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The Pleistocene Glacial Record at Two Quarries in Decatur County, Iowa

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The Pleistocene stratigraphy and sedimentology of two quarry exposures near Grand River and Decatur City in Decatur County, Iowa document a sequence of Pleistocene sediments overlying striated Pennsylvanian limestone which represent at least two pre-Illinoian glacial advances into the ancestral Grand River valley. Two pre-Illinoian diamictons separated by a clast pavement were observed at the Decatur City quarry; a single diamicton was present at the Grand River quarry. At both quarries, the diamictons exhibit comparable lithologic properties and are genetically interpreted as basal tills. The pre-Illinoian tills are tentatively correlated with the Alburnett Formation in eastern Iowa, primarily on the basis of clay mineralogy data. Fluvial erosional and depositional processes succeeded till deposition at both quarry sites. The tills are overlain by a fining-upward fluvial sequence upon which a well developed Yarmouth-Sangamon paleosol is developed. Sangamon Soil developed upon a pebbly diamicton overlies the fluvial sediments. The pebbly diamicton probably originated as colluvium from pre-Illinoian tills at higher landscape positions during late Sangamonian pedimentation. Lastly, periglacial conditions during mid-to-late Wisconsinan time resulted in multiple episodes of loess deposition corresponding to, in ascending order, the Pisgah Formation, Farmdale Soil and Peoria Loess, all Wisconsinan stratigraphic units.
INDEX DESCRIPTORS: Decatur County, pre-Illinoian till, clast pavements, Pleistocene stratigraphy.

The pre-Illinoian Pleistocene stratigraphy of Iowa has been studied and formally developed primarily in east-central Iowa and southeast Iowa (Hallberg, 1980a, 1980b) and in western Iowa and eastern Nebraska (Boellstorff, 1978; Bettis, 1990). In contrast, little recent work has been published on pre-Illinoian history of south-central Iowa beyond the extent of the Wisconsinan Des Moines Lobe.

This study focuses on the Pleistocene stratigraphy of Decatur County, Iowa, as revealed in two quarry exposures: Martin Marietta Corporation's Grand River and Decatur City Quarries (Figure 1). A general sequence of pre-Illinoian glacial diamictons, sand and gravel deposits, paleosols and Wisconsinan loess was encountered at each quarry. These two quarry sites present a cross-section through a Pleistocene landscape typical of much of the Southern Iowa Drift Plain physiographic region (Prior, 1991). The objective of this study is to document the stratigraphy and sedimentology of Pleistocene deposits at two locations in south-central Iowa and present the results in terms of recent Pleistocene stratigraphic studies and nomenclature developed elsewhere in Iowa.

PREVIOUS WORK

Much of the early work concerning the Pleistocene geology of south-central Iowa has been described in various Iowa Geological Survey reports dealing with specific counties. Bain (1898), Bain and Tilton (1897) and Tilton (1929) documented the geology of Decatur, Madison and Clarke counties, respectively.

The Pleistocene stratigraphy described by Bain (1898) is generally consistent with that described in this study. Bain (1898) observed a blue to blue-black "boulder clay" (i.e., till), which he assigned as "Kansan", at the base of the Pleistocene section. At some exposures, an older "pre-Kansan" boulder clay was observed. Overlying the boulder clays were successive deposits of stratified gravel, sand, and loess. Clearly defined zones of weathering ("gumbo") were present at most locations. Buried forests as thick as nine feet were occasionally encountered between separate boulder clays. Striations measured near Lamoni upon Pennsylvanian Winterset limestone had a direction of S 1°W (Bain, 1898). The deposits described by Bain (1898) nearly a century ago in the Decatur County area have never been adequately described and interpreted in conjunction with modern methods and the latest Pleistocene stratigraphic framework.

The latest unifying study of the area remains that of Ruhe (1969), who, at that time, embraced the classical four-fold model of Pleistocene glaciation in Iowa. Most recent geomorphological work in southern Iowa has dealt mainly with Wisconsinan and Holocene fluvial processes (e.g., Bettis and Littke, 1987).

