ARKOSIC CONGLOMERATE BEDS IN MASON, MENARD, AND KIMBLE COUNTIES, TEXAS

A Thesis

By

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Field work on this problem was done through the courtesy of landowners of the northwestern Llano basin area.

Maps and equipment used by the writer were the property of the Department of Geology of the Agricultural and Mechanical College of Texas.

Petrographic thin sections were prepared by Rudolf von Huene, Pasadena, California.

FRONTISPIECE

THE LLANO BASIN. VIEW TO SOUTH FROM TOP OF BLUFF NEAR OUTCROP NO. 10. CRETACEOUS ROCKS FORM THE BLUFFS AT RIGHT AND IN DISTANT BACKGROUND. PALEOZOIC SEDIMENTARY ROCKS CROP OUT IN THE FLOOR OF THE BASIN.

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ARKOSIC CONGLOMERATE BEDS IN MASON, MENARD, AND KIMBLE COUNTIES, TEXAS

INTRODUCTION

HISTORY AND NATURE OF THE PROBLEM

The outcrop of a bed of arkosic conglomerate which caps a hill 2.2 miles southwest of Streeter, Mason County, Texas, was seen and reported independently during the summer of 1953 by Fred R. Grote, a graduate student, and by C. J. Tracy, J. B. Dunlap, Jr., and L. F. Rogers, Jr., a Geology 300 field party, all students of geology at the Agricultural and Mechanical College of Texas. Drs. H. R. Blank and T. J. Parker and Mr. C. L. Seward of the Texas A. & M. College Geology Department faculty correlated this bed with another bed of arkosic conglomerate exposed on the Eckert property farther southwest which had been discovered by Dr. Parker and Mr. Seward some time previously. That same summer these three gentlemen located two more outcrops of similar rock and float from a third. No published reference to the conglomerate was known. They saw that it rests unconformably over the Paleozoic rocks of the Llano uplift and occurs at the approximate level of the base of the surrounding cliffs of Cretaceous strata. These facts led them to assume that the conglomerate was lower Cretaceous in age or older, occurring as dissected upland remnants in the Llano basin after the softer overlying Cretaceous sediments were removed by erosion.

The following spring semester, Dr. Blank suggested to the writer of this paper that he describe the conglomerate in detail for his master's thesis, the problem to include mapping outcrops, describing the conglomerate, establishing its age, determining the nature of the depositional surface, and, to the extent possible, interpreting the geomorphic history of the area. The writer was interested in the problem and adopted it. This paper is a presentation of data, evidence, and ideas assimilated by him in his attempt to resolve its various phases.

LOCATION

Fourteen outcrops or outcrop areas of the arkosic conglomerate have been located in northwestern Mason County, southeastern Menard County, and northeastern Kimble County, Texas (map, Plate I). Probably more outcrops exist but were not located by the writer in the course of his field work. All outcrops found were in the northwestern part of the topographic Llano basin or, expressed differently, on the northwestern flank of the structural Llano uplift. No outcrops were located by reconnaissance north of the Cretaceous ridge in the northern part of the mapped area or nearer the center of the basin to the southeast. The area in which outcrops have been found is approximately 14 miles long by 4 miles wide, extending northeast-southwest from the Cretaceous escarpment 4 miles northwest of Grit, Mason County, to a point 3 miles northeast of London, Kimble County. The area is easily accessible by Texas Highway No. 29, U. S. Highway No. 377, and various county and ranch roads.

METHODS

The writer spent four weeks in the field during the summer of 1954 gathering descriptions, data, and samples of the conglomerate. Outcrops were mapped to a scale of one inch to one mile, using United States Department of Agriculture Aerial Photo-Mosaic No. DFZ USDA - 429-48 as a base map. Outcrops and lithologies were described in the field. Representative hand specimens of the arkosic conglomerate were collected for reference and were photographed at College Station.

Elevations of outcrops were measured with a Paulin surveying aneroid. Without a second aneroid in a fixed location to record rapid fluctuations in atmospheric pressure, the accuracy of readings obtained with this instrument was limited to about plus or minus ten feet, even though two or three separate readings were taken on most outcrops. Relative elevations of outcrops close to one another were measured within closer limits.

All photographs were made with a Praktiflex FX single-lens reflex 35 mm. camera. Photo-micrographs were made through an American Optical Co. petrographic microscope using a 2.8X objective and a 6X ocular, the camera coupled to the microscope by means of a thick rubber washer held in a filter adapter ring. Exposure was one-half second at full aperture on Kodak Plus-X film.

DESCRIPTION OF THE ROCK

GENERAL GEOLOGIC RELATIONS

The arkosic conglomerate bodies are terrestrial stream deposits, as is shown by channelled-in lower surfaces and cross-bedding, described in detail later (Figs. 1-4). They are underlain at some locations by beds of sandy clay. These deposits lie unconformably upon the dissected remnants of an erosion surface on the Paleozoic rocks of the Llano uplift, the elevation of which approximately equals that of the base of the bluffs of Cretaceous rocks to the north and west. This surface slopes to the southwest at an average of eight feet per mile, more steeply in the northeastern part of the area and less steeply in the southwestern part. The total relief of the surface is 128 feet between outcrop no. 14 at the northeastern end of the area (elevation 1858 feet) and outcrop no. 2 at the southwestern end (elevation 1730 feet). The surface is not smooth and even, but rather bears many low topographic irregularities. Outcrops no. 1 and 2, for example, show a 22-foot difference in elevation although they are only about one-half mile apart. Outcrop no. 11 is approximately 100 yards west of outcrop no. 10 and is 10 feet lower. Elevation variations like these seem to indicate an irregular surface with two dominant subparallel levels as is shown on the topographic profile, Plate II.

If the conglomerate bodies are considered to be terrestrial stream deposits, these two levels would indicate the existence of two terrace levels--an older, higher one and a younger, lower one.

The original areal extent of the conglomerate deposits is unknown and would be difficult to estimate accurately because of post-depositional erosion and possible covering by younger beds. That the arkosic conglomerate of the higher terrace level was not a continuous blanket deposit over the entire area may be shown by the absence of that material on top of a hill of the Cap Mountain limestone on the Immanuel property approximately 1.5 miles north of Streeter, Mason County. This hill reaches an elevation of 1838 feet, higher than the nearest conglomerate exposures (outcrops no. 5, 6, and 9).

At most locations the conglomerate directly overlies the Paleozoic sedimentary rocks but at outcrops no. 2, 10, and 11 it is separated from them by beds of sandy, greenish-brown clay which reach a maximum thickness of eight feet at outcrop no. 2. At that outcrop the clay contains approximately 15 per cent by weight of rounded, poorly sorted, deeply pitted, quartz sand grains. No fossils, microscopic or otherwise, were found in it. The intense chemical weathering of the sand-grain surfaces may indicate that the clay was once exposed to leaching by groundwater as a subsoil. The bed's lack of fossils and its position beneath the terrestrial conglomerate also suggest terrestrial origin of the clay.

Overlying beds have been stripped away at most locations; basal marine Cretaceous sediments overlie the conglomerate at outcrops no. 10, 11, and 14. The Paleozoic rocks are cut by many normal faults and are gently folded. Neither the arkosic conglomerate nor the overlying marine Cretaceous sediments are involved in these structural features.

The longest axis of the area in which conglomerate outcrops have been found extends northeast-southwest along the western flank of a broad, gentle, much-faulted, southward-plunging, Paleozoic anticline, so that the conglomerate lies over progressively younger rocks from the Hickory sandstone (upper Cambrian) on the northeast to the Ellenburger limestone (lower Ordovician) and down-faulted Marble Falls limestone (Pennsylvanian) on the southwest. Pre-Cambrian granite of the Town Mountain series is exposed in the crest of this anticline about five miles east-northeast of the northernmost conglomerate outcrops. The Streeter granite mass, also of Pre-Cambrian age, lies about five miles east of the central part of the conglomerate outcrop area. Pre-Cambrian metamorphic rocks crop out on the flanks of both of these granite bodies. Geologic units exposed in the conglomerate-outcrop area are listed and briefly described in Appendix II.

THICKNESS AND BEDDING

The thickness of the conglomerate beds ranges from 0.5 foot to approximately 8 feet, with no dominant direction of thickening. Thickness variations may occur within very short horizontal distances. At outcrop no. 2, the road cut at Bear Creek crossing on U. S. Highway no. 377, the conglomerate is distinctly channelled into the underlying sandy clay, the thickness of the bed ranging from 0.5 foot on the divides to 4 feet in the channels. (Figs. 1-3).

At most outcrops the conglomerate weathers as a single massive bed but contains inconspicuous thinner beds of coarser conglomerate alternating with finer conglomerate (Figs. 17, 24). The conglomerate is cross-bedded in a channel-fill at outcrop no. 2 (Fig. 4).

LITHOLOGY

CLASTICS AND THEIR SOURCES

The conglomerate is arkosic at all locations. It consists predominantly of pebbles of milky quartz and pink microcline, with lesser admixtures of pink and red (hematite-stained) quartz, gray quartzite, and light gray chert. In most localities the conglomerate is poorly sorted, the grains ranging from 3/8 inch in diameter to fine sand size. The average diameter in most locations is 3/16 inch to 1/4 inch. Quartz pebbles are commonly slightly larger than feldspar pebbles. This is not true at outcrop no. 1, where the coarsest conglomerate has been found (Fig. 5). Here littleworn, tabular, crystal-form microcline pebbles up to 1 inch by 1-1/4 inches (third dimension obscured) are quite common, with pebbles of milky quartz up to one inch in diameter less abundant. The average grain diameter here is approximately 3/8 inch. The finest material found occurs as lenses in the conglomerate at outcrops no. 3, 5, 9, and 10. It contains no particles larger than medium sand size (Figs. 12, 20, 28). Most feldspar pebbles are sub-angular, quartz pebbles sub-round. Many medium and coarse quartz sand grains are well rounded.

The microcline and quartz pebbles were derived for the most part from the Town Mountain granite. This rock contains quartz and microcline grains similar in size, shape, and color to those of the conglomerate. It is the only rock in the Llano uplift area that contains abundant subhedral microcline crystals as large as the larger ones found in the conglomerate (Figs. 7, 8). The elevation of the highest point on the Town Mountain granite exposure about five miles east-northeast of the northernmost conglomerate outcrop was measured to be 1873 feet, 15 feet higher than the highest conglomerate outcrop. This exposure, then, is high enough to have served as the source area for the quartz and microcline pebbles. The finer grained Streeter granite reaches a maximum measured elevation of 1768 feet, 90 feet lower than the highest conglomerate outcrop. Unless its elevation has been greatly lowered by erosion since the conglomerate was deposited, it could not have furnished sediments to the entire area of conglomerate outcrops. There is no reason to believe, however, that the Streeter granite body could not have furnished some of the finer admixtures in the lower conglomerate outcrops.

The well-rounded medium and coarse sand grains were probably eroded mainly from local exposures of the Hickory and Lion Mountain sandstones, which contain similar grains.

The conglomerate contains occasional pebbles and cobbles of massive milky quartz, light gray chert, and gray quartzite up to eight inches in diameter, much larger than the pebbles surrounding them. These are sharply angular to well rounded. The fragments of massive quartz were evidently derived from Pre-Cambrian pegmatite dikes in the area. A few of them are ventifacts, doubtless derived from the basal conglomerate of the Hickory sandstone in a second cycle of erosion. Most, if not all of the chert was derived from the Ellenburger limestone, its light gray color being typical of cherts from that group. The largest cobbles are of gray quartzite, probably eroded from the Pre-Cambrian metamorphic rocks which crop out on the flanks of the granite exposures. The writer has not located exposures of quartzite of this type in the metamorphics.

Limestone fragments are almost completely absent from the conglomerate, their only occurrence being a few pebbles of Morgan Creek limestone in the probably-reworked, lower terrace material of outcrop no. 11. The absence of limestone fragments is unexpected, because the granite-derived material must have been transported over outcrops of the Ellenburger and Cap Mountain limestones to be deposited in some of the known localities, and at several places it directly overlies these limestone units. Abrasion would not completely destroy limestone pebbles within such short distances of transport, and if solution were very intense, the feldspar grains should be more altered. Solution may have been just sufficiently intense to remove limestone pebbles without substantially affecting adjacent microcline grains or conditions of erosion and deposition could have been such that limestone fragments were not included in the conglomerate.

CEMENTING MATERIALS AND TOPOGRAPHIC EXPRESSION

Cementing materials in the conglomerate vary from one location to the next. They include calcite, hematite, silica, limonite, and mixtures of these. The conglomerate is very hard or very soft depending upon the composition and nature of the cement.

The least consolidated conglomerate occurs at outcrops no. 1, 3, 7, and 13, where the quartz and microcline grains are set in a matrix of soft, reddish-brown, hematitic clay.

