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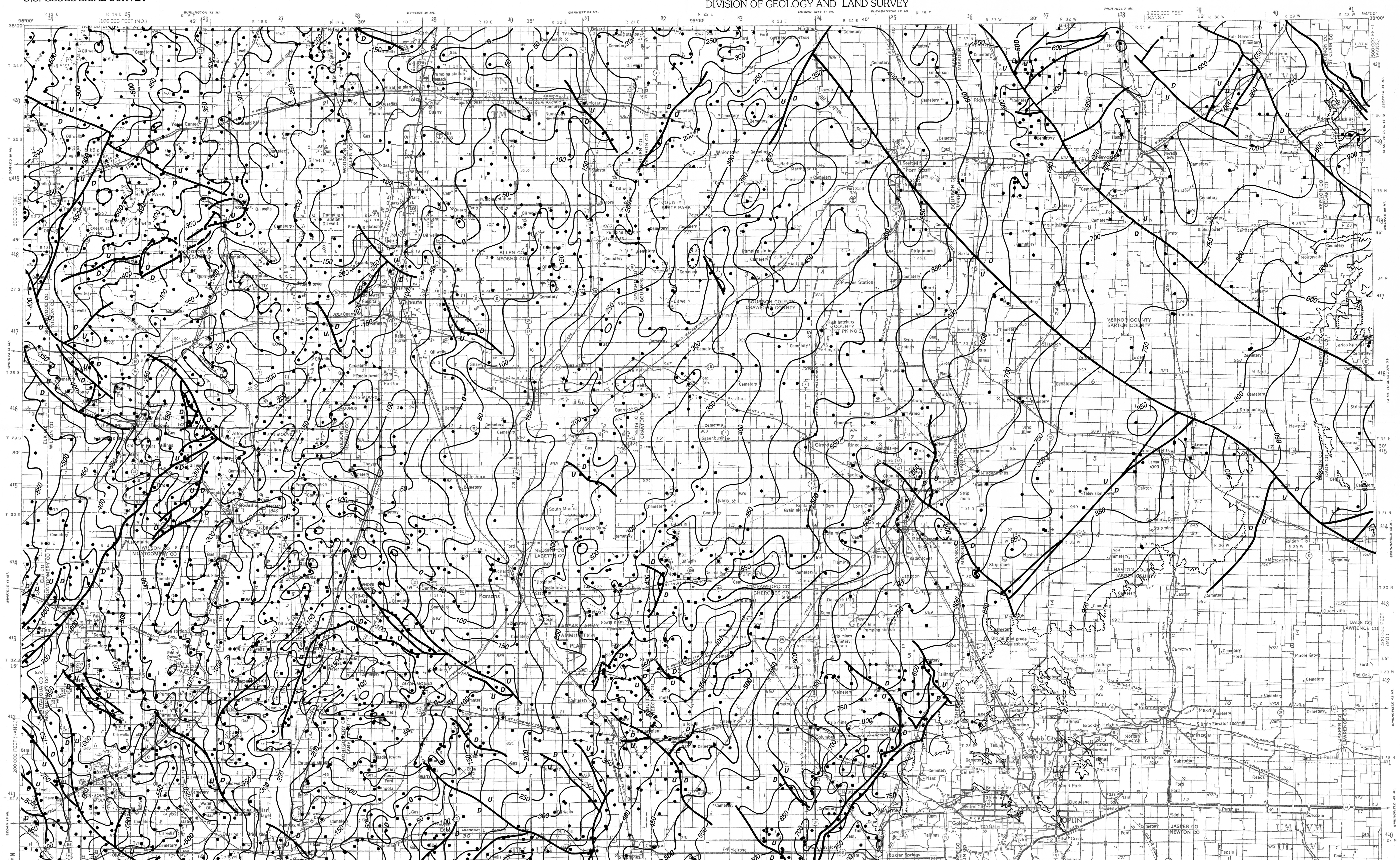
U.S. GEOLOGICAL SURVEY

