DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

TECTONIC EVOLUTION IN CENTRAL AND EASTERN KENTUCKY: A MULTIDISCIPLINARY STUDY OF SURFACE AND SUBSURFACE STRUCTURE

By

Douglas F.B. Black *

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Work done in cooperation with the Kentucky Geological Survey
State Geologists: Wallace W. Hagan 1960 to 1978
Donald C. Haney 1978 to date

* U.S. Geological Survey
National Center, Reston, Virginia

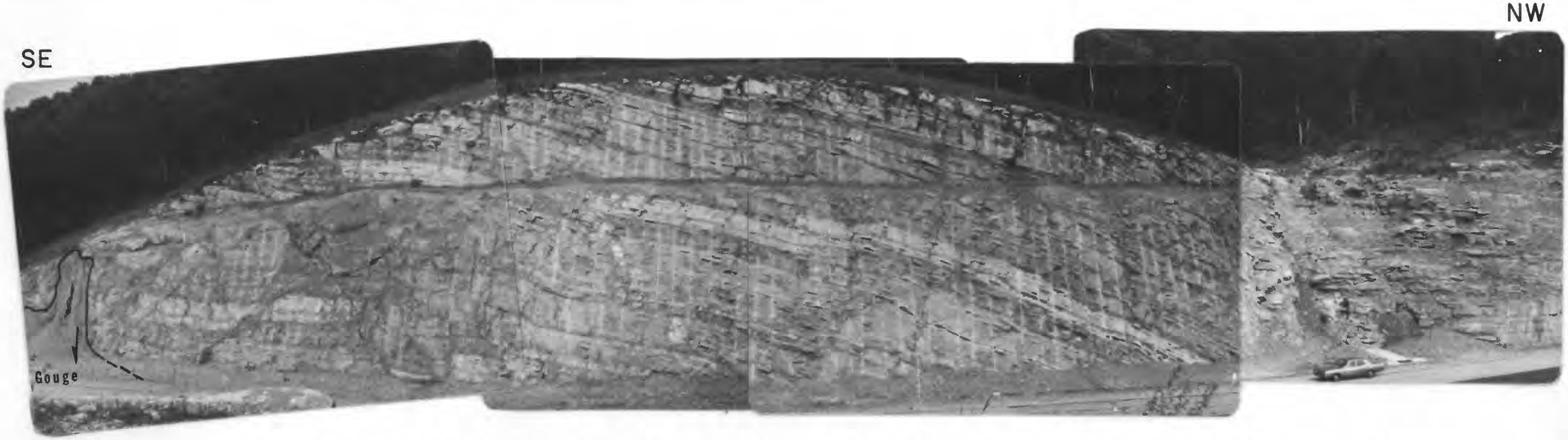
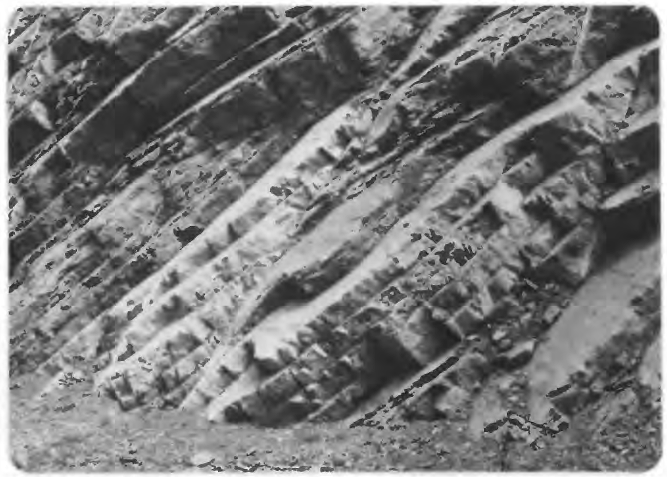


PHOTO MOSAIC OF FAULTING AND FOLDING ON UPTHROWN SIDE OF THE LEXINGTON FAULT SYSTEM AT CAMP NELSON, KENTUCKY

SYNTHETIC SHEAR FRACTURES RELATED TO DEEP-SEATED LEFT-LATERAL STRIKE-SLIP MOVEMENT ALONG MAJOR FAULT OF THE LEXINGTON FAULT SYSTEM



OVERTHRUST CAUSED BY MONOCLINAL FLEXURE

Frontispiece. Ordovician rocks cut by normal, reverse, strike-slip, and overthrust faults on the upthrown side of the Lexington Fault System, Camp Nelson, KY, record a history of varied stress.

B

ABSTRACT

Geological and geophysical mapping of Kentucky between 82 and 86 degrees W. Longitude shows that surface structures in this area conform with a network of reactivated basement faults. Our geologic mapping at 1:24,000 scale has provided elevation control on a variety of Paleozoic strata. Structure-contour maps based chiefly on outcrop data have been compiled at intervals of 20 and 40 feet over a broad area of the southeastern craton. Structural alinements plotted from these detailed maps are found to parallel magnetic and gravity gradients that in turn record ancient faults corroborated by seismic-reflection and deep drilling data. Other products of this research include: 1) Maps showing the measured strike of faults, joints, mineral veins, and sinkhole alinements; 2) stratigraphic data from deep wells; 3) a seismotectonic map of recorded earthquakes; 4) petrographic analyses of basement rock samples; and 5) image maps combining geologic and structural data on side-looking radar mosaics. The history of tectonism in the region over the past billion years is interpreted from these data and structural relations observed during mapping are explained.

Oldest rock in the area is 1.5 Ba granite surrounded by ~900 Ma granulite metamorphic rock of the Grenville Province. In Late Proterozoic time several northeast and northwest-trending faults were intruded by gabbro and basalt that is younger than enclosing basement as shown by greenschist-alteration which retrograded the Grenville wall rock. Regional uplift and erosion followed, which was succeeded by east-northeast and north-northwest faulting and rift subsidence that resulted in a regional network of crossing graben and intervening horsts. Local dilation was coeval with Iapetus spreading to the east, and fault-related felsic volcanism accompanied block subsidence. The rhyolite that partially filled these graben is unaltered, as are overlying sedimentary rocks of Cambrian age. Thickness differences in Paleozoic strata record tilted block faulting and varied rates of subsidence, chiefly in Cambrian time. Seismically reflected fault traces higher in the section exhibit preferred concentration above the basement faults and upward propagation of these is evident from the progressively smaller offsets of younger Paleozoic strata. Relative timing of sedimentation and erosion, faulting, fault-related alteration and mineralization, diapiric intrusion, and cryptoexplosion cratering events, helps to record intermittent tectonic activity involving rocks as young as Late Pennsylvanian in age. The Mesozoic and Cenozoic section is missing throughout the region, except for Tertiary and Holocene alluvium which also is faulted locally.

Variable stress is inferred from: normal, reverse, thrust, strike-slip, and scissor faults; antithetic and synthetic folds; and draped monoclines. Small domes, basins, diatremes and crypto-explosion structures also appear to have formed in response to jostling movements of the basement blocks. This recurrent block faulting has influenced sedimentary processes and, locally, the accumulation of oil and gas. Several discoveries made along the traces of ancient faults and related zones of persistent weakness were predicted in earlier reports, and recognition of criteria found to be useful in the interpretation of such zones should aid in future exploration for energy and mineral resources.

FRONTISPIECE

Ordovician rocks offset by the Lexington Fault System along the Cincinnati Arch record evidence of a varied tectonic history. Here, about 300 feet of normal displacement down to the east has occurred along the brecciated fault shown in Inset A (Black and Haney, 1975). Reversed drag exhibited by the monocline to the west records compressive uplift as well as subsidence along this fault. Vertical stresses related to uplift also are recorded by conjugate shears close to the major fault. Strike-slip offsets of adjacent fault blocks are recorded by horizontal slickensides and corrugation on pairs of vertical shears in Inset B; by facies contrasts in juxtaposed strata; and at depth by lateral offset of magnetic anomalies. Left-lateral displacement is indicated by the synthetic and antithetic joint sets in this Ordovician rock, but the magnitude of post-Ordovician translation was not determined.

As shown to the right of the principal fault in A, horst and graben structures are displayed by offsets of the "white" marker bed in Middle Ordovician Camp Nelson Limestone. These conjugate faults, together with reverse buckling, monoclinal folding, and compressive overthrusting of the upthrown block displayed by this bed higher in the roadcut, imply faulting occurred during local uplift, generated from below and involving well-indurated rock.

Slickensided thrust faults developed on the flank of the monocline are illustrated in C and also are discernible in A, in the cut face west of the principal fault. These overthrusts are attributed to compressive shortening caused by flexure. Intense fracturing is evident in the hinge zone, but bedding was traced continuously across the monocline trough with no apparent offset.

Original orientation of the fractures was determined several hundred meters from the principal fault. Tilted offsets close to the fault were measured from: 1) Rotated dips of the corrugated fracture set shown in B; 2) shallow plunge of the projected axes of intersection of conjugate fault sets caused by vertical uplift in A; and 3) similarly shallow plunge displayed by slickensides on the nearly vertical face of the major fault. These dip at a low-oblique angle toward the observer as viewed in photo A, and were exposed by removing the breccia covering the fault plane.

Wrenching under transpressive stress related to deep-seated translation of basement and overlying rocks is suggested to have caused the vertical fractures illustrated in B. They occur at an acute angle to the principal fault strike, and exhibit horizontal corrugation ("mullion structure" of Heyl, 1972), classic evidence of synthetic shear characteristic of wrench tectonics. Conjugate wedge faulting is corroborated by drill data north of this area where the original scarp of the Kentucky River Fault, bounded by Precambrian, Cambrian, and Ordovician rock, is offset northward. If ancient counterparts of the Brumfield and Kentucky River Fault Systems were once coextensive a total of about 30 km of sinistral offset has occurred along the Lexington System, beginning perhaps during Late Proterozoic volcanism and extending through Cenozoic time. Late extension is implied by Pennsylvanian gravel drilled at 1400 feet in faulted Cambrian rock nearby (Freeman, 1953), and by another crushed cobble of Mississippian chert embedded in Camp Nelson Limestone bounding a fault mapped by D.E. Wolcott (1969).

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PLATE 11: Form-contour map of central Kentucky structure showing wells drilled to the Middle Ordovician Tyrone Limestone (T) and locally to Precambrian basement (Z, Y; tables 2 and 3). Structure contours, at intervals 20 and 40 feet, were traced from geologic quadrangle maps cited in Table 1. They depict structural relief on various lithologic contacts, based chiefly on surface mapping and locally on shallow drilling. The unsmoothed contours reflect close-spaced outcrop data, and abrupt changes in strike reveal a blocky fabric mapped in unique detail over an extensive area.

Plate 12: Form-contour map of eastern Kentucky structure showing wells drilled to the Middle Ordovician Tyrone Limestone (T) and locally to Precambrian basement (Z, Y; tables 2 and 3). Structure contours at intervals of 20 and 40 feet were traced from geologic quadrangle maps cited in Table 1. They depict structural relief on various lithologic contacts, based chiefly on surface mapping and locally on shallow drilling. The unsmoothed contours reflect close-spaced outcrop data, and abrupt changes is strike reveal a blocky fabric mapped in unique detail over an extensive area.

FIGURES

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INTRODUCTION AND ACKNOWLEDGMENTS

Tectonic interpretations in this report are based chiefly on comparisons of geological, geophysical, remote-sensing, and drill data compiled from work done in Kentucky and adjacent states. The regional structure-contour maps were compiled from 7 1/2-minute geologic-quadrangle reports, and are based on contact elevations measured in the field during the United States Geological Survey-Kentucky Geological Survey Cooperative Mapping Program (1960-78). Surface and subsurface structures have been interelated by using these data in conjunction with: 1) Aeromagnetic and gravity maps; 2) seismic-reflection profiles; 3) borehole logs from wells that penetrate Ordovician or older strata; 4) petrographic analyses of Precambrian basement sampled at 42 localities; 5) side-looking airborne radar imagery; 6) joint-related karst alinements plotted from topographic maps or locally from air photos; and 7) measured strike directions of surface faults, joints, and mineralized vein deposits of the Central Kentucky Mineral District.

Statewide geologic mapping was completed at 1:24,000 scale by 203 geologists and about 60 cartographic and support personnel assigned to the program at various times. Field investigations were conducted at an average rate of 1.1 man-years per 7 1/2-minute quadrangle, and 707 reports covering all of Kentucky were published by the U.S. Geological Survey. Structure contours were drawn at intervals of 10 to 40 feet on a variety of stratigraphic horizons (table 1). This study includes parts of 512 quadrangles and 475 geologic-quadrangle reports. Original contours are shown and labled index contours were projected to key beds (plate 4).

Geologic cross sections (plates 6-10) were compiled; 1) from topographic and structural data on the quadrangle maps; 2) from Vibroseis* reflection data purchased by the USGS from Geophysical Service, Inc. (1974; Tegland, 1978); and 3) driller's logs and drill samples supplied by the Kentucky Geological Survey. The migrated seismic-profile data are proprietary and therefore were not included. My interpreted sections are published by agreement with the contractor. Well logs projected to the traverse were scaled to the profiles by R.E. Mattick and F.N. Zihlman (USGS) using borehole velocity data. Formation contacts that separate contrasting rock types were found to conform with the boundaries between letter-designated zones of contrasting seismic signature (fig. 1). The sections cross several major structural features of the midcontinent, some previously known and others defined in this report. From west to east they include: The Lexington Fault System which follows the crest of the Cincinnati Arch; the east flank of the Jessamine Dome and Eastern Kentucky Platform; the Kentucky River, Irvine-Paint Creek, and Rockcastle River Faults which define the Middle Kentucky Terrace and Rome Graben of the Rome Trough; the Perry County Prominence, Floyd County Embayment, Southeastern Kentucky Uplift; the Pine Mountain Fault System and Cumberland Allochthon; and at basement depth below the allochthon the New York-Alabama Lineament, Wise County Prominence, and part of a half-graben to the southeast, the Fishtrap Lake Depression.

*Vibroseis is a trademark of the Continental Oil Company; use of this term is not intended as an endorsement by the USGS.

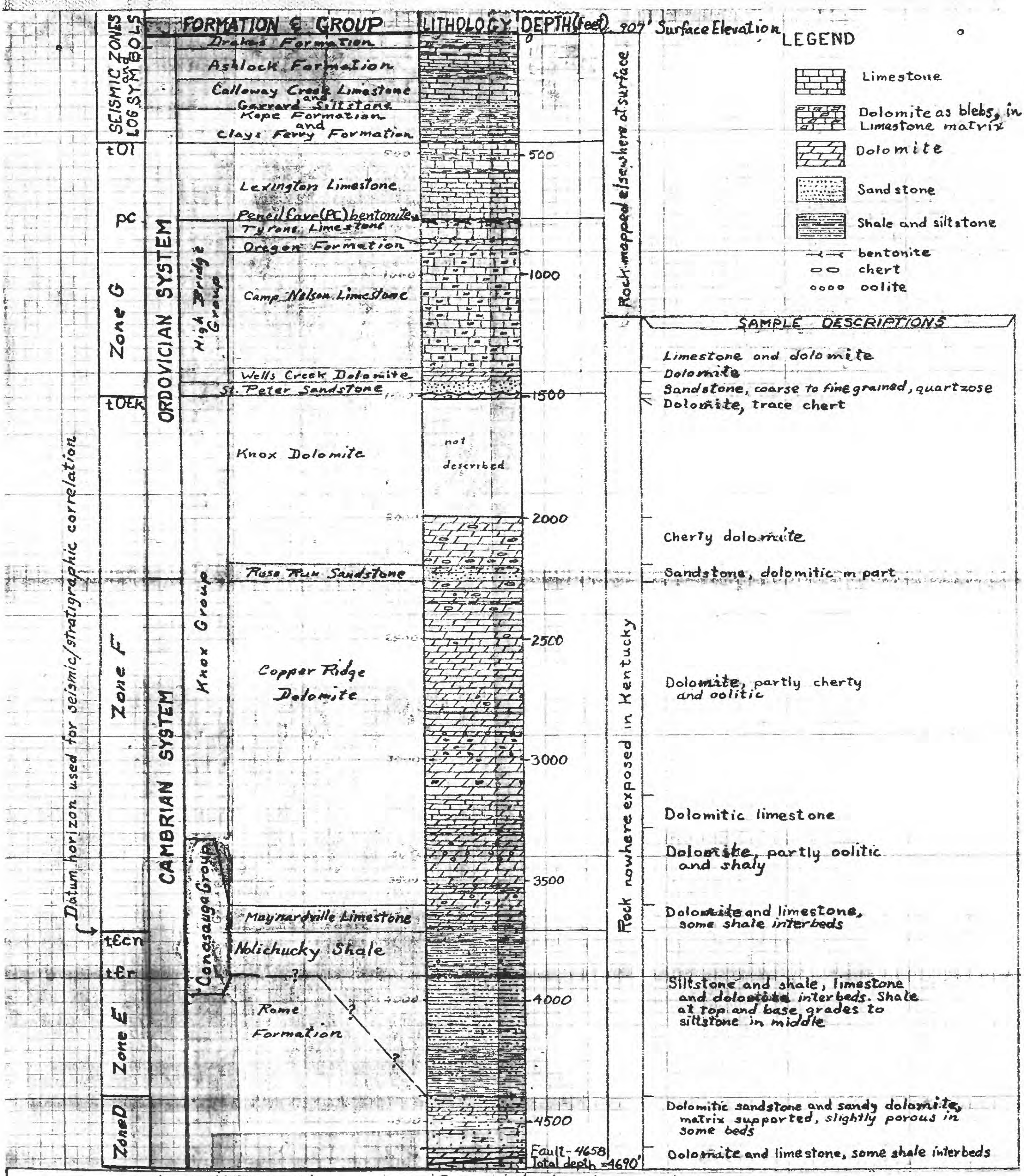


Figure 1. Graphic lithologic log of the Peter Widener Co. No. 1 Russell Glover drill hole showing correlative seismic reflector zones, (Clark County J), central Kentucky.

Offset traces of surface faults and folds on the mosaicked structure-contour maps (plates 1 and 2) were found to parallel geophysical gradients (plate 3) which reflect deep-seated faults involving basement. This paralellism was first recognized from comparisons of tectonic, gravity, and aeromagnetic maps combined in a sixty-quadrangle area in central Kentucky (Black and others, 1976; figs 2 and 4). Our early findings led to tectonic mapping over the expanded area of this study (plates 1, 2, 4) and also encouraged further magnetic and gravity surveys (plate 3, fig.2; Johnson and others, 1978; 1980a; 1980b; Keller and others, 1978; Keller, 1979) supported by the Kentucky Geological Survey and Tennessee Valley Authority, by universities in Kentucky, Ohio, and Texas, and by the United States Geological Survey.

Side-looking airborne radar imagery was flown and compiled as a mosaic of the study area by INTERA Technologies, Inc. (1984) under contract to the U.S. Geological Survey (plates 1 and 2).

Drill cuttings provided by the Kentucky Geological Survey from 42 wells that penetrated Precambrian basement rock were analyzed by E.R. Force, USGS, Reston, Virginia (table 3). Rock types are shown (pls. 3, 11, 12) together with elevations on the Precambrian basement, top of Middle Ordovician Tyrone Limestone, and isopach intervals between these contacts (McGuire and Howell, 1963). Drill logs of 14 deep wells were projected to the seismic traverse. Velocity data from one of the wells were used to scale the logs to the seismic profiles. The combined data indicate that the greatest amount of movement on the large subsurface faults took place prior to Late Cambrian time. These and later offsets are well displayed by zones of stratigraphic reflectors found to correspond quite closely with the formational contacts.

Regional geologic maps shown on colored slides (plates 1 and 2) were compiled by McDowell, Grabowski, and Moore (1981) Sheets 2 and 3. Measurements of joint directions and attitudes used in this study to determine fracture trends in central Kentucky, were taken from graduate-student theses (Stafford, 1962, and Phillips, 1976; fig. 3) and from 7 1/2-minute quadrangles. A map of joint-related sinkholes in part of central Kentucky was also prepared, and rose diagrams constructed from these data were compared with strike directions of Mississippi Valley-type vein deposits (Jolly and Heyl, 1964; Robinson, 1931; Fohs, 1907). They show conjugate faults which I infer developed under north-directed compression prior to Devonian unconformity. Digital plotting of the maps and diagrams was done with equipment provided by the National Mapping Division of the USGS, with helpful program assistance provided by M.A. Domaratz, V.M. Caruso, and Jo Anne Stapleton.

Valuable contributions to this study were made by geologists and geophysicists cited above, by authors of Geologic Quadrangle Reports cited in Table 1, by earlier workers cited elsewhere in the report, and by still other geologists and geophysicists who technically reviewed the manuscript and illustrations. I have drawn freely upon their work and am grateful for their support. Their original data are shown wherever possible, and this work is of lasting value. Where this work is not cited, responsibility for the tectonic interpretations based on these data is mine.

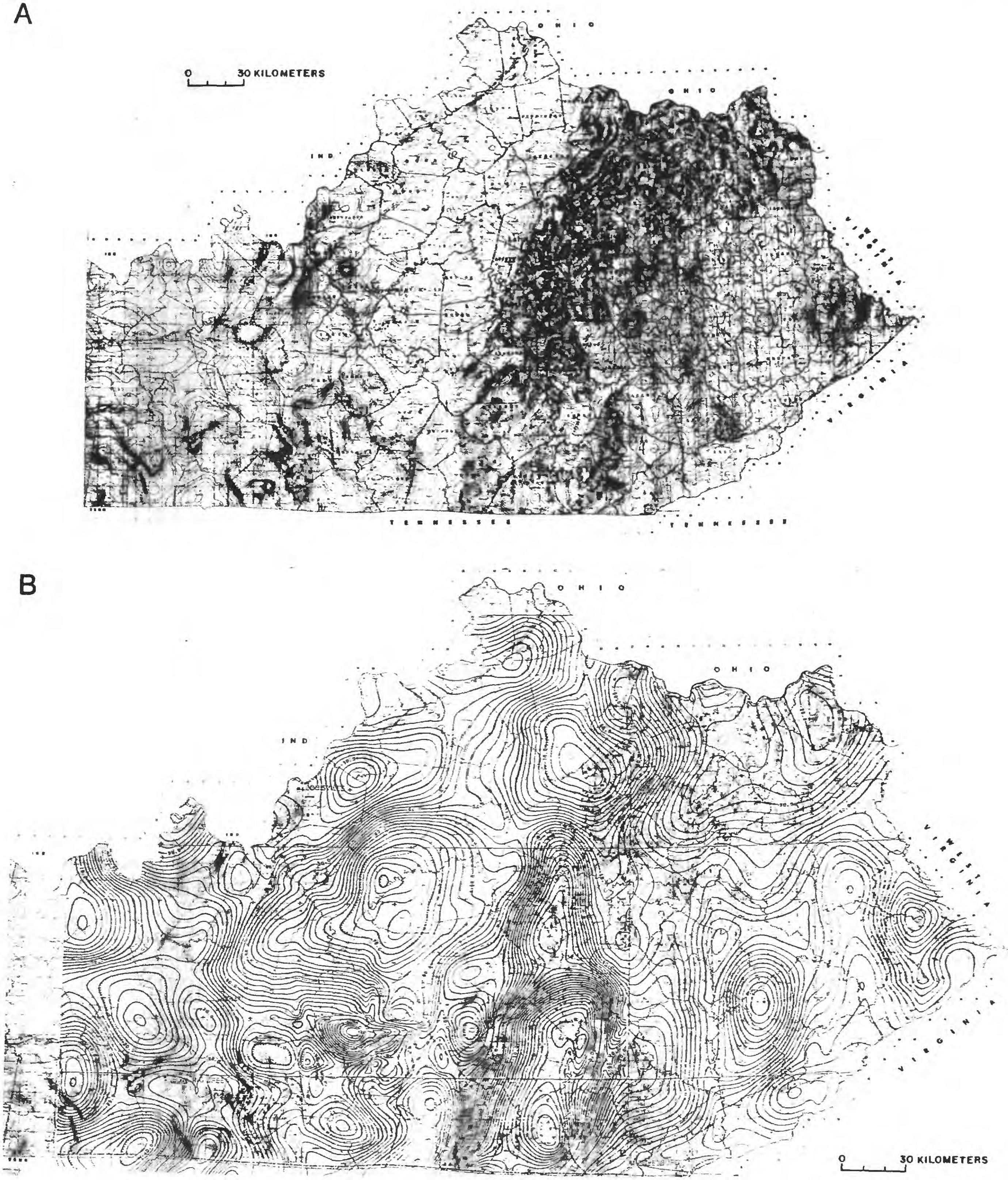


Figure 2. Gravity and magnetic anomalies of central and eastern Kentucky. A) Aeromagnetic data (Johnson and others, 1978; 1980a; 1980b) are shown in overlay with: B) Bouguer gravity data traced from a preliminary map by Keller and others (<u>in</u> Seay, 1979). Contour intervals: 50 gammas (A, B); 2 milligals (B).

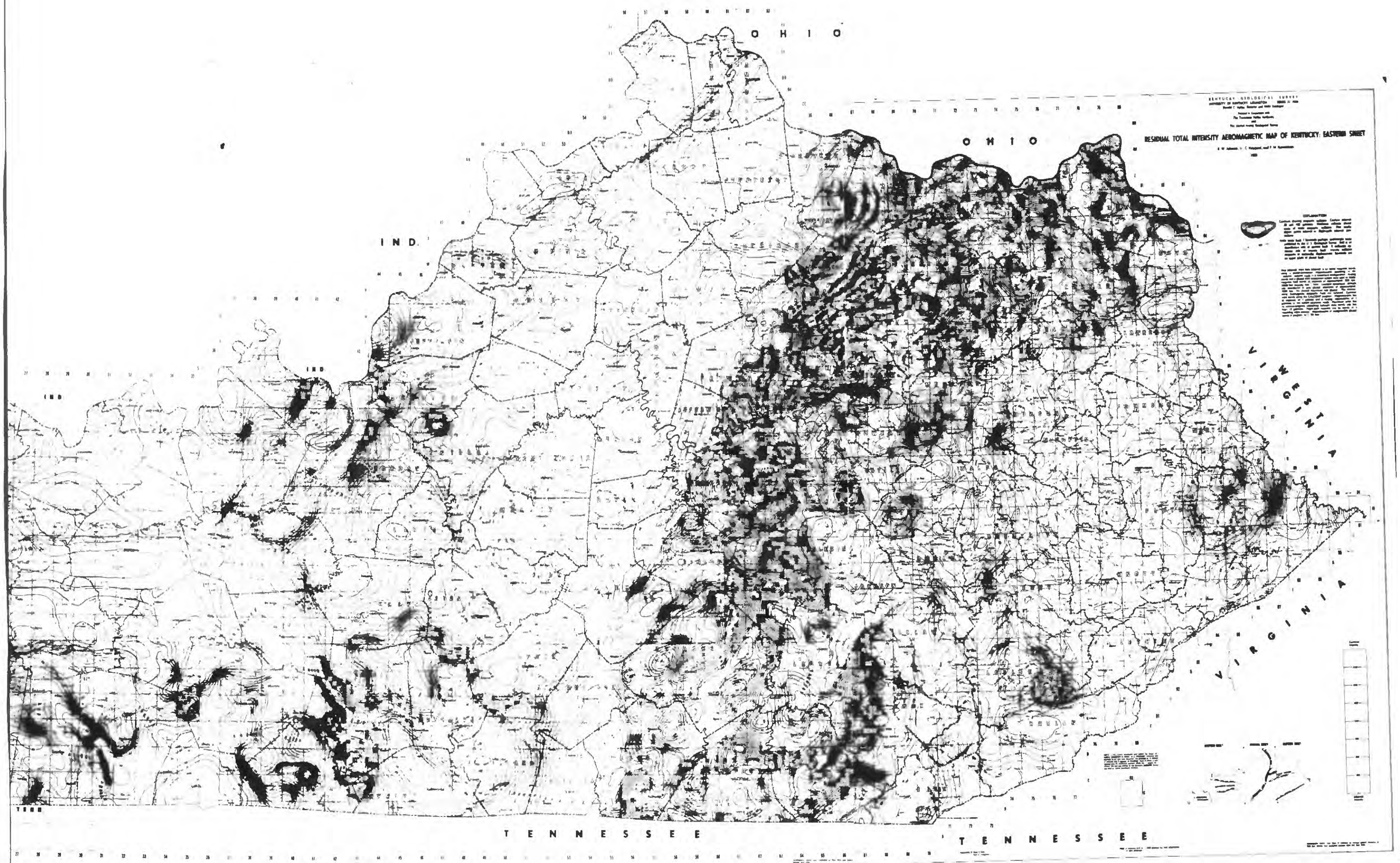


Figure 2A. Magnetic anomaly map of central and eastern Kentucky (Johnson et al, 1978; 1980a; 1980b). Contour interval: 50 gammas

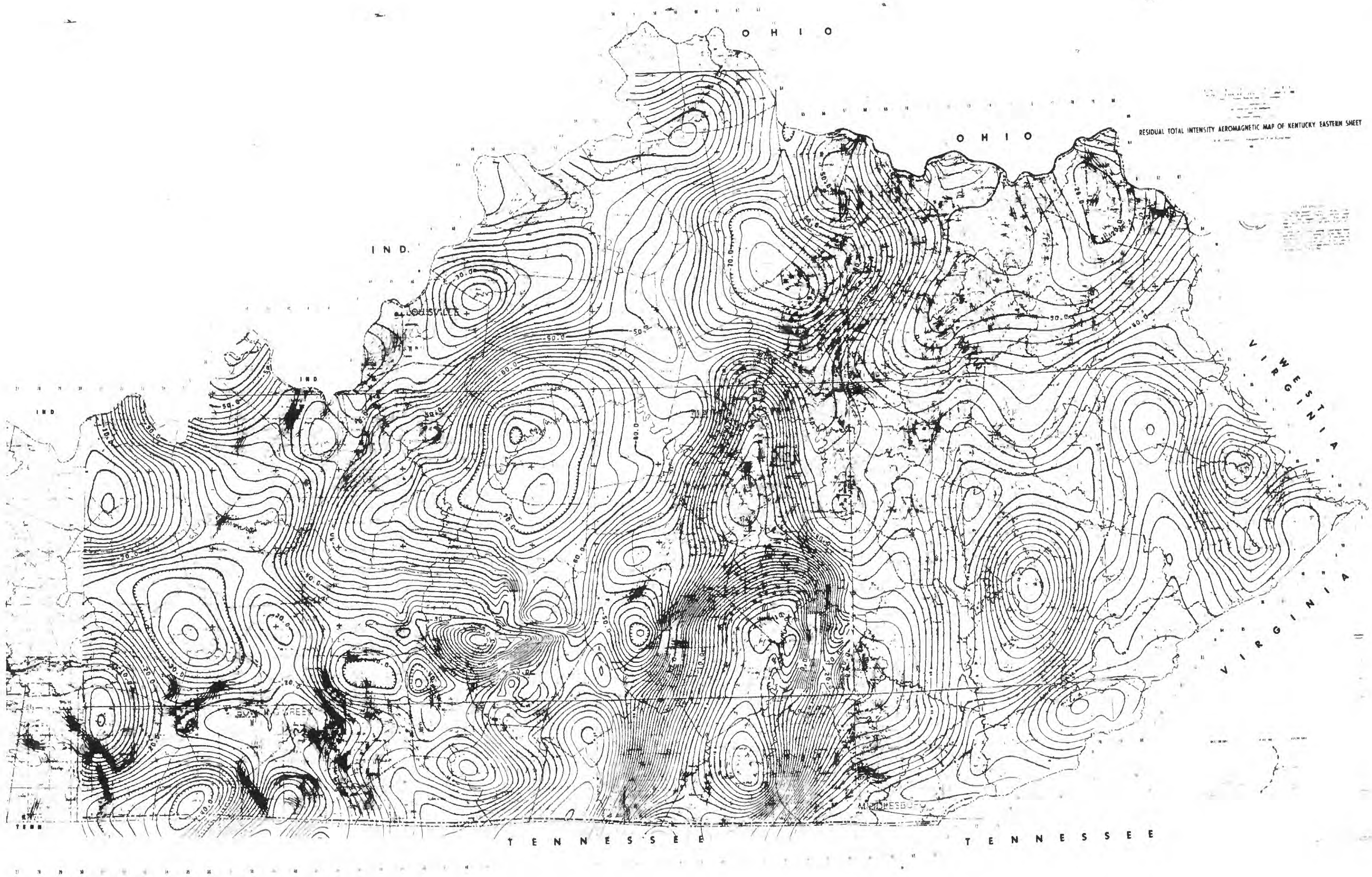


Figure 2B. Bouguer gravity contours (Keller, <u>in</u> Seay, 1979) are overlaid on the magnetic map (2A). Contour interval: 2 milligals

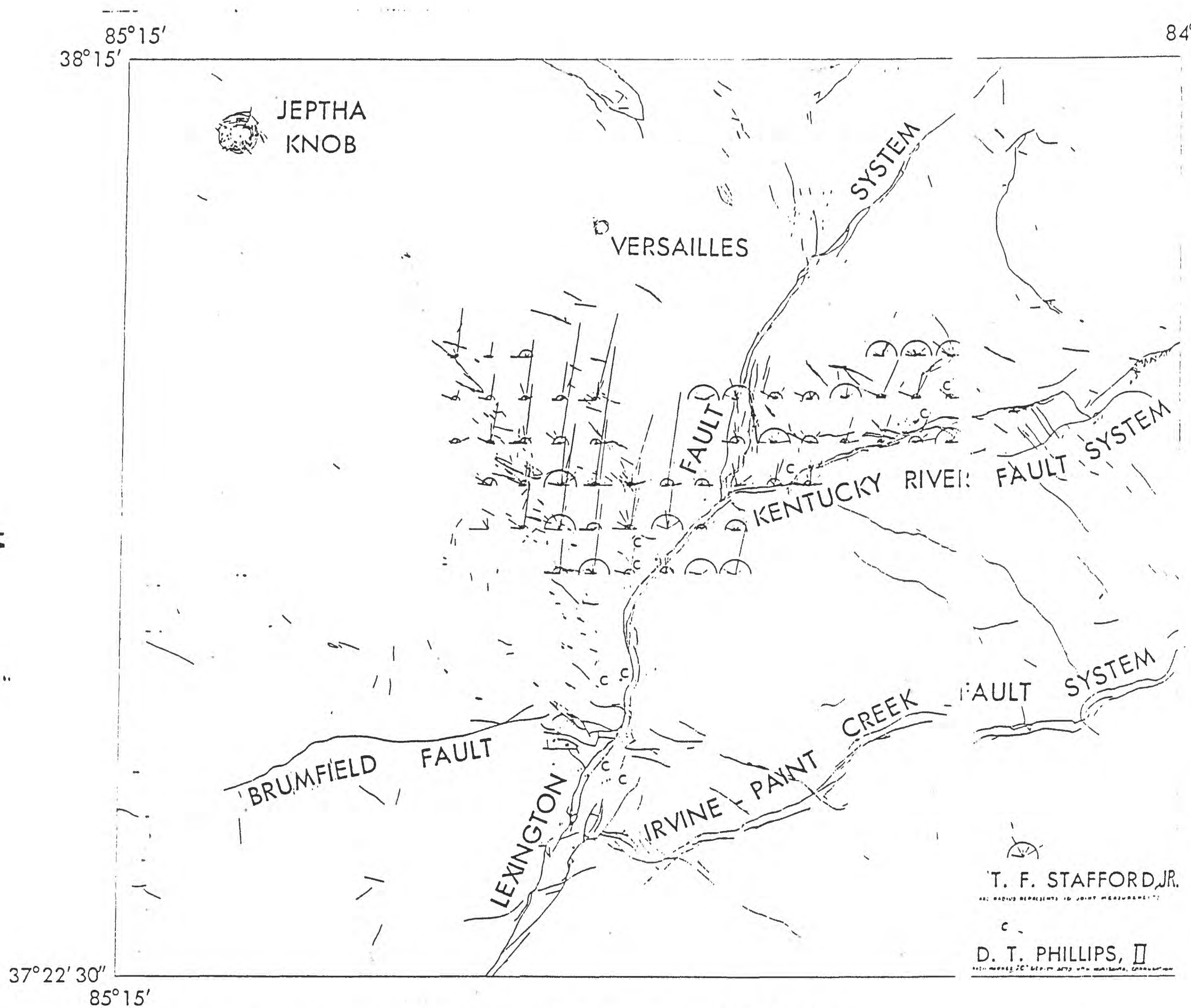


Figure 3. Fracture trends in central Kentucky (plotted from measurements made by Stafford, 1962; Phillips, 1976).

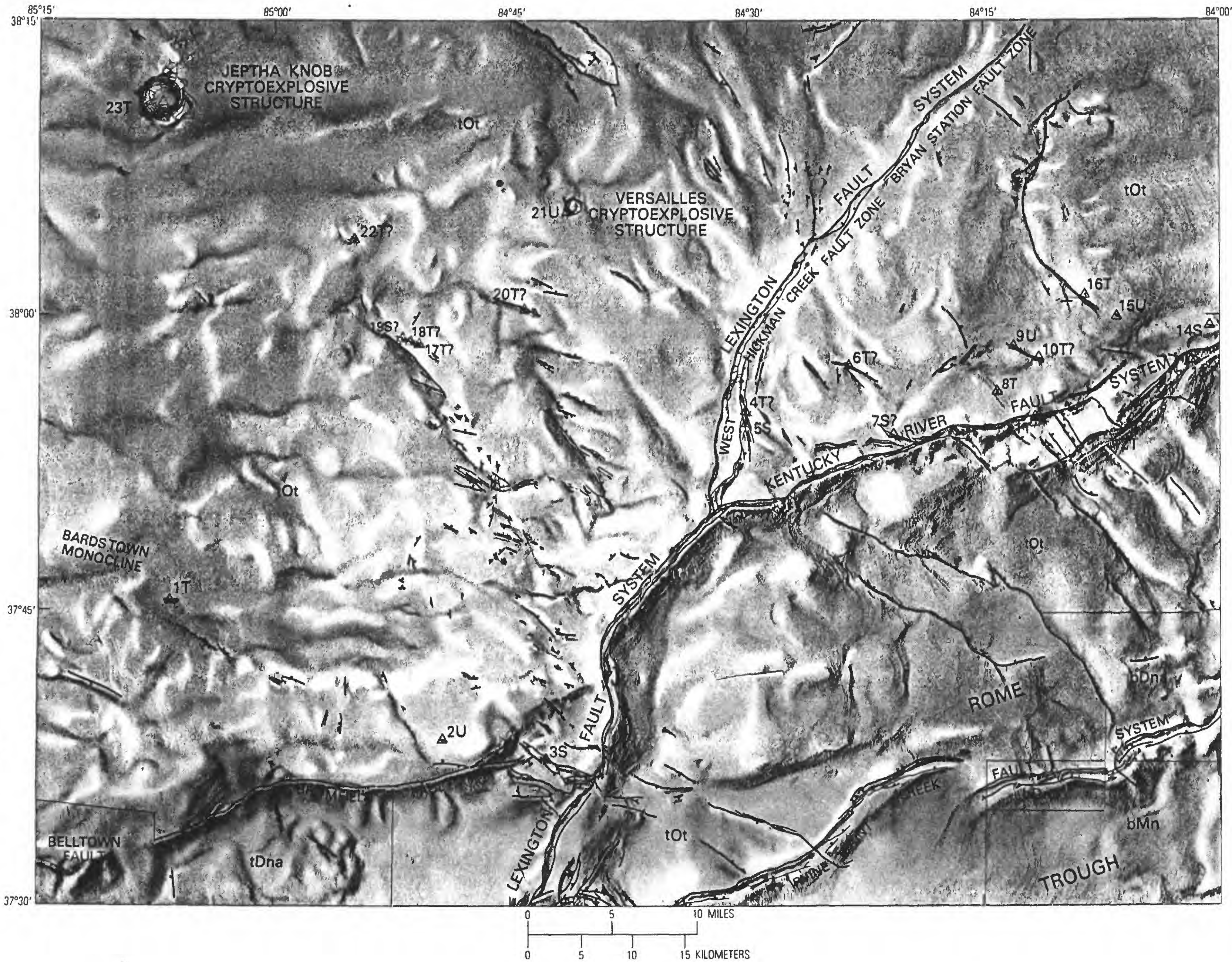


Figure 4. Digitally prepared shaded-relief map of the Central Kentucky Mineral District showing the contoured surface of the Ordovician Tyrone Limestone and fault-related dolomite bodies.

STRUCTURAL MAPPING AND RELATED STUDIES

Surface structures in Paleozoic rocks that are exposed in the study area are interpreted from: geologic quadrangle maps; strike-direction plots of measured joints, mineral veins, and alinements of karst features; side-looking airborne radar (SLAR) image mosaics; field information acquired from my own mapping and from findings reviewed during my tenure as geologic map editor. Structure contouring (plates 1, 2, 4) was based on closely spaced barometric elevation-control points plotted on formation contacts visited by the geologists at a minimum of several hundred to more than 2000 outcrop localities per 7 1/2-minute quadrangle. Field-station density depended mostly on local structural complexity, and contours were drawn on a variety of Paleozoic horizons listed in Table 1. The contours were compiled on the maps as originally drawn except in a 60-quadrangle area in central Kentucky (fig. 4) where they were projected to the top of the Tyrone Limestone from measured surface sections and borehole core logs (not included).

Known faults were more accurately traced in the field, and many others were newly discovered. Vertical displacements were defined by the geologists as shown by the included contour data, but transverse components were more difficult to recognize, even during detailed mapping, because of gentle dips and limited means of measuring horizontal displacements. Locally, however, field evidence of strike slip was recognized from: 1) Vein segments offset by a series of right-lateral en echelon faults of the Becknerville Fault Zone in east-central Kentucky (Black, 1968); 2) oblique or horizontal mullion corrugations along right- and left-lateral faults of the Kentucky River and Lexington Fault Systems (Heyl, 1972; Black and Haney, 1975); 3) slickensides at other localities, where the magnitude and sense of strike slip were not determineable, however: and 4) laterally offset facies, as across the Russell Fork Fault (Cumberland Allochthon; Englund, 1971) where about 4 miles (6.5 km) of dextral slip is indicated.

The mosaic of 7.5-minute quadrangles plotted on the tectonic maps affords regional overview of surface structures. Previously unrecognized components of lateral displacement are here apparent from such features as: 1) conjugate sets of faults and joints; 2) buttressed fold belts that reflect past compressive stress, even where principal displacement has resulted from block subsidence, 3) en echelon fault swarms characteristic of tectonic wrenching; 4) grid-locked patterns of surface faults and blocky geophysical anomalies; 5) thrust faults of southeast and northwest dip, here called forethrusts and backthrusts; and 6) drag folds apparent both from outcrop relations and from the seismic interpretations.

