1974

A study of the subsurface stratigraphy of the upper Cambrian in Western Missouri

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A STUDY OF THE SUBSURFACE STRATIGRAPHY OF THE UPPER CAMBRIAN IN WESTERN MISSOURI

BY

JOSEPH L. THACKER, JR., 1942 -

A THESIS

Presented to the Faculty of the Graduate School of the

UNIVERSITY OF MISSOURI - ROLLA

In Partial Fulfillment of the Requirements for the Degree

MASTER OF SCIENCE IN GEOLOGY

1974

Approved by

(Advisor)

ABSTRACT

Megascopic examination of diamond-drill cores supplemented by insoluble residue data provides a usable means of studying the lithologic characteristic of Upper Cambrian strata in the subsurface of western Missouri.

The stratigraphic relationships within each Cambrian formation and the relationships of each Cambrian unit to formations above and below are discussed.

The relationship of Upper Cambrian strata to the Precambrian surface in western Missouri and easternmost Kansas is illustrated. The Lamotte Sandstone is overlapped by the Reagan Sandstone against Precambrian topographic highs and the Bonneterre and lower Davis are replaced by sandstones similar to the Reagan in southwest Missouri and southeast Kansas. Northward, in western Missouri, from Jasper County to Bates County the Bonneterre and lower Davis (?) is absent and in easternmost Kansas the Lamotte, Bonneterre, and Davis Formations have been overlapped by the Derby-Doerun Dolomite.

All Upper Cambrian formations thin westward, away from the St. Francois Mountains, across the study area. However, pre-Derby-Doerun units thin more rapidly than do the Derby-Doerun, Potosi, or Eminence Formations.

The areal extent of the Sullivan Siltstone and the Whetstone Creek Members of the Bonneterre Formation in the central and western portions of southern Missouri has been determined and the westward extent of the Whetstone Creek Member is believed to represent an

erosional surface on the top of the Bonneterre.

The "green clay residue facies" and the "spongy chert residue facies" occur by facies substitution with more typical, chert-bearing Potosi and Eminence Dolomites. Although the reasons for these residue facies in the Potosi and Eminence are not fully known at this time, the areal distribution of these units in the study area have been determined.

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I. INTRODUCTION

A. Statement of Problem

Investigations of the surface characteristics of Upper Cambrian strata in Missouri have been carried on by geologists for many years but very little attention has been paid to their subsurface relationships. This report is the result of a study of the subsurface relationships of Cambrian strata in western Missouri and extreme eastern Kansas.

The writer became interested in the Cambrian of Missouri in 1969, when at the suggestion of Dr. Wallace B. Howe, Missouri State Geologist, he started a study, with other geologists, to correlate the subsurface Cambrian strata across southern Missouri along a traverse from the St. Francois Mountain region to northeastern Oklahoma (Kurtz, et al., 1974).

Important outgrowths of that study were: the identification of two new members of the Bonneterre Formation; the identification of informal residue units in the Potosi and Eminence Dolomites; the recognition of the Reagan Sandstone in extreme southwest Missouri; and, the recognition of the fact that not all of Upper Cambrian time or stratigraphic units are represented in southwest Missouri.

The primary purpose of this investigation is to study further the geology of subsurface Cambrian units in western Missouri in a more regional nature and to:

1) delineate the stratigraphic relationships and regional extent of the Sullivan Siltstone and Whetstone Creek Members of the Bonneterre Formation;

2) determine the areal extent and geologic relationships of the "green clay residue facies" to the Potosi Dolomite;

3) determine the areal extent and geologic relationships of the "spongy chert residue facies" to the Eminence Dolomite;

4) determine the areal extent of the Reagan Sandstone in southwestern Missouri and, if possible, its relationship to the Lamotte Sandstone, the basal Cambrian sandstone in Missouri;

5) determine, as best as possible, the relationship of Upper Cambrian strata to the Precambrian topography in far western Missouri;

6) and, to extend Upper Cambrian terminology used in the subsurface of western Missouri across the state border to demonstrate the distribution and extent of Upper Cambrian units in easternmost Kansas.

B. Acknowledgements

It is with deep appreciation that I acknowledge the following people who have been instrumental in the preparation of this study: Dr. Thomas R. Beveridge, my Thesis Advisor, for his suggestions, aid, and constructive criticism; Drs. A. C. Spreng and John D. Rockaway, second and third readers, for their critical appraisal of my work; K. H. Anderson, Chief, Subsurface Section, Missouri Geological Survey

and Water Resources, for his many helpful suggestions during the preparation of this manuscript; Douglas Stark, Chief, and Billy Ross, Graphics Section, Missouri Geological Survey, who prepared the illustrations for this report; and Dr. Wallace B. Howe, State Geologist, for his encouragement through the completion of this work.

Special thanks go to Paul E. Gerdemann, Chief Geologist, St. Joe Minerals Corporation; John E. Teet, Regional Geologist, The New Jersey Zinc Company; Dennis J. Ryan, Senior Exploration Advisor, Kerr-McGee Corporation; and Dan R. Stewart, Exploration Manager, Azcon Corporation, for making diamond-drill core available to me for this study.

Finally, but not least importantly, I express my sincere appreciation to my wife who has persevered and seen the completion of this work and who typed the many drafts of this thesis.

C. Location and Physiographic Setting

The study area for this report occupies the major portion of southern Missouri. It is bounded on the north by the Missouri River, the south by the Missouri - Arkansas border, and stretches across southern Missouri from the St. Francois Mountains area into eastern-most Kansas.

According to Bretz (1965), the area of study occupies the western half of the Salem Plateau and the eastern half of the Springfield Plateau which are two major subdivisions of Fenneman's (1938) Ozark Plateaus physiographic province.

The boundary between these two physiographic regions is marked by a highly irregular escarpment called the Eureka Springs Escarpment by Bretz (Burlington Escarpment of earlier workers) which runs sinuously from north to south and divides the study area approximately in half. Bretz states that this escarpment represents, "stratigraphically the edge of retreating Mississippian formations that, ..., once completely covered the province" (p. 14).

East of the Eureka Springs Escarpment, the Salem Plateau is held up by carbonate rocks of Ordovician age while west of this boundary the Springfield Plateau is underlain by rocks of Mississippian age.

D. Data Collecting Procedures

Data for this study were obtained from diamond-drill cores and insoluble residue logs which penetrate the subsurface Cambrian section in western Missouri (Figure 1).

No systematic or statistical means of data selection was possible in this study due to the sparsity and sporadic distribution of available cores and residue logs which penetrate the complete Upper Cambrian succession of strata.

The lithologies in thirteen cores were described megascopically, with the use of 10x hand lens. Each core was sampled on five-foot intervals, and the samples digested in hydrochloric acid, for the retriveal of insoluble residues. The residues were then plotted on strip-logs and each residue log was summarized.

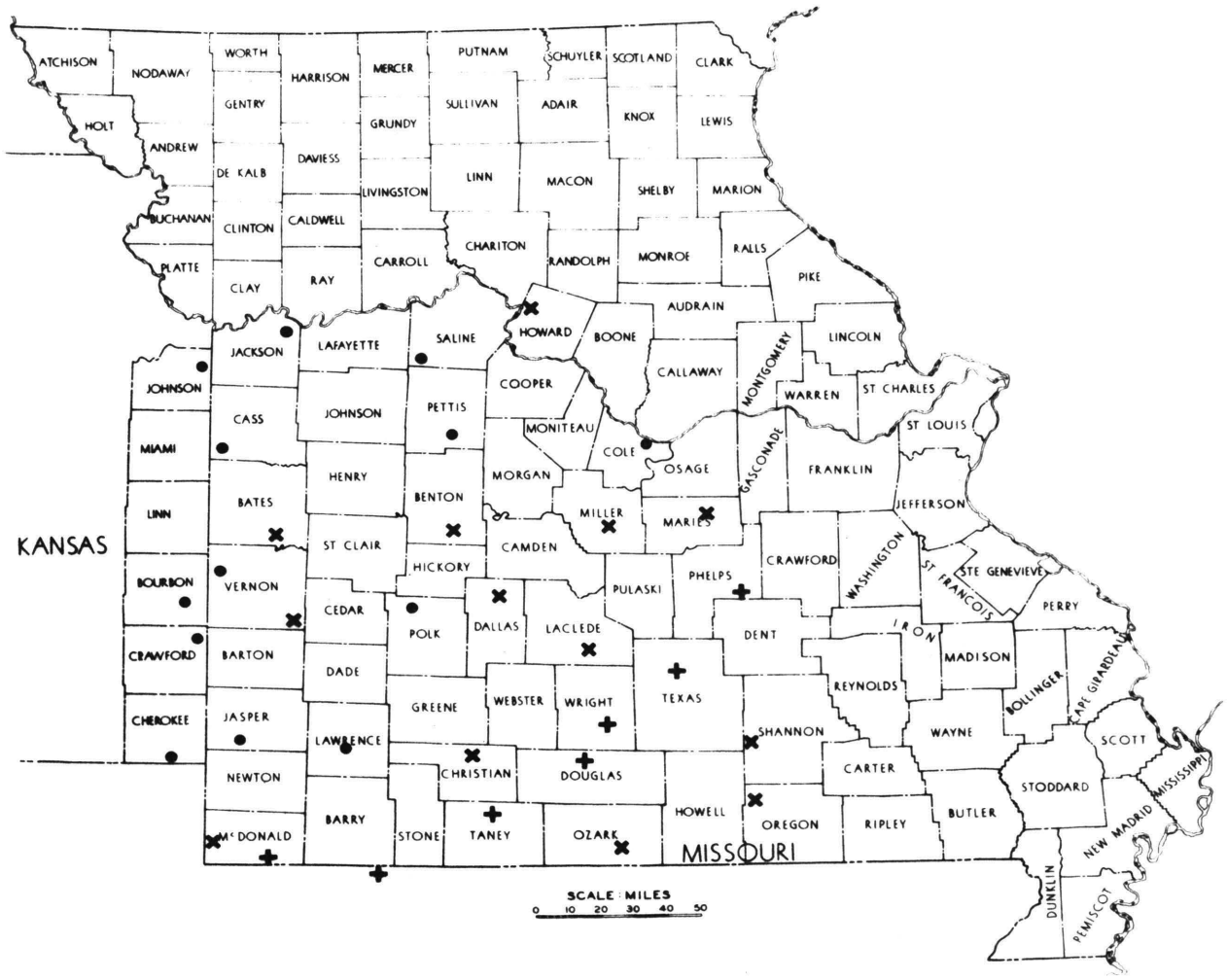

Figure 1 - Distribution of Cambrian wells and diamond-drill cores in southern Missouri and easternmost Kansas used in this study. 0's indicate deep wells; X's indicate diamond-drill cores; +'s indicate previously described diamond-drill cores whose data are used in this study.

Data from an additional seven diamond-drill cores which were described by the writer for another report (Kurtz et al., 1974), are also used in this study. For the lithologic descriptions of these cores and their supplementary residue log summaries, the reader is referred to this publication. A listing of the names and locations of these seven cores can be found in the Appendix following this report.

In those areas where there were no drill-cores available, sufficiently deep, insoluble-residue-logs were selected from the files of the Missouri Geological Survey to fill data gaps where possible. In all, thirteen residue logs were used in this study.

A description of the lithologies found in each diamond-drill core is on file at the Missouri Geological Survey and is available for public inspection. A summary of each residue log used in this study is given in the Appendix.

Two rather large areas in western Missouri contain no sufficiently deep, diamond-drill cores or residue logs which penetrate the complete Cambrian section (Figure 1).

II. REVIEW OF LITERATURE

Reports on the geology of Cambrian formations in Missouri were published as early as the mid-1890's. Winslow (1894) produced a report on the history of lead and zinc mining in Missouri and the geology of Missouri's mining districts. Winslow's report was soon followed by Gallaher (1900), Nason (1901), Bain and Ulrich (1905), Buehler (1907), Buckley (1908), and Ulrich (1911), each of whom reported on the Cambrian stratigraphy in southeast Missouri. However, because these early geologists were principally concerned with the mineral resources of Missouri, most of the emphasis in their reports was centered around those Cambrian horizons containing some type of ore deposit.

Later workers such as Weller and St. Clair (1928), Bridge (1930), and Dake (1930) added additional information to the stratigraphic relationships and boundary limitations of the Cambrian units in southeast Missouri.

More recently the surface exposures of Cambrian strata have received concentrated study by Hendriks (1954), Howe (1966 and 1968), and Snyder and Gerdemann (1968).

Despite all the investigations in Cambrian outcrop areas, there have been very few, detailed, subsurface investigations of the Cambrian stratigraphy in Missouri and particularly in western Missouri. Koenig (1954) made a preliminary regional study of the lithofacies and thickness changes in the subsurface Bonneterre

Formation. McCracken (1964) correlated the insoluble residue zones of the Cambro-Ordovician rocks in northeast Oklahoma and surrounding states and Chenoweth (1968) compiled a very generalized report on the overlap of Arbuckle (Upper Cambrian and Lower Ordovician) rocks in the southern Mid-Continent area, in which he included most of Missouri.

Finally, the Cambrian strata in the Ozark region of Missouri have been correlated through the subsurface with the type Cambrian area of the Upper Mississippi Valley region, by Howe et al. (1972), and the subsurface Cambrian units in southwest Missouri have been correlated with Cambrian formations in the subsurface immediately west of the St. Francois Mountains by Kurtz et al. (1974).

This study is intended to supplement early investigations and provide a working knowledge of relationships within the subsurface Cambrian formations throughout Missouri, south of the Missouri River.

III. GENERAL GEOLOGIC SETTING

Cambrian strata in Missouri are made up of various types of carbonate rocks which appear to represent continuous deposition (Howe, 1968). With the exception of the lower Lamotte Sandstone, which may be Middle Cambrian (Albertan), the strata are Upper Cambrian (Croixian) in age and have been correlated with the Upper Cambrian sections in Texas (Bridge, 1937) and the Upper Mississippi Valley Region (Howe et al., 1972).

All of the Upper Cambrian section in Missouri is a vast facies complex of varied lithic units which has led to many difficulties in regional and statewide correlations of various formations. Howe (1968, pp. 9 &10), best summed up this problem when he states . . .

> "The problems of stratigraphic classification and nomenclature of recurring atypical facies in a succession that appears to represent essentially uninterrupted sedimentation are formidable . . . the dominant or more widely distributed facies have received names and have thus become the basis of an established column, and in which minor, atypical facies are recognized as lithic entities usually but not always assignable to a position within the established framework."

With the exception of the Decaturville structure in Laclede and Camden Counties, Missouri, and the Lake of the Ozarks area where rivers have cut down through younger strata exposing upper Eminence dolomites, surface exposures of Upper Cambrian rocks are restricted to those areas immediately surrounding the St. Francois Mountains. Away from these uplifted Precambrian mountains, younger formations are exposed on the surface in a, roughly, concentric pattern.

Because of this the St. Francois Mountain area has become a reference area to Cambrian strata in the Mid-Continent Region of the United States.

Cambrian formations dip away from this uplift, underlying younger Paleozoic strata, and are present everywhere in the subsurface of Missouri except where they have undergone facies substitution with, or have been overlapped by, younger Cambrian units against high Precambrian knobs.

According to Hayes and Knight (1961), the total thickness of Upper Cambrian strata in Missouri approximates 2000 feet. The Upper Cambrian (Croixian) Series in Missouri is made up of seven formations which in ascending order (decreasing age) are: The Lamotte Sandstone; the Reagan Sandstone; the Bonneterre Formation; the Davis Formation and the Derby-Doerun Dolomite which are combined to form the Elvins Group; the Potosi Dolomite; and, the Eminence Dolomite (see stratigraphic column, Figure 2).

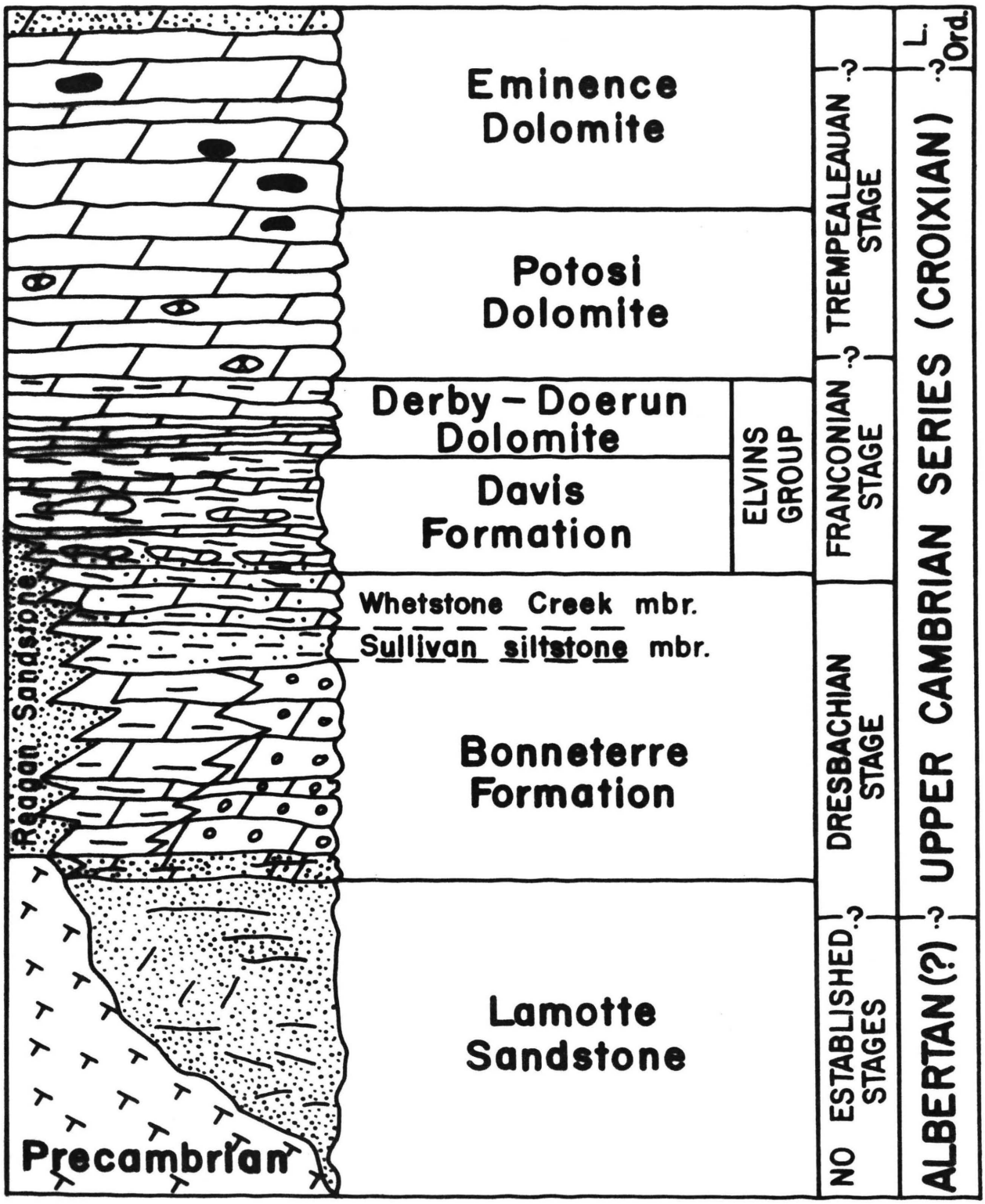

Figure 2 - Composite stratigraphic column of subsurface Upper Cambrian formations in western Missouri.

IV. RELATIONSHIP OF PRECAMBRIAN TERRANE TO UPPER CAMBRIAN SEDIMENTS

Eva Kisvarsanyi (1974) has recently compiled a topographic map of the buried Precambrian surface in Missouri. According to Kisvarsanyi the Precambrian surface slopes away from the St. Francois Mountains across southern Missouri and reaches its maximum depth in the Ozark - Oregon county, Missouri area.

Two Precambrian highs occur within the study area for this report. The "Central Missouri High" encompasses the western half of Laclede County, extends across Dallas and Camden Counties, and terminates in the northwestern corner of Benton County, Missouri. The "Southwest Missouri High" represents the northeasternmost extension of the Spavinaw Arch and occupies the southwestern corner of Missouri.

A pronounced embayment on the Precambrian surface extends from Christian County, Missouri, northeastward between the "Central Missouri High" and the "Southeast Missouri High" (St. Francois Mountains area). As might be expected, this embayment occupies that portion of southern Missouri containing the thickest section of Upper Cambrian sediments.

Localized Precambrian knobs existed throughout southern Missouri and produced strong, but local, effects upon sediment deposition during early Paleozoic time.

The basal Paleozoic sandstones in southern Missouri (Lamotte and Reagan) fill valleys between Precambrian knobs and ridges. The

remainder of the Cambrian strata above the basal sandstones are made up of shelf-deposited carbonates containing varying amounts of terrestrial clastic material.

In the southwestern corner of Missouri and in the extreme western Missouri - eastern Kansas area, lower Upper Cambrian formations are not present. In southwest Missouri the Lamotte Sandstone is overlapped by the Reagan Sandstone against the rapidly rising flanks of the "Southwest Missouri (Precambrian) High". The Bonneterre Formation and the lower portion of the Davis Formation change facies to the Reagan along the flanks of this Precambrian high. The Reagan is then overlapped by the Derby-Doerun on top of the high. Northward, in extreme western Missouri and eastern Kansas, the Bonneterre is absent by facies substitution with the Lamotte Sandstone and the Lamotte is directly overlain by the Davis. It should be noted that in the Vernon and Bates Counties, Missouri drill-holes (see Figure 1) the basal Paleozoic sandstone exhibits lithologic characteristics which may be more typical of the Reagan Sandstone than of the Lamotte. In these two holes the sandstone is coarser grained than typical Lamotte, the grains are more angular in shape, and there is considerable shale content. These three lithologic characteristics may indicate that this sandstone is better termed Reagan. But, until further work can be done in this portion of the stratigraphic section the basal sandstone in these two drill-holes is assigned to the Lamotte. This situation holds true as far north as Cass County, Missouri where Bonneterre strata are again recognizable in the subsurface.

V. UPPER CAMBRIAN STRATA IN WESTERN MISSOURI

The stratigraphic relationships and lithologic characteristics of subsurface Cambrian formations in western Missouri have been traced across the Missouri - Kansas border and correlated with the Upper Cambrian strata in the subsurface of eastermost Kansas. The occurrence and distribution of each Cambrian formation in eastern Kansas is discussed under the appropriate subheading.

A. Lamotte Sandstone

The Lamotte is the basal Paleozoic sandstone which underlies essentially all of western Missouri and rests unconformably on the Precambrian basement. Exceptions to this rule occur in the extreme southwestern corner of the state where the Lamotte is not present and in local areas where the Lamotte pinches out against high Precambrian knobs.

The Lamotte was named by Winslow (1894) for sandstone exposures in the vicinity of Mine La Motte, Madison County, Missouri. Winslow described the Lamotte as being more than 250 feet thick and immediately overlying the Precambrian crystalline basement. Ojakangas (1963) described the Lamotte in the outcrop area surrounding the St. Francois Mountains as a "time-transgressive marine orthoquartzite sandstone containing arkose sandstones and conglomerates in its lower part". Howe (1972) added that the Lamotte may also be partly fluvial and aeolian in nature.