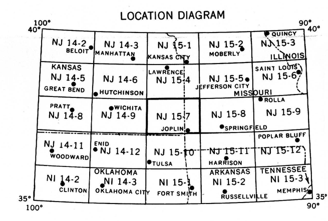
PREPARED IN COOPERATION WITH THE
KANSAS GEOLOGICAL SURVEY AND THE MISSOURI DEPARTMENT OF NATURAL RESOURCES,
DIVISION OF GEOLOGY AND LAND SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-2125-C
FOLIO OF THE JOPLIN 1° X 2° QUADRANGLE, KANSAS AND MISSOURI



Base from U.S. Geological Survey, Joplin, 1973

Scale 1:250,000



LOCATION DIAGRAM

EXPLANATION

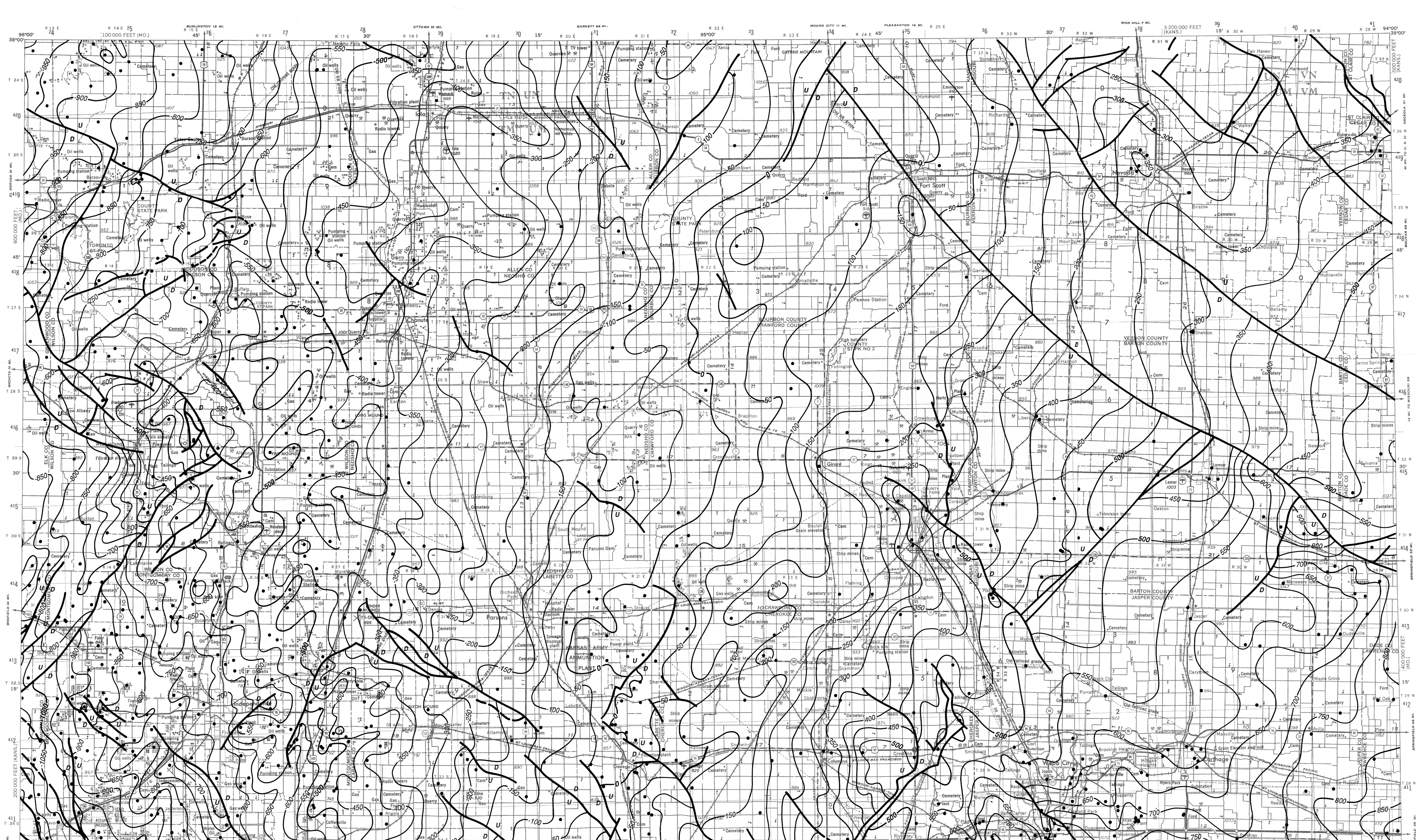
Contact—Erosional edge of Mississippian carbonates

