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Geomorphology in Iowa 1943-1968
An Annotated Bibliography of the Literature

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Abstract. A study of what has been written about the geomorphology of Iowa since the publication of the Kay volume, *The Pleistocene of Iowa*, in 1943, resulted in the compilation of an annotated bibliography. An examination of the subject material and procedures described suggests: studies since 1943 are process oriented rather than time oriented; increased use of paleosols and buried erosion surfaces; introduction of radiocarbon dating; and a lack of discussion about a framework for geomorphology.

INTRODUCTION

In 1943 the Iowa Geological Survey published a volume entitled *The Pleistocene of Iowa* which contained three papers, two of them published earlier in the reports of the Iowa Geological Survey by George F. Kay and his associates. This publication, commonly referred to as the Kay volume, summarized most of the work of the Iowa Geological Survey and others on the glacial deposits (especially their stratigraphy) as well as the glacial landforms of Iowa. It also discussed the development of drainage, loess accumulation, physiographic regions, as well as erosional and depositional forms of all types. Our study involves what has been written about the geomorphology of Iowa since the publication of the Kay volume.

Our criterion of what deals with geomorphology is quite inclusive. Geomorphology is that branch of geology which concerns itself with the study and explanation of the origin of landforms and landscapes. The methods of study are usually those of the geologist employing the past to explain the present, although not necessarily so. Our orientation is that of a geological geormorphologist rather than a geographical geomorphologist (R. J. Russell's presidential address to the Association of American Geographers, 1949), but we have included reports which fall within both of these methods of study.

Papers dealing primarily with stratigraphy of Pleistocene deposits have not been included, as they do not fall within the definition of geomorphology. Within the years 1943 to 1968 we have identified 65 papers written by 109 authors which, in our opinion, totally or partially emphasize geomorphology in Iowa. These include published papers in scientific journals, abstracts, and theses. In the summaries that follow we have used the authors stratigraphic terms although recognizing that some may have been changed to bring them in accord with current usage. Annotations are necessarily brief due to space limitations.

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ALLUVIAL PROCESSES AND LANDFORMS

Gwynne (1950) discussed the post-constructional changes in artificial roadside terraces cut into loess along State Route 127 in Harrison County. Within the year rivulet erosion commenced down the risers as a result of material accumulating on the treads. Erosion was most effective on the north facing slopes. In spite of the ragged appearance, the design has been reasonably successful with regard to maintenance requirements.

Hussey and Zimmerman (1953) compared artificially straightened sections of Skunk River and Squaw Creek, southeast of Ames, with a report by the Army Engineers at Vicksburg, Mississippi, which showed that the effect of the initial angle of attack (alignment of the flow of water into the straight channel) affected the size of the meander developed. The engineers reported: the greater the angle of attack, the shorter the radius of the meander developed. Hussey and Zimmerman determined that the sections of Skunk River and Squaw Creek were straightened about 1913. A study of 1939 aerial photographs revealed that meanders with large angles of attack did indeed have shorter radii. Additional photographs flown in 1952 indicated that the bends had migrated downstream and were approaching the character of true meanders. They concluded: the initial advantage (angle of attack) has an increasingly important effect on the rate of meander development.

Shrader and Hussey (1953) evaluated four alternative hypotheses involving the evolution of the level interfluvial divides on the Kansan till plains in southern Iowa and northern Missouri. The authors favored the concept that the divides are remnants of flat coalescent interfluvial surfaces developed in response to reestablishment of drainage in the Kansan till plain and subsequent dissection. In summary, they felt that Kansan ground moraine deposited as swell and swale topography was dissected by long periods of little erosion (soil profile development) and short periods of rapid erosion—in response to climate change; concurrently with dissection the swales were filled. Leveling was more rapid in areas with more depositional relief, and all areas not dissected tended to approach a common plain. During or following Illinoian glaciation, loess was deposited. Then that portion of the Kansan plain not covered by more recent glaciation was further weathered. Subsequent loess deposition was widespread during closing stages of the Iowan glaciation and the even distribution on the Sangamon surface suggests large portions of the Kansan and Illinoian plains have been stable since the close of the Iowan.

Ethington (1955) reconstructed the evolution of the drainage in Benton County through the use of aerial photographs.

