BUREAU OF ECONOMIC GEOLOGY
The University of Texas
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JOHN T. LONSDALE, Director

Report of Investigations—No. 11

Correlation Between Surface and Subsurface Sections of the Ellenburger Group of Texas

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Leo Hendricks

INTRODUCTION

The Ellenburger of Texas was first defined as a marine limestone formation of Cambrian and Ordovician age (Paige, 1912), but recently it has been subdivided into several formations and the term Ellenburger given group status (Cloud and Barnes, 1948). The group forms an important unit in the geology of Texas, its

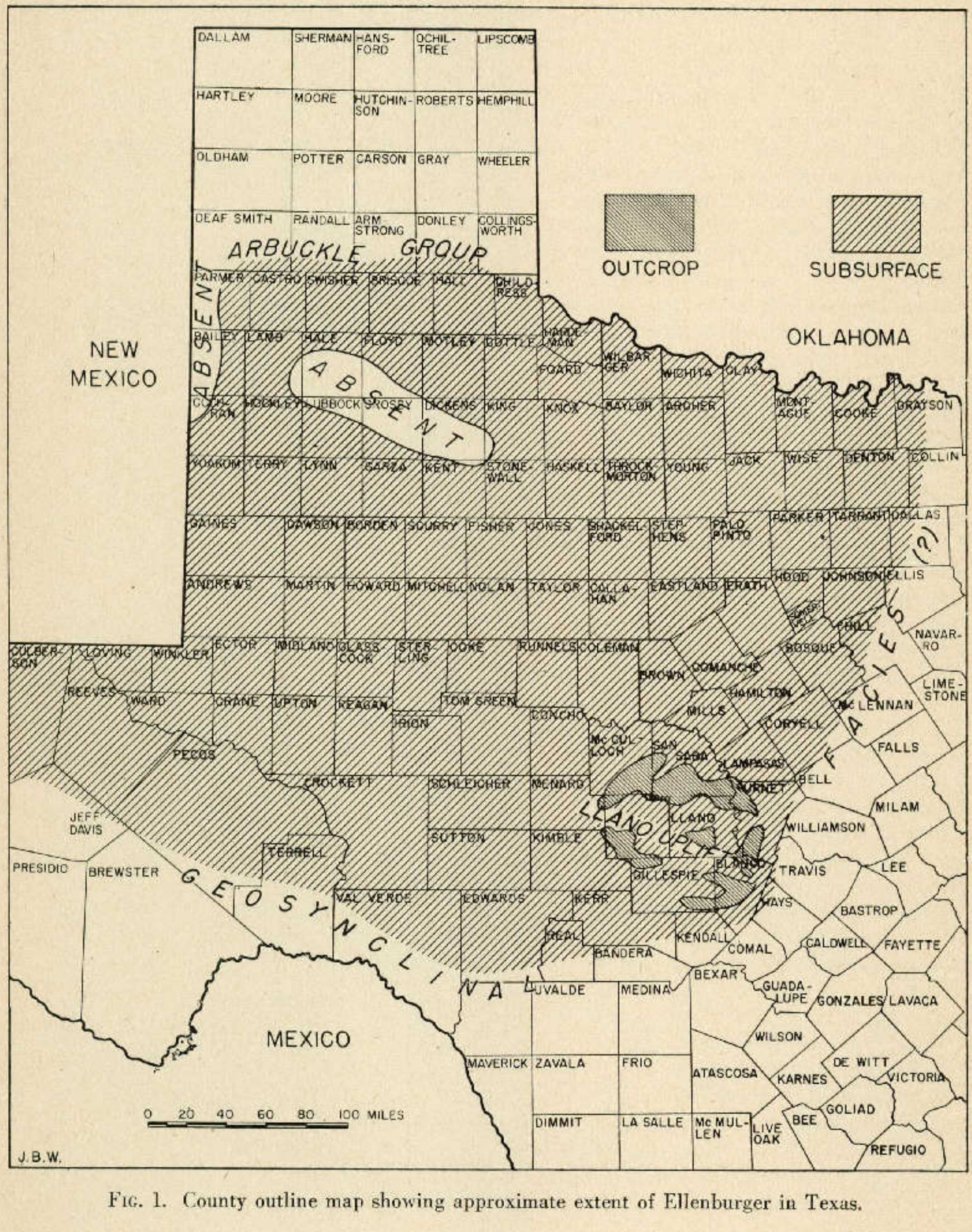

FIG. 1. County outline map showing approximate extent of Ellenburger in Texas.

known extent in both surface and subsurface covering approximately one-half of the State (fig. 1). Consequently the Ellenburger has received the attention of many geologists over a period of more than forty years. The greatest amount of information concerning the Ellenburger has come from wells drilled in exploration for oil and gas. This information from the subsurface is the basis for present concepts of the lateral extent and regional changes in thickness and lithologic character of the group (Sellards, 1933b). The top of the group serves as an important key horizon for mapping structure in the subsurface of large parts of north, central, and southwest Texas (Sellards and Hendricks, 1946). Data from well samples and cores have been used to make qualitative subdivisions and correlations within the formation (Cole, 1942, p. 1398; Crowley and Hendricks, 1945, p. 413). No paleontological correlations are possible from well data because well samples and cores from the Ellenburger are practically barren of fossils.

Use of the term "Ellenburger" has some geographical as well as geological limitations. Rocks in the subsurface of northern Texas referred to as Ellenburger are identical with rocks in the subsurface of southern Oklahoma referred to the Arbuckle group (Decker, 1939). The two groups exhibit recognizable differences in their respective type areas, but the gradation from one to the other is so gradual that no well-defined transition zone can be recognized. Both the Arbuckle and the Ellenburger are assumed to lose their identity eastward in a geosynclinal clastic facies of Ordovician rocks (Sellards, 1938). Southward the Ellenburger possibly grades in part into the limestone formation of Lower Ordovician age recognized in the Marathon uplift as the Marathon formation (King, 1937). Westward a portion of the Ellenburger probably grades into the Lower Ordovician El Paso limestone (Richardson, 1909). Northwestward the group in part may grade into the Manitou formation of Colorado (Brainerd, Baldwin, and Keyte, 1933). Thus the rocks referred to as Ellenburger are largely a facies unit deposited in a great epicontinental sea.

The best evidence for stratigraphic correlation of the group has come from field study and interpretation of faunal evidence from the outcrop. Dake and Bridge

Table 1. Thicknesses of units of the Ellenburger group (Lower Ordovician) as measured in various parts of the Llano uplift.

	Bear Spring area	Cherokee area	Gorman and Tanyard areas	Warren Springs–Moore Hollow area	Backbone Mountain area	Johnson City area
Ellenburger group (total)	973	1128	1457	1512	1457+*	1826
Honeycut formation (total)	......	142	325	453	402	679
Gorman formation (total)	450	426	474	456	483	490
Calcitic facies	237	275	383	242	263	246
Dolomitic facies	213	151	91	214	220	244
Tanyard formation (total)	523	560	658	603	572*	657
Staendebach member (total)	229	300	456	353	481*	415
Calcitic facies	......	176	137	121	......	33
Dolomitic facies	229	124	319	232	481*	382
Threadgill member (total)	294	260	202	250	91	242
Dolomitic facies	......	260	64	174	91	59
Calcitic facies	294	......	138	76	......	183

*Includes 100 feet allowed for a fault between the Gorman formation and the dolomitic facies of the Staendebach member of the Tanyard formation.

(1932) recognized several faunal zones of Cambrian and Ordovician age in the beds mapped as Ellenburger. In a recent co-operative project V. E. Barnes, of the Bureau of Economic Geology of The University of Texas, and P. E. Cloud, Jr., of the U. S. Geological Survey, (Cloud and Barnes, 1948) mapped portions of the Ellenburger outcrop in detail in the Llano uplift of Texas (Pl. I). A summary of their major concepts concerning the group follows.

The Ellenburger group is now limited to beds of Lower Ordovician age.

The Ellenburger is known to be present at the surface only in the Llano uplift region of central Texas, also known as the Central Mineral region. The group was studied and mapped in detail, and complete sections were measured in eight areas within the Llano uplift region (Pl. I). Reconnaissance studies were made throughout much of the outcrop area of the group, which surrounds and lies partly within the large topographic basin at the center of the Llano uplift. Three formations can be recognized as making up the group in the area of its outcrop.

The Tanyard, the oldest formation, is an inconsistent series of limestone and dolomite beds that averages 590 feet thick in seven measured sections. Changes in thickness are due chiefly to thinning from east to west. The limestones and dolomites characteristically have very abrupt lateral gradation from one to the other. Two members are recognized within the formation.

The Threadgill, lower member of the Tanyard, is predominantly dolomite but may be partly or all limestone, depending on facies. The member is essentially nonglauconitic, nonarenaceous, and without silt in the eastern side of the region, but silt is present in it on the western side. The member averages 234 feet thick in eight sections measured. Some bases for recognition in the field are diagnostic fossils, coarseness of grain of dolomite beds, typically nonporcelaneous chert.

The Staendebach, upper member of the Tanyard, generally is made up of a lower dolomite unit and an upper limestone unit but in places is all dolomite. The member averages 359 feet thick in seven sections measured. Field recognition is based largely on intermediate and fine grain size of the dolomite, the typically porcelaneous chert, and diagnostic fossils.

The Gorman formation lies on the Tanyard with some slight evidence of local disconformity. The formation consists generally of a lower unit of microgranular dolomite and an upper unit of limestone with dolomite occurring in the middle of this upper unit. The formation averages 463 feet thick in six sections measured where erosion had removed little or none of the rocks before later deposition. Recognition of the formation is based on diagnostic fossils, the usually very fine grain of the dolomites, the typically chalcedonic to porcelaneous chert, and the presence of sand grains occurring in zones.

The Honeycut formation, lying conformably on the Gorman, consists in its fullest known development of a lower unit of alternating limestone and dolomite, a middle unit of dolomite, and an upper unit of limestone. The dolomites are generally microgranular, and the cherts are chalcedonic to porcelaneous. Recognition depends on diagnostic fossils, generally lighter color of the dolomites, absence of sand except in the lower 50 feet. The formation was entirely removed by erosion before later deposition in the western half of the outcrop area, and it was differentially eroded over the remainder of the area. Thus no definitive upper limit can be placed on the formation from surface study. Its greatest known thickness at the surface is 679 feet.

Field evidence and succession of faunas indicate that deposition was almost if not entirely, continuous from time of deposition of the oldest to the youngest rocks in the Ellenburger group. Conglomerate at one locality and a slight irregularity of contact at another indicate a possible break in sedimentation between the Tanyard and the Gorman. Sediments apparently were rather pure, chemically precipitated, lime muds that became limestone or dolomite under diagenetic processes. The Ellenburger in the area of its outcrop is remarkably free of terrigenous material, sand in the Gorman formation being the most notable exception. The bulk of the evidence indicates that deposition occurred in a large, shallow-water area separated from land to the south and east by a deep trough, or by persistent currents that successfully withheld water-borne terrigenous material. Changes in faunal make-up from one level to another possibly were due to regional changes in ocean depth, salinity, temperature, or other conditions affecting life in the sea.

The Ellenburger lies with apparent conformity on the Upper Cambrian in the western part of the Llano uplift region, but irregularity of contact indicates it may be unconformable with the Upper Cambrian in the eastern part of the region. Throughout the Llano region the Ellenburger has a compound unconformity at its top, having been reached by erosion in some or all of its extent by at least eight cycles of erosion, each followed by overlapping deposition. Differential erosion has brought about a thinning of the Ellenburger westward across the area of its outcrop (Table 1, p. 6). Devonian and younger formations rest on successively older Ellenburger beds from east to west. The Honeycut formation has all been removed west of the longitude of western San Saba County.

The Ellenburger contains beds of earliest Ordovician age, being apparently conformable, in at least a part of its occurrence, with Upper Cambrian. The group does not contain beds equivalent to youngest Lower Ordovician in its outcrop area. Lower Ordovician beds younger than Ellenburger are present at the surface in the Marathon, Van Horn, and El Paso regions of west Texas, in the Wichita and Arbuckle Mountains of Oklahoma, and in the Ozark region of Missouri and Arkansas. Regional correlation with these areas is shown on Plate VI.

The above summary presents briefly the nature and stratigraphic significance of the Ellenburger as now defined in the area of its outcrop. In its subsurface occurrence the Ellenburger has been defined as including beds up to the base of the Simpson formation of Middle Ordovician age (Sellards, 1933a). Thus the Ellenburger in a portion of its occurrence may contain some beds younger than any occurring in the Honeycut formation in its thickest development. The youngest known beds assigned to the Honeycut formation are overlain by rocks of Devonian age. It seems most likely that the hiatus of the unconformity includes beds present underneath Middle Ordovician in west and north Texas. Whether those Lower Ordovician beds younger than Honeycut as defined should be included in the Honeycut becomes a matter of judgment based on evidence from many sections. Especially, subsurface sections of north Texas should be compared with sampled sections of Lower Ordovician rocks present in the Arbuckle and Wichita Mountains of Oklahoma.

An understanding of the occurrence of the Ellenburger formations in the subsurface involves the use of dependable correlative criteria common to both outcrop and subsurface data. Since faunal evidence obtained so far in well data is too rare to be of use, the physical or qualitative characteristics of the Ellenburger subdivisions offer the only recourse for correlative data to be found in both outcrop and well samples. The major lithologic characteristics may serve to distinguish the group as a whole from other rocks but do not offer evidence for widespread correlation within the group. Cloud and Barnes found that grain size in the dolomites was a general guide for recognizing some subdivisions, and this is true to some extent in more widespread subsurface correlation. The alternation of limestone and dolomite has no stratigraphic significance, since one grades laterally into the other in an unpredictable manner.

The insoluble residues of the Ellenburger offer the best qualitative evidence found to date for recognizing subdivisions within the group. The possibility of subdividing the Ellenburger in certain areas of its subsurface extent on the basis of insoluble residues alone has been demonstrated (Cole, 1942; Crowley and Hendricks, 1945). Cloud and Barnes noted characteristics of the chert impurities in the limestones and dolomites on the outcrop peculiar to certain formations. The characteristics are evident in both the embedded chert and the chert formed at the surface under the processes of erosion. It will be shown that samples taken from surface sections and digested in acid will yield residues that show a qualitative variance from one level of the Ellenburger to another. The change in residue quality does not coincide with formational boundaries in every case, but the points of change are sufficiently consistent that the residues offer a clue to formation identification, if not exact definition. The chief asset of the residues is the fact that variations in residue quality can occur with age despite little or no change in major type of sedimentation. The chief weakness of the insoluble residues as an aid to stratigraphic study of the Ellenburger is the fact that residue quality is an expression of facies and can change laterally with change in sedimentary conditions affecting deposition of insoluble material.

The term "insoluble residue" is here used in the same sense as others have used it (McQueen, 1931; Ireland, 1936). The samples were treated with dilute hydrochloric acid or, in some cases, with dilute acetic acid. The residual material is therefore known to be insoluble only in those acids.

One of the objectives of field work on the Ellenburger was to obtain sets of samples from measured sections whose insoluble residues could be compared with those from subsurface sections. Therefore Cloud and Barnes selected and marked sections that offered the best opportunity for obtaining samples from beds in place. The very careful and painstaking field work of Cloud, Barnes, and their assistants, principally L. E. Warren and R. L. Heller, has made it possible to collect dependable surface samples for comparison with subsurface samples. It is with great pleasure that this opportunity is used to express appreciation for the excellent manner in which they clarified the field relationships of the various sections. Grateful acknowledgment is made for their generous cooperation in gathering samples from the field for comparison with samples from the subsurface.

Other sources of help on the subsurface study of the Ellenburger include various oil companies and geologists operating in north and west Texas. Their generous help in making samples and residues available for study made the project possible.

The work of investigation has been carried on under the auspices of the Bureau of Economic Geology of The University of Texas, and the writer wishes to acknowledge the great value of the assistance and encouragement received from the Director of the Bureau.

ACQUISITION AND STUDY OF RESIDUES FROM SURFACE SECTIONS

The insoluble residue characteristics of each of the Ellenburger formations presented here are revealed in samples from measured sections in each of the areas mapped in detail by Cloud and Barnes (Pl. I). The samples are from six composite sections, representing the total measureable thickness for each of the six areas, and from one incomplete section. The sections are designated as follows:

1. Gorman Falls—Tanyard
2. Cherokee Creek
3. Warren Springs—Moore Hollow
4. Backbone Mountain
5. Johnson City
6. Threadgill Creek
7. Llano River

Sampling the sections was done in part by Cloud, Barnes, and assistants and in part by the writer, assisted by L. E. Warren. All the sampling was based on measurements by Cloud and Barnes. Preparation of all residues was under the supervision of the writer.

In sampling the Ellenburger, fresh chips were broken from beds at as short vertical intervals as exposures would allow. Chips from a 5-foot interval were combined to form one sample. Different types of rock occurring in a 5-foot interval were represented in their proper proportion so far as sight judgment could allow. Each sample was crushed in a small jaw crusher and a thorough mixing of fragments from each chip obtained. A uniform portion of each crushed sample, averaging about 30 grams of the material, was used in making residues. The fines were not screened from the crushed material, but the rock flour resulting from the crushing was removed by washing and decanting before adding the acid. Solution was carried out in 400-ml. pyrex beakers, using approximately 12 percent hydrochloric acid, or approximately 10 percent acetic acid. After complete digestion of the soluble rock the clay-size particles were removed from the residue by washing and decanting. The remaining residue was dried on an electric hot plate and bottled.

This method of collecting and preparing surface samples for study was followed because experience in using residues from the Ellenburger as an aid in stratigraphic study has shown that the mass characteristic of the residues is the most informative. Few, if any, residual materials are individually diagnostic of a formation. Hence in sampling for residue study, as much as possible of the vertical extent of the formation must be included. Trench sampling would be ideal but is impractical. Spot sampling at intervals of a few feet will not catch enough of the mass characteristics.