In western Missouri the Lamotte is made up, almost entirely, of fairly well-sorted, fine to medium grained, rounded and frosted quartz grains which grade downward into a coarser sandstone whose grains are more angular in shape. The lower portions of the Lamotte commonly consists of sandstone whose grains range up to granule (and occasionally, pea gravel) in size. The color of the Lamotte ranges from white or light-gray to dark-gray. The color is dependent upon the amount of shale present in the formation which usually occurs as wavy partings and as small clasts incorporated within the sandstone. Shale in the Lamotte occurs, more commonly, in only the upper portion, but occasionally persists throughout the unit. Red, hematitic shale and hematite coatings on quartz grains are common in the middle and lower Lamotte. The occurrence of hematite is commonly, but not always, restricted to thin horizons, resulting in alternating red and white to gray beds which produces a banded appearance in the sandstone.

The distribution and thickness of the Lamotte is shown on Figure 3. As can be seen, the unit generally thins toward the west and northwest. The highly irregular thicknesses of the Lamotte is due to the high-relief Precambrian surface upon which it was deposited. In the south-half of the study area, Lamotte sand fills valleys between high-rising, Precambrian peaks. However, in the northern portion of the study area, the Precambrian surface flattened-out and the Lamotte appears more as a shelf deposit. It should be noted that this map only gives a general idea of Lamotte thicknesses, and due to a lack of sufficient control points in western Missouri which penetrate the complete Lamotte section, may not reflect the true nature of its

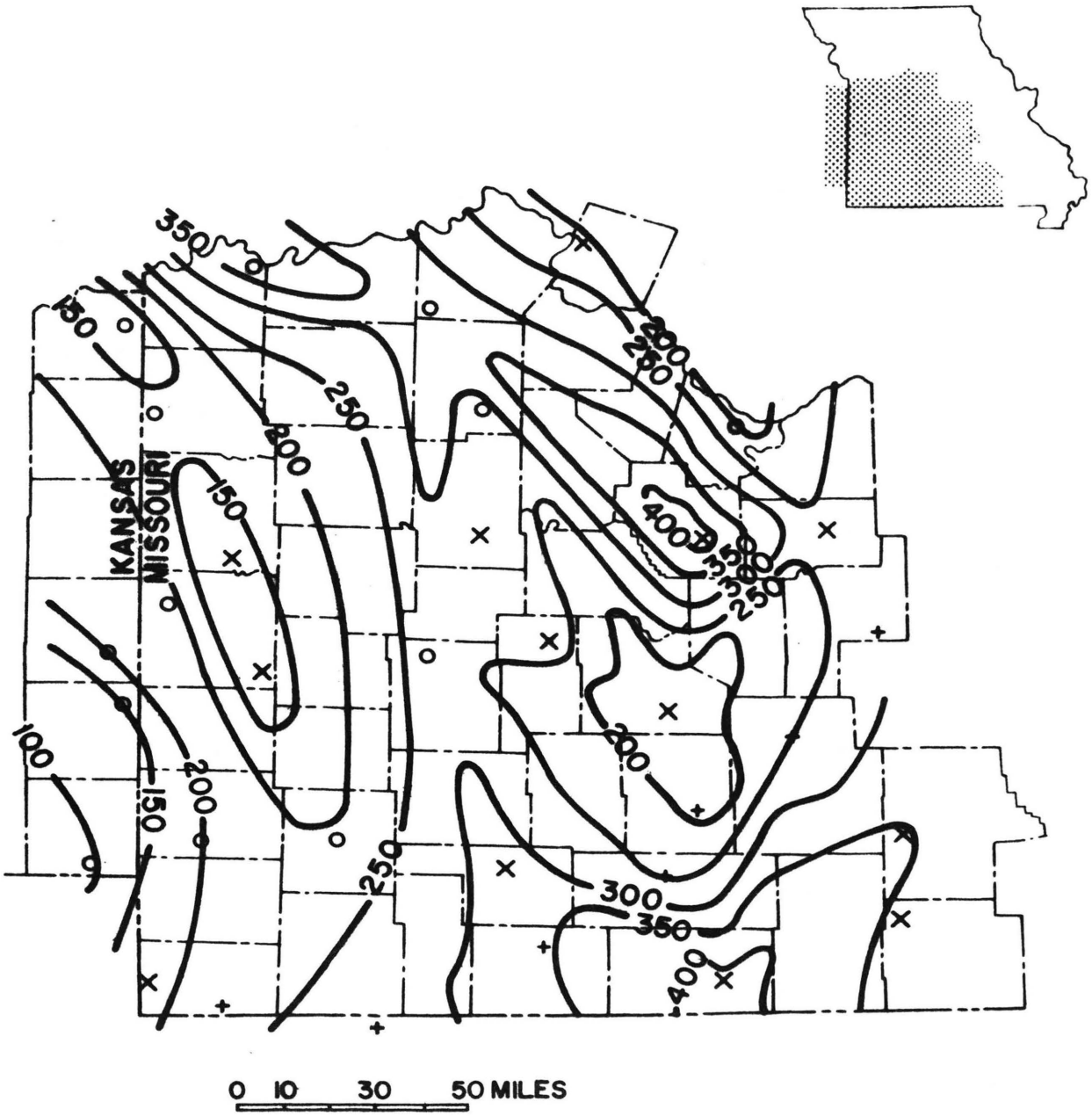

Figure 3 - Isopach map of the Lamotte Sandstone.
Contour Interval = 50 feet.

distribution.

In many localities the basal Lamotte often contains large amounts of fine to coarse grained, pink feldspar detritus and shale. Such a feldspathic sandstone has been termed arkose and may be correlative with the Rice Formation in Kansas described by Scott (1966) and the pre-Mt. Simon section in the Michigan Basin reported by Catacosinos (1973).

The boundary between the Lamotte and the overlying Bonneterre Formation is commonly represented by a "transition" zone consisting of dolomitic, shaly, and sometimes glauconitic, sandstone. Ojakangas (1963) placed this "transition" zone in the Lamotte, however, the writer feels this unit is more correctly placed in the lowest Bonneterre. This unit will be more fully discussed later.

The Lamotte Sandstone has been correlated with the Mt. Simon Sandstone in northeastern Illinois by Buschbach (1964), and in the Upper Mississippi Valley Region by Bridge (1936). Howell (1944) termed the Lamotte a facies equivalent of the Reagan Sandstone in Oklahoma and Kansas.

The exact age of the Lamotte is not known. Howe (1972) states that some of the Lamotte is probably pre-Upper Cambrian in age and that it may represent "part or all of Early, Middle, and/or early stages of Late Cambrian time". Kurtz et al. (1974) states that the Lamotte predates the Bonneterre Formation which contains an upper Cedaria Zone fauna in the outcrop (Lochman, 1940) and a possible Cedaria Zone fauna in the subsurface. Lochman (1940) determined that the basal Bonneterre fauna were representative of the upper portion of

the Cedaria Zone.

B. Reagan Sandstone

The Reagan was first named by Taff in 1902 for sandstone exposures around the town of Reagan, Oklahoma. Decker (1933) described the Reagan as a pebbly sandstone 500 feet thick which carries much glauconite and becomes calcareous at its top.

The Reagan was first recognized in Missouri by Kurtz et al. (1974). Its distribution and thickness in western Missouri and eastern Kansas are shown on Figure 4. Due to a lack of sufficient deep drill-holes in this region which penetrate the entire succession of Cambrian strata, the distribution of the Reagan Sandstone as shown is probably exaggerated. The only holes which cut the Reagan are in Lawrence and McDonald Counties, Missouri, Carroll County, Arkansas, and Crawford and Cherokee Counties, Kansas. It is felt by the writer that the Reagan does not extend as far north or east as shown. However, for the purpose of illustrating the distribution of the Reagan in southwestern Missouri the zero contour line was drawn through the closest peripheral holes which penetrated the entire Cambrian section and contained no Reagan Sandstone.

The Reagan is a poorly sorted quartz sandstone. It differs from the Lamotte in that it is generally coarser grained and its grains are commonly angular in shape while the Lamotte is made up, primarily, of rounded and frosted grains. It is commonly glauconitic, quite shaly, may be very silty, and is usually dolomitic in its upper portion.

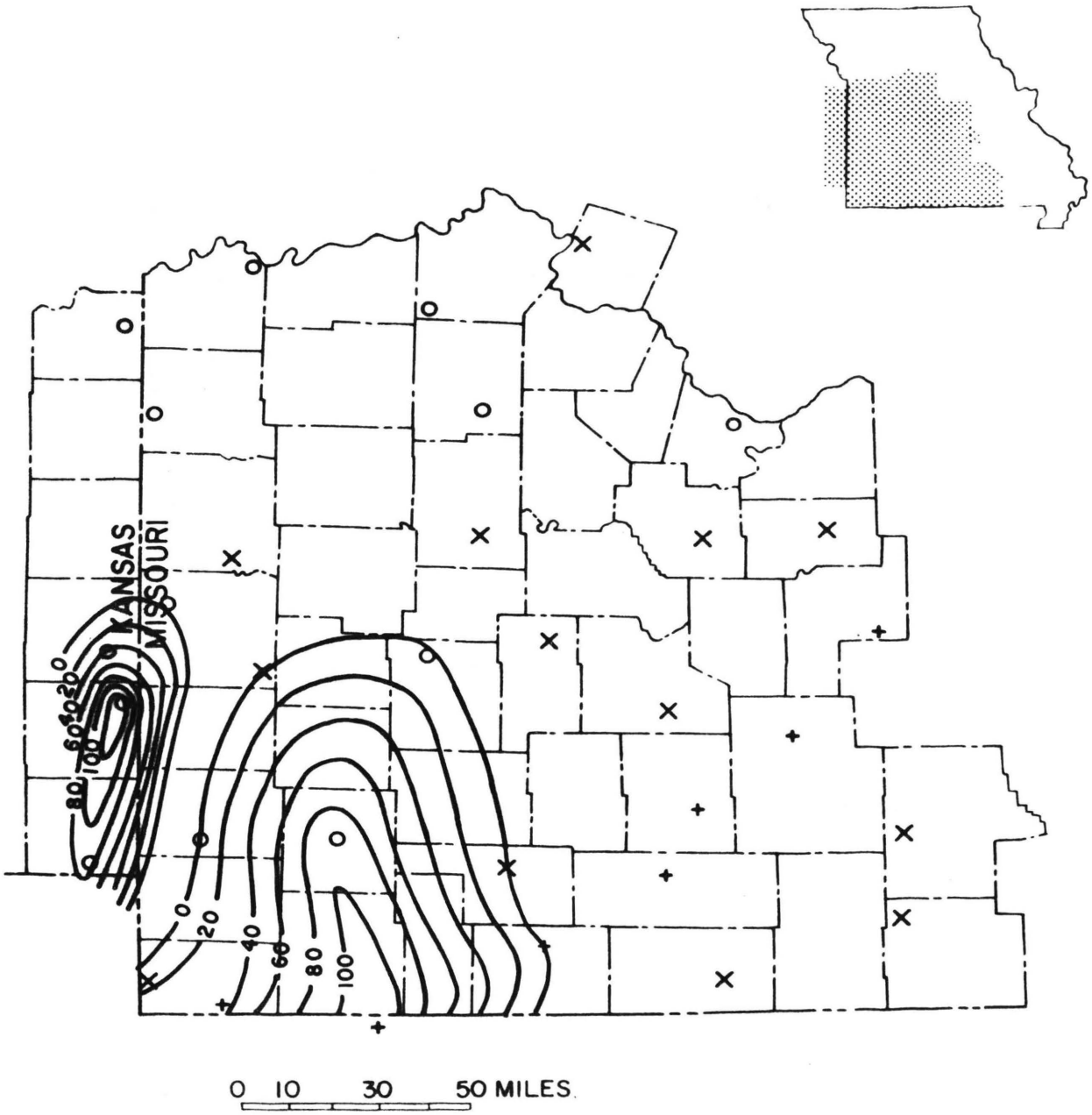

Figure 4 - Isopach map of the Reagan Sandstone.
Contour Interval = 20 feet.

As stated earlier, Howell (1944) defined the Reagan and Lamotte Sandstones as facies equivalents. Kurtz et al. (1974, p. 15) termed the Reagan "a nearshore facies of the Bonneterre and Davis Formations" and demonstrated this relationship in their cross section. The writer agrees with this interpretation but cannot demonstrate the exact Lamotte-Reagan relationships at this time. As related earlier the basal Paleozoic sandstone encountered in the Vernon and Bates Counties, Missouri drill-holes only adds confusion to this problem.

Approaching the Southwest Missouri (Precambrian) High from the northeast Kurtz et al. have shown the Lamotte pinching-out against the Precambrian surface and being overlapped by the Reagan. This interpretation of the Lamotte-Reagan relationship in southwest Missouri disputes Howell's (1944) interpretation.

The problem arises in tracing the Lamotte and Reagan Sandstones north from the Southwest Missouri High into extreme western Missouri. If the basal sandstone in Vernon and Bates counties is better assigned to the Reagan, then the interpretation by Kurtz et al. is more likely as there is no known occurrence of Lamotte and Reagan together which demonstrates a facies relationship as stated by Howell.

However, if the basal sandstone in these two counties is better termed Lamotte, then either of the two mentioned interpretations of the Lamotte-Reagan relationship may be valid.

If the Davis carbonates are underlain by Lamotte sands in this part of western Missouri simply by lack of Bonneterre deposition (the possible reasons for which are unknown at this time) the writer would disagree with Howell. However, if the Lamotte underlies the

Davis due to facies substitution with the Bonneterre then the Lamotte must share a facies equivalence with the Reagan. This problem requires much more study before the definite stratigraphic relationships between the Lamotte and Reagan Sandstones can be ascertained.

The Reagan is unconformable upon the underlying Precambrian surface but commonly has a conformable and gradational boundary with the overlying dolomitic units.

Stitt (1971) assigned an age to the Reagan as ranging from late Dresbachian through early Franconian time.

C. Bonneterre Formation

The Bonneterre Formation was first named by Nason (1901) for those non-cherty limestones cropping out in the vicinity of Bonne Terre, St. Francois County, Missouri. However, Nason also included in the Bonneterre strata now assigned to the Davis Formation. Current usage of the term Bonneterre is essentially the same as that defined by Buckley (1908).

The Bonneterre in western Missouri is a highly variable and complex lithic unit. East of the Lake of the Ozarks area it is dominated by calcareous micrites and calcarenites with well defined oolite facies. West of the Lake area the Bonneterre is typically dolomitized and the oolite facies is poorly preserved or absent.

Due to the complex nature of the Bonneterre, it is more easily defined by subdividing it into five recognizable lithic units. These are in ascending order: 1) Bonneterre-Lamotte "transition" beds;

2) Dolomite calcarenite; 3) Intertonguing oolite and shaly micrite; 4) Sullivan Siltstone Member (Kurtz et al., 1974); 5) and, the Whetstone Creek Member (Kurtz et al., 1974).

Bonneterre-Lamotte "transition" beds - - This unit is one of the most persistent lithic units of the Bonneterre in western Missouri. It ranges in thickness up to 75 feet and typically consists of coarsely crystalline dolomite which contains abundant scattered quartz sand grains. With depth this sandy dolomite grades downward to a slightly dolomitic sandstone just above the underlying Lamotte. The "transition" beds are typically shaly, may be quite glauconitic and commonly contain large, black, oboloid phosphatic brachiopods.

Westward across southern Missouri the "transition" beds generally thicken and become a major entity of the Bonneterre. This is undoubtedly due to the proximity of the high-rising Precambrian surface along the western border of Missouri which provided an additional source for sediments. However, it is not uncommon for the Bonneterre carbonates to overlap the "transition" beds against these same Precambrian knobs.

Ojakangas (1963) placed the "transition" beds in the upper portion of the Lamotte. However, it is believed by the writer that the "transition" beds represent a reworking of underlying Lamotte Sandstone during Bonneterre deposition resulting in sand grains from below being incorporated within marine carbonates.

Howe et al. (1972) postulates a regional unconformity at the top of the underlying Lamotte. The writer has no reason to deny this

statement. If the "transition" beds represent a reworking of the Lamotte rather than a transition from Lamotte sand to Bonneterre carbonates, then they also represent a change from a regressive environment during Lamotte deposition to a transgressive environment during Bonneterre deposition. This indicates an unconformable relationship between the Lamotte and the Bonneterre. It is generally agreed by geologists that an unconformity does exist, at least subregionally, where the "transition" beds were not deposited or were removed and Bonneterre carbonates lie directly upon the Lamotte Sandstone.

Dolomite Calcarenite - - This is one of the least persistent units of the Bonneterre and is not recognizable west of the Lake of the Ozarks area. The absence of this unit in western Missouri is probably due to its being lapped-out by younger Bonneterre carbonates against the westward rising Precambrian surface.

These lower calcarenite beds in the Bonneterre are typically coarse grained and nearly always dolomitic. They may contain any combination of gray, green, or brown shale, quartz sand grains, quartz silt, or glauconite and average 25 to 30 feet in thickness.

The lower calcarenite beds are typically gradational with the underlying "transition" beds and commonly are in sharp contact with the overlying oolitic or shaly micrite unit.

Intertonguing Oolite and Shaly Micrite - - This unit represents two distinguishable lithologic facies of the Bonneterre, an oolite facies

and a micrite and shale facies, both of which were described by Kurtz et al. (1974). However, in this report these two facies have been combined and will be discussed as one unit.

This unit is recognizable in the subsurface of western Missouri from the Cambrian outcrop area westward to a line drawn roughly through Howard, Dallas, Christian, and Taney Counties, Missouri. East of this rough boundary the Bonneterre is thickest (see Figure 5) and this unit makes up the bulk of the Bonneterre Formation.

To prevent unnecessary duplication the reader is referred to the above mentioned publication in which Kurtz describes at length the lithologic characteristics of these two facies.

As stated by Kurtz (p. 22) the "oolite facies developed on and supported shallow marine carbonate banks" while the micrite and shale facies was "deposited in a more off-shore position in deeper water".

The oolite unit and the micrite and shale unit are often facies equivalents and commonly show a sharp contact which is believed to be conformable with the overlying siltstone.

Sullivan Siltstone Member - - This member of the Bonneterre was formally recognized by Kurtz et al. (1974). It was named for the laminated quartz siltstones containing variable amounts of finely crystalline carbonates which are exposed along Crooked Creek in Crawford County, Missouri. This is the only known surface exposure of this unit in Missouri, but it is very widespread in the subsurface throughout the central and western portion of the state.

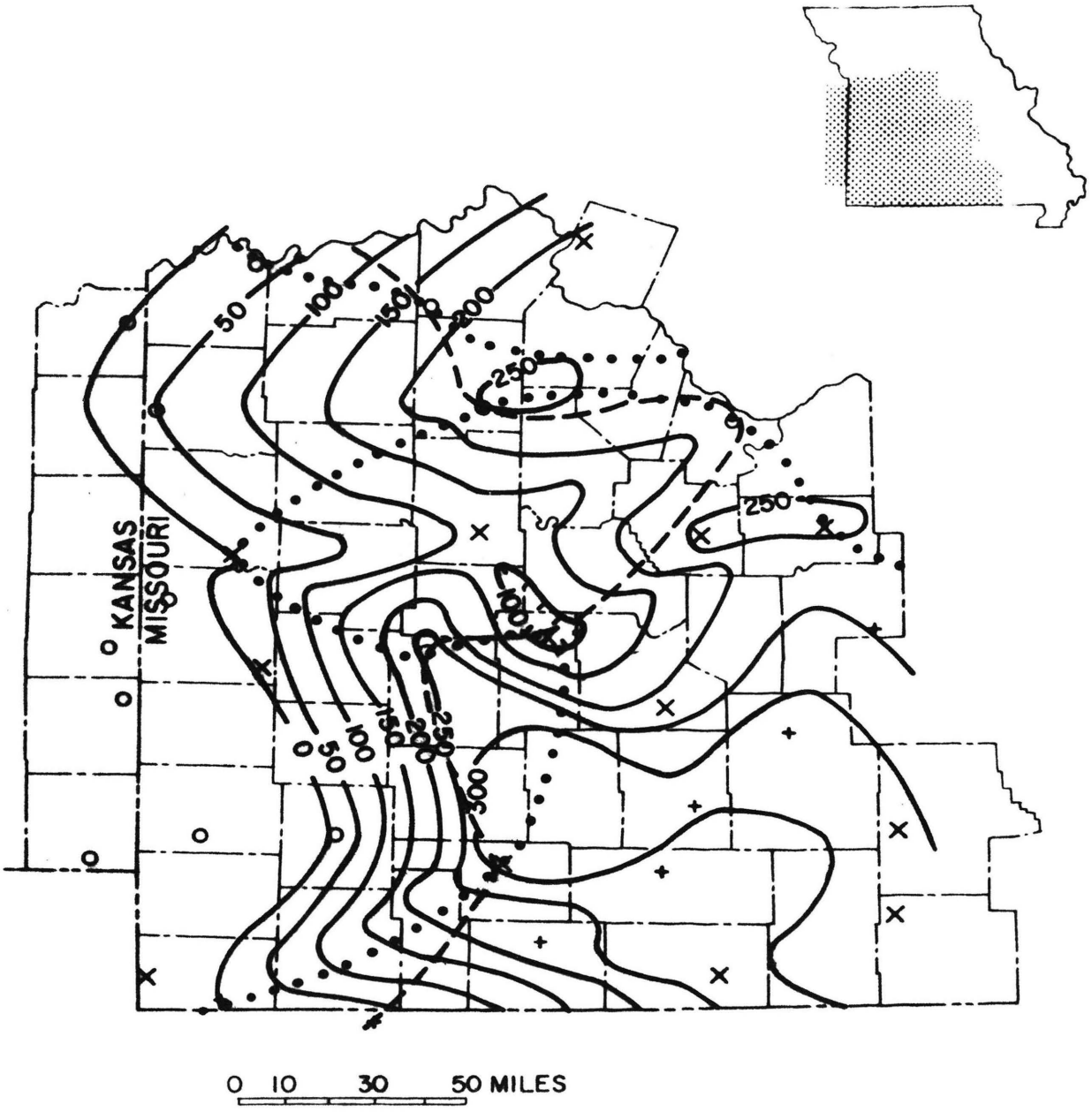

Figure 5 - Isopach map of the Bonneterre Formation. Dashed line represents westernmost extent of Sullivan Siltstone Member. Dotted line represents westernmost extent of Whetstone Creek Member. Contour Interval = 50 feet.

As shown on Figure 5 the Sullivan Siltstone is present where the Bonneterre is thickest. It attains its maximum thickness in the Texas, Phelps, and Dent Counties area (Figure 6). Westward the siltstone thins gradually. Everywhere in western Missouri the base of the Sullivan Siltstone appears to be conformable with underlying strata. Because the westward extent of the siltstone more or less parallels the areas of thick Bonneterre development, the top of this unit is also believed to be conformable with the overlying Whetstone Creek Member.

Whetstone Creek Member - - The Whetstone Creek Member of the Bonneterre Formation was formally named by Kurtz et al. (1974) for those heterogeneous, coarse grained, calcarenite beds in the upper portion of the Bonneterre which are present in the subsurface throughout much of western Missouri. The most distinctive feature of the Whetstone Creek is its complete lack of a characteristic lithology. It is commonly a coarse grained calcarenite containing varied amounts of quartz sand, quartz silt, and/or shale, but any of these lithologies may dominate at any one locality. The reader is referred to the above publication for a detailed description of this unit.