BEDROCK GEOLOGY AND GEOMORPHOLOGY

The bedrock geology of Decatur County primarily consists of limestone and shale of the Pennsylvanian Kansas City Group (Iowa Department of Transportation (DOT) quarry geology files). At the Grand River and Decatur City Quarries, the Winterset Limestone is the uppermost bedrock unit exposed, and directly underlies the Pleistocene deposits at each quarry. Shale occurs as thin interbeds in

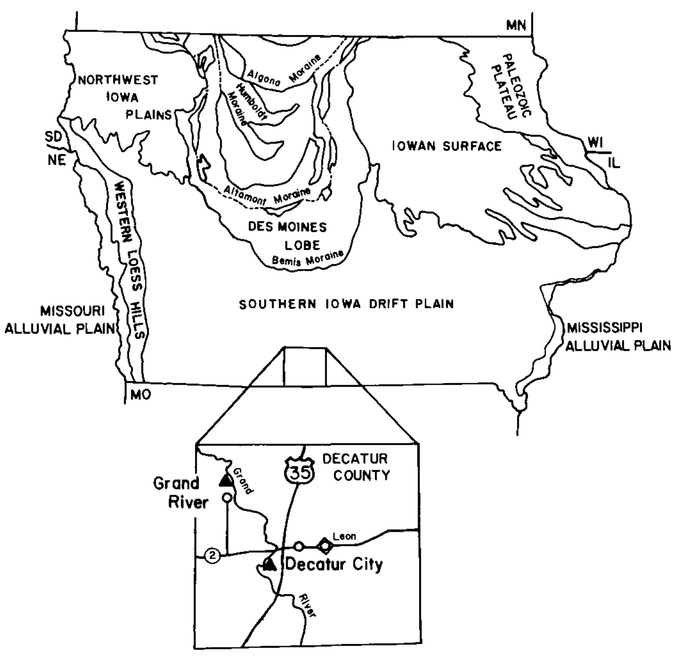

Fig. 1. Location of Martin Marietta Grand River and Decatur City quarries in Decatur County, Iowa (modified after Prior, 1991).

the Winterset limestone.

The bedrock surface in Decatur County is dominated by the Decatur and Leon Channels, two large bedrock valleys that divide the county along a north-to-south axis (Cagle, 1973). Smaller bedrock valleys branch off either side of this main valley. One such unnamed valley trending northwest to southeast contains the Grand River.

The physiography of Decatur County is strongly influenced by fluvial dissection of the post-glacial landscape. The landscape of the county is generally characterized by narrow uplands, rolling hillslopes and floodplains (Prior, 1991). Floodplains occupy the valleys of the Grand (formally Thompson), Weldon, and Little Rivers and the major tributary streams (Cagle and Stinehilber, 1967). Both the Grand River and Decatur City Quarries are located adjacent to the Grand River, which flows south-southeasterly through Decatur County (Figure 1).

METHODS

The salient features at each quarry were photographed, measured and described according to standard field techniques. The following orientation data were collected where available at each quarry: (1) striations on bedrock, (2) bulletsones and logs in diamicton, (3) diamicton pebble fabrics, and (4) orientation of clasts and striae on clasts in clast pavements. The methods of field measurements and techniques of numerical analysis of orientation data have been described elsewhere (Mark, 1973, 1974; Stewart et al., 1988; Anderson and Stephens, 1972).

Sediment samples were taken systematically from selected vertical profiles at each quarry. Grain size analyses were performed following standard sieve and hydrometer techniques (Stewart and Gedlinske, 1986). Selected samples of diamicton pebbles greater than 4 mm in size were retained for lithologic determinations.

Selected samples of diamicton from each site were sent to the Iowa Department of Natural Resources Geological Survey Bureau (GSB) for semi-quantitative analysis of the clay mineralogy according to the method of Hallberg et al. (1978). The specific surface area of diamicton samples was determined using the methods of Heilman et al. (1955) and Cihacek and Bremner (1979).

RESULTS

Grand River Quarry

The Grand River Quarry is located in the SW 1/4 SW 1/4 of Sec. 15, T70N, R27W. The measured section depicted in Figure 2 is a south-