The residues were examined under a binocular microscope, using a magnification of 15.6 diameters for the most part. Light source was a fluorescent lamp with a daylight-type bulb. The data considered were almost entirely qualitative, being quantitative only to the extent of sight comparison of quantities of materials.

Residues obtained from the Ellenburger by treating with hydrochloric acid are made up of four broad types of material—chert, non-clastic quartz, clastics, and accessory constituents. Each of these types occurs in a variety of forms and combinations, thus producing the qualitative variations that are significant in stratigraphic interpretation. Chert is the most significant material, occurring in a wide variety of textures, structures, and degrees of transparency. The distinction between chert and quartz is somewhat arbitrary, since all types of chert are varieties of the mineral quartz. In describing the residues the term quartz is reserved for material with the fracture, luster, and crystal habit of the mineral. By assigning symbols, either colored or drawn, to represent the various materials in residues, the succession found in a section can be presented on a log strip. Correlation between sections can best be accomplished by matching plotted logs.

Samples from limestone beds in the Ellenburger may be dissolved in acetic acid, in which the dolomite is insoluble. Samples from the limestone portions of several sections, both surface and well sections, have been treated with acetic acid for comparison with residues from hydrochloric acid. Few differences have been discovered between the two types of residues. The acetic acid residues from surface sections have yielded a few conodonts, but they are much too rare to be of use in stratigraphic work. The effervescence from acetic acid is less violent, thus leaving more of the delicate clay and fine clastic aggregates intact. This particular quality of the residues is an aid in distinguishing fine-grained, gray Ellenburger limestone from similar Mississippian limestone in the subsurface of north Texas. Soft shale fragments preserved in the acetic acid residues from the Mississippian limestone contain fossil imprints while those from the Ellenburger limestone do not. Although acetic acid residues do not seem to offer much additional aid in the area and portions of the section where they have been used, the method has not been given an exhaustive trial. In other areas and portions of the section positive results may be obtained.

Table 2. Genetic classification of residues.[1]

ALLOGENIC	AUTHIGENIC	
	Syngenetic	Epigenetic
Silt	Chert (segregated)	Chert (interstitial)
Sand	Shale partings	Quartz
Shale fragments	Clay masses	Siliceous oolite and ooliths
Mineral fragments (e.g., mica)	Pyrite (crystalline)	Pyrite (interstitial)
	Glauconite	Anhydrite
Siliceous spicules	Sedimentary feldspar, mica	Replaced fossils
	Fossil fragments	

[1]Ireland (1936) has given a similar classification of residues from lower Paleozoic formations of Oklahoma.

EVALUATION OF RESIDUES AS AN AID IN ELLENBURGER STRATIGRAPHY

The insoluble residues obtained from the Ellenburger deposits represent the accessory constituents in the main body of rock. They are the products of minor sources of deposits which were greatly overshadowed by the carbonate deposits. The degree of relationship between the sources of these major and minor deposits may vary widely. On the one hand, sand grains and shale fragments in the residues represent mechanical deposition in the midst of a chiefly precipitated sediment and are syngenetic deposits in relation to the enclosing rock. Although they are very closely related to the major sediments as to time of deposition, they may have an entirely independent source. On the other hand, the various types of chert found in the residues represent deposition from solution, just as the carbonates do. Part of the cherts appear to be syngenetic in relation to the enclosing rock, and part have a secondary or epigenetic appearance. The source of the syngenetic cherts may be the same as, or very closely related to, the source of the major sediments. The epigenetic cherts may be the result of alteration of syngenetically deposited siliceous material, or their silica may have been brought in by circulating ground waters after the deposition of the carbonates and their accompanying syngenetic materials.

It is conceivable that minor sources of sediments, such as furnished the insoluble materials, may be modified or completely disrupted by a change in conditions too small to be reflected in the major portion of the sediments. For example, the failure of some transporting agent that had been depositing scattered sand grains in a calcareous deposit would not necessarily affect the deposition of limestone. Likewise, the modification of chert formation in minor amounts would not necessarily affect the carbonate deposits. However, any change in conditions that modified the type of insoluble accessory materials being deposited would be evident in the insoluble residues. Thus the residues may in some cases afford a more sensitive tool for detecting changes in conditions than the bulk of the sediments.

Accessory materials undoubtedly exhibit lateral gradation from one type to another during the same time interval, varying with the numerous local conditions influencing sedimentation in a basin. Some accessory materials, however, appear to be the result of regional influences and carry through minor changes in local conditions. Those changes in residues due to change in local conditions may be used for local correlation only. A more widespread change due to modification of regional influences may be used for wider correlation. Average temperature and solute content of the water, for example, are regional conditions subject to modification that may affect the accessory materials throughout a sedimentary basin.

In using insoluble residues as an aid in stratigraphic study of the Ellenburger each type of residue material has been carefully evaluated and is relied upon in correlation only within the probable limits of its dependability. The syngenetic cherts are the most widespread of the insolubles and are the most thoroughly disseminated through the group. This, perhaps, is due to their being rather closely related in method of deposition to the major sediments, which indicates that they are the result of regional influences and not local conditions. By the nature of their occurrence, then, the syngenetic cherts are the most important and diagnostic of the residue materials.

Other significant materials in the residues may be of diagnostic value but to a lesser degree than the syngenetic cherts. Any of the mechanically deposited materials such as sand grains, shale inclusions, and silty material may occur in zones that can be correlated locally—within the limits of an oil field, for example. Silicified ooliths and oolitic cherts are more likely to be due to specialized local conditions than to widespread influences.

RECOGNITION OF THE ELLENBURGER FROM STUDY OF SAMPLES

Gross lithology has long been a criterion for recognizing Ellenburger rocks from samples. Typical Ellenburger limestones have a high degree of purity, light color, sublithographic texture, and complete absence of any direct evidence of organic origin. Fracture of the limestone is sharp, with a minimum of powdering along the edges of small chips in crushed samples. Typical Ellenburger dolomites have a well developed sucrose texture, are generally light in color, and also exhibit a high degree of purity. These characteristics usually serve to distinguish the group from all rocks found lying immediately above the Ellenburger in the outcrop region. Dolomite in the Edwards formation of the Lower Cretaceous is the only similar rock in the area.

Recognition of the base of the Ellenburger from samples can be quite difficult where similar lithologies are in contact at the systemic boundary. In the eastern and southeastern portion of the outcrop area Ellenburger dolomites rest upon Wilberns dolomites, as illustrated by the Johnson City section and the Gorman Falls-Tanyard section (Pl. II). The Wilberns dolomite is usually finer grained than the Ellenburger dolomite. Stratigraphic recognition is aided by a study of insoluble residues. Lowermost Ellenburger dolomites are characteristically lower in residue content, with the residues being marked by the presence of granulated chert and waxy shale flakes. Wilberns dolomites usually furnish more residue, with granular chert predominating and drusy quartz common.

In the western part of the outcrop area silty, somewhat impure Ellenburger limestones containing some glauconite rest on similar limestones in the Wilberns formation, as shown by the Llano River section (Pl. II). Here the texture of the limestones and the glauconite content furnish clues to stratigraphic identification. The Wilberns limestones are typically granular, in contrast to the extremely fine to sublithographic texture of the Ellenburger limestones, and contain a greater abundance of glauconite. Comparative abundance of glauconite is most easily observed in the residues from the limestones.

Residues alone are not a dependable source of evidence for identifying the Wilberns-Ellenburger contact throughout the outcrop area. Ellenburger-type residues, dominated by cherts, and Wilberns-type residues, high in silty, argillaceous material, can be recognized in samples from those formations throughout the outcrop area. But in the eastern sections Ellenburger-type residues extend down into the Wilberns dolomites, and in the western sections Wilberns-type residues extend up into the Ellenburger. In the eastern sections the boundary can be determined fairly closely from the residues because of a change in the nature of the chert, as noted above. In the western sections, however, no widely dependable diagnostic change occurs in the silty, argillaceous residues present both above and below the boundary. Increase in the amount of glauconite is an indication of Wilberns age. This, together with the granular texture of the limestones, seems to be the best criterion for distinguishing Ellenburger from Wilberns in samples from the western portion of the outcrop area.

The transgression of silty, argillaceous residue material across time lines as established by fossil evidence is shown on Plate II. The insoluble material is typical of Wilberns limestones but does occur in Wilberns dolomites; for example, in the Warren Springs-Moore Hollow section the material is present in the lower portion of the Pedernales dolomite member. Farther west, in the Threadgill Creek section, the lower half of the Threadgill member of the Tanyard formation yields silty, argillaceous residues. Still farther west, in the Llano River section, the material occurs throughout the Threadgill. The upper limit of the occurrence of silty, argillaceous residues in the Cambrian-Ordovician sections is presented as a transgressing but recognizable boundary on the correlation chart of Plate II.

RECOGNITION OF FORMATIONS IN ELLENBURGER GROUP

Recognition of the formations in the Ellenburger group from a study of systematically sampled sections must be based on rock characteristics alone since no microfaunal evidence is present. The rock characteristics considered in the Ellenburger samples consisted of the lithology and texture of the original rock and the various types of materials present in insoluble residues from the samples. Standard lithologic logs were prepared of all composite sections that were measured and sampled. In addition, highly detailed logs of the residues from each section were made. Comparison of the lithologic and residue logs from all the surface sections demonstrated that recognition of the Ellenburger formations from sample logs is possible to a fair degree of accuracy.

The standard lithologic logs showing texture of the dolomites can serve only as general guides when used alone. The best evidence for recognition of formations is found in the combinations of residue associations shown on the residue logs. The lithologic logs can be an aid in deciding exact points when used with the residue logs, for it often seems logical to place a formation top where a change in lithology or texture occurs.

Careful study of the highly detailed residue logs showed that the residue materials most pertinent to the recognition of the formations can be classified as follows:

Non-granular chert
Granulated chert
Non-clastic quartz
Sand
Silt
Argillaceous material
Glauconite

Consequently a set of black and white and color symbols was devised for showing on logs the occurrence of these materials in the surface sections.

Non-granular chert is that in which no grain could be distinguished under low magnification. Chalky, earthy textured cherts, porcelaneous cherts, and intermediate types bordering on granular were usually logged as non-granular. Those logged as granular showed a definite grain on the broken surfaces. The granulated chert occurs in very rough irregular fragments that have the appearance of being aggregates of irregular chert grains.

The non-clastic quartz includes fragments of the mineral quartz that are dolomoldic, drusy, or show other evidence of having been deposited in place in the rock.

The sand grains are rounded to subrounded, usually frosted, quartz fragments. The silt is made up of silt-size siliceous grains which appear to be clastic in origin. Some of the material, however, may be the result of precipitation and growth of small grains in place. The silt occurs both free and embedded in argillaceous material.

The argillaceous material includes flakes of shale, clay-like masses, and spongy, porous masses not properly described as either clay or shale.

For detailed discussion of residue material, see page 18.

TANYARD FORMATION

The outstanding sample characteristic of the Tanyard formation in the standard section area of Tanyard and Gorman Falls (Pl. II) is the predominance of granular chert in the residues of all but the uppermost beds of the formation (sample descriptions, p. 36). Non-granular chert ranging from smooth, conchoidal to chalky in appearance may be present but not as abundantly or persistently as granular chert. The granular chert from the dolomitic facies of the Tanyard is characteristically dolomoldic. Drusy quartz is fairly common in the formation. The chert and quartz of the formation are largely interstitial in occurrence below the weathered surface, although large masses of chert form at the surface as a result of concentration under weathering processes. Thus, crushed samples of Tanyard rocks do not commonly show free fragments of chert, even though the percentage of insoluble residue may be high. Oolitic chert, both granular and non-granular, appears sporadically in the Tanyard section.

In the eastern sections the Threadgill member of the Tanyard formation can be distinguished on the logs from the Staendebach. The Threadgill member contains the special type of granular chert best described as granulated chert. The chert appears as very rough, highly granulated fragments, added to the other chert materials common to the Tanyard. In some samples the granulated chert becomes the most abundant material. Green and red waxy shale flakes also appear more consistently in Threadgill residues than in Staendebach residues. Threadgill samples average a noticeably smaller percentage of residue material than either Staendebach or Wilberns dolomite samples.

A marked change occurs in the nature of the residues from Tanyard samples in moving westward across the outcrop area. The residue log of the Threadgill Creek section, Gillespie County (Pl. II), shows normal Tanyard-type residues from the upper half of the member, but the lower half has the argillaceous, silty residue material similar to residues from the underlying Wilberns. In the Llano River section, located still farther west in Mason County, the silty, argillaceous residues have replaced cherty residues through all of the Threadgill and have transgressed slightly into the base of the Staendebach. Most of the Staendebach section has normal Tanyard residues, with one notable feature: the granulated chert typical of Threadgill in the eastern sections is present in the Staendebach in the Llano River section. Thus, the upper Tanyard can be recognized from residue samples in the western outcrops, but the lower portion is better distinguished by the subgranular texture of the limestones, as noted previously.

The uppermost beds of the Tanyard, averaging about 100 feet in the outcrop sections, do not furnish residues that are typical of the remainder of the formation. The cherts in the upper beds are largely non-granular and are similar in nature to those from the overlying Gorman formation. The chief distinction between the residues of the upper beds and those from the Gorman is the absence of sand in the Tanyard residues. This criterion appears dependable throughout the outcrop area.

It will be noted on the lithologic logs (Pl. II) that the texture of the Tanyard dolomites ranges from coarse to fine, with coarse and medium predominating. The coarsest dolomites are found in the dolomitic facies of the Threadgill member, with the Staendebach dolomite grain averaging somewhat smaller. The Tanyard limestones all have a very smooth fracture and are subgranular. In the eastern sections the limestones are pure and very light in color. In the western sections the lower limestones become grayish and furnish silty, argillaceous residues.

Gorman Formation

Residue logs of the Gorman formation outcrop sections (Pl. II) show the chief constituents to be non-granular chert and sand. (Sample descriptions of type section, p. 26.) Subordinate materials are granular chert, quartz, shale, and other argillaceous material. The non-granular chert consists largely of smooth opaque and smooth translucent varieties but includes some chalky and subporcelaneous. The chert for the most part is not interstitial, and free fragments are found in the crushed samples of the rock. The chert occurs in thin seams, beds, and irregular nodules in the limestones and dolomites and because of its manner of occurrence is not typically dolomoldic. Zones of oolitic chert are present. Near the middle of the formation some of the chert usually contains embedded sand grains. The sand in the Gorman residues is composed of pure, frosted quartz grains, and the larger grains are rounded. The sand occurs both as scattered, individual grains and as sandy zones in the formations. Grain sizes in the sandy zones show poor sorting, ranging from fine to medium coarse.

The dolomites of the Gorman are persistently finer in texture than the Tanyard dolomites in the eastern Ellenburger sections. Grain sizes are fine to very fine. However, in the Llano River section the lower dolomites of the Gorman are coarse in texture.

The occurrence of sand together with the grain size of the dolomite in the eastern area furnish the criteria for determining both the base and the top of the Gorman from samples. The overlying Honeycut contains very little sand except in the lower 50 feet of beds.

Honeycut Formation

Residues from the Honeycut formation are composed largely of non-granular chert, similar to that in the Gorman. (Sample descriptions from Gorman Falls—Tanyard section, p. 23.) In general, there is a slightly smaller percentage of insoluble material in the Honeycut than in the Gorman. Scarcity of sand in the Honeycut residues, however, is the most noticeable difference in surface sample residues from the two formations. Thus, recognition of the Honeycut from residues must be based largely on the predominance of non-granular chert, with the absence of the sand that characterizes the Gorman. Dolomites of the Honeycut are similar to those of the Gorman but show a tendency to be finer textured. Most of the microgranular dolomite of the Ellenburger group is found in the Honeycut samples.

POINTS OF CORRELATION ON THE ELLENBURGER SURFACE SECTION SAMPLE LOGS

The type section for the Ellenburger group, as designated by Cloud and Barnes (1948), is the composite section made up of their Gorman Falls, Spicewood Creek, and Tanyard sections. They designated the composite section made up of their Warren Springs and Moore Hollow sections as a standard section for the Ellenburger. The logs of the two composite sections therefore are type logs to which other logs should be referred. Several correlative points are evident on the two logs that can be recognized on the logs of the other surface sections.

The most marked and persistent feature of the logs is the change on the residue logs from non-granular cherts above to granular cherts below at a level near the top of the Tanyard formation. The level marked by the change serves as a dependable correlative horizon for relating the sections on the basis of sample evidence. When the logs are leveled on that horizon, the tops of the Tanyard as determined by field and fossil evidence are not far from alignment. Thus it is felt that any section of the Ellenburger including this portion of the section can be closely correlated with the type Ellenburger section.

The presence of sand in the Gorman and in the base of the Honeycut and the absence of sand in the Tanyard are other characteristics appearing on all residue logs of those formations. Hence, the lowest occurrence of sand makes a fairly good correlative point, marking approximately the base of the Gorman.

A granulated chert zone is present in the Tanyard on all residue logs showing the complete formation. The granulated chert appears in the Threadgill member in the eastern sections and in the lower part of the Staendebach in the westernmost section.

The granulated chert zone is a good correlative marker in the facies of the Ellenburger represented by the eastern sections but indicates somewhat younger beds with changing facies westward.

A sandy chert zone is typically present near the middle of the Gorman formation. The chert is usually free of sand even though sand is abundant in the residue. But in this particlar zone many of the sand grains are embedded in the chert.

The horizons present on the residue logs listed above furnish the means for correlating the logs of the sections and are a valuable aid in recognizing formations from sample information. No distinctive feature of the gross lithology occurring persistently at a given level is evident from the sample study.