Brice (1958) described the steps developed on loess in southern Nebraska and along the Missouri River in western Iowa and northeastern Missouri. He found little or no field or laboratory evidence to substantiate that these steps originated by slumping. He observed low sod scarps formed by breaks in sod cover as the initial stage of step scarp development. Most breaks in the sod are caused by drought, overgrazing, burrowing or the hoofs of grazing animals following paths along the slope contour. Erosion scarps develop on the downslope facing edges of the bare patches and are heightened by sheet wash flowing over the protected sod cap and undermining the silt at the base. The scarp retreats up and into the slope, and those segments more closely parallel to contour lines retreat more rapidly as they receive more sheet wash per unit length. The retreat rate is a maximum of one inch per year. Estimated sediment eroded from step scarps in the Dry Creek basin in Nebraska is 9.3 acre-feet per year. Heavy sod cover reduces step development. Steps develop on slopes of 6 to 33 degrees. Above 33 degrees, slumping occurs.

Glenn and Dahl (1959), using Fisk's terminology, described the geomorphology of the Missouri River valley adjacent to Iowa. This report is part of a larger study of the Missouri River valley to determine the geology and engineering properties of alluvial deposits. The section of the Missouri River under study was divided into three parts on the basis of floodplain width and channel characteristics. Sioux City to Crescent City: The flood plain is 5 to 16 miles wide and the meandering channel has an average gradient of one foot per mile. Crescent City to the mouth of the Platte River: The valley width averages 4.5 miles, and the meandering channel has a gradient of 0.47 feet per mile. Mouth of the Platte River to the Iowa-Missouri State Line: Here the floodplain is 5 to 7 miles wide and the channel is braided, having a gradient of 1.33 feet per mile. In this lower section the segment from Plattsmouth to Nebraska City represents an extensive alluvial fan of the Platte being reworked by the Missouri River—hence the braiding.

DeKoster, Hussey and Munson (1959), using aerial photographs and topographic maps established that drainage characteristics of the Des Moines River valley between Humboldt and Des Moines are dependent on the age of drift on which drainage has developed. North of Boone County the river flows on the Mankato drift sheet. Here the drainage is poorly developed and non-integrated. In northern Boone County the river cuts through the Cary moraine of the Mankato and flows across the Cary ground moraine. Here the tributaries are short, intermittent, and deep. Gullies and washes are characteristic. South of Des Moines the river flows from Cary drift onto Kansan age material. The drainage here is well integrated and marked by a few far-reaching primary tributaries.

Glenn, Dahl, Roy and Davidson (1960) submitted a summary report on the alluvial morphology and engineering soil classification of the Missouri River valley deposits. The geomorphic aspects include several mosaics of the Missouri Valley. Channel fills, point bars, masked point bars and channel fills, Missouri River bars, and flood basin and tributary channels are mapped on nine Missouri River sheets prepared by the U. S. Corps of Engineers Office in Omaha. Aerial photographs of these features are also included. They concluded that an aggrading stream carrying excess coarse-grained material was the source of the thick substratum sands and gravels.

Anderson (1968) reconstructed the drainage evolution in the Rock Island area, both in western Illinois and eastern Iowa.

Anderson and Lohnes (1966) made a morphometric comparison of Hayden Prairie in north-central Howard County with an adjacent cultivated area. Both areas are drained by the same tributary to Beaver Creek and drainage is developed in glacial till. They conclude that the mean value of valley side slope angles was higher in the cultivated area. However, analysis of variance led to acceptance of equal means. Elevation-percent area curves indicate landscape under cultivation has been lowered 0.132 feet during the last 100 years. Elevation-percent area curves also show erosion rates are in agreement with those calculated from sediment yield data, thus supporting the elevation-percent area curve approach. The authors stated that stream gradient is inversely proportional to erosion rate, suggesting that the till erodibility varies from one first order basin to the next.

Daniels (1960) discussed the changes in the Willow Drainage Ditch in Harrison County between 1919-1920 and 1958. Since construction, that section of the ditch on the Missouri River valley has filled, due to a lower gradient and periods of high water; while in the Willow River valley it has entrenched in response to a constructed gradient deeper than the original. Entrenchment is deeper upstream with a maximum depth of 42 feet at the Monona-Harrison County line. Evidence points to several episodes of entrenchment.

