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Abstract. Stone lines occur as layers or sheets of stones on the Cary drift plain in central Iowa. One occurrence is with the filling of depressional areas and is not discussed in the present paper. Another occurrence is along drainageways and seems to be reflected in the present landscape by nearly flat surfaces. A map of an area in Boone County, Iowa, is presented, showing the distribution of the surfaces, and sections along two traverses on one of the surfaces are shown. Engineering and pedologic significance and some of the proposed origins are discussed briefly. Particle size data indicate that material overlying the stone line becomes gradually coarser and thinner downslope, in contrast to the trend observed in swales.

Stone lines are not uncommon in soils in Iowa; pebble bands, lag-gravels and stone lines have been described from time to time by various authors and repeatedly in the publications of the Iowa Geological Survey. Stone lines usually occur as planar concentrations or layers of stones directly above or on the till (Fig. 1). The stones range in size from coarse sand to cobbles and occasionally, boulders. When seen in cross-section, as in road cuts, they appear as bands or lines of stones overlain by fine-textured material of varying thickness. The thickness of the stone line generally varies from 4 to 8 inches, but may approach 12 inches in places. Flat or tabular-shaped stones usually lay roughly parallel to the stone line. Most stone lines are not continuous regionally, but may be locally.

Two different occurrences of stone lines were found on Cary till in Boone and Story counties. One is apparently associated with the filling of basins that lack external drainage. The other is usually much stronger and is associated with drainageways, being linearly disposed along them. This paper is concerned with the latter.

Study area. An area in Boone County, T83N, R28W, including parts of sections 1, 2, 10, 15, 16, 21 and 22, was selected for mapping. Quite strongly developed stone lines appear in the road cuts of this area. Also there seems to be definite relationship between stone line surfaces and the present topography.

The area was mapped by drilling to the stone line and when possible through it into the underlying till. Where the stone lines were found and penetrated, all were directly on the Cary till.

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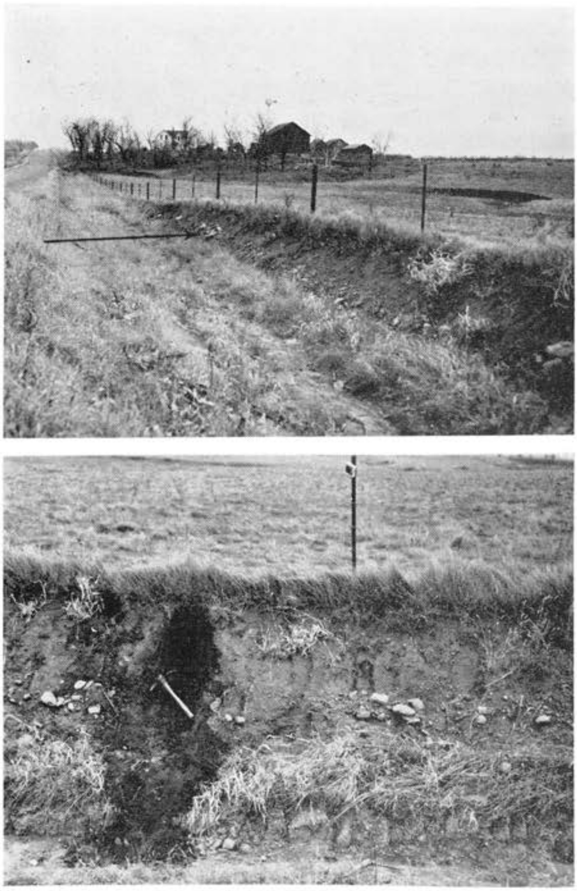


Figure 1. Stone lines in road cuts.

SURFACES

The topographic expression of the stone lines consists of nearly flat surfaces contained within the valley walls and usually inclined gently toward the present streams. The surfaces extend from the modern floodplain sideslopes to the break in slope that marks the upland (Fig. 2). Some of the surfaces are continuous along the stream for half a mile or more. In places the surfaces are somewhat dissected by gullies, but can be traced in the field without great difficulty.

The surfaces seem to emerge from beneath the present landscape in the northern part of the area and become relatively higher on the landscape with respect to the present streams toward the south. There appears to be a second and higher level surface in the southern part of the area mapped and possibly a third and still higher surface. It is not known how far south of this area the surfaces extend.