PROBLEMS IN RECOGNIZING ELLENBURGER FORMATIONS IN THE SUBSURFACE

The subdivision of the Ellenburger into formations rests primarily on faunal evidence. But in choosing formation boundaries Cloud and Barnes used the best physical breaks available in the rather homogeneous group of beds. Thus the formations are essentially time-rock units with fairly mappable boundaries marked by changes in such physical characters as grain size of the dolomite, occurrence of sand, and nature of contained chert. When physical evidence fails, fossils can be sought to help establish formation boundaries in surface mapping. Each formation carries a definite age meaning.

Recognition of formations from subsurface samples must be based on physical evidence alone. The point of greatest concern is whether or not the physical evidence available continues to have the same age significance that it has at the surface. Evidence from the surface section sample logs supports the idea that some of the physical evidence usable in correlating the sections does have age significance. The most dependable horizon recognizable in the samples is the level marked by the change from non-granular to granular chert in the residues. This change occurs consistently near the top of the Tanyard formation, regardless of the location of the section. Other marked zones, such as the granulated chert zone of the Threadgill member and the sandy chert zone of the Gorman formation, appear to have consistent age significance over a large area in the eastern portion of the outcrop area. In a westerly direction the granulated chert zone to some extent appears to migrate up the section across time lines. It is in the eastern portion of the outcrop area that the type and standard sections are located. Therefore, the succession as developed in the eastern sections may be thought of as representing typical Ellenburger facies. Sample log evidence indicates that where typical Ellenburger facies is developed the physical evidence has age significance, and the time-rock unit type of formation can be recognized on the basis of that evidence.

CORRELATION OF ELLENBURGER SUBSURFACE SECTIONS

Central Texas to North Texas

Hundreds of wells have penetrated a portion of the Ellenburger section in the subsurface of north-central and north Texas. A few wells have drilled through the group, and many have drilled several hundred feet. Enough sections are available for general correlation of the Ellenburger beds of the area with the formations defined at the surface.

Plate III presents the plotted logs and stratigraphic correlation chart for a series of sections on a traverse from the southern side of the Llano uplift northward to northern Archer County. All formations described at the surface can be recognized along the traverse at least as far north as Erath and Somervell counties. In northern Archer County the Tanyard-Gorman boundary can be determined, but available criteria fail to distinguish the Gorman-Honeycut boundary or to establish clearly the base of the Tanyard. Residues from the entire upper Ellenburger section become notably arenaceous in extreme north Texas. It is felt that the subsurface Ellenburger sections in this area can best be correlated with surface sections exposed in the Wichita Mountains of Oklahoma.

Plate IV presents the sections and their correlations on a traverse from Fisher County eastward to Somervell County.

The well sections of north Texas have been correlated with the surface sections very largely on the basis of evidence on the residue logs. The best control point for correlating the sections is again the contact of the granular and non-granular chert zones, as was true with the surface sections alone. This characteristic change in chert type has been observed in all the wells investigated in north Texas that contain that particular portion of the section. Because of its persistent appearance near the same stratigraphic level throughout the outcrop area, the level is considered a fairly dependable time marker. For this reason the top of the Tanyard has been placed at the top of the granular chert zone in the subsurface sections. This probably results in a slight error in correlating with the surface sections, but it does offer a consistent correlation of the top of the formation from well to well.

The criteria for recognizing the base of the Tanyard change with geographic location. The problem seems identical with that encountered at the surface. The most easterly wells that pass through the Ellenburger encounter a dolomite section below beds bearing typical Tanyard residues (Seaboard No. 1 Dawson in Hamilton County, Pl. III, and McCarthy No. 1 Hedrick in Erath County, Pl. IV). Residues from this lower dolomite section are similar in nature and abundance to those from the Pedernales dolomite member of the Wilberns formation. They are therefore considered Cambrian in age. The lower portion of the Tanyard in the easterly sections contains residues typical of the Threadgill member; that is, a proportionately small amount of residue containing waxy shale flakes and some granulated chert. Sections penetrated so far indicate that the Threadgill and Staendebach members of the Tanyard are recognizable in an area extending from western Eastland County to eastern Erath County in width (Pl. IV) and reaching northward at least through the latitude of the north edge of Erath County. The top of the Cambrian in the eastern sections in this area is placed at the point of sudden increase in amount of residue, which contains an abundance of granular, drusy, dolomoldic chert and drusy quartz.

In moving west across the above described area the Upper Cambrian residues change from predominantly chert to silty, argillaceous material. On the basis of evidence seen in the surface sections it is assumed that the change to silty argillaceous residues continues upward into the Tanyard formation in a westerly direction. In eastern Taylor County (Pl. IV) the lowermost Tanyard beds apparently contain such residues. Therefore, from about the longitude of eastern Taylor County westward the Tanyard-Cambrian boundary is best determined on the granularity of the limestone, if present, and abundance of glauconite in the Cambrian, as is the case in the western portion of the outcrop area.

Determination of the Gorman-Honeycut boundary can be made with less assurance than the other stratigraphic boundaries in the section. The sandy character of the Gorman residues is a general guide throughout most of the north Texas area. Accordingly the top of the Gorman is placed at the top of the persistently sandy residue section found in wells in the area extending from the outcrop of the Ellenburger northward to approximately the Archer-Young County line. From about this latitude northward the entire upper Ellenburger section furnishes sandy residues, and the Gorman and Honeycut have not been distinguished from each other in sections in Archer and Wichita counties.

It is the opinion of the writer that complete Ellenburger sections in the Archer-Wichita County latitude include beds that are younger than Ellenburger at the outcrop. A careful comparison should be made of sample criteria from the subsurface sections with sample criteria from surface sections in the Wichita and Arbuckle Mountains of Oklahoma. Such a comparison may reveal evidence for correlating the extreme north Texas Ellenburger with formations of the Arbuckle group. Should this be so, the youngest Ellenburger beds of north Texas may correlate with the upper Kindblade or lower West Spring Creek formation of Oklahoma. Cloud and Barnes (1948, p. 65) considered the West Spring Creek and approximately the upper third of the Kindblade to be younger than Honeycut at the outcrop.

Plate IV presents the thinning of the Ellenburger group westward by erosional loss at the top and probably depositional thinning of the Tanyard at the base. In Taylor County the Honeycut is missing, 185 feet of Gorman remains, and the Tanyard is 370 feet thick. In Fisher County all the Honeycut and Gorman section is missing, and only 300 feet of Tanyard is present to represent the group.

Prolific oil production from the Ellenburger has been found in only one field to date in north Texas. The K. M. A.-Ellenburger field of Wichita and Archer counties is producing in part from the top of the Tanyard and in part from the base of the Gorman formation (Shell No. 18E Preston, Pl. III). Crowley (1946)[2] has shown that there is a remarkable difference in the initial potential production from the two formations. The wells completed in the Tanyard in general have initial potentials greater than 1,000 barrels of oil per day. The wells completed in the Gorman in general have potentials less than 500 barrels per day.

Central Texas to West Texas

Wells drilled in an area extending westward from the southernmost edge of the

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[2]Contact of Crowley's Units B and C is the Gorman-Tanyard contact of this paper.

Ellenburger outcrop area encounter a uniform section of Ellenburger beds. Plate V presents the logs and a correlation chart for a traverse extending from Blanco County westward to Crane County. The sections have been correlated almost entirely on the basis of the residue logs. Residues are sufficiently similar to those of the outcrop samples to permit a reasonable correlation.

The Tanyard formation is recognized by the granularity of its chert residues. Most of the Tanyard sections contain a granulated chert zone, similar to the Tanyard of the Llano River section in Mason County (Pl. II). The major change in residue characteristics is the presence of sand in the west Texas sections. The Tanyard is underlain in some sections by a highly glauconitic limestone which is tentatively correlated with the Wilberns formation of central Texas. This correlation admittedly is debatable, it being possible to argue that the glauconitic limestone facies of the Wilberns has simply migrated up the section into beds of Ordovician age. The Tanyard of west Texas is less than half as thick as that at the outcrop. Most Ellenburger sections in west Texas have about 300 feet of Tanyard. Lithologically the Tanyard of west Texas is a medium to coarse dolomite. Good porosity is evident in some portion of most sections.

The Gorman-Tanyard boundary is placed at the top of the section dominated by granular chert as in north Texas. The Gorman residues of west Texas contain a slightly larger percent of granular chert than do those of central Texas, but non-granular chert is a persistent and usually dominant constituent of the Gorman residues. Also the granular chert in the Gorman is extremely fine to subgranular. Sand is commonly present, usually as free grains. But a non-granular, sandy chert zone in the upper part of the formation is characteristic. The upper boundary of the Gorman is not a well-defined horizon but must be determined by correlating horizons above and below the boundary, as noted below.

The upper part of the Gorman is composed of very fine dolomite, showing little evidence of porosity. The lower portion of the formation is made up largely of medium to coarse dolomite. These lower beds exhibit sporadic zones of porosity.

All the Ellenburger above the Gorman in west Texas is here placed in the Honeycut formation. Correlation of the residue logs and thicknesses of sections indicate that only a minor portion of the Ellenburger of west Texas is younger than the youngest Honeycut exposed at the outcrop (Pl. V). There is no marked physical evidence for defining a formation younger than Honeycut. Therefore, it is considered logical to place the youngest Ellenburger beds in the subsurface of west Texas in the Honeycut, even though some of those beds may be younger than any Honeycut at its type locality.

The residues of the Honeycut are largely non-granular chert, with some sand and granular chert. Both sand and granular chert occur in slightly smaller percentages than in the Gorman. One granulated chert zone occurs rather persistently in the lower part of the formation. This granulated zone and the sandy chert zone in the upper part of the Gorman serve as correlative aids in determining the Gorman-Honeycut boundary. The boundary is placed between the above described zones at a point on the residue logs where there is a slight increase in residue percentage, with an increase in the percentage of granular chert in the residue. This point is usually about midway between the granulated chert zone of the Honeycut and the sandy chert zone of the Gorman.

The Honeycut in most localities contains a sublithographic, white limestone member in its upper part, with the remainder of the formation being composed of very fine to extremely fine dolomite. Any porosity present is correspondingly fine. The formation is rendered more porous and permeable by fracturing in areas of sharp structural disturbance.

The series of sections and logs presented on Plate V are designed to establish a reference cross section to which other sections in west Texas can be referred. The traverse of the sections follows the trend of what may be termed the "normal" facies of the Ellenburger. That is, all the formations are present and contain lithology and residues similar to the type and standard sections of the Ellenburger. Farther westward this facies must grade into the impure dolomitic rocks making up the El Paso formation exposed on

Beach Mountain in the Van Horn region. Southward the Ellenburger of west Texas must eventually grade largely into the impure limestone facies represented by the Marathon formation exposed in the Marathon uplift. But until the Ellenburger loses its identifying characteristics in adjacent facies it should be possible to recognize its formations by comparison of insoluble residue logs.

Excellent oil production has been obtained from all portions of the Ellenburger section in west Texas. Both fracture and interstitial porosity occur, depending on the geological history of the structure. The sections on Plate V include the Humble No. 4-C Fee, a well in the Todd field of Crockett County where Ellenburger production is from the Honeycut formation.

SYSTEMATIC DISCUSSION OF RESIDUES[3]

Chert

The term "chert" is applied to the cryptocrystalline varieties of quartz found in the residues, regardless of color. The chert is composed mainly of microscopic fibers of chalcedony or particles of quartz, or a mixture of both. The quality of the chert that has proven to be diagnostic in studying the Ellenburger is texture. Three main textural groups found in the Ellenburger residues have been designated as *smooth*, *granular*, and *chalky*. The majority of the chert encountered can be readily placed in one of the major groups, with a small minority showing intermediate nondeterminate characteristics. Each of the textural groups shows variations in appearance, making it possible to subdivide each group into recognizable types.

The chert described as smooth textured has a conchoidal to flat fracture surface devoid of roughness. It has no distinctive structure, crystallinity, or granularity. Some of it is botryoidal in form. The types recognized are ordinary, chalcedonic, and porcelaneous. The ordinary smooth chert typically has a flat fracture, may be any color but is usually white or gray, is mostly opaque but some variations show slight translucency. It occasionally presents a mottled or flocculated appearance. It is generally homogeneous but may have slight evidence of granularity or crystallinity. The chalcedonic smooth chert is transparent to translucent and is described as smoky, milky, waxy, or greasy in appearance. Variations are tinted with various colors, but the most common is light blue-gray. It can also be finely mottled or have flocculated inclusions. The fracture is more usually conchoidal than flat. The porcelaneous type of smooth chert has a very smooth fracture surface, is opaque to subtranslucent, and is typically china-white, resembling china-ware or glazed porcelain. It grades into an extremely fine granular chert resembling unglazed porcelain.

The granular chert found in the Ellenburger residues is composed of distinguishable grains, granules, or druses. It has an uneven, or rough, fracture surface and a dull to slightly glimmering luster. Fragments of the chert range from hard to soft. Two types recognized are designated as *compact* and *granulated*. The compact type is mostly homogenous, has relatively uniform-sized grains, and some of it appears saccharoidal. The grain size varies from an extremely fine type that is gradational from the smooth porcelaneous up to a size that is easily distinguishable under 10-power magnification. The grains rarely reach 0.5 mm in size. The granulated type of granular chert is composed of tiny grains or granules of chert tightly to loosely held together in small, irregular masses or fragments. The individual grains making up the small masses may appear saccharoidal, grade from angular to drusy, and range from extremely fine up to grains 0.5 mm in size. This type of chert seems always to be well disseminated through the enclosing carbonate rock and is found more commonly in dolomite than in limestone.

The chalky chert in the Ellenburger residues is so called because of its textural resemblance to chalk. Much of it bears a strong resemblance to tripolite and may be tripolitic in origin in that it may represent an aggregation of siliceous particles, the particles being possibly colloidal in size. Some of the chert may be an alteration product formed by the leaching of other

[3]In June 1946 a group of geologists familiar with residue work met in conference in Midland, Texas, and worked out a systematic classification based on appearance and agreed on descriptive terms for materials found in residues. All descriptions of the appearance of Ellenburger residues follow the outline published as a result of the conference. See Ireland and others (1947).

kinds of chert, notably the smooth varieties. Fragments have an uneven or rough fracture and usually a dull or earthy appearance. Some varieties are extremely fine porous.

All the Ellenburger cherts exhibit a variety of structures. The most common structural features are described as porous, dolomoldic, oolitic, pseudo-oolitic, oomoldic, lacy, drusy, banded, and dolomorphic. In addition, the chert may be sandy, silty, spicular, quartzose, and very rarely fossilferous.

Dolomoldic chert contains dolomolds, a dolomold being a rhombic opening left in an insoluble residue by the solution of an embedded dolomite crystal (Ireland and others, 1947). The occurrence of the dolomolds may vary from widely scattered individual openings to very closely spaced, interconnecting openings. The latter occurrence results in a skeleton-like structure and is described as siliceous skeletal dolomolds. The skeletal dolomolds are interstitial chert filling what otherwise would be pore space between the dolomite crystals.

Oolitic chert contains ooliths (DeFord and Waldschmidt, 1946). Ooliths as applied to insoluble residues of the Ellenburger are spheroidal bodies with a nucleus or central mass enclosed by one or more surrounding layers of the same or different material. The ooliths are typically siliceous but are very rarely composed of clay, pyrite, or limonite. The ooliths in some cases are of different color and texture than the surrounding matrix. The occurrence varies from widely scattered to very closely spaced, the latter occurrence forming essentially a siliceous oolite. The ooliths also occur free or in loosely held aggregates. The ooliths grade from very small to large but generally average about 1 mm in size. Internally the ooliths have either a distinct or indistinct nucleus surrounded by concentric, radiate, or massive material. Externally the ooliths are smooth or covered with very fine druse.

Pseudo-oolitic chert contains rounded, pellet-like bodies with no peripheral layer, some of which do not exhibit sharp distinction between pellet and matrix. Origin of this particular structure is obscure and possibly varied. The pellets possibly are ooliths with the outside layer absorbed in the process of replacement, or they may result from replacement of pellet limestone. A similar structure has been described as pseudospicular because of its resemblance to the pattern formed by the spicular meshwork of certain lithistid sponges (Cloud, Barnes, and Bridge, 1945, p. 136).

Both oolitic and pseudo-oolitic chert may be largely the result of replacement. The replacement possibly involved the spherical bodies only, or it could have affected both bodies and matrix.

Oomoldic chert contains spherical cavities formerly occupied by ooliths, each opening being an oomold. The size of the oomolds ranges from microscopic to easily megascopic, and the average is approximately 1 mm in diameter. Their occurrence varies from widely scattered to very abundant. If the oomolds are so abundant that the constituent chert makes up 25 percent or less of the mass, the chert is described as skeletal oomoldic.

Lacy structured chert is a highly porous chert with irregular openings, the constituent chert comprising 25 percent or less of the mass. This chert is largely interstitial material, filling irregular spaces in the carbonate rock that would otherwise be porous. Rarely, the lacy chert appears to be organic in origin, possibly associated with some form of plant life. In the latter case the chert is not interstitial in character but simply embedded.

Drusy chert is in part, at least, encrusted with subhedral quartz crystals. Size of the crystals ranges from microscopic to megascopic. The granular cherts are much more commonly drusy than the smooth or chalky cherts.

Banded chert is made up of layers with either textural or color variations. The layers are microscopic or megascopic. They are flat, as in banded vein filling, or curved, suggesting concretionary structure.

Dolomorphic chert is formed from previously dolomitic or dolomoldic chert whose dolomite rhombs have been replaced or their molds refilled with another mineral. "Dolomorphic" is synonymous with "dolocastic" as used by Cloud, Barnes, and Bridge (1945) but is preferable in order to avoid confusion with "dolocastic" as used by other writers (McQueen, 1931).

To be present in insoluble residues, dolomorphic chert must have the dolomite rhombs replaced or their molds filled with an insoluble mineral. It is rare in Ellenburger residues.