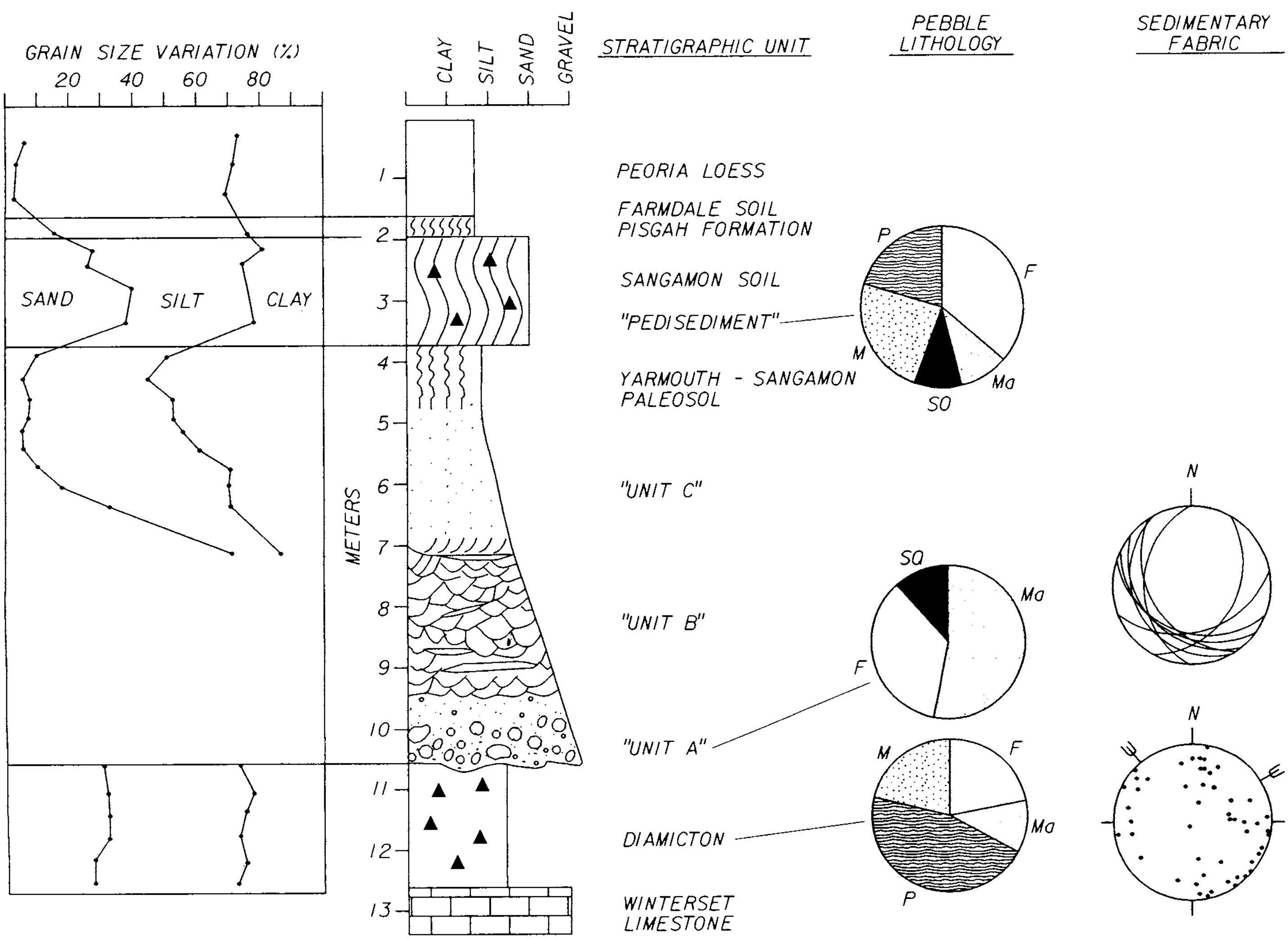

Fig. 2. Stratigraphic section of Grand River Quarry. Scale at top of stratigraphic log indicates typical matrix grain size of sediments depicted. Lithologic designations of pebbles: F = felsic igneous and metamorphic; M = mafic igneous and metamorphic; SQ = Sioux Quartzite; M = Mesozoic (sandstone, gray shale); P = Pennsylvanian (limestone, black shale, chert). Stereonet represents cyclographic traces of cross-bedding in Unit B. Till pebble fabric depicted in lower hemisphere stereographic projection ($N = 50$; $V_1 = 143°, 4°$; $S_1 = 0.442$).