The most common cement is a brown or purplish black mixture of silica and hematite, this being especially abundant on the higher terrace level. When thoroughly cemented by this material, the arkosic conglomerate is extremely hard and resistant to erosion. It commonly caps hills of softer Paleozoic sedimentary rocks whose flanks are thickly littered with slumped boulders of the conglomerate, remaining even after the underlying material has been eroded away. Wherever the conglomerate is cemented by large quantities of this silica-hematite mixture, it directly overlies some part of the upper Cap Mountain-Lion Mountain-Welge section, most commonly the Welge sandstone. The Welge sandstone is quartzitic at most locations where it is overlain by the conglomerate, cemented by the same dark reddish brown ferruginous silica that binds the conglomerate. Dr. H. R. Blank has suggested that this cement was probably derived from the glauconite of the Lion Mountain sandstone and deposited in the overlying Welge sandstone and arkosic conglomerate by ascending ground water. The chemistry of this would be as follows:

$$K\text{-}Fe^{II}(OH)\text{-Silicate} \xrightarrow{HOH} KOH + Fe(OH)_2 + H\ \text{Silicate (Colloidal)}$$

$$KOH \xrightarrow{+CO_2} K_2CO_3$$

$$Fe(OH)_2 \xrightarrow{+O_2} Fe(OH)_3 \xrightarrow{-H_2O} Fe_2O_3$$

$$H\ \text{Silicate} \xrightarrow{-H_2O} SiO_2$$

$$Fe_2O_3 + SiO_2$$

This hypothesis is substantiated by the presence of similar cement in Pleistocene gravel terrace deposits overlying the Newby glauconitic sand (Eocene, Reklaw) and a glauconitic bed in the Queen City formation (Eocene) in Burleson County, Texas. This cement is absent where the gravels overlie non-glauconitic beds (J. B. Dunlap, Jr., personal communication).

Figures 35 through 40 illustrate this hematite-silica cement as it appears in petrographic thin sections. The siliceous nature of the cement is apparent in hand specimens, but the silica contains enough hematite to make it opaque in thin sections. The cement layer tends to maintain a constant thickness, even when it lines the walls of voids (Figs. 36, 37, and 39). Figure 35 illustrates a quartz grain broken in two, the two segments only slightly out of optical continuity but separated by a thin band of cement. Two other quartz grains similarly broken and separated were found on this same section, which was made of a specimen from outcrop no. 1. The grains must have been broken after they were deposited but before cementation was complete. It is possible that their fracturing was caused by shrinkage of the surrounding cement or by expansion of cement in cracks in the grains during the cementation process. The writer has no evidence to support either of these hypotheses.

The cement is almost pure hematite at outcrops no. 13 and 14 (higher terrace level), where the conglomerate lies over the hematitic upper Hickory sandstone (Fig. 41). In places the cement is continuous between the Hickory sandstone and the conglomerate with no visible break.

The conglomerate is cemented by white to light gray or light yellowish brown crystalline calcite at outcrops no. 2, 8, 11, and 12 (Figs. 42 and 43). A small amount of calcite cement occurs along with the ferruginous silica cement at outcrop no. 10. Where the cement is calcite, nearly all color, even the pink of the microcline, has been leached from the conglomerate. Only the pink and red quartz pebbles retain their color, causing them to be much more conspicuous than in other cements. Gradations from calcite cement to a porous cement of siliceous hematite may be seen at outcrops no. 2 and 10 (Figs 44 and 45). Whether this gradation is original or is caused by weathering of the conglemerate after the calcite cement is removed by solution is not certain. That such gradations are not present in the fresh conglomerate exposed in the road cut at outcrop no. 2 but are common in the weathered material along Bear Creek at that same location supports the hypothesis that this is a phenomenon of weathering. The minor amount of calcite cement at outcrop no. 10 could have been introduced by groundwater.

The calcite-cemented conglomerate does not cap hills. It occurs at lower elevations than nearby exposures of conglomerate with ferruginous-siliceous cement, as at outcrops no. 1 and 2, 6 and 8, and 10 and 11. The calcite-cemented arkosic conglomerate, then, is restricted to the lower terrace level, with the exception of the small amount of calcite-cemented material at outcrop no. 10.

TABLE I

OUTCROP DATA

OUTCROP NUMBER	ELEVATION	THICKNESS (FEET)	CEMENT	UNDERLYING UNIT	OVERLYING UNIT	TERRACE LEVEL
1	1751 Base	1.2	Ferruginous silica Hematitic clay	Ellenburger Ls.	None	High
2	1730 Base	0.5 to 4	Calcite Hematite with thin bands of ferruginous silica	Sandy Clay over Ellenburger Ls. and Marble Falls Ls.	Pleistocene Conglomerate	Low
3	1764 Base	2	Hematitic clay Siliceous hematite Limonitic clay	Ellenburger Ls.	None	High
4	1745 Top	0.8(?)	Siliceous hematite	San Saba Ls. (?)	None	Low
5	1787 Base	5 to 7	Ferruginous silica	Cap Mountain Ls. Lion Mountain Ss. Welge Ss.	None	High
6	1790 Base	1.2	Ferruginous silica	Welge Ss.	None	High
7	----	1	Ferruginous silica	Welge Ss.	None	High
8	1781 Base	0.7	Calcite	Welge Ss. (?)	Soil	Low
9	1827 Base	0.5 to 8	Ferruginous silica Siliceous hematite	Cap Mountain Ls. Lion Mountain Ss. Welge Ss.	None	High
10	1853 Top	1.3	Ferruginous silica Calcite Hematitic clay	Sandy Clay over Welge Ss.	Cretaceous conglomeratic sand	High
11	1843 Top	2 to 3	Calcite	Sandy Clay over Morgan Creek Ls.	Cretaceous sand	Low
12	1828 Top	1.5 (?)	Calcite	Hickory Ss.	None	Low
13	1832 Base	1.5	Hematite Hematitic clay	Hickory Ss.	None	High
14	1858 Base	1	Hematite with thin bands of ferruginous silica	Hickory Ss.	Cretaceous sand	High

The calcite cement could have been introduced contemporaneously with deposition of the conglomerate of the lower terrace level if that conglomerate were deposited in tidal estuaries at the margin of the transgressing lower Cretaceous sea. Marine calcium carbonate precipitation might then have taken place directly into the conglomerate to form the cement. The writer considers secondary origin of the calcite cement to be more likely. He suggests that most of the conglomerate bodies of the lower terrace level were uncemented stream deposits when calcareous lower Cretaceous sediments were deposited above them. The calcite cement would subsequently be deposited in the conglomerate by percolating ground water.

AGE

No fossils were found in the conglomerate, so it could not be dated directly.

The conglomerate overlies brecciated Pennsylvanian Marble Falls limestone at outcrop no. 2. It is not involved in late Pennsylvanian folding and faulting in the rocks that underlie it. These facts require that the age of the conglomerate be post-Pennsylvanian. According to Paige (1912), lower Cretaceous marine sediments were deposited over the whole area of the Llano uplift and were not breached until early in the Pleistocene epoch. His evidence supporting this is the absence of granite debris in the Pliocene Uvalde formation near Austin and the presence of abundant granite debris in the oldest recognized Pleistocene terrace of the

Colorado River in the same area. The Cretaceous cover would have prevented deposition of the conglomerate at any time from lower Cretaceous to Pleistocene. Superposition of Cretaceous beds at outcrops no. 10, 11, and 14, the absence of fragments of Cretaceous limestone and dark gray chert, and the southwest dip of the depositional surface--roughly perpendicular to post-Cretaceous drainage (Paige, 1912)--preclude the possibility of Pleistocene age. The conglomerate, then, was deposited at some time between the end of the Pennsylvanian period and the time of deposition of the lowermost marine lower Cretaceous sediments in the area.

Not all the deposits of arkosic conglomerate in this area are of the same age. There is a break between the times of deposition on the upper and lower terrace levels, and it is not likely that all deposits on either level are exactly contemporaneous. The length of the time interval which separated deposition upon the upper and lower terrace levels may not be established with certainty. The present steepness of the conglomerate-bearing surfaces, if original, would suggest deposition by moderately fast, rapidly eroding streams. The average difference in elevation between the upper and lower terrace levels is approximately 20 feet. If erosion were rapid, this small difference would require that the time interval be a very short one. However, it cannot be proven that the present slope of eight feet per mile to the southwest existed when conglomerate was being deposited upon either or both of the levels. Other possible sequences of events could have allowed a long time interval to pass between the times of origin of conglomerate bodies on the upper and lower terrace levels. For example, the apparently random scattering of upper terrace deposits within the conglomerate-outcrop area might be construed to indicate that they were laid down as a widespread surface gravel upon a nearly baseleveled surface. Such a surface must have been later tilted and uplifted to allow streams of the lower terrace level to be incised immediately before the area subsided beneath the lower Cretaceous sea. This postulated explanation seems unduly complex. In the writer's opinion, deposition of the upper-terrace conglomerate in a number of valleys by heavily-laden streams which flowed upon a surface whose slope has been little changed is quite compatible with presently known facts. Incising of valleys to form the lower terrace level could possible have been caused by uplift of the area, but this explanation seems unlikely in view of the immediately subsequent rise of the lower Cretaceous sea. Erosion of stream beds down to the lower terrace level was probably caused by an increase of precipitation as the sea transgressed. This interpretation seems simpler and, therefore, more acceptable. It requires neither near-peneplanation nor tectonic movements other than vertical subsidence of the Llano uplift area beneath the lower Cretaceous sea. If this solution is correct, all of the conglomerate must have been deposited within a relatively brief interval of geologic time.

The oldest marine Cretaceous sedimentary rocks over the Llano uplift are of Glen Rose age (Barnes, 1948)--lower Albian (Stephenson, et al, 1942)--well up in the lower Cretaceous epoch. The calcite-cemented arkosic conglomerate of the lower terrace level is intimately associated with these sediments. It seems logical, then, that the conglomerate is no older than pre-Glen Rose lower Cretaceous. Jurassic age is quite possible and even Triassic or Permian age cannot be eliminated, especially for the material on the higher terrace level, but could be proven only by paleontological evidence. In the absence of such evidence the writer considers the conglomerate to be of lower Cretaceous age throughout.

C O N C L U S I O N S

ORIGIN OF THE CONGLOMERATE

The arkosic conglomerate at the base of the Cretaceous section in the northwestern part of the Llano basin was deposited by streams which flowed upon the Wichita paleoplain, the regional pre-Cretaceous erosional surface named and described by R. T. Hill (1901). The Llano uplift area was topographically high on the Wichita paleoplain. This was noted by Hill and was shown by L. D. Cartwright (1932) on a contour map of its surface which he compiled largely from well data (Fig. 46).

The streams that deposited the conglomerate had their headwaters in an area where granite of the Town Mountain series was exposed, and this rock furnished the greater part of their sedimentary load. The streams flowed across exposures of the Paleozoic sedimentary rocks of the Llano uplift toward the rising lower Cretaceous sea to the southwest.

Accelerated erosion resulted in the formation of a high terrace level. Much arkosic gravel left on this high level was cemented by hematite and silica furnished by weathering of glauconite in underlying beds. As the sea transgressed over the uplift in Glen Rose time, gravels in the stream channels were covered by marine Cretaceous sediments and are now preserved as a lower terrace level of arkosic conglomerate cemented for the most part by calcite derived from percolating waters. Conglomerate of both terrace levels is underlain in places by beds of terrestrial sandy clay, possibly part of a former soil profile into which streams cut their channels.

The conglomerate may be shown to be younger than Pennsylvanian and older than the lower Cretaceous Glen Rose formation. Without contradictory paleontological evidence, the writer considers it to be pre-Glen Rose lower Cretaceous in age.

PROPOSED NOMENCLATURE OF THE UNIT

The Cretaceous basement sands were described by R. T. Hill (1901) as "of shallow-water or near-shore origin, representing the ancient marginal deposits of the sea as it encroached upon the land." He mentioned that these sands are frequently conglomeratic, especially near the base.

Nomenclature applied to these beds has been revised at various times since Hill's investigations, the most recent being V. E. Barne's (1948) designation of the basal Cretaceous sands in this area as the Hensell sand member of the Shingle Hills formation. Hill's basic description has not changed, however; the lowermost Cretaceous sands and conglomerates in this area are still defined as being of marine origin.

The arkosic conglomerates and sandy clays that in places underlie them that are described in this paper are demonstrably of non-marine origin, and therefore should not be incorporated as part of the lowermost Cretaceous unit in the area as it is presently defined. Because of the undetermined age relationships of different bodies of arkosic conglomerate, a formation--member classification of the rocks described in this paper is considered premature at this time. The writer suggests that these terrestrial beds which occur immediately below the marine lower Cretaceous rocks of the northwestern Llano uplift area be referred to as the London beds until a proper classification can be set up. This name was derived from the town of London, Kimble County, which is three miles southwest of a complete sequence of exposures located at and immediately west of Bear Creek crossing on U. S. Highway No. 377. These outcrops are described in Appendix I as outcrops no. 1 and 2. The name Londen beds carries no definite implications as to the age of the whole assemblage of conglomerate outcrops or of any one bed relative to another.

FIGURE 1

ROAD CUT AT BEAR CREEK CROSSING, OUTCROP NO. 2. BED OF ARKOSIC CONGLOMERATE IS CHANNELLED INTO SANDY CLAY BENEATH AND IS OVERLAIN BY PLEISTOCENE CONGLOMERATE.

FIGURE 2

ARKOSIC CONGLOMERATE CHANNELLED INTO SANDY CLAY, OUTCROP NO. 2.

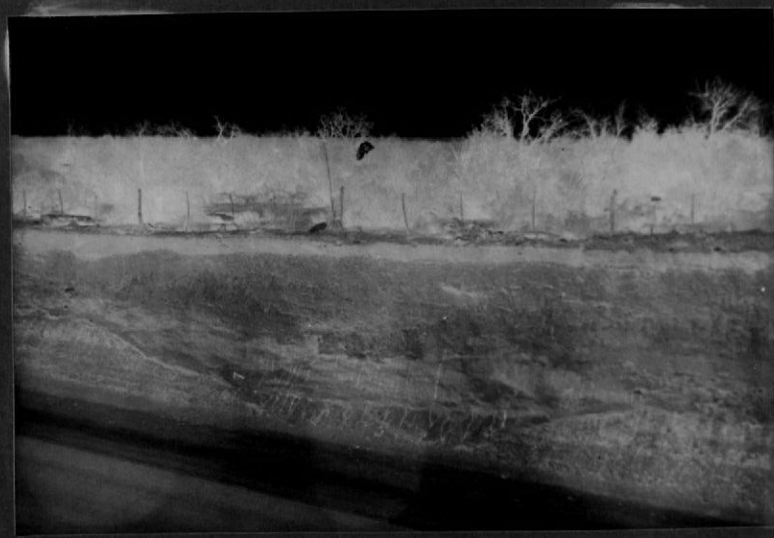

FIGURE 3

CHANNEL FILL OF ARKOSIC CONGLOMERATE, OUT-CROP NO. 2.