The thickness and distribution of the Whetstone Creek is shown on Figure 7. It attains its maximum thickness of 101 feet in Taney County, Missouri and thins rapidly westward and more gradually northward. The dashed line as shown on Figure 5 represents the westward extent of the Whetstone Creek and may also represent the edge of an erosional surface on the Bonneterre. If this is true then the contact

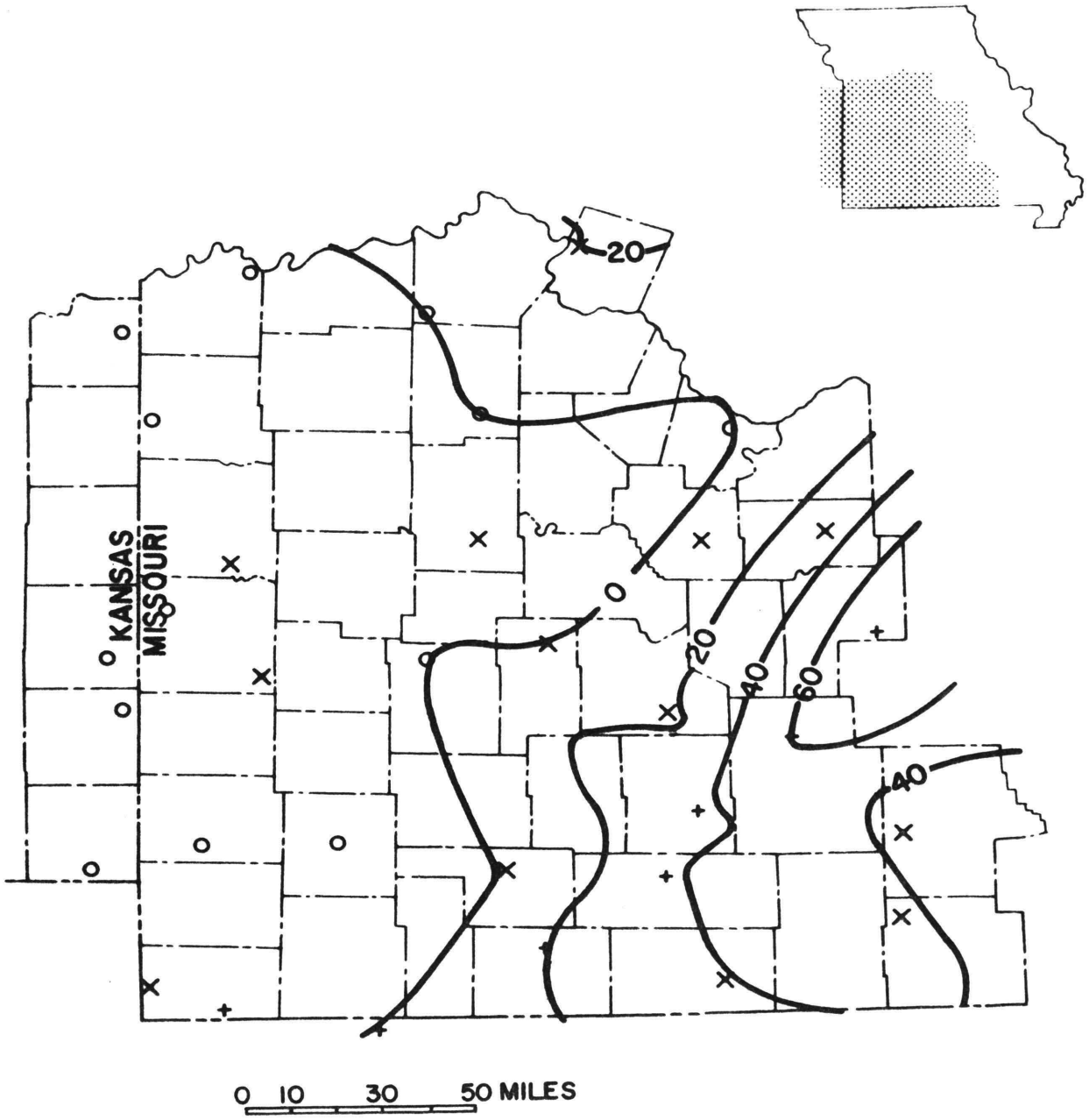

Figure 6 - Isopach map of the Sullivan Siltstone Member of the Bonneterre Formation. Contour Interval = 20 feet.

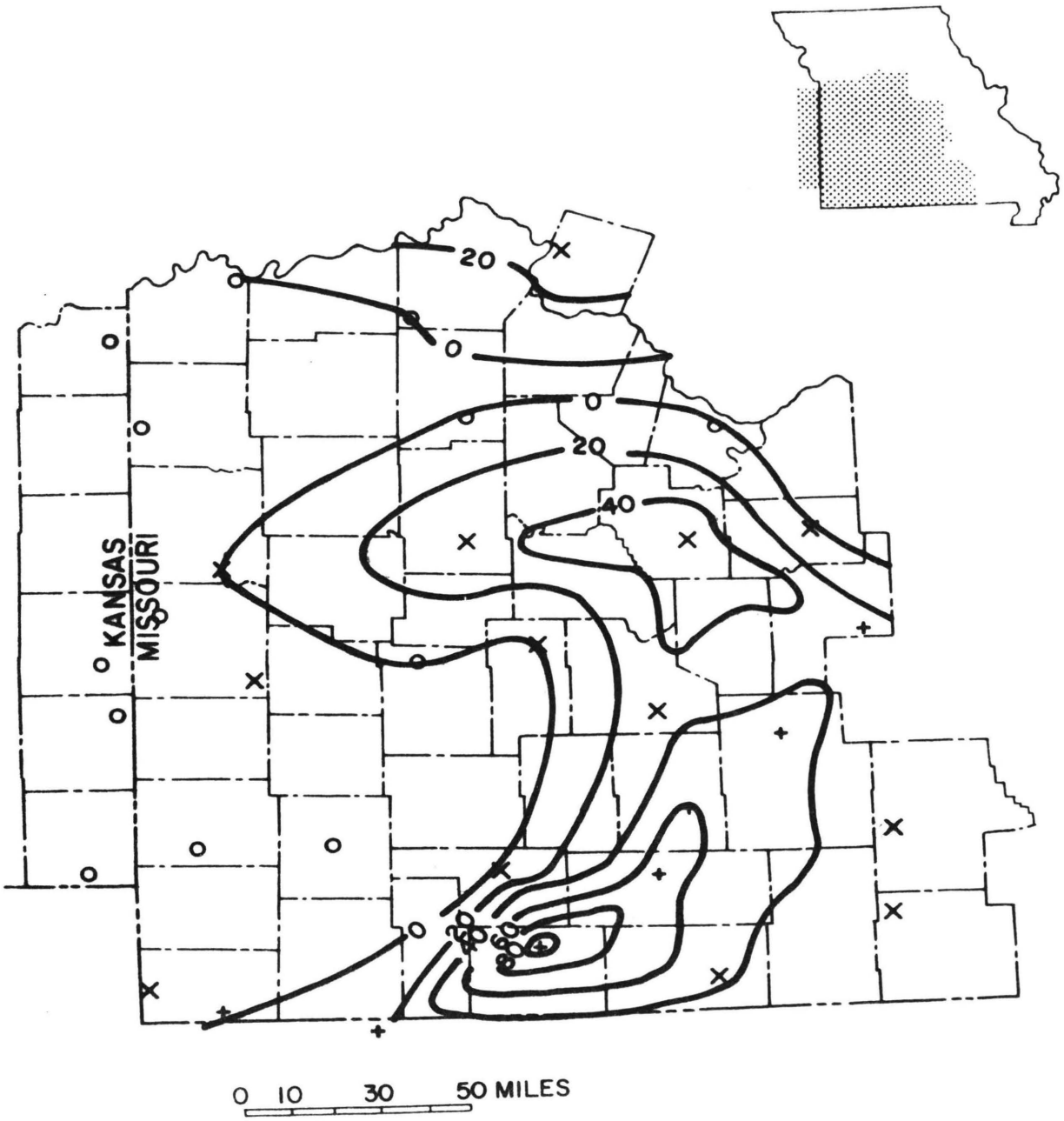

Figure 7 - Isopach map of the Whetstone Creek Member of the Bonneterre Formation. Contour Interval = 20 feet.

of the Bonneterre with the overlying Davis Formation is unconformable throughout most of western Missouri.

The Bonneterre-Davis contact is believed to be unconformable throughout most of Missouri. However, occasionally it is impossible to distinguish the Whetstone Creek Member of the Bonneterre from the overlying Davis shales. This indicates that the boundary between these two formations is, at least subregionally, conformable.

As shown on Figure 5 the entire Bonneterre Formation thins westward from a maximum thickness in Christian, Wright, and Texas Counties, Missouri and is absent in extreme western Missouri and eastern Kansas. As noted earlier, the absence of the Bonneterre is the result of facies substitution with the Reagan Sandstone in southwest Missouri with eventual overlapping by the Derby-Doerun on top of the "Southwest Missouri (Precambrian) High". In extreme western Missouri, south of Cass County, the Bonneterre is absent and the Lamotte ? is overlain by the Davis Formation. In eastern Kansas it has been overlapped by younger Upper Cambrian formations against the Precambrian basement.

The Bonneterre has been correlated with the Eau Claire Formation of northeastern Illinois by Buschbach (1964).

The Bonneterre is known to be Dresbachian in age and the biostratigraphic zonation of the Bonneterre Formation has been completed by two workers in separate publications. Lochman (1940) determined the biostratigraphy of the lower Bonneterre and Kurtz et al. (1974) worked out the biostratigraphy of the upper Bonneterre.

D. Elvins Group

The name Elvins was originally applied by Bain and Ulrich (1905) to that section of strata in St. Francois County, Missouri overlying the Bonneterre Formation and underlying the Potosi Dolomite. However, the Elvins as defined by Bain and Ulrich was thinner than what is presently recognized as Elvins. They considered it to be of formational rank and considered the Davis Formation to be part of the upper Bonneterre Formation.

Bridge (1937) expanded the lower Elvins to the basal boundary recognized today and raised the Elvins to group ranking to include in ascending order, the Davis Formation, the Derby Dolomite, and the Doe Run Dolomite.

1. Davis Formation

The original reference to the Davis was by Buckley (1907) who referred to it as the lowest member of the Elvins Formation. Later, Bridge (1937) raised the Elvins to group status and showed in a table (p. 234) the Davis Formation as the basal unit of the Elvins, overlying the Bonneterre Formation and underlying the Derby Dolomite.

Typically, the Davis is distinguished from the formations above and below by its high shale content. In central Missouri the Davis commonly consists of interbedded green shales, sandy limestones, and calcareous siltstones. Howe (1972, p. 13) states that these interbedded lithologies commonly occur in repetitive sequences which are

terminated by mud-chip breccia zones (flat-pebble conglomerates in core descriptions). Westward across southern Missouri from the St. Francois Mountains to the Lake of the Ozarks area the interbedded shales and limestones dominate the Davis and sands and silts become less prominent. West of the Lake area and extending into eastern Kansas the sands and silts again become important constituents of the Davis and sandy and silty carbonates interbedded with green shales dominate the Davis lithologies. In extreme western Missouri and eastern Kansas sandy and silty carbonates make up the bulk of the Davis with interbedded shales being only minor constituents.

The carbonate portion of the Davis is characterized by limestone in most of the central and east-central part of southern Missouri. However, west of the Lake of the Ozarks area the Davis carbonates have been dolomitized and these dolomites prevail throughout western Missouri and eastern Kansas. Large subregional limestone lenses, which are not yet fully understood, occur within the Davis in the Vernon - Bates County, Missouri and Christian - Taney County, Missouri areas.

In the Douglas County, Missouri area typical Davis lithology is missing and the entire Davis-Derby-Doerun interval is represented by Derby-Doerun lithology (Kurtz et al., 1974). It is believed that the Davis shales were not deposited in this localized area as the "shallow water environment just heralded by extensive oolite development in the Bonneterre (below) became areally localized in younger strata in Douglas County" (p. 17).

The contact of the Davis with the overlying Derby-Doerun Dolomite appears to be conformable and is commonly placed at the stratigraphic horizon where green shales in the Davis below are replaced by brown shales in the Derby above. However, this contact is not always sharply defined because an intertonguing of Derby and Davis beds quite often occurs.

The thickness and distribution of the Davis Formation throughout southern Missouri and eastern Kansas are shown on Figure 8. As can be seen the Davis thins gradually across the study area and more rapidly along the Missouri - Kansas border, and is absent in a large part of eastern Kansas. The absence of the Davis in eastern Kansas is believed to be the result of overlapping by the Derby-Doerun against more positive Precambrian knobs. The thinning of the Davis in southwest Missouri is the result of facies substitution by the Reagan Sandstone with lower Davis carbonates as illustrated by Kurtz et al., 1974. The Davis is absent in the extreme southwest corner of Missouri where the Derby-Doerun has completely overlapped the Davis on top of the Precambrian high.

The Davis has been correlated with representative Cambrian deposits in the Upper Mississippi Valley Region. Buschbach (1964) correlated the Davis with the Galesville and Ironton Sandstones and the lower Franconia Formation in northeastern Illinois. Howe et al. (1972) more clearly equates the Davis with the Tomah and Birkmose Members of the Franconia Formation and the Ironton-Galesville Sandstones.

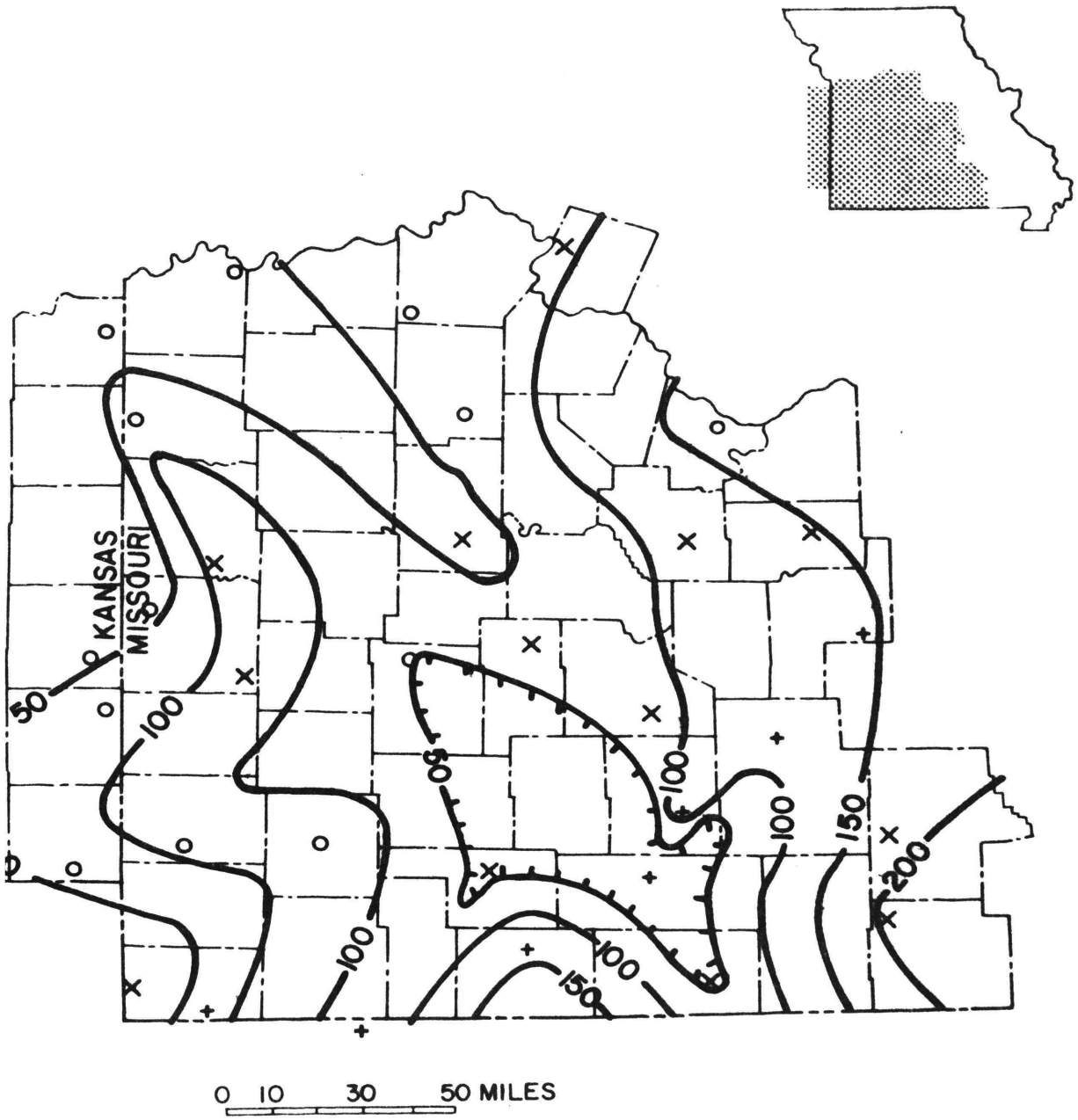

Figure 8 - Isopach map of the Davis Formation.
Contour Interval = 50 feet.

The Davis is Franconian in age and detailed biostratigraphic zonation of the Davis has been compiled by Kurtz in the St. Francois Mountains area (1960) and in southern Missouri (Kurtz et al., 1974).

2. Derby-Doerun Dolomite

The Derby-Doerun is a compound term used by the Missouri Geological Survey. The original Derby and Doe Run Dolomites were names given by Buckley (1907) to the two dolomitic units overlying the Davis shales and underlying the more cherty Potosi dolomites. The Derby-Doerun represents the upper portion of the Elvins Group.

The Derby-Doerun is one of the most consistent units, in both lithologic characteristics and distribution, of all the Upper Cambrian formations present in the subsurface throughout the central and western portions of southern Missouri.

In the central and west-central part of southern Missouri the Derby-Doerun can be subdivided into two distinctive lithologic units.

The lower Derby-Doerun is commonly composed of irregular, thin bedded, fine to medium crystalline, argillaceous dolomite beds separated by wavy brown shale partings and thin shale beds. This unit typically contains abundant quartz silt and is glauconitic. Occasionally, the lower Derby-Doerun contains as much silt and shale as does the underlying Davis beds. When this situation occurs it is sometimes difficult to distinguish these two formations.

The Upper Derby-Doerun is typically composed of massive bedded, fine to medium crystalline, highly burrowed, argillaceous dolomite.

This upper unit of the Derby-Doerun is often times calcarenitic and, occasionally, the calcarenite beds are represented by oolites. Locally, stromatolites may be an important constituent of the upper Derby-Doerun and when preserved in the rock record generally occur as digitate forms on a base of planar stromatolitic dolomite.

The contact between the upper and lower Derby-Doerun is commonly marked by a horizon at which there is a sudden appearance of clastic material in the lower Derby-Doerun. This horizon has been termed the "Top of the Cambrian Clastics" and has been an invaluble aid in correlating Cambrian units in subsurface stratigraphic work at the Missouri Geological Survey for many years.

In southwestern Missouri the entire sequence of Derby-Doerun strata contains abundant clastic material. However, this should be expected due to the proximity of subsurface Precambrian knobs in this area which would contribute large amounts of terrestrial clastic material to Cambrian carbonate deposition.

The relationship of the Derby-Doerun to the overlying Potosi Dolomite has not been well defined. Most Cambrian workers believe the Derby-Doerun-Potosi contact is conformable. No evidence has been found within the study area to dispute this conclusion. Dake (1930) after working with surface expressions of Cambrian formations, states "there is no evidence, within the confines of the Potosi Quadrangle, to indicate that the contact between the Derby-Doerun and Potosi is anything but a perfectly conformable gradation" (p. 116). Howe et al. (1972) reported a facies gradation of the Potosi with the Derby-Doerun as this boundary was traced northward from the St. Francois Mountains

into northeastern Illinois.

Figure 9 shows the thickness and distribution of the Derby-Doerun Dolomite in southern Missouri and extreme eastern Kansas. As can be seen very little change occurs in the thickness of the Derby-Doerun throughout the study area but this Cambrian unit does thin, very gradually, westward. The scattered and restricted thin areas in the Derby-Doerun, illustrated as depressions on the isopach, are believed to be due simply to lack of deposition. The depression shown in Vernon County, Missouri is of special interest. Here, the Stubblefield oil and gas test well (see Appendix) is the only Precambrian hole in western Missouri which does not contain Derby-Doerun strata. In this one well the only Upper Cambrian sediments penetrated were those of the Eminence Dolomite which are immediately underlain by pre-Upper Cambrian metasediments as reported by Skillman (1948).

The Derby-Doerun has been correlated with the Upper Franconia Formation in northeastern Illinois by Buschbach (1964) and in the Upper Mississippi Valley Region by Bridge (1936). Howe et al. (1972) reports a facies substitution relationship of the Derby-Doerun with the Reno Member (upper Franconia Formation) and the lower St. Lawrence Formation of the Upper Mississippi Valley Region.

The Derby-Doerun is regarded as late Franconian in age but due to the dolomitic nature of this formation, fossil preservation is so poor that proper faunal zonation is extremely difficult in southern Missouri.

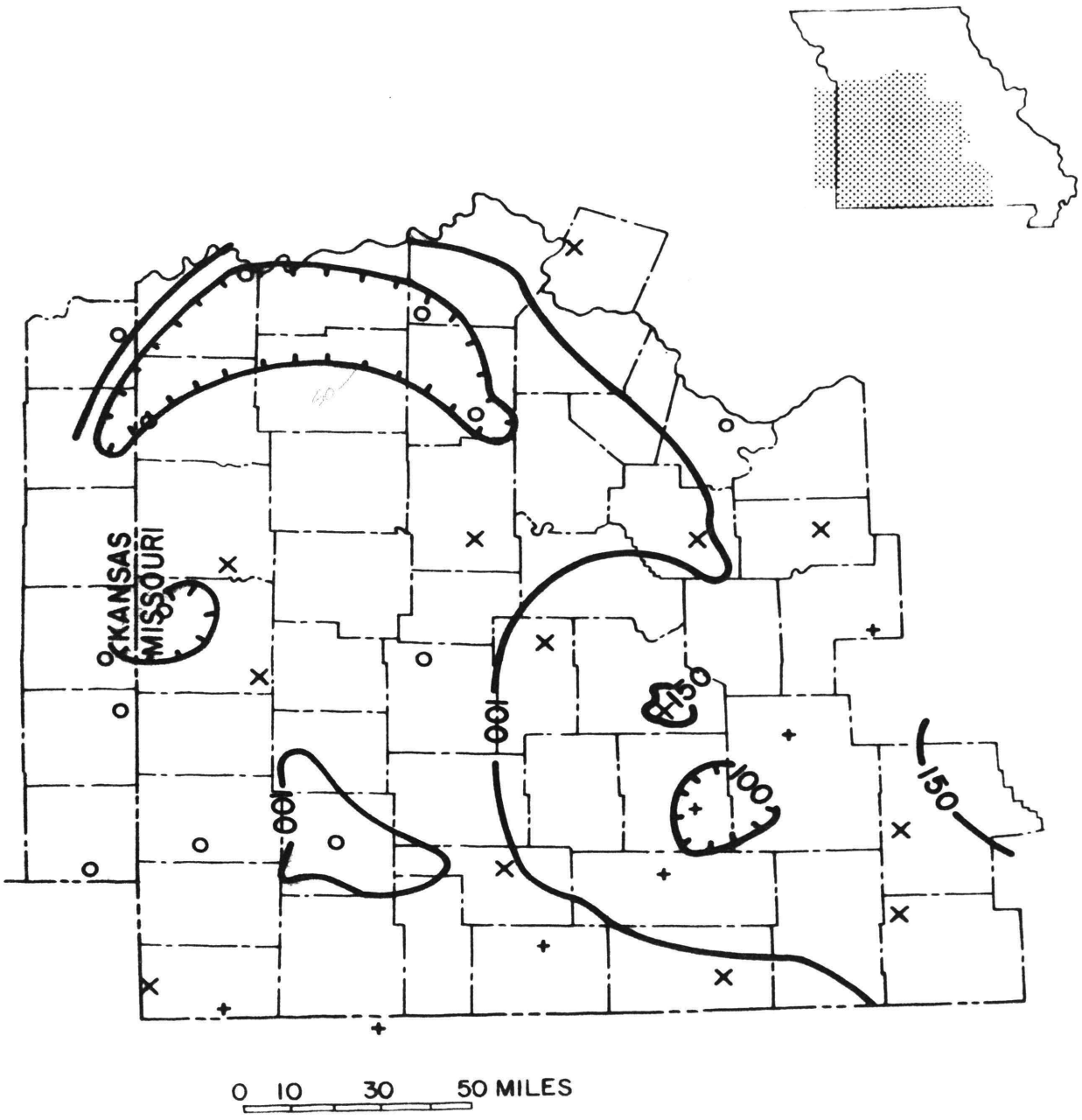

Figure 9 - Isopach map of the Derby-Doerun Dolomite.
Contour Interval = 50 feet.