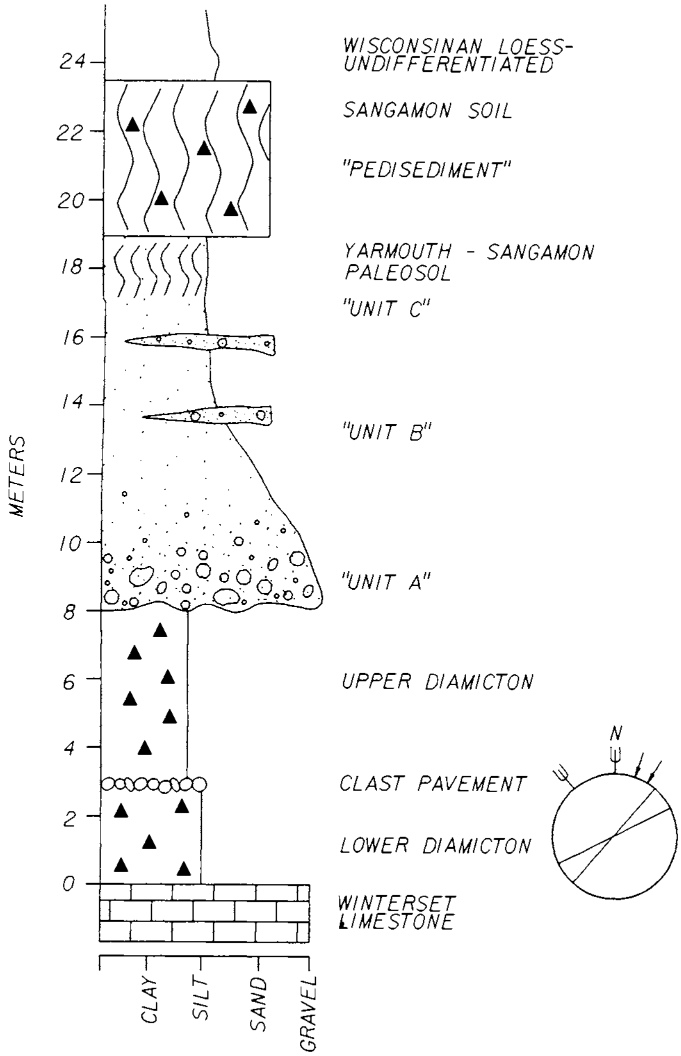

Fig. 3. Stratigraphic section measured at the Decatur City Quarry. Depicted on stereograms are orientations of pavement clasts (arrows), and conifer logs (lines) at inter-till contact, and average orientation of striations observed at quarry on bedrock surface (symbol as in Figure 2).

facing wall on the east side of the quarry.

Two sets of striations were observed on bedrock at the quarry. Numerous narrow (≤ 1mm) striae were measured at orientations ranging from 040°-060°. A second set of striae, less numerous and fainter, were observed oriented at 320°-330°. No relative age relationships could be firmly established.

A single dark gray diamicton (7.5YR 3/0), directly overlies the Winterset limestone (Figure 3). This unit varies in thickness from approximately one meter near the west edge of the quarry wall to about three meters near the east edge of the quarry section. The diamicton is massive, loam textured, and in the field exhibits vertical and lateral textural homogeneity (Table 1). The result of a single semi-quantitative clay mineral analysis indicates a clay mineral suite consisting of 48% expandable clay minerals (smectites and vermiculite), 19% illite, and 34% kaoline + chlorite. The specific surface area values (n = 3), averages 105 m^2/g.

The pebble lithology of the diamicton at the Grand River Quarry is summarized in Table 2 and Figure 3. Sedimentary rock clasts accounted for 68% of the pebbles; 46% of the total consists of typically dominant Paleozoic lithologies (limestone, black shale, and chert). Typical Mesozoic lithologies (gray shale and sandstone) accounted for 22%, and Precambrian igneous and metamorphic rocks accounted for 32% of the total. Because of its low percentage in till at both quarries, dolostone was grouped with local Paleozoic clasts for convenience.

A pebble fabric measured in the diamicton is significantly non-isotropic at the 97.5% level (V_1 = 143°, 04°, S1 = 0.442), although there is not a tight clustering exhibited upon the stereogram (Figure 2).

The diamicton is overlain by a fining-upward sequence of clastic sediments, which in this study is informally divided into three units. Unit A consists of gravel and boulders with intermixed sand deposited directly upon the diamicton. Unit B is primarily cross-bedded sand with intercalated, discontinuous lenses of clayey silt. Unit C consists mainly of clayey silt. The entire sequence becomes finer upward, as does each individual unit (A, B, or C) (Figure 2).

Unit A consists of cobble to boulder-sized particles whose lithology includes mafic rocks (53%), felsic rocks (31%), and Sioux Quartzite (16%). Clasts of the less durable Phanerozoic sedimentary rocks are notably lacking. Unit A was structureless and graded conformably upward into Unit B. The contact between the diamicton and Unit A is an erosional unconformity.