Subsurface structures were determined from drilling data (tables 2 and 3), geophysical maps (plate 3, fig. 2) and seismic sections (plates 6-10) correlated with the surface geology and drilled strata found to correspond with seismic reflector zones at 14 well localities close to the line of seismic traverse. An inherited relationship (plate 5) is indicated between faults and linear folds mapped from outcrop, and faults that extend upward from basement as recorded by magnetic, gravity, and seismic data.

TERMINOLOGY

Nomenclature used for geologic structures that were known prior to the USGS/KGS mapping program has been retained or only slightly modified herein. In addition, many features were newly interpreted from the regional structure-contour maps, analyzed in combination with aeromagnetic, gravity, seismic-reflection, and drilling data assembled for this study. Such features have been described and are informally named in this and companion reports.

Zones of folding and faulting in Paleozoic rocks, recorded both in outcrop and on seismic profiles, have been found to occur preferentially above the traces of ancestral faults that define a regional mosaic of variably offset basement blocks. These linear but commonly irregularly offset zones of inherited weakness are here called lineaments. They are defined by: 1) alinements of surface structures that parallel, 2) linear trends of magnetic and gravity gradients, 3) local drainages that suggest structural control, and 4) contrasts in geomorphic expression and vegetation expressed on air photos, airborne-radar and satellite imagery.

At the surface the lineaments are expressed as alinements of mapped faults and swarms of faults; by folds that parallel faults or occur as "kink" belts that cut across the dominant structural grain; by tightly contoured structural basins or local domes; and fault-related diatremes and circular cryptoexplosion structures.

Basement counterparts of the surficial structures are quite commonly expressed by magnetic gradients or linear troughs that reflect differences in composition and offsets of magnetically susceptible basement rock (Vacquier et al, 1951). These faults parallel inherited surface structures and many are confirmed by drilling, gravity, and seismic data. The irregular lineaments further define: 1) Blocky areas of negative gravity and muted magnetic intensity here referred to as geophysical troughs and embayments (after Weaver and McGuire, 1981) and; 2) positive anomalies called prominences. Tightly spaced contours of the geophysical gradients reflect abrupt changes in the thickness of non-susceptible low-density felsic-volcanic and sedimentary cover rocks which fill the basement graben and thin over the adjoining basement horsts. Where structural or drilling data that suggest basement block faulting are inconclusive, the areas of positive and negative anomaly are called highs and lows. The accordance between alined surface structures and geophysical gradients is shown both on the tectonic maps (plates 1, 2, 4) and the magnetic anomaly map (plate 5). The magnetic data are separately shown on plate 3 together with drilling and seismic-reflection data, and again on figure 2 in overlay with Bouguer-gravity contour data.

Rocks in the study area have undergone repeated periods of crustal extension as well as periods of variably directed lateral compression. Both subsidence and uplift are indicated by surface relations in areas overlying faulted margins of basement blocks; and many of the structures reflect transverse movements caused by horizontal and oblique compression as evidenced by local buckling and grid-locked arrays of crossing and abutting fault patterns. Linear zones of en echelon faults and folds are among newly discovered features ascribed to transpression (modified from Harland, 1971). As reported by Reading (1980), fault swarms of this type suggest convergent strike slip. They are prevalent in this area and are attributed to torsional stress of the surface rock caused by rejuvenated translation along basement faults. A Rhomboidal structure ascribed to divergent strike slip under transtensile stress (ibid.) was also mapped along the Kentucky River Fault System (Black, 1986). Here Silurian (?) crossfaults have offset an earlier fault scarp, known by increased thickness in Cambrian strata drilled south of its irregular trace. Later dextral slip along its strike resulted in transtensile dilation, ancillary scissor faulting, and variable subsidence of crevasse blocks which define the rhomboidal structure. Two additional structures of this type are suspected from joint patterns on the radar images along the Belltown-Brumfield and Irvine-Paint Creek Fault Systems (See plate 1). Thus three east-northeast trending faults crossing the western and eastern flanks of the Cincinnati Arch, respectively, are marked by rhomboidal fracture. Opposing vergence is indicated, right-lateral east of the Arch and left-lateral to the west. These data agree with left- versus right-handed strike slip noted earlier by Clark and Royds (1948) along faults to the west, and by Heyl (1972) along faults to the east. This strike-slip faulting is inferred herein to have accompanied buckling of basement blocks which support the Cincinnati Arch.

Methods of seismic profiling (Geophysical Service, Inc., 1974) are described by Tegland (1978) from a comparable line of traverse in Tennessee. Stratiform seismic events are called stratal reflectors grouped as alphabetized reflector zones of similar seismic character whose boundaries are correlated with drilled contacts between formations of contrasting lithology (plates 6-10). Oblique reflectors which crosscut the stratiform fabric commonly separate offset sequences of stratal reflectors and thus are interpreted as faults. Adjacent curved reflectors are interpreted as relict drag folds which record the sense of past displacements, although not necessarily related to the most recent events. Normal as well as reverse drag folds also occur in outcrop. The term forethrust is used arbitrarily for oblique reflectors that dip south and east, exemplified by sole faults of the Pine Mountain Fault System, and backthrusts are reflectors of opposite northwest dip that commonly are paired with forethrusts where buckled drag folds also corroborate opposing vergence.

BASEMENT FAULTS AND INHERITED STRUCTURES IN CENTRAL KENTUCKY

Except for anomalous graben blocks downthrown as much as 800 feet locally (Black and others, 1980), surface faults and folds in the region encompassed by Plate 1 exhibit no more than about 300 feet (100 m) of strtigraphic throw. Drilling, geophysical mapping, and seismic-reflection data, however, show that these moderate surface structures were inherited from great basement faults (plate 3). Lineaments ascribed to such zones of inherent weakness have been plotted where alinements of surface structures and linear geophysical gradients coincide (plate 5). The drill-correlated seismic data suggest extensional faulting was dominant in Late Proterozoic and Cambrian time. Structural relief of the basement along the line of seismic traverse is about 10,000 feet (3,050 m) drilled beneath 2,500 to 12,500 feet (760 to 3000 m) of Paleozoic sediments. Offsets higher in the stratigraphic section record variably directed compression as well as extension caused by intermittent tectonism active during and after the Paleozoic.

At the west edge of the seismic traverse, the Lexington Fault System (Black and others, 1976; Black, 1986a, 1986b) displays a history of normal, reverse, and strike-slip displacements both along and across its segmented but generally northeasterly trend. Where the system meets crossfaults of more easterly trend, offset segments define the margins of structural blocks which include magnetically susceptible basalt in Precambrian basement. Lateral offsets of the surface rock are small in comparison to basement displacements of as much as 20 miles evidenced by the magnetic data. The gradients mimic the surface faults and extend beyond as the Lexington Lineament (Black et al, 1976; 79). To the west, the Kentucky-Ohio Trough and Lake Cumberland Embayment occur as broad northeast-trending magnetic and gravity lows that conform with the west flanks of the Jessamine Dome and Cumberland Saddle, and in south-central Kentucky the Lexington Lineament follows the western edge of one of several elements of the East Continent Gravity High (ECGH) of Keller and others (1975; plate 5).

Geologic structure in north-central Kentucky (plate 1) is projected to the top of the Middle Ordovician Tyrone Limestone. The map shows locations of selected drill holes that penetrated the Tyrone where it is overlain east and west of the Lexington Lineament by marine strata whose gentle dips reflect the deeper blocky structures. The Tyrone consists chiefly of micrograined limestone which contrasts with the overlying bioclastic Lexington Limestone (the "Trenton Lime" of drillers). The contact is well defined in outcrop and drill cuttings and, though disconformable, is also nearly isochronous as shown by the Pencil Cave volcanic ash beds which occur within and just above the Tyrone (fig. 1). These are recorded as bentonite peaks widely correlated on gamma-ray and neutron logs. The Middle Ordovician High Bridge Group includes the Tyrone, Oregon, and Camp Nelson Formations. These are the oldest rocks exposed in Kentucky. They crop out in the crestal area of the Jessamine Dome of the Cincinnati Arch, and younger Paleozoic rocks ranging to Late Pennsylvanian in age are exposed down dip. This occurs both to the west down the flanks of the Jessamine Dome and Cumberland Saddle where the rocks dip into the Illinois Basin, and to the east where they dip into the

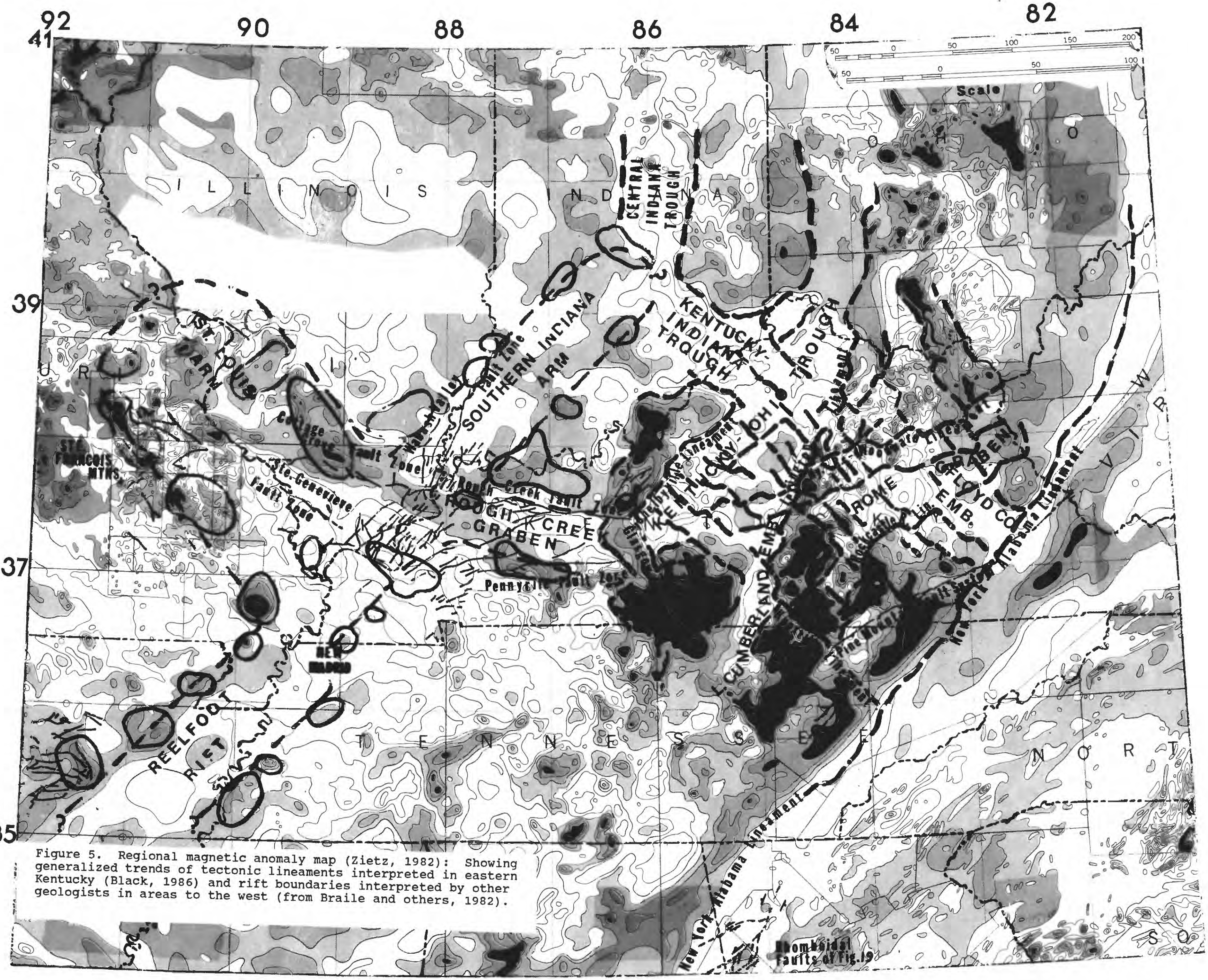


Figure 5. Regional magnetic anomaly map (Zietz, 1982): Showing generalized trends of tectonic lineaments interpreted in eastern Kentucky (Black, 1986) and rift boundaries interpreted by other geologists in areas to the west (from Braile and others, 1982).

Eastern Kentucky Syncline of the Appalachian Basin. Permian fossils occur in a graben west of the study area, and diatremes of this age occur in Elliott County (plate 2). Except for these rocks and alluvium of Tertiary and Holocene age, the remainder of the Permian, Mesozoic, and Cenozoic section is missing because of later uplift and erosion throughout central and eastern Kentucky.

Both the northeast and east-northeast fault systems display fault-parallel folds, including: drape folds that imply extension and subsidence, rejuvenated at some time after deposition of the surface rocks; and crenulated folds which reflect compressional forces directed at a high angle to the fault strike. En echelon folds and faults also indicate wrench displacements generated by transcurrent movements along the reactivated basement faults. The linear folds commonly extend beyond the limits of the surface faults where their traces closely parallel the geophysical fabric and where subsurface faulting is indicated by draping or buckling of the surface rocks. None of the regional lineaments is rectilinear. Instead, these display abrupt strike changes where they intercept crosscutting structures (fig. 5). The resulting block-mosaic of ancient and inherited faults is magnetically expressed and seemingly characteristic of the southeastern cratonic region.

Inherited faulting is indicated by the intimate parallelism of irregular surface structures of the Lexington Fault System and deep faulting expressed by the steep magnetic gradient and narrow trough defined as the Lexington Lineament (Black et al, 1976) now shown to extend beyond the limit of the surface faults into Ohio and Tennessee. This gradient occurs to the west rather than east of the surface faulting which suggests westward throw at basement depth (compare with magnetic and seismic expression of basement offsets along the Kentucky River and Irvine-Paint Creek Faults). In this study I suggest that the Kentucky-Ohio Trough originated as a graben; that the early throw was opposite to that of the present Lexington Fault System; and that the Cincinnati Arch formed much later by upward buckling of the supporting basement blocks. The youngest rocks known to have been involved in the late faulting are of Mississippian age, preserved in a fault-parallel graben just south of the area shown in the frontispiece where uplift and translation as well as subsidence are indicated.

Kinematic relations at other outcrop localities (Black and Haney, 1975) also indicate variable stresses caused by multiple post-Ordovician events. Local studies of mapped faults, measured joints, and karst alinements plotted in relation to Mississippi Valley-type vein deposits in Middle and Late Ordovician limestone of the Central Kentucky Mineral District have provided evidence for north-directed compression at the time of vein emplacement. Principal elements of this work are shown graphically in figures 4, 6, 7, and 8. Most of the veins occur along a generally north-striking joint set which, although varying slightly to east and west, bisects sets of mapped faults and sinkhole alinements of similarly variable but dominantly northwest and northeast strike. Some of the sinkholes are clustered on alluviated terraces which bounded ancestral drainages. Others, however, occur along linear traces which in many cases coincide with mapped faults defined by stratigraphic offsets. Though strike-slip components are rarely

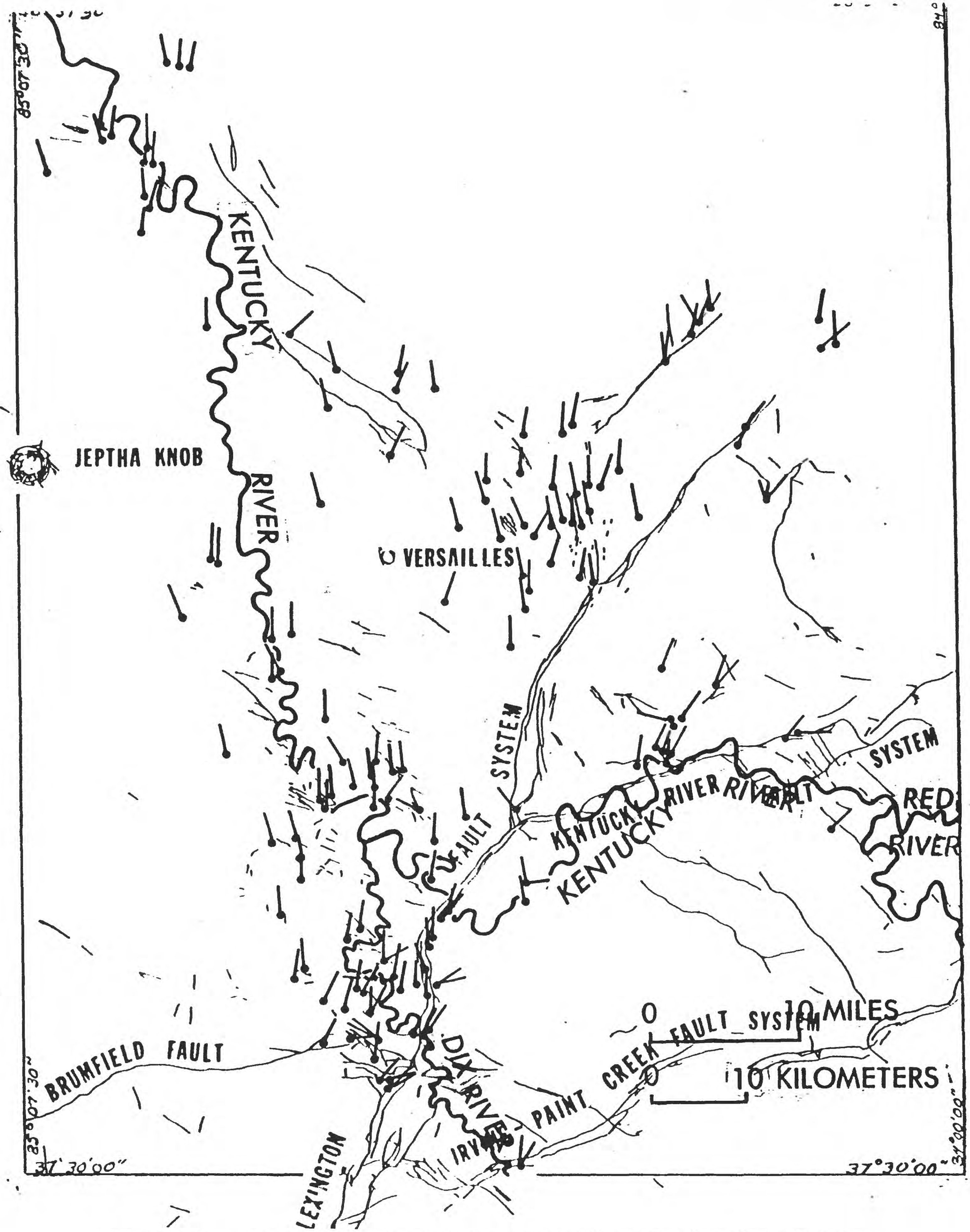


Figure 6. Map of the Central Kentucky Mineral District showing vein localities and strike directions (after Robinson, 1931).

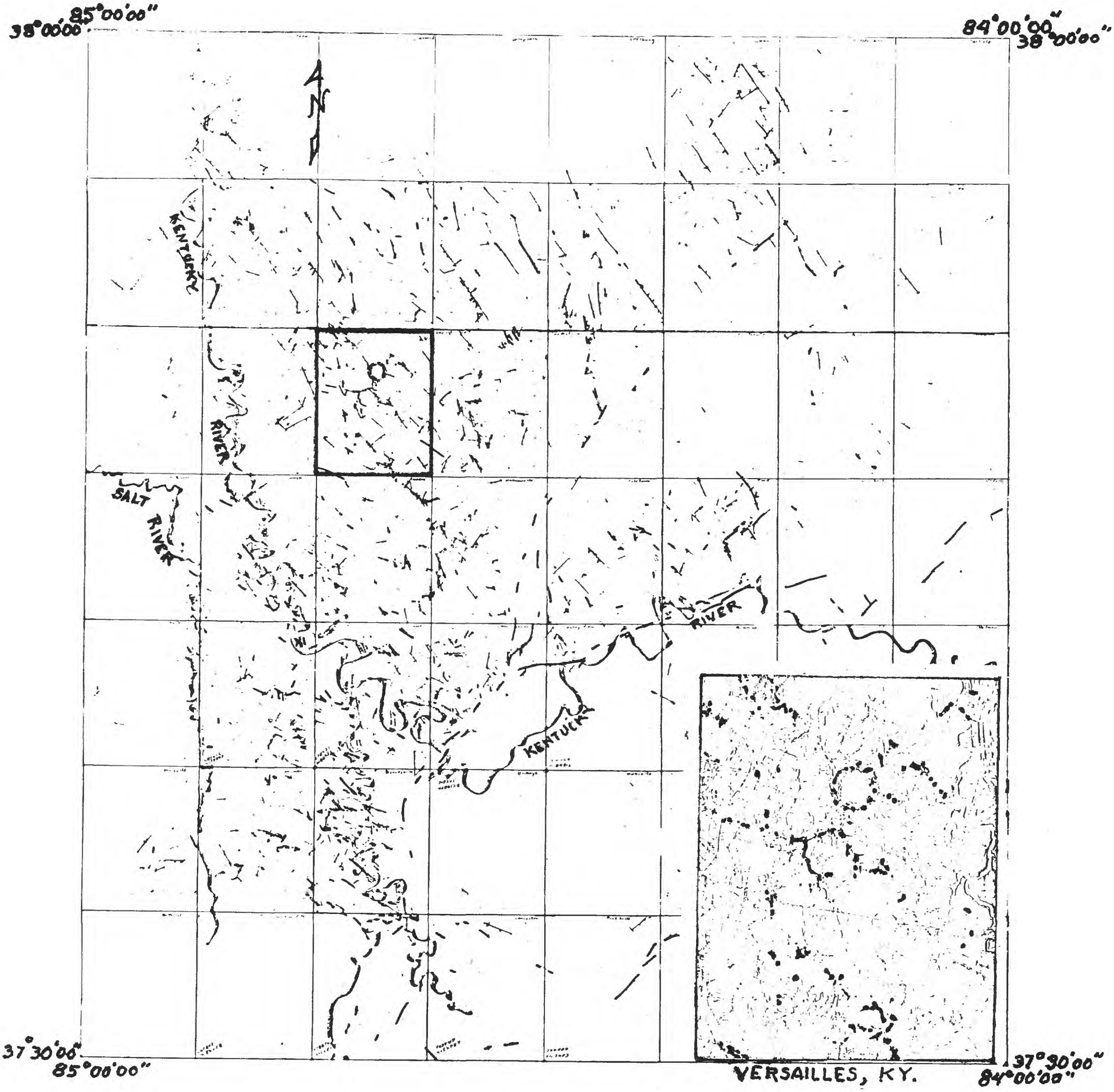


Figure 7. Map showing sinkholes (dots) and corresponding fracture trends in central Kentucky. Depression contours were darkened as shown on the inset map of the Versailles quadrangle. The linear traces depict sinkhole alinements. They coincide with 1) mapped faults and 2) with fracture sets where vertical offsets were not detectable. Their conjugate traces suggest strike-slip faulting.

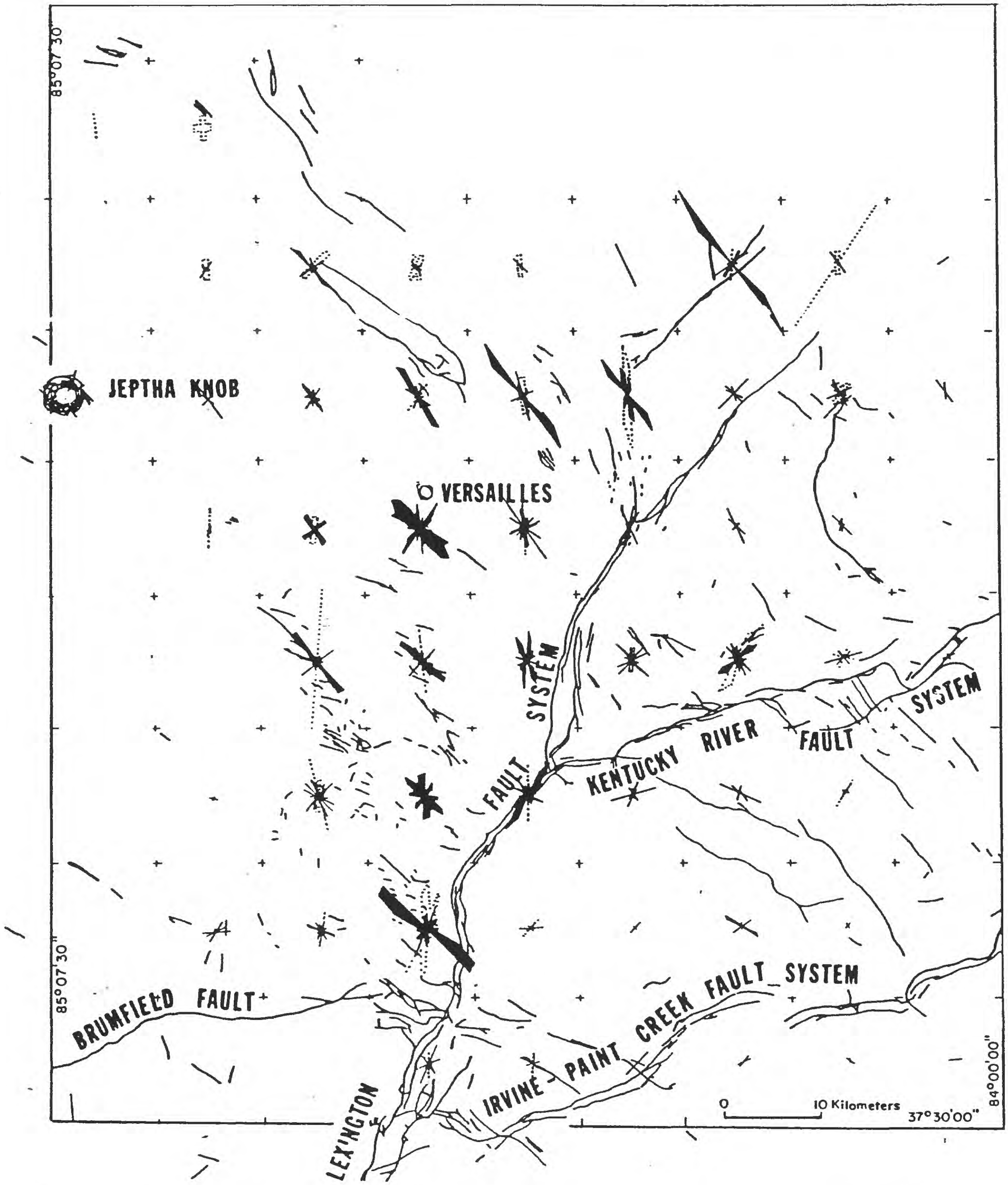


Figure 8. Rose-diagrams centered on 7.5-minute quadrangles in the Central Kentucky Mineral District. Dotted radii depict the northerly strike of mineral veins (fig. 6) many of which bisect conjugate sets of sinkhole alinements (fig. 7). These relations suggest mineralization accompanied north-directed compression.

identifiable, conjugate relations between the karst alinements and the bisecting vein deposits indicate north-directed stress during pre-Devonian mineralization, and west-directed stress at some later (Alleghenian ?) time when the veins were offset, again along reactivated basement faults parallel to and north of the Kentucky River Fault System. Here, drape folds suggest prolonged subsidence along an originally rectilinear fault scarp, but this scarp also was offset by crossing strike-slip faults at some time after the Cambrian as determined from drilled relations. Stress directed across the strike of these faults is recorded by fault-parallel thrusts, buttressed folds, and angular offsets caused by crossing strike-slip faults. Translation along the strike is indicated by offset vein segments, distinct sedimentary facies on opposite sides, geophysical anomaly offsets and en echelon faults developed at an acute angle to the fault trace. The en echelon faults suggest wrench couple under transpressive stress (Harland, 1971) attributed to convergent strike slip along the reactivated faults. Here too, a rhomboidal array of ancillary faults records transtensile stress caused by divergent strike slip where earlier crossfaulting had diverted the trend of the ancient fault. These relations are discussed further in later sections of the report where the seismic sections provide additional information.

BASEMENT PETROLOGY AND INFERRED TECTONIC HISTORY

Basement horsts and graben that developed over large areas of the southeastern craton, as a result of intracratonic rifting in Late Precambrian through Cambrian time, are interpreted herein from the blocky patterns of geophysical lineaments (Henderson and Zietz, 1972; Black and others, 1976, 79; Keller and others, 1982; Braile and others, 1983; Black, 1986a, 86b). In Kentucky, where the geology has been mapped in detail, linear concentrations of Paleozoic (and younger) structures are found to correspond with gradients bounding magnetic and gravity anomalies. The combined data suggest a tessellated mosaic of variably subsident basement blocks offset along a crosshatched network of reactivated faults. Magnetic intensity varies with the susceptibility of the basement rock and with depth of burial beneath nonsusceptible, low-density felsic-volcanic and sedimentary cover rock. Seismic and drilling data (plates 6-10, 11, 12) locally confirm these remotely sensed faults. In Kentucky, Ohio, and Tennessee (figs. 9 and 10) these faults separate polygonal blocks of 1.5 Ga granite and < 0.95 Ga metamorphic rock of the Grenville Province. Undated mafic dikes and felsic flows have been drilled along the ancestral faults in this area, including the Lexington, Kentucky River-Woodward, and Olive Hill Lineaments where gabbro, basalt, rhyolite, and aplite were emplaced after Precambrian Y, Grenvillian time, but before the deposition of Precambrian Z (?) and Cambrian-age sediments.

As inferred from petrographic analyses by E.R. Force (USGS) the history of early events included: 1) Granulite metamorphism of all but the pods of granite; 2) rifting and mafic volcanism; 3) greenschist alteration of the basalt and retrograding of the granulite; 4) cessation of metamorphism, uplift, and regional erosion; and 5) renewed rifting accompanied by felsic volcanism and sedimentary infilling in the developing graben. Continued movement along many of the same faults is described later from seismic records and outcrop data on younger Paleozoic strata.

Basement rock types sampled from the drill cuttings include:

1) 1.5 Ga granite and 917 Ma granulite facies of Proterozoic Y age. In northern Ohio (Bass, 1960; 1970) and southern Kentucky and Tennessee (Bayley and Muehlberger, 1968) the Grenville rocks extend 100 miles west of the Lexington Lineament, wheras in west-central Kentucky the drillholes to basement bottom in rhyolite.

2) Weakly metamorphosed basalt (labelled Proterozoic Z, plate 3) drilled immediately east of the Lexington Lineament along the Somerset Prominence (ECGH of Keller and others, 1975; 1982). The basalt has not been dated but is younger than Grenville as shown by greenschist-facies metamorphism which altered the basalt and retrograded the enclosing Grenville, also to greenschist grade.

3) Undated rhyolite, dacite, and aplite which is unaltered but appears related to the same faults as the basalt. These rocks occur along the Lexington Lineament in the Kentucky-Ohio Trough, both in Ohio and Kentucky; in the Rome Trough at the juncture of the Kentucky River-Woodward and Olive Hill Lineaments; and in the Floyd County Embayment. The unaltered felsites are younger than both the Grenville and weakly metamorphosed basalt, and may be of Late Proterozoic age. They occur above granitic and metamorphic rocks in drill holes labelled by Z/Y symbols on Plates 3, 11, 12.

No.*	Operator	Farm	County	Township	Lot or Section	Elevation (Ft.)	Basement Top (Depth in Ft.)	Total Depth (Ft.)	Basement Lithology
1....	Wiser Oil Co.	F. A. Smith	Medina	Hinckley	Lot 69	1,200	6,580	7,040	Slightly foliated(?) pink gneiss; syenite gneiss; marble
2....	C. W. White	P. and B. Arting	Huron	Peru	Sec. 2	749	Between 3,650–3,800	4,270	Gneiss and schist
3....	Ohio Oil Co.	W. H. Bruns	Sandusky	Woodville	NW. Sec. 9	655	2,677	2,822	Gneiss and schist
4....	J. S. Brailey	S. E. Killian	Wood	Liberty	SW., SE. Sec. 12		2,912	2,927	Slightly foliated gray gneiss
5....	J. E. Fennerty *et al.*	D. L. Norris	Hancock	Marion	Sec. 3, about 3 m. NE. of Findlay	830	Less than 2,760(?)	About 2,980	Gneiss and schist
6....	C. L. Wise *et al.*	H. E. Vance	Delaware	Orange	Lot 11, Sec. 3	920	3,850	4,291	Gneiss and schist
7....	Kewanee Oil Co.	E. A. Hopkins	Fayette	Union	Lot 663	965	3,540	4,708	Basic amphibolite; marble; calc-silicate granulite; pink augen gneiss
8....	Kewanee Oil Co.	Esther Wilson	Fayette	Concord	Lot 1002	1,017	3,340	3,494	Basic amphibolite
9....	Kewanee Oil Co.	L. Barnes	Fayette	Jasper	Lot 5351	1,044	Between 3,370–3,380	3,410	(?) Highly weathered
10....	T. D. Friend	Mattinson	Clark	Madison	Lot 2066	1,087	3,366	4,647.5	Shale or tuff; carbonaceous limestone; aphanitic volcanic(?)
11....	National Assoc. Petroleum	E. Walker	Miami	Lost Creek	NW. Sec. 13	1,030	3,253	3,513	Quartz-poor porphyritic, aphanitic volcanic
12....	Sun Oil Co.	D. M. Nelson	Shelby	Perry	SW. Sec. 24	1,049.7	3,135	3,265	Shale or tuff; hematitic syenite
13....	Gump Oil Co.	J. W. and B. Fogt	Shelby	Salem	NW. Sec. 3	1,037.3	3,287	3,360	Alkaline(?) igneous
14....	Ohio Oil Co.	Virgil Johns	Logan	McArthur	Lot 9930, Bellefontaine	1,190	3,252	3,361	Aphanitic volcanic, minor phenocrysts

—Ohio basement well location map. Line shows approximate boundary between Grenville metamorphic rocks on east and unmetamorphosed, massive volcanic and sedimentary rocks on west.

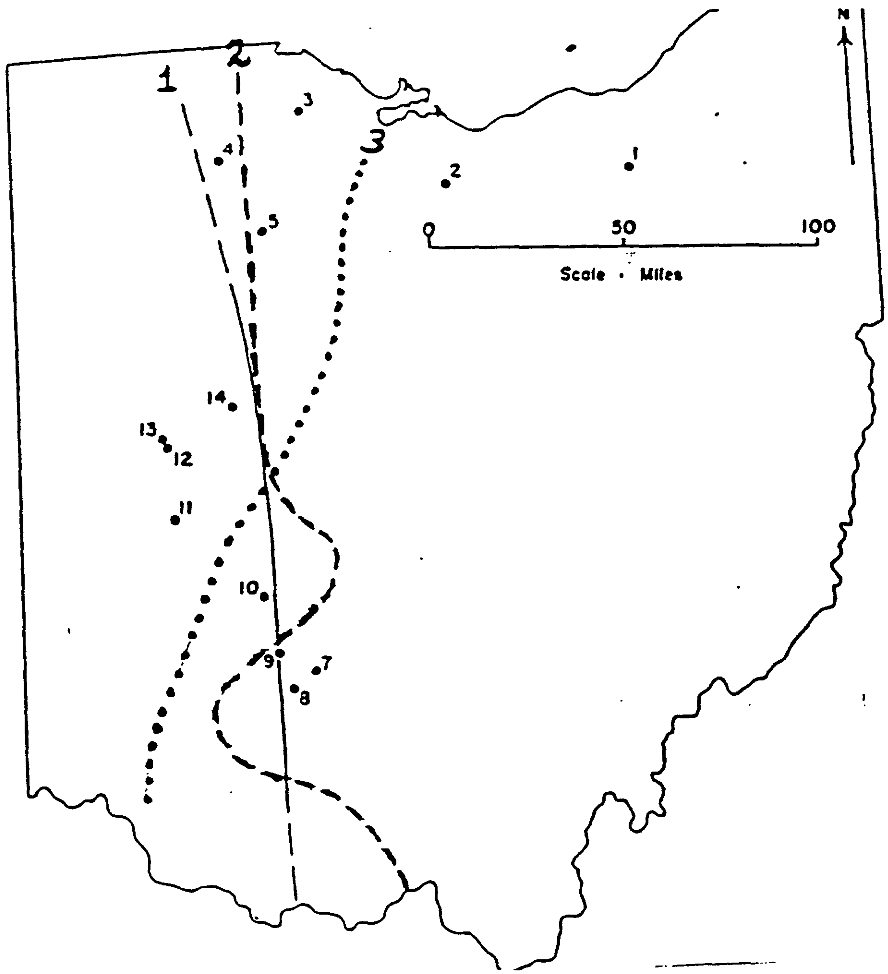


Figure 9. Map of basement wells in Ohio (after Bass, 1960). The Grenville Front as interpreted by: 1) Bass (1960); 2) Hofmann et al (1972); and 3) McCormick (1961) is questioned in this report.

4) Olivene and serpentine from drillholes near Louisville, Ky. (plate 3) are uncorrelated but may imply occurrence of greenstone dikes in basement of that area. In northern outcrops, greenstone dikes are most commonly found in older rock west of the Grenville Front, but they also occur sparingly in the Grenville metamorphic terrane. This may imply older basement occurs just west of the Kentucky-Ohio Trough or perhaps further west as postulated later.

5) Mafic alkalic intrusives, radiometrically dated as Permian (Zartman and others, 1967; Brown, 1977), crop out as kimberlite diatremes at three localities in the area of intersection of the Kentucky River-Woodward and Olive Hill Lineaments. Other buried occurrences also may be reflected by strong positive anomalies, for example along the Hyden Lineament in southeastern Kentucky.

Basement faults of east-northeast, northeast, north, north-northwest, northwest, and nearly east-west trend are interpreted in various parts of the study area. The largest blocks appear to have formed along ancient, nearly orthogonal sets of northeast and northwest-trending faults. These blocks are crosscut by what appear to have been younger generations of east-northeast, east, and north-trending faults which developed where the early faults would not accommodate later, differently oriented stress. Block separation and slight rotation accompanied gabbroic intrusion. This was followed by erosion, graben subsidence and concomitant infilling, first by rhyolite and then by sediments of Cambrian age. Regional fault sets of east-northeast and north-northwest trend in eastern Kentucky, are rotated to nearly east and north strike in western and northern Kentucky and adjacent states. This rotation affected the major basement blocks and occurred, at least partly, during mafic intrusions in Proterozoic time. This is inferred from the southward divergence displayed by inherited faults bounding the Kentucky-Ohio Trough, and from north-pointing wedge anomalies which reflect basalt drilled along borders of the trough. Differential amounts of extension are indicated by these basalt wedges and seismic data suggest erosion prior to the later graben faulting and rhyolite extrusion. Felsic flows and clastic sediment of Cambrian age accumulated in the resulting graben, and normal, reverse, and transverse faulting, involving much younger rock has recurred many times along these same zones of weakness. Many of the faults that define the interlocked mosaic of mobile crustal blocks are still active, as indicated by faulted alluvial deposits; sandstone dikes in adjacent bedrock; Holocene gravel, found entrained along a deeply buried fault drilled in Cambrian limestone but derived from Mississippian fossiliferous chert and conglomeratic sandstone of Pennsylvanian age, and as a broken fragment found embedded in Ordovician wall rock; and by recorded earthquakes centered along many of the lineaments. Centers of Mercalli-scale felt intensity are shown on Plate 3, together with basement rock types identified in drill samples; surface faults; and conformal blocky patterns of magnetic anomalies and linear gradients which, where they have been crossed by the seismic traverse, also correspond with deep-seated faults shown to have been propagated upward on Plates 6 through 10. The combined data suggest rift subsidence along the Kentucky-Ohio Trough, which has caused me to question assumptions that I made in earlier reports.

QUESTIONABLE CORRELATIONS WITH THE GRENVILLE FRONT IN CANADA

The Grenville Front Tectonic Zone (GFTZ, Green et al, 1988) was earlier thought to cross this area by various workers. Black et al (1976, '79) inferred that it was reflected by the Lexington Lineament and that rhyolite drilled west of the lineament in Ohio and Kentucky was older than Grenville (fig. 10). I subsequently discovered, however: 1) That only the Grenvillian rocks had been dated; 2) that the western rhyolite was only inferred to be older than Grenville based on its lithologic similarity to rock west of the front in Canada; 3) that dated metamorphic rock of Grenville age occurs well to the west of the Lexington Lineament, both in northwest Ohio and northern Tennessee; 4) that similar rhyolite occurs above metamorphic rock in several drillholes east of the presumed front (plates 3, 5, 12) and; 5) that untenable amounts of strike-slip displacement along crosscutting basement faults would be required to explain great salients in the presumed front <u>if</u> felsic basement in the Kentucky-Ohio Trough were truly older.

Instead, structural and geophysical data preclude transverse faulting of such great magnitude and the western felsites appear to be coeval with similarly unaltered volcanics to the east where rhyolite and aplite overlie Grenville rock and underlie unaltered sediments drilled in the Rome Trough and Floyd County Embayment. Block subsidence affords a simple explanation for the rhyolitic flows. I infer they occurred as graben fill, concentrated along rifts of Late Proterozoic and Cambrian age, both in this area and along an aulacogen of similar age to the southeast (Rankin, 1976) where felsic volcanism is reported to have accompanied Iapetus spreading along faults of similar strike to those described here.

Bass (1960) first correlated granulite basement in Ohio with the Grenville. He inferred, however, that felsic rock drilled in the area of the Kentucky-Ohio Trough was older, not younger, than metamorphosed rocks to the east. This rhyolite was not dated and his assumption was based only on lithologic similarity with rocks west of the front in Canada. Bass proposed that the metamorphic front crossed Ohio as shown (fig. 9) but alternative traces were inferred by others (fig. 10). Black and others (1976) extended the front southward into Kentucky along the Lexington Lineament and the faulted crest of the Cincinnati Arch. Prior to compiling the regional structure, I had assumed the front must be greatly offset westward following the Grenville Front Extension of Bayley and Muehlberger (1968), where it again veered southward in south-central Kentucky to follow the crest of the Nashville Dome into Tennessee. Completion of the multidisciplinary mapping has now identified problems with the early interpretations, however, and an alternative idea which satisfies known constraints is offered.