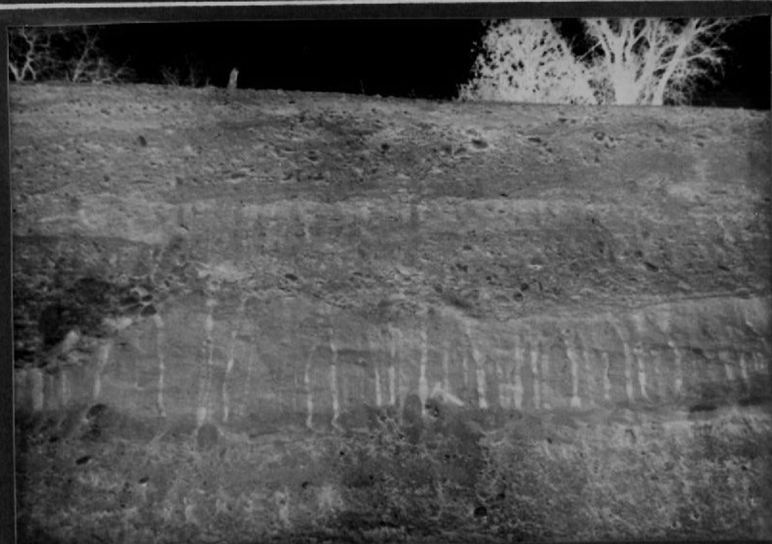

FIGURE 4

CROSS-BEDDING IN CHANNEL FILL OF ARKOSIC CONGLOMERATE ILLUSTRATED IN FIGURE 3.

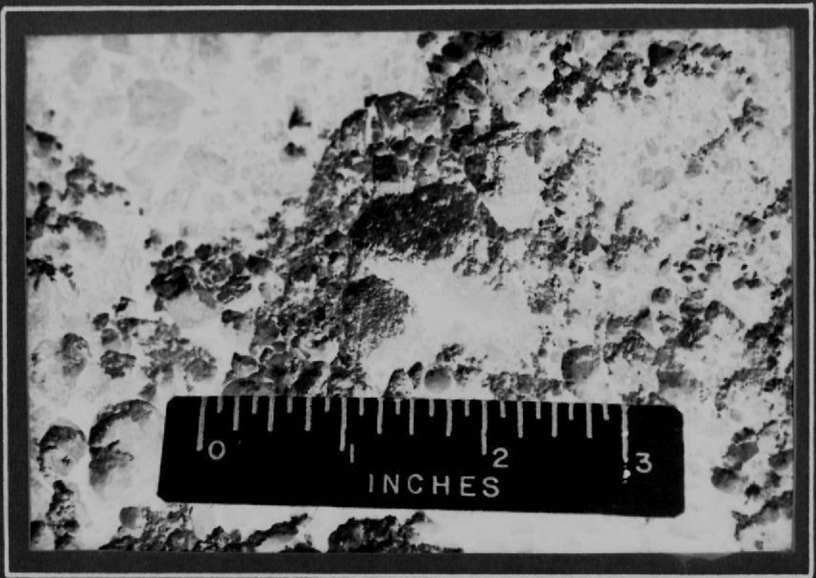

FIGURE 5

VERY COARSE ARKOSIC CONGLOMERATE AT OUTCROP NO. 1.

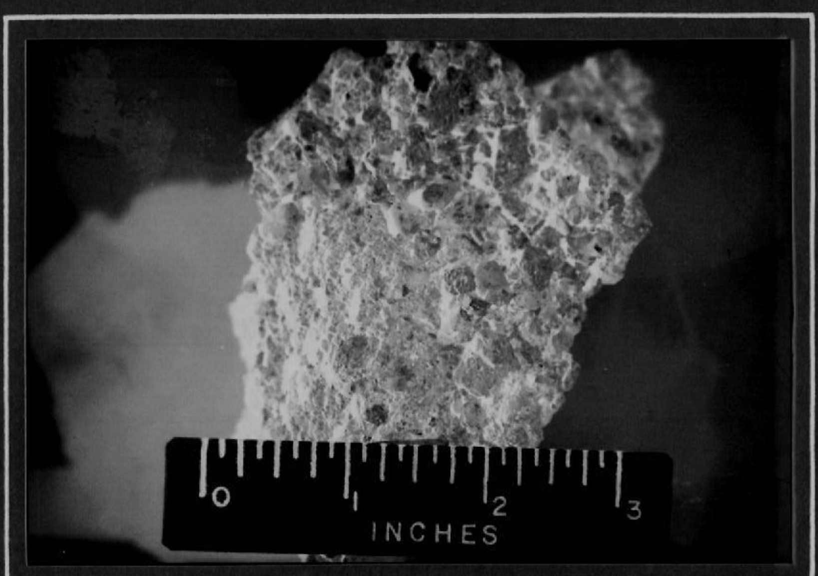

FIGURE 6

AVERAGE SPECIMEN FROM OUTCROP NO. 1.

FIGURE 7

SUBHEDRAL CRYSTALS OF PINK MICROCLINE WEATHERING OUT OF TOWN MOUNTAIN GRANITE NEAR EL. 1845.

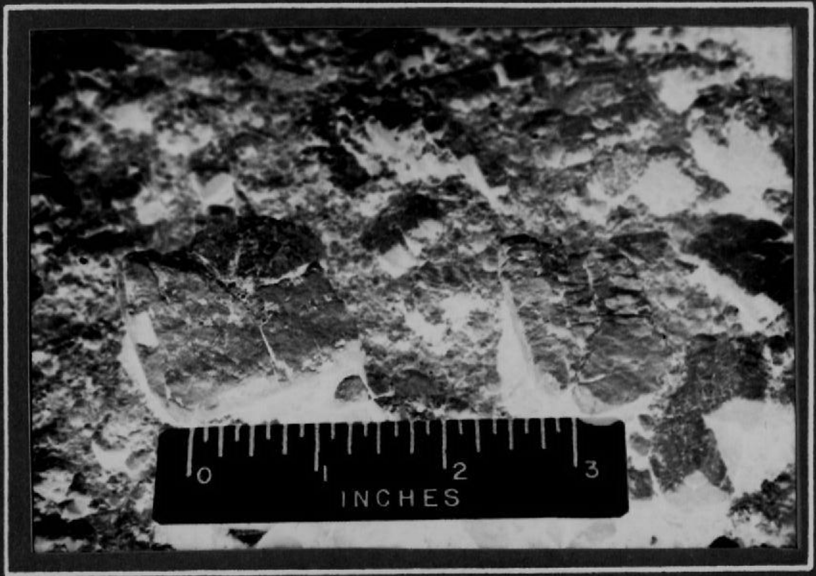

FIGURE 8

SUBHEDRAL CRYSTALS OF PINK MICROCLINE WEATHERING OUT OF TOWN MOUNTAIN GRANITE NEAR EL. 1845.

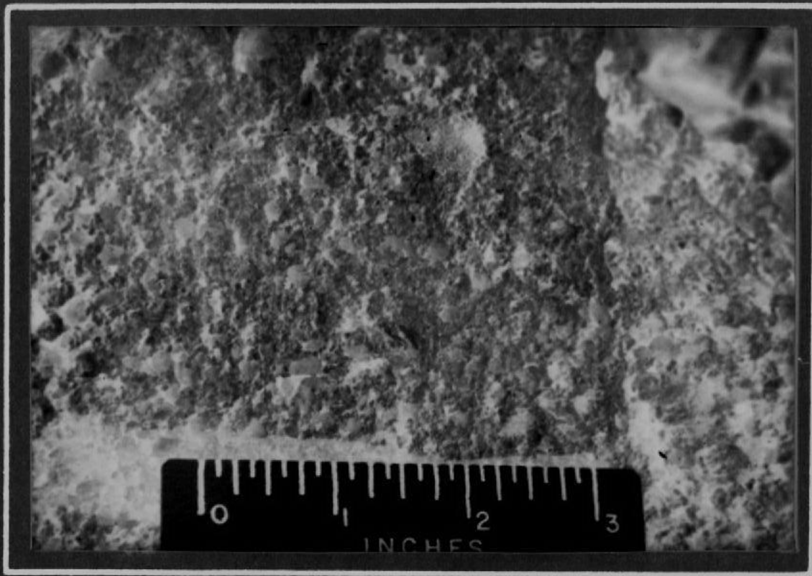

FIGURE 9

CALCITE-CEMENTED ARKOSIC CONGLOMERATE, OUT-CROP NO. 2.

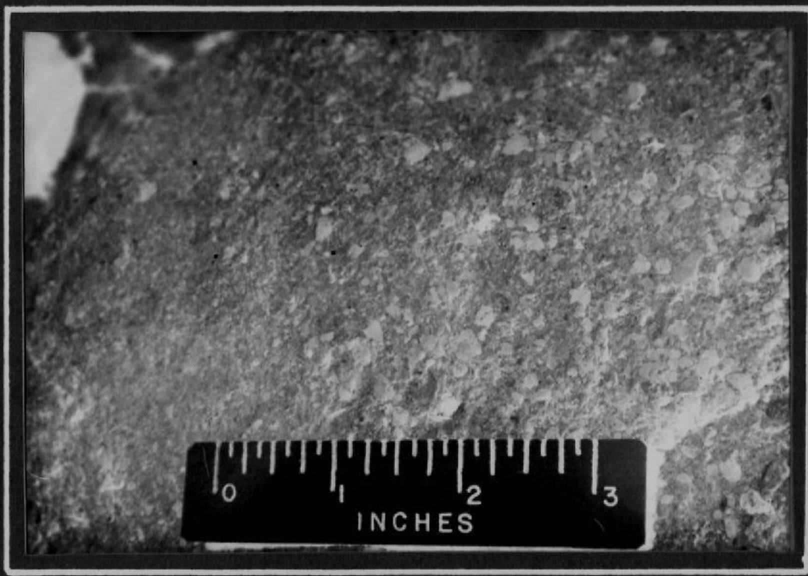

FIGURE 10

CALCITE-CEMENTED ARKOSIC CONGLOMERATE, OUT-CROP NO. 2.

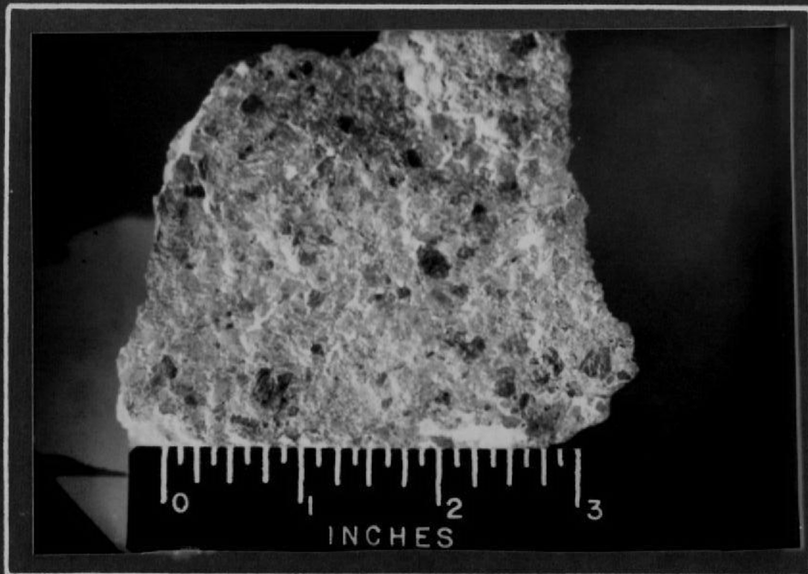

FIGURE 11

ARKOSIC CONGLOMERATE FROM OUTCROP NO. 3.

FIGURE 12

ARKOSIC SANDSTONE FROM OUTCROP NO. 3.

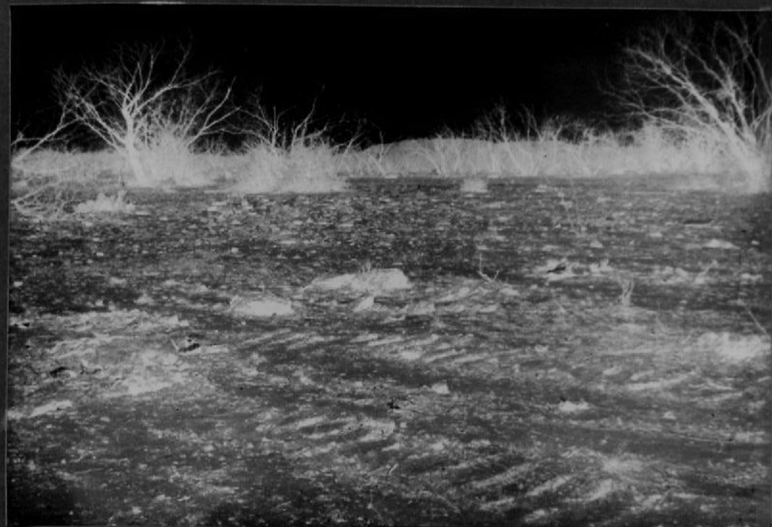

FIGURE 13

OUTCROP NO. 4.