E. Potosi Dolomite

The Potosi was first named for the cherty carbonates containing quartz druse which are exposed at the surface in the vicinity of the town of Potosi, Washington County, Missouri (Winslow, 1894). Buckley (1909) restricted the Potosi to the siliceous cherty and drusy dolomite underlying the Eminence Dolomite and overlying the Doerun Formation (Buckley's Doerun Formation is equivalent to the upper portion of what is now termed the Derby-Doerun Dolomite).

The Potosi in the central and western portion of southern Missouri is primarily a fine to medium crystalline, medium gray to medium brown dolomite which is occasionally calcarenitic and commonly is highly burrowed. It is typically vuggy with rinds of quartz druse commonly lining the larger openings. Howe, et al. (1972) reports the principle lithic components of the Potosi in the St. Francois Mountain area are: "dolomitized oolitic calcarenite, digitate stromatolites and planar stromatolites" (p. 15). However, in the study area of this report the principle lithic component of the Potosi is massive bedded, burrowed carbonates. Planar and digitate stromatolites are noted in the Potosi of the study area but their occurence seem to be generally restricted to the eastern and south-central fringes of the area under study.

Planar stromatolite development is generally believed to be restricted to shallow subtidal to supratidal environments while digitate stromatolite growth is most prominent in shallow subtidal marine environments. The eastern fringe of the study area undoubtedly

represented such an environment off the positive St. Francois Mountains during Potosi deposition. The Potosi throughout the remainder of southern Missouri is composed of deeper water carbonates.

Green clay commonly occurs as cavity and interstitial fillings between dolomite crystals in restricted stratigraphic horizons throughout the Potosi. This green clay is preserved in the insoluble residues from the Potosi and appears as green, oftentimes dolocastic, shales. However, in Douglas County, Missouri and occurring in a narrow belt northwestward, these green shales become an important entity of the Potosi residues. In this localized band in the study area the green shales appear to replace the more typical brown "quartzose" cherts and quartz druse residues of the Potosi. These green shale residues in the Potosi have been referred to informally as the "green clay residue facies" of the Potosi by Kurtz et al. (1974).

The exact areal extent of this residue facies in southern Missouri has not been fully determined but appears to be a prominent lithic component of the Potosi in an areally restricted band across southern Missouri extending north and northwest from Ozark and Douglas Counties to Jackson County (see Figure 10). North of Dallas County these green shales rise in section and occupy a higher stratigraphic position in the Eminence Dolomite in Benton and Jackson Counties. These same green shale residues occur in the Potosi in the Shannon County, Missouri core (SV-1) and comprise a significant portion of the Eminence Dolomite interval in the Pierce City Water Well No. 3, Lawrence County, Missouri.

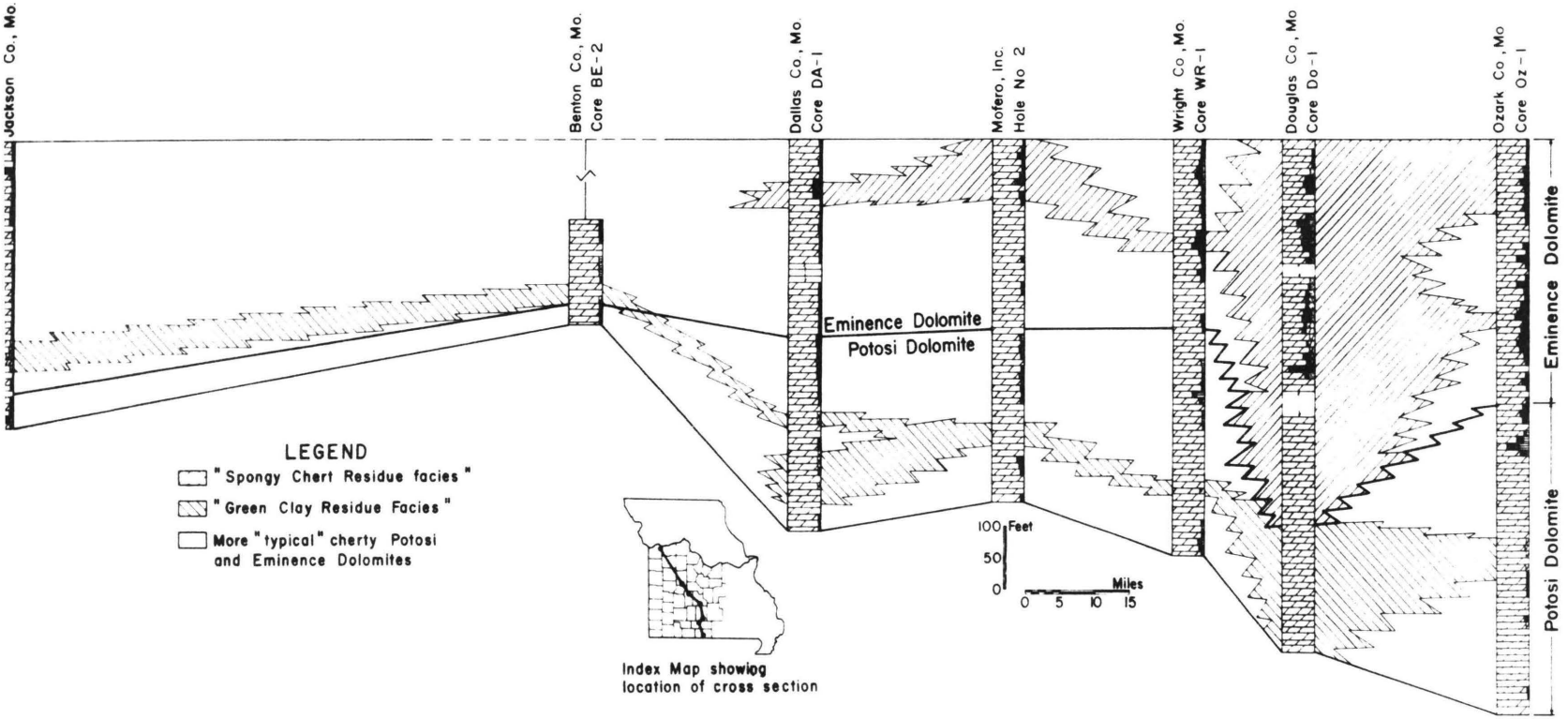

Figure 10 - Cross section of subsurface Potosi and Eminence Dolomites illustrating stratigraphic relationships of the "green clay residue facies" and the "spongy chert residue facies".

The "green clay residue facies" does not appear in the Potosi or Eminence residues between Douglas and Lawrence Counties or between Douglas and Shannon Counties. The relationship of these three separate occurrences of this residue facies is not known at this time.

As shown on Figure 10 the "green clay residue facies" of the Potosi is present by facies substitution with more typical Potosi chert residues. Kurtz et al. (1974) relates this residue facies of the Potosi to shallow subtidal to supratidal reef and calcarenite build up during Potosi deposition.

The Potosi appears to be conformable with the overlying Eminence Dolomite as oftentimes the boundary between these two units is represented by a "zone" in which Eminence dolomites grade downward into Potosi dolomites.

Figure 11 shows the thickness and distribution of the Potosi throughout the study area. As can be seen the Potosi attains its maximum thickness in the eastern portion of the study area and thins rapidly to the central portion. Continuing west the Potosi thins more gradually into eastern Kansas.

A comparison of the Potosi isopach with the Eminence isopach (Figure 12) illustrates the conformable relationship of these two formations, as discussed above, throughout the major portion of southern Missouri. Except for the southwestern corner of Missouri the combined thickness of the Potosi and Eminence appears to be essentially uniform which supports the idea of a conformable boundary. In general, where the Potosi is thin, the Eminence is thick and vice versa.

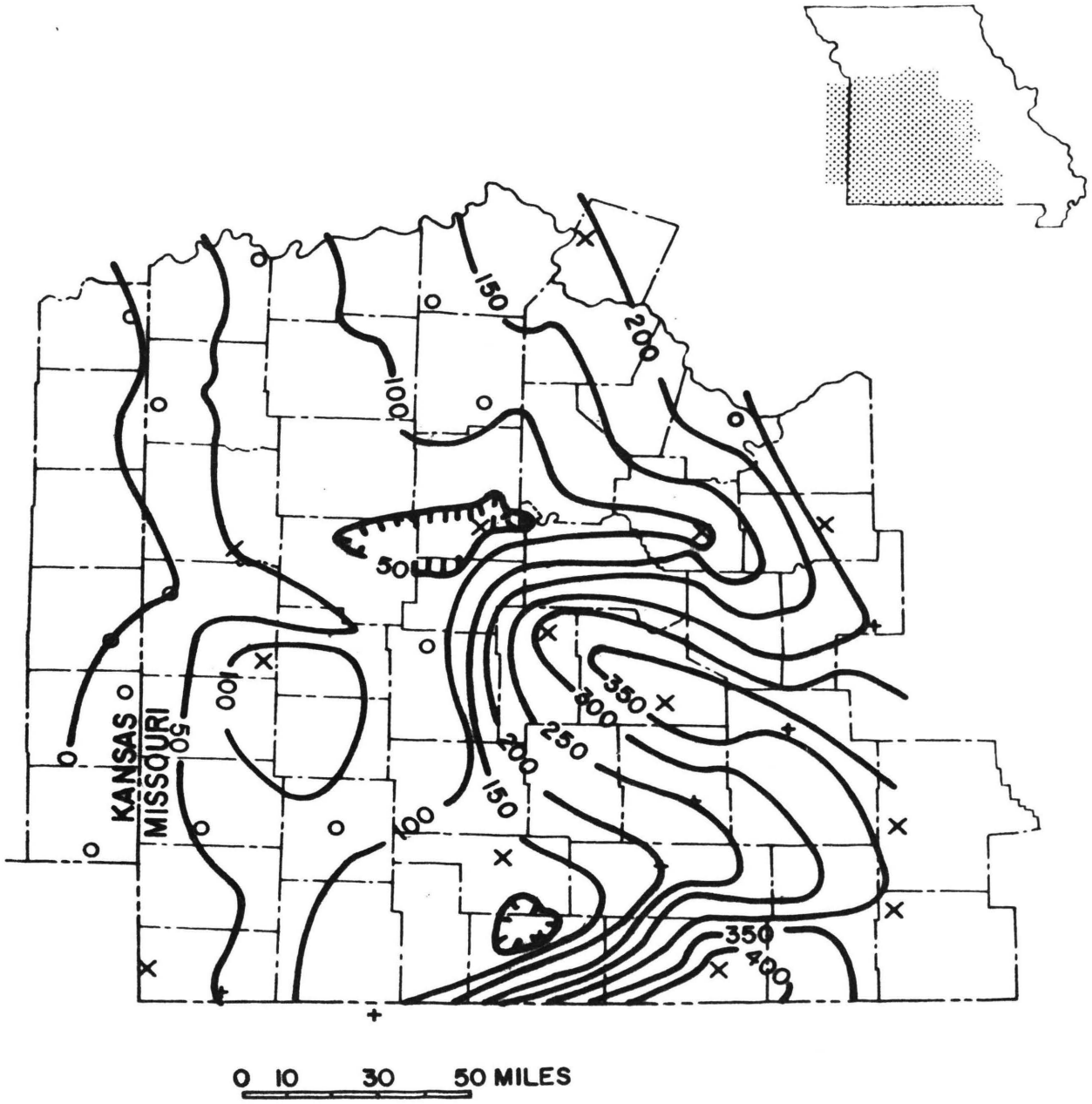

Figure 11 - Isopach map of the Potosi Dolomite.
Contour Interval = 50 feet.

In the southwestern corner of Missouri the Eminence appears to maintain a more or less uniform thickness while the Potosi becomes quite thin. It is postulated from this evidence that the Potosi-Eminence contact may be subregionally unconformable in southwestern Missouri. However, it should be noted that no evidence for such an unconformity was found in the rock record of the deep holes, examined for this report, in this corner of Missouri.

The Potosi is generally assigned an early Trempealeauan age and has been correlated with the Potosi Dolomite (formally called Tremplealeau) in northeastern Illinois by Buschbach (1964). Bridge (1936) equated the Potosi to the St. Lawrence Formation of the Upper Mississippi Valley Region but Howe et al. (1972) restricted the Potosi to only the upper portion of the St. Lawrence.

F. Eminence Dolomite

The Eminence Dolomite was named for the very cherty dolomite exposures in the vicinity of the town of Eminence, Shannon County, Missouri (Ulrich, 1911). However, the first mention of this formation in print was in 1908 when Buckley listed the Eminence in a table of Missouri formations. The Eminence is composed of those cherty dolomites which overlie the Potosi drusy dolomites and underlie the Gunter Sandstone Member of the Gasconade Dolomite.

In the study area the Eminence is made up of medium to coarsely crystalline, medium gray, massive bedded, highly burrowed dolomites. It is commonly very vuggy (more so than the underlying Potosi) with the

openings ranging in size from small pores to large cavities. Chert in the form of massive fillings and interstitial fillings between dolomite crystals occurs in restricted horizons throughout the Eminence. The lower portion of the Eminence frequently contains quartz druse rinds lining cavities.

Planar and digitate stromatolites are found in the Eminence but their frequency of occurrence is much higher in the western half of the study area. This differs markedly from the frequency of occurrence of stromatolite beds in the underlying Potosi. The reason for this abrupt change in stromatolite depositional areas in the Potosi-Eminence rock record are not known. However, the distribution of stromatolites does suggest that the very shallow marine environment of deposition must have shifted from the eastern fringes of the study area during Potosi deposition to western Missouri during deposition of Eminence carbonates.

Small amounts of green clay occurring as cavity fillings, stylolite plane fillings, and/or interstitial fillings between dolomite crystals is common throughout the Eminence.

At roughly the longitude of the Lake of the Ozarks area the Eminence lithology appears to undergo a change from predominantly burrowed carbonates on the east, more typical of the Eminence around the St. Francois Mountains, to interbedded burrowed carbonates and calcarenite beds on the west. The calcarenites are commonly represented as oolite beds. Also, the amount of green clay occurring within the Eminence increases considerably in the western part of southern Missouri.

West of the Lake of the Ozarks area the insoluble residues of the Eminence change character from the white cherts and gray "quartzose" cherts more typical of the Eminence in the eastern half of the study area. In western Missouri the Eminence residues are much lower in volume but contain, proportionally, more shale, and quartz sand grains become an important entity of the residues throughout the Eminence interval.

In Douglas County, Missouri, reaching southward into Ozark County, and extending northward into Wright, Laclede, and Dallas Counties, portions of the Eminence change facies to a rock whose insoluble residues are characterized by tripolitic cherts, finely porous cherts, and fine pelletal cherts. Such a residue facies have been termed the "spongy chert residue facies" of the Eminence (Kurtz et al., 1974). This residue facies exhibits a facies relationship with the more commonly occurring Eminence residues (see Figure 10) and is associated with a ridge of thick carbonate buildup within the distribution of the Eminence (Figure 12).

As shown on Figure 12 the Eminence thins westward across the central and western portions of southern Missouri. The thinned area in the east-central part of the study area reflects a thickened area in the Potosi distribution map and the build-up of Eminence dolomites in the northeast portion of the study area reflects a thinned section of underlying Potosi dolomites. Such thickening of the Eminence over thin Potosi and thin Eminence over thick Potosi lends strong credence to the belief that over much of southern Missouri the Eminence lies conformably on the Potosi.

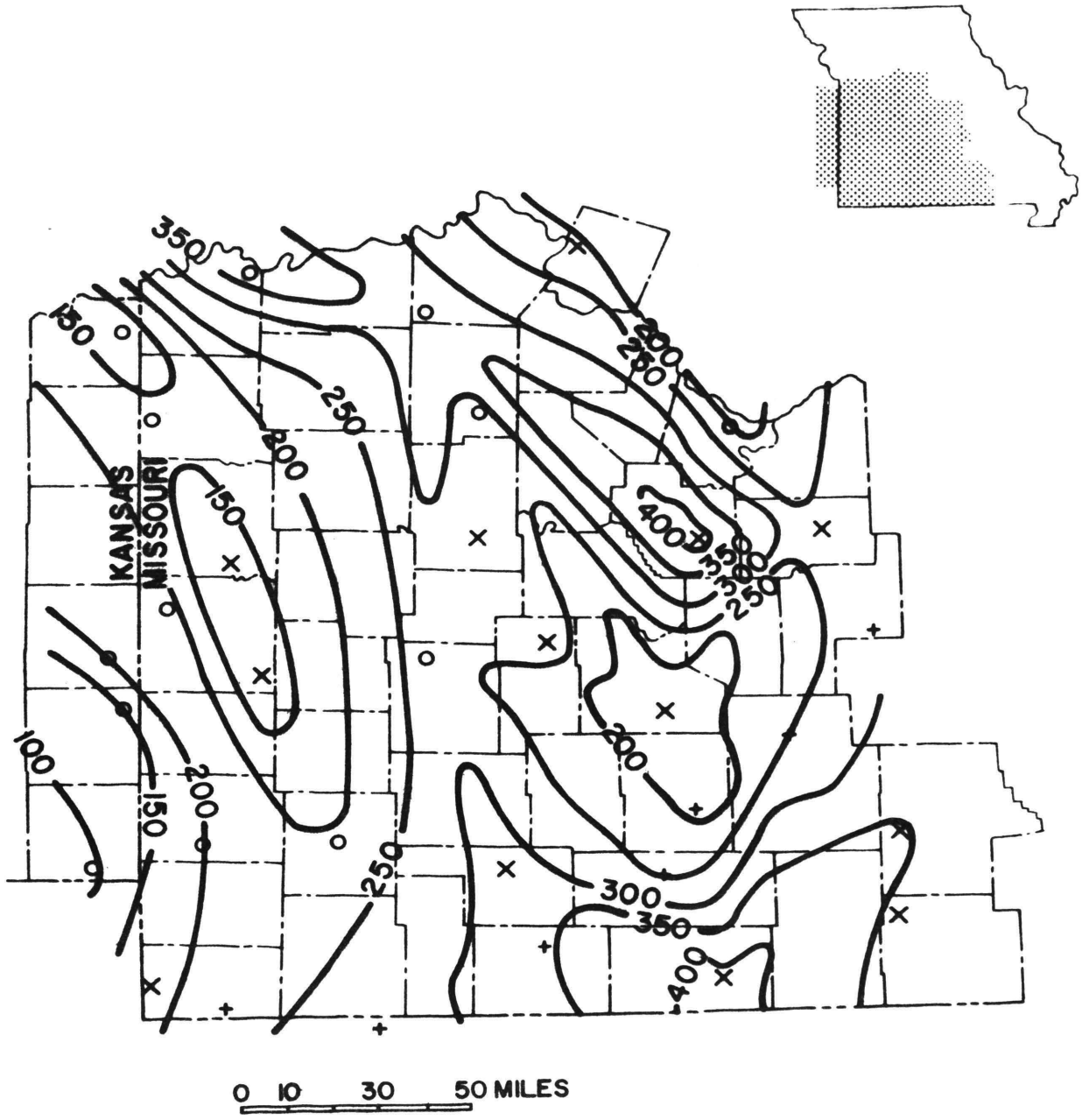

Figure 12 - Isopach map of the Eminence Dolomite.
Contour Interval = 50 feet.

The Eminence is unconformable with the overlying Gunter Sandstone Member of the Gasconade Dolomite. The Eminence is now considered to be the uppermost Cambrian formation in Missouri.

The Eminence is assigned a late Trempealeauan age and has been correlated with sandy dolomites (Eminence Formation) in northeastern Illinois by Buschbach (1964) and Howe et al. (1972).

VI. CAMBRIAN-ORDOVICIAN BOUNDARY

The stratigraphic position of the Cambrian-Ordovician systemic boundary is highly questionable in Missouri and no recent work on this problem has been completed since that of Bridge (1930).

Howe et al. (1972) discuss in considerable detail Bridge's early work on Eminence trilobites and more recent works on Cambro-Ordovician trilobites in Wisconsin (Davis, 1970) and Oklahoma (Stitt, 1971).

These more recent works may tend to place the top of the Cambrian System in Missouri somewhere within the upper one-third of the Eminence succession of dolomites. However, because there has been no work on this problem, in Missouri, in the last forty-four years the traditionally defined Upper Cambrian boundary of Missouri has been used in this report.

The Gunter Sandstone Member of the Gasconade Dolomite has been traditionally accepted as the basal Ordovician unit in Missouri which unconformably overlies the Eminence Dolomite.

The writer believes that the Eminence-Gunter contact does represent an unconformity at the type section of the Gunter at Hahatonka Spring, Camden County, Missouri (Ball and Smith, 1903). However, in many of the diamond-drill cores and well cuttings examined by the writer, thin sandstone stringers which occur below the Gunter in the Eminence dolomites may indicate a conformable Eminence-Gunter boundary, at least locally.

This is an important problem occurring within the Cambro-Ordovician succession of strata in Missouri and one in which more work is needed.

VII. CONCLUSIONS

The subsurface stratigraphy of Upper Cambrian formations in western Missouri and eastern Kansas has been discussed including the stratigraphic relationships within each formation and the stratigraphic relationships of each formation to that rock unit above and below. Each Cambrian formation present in the subsurface in western Missouri has been isopached to illustrate the thickness and distribution of the unit throughout the study area.

The stratigraphic boundaries between Cambrian formations in western Missouri have been traced across the state line and correlated with Upper Cambrian strata in the subsurface of eastern Kansas.