Problems include: 1) Continuity of the Somerset Prominence (ECGH) which is offset by several crossfaults, but not in amounts needed to explain great salients in the front; 2) granulite rock as old as 950 Ma (Grenville age) 100 miles west of the Lexington Lineament in northwestern Ohio, southern Kentucky, and northern Tennessee (Bass, 1960, McCormick, 1961, Hofmann and others, 1972, Bayley and Muehlberger, 1968); 3) questionable correlations made between unaltered rhyolite of unknown age (Bass, 1960) in the Kentucky-Ohio Trough based only on lithic similarities with older

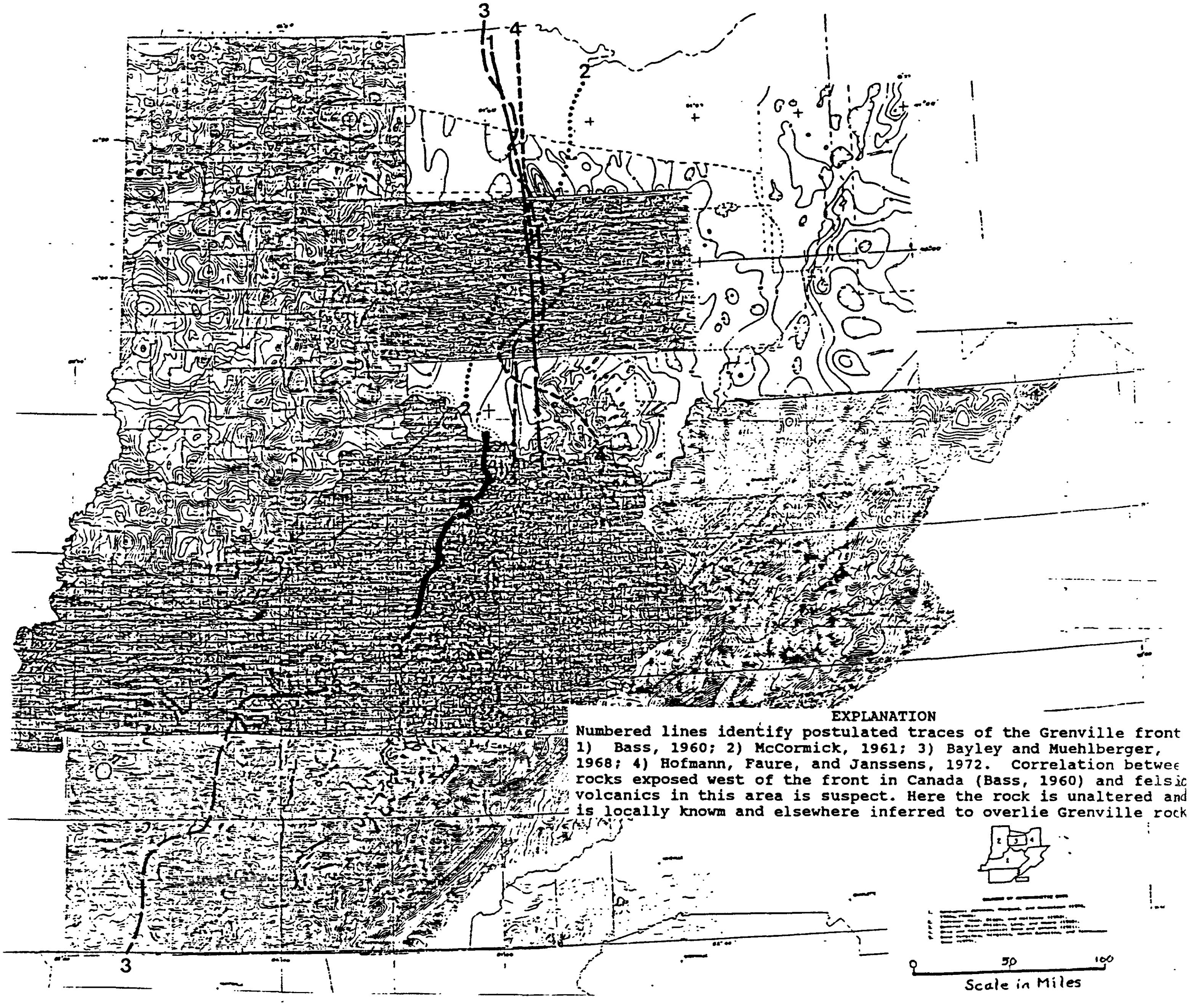


Figure 10. Map showing magnetic coverage in the region, and the questionable trace of the Grenville front as inferred by earlier workers, including Black and others (1976, 1979; Line No. 5)

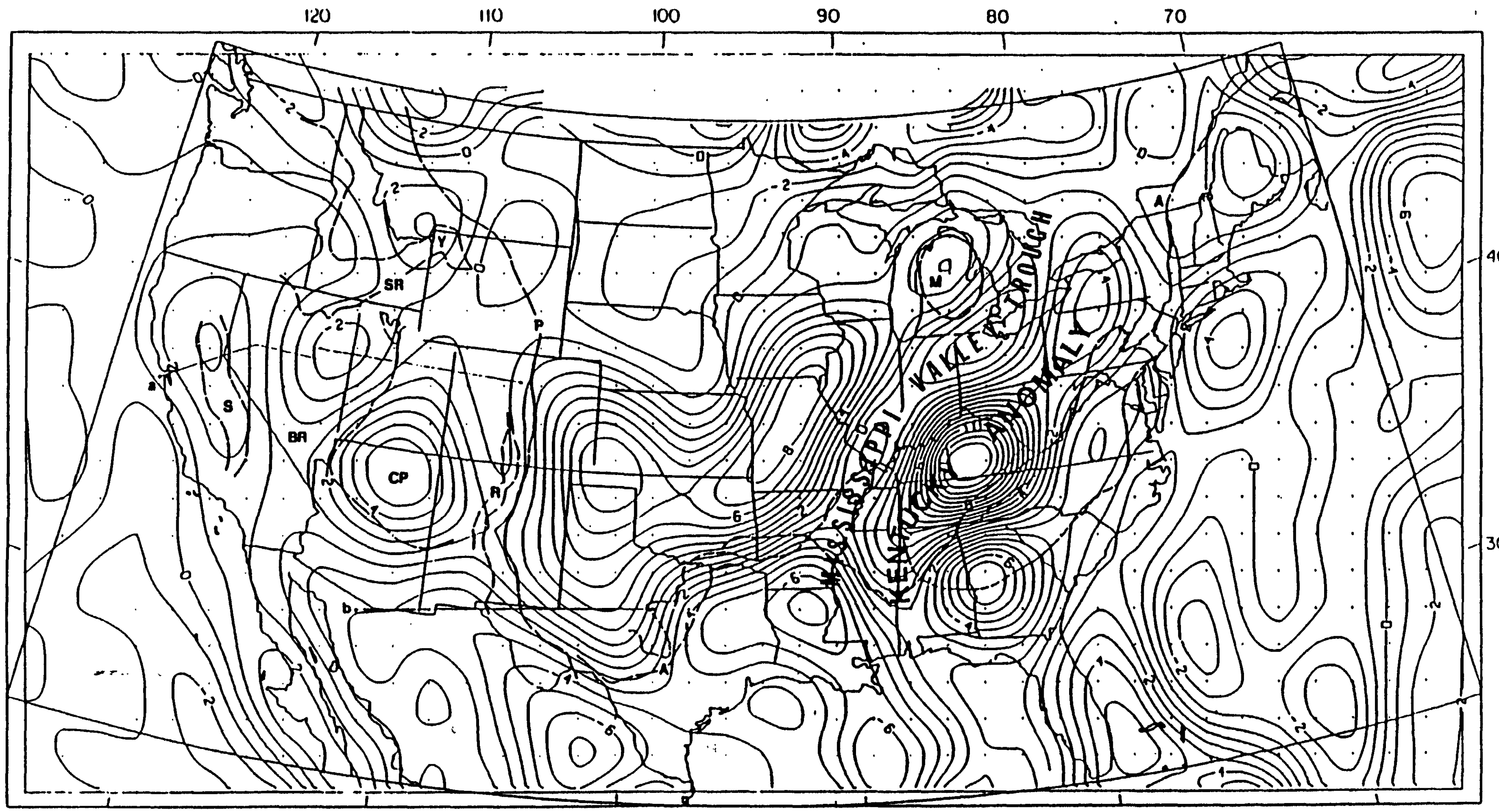


Figure 11. Magsat anomaly map of the United States recorded to a depth of 40 km below ground surface (Mayhew, 1980). The magnetic trough west of the Kentucky Anomaly follows the trend of Cambrian rifts (Braile et al; fig. 2) and extends to the northeast where it also conforms with the western limit of Grenville metamorphism in Canada. An eastward decrease in the ages of Grenville samples may reflect progressive uplift and cooling following metamorphism

felsite west of the front in Canada (Wynn-Edwards, 1972); 4) an overly abrupt transition between unaltered rhyolite and granulite characteristic of age-dated Grenville, sampled in closely spaced wells on opposite sides of the presumed front and questioned, first in Ohio by Bauman (1976), and by Black and Force (1982); 5) structural and geophysical evidence that the Kentucky-Ohio Trough originated as a basement graben like others in the area, and; 6) that the sequence of metamorphic and volcanic events deduced from basement petrology (table 3) was compatible with Late Proterozoic rifting, as also inferred to the west (Braile and others, 1983).

I therefore suggest the western troughs reflect rift graben filled with low-density, non-magnetic, unaltered felsic volcanic and sedimentary rocks sensed as broad gravity and magnetic lows. They underlie the flanks of later uplifts including the Jessamine and Nashville Domes of the Cincinnati Arch, and the Kankakee Arch in Indiana. They resemble other known graben in the area, where rhyolite flows that partly filled these basement graben also are unmetamorphosed. Rhyolite drilled at the juncture of the Olive Hill and Kentucky River-Woodward Lineaments in the Rome Trough, and aplite in the Floyd County Embayment (plate 5) are underlain and surrounded by granulite rock characteristic of the Grenville Province. I infer similar rock may underlie the western rhyolite flows, but drilling was terminated on contact with igneous rock.

Westward ramping of the Grenville rock (Green et al, 1988) is shown by seismic profiling across the GFTZ in Lake Huron and Georgian Bay and supported by east-over-west kinematic evidence. If similar thrusts dipped east of the Lexington Lineament, they would be apparent on Plate 6. Their absence is further evidence of the questionable nature of correlations made with the tectonic front. The alteration zone that is ten kilometers wide in Canada is also absent, or at least much narrower in Ohio (Bauman, 1976).

The earliest events that can be interpreted in this region appear to be related to uplift, erosion, and attendant lowering of the geothermal gradient following granulite metamorphism of the basement rock in Grenville time. Regional cooling across the Grenville Province occurred from west to east, as inferred from a pervasive decrease in radiometric age of basement reported from drill samples across Ohio and Kentucky by Bass (1960; 1970) and in northern areas of Grenville outcrop by Wynn-Edwards (1972). I suggest progressive uplift of the deeply buried rock began in the area reflected by the Kentucky Anomaly of Mayhew and Estes (1980) and gradually affected an expanded area east of the magnetic low called the Mississippi Valley Trough on Figure 11. My concept is necessarily speculative, but uplift and cooling as covering rocks were removed by erosion would have caused progressive lowering of radiometric age away from the uplift. This conforms with present geochronologic theory (J.G. Arth, USGS, personal commun. 1985).

Following metamorphism and erosion: 1) This ancient terrane was crosscut by faults which were intruded by gabbro and basalt. 2) These mafic dikes and enclosing Grenville rocks are altered to greenschist grade, apparently resulting from magmatic heating. 3) Uplift and erosion of both rock types is apparent from the seismic unconformity. 4) Unaltered (therefore younger) rhyolitic volcanic flows were then extruded along many of the same faults.

5) The felsic flows partly filled the developing graben, followed by younger marine deposits which accumulated during renewed block subsidence that; 6) had begun in Proterozoic time and continued into Late Cambrian time when sediments of that age filled the graben and eventually overlapped the adjacent basement horsts. This rifting on the craton was: 7) coeval with Iapetus spreading to the east (Rankin, 1976) and; 8) similar extension to the west, which resulted in a crosshatched network of early rifts (Braile et al, 1983; fig. 3). Many of the younger structures developed preferentially above these same faults and are illustrated in the seismic sections which follow.

TECTONIC FEATURES CROSSED BY THE SEISMIC TRAVERSE

R.E. Mattick and F.N. Zihlman (USGS, Reston) used seismic velocity data from the S.B. Williams well (Breathitt County A) to scale well logs plotted on Plates 6-10, to time profiles provided by the contractor, Geophysical Services, Inc. The stratigraphic units show close correspondence with zones of seismic reflectors interpreted from the raw profiles (not included). Signal returns are unrecorded in the upper tenth of a second and were judged to be unreliable just below this interval. Faults mapped at the surface were therefore projected steeply down dip where they were found to intercept fault traces reflected at greater depths.

The seismic data were correlated with mapped lithologies as follows: Zone G includes limestone of Middle and Late Ordovician age that overlies the Early Ordovician Knox unconformity; Zone H1 includes Late Ordovician shale, limestone, and siltstone mapped in central Kentucky; Zone H2 does not crop out but is evident in the subsurface of eastern Kentucky where it is equated with shale and sandstone of Silurian age; Zone I encompasses dolomite and limestone of Silurian and Devonian age that extends eastward into the subsurface as the "Corniferous" of drillers; Zone J reflects Devonian and Mississippian black shale; Zone K is Mississippian mudstone and siltstone; and Zone L includes Mississippian shale, dolomite, and limestone. Zonation was not attempted in shallow strata of Pennsylvanian age. Lower Ordovician and Cambrian rocks do not crop out but are described from drilling logs. Thickness changes of syntectonic sedimentary strata help to record periodic movements of basement fault blocks, most active during Cambrian deposition but reflected by relations of younger strata as well.

THE EASTERN KENTUCKY PLATFORM

Lexington Fault System The west end of the seismic traverse at Lexington, Ky., falls between the western and eastern boundary faults of a northeast-trending graben, one of a series of faulted segments that make up the Lexington Fault System. This system follows the faulted crests of the Jessamine Dome and Cumberland Saddle which, together with the Nashville Dome to the southwest, define the Cincinnati Arch (plate 1). Here, marine siltstone and shale of Late Ordovician age in a northeast-striking graben are downthrown about 150 feet against Middle Ordovician limestone (MacQuown and Dobrovolny, 1968). Two faults, downthrown to east and west, respectively (A-B, plate 6, a), converge just north of the traverse, while a third fault, not included in the section, is downthrown eastward about 300 yards beyond the west end of the seismic section. Surface faults extend irregularly 20 miles to the northeast and 60 miles southwest of this area. The system comprises a series of offset fault segments. Displacements of as much as 600 feet occur locally where spalled blocks derived from formations of Silurian (MacQuown, 1968) to Mississippian age (Wolcott and Cressman, 1971), now eroded in central Kentucky, are preserved. These elongate fault slices are wedged along crevasse faults within and bordering the more extensive graben blocks that make up the fault system (Black and others, 1981). Except for these local graben, the total throw across surface faults of the system ranges between 0 and about 200 feet, down to the east.

Lexington Lineament The basement counterpart of the fault system, the Lexington Lineament (plate 5), is well defined (Black and others, 1976) by west-dipping magnetic and gravity gradients. They parallel a narrow magnetic low which lies to the west of the surface faults and closely follows their irregular traces. The geophysical features extend well beyond the limits of surficial faulting, however, both northeastward into Ohio and southwestward into Tennessee. In Kentucky and Ohio, this lineament marks the eastern boundary of a broad, northeast-trending gravity and magnetic depression, the Kentucky-Ohio Trough, while to the south it separates the Lake Cumberland Embayment of the Kentucky-Ohio Trough on the west from a fault-related mafic dike reflected by the East Contintent Gravity High (ECGH, of Keller et al, 1975). The ECGH consists of three widely separated magnetic and gravity anomalies in northeast, south-central, and southwestern Kentucky, each partly extending into adjoining states (plate 5).

Fault traces are seismically defined by oblique reflectors, by stratigraphic offsets, and commonly by dragged bedding. The eastern graben fault (at a, pl. 6) of the Lexington Fault System thus was joined to a steep west-dipping oblique reflector which displaces bedding reflectors of Zones G and F near the western edge of the section, and west of a pronounced anticlinal fold in the upper contact of reflector Zone F. Zone G includes the Middle Ordovician High Bridge Group and the overlying Lexington Limestone. Zone F includes the Ordovician and Cambrian Knox Group and underlying Maynardville Limestone of the Conasauga Group. Most faults below Zone E, Cambrian Nolichucky Shale of the Conasauga Group, suggest extensional origin whereas Zone D, the upper unit of the Cambrian Rome Formation, thickens to the east of a west-dipping reverse fault which intercepts the west margin of the time section at 0.6 seconds (b). Local uplift is compatible with surface structure (See frontispiece) but early subsidence west of the lineament is also inferred (See below).

Interpretive Notes. The geophysical gradient that defines the Lexington Lineament lies to the west, rather than east of the westernmost fault (not shown). Cambrian-age rocks of Zone F and below dip westward at the western end of the section, toward this fault. The apparent drag is opposite to the throw of the surface faults and appears related to early downfaulting west of Plate 6. Basement east of this fault is displaced, but the throw is small as compared to the Kentucky River-Woodward or Irvine-Paint Creek Lineaments, or deeply buried grabens of the Rome Trough, Floyd County Embayment and Fishtrap Lake Depression. The Kentucky-Ohio Trough is thus inferred to reflect a similar graben, downthrown west of the Lexington Lineament by analogy with these structures, all of which developed along extensive rifts in Cambrian time.

Later uplift is ascribed to tilted buckling of fault blocks along the Cincinnati Arch. The attitudes of the tilted basement blocks are reflected by structure contours drawn on Ordovician and younger strata which also record late extension and graben subsidence along the faulted crest. Transverse offsets are also indicated, both by inherited surface structures and by offset anomalies recorded on the geophysical maps. Tight folding in strata that overlie Zone E record compressive stress, presumably also related to later uplift. The pronounced bulge (c) shown by the upper contact of Zone F, Cambrian/Ordovician Knox Dolomite, resembles the monocline in the frontispiece. Reflectors both above and within the Knox exhibit parallel folds but the base of the zone is not disrupted. Low-oblique reflectors east of the Lexington Lineament resemble thrusts in southeastern Kentucky. Here, these suggest west-or northwest-directed compression, and east and west dipping reverse faults within the folded interval suggest detachment of the Knox (analogous to perched anticlines defined in the Appalachian fold belt by L.D. Harris, 1979, USGS, personal commun., based on proprietary seismic data). Northwest-directed compression is also recorded at the surface: by a thrust fault of the Austerlitz Fault Zone (Outerbridge, 1975); and by another thrust mapped along the Clays Ferry Fault of the Kentucky River System (Black, 1968). Two closely parallel shallow-dipping overthrusts reflected immediately east of the cluster of normal and reverse faults (d, plate 6) also indicate west- or northwest-directed compression. The westernmost of these appears to ramp steeply upward from within the basement. It crosses Zone D and dips less steeply above Zone E. The other projects westward from apparent tangency with the base of the Maynardville Limestone, Zone F, or it may ramp upward from a sole fault within reflector Zone E, the underlying Cambrian-age Nolichucky Shale.

<u>East Continent Gravity High and Clark County Embayment</u> The seismic traverse crosses the Eastern Kentucky Platform where it includes parts of both the positively anomalous East Continent Gravity High (ECGH, Keller and others, 1975) and an adjacent low to the northeast, the Clark County Embayment of the Rome Trough (Black, 1986). Basement of the Eastern Kentucky Platform north of the Kentucky River Fault System is truncated by a relatively planar Proterozoic unconformity. This dips gently northwestward except in the area west of Winchester, Ky (Black, 1974) where its surface is disrupted by two small-displacement grabens (e and f) that encompass the Clark County Embayment. Similar dips at the surface are shown on the tectonic map (plate 1), and northwest-striking faults that parallel the magnetic gradients reflect the seismically recorded graben-boundary faults, again suggesting an inherited relationship between basement and surface structures.

The westernmost graben fault coincides with the trace of a northwest-striking scissor fault (Black, 1968; MacQuown, 1968) which also corresponds with the steep northwest-striking magnetic and gravity gradient that truncates the northeastern tip of the strongly positive East Continent Gravity High. The ECGH reflects basalt in the basement, drilled at localities shown on Plate 3 and in Tennessee. Modelling studies (Keller and others, 1982) combined with the drilling data indicate that this gravity and magnetic anomaly reflects a mafic intrusive body that extends to great depth. As defined, the ECGH comprises three such elongate anomalies, parts of which project beyond Kentucky. The middle anomaly belt is herein called the Somerset Prominence (plate 5), bounded on the west by north- and northeast-striking faults of the Lexington Lineament, and on the east by the Clark County Embayment and more southerly graben of the Rome Trough. The prominence broadens to the south where its offset margins are

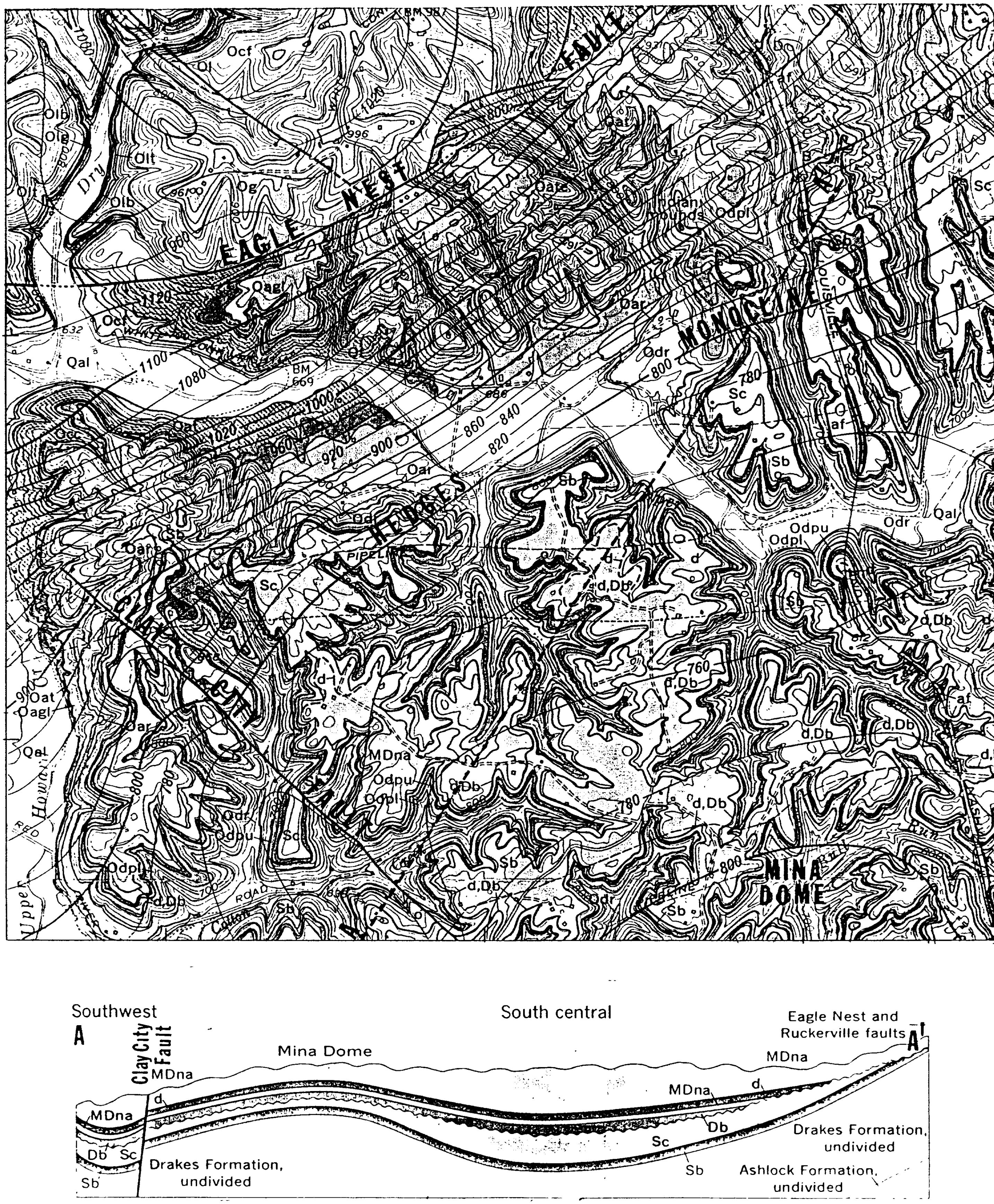


Figure 12. Geologic map and cross section of the Hedges Monocline (Black, 1975) showing Silurian unconformity and Devonian onlap.

gradient. Anomalies north of this area suggest dextral offset along the northeast-striking Elizaville Lineament. Beyond the Lexington Lineament to the northwest, several grabens crosscut the area of the Kentucky-Ohio Trough along a broad northwest-striking magnetic and gravitational low that extends northwest into southern Indiana, here called the Kentucky-Indiana Trough.

Offsets of blocky anomalies, variations in their intensity, and seismic and surface evidence of faulting in the Clark County Embayment, suggest that the gridlocked pattern of magnetic highs and lows may reflect ancestral faults in shallow, magnetically susceptible basement. Basement here is undated but is almost certainly Grenville, Proterozoic Y in age, as reported by Bass (1960) just to the north in Ohio. Early Cambrian facies of the Rome Trough, downthrown to the south, were either eroded or not deposited on the Eastern Kentucky Platform. The Clark County Embayment appears to reflect a zone of concentrated faults, now uplifted but similar to the other dilational rift zones that were active throughout this region in Late Proterozoic and Cambrian time concurrent with spreading of plates bounding the Iapetus Sea

Analogous structure A more youthful graben that appears analogous to the Clark County Embayment was recently examined by shipborne seismic-reflection surveys conducted by the USGS Office of Marine Geology across the Bahia De Samana', Dominican Republic (N.T. Edgar, R. Rodriguez, and D. Bush, 1985) illustrated on the map and seismic profile (fig. 13). The figure shows the northern fault bounding the subsident block where crossed by both legs of traverse A-A'. Crenulated folds at a high angle to each of the legs exhibit comparable wavelength and amplitude. Concentrations of folds and faults also occur along traverses across other areas of the bay (not shown). Where crossed in different directions, as along B-B', perpendicular and subparallel to the strike of the graben, correlative folds display dissimilar wave forms (N.T. Edgar, oral commun. 1986). From this the geologists determined that the folds strike northwest at an angle to the west-northwest fault. This may indicate antithetic folding that would accompany sinistral wrench faulting (Harding, 1974; diagram on fig. 15).

Interpretive Notes. Where crossed by the seismic traverse, faults bounding the Clark County Embayment do not greatly offset basement. Consequently, differences in thickness of nonmagnetic overburden do not explain the pronounced contrasts in geophysical anomalies within and bounding the embayment. Decrease in density and magnetic susceptibility of basement rock of the Clark County Embayment might be explained, however, by concentrated fracture, solution, and hydrothermal alteration. The Bahia de Samana' and similar features on Landsat images of the Carribean area resemble and may be youthful analogues of rift grabens of Proterozoic and Cambrian age in Kentucky. Crenulated folds in the graben bear similar angular relation to bounding faults as do gentler folds mapped along deeply buried rift structures in Kentucky. Here, rupture analogous to that recorded in the Bahia de Samana' may once have provided fractured conduits for solutions that altered basement magnetite (table 3) to less susceptible forms of iron.

inferred to reflect a series of right-lateral, east-northeast to northeast-striking basement faults: The Kentucky River, Irvine-Paint Creek, Burnside, and Alpine Lineaments. Right-lateral basement offset also is inferred north of the seismic traverse along the northeast-striking Elizaville Lineament which crosses the Clark County Embayment and truncates the Somerset anomaly. Petrographic analyses of drilled samples (table 2) show: That basalt reflected by the prominence is weakly altered; that it was emplaced along faults in granulitic Grenville rock retrograded to greenschist so the basalt is probably of Late Proterozoic age.

Seismic Responses. Only the northern tip of the ECGH is crossed by the seismic traverse, here well north of the section modelled by Keller and others (1982), but the geophysical maps indicate continuity of the body, and the seismic data show that it is truncated by a regional unconformity, also apparently of Late Proterozoic age. In the interval below the unconformity the reflector traces suggest local convolute structure (plate 6), but I was unable to detect a variation in the seismically translucent crystalline basement that might suggest a compositional change, nor could faults be traced to significant depths even beneath the obvious offsets in strata overlying the basement surface.

Plates 6 to 10 are drawn at approximately equal horizontal to vertical scale. Zone D, the upper part of the Rome Formation, thickens in the embayment area and onlaps basement (k) to the southeast where it pinches out beneath throughgoing strata of Zone E. Zone E dips gently to the northwest but displays no stratigraphic offset in this part of the platform area. Tilting of the unconformable basement surface and principal subsidence thus occurred before deposition of Zone E. Northwestward dips contoured structurally on exposed rock of Ordovician and Silurian age are compatible with the apparent dip of Zone E shown in the platform area and south of the Kentucky River Fault System. The parallel strata record a prolonged period of relative quiescence during marine deposition. Graben infilling was largely completed in Cambrian time. Another unconformity, known from drilling to Knox Dolomite (Zone F) suggests slight uplift in Early Ordovician time, but the mapped strata of Ordovician to Middle Silurian age indicate renewed submergence and undisturbed marine deposition. Onlap and thickened section in Devonian-age rocks south of the Ruckerville Fault of the Kentucky River Fault System again record tilting and relative uplift of the Eastern Kentucky Platform in Late Silurian to Middle Devonian time (fig. 12; Black, 1975).

Interpretive Notes. The easternmost graben fault (f; pl.6) is close to the northeast margin of the northwest-trending Clark County Embayment which extends irregularly between the Kentucky-Ohio and Rome Troughs, across both the Eastern Kentucky Platform and Middle Kentucky Terrace. Crossing and abutting patterns of surface faults and corresponding magnetic lineaments of northeast and northwest strike are quite apparent in this area (pl. 5). In the area north of the traverse, the southeast margin of one of a set of positive anomalies that bound the Clark County Embayment on the northeast corresponds with the Austerlitz Fault Zone of Outerbridge (1975). This fault zone strikes northwest and thence curves to north and northeast, precisely along the trace of the

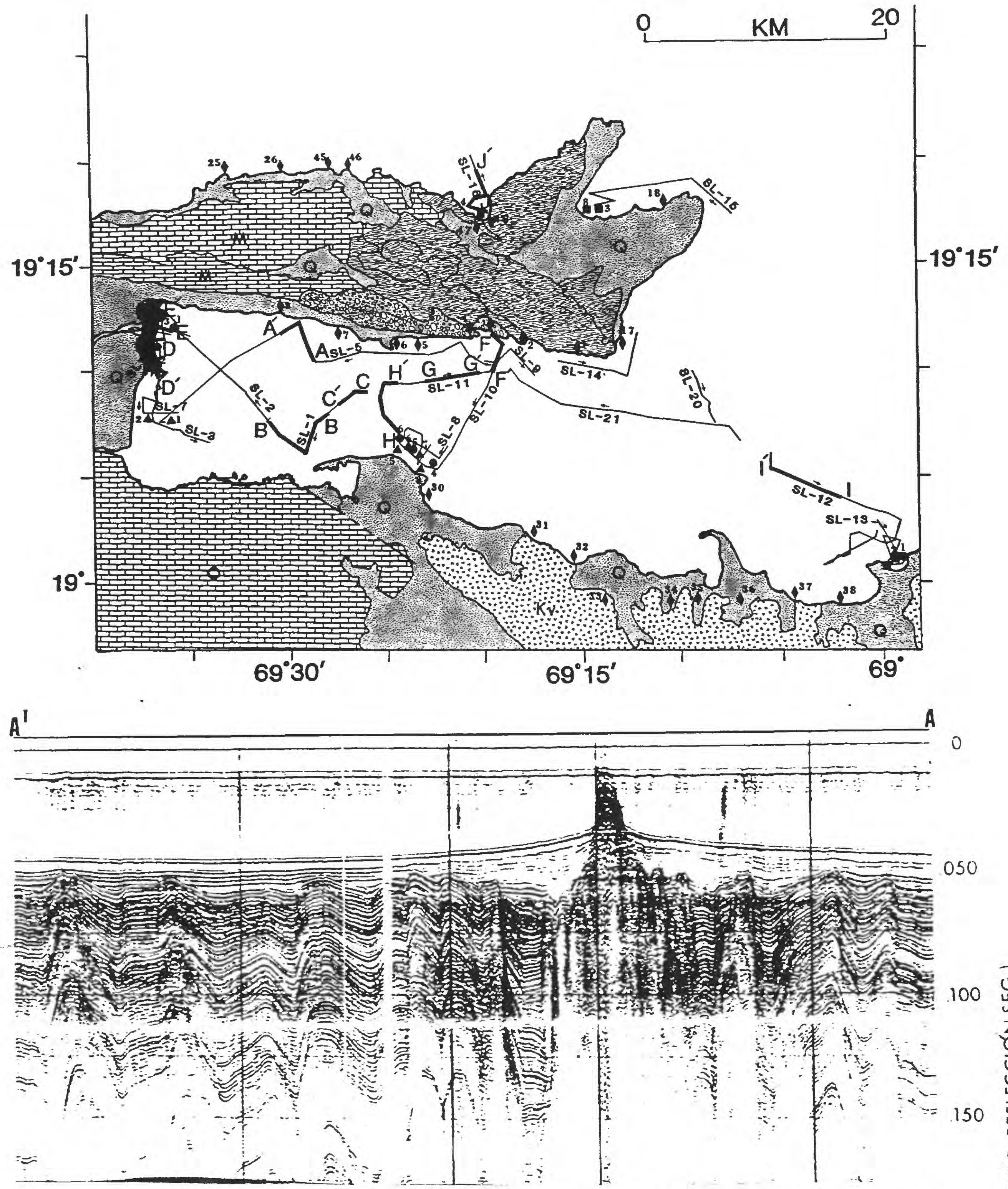


Figure 13. Shipborne seismic-reflection profile A-A' and map of the Bahia De Samana', Dominican Republic (from Edgar, 1985).

TECTONIC FEATURES OF THE ROME TROUGH

The Middle Kentucky Terrace (plate 5) extends irregularly east-northeastward across middle Kentucky as a train of laterally offset fault blocks downthrown to the south of the Jessamine Dome in west-central Kentucky and the Eastern Kentucky Platform to the east. The segment east of the Lexington Lineament is included in the Rome Trough of McGuire and Howell (1963). Here, the terrace is stepfaulted along the Kentucky River-Woodward Lineament and, to the south, is upthrown relative to the Rome Graben along the Irvine-Paint Creek Fault System. To the west of the Lexington Lineament the terrace is offset 17 miles to the south-southwest. Here it is stepfaulted southward along the Belltown and Brumfield Faults and again downthrown along the Stoner Creek Monocline to the south. This segment is included as part of the Cumberland Saddle bounding an eastward extension of the Moorman Syncline. The saddle lies east of the Rome Trough, and west of the Rough Creek Graben of Soderberg and Keller (1981). This graben is a basement counterpart of the syncline which extends westward into Missouri. The Middle Kentucky Terrace, however, is truncated on the west by the Elizabethtown Lineament (plate 5) where magnetic basement rock has been downthrown and laterally offset along a northwest-striking gradient and a series of en echelon surface faults which suggest left-lateral displacement. The Rome Trough and Moorman Syncline were both included as elements of the 38th Parallel Lineament of Heyl (1972) and Eastern Interior Aulacogen of Harris (1978). My studies suggest that they are only part of a regional network of intersecting Cambrian rifts (Black, 1986a).

Seismic Interpretations. Surface rocks on the downthrown side of the Ruckerville Fault are of Ordovician to Devonian age, and progressively younger formations crop out to the southeast as shown by horizons contoured by the mappers (heavy lines on plates 6-10). Signal returns were not recorded near the surface, but selected contacts have been projected to correlative reflectors across this interval. Cambrian sediments reflected by zones A, B, and C on the Middle Kentucky Terrace thicken to the northwest where they abut basement faults of the Kentucky River-Woodward Lineament. These units were eroded from the Eastern Kentucky Platform which is upthrown to the north. Zone A-1 was locally deposited in an early basement graben (at j) south of the lineament, while the overlying reflector zone A-2 exhibits onlap, thinning, and pinch-out onto the tilted basement surface which rises gently to the south. Zones A-1 and A-2 also occur as local deposits that reflect early subsidence in the Rome Graben and Floyd County Embayment, and A-2 occurs in the Fishtrap Lake Depression of southeastern Kentucky. Note that basement and Cambrian-age rocks dip northwest, whereas rocks of Ordovician and younger age dip southeast into the Appalachian Basin. Northward tilting during early subsidence of the terrace block is implied by the dip of the basement surface and early strata deposited on the Middle Kentucky Terrace. Continued subsidence during the deposition of sediments reflected by zones A-3 and B would also explain the greater thickness of zone B south of the Ruckerville Fault than in other areas of the traverse. Zone A-3, only shown here and on Section DE (plate 7), may reflect talus deposits.

Zone B overlaps A-2 and onlaps basement and another talus(?) deposit to the southeast where zones B and C abut a pronounced north-dipping oblique reflector which marks the northern fault of the Pomeroyton Prominence. Zones B and C exhibit complementary thicknesses and together thin gradually southeastward across the terrace. In a trough deposit above and south of the graben at j, zone C thickens at the expense of B (l and m). Here, oppositely dipping oblique reflectors define faults that slightly offset the basal contact of zone C. This minor faulting accompanied renewed subsidence in the area overlying and south of the graben during infilling by trough deposits of zone C. The upper beds of zone C overlap zone B to the south with no evidence of faulting that had accompanied earlier sedimentation. Drape folding of zones C, D, and E and thickening of zone F, the Cambrian and Ordovician Knox Dolomite, also occurred in the area overlying the deep basement graben. The stratigraphic relations imply that build-up of Knox carbonate rock generally kept pace with subsidence here and to the south. Uplift and erosion in Early Ordovician time resulted in a regional unconformity; recognized in drill cores from karst solution and beekite banding of the upper Knox (zone F). Offsets of this contact reflect normal displacements that occurred after erosion of the Knox, but reverse drag folds just north of the Ruckerville Fault and an overthrust and crenulated folds mapped at the surface (Black, 1968) also indicate compression and strike slip of the surface rocks. The steep southward dip of the Hedges Monocline (fig. 12) is attributed partly to post-Silurian uplift but mostly to much later subsidence along the Ruckerville Fault (Black, 1975). The dip flattens out to the south over a narrow basement terrace, but again steepens and veers to the southeast where the seismic traverse follows a broad flat-bottomed syncline across the breadth of the Middle Kentucky Terrace (plate 1).

Interpretive Notes. Initial basement faulting of the Middle Kentucky Terrace is expressed by displacements along the Kentucky River-Woodward Lineament. Restricted accumulations of earliest sediments show that faulting began in a deep basement graben just south of the Ruckerville Fault (plate 6). This developed after basement erosion but early in the history of block faulting which separated the Eastern Kentucky Platform from the Middle Kentucky Terrace. Subsidence in the narrow graben was accompanied by the accumulation of Late Proterozoic(?) and Early Cambrian sediments which filled its trough and onlapped the terrace unconformity. Great displacement has resulted from intermittent subsidence and variable tilting of the terrace block which partly controlled the patterns of sedimentation over time. The original bedding is undeformed except near the marginal faults. This suggests that pitching and yawing movements affected the entire terrace block.

Conclusions: Restricted accumulations of earliest sediments on the Middle Kentucky Terrace show where faulting began in the underlying Grenvillian basement rock. Initial basement faulting occurred along the Kentucky River-Woodward Lineament followed shortly by infilling of a deep graben to the south. Pitching of the terrace block caused variations in thickness and changes in the centers of deposition of younger Paleozoic strata. The Rome and Kentucky-Ohio Troughs, Floyd County Embayment, and Fishtrap

Lake Depression reflect elongate grabens shown to conform with mapped magnetic and gravity lows attributed to thick sedimentary cover overlying susceptible basement rock. The crossing pattern of grabens in this area, coupled with elements of the Reelfoot Rift and Rough Creek Graben mapped by geologists in areas to the west, suggests regional dilation that persisted throughout Early Cambrian time. Extensional faulting was first concentrated in spreading centers defined by increased thicknesses of Cambrian sediments. Outlying extension faults that formed as dilation continued encompassed broadening areas of subsidence. Tilting movements of huge basement blocks recorded by thickness changes in overlying sedimentary sequences can be partly reconstructed from the seismic data. The large magnitude of throw confirmed by drilling along the bounding faults suggests they extend to great depth, and inherited structures imply continued block mobility.

KENTUCKY RIVER FAULT SYSTEM AND KENTUCKY RIVER-WOODWARD LINEAMENT

The Kentucky River Fault System extends for 42 miles east-northeast of its intersection with the Lexington Fault System. It comprises a series of offset fault segments defined by normal and reverse faults which strike east-northeast and south-southeast with steep south or west dip, and locally a rhomboidal array of grabens bounded by southeast-striking transtensile crossfaults, downthrown to the southwest and northeast (plates 1, 2, 11, 12). The surface faults (Black, 1968) record: Normal components of as much as 300 feet; minor reverse offset both across and oblique to the trend of the principal faults and; lateral offset of at least 3000 feet determined from mineral veins segmented by en echelon faults north of and parallel to the major faults. Drilling and seismic data show nearly 4000 feet of southward throw at basement depth, however, and the magnetic maps show that lateral offsets involving basement have occurred both along and across the strike of the principal faults. About 7 miles of dextral offset of the Somerset Prominence of the ECGH is indicated, and north-directed compression is also implied by wedge-shaped fault blocks that crosscut the Kentucky River System. At its eastern end the fault system veers sharply to the southeast, flanking a local magnetic depression. Gradients bounding this low reflect deep-seated counterparts of the Ruckerville and Levee Faults (Black, 1975; McDowell, 1978) downthrown to south and southwest, respectively. Beyond this area, the Kentucky River-Woodward Lineament extends irregularly across eastern Kentucky (Black, 1986; plate 5) where it bounds the Rome Trough of McGuire and Howell (1963).

Kentucky River-Woodward Lineament. The southeast-striking Levee Fault is buried just north of its intersection with another basement fault which I infer follows the east-northeast striking Means Monocline and an accordant magnetic trough. The lineament veers east-northeast along the toe of the Means Monocline; thence southeastward and again eastward along the traces of the Cave Run and Paragon Monoclines; where it again extends to the surface as the Little Sandy Fault. To the east, this fault is truncated by the Olive Hill Lineament and offset northward where the lineament again veers eastward and extends beyond the West Virginia border along the Willard-Burnham Monocline. This is drape-folded above its basement counterpart, the Woodward Fault of Silberman (1972) and a magnetic trough south of the Northeast Kentucky Prominence.