Steiner (1961) investigated the terraces along the Cedar River from Cedar Rapids to Moscow. He mapped a set of terraces about 20 feet above river level which were traced by lateral continuity and elevations. Steiner concluded that the loess deposits on the terraces upstream from Rochester were younger than those that merge with the West Liberty Plain downstream. He therefore suggested the upstream portion of the terrace may be younger than the downstream portion. The author recommended further investigation to establish the age and history of the terrace in the Cedar Valley and their relationship to extinct Lake Calvin.

In a preliminary investigation of the Little Sioux River valley, Pedersen and Lohnes (1963) described the aerial extent, thickness, and materials that comprise the modern alluvium and terrace sediments. Downstream from Anthon, Woodbury County, one terrace 60 feet above the floodplain is present. From Correctionville to Gillet

Grove (north Woodbury County to central Clay County) three distinct terraces are evident. Upstream from Gillet Grove only the intermediate level persists. North of Milford (Dickinson County) this terrace is no longer confined to the valley and is considered outwash which is terminated on the north by a Mankato end moraine. Remnants of a terrace upstream from Spencer and Milford lie about 15 feet above the floodplain which differs from those downstream in that it is composed of sandy fill with very little gravel. Exposures in Cherokee and Buena Vista Counties indicate that the till surface under each terrace level is higher than the till surface under each successively lower terrace, i.e., the terrace fills are deposited in successive steplike benches. This suggests three cycles of cut and fill, with each successive cycle trenching its channel to a lower depth than the previous one. The modern alluvium represents fill of a fourth cycle.

The Scotch Grove Strath, named for the village of Scotch Grove in central Iowa County, consists of a pair of discontinuous rock terraces lying 60 to 80 feet below the upland along the Maquoketa River in east-central Iowa (Hedges and Darland, 1963). Except in the Richland highlands, the Maquoketa River is bordered by rock terraces, which cut across structure. A series of shallow phreatic caves 20 to 60 feet below the terraces, which also transect structure, indicate the terraces are erosional rather than structural features. The caves contain evidence of aeration followed by filling with fluvial and lacustrine sediments. Since the Maquoketa Valley has been neither aggraded nor dammed up to the level of the caves since Kansan time, the authors believe that caves and the related strath are of Aftonian age.

Ruhe and Daniels (1965) discussed two types of erosion, 'geologic' —the result of natural processes, and 'accelerated'—induced by the activities of man. They reiterate two reasons for confusion between the two: (a) rates of regional denudation may not be very useful in establishing erosion rates on a hill slope or local stream channel, and (b) benchmarks in time may not be abundant enough to index centuries or decades. However, radiocarbon dating establishes an absolute chronology, thus erosion and deposition during the near geologic past and historical time can be placed in a better perspective. Drilling and outcrop data establish areal extent and thickness of deposits in several side valleys, through valleys, and stream channels in Iowa. Volumes obtained are related to radiocarbon bench marks. Rates of erosion and deposition are also obtained. These are related to similar data for arroyos and pediments in New Mexico.

Quantitative Geomorphology

Ruhe (1950) outlined a method of differentiating between Wisconsin drifts. Slope of glacial material is established from roadcut profiles using horizontal and vertical distances. Percentages of slope are then grouped as follows: 0-3, 3-6, 6-16, and 16-40. Next, dividing up the traverse into equal increments and then establishing how many of the increments are of a specific slope range, one can determine the frequency of percent of each slope range. Frequency-percent is then plotted against percent slope (by range). Ruhe plotted frequency-percent and percent slope for ground moraine topography. Closely similar curves for Cary and Mankato drift are evident. The Iowan and Tazewell curves are also similar. The author concluded that the similarity of curves indicates the drifts are closely related in time.

Gordon (1960) set out to determine if quantitative morphometric techniques were sensitive enough to indicate obvious topographical differences between stream basins, and what differences could be established between basins in Kansan and Iowan drift, if any. Using methods developed by Horton and Strahler he investigated 26 second and third order drainage basins. He measured or computed nine parameters. For several reasons he found most of the above parameters inadequate to express differences between basins in Kansan and Iowan drift. However, the compaction coefficients did express the homogeneity of drainage developed on glacial till and the mean slopes of basins developed on Kansan drift were definitely greater than those on Iowan drift. Gordon lists six factors responsible for the poor correlation results.

