GEOLOGY OF WESTERN PAYNE COUNTY, OKLAHOMA

By

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GEOLOGY OF WESTERN PAYNE COUNTY, OKLAHOMA

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PREFACE

This thesis is a geologic study of the surface rocks of western Payne County, Oklahoma. Included is a geologic map of the study area and a summary of the general geologic features, including paleocurrent trends, depositional environments, and measured sections of the Permian rocks that crop out in the area. Also, presented is a shallow subsurface structural contour map, correlation section of stratigraphic units, and reconnaissance map of the depth to the salt water-fresh water contact.

The writer is grateful to individuals and companies who assisted in this study. Dr. John W. Shelton suggested and supervised the investigation. Dr. John D. Naff and Dr. Alex R. Ross served on the author's committee and made helpful suggestions, comments, and criticisms of this study. Dr. Tommy B. Thompson and Dr. Zuhair Al-Shaieb helped in petrographic study, and Dr. John E. Stone assisted with physiography and soils. Dr. Charles J. Mankin, Director of the Oklahoma Geological Survey, provided financial support for field investigation, aerial photographs, and a base map. Plane-table geologic maps were provided by Mr. G. E. McKinley and A. D. Buzzalini with the Skelly Oil Company, Mr. Fred Oglesby and R. Strom with Cities Service Oil Company, and Mr. J. G. Ruby and M. H. Udden with Sun Oil Company. The subsurface data was made available by Mr. Jack Berry of Thomas N. Berry and Company and the Oklahoma City Geologic Society Well Log Library. The author owes a special thanks to John S. Ross who offered many helpful suggestions.

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CHAPTER I

ABSTRACT

The study area in western Payne County, Oklahoma, is in the Central Redbed Plains and is almost entirely within the Cimarron River drainage basin. Only the extreme northern part lies in the Arkansas River drainage basin. Maximum elevation is 1175 ft in the west, and minimum elevation is 825 ft in the southeast; local relief commonly is about 100 ft. Major soil associations include the Kirkland-Zaneis, Vernon-Lucien, Dougherty-Teller-Vanoss, and Yahola-Port.

The surface rocks are Early Permian (Leonardian) in age; all units become progressively younger westward. The stratigraphic section is composed of units assigned to the Wellington Formation. The section is characterized by red beds in a repetitious sequence of shale, lenticular sandstone, and nodular dolomite. The sandstones are fine- to very fine-grained, feldspar-rich subarkose to quartz-rich subarkose, with an overall paleocurrent trend of N35°W. The sandstones exist as single genetic units, up to 25 ft thick, multistoried complexes, as much as 80 ft thick, and widespread multilateral units. The sandstones characteristically have undulatory erosional bases, although some have gradational bases. The amount of sandstone increases southward at the expense of mudrock and nodular dolomite. In general, sand deposition during arid climatic conditions was in a tide-dominated deltaic environment. The area lies southeast and south of prominent mudrock with thin

well-defined carbonate beds representative of tidal-flat conditions.

The area is characterized by gentle westerly homoclinal dip, generally 40 to 60 ft/mi. Local structural noses, averaging 1 sq mi in areal extent, are present in the subsurface as larger complexes, which increase in size and intensity with depth. Two sets of vertical joints, with mean trends of N55°E and N45°W, are similar to those of central Payne County.

Petroleum is the major mineral resource, with cumulative production of some 45 million bbl and 183 million cu ft of gas primarily from Pennsylvanian and Ordovician sandstones. Other resources include sandstone for local road subbase material; nodular dolomite for local county road material; sand for fill, asphalt, masonry purposes, and concrete; and clay for brick. Potable ground water is best developed in irregularly distributed sandstones and in terrace and floodplain sands of the Cimarron River. The distribution of the fresh ground water reflects local sandstone development, topography, and saline influent from Cimarron River.

CHAPTER II

INTRODUCTION

Payne County is located in north-central Oklahoma, west of Tulsa and north-northeast of Oklahoma City. The study area consists of about 350 sq mi in western Payne County and includes all or parts of Ts 17, 18, 19, 20N; Rs 2E, 1E, and 1W (Fig. 1). The county seat and largest city is Stillwater, located on the eastern edge of the study area. The city of Perkins is along the Cimarron River in the southeast corner of the area. Interstate 35 in the west and U. S. 177 in the east are north-south highways in the study area. State Highways 51 and 33 extend east-west across the area, and Highway 86 extends northward from 51 in the northwestern part of the county. County roads are generally well kept with periodic grading and a surface of crushed rock. The only rail service in the area is to Stillwater from the northeast by the Atcheson, Topeka, and Santa Fe Railroad.

Objectives and Methods

The main objectives of this study are to prepare a geologic map of western Payne County and to describe the general geologic features of the area. Secondary objectives include determination of general depositional environments and paleocurrents.

Preparation of the geologic map (Fig. 2), included use of the following data: (1) local, unpublished, detailed maps of petroleum

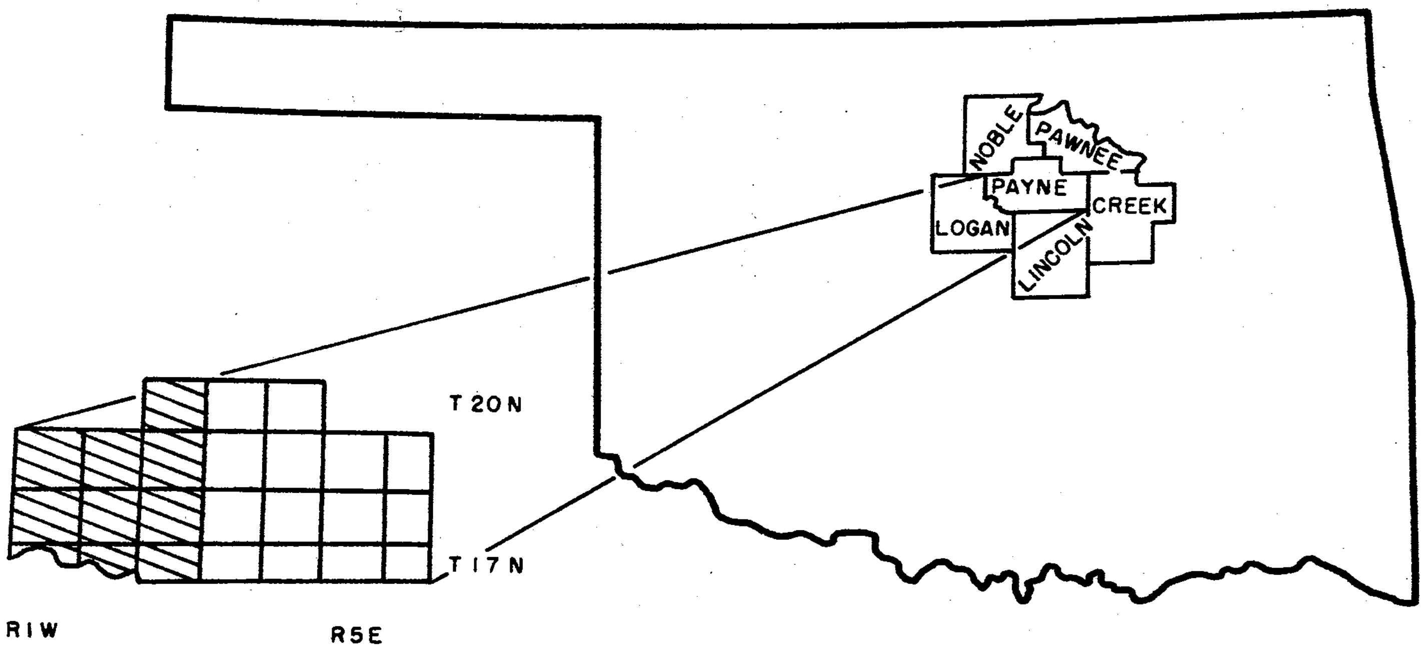

Fig. 1.-Location map of study area.

geologists, including maps by Ellison, Hudson, Rixleben, Peabody, Castile, and Schmurr; (2) unpublished geologic map of Payne County by P. P. Chandler; (3) county soil report and map by Cobb and Hawker (1918); (4) Oklahoma soil report and map by Gray and Galloway (1959); (5) soil report and map by Hayes et al. (1967); (6) unpublished geomorphologic map of Stillwater Creek by Voss, White, and Wafaie; (7) aerial photographs; (8) U. S. Geological Survey topographic maps; and (9) electric logs of wells drilled for oil and gas. Because lateral persistence of units is uncommon in the area, methods had to be improvised for mapping. Shallow subsurface structural contour maps for western Payne County (Fig. 2) were prepared of carbonate units cropping out in eastern Payne County, and a stratigraphic correlation section (Fig. 3) was compiled of the surface formations from electric log data. The stratigraphic position of each bed on the surface was then estimated by comparing the elevation of each bed with that of the key bed in each well and on the structural contour maps. Further control was obtained from the unpublished maps, which were used as a supplement to the surface data plotted on aerial photographs and topographic maps.

Measured sections were prepared on forms prepared by Shelton (1963) as graphic records of some of the surface units for sedimentologic and stratigraphic study. From rose diagrams paleocurrent directions and trends were estimated for each sandstone studied, for 3 unnamed units of the Wellington Formation, and the entire formation.

Previous Investigations

Although many independent studies by petroleum geologists of surface and subsurface geology of western Payne County have been conducted, none of these has been published. Most of the work was conducted during the 1920's and 1930's when exploration work for structural traps did not generally include seismic techniques. Maps which were made available to the writer through John Ross were contributed by various companies. These maps include those prepared by C. W. Ellison (1951; courtesy of William A. Jenkins), H. K. Hudson (courtesy of Cities Service Oil Company), Rixleben (1930; courtesy of Skelly Oil Company), and H. W. Peabody, Castile, and C. Schmurr (1922-1932; courtesy of Sun Oil Company). Philip P. Chandler prepared a geologic map of Payne County during the early 1960's. A short report of the surface, subsurface, and petroleum geology of Payne County was assembled by Koschmann (1930). Hayes et al. (1967) constructed a general map of Payne County showing the geologic units with engineering significance. A soil report and map of Payne County were prepared by Cobb, Hawker, and Bennett (1918). Brief reports of some of the geologic materials of Payne County which might be utilized in construction were made by Gould (1911, 1927) and Snider (1911). Gould (1905) also noted the ground water features of Payne County.

CHAPTER III

PHYSIOGRAPHY AND SOILS

Physiographically western Payne County lies in the Central Redbed Plains just west of the Northern Limestone Cuesta Plains (Curtis and Ham, 1957). The area has the typical Redbed Plains characteristics; i.e., rolling plains with broad valleys and hills formed by nonresistant, red shales and lenticular sandstones, respectively. Several cuesta-like ridges formed by sandstone show some continuity. For example, a sandstone in the upper part of the Wellington (Pw-620) forms a ridge which is 7 mi in length in the northwestern part of Payne County, extending from highway 86 to I-35 (Fig. 2).

Drainage anomalies at the Ramsey oil field, Stillwater Airport oil field, and Lost Creek oil field are slight. However, they reflect the effects of local structure on topography. All these fields show structural nosing at the Lower Permian Fort Riley and Red Eagle Limestone horizons, as well as the Pennsylvanian Oswego Limestone.

The overall slope of western Payne County is to the south and southeast. Surface elevation is approximately 1130 ft immediately south of Long Branch Creek in the north. In western and west-central parts of the area the elevation is as much as 1175 ft. The lowest elevation in the area is 827 ft along the Cimarron River just south of Perkins. Local relief commonly approaches 100 ft; in some cases it ranges upward to as much as 150 ft.

The bulk of western Payne County lies within the Cimarron River drainage basin; a small area in the extreme northern part of the area is drained by Long Branch Creek of the Arkansas River basin. The major tributaries of the Cimarron River, all of which are intermittent streams, are Stillwater Creek in the north, Lost Creek in the southeast, Wild Horse Creek in the south, and Clear Creek in the west. Cimarron River exhibits characteristics of both a braided and a meandering stream.

Western Payne County has a mild climate with an annual mean temperature of 59°F; seasonal means range from 79°F in the summer to 38°F in the winter. The average yearly rainfall is 34 inches.

The soils of the study area consist of four main types: the Kirkland-Zaneis association, Vernon-Lucien association, Doughtery-Teller-Vanoss association, and Yahola-Port association. The geology of the area exerts a strong influence on the type soil developed. The Kirkland-Zaneis association is a very well developed brown soil that forms on Permian red beds where the Redbed Plains type of topography is present. The parent material of the Kirkland series is claystone, and that of the Zaneis series is sandstone. The Vernon-Lucien association is a poorly developed red soil that also forms on Permian red beds. The parent material of the Vernon series is claystone and that of the Lucien series is sandstone. The Doughtery-Teller-Vanoss association is the dominant soil of the terrace and associated eolian deposits. They are generally present in the southern part of the study area along the Cimarron River. The Yahola-Port association is the major soil that forms on the floodplain sediments of the Cimarron River and major creeks of the area. The Yahola series characterizes the Cimarron River floodplain soils, and the Port series dominates the soils of the major creeks (Cobb and Hawker, 1918; Gray and Galloway, 1959; Ross, 1972). In a number of upland areas, scarplets, generally 1 to 3 ft high, occur along stream gullies, creeks, and terraces on silt or silty loam soils. They are thought to be related to a veneer of loess on upland areas (Ross, 1972).

CHAPTER IV

STRATIGRAPHY

The surface rocks of the study area are of Early Permian age. The stratigraphic section, which is included in the Wellington Formation of the Sumner Group, Leonardian Series, is approximately 800 ft thick. It extends upward from the top of the Herington Limestone at the base of the Wellington Formation. The surface exposure of successively younger beds in a westerly direction is due to the gentle westward structural dip in that direction.

During Early Permian the area was part of the Oklahoma platform, which as a slowly subsiding feature was the site for deposition of lenticular sandstones, red mudrock, and very thin discontinuous carbonates.

Permian System

Wolfcampian Series

Herington Limestone. The Herington Limestone is the uppermost unit of the Chase Group and of the Wolfcampian Series. In Noble County, the Herington grades southward from a fossiliferous grainstone-packstone, less than 8 ft thick, to a thin sequence of red, nodular, dolomitic limestone and interbedded sandstone (Shelton, 1973). In Payne County, the Herington Limestone is essentially identical to the red, nodular, dolomitic limestone and interbedded sandstone of southern Noble County.

It occurs in lenses, less than 1 ft thick, which can be traced southward to the Lincoln-Payne County line only by extrapolating stratigraphic thicknesses at points of subsurface control and mapping overlying sandstones (Fig. 2). In the northern part of the county, the nodules which are pink and finely crystalline, are associated with a thin, lenticular sandstone. This very fine-grained sandstone is less than 5 ft thick and exhibits initial dip (Ross, 1972). South of Stillwater Creek the nodules are red, sandy, and interlaced with calcite or dolomite veinlets.

Leonardian Series

Wellington Formation. The Wellington Formation is the lowest unit of the Sumner Group and of the Leonardian Series. In Noble County, the Wellington is a sequence of red shale or claystone, lenticular sandstones, gray-green shale and thin dolomite beds. Aside from the red color the most dominant characteristic of the Wellington in Noble County is its facies change whereby the lenticular sandstones are developed southward at the expense of red mudrock and thin dolomite units (Shelton, 1973). The formation in western Payne County is not only lithologically similar to the Wellington of Noble County but it also is characterized by better sandstone development southward.

The Wellington was subdivided by Patterson (1933) into a lower member, the Fallis, dominated by sandstone, and an upper member, the Iconium, dominated by shale. This subdivision is difficult to follow in the study area because of the continuing southward increase of sandstone through Noble and Payne Counties. In Noble County, Shelton (1973) subdivided the Wellington into 4 unnamed units using three key beds. In Payne County, the Wellington is subdivided into 3 unnamed units using two relatively prominent sandstone sequences as key beds. The key sandstones, 200 and 600 ft above the base of the Wellington and designated Pw-200 and Pw-600, respectively, separate the formation into lower, middle, and upper units. Each bed mapped is designated by a symbol which consists of the formational abbreviation and the footage above the base of the formation.

Lower unit and lower key bed. The lower unit of the Wellington Formation, some 200 ft thick, is characterized by red mudrock, discontinuous lenticular sandstones and thin, discontinuous carbonate beds. The interval between the Herington Limestone and Pw-200 has no sandstone which is continuous throughout the area, but several units are locally developed. Sandstone Pw-40 is relatively continuous in the north but discontinuous in the south, and Pw-80, Pw-100, and Pw-160 are quite restricted and/or discontinuous in development. Pw-120 and Pw-180 are sandstone sequences mappable only in the north, whereas Pw-20 and Pw-60 are developed only in the south. Several of these sandstone sequences are multistoried and multilateral complexes which range up to 50 ft thick and a mi or more in outcrop length (Section 2, p. 54). Pw-140 is associated with a carbonate which is a clay-pebble conglomerate, less than one ft thick in the north, and a nodular dolomite or dolomite-cemented, cellular sandstone, 1-2 ft thick, with animal trails in the south (Section 1, p. 53).

The lower key bed, Pw-200, is a series of lenticular sandstones, with an overlapping area of development at approximately the same stratigraphic position. It ranges in thickness from less than 5 ft thick for a genetic unit in Sec. 21, T20N, R2E, to a multistoried complex over 50 ft thick (Section 3, p. 55). It is generally characterized by a sharp undulatory base, although a gradational base is locally developed (Section 3, p. 55). Pw-200 is fine- to very fine-grained, exhibits moderate to good sorting, and contains occasional intraformational rocks fragments (Section 4, p. 56).