Spicular chert contains siliceous or silicified spicules, chiefly sponge spicules. Generally the spicules occur as individual needle-like bodies embedded in the chert, but in some samples the meshwork formed by a mass of the spicules is preserved. Occurrence of the spicular chert is indicative but not absolutely diagnostic of certain levels of the Ellenburger.

Quartzose chert contains inclusions and veins of crystalline quartz, ranging from microscopic to megascopic.

Quartz

Quartz in the Ellenburger insolubles means the nondetrital occurrence of the crystalline, colorless, clear to cloudy mineral. It occurs in euhedral, subhedral, and anhedral forms. The euhedral quartz occurs as doubly terminated crystals embedded in the carbonate rock and as free crystals in the residues. The crystals vary from microscopic to megascopic in size and from fine, needle-like to short and stubby in shape. The subhedral quartz occurs chiefly as drusy encrustations on rock surfaces. When the encrustations have been removed from carbonate rocks by solution they occur in the residue as free or clustered, partially developed crystals. The anhedral quartz shows no outward crystal development. It exhibits textures ranging from smooth, glassy to granular and granulated.

Clastics

The constituents of clastic origin found in the Ellenburger residues are the argillaceous materials—clay and shale; silty material; and sandy material. These constituents occur generally disseminated through the carbonate rock but may occur as small, discontinuous seams or partings. All the material included in this category is considered to be detrital in origin. This distinction becomes difficult and many times a matter of individual judgment when dealing with finely divided, probably precipitated silica and fine silt.

A large portion of the argillaceous material in Ellenburger residues is clay-like in appearance and is here referred to as clay. It occurs interstitially in limestone and dolomite, in two principal forms. One form is best described by the term spongy and occurs in porous, earthy, fragile masses. The other form is flaky, the flakes being usually very crinkled and irregular in shape. The clay exhibits many of the structural forms found in chert including dolomoldic, skeletal dolomoldic, lacy, oolitic, or oomoldic forms. It also contains silt or sand grains in some occurrences. The color generally is dull gray to white, but shades of purple, red, and green occur. The flaky form is much more abundant in limestone than in dolomite.

The shale in Ellenburger insolubles occurs as thin partings and interstitial fillings in the limestone and dolomite. In texture it grades from waxy to granular and is hard to soft in character. The majority of the shale is some shade of gray, but green is common, with maroon, brown, and purple being more rare. Laminated, porous, dolomoldic, oolitic, and oomoldic forms occur. Impurities make the shale silty, sandy, micaceous, pyritic, or glauconitic.

Silty material in the residues is characterized by detrital quartz grains of silt size, that is, larger than clay particles, and with a maximum of approximately 1/16 mm. The silt occurs in the residue as loose grains or as poorly to well consolidated aggregates. The aggregates are usually held together by an argillaceous matrix. In some occurrences the silty material is sandy, glauconitic, pyritic, or micaceous. In addition the well-consolidated aggregates exhibit porous, dolomoldic, oolitic, or oomoldic structure.

The sandy portion of the clastic material in the residues occurs largely as loose grains in the residues but also is present in poorly to well-consolidated aggregates. The aggregates are in a shale, chert, or quartz matrix. The grains are, with rare exception, composed of clear quartz. They range in size from just above silt size to more than 2 mm. The most common form is subrounded to rounded with a frosted surface. A minor portion of the sand found in the Ellenburger is angular. Still fewer of the grains exhibit secondary growth. The sand occurs in laterally discontinuous zones in the carbonate rocks. The amount of sand in the zones varies from widely scattered grains to very abundant. But rarely does the sand become abundant enough to form sandstone. Some zones are gradational at the top and bottom, while others show an abrupt disappearance of sand from the section at either the top or bottom of a zone.

Accessory Materials

Accessory materials are those that occur sporadically, or more or less continuously in small amounts, in the Ellenburger residues. These materials are both mineral and organic in nature. Brief mention of each follows.

Pyrite is the commonest accessory. It occurs as interstitial filling and as individual crystals. The crystals range from microscopic to megascopic in size. The pyrite is often associated with waxy shale partings in the rock, occurring as minute crystals embedded in the shale. Some of the mineral called pyrite may actually be *marcasite*, as distinction between the minerals in small occurrences is difficult.

Mica, commonly muscovite, more rarely biotite, occurs as very small, thin flakes. The flakes occur either free or embedded in the shale or any of the aggregates found in the residues.

Feldspar appears rarely in the residues as minute, light-colored crystals, probably sedimentary in origin. Feldspar also occurs as detrital grains at certain places in the Ellenburger.

Limonite is more common in residues from surface samples than from well samples. Commonly it appears to be replacements of pyrite.

Anhydrite appears erratically in subsurface sections of the Ellenburger, usually in a clear, crystalline form. The common occurrence of anhydrite in drilling muds makes it difficult to determine small amounts in place in well samples.

Glauconite occurs in the residues usually as small grains, either free or embedded in shale or silty aggregates. It occurs also as interstitial filling and is dolomoldic when thus occurring in dolomite. Glauconite is more common in the lower portion of the Ellenburger than elsewhere.

Millerite, in typical needle-like crystal clusters, occurs very rarely.

Fossil fragments are too rare and nondiagnostic to offer faunal evidence with correlative significance. The commonest fragments are sponge spicules, either free or embedded in chert. Both simple, needle-like forms and six-pointed, hexactinellid types are found. Rarely small gastropods and fragments of brachiopods in siliceous replacements are found. As noted above, a few conodonts have been obtained from acetic acid residues of limestone samples.

Beekite is a form of chalcedonic chert associated with fossil replacement. The chert forms a series of rough, button-shaped bodies made up of roughly concentric rings of chert, partly or wholly covering the fossil surface. The material is frequently observed on the outcrop, and fragments of the beekite bodies appear sporadically in the residues.

Other insoluble minerals and materials than those mentioned above undoubtedly occur in trace amounts in the Ellenburger residues. An exhaustive study and identification of all the more rare constituents of the residues has not been attempted by the writer. Goldich and Parmelee (1947) have published detailed analyses of samples from portions of Ellenburger surface sections.

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SAMPLE DESCRIPTIONS

Gorman Falls Section, San Saba and Lampasas Counties, Texas

	Feet below top
Honeycut formation, 0–325 feet—	
Dolomite—extremely fine, very light gray. RESIDUE: *Clay*—sponge-like, yellow. *Silt*—fine quartz. *Chert*—trace smooth, white, grading to chalky. *Sand*—few fine, rounded frosted grains. *Spicule*—fine, needle-like.	0– 5
Dolomite—extremely fine, ash-gray, 50 percent. Limestone—smooth ash-gray, 50 percent. RESIDUE: *Clay*—sponge-like and flaky, white. *Silt*—quartz, grading up to very fine sand. *Sand*—small amount, grading to silt. *Chert*—trace white, smooth, very roughly nodular.	5– 10
Limestone—smooth, very light gray. RESIDUE: *Clay*—crinkled flaky, light buff, some white. *Chert*—trace smooth, light buff. *Silt*—trace.	10– 15
Dolomite—extremely fine, ash-gray. RESIDUE: *Clay*—sponge-like, lacy.	15– 20
Limestone—smooth, dove-gray, 90 percent. Dolomite—extremely fine, light gray, 10 percent. RESIDUE: *Chert*—ordinary smooth and porcelaneous, white; chalky, finely porous; some fine granular, white. *Spicules*—abundant, needle-like, curving, and finely branching. *Clay*—sponge-like, white to buff.	20– 25
Dolmite—extremely fine, light cream-colored, 50 percent. Limestone—smooth, gray, 50 percent. RESIDUE: *Clay*—sponge-like and flaky, white, some maroon. *Chert*—small amount hard, chalky. *Spicules*—fine, needle-like, some with extremely fine end filament.	25– 30
Dolomite—extremely fine, light cream and ash-gray. RESIDUE: *Clay*—sponge-like, grayish, lacy. *Chert*—small amount chalcedonic, concretionary. *Quartz*—trace anhedral, rough fragment. *Silt*—small amount, very fine. *Spicules*—few fine, needle-like.	30– 35
Dolomite—extremely fine, light gray. Limestone—some smooth, gray. Chert—some smooth, gray to brown. RESIDUE: *Chert*—smooth, brownish gray, slightly chalcedonic, with finely flocculent structure, in part pseudo-oolitic. *Silt*—small amount very fine. *Clay*—small amount gray, sponge-like. *Spicules*—few fine, needle-like.	35– 40
Limestone—smooth, gray. RESIDUE: *Clay*—crinkled flaky, brown, purple, and white. *Spicules*—few needle-like.	40– 45
Limestone—smooth, dove-gray. Chert—small amount grayish white. RESIDUE: *Chert*—smooth, buff; fine granular, grayish, in part quartzose. *Clay*—crinkled flaky, brown. *Spicules*—few very fine, needle-like.	45– 50
Dolomite—extremely fine, light gray, 80 percent. Limestone—smooth, gray, 20 percent. RESIDUE: *Clay*—sponge-like, lacy, and crinkled flaky, gray. *Spicules*—fine, needle-like.	50– 55
Dolomite—extremely fine, light gray, 90 percent. Limestone—smooth, light gray, 10 percent. RESIDUE: *Clay*—small amount crinkled flaky, white, buff, and gray. *Chert*—trace chalcedonic.	55– 60
Limestone—smooth, light gray. RESIDUE: *Chert*—fine granular, white, porous, small amount quartzose, trace pseudo-oolitic. *Quartz*—few fine to very fine angular grains. *Clay*—trace flaky.	60– 65
Dolomite—extremely fine, light buff, 90 percent. Limestone—smooth gray, 10 percent. RESIDUE: *Sand*—abundant, very fine, angular; fine to coarse, well rounded and frosted. *Chert*—chalcedonic, drusy in part. *Clay*—small amount sponge-like, lacy.	65– 70
Dolomite—extremely fine, light gray, 50 percent. Limestone—extremely fine to smooth, light gray, 50 percent. RESIDUE: *Chert*—chalky, soft, porous. *Clay*—sponge-like, lacy, and crinkled flaky, white and buff.	70– 75
Limestone—smooth, light gray and gray. RESIDUE: *Chert*—small amount very rough, concretionary, white. *Clay*—small amount crinkled flaky, buff.	75– 80
Limestone—smooth, very light gray. RESIDUE: *Clay*—crinkled flaky, white, some buff. *Chert*—small amount very roughly concretionary, smooth white. *Spicules*—few extremely fine.	80– 85

	Feet below top
Limestone—smooth, dove-gray	85– 90
RESIDUE: *Clay*—crinkled flaky, light buff to white. *Chert*—trace smooth, light buff.	
Limestone—smooth, light, slightly buff-gray	90– 95
RESIDUE: *Clay*—crinkled flaky, and sponge-like buff-brown to gray. *Shale*—trace, smooth textured, gray.	
Dolomite—extremely fine, light cream	95–100
RESIDUE: *Clay*—small amount sponge-like. *Silt*—trace.	
Dolomite—extremely fine, very light cream	100–105
RESIDUE: *Clay*—sponge-like, gray, in part lacy.	
Limestone—smooth, gray	105–110
RESIDUE: *Clay*—sponge-like to slightly compact, white; crinkled flaky, buff. *Silt*—small amount.	
Dolomite—extremely fine, very light gray, 50 percent. Limestone—smooth, gray, 50 percent	110–115
RESIDUE: *Clay*—crinkled flaky, brown. *Silt*—coarse, grading to very fine sand. *Chert*—fine granular, grayish, in roughly botryoidal fragments.	
Limestone—smooth, gray, 90 percent. Dolomite—extremely fine, very light cream, 10 percent	115–120
RESIDUE: *Chert*—fine granular, slightly translucent-brownish gray. *Clay*—sponge-like, grayish white.	
Limestone—smooth, gray, 60 percent. Dolomite—extremely fine, very light cream, 20 percent. Chert—smooth, gray, 20 percent	120–125
RESIDUE: *Chert*—chalcedonic, gray and maroon, in part spicular; small amount rough, fine granular, gray. *Silt*—small amount. *Clay*—small amount crinkled flaky. *Spicules*—few needle-like.	
Limestone—smooth, gray	125–130
RESIDUE: *Clay*—crinkled flaky, brown and maroon. *Chert*—small, granular fragments, apparently fragments of silicified fossils and small concretions. *Spicules*—abundant needle-like, few with finely branching ends.	
Limestone—smooth, gray	130–135
RESIDUE: *Chert*—smooth, in part slightly chalcedonic, in part porcelaneous, traces psuedo-oolitic structure, some spicular, white to buff. *Clay*—flaky and sponge-like, light buff. *Spicules*—fine, needle-like.	
Limestone—smooth, gray, in part with uneven, fragmental-appearing structure. Dolomite—trace very fine, light gray	135–140
RESIDUE: *Chert*—smooth, light buff to white, spicular; chalky, hard; some granular, white. *Clay*—sponge-like, some flaky, white, buff and brown in part dolomoldic. *Spicules*—fine, needle-like.	
Limestone—smooth, gray, in part maroon splotched, in part with indistinct, uneven structure	140–145
RESIDUE: *Chert*—smooth, variegated powder-white and grayish chalcedonic, spicular in part. *Clay*—sponge-like, maroon and buff. *Spicules*—few, needle-like.	
Limestone—smooth, gray	145–150
RESIDUE: *Clay*—crinkled flaky, buff and white. *Chert*—chalky, soft, porous; trace roughly concretionary, chalcedonic. *Spicules*—few fine, needle-like. *Sand*—few fine, frosted grains.	
Limestone—smooth, gray	150–155
RESIDUE: *Clay*—crinkled flaky, rust colored. *Chert*—small amount white, finely nodular, concretionary.	
Limestone—smooth, gray	155–160
RESIDUE: *Chert*—fine granular, gray, scattered porosity. *Clay*—some sponge-like, light gray. *Shale*—grayish green, slightly waxy.	
Limestone—smooth, gray, in part with indistinct fragmental structure	160–165
RESIDUE: *Clay*—sponge-like, white; some flaky, buff. *Spicules*—needle-like, few finely branching.	
Limestone—smooth, gray	165–170
RESIDUE: *Chert*—smooth, white to grayish white, in part slightly chalcedonic. *Clay*—some flaky, pink. *Fossil*—small, silicified gastropod.	
Limestone—smooth, light gray, some pinkish maroon	170–175
RESIDUE: *Clay*—flaky, buff, pink, maroon, and white. *Chert*—small amount smooth, white.	

Feet below top

Limestone—smooth, dove-gray 175–180
RESIDUE: *Quartz*—anhedral, granular to subhedral, drusy. *Chert*—small amount hard, chalky. *Clay*—flaky, buff.

Limestone—smooth, dove-gray. Dolomite—small amount very fine, light gray 180–185
RESIDUE: *Chert*—grayish white, chalcedonic, in part pseudo-oolitic; some soft, extremely fine porous, chalky. *Clay*—flaky, greenish gray.

Limestone—smooth, gray, in part finely dolomitic 185–190
RESIDUE: *Chert*—fine granular, brownish gray, oolitic, scattered fine dolomolds and porosity. *Spicules*—trace fine, needle-like.

Dolomite—very fine, light gray. Limestone—some smooth, gray, dolomitic 190–195
RESIDUE: *Quartz*—anhedral, in rough fragments with subhedral, drusy surfaces. *Clay*—sponge-like, lacy, and very finely skeletal dolomoldic; some flaky.

Dolomite—extremely fine, light buff-gray, 80 percent. Limestone—smooth, very light gray, 20 percent 195–200
RESIDUE: *Clay*—sponge-like, flaky, and extremely fine skeletal, fragmental dolomoldic. *Quartz*—anhedral, rough to nodular, and subhedral, drusy. *Spicules*—fine, needle-like.

Limestone—smooth, very light gray, 90 percent. Dolomite—extremely fine, light buff, 10 percent 200–205
RESIDUE: *Clay*—crinkled flaky, white. *Chert*—trace smooth, white. *Quartz*—trace anhedral.

Limestone—smooth, light gray, 90 percent. Chert—smooth, light tan, 10 percent 205–210
RESIDUE: *Chert*—smooth, white and tan; fine granular, grayish, and finely laminated, tan.

Limestone—smooth, dove-gray 210–215
RESIDUE: *Clay*—very crinkled flaky, tan to white. *Chert*—trace chalcedonic. *Spicules*—trace fine, needle-like.

Limestone—smooth, very light gray 215–220
RESIDUE: *Clay*—flaky, grayish white and pink. *Chert*—small amount chalcedonic, pseudo-oolitic. *Spicules*—very fine, needle-like.

Limestone—smooth, dove-gray 220–225
RESIDUE: *Clay*—flaky, buff to gray. *Chert*—trace smooth white.

Limestone—smooth, dove-gray 225–230
RESIDUE: *Chert*—smooth, white to fine granular porcelaneous; some fine granular, slightly translucent-gray, scattered porosity. *Spicules*—few extremely fine.

Limestone—smooth, gray, 50 percent. Dolomite—extremely fine, light, slightly buff-gray, 50 percent 230–235
RESIDUE: *Clay*—flaky, light green and white; some sponge-like, white. *Silt*—very fine. *Sand*—few fine, frosted grains. *Spicules*—fine, needle-like.

Limestone—smooth, dove-gray. Chert—some smooth grayish white 235–240
RESIDUE: *Chert*—smooth, grayish white, and chalcedonic. *Quartz*—rough, granular, some lacy. *Clay*—flaky, greenish, buff, and white. *Silt*—small amount very fine. *Spicules*—fine, needle-like.

Limestone—smooth, light gray. Chert—some smooth white 240–245
RESIDUE: *Chert*—smooth, buff to white; granular, transclucent-gray, quartzose, porous; small amount hard, chalky, buff. *Clay*—flaky, brown to greenish. *Sand*—fine, rounded, frosted. *Silt*—small amount very fine.