Freeman (1953) was first to report thinning of the Cambrian section across middle Kentucky where great thicknesses of strata present in southern wells are missing in shallower basement tests to the north. Thomas (1960) equated the deep strata with a basal sandstone of unknown age and facies of the Cambrian-age Rome Formation which crop out in allochthons of the Valley and Ridge Province. Woodward (1961) ascribed the thick Cambrian section of eastern Kentucky to a "deep fault or great declivity." McGuire and Howell (1963) tabulated drilling data available at that time and named the Rome Trough, south of both the Woodward Fault and more westerly faults of the Kentucky River Fault System. These were included, along with cryptoexplosion structures and faults of similar trend to east and west, as part of a transcontinental rift system, the 38th Parallel Lineament of Heyl (1972).

Hand-held magnetometer traverses across the Boonesborough Fault of the Kentucky River Fault System at Stoner Branch (Black, 1974) first demonstrated correspondence between a strong magnetic gradient detected just south of the outcrop trace of the fault and a drill-proven fault at basement depth. The field intensity decreased sharply immediately south of the surface fault and fell off at a fairly consistent rate of about 50 gammas every 5 paces southward along the creek. Northwest-striking cross-faults in the area, however, displayed little change in intensity, implying small vertical offset at basement depth. Magnetic and gravity surveys run following these tests (Black, Keller, and Johnson, 1976) also revealed correspondence between geophysical gradients, accordant faults and monoclinal folds mapped at the surface, and abrupt contrasts in drilled depths to basement. As shown in the traverse area (plate 5), the Boonesborough Fault is flanked on the south by a magnetic trough, and on the north by a fault-parallel high. This bends southward along an unnamed offsetting fault, and again eastward north of the Ruckerville Fault. In theory (Vacquier and others, 1951), faulting at depth of the magnetic source rock should occur at the midpoint of gradient slope. This appears to fit the mapped relations at Stoner Branch and seismic data where the section crosses the Ruckerville Fault.

Surficial faults and folds of the Kentucky River-Woodward Lineament display only moderate displacement (g; pl. 6), whereas the ancestral basement faults that separate the Eastern Kentucky Platform (Thomas, 1960) and Middle Kentucky Terrace are greatly downthrown to the south. Both the Middle Kentucky Terrace and the Rome Graben to the south are included in the Rome Trough as step-faulted elements (Black, 1986a). The Terrace is downthrown south of the Eastern Kentucky Platform by faults of the Kentucky River-Woodward Lineament, and the Rome Graben is downthrown south of the Irvine-Paint Creek Lineament. Deeply buried faults south of the Rome Graben are more difficult to discern, but synclinal folds, hinged uplift to the south, muted magnetic response, as well as seismic data all suggest northward subsidence of basement along the Rockcastle River and Warfield Lineaments, and these are inferred to define the southern boundary of the Rome Trough.

<u>Seismic Interpretations.</u> Great displacement (C-D; pl. 6) across the Kentucky River-Woodward Lineament occurred in Cambrian time along southeast-dipping normal faults. Basement lies at a depth of about 3000 feet along the southern edge of the Eastern Kentucky Platform and quickly drops off to 7000 feet (h-i) at the north edge of the Middle Kentucky Terrace. A deeper graben (j) occurs south of these faults where stratiform reflectors of zone A-1 are enclosed by skewed reflector patterns characteristic of the crystalline basement. Basement in this graben appears to be more than 12,000 feet deep, although this has not been tested by drilling. Late Precambrian or earliest Paleozoic faulting occurred along the graben margins, followed by infilling with layered sediments reflected by zone A-1. Renewed faulting then occurred intermittently during the deposition of contrasting rock types in zones A-2, A-3, B, and C, uncorrelated units of Waucaban and Albertan (Cambrian) age. Northwest thickening of B suggests tilted block subsidence caused increased accumulation of sediment

near the western fault (h). Subsequent deposition of zone C was preceded and also accompanied by minor downfaulting to the east of the area of earlier subsidence. Zone D is recognized on both sides of the ancestral fault system but is either thin or missing along the uplifted edge of the Eastern Kentucky Platform (at k). Zone E is displaced by the Kentucky River Fault System but except for this, little change in thickness occurs in reflector zones E and above. Zone E is equated with Cambrian-age Nolichucky Shale of the Conasauga Group, and zone D with the upper member of the Rome Formation. Accurate measurements in drillholes on opposite sides of the fault system (Webb, 1969) defined small displacement of the Knox Dolomite of Cambrian and Ordovician age, zone F. This faulting occurred during regional uplift that preceded Knox unconformity in the Early Ordovician. Renewed submergence and a prolonged period of tectonic quiescence followed this erosion, known from widespread deposition of shallow marine carbonate rock that continued throughout the Ordovician and at least into Middle Silurian (Wenlock) Bisher Limestone time (Berry and Boucot, 1970) with little, if any, tectonic interruption.

The seismically recorded Ruckerville Fault (h) is among the structures reactivated just prior to Middle Silurian to Devonian unconformity. Uplift and erosion of the Ordovician and Silurian rocks was followed by onlap of Middle Devonian sediments here and at other localities along east-trending faults. The Ruckerville Fault is bounded on the south by the Hedges Monocline (Black, 1975). The toe of the monocline (plate 1) appears to reflect an offset extension of the Eagle Nest Fault (i) which bends to the southeast just west of the traverse. The Hedges Monocline is unfaulted at the surface where beds of Silurian to Devonian age are well exposed, but it reflects step faulting at basement depth as do both the Ruckerville and Eagle Nest Faults at the surface.

Interpretive Notes. South of Hedges, Simmons (1967) mapped local monadnocks of Middle Silurian Bisher Limestone, surrounded and overlain by Middle Devonian Boyle Dolomite, and Devonian to Early Mississippian New Albany (Chattanooga) black shale. These sediments onlapped a regional unconformity attributed to wave-cut erosion implied by: 1) The planar nature of the unconformity, 2) similarities between shallow-marine to supratidal (sabkha-type) carbonate sediments both below and close above the unconformity, and 3) subaerial dessication cracks in some dolomite beds. The dolomite occurs chiefly in thin-bedded sequences, intercalated with green dolomitic mudstone in the Silurian strata and locally, with black shale low in the Devonian section. Stratigraphic and structural relations south of the Ruckerville Fault are portrayed in the diagrammatic cross section (fig. 12; Black, 1975). The patterns of sediment distribution and deformation imply emergence and erosion north of the fault and later marine encroachment from the south. The Silurian units are variably preserved beneath the unconformity, while Devonian units onlap the Hedges Monocline and successively pinch out onto its flank. The amount of structural relief attributable to pre-Devonian events was determined in this area by comparing total relief on originally flat-lying Silurian beds with thicknesses of onlapping Devonian beds, also deformed during later events. Only 25% of the structural relief contoured on Silurian strata is ascribed to pre-Devonian uplift, whereas 75% has resulted from later subsidence and drape folding of these beds. Devonian onlap onto other east-striking folds is indicated all across the region: From drill data on a buried anticline south of the Glencairn Fault (Freeman, 1951; pl. 2); and onto the same unconformity exposed in uplifted strata south of the drape-folded Hiseville Monocline (Lewis, 1972; Black, 1986b; pl 1).

Transverse offsets along strike of the Kentucky River Fault System are indicated by: 1) Segmented mineral veins displaced by east-northeast striking en echelon faults of the Becknerville Fault Zone north of the Boonesborough Fault where 3000 feet of right-lateral displacement was determined (Black, 1967; 1968); 2) tight chevron folds adjacent and at a high angle to the strike of the Boonesborough and Eagle Nest Faults (Black, 1974; 1975); 3) wrench-related faults and joints developed at an acute angle to the principal faults; and 4) rhomboidal fault patterns that herein are attributed to transtensile stress (Harland, 1971). Transverse movements across strike of the Kentucky River Fault System are implied by: 1) Magnetic anomalies offset along trends of northwest- and northeast-striking surface faults; 2) north-striking veins and extension fractures that bisect northwest- and northeast-striking conjugate shears combined in classic patterns (Ode', 1956) that indicate north-directed compressional stress; 3) similarly oriented joints, faults, and sinkhole alinements (figs. 6, 7, 8); and 4) dextral offset of an ancient fault scarp, known from drilling to basement within the rhomboidal structure west of the Eagle Nest Fault (See Clark County H, plate 11).

Analogous Structures That Suggest Transverse Displacement. Renewed transverse stress along and within the ancestral rift structures is suggested by the development of ancillary faults and folds at an acute angle to the strike of the ancient faults. Seismic surveys across the Bahia de Samana', Dominican Republic (See above) provide evidence of such stress, and analogous faults in Iran, Georgia, and Alabama support inference of strike slip along and across the trend of the Kentucky River Fault System.

Figure 14a shows a rhomboidal structure characteristic of sinistral wrenching determined from detailed mapping in Iran by Tchalenko and Ambraseys (1970). Figure 14b shows a similar, but oppositely oriented rhombic array of faults mapped along the Kentucky River Fault System. The mirrored fault patterns record transverse movements of opposing sense. In Iran these faults reflect left-lateral wrenching that occurred in historic time. By analogy the Kentucky faults record right-lateral strike slip. Figure 15 is a paper model designed to illustrate en echelon faults and the sense of movement generated by transverse faulting at basement depths and transmitted upward through overlying rock.

Figure 19 displays another left-lateral rhomboidal structure southeast of the Rome Fault in Georgia and Alabama. The figure includes a topographic map showing mapped faults traced from the Geologic Map of Georgia, and a side-looking radar image mosaic (INTERA Technologies, Inc., 1984) annotated to show these and additional faults inferred from the radar data. The mapped faults follow drainage patterns enhanced by shaded relief on the radar image within and beyond the rhomboidal structure. From comparisons made with features mapped in Iran, opposing arrows depict the sense of lateral offsets inferred in the Rome area. Fault patterns identified on the geologic maps in both areas are quite similar. These and additional features pointed up by the radar image, suggest left-lateral displacements like those proven in Iran. Drag features also indicate left-lateral strike slip northwest of the rhomboidal structure, along crossfaults adjacent to a salient in the Rome Fault. Here, rocks of the Cambrian-age Conasauga Group to the south are thrust against previously folded Pennsylvanian and older rocks of the Valley and Ridge. Both the geologic map and radar image show abrupt changes in strike of the folded rocks north of the irregular trace of the Rome overthrust. They occur across northeast-striking faults and imaged fractures, and appear to define dicreet fault blocks that have been dragged toward the northeast, rotated, and offset from one another at some time after northwest compression in the Valley and Ridge. The magnetic trace of the New York-Alabama Lineament (fig. 3) is plotted on the image west of the zone of tight crenulated folds. Faults bounding the rhomboidal structure strike at an angle to the lineament but to the northeast their extended traces parallel its strike. Left-lateral offset along the lineament has been suggested (Hildenbrand, 1985) from relations of adjacent magnetic anomalies. Although similar sense of displacement suggests that the features may be related, seismic research will probably be required to allow correlation with the inferred basement faults.

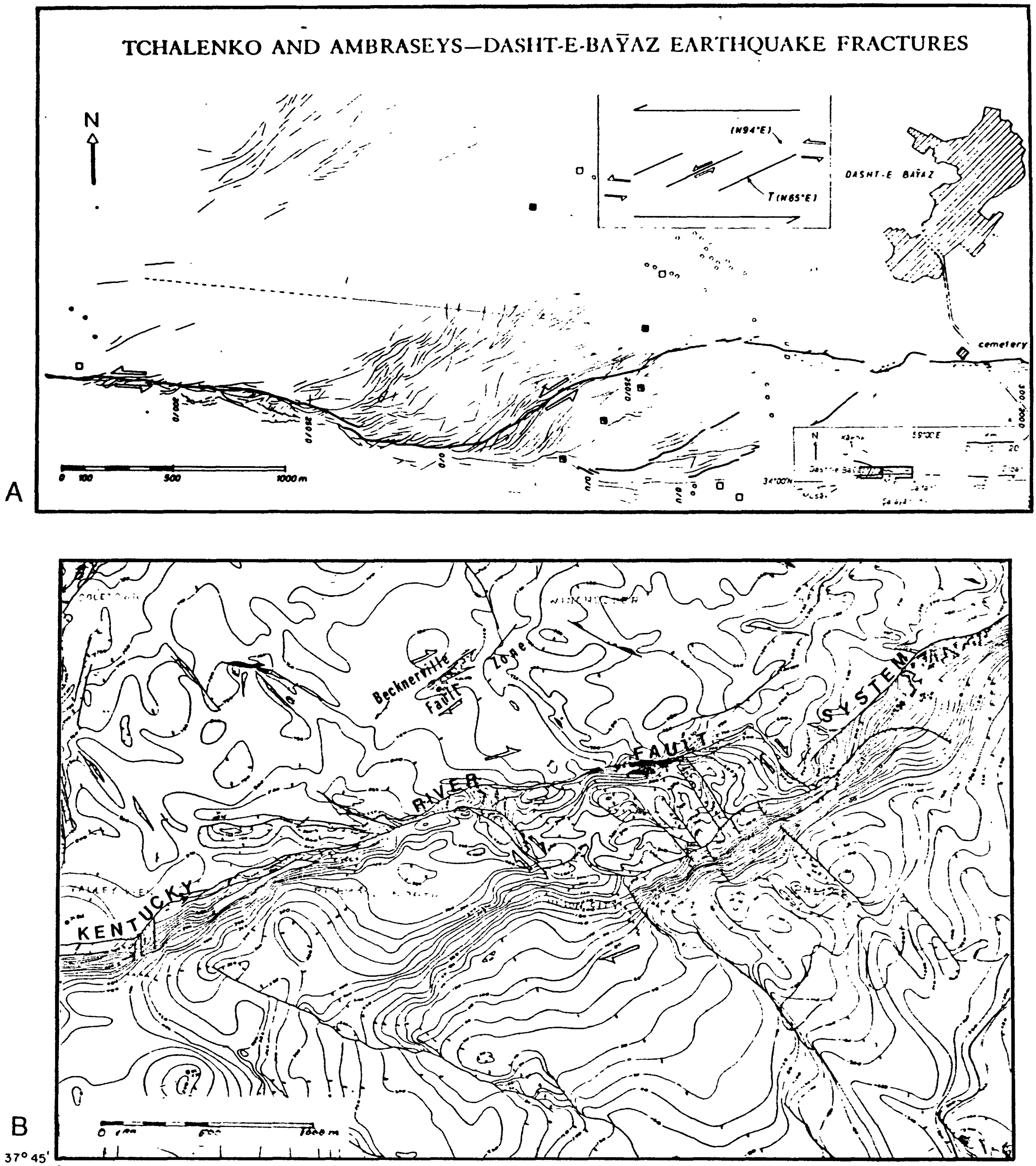


Fig. 14. Wrench-tectonic analogs. A) Fractures associated with recent transverse faulting in Iran are compared with B) contoured geologic structure of the Kentucky River fault system. As much as 914 m of right-lateral vein offset was mapped across faults of the Becknerville fault zone to the north (Black, 1968). Left-lateral displacement along the Iranian faults reported by Tchalenko and Ambraseys (1970), mirrors right-lateral displacement in Kentucky as indicated by the fault patterns and offset veins (see arrows).

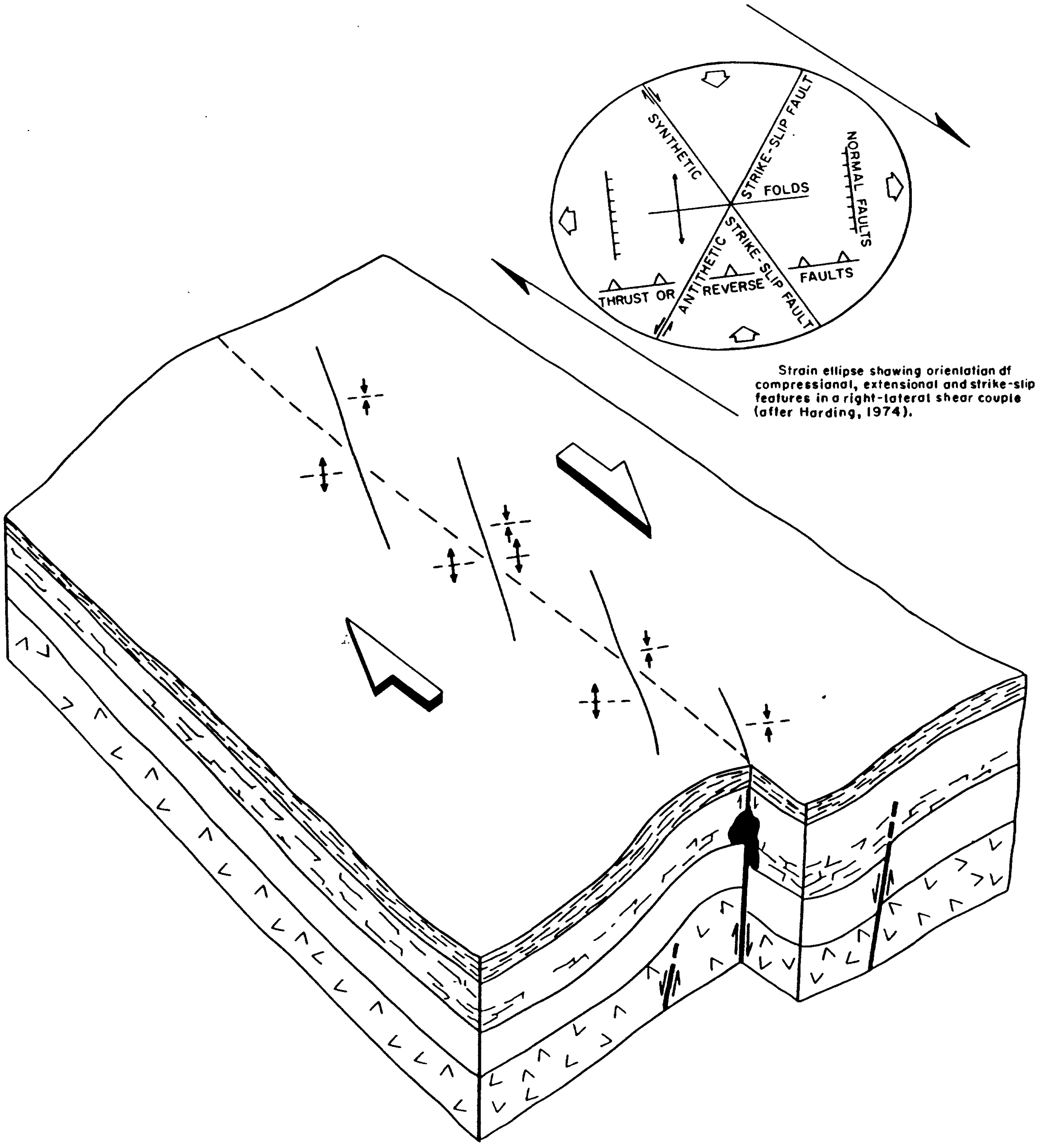


Figure 15 Illustrative model showing tectonic mechanism proposed to explain <u>en echelon</u> fault swarms and rhomboidal structures mapped along the trends of strike-slip faults. Cut paper along <u>en echelon</u> faults and press along opposing arrows thereby forming antithetic folds and synthetic strike-slip and scissor faults.

THE POMEROYTON PROMINENCE AND IRVINE-PAINT CREEK FAULT SYSTEM.

The Pomeroyton Prominence is a basement horst that follows the southern edge of the north-dipping Middle Kentucky Terrace (plate 7, section DE). Its south scarp is formed by a fault that projects upward as the Glencairn Fault of the Irvine-Paint Creek Fault System (a). To the north it is bounded by a north-dipping fault (b) that fails to reach the surface because of a crossfault higher in the section. Only the Glencairn Fault extends to the surface where it offsets Pennsylvanian rock (Weir, 1974a; 1974b), but other deep faults extend upward to shallow depths where they offset zones J and K, the Devonian New Albany Shale and the lower part of the Early Mississippian Borden Formation. These faults were not mapped, and because contours were drawn on the overlying Newman Limestone I conclude that they terminate within the Borden where it thickens in a flat-bottomed syncline that parallels the Irvine-Paint Creek Lineament (plates 2 and 5). While principal displacement must have preceded Newman deposition, the synclinal folds conform with marginal faults that bound the basement horst, and a complex history of intermittent uplift and subsidence is implied by both normal and reverse drag folds adjoining conjugate faults that overlie the prominence. Several mapped features also suggest past compression and intervening periods of relaxation. These include: Crenulated folds that parallel the east-trending faults of the Irvine-Paint Creek System; low dip of the Little Sandy Fault, which originated as an overthrust but was later downthrown to the southeast; truncation and left-lateral offset of the Blaine Fault along the trace of the Olive Hill Lineament; and Permian-age diatremes at the intersection of the Olive Hill and Kentucky River-Woodward Lineaments where reactivated faulting was accompanied by magmatic intrusion of kimberlite dikes.

Seismic Interpretation. Faulted uplift of the Pomeroyton Prominence and northward tilting of the Middle Kentucky Terrace post-dated widespread erosion of the Grenville basement in Late Proterozoic or Early Cambrian time. The earliest sediments are preserved in graben in several areas south of the prominence and in the terrace graben described earlier (plate 6). To the south, zones A-1, A-2, and B reflect sediments widely deposited in the Rome Trough. These units abut faults both north and south of the prominence which record early periods of uplift and subsidence. Deposition kept pace with continued subsidence and the prominence was onlapped by sediments reflected by zone C (at c) and later overlapped by zone D. In northerly areas of the terrace the same early units progressively onlapped the northwest-dipping basement unconformity in a southerly direction and zones B and C abut the north-dipping basement scarp. Initial uplift of the prominence and northward tilting of the terrace block became quiescent prior to deposition of zones D and E which engulfed the prominence, but younger sets of conjugate faults offset these rocks as well as strata much higher in the section. Zone E exhibits reverse drag and pronounced thickness changes (d) which suggest compressional flexure may have accompanied closing of Cambrian rifts. Similar features in zones H, I, and J, Ordovician, Silurian, and Devonian strata (e), record renewed movements along conjugate faults which were propagated upward during Mississippian and later tectonism.

All the faults exhibit vertical components of displacement which record either uplift of the prominence or subsidence of the adjacent blocks. Uplift is implied by offset of the originally planar basement unconformity, by the conjugate habit of overlying faults, and by reverse as well as normal drag folds in affected strata. Just north of the Pomeroyton Prominence reverse drag in Early Cambrian rocks is reflected by zones C, D, and E where the beds adjoin the north-dipping fault (b). This fault bounds the basement uplift and extends upward through the Cambrian section. Other north- and south-dipping faults above the prominence also display varying amounts of listric normal faulting, and adjacent reflectors high in the section also exhibit reverse drag. All along the traverse, reverse drag occurs most commonly where such conjugate faults overlie tilted basement blocks. They suggest hinged uplift, and their reversal of displacement sense suggests alternate buckling and release of compressional stress. Here, uplift occurred at the edge of the tilted Middle Kentucky Terrace which acted as a buttress that resisted later compressive stress. Concentrations of younger faults overlying the existing basement faults imply such stresses found upward release above ancestral zones of weakness, thereby deforming overlying strata. This ramp faulting along both north- and south-dipping faults must have occurred during or after Devonian time as shown by reverse drag folds in strata at least as young as the Devonian beds here correlated with reflector zone J. Relaxation of previous lateral stress is inferred from subsidence and normal offsets along these faults and locally, antithetic faulting of the downthrown blocks.

Interpretive Notes. Surface mapping and drilling data in quadrangles south of the Glencairn Fault and west of the line of traverse support these seismic interpretations and also indicate: 1) Crenulated folding of Late Mississippian rocks, 2) uplift and subsequent erosion of anticlinal folds; 3) recurrent folding that postdated Early Pennsylvanian sedimentation; and 4) later undated downfaulting. Figure 16 illustrates structural relations along and south of the Glencairn Fault. A series of buttressed folds south of the fault includes: A steep syncline (A) contoured on Pennsylvanian sandstone in the Slade Quadrangle (Weir, 1974b); an adjacent anticline (B) exposing Mississippian Newman Limestone at its eroded crest in the Zachariah quadrangle to the south (Black, 1978); and more southerly crenulated folds of lower amplitude (C, D) that extend eastward into the Campton quadrangle (Cosgren and Hoge, 1978). The inset map (E) was contoured on the Newman from drill data generously loaned to me by oil companies in the area.

A small fault at the crest of the northern anticline offsets the deeply eroded Newman but not the unconformable Pennsylvanian rock. This steep-flanked anticline is parallel to the Glencairn Fault and, together with the bounding synclines, suggests that folding both predated and postdated unconformity. Compression is indicated by these tight folds which decrease in amplitude away from the abutting Glencairn fault. Thus, uplift allowed local erosion of all but 30 feet of the Newman which is 120 feet thick in nearby wells, and all of the Mississippian Pennington Shale which is thinly preserved below the unconformity in outcrops in this area, but hundreds of feet thick in southeastern Kentucky.

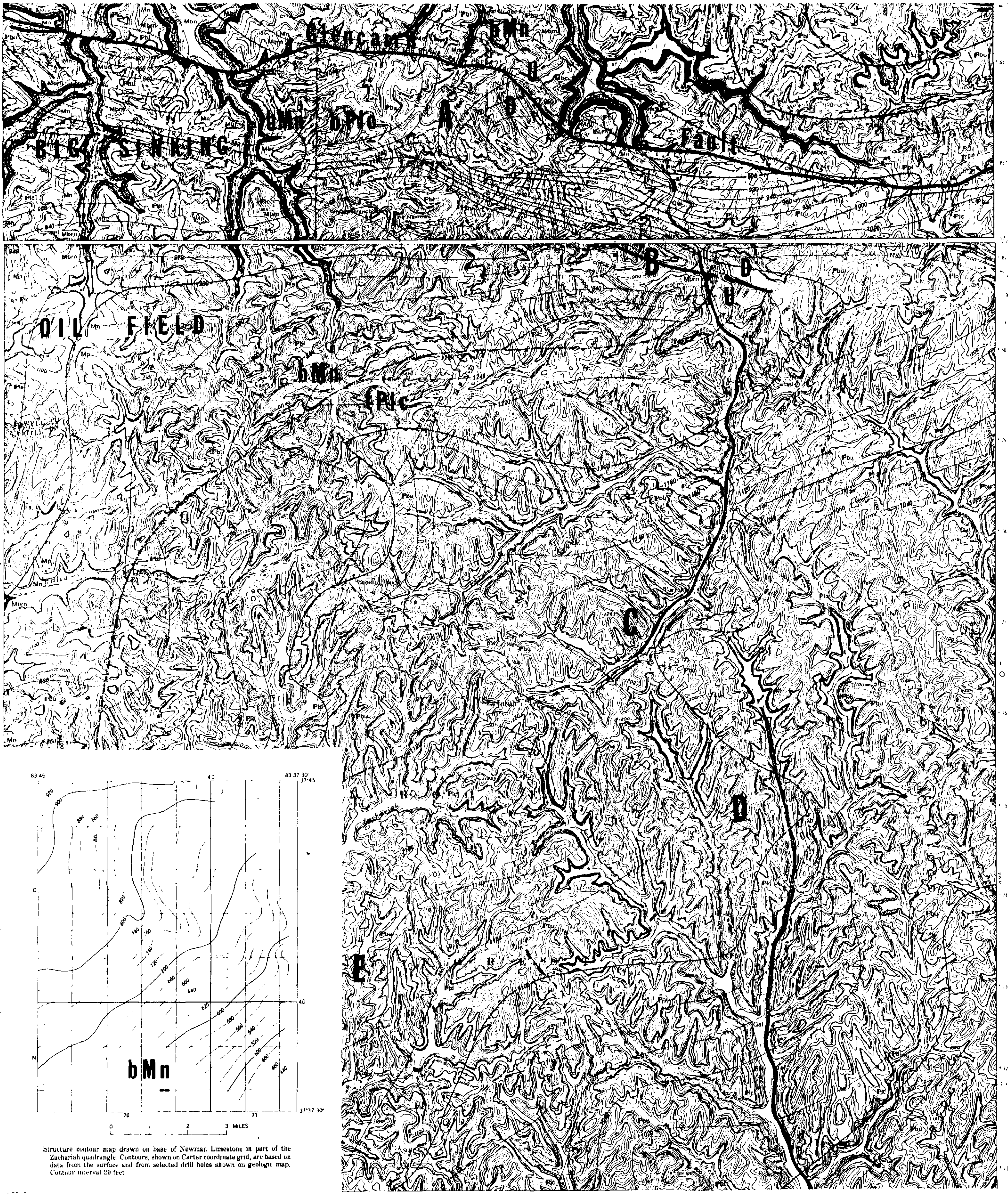


Figure 16. Geologic map of parts of the Slade and Zachariah quadrangles showing structural relations south of the Glencairn Fault of the Irvine-Paint Creek System (Weir, 1974; Black, 1978). Contoured horizons are identified by stratigraphic symbols.

The more southerly syncline and anticline were contoured on Early Pennsylvanian Corbin Sandstone of the Lee Formation in the Campton (Cosgren and Hoge, 1978) and Zachariah quadrangles. Although drawn on sandstone, this contact closely underlies flat-lying Zachariah (Lily) coal and thus provides a reliable record of deformation that postdated the unconformity. These folds also affect underlying sequences of Pennsylvanian shale, sandstone, and coal above the unconformity. They occur to the south and at a small angle to the Mississippian folds, suggesting differently directed compressive stress generated by time-separated pulses. Both generations of folds overlie and appear to be related to the great boundary faults of the Rome Graben. Their fault-parallel axial traces imply that the compressional forces acted at a high angle to the fault strike. The seismic cross sections also show conjugate faults and both synclinal and anticlinal folds just south of the Glencairn fault, and these appear to be comparable to the structures determined from the surface mapping. All of the rocks were later downthrown by the Glencairn Fault. The age of this faulting is undetermined, but similar repetetive folding and faulting is also evident along the fault system to the east, there involving much younger Pennsylvanian rock.

Recurrent movement that began in Silurian time north of the Cumberland Saddle, and along the Kentucky River Fault System to the west (Black, 1986b) is also indicated south of the Irvine-Paint Creek Fault System, but at a slightly earlier time. In all three areas previously undeformed carbonates of Ordovician and Silurian age are buckled upward along east-northeast trending faults. Here, however, onlapping facies include fossils of Silurian age as reported by Freeman (1953), whereas to the west marine shale and mudstone of Middle Devonian and Mississippian age directly overlie the unconformity. Thus, compressional buckling across the strike of east-trending faults is evident all across middle Kentucky between Silurian and Early Mississippian time. Movements are also recorded in the Late Mississippian, and indicated but not well dated in Pennsylvanian and later times.

Analogous Structures. Figure 17 was taken from a report by Sheridan (1987) who discusses passive-margin structures in strata of Middle Jurassic to Holocene age along the present-day Atlantic seaboard of the United States. Youthful offshore structures of the Carolina Trough (Grow et al, 1983) and Blake Plateau (Dillon et al, 1979) closely resemble the Late Proterozoic and Paleozoic structures in this area. Stratigraphic relations are also much like those of marine shelf deposits of the Eastern Kentucky Platform, Middle Kentucky Terrace, and Rome Graben, and similar tectonic genesis of half-graben structures described by these authors may be inferred. Inter-comparison of the depositional environments and related mineral and energy resources of these ancient and more recent continental shelf terranes should be advanced by further geophysical and geological research.

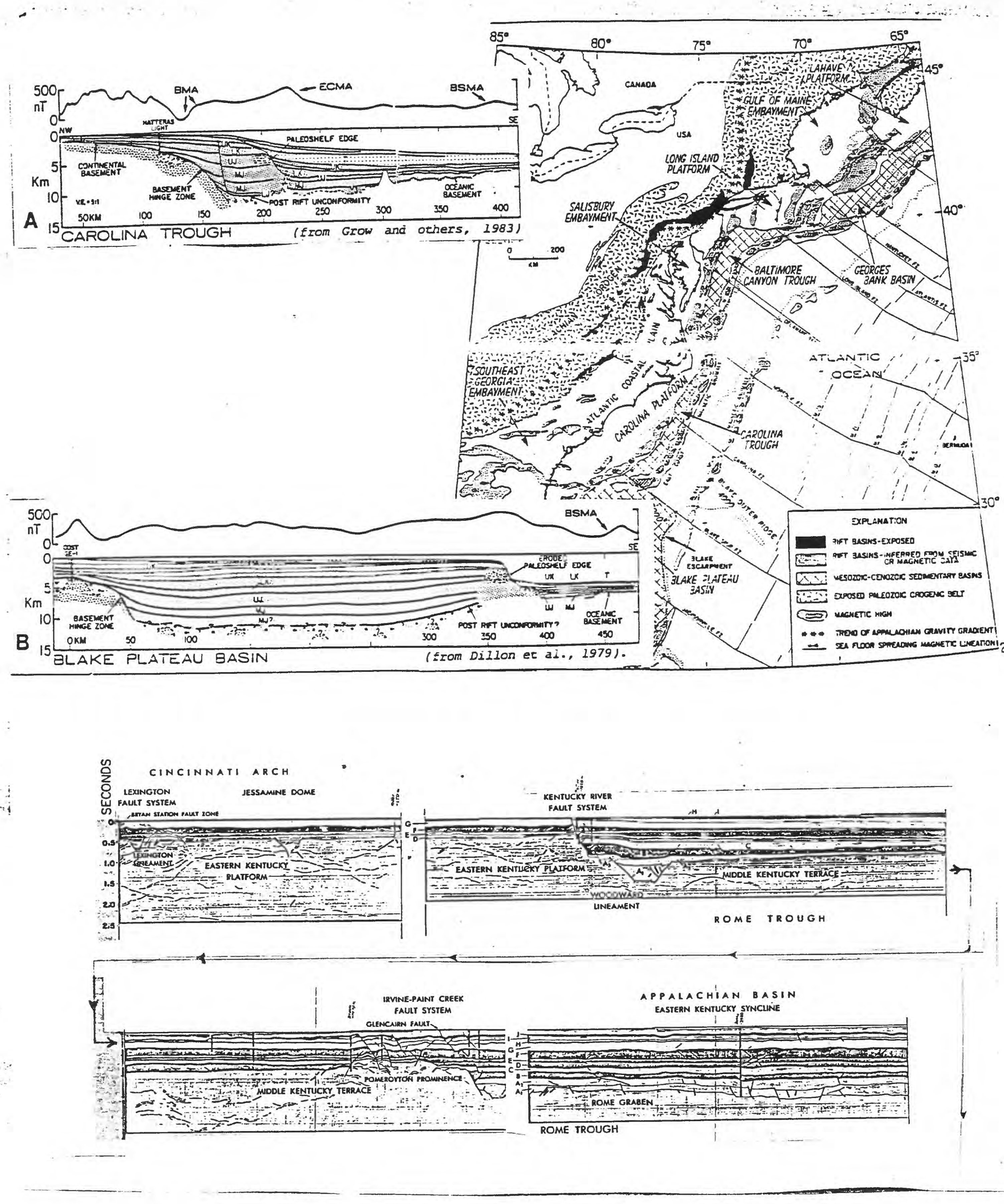


Figure 17. Seismic cross sections showing Mesozoic and Cenozoic stratigraphy and structural relations of the Atlantic continental shelf (Sheridan, 1987; Grow et al, 1983; Dillon et al, 1979) that resemble Eocambrian structures of the Eastern Kentucky Platform, Middle Kentucky Terrace, and Rome Graben (Plates 6, 7, and 8).

THE ROME GRABEN, EMBAYMENTS SOUTH OF THE ROME TROUGH, AND THE PERRY COUNTY PROMINENCE

The Rome Graben is included (Black, 1984) with the Middle Kentucky Terrace as part the Rome Trough of McGuire and Howell (1963). It conforms with the Eastern Kentucky Syncline (McFarlan, 1943; pl. 2) and extends from the Somerset Prominence in central Kentucky irregularly eastward across eastern Kentucky into West Virginia (plate 5). Faults of the Irvine-Paint Creek Lineament bound the Rome Graben on the north, and the Rockcastle River and Warfield Lineaments define its irregular southern border. These reflect basement faults that were once coextensive but now are offset and downthrown north of the Rockcastle River Uplift, Perry County Prominence, and Pike County High of eastern Kentucky. Deep-seated scarps of the Rome Graben are expressed by inherited faults and folds where basement is relatively shallow. As depth to basement increases to the southeast, the surface faults die out and folds become less distinct. Magnetic gradients that also follow the trends of basement faults are well defined north of the Rockcastle River Uplift, less pronounced along the Tiptop Syncline and Lambric Fault, and quite gradual east of the Perry County Prominence where they are more deeply buried. Geophysical lows adjoining the Rome Graben are here called embayments, after Weaver and McGuire (1977). They conform with downfaulted graben where great thicknesses of nonmagnetic sedimentary rock overlie magnetic basement. Embayments of the Rome Graben were defined from drill data by Weaver and McGuire (1977) and from geophysical models interpreted by Ammerman (1976) and Keller (<u>in</u> Seay, 1979).

<u>Correlations.</u> The seismic sections corroborate their models and record additional faults in basement and overlying stratified deposits differentiated by means of contrasts in their seismic properties (plate 7). Zones A, B, and C probably correlate with Antietam Sandstone, Tomstone Dolomite, and the limy lower half of the Rome Formation (Wilson and Sutton, 1976). Numbered divisions of A reflect uncorrelated seismic facies. Zone D correlates with shale and sandstone high in the Rome Formation; E with Nolichucky Shale of the Cambrian Conasauga Group; and F with carbonates that include the Conasauga Maynardville Limestone and Knox Dolomite of Cambrian and Early Ordovician age. The top of F is a seismically indistinct unconformity plotted chiefly from drilled intervals.

Zone G projects eastward from exposures in central Kentucky and includes Middle to Late Ordovician carbonate rock of the High Bridge Group and Lexington Limestone (Cressman, 1973), and shale and limestone of the Late Ordovician Cincinnatian Series (Peck, 1966). Zones H, I, and J encompass strata of Late Ordovician to Devonian age as follows: Zone H-1 includes Late Ordovician shale and carbonate (Weir and others, 1984); H-2 and I are interbedded dolomite, shale, and sandstone of Silurian age (McDowell, 1983; Freeman, 1951) that record unconformable onlap; and J reflects Devonian black shale. Widespread marine deposition occurred both before and after erosion, and abrupt changes in thickness reflect uplift (see above) or subsidence that occurred along basement faults rejuvenated during this time interval. Zone H-2 is missing in the west but thickens abruptly over the Floyd County Embayment where block subsidence late in the Ordovician or early in Silurian time allowed rapid deposition. Gradual tilting of basement toward the Appalachian Basin also is recognized from: 1) progressive downward steepening of zones J through A above the originally flat-lying basement unconformity; 2) southerly dips of zones K and L, the Mississippian Borden and Newman Formations; and 3) basinward thickening of younger Carboniferous deposits down-the-dip across southeastern Kentucky (Froelich, 1973) into western Virginia (Englund, 1971). Such factors imply rotational tilting of mobile blocks activated at great, but unknown, depths.

Seismic Interpretations. Where the seismic traverse crosses the Rome Graben, early faulting is recorded (pls. 7-8; f-g, a-b) in four narrow grabens where strata of zone A-1 occur at depths slightly below that in the Orville Banks well (12,254 feet). Basement tilting is evident along marginal faults where varied rates of subsidence are indicated by accompanying deposits which eventually overlapped the basement horsts. To the north, zones A to D are confined by a basement scarp that bounds the Pomeroyton Prominence, whereas onlap of the Perry County Prominence to the south occurred earlier during deposition of zones A and B.

The seismic traverse crosses a step-faulted basement terrace of the Perry County Prominence (plate 8, c-d). The terrace is downthrown east of the Hyden Lineament; to west of the traverse (pls. 2 and 5) and east of the lineament (Leslie A, plate 12). Here, basement is 8232 feet below sea level, which is about the same depth as that where the traverse crosses the terrace block. Eastward throw of this block is inferred from drape folding along the Buffalo Creek Monocline and from decreased magnetic intensity east of the Hyden Lineament, its basement counterpart. Variation in thickness of A-2 appears related to northwest tilting of the basement terrace, evidently in early stages of subsidence and infilling of the Rome Graben. An upward decrease of deformation in the graben is indicated by: Faulted offset of basement; drape-folding of zones A through E; widespread continuity of F (Knox Dolomite), and subsequent erosion known from drill data on the Knox unconformity. This contact is poorly reflected because it separates rock types with similar properties, i.e. dolomite of F and limestone of G, but drilling to the Knox unconformity shows that periodic subsidence was followed by uplift involving Early Ordovician rocks. In areas above and bordering the Rome Graben, zones F and G display complementary thicknesses which show that graben subsidence again followed emergence of the Knox. Zone G thins above both the Pomeroyton and Perry County Prominences but thickens over much of the graben area. This thickening occurs north of a concentration of north-dipping faults (at e, pl. 8). This fault zone also marks the axial trace of later hinged dip reversal of the Southeastern Kentucky Uplift (discussed below).

Reversed Dip and Hinged Uplift South of the Rome Graben. Rocks of Carboniferous age thicken persistently southeastward across eastern Kentucky (Englund, 1971; Froelich, 1973) but the dip on these same rocks is reversed to the northwest where they cross the Rockcastle River and Warfield Lineaments (plate 4). This gradual thickening toward the Appalachian Basin was measured between marker beds, mapped in detail and logged in drillholes in areas as far south as the Cumberland Allochthon of southeastern

Kentucky, Tennessee, and Virginia. Cosgren and Rice (1979) show that the unconformable base of the Pennsylvanian dips to the southeast except where it locally flattens out just north of the Allochthon Front. Thickening of Carboniferous strata into the Appalachian Basin, combined with progressive downward steepening of dip on older beds (pls 7-10) seem best explained by protracted tilting of underlying basement caused by basinward subsidence, reactivated by stages at least as early as Late Mississippian and persisting into latest Pennsylvanian time.

By contrast, south of the Rome Graben the same shallow beds dip northwest into the Eastern Kentucky Syncline (pl. 4). Wedge sediments that had accumulated on Carboniferous slopes were later tilted upward to form the Southeastern Kentucky Uplift. This dip reversal south of the Rome Graben responded to hinged tilting of the basement, buckled upward from great depth. Shallow dips of the more recent deposits were reversed, but the amount of hinged rotation was not sufficient to reverse steeper dips of older beds that had experienced the cumulative effects of repeated tilting during gradual basinward downwarping of the supporting basement.