FIGURE 14

ARKOSIC CONGLOMERATE FROM OUTCROP NO. 4

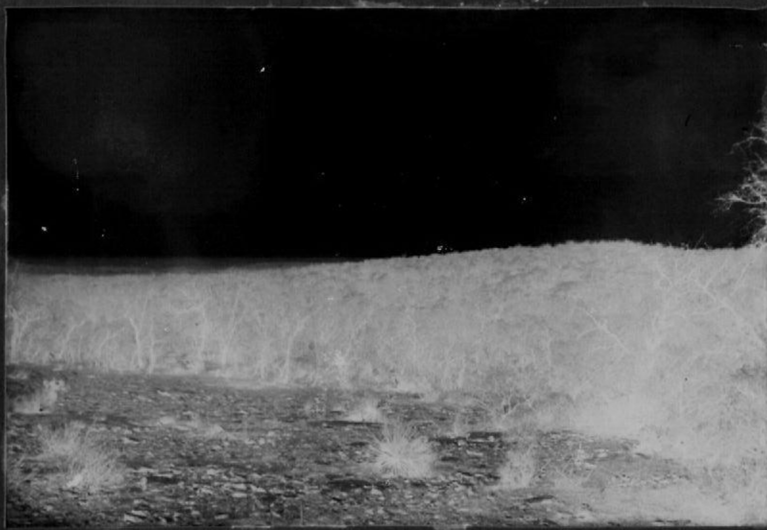

FIGURE 15

HILL CAPPED BY ARKOSIC CONGLOMERATE (PART OF OUTCROP NO. 5). VIEW TO SOUTH

FIGURE 16

SLUMPED BOULDERS OF ARKOSIC CONGLOMERATE AT OUTCROP NO. 5.

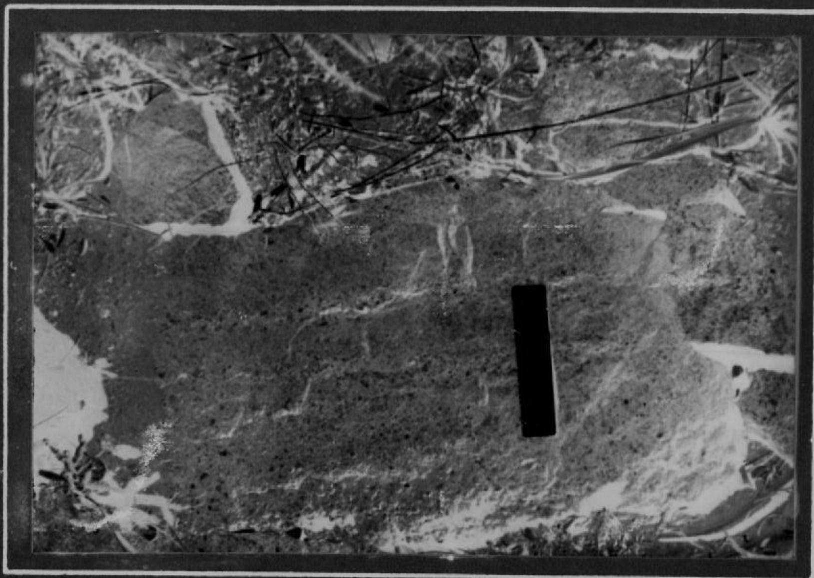

FIGURE 17

BEDDING IN BOULDER OF ARKOSIC CONGLOMERATE AT OUTCROP NO. 5.

FIGURE 18

COBBLE OF GRAY QUARTZITE EMBEDDED IN ARKOSIC CONGLOMERATE AT OUTCROP NO. 5.

FIGURE 19

ARKOSIC CONGLOMERATE FROM OUTCROP NO. 5. GLITTER OF SPECIMEN AT LEFT IS FROM FRESHLY BROKEN FERRUGINOUS SILICA CEMENT. NOTE ANGULARITY OF LARGE QUARTZ PEBBLE IN SPECIMEN AT RIGHT AND CONTINUITY OF BROKEN SURFACE ACROSS ITS CONTACT WITH CEMENT.

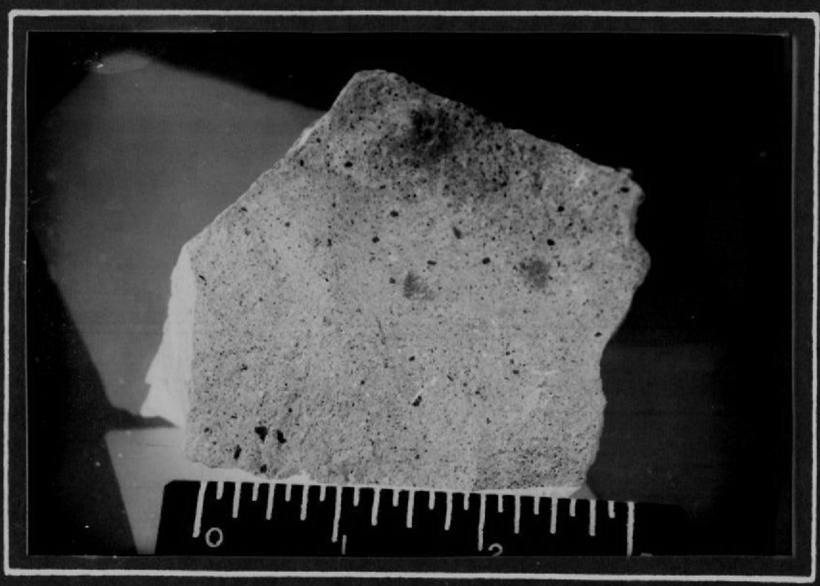

FIGURE 20

ARKOSIC SANDSTONE FROM OUTCROP NO. 5. CEMENT IS FERRUGINOUS SILICA. NOTE SMOOTH CONCHOIDAL FRACTURE.

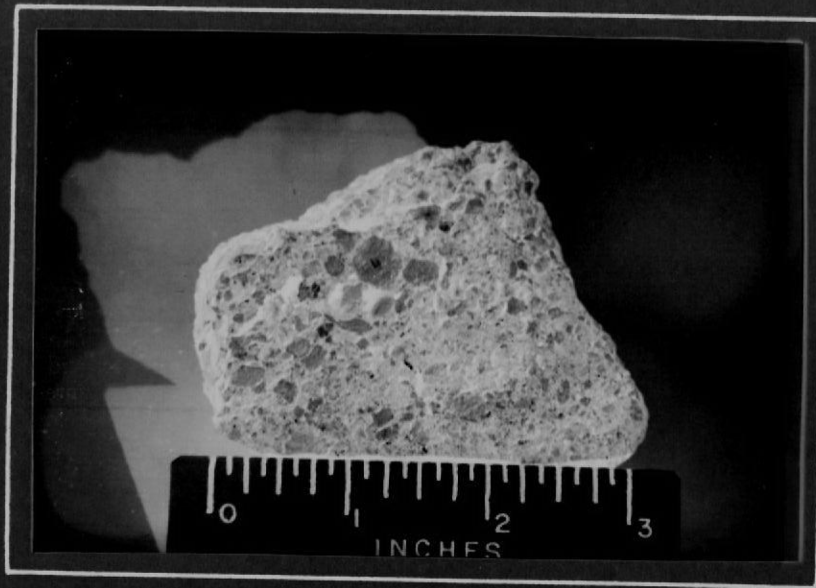

FIGURE 21

ARKOSIC CONGLOMERATE FROM OUTCROP NO. 5.

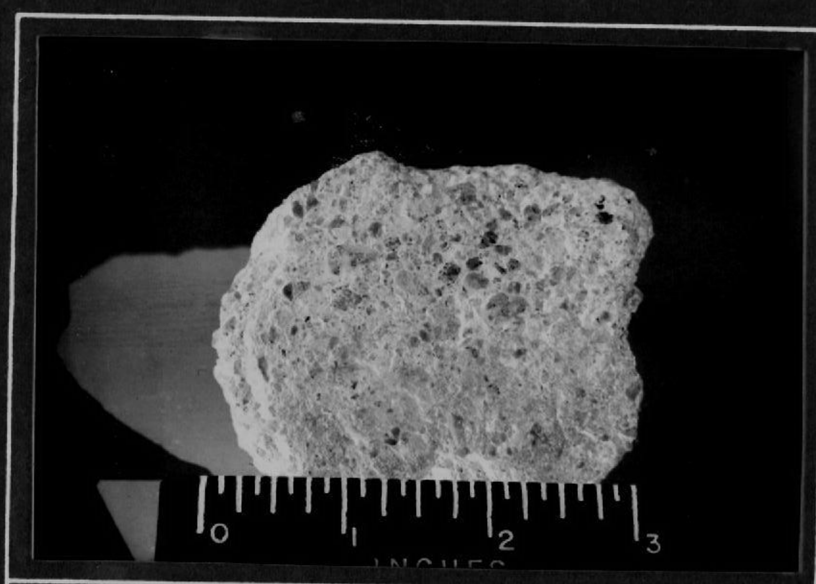

FIGURE 22

ARKOSIC CONGLOMERATE FROM OUTCROP NO. 7.

FIGURE 23

OUTCROP NO. 6. LEDGE IN CENTER BACKGROUND IS ARKOSIC CONGLOMERATE IN PLACE. ROCK EXPOSED IN FOREGROUND TO RIGHT OF PRICKLY PEAR IS QUARTZITIC WELGE SANDSTONE.

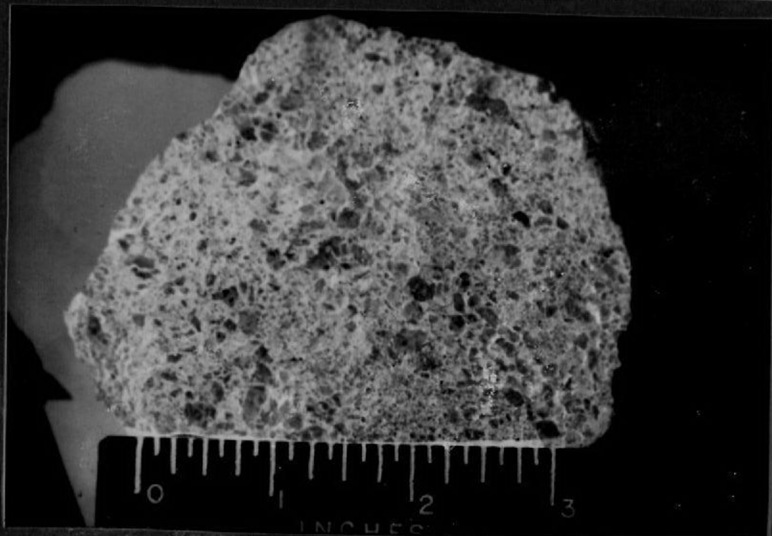

FIGURE 24

ARKOSIC CONGLOMERATE FROM OUTCROP NO. 6. NOTE STRATIFICATION. CEMENT IS FERRUGINOUS SILICA.

FIGURE 25

OUTCROP NO. 8. OVERLYING MATERIAL IS RECENT ALLUVIUM.

FIGURE 26

TYPICAL SMALL EXPOSURE OF BED OF ARKOSIC CONGLOMERATE IN OUTCROP AREA NO. 9.

FIGURE 27

THICK LEDGE OF ARKOSIC CONGLOMERATE, EL. 1827 IN OUTCROP AREA NO. 9.

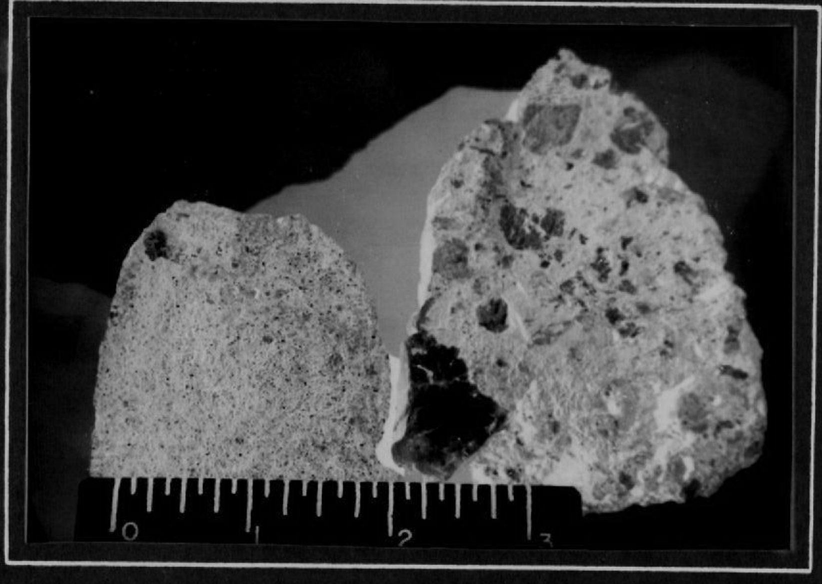

FIGURE 28

ARKOSIC MATERIAL FROM OUTCROP ILLUSTRATED IN FIGURE 27. NOTE VARIATION IN GRAIN SIZE.

FIGURE 29

BENCH CAPPED BY BED OF ARKOSIC CONGLOMERATE, OUTCROP NO. 10.

FIGURE 30

ARKOSIC CONGLOMERATE FROM OUTCROP NO. 10. DARKER BAND IN UPPER RIGHT PORTION OF SPECIMEN IS A STREAK OF FERRUGINOUS SILICA CEMENT.

FIGURE 31

ARKOSIC CONGLOMERATE FROM OUTCROP NO. 12.
CALCITE CEMENT.