The relationship of Upper Cambrian formations to the Precambrian basement in western Missouri and eastern Kansas has been illustrated by isopach maps and discussed throughout the text.

Megascopic descriptions, using a 10x hand lens, of diamond-drill cores accompanied by insoluble-residue studies of the cores and additional deep holes in western Missouri and eastern Kansas have provided the data used in this report.

It has been shown that the lower Upper Cambrian formations (the Lamotte, Bonneterre, and lower Davis formations) are not present in a large part of western Missouri and extreme eastern Kansas. In southwestern Missouri this is due to two factors. First, the Lamotte is not present because it has been overlapped against the flanks of the "Southwest Missouri (Precambrian) High" by the Reagan Sandstone.

Secondly, the Bonneterre and Davis Formations change facies upward, to the Reagan on the flanks of this high and are overlapped by the Derby-Doerun on top of the high. In a large portion of the remainder of extreme western Missouri the Bonneterre is absent, the reasons for which are not fully understood at this time. However, in much of eastern Kansas the Bonneterre and Davis Formations appear to have been overlapped by the Derby-Doerun against the Precambrian basement terrane.

This overlapping of lower Upper Cambrian formations by younger Upper Cambrian units in western Missouri and eastern Kansas substantiates the contention of Kurtz et al. (1974) that not all of Upper Cambrian time is represented by the rocks in this area. A detailed discussion of this fact has been put forth by Kurtz et al. and is, therefore, not included in this report.

In addition, the following conclusions concerning the stratigraphic relationships within the Upper Cambrian section in western Missouri can be drawn:

1) The Reagan Sandstone in Missouri is restricted to the southwestern corner of the state. Due to a lack of data the exact relationship of the Reagan to the Lamotte Sandstone cannot be demonstrated at this time. However, it is believed by the writer that the two sandstones are distinguishable and do not share a facies relationship as postulated by Howell (1944).

2) The Lamotte-Bonneterre boundary is believed to be unconformable. Although there is no evidence of an erosional surface at this stratigraphic horizon, the basal Bonneterre beds (Bonneterre-

Lamotte "transition" beds) are interpreted to represent a stratigraphic "zone" in which reworked Lamotte sand is incorporated into Bonneterre carbonates.

3) The areal extent of the Sullivan Siltstone Member of the Bonneterre Formation in the central and western portions of southern Missouri has been shown. The Sullivan Siltstone occurs only in those areas of Missouri where the thickest deposition of Bonneterre carbonates occurred or where the thickest section of Bonneterre was preserved in the rock record.

4) The distribution of the Whetstone Creek Member of the Bonneterre Formation in the study area has been illustrated. It has been postulated that the westernmost occurrence of this unit represents the eastern edge of a subregional erosion surface on the Bonneterre.

5) The Davis Formation is believed to lie unconformably over the Bonneterre in most of southern Missouri but is locally conformable with the Bonneterre.

6) The Derby-Doerun Dolomite is one of the most uniformly distributed Upper Cambrian formations present in western Missouri and easternmost Kansas and is conformable with the underlying Davis everywhere in the study area.

7) The areal extent of the "green clay residue facies" of the Potosi in southern Missouri has been illustrated and the relationship of this insoluble residue facies to the Potosi Dolomite has been discussed. It appears this informally recognized facies is associated with a "nose" of thick Potosi buildup through the central part of the study area.

8) The Potosi and the underlying Derby-Doerun appear to be conformable everywhere within the study area and their boundary is commonly represented by a "transition" zone in which Derby-Doerun lithology grades upward into drusy Potosi dolomites.

9) The distribution of the "spongy chert residue facies" in southern Missouri has been established and its relationship to the Eminence Dolomite has been discussed. This informal residue facies of the Eminence is associated with a ridge of thick Eminence dolomites in the central portion of the study area.

10) The combined Potosi-Eminence interval is relatively uniform throughout most of the study area and the Eminence appears to overlie the Potosi conformably. However, in the southwestern corner of Missouri the thickness of the Eminence remains fairly constant while the Potosi thins dramatically. A possible unconformity between the two formations is postulated in this local area of Missouri.

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VITA

Joseph Leroy Thacker, Jr. was born on October 20, 1942, in Kansas City, Missouri where he received his primary and secondary education. He has received his college education from the University of Kansas City, in Kansas City, Missouri; Kansas City Junior College, in Kansas City, Missouri; University of Missouri at Kansas City, in Kansas City, Missouri; and the University of Hawaii, in Honolulu, Hawaii. He received a Bachelor of Science degree in Geology from the University of Missouri at Kansas City, in Kansas City, Missouri, in June, 1965.

He has been a staff geologist at the Missouri Geological Survey and Water Resources, in Rolla, Missouri, since February 1968.

He has been enrolled in the Graduate School of the University of Missouri - Rolla since January, 1971.

APPENDIX - - METHODS OF DATA COLLECTION AND RESIDUE-LOG SUMMARIES

A. Core Logging Methods

The lithologies of the diamond-drill cores used in this study were described megascopically with the aid of a 10x hand lens.

No detailed petrographic study has been performed on the cores. The major lithologic subdivisions have been established and their lithologies described in order to obtain a record of the gross subdivisions of the lithologies present in each core studied. Copies of the core descriptions are on file at the Missouri Geological Survey and are available for inspection.

No paleontologic studies have been carried out for this report.

B. Insoluble Residue Preparation and Logging Techniques

Grohskopf and McCracken (1949), give a detailed account of the preparation of insoluble residues used in subsurface stratigraphic studies at the Missouri Geological Survey and the techniques used in logging them. These same methods have been applied to samples from the drill-holes used in this study and the reader is referred to this publication for a description of these procedures.

Every diamond-drill core used in this study was chip-sampled on one-foot intervals and the chips were combined into five-foot samples. The insoluble residues were obtained from these core chips and then described. The resulting insoluble residue log summary is simply a written description of the residue succession as illustrated in its respective insoluble residue log and supplements each

megascopic core description.

The definitions of a few terms used in the residue log summaries are listed below for those unfamiliar with insoluble residue terminology.

1. "Quartzose" - a textural term meaning very finely crystalline quartz, the individual crystal faces of which are too small to be distinguished at a magnification of 10x: could also be termed a microscopic quartz druse.
2. Dolocastic - a textural term frequently applied to chert and shale residues indicating rhombohedral cavities caused by the solution of dolomite crystals.
3. "Pepper" glauconite - a grain size term used by the writer in the core descriptions and insoluble residue log summaries indicating silt size glauconite grains.

The amount of insoluble residue occurring within a unit of strata, as discussed in the residue log summaries, is always expressed as a percentage indicating the percent by volume of insoluble material contained within that stratigraphic unit.

Small discrepancies in the footages given for lithologic breaks and formational boundaries between the residue-log summaries and the core descriptions are to be expected due to the gross subdivisions used in the core logging and the smaller-scaled, more detailed methods used in sampling for insoluble residues.

However, where large discrepancies developed, more confidence was placed in the gross lithologic core descriptions as it is felt that the overall lithologic characteristics in Cambrian strata give

a better picture of the stratigraphic relationships involved.

C. Insoluble-Residue-Log Summaries

New Jersey Zinc Company
Hole No. W-1 McDonald County, Missouri
SW¼, sec. 21, T.22n., R. 34W.
Elevation: 1768 - Total Depth: 1516'
MGS No. 26287
Core through Subject Interval
Core description on file at the Missouri Geological Survey

FORMATION SUMMARY FROM CORE DESCRIPTION

Interval	Formation	Thickness
1222.0'-1406.0'	Eminence Dolomite	184.0'
1406.0'-1415.0'	Potosi Dolomite	9.0'
1415.0'-1485.0'	Derby-Doerun Dolomite	70.0'
1485.0'-1504.0'	Reagan Sandstone	19.0'
1504.0'-1516.0'T.D.	Precambrian	12.0'

INSOLUBLE-RESIDUE-LOG SUMMARY - (W-1)

Eminence Dolomite - (1225.0' - 1400.0')

The Eminence can be divided into two units on the basis of insoluble-residue type.

The upper Eminence (1225.0' - 1285.0') contains residue which, generally, make up less than 10% of each sample. The residues of this unit consist, primarily, of gray shale and fine grained, quartz sand with lesser amounts of gray, "quartzose" chert, dolocastic, white cherts, and white, tripolitic cherts.

The lower Eminence (1285.0' - 1400.0') contain residues which comprise 5% - 20% of each sample and are made up, primarily, of white tripolitic cherts, white dolocastic cherts, and green shale with lesser amounts of gray, "quartzose" and finely "quartzose" cherts.

Potosi Dolomite - (1400.0' - 1410.0')

The residues from the Potosi make up 10% - 15% of each sample and consist of white, dolocastic chert with minor quantities of brown, finely porous chert and green shale.

Derby-Doerun Dolomite - (1410.0' - 1505.0')

The Derby-Doerun can be divided into two units on the presence or absence of quartz silt and on the percent, by volume, of residue in each sample.

The upper Derby (1410.0' - 1430.0') contains insoluble residues which make up 25% - 30% of each sample and consist of brown and green shale with minute amounts of fine grained, glauconite.

The residues from the lower Derby (1430.0' - 1485.0') make up more than 40% of each sample and increase in volume with depth. Here they consist of approximately equal amounts of brown shale, gray shale, and quartz silt.

Reagan Sandstone - (1485.0' - 1505.0')

This interval is tentatively assigned to the Reagan Sandstone due to its slightly dolomitic, silty, and shaly make-up. Fragments of Precambrian, igneous detritus occur throughout the lowest 5'.

Precambrian - (1505.0' - 1516.0')

The Precambrian section in this core is represented by red, medium crystalline granite.

St. Joe Minerals Corporation - Core #65W12
Hole No. OZ-1 Ozark County, Missouri
NE¼, sec. 32, T.23N., R.12W.
MGS No. 27496
Drill cuttings to 875 feet - Core below 875 feet into Lamotte Sandstone
Core description on file at the Missouri Geological Survey

FORMATION SUMMARY FROM CORE DESCRIPTION

Interval	Formation	Thickness
875.0'-1026.0'	Eminence Dolomite	151.0'
1026.0'-1512.0'	Potosi Dolomite	486.0'
1512.0'-1606.0'	Derby-Doerun Dolomite	94.0'
1606.0'-1654.0'	Davis Formation	48.0'
1654.0'-1948.0'	Bonneterre Formation	294.0'
1654.0'-1697.0'	Whetstone Creek Mbr.	43.0'
1697.0'-1736.0'	Sullivan Siltstone Mbr.	39.0'
1915.0'-1948.0'	Bonneterre-Lamotte "transition" Beds	33.0'
1948.0'-2026.0'T.D.	Lamotte Sandstone	78.0'

INSOLUBLE-RESIDUE-LOG SUMMARY - (OZ-1)

Eminence Dolomite - (610.0' - 1025.0')

The residues throughout the Eminence consist, primarily, of gray "quartzose" and finely "quartzose" cherts with lesser amounts of white chalcedony, white, tripolitic cherts, and brown "quartzose" chert. However, the interval 875.0' - 900.0' contains residues made up of white, tripolitic, finely porous, and fine pelletal cherts indicating that this thin interval is correlative with the "spongy chert residue facies" of the Eminence (Kurtz, et al, 1974).

On the basis of abundance, the Eminence can be divided into three recognizable residue units; an upper Eminence (610.0' - 770.0') which contains residues making up, generally, 5% - 15% of each sample; a middle Eminence (770.0' - 945.0') containing residues which comprise 20% - 60% of each sample; and, a lower Eminence (945.0' - 1025.0') which contains residues making up less than 10% of each sample.

Potosi Dolomite - (1025.0' - 1510.0')

The residues in each sample from the Potosi are low in volume, generally less than 10%, and are made up of white, finely porous, finely dolocastic, and finely "quartzose" cherts; brown, with some gray, finely "quartzose" cherts; brown shale in the center portion; and, minor amounts of rounded and frosted, quartz sand grains in

the upper half of the Potosi.

However, in the interval 1200.0' - 1275.0' the dominant insoluble residue is green shale making this interval correlative with the "green shale residue facies" of the Potosi (Kurtz, et al, 1973).

Derby-Doerun Dolomite (1510.0' - 1605.0')

The Derby-Doerun can be divided into two distinctive residue units on the basis of residue type and percent by volume.

An upper Derby (1510.0' - 1540.0') contains residues which make up less than 10% of each sample and consist of, white, finely "quartzose" cherts; brown, finely "quartzose" cherts; brown shale; quartz silt; and, minor amounts of "pepper" glauconite.

The lower Derby (1540.0' - 1605.0') contains residues which consist of brown shale, quartz silt, and "pepper" glauconite. In this portion of the Derby the residues make up from 15% to 40% of each sample.

Davis Formation - (1605.0' - 1655.0')

The residues in the Davis range from 25% to 60% of each sample and consist, primarily, of fine-medium, rounded and frosted, quartz sand grains and green shale. Fine-medium grained, pellet glauconite is prevalant throughout the Davis making up as much as 25% of the residue in each sample.

Bonneterre Formation - (1655.0' - 1950.0')

The Whetstone Creek Member of the Bonneterre (1655.0' - 1690.0') contains residues which consist, primarily, of fine, rounded and frosted quartz sand grains and green shale, with minor amounts of fine, pellet glauconite.

The residues from the Sullivan Siltstone Member (1690.0' - 1735.0') consist of quartz silt with lesser amounts of green shale and minor amounts of very fine glauconite. The residues make up 70% - 90% of each sample from the Sullivan Siltstone.

Residues from the "oolite facies" (1735.0' - 1915.0') can be divided into two recognizable units on the basis of residue type. The upper unit (1735.0' - 1825.0') contains residues consisting of quartz silt, green and brown shale, and, fine-medium grained pellet glauconite and make up from 5% to 60% of each sample in this interval. The lower unit (1825.0' - 1915.0') contains residues which make up 10% - 15% of each sample, and consist of fine, rounded and frosted sand grains, brown shale, and fine-medium grained, pellet glauconite.

The lowest recognizable unit of the Bonneterre, the Bonneterre-Lamotte "transition" Beds (1915.0' - 1950.0'), contains residues which increase in percent by volume with increasing depth and range from 15% in the upper portion of this unit to 80% in the lowest few feet. The residues here are made up, primarily, of medium, rounded and frosted, quartz sand grains with lesser amounts of gray and brown shale and fine, pellet glauconite.

Lamotte Sandstone - (1950.0' - 2026.0' T.D.)

The Lamotte consists, almost entirely, of quartz sand which is fine-medium grained in the upper portion of this interval and increases in grain size with increasing depth. Small amounts of gray shale occur throughout.

American Zinc, Lead and Smelting Company
Hole No. L-4 Oregon County, Missouri
Sec. 7, T.25N., R. 6W.
Elevation: 778.12' Total Depth: 3000'
MGS No. 25610
Core from 975 feet through subject interval
Core description on file at the Missouri Geological Survey

FORMATION SUMMARY FROM CORE DESCRIPTION

Interval	Formation	Thickness
975.0'-1295.0'	Potosi Dolomite	320.0'
1295.0'-1405.5'	Derby-Doerun Dolomite	110.5'
1405.5'-1610.5'	Davis Formation	210.0'
1610.5'-2004.0'	Bonneterre Formation	393.5'
1610.5'-1615.5'	Whetstone Creek Mbr.	10.0'
1615.5'-1665.0'	Sullivan Siltstone Mbr.	49.5'
2004.0'-2250.0'	Lamotte Sandstone	246.0'
2250.0'-3000.0'T.D.	Precambrian	750.0'

INSOLUBLE-RESIDUE-LOG SUMMARY - (L-4)

Eminence Dolomite

Coring operations in this hole were commenced at a depth of

975', in the Potosi Dolomite. Because no uphole, churn-drill samples were saved, there is no stratigraphic record of the rock above the Potosi.

Potosi Dolomite - (975.0' - 1280.0')

The insoluble residues throughout the Potosi average less than 10% and consist, primarily, of brown, finely "quartzose" cherts and quartz druse. Added to these dominant residue types are lesser amounts of gray, finely "quartzose" cherts; white, finely "quartzose" cherts; white, finely porous and dolocastic cherts; and, minute quantities of green and gray shale.

Derby-Doerun Dolomite - (1280.0' - 1420.0')

The Derby-Doerun in this hole contains residues which can be divided into two recognizable zones.

The upper zone (1280.0' - 1355.0') contains very low-volume residues (less than 10%) which are made up of brown shale and quartz silt with lesser amounts of white cherts, finely "quartzose" cherts, and small, dickite masses.

The lower Derby residue zone (1355.0' - 1420.0') contains high volume residues (20% - 70%) which consist of brown shale and quartz silt with fine, rounded and frosted, quartz sand grains occurring in the lowest 20'.

Davis Formation - (1420.0' - 1605.0')

The entire succession of Davis strata contains high-volume residues, generally, exceeding 50% which consist of approximately equal amounts of green shale, quartz silt, and fine, rounded and frosted, quartz sand. "Pepper" glauconite occurs downward through the Davis to a depth of 1560.0'. Below this point, pellet glauconite is abundant throughout the remainder of the Davis.

Bonneterre Formation - (1605.0' - 2005.0')

The Bonneterre in this hole can be divided into five recognizable residue zones on the basis of abundance and type of residues.

The uppermost 10' of the Bonneterre contains residues consisting solely of green shale and correlates with the Whetstone Creek Member.

Immediately underlying the green-shale-residue unit and extending to a depth of 1665.0', the Bonneterre is made up of high-volume residues which are comprised of quartz silt with varying amounts of gray and brown shales. This unit represents the Sullivan Siltstone Member.

Underlying the silt, the next 120.0' of the Bonneterre (1665.0' - 1785.0') contains residues of low-volume (generally, less than 10%) which consist of varying amounts of quartz silt, gray shale, brown shale, and "pepper" glauconite.

The fourth distinctive residue zone in the Bonneterre (1785.0' -

1925.0') contains a highly varied, high-volume residue assemblage. The residues in this interval are made up of any combination of quartz silt; fine, rounded and frosted, quartz sand grains; green shale; and, occasionally, gray shale. "Pepper" to fine, pellet glauconite occurs throughout this interval.

The base of the Bonneterre (1925.0' - 2005.0') exhibits a very, high-volume residue zone (greater than 70%) which is made up, primarily, of fine-coarse, angular, quartz sand grains containing smaller but significant quantities, of gray shale and medium grained, pellet glauconite. This unit of the Bonneterre is more accurately termed a dolomitic sandstone and represents a "transition" from Bonneterre to Lamotte lithology.

Lamotte Sandstone - (2005.0' - 2250.0')

The Lamotte is made up of fine-coarse, angular-rounded and frosted, quartz sand grains which becomes granular in the lowest 30'. Varying amounts of gray shale occur in the uppermost 10' and red, hematitic shale in the lowest 20' - 25'. The entire lower half of the Lamotte has red, hematite coatings on the sand grains.

An abundance of shale and feldspar detritus in the lowest 5' - 7' of the Lamotte produces a rock which may be better termed an arkose.

Precambrian - (2250.0' - 3000.0' T.D.)

The Precambrian section in this hole is represented by fine grained, equigranular gabbro which is highly weathered in the uppermost 15'.

Only the upper 30' of the Precambrian section was described and sampled for the residue log. A detailed description of the entire Precambrian section has been compiled by Eva Kisvarsanyi of the Mineral Resources Section, Missouri Geological Survey and Water Resources.

M.G.S. No. 6507
Atlas Powder Company
Water Well No. 4
NW¼, SW¼, SE¼, sec. 36, T. 28N., R. 32W.
Jasper County, Missouri
Residues Logged by J. Grohskopf, M. McCracken, and K. Anderson

INSOLUBLE-RESIDUE-LOG SUMMARY

Eminence Dolomite - (1120.0' - 1320.0')

The Eminence Dolomite in this hole contains a very low percentage of insoluble residues. Each sample from the Eminence here shows a residue of less than 10 percent.

Residues from the upper 110.0' are made up primarily of gray, "quartzose" chert with lesser amounts of white, finely dolocastic chert and white, pelletal chert. Minute quantities of quartz crystals,

irregular shaped quartz masses, and quartz druse are sparsely sprinkled throughout.

The lower 90.0' of the Eminence in this hole contain residues made up of gray, "quartzose", and tripolitic white chert. Chips of weathered igneous material occur in the lowest 15'.

Potosi Dolomite - (1320.0' - 1375.0')

Insoluble residues from the Potosi are primarily made up of dolocastic, brown "quartzose" chert with lesser amounts of massive, brown "quartzose" chert, quartz druse, quartz crystals, and irregular shaped quartz masses. Finely dolocastic, white chert makes up the bulk of the residues in the upper 15' of the Potosi.

The volume of residue in each sample ranges from 2% - 3% in the lowest 15' of the Potosi.

Derby-Doerun Dolomite - (1375.0' - 1455.0')

The Derby-Doerun in this hole can be divided into two units on the basis of insoluble residue percentage.

The upper Derby (1375.0' - 1410.0') contains residues which make up less than 5% of each sample. The residues of this unit are composed, primarily, of finely porous, brown, shale. White shale and irregular shaped quartz masses, along with small amounts of glauconite occur in the lowest 15' of this unit.

Residues from the lower Derby-Doerun (1410.0' - 1455.0') average 20% - 30% and are composed of finely porous, brown shale and quartz silt. Shale is more abundant than silt in the residues from the upper portion of this lower unit. However, with increasing depth, the silt content increases and the amount of shale in the residue of each sample decreases so that the lowest 10' of the Derby shows a 25% insoluble residue made up of 20% quartz silt and 5% brown shale.

Davis Formation - (1455.0' - 1565.0')

The Davis Formation can be divided into two units on the basis of residue content.

Residues from the upper Davis (1455.0' - 1495.0') make up 30% - 60% of each sample, and are composed almost entirely of quartz silt. Small amounts of gray shale also occur in the upper 30' while "pepper" glauconite occurs in the lowest 25' of this upper Davis unit.

Residues from the lower Davis (1495.0' - 1565.0') range from 50% in the upper part of this unit to 20% in the lower portion. The residues in this unit are made up almost entirely of fine grained sand. Small amounts of green shale and "pepper" glauconite occur throughout the lower Davis.

Lamotte Sandstone - (1565.0' - 1705.0')

The entire Lamotte Sandstone in this hole is made up of medium-

coarse grained, quartz sand. The sand grains are subangular to rounded and frosted in the upper 35' of the Lamotte but are angular in shape throughout the remainder of the formation.

The upper 40' of the Lamotte is iron stained a yellow color. Gray, igneous material occurs throughout the Lamotte and is particularly abundant in the interval 1620.0' - 1700.0'.

Precambrian - (1705.0' - 1747.0' T.D.)

The Precambrian in this hole is represented by pink, coarse crystalline granite, the uppermost 25' of which is highly weathered.

M.G.S. No. 26938
State Sanitorium at Mt. Vernon, Missouri
Water Well No. 5
Sec. 26, T. 28N., R. 27W.
Lawrence County, Missouri
Residues Logged by J. Wells

INSOLUBLE-RESIDUE-LOG SUMMARY

Eminence Dolomite - (1065.0' - 1270.0')

The insoluble residues from the Eminence Dolomite in this well are very low-volume, making up less than 10% of each sample.

The upper 150' of the Eminence show residues composed of very small amounts of dolocastic, green shale and white, "quartzose" chert.