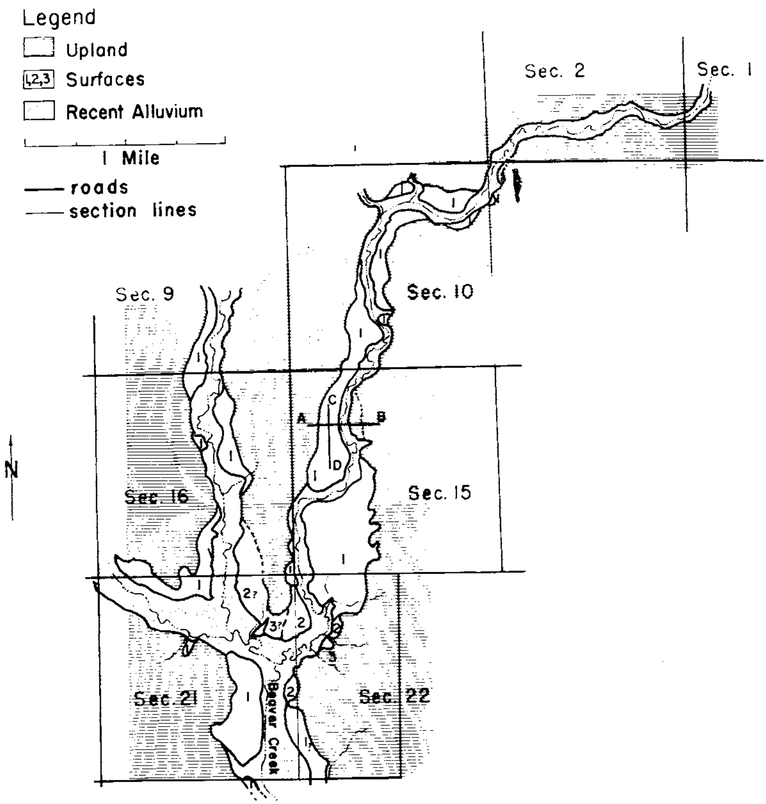


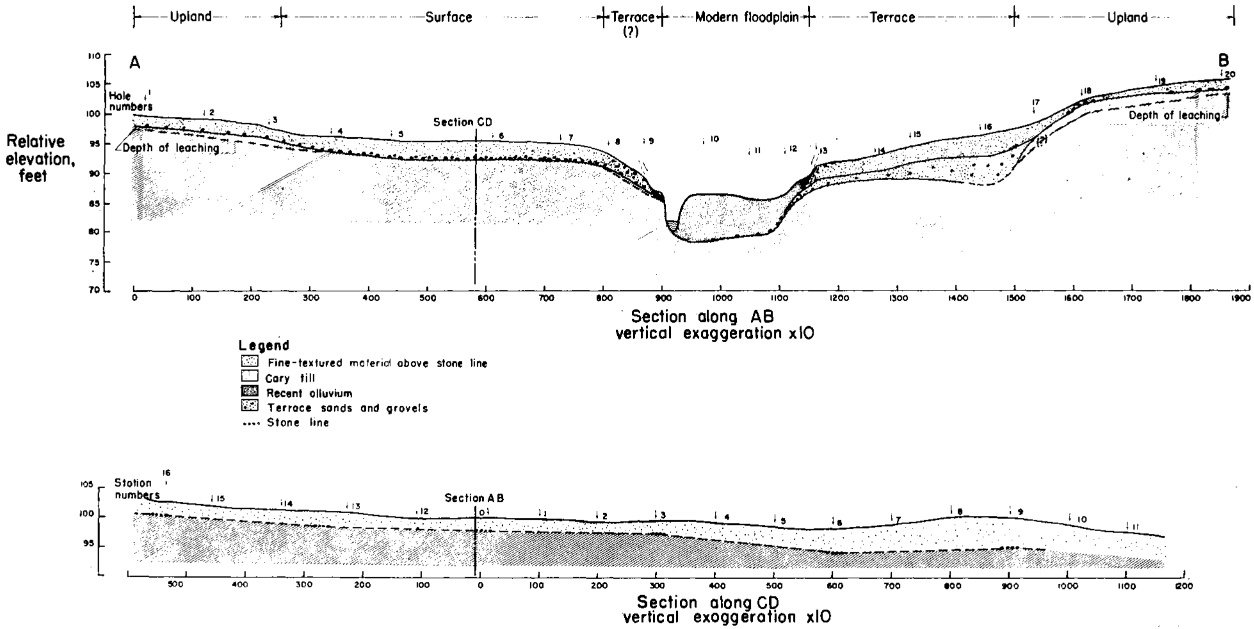
Figure 2. Map of study area.

