U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-1835-F
PAMPHLET

MAP SHOWING DISTRIBUTION OF ALKALINE IGNEOUS ROCKS AND ASSOCIATED CARBONATITES AND PERIDOTITES IN THE NORTHERN MIDCONTINENT, U.S.A.

Compiled by

F. Allan Hills[1], Richard W. Scott, Jr.[1], Theodore J. Armbrustmacher[1], and Pieter Berendsen[2]

INTRODUCTION

This 1:1,000,000-scale map of the northern Midcontinent area shows the locations of alkaline igneous rocks and associated carbonatites and mica peridotites, and of structural domes and diatremes known or thought to be associated with similar igneous rocks. In addition, it shows the location of other structural features and geophysical anomalies of uncertain origin that may be related to buried igneous rocks. These include cryptoexplosion features, some of which have been interpreted as astroblemes, and gravity and magnetic anomalies that have been interpreted to result from buried mafic plutons. Precambrian igneous rocks having a wide range of compositions are exposed or buried at shallow depth in South Dakota, Minnesota, and Wisconsin, and they are found beneath the Paleozoic strata throughout the study area. Only those Precambrian rocks that are clearly alkaline, carbonatitic, or kimberlitic are included in this compilation. Table 1 shows a summary of available information on the petrology, structural setting, and age of each occurrence or group of occurrences and lists the principal references for each. Because the authors have not studied most of the occurrences in this compilation, they made no attempt to change the rock terminology to make it consistent or up to date. Generally, the name used for each occurrence is the one in the most recent, cited publication on the occurrence. Figures 1 and 2 are larger scale maps that show the locations of igneous rocks and diatremes where they are clustered too closely to be shown clearly on the main map.

This map is part of a folio of maps and cross sections of the northern Midcontinent area (bounded by lats 36°-46° N. and longs 88°-100° W.) prepared under the Midcontinent Strategic and Critical Minerals Project. This project is a cooperative activity between the U.S. Geological Survey and the geological surveys of the included States. Other maps in this folio to date include U.S. Geological Survey Miscellaneous Field Studies Maps MF-1835-A through E (Mugel, 1986; Jorgensen and others, 1986; Marvin, 1988; Pratt, 1987; Anderson, 1988) and U.S. Geological Survey Miscellaneous Investigations Service Map I-1853-A (Sims, 1990).

[1]U.S. Geological Survey, Denver, CO 80225.
[2]Kansas Geological Survey, Lawrence, KS 66044.

REFERENCES CITED

Amos, D.H., 1967, Geologic map of part of the Smithland quadrangle, Livingston County, Kentucky: U.S. Geological Survey Geologic Quadrangle Maps of the United States, Map GQ-657, scale 1:24,000.

Anderson, R.R., compiler, 1988, Phanerozoic structural features in the northern Midcontinent, U.S.A.: U.S. Geological Survey Miscellaneous Field Studies Map MF-1835-E, scale 1:1,000,000.

Baxter, J.W., Desborough, G.A., and Shaw, C.W., 1967, Areal geology of the Illinois fluorspar district, Pt. 3--Herod and Shetlerville quadrangles: Illinois State Geological Survey Circular 413, 41 p.

Berendsen, P., Cullers, R.L., Mansker, W.L., and Cole, G.P., 1985, Late Cretaceous kimberlite and lamproite occurrences in eastern Kansas, U.S.A.: Geological Society of America Abstracts with Programs, v. 17, no. 3, p. 151.

Bickerman, M., Lidiak, E.G., and Lewis, Richard, 1982, K-Ar ages of phlogopite from mica peridotite, Omaha oil field intrusion, Gallatin County, southern Illinois: Geological Society of America Abstracts with Programs, v. 14, no. 5, p. 255.

Bickford, M.E., Mose, D.H., Wetherill, G.W., and Franks, P.C., 1971, Metamorphism of Precambrian granitic xenoliths in a mica peridotite at Rose dome, Woodson County, Kansas--Part 1, Rb-Sr isotope studies: Geological Society of America Bulletin, v. 82, p. 2863-2868.

Brock, M.R., and Heyl, A.V., Jr., 1961, Post-Cambrian igneous rocks of the central craton, western Appalachian Mountains, and Gulf Coastal Plain of the United States, *in* Short papers in the geologic and hydrologic sciences: U.S. Geological Survey Professional Paper 424-D, p. D33-D35.

Brookins, D.G., 1970a, Kimberlite at Winkler crater, Kansas: Geological Society of America Bulletin, v. 81, p. 241-246.

_____1970b, The kimberlites of Riley County, Kansas: Kansas State Geological Survey, Bulletin 200, 32 p.

Brookins, D.G., Della Valle, R.S., and Bolivar, S.L., 1976, Uranium geochemistry of some United States kimberlites [abs.]: American Geophysical Union Transactions (EOS), v. 57, p. 762.