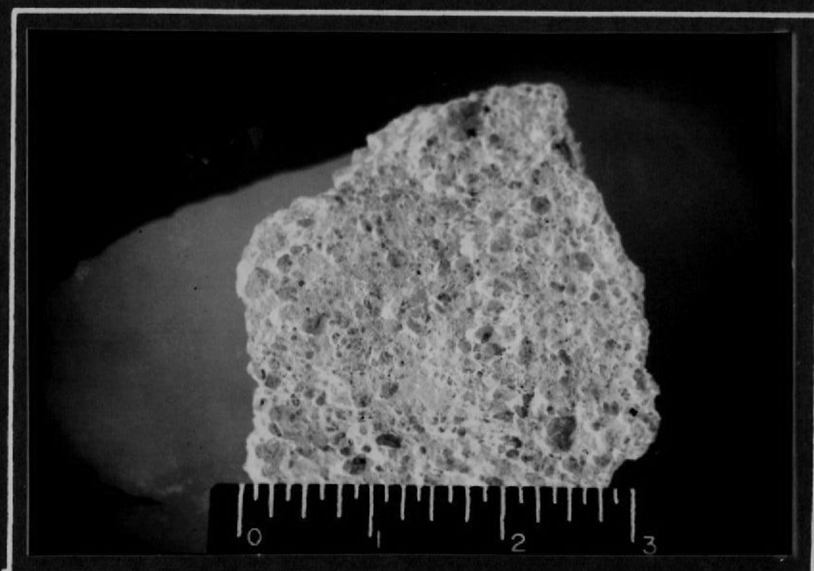

FIGURE 32

ARKOSIC CONGLOMERATE FROM OUTCROP NO. 13.
HEMATITE CEMENT.

FIGURE 33

OUTCROP NO. 14. A THIN VENEER OF ARKOSIC CONGLOMERATE OVERLIES HICKORY SANDSTONE IN THE FOREGROUND. IT IS OVERLAIN BY LOWER CRETACEOUS MARINE SEDIMENTARY ROCKS WHICH FORM THE BLUFF IN THE BACKGROUND.

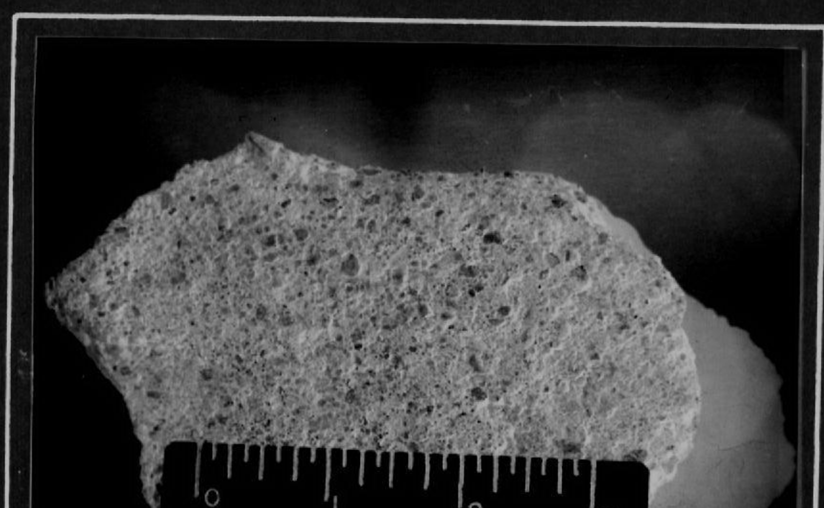

FIGURE 34

ARKOSIC CONGLOMERATE FROM OUTCROP NO. 14. HEMATITE CEMENT.

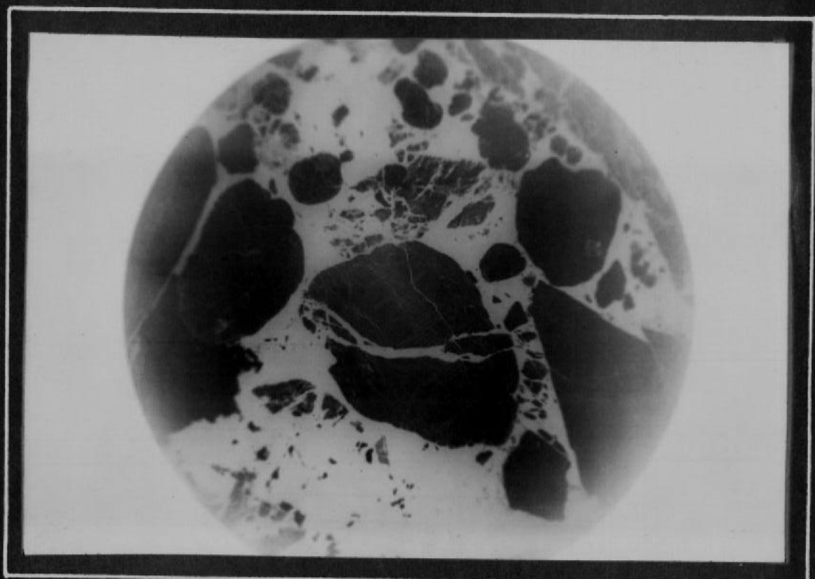

FIGURE 35

THIN SECTION OF ARKOSIC CONGLOMERATE FROM OUTCROP NO. 1. NOTE BROKEN QUARTZ GRAIN SEPARATED BY BAND OF CEMENT. ORDINARY LIGHT, X 10.

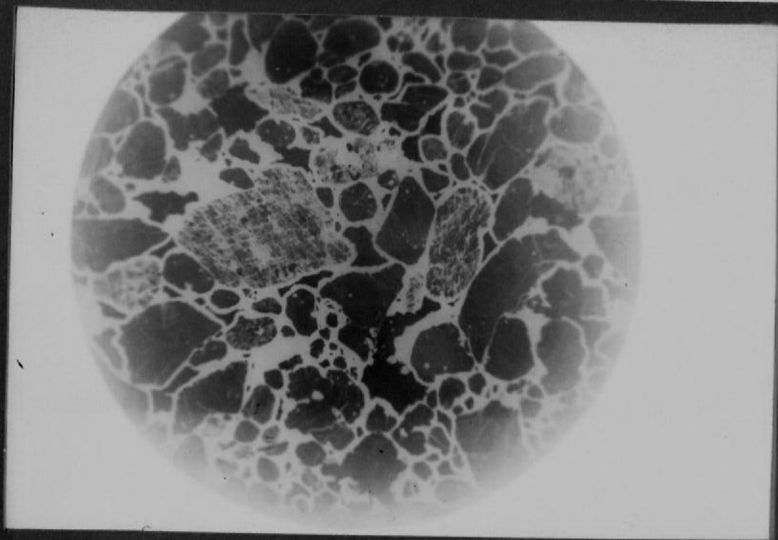

FIGURE 36

THIN SECTION OF ARKOSIC CONGLOMERATE FROM OUTCROP NO. 6. CEMENT IS A MIXTURE OF SILICA AND HEMATITE. ORDINARY LIGHT, X 10.

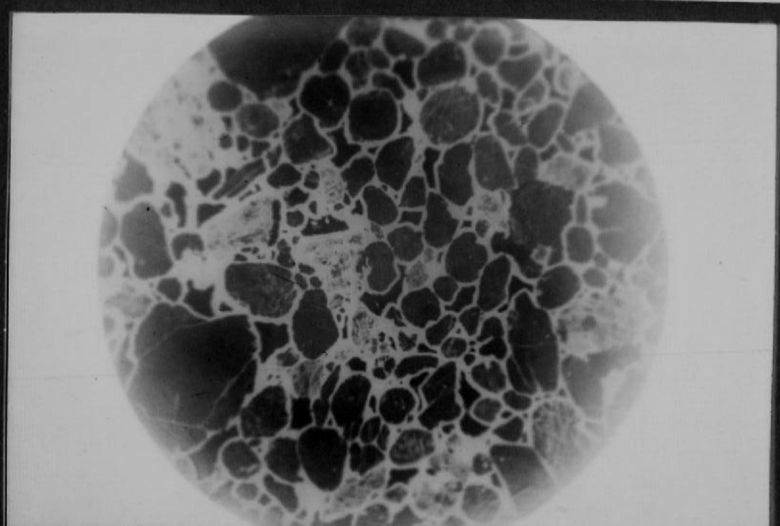

FIGURE 37

DIFFERENT AREA ON SLIDE ILLUSTRATED IN FIGURE 36. NOTE TENDENCY OF CEMENT LAYER TO MAINTAIN CONSTANT THICKNESS. ORDINARY LIGHT, X 10.

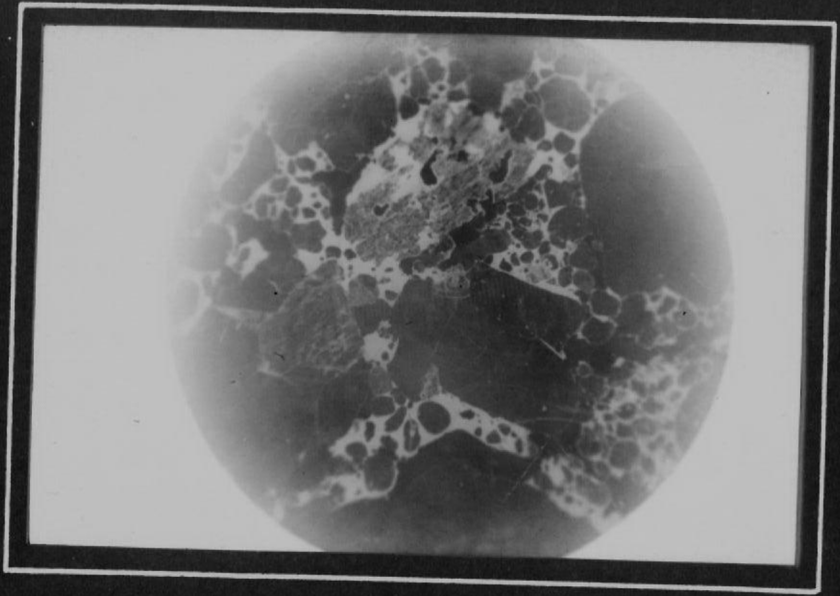

FIGURE 38

THIN SECTION OF ARKOSIC CONGLOMERATE FROM OUTCROP NO. 3. CEMENT IS SILICEOUS HEMATITE. ORDINARY LIGHT, X 10.

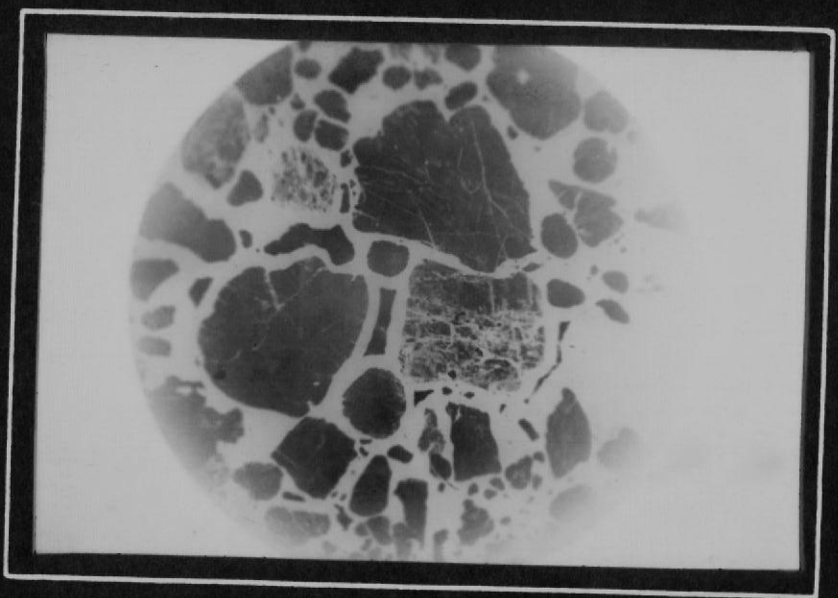

FIGURE 39

THIN SECTION OF ARKOSIC CONGLOMERATE FROM OUTCROP NO. 5. FERRUGINOUS SILICA CEMENT. ORDINARY LIGHT, X 10.

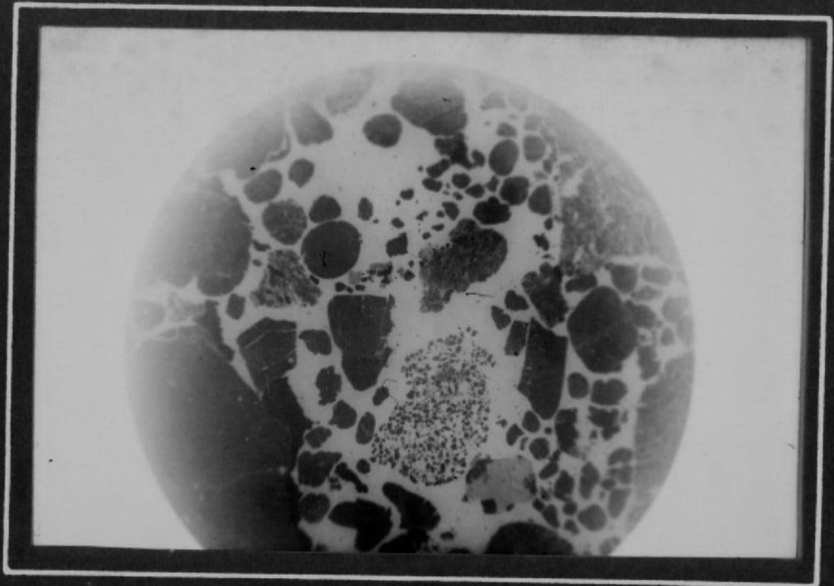

FIGURE 40

THIN SECTION OF ARKOSIC CONGLOMERATE FROM OUTCROP NO. 10. CEMENT IS FERRUGINOUS SILICA. NOTE SILTSTONE GRAIN, CONTRASTING ANGULARITY AND ROUNDNESS OF QUARTZ GRAINS. ORDINARY LIGHT, X 10.