Limestone—smooth, light gray, 80 percent. Dolomite—extremely fine, light gray, 20 percent 245–250
RESIDUE: *Clay*—flaky, brown to gray. *Sand*—fine to very fine, rounded, frosted. *Silt*—small amount.

Limestone—smooth, light gray. Dolomite—small amount fine, light gray 250–255
RESIDUE: *Quartz*—anhedral, very rough, porous. *Clay*—flaky, gray and greenish. *Silt*—coarse quartz.

Limestone—smooth, light gray, trace finely dolomitic 255–260
RESIDUE: *Clay*—flaky, light greenish, some pink to maroon. *Silt*—very fine.

Limestone—smooth, light gray, some finely dolomitic 260–265
RESIDUE: *Clay*—flaky, light greenish. *Silt*—coarse to very fine.

Dolomite—extremely fine to very fine, light buff and light pinkish gray. Limestone—trace light gray, dolomitic 265–270
RESIDUE: *Quartz*—subhedral, in irregular, porous masses. *Chert*—chalky, soft, white. *Sand*—fine to very fine, lightly frosted. *Silt*—very fine. *Clay*—white, finely fragmental dolomoldic.

Feet below top

Dolomite—very fine, light gray ... 270–275
RESIDUE: *Clay*—white, very fine fragmental and skeletal dolomoldic. *Silt*—very fine. *Quartz*—subhedral, in rough, irregular fragments.

Limestone—smooth, light gray ... 275–280
RESIDUE: *Clay*—crinkled flaky, white, some pink. *Sand*—fine to medium coarse, well rounded, lightly frosted. *Chert*—small amount smooth, white.

Dolomite—extremely fine, buff, some light gray ... 280–285
RESIDUE: *Quartz*—subhedral, as loose grains and in very rough, irregular fragments. *Clay*—brown to gray, extremely fine dolomoldic in extremely fine fragmental and skeletal dolomoldic fragments.

Dolomite—very fine to fine, light gray, in part with scattered sand grains ... 285–290
RESIDUE: *Sand*—coarse to fine, rounded, frosted, some showing secondary growth. *Clay*—white and brown, finely fragmental dolomoldic. *Silt*—small amount.

Limestone—smooth, light gray. Chert—trace smooth, grayish white and brown ... 290–295
RESIDUE: *Chert*—smooth, porcelaneous and ordinary, white to brown; small amount soft chalky. *Clay*—sponge-like and flaky, white and brown. *Quartz*—few medium stubby, euhedral prisms.

Limestone—smooth, dove-gray, 90 percent. Dolomite—very fine, buff, 10 percent ... 295–300
RESIDUE: *Quartz*—anhedral and subhedral, in very rough, porous fragments. *Clay*—brown to white, sponge-like, in part lacy, in part finely fragmental and skeletal dolomoldic, some flaky.

Dolomite—extremely fine to very fine, brown to light gray ... 300–305
RESIDUE: *Quartz*—milky, granular, anhedral, in extremely rough, irregular flakes and masses, with a few drusy surfaces. *Clay*—brown, extremely fine fragmental.

Dolomite—extremely fine, light buff-gray, 90 percent. Chert—smooth, white, oolitic, 10 percent ... 305–310
RESIDUE: *Chert*—smooth, white, oolitic, in part chalcedonic, containing scattered sand grains; fine granular, translucent-grayish, extremely fine dolomoldic. *Sand*—few coarse, rounded, frosted grains.

Dolomite—very fine, gray. Limestone—small amount, smooth, very light gray ... 310–315
RESIDUE: *Clay*—buff, finely fragmental skeletal dolomoldic. *Chert*—trace fine granular, white nodular.

Limestone—smooth, grayish white, 50 percent. Dolomite—very fine, gray, 50 percent ... 315–320
RESIDUE: *Clay*—buff-brown, finely skeletal dolomoldic, and very finely fragmental. *Chert*—trace smooth white.

Dolomite—very fine, buff-gray, in part highly arenaceous, 70 percent. Limestone—smooth, gray to maroon mottled, in part arenaceous, 30 percent ... 320–325
RESIDUE: *Sand*—abundant, coarse to very fine, well rounded, very finely frosted, some grains lightly colored by maroon fillings in frosting. *Clay*—small amount light buff, sponge-like, in part lacy.

Gorman formation, 325–745 feet—

Limestone—smooth, light gray, in part dolomitic ... 325–330
RESIDUE: *Clay*—gray, flaky. *Fossil*—fragments silicified brachiopod.

Limestone—smooth, dove-gray, with few embedded, frosted sand grains ... 330–335
RESIDUE: *Sand*—coarse to fine, rounded, very lightly frosted. *Clay*—greenish gray, flaky.

Limestone—smooth, light gray ... 335–340
RESIDUE: *Clay*—small amount flaky, white, light buff, and pink.

Limestone—smooth, very light gray ... 340–345
RESIDUE: *Clay*—flaky, white to slightly greenish. *Chert*—trace fine granular, slightly translucent, porous.

Limestone—smooth, gray ... 345–350
RESIDUE: *Clay*—flaky, gray, slightly granular. *Quartz*—very delicately lacy fragments.

Limestone—smooth, dove-gray ... 350–355
RESIDUE: *Clay*—flaky, buff.

Limestone—smooth, light gray ... 355–360
RESIDUE: *Clay*—crinkled flaky, buff, gray, and maroon.

Limestone—smooth, light tan-gray, 80 percent. Dolomite—fine, gray, 20 percent ... 360–365
RESIDUE: *Clay*—crinkled flaky, yellowish brown.

Limestone—smooth, light gray finely splotched with brown ... 365–370
RESIDUE: *Clay*—crinkled flaky, white to buff. *Chert*—trace chalcedonic.

Feet below top

Dolomite—very fine, light buff-gray 370–375
RESIDUE: *Chert*—smooth, white; trace hard chalky; trace fine granular, white. *Clay*—buff, very finely fragmental, and brown, skeletal dolomoldic.

Dolomite—very fine, light gray, buff, and brown 375–380
RESIDUE: *Clay*—buff, extremely fine fragmental. *Chert*—trace fine granular, dolomoldic, drusy. *Sand*—few fine to medium, rounded lightly frosted grains.

Dolomite—very fine to extremely fine, light buff-gray, 90 percent. Chert—smooth, grayish white, in part oolitic, 10 percent 380–385
RESIDUE: *Chert*—ordinary smooth and porcelaneous, white, in part indistinctly oolitic; small amount hard, chalky. *Clay*—small amount extremely fine fragmental, buff.

Dolomite—very fine, light gray, 50 percent. Limestone—smooth, very light gray, 50 percent 385–390
RESIDUE: *Silt*—extremely fine. *Clay*—small amount flaky, greenish.

Limestone—smooth, very light gray 390–395
RESIDUE: *Clay*—flaky, slightly greenish white, and buff.

Limestone—smooth, dove-gray. Dolomite—small amount very fine, buff-gray 395–400
RESIDUE: *Clay*—flaky, greenish brown.

Limestone—smooth, gray 400–405
RESIDUE: *Chert*—chalky, hard; smooth, white, trace oolitic. *Clay*—sponge-like, white, flaky, greenish brown. *Silt*—small amount.

Limestone—smooth, dove-gray 405–410
RESIDUE: *Clay*—flaky, gray and buff. *Sand*—small amount fine, rounded, very lightly frosted. *Chert*—trace smooth, white, finely oolitic.

Limestone—smooth, light gray. Dolomite—small amount fine, light gray 410–415
RESIDUE: *Clay*—flaky, whitish gray. *Quartz*—trace drusy.

Dolomite—fine to medium fine, gray 415–420
RESIDUE: *Clay*—flaky, buff to gray. *Sand*—fine to very fine, rounded, very lightly frosted. *Silt*—coarse to very fine. *Chert*—trace smooth, white.

Limestone—Smooth gray in part dolomitic, 80 percent. Dolomite—extremely fine, buff 420–425
RESIDUE: *Clay*—flaky white, and extremely fine fragmental, brown.

Limestone—smooth, gray 425–430
RESIDUE: *Chert*—smooth, white, in part with very finely flocculent structure. *Sand*—small amount fine, rounded, frosted.

Limestone—smooth, very light gray 430–435
RESIDUE: *Clay*—flaky, slightly greenish brown, and gray. *Silt*—small amount coarse. *Sand*—few fine, slightly frosted grains.

Limestone—smooth, gray, in part indistinct, finely fragmental structure 435–440
RESIDUE: *Sand*—very fine to medium, rounded, frosted. *Silt*—coarse to very fine. *Clay*—flaky, brown to buff.

Limestone—smooth, light gray, 50 percent. Dolomite—very fine, light gray, 50 percent 440–445
RESIDUE: *Clay*—small amount, extremely fine, fragmental.

Dolomite—very fine, light gray 445–450
RESIDUE: *Chert*—smooth to slightly chalky, very finely scattered to abundant dolomoldic; some very fine granular white, very finely dolomoldic.

Limestone—smooth, gray 450–455
RESIDUE: *Clay*—flaky, white. *Shale*—small amount dark green, waxy. *Sand*—small amount fine, rounded, lightly frosted. *Silt*—coarse.

Limestone—smooth, gray, 70 percent. Dolomite—fine, gray 20 percent. Chert—smooth, gray, oolitic, 10 percent 455–460
RESIDUE: *Chert*—smooth, green (stained by acid solution ?) and gray, in part chalcedonic, highly oolitic and partly arenaceous; fine granular, very finely porous, white. *Sand*—small amount fine, rounded, frosted.

Limestone—smooth, light gray, 50 percent. Dolomite—extremely fine, light gray 460–465
RESIDUE: *Clay*—crinkled flaky, greenish gray and white. *Chert*—chalky, soft, grayish white.

Dolomite—extremely fine, light gray 465–470
RESIDUE: *Clay*—small amount sponge-like, gray. *Chert*—small amount smooth, white.

Dolomite—extremely fine, light gray 470–475
RESIDUE: *Silt*—fine. *Sand*—few fine, frosted grains.

Dolomite—extremely fine, light gray, some buff 475–480
RESIDUE: *Silt*—fine to coarse, angular, loose and in soft, argillaceous aggregates. *Sand*—very fine, rounded, very slightly frosted.

Feet below top

Limestone—smooth, very light gray. Dolomite—small amount very fine, buff 480–485
Residue: *Chert*—smooth, gray to white, in part fine to medium, oolitic, part pseudo-oolitic, contains scattered sand grains, has scattered porosity. *Sand*—very fine to medium, rounded, very slightly frosted. *Clay*—crinkled, greenish white.

Limestone—smooth, very light gray 485–490
Residue: *Clay*—crinkled flaky, white, gray, and buff. *Sand*—fine to very fine, well rounded, very slightly frosted. *Silt*—small amount. *Spicules*—fine, needle-like. *Shale*—trace gray, slightly waxy.

Limestone—smooth, dove-gray 490–495
Residue: *Clay*—crinkled flaky, buff to gray. *Sand*—very fine, slightly frosted.

Limestone—smooth, light gray 495–500
Residue: *Clay*—crinkled flaky, white, some greenish gray, some muddy gray. *Sand*—very fine, very slightly frosted.

Limestone—smooth, light gray 500–505
Residue: *Clay*—crinkled flaky, slightly greenish buff, some white. *Sand*—small amount very fine, very slightly frosted.

Limestone—smooth, light gray 505–510
Residue: *Clay*—crinkled flaky, slightly greenish buff, brown, some white. *Silt*—very small amount.

Limestone—smooth, very light gray 510–515
Residue: *Chert*—chalky, white, porous; smooth, white. *Clay*—flaky, greenish gray, some white. *Sand*—small amount very fine, slightly frosted.

Limestone—smooth, dove-gray 515–520
Residue: *Clay*—crinkled flaky, white, greenish gray, buff. *Silt*—small amount coarse. *Sand*—very small amount very fine, very slightly frosted.

Limestone—smooth, very light gray 520–525
Residue: *Clay*—crinkled flaky, light gray, greenish gray, and buff, in part slightly silty. *Silt*—small amount very fine.

Limestone—smooth, very light gray 525–530
Residue: *Clay*—crinkled flaky, white to slightly greenish.

Limestone—smooth, dove-gray, in part arenaceous, 90 percent. Chert—smooth, light buff, 10 percent 530–535
Residue: *Chert*—smooth, white to very light buff; chalky, soft, white. *Sand*—coarse to fine, rounded, frosted. *Clay*—flaky, greenish gray and white, very finely fragmental.

Limestone—smooth, light gray 535–540
Residue: *Clay*—flaky, white to buff. *Sand*—well sorted, fine, rounded, lightly frosted.

Limestone—smooth, light gray 540–545
Residue: *Clay*—flaky, slightly greenish, light gray, bpff. *Sand*—very fine, slightly frosted, grading to coarse silt. *Silt*—small amount coarse.

Limestone—smooth, very light gray 545–550
Residue: *Chert*—gradational between chalky and fine granular, hard, white, finely porous; fine granular, translucent-gray, in part porous, and in part pseudo-oolitic.

Limestone—smooth, light gray, in part indistinct fragmental structure 550–555
Residue: *Clay*—flaky and sponge-like, greenish buff and white.

Limestone—smooth, very light gray 555–560
Residue: *Clay*—crinkled flaky, brown to buff, some white. *Chert*—small amount chalky. *Silt*—very fine.

Limestone—smooth, light gray, some maroon staining 560–565
Residue: *Clay*—flaky, greenish buff and salmon-pink. *Silt*—small amount very fine. *Chert*—trace smoky, chalcedonic.

Limestone—smooth, light gray 565–570
Residue: *Clay*—small amount flaky, buff. *Silt*—trace very fine.

Limestone—smooth, light gray 570–575
Residue: *Clay*—crinkled flaky, greenish buff to brown, some white.

Limestone—smooth light gray, with few embedded sand grains 575–580
Residue: *Sand*—coarse to fine, rounded to subrounded, lightly frosted. *Clay*—crinkled flaky, brown to buff.

Limestone—smooth, light gray. Chert—small amount white, calcareous 580–585
Residue: *Chert*—chalky, white, finely porous, some gradational to fine granular; fine granular white; smooth, white. *Clay*—crinkled flaky, greenish gray to buff.

Limestone—smooth, light gray, 50 percent. Dolomite—coarse light gray, 50 percent 585–590
Residue: *Chert*—very small amount gray chalcedonic. *Clay*—trace flaky white.

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Limestone—smooth, light gray 590–595
RESIDUE: *Chert*—smooth, white, small amount chalky white. *Clay*—crinkled flaky, greenish buff.

Limestone—smooth, light gray, 90 percent. Chert—smooth, white, 10 percent 595–600
RESIDUE: *Chert*—smooth, variegated white and grayish white, with trace druse. *Clay*—small amount flaky, greenish gray.

Limestone—smooth, very light gray 600–605
RESIDUE: *Clay*—crinkled flaky, white and buff.

Limestone—smooth, light gray, 50 percent. Dolomite—extremely fine, light gray, 50 percent 605–610
RESIDUE: *Clay*—white, gray, some brown.

Dolomite—extremely fine, gray 610–615
RESIDUE: *Clay*—sponge-like, white. *Silt*—fine to very fine.

Dolomite—extremely fine, some fine, light gray, 60 percent. Limestone—smooth, light gray, 40 percent. Chert—trace, grayish white 615–620
RESIDUE: *Chert*—smooth, gray to grayish white, some finely porous. *Clay*—flaky, grayish white.

Limestone—smooth, light gray. Dolomite—small amount medium, light gray 620–625
RESIDUE: *Clay*—flaky and finely fragmental, in part dolomoldic, slightly grayish white. *Chert*—trace smooth, white. *Silt*—small amount very fine.

Limestone—smooth, dove-gray 625–630
RESIDUE: *Chert*—smooth, white; trace chalky. *Clay*—flaky, light green and brown. *Silt*—fine to very fine.

Limestone—smooth, light gray 630–635
RESIDUE: *Clay*—sponge-like and flaky, brown and white, in part finely fragmental. *Chert*—trace smooth, white. *Silt*—very fine. *Sand*—few fine, frosted grains.

Limestone—smooth, light gray 635–640
RESIDUE: *Clay*—flaky, light green. *Chert*—smooth, white. *Silt*—trace very fine. *Shale*—some light green, slightly waxy.

Dolomite—very fine to extremely fine, light gray 640–645
RESIDUE: *Clay*—finely fragmental, skeletal dolomoldic, white. *Silt*—small amount very fine. *Sand*—few very fine grains.

Dolomite—extremely fine, very light gray 645–650
RESIDUE: *Sand*—very fine, slightly rounded and frosted to extremely fine, angular.

Dolomite—extremely fine to very fine, light gray, some buff 650–655
RESIDUE: *Sand*—very fine, slightly rounded and frosted to extremely fine. *Clay*—sponge-like, white and buff, slightly dolomoldic.

Dolomite—extremely fine, buff; and fine, light gray 655–660
RESIDUE: *Sand*—coarse, well rounded to fine, subrounded, frosted, free and in argillaceous clusters. *Silt*—small amount. *Clay*—small amount flaky, brown and greenish gray. *Chert*—trace chalky.

Limestone—very smooth, white, 80 percent. Chert—smooth and chalky white, 20 percent 660–665
RESIDUE: *Chert*—chalky, hard to very soft; smooth, white.

Dolomite—extremely fine, light buff-gray; and medium fine, gray 665–670
RESIDUE: *Clay*—buff, brown, and white, finely fragmental skeletal dolomoldic and flaky, porous. *Sand*—small amount, very slightly frosted. *Silt*—small amount.

Dolomite—extremely fine to fine, light buff-gray 670–675
RESIDUE: *Clay*—slightly greenish, light buff to brown, finely skeletal dolomoldic, some flaky. *Sand*—medium to fine, subrounded, lightly frosted. *Silt*—small amount.