Traverse Profiles

Two traverses were run on one of the surfaces: one in an east-west direction across the stream valley, shown on the map as AB; and one perpendicularly to this, running approximately parallel to the stream, shown as CD (Fig. 2). A detailed geologic section was drawn along AB and a section showing relative elevations on the surface along CD.

The section along AB begins in the upland and shows about 2 feet of fine-textured material above a weak stone line (Fig. 3). The nearly flat surface begins at the foot of the gentle slope marking the edge of the upland and extends for approximately 650 feet toward the stream. About 2½ to 3 feet of fine-textured material overlies a strong stone line on the till.

Figure 3. Traverse profiles.



Between the surface and the floodplain of the stream is an area which may be part of the surface that is now slumping or in creep, or it may be part of the terrace occurring on the other side of the stream. The soil here is very gravelly at the surface and down to the underlying till.

A terrace containing 1½ to 3 feet of gravel and coarse sand extends from the floodplain toward the upland and is overlain by fine-textured material of variable thickness. A slight increase in slope marks the beginning of the upland. A stone line immediately above the till at the edge of the upland becomes more weakly developed toward the upland.

The section along CD shows the nearly level configuration of the surface. Holes were drilled at intervals of 100 yards to the stone line. The relatively high area near the end marked D appears to correspond to the general level of the surface. Both the stone line and the present topographic surface show a slight inclination from A toward B, or from north to south.

It is particularly interesting to note that the thickness of the material above the stone line remains essentially constant, 2½ to 4 feet. The texture of this material is variable.

Traverse Samples

A sampling traverse was established along the road which forms the north border of Sec. 15, Fig. 2. This is also shown in Fig. 1. To determine gravel contents, 40 to 80 lb. samples were dispersed in water, using a small concrete mixer and a commercial detergent, and sieved through a 3-foot diameter No. 10 sieve. Material retained was dried and sieved through a nest of sieves on a mechanical shaker. Silt and clay contents were determined by pipette analysis with sodium metaphosphate as dispersing agent.

Textural data (Table 1) clearly show positions of the stone lines. Comparisons of total gravel plus cobble contents indicate that if the stone line is a lag concentrate derived from glacial till, approximately six times the thickness of the stone line would have been removed—a total deflation of about 2½ to 3 feet. Apparent lack of cobbles in the glacial till is assumed due to the smaller sample size.

Data in Table 1 indicate that surficial deposits on top of the stone line become finer textured upslope. This is the reverse of the textural trend in swale deposits.

Table 1. Soil color and textural data.