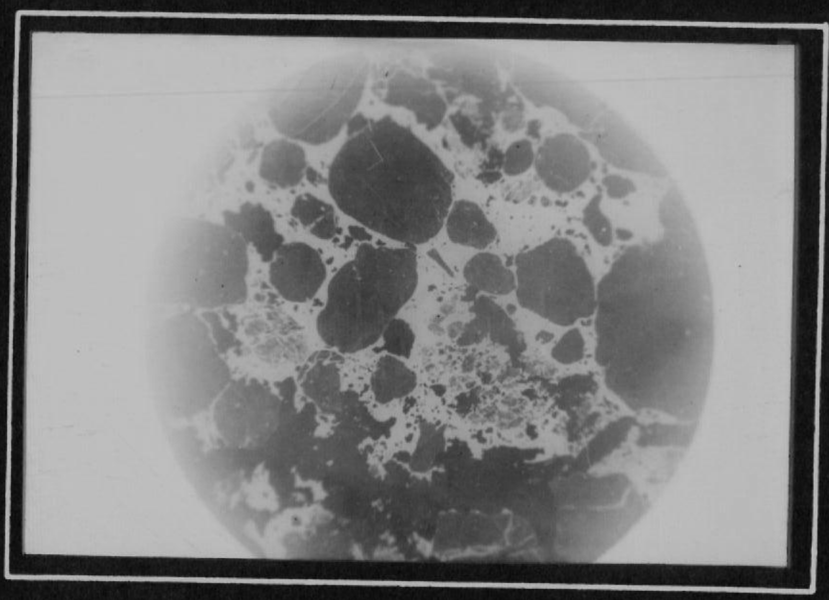

FIGURE 41

THIN SECTION OF ARKOSIC CONGLOMERATE FROM OUTCROP NO. 13. HEMATITE CEMENT. NOTE MUCH-WEATHERED FELDSPAR GRAIN NEAR CENTER AT 5 O'CLOCK. ORDINARY LIGHT, X 10.

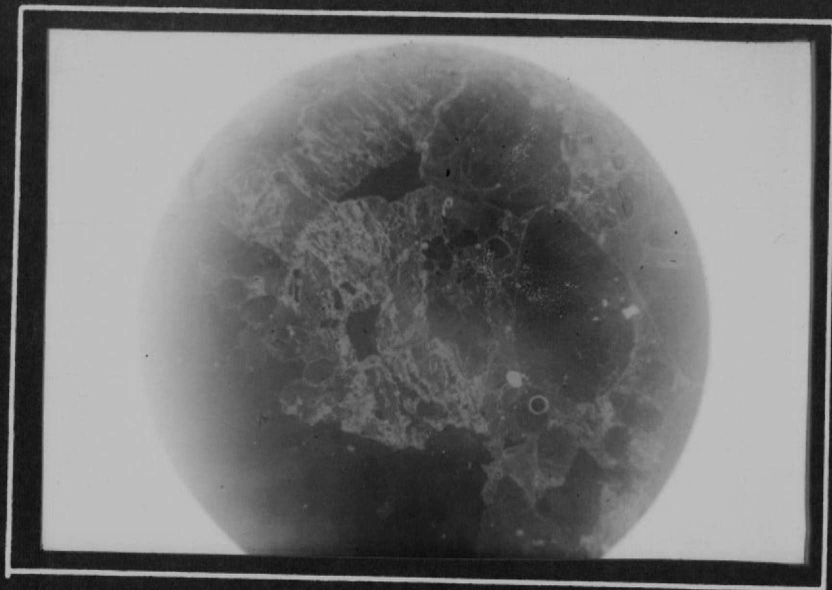

FIGURE 42

THIN SECTION OF ARKOSIC CONGLOMERATE FROM OUTCROP NO. 2. CALCITE CEMENT. ORDINARY LIGHT, X 10.

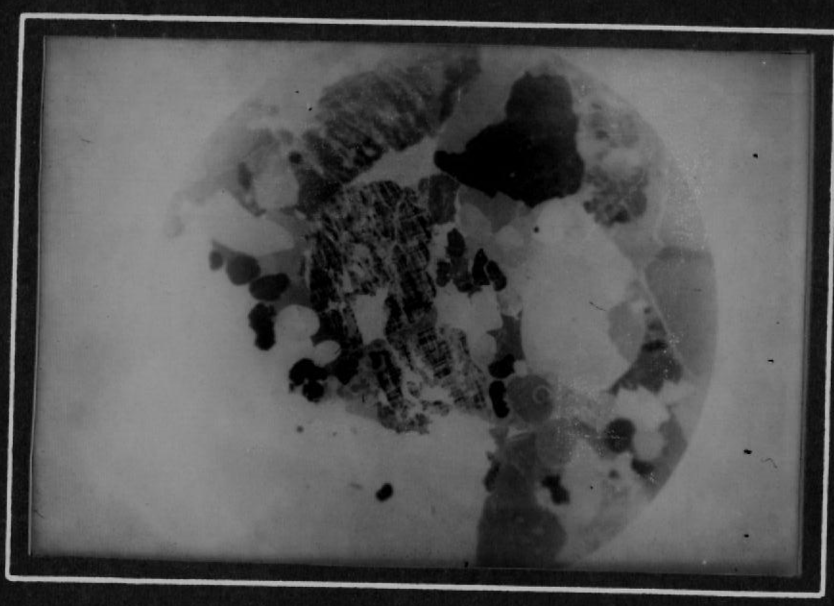

FIGURE 43

SAME AS ABOVE, CROSSED NICOLS.

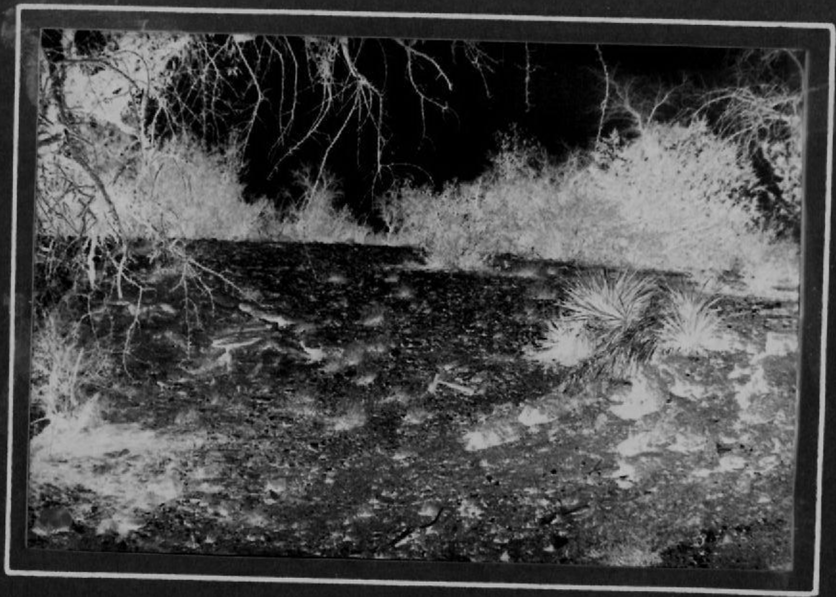

FIGURE 44

GRADATION FROM CALCITE CEMENT (LEFT) TO SILICEOUS HEMATITE CEMENT (RIGHT) AT OUTCROP NO. 2.

FIGURE 45

GRADATION FROM CALCITE CEMENT (LEFT, POORLY EXPOSED) TO FERRUGINOUS SILICA CEMENT (RIGHT) AT OUTCROP NO. 10.

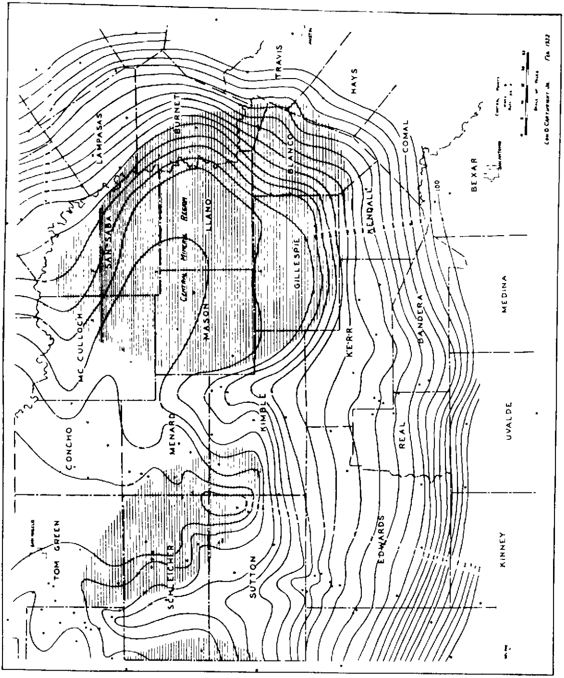

FIG. 1.—Contour map of pre-Cretaceous surface on Edwards Plateau Outcropping resistant formations on this surface are indicated by shading. Outcropping easily eroded formations are blank Contour interval, 100 feet.

FIGURE 46

REGIONAL TOPOGRAPHY OF THE WICHITA PALEOPLAIN AS CONTOURED BY L. D. CARTWRIGHT, JR. (1932). REPRODUCED BY PERMISSION OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS.

REFERENCES

Barnes, V. E., Ouachita Facies In Central Texas, Bureau of Economic Geology Report of Investigations No. 2, University of Texas, Austin, Texas, December, 1948, pp. 5-8.

Cartwright, L. D., Jr., "Regional Structure of Cretaceous on Edwards Plateau of Southwest Texas," Bulletin of the American Association of Petroleum Geologists, Volume 16, Number 7, pp. 691-700 (July, 1932).

Hill, R. T., Geography and Geology of the Black and Grand Prairies, Texas, Twenty-first Annual Report of the United States Geological Survey, Part 7--Texas, Government Printing Office, Washington, D. C., 1901, pp. 363-367, 171-199.

Paige, Sidney, Geologic Atlas of the United States, Folio 183 (Field Edition), Llano-Burnet Folio, United States Geological Survey, Washington, D. C., 1912, pp. 83-84.

Sellards, E. H., et al, the Geology of Texas, Volume I, Stratigraphy, University of Texas Bulletin Number 3232, University of Texas, Austin, Texas, August, 1932, pp. 272-322.

Stephenson, L. W. et al, "Correlation of the Outcropping Cretaceous Formations of the Atlantic and Gulf Coastal Plain and Trans-Pecos Texas," Bulletin of the Geological Society of America, Volume 53, pp. 435-448 (1942).

A P P E N D I X

A P P E N D I X I

DESCRIPTIONS OF INDIVIDUAL OUTCROPS

OUTCROP NO. 1

Arkosic conglomerate crops out here at the top of the hill immediately west of Bear Creek crossing in the ditch beside U. S. Highway No. 377. The conglomerate is composed predominantly of pebbles of milky quartz and almost unweathered pink microcline. The microcline pebbles here are coarser than at any other outcrop of the conglomerate known to the writer. Typical large microcline pebbles measured 1 inch by 1-1/4 inches, 1-1/2 inches by 5/8 inch, and 3/4 inch by 7/8 inch (third dimensions buried in boulders). These are tabular crystal-form and show little wear. Quartz pebbles range up to one inch in diameter. They are subangular to well rounded. Three singly terminated quartz crystals, the largest approximately 1/2 inch in diameter by 3/4 inch long, with edges only slightly rounded by weathering were found in the conglomerate at this outcrop. The average grain diameter here is about 3/8 inch.

The conglomerate bed is approximately 1.2 feet thick. The top 0.7 foot is cemented by streaks of hard ferruginous silica and is bouldery. The bottom 0.5 foot is unindurated, the quartz and feldspar pebbles set in a matrix of reddish brown hematitic clay.

The conglomerate bed is underlain by much weathered, nodular or conglomeratic limestone of the Ellenburger lithology which apparently formed a hill on the Wichita paleoplain.

OUTCROP NO. 2

A bed of arkosic conglomerate is well exposed for a distance of about 150 yards in the sides of the road cut at Bear Creek crossing on U. S. Highway No. 377. The conglomerate is composed mainly of pebbles of milky quartz and light gray microcline up to 1/2 inch in diameter, somewhat coarser than average but finer than that at outcrop no. 1 immediately to the west. Some quartz grains are rounded, but these are more commonly subangular. Microcline grains are subangular and not so abundant as at most other outcrops.

The cement is hard, white to gray, crystalline calcite, softer or absent near the top of the bed where the conglomerate has been reworked. Quartz grains stained red or pink by hematite, common at other outcrops, are very conspicuous here against the light-colored background. There is a band of hematite approximately 1/8 inch thick at the base of the conglomerate bed.

Both the thickness and elevation of the conglomerate bed change rapidly laterally. It is distinctly channelled into the bed of sandy clay that lies beneath it. The thickness of the conglomerate bed varies from 0.5 feet between the channels to 4 feet in them. Cross-bedding is visible in one thick channel deposit.

The bed may be traced from the road cut southward along the east bank of Bear Creek for a distance of about 75 yards. The calcite cement here contains occasional bands of ferruginous silica and hematite-stained spots up to one foot in diameter. About 65 yards south of the road out the calcite cement grades abruptly into one of limonite or hematite with a few thin bands of ferruginous silica, the clastic lithology remaining constant.