Limestone—smooth, light gray, 50 percent. Dolomite—extremely fine to fine, buff-gray, 50 percent 675–680
RESIDUE: *Clay*—light buff, some brown, fragmental skeletal dolomoldic. *Silt*—small amount. *Chert*—trace smooth, white.

Limestone—smooth, light gray, in part arenaceous. Chert—some smooth, gray 680–685
RESIDUE: *Chert*—smooth, white to grayish, some indistinctly mottled, some with embedded sand grains; small amount chalky. *Sand*—coarse, well rounded to very fine, angular, frosted. *Silt*—small amount coarse.

Limestone—smooth, light gray 685–690
RESIDUE: *Chert*—smooth, white to light tan; small amount very fine granular, light tan; small amount chalky, white. *Sand*—coarse to very fine, subrounded, frosted. *Silt*—coarse to fine. *Clay*—flaky and finely fragmental, greenish buff and white.

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Limestone—smooth, very light gray	690–695

RESIDUE: *Clay*—flaky, grayish white, some brown. *Silt*—coarse to very fine. *Sand*—few medium rounded, frosted grains.

Limestone—smooth, light gray 695–700
RESIDUE: *Clay*—flaky, light greenish gray, some buff and brown. *Sand*—fine to very fine, frosted. *Silt*—coarse to very fine.

Limestone—smooth, gray, some maroon, 80 percent. Chert—smooth, gray, oolitic, 20 percent 700–705
RESIDUE: *Chert*—smooth, gray, oolitic, few embedded sand grains; smooth, white. *Clay*—sponge-like and flaky, greenish white and brown. *Sand*—small amount fine, rounded, frosted. *Silt*—small amount coarse to fine.

Limestone—smooth, light gray, in part with indistinct fragmental structure, 60 percent. Dolomite—extremely fine, light gray, 40 percent 705–710
RESIDUE: *Clay*—flaky to sponge-like, white, some buff. *Sand*—fine, slightly frosted. *Silt*—coarse to very fine.

Dolomite—extremely fine, grayish white 710–715
RESIDUE: *Silt*—fine, abundant. *Chert*—chalky, white. *Clay*—small amount very delicately sponge-like.

Dolomite—extremely fine, very light buff, and grayish white 715–720
RESIDUE: *Silt*—abundant, coarse to fine, slightly argillaceous, chiefly loose, few porous, silty fragments.

Dolomite—fine to extremely fine, light gray, small amount pink 720–725
RESIDUE: *Clay*—white, skeletal and finely fragmental dolomoldic. *Chert*—very soft, chalky, porous and dolomoldic, trace smooth, gray, oolitic. *Sand*—small amount very fine, frosted. *Silt*—trace.

Dolomite—very fine to extremely fine, very light gray 725–730
RESIDUE: *Chert*—soft, chalky, grayish white, finely dolomoldic. *Clay*—flaky, slightly cream-white, finely dolomoldic in part. *Sand*—small amount very fine, slightly frosted. *Silt*—coarse.

Dolomite—extremely fine to very fine, grayish white 730–735
RESIDUE: *Sand*—coarse, well rounded to very fine; subrounded, frosted. *Silt*—coarse to very fine. *Clay*—small amount sponge-like, white.

Dolomite—extremely fine to very fine, light gray, in part sandy 735–740
RESIDUE: *Sand*—coarse to very fine, rounded, frosted, with well developed secondary growth, showing some well-terminated quartz crystals. *Silt*—small amount very fine.

Limestone—smooth, light gray 740–745
RESIDUE: *Clay*—sponge-like and flaky, slightly greenish, light gray. *Sand*—coarse to fine, well rounded and frosted.

SPICEWOOD CREEK SECTION, SAN SABA COUNTY, TEXAS

Gorman formation, 0–57 feet—

Dolomite—extremely fine to very fine, light, very slightly buff, 60 percent. Limestone—extremely fine, grayish white, 30 percent 0– 5
RESIDUE: *Silt*—coarse to fine. *Clay*—in very fine particles. *Sand*—few very fine grains. *Chert*—trace smooth, white, in part chalcedonic.

Dolomite—extremely fine, light, very slightly buff; and very fine, very light gray 5– 10
RESIDUE: *Clay*—extremely fine, fragmental dolomolds. *Silt*—small amount loose.

Dolomite—extremely fine, light buff; and very fine, very light gray with scattered pinkish stains. Chert—trace ordinary to porcelaneous smooth 10– 15
RESIDUE: *Chert*—smooth, white, approaching porcelaneous. *Clay*—sponge-like, extremely fine to very fine skeletal dolomoldic, and in very fine particles. *Silt*—small amount loose.

Dolomite—extremely fine, very light gray, with irregular, light buff coloration 15– 20
RESIDUE: *Chert*—chalky, argillaceous, extremely fine, abundant to skeletal dolomoldic. *Clay*—sponge-like, extremely fine skeletal dolomoldic. *Sand*—very fine, rounded, frosted, loose, and in small aggregates. *Silt*—loose.

Dolomite—very fine, very light gray. Chert—small amount smooth white, in part finely dolomitic; trace extremely fine granular chert 20– 25
RESIDUE: *Chert*—smooth, white, in part silty; very fine granular, very slightly translucent. *Clay*—sponge-like, extremely fine dolomoldic, and in very fine particles. *Silt*—trace white siltstone.

	Feet below top
Dolomite—extremely fine to very fine, very light gray. RESIDUE: *Clay*—sponge-like and flaky, finely dolomoldic. *Sand*—very fine, lightly frosted. *Silt*—loose.	25– 30
Dolomite—extremely fine, unevenly light buff colored, 50 percent; very fine to fine, light gray, 50 percent. RESIDUE: *Chert*—smooth, white, quartzose and drusy, scattered to abundant finely dolomoldic; chalky, white, scattered dolomoldic. *Quartz*—subhedral, finely drusy. *Clay*—sponge-like, extremely fine to very fine skeletal dolomoldic. *Silt*—loose.	30– 35
Dolomite—extremely fine, grayish white, in part with embedded, very fine to fine sand grains. RESIDUE: *Sand*—unassorted, very fine to coarse, rounded, frosted. *Clay*—extremely fine fragmental skeletal dolomoldic. *Silt*—loose.	35– 40
Dolomite—extremely fine, light gray. Chert—small amount smooth, gray, in part with very fine pseudo-oolitic structure in chalcedonic matrix. RESIDUE: *Chert*—smooth, gray, and white, with very fine to fine, pseudo-oolitic structure in chalcedonic matrix; small amount extremely fine granular, gray, pseudo-oolitic. *Silt*—loose.	40– 45
Dolomite—extremely fine, very light gray. RESIDUE: *Chert*—ordinary smooth, white. *Sand*—few very fine, lightly frosted grains. *Silt*—small amount loose. *Clay*—few flakes.	45– 50
Dolomite—very fine, light buff-gray. Chert—small amount smooth, grayish white and finely banded. RESIDUE: *Chert*—smooth, ordinary and porcelaneous, white with some gray banding, sparingly quartzose; small amount chalky, skeletal dolomoldic. *Quartz*—small amount subhedral, finely drusy. *Sand*—very fine to coarse, rounded, frosted. *Clay*—sponge-like, very fine fragmental skeletal dolomoldic. *Silt*—small amount loose.	50– 55
Tanyard formation, Staendebach member, 57–460 feet—	
Dolomite—very fine to extremely fine, light gray with uneven, light buff coloration. RESIDUE: *Chert*—smooth, white, very finely abundant dolomoldic; extremely fine granular, slightly translucent, finely abundant dolomoldic, in part quartzose and drusy. *Quartz*—subhedral, finely drusy. *Clay*—sponge-like, very finely fragmental skeletal dolomoldic. *Silt*—very small amount loose.	55– 60
Limestone—smooth, dove-gray, in part with fine, indistinct pellet structure. Dolomite—trace fine, gray. RESIDUE: *Clay*—flaky, white, few fine dolomolds. *Sand*—few very fine, frosted grains. *Chert*—trace botryoidal chalcedonic.	60– 65
Limestone—smooth grayish white and dove-gray, 85 percent. Chert—smooth, bluish white and trace porcelaneous, 15 percent. RESIDUE: *Chert*—smooth, chalcedonic to ordinary, white; small amount chalky; small amount extremely fine granular.	65– 70
Limestone—smooth, dove-gray, in part with indistinct fragmental structure. Chert—small amount smooth, bluish white, chalcedonic, with few drusy surfaces. RESIDUE: *Chert*—chalcedonic, quartzose, in part drusy, with trace very finely banded. *Clay*—flaky, white and pink stained.	70– 75
Limestone—extremely fine, dove-gray. Chert—small amount extremely fine granular and chalcedonic. RESIDUE: *Chert*—smooth, white to chalcedonic, in part with very rough and porous contact surfaces; small amount extremely fine granular. *Clay*—sponge-like and flaky, white.	75– 80
Limestone—extremely fine to smooth, dove-gray, in part slightly dolomitic, and in part with indistinct fragmental structure. Chert—small amount smooth and some extremely fine granular, white to grayish white. RESIDUE: *Chert*—smooth, chalcedonic to ordinary, white, in part pseudo-oolitic; small amount extremely fine granular. *Clay*—sponge-like and flaky, white and cream colored.	80– 85
Limestone—extremely fine, very light gray, in part siliceous. RESIDUE: *Chert*—chalky, white, extremely fine porous, soft. *Clay*—sponge-like and flaky, white.	85– 90
Limestone—extremely fine, very light gray, 50 percent. Dolomite—coarse, very light gray, in part pink stained, 50 percent. RESIDUE: *Chert*—small amount finely oolitic, chalcedonic; trace smooth, white. *Clay*—finely flaky. *Glauconite*—trace.	90– 95
Limestone—extremely fine, slightly grayish white, in part coarsely dolomitic. RESIDUE: *Clay*—small amount finely fragmental flaky.	95–100

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Limestone—extremely fine, very light gray. Chert—small amount smooth, white to gray....100–105
RESIDUE: *Chert*—smooth, white and chalcedonic. *Clay*—sponge-like and flaky, white.

Limestone—extremely fine to smooth, very light gray. Dolomite—trace medium grained, very light gray....105–110
RESIDUE: *Chert*—fine granular, slightly translucent, in part finely oolitic, trace oomoldic. *Shale*—waxy, light green, in fine fragments.

Limestone—extremely fine, light gray....110–115
RESIDUE: *Chert*—very small amount white and chalcedonic. *Silt*—small amount angular grains, possibly feldspar.

Limestone—extremely fine to smooth, very light gray....115–120
RESIDUE: *Chert*—smooth to extremely fine, white to gray, in sharp contact with limestone, but with same texture as limestone.

Limestone—extremely fine, very light gray, in part containing dolomite rhombs. Dolomite—small amount medium coarse, grayish white. Chert—some extremely fine granular, slightly quartzose, finely oolitic....120–125
RESIDUE: *Chert*—very fine to extremely fine granular, light buff-gray, finely oolitic, in part quartzose; smooth, white, in part finely oolitic; chalcedonic, finely oolitic. *Clay*—sponge-like and flaky, white. *Quartz*—small amount subhedral grains.

Limestone—extremely fine, very light gray....125–130
RESIDUE: *Clay*—sponge-like and flaky. *Chert*—small amount soft, white, chalky.

Limestone—extremely fine, white, in part medium to coarsely dolomitic....130–135
RESIDUE: *Clay*—sponge-like, white, in fine fragments. *Chert*—small amount finely botryoidal, smooth, white; trace soft, chalky.

Limestone—extremely fine, white, in part medium to coarsely dolomitic....135–140
RESIDUE: *Clay*—sponge-like and flaky, white, in part with traces of oomolds.

Limestone—extremely fine, very light gray, in part coarsely dolomitic....140–145
RESIDUE: *Clay*—small amount flaky, white, some buff. *Chert*—trace white, botryoidal.

Limestone—extremely fine to smooth, grayish white....145–150
RESIDUE: *Clay*—sponge-like and flaky, white. *Chert*—small amount smooth, white, to chalcedonic.

Limestone—extremely fine, grayish white, slightly dolomitic. Chert—small amount extremely fine granular, gray, oolitic, very slightly dolomitic, with the dolomite rhombs and aggregates interrupting the oolitic structure....150–155
RESIDUE: *Chert*—extremely fine granular, grayish, slightly translucent, finely oolitic, few scattered dolomolds. *Clay*—sponge-like, white.

Dolomite—medium to coarse, grayish white....155–160
RESIDUE: *Clay*—flaky, small amount sponge-like, white.

Dolomite—medium, grayish white, porous, 50 percent. Limestone—extremely fine, grayish white, 50 percent....160–165
RESIDUE missing.

Dolomite—medium coarse, very light gray. Chert—small amount, very fine granular, grayish, in part oolitic....165–170
RESIDUE: *Chert*—fine granular, grayish; extremely fine granular, grayish, fine to medium oolitic. *Clay*—sponge-like, grayish white.

Dolomite—medium, light buff-gray. Chert—some smooth to extremely fine granular, grayish white, very sparingly dolomitic....170–175
RESIDUE: *Chert*—smooth to extremely fine granular, grayish, with scattered patches of chalcedonic. *Clay*—sponge-like, white to buff stained, dolomoldic.

Dolomite—coarse to medium, light gray, porous. Chert—small amount variegated smooth and extremely fine granular, white to grayish....175–180
RESIDUE: *Chert*—smooth, white, quartzose, very sparingly drusy; some variegated smooth to extremely fine granular. *Clay*—small amount flaky.

Dolomite—medium coarse, grayish and slightly pinkish white. Limestone—small amount extremely fine, light gray....180–185
RESIDUE: *Clay*—flaky, porous, grayish white. *Shale*—slightly waxy, very light green.

Limestone—smooth, very light gray, in part intermixed with coarse dolomite. Dolomite—coarse, very light gray, in part intermixed with smooth limestone....185–190
RESIDUE: *Clay*—flaky, buff stained; small amount sponge-like, white. *Chert*—small amount smooth, grayish white.

Limestone—smooth, very light gray, in part coarsely dolomitic....190–195
RESIDUE: *Clay*—flaky, very slightly greenish.

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Limestone—extremely fine, very light gray, with veinlets of pinkish dolomite. Dolomite—some medium to coarse, very light gray	195–200
Residue: *Clay*—small amount flaky, white. *Chert*—trace smooth, white.	
Dolomite—medium coarse, very light gray with slight rose coloration	200–205
Residue: *Clay*—small amount fragmental skeletal dolomoldic, some flaky. *Chert*—small amount rough, nodular, smooth white.	
Dolomite—coarse, very light gray	205–210
Residue: *Clay*—small amount sponge-like, lacy; trace fragmental skeletal dolomoldic.	
Dolomite—coarse, light gray	210–215
Residue: *Clay*—small amount sponge-like, flaky. *Sand*—small amount very fine, subangular, very lightly frosted.	
Dolomite—medium coarse, very light gray, 80 percent. Limestone—extremely fine, very light gray, 10 percent. Chert—smooth, brown, 10 percent	215–220
Residue: *Chert*—smooth, brown, small amount smooth, white. *Clay*—small amount sponge-like, buff-white. *Sand*—small amount very fine, angular.	
Dolomite—coarse, light gray and gray	220–225
Residue: *Clay*—small amount sponge-like, white and flaky, brown. *Sand*—trace very fine.	
Dolomite—medium, slightly brownish gray. Chert—small amount smooth, grayish white	225–230
Residue: *Chert*—ordinary smooth and porcelaneous, white. *Spicules*—few very fine, needle-like.	
Dolomite—variegated texture fine to coarse, slightly buff-gray	230–235
Residue: *Clay*—small amount sponge-like, white. *Chert*—small amount chalk textured, white; trace chalcedonic. *Spicules*—numerous very fine, needle-like.	
Dolomite—medium coarse and medium fine, gray, in part porous. Chert—small amount smooth and porcelaneous, white, in part oolitic	235–240
Residue: *Chert*—ordinary white, in part quartzose and drusy; porcelaneous, in part oolitic and pseudo-oolitic. *Quartz*—small amount subhedral. *Ooliths*—few free. *Spicules*—few very fine, needle-like.	
Dolomite—medium fine, gray, slightly porous	240–245
Residue: *Clay*—small amount fragmental, skeletal dolomoldic. *Chert*—trace chalcedonic. *Spicules*—few needle-like.	
Dolomite—medium fine, gray. Chert—small amount smooth, white to gray, in part pseudo-oolitic	245–250
Residue: *Chert*—smooth, grayish white, small part extremely fine porous, and small part pseudo-oolitic. *Clay*—small amount fragmental dolomoldic.	
Dolomite—medium to coarse, gray. Chert—trace smooth, white	250–255
Residue: *Chert*—smooth, white, in part indistinctly pseudo-oolitic; chalky, cream-white, scatteringly to abundantly dolomoldic. *Clay*—sponge-like and fragmental dolomoldic, cream-white.	
Dolomite—medium to fine, gray. Chert—small amount smooth, grayish white with very finely flocculent structure	255–260
Residue: *Chert*—smooth, white to grayish white, in part with poorly developed dolomolds, in part finely oolitic, some roughly porous and finely drusy. *Clay*—small amount sponge-like, dolomoldic.	
Dolomite—coarse, gray, very compact	260–265
Residue: *Clay*—sponge-like, highly porous, white and buff. *Chert*—granular, very slightly translucent and buff, roughly fragmental, sparingly dolomoldic, with some very fine druse; small amount chalky, white porous.	
Dolomite—coarse, light gray, very compact	265–270
Residue: *Chert*—granular, gray to buff-gray, in part slightly porous and sparingly dolomoldic. *Silt*—remarkably clear quartz, possibly chemical in origin.	
Dolomite—coarse to medium, gray	270–275
Residue: *Chert*—chalky, white, in very rough, porous fragments, soft to hard; trace chalcedonic. *Clay*—sponge-like, white, in very fine, fluffy fragments.	
Dolomite—medium coarse, gray, 80 percent. Chert—very fine granular gray, 20 percent	275–280
Residue: *Chert*—granular, light, very slightly translucent with some gray, in part slightly porous; small amount drusy. *Quartz*—very fine, angular grains, possibly chemical in origin.	
Dolomite—medium coarse, light gray, with scattered pink coloration	280–285
Residue: *Chert*—fine granular, white, abundant to skeletal dolomoldic, drusy. *Quartz*—subhedral, drusy. *Clay*—skeletal dolomoldic.	