Middle unit. Red mudrock, multilateral, lenticular sandstones, nodular dolomite, and algal-mat carbonate beds characterize the middle 400 ft of the Wellington Formation. The mapped sandstones are fine- to very fine-grained, and many have sharp undulatory bases and sharp lateral contacts.

The 400-ft interval between Pw-200 and Pw-600 has several relatively continuous sandstone sequences. Pw-320, Pw-380, Pw-420, Pw-460, and Pw-500 extend across the county. Pw-380 is a multilateral sandstone sequence from less than 5 ft to almost 40 ft thick, with some carbonaceous material. Pw-460 is also a good example of a multilateral sequence (Fig. 4). Pw-240 and Pw-260 are developed in the north, whereas Pw-280 is a multilateral, multistoried, carbonate-cemented sandstone in the south (Section 5, p. 57). Pw-400 is developed only in the area south of Lake Carl Blackwell. Pw-480, Pw-560, and Pw-580 are discontinuous sandstones occurring only in the south. Pw-480 and Pw-580 have intraformational fragments. The thickness of Pw-480 increases southward from as little as 2 ft to over 20 ft in Sec. 32, T18N, R1E. This southward increase in sandstone thickness characterizes several other units, especially those from 240 to 300 ft above the base. That interval contains several thin sands in T18N, Rs 1 and 2E, but is largely sandstone at Horsethief Canyon in Lincoln County, just south of the

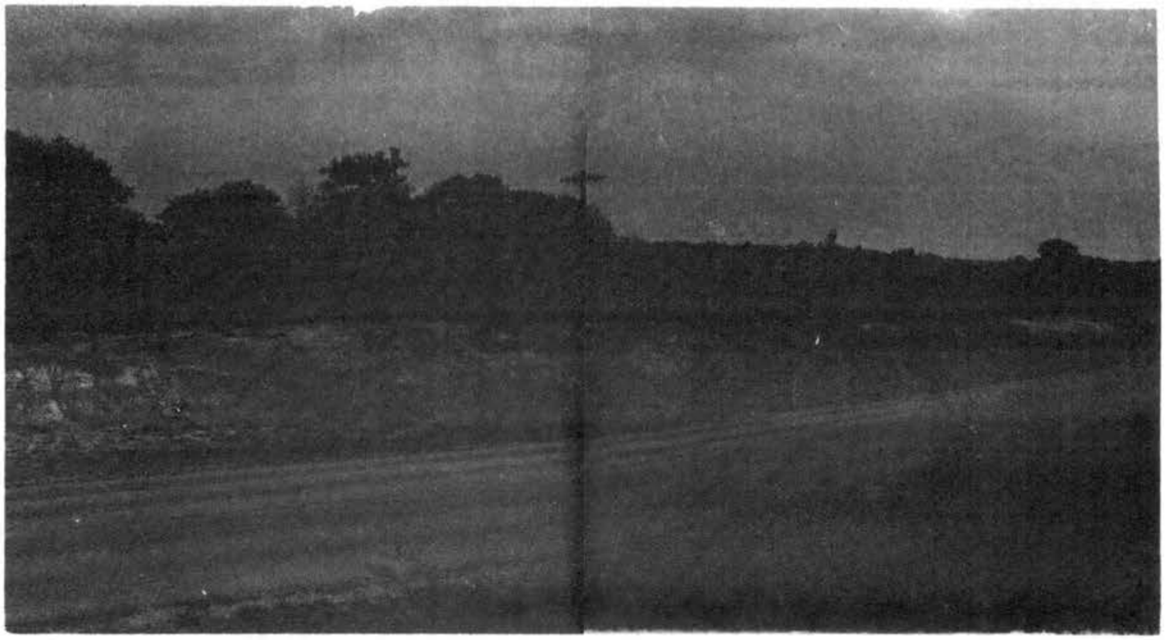

Fig. 4.-Sandstone Pw-460 showing multilateral development in Sec. 21, T19N, R1E.

Cimarron River (Fig. 5; Section 6, p. 58). Pw-500 in Sec. 10, T19N, R1W, is a 5-ft genetic unit associated with nodular dolomite (Section 10, p. 61), whereas it is over 20 ft thick in Sec. 17, T18N, R1E (Section 12, p. 63). At the latter locality the multistoried sandstone contains carbonate-cement, intraformational fragments, iron replacing wood fragments, and crinoid fragments. Farther south in Sec. 31, T18N, R1E, Pw-500 is a multilateral, multistoried complex, almost 50 ft thick, with 3 dolomite, clay-pebble conglomerates (Section 11, p. 62).

Dolomite lenses are locally developed at various stratigraphic positions in the middle unit of the Wellington Formation. The most impressive outcrop of dolomite in the study area is a sequence of algal-mat carbonate beds in Sec. 15, T19N, R1W (Section 14, p. 64), which contain stromatolites similar to the type-SS structures found in low intertidal areas (Logan, Rezak, and Ginsburg (1962).

Upper unit and upper key bed. The upper part of the Wellington Formation exposed in Payne County includes 180 ft of rather persistent sandstone sequences, composed of individually lenticular units, thin nodular dolomite, and thin carbonate beds.

The upper key bed, Pw-600, is a fairly continuous sandstone throughout the area, with lenticular bodies developed at approximately the same stratigraphic position. It is 5 to 15 ft thick, is characterized by a sharp undulatory base, is fine- to very fine-grained, and well sorted (Section 17, p. 67). Locally nodular dolomite is associated with Pw-600.

Pw-620, Pw-640, Pw-660, Pw-680, Pw-700, and Pw-740 are similar in range of thickness, lateral continuity, and grain size. Pw-640 and

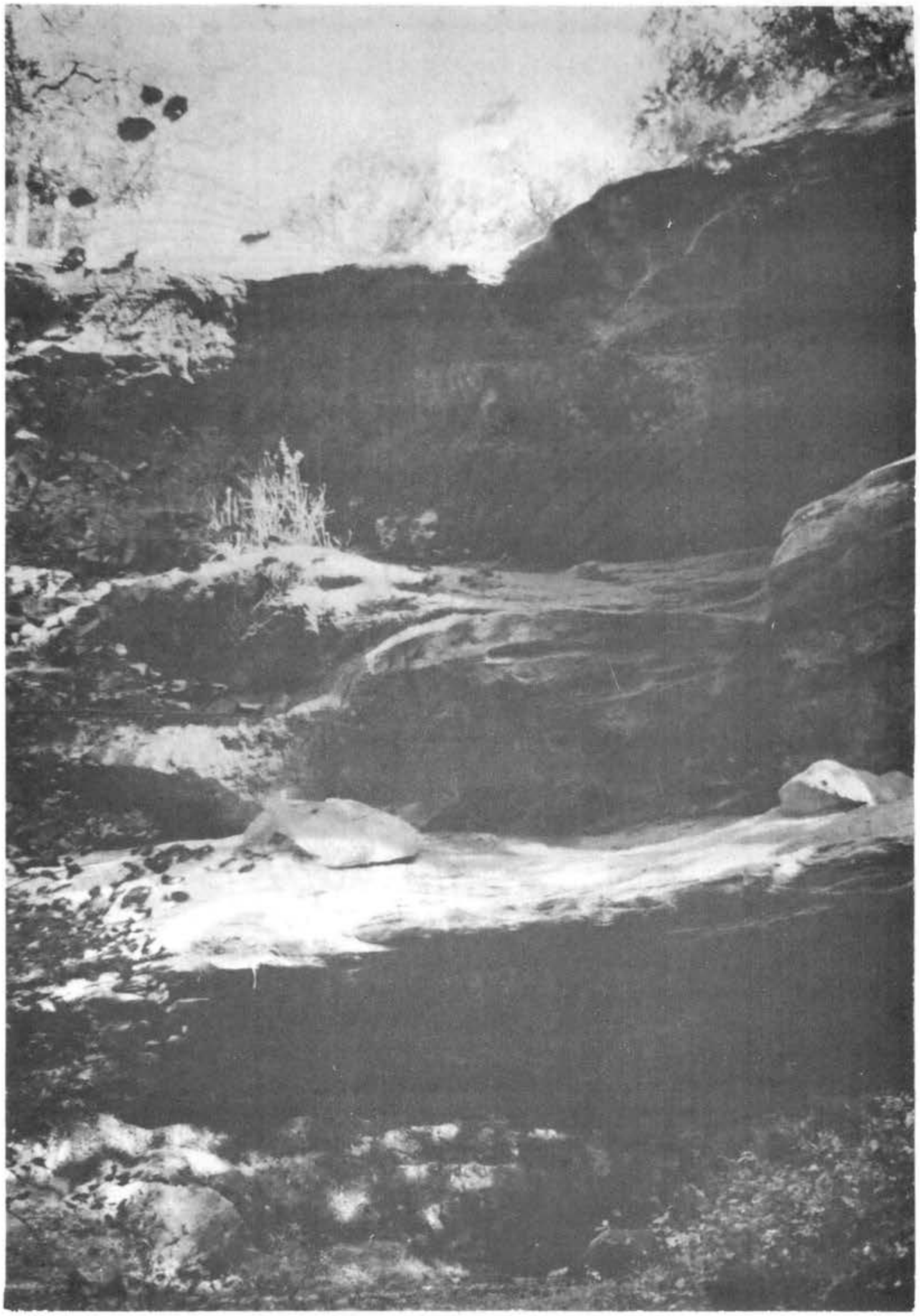

Fig. 5.-Sandstones Pw-240 through Pw-300 as a continuous exposure, approximately 60 ft high, in Sec. 14, T17N, R1E, Logan County, just south of the Cimarron River.

Pw-660, with some medium-grained beds, is coarser than other beds (Sections 19 and 20, pp. 68 and 69). Pw-640 contains fossil fragments in Sec. 8, T19N, R1W. Pw-640 and Pw-740 are not so continuous as the other beds. Thin limestone and nodular dolomite beds are commonly associated with Pw-620. In Secs. 1 and 13, T18N, R1W, 2 nodular dolomite beds are present, whereas 3 limestone beds are locally present to the south (Section 16, p. 66). Pw-660 in Sec. 5, T19N, R1W, contains large-scale spill-over cross-bedding (Bernard, 1970; Fig. 6; Section 21, p. 69). Pw-680 was quarried in Sec. 17, T19N, R1W, for subbase material for I-35 (Fig. 2). Intraformational clay and carbonate fragments are locally present in many of the sandstones in the upper unit (Sections 18, 19, 20, and 22, pp. 67, 68, 69, and 70).

Quaternary

The Quaternary deposits of Payne County are alluvial sand, silt, and clay and eolian sand and silt. These sediments, except for eolian silt, occur on the floodplain and terraces of the Cimarron River and along major creeks.

Terrace Deposits

Terraces are mapped along and north of the Cimarron River and along the major creeks. They are best developed along the Cimarron River and Stillwater Creek. The Cimarron terraces are composed primarily of sand, with small amounts of gravel, silt, and clay. Silt occurs as loess blanketing parts of the terraces and uplands. Tree-covered sand dunes are present on the lower Cimarron terrace surfaces. In Sec. 24, T18N, R1W, 4 miles north of the river and 120 feet above it, a sand pit

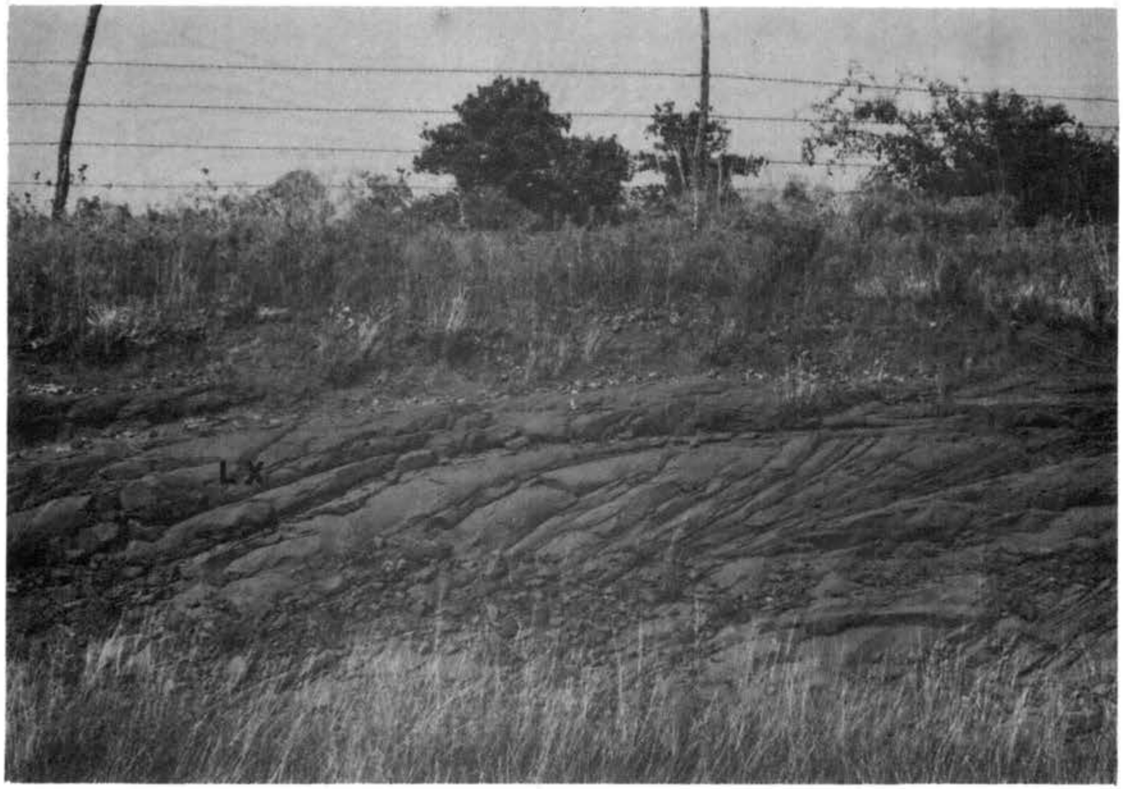

Fig. 6.-Large-scale cross-bedding (LX) in sandstone Pw-660 is the spill-over type. Location is in Sec. 5, T19N, R1W; fence post is about 5 ft high.

contains over 20 ft of terrace deposits (Fig. 7; Section 23, p. 70). High terraces may be present in the upland areas as a veneer-like cover of very fine-grained sand as far north as Highway 51.

Alluvial Deposits

Alluvial deposits are present on the floodplain and in the channel of the Cimarron River and major creeks. The river deposits consist primarily of sand, with some gravel at low-water level and silt-clay interbeds. Along Stillwater Creek the thickest exposure of alluvium is about 20 ft of very fine-grained sand and silt, with clay.

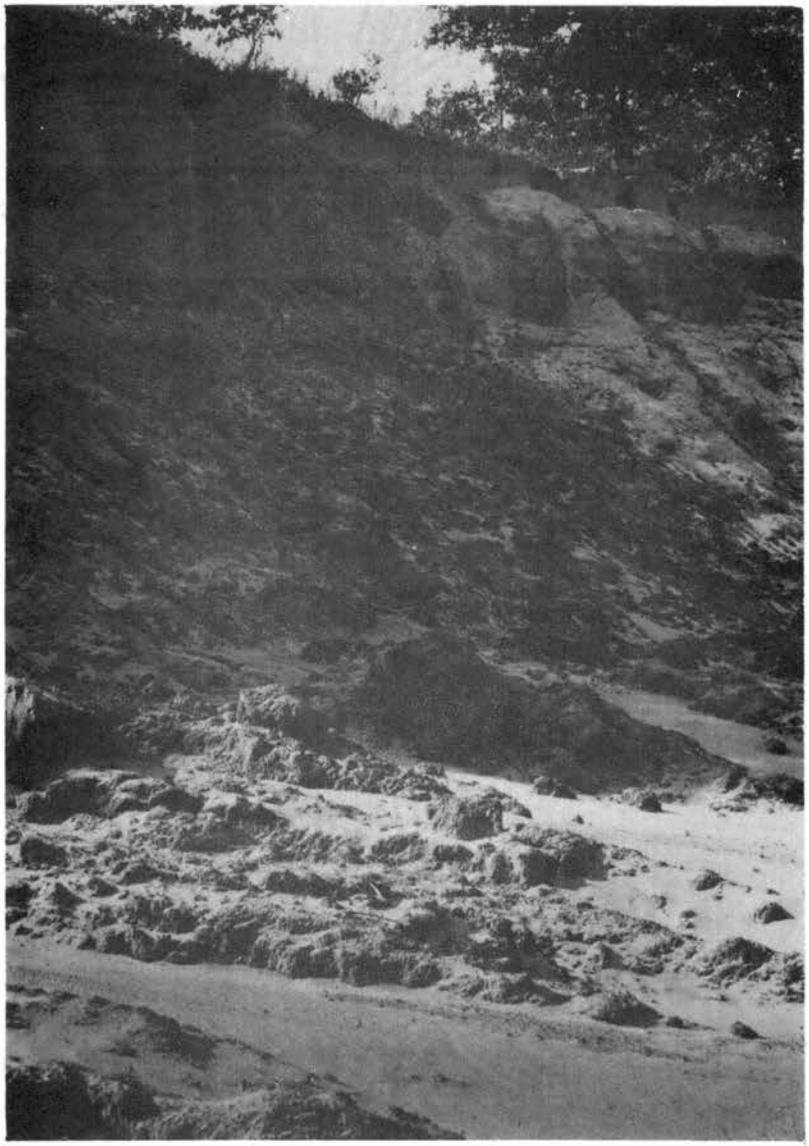

Fig. 7.-Exposure of terrace sand with some 20 ft shown; total thickness is 40 ft. Location is in Sec. 24, T18N, R1W, or 4 mi north of and 120 ft above the Cimarron River.