Structure contour—Drawn on top of Mississippian carbonates. Contour interval 50 ft. Datum is mean sea level

Subsurface fault—Interpreted from drill-hole data. U, upthrown side; D, downthrown side. Dashed where approximately located

Drill hole

MAP A. TOP OF MISSISSIPPIAN CARBONATES



Base from U.S. Geological Survey, Joplin, 1973

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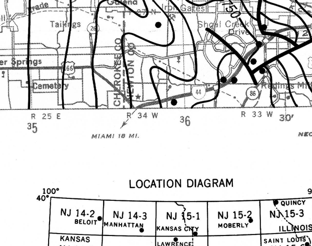

LOCATION DIAGRAM

EXPLANATION

Structure contour—Drawn on top of Arbuckle Group. Contour interval 50 ft. Datum is mean sea level

Subsurface fault—Interpreted from drill-hole data. U, upthrown side; D, downthrown side. Dashed where approximately located

Drill hole

MAP B. TOP OF ARBUCKLE GROUP

FOLIO NOTE

This publication is a part of the folio of maps of the Joplin 1° X 2° quadrangle, Kansas and Missouri, which was prepared under the Conterminous United States Mineral Assessment Program. Other publications in this folio to date include the U.S. Geological Survey Miscellaneous Field Studies Maps MF-2125-A and B (Erickson and others, 1990; Grisafe and Rueff, 1992). Additional maps showing other geologic aspects of the Joplin quadrangle will be published as U.S. Geological Survey maps bearing this same serial number with different letter suffixes (MF-2125-D, -E, and so forth).

INTRODUCTION

These two structure-contour maps are the products of a joint geological, geochemical, and geophysical investigation to assess the mineral-resource potential of the Joplin 1° X 2° quadrangle, conducted by the U.S. Geological Survey, the Kansas Geological Survey, and the Missouri Department of Natural Resources. The maps were drawn to show the tops of the Mississippian carbonate rocks and rocks of the carbonate-dominated Upper Cambrian and Lower Ordovician Arbuckle Group.

The Mississippian and Arbuckle horizons were chosen as datum planes because they were extensively drilled for oil and gas throughout the study area. The Arbuckle horizon is continuous across the region in the subsurface; the Mississippian carbonate rocks are exposed in the southeastern part of the quadrangle and extend in the subsurface throughout the rest of the quadrangle. In the Mississippian outcrop area a number of formations in the Osagean, Meramecian, and possibly Chesterian Series have been mapped. They are discussed in publications by Merriam (1963), Zeller (1968), and Thompson (1986). A prominent post-Mississippian unconformity cuts across the westerly dipping Mississippian formations, thus affecting progressively younger rocks. The picture is further complicated by pre-Pennsylvanian tectonic processes that affected the distribution of the Mississippian formations at the pre-Pennsylvanian erosional surface. Nevertheless, this erosional surface serves as an excellent datum plane on which to study the effects of post-Mississippian tectonic processes, for several reasons. Practically all of the Mississippian rocks are composed of dolomite and limestone, and as such are easily recognized by anyone involved in exploration drilling. The sources of most of the information used to construct the maps are well-completion cards and driller's logs indicating the top of the Mississippian rocks. Individual formations in the Mississippian and in the Arbuckle Group have not been mapped because electric logs that could be used to identify formations are few.