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Dolomite—medium coarse, light gray. Limestone—trace extremely fine, light gray 285–290
RESIDUE: *Chert*—fine granular, white, abundant to skeletal dolomoldic, quartzose, drusy; extremely fine granular, white to buff stained. *Quartz*—anhedral, clear and subhedral, coarsely drusy. *Clay*—small amount skeletal dolomoldic.

Dolomite—medium fine to fine, light gray, 90 percent. Chert—smooth and very fine granular, dolomitic, 10 percent 290–295
RESIDUE: *Chert*—smooth, white, scattered dolomoldic, very fine granular white, quartzose and drusy, scattered dolomoldic. *Quartz*—subhedral, drusy.

Dolomite—medium, very light gray 295–300
RESIDUE: *Quartz*—small amount anhedral, finely granular, some subhedral, drusy. *Clay*—small amount fragmental dolomoldic.

Dolomite—medium, very light gray 300–305
RESIDUE: *Clay*—fragmental, skeletal dolomoldic. *Chert*—trace fine granular, pink to white.

Dolomite—medium coarse, light gray. Chert—small amount granular, white, slightly translucent, in part oolitic and in part sparingly dolomitic 305–310
RESIDUE: *Chert*—smooth, white to buff, sparingly dolomoldic; fine granular, slightly translucent, in part oolitic, in part abundant dolomoldic. *Quartz*—subhedral, drusy, dolomoldic.

Dolomite—medium fine, light gray and some pink coloration. Chert—small amount granular, grayish white, oolitic 310–315
RESIDUE: *Chert*—fine granular, grayish white, fine to medium oolitic, few dolomoldic fragments. *Quartz*—subhedral, drusy, in part dolomoldic. *Clay*—fragmental skeletal dolomoldic.

Dolomite—medium, light gray, sparingly cherty 315–320
RESIDUE: *Chert*—smooth, white, scattered dolomoldic, very fine granular, abundant to skeletal dolomoldic, in part finely drusy; chalky, white to grayish. *Quartz*—small amount subhedral, drusy. *Clay*—finely fragmental dolomoldic.

Dolomite—fine to medium fine, slightly buff-gray, 90 percent. Chert—grayish white, variegated smooth and fine granular texture, 10 percent 320–325
RESIDUE: *Chert*—smooth, grayish white with areas of granular texture, traces of semispherical concretionary structure, small amount finely drusy, small amount very finely oolitic. *Quartz*—subhedral grains.

Dolomite—fine, slightly buff-gray. Chert—small amount granular, grayish white, oolitic....325–330
RESIDUE: *Chert*—fine granular, grayish white, finely oolitic, few scattered dolomolds, slightly drusy. *Clay*—sponge-like, white and buff, finely fragmental.

Dolomite—medium fine, gray. Chert—traces fine granular 330–335
RESIDUE: *Chert*—granular, white, abundant dolomoldic, quartzose and drusy. *Quartz*—subhedral grains, drusy clusters. *Silt*—quartz grains, probably chemical in origin.

Dolomite—medium fine, light gray and fine, dark gray. Chert—some grayish white, fine granular, dolomoldic 335–340
RESIDUE: *Chert*—granular, grayish white, abundant dolomoldic, drusy, some concretionary structure. *Quartz*—subhedral, drusy, dolomoldic.

Dolomite—medium fine, gray. Chert—some gray granular 340–345
RESIDUE: *Chert*—finely granular, abundant to skeletal dolomoldic; granular, light brown, oolitic, smooth, white. *Quartz*—coarse, subhedral grains and drusy clusters.

Dolomite—fine to medium fine. Chert—small amount gray, granular 345–350
RESIDUE: *Chert*—fine granular, buff stained, skeletal dolomoldic; fine granular, grayish, smooth, white. *Quartz*—subhedral grains and drusy.

Dolomite—fine, gray. Chert—small amount granular white, in part dolomitic 350–355
RESIDUE: *Chert*—very fine granular, grayish white, abundant to skeletal dolomoldic, quartzose and drusy in part; smooth, white. *Quartz*—subhedral grains and druse.

Dolomite—fine to medium fine, gray 355–360
RESIDUE: *Chert*—granular, slightly translucent-grayish, scattered to abundant dolomoldic, slightly drusy. *Quartz*—subhedral grains, few drusy clusters.

Dolomite—medium fine, gray to buff-gray. Chert—small amount fine granular, light gray 360–365
RESIDUE: *Chert*—granular, grayish, in part pseudo-oolitic, part quartzose, slightly drusy. *Quartz*—small amount subhedral grains and druse.

Dolomite—medium fine, gray and dark gray 365–370
RESIDUE: *Chert*—fine granular, grayish; smooth, white, chalky, hard and rough; smooth, buff stained, skeletal dolomoldic. *Quartz*—anhedral, granular, coarsely drusy; subhedral grains and druse.

	Feet below top
Dolomite—fine, buff-gray and gray. RESIDUE: *Chert*—granular, white, dolomoldic, quartzose, and drusy. *Quartz*—subhedral grains and drusy clusters.	370–375
Dolomite—fine to very fine, brown. Chert—small amount granular, grayish, pseudo-oolitic. RESIDUE: *Chert*—fine granular, grayish, slightly translucent, in part oolitic and pseudo-oolitic, and in part drusy, with scattered dolomolds; smooth, grayish white. *Quartz*—subhedral grains and drusy flakes.	375–380
Dolomite—fine to very fine, gray and buff-gray. RESIDUE: *Quartz*—granular, coarsely drusy, dolomoldic, subhedral grains; very finely granulated. *Chert*—trace granular, white.	380–385
Dolomite—very fine, gray. RESIDUE: *Chert*—very finely granulated, grayish white. *Clay*—flaky, dolomoldic.	385–390
Dolomite—very fine to fine, gray. RESIDUE: *Clay*—very finely fragmental dolomoldic. *Chert*—finely granulated grayish white; trace smooth, white.	390–395
Dolomite—fine to medium fine. RESIDUE: *Chert*—smooth, white, in part finely dolomoldic; chalky, hard, in part finely dolomoldic, small amount fine granular quartzose. *Quartz*—few subhedral grains and drusy flakes.	395–400
Dolomite—very fine, gray. Chert—small amount granular, grayish. RESIDUE: *Chert*—smooth, grayish, slightly chalcedonic, in part quartzose; fine granular, grayish, in part pseudo-oolitic. *Quartz*—few subhedral grains and granulated, dolomoldic fragments. *Clay*—small amount sponge-like, dolomoldic.	400–405
Dolomite—fine to medium fine. RESIDUE: *Quartz*—anhedral, granular, dolomoldic, drusy; anhedral and subhedral grains. *Chert*—fine granular, white, skeletal dolomoldic; small amount chalky. *Clay*—small amount sponge-like, dolomoldic. *Spicules*—extremely fine, needle-like.	405–410
Dolomite—fine and medium fine, buff and gray. RESIDUE: *Chert*—fine granular, white and buff, drusy, skeletal dolomoldic. *Quartz*—drusy, dolomoldic flakes, subhedral grains and granules.	410–415
Dolomite—medium, gray and slightly buff-gray. RESIDUE: *Chert*—granular, skeletal dolomoldic, white and buff, quartzose and finely drusy. *Quartz*—drusy clusters, subhedral and anhedral grains, fine granules.	415–420
Dolomite—very fine, light buff and medium fine, light gray. RESIDUE: *Chert*—very fine granular, buff to white, skeletal dolomoldic; finely granulated, grayish white. *Quartz*—drusy, dolomoldic, subhedral grains.	420–425
Dolomite—very fine, buff, some gray. RESIDUE: *Chert*—finely granulated, grayish white; trace smooth, white, pseudo-oolitic. *Clay*—flaky, gray, and skeletal dolomoldic, buff.	425–430
Dolomite—very fine to fine, buff-gray. RESIDUE: *Chert*—finely granulated, white, many of the granules rhombic, indicating chert replacement of dolomite; smooth, white grading to hard, chalky. *Quartz*—few subhedral grains, trace fine granular, lacy.	430–435
Dolomite—medium to medium fine, light gray. RESIDUE: *Chert*—very fine granular, brown and grayish, skeletal dolomoldic, smooth, brown and white, abundant dolomoldic. *Quartz*—silt-size granules, few subhedral grains.	435–440
Dolomite—very fine to medium fine, buff and gray. RESIDUE: *Chert*—smooth, brown, very fine, scattered dolomolds; very fine granular, white and buff, partly dolomoldic, very finely granulated. *Quartz*—very finely granulated, subhedral grains, and few finely drusy flakes.	440–445
Dolomite—fine, light gray. RESIDUE: *Quartz*—very coarse, subhedral grains, drusy clusters; very finely granulated.	445–450
Dolomite—medium, light gray. RESIDUE: *Chert*—chalky, soft, in part dolomoldic. *Quartz*—subhedral grains and small, dolomoldic, drusy fragments.	450–455
Dolomite—medium, light gray, slightly porous. RESIDUE: *Chert*—very fine grained, skeletal dolomoldic, drusy, buff stained. *Quartz*—subhedral, few anhedral grains, drusy clusters.	455–460

Tanyard Section, Burnet County, Texas

	Feet below top
Tanyard formation, Staendebach member, 0–336 feet—	
Limestone—extremely fine, dove-gray. Chert—trace granular, white, oolitic. RESIDUE: *Chert*—smooth, white, with scattered ooliths; some very fine granular, grayish chert, slightly quartzose. *Quartz*—few banded, drusy fragments, subhedral grains.	0– 5
Limestone—extremely fine, dove-gray. RESIDUE: *Clay*—sponge-like and flaky, white and maroon.	5– 10
Limestone—extremely fine, very light gray. RESIDUE: *Chert*—chalky, white, brittle. *Clay*—flaky, white.	10– 15
Dolomite—coarse, light gray, with maroon coloration, 60 percent. Limestone—extremely fine, very light gray, 40 percent. RESIDUE: *Chert*—chalky, soft, porous, white, slight maroon coloration. *Clay*—flaky, white and maroon.	15– 20
Dolomite—coarse, light gray. RESIDUE: *Clay*—finely fragmental dolomoldic and flaky, white and maroon.	20– 25
Dolomite—coarse to very coarse, light gray. RESIDUE: *Clay*—flaky, porous, and finely fragmental dolomoldic, white, gray, and maroon.	25– 30
Dolomite—coarse to very coarse, light gray. RESIDUE: *Clay*—flaky and finely fragmental dolomoldic, white, gray, and maroon.	30– 35
Dolomite—very coarse, light gray, in part maroon stained. RESIDUE: *Clay*—small amount flaky and finely fragmental dolomoldic, maroon and white.	35– 40
Dolomite—medium coarse, light gray, with maroon staining. RESIDUE: *Chert*—granular, gray to grayish white, quartzose in part. *Quartz*—small amount finely drusy. *Clay*—sponge-like and flaky, white.	40– 45
Dolomite—medium to coarse, light gray. RESIDUE: *Clay*—very small amount sponge-like, grayish.	45– 50
Dolomite—medium coarse to coarse, light pinkish gray. RESIDUE: *Chert*—very fine granular, white, abundant dolomoldic. *Clay*—small amount sponge-like, dolomoldic, and flaky.	50– 55
Dolomite—coarse, light gray, in part slightly pinkish. RESIDUE: *Chert*—very fine granular to slightly chalky, white, skeletal dolomoldic. *Quartz*—subhedral grains. *Clay*—finely fragmental, skeletal dolomoldic.	55– 60
Dolomite—coarse, in part pinkish, light gray. RESIDUE: *Quartz*—fine to coarse, subhedral grains, and dolomoldic, drusy clusters. *Clay*—white and maroon, finely fragmental dolomoldic.	60– 65
Dolomite—medium coarse to coarse, some fine, pinkish and light gray. RESIDUE: *Clay*—small amount, white, some maroon, finely fragmental dolomoldic. *Chert*—trace soft chalky.	65– 70
Dolomite—coarse, light gray, and slightly pinkish. RESIDUE: *Chert*—very fine granular, some smooth, white, finely drusy, sparingly dolomoldic. *Quartz*—very fine to medium, subhedral grains, drusy clusters. *Clay*—sponge-like and finely fragmental dolomoldic, gray to white.	70– 75
Dolomite—fine to medium fine, light gray, some pink. RESIDUE: *Chert*—very fine granular, scattered to abundant dolomoldic, white, some maroon. *Quartz*—highly drusy, dolomoldic flakes and fragments; fine to very coarse, subhedral grains.	75– 80
Dolomite—medium, light gray with pinkish streaks. RESIDUE: *Quartz*—anhedral, slightly drusy; fine, angular and subhedral grains. *Clay*—very small amount fragmental dolomoldic.	80– 85
Dolomite—medium fine to medium, gray. RESIDUE: *Chert*—chalky, soft, white, skeletal dolomoldic; trace smooth, white. *Clay*—white, finely fragmental dolomoldic. *Spicules*—few extremely fine, needle-like.	85– 90
Dolomite—medium to medium fine, light gray, slightly pinkish gray and gray. RESIDUE: *Clay*—very small amount sponge-like and finely fragmental dolomoldic. *Spicule*—long, needle-like.	90– 95
Dolomite—medium fine to medium, gray. RESIDUE: *Chert*—very fine granular, gray, scattered to abundant dolomoldic; chalky, white, abundant to skeletal dolomoldic; chalcedonic, in part drusy. *Clay*—white, finely fragmental, dolomoldic. *Quartz*—drusy fragment, subhedral grains.	95–100

Feet below top

Dolomite—coarse, light gray 100–105
RESIDUE: *Chert*—chalky, white, abundant to skeletal dolomoldic, in part finely fragmental.

Dolomite—coarse, some medium fine, pinkish gray..105–110
RESIDUE: *Clay*—small amount sponge-like, flaky, white.

Dolomite—coarse, light gray, some pinkish gray..110–115
RESIDUE: *Chert*—chalky, grayish white to white, skeletal dolomoldic; smooth, white, skeletal dolomoldic; fine granular, white, drusy, in part dolomoldic. *Quartz*—anhedral, granular, finely drusy, subhedral grains. *Clay*—white, finely fragmental dolomoldic.

Dolomite—medium, light gray..115–120
RESIDUE: *Chert*—very fine granular, white, skeletal dolomoldic, in part finely drusy; chalky, grayish, skeletal dolomoldic. *Quartz*—very fine, subhedral grains. *Clay*—white, finely fragmental dolomoldic.

Dolomite—medium to coarse, light and pinkish gray..120–125
RESIDUE: *Chert*—smooth, white to pinkish, very finely drusy, skeletal dolomoldic. *Quartz*—very finely drusy fragments. *Clay*—white, finely fragmental dolomoldic.

Dolomite—coarse, light gray..125–130
RESIDUE: *Chert*—smooth, white, abundant to skeletal dolomoldic; finely granular, white to buff, in part quartzose and finely drusy, skeletal dolomoldic. *Quartz*—few finely drusy flakes. *Clay*—white, finely fragmental dolomoldic.

Dolomite—medium coarse, light gray..130–135
RESIDUE: *Chert*—fine granular, white, quartzose and finely drusy, skeletal dolomoldic; smooth, white, skeletal dolomoldic. *Quartz*—anhedral, granular, drusy, dolomoldic, very fine, angular to medium, subhedral grains. *Clay*—white, finely fragmental, dolomoldic. *Silt*—clear quartz, probably chemical in origin.

Dolomite—medium coarse, light gray 135–140
RESIDUE: *Quartz*—fine to very coarse, subhedral grains, few drusy clusters. *Chert*—very fine granular, white, abundant to skeletal dolomoldic, quartzose and drusy. *Clay*—very finely fragmental, dolomoldic, white and pink.

Dolomite—medium, light gray..140–145
RESIDUE: *Quartz*—anhedral, dolomoldic, drusy, subhedral grains and clusters. *Chert*—small amount chalky, dolomoldic. *Clay*—cream and white, very finely fragmental dolomoldic.

Dolomite—medium, light gray and fine, buff-gray, 90 percent. Chert—very fine granular, white, 10 percent..145–150
RESIDUE: *Chert*—white, variegated smooth and fine granular, oolitic; very fine granular, cream-white, abundant to skeletal dolomoldic, drusy in part. *Quartz*—fine to coarse, subhedral grains, drusy clusters. *Clay*—finely fragmental dolomoldic, white.

Dolomite—fine to medium gray, in part slightly pinkish..150–155
RESIDUE: *Chert*—very fine granular, white and pink, drusy, abundant to skeletal dolomoldic. *Quartz*—fine to very coarse, subhedral grains, drusy clusters. *Clay*—white, finely fragmental dolomoldic.

Dolomite—fine to medium, gray..155–160
RESIDUE: *Quartz*—fine to coarsely drusy fragments; fine to very coarse, subhedral grains. *Chert*—fine granular, grayish white, scattered to abundant dolomoldic.

Dolomite—medium fine to medium, gray..160–165
RESIDUE: *Quartz*—drusy flakes and fragments, in part dolomoldic; fine to coarse, subhedral grains. *Clay*—white and maroon flecked, skeletal dolomoldic.