Residues from the lowest 55' of the Eminence are slightly higher

in volume percentage, but still make up less than 10% of the rock samples. Here they are composed of white, brown, and gray, finely "quartzose" cherts.

Potosi Dolomite - (1270.0' - 1360.0')

Insoluble residues from the Potosi in this well can be divided into an upper and lower sequence on the basis of volume percentage.

The upper Potosi (1270.0' - 1330.0') show residues which are very low-volume (less than 5%) and are made up, predominantly of brown, finely "quartzose" chert with some white, finely "quartzose" chert occurring in the upper 10'.

The lower Potosi (1330.0' - 1360.0') contains higher-volume residues (5% - 12%) which are made up of brown, finely "quartzose" cherts. Very small amounts of quartz druse also occurs in the lowest 20'.

Derby-Doerun Dolomite - (1360.0' - 1470.0')

The upper 25' of the Derby-Doerun contains insoluble residues which represent less than 5% of the rock samples. The residues consist of finely porous, brown shale with lesser amounts of finely dolocastic, white chert.

The remainder of the Derby-Doerun (1385.0' - 1470.0') contains residues made up entirely of finely porous, brown shale. The volume

percentage of the residue in each sample in this portion of the Derby is much higher than the upper portion. Here, the residue percentage curve ranges from 10 to 50 percent.

Davis Formation - (1470.0' - 1610.0')

The Davis in this well can be divided into three units on the basis of residue type and abundance.

The upper Davis (1470.0' - 1500.0') contains insoluble residues made up primarily of greenish-brown to green shale with small amounts of quartz silt sprinkled throughout. The residues make up 50% - 80% of the samples in this upper unit.

The middle Davis in this well (1500.0' - 1545.0') contains residues made up primarily of quartz silt with lesser amounts of green shale. The ratio of silt to shale reverses in the lower half of this unit and green shale becomes the dominant residue. The insoluble residues in this portion of the Davis comprise 60% - 80% of the total rock in each sample.

The lower Davis (1545.0' - 1605.0') contains residues made up almost entirely of finely dolocastic, green shale. Small quantities of quartz silt occur in the upper 15' and the lowest 10' of this unit. Here the residues comprise 15% - 40% of the rock in each sample.

The lowest 5' of the Davis (1605.0' - 1610.0') shows a residue made up of subangular to rounded, quartz sand grains which comprises 50% of the rock in this sample. This 5', sandy unit is interpreted

as representing a reworking of the Reagan Sandstone below, during Davis deposition.

Reagan Sandstone - (1610.0' - 1705.0' T.D.)

The Reagan Sandstone is made up of a fine to coarse grained, quartz sandstone overlying a quartz silt unit.

The upper sandstone portion of the Reagan (1610.0' - 1682.0') can be divided into two units on the basis of grain size and degree of rounding.

The upper unit (1610.0' - 1655.0') is made up, entirely, of fine to coarse grained, subangular to rounded, quartz sandstone. Gray and green shale occurs in the lower portion of this unit. The lower unit (1655.0' - 1682.0') of this upper portion of the Reagan, is made up of medium-coarse grained, rounded quartz sandstone. Gray shale is more abundant here than in the upper unit and pellet glauconite occurs in the lowest 5' of this unit.

The lower portion of the Reagan (1682.0' - 1705.0') is made up of quartz siltstone containing abundant gray shale and fine grained pellet glauconite.

New Jersey Zinc Company
Hole No. H-12 Christian County, Missouri
$N\frac{1}{2}$, $SE\frac{1}{4}$, sec. 18, T. 29N., R. 20W.
Elevation: 1161' Total Depth: 1931'
M.G.S. No. 26673
Core through Subject interval
Core description on file at the Missouri Geological Survey

FORMATION SUMMARY FROM CORE DESCRIPTION

Interval	Formation	Thickness
1030.0' - 1350.0'	Eminence Dolomite	320.0'
1350.0' - 1468.0'	Potosi Dolomite	118.0'
1468.0' - 1563.0'	Derby-Doerun Dolomite	95.0'
1563.0' - 1605.0'	Davis Formation	42.0'
1605.0' - 1919.0'	Bonneterre Formation	314.0'
1919.0' - 1931.0' T.D.	Lamotte Sandstone	12.0'

INSOLUBLE-RESIDUE-LOG SUMMARY - (H-12)

Residues Logged by J. Wells

Eminence Dolomite - (1030.0' - 1350.0')

The insoluble residues of the Eminence are generally low in volume (less than 10%) and can be divided into two units on the basis of residue type.

Residues from the upper Eminence (1030.0' - 1300.0') are made up of white chalcedony; white, tripolitic chert; gray, "quartzose" and finely "quartzose" cherts; green shale; and, small amounts of rounded and frosted quartz sand grains. Residues from the lower Eminence (1300.0' - 1350.0') consist almost entirely of gray, finely "quartzose" chert with minor amounts of quartz druse.

Potosi Dolomite - (1350.0' - 1475.0')

The insoluble residues of the Potosi, generally, run higher in

percent by volume, than those in the Eminence, (10% - 25%) and can be divided into two units on the basis of residue type.

The upper Potosi (1350.0' - 1405.0') are composed, predominately, of brown, finely "quartzose" cherts with minor amounts of gray, finely "quartzose" cherts and average 10% or less.

The insoluble residues from the lower Potosi (1405.0' - 1475.0') average 10% - 25% and are white, finely dolocastic chert; brown, dolocastic, "quartzose" chert; brown, finely "quartzose" chert; quartz druse; and, minor amounts of gray, finely "quartzose" chert.

Derby-Doerun Dolomite - (1475.0' - 1560.0')

Insoluble residues from the Derby-Doerun range from, 15% to as much as 70% and are made up primarily of brown, finely porous shales.

Minor amounts of quartz silt occur in the upper most portion of the Derby (1475.0' - 1510.0'). Below 1510.0', large amounts of quartz silt are present producing a very silty, brown shale residue in percentages ranging from 40% to 70%.

The residues from the lowest 10' of the Derby also contain green shales indicating that this interval may represent a transition from Derby lithology to Davis lithology.

Davis Formation - (1560.0' - 1605.0')

The insoluble residues from the Davis range from 30% to 70%

and are composed, predominately, of green shale and quartz silt with minor amounts of brown shale. The residues in the lowest 15' of the Davis are much lower in volume percentage than those in the upper Davis and range from 30% to 40%.

Bonneterre Formation - (1605.0' - 1920.0')

The insoluble residues from the Bonneterre Formation can be divided into 4 units on the basis of residue type and on volume percentages. The uppermost unit of the Bonneterre (1605.0' - 1655.0') contains residues made up of brown shale and quartz silt and range in volume from 2% to 30% of each sample.

Below the upper unit of the Bonneterre and ranging to a depth of 1750.0', the residues made up 30% - 60% of each sample and are composed of brown and green shale and quartz silt with minor amounts of glauconite occurring in the lowest 35'.

Unit 3, (1755.0' - 1790.0') contains insoluble residues made up of quartz silt, fine quartz sand and gray shale with small amounts of pellet glauconite. The insoluble residues comprise 100% of each sample in this interval.

The lowest recognizable residue zone of the Bonneterre (1790.0' - 1920.0') contain insoluble residues which made up 30% - 80% of each sample. The residues are comprised of quartz silt, fine quartz sand and gray, green, and brown shales, with lesser amounts of pellet glauconite.

Lamotte Sandstone - (1920.0' - 1931.0' T.D.)

The residues from the Lamotte are composed, predominately, of fine to medium, rounded and frosted, quartz sand grains with lesser amounts of gray shale.

Kerr-McGee Corporation
Hole No. SV-1 Shannon County, Missouri
NW¼, SW¼, sec. 26, T. 29N., R. 6W.
Elevation: 1080' Total Depth: 2130
M.G.S. No. 23001
Core from 770' through subject interval
Core description on file at the Missouri Geological Survey

FORMATION SUMMARY FROM CORE DESCRIPTION

Interval	Formation	Thickness
770.0' - 847.0'	Eminence Dolomite	77.0'
847.0' - 1216.0'	Potosi Dolomite	369.0'
1216.0' - 1364.0'	Derby-Doerun Dolomite	148.0'
1364.0' - 1550.0'	Davis Formation	186.0'
1550.0' - 1861.0'	Bonneterre Formation	311.0'
1550.0' - 1578.0'	Whetstone Creek Mbr.	28.0'
1578.0' - 1609.0'	Sullivan Siltstone Mbr.	31.0'
1861.0' - 2121.0'	Lamotte Sandstone	260.0'
2121.0' - 2130.0' T.D.	Precambrian	9.0'

INSOLUBLE-RESIDUE-LOG SUMMARY - (SV-1)

Residues Logged by J. Wells

Eminence Dolomite - (495.0' - 850.0')

The Eminence can be divided into two recognizable residue units

on the basis of residue type and residue quantity.

The upper Eminence (495.0' - 650.0') contains residues which make up from less than 5% to 25% of each sample from this interval. They consist primarily, of brown, "quartzose" cherts with lesser amounts of green shale; white, "quartzose" cherts; white, tripolitic cherts; white, pelletal cherts; and white, siliceous oolites.

The lower Eminence (650.0' - 850.0') contains residues which range from 15% to 30% and consist, primarily of white, tripolitic cherts; white, pelletal cherts; white, dolocastic cherts; and smooth, white cherts. Lesser amounts of brown, "quartzose" chert, green shale, and quartz druse are also present in this unit.

This lower unit of the Eminence is correlative with the "spongy chert residue facies" of the Eminence (Kurtz, et al., 1974).

Potosi Dolomite - (850.0' - 1215.0')

Except for the restricted interval 880.0' - 905.0' where the residues range from 30% to 80%, the percentage of residue in each sample from the Potosi averages less than 10%.

On the basis of residue type, the Potosi can be divided into three distinguishable units.

The upper unit (850.0' - 950.0') contains residues made up, primarily, of white, dolocastic cherts and quartz druse with lesser amounts of brown, "quartzose" and finely "quartzose" cherts. The middle unit (950.0' - 1080.0') contains residues consisting, almost

entirely, of brown, finely "quartzose" cherts. The lower unit (1080.0' - 1215.0') dominant residues are green, dolocastic shale.

The lower unit is correlative with the "green shale residue facies" of Kurtz, et al., 1974.

Derby-Doerun Dolomite - (1218.0' - 1365.0')

The Derby-Doerun contains two, distinctive residue units. The upper unit (1215.0' - 1270.0') contains residues which make up less than 3% of each sample from this interval, and consist of brown, finely porous shale. The lower unit (1270.0' - 1365.0') contains residues which make up 10% - 80% of each sample and consist of brown shale with minor amounts of green shale and quartz silt.

Davis Formation - (1365.0' - 1550.0')

The residues from the Davis are high in volume, ranging from 50% to 90% of each sample.

On the basis of residue type the Davis can be divided into three units, an upper unit (1365.0' - 1445.0') and a lower unit (1475.0' - 1550.0') whose residues consist mostly of green shale with lesser amounts of quartz silt, and a middle unit (1445.0' - 1475.0') whose residues consist mostly of fine, angular, quartz sand and silt with lesser amounts of green shale. Fine pellet and "pepper" glauconite occurs throughout the Davis.

Bonneterre Formation - (1550.0' - 1860.0')

The Whetstone Creek Member of the Bonneterre (1550.0' - 1575.0') contain residues which consist entirely of green and gray shale and make up 50% - 100% of each sample taken from this unit.

The residues from the Sullivan Siltstone Member (1575.0' - 1605.0') consist wholly of quartz silt and make up 60% - 100% of each sample from this member.

The remainder of the Bonneterre (1605.0' - 1860.0') can be divided into two recognizable residue units. The upper unit (1605.0' - 1685.0') contains residues which consist, primarily, of quartz silt with minor amounts of green and brown shale and make up from less than 3% to 40% of each sample taken from this interval. The residues from the lower unit (1685.0' - 1860.0') consist mostly of green shale with varying amounts of quartz silt and make up 50% to 90% of each sample in this interval. "Pepper" and fine, pellet glauconite occur throughout these lower two units of the Bonneterre.

Lamotte Sandstone - (1860.0' - 2121.0')

The Lamotte consists, almost entirely, of fine to medium, angular to rounded and frosted, quartz sand grains. Minor amounts of gray shale occur in the upper 40' of the Lamotte, and red, hematitic shale occurs in varying amounts throughout the remainder of the sandstone.

Precambrian - (2121.0' - 2130.0' T.D.)

The Precambrian portion in this hole consists of reddish-purple colored, rhyolite porphyry.

Mofero Incorporated - Well #2
Laclede County, Missouri
C., SW¼, sec. 20, T. 33N., R. 14W.
Elevation: 1183' Total Depth: 1995'
M.G.S. No. 24544
Core through subject interval
Core description on file at the Missouri Geological Survey

FORMATION SUMMARY FROM CORE DESCRIPTION

Interval	Formation	Thickness
500.0' - 660.0'	Eminence Dolomite	160.0'
660.0' - 1060.0'	Potosi Dolomite	400.0'
1060.0' - 1215.0'	Derby-Doerun Dolomite	155.0'
1215.0' - 1308.0'	Davis Formation	93.0'
1308.0' - 1518.0'	Bonneterre Formation	210.0'
1308.0' - 1342.0'	Whetstone Creek Mbr.	34.0'
1342.0' - 1360.0'	Sullivan Siltstone Mbr.	18.0'
1518.0' - 1825.0'	Lamotte Sandstone	307.0'
1825.0' - 1995.0' T.D.	Precambrian	170.0'

INSOLUBLE-RESIDUE-LOG SUMMARY
MOFERO, INC. CORE #2

Residues Logged by J. Wells, December 1966

Eminence Dolomite - (500.0' - 660.0')

On the basis of residue abundance, the Eminence can be divided

into an upper, high residue zone, and a lower, low residue zone.

The upper Eminence unit (500.0' - 600.0') contains residues which make up 10% - 50% of each sample, consisting of brown, "quartzose" cherts; siliceous, brown oolites; white, tripolitic cherts; and, white, pelletal cherts. This unit can probably be correlated with the "spongy chert residue facies" of the Eminence (Kurtz, et al., 1974).

The lower Eminence (600.0' - 660.0') contains residues which make up less than 3% of each sample, and consist of green shale; white, tripolitic and dolocastic cherts; and, gray, finely "quartzose" cherts.

Potosi Dolomite - (660.0' - 1060.0')

The insoluble residues in the Potosi range from less than 3% to as much as 20%. On the basis of residue type, the Potosi can be divided into three residue units.

The upper Potosi (660.0' - 790.0') contains residues made up, primarily, of gray, finely "quartzose" cherts with lesser amounts of white, dolocastic and tripolitic cherts; gray, "quartzose" chert; and, green shale.

The middle Potosi unit (790.0' - 950.0') contains residues made up of approximately equal proportions of brown, finely "quartzose" chert; white, dolocastic chert; and, quartz druse. Minor amounts of gray, "quartzose" and finely "quartzose" cherts occur throughout this unit.

The lower Potosi unit (950.0' - 1060.0') contain residues made up, primarily, of green, dolocastic shale with lesser amounts of brown, finely "quartzose" chert; gray, finely "quartzose" chert; and, quartz druse. This unit is believed to be correlative with the "green clay residue facies" of the Potosi (Kurtz, et al., 1974).

Derby-Doerun Dolomite - (1060.0' - 1215.0')

The Derby-Doerun in this hole contains three distinctive residue zones.

The upper zone (1060.0' - 1110.0') contains very, low-volume residues (less than 5%) which are made up of: brown, finely porous cherts; brown, "quartzose" and finely "quartzose" cherts; and, small quartz masses. White, finely dolocastic and finely porous cherts also occur in the residues of the upper 5' - 10' of the Derby.

The middle residue zone present in the Derby (1110.0' - 1160.0') contains residues which average 20% - 25% and are made up entirely of brown shales.

The lower Derby-Doerun residue zone (1160.0' - 1215.0') contains residues which range from 10% to 60% and consist of approximately equal proportions of green and brown shale. Referring to the overall appearance of the core in this interval, this unit appears as an interfingering of Derby and Davis lithologies and is, therefore, referred to as the Derby-Davis "transition" beds.

Davis Formation - (1215.0' - 1310.0')

Throughout the Davis the residue in the samples range from 10% - 70%. The upper Davis (1215.0' - 1270.0') contains residues made up of green shale with only minute quantities of brown shale occurring in the uppermost 15'.

The lower Davis (1270.0' - 1310.0'), on the other hand, contains residues made up, predominately, of fine, angular, quartz sand and silt with only minor amounts of green shale. "Pepper" and fine, pellet glauconite occur throughout this lower portion of the Davis.

Bonneterre Formation - (1310.0' - 1520.0')

The upper Bonneterre or Whetstone Creek Member (1310.0' - 1345.0'), contain residues made up of fine, angular quartz sand which grades into quartz silt with increasing depth. Minor amounts of brown shale and "pepper" glauconite occur throughout. The residue percentages vary from 15% to 90% in this interval.

The Sullivan Siltstone Member (1345.0' - 1360.0'), contains residues which make up 60% - 70% of the rock in its interval, and consist of quartz silt with minute amounts of "pepper" glauconite.

Very low-volume residues (less than 10%) range down from the Sullivan Siltstone to a depth of 1465.0' and consist of fine, angular sand grains and brown shale with "pepper" glauconite occurring in the lowest 35'.

The base of the Bonneterre (1465.0' - 1520.0') contains residues which range from 15% to 60%. The residues of this interval are made up of varying amounts of quartz silt and green shale with minor amounts of "pepper" and fine, pellet glauconite.

Lamotte Sandstone - (1520.0' - 1825.0')

The Lamotte is made up of fine-medium, rounded and frosted quartz sand grains, with minor amounts of gray shale, in the upper one half of its section. The grain size increases with depth. The lowest 60' - 70' of the Lamotte is very coarse grained and contains abundant feldspar detritus producing an arkosic appearing section.

Precambrian - (1825.0' - 1995.0' T.D.)

The Precambrian section in this core is made up of medium-coarse crystalline diorite which is intruded near the top by granite pegmatite.

M.G.S. No. 2345
I. I. Arnold
SW¼, SE¼, sec. 16, T. 26 S., R. 24 E.
Bourbon County, Kansas
Originally logged by M. McCracken
Re-logged by J. Thacker, January, 1974

INSOLUBLE-RESIDUE-LOG SUMMARY

Eminence Dolomite - (1475.0' - 1675.0')

The Eminence in this hole is represented by low-volume residues (less than 10%) which consist of smooth and translucent, white cherts; white chalcedony; white, finely porous and finely "quartzose" cherts; gray chalcedony; and, gray "quartzose" and finely "quartzose" cherts. Minute amounts of quartz silt and irregular shaped, quartz masses occur spordically throughout. Finely dolocastic white cherts become common in the lower portion of the Eminence.

The Potosi Dolomite is not present in this hole and the Eminence is underlain by the Derby-Doerun Dolomite.

Derby-Doerun Dolomite - (1675.0' - 1735.0')

The Derby-Doerun contains residues averaging 10% - 20% in its upper portion which increase with depth to approximately 40% in the lowest Derby-Doerun.

The residues consist of finely porous and finely dolocastic brown shales and quartz silt. Small amounts of green shale occur in lowest Derby-Doerun and probably indicate a transition from Derby-Doerun to Davis lithology.

Davis Formation - (1735.0' - 1780.0')

The Davis contains residues which make up 50% - 60% of each sample.

The residues consist, almost entirely, of green shale and quartz silt. Fine, "pepper" glauconite occurs in the upper Davis and grades into coarse pellets in the lower Davis. The lowest 20' contains large proportions of pellet glauconite.

The Bonneterre Formation is not present in this hole and the Davis is immediately underlain by the Reagan Sandstone.

Reagan Sandstone - (1780.0' - 1808.0')

The Reagan is made up of fine-coarse, angular to rounded and frosted quartz sand grains. Fine-coarse grained pellet glauconite is common in its upper 10' and the uppermost 5' is dolomitic. Weathered igneous detritus occurs throughout.

The Reagan is immediately underlain by Precambrian schists.

St. Joe Minerals Corporation - Core #62W161
Hole No. VE-2 Vernon County, Missouri
NE¼, sec. 6, T. 34N., R. 29W.
Total Depth: 1808'
M.G.S. No. 27471
Core from 1115 feet to lower Lamotte Sandstone
Core description on file at the Missouri Geological Survey

FORMATION SUMMARY FROM CORE DESCRIPTION

Interval	Formation	Thickness
1115.0' - 1230.0'	Eminence Dolomite	115.0'
1230.0' - 1365.0'	Potosi Dolomite	135.0'
1365.0' - 1458.0'	Derby-Doerun Dolomite	93.0'
1458.0' - 1584.0'	Davis Formation	126.0'
1584.0' - 1808.0' T.D.	Lamotte Sandstone	224.0'

INSOLUBLE-RESIDUE-LOG SUMMARY - (VE-2)

Eminence - Potosi Dolomites - (1110.0' - 1370.0')

The residues in the Potosi - Eminence interval of this core do not clearly define a Potosi-Eminence contact. However, more typical Potosi residues do occur in the lowest 15' (1355.0' - 1370.0').

Megascopic examination of the core does reveal a change in lithology, from Potosi Dolomites to Eminence Dolomites, at a depth of 1230.0' which will be used in the remainder of this report for the Potosi-Eminence break.

The residues from this interval can be broken into three recognizable zones on the basis of residue type.

The upper residue zone (1110.0' - 1250.0') contains residues not typical to the Eminence or Potosi and consist, primarily, of brown shale, with lesser amounts of fine quartz sand grains; white cherts; and, gray, finely "quartzose" cherts.

The middle zone (1250.0' - 1355.0') contain residues more typical of the Eminence and consist, predominantly, of gray, finely "quartzose" cherts with minor amounts of white and brown, finely "quartzose" cherts.

The lowest zone in this interval (1350.0' - 1370.0') is the only portion of this interval which contains residues more typical of the Potosi. The residues here are made up of white, finely dolocastic cherts, dolocastic, brown "quartzose" cherts, and quartz druse.

Derby-Doerun Dolomite - (1370.0' - 1465.0')

The Derby-Doerun can be divided into an upper (1370.0' - 1400.0') low-volume zone (less than 3%) and a lower (1400.0' - 1465.0') high-volume (10% - 60%) zone.

The upper zone contains residues made up of approximately equal proportions of finely dolocastic, white chert, brown shale, and quartz silt while the residues from the lower zone are made of equal proportions of brown shale and quartz silt.

Davis Formation - (1465.0' - 1585.0')

The Davis contains residues which range from 30% to 70% and are made up of varying amounts of green shale and quartz silt.

The uppermost 25' of the Davis contain some brown shale in its residues indicating that this interval probably represents a "transition" from Derby-Doerun lithology to Davis lithology.

Lamotte Sandstone - (1585.0' - 1825.0' T.D.)

The Lamotte consists of fine-coarse, angular-rounded and frosted, quartz sand grains with varying amounts of green and gray shale occurring throughout its upper 175'. The sand becomes coarse grained to granular and contains abundant feldspar detritus in the interval 1750.0' - 1800.0'.

The lowest 8' of the Lamotte is extremely coarse grained, contains abundant feldspar detritus and gray shale, and is identified as arkose.