CHAPTER V

STRUCTURE

A shallow subsurface structural map (Fig. 2) was prepared with the Permian Fort Riley Limestone as the key bed. The map illustrates gentle, homoclinal westward dip in the eastern and central part of the area, with a slight shift to the west-southwest in the two westernmost townships. Payne County is part of the Prairie Plains homocline, a regional feature dipping off the Ozark uplift (Arbenz, 1956; Fig. 2). The average dip of the area ranges from 40 to 60 ft per mi, with local increases to as much as 100 ft per mi. The structural configuration of the Fort Riley is comparable to that of the stratigraphically lower Permian Red Eagle and Pennsylvanian Oswego Limestones. Very gentle folds, or noses and saddles, were formed by local flattening and steeping of the homoclinal dip. In some cases, the subtle structures are expressed topographically by drainage anomalies. The only structures in western Payne County with eastward dip are the Stillwater Airport oil field in T20N, R2E (Fig. 2), and the Lost Creek oil field in T18N, R2E (Fig. 2), both of which are about 1 sq mi in areal extent. They combine with other less prominent noses to form complexes which are several miles in areal extent. Earlier, Shannon (1917), Koschmann (1930), and Powers (1931) had indicated folding of the region increases in intensity with depth. The larger structures at depth are thought to be the result of differential vertical uplift of basement blocks (Powers, 1931;

Clayton, 1965) along upthrust faults. Some of the smaller structures, however, are more likely the result of differential compaction, associated with buried hills or isolated, lenticular sand bodies (Clayton, 1965; Ross, 1972).

Although no faults were noted on the surface of western Payne County, one may be present in the shallow subsurface at the Stillwater Airport oil field. Open joints are not uncommon on the surface in western Payne County in sandstones. These joints are usually vertical to near vertical and are thought to be extensional in nature. A plot of strike frequency for 51 joints (Fig. 8) shows two sets, averaging N55°E and N45°W, respectively, directions which are very similar to those in central Payne County (Ross, 1972), Noble County (Shelton, 1973), and the large area north and northwest of the Ouachita Mountains (Melton, 1931). The northwest set is subparallel to individual faults of the en echelon fault zones in eastern Payne County and Creek County.

Tectonically Payne County is part of the Central Oklahoma platform, which corresponds to the southern portion of the Prairie Plains homocline (Arbenz, 1956). The north-trending Nemaha Ridge, with basement fault blocks and gently folded Pennsylvanian beds, is located about 15-25 mi west of the area.

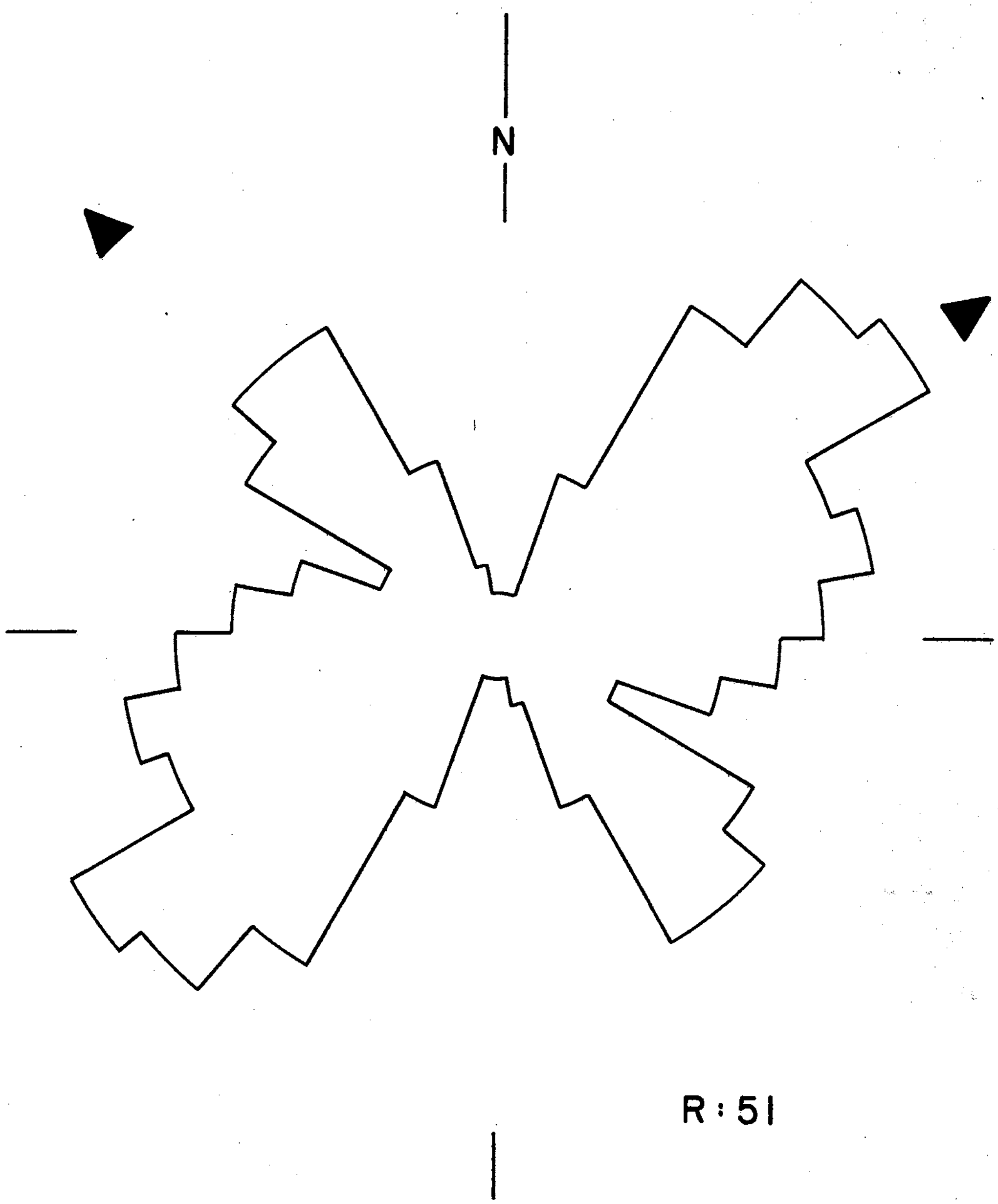

Fig. 8.-Strike frequency diagram of 51 joints, showing N55°E and N45°W directions. A 30-degree sliding average was used in preparation of the diagram.

CHAPTER VI

PETROLOGY

The most prominent rock type at the surface in western Payne County is sandstone, but mudrock, including mudstone with some shale, is the most abundant rock type. Very thin, irregularly distributed carbonate units at the surface are dolomite and, less commonly, limestone. Sedimentary structures, textural features, and composition were examined for sandstones. For the most part only field observations were made of mudrock and carbonate.

Sandstones

Structures

The observed sedimentary structures in western Payne County sandstones in order of abundance are: medium-scale cross-bedding (148 readings), initial dip, with associated large-scale cross-bedding, (100 readings), small-scale cross-bedding (78 readings), parting lineation (64 readings), and cut-out (7 readings). Medium-scale cross-bedding is recognized in the field as a surface which represents the foreset beds of migratory sand dunes (Fig. 9). These foreset beds dip in the migrating direction of the dunes, and they are either festoon or planar in nature. In some exposures a major problem was separation of initial dip and medium-scale cross-bedding. The initial dip is separated from

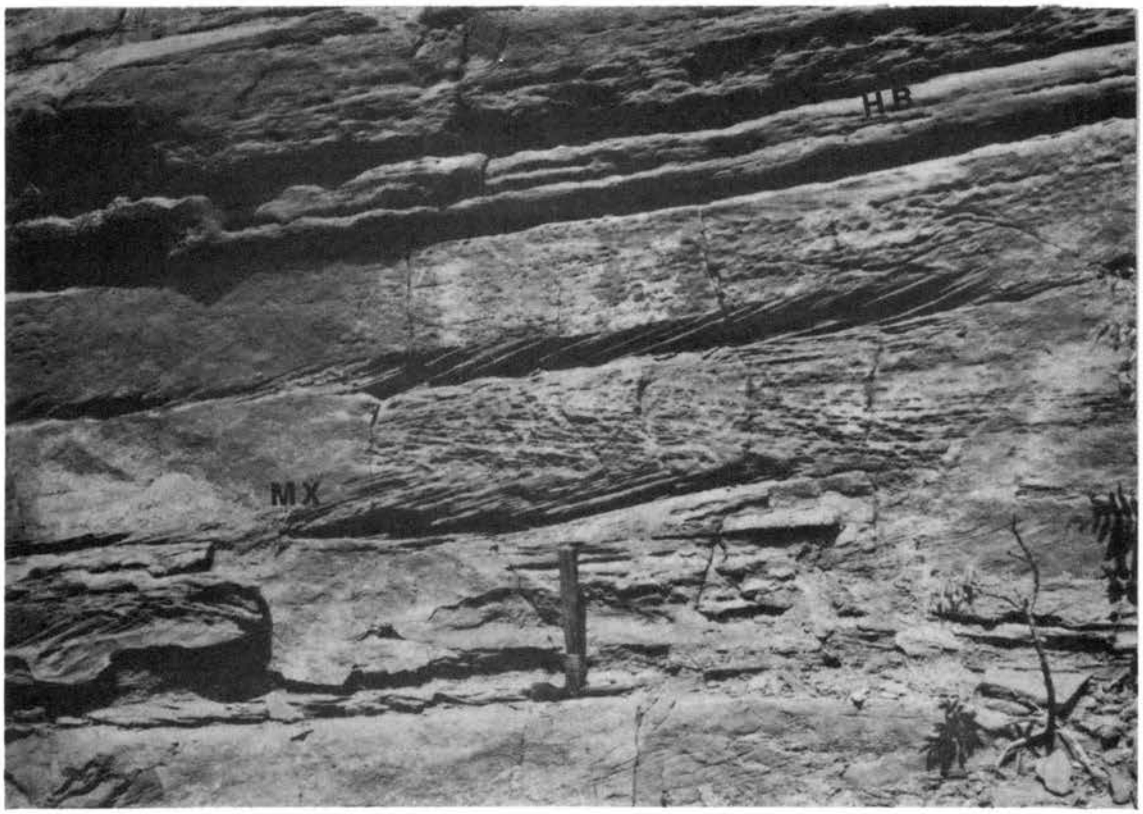

Fig. 9.-Medium-scale cross-bedding (MX) above and below the hammer and horizontal bedding (HB) in upper part of sandstone Pw-580, in Sec. 2, T18N, R1W.

medium-scale cross-bedding generally by a lower angle, larger size, and a parallel relationship to associated cut-outs. The presence of shale interbeds also reflects the presence of initial dip. However, where it was not possible to make a certain decision, those directional data were not recorded. Of all the paleocurrent indicators medium-scale cross-bedding has the widest range of direction.

Initial dip is a cross-stratification feature that forms on and parallel to a depositional slope (Fig. 10), and the dip direction is generally perpendicular to the paleocurrent. Medium-scale cross-bedding foresets are expected to be perpendicular to the associated initial dip, but some foreset dips were observed which are subparallel to the initial dip. Allen (1968) indicates that certain foreset beds of medium-scale cross-bedding may form an acute angle to initial dip. Large-scale cross-bedding (Fig. 6) noted in Pw-660, in Sec. 5, T19N, R1W, has been designated by Bernard et al. (1970) as spill-over cross-bedding, and it is analogous to initial dip of foreset beds of deltas in certain large Pleistocene lakes. The paleocurrent direction of initial dip in the study area gives a very wide range of direction.

Small-scale cross-bedding represents the foreset beds of small migratory ripples, with the foreset dip indicating depositional current direction. Small-scale cross-beds in the area reveal a rather narrow range of paleocurrent direction. Parting lineation in horizontal beds generally parallels depositional trend. Parting lineation, which is present more commonly near the top of the sandstone bodies, reveals a rather narrow range in depositional trend. Cut-outs are of 3 separate types: single genetic sandstone units cutting into mudrock (Fig. 10); multilateral sandstone complexes with multiple cut-outs in mudrock and

Fig. 10.-Contact between mudrock (dark) and sandstone Pw-200 (light), showing initial dip (ID) and cutout (CO) in Sec. 16, T20N, R2E. Fence post is 5 ft high.

sandstone alike (Fig. 4); and small lenses of siltstone and mudstone in the upper part of some multistoried sandstone units. Other structures noted in the field include deformed bedding, burrows, and trails.

A total of 397 paleocurrent measurements were made from Wellington sandstones. The lower unit of the Wellington Formation, some 200 ft thick, has an average direction of N30°E with a minor direction of S30°W (Fig. 11). The middle unit of the Wellington, from Pw-200 to Pw-600, has a major direction of N55°W and a minor trend of N55°E (Fig. 12). The upper unit of the Wellington, from Pw-600 to Pw-780, has a major direction of N45°W and a minor direction of N50°E (Fig. 13). The cumulative major paleocurrent for the Wellington Formation is N35°W with minor directions of N40°E, S35°E, and S60°W (Fig. 14).

Texture and Composition

Conglomeratic beds are present at the base of several sandstones. Two types are present in all 3 Wellington units in the study area: (1) carbonate, clay-pebble conglomerate and (2) clay-pebble conglomerate. The carbonate, clay-pebble conglomerate contains pebbles, up to 80 mm in diameter in a matrix of clay, carbonate, and fine- to very fine-grained sand (Fig. 15). Clay-pebble conglomerates in the area consist of pebbles, as much as 100 mm in diameter, in a matrix of red to maroon clay and fine- to very fine-grained sand, with carbonate coating some of the pebbles (Fig. 16). The carbonate pebbles are thought to have been derived from local breaking up of tidal-flat carbonates. The clay pebbles are locally derived from erosion of tidal flats, interdistributary bays, or distributary banks (Ross, 1972).

Sandstones of western Payne County are generally well sorted and

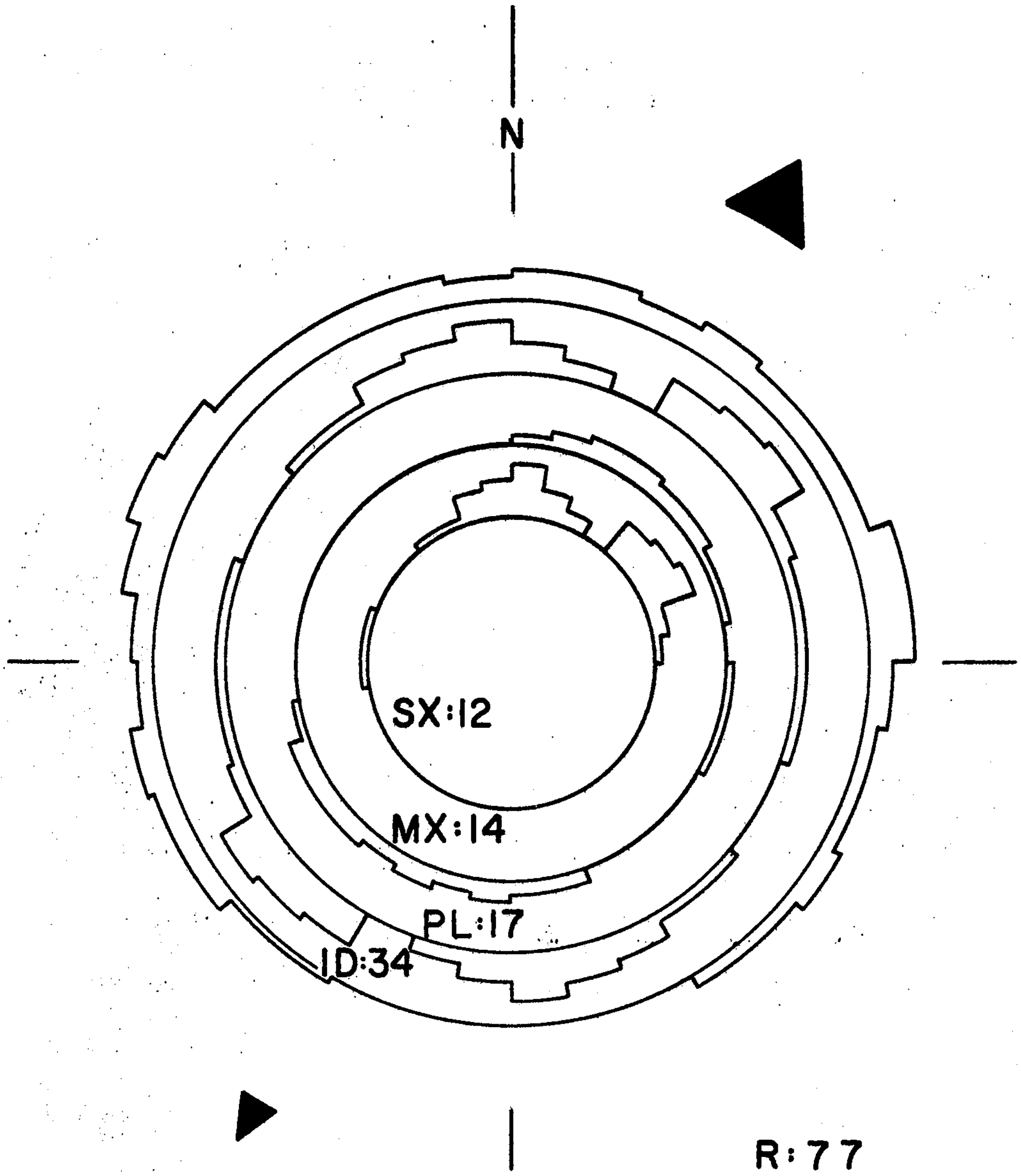

Fig. 11.-Paleocurrent diagram of sandstones in the lower unit, Wellington Formation, showing a primary direction of N30°E and secondary direction of S30°W. Size of arrow indicates prominence of direction. SX = small-scale cross-bedding, MX = medium-scale cross-bedding, PL = parting lineation, ID = initial dip, LX = large-scale cross-bedding, CO = cut-out trend, and R = total number of readings. A 30-degree sliding average was used in preparation of diagram.