Interpretive Notes. Stratified rocks at similar depths in the Rome Graben and Floyd County Embayment (pls. 8-9) imply early subsidence began in both grabens at about the same time and along preexisting sets of crossfaults which include: 1) East-west and north-south fault sets of the Eastern Interior Aulacogen (Harris, 1978) and; 2) others of northwest and northeast strike that bound the Embayment as well as other graben throughout the area. The rectilinear habit, variable strike, and lateral offsets among the fault sets imply they formed as conjugate shears, and crossing or abutting relations suggest differently directed transverse slip preceded graben subsidence in Proterozoic (?) and Cambrian time.

Just east of the traverse, the Floyd County Embayment joins the Rome Graben from the south across the Rockcastle River and Warfield Lineaments. It extends into southeastern Kentucky where it is truncated by northeast-striking basement faults of the New York-Alabama Lineament (King and Zietz, 1978). Blocky patterns of surface folds, and corresponding magnetic gradients, indicate buried faults inherited from basement. Their angular junctures suggest that the ancestral faults were once coextensive but were later displaced. Lateral offsets reflect cumulative effects of horizontal stress; and vertical offsets determined from mapped stratigraphic relations, seismic and drilling data, record uplift and subsidence along many of the same faults. Northwest vergence during compressive buckling of the Southeastern Kentucky Uplift is implied from its northeast trend, hinged along the Rockcastle River and Warfield Lineaments, and tilted upward from the south prior to more northerly thrusting of the Cumberland Allochthon.

The regional dip reverses from southeast to northwest where the traverse crosses the Tiptop Syncline as shown on Plate 4; and just south of drillhole Breathitt County A, Plate 12. The hinge zone extends irregularly both westward along the Rockcastle River Lineament and eastward along the Warfield Lineament though offset slightly north of the Lambric Fault. Surface rocks to the north of the Tiptop Syncline dip toward the Appalachian Basin, but at a gentler angle of dip than that of deeper, seismically recorded strata. Between the Tiptop Syncline and the Pine Mountain Fault the surface rock dips northwestward all across the Southeastern Kentucky Uplift, whereas the original southeast dip persists at depths recorded by the seismic data. These data also suggest compression across the hinge zone, marked by backthrusts that extend upward through most of the Paleozoic section overlying the southernmost downthrown block of the Rome Graben (at e, pl. 8). Similar local zones of imbricate reverse faults (described later) also occur to the south beneath the Allochthon front, thereby recording hinged squeezing caused by northwest compression along both edges of the uptilted block. This buckled uplift as well as transverse offsets of basement anomalies required mobility of the transported blocks at great, but seismically unrecorded, depth.

The irregularly offset traces of monoclines and synclines and corresponding magnetic gradients along the Rockcastle River and Warfield Lineaments combine to suggest their inheritance from basement fault blocks variably offset along the southern boundary of the Rome Graben. Ancient coextension of the lineaments across the Floyd County Embayment is inferred from subparallel trends of disjointed segments. For example, the Tiptop Syncline just east of the traverse is alined with a seismically detected fault. The Lambric Fault (Danilchik, 1977) strikes parallel to this syncline but is dextrally offset to the southeast. A similar fold, north of the Warfield Fault and Kermit Dome (Huddle and Englund, 1962; this paper) is draped northward into the Martin County Depression which extends eastward into West Virginia. This downthrown block is here included in the Rome Graben, but its original coextension with the Middle Kentucky Terrace, and subsequent sinistral offset east of the Olive Hill Lineament, is presumed.

Much later tilting of the Southeastern Kentucky Uplift and overthrusting of the Cumberland Allochthon blocks involved Late Pennsylvanian sediments which are the youngest preserved in this part of Kentucky, those of Permian and younger age having been eroded. Fault-related diatremes, dated as Permian (Brown, 1977; Zartman and others, 1967) also occur at the juncture of the Olive Hill and Woodward Lineaments. These intrusions occurred during interblock movements which I propose included minor sinistral and dextral offset along preestablished faults of the Olive Hill and Woodward Lineaments, respectively. Offsets of Carboniferous rock in this area record north- and west-directed compression and thus may be related to Alleghenian orogeny to the east and south. Late Pennsylvanian strata included in the Southeastern Kentucky Uplift and Cumberland Allochthon also limit the ages of these structures which formed under northwest- and north-northwest directed stress. Their trends parallel the strike of the Middle and Southern Appalachians, again suggesting their affinity.

THE FLOYD COUNTY EMBAYMENT OF THE ROME TROUGH

The Floyd County Embayment is a gravity and magnetic trough inferred by Ammerman (1976) to reflect a structural depression west of the Pike County High. My seismic investigations support his interpretation and further suggest the embayment is a rifted branch of the Rome Graben, an aulacogen that developed at a high angle to the graben as part of a crosscutting regional network of such features, of Proterozoic to Cambrian age. From its juncture with the Rome Graben the embayment extends southeastward between the Perry County Prominence and Pike County High where it abuts the northeast-striking New York-Alabama Lineament (King and Zietz 1978). Southeast of the embayment the seismic data (plate 10) record: 1) Basement faults that correspond with this lineament; 2) the Wise County Prominence, a narrow basement horst of unknown extent; and; 3) the Fishtrap Lake Depression, a broad negatively anomalous block downthrown east of the lineament. In the Blue Ridge Province southeast of this area, Rankin (1976) defined an aulacogen of the Iapetus Sea that alines with this embayment. The embayment is not traced across the intervening Fishtrap Lake Depression, however, and transverse faulting suspected along the New York-Alabama Lineament would have offset earlier structures, so it seems unlikely that the graben were originally coextensive.

Seismic Interpretations. The seismic traverse follows an irregular easterly and southerly course across the Perry County Prominence, Floyd County Embayment, and Wise County Prominence. The thickest Paleozoic section measured from the data occurs over the trough of the Floyd County Embayment (plate 9, a) where the reflection time between Precambrian basement and the 1100-foot datum is 2.1 seconds or about 13,500 feet (calculated using a depth-to-time ratio of 12,420 feet in 1.75 seconds scaled from depth to basement in the Stratton well, Pike County A; pl. 3).

The nature of early faulting in the embayment is similar to that previously described in greater detail in the Rome Graben. Earliest dilation and subsidence occurred where zones A-1 and A-2 are thickest: In the broad central trough; and in narrow graben (9b and 10a) flanking the basement prominences. Faulting also was active intermittently during deposition of zones B through F: Zone B thickens toward the middle of the embayment; C is of more uniform thickness implying quiet deposition, but is also faulted; the base of D is again bowed downward over the embayment implying further subsidence, but thins abruptly above bounding faults that flank the prominences (9c, 10b). Zone D overlaps both the Wise County Prominence and Fishtrap Lake Depression, marking cessation of Cambrian faulting in the area beyond the embayment. Over the embayment trough, however, increased thicknesses of zones E and F imply subsidence must have resumed in Late Cambrian time (9d-9e).

Zone H-2 (10c) is first evident just southeast of a zone of backthrusts (9f) in the Floyd County Embayment. Here it extends eastward and southward to the limit of the seismic traverse. H-2 is roughly correlated with the lower part of the "Corniferous", a driller's term for interbedded carbonate and clastic rocks of Silurian and Devonian age (Freeman, 1951). Local thickening of section in this interval is known from drill data. In the Signal Oil Stratton well (Pike County A; plate 12), shale and sandstone of the basal Silurian Clinton Formation (not logged in wells to the west) occur near the base of zone H-2. On the drill-log, the total interval from the base of the Silurian to the Mississippian (H-2, I, and J) is 2,100 feet, whereas rocks of Devonian age (I and J) thin to 950, 840, and 530 feet in drillholes Breathitt A, Leslie A, and Wolfe H, respectively (plate 12). Isopach mapping by R.C. Shumaker (West Virginia Univ., oral commun. 1986) shows that Late Devonian Berea Sandstone thickens east of a pinch-out edge which crosses the traverse at the west edge of zone H-2. Thickening of zone J (which would include the Berea) is not apparent along the line of section but the Berea is 117 feet thick in the Stratton well to the northeast. Thus, intermittent subsidence in at least the northern part of the embayment, must have continued into Late Devonian time during Berea deposition.

Compressional Uplift. Silurian rocks of H-2 extend southeastward beneath sole faults of the Cumberland Allochthon where zones I and J (Devonian Ohio Shale, Berea Sandstone, and Sunbury Shale) are ramped upward above H-2 as fault slivers of the Pine Mountain System (10d). These forethrusts truncate rocks earlier deposited in the Floyd County Embayment which were later upthrown as reactivated fault blocks of the Southeastern Kentucky Uplift. The hinged uplift of underlying basement prior to overthrusting is recorded by south-dipping monoclinal folds and a corresponding succession of reverse faults which extend upward and terminate beneath the crosscutting overthrusts (10a,b,d). This may be the same zone described earlier (pl. 9, e-f) close to the allochthon to the west where north-directed compression is also indicated.

I infer: Northward tilting of the Southeastern Kentucky Uplift caused reversal of the original southeastward dip of Carboniferous deposits flanking the Appalachian Basin. These beds were rotated upward to their present northwest dip but older strata still dip to the southeast, except near the edge of the embayment where basement is now horizontal. Late Pennsylvanian rocks involved in the uplift have been eroded just north of the allochthon but crop out to the north as well as south of the Pine Mountain front. Faults of this system strike east-northeast and, together with those of the Cumberland Fault System to the south (plate 4), ramp upward from a "master decollement" (Harris, 1976; Cook and others, 1979; Milici and others, 1979; Harris and others 1981) that underlies a succession of additional ramp faults of the Appalachian orogen. The northeast trending Eastern Kentucky Uplift parallels the Alleghenian structures to the east and north whereas the overthrusts reflect more northerly vergence equated with younger Middle Appalachian structures to the southeast.

Transverse displacements that involved basement are shown by blocky anomalies on the geophysical maps, and concordant offsets among faults and folds mapped at the surface (plates 4 and 5). These gentle structures show that moderate interblock movements occurred after Pennsylvanian time, but more extensive offsets of the basement blocks have resulted from cumulative movements that began in the Precambrian. Strike slip is exemplified along the trace of the Olive Hill Lineament. This trends southeastward across part of Ohio and northeastern Kentucky; thence irregularly southward across the Middle Kentucky Terrace where it separates offset domes of the Paint Creek Uplift and adjoining basins of the Rome Graben, downthrown to the south and east; and again southeastward bordering the Floyd County Embayment. As much as fifteen kilometers of sinistral slip is implied along ancestral faults of the Olive Hill Lineament _if_ the Little Sandy and Paint Creek Faults west of the Lineament and Willard-Burnaugh Monocline and Blaine Fault to the east were once coextensive. Westerly compression directed across the lineament is also indicated by upwarping of the Paint Creek Uplift and dextral offsets among impingeing blocks separated along the Woodward, Paint Creek, and Warfield Lineaments. North of this area the Eastern Kentucky Platform is also set northward along the Olive Hill Lineament which veers northwest. Here the Northeastern Kentucky Prominence reflects a basement uplift of Cambrian age, earlier defined by McGuire and Howell (1963) from deep drill data. To the northwest in Ohio, the Olive Hill Lineament and the Kentucky-Ohio Trough intersect. Here too northeasterly uplift and left-lateral offset of basement is suggested by the anomaly patterns (fig. 5).

Igneous bodies, bordering the Rome Trough and sampled where the Woodward and Olive Hill Lineaments intersect, indicate fault-related intrusions in Precambrian and Permian time. The rock types include: 1) Rhyolite (Black and Force, 1982), collected as unaltered drill samples overlying highly metamorphosed Grenville basement drilled in the same well; and 2) kimberlite diatremes mapped by Brown (1977), which crop out near the junction of these crosscutting basement faults. The rhyolite is similar to that in flows of the Kentucky-Ohio Trough, which are also fault-related and of equivalent Proterozoic age (Black, 1986a). The kimberlite was radiometrically dated as Permian by Zartman and others (1967) so the diatreme intrusion probably accompanied basement faulting renewed at that time. Separate intrusive events are indicated by the incompatibility of the two rock types which were derived from different magmas. The trace of the Olive Hill Lineament in Ohio is tangent to the Adams County cryptovolcanic structure (Bucher, 1933), one of many such circular structures mapped at the surface in this region. All of these occur along geophysical lineaments, which with other data (Black, 1986b) suggest their relationship to reactivated basement faults, though this is controversial.

Several conflicting opinions have been offered regarding the eastward trend of the Rome Trough beyond the limits of surface faulting (Woodward, 1961; Summerson, 1962; Heyl, 1972; Silberman, 1972). In the study area I suggest it is bounded by the Kentucky River-Woodward Lineament on the north and by the Rockcastle River and Warfield Lineaments on the south (plate 5). The Floyd County Embayment is bounded on the west by the Perry County Prominence and, apparently, on the east by a similar uplift reflected by the Pike County High, as also inferred earlier by Ammerman (1976).

FEATURES OF THE CUMBERLAND ALLOCHTHON

Pine Mountain Fault System. The seismic traverse follows a winding road southward across Pine Mountain (plate 3). Thereafter the section is broken, parallels the Cumberland Allochthon front, is again broken and thence veers southward down the southerly dip of strata of the allochthonous plate. North of the allochthon, the gentle northerly dip of rocks of the Southeastern Kentucky Uplift is shown in red on the structure profile (pls. 9 and 10). Steep dips of rock of the overthrust plate were not contoured so the red line terminates in this area. Devonian strata crop out locally in fault slivers along the sole of the allochthon, and Mississippian and Pennsylvanian rocks crop out on the north face of Pine Mountain. Formation contacts were projected downward so as to intercept equivalent reflectors. Near-surface structural relations were plotted without vertical exaggeration based on a geologic cross section drawn perpendicular to the strike of the Pine Mountain Fault System (Rice, 1973). The ratio of horizontal to vertical scale was measured as 1.0 : 0.8 in deep drillholes. Drill data from an undisturbed area in Pike County were projected to the line of section at two places. These data were scaled to the time sections and used to determine seismic signatures of the drilled units which were then compared with similar signatures in the area of imbricate thrusting. The resulting interpretations appear to be structurally sound. Fault slivers like those on the seismic profiles (10f), were also mapped along the Pine Mountain front above the sole of the allochthon (refer to cross sections on the geologic reports in this area; table 1; fig. 21).

Seismic Interpretations. In projections made between the surface and seismic sections in the Pine Mountain area, I have correlated zones K and L with the Grainger Formation and Newman Limestone of Mississippian age; and zones J and I with Devonian and Mississippian Sunbury Shale, Berea Sandstone, and Bedford Shale (Rice, 1973). This places zone J in an interval roughly equivalent to the youngest Devonian rocks in areas to the west where the Sunbury Shale, the uppermost unit of the Chattanooga black shale sequence, is absent. In the region south of Pine Mountain, thicknesses shown by reflector zones I, J, K, and L (plate 10) correspond with stratigraphic units in the Stratton well (Pike County A, plate 3). The same distant well data were projected north of Pine Mountain where the intervals conform with the deep strata, but reflectors higher in the section do not.

Faults of the Pine Mountain System were defined by: Oblique reflectors evident from the profiles; stratigraphic offsets; and curved traces of dragged bedding recorded by strata adjoining the oblique reflectors. At least two buried surfaces of decollement are indicated by the relations of the major ramp faults. One of the zones (g) approaches tangency above zone E, the Cambrian-age Nolichucky Shale, where horizontal slippage is indicated by ramp faulting here and to the west. The other (at h) is asymptotic to the base of zone I, here correlated with the Ohio Shale (basal Chattanooga equivalent) where slippage has also been recorded by the mappers in several areas along the fault system. The seismic profile data do not indicate disruption of bedding in areas south of the Pine Mountain Fault System; nevertheless an inferred sole fault is drawn at the base of the Chattanooga. A slip surface parallel to bedding at this level is implied by about six miles of offset indicated by segmented fault slivers (f) thrust along ramp faults that curve upward from this horizon.

Interpretive Notes. Thrust-related shortening of section caused by this imbricate faulting was estimated by realinement of offset strata, particularly otherwise continuous segments of zone J, recognized in fault slices bounded by the oblique ramp faults. Displacements were measured horizontally rather than along the traces of the oblique reflectors. This allowed comparison with strike-slip displacements of allochthonous blocks reported east and west of this area. Right-lateral displacement of about four miles was reported from facies offsets along the Russell Fork Fault east of this area (Englund, 1971), whereas about twelve miles of left-lateral strike slip occurred along the Jacksboro Fault which forms the western boundary of the allochthon in Tennessee. The six miles of foreshortening in this area thus is proportional to displacements to the east and west, and the differing amounts of displacement indicate clockwise rotation of the allochthonous plate during transport to the north-northwest.

Sole faults of the Pine Mountain System truncate faulted strata of Mississippian and Pennsylvanian age involved in the Southeastern Kentucky Uplift. Northwestward compression caused tilted uplift of basement; and reversal of the earlier southeast dip of these strata. Monoclinal folds and backthrusts that occur beneath and north of the overriding Cumberland Allochthon, define the area of uplift (10e, 9g) and also its earlier Allegheny age.

THE NEW YORK-ALABAMA LINEAMENT, WISE COUNTY PROMINENCE, AND FISHTRAP LAKE DEPRESSION

Several basement structures that underlie the Cumberland Allochthon are newly interpreted on Plate 10. These include: Faults reflected by the northeast-striking New York-Alabama Lineament of King and Zietz (1978); the Wise County Prominence, a narrow horst upthrown along the lineament trace; and the Fishtrap Lake Depression, a half graben, again downthrown to the east of the Floyd County Embayment but only partly crossed by the seismic traverse. A second traverse that crosses the New York-Alabama Lineament was interpreted by Milici and others (1979; fig. 18). This area is just south of the Powell Valley Anticline of the Cumberland Allochthon where several ramp faults marked by oblique reflectors extend upward from a "master decollement". In an area encompassed by a magnetic gradient similar to that reported here, several seismic discontinuities were noted as possible faults in the basement and Cambrian section, but these were not plotted (Wallace Dewitt and K.C. Bayer, USGS Reston, oral commun. 1988). King and Zietz inferred that the contrast in magnetic intensity on opposite sides of the New York-Alabama Lineament reflected a difference in basement composition. They attributed its linear trace to either a strike-slip fault, or a suture that had joined a separate terrane to the craton during collision. The seismic data would support either hypothesis. However, Grenville rock is exposed east of the lineament (Herz and Force, 1987) and if original continuity of the basement is assumed, the magnetic data appear to indicate great sinistral offset (Hildenbrand, 1985).

Basement Considerations. The New York-Alabama Lineament conforms with the western scarp of the Wise County Prominence. To the southeast, the Fishtrap Lake Depression is expressed by a broad gravity and magnetic low. Although there is a distinct change in geophysical expression across the lineament, there is little relief (i) and no detectable change in seismic character of the basement. Billion-year-old Grenville metamorphic rock has been drilled in basement wells west of the lineament, but I have no record of deep drilling to the east. Aplite occurs at 12,420 feet in the Stratton well (Pike County A; plate 3) just northwest of the lineament along the edge of the Pike County High. The magnetic high could not be caused by the felsic rock, however. Although the aplite is undated, its proximity to the adjacent depression suggests that it may correlate with felsic volcanic flows drilled elsewhere in the region where they occur in graben that subsided in Late Proterozoic and Cambrian (Iapetus) time.

Magnetic and gravity anomalies were compared across the lineament trace by Hildenbrand (1985, p, 255) who postulated 200 kilometers of left-lateral strike slip at some time after the emplacement of the basement source rocks based on their apparent offset. Steep faults that abut reflector zones bounding the Wise County Prominence also suggest that this narrow fault block may have been wedged upward during translation. Though basement has not been drilled east of the lineament, metamorphic rocks of the Grenville Province are thrust to the surface as allochthonous blocks in the Roseland District of the Blue Ridge Province of central Virginia (Herz and Force, 1987). This too suggests that

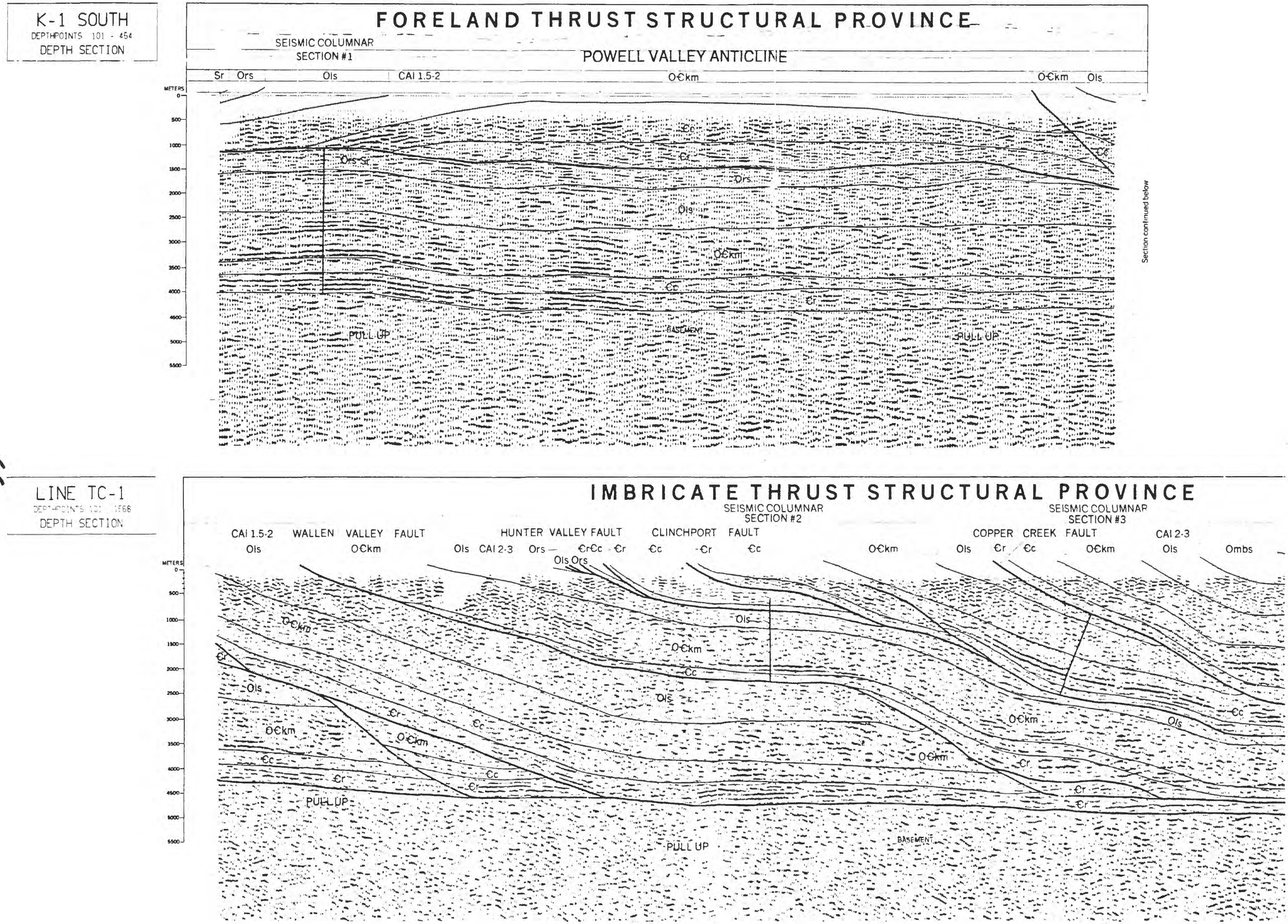


Figure 18. Seismic cross sections interpreted by Milici, Harris, and Statler (1979) in the Valley and Ridge of eastern Tennessee.

the adjacent plates were once connected, and that strike-slip faulting best explains apparent offset of magnetic anomalies. Thus, several periods of faulting and variably directed tectonic forces are recorded by structures related to the New York-Alabama Lineament, Southeastern Kentucky Uplift, and Pine Mountain Fault System. All of these fault zones converge close to the line of traverse where their varied depths and strike directions suggest historic changes in stress in the Appalachian foreland region.

Seismic Interpretations. The New York-Alabama Lineament extends to the northeast and southwest of its crossing of the Pine Mountain Fault System. This strikes east-northeast and diverges from the lineament trace at an angle of about 25 degrees (fig. 5). Basement blocks of the Wise County Prominence are upthrown relative to both the Floyd County Embayment and Fishtrap Lake Depression (pls. 9, 10). The magnetic gradient that defines the lineament conforms with the step-faulted northwest edge of the Wise County Prominence. Early uplift of the prominence is recorded by missing strata low in the seismic section and by reverse faults involving overlying beds. Much later buckling of the Southeastern Kentucky Uplift is also recorded by strata high in the section. Here, beds that earlier dipped to the southeast toward the Appalachian Basin are now horizontal and Carboniferous rocks contoured at the surface now dip northwestward. Here too, zones of reverse faults related to the uplift (9f, 10d) extend up through the section where the affected strata are truncated by still younger thrust faults of the Pine Mountain System (10f). Zones A-2 and B, early sediments in the Floyd County Embayment, abut the prominence which was uplifted both before and after the deposition of zone C. To the south adjoining the Fishtrap Lake Depression, similar uplift is evident where A-2 and B abut the prominence which here too is onlapped by B and overlapped by C. Although horizontal components of displacement along these early faults cannot be determined from the seismic data, vertical components are apparent along steep faults that display variable throw involving basement and reflector zones A through F.

Where the Wise County Prominence adjoins the Floyd County Embayment, drag folds in adjacent beds imply reverse displacement along the northwest face of the basement scarp. The steep dip of oblique reflectors low in the stratigraphic section suggest that these vertical offsets could have been produced by rejuvenated translation of basement in Cambrian time. Alleghenian uplift is implied by faults and folds that extend upward in the section and involve strata as young as Late Pennsylvanian age. North-dipping backthrusts predominate north of the prominence, and forethrusts (10g) that ramp upward from zone E project over the prominence.

A nearly vertical north-trending fault that crosscuts the south-dipping flank of Pine Mountain was mapped close to the allochthon front by Rice (1973). It occurs high in the section (10j) above the basement fault zone west of the prominence. The eastward throw and reverse drag folds recorded east of this fault were interpreted from seismic reflector zones K and L, correlated with the Mississippian Newman Limestone and Grainger formations. The possibility that this fault might reflect strike slip caused by renewed translation of basement blocks adjoining the New York-

Alabama Lineament was considered but seems unlikely. The fault appears to be restricted to the uppermost thrust plate of the Cumberland Allochthon because underlying strata, as well as back-thrusts and fault slices related to earlier forethrusts appear to be intact. This suggests that later strike slip, inferred to have offset Valley and Ridge rocks to the southwest (fig. 19) did not extend into this area. This fault more likely reflects minor shear, caused by one of many such thrusting events.

Interpretive Notes. The New York-Alabama Lineament can be traced southwestward beneath the Cumberland Allochthon where the southeast dip of the magnetic gradient is gentler than elsewhere along the lineament trace (fig. 5). The variation in magnetic field intensity is probably controlled by lithologic differences in the underlying basement rock. The distribution of anomalies on opposite sides of the lineament (Hildenbrand, 1985) suggests that the magnetic source rocks were once connected but were later greatly displaced by left-lateral strike slip along faults that parallel the lineament. Zones of oblique reverse faults higher in the section are truncated by shallow ramp faults of the Pine Mountain System, suggesting that intermittent faulting was caused by separate compressional events. I infer that the earlier fault sets formed during buckling of the Southeastern Kentucky Uplift, caused by northwestward compression as indicated by dip reversal of Carboniferous strata contoured at the surface. The younger faults also formed under compression, but this time from the south-southeast. The relative ages of the successive events established from these data may also apply to parallel structures of the Middle and Southern Appalachians whose regional trends parallel the northeast and east-northeast strikes of the local structures as shown by the SLAR image mosaics (plates 1 and 2).

Northeast of Pine Mountain, two mutually parallel sets of folds that are slightly offset from one another are shown on the north flank of the Southeastern Kentucky Uplift (plate 2). These include the Lookout and D'Invilliers Anticlines and the adjoining Hellier and Pinson Synclines. Their axes strike northeast at an angle to the more easterly trend of the uplift, however, which suggests that compression that caused the broader structure was differently directed than that which later caused the folding on its flank. Both sets of kink folds parallel the New York-Alabama Lineament but are slightly offset from one another. The Hellier and Pinson synclines overlie the trace of the magnetic lineament, and the anticlinal folds are similarly offset and occur just to the northwest. An inherited relationship seems likely between these surficial folds and the Wise County Prominence, but simple drape folding over the ancient basement uplift would not explain their crenulated structure. Their northeast strike also differs from the predictable trend of folds that would be expected to form (Harding, 1974) from youthful strike slip (below) along the New York-Alabama Lineament. Nevertheless, compressional forces late in the history of this area originated at great depth as indicated by: 1) Buckling of basement rock under the Southeastern Kentucky Uplift; 2) susbequent kink folding of the near-surface rocks; and 3) later overthrusting of the allochthonous plate.

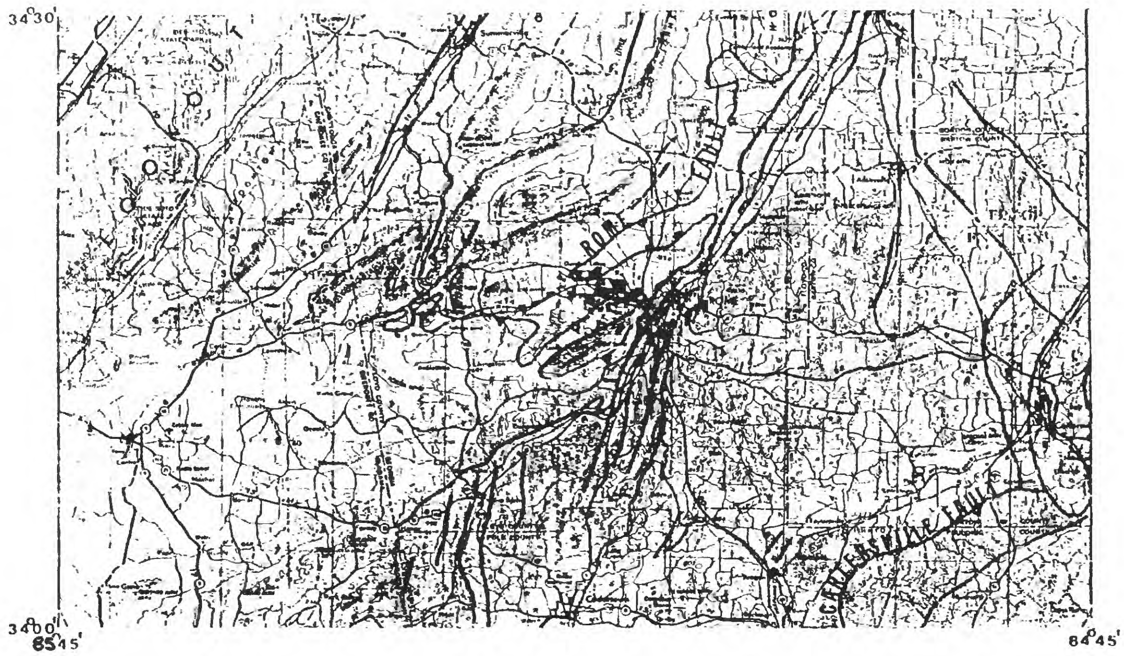
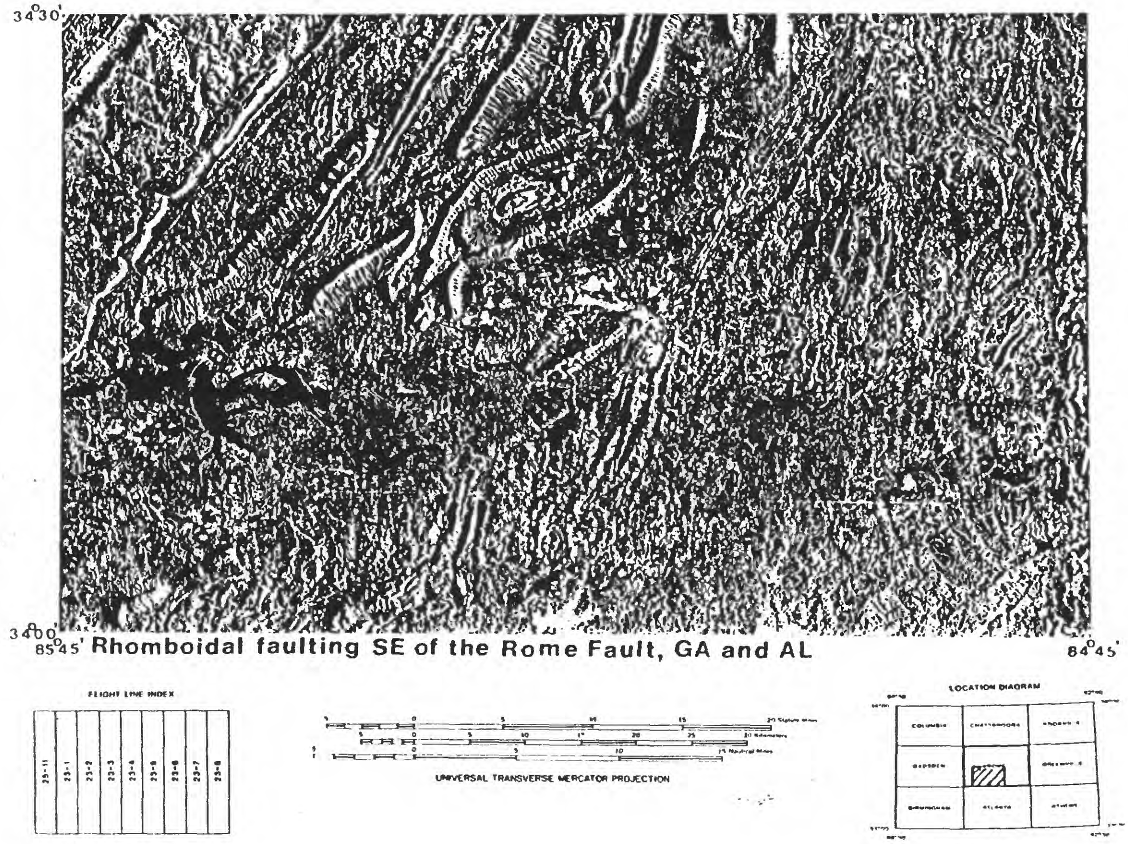


Figure 19a) Mapped faults in the Rome quadrangle (Butts and Gildersleeve, 1948; Pickering, 1976). 19b) Radar image mosaic showing rhomboidal fracture pattern similar to that caused by sinistral faulting in Iran (fig. 14). Arrows depict inferred slip along these faults, and also along faults to the north where previously folded Valley and Ridge strata exhibit clockwise rotation and drag faulting along an offset in the Rome Fault.



Transverse Displacement. Differing geophysical character on opposite sides of the lineament implies a lithologic contrast in the basement terrane. The differences are not apparent from the seismic data, and vertical components of faulting appear to be of insufficient magnitude to cause a change in magnetic intensity. Transverse displacements of the ancestral basement might explain these differences, however, as suggested by several factors. These include: 1) the rectilinearity of the lineament trace and the abrupt change in geophysical signature first noted by King and Zietz (1978); 2) misaligned magnetic and gravity anomalies on opposite sides of the lineament, potentially offset by left-lateral slip of about 200 kilometers (Hildenbrand, 1985); and 3) rhomboidal structure that reflects rejuvenated left slip along the Rome Fault (Black, 1986b), possibly related to translation of basement along the lineament in Georgia and Alabama.

The rhomboidal fault pattern (fig. 19) is interpreted from radar image data compared with the mapped geology. The faulting is analogous with that caused by left-handed slip of the Dasht-E'-Bayaz fault in Iran (Tchalenko and Ambraseys, 1978) and right slip determined from mapping in Kentucky, (Black, 1986b). The Rome structure: 1) lies east of the lineament, 2) occurs near an offset in the trend of the Rome Fault, 3) reflects northeasterly left-lateral strike slip, 4) at some time following Alleghenian compressional folding and faulting of rocks of Pennsylvanian and older age in the Valley and Ridge west of the Rome Fault.

The Fishtrap Lake Depression is reflected by a broad magnetic low. The isogams trend north-northeast and intercept the northeast-striking New York-Alabama Lineament at a small angle, possibly suggesting the presence of deeply buried cross-faults. The lineament trace, though slightly offset, is nearly rectilinear, and strike-slip displacement would appear to be indicated at some time in its history. The irregularities occur at junctures with magnetic lows expressed beyond the lineament to the northwest. Such lateral offsets occur at intersections with both the northeastern and southwestern borders of the Floyd County Embayment (plate 5) and to the southwest as shown on the regional magnetic map (fig. 5; Zietz, 1982) in the area just north of Knoxville, Tennessee, where a narrow trough, herein identified informally as the Knoxville Lineament, is shown to intercept the major lineament trace. To the northwest of this juncture, the Knoxville Lineament is irregularly offset but trends dominantly northwestward where it can be traced (plate 5) into south-central Kentucky just north of the Tennessee border. Apparent offset along the Knoxville Lineament is left-lateral, and the southwest and northeast margins of the Floyd County Embayment display left- and right-lateral offsets, respectively. A fourth offset, also left lateral, occurs just northeast of the Pike County High as displayed on the regional magnetic map just across the Kentucky border in West Virginia. At their junctures with the New York-Alabama Lineament these inferred faults only slightly offset its trace, in contrast to greater offsets at lineament intersections observed in areas to the northwest. This suggests slippage along the major lineament truncated older fault blocks which, during later movement, again offset its trace.

SUMMARY AND CONCLUSIONS

This study of the history of eastern cratonic tectonism has demonstrated an inherited relationship between mapped structures of Paleozoic and later age, and ancestral faults that developed during widespread rifting and volcanism in Late Proterozoic and Cambrian (Iapetus) time. Pricipal contributions have included: 1) The compilation of regional structure-contour maps throughout central and eastern Kentucky based on field mapping at 1:24,000-scale, 2) comparison with similarly extensive magnetic, gravity, and airborne-radar data, 3) interpretation of a line of seismic-reflection profiles across eastern Kentucky and part of Virginia, 4) correlation of surface and subsurface strata from drill data, and 5) petrologic analyses of Precambrian basement rock types. Where possible, analogous structures mapped by workers in other areas also were used to interpret apparent genetic similarities.

The strike, sense of displacement, and the irregular traces of faults ancestral to the surface structures were determined by the combined use of the empirical data, and many buried faults were successfully located. Based on this information, parts of the tectonic history of a large area of the cratonic interior of the southeastern United States have been interpreted, reaching back about a billion years into Grenville time. Remobilization of basement fault blocks caused upward propagation of inherited faults marked by lineaments where predicted oil and gas fields were subsequently discovered. Similar mapping should help in future exploration for structural traps and mineral deposits in this and other mildly deformed regions of the midcontinent.

Methods Some faults that were mapped at the surface were known from drilling to intercept and offset Precambrian basement rock. These are evident, both on the structure-contour maps and on the seismic profiles. They, and other buried faults crossed by the traverse line are commonly adjoined by linear folds which, together with many untested surface faults and folds in other areas, were found to parallel or coincide with linear gradients detected on the aeromagnetic and gravity maps. The corresponding aspects of the multiple data sets thus indicate that many of the faults that had offset Precambrian basement were later extended upward through the overlying Paleozoic section. This implies magnetic gradients are potential harbingers of ancient faults elsewhere. The combined data were used in the interpretation of polygonal basement anomalies bounded by tectonic lineaments which have been plotted on both the aeromagnetic and structure-contour maps to illustrate corresponding features. The seismic profiles confirm the location of these reactivated basement blocks, and relict drag features also record past displacements along some of the faults that suggest differing conditions of stress at various times. Both normal and reverse offsets occur, in many cases along the same faults, and various tectonic events are relatively dated by their effect on involved stratigraphic units. Fault concentrations that disrupt thick successions of Paleozoic strata occur at widely spaced intervals in zones that overlie ancestral basement faults (except in the areas of Appalachian thrusting); and where the younger rocks are undisturbed basement is unbroken. This suggests a deep-seated origin for the intracratonic faults.

<u>Deep faults</u> Tilted offset that occurred among basement blocks in Cambrian time, was later renewed by gentler flexures along the same faults. The attitudes of the basement blocks are displayed seismically by an originally planar unconformity. This was drawn at the contact of skewed and discontinuous reflectors that characterize the Precambrian crystalline rock below, and laterally persistent zones of alternately banded and unbanded reflectors that define the overlying layered sedimentary rocks. Intervals between selected lithologic contacts and local faults were measured from driller's logs scaled to the seismic profiles. These were correlated with well-defined reflector zones including the basement unconformity. Their correlation allows interpretive reconstruction and dating of tectonic events, based on relations of continuous zones of undisturbed reflectors and local offsets, commonly bounded by oblique reflectors. Some of these faults do not reach the surface, and their absence also helps to delimit the ages of events that predated deposition of exposed strata.

Ancestrally faulted crustal blocks are shown to have moved independently and also as composite slabs at various times. They have been downfaulted, uplifted, variably tilted, and laterally offset with respect to one another by past extension and variably directed compression. Both vertical and lateral offsets shown by the basement graben and adjacent horsts, developed chiefly during Cambrian sedimentation. Renewed faulting that occurred later in Paleozoic time can be dated by regional unconformities and local stratigraphic relations, and the seismic data record an upward decrease in the magnitude of stratigraphic offsets.

<u>Shallow faults</u> Reverse drag, also mapped in surface rocks of Ordovician through Pennsylvanian age, is recognized at various levels on the seismic profiles where southeast-dipping reflectors here called forethrusts, and opposing backthrusts have offset the adjoining beds. Though slippage parallel to bedding can only be inferred, it is required to account for horizontal components of displacement displayed by the ramp faults. Decollement surfaces are indicated where the oblique reflectors approach tangency with underlying strata, notably: banded reflectors correlated with the Chattanooga Shale of Devonian and Mississippian age, and Cambrian Nolichucky Shale. However, tectonic mobility is also required at much greater depth; to allow for vertical offsets of the basement surface, as well as lateral offsets indicated by the grid-locked mosaic of ancient fault blocks interpreted from the geophysical and geological maps. Basement features that might explain these relationships were not recognized at limited depths recorded by the seismic survey, but offsets of the fault blocks suggest deep-seated flexures which I have attributed to continental migration.