Brown, J.S., Emery, J.A., and Meyers, P.A., Jr., 1954, Explosion pipe in test well on Hicks Dome, Hardin County, Illinois: Economic Geology, v. 49, p. 891-902.

Clegg, K.E., 1955, Metamorphism of coal by peridotite dikes in southern Illinois: Illinois Geological Survey Report of Investigations, no. 178, p. 5-18.

Clegg, K.E., and Bradbury, J.C., 1956, Igneous intrusive rocks in Illinois and their economic significance: Illinois Geological Survey Report of Investigations, no. 197, 19 p.

Cordua, W.S., 1985, Rock Elm structure, Pierce County, Wisconsin--A possible cryptoexplosion structure: Geology, v. 13, p. 372-374.

Cullers, R.L., Mullenax, J., Di Marco, M.J., and Nordeng, S., 1982, The trace element content and petrogenesis of kimberlites in Riley County, Kansas, U.S.A.: American Mineralogist, v. 67, p. 223-233.

Cullers, R.L., Ramakrishnan, S., Berendsen, P., and Griffin, T., 1985, Geochemistry and petrogenesis of lamproites, Late Cretaceous age, Woodson County, Kansas, U.S.A.: Geochimica et Cosmochimica Acta, v. 49, no. 6, p. 1383-1402.

Englehardt, R.L., 1973, The petrology of some igneous dikes of western Kentucky: Richmond, Ky., University of Eastern Kentucky M.S. thesis, 59 p.

English, R.M., and Grogan, R.M., 1948, Omaha pool and mica-peridotite intrusives, Gallatin County, Illinois: Illinois Geological Survey Report of Investigations, no. 130, p. 189-212.

Franks, P.C., 1959, Pectolite in mica peridotite, Woodson County, Kansas: American Mineralogist, v. 44, p. 1082-1086.

Greenberg, J.K., and Brown, B.A., 1985, Deformational and metamorphic features associated with 1,500-Ma anorogenic magmatism in Wisconsin, *in* Tithis, August, ed., The crust--The significance of granites/gneisses in the lithosphere: Theophrastus Publications, p. 79-93.

Grohskopf, J.G., 1955, Subsurface geology of the Mississippi embayment of southeast Missouri: Missouri Division of Geological Survey and Water Resources [Report], 2nd ser., v. 37, 133 p.

Harlem, C.L., 1982, The Elk Creek Carbonatites, *in* Schultz, C. B., ed.: Nebraska Academy of Sciences and Affiliated Societies Proceedings, v. 92, p. 48-49.

Hendriks, H.E., 1965, The Crooked Creek structure *in* Snyder, F.G., and others, Cryptoexplosion structures in Missouri--Geological Society of Amercia Guidebook, 1965 Annual Meeting: State of Missouri Report of Investigations no. 30, p. 68-72.

Heyl, A.V., Jr., and McKeown, F.A., 1978, Preliminary seismotectonic map of the central Mississippi Valley and environs: U.S. Geological Survey Miscellaneous Field Studies Map MF-1011, scale 1:500,000.

Hildenbrand, T.G., Kane, M.F., and Stauder, S.J., 1977, Magnetic and gravity anomalies in the northern Mississippi embayment and their special relation to seismicity: U.S. Geological Survey Miscellaneous Field Studies Map MF-914, scale 1:1,000,000.

Jorgensen, D.G., Helgesen, J.O., Leonard, R.B., and Signor, D.C., 1986, Equivalent freshwater head and dissolved-solids concentration of water in rocks of Cambrian, Ordovician, and Mississippian age in the northern Midcontinent, U.S.A.: U.S. Geological Survey Miscellaneous Field Studies Map MF-1835-B, scale 1:1,000,000.

Kidwell, A.L., 1947, Post-Devonian igneous activity in southeastern Missouri: State of Missouri Department of Business and Administration, Division of Geological Survey and Water Resources, Report of Investigations no. 4, 83 p.

Kisvarsanyi, E.B., and Howe, W.B., 1983a, The southeast Missouri minerals district and its relationship to post-Precambrian igneous activity: Missouri Geological Survey map no. OFM-83-170a-GI, scale 1:250,000.

_____1983b, Bee Fork center contoured on the top of the volcaniclastic facies: Missouri Geological Survey map no. OFM-83-170b-GI, scale 1:24,000.

_____1983c, Cross section A-A', Bee Fork: Missouri Geological Survey map no. OFM-83-170c-GI.

_____1983d, Isopach map of volcaniclastic facies in the lower Bonneterre Formation along the Viburnum trend (Bee Fork area): Missouri Geological Survey map no. OFM-83-170d-GI, scale 1:24,000.