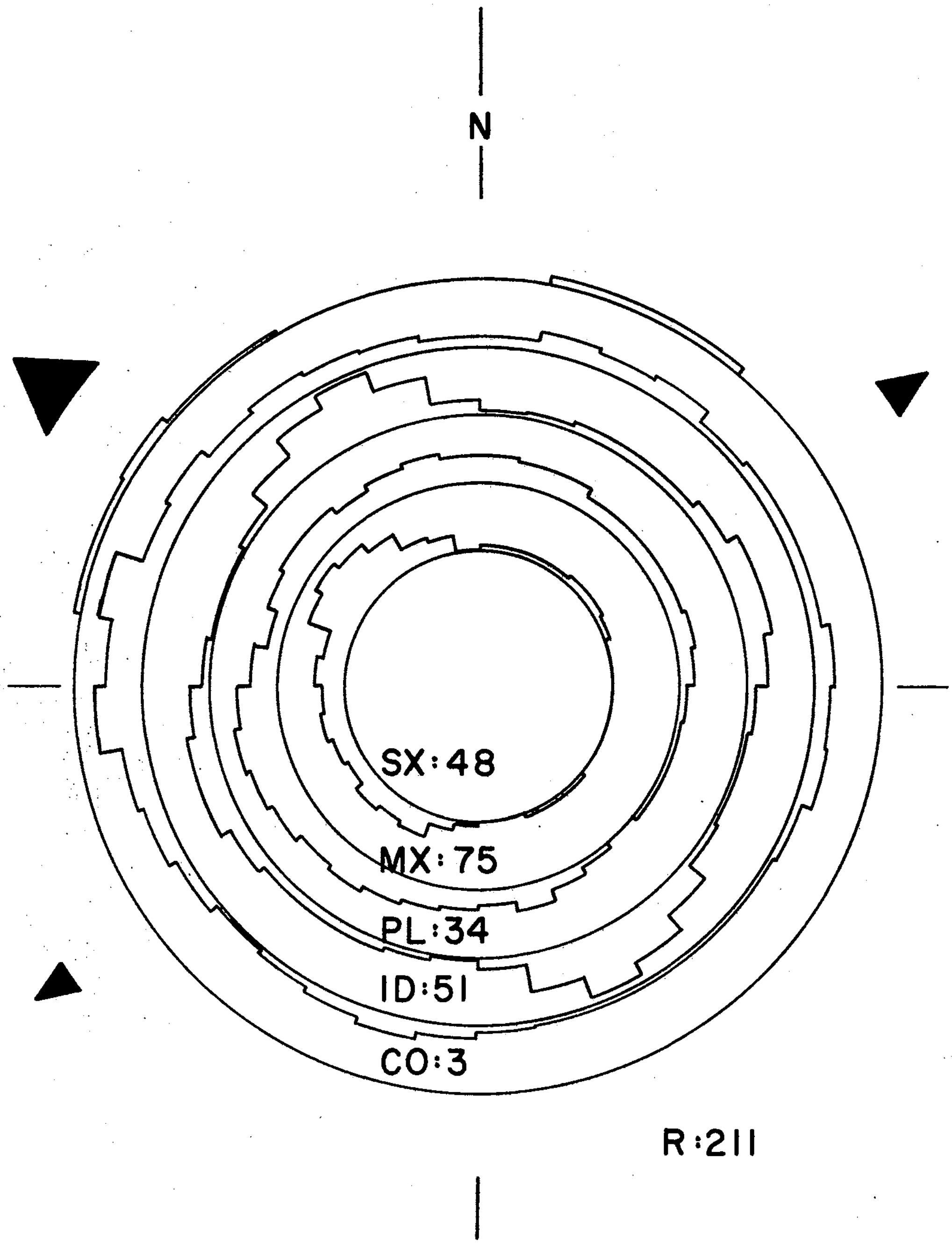

Fig. 12.-Paleocurrent diagram of sandstones in the middle unit, Wellington Formation. Primary direction is N55°W. Secondary trend is N55°E. Key for symbols is in Figure 11.

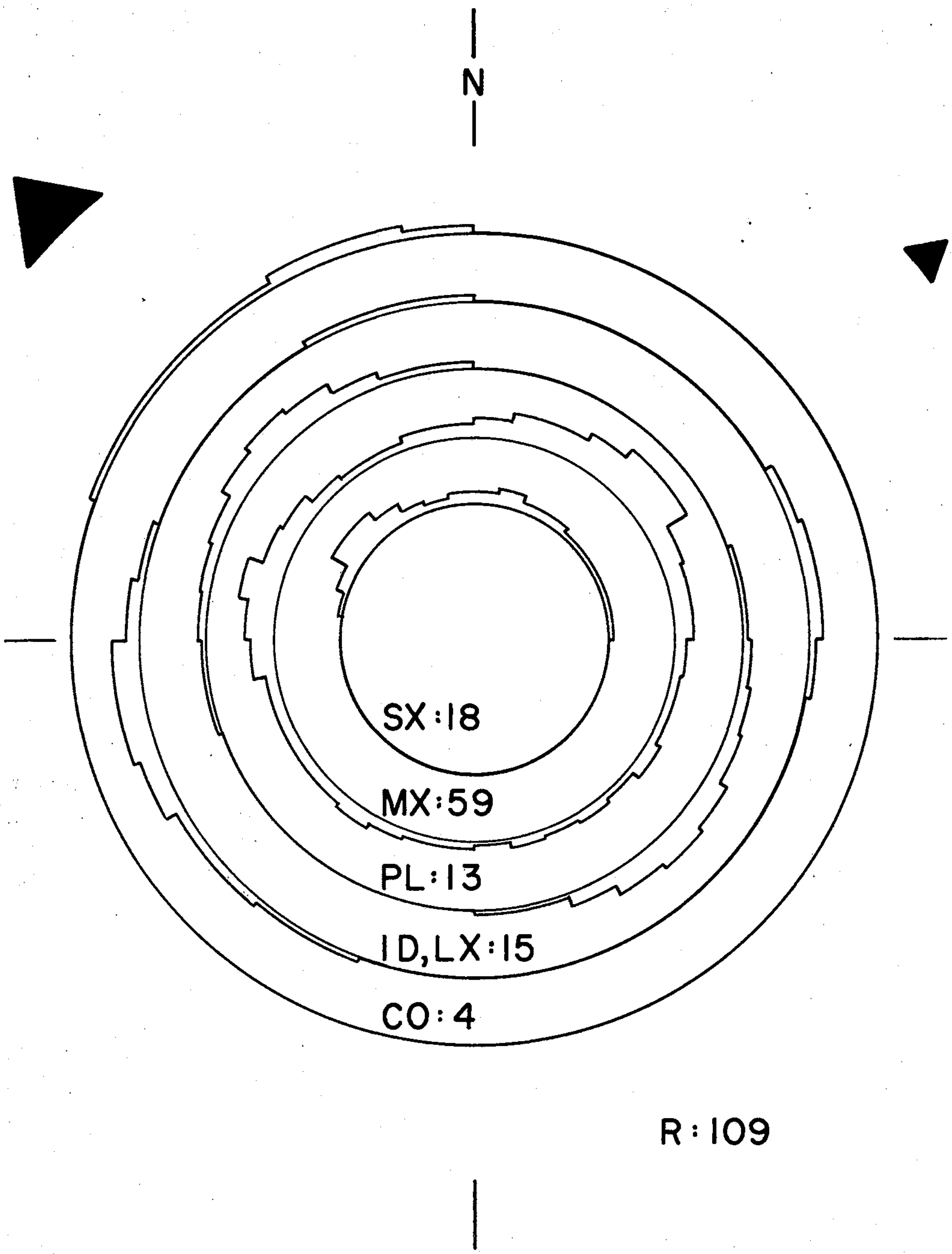

Fig. 13.-Paleocurrent diagram of sandstones in the upper unit, Wellington Formation. Primary direction is N45°W. Secondary direction is N50°E. Key for symbols is in Figure 11.

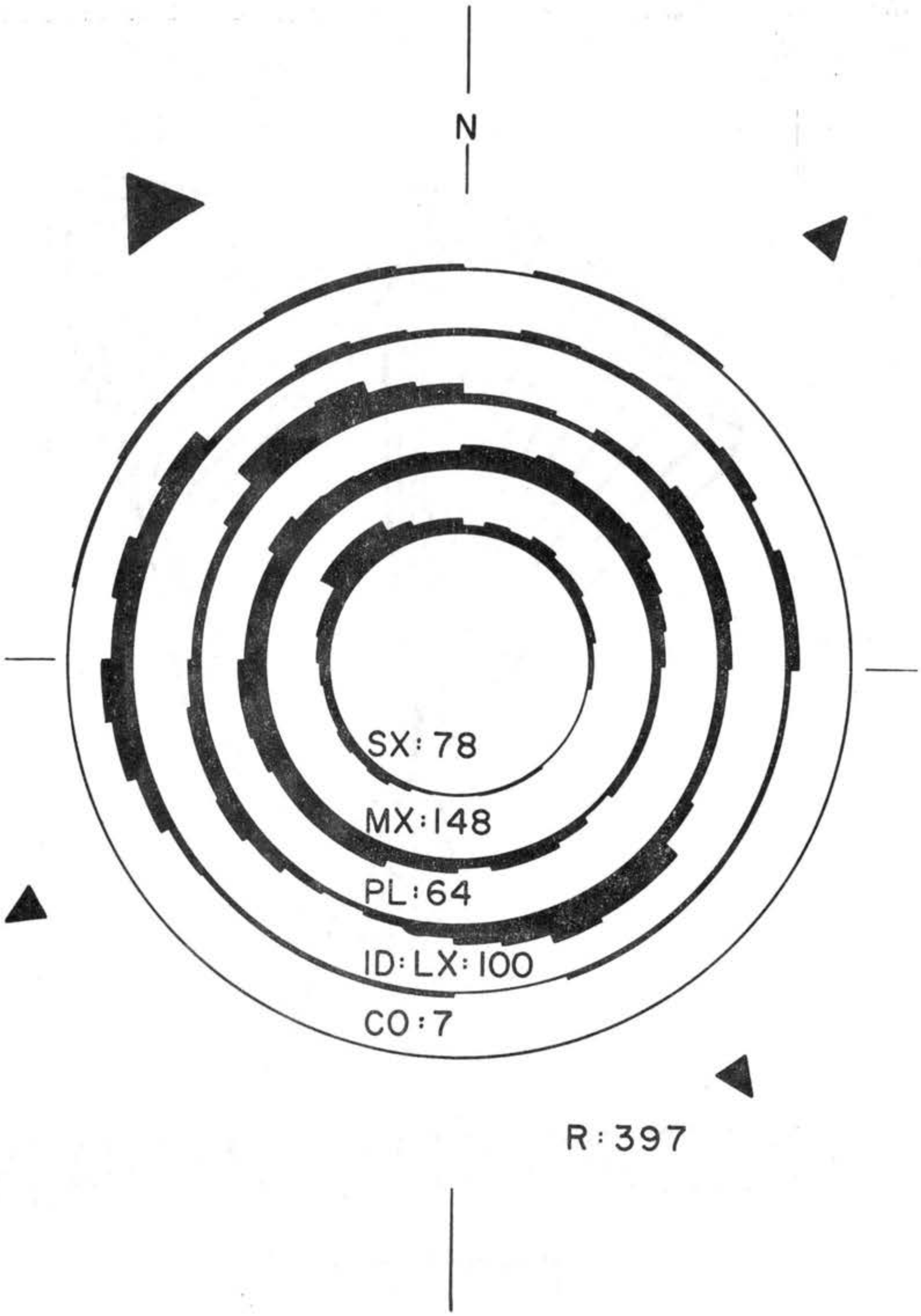

Fig. 14.-Composite paleocurrent diagram of Wellington sandstones of western Payne County, showing an average major direction of N35°W with secondary directions of N40°E, S35°E, and S60°W. Key for symbols is in Figure 11.

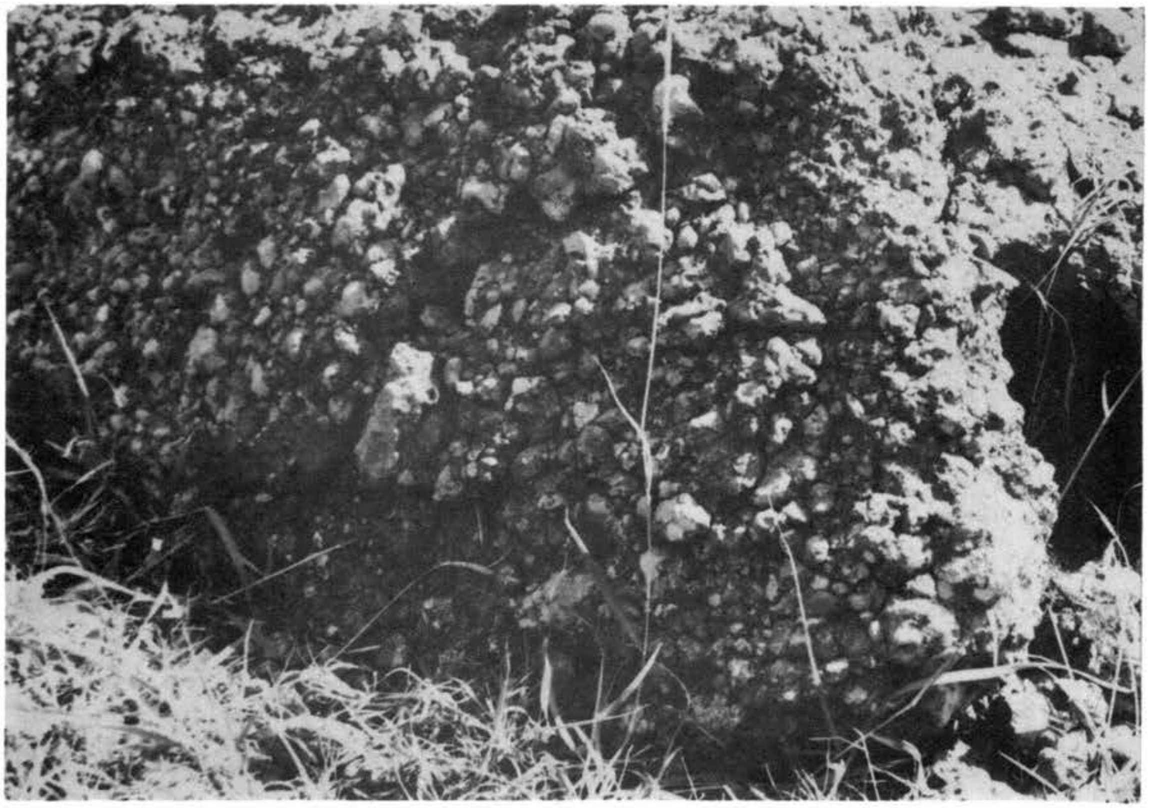

Fig. 15.-Carbonate, clay-pebble conglomerate in upper unit of Wellington Formation, in Sec. 23, T18N, R1W. Width of photograph is 3 ft.

Fig. 16.-Clay-pebble conglomerate (CP) in upper unit of Wellington Formation, with carbonate (C) coating many pebbles. Location is Sec. 9, T18N, R1W.

medium- to very fine-grained. In the field most of the sandstones are friable as a result of limited cementation. Varying amounts of reddish stain are present in most sandstones, although some are white to tan. Green siltstone has been observed at the base of several sandstone units. The color is probably the result of reduction of the iron oxide and/or the presence of chlorite as a clay mineral.

Pw-200 and Pw-600 are considered typical Wellington sandstones. Both sandstones are well sorted. The average grain size of the former is 0.15 mm and the grains are dominantly subangular, with angularity ranging from subrounded to angular (Fig. 17). Concavo-convex, line, and point contacts are present. Many grains are coated by hydrous iron oxide. The rock is classified as a feldspar-rich subarkose; it contains approximately 70 percent quartz, 25 percent feldspar, 3 percent muscovite and sericite, 1 percent hematite, and a trace of carbonate. Average grain size of Pw-600 is 0.09 mm; grains are generally subangular; and contacts are concavo-convex, line, and point. It is a quartz-rich subarkose composed of 93 percent quartz, 3 percent feldspar, 2 percent hematite, 1 percent carbonate, and less than 1 percent muscovite and sericite (Fig. 18). The matrix is of clay and iron oxide.