Unit B is a 2 to 4.5 m thick sequence of cross-bedded sand with intercalated thin (5-15 cm), discontinuous lenses of silt. Strike and dip orientations of foreset beds are shown in Figure 2.

The sandy deposits of Unit B become finer upward and grade conformably into Unit C. In contrast to Unit B, Unit C does not

Table 1. Summary of Textural and Mineralogical Data for Diamicton Samples

	GRANULOMETRIC ANALYSES				CLAY MINERALOGY			SPECIFIC SURFACE AREA	
Location	Sand	Silt	Clay	N	Expandables	Illite	Kaolinite plus Chlorite	m^2/g	N
Grand River Quarry	30	44	26	6	48	19	34	105	2
Decatur City Quarry									
Upper Diamicton	33	40	27	2	48	19	33	105	2
Lower Diamicton	26	47	27	2	ND	ND	ND	105	2

Notes:

All textural and mineralogical parameters represent means of the designated number of analyses.

Only one sample of diamicton was analyzed for clay mineraology at each quarry.

ND = Not determined.

Table 2. Tabulation of Pebble Lithologies, in Percent

	PRECAMBRIAN LITHOLOGIES			PALEOZOIC LITHOLOGIES					MESOZOIC LITHOLOGIES			
Location	Felsic	Mafic	Total	Limestone	Chert	Black Shale	Dolostone	Total	Sandstone	Gray Shale	Total	Number of Clasts
Grand River Quarry	21	11	32	27	2	11	5	45	16	6	22	273
Decatur City Quarry												
Upper Diamicton	14	5	19	54	2	9	4	69	8	4	12	170
Lower Diamicton	9	6	15	69	1	5	1	76	5	4	9	211

exhibit a fining-upward texture that is detectable in the field, but only through the use of grain size analysis (Figure 2). The lowermost sample of Unit C (Figure 3) was distinctly sandier than samples above and contained flecks of organic matter. From about 5m to 3.5m, the clayey silt had a mottled appearance, with a yellow-brown oxidized color (10YR 5/8-6/8) and a brownish-gray color (10YR 6/2). The structure of this interval was very fine to fine, subangular blocky with some slickensides and iron and manganese encrustations present along fracture surfaces.

Unit C is overlain by a reddish (5YR 4/6-5/8) sandy diamicton that is 2 meters thick. Brown (10YR 6/2) clay balls with clay skins were found in this unit. The pebble lithology of this unit (Figure 2) shows that igneous and metamorphic rocks predominate (56%). These clasts were extremely weathered, which precluded more detailed categorizations. Mesozoic rocks accounted for 23% of the pebbles. Paleozoic red shale and chert were also present in minor quantities (8% and 13%, respectively). No limestone or dolostone were present.

The reddish diamicton is overlain by 30 cm of yellowish-brown (10YR 5/4) loess, which grades into a 60-cm-thick dark brown (10YR 3/3) paleosol developed upon loess, that is capped by at least 1.5 m of yellowish brown (10YR 5/4) loess.

Decatur City Quarry

The Decatur City Quarry is located in the SW 1/4 Sec. 32 T68N, R26W, and NW 1/4 Sec. 5, T67N, R26W. As at the Grand River Quarry, the Pleistocene deposits lie unconformably upon the Winterset limestone (Figure 3). Numerous striations were observed at the quarry (Figure 4), where quarrying operations had exposed two broad bedrock benches. The upper bench was approximately 6-7 m higher than was the lower. The upper bench was marked by a 1-m-high step, against which a very dark gray diamicton (matrix color 10YR 3/0) was lodged. The uppermost bench was extensively striated in two directions. The older set ranged from 289° to 330° with most striae trending between 320° and 330°. This set was crosscut by a younger set of striae generally oriented north to south. Both sets of striae were developed to comparable depths (1 to 3 mm) and had lengths over 1 m. Striae on the lower bench were much less numerous and were mainly oriented 040°.

The Pleistocene section at the Decatur City Quarry was measured to a height of 23 meters above the bedrock surface near an apparent bedrock channel several hundred feet north of the exposed limestone benches (Figure 3). Two diamictons are present at this location in the quarry; only the upper dark gray diamicton discussed above is ob-

Fig. 4. Photograph of numerous large striations observed at Decatur City Quarry.

Fig. 5. Photograph of boulder pavement, indicated by arrows, separating two tills at Decatur City Quarry.

served near the limestone benches. The lower diamicton present at the quarry is 2.8 meters thick, and is deposited directly upon limestone. The diamicton exhibits a light yellow-brown matrix (10YR 5/3) and is extensively fractured (fracture color: 10YR 5/1).