Milling and Tuttle (1964) reported on a morphometric study of two adjacent (east flowing) drainage basins—Old Man Creek and Clear Creek—in Johnson and Iowa Counties. They evaluated their results in terms of the morphometric laws of normal streams as proposed by Horton, and later modified by Strahler and Schumm. Using topographic maps and field observations they established that both basins have a greater part of their drainage area to the north of the major stream. They concluded that the asymmetry is probably due to: (1) the inequal distribution of loess, (2) the influence of the regional slope, and (3) the differences in insolation between the north and south slopes. On the basis of parameters measured and limited geologic investigations they suggested that the basins are not misfit, as previously thought, but normal. The possibility exists that these valley forms are polygenetic—both erosional and depositional in character.

McConnell (1966) made a statistical analysis of some spatial relationships of mean topographic slope beyond the relationship with local relief. The study was conducted on erosional terrain in the glaciated Upper Mississippi Valley. Sixteen quadrangles were used in the sample and twelve of these were totally or partially in eastern Iowa, bordering the Mississippi River. Nebraska, Kansan, Illinoian, and early Wisconsin drifts are involved. He suggests from his statistical analysis that slope (S) is a function of: available relief (V), a dissection factor (D), a position factor (P), an orientation factor (O)—relating to effects of microclimate and weathering processes on steepness of slope, an age materials factor (T), and a type of materials factor (M). His conclusions are: (1) If degradational processes have been operating during a limited time then slope varies directly with vertical topographic dimension, i.e., relief. (2) Slope increases with increasing relief, but does not necessarily decrease with decrease in relief, since angle of slope equilibrium depends on materials upon which the slope is developed. (3) As streams approach base level, the mean topographic slope tends to become independent of relief. (4) The longer fluvial processes operate, the more differences in slope are produced by factors other than relief and long-channel profile. (5) Slope decreases with distance from the mouth of a drainage basin and increases as dissection progresses. Slope does not decrease or increase if dissection ceases. (6) Slope is steeper on consolidated materials, but on both unconsolidated and consolidated materials it increases, with fineness of texture. (7) There is some evidence that slopes most affected by mechanical weathering are steeper than those which are inclined so as to receive greater amounts of solar insolation.

Tuttle and Milling (1966) did a quantitative study comparing stream discharge with valley sizes and shapes. Discharge data were collected from the records of 67 gaging stations in Iowa. Valley bottom width and topographic 'coordinates' of the valleys (at the gaging stations) were measured from topographic maps. The valley cross-sectional area, shape factor, and other parameters were calculated from the topographic 'coordinates' by an IBM 7044 computer. The authors analyzed three variables which partially influence shape and size of valleys: discharge, resistance of material to weathering and erosion, and geologic time. They found the analysis of the relationships between these variables suggested: (1) Valley size varies directly with discharge. (2) Valley size varies inversely with increasing rock resistance. (3) Valley size varies directly with geologic time. (4) Valley shapes are more triangular in areas of more resistant rock. (5) Valley shapes grow more rectangular and less triangular with time. Generally, the valleys are well adjusted to discharge and have reached equilibrium. Valleys in pre-Wisconsin drift are better adjusted than those in Wisconsin drift.

Roberts (1966) related the spatial variation of slopes to associated climatic and watershed variables. Thomas and Tuttle (1967) found average slope characteristics generally related to age of drift.

Glacial Landforms

Scholtes and Smith (1950) discussed the areal extent and morphology of the paha of northeast Iowa. Cores from a traverse across a lone paha in the northwest part of Grundy County revealed that soils on the paha loess differed morphologically from soils on surrounding Iowan drift. Paha soils are lower in clay content, better oxidized, and have less well developed profiles than most surrounding soils. The core of the paha, like most others investigated, is of strongly weathered till or gumbotil which is thought to be Kansan in age. A paha northeast of Hampton in Franklin County is one of the largest observed. A congerie of a number of loess ridges, it is about 10 miles long and varies from one-half to one mile in width. Material contained in it (sand, silt and clay) appears not much better sorted than drift, suggesting silt and clay particles may have moved as aggregates, probably of sand size. Sand size material could move by saltation to form longitudinal dunes. Paha were found to exist in most of the counties in the Iowan drift area. They occur well within the Iowan drift and are not confined to the border areas of the drift sheet.