Carbonates

Lenses of nodular dolomite (Fig. 19) and dolomitic nodules within mudrock are the main types of occurrences of carbonate in the area. Carbonate minerals are also present as pebbles in conglomerates, cement in sandstone, and fossil fragments. A petrographic study of nodular dolomite Pw-620 indicates that it is a grain-supported, muddy carbonate (a packstone). The supporting grains are pellet-like and average 0.15

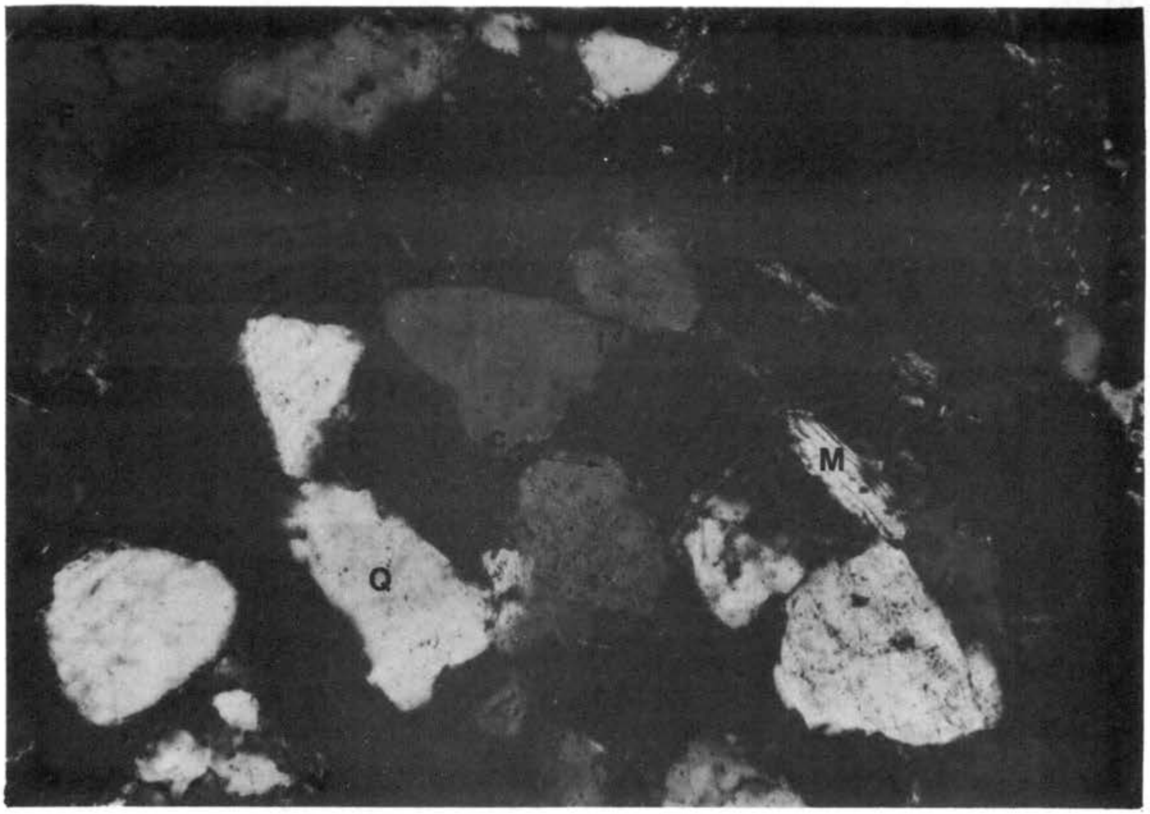

Fig. 17.-Photomicrograph of Pw-200 with quartz (Q), feldspar (F), muscovite (M), and hydrous iron oxide rimming many grains. Concavo-convex (c) and line (l) contacts indicate close packing of grains, which are dominantly subangular. Crossed nicols. Width of photograph is 0.90 mm.

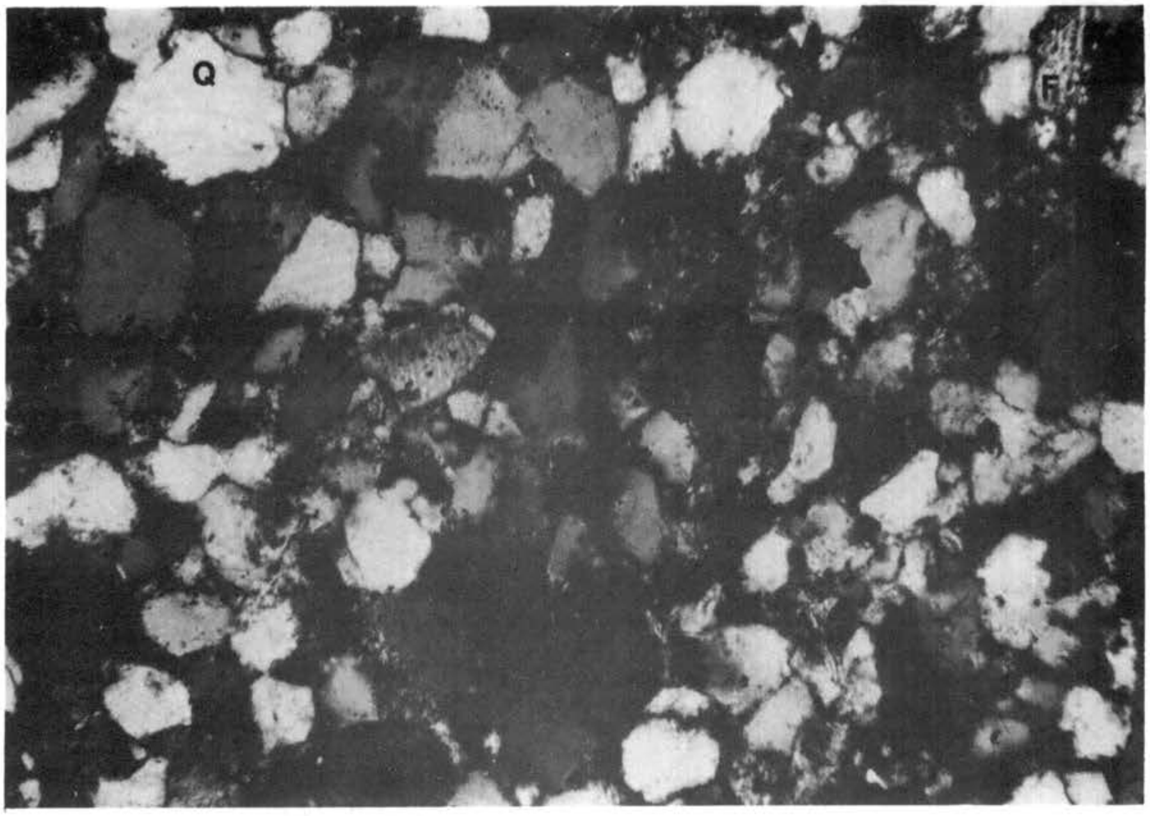

Fig. 18.-Photomicrograph of Pw-600 with quartz (Q), feldspar (F), and occasional muscovite and sericite. The average grain is subangular and contacts range from point to concavo-convex. Crossed nicols. Width of photograph is 0.90 mm.

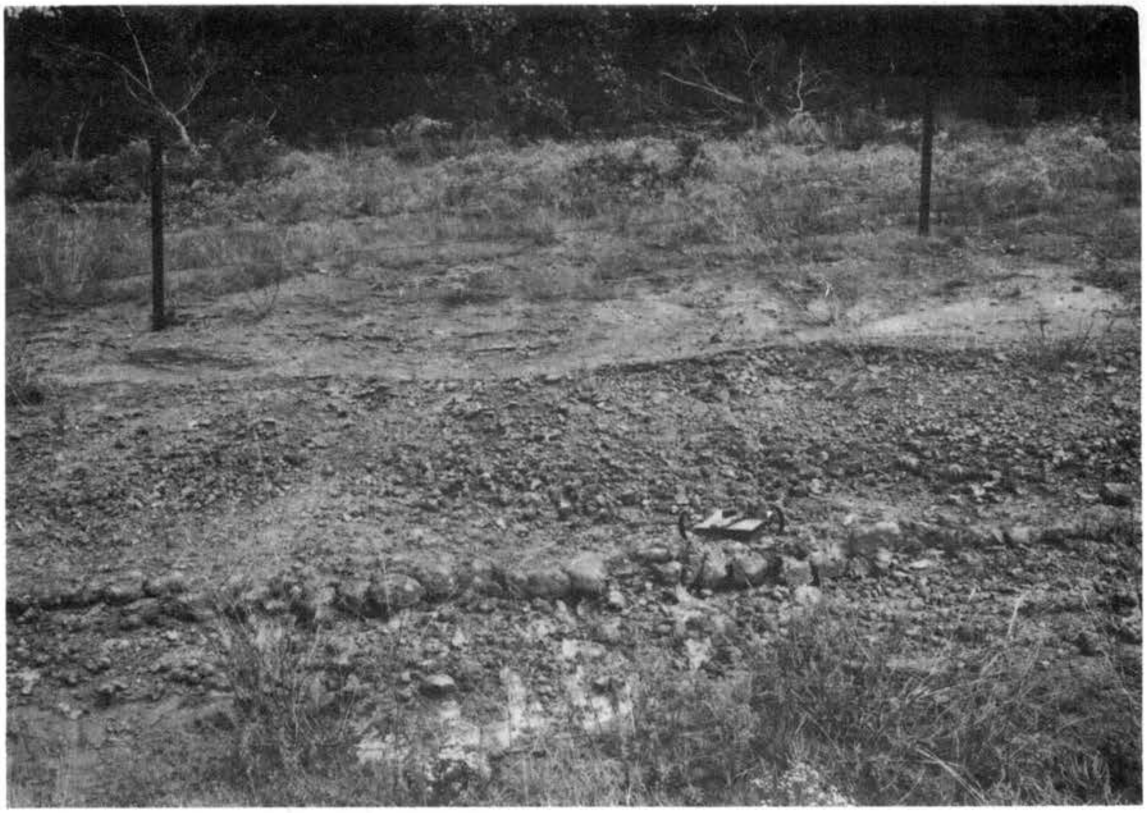

Fig. 19.-One of 2 beds of nodular dolomite in the upper unit of Wellington Formation in Secs. 1 and 13, T18N, R1W. Hammer and notebook for scale.

mm in diameter. Many of the pellets have a thin accretionary rim. The mud includes iron-oxide-stained clay, or micrite, and silt-sized quartz grains. Secondary sparry calcite is also present as veinlet and vug linings (Fig. 20). One vug containing secondary kaolinite was noted.

Depositional Framework of Surface Rocks

The average environmental conditions were those of a delta. The lenticular sandstones are thought to represent regressive deposits in distributary and tidal channels. Sandstones with gradational bases and horizontal interbeds are believed to represent delta fringe. Mudrock is thought to have been deposited in interdistributary bays and on tidal flats. During maximum regression mud may have been deposited in flood basins. Tidal-flat conditions are suggested by the thin nodular dolomites. Each dolomite is thought to represent supratidal conditions during a minor transgression, with seasonal and storm tides supplying water for deposition. The northwesterly trend of paleocurrents suggests a northeasterly depositional strike (Fig. 14). The general climate during the deposition of the red beds was probably arid (Walker, 1967).

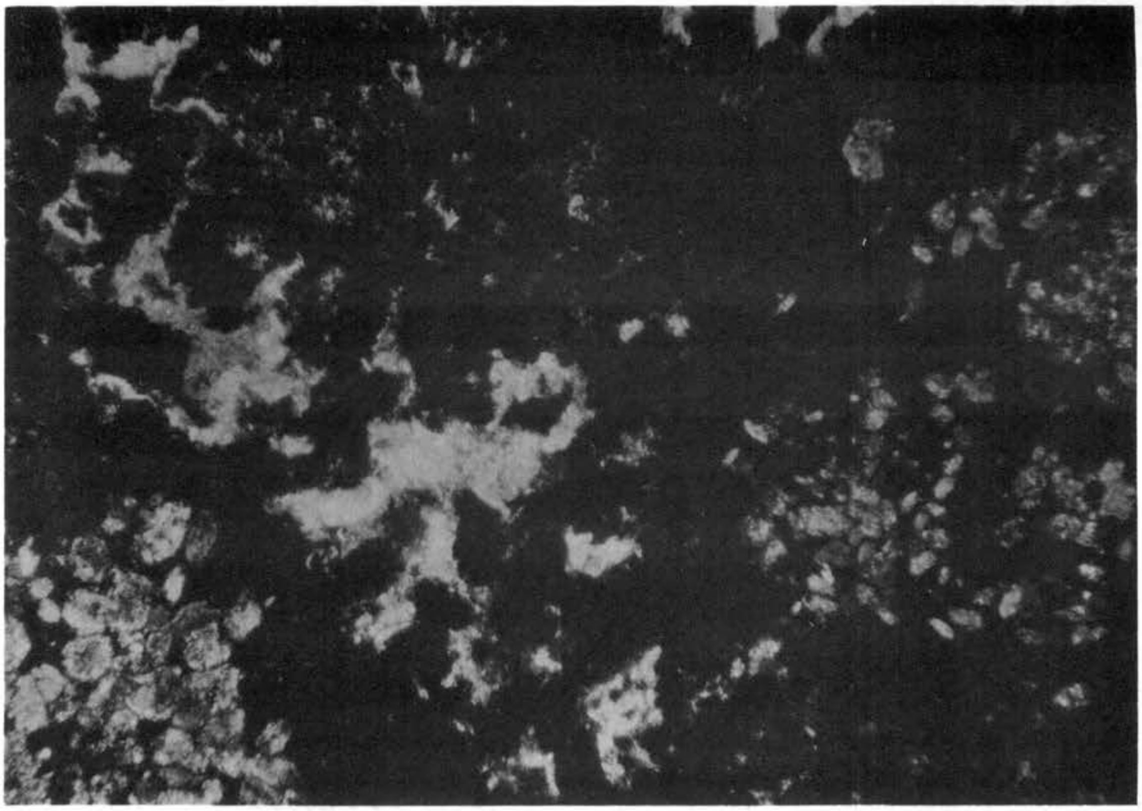

Fig. 20.-Photomicrograph of nodular dolomite Pw-620 with pellet-like grains, patches of mud (dark), and secondary carbonate calcite filling veinlets and vugs (clear). Crossed nicols. Width of photograph is 0.90 mm.

CHAPTER VII

ECONOMIC GEOLOGY

Mineral resources of economic importance in western Payne County consist of petroleum, ground water, and construction material for local uses. Presently uneconomical ore deposits of copper, silver, gold, and uranium occur in central Payne County; however, no deposits have been noted in the area of study.

Petroleum

Since the discovery of oil in 1926 in western Payne County, 45 million bbl of oil and 683 million cu ft of gas have been produced (International Oil Scouts Assoc., 1971). Although petroleum production is from various fields throughout the study area, almost 46 percent of the total has been from Ramsey oil field. Production from Stillwater field accounts for 12 percent of the total, and Orlando field has contributed a similar amount.

Major reservoirs of western Payne County are primarily of lenticular Pennsylvanian and Ordovician Simpson sandstones. Relatively minor production has been from Devonian and Mississippian reservoirs.

Construction Materials

Sandstones of western Payne County have been used locally as building stone, but they are considered to be too friable for modern construction purposes. However, Pw-680 was quarried in Sec. 17, T19N, R1W, for subbase material for Interstate Highway 35 (Fig. 2). Locally in western Payne County nodular dolomite is used as a road metal for county roads. The mudstone throughout the study area may be suitable for brick (Snider, 1911; Gould, 1911). It is likely, however, that poor response to high temperature limits its use as material for lightweight aggregate (Burwell, 1954). Abundant sand, present on the floodplain and terraces of the Cimarron River, with small amounts of gravel, is available for use as subbase material and in fills, asphalt, concrete, and masonry work. Basically, the material of the terraces is used for fill and in asphalt. The sand pits in both the terrace deposits near Perkins and high-level terrace deposits in Sec. 4, T18N, R1W, are intermittently in operation (Fig. 2). The sand from the floodplain is class A and masonry grade. A slurry operation, southwest of Perkins, which produces approximately 50,000 tons annually, supplies local concrete plants and masonry contractors (Ross, 1972; Fig. 2).

Ground Water

Ground water at shallow depths is locally plentiful in terrace and floodplain deposits of the Cimarron River. Some 443 electric logs of wells drilled for oil and gas were used in preparing a preliminary map showing depth of base of fresh water in the study area. Where the sandstones of the surface rocks are locally well developed as in T18N, R1 and 2E, an excellent source of potable water is available (Fig. 21). Another local area where the depth of fresh water units is greater than 150 ft is north of Stillwater. Other areas of significant potable water may be present but are not noted because of sparsity of useful data. The distribution of ground water is thought to reflect sandstone development primarily and topography and saline influent from the Cimarron River secondarily.

Engineering Properties of Soils

Hayes *et al*. (1967) have compiled the highway engineering characteristics of the soils of Oklahoma, including Payne County. The grain size and various soil "constants," which are liquid limit, plastic index, shrinkage limit, and subgrade suitability are used in describing major soil associations in western Payne County. Liquid limit is the moisture content, in percent related to a dried sample, at which a soil goes from a plastic to a liquid state. The lower the percentage the better a soil is suited for subgrade material. Plastic limit is the moisture content, in percent of oven-dry soil at which the soil changes from a semisolid state to a plastic state. The lower the percentage, the more favorable the soil. The plastic index is the numerical difference between liquid limit and plastic limit. The symbol NP indicates that a soil is nonplastic. Shrinkage limit is the moisture content, in percent of oven-dry soil at which a wet soil will not experience further shrinkage. A larger percentage is generally considered more favorable than a lower percentage. Suitability categorizes the soil as to its qualities for a subgrade material in highway construction. The soil constants, particle size, and subgrade suitability of the soils in western Payne County, tabulated by Hayes, *et al*. (1967), are given in Table I.