Oil and gas are also found in the overlying Pennsylvanian sedimentary rocks, most notably in channel sands of the Cherokee Group (Middle Pennsylvanian). Those units, however, are too discontinuous to serve as good datum planes. Younger Pennsylvanian sedimentary formations, although laterally continuous, are progressively more deeply eroded from west to east across the quadrangle. The tops of these formations are less frequently recorded in the drill records as well, limiting their use as datum planes. The Simpson Group (Middle Ordovician) and Viola Limestone (Upper Ordovician) are absent in most of the quadrangle, but where present, they sequentially overlie the Arbuckle Group.

Strata in the quadrangle generally dip to the west. For example, the top of the Arbuckle Group ranges from about 1,000 feet above sea level in the southeastern part of the quadrangle to about 1,100 feet below sea level in the southwest. Post-Pennsylvanian uplift of the Ozark dome resulted in the erosion of the Mississippian carbonate rocks and younger sedimentary rocks in the southeastern part of the quadrangle.

The thickness of the Mississippian carbonate rocks varies across the quadrangle, but averages about 300 feet. The Arbuckle Group is 1,300 feet thick in the southeastern part of the quadrangle, but pinches out over buried Precambrian monadnocks.

Structures within the Joplin quadrangle record the compound movements of tectonic events that have occurred since the Precambrian. Four periods of deformation can be documented. Later movements tended to concentrate along older zones of weakness.

METHODOLOGY

The structures shown on these maps were interpreted using data from oil wells. To achieve optimum control, our goal was to use at least one well per square mile; however, this was not everywhere possible because the wells are so unevenly distributed (see maps A and B). Whereas the quadrangle covers about 7,650 square miles, the Mississippian-carbonate map was based on data from approximately 3,250 wells, and the Arbuckle map was based on data from only about 600 wells. In areas of concentrated drilling, such as oil fields, the data were examined for consistency and only the wells with the deepest penetrations were used.

This data set allows us to map and define regional structures. Structures that may be very important in the localization of metal accumulations, hydrocarbons, or other commodities are of necessity generalized and probably more complex than this study could address.

The maps were constructed using readily available sources of data, which include the following: (1) **Drillers' logs** are written descriptions of the type of rock encountered in the drill hole. Although the quality and accuracy of the descriptions vary widely, these were an important source of information. Many of the drill holes used in this compilation predate modern logging and reporting systems. (2) **Completion cards** record most oil- and mineral-exploration boreholes drilled in Kansas. The cards carry information on the location of the drill holes and usually list the tops of the formations that are encountered. (3) **Electric logs** were used to determine formation tops not recorded on completion cards and to verify questionable formation picks. (4) **Insoluble-residue logs** prepared from drill hole cuttings are available for a number of wells in the Missouri part of the quadrangle. They have been used to determine the tops of the Mississippian carbonates and the rocks of the Arbuckle Group.

Elevation data for the tops of the formations were entered into a database containing the location and elevation of the drill hole. Maps showing well locations and elevations with respect to sea level were plotted using the information in the database. Computerized contouring was not used because of the structural complexity of the area. Manual contouring allowed consistent interpretation of structures identified at various depths.

ACKNOWLEDGMENTS

Although all of the data used in the construction of the maps were collected by the principal authors, we benefitted greatly from the comments and suggestions of the many persons involved in the CUSMAP project. The authors would like to thank the entire team for their contributions.

MAJOR FAULT AND FOLD TRENDS IN THE JOPLIN QUADRANGLE

The structure-contour maps provide a better understanding of the structural history affecting the Paleozoic rocks and the Precambrian basement and integrate this information with that obtained in other investigations of the CUSMAP program.