The matrix of the lower diamicton consists of 25% sand, 47% silt, and 27% clay, with an average specific surface area of 103 m^2/g (Table 1). Matrix pebbles are mainly sedimentary rock fragments (Table 2). Limestone (69%) predominates, with subordinate amounts of Mesozoic rocks (9%), mainly sandstone and gray shale. Igneous and metamorphic rocks make up the remainder.

A clast pavement occurs at the contact between the upper and lower diamictons. The clast pavement consists of prolate angular limestone pebbles and boulders up to 30 cm in length. The long axis trends ranged from 345° to 076°, although most were generally oriented toward the northeast at an average azimuth of 032°. The majority of stones plunged gently toward the east (Figures 3 and 5). Three conifer logs up to 40 cm long were also observed in the boulder pavement at the contact between the upper and lower diamictons. The long axes of the logs also trended northeast, with an average azimuth of 052° (Figure 3).

The upper diamicton has a black matrix (10YR 3/0) and lacks the extensive fracture development of the lower unit. The upper diamicton contains slightly more sand and less silt than the lower diamicton. The pebble lithology of the upper diamicton unit is similar to that of the lower diamicton in that sedimentary rocks (81%) predominate (Table 2). Paleozoic rocks account for the majority of all clasts with lithologies of limestone and black shale most common. Expandable clay minerals comprise the largest proportion of the clay mineralogy suite of the upper diamicton. The specific surface area of the upper diamicton is similar to the lower (Table 2).

Approximately 1.5 m of cobble to boulder gravel overlie the upper diamicton (Figure 3). The gravel grades upward into sand with minor gravel and then to predominantly clayey silt. The gradational contact from gravel to silt occurs over a distance of approximately 0.5 m. The clayey silt is approximately 9 m thick, and contains local thin (40-70 cm) lenses of sand and gravel.

A reddish diamicton 4.5 m thick caps the clayey silt; this unit is comparable to the reddish sandy diamicton encountered at the Grand River Quarry. The reddish diamicton is capped by stratigraphically undifferentiated Wisconsinan loess generally comparable to the loess sequence observed at the Grand River Quarry.

DISCUSSION

Striations and diamicton stratigraphy at the Grand River and Decatur City quarries imply at least two pre-Illinoian glacial advances into the Grand River Valley. The earliest episode appears to have been from the north-northwest, as evidenced by the oldest set of striations at the Decatur City Quarry, oriented 320° to 330°, which correspond to the striations similarly oriented at the Grand River Quarry. The oldest striations are associated with the deposition of the lower diamicton observed at the Decatur City Quarry. Following deposition of the lower unit, the observed oxidation and fracture pattern developed, presumably during subaerial exposure of the diamicton during a non-glacial interval. Furthermore, the non-glacial climate was evidently amenable to the growth of coniferous trees upon the landscape, which were subsequently incorporated into the younger overlying diamicton during a later glacial advance.

A later glacial advance is evidenced by the locally divergent striations at the Decatur City Quarry (N-S) and the Grand River Quarry (055°) that cross-cut the other striations at each site, as well as the upper diamicton exposed at the Decatur City Quarry. The N-S striations observed by Bain (1898) probably correspond to this second glacial event. The northeast trend of log orientations in the younger diamicton at the Decatur City Quarry in conjunction with the northeast orientations of pavement clasts at its contact with the lower diamicton support a northeasterly provenance for the upper diamicton. The clast pavement likely reflects an episode of tractional deposition of coarse basal debris from local limestone outcrops (cf. Stewart et al., 1988).

At the Decatur City Quarry, the lower diamicton was evidently protected from glacial erosion by the exposed limestone benches. The lower diamicton was only observed preserved at the Decatur City Quarry in a bedrock low area. On upper bench surfaces at the Decatur City Quarry and at exposures at the Grand River Quarry, the later glacial advance likely incorporated the lower diamicton and striated the bedrock surfaces. The exposures at the Grand River Quarry nowhere exhibited a separate older diamicton at the time field work was conducted, and consequently the only evidence of earlier glaciation is the divergent, northwest-trending set of striations.