TABLE I

HIGHWAY ENGINEERING CHARACTERISTICS OF SOIL SERIES*

Soil Series & Horizons by County	Sieve Analysis (% Passing)				Particle Sizes			Soil Constants			Subgrade Suitability		
	No.10	No.40	No.60	No.200	%Sand	%Silt	%Clay	Liquid Limit	Plastic Index	Shrinkage Limit	Good	Fair	Poor
Kirkland													
A	100	100	98	81	34	46	20	29	9	17	X		
B	100	100	100	88	19	39	42	51	26	10			X
Zaneis													
A	100	99	98	73	41	39	20	36	12	17	X		
B	100	100	99	85	27	34	39	46	21	12			X
C	100	100	99	85	38	34	28	39	19	15	X		
Vernon													
A	100	99	99	93	16	49	35	41	19	11	X		
B	100	99	99	97	7	34	59	62	31	18			X
Lucien													
A	100	95	99	51	52	34	14	25	5	17	X		
AC	100	100	99	64	53	33	14	26	6	17	X		
C	100	99	99	41	69	19	12	22	2	17	X		
Dougherty													
A	100	98	74	19	91	7	2	NP	NP	-	X		
B	100	99	88	34	69	4	27	33	15	17	X		
C	100	99	72	13	90	3	7	NP	NP	-	X		
Teller													
A	100	99	81	45	69	22	9	NP	NP	-	X		
B	100	98	88	58	56	21	23	29	12	13	X		
C	100	99	95	69	53	26	21	32	12	17	X		
Vanoss													
A	100	99	91	65				19	4	-	X		
B	100	97	79	65				33	13	29		X	
C	100	98	81	42				24	7	-	X		
Yahola													
A	100	100	99	64	62	30	38	NP	NP	-	X		
C	100	97	67	14	14	5	2	NP	NP	-	X		
Port													
A	100	100	99	81	38	45	27	26	7	-	X		
C	100	100	99	52	63	17	10	NP	NP	-	X		

* After Hayes <u>et al</u>. (1967).

Kirkland-Zaneis Association

The Kirkland and Zaneis association is brown well developed soils which formed on Permian red beds present on the Central Redbed Plains type of topography. The Kirkland series formed on claystone. It has 2 distinct horizons, with the A horizon rated good for subgrade material, and the B horizon poor for subgrade material.

The Zaneis series is a well developed soil on sandstone. It has 3 distinct horizons. The A and C horizons are good subgrade material, but the B horizon is rated a poor subgrade material.

Vernon-Lucien Association

The Vernon-Lucien association are red poorly developed soils on the Permian red beds present on the Central Redbeds Plains type of topography. The Vernon series which formed on claystone, has 2 horizons. The A horizon is considered a good subgrade material, whereas the C horizon is rated a poor subgrade material.

The Lucien series is a poorly developed soil on sandstone. Between the A horizon and the C horizon is an intermediate AC horizon, and all 3 horizons are rated good for subgrade material.

Dougherty-Teller-Vanoss Association

The Dougherty-Teller-Vanoss association soils are developed on the terrace and eolian deposits along the Cimarron River. The Dougherty series has 3 horizons, which are all good subgrade material. The Teller series also has 3 horizons which are considered good subgrade material. The Vanoss series has 3 horizons, with 2 of them considered as good subgrade material. The B horizon, however, is only fair subgrade material.

Yahola-Port Association

The Yahola-Port association soils are found on the floodplain along the Cimarron River and its tributaries in western Payne County. The Yahola series is found along the Cimarron River. It has 2 horizons, and they are good subgrade material. The Port series is developed on the major tributaries of the Cimarron River. It has 2 horizons which are rated good for subgrade suitability.

CHAPTER VIII

SUMMARY

The principal conclusions resulting from this study are as follows:

1. The study area contains red beds of the Leonardian Wellington Formation, about 780 ft thick.
2. The stratigraphic section is represented by a sequence of lenticular sandstone, mudrock, and nodular dolomite.
3. The various sandstone sequences in the section exist as genetic units from less than 2 ft to as much as 25 ft thick and, in some cases, multilateral and multistoried complexes with a maximum thickness of 80 ft. The sandstone bodies are characterized by undulatory bases, medium-scale cross-bedding, initial dip, small-scale cross-bedding, parting lineation, and cut-out. However, in the lower part of the section a few of the sandstones have gradational bases. Locally trails and burrows are present, as well as fossil fragments.
4. The grain size of the sandstone units ranges from medium- to very fine-grained. The sandstones are moderate to well sorted, subangular to subrounded, feldspar-rich subarkose to quartz-rich subarkose.
5. The nodular dolomites are dismicrites and packstones.
6. The major paleocurrent trend is about N35°W. A tide-dominated delta characterizes the Wellington interval. The source areas

are the Ouachita, Arbuckle, and Wichita Mountains in southern Oklahoma.

7. The area is characterized by homoclinal dip to the west at 40 to 60 ft/mi. Subtle structural noses, with local dip as much as 100 ft/mi, increase in size and intensity with depth. The local structures, which are less than 1 sq mi in areal extent, combine to form complexes several times that size.

8. Two joint sets strike N55°E and N45°W respectively; these directions are similar to those of sets in central Payne County. The northwesterly direction is sub-parallel to the en echelon fault zone in eastern Payne County and Creek County.

9. Petroleum is the major mineral resource. Some sandstone can be used locally as road subbase material; nodular dolomite is used locally as a county road base material; mudrock may be a source material for brick; and sand is used for fill, asphalt, masonry, and concrete. Potable ground water is best developed in irregularly distributed sandstones and in terrace and flood-plain sands of the Cimarron River. Distribution of fresh water reflects local sandstone development, topography, and saline influent from the Cimarron River.

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APPENDIX

MEASURED STRATIGRAPHIC SECTIONS

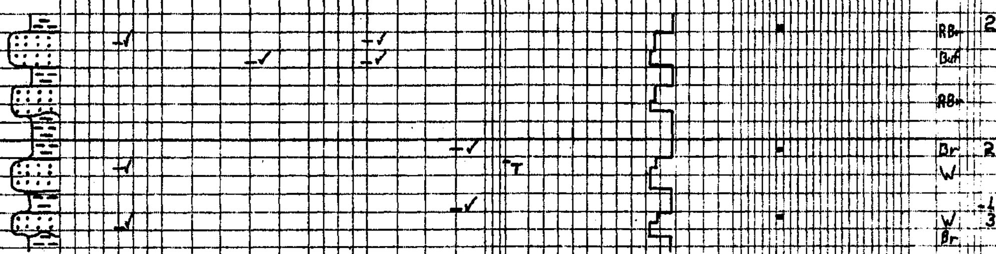
SE SW Sec. 20 T.18N R. 2E Map Photo

Payne Co., Oklahoma Section No. 1

Area Structural Dip By A. J. Garden

Outcrop Pattern--Linear belt Formation Pw-140

FOOTAGE	ENVIRONMENT	DIRECTIONAL DATA	LITHOLOGY	LATERAL EXTENT	SEDIMENTARY STRUCTURES	TEXTURE	CONSTITUENTS	FAUNA	COLOR	POROSITY (%)	REFERENCE NUMBER	SAMPLE NUMBER



20

0

RF: N70E ID: N35W

N85E

Ref. No. 1) Cellular, nodular dolomite.

2) Nodular dolomite.

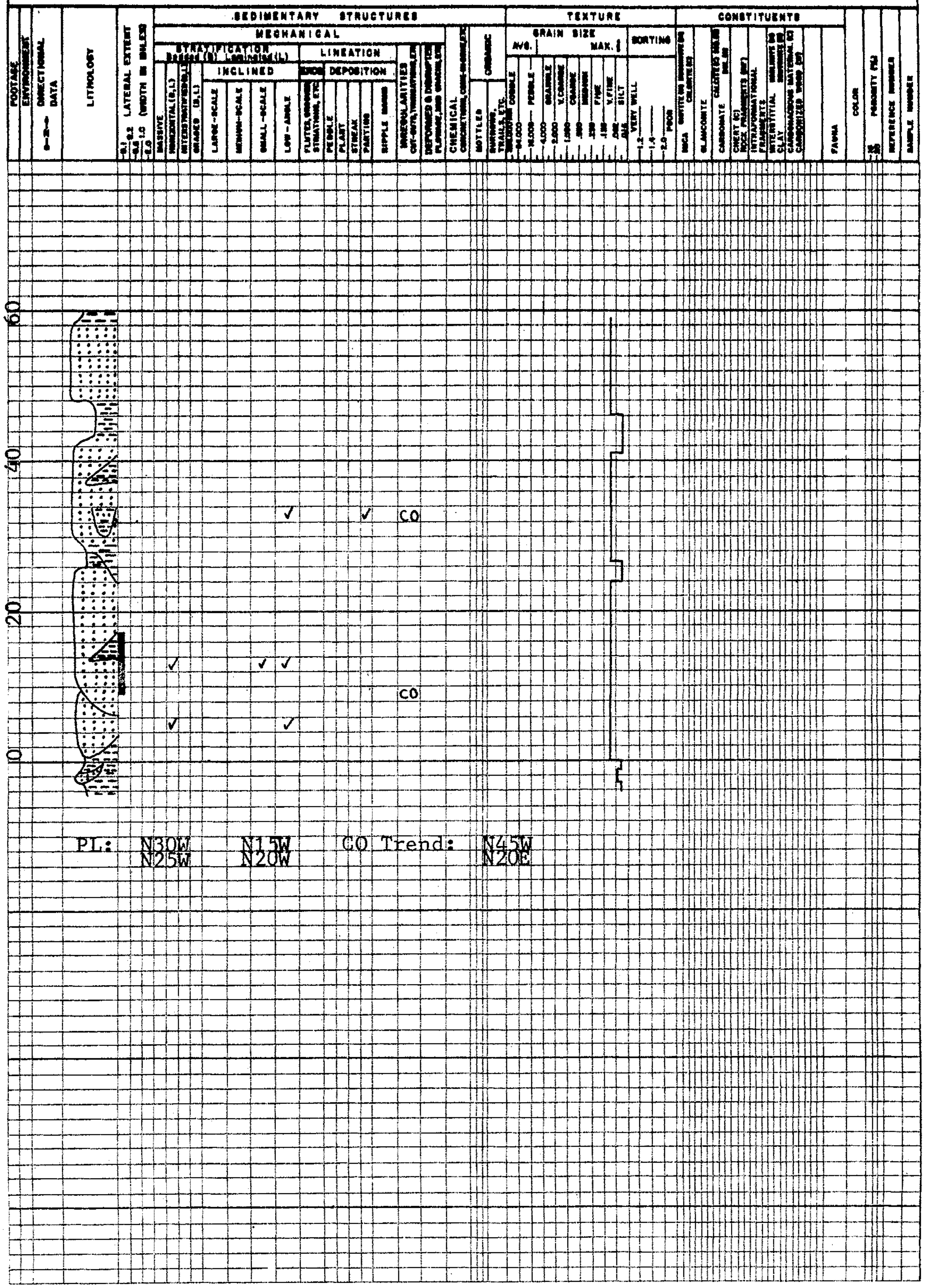
3) Dolomite veinlets in sandstone.

SE SE Sec. 20 T20N R. 2E Map ______ Photo ______

Payne Co., Oklahoma Section No. 2

Area ______ Structural Dip ______ By A. J. Garden and

Outcrop Pattern--Linear ______ belt ______ Formation Pw-200 J. W. Shelton

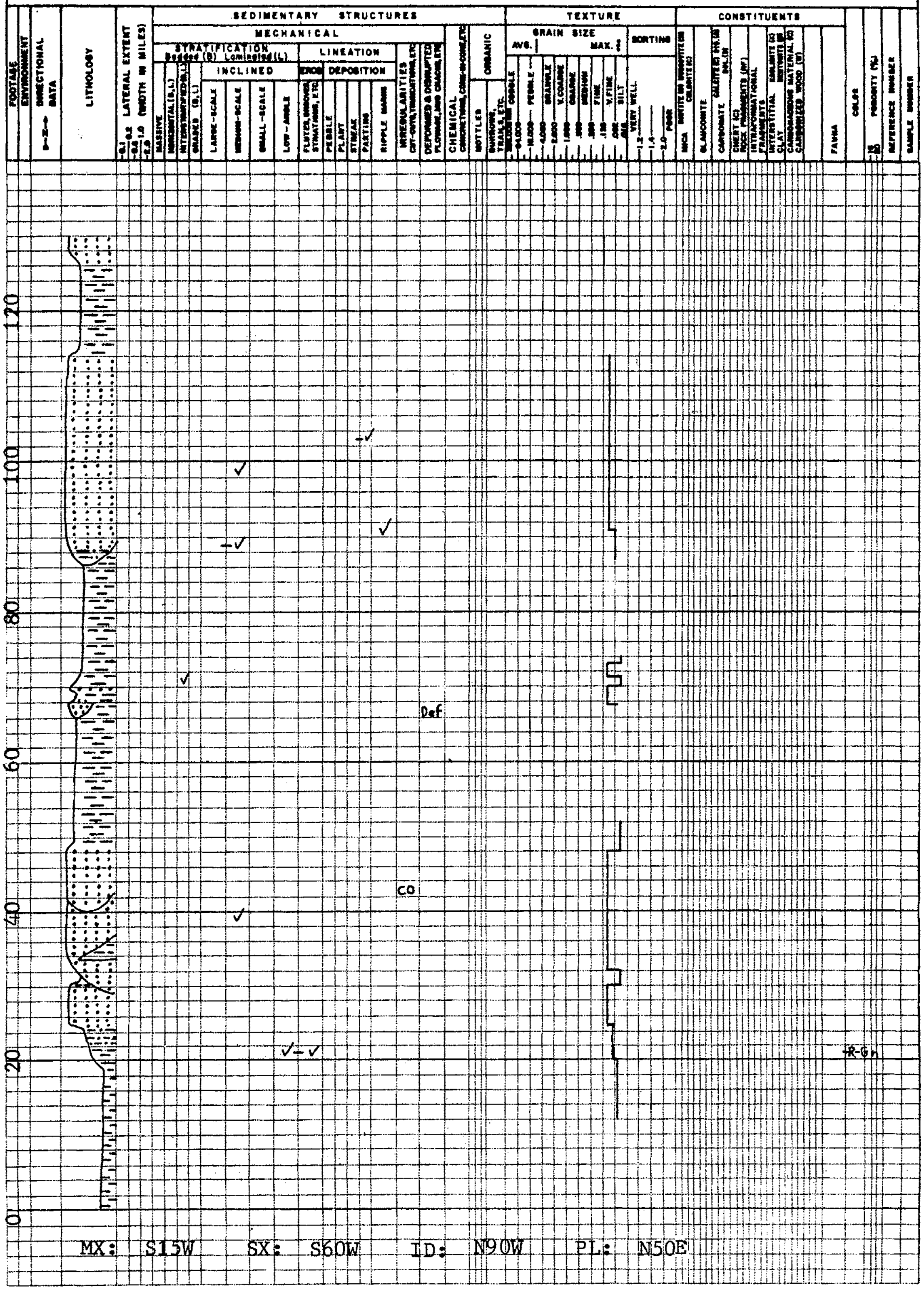


NW SW Sec. 32 T. 19N R. 2E Map ______ Photo ______

Payne Co., Oklahoma Section No. 3

Area ______ Structural Dip ______ By A. J. Garden and

Outcrop Pattern--Linear ______ belt ______ Formation Pw-200 J. W. Shelton

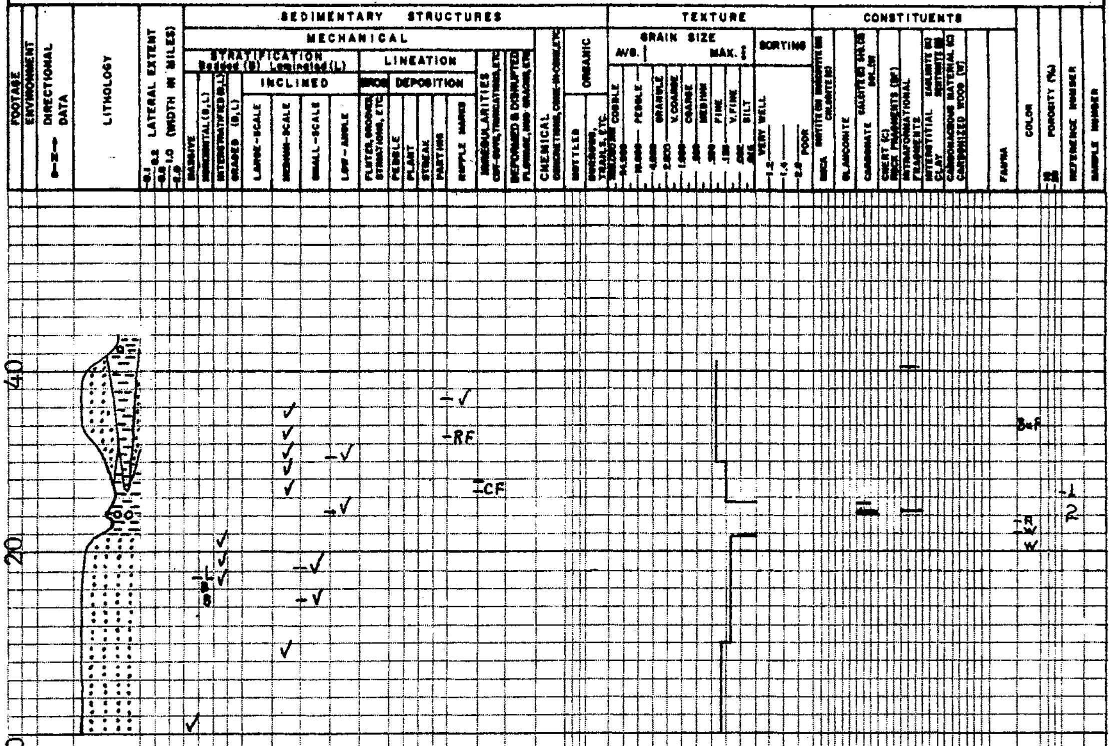


SW NW Sec. 9 T. 18N R. 2E Map ______ Photo ______

Payne Co., Oklahoma Section No. 4

Area ______ Structural Dip ______ By A. J. Garden and

Outcrop Pattern--Linear ______ belt ______ Formation Pw-200 J. W. Shelton



MX:	S75W	S45W	S60W	SX:	S65W	ID:	N25E	N45E
	S45W	S45W	S40W		S45W		N45E	
		S35W	S80W		S30W		N65W	
		S40W	N60W				N35W	
		S25W	S75W				S40E	

Ref. No. 1) Cut-and-fill with shale.