M.G.S. No. 26784
John M. Greathouse, Well No. 1
Oil and Gas Test
SE¼, SW¼, sec. 16, T. 35N., R. 23W.
Polk County, Missouri
Residues Logged by J. Wells

INSOLUBLE-RESIDUE-LOG SUMMARY

Eminence Dolomite - (720.0' - 1000.0')

The insoluble residues from the Eminence in this hole make up a very low-volume percentage in each sample examined. The uppermost 10' of the Eminence shows a residue made up, almost entirely, of fine, rounded, quartz sand grains with a very small amount of green shale. Some of these sand grains may have fallen down the drillhole from the overlying Gunter Sandstone immediately above the Eminence. The residue represents 15% of the rock in this upper 10'.

The residues from the remainder of the Eminence, to a depth of 910.0', make up 5% or less of the rock in each sample. They are primarily composed of fine, rounded, quartz sand grains and contain minute amounts of green shale, smooth, white chert, and white, finely "quartzose" chert.

Below 910', and to the base of the Eminence, the residues are

primarily composed of iron sulfide (FeS_2) and, occasionally, contain minute amounts of smooth, white chert, white, finely "quartzose" chert, and brown, "quartzose" chert.

Potosi Dolomite - (1000.0' - 1070.0')

The Potosi can be divided into an upper and lower unit on the basis of residue percentage and content.

The upper Potosi (1000.0' - 1040.0') contains residues made up of brown, finely "quartzose" cherts; white, finely "quartzose" and finely dolocastic cherts; irregular shaped quartz masses; and, iron sulfide. These residues represent less than 10% of the rock in each sample examined.

The residues from the lower Potosi (1040.0' - 1070.0') represent 10% - 20% of the rock in each sample and are made up of dolocastic, brown "quartzose" cherts; white, dolocastic cherts; brown, finely "quartzose" cherts; dolocastic, quartz masses; and, quartz druse.

Derby-Doerun Dolomite - (1070.0' - 1130.0')

The top of the Derby-Doerun is determined by the first occurrence of brown shale in the residues below the brown "quartzose" cherts in the Potosi Dolomite.

The Derby in this hole can be divided into two units on the basis of residue types.

The upper Derby unit (1070.0' - 1090.0') contains residues which

make up less than 10% of the rock in each sample. The residues are, primarily, of brown, finely "quartzose" chert with lesser amounts of brown, finely porous chert; brown, "quartzose" chert; and, brown shale.

The lower Derby unit (1090.0' - 1130.0') contain residues made up entirely of finely porous, brown shale. The residues in this unit make up 15% - 20% of the rock in each sample.

Davis Formation - (1130.0' - 1180.0')

The residues from the Davis Formation in this hole are made up, almost entirely, of finely porous, green shale. There is some mixing of green and brown shale in the residues from the upper 20' of the Davis which suggests a possible interfingering of Derby-Doerun and Davis lithologies in the subsurface strata surrounding this well.

Quartz silt is logged in the lowest 30' of the Davis but comprises only 10% of residue in each sample.

The residues make up 20% - 25% of the rock in the samples from the upper Davis in this hole. With increasing depth the residue percentages increase so that in the lowest Davis the residues make up 40% of the samples.

Bonneterre Formation - (1180.0' - 1440.0')

The Bonneterre Formation in this hole can be divided into three units; an upper dolomite unit; a middle sandstone; and, a lower sandy, shaly dolomite.

The upper dolomite unit (1180.0' - 1330.0') is made up of medium-coarse crystalline dolomite containing insoluble residues consisting of green shale with some, finely porous, brown shale. "Pepper" glauconite is sprinkled throughout the center portion of this unit.

The residues in this dolomite unit make up 15% - 20%, of the rock, in each sample in the uppermost part of the Bonneterre. However, with increasing depth the residue percentage decreases to less than 5 percent. Fine, angular sand grains make up the residues at the base of this unit and represent a reworking of the sandstone unit below during deposition of this upper dolomite unit.

The middle, sandstone unit of the Bonneterre in this hole (1330.0' - 1380.0') is made up entirely of fine-medium grained, angular, quartz sand. Minute amounts of fine grained glauconite are sprinkled throughout.

The lower sandy and shaly dolomite unit (1380.0' - 1440.0') is made up, entirely, of fine-coarse crystalline dolomite containing abundant gray and finely porous, brown shale, and fine grained, angular, quartz sand. Pellet glauconite occurs in the upper 30' and "pepper" glauconite occurs in the lowest 30' of this unit. The shale content decreases with depth leaving only the sand grains comprising the residues in the lowest few feet of the Bonneterre.

Lamotte Sandstone - (1440.0' - 1530.0' T.D.)

The Lamotte Sandstone in this hole is made up, entirely, of

fine-medium grained, quartz sand. The sand grains throughout the Lamotte are, for the most part, angular in shape but some rounded and frosted grains occur throughout the formation.

St. Joe Minerals Corporation - Core #63W5
Hole No. DA-1 Dallas County, Missouri
SE¼, sec. 5, T. 35N., R. 18W.
Total Depth: 1398'
M.G.S. No. 27480
Core from 596 feet to lower Lamotte Sandstone
Core description on file at the Missouri Geological Survey

FORMATION SUMMARY FROM CORE DESCRIPTION

Interval	Formation	Thickness
596.0' - 866.0'	Potosi Dolomite	270.0'
966.0' - 972.0'	Derby-Doerun Dolomite	106.0'
972.0' - 1043.0'	Davis Formation	71.0'
1043.0' - 1126.0'	Bonneterre Formation	83.0'
1100.0' - 1126.0'	Bonneterre-Lamotte "transition" Beds	26.0'
1126.0' - 1398.0' T.D.	Lamotte Sandstone	272.0'

INSOLUBLE-RESIDUE-LOG SUMMARY - (DA-1)

Eminence Dolomite - (235.0' - 530.0')

The residues from most of the Eminence section in this hole occur in percentages of less than 10%, and are made up, primarily, of gray, "quartzose" and finely "quartzose" cherts. Minor amounts of green shale and fine, rounded and frosted sand grains occur throughout.

However, two zones which differ from the above description occur at 290.0' - 330.0' and 510.0' - 530.0'. Here the residues are generally higher in volume than in the rest of the Eminence and consist of white chalcedony; white, tripolitic chert; white, pelletal chert; and, white, finely porous chert. These two restricted intervals are believed to be correlative with the "spongy chert residue facies" of the Eminence (Kurtz, et al., 1974).

Potosi Dolomite - (530.0' - 860.0')

The percent of residue in samples from the Potosi ranges from 10% - 15% in the upper Potosi to less than 5% in the lower Potosi.

On the basis of residue type the Potosi can be divided into two differing and repeating residue zones. The first zone which occurs at the top (530.0' - 655.0'), middle (675.0' - 715.0'), and base (790.0' - 860.0') of the Potosi contains residues made up, primarily, of gray, finely "quartzose" cherts with lesser quantities of white, finely porous and finely dolocastic cherts.

The intervening residue zone occurs at 655.0' - 675.0' and 715.0' - 790.0' and contains residues made up, predominantly, of green, occasionally dolocastic, shale with lesser amounts of gray, finely "quartzose" chert. This residue zone is believed to correlate with the "green clay residue facies" of the Potosi (Kurtz, et al., 1974).

Derby-Doerun Dolomite - (860.0' - 970.0')

The Derby-Doerun in this core contains residues averaging less

than 10% of each sample and consist of quartz silt, gray and brown shale, dickite, and "pepper" glauconite.

Davis Formation - (970.0' - 1040.0')

The insoluble residue in the samples from the Davis in this core range from 20% - 70% and consist of approximately equal proportions of fine, rounded and frosted, quartz sand grains and green shale. Fine-coarse pellet glauconite is relatively abundant throughout, making up as much as 15%, by volume, of the total residue in each sample.

Bonneterre Formation - (1040.0' - 1130.0')

Residues of samples taken from the Bonneterre in this core range from 15% - 20% in the upper Bonneterre to 70% - 80% in the lower Bonneterre. The residues consist of fine-medium, rounded and frosted, quartz sand grains with varying amounts of green and brown shale. Fine pellet glauconite occurs in the uppermost 20' of this unit.

The lowest 35' of the Bonneterre in this core is interpreted as representing the Bonneterre-Lamotte "transition" beds.

Lamotte Sandstone - (1130.0' - 1398.0' T.D.)

The Lamotte is made up of quartz sand grains, the upper half of

which is fine-medium grained, rounded and frosted, and contains small amounts of green and brown shale.

The lower half of the Lamotte is coarser grained, becoming granule at its base, and is highly argillaceous.

The lowest 15' of the Lamotte is very coarse grained, and contains abundant, shale and feldspar detritus and is termed arkose.

M.G.S. No. 8617
Mrs. Gladys Waymire
NW¼, SE¼, SW¼, sec. 31, T. 37N., R. 32W.
Vernon County, Missouri
Residues Originally Logged by J. Grohskopf
Re-logged by J. Thacker, January, 1974

Skillman (1948) divided the Upper Cambrian series of insoluble residues, which was penetrated by this well, into the Eminence Dolomite, (1175.0' - 1260.0'); Potosi (?) Dolomite, (1260.0' - 1300.0'); undifferentiated Elvins-Bonneterre, (1300.0' - 1385.0'); and, the Lamotte Sandstone (?), (1385.0' - 1405.0').

However, upon re-examination of the residues in this well, it is believed by the writer that, except for the lowest 30', the entire sequence of Upper Cambrian residues in this well are representative of the Eminence Dolomite

The lowest 30' of Upper Cambrian sediments is a dolomitic sandstone posing the problem of where this unit fits into the Upper Cambrian section.

Because this 30-foot unit is the basal, Upper Cambrian sandstone in this well, and for this reason only, it is tentatively referred to

the Lamotte Sandstone. However, it should be noted that this dolomitic sandstone has more dolomite in it than is typical of the Lamotte (Skillman, 1948).

INSOLUBLE-RESIDUE-LOG SUMMARY

Eminence Dolomite - (1155.0' - 1375.0')

The residues from the Eminence in this well are typically low-volume (averaging less than 10%) and consist of gray, "quartzose" and finely "quartzose" cherts. Smooth, white cherts; white, tripolitic cherts; white, pelletal cherts; and, white chalcedony occur in significant amounts in the upper 85' of the Eminence.

The residues in the lower half of the Eminence (1245.0' - 1375.0') contain large proportions of fine-coarse, quartz sand grains which become granular at 1300.0' and continue throughout the remainder of the Eminence. The granular grains are derived from the underlying, Pre-Upper Cambrian sediments.

Lamotte Sandstone (?) - (1375.0' - 1405.0')

The residues from the Lamotte (?) in this well range in volume up to 80% and consist of fine-granular, rounded and frosted, quartz sand grains. Small amounts of green shale occur in the upper 5' of the Lamotte and fragments of weathered, feldspar detritus occurs throughout.

Pre-Upper Cambrian Sediments - (1405.0' - 2331.0' T.D.)

For a description of the Pre-Upper Cambrian sediments in this well, the reader is referred to Margaret Skillman's report, 1948.

St. Joe Minerals Corporation - Core #62W134
Hole No. BA-1 Bates County, Missouri
NW¼, sec. 7, T. 38N., R. 30W.
Total Depth: 1566'
M.G.S. No. 27411
Core through subject interval to lower Lamotte Sandstone
Core description on file at the Missouri Geological Survey

FORMATION SUMMARY FROM CORE DESCRIPTION

Interval	Formation	Thickness
996.0' - 1121.0'	Eminence Dolomite	125.0'
1121.0' - 1179.0'	Potosi Dolomite	58.0'
1179.0' - 1262.0'	Derby-Doerun Dolomite	83.0'
1262.0' - 1396.0'	Davis Formation	134.0'
1396.0' - 1566.0' T.D.	Lamotte Sandstone	170.0'

INSOLUBLE-RESIDUE-LOG SUMMARY - (BA-1)

Eminence Dolomite - (995.0' - 1120.0')

The residues from the Eminence in this hole are not typical of those found in the Eminence surrounding the St. Francois Mountains.

Here, the residues make up less than 3% of each sample, and consist of brown shale and fine, rounded and frosted, quartz sand grains.

Only the lowest 10' of the Eminence contains those residues typically found farther east. These are gray, finely "quartzose" cherts and gray chalcedony.

Potosi Dolomite - (1120.0' - 1175.0')

Only the residues in the upper half of the Potosi (1120.0' - 1150.0') are typical of those found in the Potosi farther east. They consist, primarily, of brown, finely "quartzose" cherts with some gray, finely "quartzose" cherts.

The lower half of the Potosi (1150.0' - 1175.0') contains residues more common to the Derby-Doerun which are brown shale, quartz silt, and white, finely dolocastic chert.

Derby-Doerun Dolomite - (1175.0' - 1265.0')

The residues from the Derby-Doerun range from less than 10% to as high as 50% throughout the succession of Derby strata. They consist of brown shale with only minor amounts of quartz silt in the upper Derby (1175.0' - 1225.0') and equal amounts of brown shale and quartz silt in the lower Derby (1225.0' - 1265.0'). Minute quantities of dickite occur throughout.

Davis Formation - (1265.0' - 1400.0')

The residues from the Davis range from 30% to 70% and increase

in abundance with increasing depth.

On the basis of residue type, the Davis can be divided into two recognizable units; an upper unit (1265.0' - 1310.0') whose residues contain approximately equal proportions of green shale, brown shale, and quartz silt (this unit may represent a transition from Derby to Davis lithology), and a lower unit (1310.0' - 1400.0') whose residues consist of equal amounts of green shale and quartz silt. The lowest 10' - 15' of the Davis contains abundant pellet glauconite which makes up approximately 10% of the residue.

Lamotte Sandstone - (1400.0' - 1466.0' T.D.)

Fine-medium, rounded and frosted, quartz sand grains make up the upper half of the Lamotte while fine-coarse, angular to rounded and frosted, quartz sand grains make up its lower half. The lowest 10' of the Lamotte becomes slightly granule. Varying amounts of gray and green shale occurs throughout.

St. Joe Minerals Corporation - Core #62W157
Hole No. BE-2 Benton County, Missouri
SE¼, sec. 5, T. 39N., R. 2W.
Total Depth: 1280
M.G.S. No. 27402
Core from 844 feet to upper Lamotte Sandstone
Core description on file at the Missouri Geological Survey

FORMATION SUMMARY FROM CORE DESCRIPTION

Interval	Formation	Thickness
844.0' - 973.0'	Eminence Dolomite	129.0'
973.0' - 1009.0'	Potosi Dolomite	36.0'
1009.0' - 1092.0'	Derby-Doerun Dolomite	83.5'
1092.0' - 1124.0'	Davis Formation	31.5'
1124.0' - 1230.0'	Bonneterre Formation	106.0'
1124.0' - 1160.0'	Whetstone Creek Mbr.	36.0'
1191.0' - 1230.0'	Bonneterre-Lamotte "transition" beds	39.0'
1230.0' - 1280.0' T.D.	Lamotte Sandstone	50.0'

INSOLUBLE-RESIDUE-LOG SUMMARY (BE-2)

Eminence Dolomite - (844.0' - 975.0')

The residues from the Eminence in this hole range from 5% to 20% and consist of approximately equal proportions of gray, finely "quartzose" chert; white, finely dolocastic chert; and, dolocastic, green shale.

Potosi Dolomite - (975.0' - 1010.0')

The residues from this thinned sequence of Potosi, generally, make up less than 10% of each sample and consist of brown, finely "quartzose" cherts; dolocastic, brown, "quartzose" cherts; white, finely dolocastic cherts; and, quartz druse.

Derby-Doerun Dolomite - (1010.0' - 1095.0')

The residues range from 5% to 20% throughout most of the

Derby-Doerun in this hole but increase to 30% in its lowest 15', and consist of brown shale throughout. Quartz silt occurs, sporadically, throughout the Derby down to 1055.0' where it becomes more abundant and continues on down into the underlying Davis.

Davis Formation - (1095.0' - 1120.0')

The Davis is greatly thinned in this hole and contains green shale, brown shale, and quartz silt residues which make up 40% - 60% of each sample.

Bonneterre Formation - (1120.0' - 1230.0')

The upper 35' of the Bonneterre is a coarse crystalline dolomite which is tentatively referred to the Whetstone Creek Member and contains residues consisting of quartz silt with lesser amounts of green and brown shale. Fine-medium grained, pellet glauconite occurs throughout.

The residues from the remainder of the Bonneterre consist of fine-medium, rounded and frosted, quartz sand grains and varying amounts of green and brown shale. The amount of sand increases with depth resulting in a dolomitic sandstone in the lowest 10' - 15' of the Bonneterre which represents the Bonneterre-Lamotte "transition" beds.

Lamotte Sandstone - (1230.0' - 1280.0' T.D.)

The Lamotte consists of fine-medium, subangular-rounded and frosted, quartz sand grains with varying amounts of green shale in its upper half and brown shale in its lower half.

St. Joe Minerals Corporation - Core #62W136
Hole No. MI-4 Miller County, Missouri
NW¼, sec. 3 T. 39N., R. 13W.
Total Depth: 1374'
M.G.S. No. 27412
Core from 716 feet to upper Lamotte Sandstone
Core description on file at the Missouri Geological Survey

FORMATION SUMMARY FROM CORE DESCRIPTION

Interval	Formation	Thickness
716.0' - 802.0'	Eminence Dolomite	86.0'
802.0' - 895.0'	Potosi Dolomite	93.0'
895.0' - 989.0'	Derby-Doerun Dolomite	94.0'
989.0' - 1101.0'	Davis Formation	112.0'
1101.0' - 1359.0'	Bonneterre Formation	258.0'
1101.0' - 1154.0'	Whetstone Creek Mbr.	53.0'
1154.0' - 1163.0'	Sullivan Siltstone Mbr.	9.0'
1339.0' - 1359.0'	Bonneterre-Lamotte "transition" Beds	20.0'
1359.0' - 1374.0' T.D.	Lamotte Sandstone	15.0'

INSOLUBLE-RESIDUE-LOG SUMMARY (MI-4)

Eminence Dolomite - (380.0' - 800.0')

The residues from the Eminence consist of gray, chalcedony; gray, "quartzose" and finely "quartzose" cherts; and, minor amounts of white, tripolitic cherts and round and frosted, quartz sand grains in

the upper half. Quartz druse is a minor constituent of the residues in the lower half. The amount of residue in each sample averages less than 10%, throughout the Eminence.

Potosi Dolomite - (800.0' - 895.0')

Residues from the Potosi range from 10% to as high as 50% and consist, primarily, of brown, finely "quartzose" cherts and quartz druse with lesser amounts of oolitic, brown "quartzose" cherts and gray, finely "quartzose" cherts.

Derby-Doerun - (895.0' - 995.0')

The Derby-Doerun can be divided into two distinctive residue zones: an upper zone (895.0' - 955.0') whose residues consist almost entirely of quartz silt with only minor amounts of brown shale; and, a lower zone (955.0' - 995.0') whose residues are much higher in volume than those in the upper zone and consist of equal amounts of quartz silt and brown shale. "Pepper" glauconite occurs throughout the Derby.

Davis Formation - (995.0' - 1100.0')

The Davis contains insoluble residues of varying amounts ranging from 25% to 100% and consisting predominantly, of green shale with varying amounts of quartz silt. Low-volume, brown shale residues

occur sporadically, throughout the Davis.

Bonneterre Formation - (1100.0' - 1360.0')

The upper Bonneterre (1100.0' - 1155.0') is a coarsely crystalline dolomite containing high volumes of quartz silt residue with varying amounts of green shale. This upper unit of the Bonneterre is assigned to the Whetstone Creek Member.

The next 10' of the Bonneterre (1155.0' - 1165.0') contains residues made up entirely of quartz silt and is assigned to the Sullivan Siltstone Member.

From the base of the siltstone to a depth of 1335.0', the Bonneterre contains residues of varying amounts which are made up of approximately equal proportions of quartz silt, green shale, and brown shale. "Pepper" and fine pellet glauconite occur throughout this unit of the Bonneterre strata.

The lowest 25' of the Bonneterre (1335.0' - 1360.0') consists of high volumes of fine-coarse, rounded and frosted, quartz sand grains and is assigned to the Bonneterre-Lamotte "transition" beds.

Lamotte Sandstone - (1360.0' - 1374.0' T.D.)

The Lamotte in this core consists of fine-coarse, rounded and frosted, quartz sand grains with minor amounts of brown and green shale.

St. Joe Minerals Corporation - Core #63W72
Hole No. MA-1 Maries County, Missouri
SW¼, sec. 30, T. 40N., R. 8W.
Total Depth: 1547'
M.G.S. No. 27448
Core from 701 feet through subject interval
Core description on file at the Missouri Geological Survey

FORMATION SUMMARY FROM CORE DESCRIPTION

Interval	Formation	Thickness
701.0' - 756.0'	Potosi Dolomite	55.0'
756.0' - 842.0'	Derby-Doerun Dolomite	86.0'
842.0' - 891.0'	Derby-Davis Transition	49.0'
891.0' - 1035.0'	Davis Formation	144.0'
1035.0' - 1288.0'	Bonneterre Formation	253.0'
1035.0' - 1042.0'	Whetstone Creek Mbr.	7.0'
1042.0' - 1267.0'	Sullivan Siltstone Mbr.	25.0'
1258.0' - 1288.0'	Bonneterre-Lamotte "transition" Beds	30.0'
1288.0' - 1521.5'	Lamotte Sandstone	233.5'
1521.5' - 1547.0' T.D.	Precambrian	25.5'

INSOLUBLE-RESIDUE-LOG SUMMARY - (MA-1)

Eminence Dolomite - (235.0' - 495.0')

The residues throughout the Eminence are low in volume, generally, less than 10%. They consist, primarily, of gray, "quartzose" and finely "quartzose" cherts with some white chalcedony and white, tripolitic cherts. The upper portion of the Eminence (235.0' - 390.0') also contains significant amounts of rounded and frosted, quartz sand grains, while the lower Eminence (405.0' - 495.0') contains quartz druse.

Potosi Dolomite - (495.0' - 760.0')

The residues in the Potosi are higher in volume than those in the Eminence and range from less than 10% to 40%. They are made up of brown, sometimes dolocastic, "quartzose" cherts; brown, finely "quartzose" cherts; white, dolocastic cherts; white chalcedony; and, significant amounts of quartz druse.

Derby-Doerun Dolomite - (760.0' - 885.0')

Derby-Doerun residues are, generally, high in volume and are made up of approximately equal proportions of brown shale and quartz silt. Hexactinellid spicules occur in the 5' interval 770.0' - 775.0' and green shale occurs in varying amounts in the interval 830.0' - 860.0'.

Davis Formation - (885.0' - 1035.0')

The Davis in this hole contains residues which are very high in volume (50% - 90%) and are made up of approximately equal amounts of green shale and quartz silt. Fine, round and frosted, quartz sand grains occur in the lowest 25' of the Davis and fine, pellet glauconite is abundant in the interval 970.0' - 1020.0'.

Bonneterre Formation - (1035.0' - 1290.0')

The residues in the Bonneterre occur in varying amounts and range from 10% to 70%.

The major portion of the Bonneterre (1035.0' - 1255.0') contains residues made up of quartz silt with lesser amounts of gray shale, green shale, and brown shale. "Pepper" and fine, pellet glauconite occur throughout this portion of the Bonneterre.