Gwynne (1950) reported three significant glaciated bedrock surfaces on Mississippian limestone in Iowa. These are in quarries north of Ames in Story County, north of LeGrand in Marshall County, and east of Winterset in Madison County. Temporary availability of such exposures is noted due to quarry expansion, etc. The bearing of the striae of the three localities described shows definite ice movement toward the south-southeast and southeast. Specifically, this report contributes to the knowledge of ice movement in central Iowa.

Ruhe (1952) reviewed four lines of evidence used to separate Cary drift from older adjacent drift of the Des Moines Lobe. He discussed the limited applicability of three of these criteria: (1) Prominent marginal end moraine, (2) thin, poorly sorted loess mantle on Cary drift as opposed to a continuous well sorted loess cover on adjacent older drifts, and (3) exposed sections showing calcareous Cary till on well sorted Iowan-Tazewell loess or older deposits. However, the fourth criteria, erosional topographic discontinuity (the differences in types of integrated drainage on the surfaces of adjacent drifts), has continuous areal application around the Des Moines Lobe. From detailed drainage maps Ruhe noted: (1) Drainage patterns of the Iowan and Tazewell surfaces are similar. (2) Drainage patterns of the Cary and Mankato surfaces are similar. (3) Contrast is marked between well-integrated Tazewell systems and poorly integrated Cary systems. The patterns support earlier conclusions that the Iowan and Tazewell are closely related in time, as are the Cary and Mankota. He next used angular topographic discontinuity (the discordance of trends of morainal ridges of two adjacent morainal systems) to set off the Bemis moraine system (Cary), from the younger Altamont moraine system (Mankato). The angular discordance of trends of moraine ridges of the Altamont and Bemis systems shows the overlap of the older by the younger complex. Overriding of the older moraine bv a younger ice mass is indicated. Erosional and angular topographic discontinuities do not exist between the morainic systems of the Mankato drift in Iowa.

Thomas, Hussey and Roy (1955) reported on a drumlinoid hill in Story County about four miles north of Nevada. The hill is about two miles long, one-fourth mile wide, 60 feet high, oriented northwest-southeast, and has an essentially even crest. Sand and silt is overlain by Wisconsin till and underlain by Kansan gumbotil, which in turn is underlain by oxided Kansan till. Analysis of the environmental requirements of gastropod and ostrocod faunas (recovered also from other localities on the Des Moines Lobe) indicate water to be important within the depositional site. Modern representatives of some of these species are known in abundance in Arctic areas and in high, cold mountains. This indicates that such fauna lived in close proximity or on terminal stagnant ice. The authors conclude there is no evidence for relating the hill to post-glacial erosion. The character of the deposits have features common to both drumlins and paha.

Tuttle (1956) described the areal extent and composition of an Iowan age kame field in the vicinity of Grand Mound and DeWitt in Clinton County. He identifies 22 kames most of which rise 20 to 30 feet above the Iowan till plain and which range in diameter from 200 feet to nearly one mile. The larger kames are used as gravel pits and the internal structures where visible are that of alternating beds of sand and gravel arranged in typical crossbedded attitudes. Location of the kames (on the Clinton Lobe), and the similarity of the kame gravel and Iowa drift strongly suggests that the kames are Iowan. Since the gravels are apparently undisturbed by ice movement, this lobe probably melted by downwasting. The absence of distinct end moraines associated with Iowan glaciation in this areas indirectly indicates melting bv downwasting. A high percentage of carbonates also suggests that a major portion of the drift may be of local origin.

Tuttle, Feulner and Northup (1956) described the boulder train near Strawberry Point. The boulder train indicates Iowan ice moved east and slightly northeast in the margin.