2) Carbonate, clay-pebble conglomerate.

SW SW Sec. 7 T. 18N R. 2E Map ______ Photo ______

Payne Co., Oklahoma Section No. 5

Area ______ Structural Dip ______ By A. J. Garden and

Outcrop Pattern--Linear ______ belt ______ Formation Pw-280 J. W. Shelton

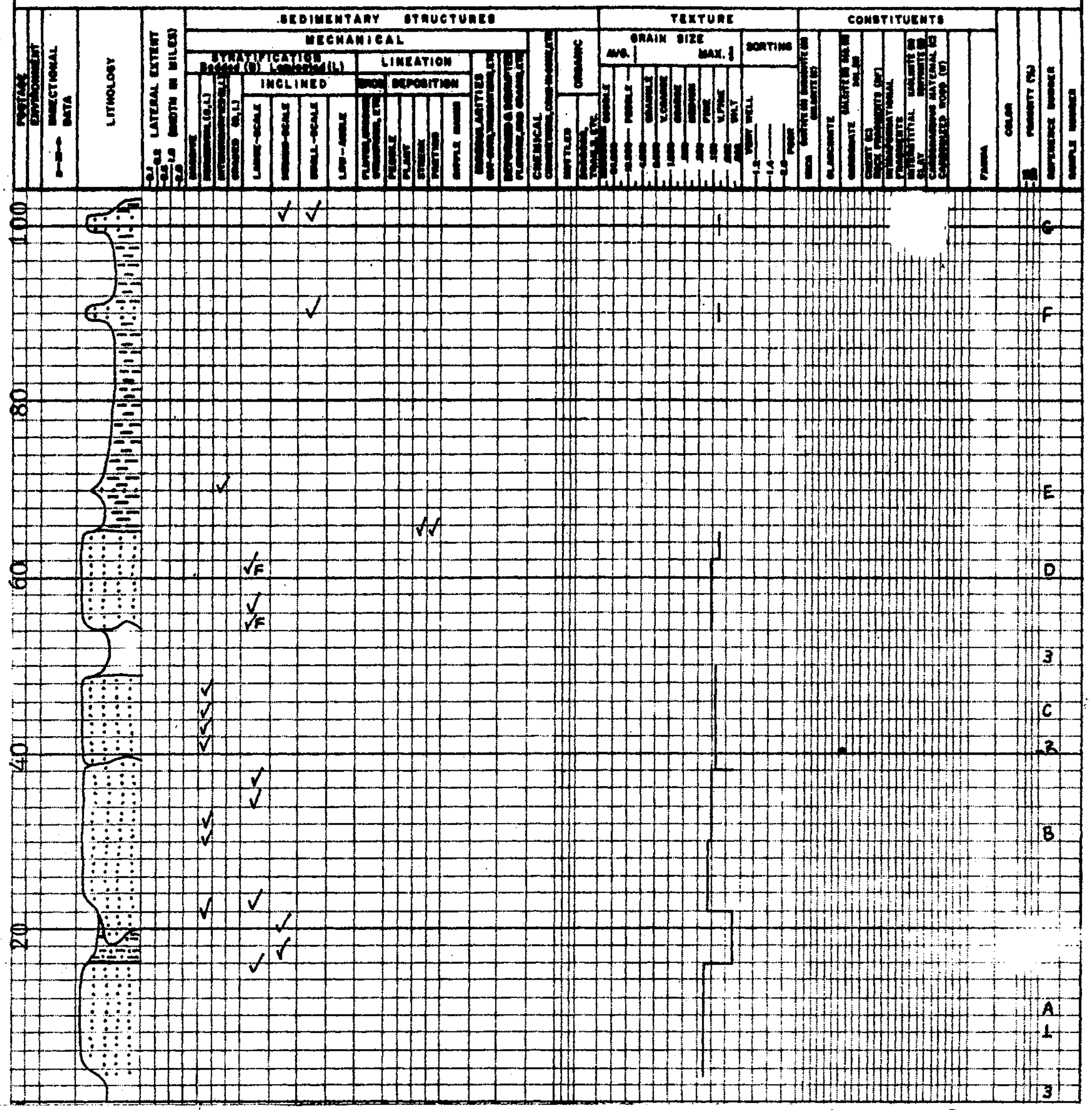
FOOTAGE | ENVIRONMENT | DIRECTIONAL DATA | LITHOLOGY | LATERAL EXTENT | SEDIMENTARY STRUCTURES: MECHANICAL (STRATIFICATION, INCLINED, LINEATION), CHEMICAL, ORGANIC | TEXTURE: GRAIN SIZE, SORTING | CONSTITUENTS | FAUNA | COLOR | POROSITY (%) | REFERENCE NUMBER | SAMPLE NUMBER

20 — √, −√, −RF-CF; −√; −√ CF; −B; √ CF; √ CF; √; L √ CF; L −√ — Color: R, Br

0

ID: N25W, N65W, N85W, N55W, S25W MX: S25E, S20E SX: S25E

NE NE Sec 23 T. 17N R. 1E Map Photo
Payne Co., Oklahoma Section No. 6
Area Structural Dip By A. J. Garden and
Outcrop Pattern - - Linear belt Formation Pw-240 - 320 J.W. Shelton



	A	A	B		A		A	G
MX:	N50W N25W N55W N10W	N20W N55W N50W N50W	N10E N80E	ID:	N90W N70W	SX:	N85W N90W	N85W N50W N90W

	D	D	D		D	G
PL:	N75E N70E	N85E N65E	N70E N70E	FMX:	N35E N45E N55E	N75W

Ref. No. 1) Springs and seeps from lowermost sandstone.
2) Fe_2O_3 stains.
3) Mostly covered.

NW NE Sec. 3 T19N R. 1E Map ______ Photo ______

Payne Co. Oklahoma Section No. 7

Area ______ Structural Dip ______ By J. W. Shelton and

Outcrop Pattern--Linear ______ belt ______ Formation Pw-380 A. J. Garden

SEDIMENTARY STRUCTURES — MECHANICAL — STRATIFICATION — LINEATION — INCLINED — DEPOSITION — CHEMICAL — ORGANIC — TEXTURE — GRAIN SIZE — SORTING — CONSTITUENTS — LITHOLOGY — FAUNA — COLOR — POROSITY (%) — REFERENCE NUMBER — SAMPLE NUMBER

MX: N15W, N30W, S80W, N75E, N70W, N35W, S50W

ID: S85E, N90W, S60W, N60E, S85E, N90W, N90W

SX: N35W, S80W, N90W

RF: N20W, N15W

PL: S60W

CO Trend: N30E, N45E, S65W, N90W

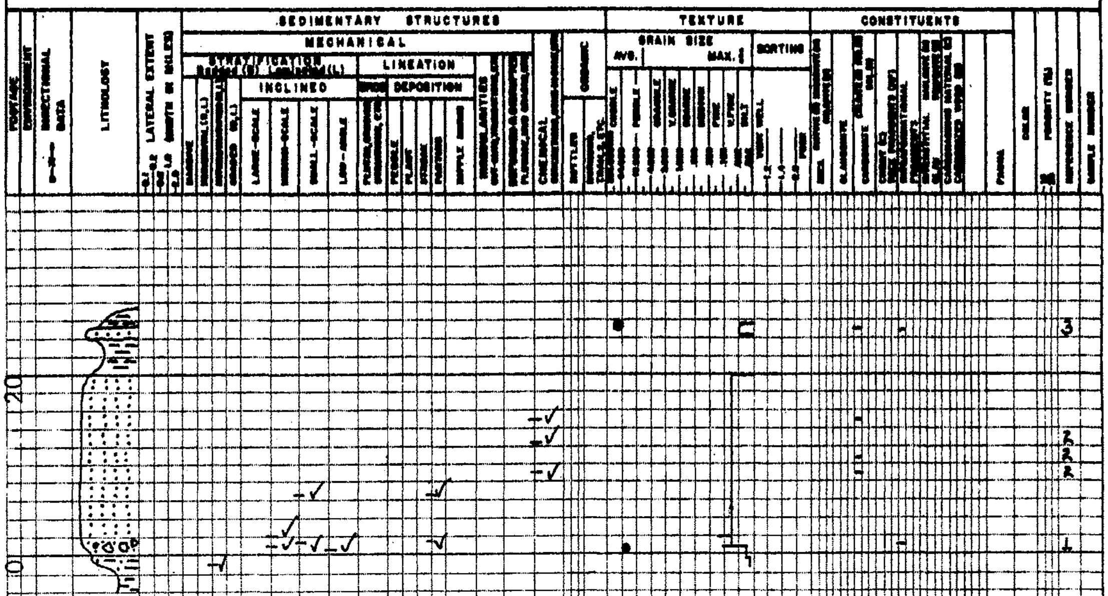
Ref. No. 1) Mostly covered at top of hill.

SW SE Sec. 35 T 19N R. 1E Map ______ Photo ______

Payne Co., Oklahoma Section No. 8

Area ______ Structural Dip ______ By A. J. Garden

Outcrop Pattern--Linear ______ belt ______ Formation Pw-420



ID: S55W MX: S80W SX: S75W PL: S60W N90W

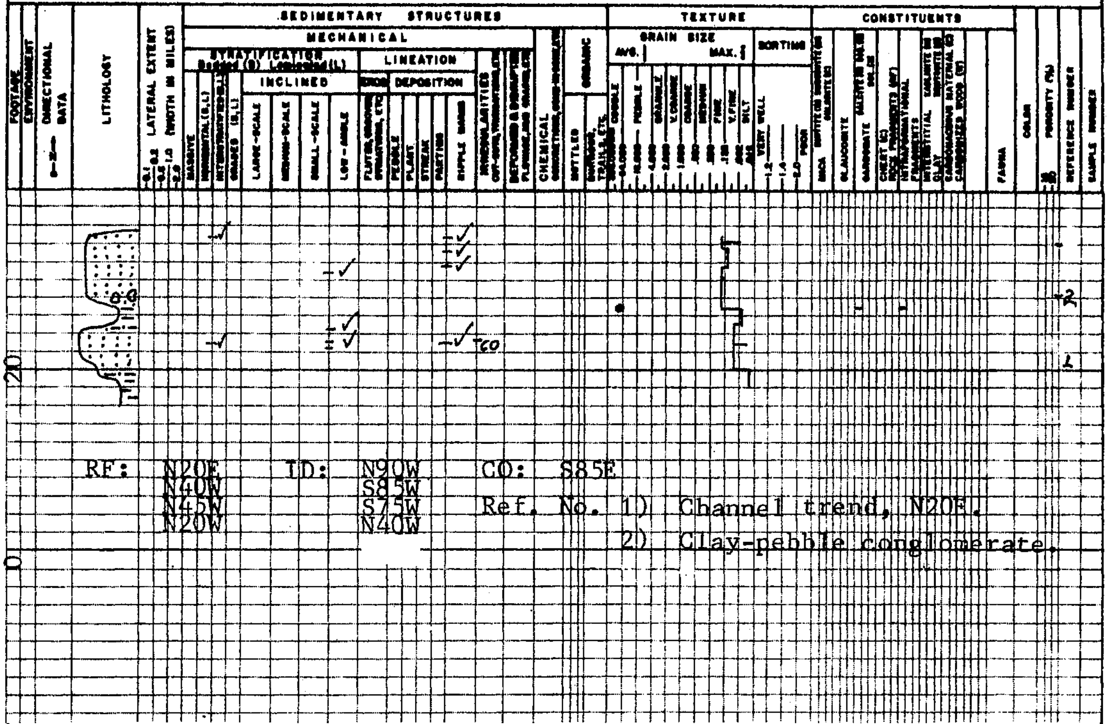
Ref. No. 1) Clay-pebble conglomerate at base; largest pebble 30mm with calcite.

2) Dolomite concretions in sandstone up to 100mm and as veins; calcite present.

3) Clay-pebble conglomerate in sandstone; largest pebble 75mm with calcite.

Note: Fe_2O_3 cemented sandstone blocks along section.

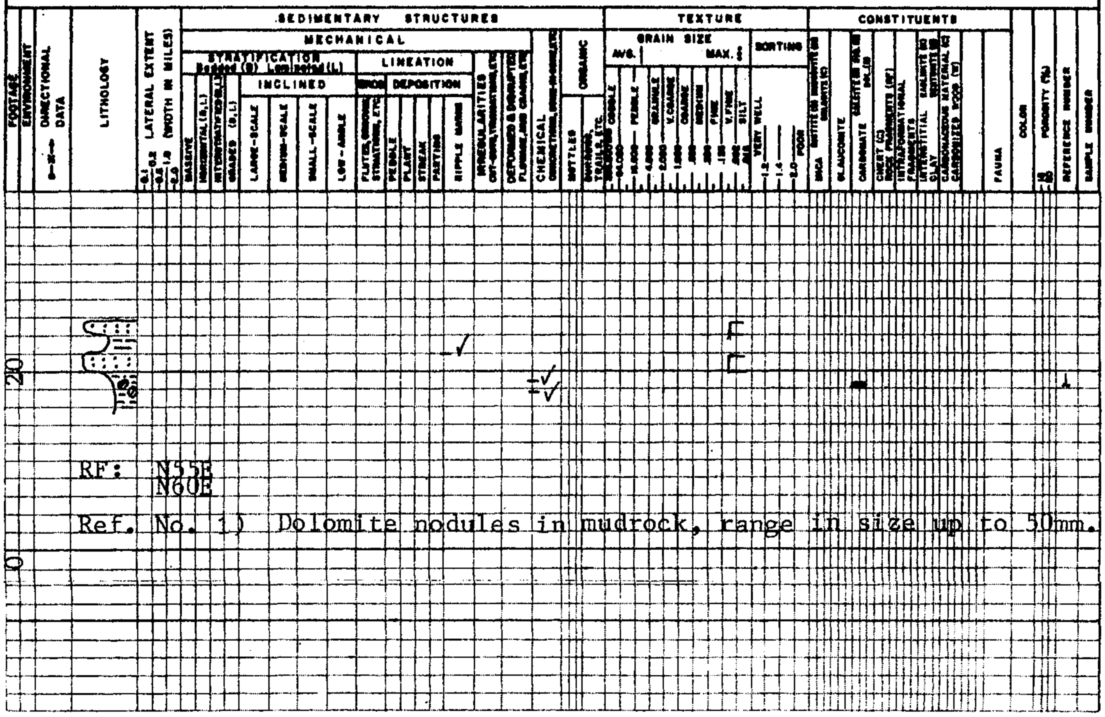
SE SE Sec. 34 T. 19N R. 1E Map ______ Photo ______
Payne Co. Oklahoma Section No. 9
Area ______ Structural Dip ______ By A. J. Garden and J. W. Shelton
Outcrop Pattern--Linear ______ belt ______ Formation Pw-460



RF: N20E, N40W, N45W, N20W
TD: N90W, S85W, S75W, N40W
CO: S85E

Ref. No. 1) Channel trend, N20E.
2) Clay-pebble conglomerate.