<u>Mechanisms</u> Compelling evidence of recurrent translation, subsidence, and uplift among ancient fault blocks in this area appears to be compatible with plate-migration theory advanced by workers in other areas. Variably directed forces, apparently generated at great depth, have produced an interlocked mosaic of fault blocks whose original fabric may have resembled that of post-Cretaceous transform structures separated by a network of orthogonal faults like that on Figure 20. In this model, the basement blocks are assumed to have been transported as elements

Figure 20. Bathymetric map showing post-Cretaceous transforms of the western Atlantic (National Geographic Society, 1975).

of an accreting but otherwise passive continental plate, buckled by subcrustal forces in a manner analogous to jostling of floe ice. Horizontal migration and sinusoidal flexing of the plate presumably would have caused dilation, subsidence, uplift, and translation, both internally among impingeing blocks and along the plate margins. This mechanism would explain widely disparate structures within constraints imposed by the limited strength of the rocks, whereas their ability to transmit stress over required horizontal distances is questionable. I infer that local flexure within this mobile block mosaic of continental scale has produced the observed lateral and vertical displacement. It also accounts for structures that appear to have developed at about the same time, but under locally differing conditions of stress.

HISTORY

A partial history of tectonic events, partly pre-dating but mostly following unconformable erosion of the basement rocks, is summarized below from local observations discussed throughout the report. The dating of events and kinematic interpretations are based on structural and stratigraphic relations mapped in outcrop and on subsurface relations interpreted from the seismic profiles and magnetic, gravity, and deep drilling data. Isotopic ages of Grenville basement and Permian diatremes were taken from earlier reports. Relative ages of undated intrusive rocks are implied by low-grade metamorphism of mafic samples, and the apparent lack of alteration of younger rhyolite and overlying sedimentary rock.

Precambrian events. The earliest events I have been able to interpret in this region were the uplift, erosion, and attendant lowering of geothermal temperature in Grenville time, following granulite metamorphism of the basement. Magnetic satellite data that sense to a depth of 40 km (Mayhew and Estes, 1980; fig. 12) record a positive anomaly, bounded on the west: By The Grenville Front in Canada, by the Indiana Arm to the southwest, and by the Reelfoot Rift in the Mississippi Embayment region (fig. 5). A progressive decrease in the radiometric age of these rocks occurs from west to east, both in drill samples from Ohio and Kentucky (Bass, 1960; 1970) and in Canadian Grenville outcrops as well (Wynn-Edwards, 1972). Tilted uplift that advanced progressively to the east can explain these relations, and also agrees with current geochronological theory (J.G. Arth, USGS, oral commun., 1985). This uplift, and attendant lowering of temperature as the overlying thicknesses of rock were removed by erosion, would have had the effect of "setting the clock" at different times as this uplift and resultant cooling progressed eastward. Though Black and others (1976; 1979) earlier equated the Grenville Front with the trace of the Lexington Lineament, felsite to the west appears to be younger, not older than Grenville to the east. I now infer that both rock types occur to the west in a graben of Cambrian age, the Kentucky-Ohio Trough, and that the Kentucky Anomaly of Mayhew and Estes (1980) reflects an earlier uplift whose gradual emergence caused cooling recorded by progressive differences in the ages of crystallization. This suggests that the metamorphic front did not occur in a vertical plane, but instead lay parallel to the cooling surface where crystallization proceeded outward, away from the area of uplift, and with decreasing depth.

Regional Faults of Late Proterozoic to Early Cambrian Age These define a basement block mosaic that developed in at least two stages. The early faults were intruded by mafic dikes which were later altered to greenschist grade together with enclosing Grenville granulitic wall rock. These rocks were then eroded to a surface of low relief expressed by a seismic disconformity. A second set either preceded or accompanied graben subsidence and infilling, first by rhyolite that has not been metamorphosed, and then by overlying sediments which also are fresh. The mafic dikes and adjacent faults have been offset, but their original trends were probably northwest and northeast. They parallel the Olive Hill, Lexington, Shelbyville, and Glasgow Lineaments in this area, and also other faults reflected by edge anomalies to the west (Braile and others, 1982). The rhyolite flows are preserved in the Kentucky-Ohio Trough and Floyd County Embayment along such northwest and northeast-trending faults, and similar flows in the Rome Trough and Rough Creek Graben indicate that a more easterly fault set had developed prior to graben infilling. East- and east-northeast trending faults bounding the grabens are coupled with conjugate faults that strike north to north-northwest. Dilation that continued along these faults into Late Cambrian time was coeval with Iapetus spreading to the east.

Block rotation caused by the intrusion of basalt is also indicated, for example by wedge-shaped anomalies on both sides of the Kentucky-Ohio Trough, as shown by the Somerset Prominence of the East Continent Gravity High and by the Louisville High to the west. Continued spreading during rhyolite emplacement also can be inferred from the southward divergence of lineaments bounding the trough. Rotation also is evident where the northeast strike of several geophysical troughs veers northward in Indiana, Ohio, and West Virginia. Rhyolite was also inferred in a trough which follows the Kankakee Arch in Indiana (Henderson and Zeitz, 1958).

Early Paleozoic events include: Graben infilling by marine clastics and carbonate deposits of Cambrian age both during and following rift subsidence; later uplift and emergence followed by erosion and karstification of the Knox unconformity in Ordovician time; renewed submergence and tectonic quiescence accompanied by marine deposition of Ordovician and Silurian strata; and north-directed compression in pre-Devonian time. Northerly (Oachita ?) compression resulted in: 1) Offsets of the east-trending faults by northwest and northeast striking sinistral and dextral faults; 2) *en echelon* wrench faults in pre-Devonian carbonate rock, where veins of Ba, Fl, Pb, Zn and oil and gas fields all occur along north-striking extension fractures that bisect conjugate shears; 3) circular explosion structures that overlie the basement shear zones where intake of sea water and escape of high-pressure steam have brecciated the near-surface rocks; and 4) uplift and erosion of Silurian and older rocks recorded in south-central, central, and eastern Kentucky, in all cases along east-trending faults.

Middle Paleozoic events Renewed subsidence, onlap, and eventual overlap of rocks underlying the unconformity is recorded by shale deposits of Middle to Late Devonian age but, at least locally, only about 25% of the total structural relief developed prior to this time, as shown by structure contours on Silurian and Ordovician strata along the Kentucky River Fault System. Devonian and Early Mississippian shale is preserved in a graben along the Lexington Fault System. This follows the northeast trend of the Cincinnati Arch and suggests that initial uplift of the Arch did not begin until some time after the deposition of these marine strata, eroded elsewhere on the Jessamine Dome. They are preserved, however, all across southern Kentucky and both west and east of the Dome. This suggests buckled uplift of the Arch happened later, perhaps during pre-Allegheny downwarping of basement into the adjoining Illinois and Appalachian Basins. The attitudes of fault blocks flanking the faulted crest of the Arch are shown by structure contours drawn on the younger rocks (plate 4). These strata dip variably westward into the Illinois Basin, and southeastward into the Eastern Kentucky Syncline where the southeast dip of shallow Carboniferous rock has been reversed to the northwest by the Southeastern Kentucky Uplift. Here too, local flattening of the deep reflector zones, which resume their southeast dip beyond the Uplift, suggests basinward subsidence of the older strata preceded upward flexing of the entire sequence.

Late Paleozoic events Concurrent uplift of the Cincinnati Arch and subsidence of the adjoining basins was complicated by periods of extensional as well as compressional faulting, shown by stratigraphic relations to have occurred at various times and in various areas during the Carboniferous. In southeast Kentucky and environs, subsidence was relatively continuous as implied by intertonguing of marine, deltaic, and continental deposits, while to the north intermittent periods of compression and transverse faulting were interspersed with relaxation and block subsidence. Unconformable erosion of marine rocks of Mississippian age was followed by subsidence and deposition of deltaic Pennsylvanian strata cut by crossbedded orthoquartzites, riverene deposits that record southwestward flow across eastern Kentucky. Intervals between coals and extensive zones of marine fossils in Middle and Upper Pennsylvanian strata, all thicken to the southeast and record intermittent subsidence of the Appalachian Basin. Except for fault-related diatremes of Permian age, Late Pennsylvanian deposits are the youngest Paleozoic rocks preserved in eastern Kentucky. The Mesozoic and pre-Tertiary Cenozoic rocks have been eroded, but the older rocks provide evidence of later tectonism. Events that occurred during and after basinal subsidence include: 1) Intra-basinal faulting of large blocky structural depressions and bounding uplifts that divide the Eastern Kentucky Syncline; 2) hinged tilting south of the Rome Graben now recorded by the Southeastern Kentucky Uplift; 3) overthrusting and strike-slip faulting caused by northwest- to west-directed Alleghenian compression, both across and along the trend of east-northeast-striking faults in eastern Kentucky; 4) lateral offset of north-striking pre-Devonian veins caused by east-west compression in central Kentucky; and 5) rhomboidal faulting that indicates opposing vergence related to buckling on opposite sides of the Cincinnati Arch. Because of erosion, the history of buckled uplift of fault blocks that support the Arch is only partly recorded. Uplift may have been generated, however, by flexures involving basement rock concurrent with Appalachian compression.

Sub-parallelism of the faults suggests that structures of the cratonic interior were somehow related to the outlying orogenic episodes. However, strength limitations of the affected rocks suggest passive transport and rippling movements of the mobile craton rather than direct transmission of horizontal stress, at least not at the shallow depths of the Proterozoic block mosaic.

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APPENDIX

TABLE 1. USGS GEOLOGIC QUADRANGLE REPORTS IN CENTRAL AND EASTERN KENTUCKY.

TABLE 2. INDEX TO DRILL DATA USED IN TECTONIC INTERPRETATIONS.

TABLE 3. COMPOSITIONAL ANALYSES OF PRECAMBRIAN BASEMENT SAMPLES IN KENTUCKY.

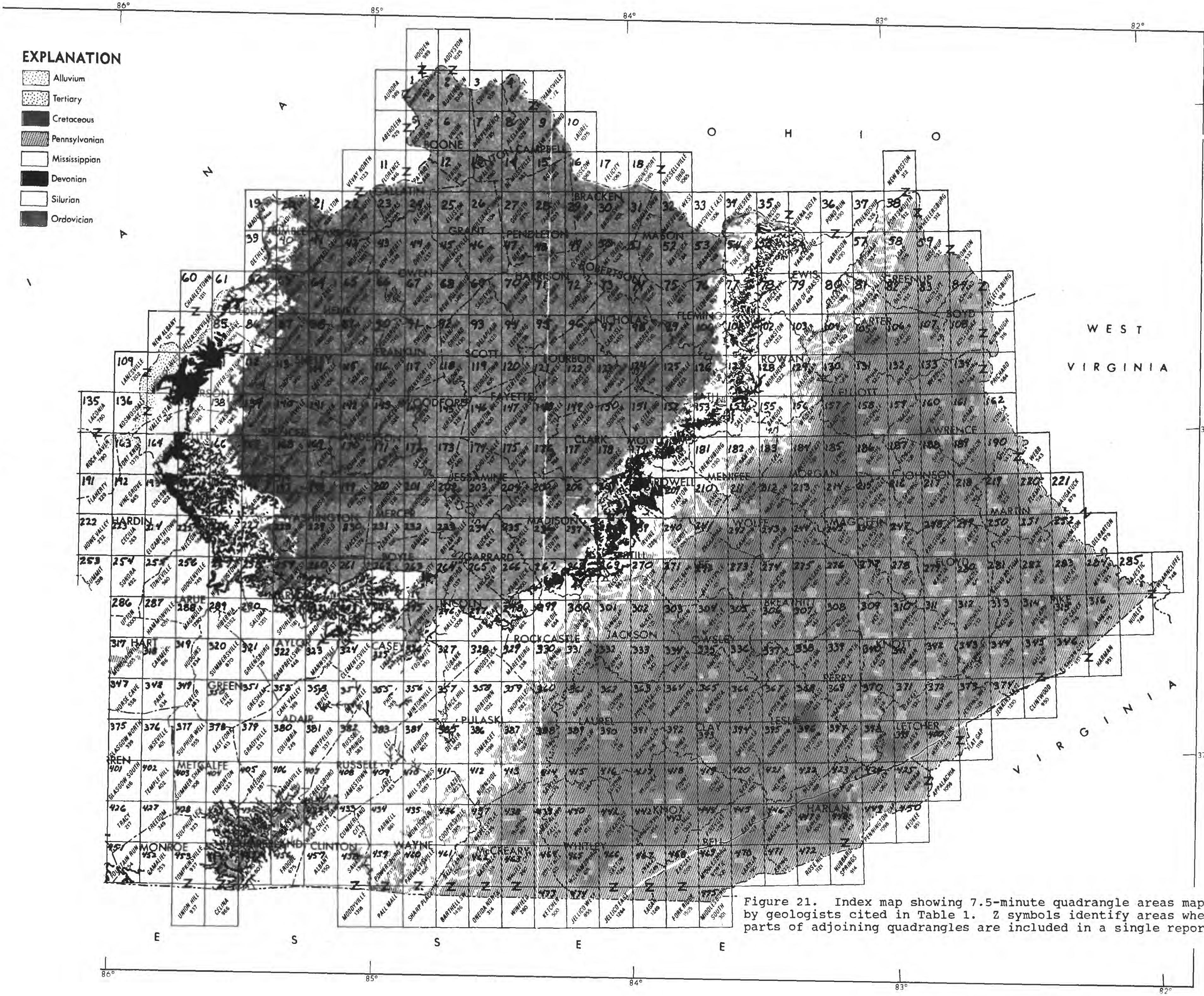

Figure 21. Index map showing 7.5-minute quadrangle areas mapped by geologists cited in Table 1. Z symbols identify areas where parts of adjoining quadrangles are included in a single report.

TABLE 1. USGS GEOLOGIC QUADRANGLE REPORTS IN CENTRAL AND EASTERN KENTUCKY: SHOWING STRATIGRAPHIC HORIZONS CONTOURED BY THE GEOLOGISTS AT 1:24000 SCALE IN QUADRANGLE AREAS NUMERICALLY KEYED TO THE INDEX MAP SHOWN AS FIGURE 21

NO.	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZONS AND MAP SYMBOLS (Base or top, age, stratigraphic unit)
1	Lawrenceburg, Aurora, Hooven W C Swadley	Fairview Formation (bOf)
2	Burlington, Addyston A.B. Gibbons	Bellevue Tongue of Grant Lake Limestone (bOglb)
3	Covington S.J. Luft	Bellevue Tongue of Grant Lake Limestone (bOglb)
4	Newport, Withamsville A.B. Gibbons	Fairview Formation (bOf)
5	Rising Sun, Aberdeen W C Swadley	Fairview Formation (bOf)
6	Union W C Swadley	Bellevue Tongue of Grant Lake Limestone (bOglb)
7	Independence S.J. Luft	Bellevue Tongue of Grant Lake Limestone (bOglb)
8	Alexandria A.B. Gibbons	Fairview Formation (bOf)
9	New Richmond A.B. Gibbons, J.J. Kohut, M.P. Weiss	Fairview Formation (bOf)
10	Laurel J.J. Kohut, M.P. Weiss, S.J. Luft	Fairview Formation (bOf)
11	Patriot, Florence W C Swadley	Fairview Formation (bOf)
12	Verona W C Swadley	Fairview Formation (bOf)
13	Walton S.J. Luft	Fairview Formation (bOf)
14	DeMossville S.J. Luft	Fairview Formation (bOf)
15	Butler S.J. Luft	Fairview Formation (bOf)
16	Moscow S.J. Luft, R.H. Osborne, M.P. Weiss	Fairview Formation (bOf)

GQ	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZONS AND SYMBOLS
17	Felicity R.H. Osborne, M.P. Weiss, W.F. Outerbridge	Fairview Formation (bOf)
18	Higginsport, Russelville W.F. Outerbridge, M.P. Weiss, R.H. Osborne	Grant Lake Limestone (bOgl)
19	Madison West W C Swadley	Saluda Dolomite Member of Drakes Formation (tOds)
20	Madison East A.B. Gibbons	Saluda Dolomite Member of Drakes Formation (tOds)
21	Carrollton W C Swadley	Grant Lake Limestone (bOgl)
22	Vevay South, Vevay North W C Swadley	Fairview Formation (bOf)
23	Sanders W C Swadley	Fairview Formation (bOf)
24	Glencoe W C Swadley	Fairview Formation (bOf)
25	Elliston W C Swadley	Fairview Formation (bOf)
26	Williamstown S.J. Luft	Fairview Formation (bOf)
27	Goforth S.J. Luft	Fairview Formation, Kope Formation (bOf, bOk)
28	Falmouth S.J. Luft	Kope Formation (bOk)
29	Berlin S.J. Luft	Fairview Formation (bOf)
30	Brooksville W.F. Outerbridge	Fairview Formation (bOf)
31	Germantown W.F. Outerbridge	Fairview Formation (bOf)
32	Maysville West A.B. Gibbons, M.P. Weiss	Grant Lake Limestone (bOgl)
33	Maysville East M.P. Weiss, F.A. Schilling, Jr., K.L. Pierce, S.A. Ali	Grant Lake Limestone, Bull Fork Formation (bOgl, bObf)

NO.	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZONS AND SYMBOLS
34	Manchester Islands J.H. Peck, K.L. Pierce	Brassfield and Crab Orchard Formations (bScb)
35	Concord, Buena Vista R.H. Morris	Sunbury Shale (bMsu)
36	Garrison, Pond Run J.R. Chaplin, C.E. Mason	Sunbury Shale (bMsu)
37	Friendship R.L. Erickson	Olive Hill Clay Bed of Lee Formation (Plcb)
38	Portsmouth, Wheelersburg, New Boston R.A. Sheppard	Olive Hill Clay Bed of Lee Formation (Plcb)
39	Bethlehem W C Swadley	Saluda Dolomite Member of Drakes Formation, Grant Lake Limestone (tOds, bOgl)
40	Bedford W C Swadley	Saluda Dolomite Member of Drakes Formation, Grant Lake Limestone (tOds, bOgl)
41	Campbellsburg W C Swadley, A.B. Gibbons	Grant Lake Limestone (bOgl)
42	Worthwhile A.B. Gibbons	Fairview Formation, Calloway Creek Limestone (bOf, bOcc)
43	New Liberty A.B. Gibbons, W C Swadley	Fairview Formation, Calloway Creek Limestone (bOf, bOcc)
44	Owenton W C Swadley	Fairview Formation, Calloway Creek Limestone (bOf, bOcc)
45	Lawrenceville W C Swadley	Beds at Elk Riffle and Point Pleasant Tongue of Clays Ferry Formation (bOcfe, tOcfp)
46	Mason S.J. Luft	Point Pleasant Tongue and lower part of Clays Ferry Formation, Tanglewood Limestone Member of Lexington Limestone (tOcfp, tOcfl, tOlt)
47	Berry S.J. Luft	Grier Limestone Member of Lexington Limestone (tOlg)
48	Kelat S.J. Luft	Point Pleasant Tongue, lower part of Clays Ferry Formation (tOcfp, tOcfl)

NO.	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZONS AND SYMBOLS
49	Claysville S.J. Luft	Grier Limestone Member, lower tongue of Tanglewood Limestone Member of Lexington Limestone (tOlg, tOltl)
50	Mount Olivet R.M. Wallace	Fairview Formation (bOf)
51	Sardis R.C. McDowell	Fairview Formation (bOf)
52	Mays Lick A.B. Gibbons	Grant Lake Limestone (bOgl)
53	Orangeburg F.A. Schilling, Jr.	Grant Lake Limestone (tOgl)
54	Tollesboro J.H. Peck	Brassfield Formation (bSb)
55	Charters R.H. Morris	Sunbury Shale (bMsu)
56	Vanceburg R.H. Morris, K.L. Pierce	Sunbury Shale (bMsu)
57	Brushart C.S. Denny	Olive Hill Clay Bed of Crider (1913) in Lee Formation (Plcb)
58	Load J.A. Sharps	Olive Hill Clay Bed of Crider (1913) in Lee Formation (Plcb)
59	Greenup, Ironton E. Dobrovolny, J.C. Ferm,	Princess No. 3 Coal Bed of Breathitt Formation (Pbp3)
60	Jefferson, New Albany, Charlestown R.C. Kepferle	Waldron Shale (tSw)
61	Owen W.L. Peterson, P.B. Wigley	Louisville Limestone (bSlv)
62	La Grange W.L. Peterson, S.L. Moore, J.E. Palmer, J.H. Smith	Brassfield Formation (bSb)
63	Smithfield S.J. Luft	Drakes Formation (bOd)
64	New Castle A.B. Gibbons	Drakes Formation and Bull Fork Formation (bOd, bObf)

NO.	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZONS AND SYMBOLS
65	Franklinton A.B. Gibbons	Calloway Creek Limestone (bOcc)
66	Gratz F.B. Moore	Calloway Creek Limestone and Millersburg Member of Lexington Limestone (bOcc, bOlm)
67	Monterey F.B. Moore	Calloway Creek Limestone, Tanglewood Limestone Member of Lexington Limestone (bOcc, tOlt
68	New Columbus F.B. Moore	Tanglewood Limestone Member of Lexington Limestone (tOlt)
69	Sadieville F.B. Moore, R.M. Wallace	Tanglewood Limestone Member of Lexington Limestone (tOlt)
70	Breckinridge R.M. Wallace	Tanglewood Limestone Member of Lexington Limestone (tOlt)
71	Cynthiana R.M. Wallace	Three tongues of Tanglewood Limestone Member of Lexington Limestone (tOltu, tOltm, tOltl)
72	Shady Nook R.M. Wallace	Tanglewood Limestone Member of Lexington Limestone (tOlt)
73	Piqua R.M. Wallace	Tanglewood Limestone Member of Lexington Limestone (tOlt)
74	Cowan L.V. Blade	Lexington Limestone, Fairview Formation (tOl, bOf)
75	Elizaville R.C. McDowell	Grant Lake Limestone (bOgl)
76	Flemingsburg J.H. Peck	Brassfield Formation, Grant Lake Limestone (bSb, tOgl)
77	Burtonville R.H. Morris	Sunbury Shale (bMsu)
78	Stricklett R.H. Morris	Sunbury Shale (bMsu)
79	Head of Grassy R.H. Morris	Sunbury Shale (bMsu)
80	Wesleyville J.C. Philley, J.R. Chaplin	Newman Limestone (bMn)

NO.	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZONS AND SYMBOLS
81	Tygarts Valley R.A. Sheppard	Olive Hill Clay Bed of Crider (1913) of Lee Formation (Plcb)
82	Oldtown C.L. Whittington, J.C. Ferm	Grayson Sandstone Bed of Lee Formation (tPlg)
83	Argillit R.A. Sheppard, J.C. Ferm	Princess No. 3 Coal Bed of Breathitt Formation (Pbp3)
84	Ashland, Catlettsburg E. Dobrovolny, J.A. Sharps, J.C. Ferm	Princess No. 7 Coal Bed of Breathitt Formation (Pbp7)
85	Anchorage R.C. Kepferle, P.B. Wigley, B.R. Hawke	Waldron Shale (tSw)
86	Crestwood R.C. Kepferle	Rowland Member of Drakes Formation (bOdr)
87	Ballardsville R.C. Kepferle	Rowland Member of Drakes Formation (bOdr)
88	Eminence S.J. Luft	Grant Lake Limestone (bOgl)
89	North Pleasureville W.L. Peterson	Calloway Creek Limestone (bOcc)
90	Polsgrove F.B. Moore	Lexington Limestone (tOl)
91	Switzer F.B. Moore	Lexington Limestone (tOl)
92	Stamping Ground F.B. Moore	Clays Ferry Formation, Millersburg Member of Lexington Limestone (bOcf, bOlm)
93	Delaplain R.M. Wallace	Upper tongue of Tanglewood Limestone Member of Lexington Limestone (tOltu, bOltu)
94	Leesburg R.M. Wallace	Upper and middle tongues of Tanglewood Limestone Member of Lexington (tOltu, bOltm)
95	Shawhan N.P. Cuppels	Lower tongue of Clays Ferry Formation (bOcfl)
96	Millersburg N.P. Cuppels, W.F. Outerbridge	Lower tongue of Clays Ferry Formation (bOcfl)

NO.	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZONS AND SYMBOLS
97	Carlisle L.V. Blade	Lexington Limestone (tOl)
98	Moorefield P.B. Wigley	Fairview Formation (bOf)
99	Sherburne W.F. Outerbridge	Grant Lake Limestone (bOgl)
100	Hillsboro J.W. Mytton, R.C. McDowell	Brassfield Formation, Bull Fork Formation (bSb, bObf)
101	Plummers Landing R.C. McDowell, J.H. Peck, J.W. Mytton	Sunbury Shale (bMsu)
102	Cranston J.C. Philley, D.K. Hylbert, H.P. Hoge	Sunbury Shale (bMsu)
103	Soldier J.C. Philley, D.K. Hylbert, H.P. Hoge	Nada Member of Borden Formation (bMbn)
104	Olive Hill K.J. Englund, J.F. Widolph, Jr.	Bruin Coal Bed of Breathitt and Grayson Sandstone Bed of Lee Formation (Pbbu, tPlg)
105	Grahn K.J. Englund	Bruin Coal Bed of Breathitt and Grayson Sandstone Bed of Lee Formation (Pbbu, tPlg)
106	Grayson C.L. Whittington, J.C. Ferm	Grayson Sandstone Bed of Lee Formation (tPlg)
107	Rush J.E. Carlson	Princess No. 7 Coal Bed of Breathitt Formation (Pbp7)
108	Boltsfork, Burnaugh F.D. Spencer	Ames(?) Limestone Member of Conemaugh Formation (tPca)
109	Louisville West, Lanesville R.C. Kepferle	New Albany Shale (tDna)
110	Louisville East R.C. Kepferle	New Albany Shale, Waldron Shale (tDna, tSw)
111	Jeffersontown F.B. Moore, R.C. Kepferle, W.L. Peterson	Brassfield Formation (bSb)

NO.	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZONS AND SYMBOLS
112	Fisherville R.C. Kepferle	Rowland Member of Drakes Formation (bOdr)
113	Simpsonville W.L. Peterson	Rowland Member of Drakes Formation, Calloway Creek Limestone (bOdr, tOcc)
114	Shelbyville E.R. Cressman	Calloway Creek Limestone (bOcc)
115	Waddy E.R. Cressman	Calloway Creek Limestone, Brassfield Formation (bOcc bSb)
116	Frankfort West F.B. Moore	Devils Hollow Member, Lexington Limestone (bOldh, tOl)
117	Frankfort East J.S. Pomeroy	Devils Hollow and Millersburg Members of Lexington Limestone (bOldh, bOlm)
118	Midway J.S. Pomeroy	Millersburg and Brannon Members Lexington Limestone (bOlm bOlb)
119	Georgetown E.R. Cressman	Millersburg and Brannon Members Lexington Limestone (bOlm bOlb)
120	Centerville S.P. Kanizay, E.R. Cressman	Millersburg Member of Lexington Limestone (bOlm)
121	Paris West W.F. Outerbridge	Millersburg Member of Lexington Limestone (bOlm)
122	Paris East W.F. Outerbridge	Millersburg Member of Lexington Limestone (bOlm)
123	North Middletown C.T. Helfrich	Lexington Limestone (tOl)
124	Sharpsburg L.V. Blade	Garrard Siltstone (tOg)
125	Owingsville G.W. Weir	Sunset Member of Bull Fork Formation (tObfs)
126	Colfax R.C. McDowell	Brassfield Formation (bSb)
127	Farmers R.C. McDowell	Sunbury Shale (bMsu)

NO.	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZONS AND SYMBOLS
128	Morehead H.P. Hoge, J.R. Chaplin	Farmers Member of Borden Formation, Lee Formation (tMbf, bPl)
129	Haldeman S.H. Patterson, J.W. Hosterman	Olive Hill Clay Bed of Crider (1913) in Lee Formation (Plcb)
130	Ault A.O. Delaney, K.J. Englund	Bruin Coal Bed of Breathitt Formation (Pbbu)
131	Bruin K.J. Englund, A.O. Delaney	Bruin Coal Bed of Breathitt Formation (Pbbu)
132	Willard W.R. Brown	Princess No. 7 Coal Bed of Breathitt Formation (Pbp7)
133	Webbville J.E. Carlson	Brush Creek Limestone Member of Conemaugh Formation (tPcb)
134	Fallsburg, Prichard J.A. Sharps	Brush Creek Limestone Member of Conemaugh Formation (tPcb)
135	Rock Haven, Laconia C.F. Withington, E.G. Sable	New Albany Shale (bDna)
136	Valley Station, Kosmosdale R.C. Kepferle	New Albany Shale (tDna)
137	Brooks R.C. Kepferle	New Albany Shale, Laurel Dolomite (tDna, tSl)
138	Mount Washington R.C. Kepferle	Brassfield Formation (bSb)
139	Waterford S.J. Luft	Rowland Member of Drakes Formation (bOdr)
140	Taylorsville W.L. Peterson	Calloway Creek Limestone (tOcc)
141	Mount Eden E.R. Cressman	Clays Ferry Formation (tOcf)
142	Glensboro E.R. Cressman	Lexington Limestone, Clays Ferry Formation (tOl, tOcf)
143	Lawrenceburg E.R. Cressman	Brannon Member of Lexington Limestone (bOlb)
144	Tyrone E.R. Cressman	Brannon Member of Lexington Limestone (bOlb)

NO.	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZONS AND SYMBOLS
145	Versailles D.F.B. Black	Grier Limestone Member of Lexington Limestone (tOlg)
146	Lexington West R.D. Miller	Cane Run Bed and Brannon Member of Lexington Limestone (tOlgc, bOlb)
147	Lexington East W.C. MacQuown, Jr., E. Dobrovolny	Millersburg Member of Lexington Limestone (bOlm)
148	Clintonville W.C. MacQuown, Jr.	Millersburg Member of Lexington Limestone (bOlm)
149	Austerlitz W.F. Outerbridge	Millersburg Member of Lexington Limestone (bOlm)
150	Sideview L.V. Blade	Kope and Clays Ferry Formations (undivided), Calloway Creek Limestone (bOkcf, bOcc)
151	Mount Sterling G.W. Weir	Calloway Creek Limestone (tOcc)
152	Preston G.W. Weir, R.C. McDowell	Brassfield Dolomite, New Albany Shale (bSb, bDna)
153	Olympia R.C. McDowell, G.W. Weir	Brassfield Formation, Borden Formation (bSb, bMb)
154	Salt Lick J.C. Philley	Sunbury Shale, Newman Limestone (bMsu, bMn)
155	Bangor D.K. Hylbert, J.C. Philley	Crinoidal Limestone Member of Newman Limestone (tMnls)
156	Wrigley J.W. Hosterman, S.H. Patterson, J.W. Huddle	Olive Hill Clay Bed of Crider (1913) in Lee Formation (Plcb)
157	Sandy Hook K.J. Englund, A.O. Delaney	Grassy Coal Bed of Breathitt Formation (Pbg)
158	Isonville K.J. Englund, A.O. Delaney	Little Caney Coal Bed of Breathitt Formation (Pblc)
159	Mazie W.F. Outerbridge	Mudseam Coal Zone of Breathitt Formation (Pbms)
160	Blaine C.L. Pilmore, C.W. Connor	Richardson Coal Zone of Breathitt Formation (Pbr)

NO.	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZONS AND SYMBOLS
161	Adams D.E. Ward	Flint Clay Bed, Peach Orchard Coal Zone of Breathitt Formation (Pbflc, Pbpo)
162	Louisa C.W. Connor, R.M. Flores	Brush Creek Limestone Member of Conemaugh Formation, Peach Orchard Coal Zone of Breathitt Formation (Pbbl, Pbpo)
163	Fort Knox R.C. Kepferle, E.G. Sable	New Albany Shale (bDna)
164	Pitts Point R.C. Kepferle	New Albany Shale (bDna)
165	Shepherdsville R.C. Kepferle	New Albany Shale (tDna)
166	Samuels R.C. Kepferle	Laurel Dolomite (tSl)
167	Fairfield W.L. Peterson	Rowland Member of Drakes Formation (bOdr)
168	Bloomfield W.L. Peterson	Calloway Creek Limestone (tOcc)
169	Chaplin W.L. Peterson	Calloway Creek Limestone, Lexington Limestone (bOcc, tOl)
170	Ashbrook W.L. Peterson	Lexington Limestone (tOl)
171	McBrayer E.R. Cressman	Clays Ferry Formation (bOcf)
172	Salvisa E.R. Cressman	Brannon Member of Lexington Limestone (bOlb)
173	Keene E.R. Cressman	Tyrone Limestone, Brannon Member of Lexington Limestone (tOt, bOlb)
174	Nicholasville W.C. MacQuown, Jr.	Brannon Member of Lexington Limestone (bOlb)
175	Coletown D.F.B. Black	Brannon Member of Lexington Limestone (bOlb)
176	Ford D.F.B. Black	Brannon Member of Lexington Limestone (bOlb)

NO.	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZONS AND SYMBOLS
177	Winchester D.F.B. Black	Brannon Member of Lexington Limestone, Garrard Siltstone (bOlb, tOg)
178	Hedges D.F.B. Black	Calloway Creek Limestone, Brassfield Dolomite (bOcc, bSb)
179	Levee R.C. McDowell	Brassfield Dolomite, Borden Formation (bSb, tMb)
180	Means G.W. Weir	Newman Limestone (bMn)
181	Frenchburg H.P. Hoge	Newman Limestone (bMn)
182	Scranton D.C. Haney, N.C. Hester	Newman Limestone (bMn)
183	Ezel G.N. Pipiringos, S.G. Bergman, V.A. Trent	Zachariah Coal Bed of Breathitt Formation (Pbz)
184	West Liberty K.J. Englund, J.W. Huddle, A.O. Delaney	Little Caney Coal Bed of Breathitt Formation (Pblc)
185	Lenox J.E. Johnston	Magoffin Member of Breathitt Formation (bPbm)
186	Dingus W.F. Outerbridge	Magoffin Member of Breathitt Formation (bPbm)
187	Redbush C.L. Rice	Van Lear Coal Bed of Breathitt Formation (Pbvl)
188	Sitka P.T. Hayes	Van Lear Coal Bed of Breathitt Formation (Pbvl)
189	Richardson J.D. Sanchez, D.C. Alvord, P.T. Hayes	Peach Orchard Coal Zone of Breathitt Formation (Pbpo)
190	Milo, Webb E.C. Jenkins	Magoffin Member of Breathitt Formation (bPbm)
191	Flaherty W C Swadley	Lost River Chert of Elrod (1899) of Sainte Genevieve and Saint Louis Limestones (tMgllr)

NO.	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZONS AND SYMBOLS
192	Vine Grove R.C. Kepferle	Salem Limestone (bMs)
193	Colesburg R.C. Kepferle	Salem Limestone (bMs)
194	Lebanon Junction W.L. Peterson	New Albany Shale (tDna)
195	Cravens W.L. Peterson	New Albany Shale (tDna)
196	Bardstown W.L. Peterson	Laurel Dolomite, Rowland Member of Drakes Formation (bSl, bOdr)
197	Maud W.L. Peterson	Calloway Creek Limestone, Gilbert Member of Ashlock Formation (tOcc, tOag)
198	Brush Grove W.L. Peterson	Calloway Creek Limestone (bOcc)
199	Cardwell W.L. Peterson	Clays Ferry Formation (bOcf)
200	Cornishville E.R. Cressman	Clays Ferry Formation (bOcf)
201	Harrodsburg J.W. Allingham	Brannon Member of Lexington Limestone (bOlb)
202	Wilmore E.R. Cressman, S.V. Hrabar	Tyrone Limestone (tOt)
203	Little Hickman D.E. Wolcott	Tyrone Limestone (tOt)
204	Valley View R.C. Greene	Tyrone Limestone, Garrard Siltstone (tOt, bOg)
205	Richmond North G.C. Simmons	Garrard Siltstone (bOg)
206	Union City G.C. Simmons	Reba Member of Ashlock Formation (bOar)
207	Palmer G.C. Simmons	New Albany Shale, Brassfield Dolomite (bDna, bSb)
208	Clay City G.C. Simmons	New Albany Shale (tDna)

NO.	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZON AND SYMBOLS
209	Stanton G.W. Weir	Newman Limestone (bMn)
210	Slade G.W. Weir	Corbin Sandstone Member of Lee Formation, Newman Limestone (bPlc, bMn)
211	Pomeroyton G.W. Weir, P.W. Richards	Corbin Sandstone Member of Lee Formation (tPlc)
212	Hazel Green W.B. Cashion	Grassy Coal Bed of Breathitt Formation (Pbg)
213	Cannel City E.G. Sable	Magoffin Member of Breathitt Formation (bPbm)
214	White Oak E.G. Sable	Magoffin Member of Breathitt Formation (bPbm)
215	Salyersville North W.L. Adkison, J.E. Johnston	Fire Clay Coal Bed of Breathitt Formation (Pbfc)
216	Oil Springs W.F. Outerbridge	Van Lear Coal Bed of Breathitt Formation (Pbvl)
217	Paintsville W.F. Outerbridge	Van Lear Coal Bed of Breathitt Formation (Pbvl)
218	Offut W.F. Outerbridge	Magoffin Member of Breathitt Formation (bPbm)
219	Inez W.F. Outerbridge	Magoffin Member of Breathitt Formation (bPbm)
220	Kermit J.W. Huddle, K.J. Englund	Taylor Coal Bed of Breathitt Formation (Pbt)
221	Naugatuck, Delbarton D.C. Alvord	Taylor Coal Bed (Naugatuck), Pond Creek Coal (Delbarton) of Breathitt Formation (Pbt, Pbpc)
222	Howe Valley R.C. Kepferle	Sample Sandstone (bMsa)
223	Cecilia R.C. Kepferle	Lost River Chert of Elrod (1899) in Sainte Genevieve and Saint Louis Limestones (tMgllv)
224	Elizabethtown R.C. Kepferle	New Albany Shale (bDna)

NO.	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZONS AND SYMBOLS
225	Nelsonville W.L. Peterson	New Albany Shale (tDna)
226	New Haven W.L. Peterson	New Albany Shale (tDna)
227	Loretto W.L. Peterson	Brassfield Dolomite (bSb)
228	Saint Catherine W.L. Peterson	Rowland Member of Drakes Formation (bOdr)
229	Springfield W.L. Peterson	Gilbert Member of Ashlock Formation, Calloway Creek Limestone (bOag, bOcc)
230	Mackville W.L. Peterson	Clays Ferry Formation (bOcf)
231	Perryville E.R. Cressman	Clays Ferry Formation (bOcf)
232	Danville E.R. Cressman	Perryville Limestone Member of Lexington Limestone (tOlgp)
233	Bryantsville D.E. Wolcott, E.R. Cressman	Calloway Creek Limestone, Tyrone Limestone (bOcc, tOt)
234	Buckeye D.E. Wolcott	Calloway Creek Limestone (bOcc)
235	Kirksville R.C. Greene	Garrard Siltstone (bOg)
236	Richmond South R.C. Greene	Ashlock Formation (bOa)
237	Moberly R.C. Greene	New Albany Shale, Brassfield Dolomite (bDna, bSb)
238	Panola R.C. Greene	New Albany Shale (bDna)
239	Irvine H.P. Hoge, P.B. Wigley, F.R. Shawe	Newman Limestone (bMn)
240	Cobhill D.C. Haney	Newman Limestone (bMn)
241	Zachariah D.F.B. Black	Newman Limestone, Corbin Sandstone Member of Lee Formation (bMn, tPlc)

NO.	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZONS AND SYMBOLS
242	Campton T.D. Coskren, H.P. Hoge	Grassy Coal Bed of Breathitt Formation (Pbg)
243	Landsaw W.R. Hansen, J.E. Johnston	Magoffin Member of Breathitt Formation (bPbm)
244	Lee City E.V. Post, J.E. Johnston	Magoffin Member of Breathitt Formation (bPbm)
245	Seitz R.W. Spengler	Magoffin Member of Breathitt Formation (bPbm)
246	Salyersville South R.W. Spengler	Magoffin Member of Breathitt Formation (bPbm)
247	Ivyton C.L. Rice	Magoffin Member of Breathitt Formation (bPbm)
248	Prestonsburg C.L.Rice	Magoffin Member of Breathitt Formation (bPbm)
249	Lancer C.L. Rice	Magoffin Member of Breathitt Formation (bPbm)
250	Thomas C.L. Rice	Magoffin Member of Breathitt Formation (bPbm)
251	Varney J.W. Huddle, K.J. Englund	Taylor Coal Bed of Breathitt Formation (Pbt)
252	Williamson D.C. Alvord, V.A. Trent	Taylor Coal Bed of Breathitt Formation (Pbt)
253	Summit F.B. Moore	Beech Creek Limestone Member of Golconda Formation (tMgc)
254	Sonora F.B. Moore	New Albany Shale (bDna)
255	Tonieville F.B. Moore	New Albany Shale (bDna)
256	Hodgenville F.B. Moore	New Albany Shale (bDna)
257	Howardstown R.C. Kepferle	New Albany Shale (tDna)
258	Raywick R.C. Kepferle	New Albany Shale (bDna)

NO.	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZONS AND SYSMBOLS
259	Lebanon West S.L. Moore	Rowland Member of Drakes Formation, New Albany Shale (bOdr, tDna)
260	Lebanon East S.L. Moore	Calloway Creek Limestone, New Albany Shale, Gilbert Member of Ashlock Formation (bOcc tDna, bOag)
261	Gravel Switch S.L. Moore	Calloway Creek Limestone, New Albany Shale (bOcc, tDna)
262	Parksville S.L. Moore	Lexington Limestone, New Albany Shale (tOl, tDna)
263	Junction City L.D. Harris	Lexington Limestone, New Albany Shale (tOl, tDna)
264	Stanford F.R. Shawe, P.B. Wigley	Calloway Creek Limestone (tOcc)
265	Lancaster G.W. Weir	Ashlock Formation (tOa)
266	Paint Lick G.W. Weir	Ashlock Formation, New Albany Shale (bOa, tDna)
267	Berea G.W. Weir	New Albany Shale (bDna)
268	Bighill G.W. Weir, K.Y. Lee, P.E. Cassity	New Albany Shale, Newman Limestone (bDna, bMn)
269	Alcorn C.L. Rice	Newman Limestone (bMn)
270	Leighton D.C. Haney, C.L. Rice	Newman Limestone (bMn)
271	Heidelberg D.F.B. Black	Newman Limestone, Beattyville Coal Bed of Breathitt Formation (bMn, Pbbe)
272	Beattyville G.W. Weir, R.E. Eggleton	Manchester Coal Bed, Breathitt Formation (Pbmn)
273	Tallega D.F.B. Black	Vires Coal Bed of Breathitt Formation (Pbv)
274	Jackson G.E. Prichard, J.E. Johnston	Magoffin Member of Breathitt Formation (bPmn)