The arkosic conglomerate is overlain by a conglomerate made up chiefly of subangular to round boulders and cobbles of very fine grained, light gray limestone up to one foot in diameter. A maximum thickness of about ten feet of this conglomerate is exposed in the road cut. Size of the fragments decreases toward the top of the bed. This conglomerate contains pebbles of dark gray chert similar to that found in the Cretaceous Edwards limestone and washed fossil Exogyra texana shells, which indicate that it is a stream deposit laid down since the Cretaceous cover was removed from the area.

The bed of arkosic conglomerate is channelled into the underlying bed of greenish brown sandy clay. This bed ranges from 5 to 8 feet in thickness. The clay contains approximately 15 per cent by weight of rounded, poorly sorted, deeply pitted quartz sand grains. The intense chemical weathering of the sand-grain surfaces may indicate that the clay was once exposed to leaching by groundwater as a subsoil on the Wichita paleoplain. No fossils, microscopic or otherwise, were found in it. This clay bed grades downward into a conglomerate composed of pebbles and cobbles of much-weathered Paleozoic limestone which rests upon Ellenburger limestone and weathered, brecciated Marble Falls limestone.

The bed of arkosic conglomerate at this outcrop lies 22 feet lower than that at outcrop no. 1 approximately one-half mile to the west. Outcrop no. 1 represents the higher terrace level; outcrop no. 2 the lower one.

OUTCROP NO. 3

Arkosic conglomerate crops out here in ditches beside the Eckert Ranch road on top of a broad, flat ridge of the Ellenburger and San Saba limestones. The conglomerate consists of pebbles of milky quartz and pink microcline cemented by yellowish brown clayey limonite or, more commonly, by dark brownish red hematite with streaks of ferruginous silica. This indurated material occurs in boulders up to one foot in diameter which are surrounded by unconsolidated arkosic gravel in a matrix of reddish brown hematitic clay. The average diameter of quartz and feldspar grains in the boulders is 3/16 inch or slightly greater; that of grains in the unconsolidated gravel is smaller, between 1/8 inch and 3/16 inch. This and the bouldery nature itself seem to indicate that the conglomerate bed here has been reworked.

The gravel contains sub-angular pebbles and cobbles of light gray chert, gray quartzite, and milky and smoky quartz up to four inches in diameter. Chert fragments are the most angular. At its base the gravel bed contains scattered pebbles and cobbles of non-arkosic, hard, hematite-cemented sandstone and siltstone.

The arkosic conglomerate and gravel rest upon an undulating, much-weathered surface of the Ellenburger limestone. The maximum thickness of the bed is about 2 feet. There is no gravel or conglomerate at all on the highest part of the ridge, where bare Ellenburger limestone crops out approximately five feet higher than and fifty yards away from the conglomerate outcrops.

About one mile farther south along this road at an elevation five feet lower than outcrop no. 3 the soil is hematite-red and contains quartz and quartzite pebbles, but no feldspar grains. This soil may represent the arkosic material after much weathering and reworking. The Welge sandstone crops out in this vicinity, forming a low knob west of the road. It is quartzitic, cemented by dark reddish brown silica.

OUTCROP NO. 4

At this location cobbles and flat boulders of arkosic conglomerate litter a small, low bench on a hill of the San Saba limestone about 30 yards west of the Eckert Ranch road. This outcrop is located on the same broad, flat ridge as is outcrop no. 3 to the southeast. The ridge continues on to the northwest to the edge of the Cretaceous cover.

The conglomerate here is lithologically similar to that in the boulders at outcrop no. 3. The cement is slightly more siliceous than at that outcrop. The thickness of the conglomerate bed is perhaps 0.8 foot; its fragmental nature makes an accurate measurement impossible.

OUTCROP NO. 5

Arkosic conglomerate is exposed here as it caps a ridge which extends from the base of the Cretaceous bluffs southeastward into the basin. The conglomerate is best exposed at the southeastern extremity of the ridge, where it is underlain by the uppermost Cap Mountain limestone, the Lion Mountain sandstone, and the Welge sandstone.

Wherever the Lion Mountain sandstone is exposed in this immediate area, its usually abundant glauconite has been leached out or altered by weathering to earthy hematite. The weathered rock is a dull reddish brown, coarse-grained sandstone. The Welge sandstone maintains its usual lithology of light brown, medium hard sandstone with recomposed crystal faces on the quartz sand grains. The upper Cap Mountain limestone shows no effects of unusually intense weathering.

The conglomerate consists of pebbles and sand grains of milky quartz and slightly weathered pink microcline ranging from medium sand size to 3/8 inch in diameter. Quartz grains are subround, feldspar grains subangular. The conglomerate contains subround to sharply angular pebbles and cobbles of massive milky quartz and gray quartzite up to six inches in diameter and well rounded pebbles and cobbles of light gray chert up to three inches in diameter. The cement is dark brownish purple ferruginous silica, so hard that pebbles of chert and massive quartz break across rather than break free from the matrix. Bedding is visible in some boulders in which one-to-two inch wide bands of coarser and finer conglomerate alternate.

The contact between the conglomerate and the Paleozoic rocks is not exposed. The southwest flank of the ridge is thickly littered with slumped boulders of the conglomerate, giving the appearance of a thick section, but float from the Lion Mountain sandstone occurs among these boulders within eight feet of the top of the ridge, and Cap Mountain limestone is exposed within four feet of the top of the ridge on the northeast flank. The maximum thickness of the conglomerate in this area is probably about 5 to 7 feet.

OUTCROP NO. 6

Arkosic conglomerate caps a low, flat hill here. The conglomerate bed is only about 1.2 feet thick, but the flanks of the hill are thickly littered with many slumped boulders of it, giving the appearance of a greater thickness. The conglomerate is very firmly cemented by ferruginous silica in some places with less siliceous, weaker cement in others. The pebbles of the conglomerate are of milky quartz and pink microcline up to 3/8 inch in diameter, subround to round, with pebbles and cobbles of massive milky quartz and light gray chert up to four inches in diameter and gray quartzite up to six inches in diameter, subround to round.

The arkosic conglomerate is underlain by the Welge sandstone, which at this location is quartzitic, cemented by dark reddish brown silica.

OUTCROP NO. 7

A low hill of the Welge sandstone one-half mile north-northeast of outcrop no. 6 is capped by a 1-foot-thick bed of arkosic conglomerate. The lithology of the conglomerate here is similar to that at outcrop no. 6; the siliceous cement in the Welge sandstone is less complete than at that outcrop.

OUTCROP NO. 8

Arkosic conglomerate floors a creek bed for about five yards at this location. It is composed of pebbles of milky quartz and light gray chert up to one inch in diameter and light gray microcline up to 3/4 inch in diameter--coarser than average. It is cemented by light yellowish gray, fairly soft calcite. The exposed bed is 0.7 feet thick, but its upper surface has been eroded and its lower surface is obscured by loose sand so that its true thickness is undetermined.

Welge sandstone without the hard ferruginous silica cement crops out in the creek bed about 150 yards downstream. It presumably underlies the conglomerate.

OUTCROP (AREA) NO. 9

Many hills and ridges in this area are capped by arkosic conglomerate. The conglomerate overlies the upper Cap Mountain limestone or the upper Cap Mountain limestone-Lion Mountain sandstone-Welge sandstone section. Where exposed, the Welge sandstone is cemented by dark reddish brown silica or siliceous hematite. Welge outcrops are not plentiful, however, and it is possible that the usual softer Welge lithology is present in places, obscured by soil or float. No outcrops of the Lion Mountain sandstone were seen in this area, although the presence of numerous hematite nodules and "trilobite hash" lenses in float on the flanks of hills capped by arkosic conglomerate indicate its obscured presence. The Cap Mountain limestone is exposed over much of this area, its lithology showing no effects of overly intense weathering.

The arkosic conglomerate is composed of grains of milky quartz and pink microcline ranging from medium sand size to 5/8 inch in diameter with no apparent pattern in the distribution of the various grain sizes. Occasional pebbles and cobbles of milky quartz and gray quartzite up to eight inches in diameter may be found, those in the one-to three-inch size range being abundant.

The cement of the conglomerate ranges from black to reddish brown, porous, nearly pure hematite to dark purplish brown silica, with mixtures between these extremes most common. Unconsolidated arkosic gravel in a matrix of hematitic clay was seen clinging to roots of trees uprooted in clearing land, but no outcrops of this were found.

The thickness of the conglomerate bed is variable. At the hill in the northern part of the area where elevation 1827 was measured it is 6 to 8 feet thick, massively bedded, with several thick ledges in place and slumped boulders littered down the flanks of the hill for a distance of 30 feet or more. An equal thickness may be found at a few other outcrops in this area, but the conglomerate bed is usually thinner, averaging 2 to 4 feet in thickness. In places it is represented only by scattered cobbles up to six inches in diameter. Several broad ridges in this area bear hematite-red sandy soil which contains occasional feldspar grains and pebbles of milky quartz. It is undetermined whether this is a residual soil developed from the arkosic conglomerate in place or is reworked material transported from nearby conglomerate exposures.

OUTCROP NO. 10

A thin bed of arkosic conglomerate crops out here in the ditch on the north side of Texas Highway No. 29 and caps a low bench on the south side of the highway. Tracing the bed of conglomeratic sand which overlies the arkosic conglomerate horizontally for about 50 yards allowed a nearly complete section from the Welge sandstone to the top of the bluff of Cretaceous strata to the north to be measured. This section is described fully below and is illustrated on Plate III.

MEASURED STRATIGRAPHIC SECTION OF A BLUFF OF LOWER CRETACEOUS ROCKS 5.3 MILES WEST OF GRIT, MASON COUNTY, TEXAS, ON TEXAS HIGHWAY NO. 29

LOWER CRETACEOUS (FORMATION NAME UNDETERMINED)	FEET
14. Limestone: Light yellowish brown, finely crystalline, hard limestone, weathering to brownish gray. Contains molds of fossils and washed pebbles of chert up to two inches in diameter and occasional sand grains. Chert pebbles subround to round, white to dark gray. This bed caps the Cretaceous rim here. ----	2.1
13. Limestone: Light brownish yellow, somewhat nodular, hard, non-crystalline limestone, weathering to light yellowish gray. Irregular fracture. ----------------------------	2.2
12. Marl: Nodular or massive, light yellow brown to white marl of varying hardness, all fairly soft. Weathers to approx. 20 degree slope, littered with talus from above. Light gray, powdery soil. ---------------------------	39.5
11. Sandstone: Light yellowish brown, medium grained sandstone with crystalline calcite cement. Supports ledge. Soft under hammer. Grains are of quartz, uniform, rounded, frosted. Weathers to darker yellow brown. ---------	0.9

10. Conglomerate and conglomeratic sand: Light gray to light tan, soft, calcite cemented conglomerate and conglomeratic coarse sand. Pebbles to 1/2 inch, average 3/16-1/4 inch. Pebbles composed of quartz, chert, limestone, calcareous sandstone. Quartz grains subangular, some chert pebbles fairly well rounded. Rare feldspar grains. Crumbles under hammer. --------------------------- 1.0-2.1

9. Caliche: Slightly sandy, white to light greenich brown, soft caliche. Weathers to light gray soil, forms gentle slope. Seems to be thoroughly calichefied light greenish brown clay. -------------------- 5.4-6.5

8. Sandstone: Very light yellowish brown to light gray, coarse grained, often conglomeratic, caliche-cemented sandstone. Soft under hammer. Lensing bedding within rock and in bed as a whole. Grains are mainly quartz, some pebbles are of limestone (weathered out and washed caliche nodules?). Grains angular to subround. -------------- 1.0-2.4

7. Sand, conglomeratic sand, and sandy clay: This bed is very variable, both vertically and horizontally. It is mainly light pea-green, fine grained, conglomeratic sand,

slightly clayey, weathered to or mottled with dark reddish brown. Contains many irregular bands and nodules of white caliche. Sand is well sorted, grains rounded, almost all quartz with a few dark green grains that are probably glauconite. Pebbles are of whitish gray smoky quartz, about the same size, shape, and roundness as in the bed below. In places, pebbles make up about 5% of the rock. This bed contains feldspar grains smaller than 1/8 inch directly above the bed described below. Toward the top and about 100 yd. to the west the feldspar grains disappear and the general grain size of the matrix becomes smaller, becoming sandy clay or clayey silt. Colors, caliche, and quartz pebbles remain fairly constant to within 1.5 ft. of the top, where there is non-conglomeratic, slightly clayey silt with only thin bands of caliche. ----------------------- 7.6-9.0

6. Indurated arkosic conglomerate: Hard arkosic conglomerate cemented by silica and hematite or by calcite. Color is dark reddish brown weathering to dark brown where cemented by silica and hematite, white to light tan weathering to gray where cemented by calcite. Pebbles are of grayish white smoky quartz and pink microcline which vary laterally from 1/2 inch to

medium sand size, average size being about 1/4 inch, perhaps slightly smaller. Contains patches of non-arkosic, dark brown, ferruginous, medium grained sandstone. Pebbles of the arkosic conglomerate are subangular to subround. The top of this bed is elevation 1853. The bed is exposed in the road ditch on the north side of the highway and supports a low bench on the south side of it. On the bench it is broken into flat boulders up to 3 ft. square which are only slightly slumped. This bed of arkosic conglomerate is of small lateral extent. ---------------------------------- 0.6

5. Arkosic gravel: Unconsolidated arkosic gravel in matrix of bright red clay. Fragments angular to subround. Quartz generally around 3/16 inch in diameter, occasional pebbles to 3/4 inch. Feldspar grains average about 1/8 inch. ------------------------------------ 0.7

4. Clay: Bright green, slightly sandy clay, weathered to red at the top. No lamination. Contains caliche nodules to 1-1/2 inches in diameter. -------------------------------- 0.7

3. Sand: Brownish green clayey sand. Rather poorly sorted, grains medium to very fine. Occasional small lumps of green clay and

caliche nodules to 1-1/2 inches in diameter. Sand grains subangular to rounded. Surfaces appear frosted, may only be clinging clay particles. Occasional small green grains could be glauconite. Gradational with overlying unit. ------------------------------ 1.1

2. Lost interval: 100 yards of gentle slope weathered to a deep sandy soil. ---------- 9.8

TOTAL: 75.1

CAMBRIAN

Wilberns Formation

Welge Sandstone Member

1. Sandstone: Sandy field strewn with boulders of red, quartzitic Welge sandstone, apparently brought up from shallow depth with roots of mesquites and scrub oaks bulldozed up when field was cleared. Thin coating of arkosic material seen on some boulders. ------------ 0.0

OUTCROP NO. 11

A bed of arkosic conglomerate crops out here at the downhill end of the stock tunnel under Texas Highway No. 29 approximately 100 yards west of and 10 feet lower than outcrop no. 10. The bed may be traced southward along the stream valley at the base of the spur of Cretaceous rocks which protrudes into the basin. The conglomerate bed is 2 to 3 feet thick. It is overlain by Cretaceous sandy clays and sands and is separated from the Morgan Creek limestone below by approximately 8 feet of sandy clay.