The diamicton exposed at the Grand River Quarry is correlated with the upper diamicton at the Decatur City Quarry based on their comparable lithologic properties (Tables 1 and 2). The lithology of the diamictons at each quarry indicates a predominantly local provenance, in view of the high percentage of Pennsylvanian lithologic indicators such as limestone fragments and black shale. The lower diamicton at the Decatur City Quarry also has comparable lithologic properties, including a high percentage of silt and clay, a similar pebble suite, and a comparable clay mineralogy according to x-ray diffraction data and specific surface area determinations. A hiatus following the deposition of the lower diamicton evidently allowed enough time to weather the unit to the presently observable degree of oxidation and fracturing.

The genetic interpretation of the diamictons observed at the two quarries is based on multiple criteria developed from extensive field and laboratory investigations in Iowa and elsewhere (e.g., Stewart et al, 1988; Kemmis et al, 1981; Hallberg et al, 1984). The properties of the diamictons imply their origin as a basal till for the following reasons:

1. The diamictons are unstratified, structureless and matrix-supported, deposited directly upon striated bedrock or clast pavements. These aspects indicate deposition from active, wet-based ice at least at or near the till-substrate interface. The upper diamicton was observed lodged into the upper limestone bench at the Decatur City Quarry.
2. The textural and lithological homogeneity of the tills is also typical of other pre-Illinoian basal tills in Iowa whose origin is inferred to reflect repeated episodes of regelation at the glacier sole (cf. Kemmis, 1981; Hallberg, 1980a, 1980b). The lithologic homogeneity of pre-Illinoian basal tills is used as supporting evidence of basal deposition in conjunction with other cololaborative field data, such as mentioned above, that more firmly establishes the mode of basal deposition. Till above the bedrock/boulder pavement is also inferred to be basal till mainly by analogy with sedimentologically comparable pre-Illinoian till elsewhere in Iowa.

On the other hand, the till pebble fabric measured at the Grand River Quarry provides inconclusive evidence both for the basal origin of the tills and polarity of glacial movement. The reason for the lack of well-developed till fabric is unclear. Minor preferred orientations evident in the till fabric in both N-S and easterly directions (Figure 2) may reflect short-lived changes in the direction of glacial flow during till deposition. The bimodiality of the till pebble fabric is generally consistent with the range of northeasterly striations measured at the quarry. Other site data nevertheless provide more conclusive evidence for till genesis and polarity interpretations.

The pre-Illinoian tills observed at the Grand River and Decatur City Quarries are tentatively correlated with the Alburnett Formation in east-central Iowa, primarily on the basis of their clay mineralogy. The percentage of expandable clays determined for the Decatur County tills (48 percent; Table 1) is more closely related to the modal Alburnett Formation percentage (43 percent) than the modal Wolf Creek

Formation percentage (62 percent) determined by Hallberg (1980b). The stratigraphic position of the Decatur County pre-Illinoian tills directly above bedrock also corresponds favorably to the Alburnett Formation, which is the oldest Quaternary formation in Iowa. Younger pre-Illinoian deposits (Wolf Creek Formation) may be preserved on higher drainage divides.

Texturally, the Decatur County tills are slightly more enriched in silt and clay than Alburnett Formation tills in eastern Iowa. The specific surface area values for the Decatur County pre-Illinoian tills are inconclusive for correlating the tills to eastern Iowa pre-Illinoian till formations. The specific surface area values for the Decatur County pre-Illinoian tills (Table 1) are higher than those reported for both the Alburnett Formation (50 to 70 m^2/g) and Wolf Creek Formation (70 to 100 m^2/g) in eastern Iowa, although undifferentiated pre-Illinoian tills in southern and southwestern Iowa are noted to have significantly higher average specific surface area values than pre-Illinoian till formations in eastern Iowa (Schilling and Gedlinske, 1992). The higher percentage of clay found in the Decatur County pre-Illinoian tills (Table 1) compared to pre-Illinoian tills of eastern Iowa (Hallberg, 1980) likely contributes to the higher specific surface area values found in this study.

Correlation between the Decatur County pre-Illinoian tills and the multiple pre-Illinoian tills described by Boellstorff (1978) in western Iowa is not possible because till differentiation methods utilized by Boellstorff (1978) were not used in this study. Boellstorff (1978) relied heavily on heavy mineral analyses, till pebble differentiation using plutonic, metamorphic and sedimentary classifications, and the stratigraphic relationship of tills to the Pearlette ash beds, in his western Iowa studies.