Sample No.	Material	Dominant Munsell color	Depth, in.	Percent cobbles >2″	Percent gravel 2 mm—2″	Percent sand 2—0.064 mm	Percent silt 0.064—0.002 mm	Percent clay <0.002 mm	Texture (U.S.D.A.)
Section 3-3, location east edge of surface 1 (Fig. 2). See arrow in Fig. 1. Relative elevation of surface, 100.0′.									
3-3-1	surf. sed.	10YR 2/1	0-10	0	3.0	41.4	35.4	20.2	loam
-3-2	”	10YR 2/2-3/2	10-16	0	7.5	41.8	30.5	20.3	loam
-3	stone line	10YR 3/2	16-24	8.5	26.5	26.1	21.2	17.7	grav. loam
-3-3	till, leached	10YR 4/3	24-44	0	5.5	44.1	30.2	19.5	loam
-3-4	till, calc.	2.5Y 6/2	44-54	0	5.4	40.5	37.2	16.9	loam
Section 3-2, 100′ west (upslope) from 3-3. Relative elevation of surface, 103.1′.									
3-2-1	surf. sed.	10YR 2/1	0-12	0	0.6	38.4	38.3	22.8	loam
-2-2	”	10YR 2/1	12-20	0	2.3	37.9	37.2	22.6	loam
-2-3	”	10YR 3/1	20-26	1.1	5.1	39.1	33.0	21.6	loam
-2	stone line	10YR 3/2	26-29	30.4	20.1	12.7	22.4	14.4	grav. cl lo
	till, leached	10YR 4/3	29-35	. .	. . .	. . .	. . .	. . .	. . .
-2-4	till, calc.	2.5Y 6/2	35-45	0	5.2	40.3	37.4	18.0	loam
Section 3-1, 218′ west (upslope) from 3-3. Relative elevation of surface, 105.3′.									
3-1-1	surf. sed.	10YR 2/1	0-14	0	0.3	21.1	52.5	25.9	silt loam
-1-2	”	10YR 2/1	14-20	0	0.8	24.8	46.1	28.0	clay loam
-1-3	”	N 2/0	20-30	0	1.5	21.6	45.1	31.8	clay loam
-1-4	”	2.5Y 5/2	30-40	0	4.3	20.0	43.9	31.9	clay loam
-1	stone line	2.5Y 5/2	40-44	3.7	30.4	45.7	8.7	11.5	grav. sa lo
. . . .	till, leached	5Y 5/2	44-50	. . . .	. . . .	. . .	. . .	. . .	. .
-1-5	till, cal.	2.5Y 6/2	50-60	0	4.9	40.2	36.6	18.2	loam

Significance of Stone Lines

Stone lines and their apparent surface expression should be of significance to the field of engineering. It was noted, for example, that where stone lines appear at or near the surface of the upland, the area seemed to be well drained. But where the stone lines have been cut through as in road cuts or stream valleys, they are often marked by seepage. The fact that some stone lines mark the upper boundary of the more firm till and are below the depth of freeze and thaw action could be of importance in planning foundations and footings.

In the field of agronomy, the stone lines and material above them have a definite topographic relation to certain fine-textured soils. The Webster, Harpster and Glencoe soils of the Clarion-Webster Soil Association are found on the material above the stone lines. This may imply a parent material other than glacial till for these soils in these areas.

Geologically, this occurrence of stone lines, plus the occurrence associated with basin filling, would indicate that stone lines occur on much of the Cary landscape.

Origin

The origin of the stone lines and surfaces is uncertain. Some of the modes of origin that have been proposed and might apply in this area are:

1. By the incorporation of coarse fragments in the subsurface by soil creep. The fragments are drawn along at the base of the creeping soil. They work their way downward in the soil profile because of the more rapid movement of the surface layers, or possibly the fragments are concentrated toward the base owing to the more rapid disintegration of the soil surface (Sharpe, 1938).
2. By the formation of sheets of gravel as a surface deposit, covered later by a mantle of younger sediment (Parizek and Woodruff, 1957).
3. By colluvial activity (de Heinzelin, 1955).
4. By pedologic activity, the "homogenization of soils" in which the upper material is broken down to a finer texture while the underlying remains coarse textured (de Heinzelin, 1955).
5. By the processes of erosion and sedimentation associated with pedimentation as the landscape was formed (Ruhe, 1956).

Other factors which might have had some influence are:

1. Wind action, resulting in removal of the fines.
2. Plastic flow of the fine material and water-saturated glacial debris under the weight of the overlying ice, or by hydrostatic pressure developed by the inter-layering of frozen and unfrozen levels.
3. Frost action.

Ruhe (1956) ascribed the origin of a late-Wisconsin gravel erosion pavement on Kansan till in Adair County, Iowa, to the processes of erosion and sedimentation that formed the landscape. Essentially, the valley slopes are attacked by running water, resulting in rilling, gullying and sheet wash. This, in turn, results in the encroachment of the valley slope on the upland. An erosion surface is formed at the foot of the slope, on which the coarser material is concentrated by the removal of the finer material. Fine-textured material is derived from the coarser concentrate on the erosion surface. This forms the fine-textured material usually found above the stone lines.

It is possible that the stone lines and surfaces could have originated in the process of basin filling on the drift plain. The present surfaces may be the remnants of former basin floors most of which were destroyed when a stream captured the drainage of the area. However, detailed borings in nearby internally drained swale areas show a much thicker layer of material above the stone line and considerable relief on the stone line surface, and this mode of origin appears improbable. No wind faceting was apparent on the stones taken from the stone lines of this area.

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