NO.	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZONS AND SYMBOLS
275	Quicksand J.R. Donnell, J.E. Johnston	Magoffin Member of Breathitt Formation (bPbm)
276	Guage K.Y. Lee, W. Danilchik, C.L. Rice	Magoffin Member of Breathitt Formation (bPbm)
277	Tiptop W. Danilchik	Magoffin Member of Breathitt Formation (bPbm)
278	David W.F. Outerbridge	Magoffin Member of Breathitt Formation (bPbm)
279	Martin C.L. Rice	Magoffin Member of Breathitt Formation (bPbm)
280	Harold C.L. Rice	Magoffin Member of Breathitt Formation (bPbm)
281	Broad Bottom C.L. Rice	Magoffin Member of Breathitt Formation (bPbm)
282	Meta D.E. Wolcott, E.C. Jenkins	Magoffin Member of Breathitt Formation (bPbm)
283	Belfry C.L. Rice, R.G. Ping, J.L. Barr	Pond Creek Coal Bed of Breathitt Formation (Pbpc)
284	Matewan V.A. Trent	Pond Creek Coal Bed of Breathitt Formation (Pbpc)
285	Majestic, Hurley, Wharncliffe W.F. Outerbridge	Pond Creek Coal Bed of Breathitt Formation (Pbpc)
286	Upton F.B. Moore	Sample Sandtone (bMsa)
287	Hammonville F.B. Moore	New Albany Shale (bDna)
288	Magnolia F.B. Moore	New Albany Shale (bDna)
289	Hibernia S.L. Moore	New Albany Shale (tDna)
290	Saloma S.L. Moore	New Albany Shale (tDna)
291	Spurligton S.L. Moore	New Albany Shale (tDna)

NO.	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZONS AND SYMBOLS
292	Bradfordsville S.L. Moore	New Albany Shale (tDna)
293	Bradfordsville Northeast S.L. Moore	New Albany Shale (tDna)
294	Ellisburg S.L. Moore	New Albany Shale (tDna)
295	Hustonville R.Q. Lewis, Sr., A.R. Taylor	New Albany Shale (tDna)
296	Halls Gap G.W. Weir	Halls Gap Member of Borden Formation (tMbh)
297	Crab Orchard J.L. Gualtieri	Drakes Formation, Halls Gap Member of Borden Formation (tOd, tMbh)
298	Brodhead J.L. Gualtieri	New Albany Shale, Halls Gap Member of Borden Formation (tDna, tMbh)
299	Wildie J.L. Gualtiere	Halls Gap Member of Borden Formation (tMbh)
300	Johnetta J.L. Gualtieri	Halls Gap Member of Borden Formation, Newman Limestone (tMbh, tMn)
301	Sandgap J.L. Gualtieri	Newman Limestone (tMn)
302	McKee G.W. Weir, M.D. Mumma	Breathitt Formation (bPb)
303	Sturgeon G.W. Weir	Manchester Coal Bed of Breathitt Formation (Pbmn)
304	Booneville G.W. Weir	Manchester Coal Bed of Breathitt Formation (Pbmn)
305	Cowcreek W.F. Outerbridge	Magoffin Member of Breathitt Formation (bPbm)
306	Canoe E.N. Hinrichs	Magoffin Member of Breathitt Formation (bPbm)
307	Haddix R.B. Mixon	Fire Clay Rider Coal Bed of Breathitt Formation (Pbfcr)

NO.	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZONS AND SYMBOLS
308	Noble E.N. Hinrichs	Magoffin Member of Breathitt Formation (bPbm)
309	Vest W.D. Danilchik, H.A. Waldrop	Magoffin Member of Breathitt Formation (bPbm)
310	Handshoe W. Danilchik	Magoffin Member of Breathitt Formation (bPbm)
311	Wayland E.N. Hinrichs, R.G. Ping	Upper Elkhorn No. 3 Coal Zone of Breathitt Formation, (Pbue3)
312	McDowell C.L. Rice	Upper Elkhorn No. 3 Coal Bed of Breathitt Formation (Pbue3)
313	Pikeville D.C. Alvord, G.E. Holbrook	Upper Elkhorn No. 2 Coal Bed of Breathitt Formation (Pbue2)
314	Millard E.C. Jenkins	Upper Elkhorn No. 2 Coal Bed of Breathitt Formation (Pbue2)
315	Lick Creek E.J. McKay, D.C. Alvord	Lower Elkhorn Coal Bed of Breathitt Formation (Pble)
316	Jamboree W.F. Outerbridge, R. Van Vloten	Lower Elkhorn Coal Bed of Breathitt Formation (Pble)
317	Munfordville S.L. Moore	Big Clifty Sandstone Member of Golconda Formation (bMgb)
318	Canmer R.C. Miller	Big Clifty Sandstone Member of Golconda Formation, Chattanooga Shale (bMgb, tDc)
319	Hudgins R.C. Miller, S.L. Moore	Chattanooga Shale (tDc)
320	Summersville S.L. Moore	Chattanooga Shale (tDc)
321	Greensburg A.R. Taylor, S.J. Luft, R.Q. Lewis, Sr.	Chattanooga Shale (tDc)
322	Campbellsville A.R. Taylor	Chattanooga Shale (tDc)
323	Mannsville A.R. Taylor	Borden Formation (tMb)
324	Clementsville A.R. Taylor, R.Q. Lewis, Sr.	Muldraugh Member of Borden Formation (bMbm)

NO.	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZONS AND SYMBOLS
325	Liberty A.R. Taylor, R.Q. Lewis, Sr.	New Albany Shale (tDna)
326	Yosemite A.R. Taylor, R.Q. Lewis, Sr.	New Albany Shale (tDna)
327	Eubank R.Q. Lewis, Sr., A.R. Taylor, G.W. Weir	Halls Gap Member of Borden Formation (tMbh)
328	Woodstock G.W. Weir, S.O. Schlanger	Renfro Member of Borden Formation (bMbr)
329	Maretburg S.O. Schlanger	St. Louis Limestone Member of Newman Limestone (tMnsl)
330	Mount Vernon S.O. Schlanger, G.W. Weir	Ste. Genevieve Limestone Member of Newman Limestone (tMnsg)
331	Livingston W.R. Brown, M.J. Osolnik	Uppermost sandstone unit of Breathitt Formation (tPbss)
332	Parrot D.F. Crowder	Lowermost and next higher sandstone units of Breathitt Formation (tPbss)
333	Tyner G.L. Snyder	Sandstone unit in Breathitt Formation (tPbss)
334	Maulden K.Y. Lee, C.L. Jones	Manchester Coal Zone of Breathitt Formation (Pbmn)
335	Oneida C.L. Rice, K.Y. Lee	Manchester Coal Zone of Breathitt Formation (Pbmn)
336	Mistletoe R.P. Volckman, G.W. Leo	Magoffin Member of Breathitt Formation (bPbm)
337	Buckhorn W. Danilchik, R.Q. Lewis, Sr.	Magoffin Member of Breathitt Formation (bPbm)
338	Krypton R.B. Mixon	Hazard No. 7 Coal Bed of Breathitt Formation (Pbh7)
339	Hazard North V. M. Seiders	Hazard No. 7 Coal Bed of Breathitt Formation (Pbh7)
340	Carrie V.M. Seiders	Hazard No. 7 Coal Bed of Breathitt Formation (Pbh7)
341	Hindman W. Danilchik	Magoffin Member of Breathitt Formation (bPbm)

NO.	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZONS AND SYMBOLS
342	Kite E.N. Hinrichs, C.L. Rice	Upper Elkhorn No. 3 Coal Zone of Breathitt Formation (Pbue3)
343	Wheelwright W.F. Outerbridge	Upper Elkhorn No. 3 Coal Bed of Breathitt Formation (Pbue3)
344	Dorton J.L. Barr, H.H. Arndt	Upper Elkhorn No. 2 Coal Bed of Breathitt Formation (Pbue2)
345	Hellier, Clintwood D.C. Alvord	Lower Elkhorn Coal Bed of Breathitt Formation (Pble)
346	Elkhorn City, Harman D.C. Alvord, R.L. Miller	Clintwood Coal Bed of Breathitt Formation (Pbcl)
347	Horse Cave D.D. Haynes	Chattanooga Shale (tDc)
348	Park D.D. Haynes	Chattanooga Shale (tDc)
349	Center R.C. Miller, S.L. Moore	Chattanooga Shale (tDc)
350	Exie S.L. Moore	Chattanooga Shale (tDc)
351	Gresham A.R. Taylor	Chattanooga Shale (tDc)
352	Cane Valley C.H. Maxwell, W.B. Turner	Chattanooga Shale (tDc)
353	Knifely C.H. Maxwell	Chattanooga Shale (tDc)
354	Dunnville C.H. Maxwell	Chattanooga Shale, Salem and Warsaw Formations (tDc, bMsw)
355	Phil C.H. Maxwell	Chattanooga Shale (tDc)
356	Mintonville R.Q. Lewis, Sr., A.R. Taylor	Muldraugh Member of Borden Formation (bMbm)
357	Science Hill A.R. Taylor, R.Q. Lewis, Sr.	St. Louis Limestone (bMsl)
358	Bobtown R.Q. Lewis, Sr., A.R. Taylor, G.W. Weir	St. Louis Limestone (bMsl)

NO.	QUADRANGLES, AUTHORS	CONTOURED HORIZONS AND SYMBOLS
359	Shopville N.L. Hatch, Jr.	Newman Limestone (tMn)
360	Billows N.L. Hatch, Jr.	Newman Limestone (tMn)
361	Bernstadt N.L. Hatch, Jr.	Lee Formation (tPl)
362	London N.L. Hatch, Jr.	Lily Coal Bed of Breathitt Formation (Pbly)
363	Portersburg J.B. Pomerene	Lily Coal Bed of Breathitt Formation (Pbly)
364	Manchester T.L. Finnel	Manchester Coal Bed of Breathitt Formation (Pbmn)
365	Barcreek A.R. Taylor	Manchester Coal Bed, Magoffin Member of Breathitt Formation (Pbmn, bPbm)
366	Big Creek R.Q. Lewis, Sr., D.E. Hansen	Magoffin Member of Breathitt Formation (bPbm)
367	Hyden West R.Q. Lewis, Sr.	Magoffin Member of Breathitt Formation (bPbm)
368	Hyden East H.J. Protska	Magoffin Member of Breathitt Formation (bPbm)
369	Hazard South W.P. Puffett	Magoffin Member of Breathitt Formation (bPbm)
370	Vicco W.P. Puffett	Magoffin Member of Breathitt Formation (bPbm)
371	Blackey H.A. Waldrop	Fire Clay Coal Bed of Breathitt Formation (Pbfc)
372	Mayking C.L. Rice	Upper Elkhorn No. 3 Coal Zone of Breathitt Formation (Pbue3)
373	Jenkins West C.L. Rice	Upper Elkhorn No. 3 Coal Zone of Breathitt Formation (Pbue3)
374	Jenkins East D.E. Wolcott	Lower Elkhorn Coal Bed of Breathitt Formation (Pble)
375	Glasgow North D.D. Haynes	Chattanooga Shale (tDc)

NO.	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZONS AND SYMBOLS
376	Hiseville D.D. Haynes	Chattanooga Shale (tDc)
377	Sulphur Well J.M. Cattermole	Chattanooga Shale (tDc)
378	East Fork J.M. Cattermole	Chattanooga Shale (tDc)
379	Gradyville A.R. Taylor	Chattanooga Shale (tDc)
380	Columbia R.Q. Lewis, Sr., R.E. Thaden	Chattanooga Shale (tDc)
381	Montpelier R.Q. Lewis, Sr., R.E. Thaden	Chattanooga Shale (tDc)
382	Russell Springs R.Q. Lewis, Sr., R.E. Thaden	Salem and Warsaw Formations (bMsw)
383	Eli R.E. Thaden, R.Q. Lewis, Sr.	Salem and Warsaw Formations (bMsw)
384	Faubush R.E. Thaden, R.Q. Lewis, Sr.	Salem and Warsaw Formations (bMsw)
385	Delmer R.Q. Lewis, Sr.	St. Louis Limestone (bMsl)
386	Somerset R.Q. Lewis, Sr.	St. Louis Limestone (bMsl)
387	Dykes J.H. Smith	Kidder Limestone Member of Monteagle Limestone (tMmk)
388	Ano H.K. Stager	Rockcastle Conglomerate Member of Lee Formation (bPlr)
389	London Southwest H.K. Stager	Corbin Sandstone Member of Lee Formation (tPlc)
390	Lily H.K. Stager	Lee Formation (tPl)
391	Blackwater H.K. Stager	Jellico Coal Bed of Breathitt Formation (Pbj)
392	Hima R.G. Reeves	Manchester Coal Bed of Breathitt Formation (Pbmn)

NO.	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZONS AND SYMBOLS
393	Ogle R.G. Ping, R.E. Sargent	Magoffin Member of Breathitt Formation (bPbm)
394	Creekville B. Bryant	Magoffin Member of Breathitt Formation (bPbm)
395	Hoskinton A.R. Taylor	Magoffin Member of Breathitt Formation (bPbm)
396	Cutshin R.G. Ping	Magoffin Member of Breathitt Formation (bPbm)
397	Leatherwood H.J. Protska, V.M. Seiders	Hazard Coal Zone of Breathitt Formation (Pbhz)
398	Tilford W.P. Puffett	Kendrick Shale of Jillson (1919) in Breathitt Formation (bPbk)
399	Roxana E.K. Maughan	Kendrick Shale of Jillson (1919) in Breathitt Formation (bPbk)
400	Whitesburg, Flat Gap C.L. Rice, D.E. Wolcott	Upper Elkhorn No. 3, Breathitt Formation, Taggart Marker Coal Bed of Mingo and Hance Formations (Pbue3, Pmtm)
401	Glasgow South S.L. Moore, R.C. Miller	Chattanooga Shale (tDc)
402	Temple Hill S.L. Moore, R.C. Miller	Chattanooga Shale (tDc)
403	Summer Shade W.J. Hail, Jr.	Chattanooga Shale (tDc)
404	Edmonton J.M. Cattermole	Chattanooga Shale (tDc)
405	Breeding A.R. Taylor	Chattanooga Shale (tDc)
406	Amandaville A.R. Taylor	Chattanooga Shale (tDc)
407	Creelsboro R.E. Thaden, R.Q. Lewis, Sr.	Salem and Warsaw Limestones (bMsw)
408	Jamestown R.E. Thaden, R.Q. Lewis, Sr.	Warsaw Limestone (bMw)

NO.	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZONS AND SYMBOLS
409	Jabez R.E. Thaden, R.Q. Lewis, Sr.	Salem and Warsaw Formations (bMsw)
410	Mill Springs R.Q. Lewis, Sr.	St. Louis Limestone (bMsl)
411	Frazer R.Q. Lewis, Sr.	Hartselle Formation, St. Louis Limestone (bMha, bMsl)
412	Burnside A.R. Taylor, R.Q. Lewis, Sr., J.H. Smith	Hartselle Formation (bMha)
413	Hail J.H. Smith, J.B. Pomerene, R.G. Ping	Hartselle Formation, Rockcastle Conglomerate Member of Lee Formation (bMha, bPlr)
414	Sawyer W.P. Puffett	Sandstone Member K of Lee Formation (bPlk)
415	Vox W.P. Puffett	Lee Formation (tPl)
416	Corbin W.P. Puffett	Jellico Coal Bed of Breathitt Formation (Pbj)
417	Heidrick D.E. Trimble, J.H. Smith	Jellico Coal Zone of Breathitt Fromation (Pbj)
418	Fount R.G. Ping, R.E. Sargent	Jellico Coal Zone, Magoffin Member of Breathitt Formation (Pbj, bPbm)
419	Scalf P.L. Weiss	Magoffin Member of Breathitt Formation (bPbm)
420	Beverly P.L. Weiss, C.L. Rice	Magoffin Member of Breathitt Formation (bPbm)
421	Helton D.D. Rice	Magoffin Member of Breathitt Formation (bMbm)
422	Bledsoe B. Csejtey, Jr.	Magoffin Member of Breathitt Formation, Harlan Coal Bed of Mingo Formation (bPbm, Pmhl)
423	Nolansburg B. Csejtey, Jr.	Leatherwood Coal Bed, Breathitt Formation, Harlan Coal Bed of Mingo Formation (Pbld, Pmhl)

NO.	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZONS AND SYMBOLS
424	Louellen A.J. Froelich	Leatherwood Coal Bed, Breathitt Formation, Harlan Coal Bed of Mingo Formation (Pbld, Pmhl)
425	Benham, Appalachia A.J. Froelich, B.D. Stone	Harlan Coal Zone of Mingo Formation (Pmhl)
426	Tracy S.L. Moore	Chattanooga Shale (tDc)
427	Freedom S.L. Moore	Chattanooga Shale (tDc)
428	Sulphur Lick L.D. Harris	Chattanooga Shale (tDc)
429	Dubre R.Q. Lewis, Sr.	Chattanooga Shale (tDc)
430	Waterview J.M. Cattermole	Chattanooga Shale (tDc)
431	Burkesville J.M. Cattermaole	Chattanooga Shale (tDc)
432	Wolf Creek Dam R.Q. Lewis, Sr., R.E. Thaden	Chattanooga Shale (tDc)
433	Cumberland City R.Q. Lewis, Sr., R.E. Thaden	St. Louis Limestone (bMsl)
434	Parnell R.Q. Lewis, Sr., S.J. Luft	St. Louis Limestone (bMsl)
435	Monticello A.R. Taylor	Hartselle Formation (bMha)
436	Coopersville R.Q. Lewis, Sr., A.R. Taylor	Hartselle Formation (bMha)
437	Nevelsville J.H. Smith	Kidder Limestone Member of Monteagle Limestone (tMmk)
438	Wiborg J.H. Smith	Barren Fork Coal Bed of Breathitt Formation (Pbbf)
439	Cumberland Falls J.H. Smith	Corbin Sandstone Member of Lee Formation (bPlc)
440	Wofford J.H. Smith	Blue Gem Coal Bed of Breathitt Formation (Pbbg)

NO.	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZONS AND SYMBOLS
441	Rockholds J.H. Smith	Blue Gem Coal Bed of Breathitt Formation (Pbbg)
442	Barbouville W.L. Newell	Blue Gem Coal Zone of Breathitt Formation (Pbbg)
443	Artemus D.D. Rice	Blue Gem Coal Zone, Fire Clay Coal Bed of Breathitt Formation (Pbbg, Pbfc)
444	Pineville A.J. Froelich, J.F. Tazelaar	Fire Clay Coal Bed of Breathitt Formation (Pbfc)
445	Balkan A.J. Froelich, J.F. Tazelaar	Fire Clay Coal Bed of Breathitt Formation, Hance Coal Zone of Hance Formation (Pbfc, Phahn)
446	Wallins Creek A.J. Froelich	Fire Clay Coal Zone, Breathitt Formation, Harlan Coal Bed of Mingo Formation (Pbfc, Pmhl)
447	Harlan A.J. Froelich, E.J. McKay	Harlan Coal Bed of Mingo Formation (Pmhl)
448	Evarts, Hubbard Springs J.F. Tazelaar, W.L. Newell	Harlan Coal Bed of Mingo Formation (Pmhl)
449	Pennington Gap R.L. Miller, J.B. Roen	Taggart (No. 5) Coal Bed of Wise Formation (Pwtg)
450	Keokee R.L. Miller, J.B. Roen	Not contoured
451	Fountain Run W. Hamilton	Chattanooga Shale (tDc)
452	Gamaliel D.E. Trimble	Chattanooga Shale (tDc)
453	Thompkinsville I.J. Witkind	Chattanooga Shale (tDc)
454	Vernon, Celina R.Q. Lewis, Sr.	Chattanooga Shale (tDc)
455	Blacks Ferry R. Van Horn, W.R. Griffitts	Chattanooga Shale (tDc)
456	Frogue R.Q. Lewis, Sr.	Chattanooga Shale, St. Louis Limestone (tDc, bMsl)

NO.	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZONS AND SYMBOLS
457	Albany R.Q. Lewis, Sr., R.E. Thaden	St. Louis Limestone (bMsl)
458	Savage, Moodyville R.Q. Lewis, Sr.	St. Louis Limestone (bMsl)
459	Powersburg, Pall Mall R.Q. Lewis, Sr.	Hartselle Formation (bMha)
460	Parmleysville, Sharp Place A.R. Taylor	Hartselle Formation (bMha)
461	Bell Farm, Barthell Southwest J.H. Smith	Hartselle Formation (bMha)
462	Barthell, Oneida J.B. Pomerene	Rockcastle Conglomerate Member of Lee Formation (bPlr)
463	Whitley City, Winfield J.B. Pomerene	Barren Fork Coal Bed of Breathitt Formation (Pbbf)
464	Hollyhill R.A. Loney	River Gem Coal Bed of Breathitt Formation (Pbrg)
465	Ketchen K.J. Englund	Blue Gem Coal Bed of Breathitt Formation (Pbbg)
466	Williamsburg R.W. Tabor	Jellico Coal Bed, Blue Gem Coal Bed of Breathitt Formation (Pbj, Pbbg)
467	Jellico West K.J. Englund	Blue Gem Coal Bed of Breathitt Formation, Rex Coal Bed of Hance Formation (Pbbg, Phar)
468	Saxton, Jellico East C.L. Rice, W.L. Newell	Blue Gem Coal Bed of Breathitt Formation (Pbbg)
469	Frakes, Egan W.L. Newell	Fire Clay Coal Bed of Breathitt Formation, Mingo Coal Zone of Mingo Formation (Pbfc, Pmmg)
470	Kayjay, Fork Ridge C.L. Rice, E.K. Maughan	Fire Clay Coal Bed of Breathitt Formation, Mingo Coal Zone of Mingo Formation (Pbfc, Pmmg)
471	Middlesboro North K.J. Englund, J.B. Roen, A.O. Delaney	Hance Coal Bed of Hance Formation (Phahn)
472	Middlesboro South K.J. Englund	Hance Coal Bed of Hance Formation (Phahn)

NO.	QUADRANGLE NAMES, AUTHORS	CONTOURED HORIZONS AND SYMBOLS
473	Varilla K.J. Englund, E.R. Landis, H.L. Smith	Hance Coal Bed of Hance Formation (Phahn)
474	Ewing K.J. Englund, H.L.Smith, L.D. Harris, J.G. Stephens	Harlan Coal Bed of Mingo Formation (Pmhl)
475	Rose Hill E.K. Maughan, J.F. Tazelaar	Harlan Coal Bed of Mingo Formation (Pmhl)

TABLE 2. INDEX TO DRILL HOLES
DIGITALLY LOCATED AND PLOTTED ON PLATES 11 AND 12
USING PROGRAM "CARTER", UNIVERSAL TRANSVERSE MERCATOR PROJECTION

Program "Carter" was designed by M.A. Domaratz of the National Mapping Division of the USGS. The well data were selected from records supplied by the Kentucky Geological Survey, Oil and Gas Branch of the USGS, and various published sources, especially McGuire and Howell (1963). Localities are alphabetically keyed to the maps by Kentucky Counties and are identified by drilling contractor, well number, and tract owner. At each locality the surface- or Kelly-bushing election (S) is given in feet above mean sea level. Depths in feet to selected formational contacts are shown, preceded by letter symbols: (C) -top of Mississippian-Devonian Chattanooga Shale or its stratigraphic equivalent; (T) -top of Middle Ordovician Tyrone Limestone; (K) -top of Ordovician-Cambrian Knox Dolomite; and (P) -top of Precambrian basement rock.

Most of the wells are located by two systems of coordinates: The Carter Coordinate System, used in Tennessee and Kentucky, and the Universal Transverse Mercator System. In the Carter System wells are located within sections encompassing one minute of latitude and longtiude (See plate 3). The sections are numbered from 1 to 25 within five-degree rectangles, and these are located in turn by alphabetized rows and numbered columns shown in the margins of Plate 3. Distances, in feet, are measured north, south, east, or west from section, rectangle, or quadrangle boundaries. Universal Transverse Mercator coordinates are given in meters measured east and north of UTM zone boundaries 16 or 17 as shown in the tables, but these coordinates are not given for some of the localities.

Well Identity, Surface Elevation, and Depths to Selected Horizons (in feet)			Kentucky Carter Coordinates							Universal Transverse Mercator Coordinates		
Adair County												
A. Ajax Oil and Dev. Co. No. 1 E. J. Blair												
S1000	C280	T1060	5	I	54	4800	FNL	4150	FWL	671284	4122687	16
B. Oklahoma Oil Co. No. 1 Hunter Fisher												
S690	C82	T861	10	I	51	6200	FNL	3000	FEL	654328	4121931	16
C. J. Brown Cutbirth No. 1 Trenton Gist												
S755	C155	T842	11	G	49	1300	FSL	1300	FEL	636860	4099737	16
D. F. R. Maler, Owens, Simpson No. 1 Allen Kemp												
S680	C110	T809	2	G	49	2400	FNL	7800	FEL	638369	4104316	16
E. Ajax Oil & Development Co. No. 1 E. J. Martin												
S810	C96	T875	5	I	54	1150	FNL	350	FWL	670104	4123776	16

F.	Roy Oil Co. No. 1 J. S. Rector													
	S760	C390	T1071		25	I	54	2050	FSL	450	FWL	670302	4115505	16
G.	Harvey Schmidt No. 1 F. R. Rice													
	S895	C241	T1000	K1729	1	H	51	13500	FSL	4000	FEL	654254	4109437	16
H.	Gulf Oil Corp. No. 1 J. A. Rosson													
	S933	C390	T1071		25	H	49	1700	FSL	2100	FWL	633957	4105494	16
I.	Flaws & Sadlowski No. 1 J. E. Sparks													
	S100	C311	T882		4	F	49	1400	FNL	9050	FNL	636236	4095338	16
J.	Rex-Pyramid Oil Co. No. 1 W. A. Stapp													
	S785	C72	T797	K1484	11	G	52	12200	FNL	2100	FEL	662388	4101756	16
K.	S. R. Oil Co. No. 1 Elmer Turner													
	S926	C294	T1013	K1723	13	F	51	15150	FNL	14000	FEL	651538	4091407	16
L.	Ashland Oil & Ref. Co. No. 1 R. Taylor													
	S850			P6660	24	I	54			600	FNL	2050	FEL	
Anderson County														
A.	Stoll Oil Refining Co. No. 1 Ben Bond													
	S760		T220	K825	17	S	56	9295	FSL	9450	FWL	685741	4210548	16
Barren County														
A.	Winn Davis N. 1 Mitchell Bertram													
	S697		T800	K1660	7	D	44	10200	FNL	4890	FWL	598130	4073637	16
B.	Gardner Oil Co. No. 2 John Bunch													
	S825	C418	T1220	K1945	16	G	45	6275	FSL	3575	FWL	604876	4097231	16
C.	Stoll Oil Refining Co. No. 1 C. E. Glass													
	S717		T865	K1605	20	F	45	7700	FSL	4025	FEL	610089	4088485	16
D.	West Texas Co. No. 1 R. Glass													
	S718	C177	T1146		12	G	43	13325	FSL	5800	FWL	590704	4099217	16
E.	W. T. Rich, Jr. No. 1 B. B. Houchens													
	S760	C198	T1055	K1756	17	F	43	11500	FSL	7200	FWL	591234	4089420	16

F. Don Christopher No. 1 Chester Jackman

S740	C520	T1302			10	G	43	7250	FNL	3375	FEL	595286	4102241	16

G. Elm Oil & Gas Co. No. 1 Richardson

S780	C372	T1107			25	G	44	1250	FSL	2500	FWL	597152	4095607	16

H. Wood Oil Co. No. 1 C. E. Spradin

S803	C249	T1145			15	E	43	15000	FNL	2700	FWL	589947	4081329	16

I. Charles Guinn No. 1 Stennis

S660	C1461	T960			15	F	43	13000	FSL	3700	FWL	590163	4089866	16

J. W. C. Chapman & Corwin No. 1 B. Vaugh

S710		T1045			13	F	43	12550	FNL	12750	FWL	592905	4091354	16

Bath County

A. New Domain Oil Co. No. 1 Ewing Heirs

S910	C430	T1890	K2599		21	S	71	700	FNL	2400	FEL	272480	4210416	17

B. Francis Friestadt et. al No. 1 James Richardson

S725	C18	T1120	K1806		10	S	70	2510	FNL	2180	FWL	265239	4215623	17

C. Judy & Young No. 1 Rose Run Iron Co.

S765		T960	K1587		2	T	70	2200	FNL	50	FEL	264884	4226835	17

D. Francis Friestadt et. al No. 1 James W. Wright

S796		T1036	K1660		20	T	70	220	FNL	1650	FWL	265258	4221874	17

Bell County

A. Benedum and Trees No. 1 L. B. Hurst

S1145	C2912	T4682			21	C	70	4750	FSL	650	FEL	261510	4062459	17

B. United Fuel Gas Co. No. 2 James Knuckles

S1175	C2363	T4712	K5940		5	C	71	450	FNL	1250	FWL	262302	4070106	17

Boone County

A. F. M. Ford No. 1 Cecil Connor

S908		T735	K1258	P3724	9	EE	58	6550	FNL	5500	FWL	696343	4326273	16

B. No. 1 John Grimes
S920 T730 K1268 23 DD 59 1150 FSL 11400 FEL 706046 4310357 16

C. Continental Oil Co. No. 1 Clarence Snow
S865 T630 5 DD 58 750 FNL 2450 FWL 695599 4318767 16

Bourbon County

A. City of N. Middletown No. 1 Richard Boardman
S865 T300 K875 10 T 65 6350 FNL 6350 FWL 749777 4226008 16

Boyd County

A. Inland Gas Co., Inc., No. 529 L. O. White Heirs
S644 C1652 T4410 K5244 21 W 82 750 FSL 1390 FEL 353908 4244144 17

B. Inland Gas Co. No. K 37 Amer. Rolling Mills
S671 C1463 T4023 5 V 82 150 FNL 1750 FWL 347576 4243987 17

C. Inland Gas Co. No. 533 Inland Gas Co. Fee
S802 C1746 T4398 K5176 P8509 11 V 81 1030 FNL 1310 FWL

D. Inland Gas Co. No. 537 C. E. Fannin Estate
S708 C1638 T4261 K5049 P6712 22 W 82 1200 FNL 1490 FEL

E. Inland Gas Co. No. 535 Sam McKeand
S868 C1935 T4806 K5643 P9383 25 W 83 1790 FSL 1700 FEL

Breathitt County

A. United Fuel Gas Co. No. 1 S. B. Williams
S762 C1610 T3552 K4548 P10975 13 M 75 13300 FNL 11800 FEL 297634 4157798 17

Bullitt County

A. Stoll Oil Refining Co. No. 1 George Armstrong
S410 T925 K1560 25 S 47 1625 FSL 750 FWL 617290 42069947 16

B. Paul McQueen No. 1 Orville Birdwell
S543 T976 K1525 25 S 47 4550 FSL 3100 FWL 617993 4207848 16

C.	Harris No. 1 Matt Bleemel														
	S615		T925	K1500		19	S	47	8100	FSL	8375	FEL	621796	4208986	16
D.	Beaver Dam Coal Co. No. 1 Leslie Ice														
	S695		T895	K1465		20	R	47	11875	FSL	10	FEL	624468	4200928	16
E.	Stoll Oil Refining Co. No. 1 Hugo Maraman														
	S468	C159		K1465		20	R	45	10000	FSL	1600	FWL	602884	4209305	16
F.	W. R. Mahan No. 1 Edward Marcum														
	S484		T884	K1414		2	P	46	525	FNL	7650	FEL	615004	4187763	16
G.	Beaver Dam Coal Co. No. 1 Clifford E. Samuels														
	S497		T915	K1485		2	S	46	4800	FNL	8100	FEL	614489	4214197	16
H.	Stoll Oil Refining Co. No. 1 Seninger														
	S425	C20	T1090	K1675		21	S	45	150	FSL	200	FEL	609690	4206391	16
I.	Monarch Oil & Gas No. 1 W. N. Simmons														
	S490	C250	T1350			23	S	44	600	FSL	9850	FWL	598117	4206382	16
J.	No. 1 Stowers Heirs														
	S495	C20	T1105	K1625		24	R	46	2925	FSL	8100	FWL	612332	4198025	16
Campbell County															
A.	Ashland Oil & Refining Co. No. 1 Harold Wilson														
	S748		T505	K1046	P3502	25	DD	62		1330		FSL	1910	FWL	
Carroll County															
A.	"Well at Carrolton"														
	S460		T420	K1000		21	AA	52	300	FSL	2800	FEL	658649	4281249	16
Carter County															
A.	James Proctor No. 1 Edwin Burton														
	S957	C845	T2690	K3342		25	W	77	2450	FSL	2200	FWL	311309	4245546	17
B.	South Central Petroleum No. 1 Virgil Ramey														
	S950	C968	T2692	K3606		25	X	78	2100	FSL	1000	FWL	318434	4254528	17

C.	Ralph N. Thomas No. 1 James Simmons														
	S647	C792	T2846	K3558		11	W	78	12700	FSL	2800	FEL	324421	4248374	17
D.	United Fuel Gas No. 1 Lloyd Stamper														
	S857	C852	T2752	K3415	P5060	3	V	77	2050	FNL	11100	FWL	313988	4244112	17
E.	Barrick-Ky Oil & Gas No. 1 Martha Stewart														
	S900	C1463	T3850			20	V	80	9800	FSL	4900	FEL	338142	4237952	17
F.	A. H. Carpenter No. 1 J. W. Whitt														
	S695	C756	T2830	K3418		13	W	78	12400	FNL	11825	FEL	321706	4250036	17
G.	Cabot-Ashland No. 1 Warnie Stapleton														
	S956		T2899	K3515	P5251	12	V	77	2450	FNL	1525	FEL			
H.	Inland Gas Co. No. 538 Coalton Fee														
	S796	C1530	T4024	K4780	P7156	14	V	81	2430	FSL	10	FEL			
I.	Inland Gas Co. No. 546, E. & M. McDavid														
	S791				P9970	22	U	79	2850	FSL	900	FWL			

Casey County

A.	F. B. CLine et al. No. 1 Talmage Clements														
	S1229	C235	T1007			9	J	56	10900	FNL	7750	FEL	689669	4130474	16
B.	Olds Oil Co. No. 1 Elkins														
	S875		T570	K1226		22	L	56	500	FSL	5600	FEL	690032	4143209	16
C.	O. H. Snyder et al. No. 1 W. W. Ellis														
	S868		T508			14	L	55	12800	FNL	7950	FWL	679299	4148168	16
D.	J. Shouse & I. Lykins No. 1 Sam Fair														
	S817	C88	T892	K1615		14	J	55	1780	FNL	250	FWL	678830	4129315	16
E.	Olds Oil Co. No. 1 C. J. Overstreet														
	S875		T678	K1329		6	K	54	11950	FNL	1600	FWL	670176	4138985	16
F.	Carl Rubarts No. 1 Mary Paley														
	S788		T755	K1418		25	I	55	4200	FSL	2100	FWL	678190	4116324	16

G. Bootman et al. No. 1 Pitman
S848 T660 K1390 21 I 54 4425 FSL 1500 FEL 677092 4116369 16

H. Hillsdale Oil Co. No. 1 Oscar Radler
S938 T762 K1500 20 I 56 19975 FSL 3000 FEL 691380 4118983 16

I. J. C. Buchanan & S. D. Pullem No. 1 B. F. Russell
S850 T720 21 I 54 475 FSL 1900 FEL 676995 4115163 16

J. Cities Service Co. No. Al Arthur Garrett
S1220 K2140 P8164 7 I 57 2100 FSL 1850 FEL

Clark County

A. Martin Melcher No. 1 Dewey Barrett
S871 T977 15 Q 66 1570 FSL 1460 FWL 757002 4195319 16

B. KY. Drilling & Operating No. 1 Flora Berryman
S823 T1020 K1718 14 Q 66 14600 FNL 9000 FWL 759278 4196017 16

C. Martin Melcher No. 1 Lester Burgher
S812 T1012 K1715 16 Q 66 375 FSL 300 FEL 758002 4193134 16

D. Sam Allen & Caputo No. 1 Harvey Bush
S926 T270 K855 7 R 65 6125 FNL 6900 FWL 750948 4207598 16

E. W. O. Allen No. 1 Albert Chism
S931 T620 K1262 25 R 66 4000 FSL 1350 FWL 7567720 4201607 16

F. J. C. Yates & W. B. Hodgkin No. 1 W. Z. Eubank
S745 T1000 K1600 17 R 67 7225 FNL 7375 FWL 238747 4207586 17

G. Winmar Oil Co. No. 1 Ora Haggard
S650 T795 K1488 10 Q 65 1000 FNL 2360 FEL 755748 4198199 16

H. Texaco, Inc. No. 1 Joe Williams
S650 T340 K945 P4790 9 Q 64 3000 FSL 800 FWL 746468 4197283 16

I. Peter Widener No. 1 Russell Glover
S820 T820 K1478 18 R 66 2900 FNL 1350 FWL 759652 4203298 16

J. Ashland Oil & Ref. Co. No. 1 M. W. Miller
S949 T358 K784 P3073 16 S 65 2960 FSL 240 FWL 748779 4212152 16

Clinton County

A. O. E. Ellis & Co. No. 1 Ben Aaron
S1000 C445 T1070 25 D 53 5200 FSL 1975 FWL 664239 4070100 16

B. Rogers No. 1 Jane Avery
S905 C362 T1018 17 D 53 10675 FSL 8625 FWL 666233 4071807 16

C. Smith et al. No. 1 Willie Boils
S930 T903 5 C 52 4100 FNL 2850 FWL 657118 4067132 16

D. H. A. Hockathorn No. 1 George Butler
S1005 C401 T1035 20 D 52 11325 FSL 3050 FEL 662672 4071937 16

E. M. A. Smith No. 1 Elvins Cash
S980 C360 T1047 K1760 10 C 51 7650 FNL 300 FEL 656178 4066032 16

F. Cartago Chemical Co. No. 1 Coop
S910 C289 T950 K1660 14 D 53 10600 FSL 6700 FWL 665647 4071773 16

G. Murphy & Buskirk No. 1 George Division
S960 T975 K1675 11 C 52 14500 FNL 2675 FEL 662937 4064071 16

H. Pat Mille No. 1 Perk Duval
S910 C330 T927 K1614 7 C 52 6400 FNL 8300 FWL 658792 4066461 16

I. Allen H. Barton No. 2 Garner
S953 C380 T995 7 B 52 8750 FNL 8550 FWL 659050 4056502 16

J. T & W Oil Co. No. 1 Simon Grace
S936 C388 T975 5 B 53 100 FNL 1625 FWL 66340 4059238 16

K. Allen B. Borton No. 1 Arthur Harlan
S925 C352 T944 15 C 52 14200 FNL 1400 FWL 656733 4064046 16

L. Orba Howard No. 1 J. S. Keene
S930 C419 T1078 K1783 20 D 52 6250 FSL 800 FEL 663387 4070404 16

M.	R. Parrish et al. No. 1 Ida Knox														
	S989	C347	T1017		9	D	52	9800	FNL	6250	FEL	661643	4074727	16
N.	No. 1 Kyle Bros.														
	S955	C376	T950		8	C	52	7650	FNL	13050	FEL	659736	4066098	16
O.	A. J. Lea No. 3 Irene Logston														
	S884	C302	T890		4	B	54	3500	FNL	7000	FWL	673446	4058381	16
P.	Jarvie & Marcell No. 1 Parrigan														
	S899	C360	T960		3	B	54	4300	FNL	11100	FWL	674700	4058163	16
Q.	Murphy & Buskirk No. 1 J. N. & Ethel Selvidge														
	S908	C351	T953	K1659	17	C	53	7800	FSL	8800	FWL	666480	4061687	16
R.	Beech Bottom Oil & Gas No. 1 George Smith														
	S990	C345	T1035		6	B	53	8450	FNL	3250	FWL	664884	4056703	16
S.	Belco Oil Co. No. 1 J. B. Smith														
	S993	C409	T1035	K1720	22	D	52	2075	FSL	5050	FEL	662116	4069107	16
T.	New Domain Oil & Gas Co. No. 1 Jacob Speck														
	S997	C353	T999		13	D	53	12900	FNL	9750	FWL	666536	4073877	16
U.	Robert Parish No. 2 Summers														
	S984	3151	T910		3	C	52	2750	FNL	12500	FEL	659875	4067594	16
Cumberland County															
A.	Dr. Joseph Geisen No. 1 Fred Appleby														
	S562		T610		3	C	50	700	FNL	12050	FWL	645023	4067954	16
B.	Orba Howard No. 1 Paul Bean														
	S760		T711	K1399	24	E	50	1250	FSL	5875	FWL	642978	4077762	16
C.	Smith & McCracken No. 1 William Capps														
	S670		T612	K1394	22	C	50	3125	FSL	7400	FEL	646677	4059901	16
D.	Chandler & Chandler No. 1 Carter Sisters														
	S570		T573	K1278	16	D	49	9300	FSL	4000	FWL	635082	4070839	16

E.	Dr. Joseph Geisen & Assoc. No. 1 L. A. Cash													
	S560		T596	K1330	10	D	50	9400	FNL	1875	FEL	648105	4074603	16
F.	N. B. Hunt No. 2 P. A. Davis													
	S640		T640		20	D	50	11000	FSL	2825	FEL	647868	4071569	16
G.	M. A. Walker No. 2 Herschel Flowers, Jr.													
	S952	C341	T923		10	C	51	7200	FNL	4000	FEL	655048	4066149	16
H.	H. M. Harrell No. 1 Homer Grider													
	S600		T620		3	E	51	3000	FNL	10650	FEL	652660	4085882	16
I.	Roew & Pendleton No. 1 Effie Helms													
	S591		T652		11	E	50	14200	FNL	4200	FEL	647260	4082373	16
J.	Sunburst Petroleum Co. No. 1 Alex Holman													
	S915	C291	T870	K1580	6	C	51	11875	FNL	150	FEL	650293	4064639	16
K.	Roger Layne No. 1 Madie Hume													
	S560		T391		14	C	49	15250	FNL	5700	FWL	635717	4063366	16
L.	Don N. Geyer No. 1 Frank Key													
	S698		T702	K1456	13	C	50	12750	FNL	12000	FEL	645198	4064284	16
M.	Ray Poppleman No. 1 Evell Morgan													
	S725		T626	K1313	25	E	52	4100	FNL	5800	FEL	661711	4078316	16
N.	C. Ellis No. 1 W. B. Murley													
	S605		T544	K1239	9	C	49	7800	FNL	7565	FEL	639048	4065691	16
O.	H. T. & H. Oil Co. No. 1 Charlie Orten													
	S629		T620		25	E	52	1100	FSL	?	?	657203	4077966	16
P.	M. E. Affield NO. 1 John W. Scott													
	S900		T865		16	C	51	8650	FNL	4050	FWL	650136	4061644	16
Q.	Carroco Oil Co. No. 1 Stockton													
	S575		T497		11	D	49	12875	FSL	3725	FEL	640147	4072010	16