The lowest portion of the Bonneterre (1255.0' - 1290.0') contains extremely high-volume residues which are made up of fine-coarse, rounded and frosted, quartz sand grains with minor amounts of gray and brown shale and fine, pellet glauconite. This portion of the Bonneterre represents the Bonneterre-Lamotte "transition" beds.

Lamotte Sandstone - (1290.0' - 1520.0')

The Lamotte is made up of fine-coarse, rounded and frosted, quartz sand grains which grade into granules below 1400.0'. In the center portion of the Lamotte (1390.0' - 1485.0') the quartz grains are angular to subangular in shape and are coated with red hematite.

Precambrian - (1520.0' - 1547.0' T.D.)

The Precambrian in this core is represented by very finely crystalline granite which is banded and appears gneissic.

M.G.S. No. 15420
Beaumont Petroleum Company
Oil and Gas Test Well
Lot 5, sec. 4, T. 44N., R. 33W.
Cass County, Missouri
Residues Logged by R. D. Knight

INSOLUBLE-RESIDUE-LOG SUMMARY

Eminence Dolomite - (1695.0' - 1860.0')

The Eminence in this hole can be divided into two units on the basis of insoluble residue type. The percentage of residues in each sample from the Eminence falls within the 5% - 10% range.

The residues in the upper Eminence (1695.0' - 1785.0') are made up of smooth and translucent, gray cherts; gray and brown "quartzose" cherts; and, gray shale. The residues from the lower Eminence (1785.0' - 1860.0') are made up of "quartzose" cherts, a 30 foot sequence of brown and gray "quartzose" cherts underlain by 45', predominantly, gray with some brown, finely "quartzose" cherts.

Potosi Dolomite - (1860.0' - 1895.0')

The Potosi-Eminence contact in this hole is picked on an increase in the residue content in the Potosi. The residue content in each sample increases from approximately 5% in the Eminence to 15% in the underlying Potosi. However, in this hole the residue types in the upper Potosi do not change significantly from those in

the lower Eminence.

The upper 15' of the Potosi contains residues made up, predominantly, of gray, finely "quartzose" cherts with lesser amounts of gray and white dolocastic chert and dolocastic quartz masses.

The lower 20' of the Potosi contains residues made up of brown, finely "quartzose" cherts and dolocastic, brown cherts. The amount of the residues in the samples from this lower Potosi unit also decreases and averages 5% - 10%.

Derby-Doerun Dolomite - (1895.0' - 1945.0')

The top of the Derby-Doerun in this hole is placed at the first occurrence of brown shale below the finely "quartzose" cherts of the Potosi.

The upper 25' of the Derby-Doerun contains insoluble residues made up of dolocastic, brown shales; brown, "quartzose" cherts; gray, finely "quartzose" cherts; and, dolocastic, brown cherts. The lower 25' of the Derby-Doerun contain residues made up, predominantly, of dolocastic, brown shale with some brown, "quartzose" cherts and dolocastic, brown cherts.

The volume percentage of residue in each sample from the Derby ranges from 5% in the upper 40' to 15% in the lowest 10'.

Davis Formation - (1945.0' - 2035.0')

Although assigned to the Davis, the upper 50 feet here appears

to represent an interfingering of Davis and Derby-Doerun shaly dolomites. The residues from this upper 50' are made up of 20' of dolocastic, green and brown shale underlain by 30' of finely porous and dolocastic, brown shale. The percentage of residue in each sample from this 50 foot thick unit averages 15% - 25%.

The residues from the lower 40' of the Davis in this hole are made up, entirely, of finely porous and dolocastic green shale and make up 15% - 20% of each sample from this unit.

Bonneterre Formation - (2035.0' - 2085.0')

The Bonneterre Formation in this hole is distinguished from the overlying Davis by a change in color of the shale residues from green in the Davis to gray and brown in the Bonneterre.

From 2035.0' to 2060.0' the insoluble residues in the Bonneterre are comprised of gray and brown dolocastic shale, and make up approximately 20% of each sample.

Residues from the lower 25' of the Bonneterre are made up of quartz silt; fine grained, subangular to rounded quartz sand; "pepper" glauconite; and gray to greenish-gray, dolocastic shale. Here the residues comprise from 25% to 50% of each sample.

Lamotte Sandstone (2085.0' - 2191.0' T.D.)

The insoluble residue log of the entire Lamotte in this hole indicates that the Lamotte Sandstone is a very "clean" appearing,

medium-coarse grained, subangular to rounded and frosted, quartz sandstone which is underlain by 6' of Precambrian granite.

M.G.S. No. 12960
Sedalia Water Works
Water Well No. 11
NW¼, SW¼, NW¼, sec. 22, T. 45N., R. 21W.
Pettis County, Missouri
Residues Logged by L. C. Martin, R. D. Knight, J. W. Koenig

INSOLUBLE-RESIDUE-LOG SUMMARY

Eminence Dolomite - (590.0' - 875.0')

The Eminence in this hole contains residues of low-volume (less than 10%) which are made up, predominantly, of gray, "quartzose" and finely, "quartzose" cherts. Minor amounts of fine, quartz sand grains; brown, "quartzose" cherts; white, finely "quartzose" cherts; and, gray, green, and brown shales occur throughout the Eminence.

Potosi Dolomite - (875.0' - 995.0')

Like the overlying Eminence, the Potosi contains residues of very low-volume. However, the Potosi can be divided into three residue zones on the basis of residue type.

The uppermost zone (875.0' - 925.0') contains residues made up of brown, finely "quartzose" cherts with insignificant amounts of brown, dolocastic chert.

The middle Potosi residue zone (925.0' - 970.0') contains residues made up, predominantly, of quartz silt with minor amounts of gray, finely "quartzose" chert.

The lower Potosi zone (970.0' - 995.0') consists of white, finely "quartzose" chert and quartz druse residues.

Derby-Doerun Dolomite - (995.0' - 1035.0')

The Derby-Doerun contains residues of very low percentages which are made up of brown shale, and white, finely "quartzose" cherts. "Pepper" glauconite occurs, sporadically, throughout the Derby.

Davis Formation - (1035.0' - 1105.0')

The Davis in this hole contains residues which range from 10% to 30% and are made up, almost entirely, of green shale. Minor amounts of gray shale occur near the top and small quantities of brown shale occur at the base of the Davis.

Bonneterre Formation - (1105.0' - 1255.0')

The Bonneterre can be divided into two distinguishable residue zones.

The upper Bonneterre (1105.0' - 1165.0') consists of very, low-volume residues (less than 10%) which are made up of green and brown

shales with minute quantities of "pepper" glauconite.

The lower Bonneterre (1165.0' - 1255.0') contains residues which range in percentage from 10% to 50%, and are made up of quartz silt and fine, angular quartz sand. "Pepper" glauconite occurs throughout this unit of the Bonneterre.

Lamotte Sandstone - (1255.0' - 1517.0' T.D.)

The entire Lamotte in this well is made up of subangular-rounded and frosted, quartz sand grains. The upper 2/3 of the Lamotte is fine grained and the lower 1/3 is coarse grained.

Hematite coatings on sand grains is common in the center portion of the Lamotte and gray shale occurs in its lowest few feet.

M.G.S. No. 5493
Capitol Building Group
Water Well No. 1
SE¼, NW¼, NE¼, sec. 7, T. 44N., R. 11W.
Cole County, Missouri
Residues Logged by McCracken and Grohskopf

INSOLUBLE-RESIDUE-LOG SUMMARY

Eminence Dolomite - (550.0' - 730.0')

The residues from the Eminence in this well are, generally, low in volume, making up less than 10% of the samples. They consist, primarily, of brown, "quartzose" cherts, with lesser amounts of

gray, "quartzose" cherts, and gray shale. White, "quartzose" cherts occur in the upper 70' of the Eminence.

Potosi Dolomite - (730.0' - 975.0')

The Potosi contains residues of varying percentages and can be divided into two recognizable residue zones.

The upper zone (730.0' - 925.0') contains residues making up from less than 10% to 40% of the samples and consist predominantly, of brown "quartzose" and dolocastic, brown "quartzose" cherts. Minor amounts of quartz druse occur throughout this zone.

The lower Potosi zone (925.0' - 975.0') contains residues averaging less than 10% which are made up of quartz silt, gray shale, and brown, "quartzose" chert.

Derby-Doerun Dolomite - (975.0' - 1095.0')

The Derby-Doerun in this well contains residues of very low percentages which consist, primarily, of quartz silt with lesser amounts of brown shale, brown "quartzose" chert, and "pepper" glauconite.

Davis Formation - (1095.0' - 1270.0')

The Davis consists of high percentage residues made up, predominantly, of green shale with significant amounts of a very fine

quartz sand and silt. "Pepper" glauconite occurs throughout the Davis section in this hole.

Bonneterre Formation - (1270.0' - 1485.0')

The uppermost 10' of the Bonneterre is made up of very, low-volume residues consisting of quartz silt and green shale.

The interval 1280.0' - 1310.0' consists of high-volume residues (25% - 70%) which are made up of green shale with minor amounts of very fine, quartz sand and "pepper" glauconite.

Underlying the green shale and extending to 1460.0' the Bonneterre consists of low-volume residues (less than 5%) which are made up of quartz silt and very fine sand with minute quantities of green shale and "pepper" glauconite.

Below 1460.0'; and extending to the top of the Lamotte, the Bonneterre is made up of calcareous quartz sandstone. The residues from this interval consist of fine, quartz sand grains with minor amounts of "pepper" glauconite. This portion of the Bonneterre is correlative with the Bonneterre-Lamotte "transition" beds.

Lamotte Sandstone - (1485.0' - 1600.0' T.D.)

The Lamotte in this well is composed of coarse, rounded and frosted, quartz sand grains with scattered beds of medium grained sand. Hematite staining of the sand grains occurs throughout the lower half of the Lamotte.

M.G.S. No. 4191
F. J. Kasper, Well No. 1
Oil and Gas Test
NW¼, NE¼, NW¼, sec. 8, T. 13S., R. 25E.
Johnson County, Kansas
Originally logged by E. McCracken, M. McCracken, J. Grohskopt
Re-logged by J. Thacker, January, 1974

INSOLUBLE-RESIDUE-LOG SUMMARY

Eminence Dolomite - (2045.0' - 2155.0')

The Eminence in this hole contains residues of low percentages, generally less than 10%, and can be divided into two distinctive residue zones.

The upper zone (2045.0' - 2080.0') contains residues made up of white chalcedony; white, tripolitic cherts; white pelletal cherts; gray finely "quartzose" cherts; and, lesser amounts of small, irregular shaped quartz masses and fine, rounded and frosted quartz sand grains.

The lower Eminence (2080.0' - 2155.0') contains only trace amounts of insoluble residues which consist of white chalcedony; white, tripolitic and finely porous cherts; and fine, rounded and frosted, quartz sand grains. Brown shale is common in the 10 foot interval 2090.0' - 2100.0'.

The Potosi Dolomite is not present in this hole and the Eminence is immediately underlain by the Derby-Doerun Dolomite.

Derby-Doerun Dolomite - (2155.0' - 2276.0')

The Derby-Doerun in this hole is represented by low-volume

residues (less than 5%) which consist, primarily, of finely porous, brown shales and quartz silt. Minute amounts of green shale occur sporadically throughout and fine, rounded and frosted, quartz sand grains occur in the lower portion of the Derby.

The Davis and Bonneterre Formations are not present in this hole and the Derby rests upon Precambrian granite.

M.G.S. No. 12328
Butcher Brothers, Well #1
Oil and Gas Test
NE¼, NE¼, NE¼, sec. 8, T. 48N., R. 23W.
Saline County, Missouri
Residues Logged by L. C. Martin

INSOLUBLE-RESIDUE-LOG SUMMARY

Eminence Dolomite - (1100.0' - 1430.0' ?)

The residues from the Eminence in this hole are low in volume, averaging approximately 10%, and consist, primarily, of gray and brown, "quartzose" cherts in the upper Eminence (1100.0' - 1230.0') and gray, finely "quartzose" cherts in the lower Eminence (1230.0' - 1430.0').

Fine, rounded and frosted, quartz sand grains occur, in small quantities throughout the upper 170' of this unit.

Potosi Dolomite - (1430.0' ? - 1460.0' ?)

The Potosi consists of residues made up, predominantly, of gray,

finely "quartzose" cherts with minor amounts of smooth, dolocastic, white cherts and rounded and frosted, quartz sand grains.

Finely "quartzose", brown cherts and quartz druse are the dominant residues in the lowest 30' of the Potosi.

Derby-Doerun Dolomite - (1460.0' ? - 1590.0' ?)

The residues from the Derby-Doerun are low in volume (less than 10%) and consist of brown shale with quartz druse in the upper 10' and very fine grained, glauconitic sand in the lowest 20'.

Davis Formation - (1590.0' ? - 1680.0' ?)

The Davis contains residues ranging in abundance from 10% - 30% which are made up, almost entirely, of fine, glauconitic quartz sand with minor amounts of brown shale in its upper 20'.

Bonneterre Formation - (1680.0' ? - 1850.0' ?)

The Bonneterre contains high-volume residues (20% - 70%) which are made up of fine-medium, rounded and frosted, quartz sand grains. "Pepper" and fine pellet glauconite occur throughout the Bonneterre.

Lamotte Sandstone - (1850.0' ? - 1960.0' ?)

The entire Lamotte in this hole is made up of coarse grained arkose containing numerous granite cobbles and boulders.

Precambrian - (1960.0' - 2117.0' T.D.)

The Precambrian in this hole is represented by coarse crystalline granite.

M.G.S. No. 19211
American Zinc, Lead & Smelting Co.
NE¼, NE¼, NE¼, sec. 17, T. 50N., R. 29W.
Jackson County, Missouri
Residues Logged by J. S. Wells

INSOLUBLE-RESIDUE-LOG SUMMARY

Eminence Dolomite - (1600.0' - 1995.0' ?)

The Eminence can be divided into two recognizable residue zones on the basis of residue type.

The upper Eminence (1600.0' - 1730.0' ?) contains residues which average less than 10% and are made up of gray, brown, blue, and white, "quartzose" cherts; white, silicified oolites; and, lesser amounts of brown, finely "quartzose" cherts and gray shales.

The lower Eminence (1730.0' ? - 1995.0' ?) contains residues made up, primarily, of gray, finely "quartzose" cherts. However, the

interval 915.0' - 960.0' contains relatively high percentages of dolocastic, green shale residue and is assigned to the "green clay residue facies" of Kurtz et al., 1974.

Potosi Dolomite - (1995.0' ? - 2065.0')

The residues in the Potosi range in volume from 10% to 30% and consist of brown, finely "quartzose" cherts; gray, finely "quartzose" cherts; gray, finely dolocastic cherts; and, quartz druse.

Derby-Doerun Dolomite - (2065.0' - 2095.0')

Derby-Doerun residues average less than 20% and consist entirely of gray to brown, glauconitic, quartz silt.

Davis Formation - (2095.0' - 2120.0')

The residues from the Davis in this hole are high in volume, ranging up to 100%, and consist of very fine glauconitic, quartz sand and silt. The lowest 5' of the Davis contains abundant, gray shale and pellet glauconite which marks the base of this fornation.

Bonneterre Formation - (2120.0' - 2150.0')

As in the overlying Davis, the Bonneterre contains high-volume residues. The top of this formation is marked by a brown, shaly,

quartz silt which grades into fine, glauconitic, quartz sand with increasing depth. The lowest 10' of the Bonneterre consists, of rounded and frosted, quartz sand residues which may represent the Bonneterre-Lamotte "transition" beds.

Lamotte Sandstone - (2150.0' - 2265.0')

The Lamotte is made up of quartz sand grains which appear to increase in size with depth resulting in granular sandstone in the lowest 40' of this formation. The lower half of the Lamotte is cross bedded in places.

Precambrian - (2265.0' - 3962.0' T.D.)

The Precambrian section in this hole is made up of coarse crystalline granite which is highly altered in its upper few feet with the feldspar material being weathered to white and brown clay.

Cerro Corporation - Hole No. GT-1
Howard County, Missouri
NW¼, NE¼, sec. 2, T. 51N., R. 17W.
Elevation: 675'± Total Depth: 2243'
M.G.S. No. 26695
Core through subject interval
Core description on file at the Missouri Geological Survey

FORMATION SUMMARY FROM CORE DESCRIPTION

Interval	Formation	Thickness
1277.0' - 1488.0'	Eminence Dolomite	211.0'
1488.0' - 1679.0'	Potosi Dolomite	191.0'
1679.0' - 1819.0'	Derby-Doerun Dolomite	140.0'
1819.0' - 1906.5'	Davis Formation	87.5'
1906.5' - 2123.0'	Bonneterre Formation	216.5'
1906.5' - 1934.0'	Whetstone Creek Mbr.	27.5'
1934.0' - 1953.0'	Sullivan Siltstone Mbr.	19.0'
2123.0' - 2235.5'	Lamotte Sandstone	112.5'
2235.5' - 2243.0'	Precambrian	7.5'

INSOLUBLE-RESIDUE-LOG SUMMARY - (GT-1)

Residues Logged by K. H. Anderson

Eminence Dolomite - (1280.0' - 1485.0')

The residues throughout the Eminence are typically low-volume, generally, making up less than 5% of each sample.

On the basis of residue type the Eminence can be divided into two residue zones: an upper (1280.0' - 1420.0') brown zone consisting of brown "quartzose" and finely "quartzose" cherts and brown shale; and, a lower (1420.0' - 1485.0') gray zone made up of gray, finely "quartzose" cherts with only minor amounts of quartz druse.

Potosi Dolomite - (1485.0' - 1675.0')

The Potosi in this core contains residues typical of those found in the Potosi surrounding the St. Francois Mountains.

The residues are made up of abundant quartz druse with lesser amounts of brown, "quartzose" and finely "quartzose" cherts. The lowest 25' of the Potosi also contains dolocastic, white chert and dolocastic, quartz masses.

Derby-Doerun Dolomite - (1675.0' - 1815.0')

The Derby-Doerun can be divided into two distinct residue zones. The upper zone (1675.0' - 1730.0') is made up of dolocastic and finely dolocastic, white cherts; brown, finely "quartzose" cherts; and, minute amounts of quartz druse. The lower zone (1730.0' - 1815.0') contains brown shale residues. Small quantities of dickite occur throughout the Derby.

Davis Formation - (1815.0' - 1895.0')

As in the Derby, the Davis can be divided into two distinct residue zones.

The upper zone (1815.0' - 1860.0') contains residues made up of green shale with lesser amounts of brown shale while the lower zone (1860.0' - 1905.0') contains residues consisting of varying amounts of green shale, fine quartz sand, and quartz silt.

Fine-coarse pellet glauconite occurs throughout and is particularly concentrated in the lowest 10' of the Davis.

Bonneterre Formation - (1895.0' - 2130.0')

The Bonneterre can be divided into four residue zones; an upper sandstone, underlain by silty dolomite, underlain by low-residue dolomite, underlain by sandy dolomite.

The upper, sandstone of the Bonneterre (1895.0' - 1945.0') is made up of fine angular sand grains with green shale in its lowest 10' and "pepper" glauconite common throughout. This unit is interpreted as representing the Whetstone Creek Member.

Underlying the sandstone and extending downward 10' is dolomite containing abundant quartz silt with lesser amounts of green shale. This silt unit may be correlative with the Sullivan Siltstone Member of the Bonneterre.

The third residue unit in the Bonneterre (1955.0' - 2025.0') is a low-residue zone whose residues consist of fine, angular quartz sand grains, brown shale, and fine pellet glauconite.

The residues from the lower Bonneterre (2025.0' - 2130.0') are high in volume, ranging from 15% to 60% and consist of quartz sand grains, ranging from silt to granule in size, brown shales, and fine pellet glauconite. The lowest 30' - 40' of the Bonneterre may be considered as correlative with the Bonneterre-Lamotte "transition" beds.

Lamotte Sandstone - (2130.0' - 2235.0')

The Lamotte in this core is made up of medium-coarse, quartz

sand grains which are rounded and frosted in the upper 25' and angular in shape throughout the remainder of the Lamotte.

Hematite occurs as a red stain on the quartz grains in the interval 2145.0' - 2175.0'.

Precambrian - (2235.0' - 2243.0' T.D.)

The Precambrian in this core is represented by pink, coarse crystalline granite.

Additional Data - Listed below are the names and locations of those core descriptions and insoluble-residue-log summaries which were compiled by the writer for another report (Kurtz, et al., 1974) and, whose data is also used in this study.

St. Joe Minerals Corporation - Core #66W84
Hole No. MD-1 McDonald County, Missouri
NW NW NE sec. 28, T. 21N., R. 31W.
Elevation: 940' - Total depth: 1,474'
M.G.S. No. 25812
Core through subject interval
Core description on file at the Missouri Geological Survey

St. Joe Minerals Corporation - Core #67AK1
Hole No. AK-CA-1 Carroll County, Arkansas
SW SW sec. 30, T. 21N., R. 25W.
Elevation: 1,440' - Total depth: 2,093'
M.G.S. No. 25823
Core through subject interval
Core description on file at the Missouri Geological Survey

St. Joe Minerals Corporation - Core #64W58
Hole No. TA-1 Taney County, Missouri
SE SE sec. 15, T. 24N., R. 20W.
Elevation: 750' - Total depth: 1,880'
M.G.S. No. 25827
Core through subject interval
Core description on file at the Missouri Geological Survey

St. Joe Minerals Corporation - Core #63W106
Hole No. DO-1 Douglas County, Missouri
Sec. 24, T. 27N., R. 15W.
Elevation: 1,000' - Total depth: 1,901'
M.G.S. No. 25822
Drill cuttings to 710 feet - Core below 710 feet into Precambrian
Core description on file at the Missouri Geological Survey

St. Joe Minerals Corporation - Core #64W133
Hole No. WR-1 Wright County, Missouri
SE SE sec. 16, T. 29N., R. 13W.
Elevation: 1,190' - Total depth: 1,766'
M.G.S. No. 25828
Drill cuttings to 800 feet - Core beyond into lowest Bonneterre
Core description on file at the Missouri Geological Survey

St. Joe Minerals Corporation - Core #63W121
Hole No. TE-1 Texas County, Missouri
NE SE sec. 25, T. 32N., R. 10W.
Elevation: 961' - Total depth: 1,584'
M.G.S. No. 25824
Drill cuttings to 816 feet - Core below 816 feet into Precambrian
Core description on file at the Missouri Geological Survey

St. Joe Minerals Corporation - Core #61W48
Hole No. LS-1 Phelps County, Missouri
Sec. 36, T. 36N., R. 7W.
Elevation: 1,140' - Total depth: 2,601'
M.G.S. No. 26041
Drill cuttings to 800 feet - Core below into Precambrian
Core description on file at the Missouri Geological Survey

Eagle-Pitcher Industries, Inc. - Core #P-1
King Brand Ranch
Cherokee County, Kansas
SW, NW, NE, SW, sec. 11, T. 35S., R. 23E.
Insoluble-Residue-Log Summary Only
Modified after McKnight and Fischer (1970) by Kurtz et al., (1974)

LaSalle Oil Company, No. 1 Gobl
Crawford County, Kansas
SE cor., NW$\frac{1}{4}$, sec. 20, T. 28S., R. 25E.
Insoluble-Residue-Log Summary Only
Modified after Keroher and Kirby (1948) by Kurtz et al., (1974)