Tuttle (1959) discussed the location and age of several large erratics in northeast Jasper County. These granite boulders had been formerly associated with Iowan drift. Tuttle stated that the erratics lie 20 to 25 miles south of the Iowa River valley which approximates the southern boundary of Iowan drift across Marshall and Tama Counties. Tuttle concluded that since the boulders occur in youthful stream valleys they are better associated with Kansan drift. Leighton and others had dated most of the drainage in this part of Iowa as post Kansan. The author suggested that the boulders were uncovered during erosion of drift by valley widening processes. He pointed out that if the boulders had been deposited by the Iowan glacier they should lie at higher elevations where the Iowan till occurs.

In 1962, Holte and Thorne reported the location of a calcareous fen complex in Dickinson County. Fens are often called perched or hanging bogs and differ from the normal bog in that associated waters are normally neutral or alkaline. The topography in this region is a result of 100 to 300 feet of highly calcareous Wisconsin drift (Mankato). The particular combination of soils, topography, natural springs and drainage made the formation of this fen complex possible. Several other fens are known to be within a 32-mile radius of this complex.

Engelke (1964) described several large erratics in northeast Iowa and suggested some action should be initiated for their preservation.

Wright and Ruhe (1965) reviewed the status of the Pleistocene in Iowa. They reported drifts of all four major glacial stages of the Pleistocene. They suggest that there is no Iowan drift, but instead older drift was eroded during the Wisconsin. Most of the surface loess in Iowa is dated as Wisconsin.

Paleosols and Pleistocene Erosion Surfaces

The use of paleosols as implemented by R. V. Ruhe, his associates and students, has become an important cornerstone in recent Pleistocene research. This approach, when supplemented by radio carbon dating, has contributed not only to the knowledge of Pleistocene surfaces, but appears to be the most realistic method for unravelling Pleistocene stratigraphy.

Ruhe and Scholtes (1956) showed that five or more major geomorphic surfaces are traceable in Iowa. Each Pleistocene surface has specific soils or soil associations.

Ruhe (1956) discussed geomorphic surfaces and the nature of soils in the Greenfield quadrangle of Adair County. He stated that the landscape here is characteristic of most of the southern half of Iowa. In this quadrangle the modern surface from divides to major drainage is broken at two or three places by changes in gradient. This sequence of levels is the result of multicyclic erosion. A brief description of the surfaces follows: The high level is mantled by Farmdale-Iowan-Tazewell loess and controlled by the Yarmouth-Sangamon surface. The surface, a weathered relic of the Kansan drift plain, has deep, weathered paleosols—for the most part buried. Most of the intermediate level is mantled by Farmdale-Iowan-Tazewell loess and is the Late Sangamon erosion surface. This surface is a pediment cut into Kansan till and rises gradually up the pediment-footslope and more sharply up the concave pediment backslope to the Yarmouth-Sangamon surface. A common feature is a stone line (a lag gravel erosion pavement). A finer textured pedisediment lies on the stone line. A paleosol has developed in the pedisediment, stone line, and uppermost Kansan till. The lower level is the Early Wisconsin pediment which has cut into the Kansan till below the Late Sangamon surface. The surface is mostly mantled Iowan-Tazewell loess. However, a paleosol does not separate till and loess, indicating loess deposition followed closely the cutting of the erosion surface. All surfaces have been subjected to erosion and sedimentation during Late Wisconsin-Recent time. Since all the surfaces are dissected and now occur on upland divides or interfluves, and the Tazewell loess is also bevelled by slopes, the author concludes the slopes are post-Tazewell in age. The most recent erosion has exposed paleosols and these exposures are now continuous with modern soils.

Additional reports involving paleosols and Pleistocene erosion surfaces include the following. Corliss and Ruhe (1955) investigated the Iowan terrace and associated terrace soils of the Nishnabotna Valley in western Iowa. Prill, Shrader and Nicholson (1957) discussed the relationship between topography, distribution of soils, and loess thickness on the Galva-Primghar Experimental Farm. Hall, in 1965, described the geomorphology and soils of the Iowa-Kansan border area in Tama County, and during the same year Walker finished a study of the soils and geormorphic history of selected areas of Cary till. During 1966, Genton completed an investigation of the soils, weathering zones and landscape of the upland loess in Tama and Grundy Counties.