Elliott County

A. Inland Gas Co. No. 1 Fraley
S796 C360 T3143 K4035 23 T 78 4775 FSL 1005 FWL 320376 4218292 17

B. United Fuel Gas Co. No. 1 J. H. Litton
S968 C975 T2750 K3538 P5190 22 T 76 4200 FSL 8400 FEL 307433 4218412 17

C. United Fuel Gas Co. No. 1 Ada Pennington
S918 C926 T2785 K3575 21 T 76 ? ? ? ?

D. Monitor Petroleum Corp. No. 1 Cecil Ison
S676 C1170 T3720 K4770 P9660 8 T 79 745 FSL 1665 FWL

Estill County

A. E. C. Dyer No. 1 Alexander
S643 T1343 K2120 19 O 67 10450 FSL 7000 FEL 240703 4175879 17

B. Trenton Development No. 1 H. G. Bicknell
S722 C78 T1250 K1991 24 N 66 4150 FSL 5050 FWL 759051 4164094 17

C. R. R. Snowden et al No. 1 Chrisman Mtn. Well
S860 T990 K1750 19 N 65 100 FNL 2550 FEL 755191 4166981 17

D. Roy Davis et al No. 1 Robert Masters
S727 T1044 5 O 69 4600 FNL 4100 FWL 236883 4180671 17

E. Arch Carpenter No. 2 Pruitt, Miller, Goff
S1030 C572 T2037 K2848 10 O 69 7800 FNL 1600 FEL 257153 4179073 17

F. Wood Oil Co. No. 1 Paul Rodgers
S785 T1470 K2230 4 O 68 4000 FNL 6575 FWL 244987 4180599 17

G. A. H. Carpenter No. 1 Pete Wells
S781 C1248 K1980 23 P 67 2950 FNL 12000 FWL 239364 4182846 17

H. Petroleum Exploration & South Penn. No. 1 Wiseman & Cornett
S716 T1150 K1868 3 O 67 150 FNL 12450 FWL 239469 4181945 17

I. Texaco, Inc. No.1 Glyn Tipton
S647 T974 K1749 P6800 21 O 66 2100 FSL 1700 FEL 764079 4173486 16

Fayette County

A. Keeneland Race Track No. 1 Keeneland Race Track

S951		T220	K780	9	S	59	11150	FNL	6950	FEL	709928	4214162	16

Fleming County

A. Lilly et al No. 2 John Riley

S786		T961	K1514	14	V	71	12050	FSL	6525	FWL	268738	4240324	17

B. Leonard Spencer et al Leonard Spencer

S808		T855		2	W	70	3000	FNL	4800	FEL	265691	4254337	17

C. Albert Knox No. 1 Hisa Stacey

S850		T1478	K2080	14	W	73	13500	FNL	7200	FWL	283814	4250629	17

Floyd County

A. Signal Oil & Gas Co. No. 1 M. & P. Hall Heirs

S677			P12852	1	L	81	2490	FNL	2360	FEL	344574	4150830	17

B. Kentucky-West Virginia Gas Co. No.1 Phillip Dingus

S827	C2060	T5093		7	M	82	8550	FNL	9850	FWL	348432	4158162	17

Gallatin County

A. R. B. Hager et al No. 1 P. L. & J. B. Riley

S810		T608	K1165	11	AA	55	12175	FSL	850	FEL	680913	4285343	16

B. Durham & Lucas No. 1 Carl Sanders

S740		T1212		12	AA	55	13750	FNL	5625	FEL	679428	4286660	16

C. Stoll Oil Refining Co. No. 1 John Webster

S833		T568	K1003	8	AA	57	6500	FNL	12600	FEL	691742	4289157	16

Garrard County

A. Calstrom, Harding et al No. 2 R. R. Anderson

S950		T750		8	M	60	9575	FNL	13200	FEL	716810	4159298	16

B. J. Darst et al No. 1 Emory Clark

S918		T555		10	M	61	9250	FNL	2825	FEL	727330	4159679	16

C. Walter Chenault No. 1 D. A. Hervey

S976 T720 K1442 3 M 62 2050 FNL 10350 FWL 731282 4161983 16

D. Gassaway et al No. 1 Bud Starnes

S984 T557 K1265 11 N 60 12725 FSL 1950 FEL 720056 4166181 16

E. Cox, Willis, Darst et al No. 1 Bud Starnes

S925 T660 6 M 62 10950 FNL 2700 FWL 729027 4159207 16

F. Peter Widener No. 1 Andrew Burdette

S817 K888 7 N 59 2475 FNL 1000 FEL 708505 4168651 16

G. Texaco, Inc. No. 1 Leonard Kirby

S972 T504 K1132 P5640 8 O 59 250 FSL 300 FWL 708694 4176889 16

H. Clinton Oil No. 1-V George B. Hale

S695 T180 K847 15 O 61 950 FSL 150 FEL 721824 4175594 16

I. L & M Gas No. 1 C. B. Causey

S924 T568 K1258 10 M 61 1575 FNL 2200 FWL 727374 4160168 16

J. Patrick Petroleum Co. No. 1 Broadus & Tussey

S937 T397 K1044 15 N 61 1900 FSL 625 FEL 721920 4166632 16

Grant County

A. Neal Brothers No. 1 A. B. Collins

S570 T265 5 AA 58 4925 FNL 4450 FWL 696924 4289764 16

B. Dry Ridge Mineral Well

S741 T330 K895 2 Y 59 2875 FNL 1900 FWL 708202 4272166 16

Green County

A. Sunburst Petroleum Co. No. 7 Gaddie

S630 T1256 17 K 49 7400 FSL 7100 FWL 635014 4134992 16

B. H. L. Lambert No. 1 Hattie Meadows

S567 C245 T1136 8 I 48 6650 FNL 10350 FWL 628826 4121364 16

C. Jackson Petroleum Co. No. 1 Redmon & Turner

S608 C214 T1210 K1776 16 K 49 6950 FSL 4150 FWL 634118 4134840 16

D. Johnson & Rizzo No. 1 Aried Thompson

	S735		T1313	K1981		23	T	47	2150	FSL	10400	FWL	621541	4114691	16

Greenup County

A. United Carbon No. 1 Fred Felty

	S707	C922	T3115	K3792		3	W	79	50	FNL	9900	FWL	3284070	4253654	17

B. Commonwealth Gas Co. No. 1 D. Newell

	S1054	C760	T2900	K3510	P5177	7	Z	78	3850	FNL	420	FEL			

Hardin County

A. Beaver Dam Coal Co. No. 2 W. B. Miller

	S450	C56	T1020	K1706		17	P	46	697	FSL	100	FWL	611594	4180690	16

Harrison County

A. Well at Cynthiana No. 1

	S700		T315	K785		7	W	63	7850	FNL	9200	FWL	735692	4252899	16

B. No. 1 Maybrier

	S810		T254	K975		22	X	64	4900	FSL	6850	FEL	745243	4257071	16

Hart County

A. Mud Branch Oil & Gas No. 1 Ernest Bryant

	S640	C809	T1567			12	K	43	12900	FSL	7400	FEL	593672	4136103	16

B. Cumberland Petroleum Co. No. 2 Alonzo Davis

	S823		T1241	K1876		21	L	46	1400	FSL	750	FEL	617755	4142150	16

Henry County

A. Miller & Richardson No. 1 Henderson

	S480		T164	K710		21	X	54	2925	FSL	2925	FEL	673691	4254606	16

B. Miller & Richardson No. 1 Moore

	S475		T140	K720		1	W	54	2150	FNL	2575	FEL	673839	4253062	16

C. No. 1 Frank Rickett

	S845		T705	K1270		7	X	52	11800	FNL	5450	FWL	654334	4258974	16

Jackson County

A. Patterson, Dyer & Roeder No. 1 Bond Lumber Co.
S1462 C950 T2115 K2917 25 L 66 2100 FSL 150 FWL 758152 4145527 16

B. Monitor Petroleum Corp. No. 1 Stanley Neeley
S134 C965 T2395 K3233 12 L 67 1300 FSL 700 FWL 239264 4149066 17

Jefferson County

A. Caldwell et al No. 1 Sam P. Armstrong
S485 C89 T1225 25 T 46 5700 FSL 325 FWL 609703 4217331 16

B. Dupont No. 1 Dupont
S436 T998 21 V 45 3125 FSL 4800 FEL 607902 4235019 16

C. Stoll Oil Refining Co. No. 1 Alene Schooling
S570 T625 K1205 25 U 49 1675 FSL 4650 FWL 632813 4225698 16

D. Dupont No. 1 Fee (waste disposal)
S562 C125 T1142 K1713 P5954 10 U 44 920 FSL 2760 FWL

Jessamine County

A. Stoll Oil Refining Co. No. 1 Selby Coleman
S958 T35 K618 17 Q 60 10500 FSL 7975 FWL 715024 4193132 16

B. Mack Hutchins No. 1 Clyde Teater
S735 T310 K977 17 P 60 8650 FSL 5475 FWL 714516 4183301 16

C. Kin Ark No. 1 Arch Hager
S797 T118 K780 2 P 60 1380 FNL 420 FEL 718428 4189600 16

D. Texaco, Inc. No. 1 Thomas Shearer
S947 T40 K670 P5670 6 P 60 480 FSL 310 FEL 714142 4186353 16

E. Texaco, Inc. No. 1 Park Wolfinbarger
S972 T438 K1086 P6006 1 P 60 840 FSL 2590 FEL 719266 4188448 16

Johnson County

A. Signal Oil & Gas No. 1 Elkhorn City Coal Corp.
S737 C895 T5084 K5945 P14295 7 P 82 900 FSL 1600 FEL 343381 4185091 17

B. Ashland Oil & Refining Co. No. 8 Wallace Williams
S840 T3586 K4870 19 R 79 8500 FSL 9550 FEL 328655 4200350 17

Kenton County

A. Sohio Oil Co. No. 1 Latonia Refinery
S485 T263 K685 12 EE 60 14600 FSL 5800 FEL 714611 4323941 16

Knox County

A. Schmidt No. 1 Hammond
S1031 T3350 K4381 20 F 68 7400 FSL 2625 FEL 246859 4091453 17

B. Triangle Oil & Gas No. 1 J. Stafford
S962 C1840 T3232 K4267 13 D 67 12700 FNL 12000 FWL 235982 4076401 17

Larue County

A. Allstate Oil Co. No. 1 Johnson Brothers
S508 T1002 K1475 10 O 46 11000 FNL 4400 FEL 616172 4175338 16

B. Gillispie Oil Co. No. 1 William Underwood
S635 T840 K1455 12 M 48 12575 FSL 8050 FEL 630078 4154987 16

Laurel County

A. Oliver Jenkins No. 1 Crook Heirs
S1210 C1284 T2550 K3313 4 H 67 4900 FNL 8450 FWL 236142 4115800 17

B. Globe Oil Co. No. 1 Sewell
S939 C950 T1555 K2940 24 H 64 5600 FSL 7450 FWL 746668 4109224 16

Lawrence County

A. Inland Gas Co. No. 542 W. P. & R. Young
S885 T4898 K5890 P9383 6 U 82 2320 FNL 1550 FWL

Lee County

A. Floyd Fitch No. 1 Beartrack

S1168	C960	T2383	K3205		18	N	69	7850	FSL	10550	FEL	254025	4165423	17

B. Jack Kindred No. 1 C. H. Sipple

S876	C712	T2168	K2958		19	M	69	7300	FSL	5400	FEL	255588	4165209	17

Leslie County

A. United Fuel Gas Co. No. 28 Fordson Coal Co.

S1179	C2202	T4000	K5006	P9412	8	I	73	7500	FNL	12500	FWL	282013	4122948	17

Lewis County

A. Ralph Thomas No. 1 Daisy Adams

S555		T1925	K2560	P4175	13	Y	76	16350	FSL	9700	FWL	306865	4268395	17

B. H. P. Purnell No. 1 F. Ferguson

S612		T985			4	Y	72	150	FNL	9175	FWL	277769	4273374	17

C. Ashland Oil and Refining Co. No. 1 Dewey Wolfe

S1113	C773	T2773	K3355		13	Y	77	1000	FSL	820	FWL			

D. Pure Oil Co. No. 1 Ohio Cities

S999	C270	T1850	K2446		4	W	74	6000	FNL	6100	FWL	290820	4252730	17

E. United Fuel Gas Co. No. 1 Alice Shepherd

S903	C605	T2240	K2863	P4335	19	W	75	1050	FNL	2050	FEL	301338	4248420	17

Lincoln County

A. Olds Oil Co. No. 1 Elliott

S1030		T420	K1368		20	L	57	11750	FSL	4225	FEL	697744	4146817	16

B. Olds Oil Co. No. 1 Estes

S932	C3	T589			21	L	57	3050	FSL	2850	FEL	698227	4144177	16

C. W. B. Phillips et al No. 1 Jesse Martin

S1100		T635	K1330		7	L	58	11990	FNL	7450	FWL	701253	4148917	16

D.	California Oil Co. No. 1 A. R. Spears														
	S1138		T590	K1308	P5760	13	L	57	14150	FNL	11050	FEL	695633	4148125	16
E.	Rome Oil & Gas Co. No. 1 Foster Morrow														
	S1032		T644	K1361		13	M	58	1000	FSL	150	FEL	703173	4156624	16
Madison County															
A.	C. Ellis & State Bank No. 1 Collins (State Bank of Richmond)														
	S955		T420	K1000		11	P	61	13375	FSL	4600	FEL	726089	4185050	16
B.	Ashland Oil & Basin Drilling No. 1 Alfred Cruse														
	S787		T942	K1620		21	Q	65	4900	FSL	2900	FEL	755758	4192592	16
C.	R. R. Snowden No. 1 J. D. Evans														
	S726		T112	K1880		1	M	65	3675	FNL	4525	FEL	756210	4186222	16
D.	Chenault et al No. 1 George Ginter														
	S682		T800	K1480		12	P	65	13800	FSL	7000	FEL	754714	4186015	16
E.	Boht Oil Co. No. 1 S. W. Lackey														
	S980		T769	K1475		9	N	63	10300	FNL	7650	FWL	737629	4168904	16
F.	Kentucky Drilling & Operating Co. No. 1 R. R. Snowden														
	S872	C04	T1001	K1738		18	N	65	7600	FNL	11100	FWL	753503	4165574	16
G.	W. Chenault et al No. 1 George B. Todd														
	S850		T617	K1340		23	N	62	2950	FSL	10400	FEL	732280	4163535	16
H.	Texaco, Inc. No. 1 B. E. Perkins														
	S940		T463	K1095	P6370	11	P	61	150	FSL	350	FWL	726138	4184722	16
Meade County															
A.	William Duchscherer, Jr. No. 1 Lester Pack														
	S633	C631	T1695	K2282		13	R	41	2800	FNL	1800	FEL	577052	4201420	16
Menifee County															
A.	New Domain Oil & Gas Co. No. 28 Ewing Heirs														
	S890	C308	T1715			7	S	72	11700	FNL	7000	FWL	275456	4214385	17

B.	A. H. Carpenter No. 1 Mose Ferrel														
	S765	C260	T1620			23	S	71	1950	FSL	10400	FWL	269032	4209469	17
C.	Groover et al No. 1 Motley														
	S1115		T2452	K3158		21	R	72	1700	FSL	2500	FEL	279488	4199849	17
D.	Monitor Petroleum Co. No. 1 Alex Campbell														
	S1128	C917	T2445	K3180	P6712	14	Q	72	2500	FSL	400	FEL	275587	4194646	17
E.	United Fuel Gas Co. No. 9380-T Frank Brown et al														
	S989	C617	T2110	K2745	P5804	21	S	72	2600	FNL	1050	FWL	279369	4209647	17
Mercer County															
A.	Oil Develpment Trust No.1 J. L. Casey														
	S790		T825			2	P	55	7400	FSL	2650	FWL	683660	4182123	16
Metcalfe County															
A.	F. D. Walker No. 1 G. B. Hurt														
	S863	C162	T846			16	F	49	7525	FSL	4225	FWL	634869	4088789	16
B.	Edwin Wilson No. 3 Will Irwin														
	S724	C536	T1362			9	H	45	9450	FNL	4850	FEL	608062	4110971	16
C.	No. 4 Garnet Lane														
	S785	C521	T1286	K2037		9	H	46	7200	FNL	9750	FEL	615441	4111755	16
D.	A. E. Stokes No. 1 Roscoe Parks														
	S618	C173	T900			1	G	47	1125	FNL	2950	FEL	625024	4104496	16
E.	Stoll Oil Refining Co. No. 1 H. F. Porter														
	S608		T905	K1528		17	H	47	6550	FSL	9000	FWL	621226	4106780	16
F.	Benz Oil Corp. No. 1 Charles Nunally														
	S757				P6100	16	F	46	2600	FSL	1250	FEL			
Monroe County															
A.	Van Tein No. 1 Biggerstaff														
	S620		T554			11	C	47	14000	FNL	1350	FEL	626119	4063600	16

B. Cain & Richardson No. 1 Dessie Creek															
	S845	C182	T869			8	B	44	10475	FNL	10650	FWL	600096	4055085	16
C. H. Steffie & D. Schlock No.															
	S801	C150	T804			11	C	45	12200	FNL	1450	FEL	611195	4063942	16
D. A. S. McClintock No. 1 Kerr															
	S560		T545			8	B	49	8500	FNL	10000	FWL	637140	4056200	16
E. A. S. McClintock et al. No. 1 Dave King															
	S550		T457			14	B	49	13500	FNL	8090	FWL	636582	4054667	16
F. W. L. Rodgers et al. No. 1 Dave King															
	S750	C113	T789			10	C	45	7600	FNL	600	FEL	611436	4065347	16
Montgomery County															
A. J. T. Perry No. 1 J. Greenwade															
	S769		T880			16	S	69	8900	FSL	375	FWL	251407	4212105	17
B. Graber No. 1 N. B. Hoskins															
	S819		T504	K1114		4	R	67	2850	FNL	6900	FWL	238645	4208922	17
C. Ferguson & Bosworth No. 16-1 Alvery Potter															
	S989		T880	K1549	P4454	8	R	67	2650	FNL	1650	FEL	240377	4207076	17
Morgan County															
A. McCoun No. 2 A. C. Bradley															
	S926		T3630			5	Q	78	975	FNL	2650	FWL	317668	4198095	17
B. Allen, Ashland et al. No. 1 Richardson															
	S883	C1265	T3295	K4260		12	P	75	17075	FNL	6550	FEL	299872	4184350	17
C. Monitor Petroleum Co. No. 1 C. K. Stacy Heirs															
	S805	C1042	T2760	K3504	P7465	18	Q	74	870	FNL	880	FEL	291543	4193198	17
D. Monitor Petroleum Co. No. 1 Burchell Blanton															
	S986	C882	T2427	K3143	P6308	23	R	73	2010	FSL	2210	FWL	283856	4199827	17
E. Monitor Petroleum Co., No. 1 Freddie & Earl Ison															
	S821	C1107	T3425	K4518		3	R	78	1515	FSL	1920	FEL	320850	4206186	17

F. Ashland Oil & Refining Co. No. 1 Lee Clay Products
S778 C718 T2405 K3125 P5543 14 S 75 2030 FNL 1900 FEL 297591 4213050 17

Nelson County

A. Beaver Dam Coal Co. No. 1 John T. Boone
S510 T895 K1510 23 P 47 3450 FSL 1950 FEL 621260 4179816 16

B. Beaver Dam Coal Co. No. 1 Jodie E. Edwards
S535 C24 T970 K1554 16 P 47 550 FSL 600 FEL 618721 4180745 16

C. Calstar No. 1 Fields
S560 T813 9 M 48 6700 FNL 8600 FEL 629857 4158356 16

Nicholas County

A. Albert Knox No. 1 W. C. Sams
S620 T240 18 W 67 8925 FNL 13025 FWL 241949 4253258 17

B. Union Light, Heat & Power No. 200 James Mynear
S710 T262 K834 P2929 16 X 66 2400 FSL 2350 FWL

Oldham County

A. Louisville Gas & Electric No. 1 J. M. Bradberry
S750 T772 K1225 12 W 50 13125 FSL 9050 FEL 642843 4247858 16

B. No. 1 E. C. Klingenfus
S762 T911 K1345 4 V 49 475 FNL 9225 FWL 633918 4243560 16

C. No. 1 Raymond Moore
S590 T600 K1120 22 Y 50 2300 FSL 9025 FEL 642576 4263054 16

D. No. 1 L & N Railroad
S759 T900 K1450 3 W 50 4375 FNL 10000 FEL 642483 4251768 16

Owen County

A. Ennison No. 1 Ennis Clark
S700 T320 K895 9 W 56 11800 FNL 7300 FEL 687022 4250417 16

B.	Becker & Smith No. 1 Emmett Harris														
	S958		T522	K1120		9	Y	57	11325	FNL	9000	FEL	693328	4269217	16
C.	No. 1 Emmett Johnson														
	S661		T341	K927		1	Z	55	5550	FNL	3950	FEL	680091	4279921	16
D.	No. 1 Morgan Heirs														
	S505		T265	K760		9	Y	55	9600	FNL	9150	FEL	678745	4269404	16
E.	No. 1 Wilhoite														
	S483		T225	K690		24	X	56	2700	FSL	9375	FWL	684783	4254783	16
Owsley County															
A.	Petroleum Exploration No. 2 Burgoyne Botner														
	S1025	C1070	T2590	K3480		12	L	69	11600	FNL	8000	FWL	251858	4150304	17
Pendleton County															
A.	W. K. Snyder et al. No. 1 Williams Dawson														
	S605		T365	K800		16	AA	63	8750	FSl	250	FWL	732014	4285622	16
Pike County															
A.	Signal Oil & Gas No. 1 Henry Stratton														
	S1199	C3037	T6283	K7490	P12420	8	L	85	480	FNL	1040	FWL	370640	4149147	17
Powell County															
A.	Radure & Marcum No. 1 Robert Bellamy														
	S1140		T1930	K2668		16	P	69	7275	FSL	4300	FWL	251743	4183829	17
B.	Roe Faulkner No. 1 Derrickson														
	S638		T1240	K1967		20	Q	68	6850	FSL	1875	FEL	250140	4193005	17
C.	South Central Petroleum Co. No. 1 James Hall														
	S755		T1106	K1783		8	P	67	9350	FNL	11000	FWL	239234	4188406	17
D.	A. H. Carpenter No. 1 Shug Maloney														
	S686	C170	T1379	K2204		1	P	69	350	FNL	3300	FEL	256975	4190605	17

E.	Sam Allen No. 1 C. A. Means													
	S767		T1494	K2192	6	P	69	10450	FNL	6900	FEL	255788	4187562	17
F.	Roy Davis et al. No. 1 George Reddix													
	S918	C135	T1320	K1991	4	Q	68	1150	FNL	5000	FWL	245113	4199978	17
G.	Roy Davis et al. No. 2 George Reddix													
	S1025		T1375	K2148	5	Q	68	4250	FNL	4050	FWL	244794	4199043	17
H.	Endicott & Compton No. 1 Seales													
	S732		T1055		8	Q	67	8150	FNL	10650	FWL	239437	4198023	17
I.	Petroleum Exploration Co. No. 1 Mona Smith													
	S939	C190	T1490	K2216	23	P	68	1650	FSL	10880	FEL	247069	4182257	17
J.	Arch Carpenter No. 1 Jim Smyth													
	S1201	C62	T1782		22	P	68	2825	FSL	8275	FEL	247873	4182590	17
K.	Petroleum Exploration Co. No. 1 Hobert Tipton													
	S1318	C582	T1855		22	P	68	3450	FSL	7000	FEL	248267	4182769	17
L.	Petroleum Exploration Co. No. 1 Ernest Tipton													
	S869	C192	T1465	K2160	20	P	68	3300	FSL	1900	FEL	249875	4184525	17
Magoffin County														
A.	Cumberland Petrol. Co. No. 44 L. C. Bailey													
	S1018		T3907	K5060	6	P	79	10400	FNL	2650	FWL	324735	4185817	17
Marion County														
A.	Calstar No. 1 Allen Browning													
	S725		T733	K1295	4	M	51	3850	FNL	7500	FWL	649468	4159555	16
B.	Calstar No. 1 Charles Gaddie													
	S555		T804		6	M	49	8400	FNL	3500	FWL	633552	4157897	16
C.	Haberman & Lawther No. 1 Hall													
	S1080	C378	T1238		21	L	51	2050	FSL	3700	FEL	653726	4142933	16

Martin County

A. United Fuel Gas Co. No. 1 Jasper James, et al.
S659 C1840 T5330 K6668 19 Q 84 2450 FSL 1600 FEL 366087 4190805 17

Mason County

A. Oscar U. Brock No. 1 H. A. Henderson
S835 T560 K1060 25 Z 68 682 FSL 4350 FWL 247266 4274534 17

B. United Fuel Gas Co. No. 1 Wilson Rawlings
S764 T845 K1410 P3292 15 Y 71 950 FNL 75 FWL 267623 4269716 17

C. W. S. T. Development Co. No. 1 D. F. Weaver
S940 T695 K1235 5 AA 68 1750 FNL 1150 FWL 246857 4292323 17

McCreary County

A. Barnwell Drilling Co. No. 1 Stearns Coal Co.
S760 C656 T1630 K2500 15 C 60 14600 FSL 1600 FWL 716359 4064874 16

B. Barnwell Drilling Co. No. 3 Stearns Coal Co.
S1193 C1236 T2228 K3115 12 C 60 13900 FSL 6400 FEL 721373 4064789 16

C. A. Brauer No. 1 Stearns Coal Co.
S820 C850 T1830 K2700 14 B 60 15520 FSL 7590 FWL 718410 4055954 16

Pulaski County

A. Onie P. Hamilton et al. No. 1 Mary Adams
S935 C525 T1484 K2289 11 G 59 12300 FSL 2525 FEL 714184 4101127 16

B. D. Parmley et al. No. 2 Bill Burton
S770 C7 T672 18 H 58 7875 FSL 10000 FWL 702986 4108654 16

C. Onie Hamilton et al. No. 1 Dora Hamm
S833 C470 T1110 15 G 60 13725 FNL 875 FWL 715186 4102472 16

D. Onie P. Hamilton et al. No. 1 Nanie Nutt
S800 C293 T1005 11 G 59 14400 FNL 2750 FEL 714087 4102239 16

E. Tom Donnelly No. 1 Elmer Payne
S1140 C360 T1230 16 J 59 10200 FSL 1300 FWL 707269 4128071 16

F. Rabbitfoot et al. No. 1 C. G. Shoun
S1092 C335 T1134 K1870 9 H 59 9400 FNL 7025 FWL 709388 4112897 16

G. Fishing Creek Drilling Co. No. 1 Babe Simpson
S680 T740 K1465 3 G 58 4500 FNL 9800 FEL 704453 4105017 16

H. Joe N. Champlin No. 1 Winfred Sowder
S1060 C256 T1160 K1931 4 G 57 1450 FSL 520 FEL 695426 4104767 16

I. Amerada Hess Corp. No. 1 Ray Edwards, et al.
S946 C429 T1365 K2168 P8834 24 H 60 1450 FSL 1860 FWL 716850 4107140 16

J. Amerada Hess Corp. No. 1 H. Daulton
S1062 C310 T1105 K1886 P6670 14 H 59 2090 FSL 610 FWL 708965 4110837 16

Robertson County

A. Wilson, Snowalton & Parrish No. 1 Clinton Jett
S613 T165 K620 7 X 66 10750 FNL 8550 FWL 757066 4261929 16

Rockcastle County

A. Ajax Oil & Development Co. No. 1 Green
S890 T1037 13 L 61 12450 FSL 11800 FWL 724738 4147714 16

B. Ajax Oil & Development Co. No. 1 Griffin
S905 C247 T1345 7 K 68 6100 FSL 6050 FWL 738048 4136893 16

Rowan County

A. Ashland Oil & Refining No. 1 J. Caudill
S837 C438 T1996 K2670 19 U 74 9050 FSL 5600 FEL 293949 4229474 17

B. Frank Hinkle et al. No. 1 Boone Howard
S667 T1105 9 T 71 10950 FNL 6400 FWL 268232 4224072 17

C. Smith & Cecil No. 1 John A. Lewis
S877 T2125 K2718 16 U 75 8300 FSL 4000 FWL 296868 4229172 17

D.	Smith & Cecil No. 1 Withrow														
	S1024		T2248	K2844		16	U	75	9450	FSL	4425	FWL	297006	4229519	17
E.	Henderson Oil Co. No. 1 W. Y. Bailey														
	S737		T1357	K1988	P3779	19	U	72		910		FNL	1315	FWL	
F.	Pennzoil Co. No. 1 Carmia Jones														
	S1199	C896	T2537	K3173	P4966	4	T	75		450		FNL	3500	FWL	
G.	Kentucky Central No. 1 R. M. Perkins														
	S1240	C972	T2486	K3161	P4967	21	T	74		875		FNL	750	FWL	
Russell County															
A.	Mary-Badgett No. 1 G. W. Bernard														
	S995	C210	T950	K1736		11	G	54	12700	FNL	4440	FWL	677724	4101913	16
B.	Ledford & Watkins No. 1 Harlan Brown														
	S935	C282	T989			6	F	55	11550	FNL	1600	FWL	678528	4093030	16
C.	Wood Oil Co. No. 1 Cummins Brothers														
	S670		T594			11	E	52	14600	FSL	3700	FEL	662277	4082176	16
D.	England & Hadley No. 1 Garner														
	S621		T574			2	E	52	3750	FNL	9000	FEL	660592	4085800	16
E.	Ferguson & Bosworth No. 1 James R. Gosser														
	S1033	C228	T1060	K1830		2	G	55	4850	FNL	1430	FWL	682684	4104411	16
F.	No. 1 John Johnson														
	S895		T855			23	G	56	1800	FSL	11300	FWL	688813	4097323	16
G.	Wilson & L. H. Horn No. 1 O. G. Johnson														
	S960	C280	T1160			2	F	56	2875	FNL	875	FEL	691069	4095948	16
H.	Richardson No. 1 Edward Richards														
	S947		T977			17	G	53	10000	FSL	5350	FWL	664706	4099319	16
I.	Somerset Oil Co. No. 1 H. H. Smith														
	S820	C162	T940			15	H	55	13300	FSL	1750	FWL	678220	4109848	16

J. Ledford & Watkins No. 1 W. B. Whittle

S965	C267	T990		4	F	55	1200	FNL	5750	FWL	679726	4096210	16

K. J. H. Holt No. 1 Wilson

S890		T839		8	H	54	8900	FNL	11250	FWL	673660	4112236	16

L. Ledford & Watkins No. 1 Jason B. B. Wilson

S950	C255	T913		7	F	55	7900	FNL	8900	FWL	680729	4094190	16

M. Kendrich Butler No. 1 Woodrow Wooldridge

S595		T567		7	E	53	7250	FNL	8800	FWL	666036	4084838	16

Scott County

A. No. 1 John B. Penn

S795		T265		11	W	60	13200	FSL	17250	FEL	717883	4249558	16

Shelby County

A. No. 1 J. B. Hayden

S825		T845		4	T	53	550	FWL	9000	FWL	663353	4225577	16

B. No. 1 Sam D. Hinkle

S770		T500		24	U	52	5400	FSL	7325	FWL	655507	4227236	16

C. No. 1 Ezra Jennings

S771		T550		16	T	52	9575	FSL	4675	FWL	654850	4219246	16

D. Stoll Oil Refining Co. No. 1 Joe Whittaker

S749		T349	K940	13	T	54	12100	FNL	12150	FEL	671587	4222226	16

Spencer County

A. Stoll Refining Co. No. 1 Carlin

S717		T853		23	T	49	3550	FSL	10100	FWL	634614	4217050	16

B. Stoll Oil Refining Co. No. 1 McCall

S720		T710		17	T	50	7950	FSL	5000	FWL	640345	4218488	16

C. Stoll Oil Refining Co. No. Wilkerson

S570		T710		13	S	49	13700	FSL	10700	FWL	534896	4210899	16

Taylor County

	Well														
A.	Tay-Co. Oil Co. No. 1 Charles Bowen	S700	C270	T1128		24	L	49	4800	FSL	5900	FWL	634514	4143439	16
B.	Cash Dollar No. 1 J. E.. Davis	S830	C321	T1000		21	K	50	2100	FSL	1850	FEL	647078	4133580	16
C.	Meadow Green No. J. A. Hubbard	S702	C170	T955		14	J	50	13100	FWL	7325	FWL	642590	4127607	16
D.	William Ray No. 1 Charles Miller	S890	C458	T1374		12	L	49	12550	FNL	7650	FWL	634984	4147407	16
E.	Olds Oil Co. No. 1 T. L. & Mose Murrell	S805		T728	K1380	3	K	53	2200	FNL	11900	FWL	665878	4141871	16
F.	J. W. Bateson No. Logan Underwood	S836	C458	T1483		6	K	49	11200	FNL	1125	FWL	633137	4138540	16

Washington County

	Well														
A.	Howard Hammond No. 1 Derranger	S790		T362	K903	17	Q	54	9700	FSL	5500	FWL	670285	4191839	16
B.	Henry Leachman No. 1 Litsey	S715		T460		11	O	52	12200	FNL	4250	FEL	660296	4175712	16

Wayne County

	Well														
A.	E. M. Williams No. 1 J. W. Barnes	S980	C440	T1290	K1977	8	D	55	6125	FNL	11075	FEL	682453	4076268	16
B.	Cartago Chemical No. 1 Bertram	S1160	C280	T995		6	B	55	8400	FNL	3000	FWL	679708	4057017	16
C.	Planet Petroleum Co. No. 1 Alfred Burnett	S974	C452	T1230		5	D	57	4700	FNL	4650	FWL	694668	4076972	16
D.	Joe J. Bugler No. 1 M. Davis	S1480	C946	T1699		17	C	56	11800	FSL	7150	FWL	688289	4063358	16

E.	New Domain Oil & Gas No. 1 Jordan & MacGowan														
	S1000	C357	T1000	K1852	2	D	55	4000	FNL	8550	FEL	683208	4076931	16
F.	S. D. Jarvis No. 1 L. E. King														
	S920	C330	T1120	K1850	20	F	56	10400	FSL	4500	FEL	691566	4090755	16
G.	Vogler Brothers No. 1 Hannibal McBeath														
	S1240	C822	T1663	K2432	16	E	57	11400	FSL	4000	FEL	693408	4081851	16
H.	Hunt Oil Co. No. 1 Sexton														
	S1045		T1310		13	D	56	12860	FNL	10800	FEL	690018	4074380	16
I.	James F. Patrick No. 1 H. T. Whitson														
	S1040		T1496		15	B	56	2000	FNL	1800	FEL	687225	4055428	16
J.	Phillips & Winkler No. 4 Whitson														
	S1040	C481	T1232		6	B	56	7950	FNL	3400	FWL	687278	4057316	16
Wolfe County															
A.	KY Drilling & Operating Co. No. 1 Golden Day														
	S1275	C1021	T2440	K3174	18	P	71	2700	FNL	30	FWL	268081	4184015	17
B.	Raymond Long No. 1 Golden Day														
	S1176	C993	T2505	K3311	15	O	71	17250	FNL	2050	FWL	265529	4175950	17
C.	Oliver Jenkins No. 1 E. B. Little														
	S996	C1109	T2985	K3764	18	P	74	10850	FSL	9850	FWL	290169	4183851	17
D.	United Carbon No. 1 Blaine Rose														
	S877	C1120	T2820	K3805	15	N	73	14300	FNL	3450	FEL	279798	4167201	17
E.	James Hollon No. 1 Dewey Rose														
	S975	C1120	T2810	K3597	14	P	74	13800	FNL	8800	FWL	289894	4185598	17
F.	Howard Atha No. 1 Dewey Tyra														
	S1035	C1055	T2639	K3493	25	P	73	610	FNL	2320	FEL	280547	4182459	17
G.	L. C. Young No. 1 Sam Elkins														
	S863	C1044	T2788	K3700	25	O	73	580	FSL	1680	FWL	280010	41717310	17

H. Exxon Corp. No. 1 Orville Banks

S1058	C1482	T3422	K4374	P12254	13	O	74	3100	FSL	350	FEL	291266	4175908	17

I. F & B Co. No. 1 William O'Hair

S1082	C1134	T2846	K3713		23	P	73	850	FNL	1500	FWL	283177	4182316	17

Woodford County

A. Stoll Oil Refining Co. No. 1 Waverly

S770		T194	K740		13	T	57	13000	FNL	12200	FEL	693493	4222444	16

B. Stoll Oil Refining Co. No. 2 Waverly

S810		T228	K790		13	T	57	13200	FNL	11875	FEL	693593	4222386	16

C. Stoll Oil Refining Co. No. 1 C. Wilhoit

S660		T40	K600		17	R	57	10800	FSL	5600	FWL	692088	4201907	16

TABLE 3. COMPOSITIONAL ANALYSES OF PRECAMBRIAN BASEMENT SAMPLES IN KENTUCKY

Petrographic analyses by Eric R. Force (USGS, Reston, Virginia)
X-ray analyses by E.M. Lemmon (USGS, Reston)

Samples tabulated below were taken from drill cuttings near total depth of penetration in deep drill holes throughout Kentucky. All but two of the wells, in Webster County, western Kentucky, are located on the magnetic and tectonic maps (plates 3, 11, and 12) and keyed to the table. Selected samples were X-rayed to confirm optical mineral identifications. Up-hole contamination of the samples was prevalent, and in cases where chips could not be positively identified the notation "basement?" has been used. On the maps, certain wells are shown to include rock types not identified below. In these cases the rock or mineral names were included from earlier log descriptions. The samples were examined for inclusions of magnetite, and notes related to the crystalline character and metamorphic grade of the rocks are included.

LEGEND

Magnetite: P = present, M = minor amount, ND = not detected. * = Mineralogy confirmed by X-ray.

County and Well Symbol (Plates 3, 11, and 12)	Interval Sampled (in feet)	KGS/USGS Call Number	Rock Name	Magnetite	Key Minerals	Metamorphic Grade and/or Depth of Crystallization
Adair L	6660-65	8475	Aplite & Rhyolite	ND		
Boone A	4080-90	4763	Basement?	P		
Boyd C	9090-95	10499	Gabbro & Chlorite Schist	P	Chlorite*	Low Grade
Boyd D	7820-27	10923	Charnockite	P	Hypersthene* Plagioclase Hornblende Biotite	Low Grade, (Deep seated)
Boyd E	9440-49	10467	Altered Granite	M	Quartz Feldspar Chlorite	Low Grade, (Deep seated)
Campbell A	3600-10	9755	Mafic volcanic (altered)	P	Chlorite Epidote Calcite	Low Grade

Carter G	5240-45	10451	Gneiss, calc-silicate	P	Diopside Biotite Quartz Calcite	High Grade, followed by Low Retrograde)
Carter H	7270-72	12342	Charnockite (altered)	P	Chlorite	(Deep seated), Low Retrograde
Carter I	9970-80	12605	Basement?	ND	Quartz	
Clark H	4930-40	11064	Granite	M	Amphibole	
Clark J	3410-20	10450	Granite	P	Amphibole Diopside	(Deep seated)
Elliott B	5270-80	5537	Basement?	ND	Biotite Amphibole	
Elliott D	9960-65	11445	Rhyolite, Diopside Marble	ND		
Estill I	6800-05	10347	Basement?	ND		
Floyd A	12980-90	12779	Basement?	P		
Garrard C	5730-35	10299	Basement?	P		
Greenup B	5180-90	10231	Mafic volcanic	P	Quartz	
Jefferson D	5875-80	12048	Basement?	ND		
Johnson A	14560-66	12649	Granite (altered)	P	Quartz Biotite Feldspar Chlorite	Low Grade
Lawrence A	12700-06	12606	Charnockite	M	Quartz	(Deep seated)
Leslie A	9400-10	3907	Granite	M		

Lewis A	4185-90	4484	Granite (altered)	P	Biotite Amphibole Chlorite	Low Grade
Lewis E	4540-50	5503	Aplite	ND	Quartz Feldspar	
Lewis F	5080-82	10112	Gneiss, altered, calc-silicate	P	Quartz, Mica Plagioclase Hornblende Diopside Chlorite	High Grade, Low Retrograde
Lincoln D	6110-17	951	Rhyolite	ND	Feldspar* Quartz*	
Madison H	6390-400	10460	Mafic volcanic	P	Chlorite*	Low Grade
Mason B	3280-90	5594	Granite (altered)	P	Chlorite	Low Grade
Menifee D	6740-50	12848	Basement?	ND	Quartz Feldspar	
Metcalfe F	6100-10	9193	Rhyolite	ND	Quartz* Feldspar*	
Montgomery C	4470-80	7710	Gneiss (altered)	M	Chlorite	Unknown Grade, Low Retrograde
Morgan C	7565-70	12869	Basement?	ND		
Morgan D	7490-500	12877	Biotite Gneiss	ND	Biotite Quartz	High grade
Morgan F	5745-50	10928	Granite (altered)	P	Quartz Biotite Feldspar Hornblende Chlorite	Low Grade
Nicholas B	2950-60	13116	Rhyolite	ND		

Pike A	12460-70	11851	Granite (altered)	M	Chlorite	Low Grade
			Basement?	P		
			Biotite Granite (altered)	ND	Chlorite	Low Grade
			Rhyolitic Aplite	P		
Pulaski I	8855-60	10715	Biotite Granite	ND		
Pulaski J	6720-25	10714	Rhyolite & Aplite	P		
Rowan F	4990-97	8456	Granite (altered)	P	Chlorite	Low Grade
Rowan G	4970-77	12408	Basement?	P		
Wolfe H	12320-23	13348	Amphibolite	P	Amphibole Plagioclase Hypersthene Diopside	High Grade

NOTE: Samples identified below are from well localities west of the study area.

Webster A	14330-40	12887	Gabbro (altered) Dolomite (veins?)	P	Epidote Amphibole Celadonite Plagioclase	Low Grade
Webster B	15190-200	13411	Aplite	ND		