the sandstone boulders that are cemented into the conglomerate part of the fill (Fig. 4). It seems unlikely that any of these megaclasts was carried more than a few tens of meters from its source to its present position.

At a site on the Faden Ranch (NW1/4, sec. 18, T. 18 N., R. 54 W.) in Banner County, boulders of Ogallala sandstone and calcrete up to 80 cm in diameter, a block of Arikaree sandstone about 160 cm in intermediate diameter, and smaller siltstone boulders from the Brule Formation are cemented into the basal conglomerate filling the channel. This is the easternmost occurrence in the study area of megaclast blocks found in an Ogallala channel fill.

South of Harrisburg in Banner County, a part of a younger Ogallala sand and gravel fill is exposed on the Van Pelt Ranch (NW1/4, sec. 25, T. 18 N., R. 56 W.). This fill contains megaclast boulders of older Ogallala sandstone and megaclast blocks of older Ogallala sandstone and indurated volcanic ash. When viewed from a distance the boulders and blocks look like debris weathered from outcrops and transported by downslope movements to their present positions during the Holocene (Fig. 5A). A cluster of sandstone boulders with average intermediate diameters of about 50 cm is cemented into conglomerate at one locality (Fig. 5A, B). Other boulders also occur in the fill either in conglomerate or in loose sand. Bedding in the locally derived blocks is oriented from horizontal to vertical and some blocks may be overturned (Fig. 5C, D). Many of the blocks are cemented into trough-cross-bedded conglomerate (Fig. 5E, F). Blocks vary in size but are generally over 1 m in diameter. The largest block at the site is about 9.1 x 3.0 x 2.4 m.

Figure 6. Landsat image of study area showing channel positions (dashed lines and arrows), and megaclast locations. Boulders shown by circles; blocks by triangles.
MEGACLASTS IN ALLUVIAL FILLS

The average intermediate diameter of the ten largest blocks is about 1.7 m.

In all but the last example, megclasts occur either along, or at or near the base of filled channels. On the Van Pelt Ranch megclast boulders and blocks occur at least 10 m above the base, and at least 20 m away from the nearest adjacent side of the channel fill. The blocks occur over one half of a section and are so widely separated vertically and horizontally that they probably could not simply be parts of a bed fragmented in place and not moved significantly.

Stream-transported megclasts (either boulders and/or blocks) derived locally by erosion of bedrock outcrops occur in several Ogallala channel fills in the study area. Megclast locations, positions of channel fills, and types of megclasts are shown on a Landsat image that covers most of the study area (Fig. 6). While these very large clasts have come from several older formations crossed by younger channels, most of the megclasts have been derived from older Ogallala strata. At least some of these older beds may have been fairly well indurated before erosion because their fragments contain well-cemented interbeds.

Some segments of the channels and their fills have been removed by stream erosion during the Quaternary, but enough remain to reconstruct their geometries and paths across the area. All of the Ogallala channels containing megclasts are deeply incised into older rocks. At sites where overall incision depths can be estimated, the range is from about 20 to about 60 m. Channel width is from about 1 to 2 km. Some channels, like the one on Faden Ranch, appear to have bifurcated in the initial stages of erosion of the deepest part of the channels. The channel path is slightly sinuous along its length for distances of 20 to 30 km. The channel fills are similar to those described by Breyer (1975) as braided stream deposits.

In general, Ogallala fluvial megclasts are associated with granitic sand and gravel fills of deeply incised stream channels. Megclast frequency increases toward the mountain source areas of the streams. Overall size of the megclasts also increases westward.

CONCLUSIONS

Megclasts are far more common in Tertiary fluvial channel fills than has been previously reported. V. L. Souders (personal communication, 1983), who has worked many years on the Cenozoic geology of the Nebraska Panhandle, even feels that most Cenozoic fluvial sequences in the Great Plains close to mountain sources should contain these very large, locally derived clasts.

The presence of fluvial megclasts allows the possibility of estimating the competence of some Cenozoic streams with greater precision than has been accomplished previously. That presence also points out some parallels between ancient and modern streams in the Great Plains because Quaternary alluvium at sites along rivers and arroyos also contains megclasts.

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Cover Illustration:
64 m$^3$ megaclast block of indurated volcanic ash from the Ogallala Group included in a trough cross-bedded younger Ogallala conglomerate (see paper by Diffendal).

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