Carbon dating of paleosols in Iowa has been summarized by Ruhe and Scholtes (1955) and Ruhe, Rubin and Scholtes (1957).

General Category

Wilson (1945) reported pebble band ventifacts on Iowan till and under Peorian loess in a quarry near Palo in Linn County. He noted that the wind sculptured rock types include granite, rhyolite, diorite, greenstone, chert, quartzite, jasper, milky quartz, and conglomerate. His field investigation supported the existing view that the pebble band was formed upon wasting of the Iowan ice sheet and is the residual of wind erosion. The overlying loess is an integral part of the retreating Iowan ice sheet.

In 1954, Shaffer proposed evidence for extending the Green River Lobe of Tazewell (Shelbyville) ice west of the Mississippi River to the eastern border of the Goose Lake Channel in Clinton Countv, Iowa. Shaffer examined terraces in western Illinois and eastern Iowa and found Tazewell (Shelbyville) terrace remnants at several localities in eastern Iowa. He then reconstructed Tazewell ice activity on the basis of terrace remnants and other data. The concluding thought is that the terraces along the Iowa River should be re-examined since the Shelbyville terrace remnants along the lower Iowa may be contemporaneous with the high terrace of Lake Calvin upstream. Thus raising the possibility that the Shelbyville and Iowan are contemporaneous.

Wickstrom, Riggs and Davidson (1955) mapped and described fine sand locations in east central Iowa. Wallace and Handy (1961) reported the location and characteristics of stone lines in Cary till.

Miller (1964) mapped and described the geology of the Omaha-Council Bluffs area. He utilizes Kansas and Nebraska stratigraphic nomenclature and attempts to correlate from Nebraska to Iowa across the Missouri River flood plain. Most of the text involves a description of the stratigraphy and economic geology of the Quaternary and older systems. However, since this area is almost exclusively covered by Quaternary materials, the five geologic maps are useful in relating sediment types to topography.

Trowbridge (1966) reviewed the status of the so-called 'driftless area' in northeast Iowa. This is the area bounded on the west by the Kansan drift border, to the north by the Minnesota state line, and to the east by the Mississippi River. It includes parts of Allamakee, Clayton, Dubuque and Jackson Counties. His conclusions are essentially the same as those he and A. J. Williams held in the early 1920's. (1) There is no driftless area in Iowa. (2) More than 100 occurrences of glacial drift in this area are till—not outwash. The material is unstratified. (3) Till east of the Kansas drift border is pre-Kansan, since no till occurs on bottoms, terraces or slopes of valleys, whereas the Kansan till west of the border occupies upland surfaces and valleys (with more valley exposures).

Brown and Whitlow (1960), Whitlow and Brown (1963), and Whitlow and West (1966) described and mapped the geology of the Dubuque South, Dubuque North, and Potosi quadrangles, respectively. These investigations were primarily prompted by lead-zinc interests, however the three geologic maps and associated descriptions reflect additional information concerning the Pleistocene history of the 'driftless area.' The reports to a greater or lesser extent support the conclusions of Trowbridge (1966).

Two other investigations of general interest are the Arnold, Tyler and Rieken (1960) report on slope classes by counties and the Hidore (1960) discussion of the water resource base of Iowa.

Regional Pleistocene maps which include Iowa are the Glacial Map of the United States (Flint et al., 1959) and Pleistocene Eolian Deposits of the United States, Alaska, and parts of Canada (Thorp et al., 1952).

Trends and Concepts 1943-1968

An examination of the subject material and procedures described in these papers suggest the following: 1. the studies seem process oriented rather than time oriented; 2. more complexity of erosional and depositional processes; 3. greatly increased use of paleosols and buried erosion surfaces to decipher ancient process, ancient environments, and sequences of events; 4. the introduction of local radiocarbon dating into geomorphic studies; 5. increased use of quantitative techniques for both description, comparison, and the development of new relationships; 6. discovery and description of a greater variety of glacial depositional forms; 7. increased use of data in three dimensions in solving geomorphic problems; and 8. a lack of discussion about a framework for geomorphology (geographic cycle of Davis, slope association of Penck, dynamic equilibrium of Hack, etc.), and an emphasis on explanations, in terms of process, for present day geomorphology.

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