The lack of oxidation and soil development in the pre-Illinoian till at each quarry implies that erosion of the sections occurred following their deposition. The fining-upward sequence of clastic sediments overlying the till units at both quarry sites suggests that fluvial erosion and depositional processes succeeded till deposition at both areas. The fluvial depositional sequence at each quarry began with coarse cobble to boulder gravel laid down by high-energy streams (Unit A). The lithology of Unit A includes only the most resistent rock types typically found in the underlying tills (Sioux Quartzite and the generally fine-grained Precambrian igneous and metamorphic rocks). The predominance of these rock types and the absence of softer lithologies such as carbonates and clastic sedimentary rocks suggest that the latter were removed by high-energy streams.

The locally divergent paleocurrents observed in Unit B reflect the shifting channels of a sandy stream system that later became established at each site. Strike and dip orientations demonstrate a general southward paleocurrent at the Grand River Quarry consistent with current drainage in the Grand River valley (Figure 2). The relative stream energy suggested by the alluvial sediments at each site diminishes systematically upward, as indicated by the uninterrupted gradation from cross-bedded sandy sediment to structureless muds containing increasing amounts of silt and clay (Unit C). Unit C likely represents deposition by overbank or colluvial processes.

As fluvial deposition ceased at each quarry site and the landscape stabilized, soil development progressed during and between the Yarmouth and Sangamon interglacial stages in Unit C. The Yarmouth-Sangamon compound interglacial soil is evidenced by the fine to very fine, subangular blocky structure, the color (10YR 6/2), mottled appearance (10YR 5/8-6/8), and the well developed slickensides on ped surfaces. The brownish-gray color of the paleosol is interpreted to indicate a poorly drained solum with significant in-situ reprecipitation of iron oxides.

The paleosol is capped by the more reddish (5YR 4/6 to 5YR 5/8) Sangamon Soil, which is developed upon a pebble-rich, sandy diamicton that probably reflects pre-Illinoian till that was reworked by colluviation from a higher landscape position. This material corresponds to the "pedisediment" discussed by Ruhe (1956. 1969), a colluvial diamicton derived during development of the Late Sangamon erosion surface (Hallberg. 1980a; Kemmis et al., 1992).

The last aspects of glacially influenced sedimentation in Decatur County were two episodes of loess deposition in middle-to-late Wisconsinan time. The granulometric composition of the loess (Figure 2) is typical of Wisconsinan loess in central Iowa, which has been shown to be systematically enriched in silt and clay with respect to loess nearer the Missouri River Valley source area (Ruhe. 1969). Recently, Bettis (1990) proposed changes in the nomenclature of Wisconsinan loesses based on research in western Iowa. The basal Wisconsinan loess unit observed in Decatur County corresponds to the Pisgah Formation, defined for loess and colluvial sediments overlying Sangamon Soil. The Farmdale Soil, corresponding to the Farmdale Soil of Illinois, corresponds to the paleosol developed in the basal Wisconsinan loess. Peoria Loess has been adopted for the overlying loess, in reference to the regionally extensive loess named in Illinois.

CONCLUSIONS

Two pre-Illionian tills were observed in exposures at the Grand River and Decatur City quarries in Decatur County, Iowa. The two tills are separated by a boulder pavement at the Decatur City Quarry, whereas at the Grand River Quarry, only the upper till is present. Pavement clast and striation data indicate a northwesterly provenance for the older till, whereas the younger till was emplaced from a more north-northeasterly direction.

Bain (1898) remarked on the "Kansan" and "pre-Kansan" tills in Decatur County and also noted the occurrence of the forest bed that in some places marked the contact between the two superposed tills. Careful review of Bain's (1898) work suggests that his "Kansan" and "pre-Kansan" tills correlate with the younger and older pre-Illinoian tills described herein. The pre-Illinoian tills identified and described in this study are tentatively correlated with the Alburnett Formation in eastern Iowa primarily on the basis of clay mineralology.

The tills are overlain by a fining-upward fluvial sequence upon which the Yarmouth-Sangamon paleosol is developed. A pebbly diamicton, corresponding to the "pedisediment" described by Ruhe (1969) caps the fluvial deposits and paleosol. Sangamon Soil is well-developed in the diamicton. The diamicton is likely derived from colluvial processes occuring during Late Sangamon erosion, although its high degree of alteration impedes systematic sedimentological analysis that might indicate a specific origin. A detailed transect of test holes designed to trace the extent of the diamicton upslope from the quarry would be useful in determining whether the diamicton is a discrete unit separate from, or related to, the underlying tills.

Wisconsinan loess deposits which overlie the diamicton in Decatur County are generally comparable to similar loess deposits found elsewhere in Iowa.

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