The conglomerate is cemented by soft to fairly hard light yellowish tan calcite. The conglomerate is composed of sand grains and pebbles of quartz up to 1/2 inch in diameter, often well rounded, and sand grains and sparse pebbles of weathered gray feldspar up to 3/16 inch in diameter. The average grain size for the bed as a whole is in the coarse sand-granule range, finer than at most other outcrops. In one small area the bed contains rounded pebbles of limestone of the Morgan Creek lithology which contrast sharply with the sand-sized matrix. The scarcity, small size, and weathered condition of the feldspar grains indicate that the material in this bed has been reworked.

OUTCROP NO. 12

Several large boulders of arkosic conglomerate up to 3 feet by 3 feet by 1.5 feet were dug up at this location during construction of Texas Highway No. 29 and now lie alongside the highway. More of the same material is exposed in the ditch beside the highway.

The conglomerate here is coarser than at most other outcrops. Quartz pebbles range from 1/4 inch to 1/2 inch in diameter, gray feldspar pebbles from 1/4 inch to 3/8 inch. The cement is white to tan, hard, crystalline calcite. There are a few cobbles of similar conglomerate scattered about that are cemented incompletely by hematite and silica, but none of this material was found in place.

This outcrop is located near the base of a slope which continues upward into bluffs of Cretaceous rocks to the northeast and east. The underlying rock is obscured in the immediate vicinity of the conglomerate outcrop. The soil in a plowed field approximately 300 yards to the south is weathered middle or lower (tan-brown) Hickory sandstone, and there is no sharp break in topography between this and the conglomerate outcrop. The conglomerate is probably underlain by Hickory sandstone.

OUTCROP NO. 13

A bed of arkosic conglomerate approximately 1.5 feet thick overlies the hematitic upper Hickory sandstone here. The bed consists of cobbles of indurated conglomerate up to 5 inches by 8 inches by 8 inches and unconsolidated arkosic gravel embedded in a matrix of hematitic clay. Pebbles of milky quartz and pink microcline average 3/16 inch to 1/4 inch in diameter. Cement in the boulders is all or nearly all hematite; little or no silica is present. The cement is continuous between the uppermost boulders of Hickory sandstone and the lowermost cobbles of conglomerate. Subround quartz pebbles up to two inches in diameter occur in the conglomerate bed.

OUTCROP NO. 14

At this location a bed of arkosic conglomerate lies over the hematitic upper Hickory sandstone and is overlain by Cretaceous sandstones and marls. It occurs as a thin veneer on the upper surface of the Hickory sandstone. Arkosic material is intermingled with the uppermost Hickory sandstone and the hematite cement of both is continuous across the contact. Thin bands of ferruginous silica occur in both the conglomerate and the uppermost Hickory sandstone. The estimated maximum thickness of the conglomerate bed is 1 foot. It is finer grained than usual. The average grain size is in the medium sand-granule range with occasional pebbles of milky quartz up to 1/2 inch in diameter and of pink microcline rarely up to 1/4 inch in diameter.

APPENDIX II

PALEOZOIC ROCKS EXPOSED ON THE WICHITA PALEOPLAIN IN THE AREA CONTAINING OUTCROPS OF ARKOSIC CONGLOMERATE

	FEET
Pennsylvanian	
Bend series	
Marble Falls group[1]	
Dark gray limestone which contains dark blue-gray chert. Occurs in down-faulted block underlying outcrop no. 2. ---	600 Max.
Ordovician	
Lower	
Ellenburger group[2]	
Light gray, sublithographic, non-glauconitic limestone with nodules of light gray chert ----------------------------------	1820 Max.
Cambrian	
Upper[3]	

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[1] Sellards, E. H., et al, The Geology of Texas, Volume I, Stratigraphy, University of Texas Bulletin 3232, 1932, p. 100.

[2] Seward, C. L., Unpublished notes on lectures by him at the Agricultural and Mechanical College of Texas, Geology 306, Spring Semester, 1953.

[3] Bridge, Josiah, et al, Stratigraphy of the Upper Cambrian, Llano Uplift, Texas, Geological Society of America Bulletin, Volume 58, pp. 109-124, 1947.

	FEET
Wilberns formation	
San Saba limestone member	
Glauconitic limestone. --------------	280
Point Peak shale member	
Easily eroded gray silty shale. -----	160
Morgan Creek limestone member	
Purplish brown, abundantly glauconitic limestone. --------------------------	120
Welge sandstone member	
Light brown quartz sandstone with recomposed crystal faces on grains. --	18
Riley formation	
Lion Mountain sandstone member	
Highly glauconitic sandstone. -------	37
Cap Mountain limestone member	
Glauconitic limestone. --------------	280
Hickory sandstone member	
Basal Cambrian sandstone. Conglomeratic at base, very hematitic in upper portion. ---------------------	360
Pre-Cambrian	
Metamorphic and intrusive igneous rocks.	

PLATE 3

SECTION AT OUTCROP NO. 10 5.3 MILES WEST OF GRIT, MASON COUNTY, TEXAS, ON TEXAS HIGHWAY NO. 29

SCALE: 1 INCH EQUALS 5 FEET

SEE PAGES 56–61

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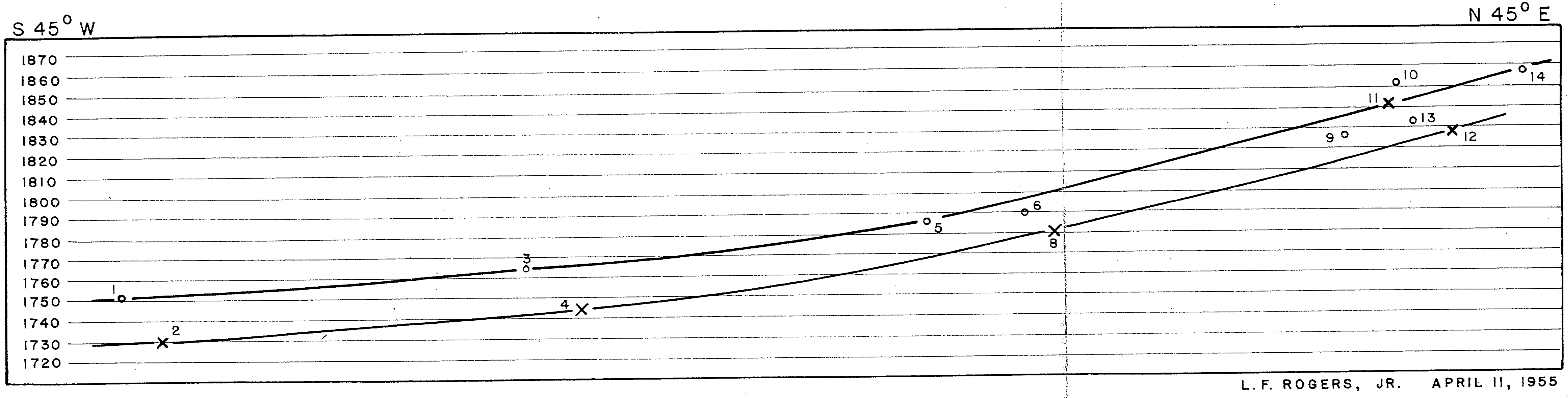
PLATE 2

TOPOGRAPHIC PROFILE



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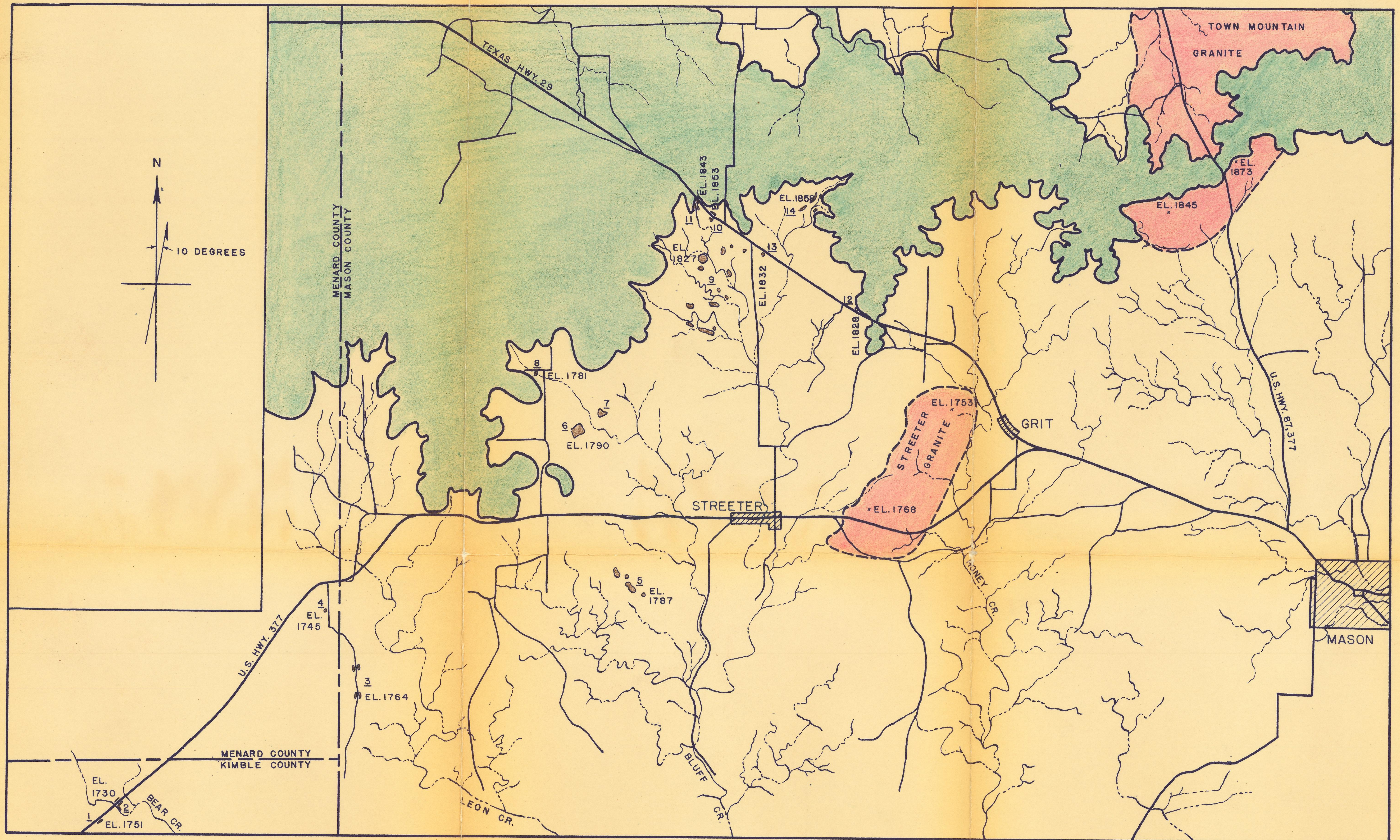
HORIZONTAL SCALE: 1 INCH EQUALS 1 MILE

VERTICAL SCALE: 1 INCH EQUALS 50 FEET

o OUTCROP ON HIGH TERRACE LEVEL

× OUTCROP ON LOW TERRACE LEVEL

PLATE I



LEGEND

LOWER CRETACEOUS MARINE SEDIMENTARY ROCKS	(green)
LOWER CRETACEOUS TERRESTRIAL ARKOSIC CONGLOMERATE	(outcrop symbol)
UNDIFFERENTIATED PALEOZOIC SEDIMENTARY ROCKS AND PRE-CAMBRIAN METAMORPHIC ROCKS	(blank)
PRE-CAMBRIAN GRANITE	(pink)
PAVED HIGHWAY	(heavy line)
UNPAVED ROAD	(light line)
INTERMITTENT STREAM	(dashed line)
OUTCROP NUMBER	12

ALL ELEVATIONS DETERMINED BY SURVEYING ANEROID.

GEOLOGIC MAP SHOWING OUTCROPS OF ARKOSIC CONGLOMERATE IN MASON, MENARD, AND KIMBLE COUNTIES, TEXAS

BASE: USDA PHOTO-MOSAIC DFZ USDA-429-48

SCALE: 1 INCH EQUALS 1 MILE

0 1 2 3 4 5 6 MILES