SE NE Sec. 10 T. 19N R. 1W Map ______ Photo ______
Payne Co. Oklahoma Section No. 10
Area ______ Structural Dip ______ By A. J. Garden
Outcrop Pattern--Linear ______ belt ______ Formation Pw-500



RF: N55E, N60E

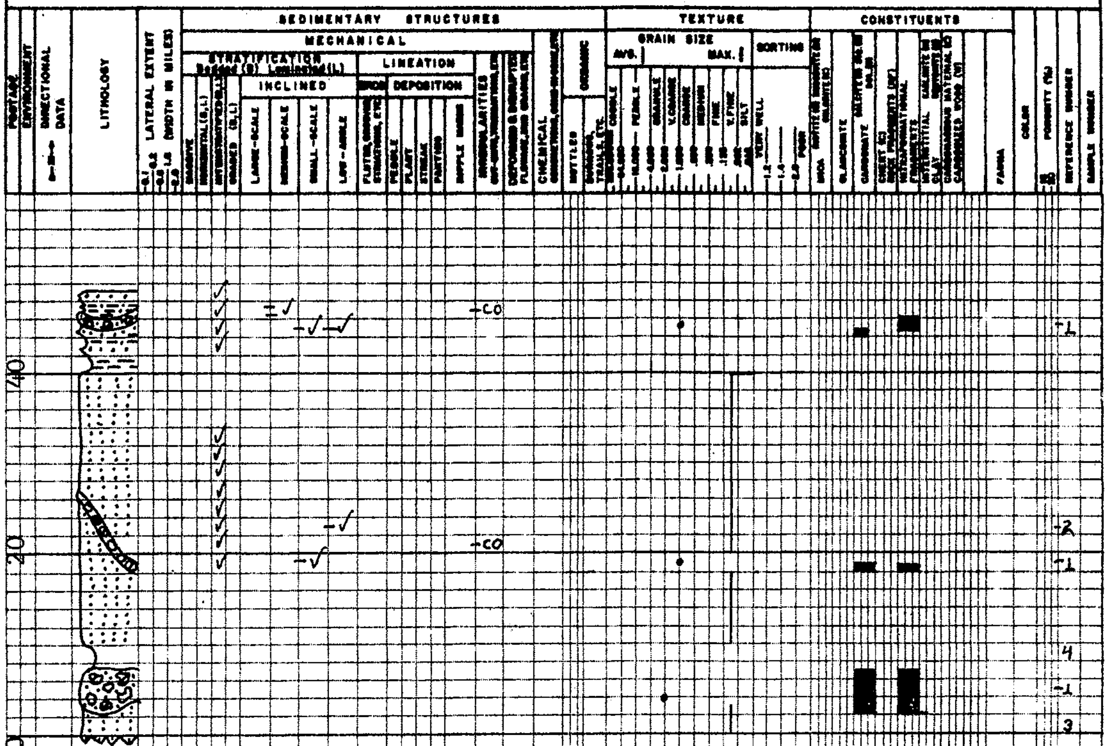
Ref. No. 1) Dolomite nodules in mudrock, range in size up to 50mm.

SE NE Sec. 31 T. 18N R. 1E Map ______ Photo ______

Payne Co., Oklahoma Section No. 11

Area ______ Structural Dip ______ By A. J. Garden and J. W. Shelton

Outcrop Pattern--Linear ______ belt ______ Formation Pw-500



ID: N05W N15E CO: S10W
N20E S05W N65W
N

Ref. No.
1) Dolomite, clay-pebble conglomerate.
2) ID or LX.
3) Base of sandstone questionable.
4) Mostly covered.

SE SE Sec. 17 T. 18N R. 1E Map ______ Photo ______

Payne Co., Oklahoma Section No. 12

Area ______ Structural Dip ______ By A. J. Garden and

Outcrop Pattern--Linear ______ belt ______ Formation Pw-500 & 560 J.W. Shelton

	A	B		B		A	B
MX:	S85W	S70W	FMX:	S10W	ID:	N15W	N50W
	S30E	S60W		S20E		S10E	
	S65E	N65W		S15W		S25W	
	S70W			N20W			
	S80W			N			
	S85W			N60E			

PL: N30E, N15E, N25E

CO Trend: N70W

Ref. No. 1) Iron-oxide concretions replacing wood fragments.

2) Fossil fragments.

3) Dolomite-calcite conglomerate.

SW SW Sec. 2 T. 18N R. 1W Map ______ Photo ______
Payne Co., Oklahoma Section No. 13
Area ______ Structural Dip ______ By A. J. Garden and
Outcrop Pattern--Linear ______ belt ______ Formation Pw-580 J. W. Shelton

SEDIMENTARY STRUCTURES — MECHANICAL (STRATIFICATION, INCLINES, LINEATION); CHEMICAL; ORGANIC — TEXTURE (GRAIN SIZE, SORTING) — CONSTITUENTS — FAUNA — COLOR — POROSITY (%) — REFERENCE NUMBER — SAMPLE NUMBER

20

0

SX: N20W, S65W, S45W; N40W, S25W
MX: S50W, S75W, S70W; S25W, N15W; S55W, S60W

Ref. No. 1) Local iron-oxide stain at top of sandstone.

NE NW Sec. 15 T. 19N R. 1W Map ______ Photo ______
Payne Co., Oklahoma Section No. 14
Area ______ Structural Dip ______ By A. J. Garden
Outcrop Pattern--Linear ______ belt ______ Formation Pw-600

SEDIMENTARY STRUCTURES — MECHANICAL (STRATIFICATION, INCLINES, LINEATION); CHEMICAL; ORGANIC — TEXTURE (GRAIN SIZE, SORTING) — CONSTITUENTS — FAUNA — COLOR — POROSITY (%) — REFERENCE NUMBER — SAMPLE NUMBER

40

20

0

RB, Br, Gy+W

ID: S70W, S80W

Ref. No. 1) Mostly covered.

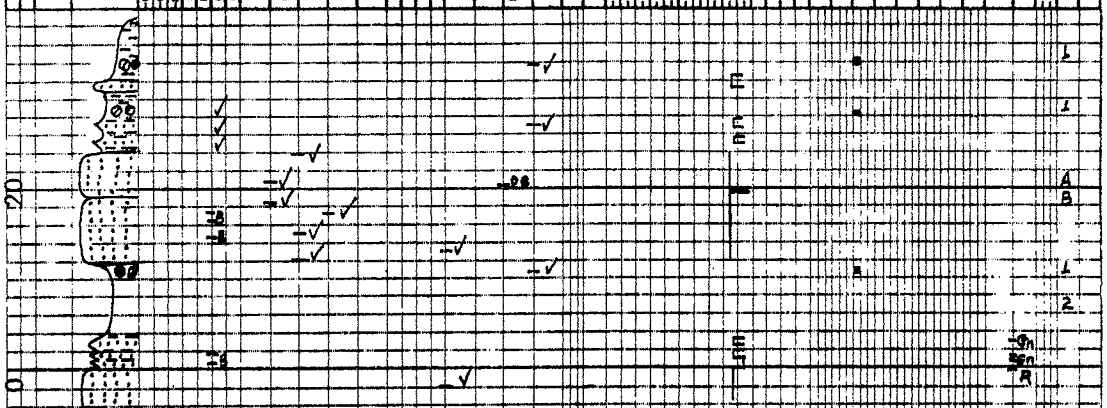
SW SE Sec. 5 T. 19N R. 1W Map Photo

Payne Co., Oklahoma Section No. 15

Area Structural Dip By A. J. Garden and J. W. Shelton

Outcrop Pattern--Linear belt Formation Pw-620

SEDIMENTARY STRUCTURES — MECHANICAL — TEXTURE — CONSTITUENTS



MX:

A	B
N75W	N85W
N65W	N70W
N45W	N85W
N50W	S30W
N65W	S10E
S75W	N90W

RF: N60W

Ref. No.

1) Dolomite nodules, ranging in size up to 100 mm, in mudrock.

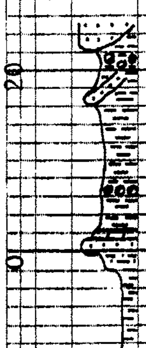
2) Mostly covered.

SE SE Sec. 5 T. 18N R. 1W Map ______ Photo ______

Payne Co., Oklahoma Section No. 16

Area ______ Structural Dip ______ By A. J. Garden and J. W. Shelton

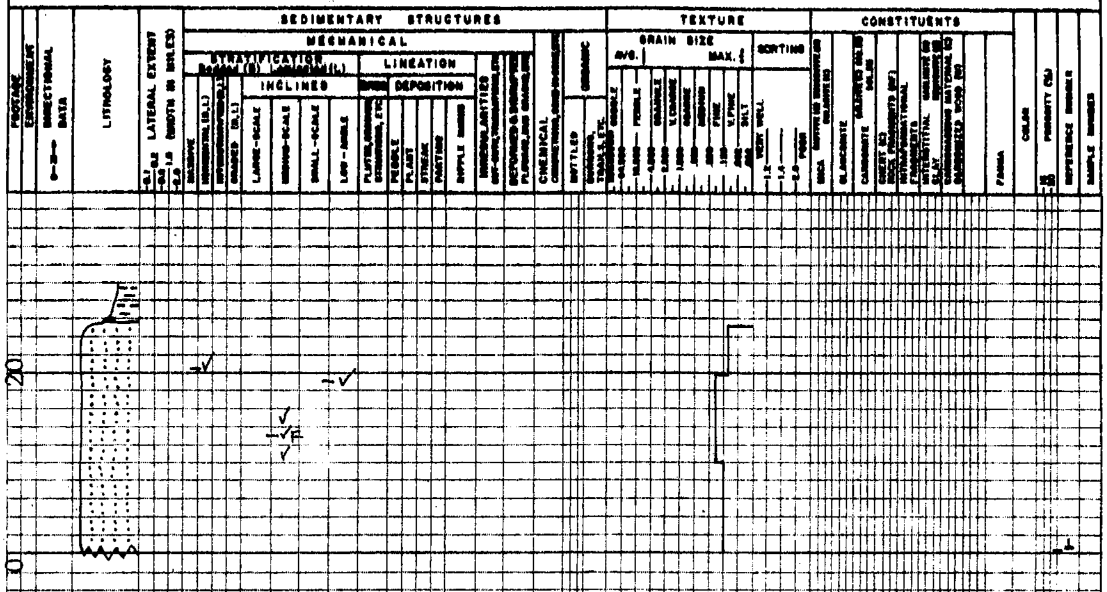
Outcrop Pattern--Linear ______ belt ______ Formation Pw-620



Ref. No. 1) Six-inch bed; possibly cut-out by sandstone channel.

2) Nodular dolomite bed.

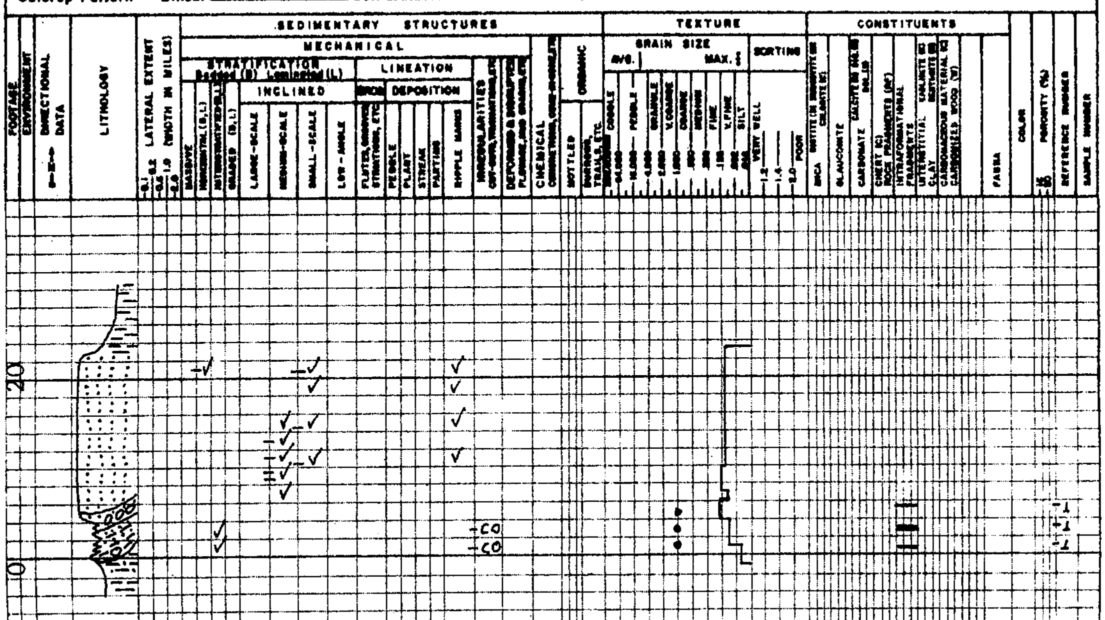
SW SW Sec. 4 T. 18N R. 1W Map Photo
Payne Co., Oklahoma Section No. 17
Area Structural Dip By A. J. Garden and
Outcrop Pattern--Linear belt Formation Pw-620 J. W. Shelton



MX: S70W
N60W
S60W
S65W

Ref. No. 1) Bottom of sandstone not seen.

NE NE Sec. 17 T. 18N R. 1W Map Photo
Payne Co., Oklahoma Section No. 18
Area Structural Dip By A. J. Garden
Outcrop Pattern--Linear belt Formation Pw-620



MX: N40E N10E
N40E N20E
N55E N05W
N55E N50E
N55E

SX: N45E
N25E
N10E

Ref. No. 1) Clay-pebble conglomerate with spring at top.

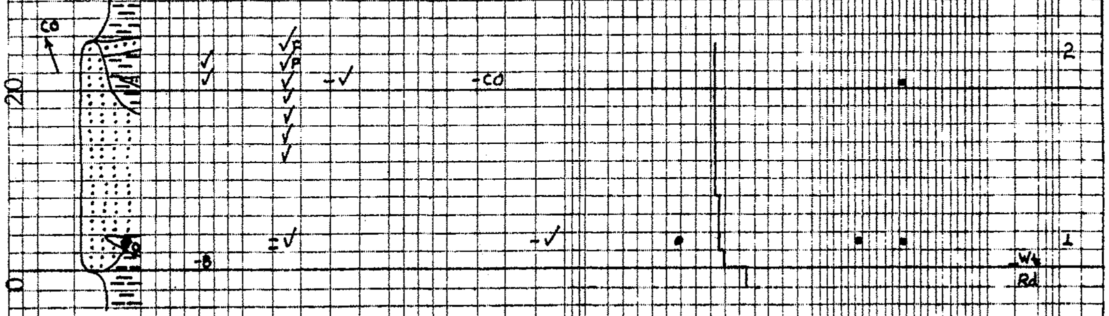
SW SE Sec. 17 T. 18N R. 1W Map ______ Photo ______

Payne Co., Oklahoma Section No. 19

Area ______ Structural Dip ______ By A. J. Garden and

Outcrop Pattern--Linear ______ belt ______ Formation Pw-640 J. W. Shelton

SEDIMENTARY STRUCTURES — MECHANICAL — STRATIFICATION — LINEATION — INCLINED — TEXTURE — GRAIN SIZE — SORTING — CONSTITUENTS — LITHOLOGY — DIRECTIONAL DATA — LATERAL EXTENT — CHEMICAL — ORGANIC — FAUNA — COLOR — POROSITY (%) — REFERENCE NUMBER — SAMPLE NUMBER



MX:	N50W	N30E	FMX: S10W	ID: S30W
	N40E	N20E	N85E	S55W
	N42W	S25E	S65E	
	N45W	N10E	N75E	
	S65E	N25E	N10E	
	N70E	S20W	N50E	
	N85E	N85E	N20W	
	N45E	N45E		

Ref. No. 1) Carbonate, clay- pebble conglomerate, base of sandstone at intersecting road.

2) FMX trends are NE to NW.

SE NE Sec. 17 T.18N R. 1W Map ____ Photo ____
Payne Co., Oklahoma Section No. 20
Area ____ Structural Dip ____ By A. J. Garden and
Outcrop Pattern--Linear ____ belt ____ Formation Pw-640 J. W. Shelton

FOOTAGE | ENVIRONMENT | DIRECTIONAL DATA | LITHOLOGY | LATERAL EXTENT | SEDIMENTARY STRUCTURES: MECHANICAL (STRATIFICATION, INCLINED, LINEATION, EROS., DEPOSITION), CHEMICAL, ORGANIC | TEXTURE: GRAIN SIZE, SORTING | CONSTITUENTS | FAUNA | COLOR | POROSITY (%) | REFERENCE NUMBER | SAMPLE NUMBER

F√
F√
F√

20

MX: N75W
N75W
S50E
N55E

FMX: N15W

~~Ref. No. 1) Probably not total thickness.~~

0

SW SW Sec. 5 T.19N R. 1W Map ____ Photo ____
Payne Co., Oklahoma Section No. 21
Area ____ Structural Dip ____ By A. J. Garden and
Outcrop Pattern--Linear ____ belt ____ Formation Pw-660 J. W. Shelton

FOOTAGE | ENVIRONMENT | DIRECTIONAL DATA | LITHOLOGY | LATERAL EXTENT | SEDIMENTARY STRUCTURES: MECHANICAL (STRATIFICATION, INCLINED, LINEATION, EROS., DEPOSITION), CHEMICAL, ORGANIC | TEXTURE: GRAIN SIZE, SORTING | CONSTITUENTS | FAUNA | COLOR | POROSITY (%) | REFERENCE NUMBER | SAMPLE NUMBER

√ √ √ √ -CO
√ √ √
√
√

20

LX: S65W
S85W
S70W
S70W

MX: N85W
S40W
S45W

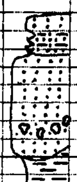
SX: N25W
N25W
N65W
N50W

PL: N80W
S80W

CO: N20W

0

NW NW Sec. 17 T. 19N R. 1W Map ______ Photo ______
Payne Co., Oklahoma Section No. 22
Area ______ Structural Dip ______ By A. J. Garden and J. W. Shelton
Outcrop Pattern--Linear ______ belt ______ Formation Pw-700



20

MX: N45W, N50W, N15W, N90W SX: N75E, N20W ID: N20W, S75W, N85W PL: N15W CO: N20W

0

NE NW Sec. 24 T. 18N R. 1W Map ______ Photo ______
Payne Co., Oklahoma Section No. 23
Area ______ Structural Dip ______ By A. J. Garden
Outcrop Pattern--Linear ______ belt ______ Formation Terrace

40

20

1

0

Ref. No. 1) Clay layers are present throughout section. Pit exposes 20 ft; other exposed on slope above pit.

VITA

Arthur John Garden

Candidate for the Degree of

Master of Science

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Major Field: Geology

Biographical:

Personal Data: Born in Pittsburgh, Pennsylvania, November 16, 1947, the son of John and Dorothy Garden.

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