The maps reveal that the Paleozoic rocks were deformed by folding and faulting concentrated in zones, many of which are continuous across the study area. The maps document faults and folds of regional significance that can be integrated into a statewide tectonic map. Minor folds resulting from differential compaction over irregularities on the basement surface are believed to be concentrated in, but not necessarily limited to, the southern tier of counties in the quadrangle, where the majority of Precambrian monadnocks are located. The distribution of data points did not allow us to map smaller localized structures throughout the area. Nevertheless, folds formed by plains-type folding (Gardner, 1917; Merriam, 1963; Parker, 1989) may play a very important role in the localization of hydrocarbons and metallic-ore deposits. This type of folding not only formed localized anticlinal and domal structures, but also may have caused significant porosity differences over short distances and influenced the localization of breccia pipes and fracture-controlled chert bodies so important in the Tri-State mining area (Brockie, 1968; McKnight and Fischer, 1970, p. 72-89). Glick (1990) and Gay (1989) describe several such folds in Arkansas, Missouri, and Kansas. The locations of the prominent Precambrian monadnocks have been published by Cole and Watney (1985). An interpretive map (1:250,000 scale) of the surface of the Precambrian basement in the quadrangle (Berendsen and Blair, 1992) may help to assess the influence of basement structures on overlying Paleozoic sedimentary rocks.

The role of faulting in the deformation of the Precambrian basement and the overlying sedimentary rocks in the midcontinent is controversial and not well understood. However, detailed structural studies of individual oil fields indicate that faulting was a primary trapping mechanism (Thomas, 1927; Hiestand, 1933; Bunte and Fortier, 1941; Smith and Anders, 1951). Subsurface structural interpretations in central Kansas (Berendsen and Blair, 1986) indicate that faulting was a major factor in the deformation of the crust in the region.

The Middle Proterozoic tectonic grain of the Joplin quadrangle is dominated by northwest-trending structures (fig. 1), many of which can be correlated with linear magnetic and gravity anomalies recognizable on regional maps (Yarger and others, 1981; Yarger, 1983; Hildenbrand and others, 1982). Some of these structures are traceable beneath 1,480-m.y.-old rhyolites in the St. Francois Mountains of southeastern Missouri and thus they predate the extrusive rocks (Sims and Peterman, 1986). The northwest-trending Bolivar-Mansfield and Chesapeake tectonic zones (Kisvarsanyi, 1984) pass through the northeastern part of the quadrangle and continue into eastern Kansas. These two zones, as well as three other tectonic zones with similar trends in Missouri, are characterized by the presence of folds and faults, cataclasis of basement rocks, and igneous intrusions.

Southwest of the Chesapeake tectonic zone, alignments of individual folds and faults continue northwestward across the quadrangle. These newly defined tectonic zones are named after either previously recognized folds and faults or descriptive geographic place names. Although the Pittsburg and Lawton tectonic zones (after the Pittsburg anticline and Lawton trough of Pierce and Courtier, 1938) are more discontinuous than the Chesapeake tectonic zone, locally they correlate with linear magnetic and gravity anomalies.

The Fall River tectonic zone (Berendsen and Blair, 1986) and the Elk River tectonic zone are present in the southwestern part of the quadrangle. The Fall River tectonic zone can be traced across Kansas; important local structures located along it include the Fredonia anticline in Wilson County and the Bendelari trough in Cherokee County.

The northwest-trending tectonic zones are regularly spaced about 20-30 miles apart. Their exact nature is incompletely known, but Horrall and others (1983) suggest that they may originally have been transform faults. In Missouri, the lateral component of the movement along these zones is always greater than the vertical displacement (Clendenin and others, 1989). Vertical displacement along these faults in Kansas is also apparently small (Berendsen and Blair, 1986).

Northeast-trending structural discontinuities that are more or less parallel to the trend of the approximately 1,200-m.y.-old Midcontinent rift system also cross the quadrangle at regularly spaced intervals. Several discontinuities have been previously described, including the well-known Miami trough and related structures (Brockie and others, 1968; fig. 1). The famous Picher field of the now defunct Mississippi Valley-type Tri-State zinc-lead mining district straddles the intersection of the Miami trough and the northwest-trending Bendelari trough.