Dolomite—medium, gray and fine, buff-gray..165–170
RESIDUE: *Chert*—fine granular, white, some pink, abundant to scattered dolomoldic. *Quartz*—small amount finely drusy. *Clay*—white, finely fragmental dolomoldic.

Dolomite—medium to fine, gray..170–175
RESIDUE: *Chert*—fine granular, white, quartzose and drusy, abundant dolomoldic. *Quartz*—very fine to coarse, subhedral grains.

Dolomite—medium fine, buff-gray..175–180
RESIDUE: *Chert*—very fine granular, grayish white, partly quartzose and drusy, abundant dolomoldic. *Quartz*—very fine to medium, subhedral grains.

Dolomite—medium to medium coarse, light gray..180–185
RESIDUE: *Clay*—small amount, grayish, finely fragmental dolomoldic.

Dolomite—medium, light gray..185–190
RESIDUE: *Clay*—small amount sponge-like, gray and white, finely fragmental dolomoldic.

Feet below top

Dolomite—medium to fine, light gray, 90 percent. Chert—fine granular, white, 10 percent 190–195
RESIDUE: *Chert*—granular, white, scattered dolomoldic. *Quartz*—very fine to coarse, subhedral grains, drusy, dolomoldic fragments.

Dolomite—fine, slightly pinkish gray, 90 percent. Chert—grayish white, granular, oolitic, 10 percent 195–200
RESIDUE: *Chert*—granular, grayish white, finely scattered dolomoldic, oolitic and pseudo-oolitic, in part quartzose; smooth, white, oolitic. *Quartz*—very fine to coarse, subhedral grains.

Dolomite—medium fine, pink, 90 percent. Chert—white, porcelaneous, 10 percent 200–205
RESIDUE: *Chert*—ordinary smooth and porcelaneous, white; very fine granular, white to pink, scattered dolomoldic. *Quartz*—fine to coarse, subhedral grains. *Clay*—small amount white and pink, very finely fragmental dolomoldic.

Dolomite—medium fine to fine, light gray and pink 205–210
RESIDUE: *Quartz*—drusy, dolomoldic fragment, and few subhedral grains. *Clay*—small amount white and pink, finely fragmental and skeletal dolomoldic.

Dolomite—medium fine, gray, some pink staining. Chert—trace white, granular, very finely oolitic 210–215
RESIDUE: *Chert*—fine granular, grayish white and pink, in part abundant dolomoldic and quartzose, in part very finely oolitic. *Quartz*—finely drusy flakes, fine angular grains. *Clay*—small amount white, finely fragmental.

Dolomite—fine, gray and pink, 80 percent. Chert—fine granular and porcelaneous, white, quartzose and drusy in part, 20 percent 215–220
RESIDUE: *Chert*—granular, white to gray, very scattered dolomoldic, in part oolitic, with trace oomolds, in part quartzose and drusy; ordinary and porcelaneous smooth, white to grayish chert. *Quartz*—anhedral, clear, drusy fragments; fine to very coarse, subhedral grains. *Clay*—small amount finely fragmental.

Dolomite—fine to medium, slightly pinkish gray 220–225
RESIDUE: *Chert*—small amount grayish, finely graunlated. *Quartz*—few subhedral grains.

Dolomite—medium to medium fine, gray and pinkish 225–230
RESIDUE: *Quartz*—fine to coarse, subhedral grains; very finely granulated. *Clay*—small amount white, finely fragmental dolomoldic.

Dolomite—medium coarse to medium, light gray 230–235
RESIDUE: *Clay*—small amount white, finely fragmental dolomoldic.

Dolomite—medium fine to fine, gray, some pinkish 235–240
RESIDUE: *Chert*—very fine granular, white, abundant to skeletal dolomoldic. *Quartz*—medium, subhedral grains, very fine, angular granules, few finely drusy flakes. *Clay*—white, finely fragmental, dolomoldic.

Dolomite—fine to medium fine, pinkish gray 240–245
RESIDUE: *Chert*—grayish, finely granulated, rhombic granules; trace fine granular, white, dolomoldic. *Clay*—small amount white, finely fragmental dolomoldic.

Dolomite—fine to medium coarse, light gray 245–250
RESIDUE: *Quartz*—finely granulated; trace dolomoldic, finely drusy; few subhedral grains. *Clay*—white, skeletal dolomoldic.

Dolomite—fine, pinkish gray, some medium, light gray 250–255
RESIDUE: *Chert*—very fine granular, very finely and abundantly drusy, skeletal dolomoldic. *Quartz*—very fine granules and fine subhedral grains.

Dolomite—fine, slightly pinkish, some medium fine, light gray 255–260
RESIDUE: *Chert*—fine granular, grayish white, in part very finely drusy, skeletal dolomoldic; smooth, white, skeletal dolomoldic. *Quartz*—fine to medium, subhedral grains, and finely granulated.

Dolomite—medium fine to coarse, light gray, porous 260–265
RESIDUE: *Quartz*—very small amount very fine, subhedral grains.

Dolomite—fine, pinkish gray 265–270
RESIDUE: *Chert*—small amount grayish, finely granular. *Quartz*—few subhedral grains. *Clay*—small amount very finely fragmental, dolomoldic.

Dolomite—fine to medium fine, some pinkish 270–275
RESIDUE: *Chert*—granular, white, in part very finely dolomoldic; chalky, in part very finely porous and dolomoldic; very fine granules in part rhombic. *Clay*—small amount sponge-like, white to buff.

Feet below top

Dolomite—medium to fine, light gray and pinkish ... 275–280
RESIDUE: *Quartz*—subhedral, very fine to very coarse grains. *Chert*—smooth, tan, and pink, skeletal dolomoldic, in part quartzose and drusy.

Dolomite—medium, light gray and fine, pinkish gray ... 280–285
RESIDUE: *Chert*—granular, white, finely drusy, skeletal dolomoldic. *Quartz*—very fine, angular grains.

Dolomite—fine, pinkish, and medium coarse, light gray ... 285–290
RESIDUE: *Chert*—granular, white, highly drusy, skeletal dolomoldic. *Quartz*—drusy, dolomoldic flakes and very fine, subhedral grains. *Clay*—gray, flaky, and very finely fragmental dolomoldic.

Dolomite—medium coarse and fine, pinkish gray ... 290–295
RESIDUE: *Chert*—small amount fine granular, white and pinkish, dolomoldic. *Clay*—small amount sponge-like, very finely fragmental and dolomoldic.

Dolomite—medium to coarse, light gray, some pinkish ... 295–300
RESIDUE: *Chert*—small amount brittle, chalky. *Clay*—gray, fragmental dolomoldic.

Dolomite—fine, gray, in part pinkish ... 300–305
RESIDUE: *Clay*—small amount white, gray, pink, finely fragmental dolomoldic. *Quartz*—trace finely drusy. *Spicules*—few very fine, needle-like.

Dolomite—fine, buff-gray and pinkish ... 305–310
RESIDUE: *Chert*—very fine granular, white to grayish, some pink, scattered to abundant, finely dolomoldic; smooth, white, with finely dolomoldic contact surfaces; chalky, slightly dolomoldic. *Quartz*—small amount dolomoldic, drusy; few subhedral grains. *Clay*—white, very finely fragmental dolomoldic.

Dolomite—medium coarse to medium fine, light gray and pink ... 310–315
RESIDUE: *Chert*—fine granular, white and pink, in part drusy, abundant to skeletal dolomoldic; chalky, small amount dolomoldic. *Quartz*—dolomoldic, drusy fragments, fine, subhedral grains.

Dolomite—coarse, grayish white ... 315–320
RESIDUE: *Chert*—granular, white, abundant to skeletal, coarsely dolomoldic, in part drusy. *Quartz*—fine to coarse subhedral grains, dolomoldic, drusy fragments.

Dolomite—medium to medium fine, light gray, some pink ... 320–325
RESIDUE: *Chert*—granular, white, quartzose and finely drusy, skeletal dolomoldic. *Quartz*—finely drusy, dolomoldic, few subhedral grains.

Dolomite—medium to coarse, light gray ... 325–330
RESIDUE: *Chert*—small amount finely granulated. *Shale*—green to dark green, waxy. *Clay*—small amount white, finely fragmental.

Dolomite—coarse, light gray ... 330–335
RESIDUE: *Shale*—small amount light green, some dark green, waxy, in fine fragments. *Chert*—trace finely granulated.

Tanyard formation, Threadgill member, 336–538 feet—

Dolomite—coarse to very coarse, light gray, some pinkish ... 335–340
RESIDUE: *Shale*—dark maroon and dark green, waxy, in part dolomoldic. *Clay*—small amount sponge-like and finely fragmental dolomoldic, white.

Dolomite—coarse, light gray, some buff staining ... 340–345
RESIDUE: *Shale*—green, waxy, in very fine fragments. *Chert*—small amount soft chalky; trace granulated.

Dolomite—coarse, light gray, some maroon stained ... 345–350
RESIDUE: *Shale*—light green, some dark green and maroon, waxy. *Chert*—small amount granulated; trace smooth, lacy.

Dolomite—coarse, light gray, some purplish ... 350–355
RESIDUE: *Shale*—waxy, grayish white to purplish and maroon, fragmental skeletal dolomoldic. *Clay*—small amount flaky. *Quartz*—few medium to coarse, subhedral grains.

Dolomite—coarse to very coarse, light gray, some purplish ... 355–360
RESIDUE: *Chert*—small amount finely granulated. *Shale*—waxy, greenish and purplish to maroon. *Clay*—trace flaky.

Dolomite—coarse to medium coarse, grayish white ... 360–365
RESIDUE: *Chert*—granulated, white. *Shale*—small amount waxy, green and maroon, fragmental dolomoldic.

Dolomite—coarse, very light gray, some slightly pinkish ... 365–370
RESIDUE: *Shale*—waxy, green, some maroon, traces of dolomolds. *Chert*—small amount white, granulated.

	Feet below top
Dolomite—coarse, very light gray. RESIDUE: *Shale*—waxy, drab green, some maroon. *Chert*—trace granular, dolomoldic.	370–375
Dolomite—coarse, some fine, very light gray, some purplish staining, 60 percent. Limestone—extremely fine, grayish white, some purplish staining, 40 percent. RESIDUE: *Shale*—small amount waxy, drab green. *Chert*—small amount very finely granulated; trace rough, granular.	375–380
Dolomite—coarse, white, 80 percent. Limestone—extremely fine, grayish white, 20 percent. Chert—trace gray granular. RESIDUE: *Chert*—granular, grayish, with granulated surfaces; small amount very finely granulated. *Shale*—very small amount green, waxy.	380–385
Dolomite—coarse to very coarse, grayish white. RESIDUE: *Shale*—small amount waxy, dark gray, greenish and maroon.	385–390
Limestone—extremely fine, grayish white. Dolomite—trace white. RESIDUE: *Chert*—gray, granular, in part porous. *Shale*—small amount waxy, greenish and maroon.	390–395
Dolomite—very coarse, white, trace pink. RESIDUE: *Chert*—small amount chalky, roughly nodular, trace of lacy. *Shale*—trace greenish, waxy.	395–400
Dolomite—very coarse, light gray and pink, 50 percent. Limestone—extremely fine, grayish white, 50 percent. RESIDUE: *Chert*—granular, gray, slightly translucent. *Shale*—waxy, grayish white, dull green, maroon, and some bright green. *Quartz*—few fine, euhedral, medium stubby prisms.	400–405
Limestone—extremely fine, slightly grayish white. RESIDUE: *Shale*—very small amount maroon and greenish gray in very fine fragments. *Silt*—very small amount silt-size rhombs.	405–410
Dolomite—very coarse, white. Limestone—small amount extremely fine, very light gray, dolomitic and dolomoldic. RESIDUE: *Shale*—very small amount waxy, greenish gray, maroon, trace bright green, in very fine fragments.	410–415
Limestone—extremely fine, grayish white, trace dolomitic, trace purplish color. RESIDUE: *Shale*—small amount waxy, buff and drab green.	415–420
Limestone—extremely fine, white, trace dolomitic. RESIDUE: *Chert*—granular, semi-transclucent-gray, highly porous to lacy; smooth, white, roughly concretionary nodules. *Shale*—very small amount waxy green.	420–425
Limestone—extremely fine, very light gray, traces dolomitic. RESIDUE: *Shale*—very small amount waxy, buff-green in extremely fine fragments.	425–430
Limestone—extremely fine, very light gray; trace finely dolomitic. RESIDUE: *Shale*—small amount waxy, green, some maroon.	430–435
Limestone—extremely fine, slightly grayish white, trace dolomitic. RESIDUE: None.	435–440
Limestone—extremely fine, slightly grayish white, trace dolomitic. RESIDUE: *Quartz*—anhedral, highly porous to lacy. *Chert*—smooth, white, roughly nodular. *Shale*—small amount waxy green.	440–445
Limestone—extremely fine, slightly grayish white. RESIDUE: *Shale*—few fine, waxy, green flakes.	445–450
Limestone—extremely fine, white, in part with slightly greenish tint. RESIDUE: None.	450–455
Limestone—extremely fine, slightly grayish white. RESIDUE: *Chert*—small amount smooth, white, finely concretionary. *Shale*—very small amount waxy, green.	455–460
Limestone—extremely fine, grayish white. RESIDUE: *Chert*—trace granular, lacy, and finely nodular.	460–465
Limestone—extremely fine, grayish white. RESIDUE: *Chert*—trace nodular, white.	465–470
Limestone—extremely fine, light gray, trace coarsely dolomitic. RESIDUE: *Shale*—trace waxy, green. *Silt*—few rhombic and angular grains.	470–475
Limestone—extremely fine, grayish white. RESIDUE: *Shale*—trace waxy green. *Silt*—small amount rhombic grains.	475–480

Feet below top

Limestone—extremely fine, grayish white, in part with indistinct, finely fragmental (pseudo-oolitic?) structure 480–485
RESIDUE: *Quartz*—anhedral, in fragments with rough, granulated surfaces. *Chert*—trace white, nodular, and granular, slightly translucent-grayish.

Limestone—extremely fine, light gray 485–490
RESIDUE: *Shale*—very small amount waxy, drab green. *Silt*—small amount, rhombic grains.

Limestone—extremely fine, grayish white, trace dolomitic 490–495
RESIDUE: *Chert*—trace, fine granular. *Silt*—rhombic grains.

Limestone—extremely fine, slightly grayish white 495–500
RESIDUE: None.

Limestone—extremely fine, slightly grayish white, in part coarsely dolomitic 500–505
RESIDUE: *Shale*—very small amount waxy, green. *Silt*—trace rhombic grains.

Limestone—extremely fine, grayish white, in part slightly dolomitic, with slightly greenish tint 505–510
RESIDUE: *Shale*—small amount waxy, green, and brownish green. *Chert*—trace fine, silicified rhombs. *Silt*—rhombic grains.

Limestone—extremely fine, grayish white, 50 percent. Dolomite—coarse, light gray, 50 percent 510–515
RESIDUE: *Shale*—trace dark green, waxy. *Silt*—trace rhombic grains.

Dolomite—coarse, light gray 515–520
RESIDUE: *Quartz*—anhedral, cloudy, rough to lacy fragments; trace finely granulated. *Shale*—small amount brownish green, waxy.

Dolomite—medium to coarse, gray 520–525
RESIDUE: *Shale*—drab green, some maroon, waxy. *Silt*—very fine, rhombic grains.

Dolomite—coarse to medium, light gray 525–530
RESIDUE: *Shale*—dark green, waxy, trace of dolomolds. *Quartz*—small amount finely granulated.

Dolomite—coarse, light gray 530–535
RESIDUE: *Chert*—small amount white, granulated, trace white, nodular. *Clay*—sponge-like, in part dolomoldic. *Shale*—small amount green, waxy. *Silt*—very fine, in part rhombic grains. *Quartz*—trace anhedral, lacy.

Dolomite—medium, light gray, 60 percent. Limestone—fine, purplish maroon, 40 percent 535–540

RESIDUE: *Quartz*—finely granulated, in part very slightly orchid tinted; trace anhedral, lacy. *Chert*—trace rough, white, chalky.

Wilberns formation, 538–570 feet—

Dolomite—very fine, dull purplish maroon, some buff-gray 540–545
RESIDUE: *Chert*—very finely granulated, slightly purplish tinted. *Clay*—small amount very finely dolomoldic, white to buff.

Dolomite—very fine, gray, some purplish coloration, in part siliceous 545–550
RESIDUE: *Chert*—very fine granular, grayish white to earthy gray, very scattered to abundant finely dolomoldic; some smooth, white, slightly chalcedonic; trace chalky. *Clay*—grayish white, mostly extremely fine fragmental. *Quartz*—small amount drusy.

Dolomite—very fine, buff-gray and slightly purplish, in part siliceous. Chert—some white, porcelaneous to very fine granular 550–555
RESIDUE: *Chert*—fine granular, slightly translucent-grayish, non-dolomoldic to abundant dolomoldic; some white, porcelaneous, some slightly chalcedonic. *Clay*—grayish white, extremely fine fragmental.

Dolomite—very fine to extremely fine, buff-gray, some purplish, in part siliceous. Chert—some granular, white 555–560
RESIDUE: *Chert*—fine granular, slightly translucent-grayish to white, in part very finely dolomoldic; some buff stained and purplish, fine granular. *Clay*—grayish white, extremely fine fragmental.

Dolomite—very fine, buff-gray, trace purplish. Chert—some very fine granular, white 560–565
RESIDUE: *Chert*—very fine granular, buff, pink stained, white, and slightly translucent-grayish, non-dolomoldic to abundant dolomoldic; some chalky, skeletal dolomoldic. *Quartz*—some finely drusy flakes. *Clay*—grayish white, extremely fine fragmental.

Dolomite—very fine, buff-gray and purplish gray 565–570
RESIDUE: *Clay*—white, some pink, finely fragmental, skeletal dolomoldic. *Chert*—soft, chalky, scattered dolomoldic.

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