The 10-to-15-mile-wide Longton tectonic zone located in the western part of the quadrangle is characterized by the presence of a major, throughgoing, northeast-trending faulted anticline flanked by a number of discontinuous faults and folds. This zone is less pronounced to the north of its intersection with the Fall River tectonic zone in central Wilson County. The Longton ridge (Jewett, 1951) in northeastern Chautauqua and southeastern Elk counties is located just to the west of the Joplin quadrangle boundary. Southeast of the Longton zone, in eastern Montgomery County, a series of northeast-trending folds and faults located near the town of Cherryvale was first described by Moore and Boughton (1921).

The Oswego zone of folding and faulting becomes recognizable midway between the Cherryvale and Miami tectonic zones. This structural feature is of interest because the discovery of a Mississippi Valley-type zinc-lead occurrence in the Mississippian carbonate rocks at its intersection with the northwest-trending Fall River tectonic zone near the town of Oswego initiated a period of active exploration during the mid-1970's.

The Silver City and Rose domes located in Woodson and Wilson Counties are characterized by the intrusion of Cretaceous lamproite along a prominent northeast-trending linear fault. The domes occur within larger (approximately 6 square miles) oval-shaped depressions (Blair and Berendsen, 1988) that are believed to be collapsed calderas.

The structural grain of the Precambrian basement (as indicated by the trends of gravity and magnetic lineaments) is dominated by northeast- and northwest-trending structures. Because this basement complex has been buried by only a thin layer of Phanerozoic sedimentary rocks, the stresses transmitted through the basement during orogenic episodes tend to cause brittle deformation in the overlying rocks along the older zones of weakness (Sykes, 1978). The strong correlation between many geophysical lineaments and structural trends mapped higher in the sedimentary section suggests that this relationship holds true in the Joplin quadrangle.

Wrench deformation along these structural trends, probably in response to the Ouachita orogeny, was prevalent during the late Paleozoic (Berendsen and Blair, 1986; Clendenin and others, 1989). High-angle normal and reverse faults, scissors and propeller faults, and en echelon faults and folds formed during this type of deformation, are examples of structures that can be interpreted across the Joplin quadrangle.

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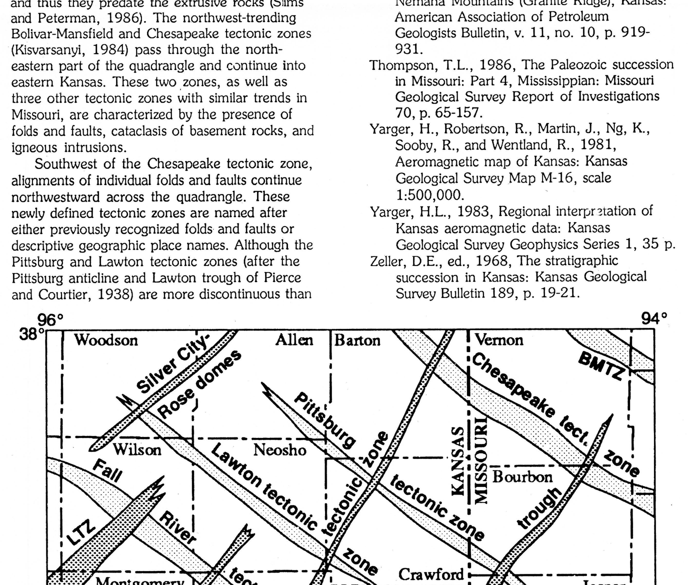

Figure 1. Major structural features in the Joplin 1° X 2° quadrangle. BMTZ, Bolivar-Mansfield Tectonic zone; CFFZ, Cherryvale fold and fault zone; ERTZ, Elk River tectonic zone; LTZ, Longton tectonic zone.

STRUCTURE-CONTOUR MAPS ON THE TOP OF THE MISSISSIPPIAN CARBONATES AND ON THE TOP OF THE UPPER CAMBRIAN AND LOWER ORDOVICIAN ARBUCKLE GROUP, JOPLIN 1° X 2° QUADRANGLE, KANSAS AND MISSOURI

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