_____1983e, The Bee Fork volcanic center and its relationship to the southeast Missouri lead-

zinc district: Geological Society of America Abstracts with Programs, v. 15, no. 6, p. 614.
Kisvarsanyi, E.B., Pratt, W.P., and Heyl, A.V., Jr., 1981, Fluorine-thorium and rare-earth-bearing kimberlitic carbonatite complexes, *in* Pratt, W.P., ed., Metallic mineral resource potential of the Rolla 1° x 2° quadrangle, Missouri, as appraised in September, 1980: U.S. Geological Survey Open-File Report 81-518, p. 35-40.
Knight, G.L., and Landes, K.K., 1932, Kansas laccoliths: *Journal of Geology, v. 40*, p. 1-15.
Koenig, J.B., 1956, The petrography of certain igneous dikes of Kentucky: Kentucky Geological Survey Series 9, Bulletin 21, 57 p.
LaBerge, G.L., and Meyers, P.E., 1983, Precambrian geology of Marathon County, Wisconsin: Wisconsin Geological and Natural History Survey, Information Circular 45, 88 p.
Lewis, Richard, 1982, Petrology and mineralogy of the monticellite alnoite associated with the Omaha oil field, Gallatin County, Illinois: Geological Society of America Abstracts with Programs, v. 14, no. 5, p. 265.
Lockwood, R.P., 1967, Petrologic study of syenites near Wausau, Wisconsin: University of Wisconsin at Madison M.S. thesis, 72 p.
_____1970, Petrology of syenites, Wausau, Wisconsin: The Compass of Sigma Gamma Epsilon, v. 48, no. 1, p. 32-44.
Mansker, W.L., Richards, B.D., and Cole, G.P., 1985, A review and comparison of Kansas kimberlites: Geological Society of America Abstracts with Programs, v. 17, no. 3, p. 166.
Marvin, R.F., compiler, 1988, Radiometric ages of basement rocks in the northern Midcontinent, U.S.A.: U.S. Geological Survey Miscellaneous Field Studies Map MF-1835-C, scale 1:1,000,000.
McDowell, R.C., Grabowski, G.J., Jr., and Moore, S.L., 1981, Geologic map of Kentucky: U.S. Geological Survey in cooperation with 10th and 11th Kentucky Geological Surveys, scale 1:250,000.
Meyer, H.O.A., and Brookins, D.G., 1976, Sapphirine, sillimanite, and garnet in granulite xenoliths from Stockdate kimberlite, Kansas: American Mineralogist, v. 61, p. 1194-1202.
Mugel, D.N., compiler, 1986, Map showing availability of data for selected deep drill holes in the northern Midcontinent, U.S.A: U.S. Geological Survey Miscellaneous Field Studies Map MF-1835-A, scale 1:1,000,000.
Offield, T.W., and Pohn, H.A., 1979, Geology of the Decaturville impact structure, Missouri: U.S. Geological Survey Professional Paper 1042, 48 p.
Pratt, W.P., compiler, 1987, Isopach and lithofacies map of the Sauk sequence (excluding basal clastics) in the northern Midcontinent, U.S.A.: U.S. Geological Survey Miscellaneous Field Studies Map MF-1835-D, scale 1:1,000,000.
Sayeed, U.A., Smith, R., and Carlson, M.P., 1972, Geophysical anomaly around Stella, Richardson Co., Nebraska: Geological Society of America Abstracts with Programs, v. 4, no. 6, p. 407.
Sims, P.K., compiler, 1990, Precambrian basement map of the northern Midcontinent, U.S.A.: U.S. Geological Survey Miscellaneous Investigations Series Map I-1853-A, scale 1:1,000,000.
Snyder, F.G., and Gerdemann, P.E., 1965, Explosive igneous activity along an Illinois-Missouri-Kansas axis: American Journal of Science, v. 263, p. 465-493.
Snyder, F.G., Williams, J.H., and others, 1965, Cryptoexplosive structures in Missouri--Geological Society of America Guidebook, 1965 Annual Meeting: State of Missouri Report of Investigations no. 30, 73 p.
Trace, R.D., 1966, Geologic map of the Marion quadrangle, Crittenden and Caldwell Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Maps of the U.S., Map GQ-547, scale 1:24,000.
Trace, R.D., and Amos, D.H., 1984, Stratigraphy and structure of the western Kentucky fluorite district: U.S. Geological Survey Professional Paper 1151-D, 41 p.
Treves, S.B., Burchett, R.R., and Low, D.J., 1982, Precambrian investigations in eastern Nebraska: Geological Society of America Abstracts with Programs, v. 14, no. 3, p. 138.
Wagner, H.C., 1954, Geology of the Fredonia quadrangle, Kansas: U.S. Geological Survey Geologic Quadrangle Map GQ-49, scale 1:62,500.
Wagner, R.E. and Kisvarsanyi, E.B., 1969, Lapilli tuffs and associated pyroclastic sediments in Upper Cambrian strata along Dent Branch, Washington County, Missouri: Missouri Geological Survey and Water Resources Report of Investigations no. 43, 80 p.
Weller, J.M., Grogan, R.M., and Tippie, F.E., 1952, Geology of the fluorspar deposits of Illinois: Illinois State Geological Survey Bulletin 76, 147 p.
Weller, Stuart, and Sutton, A.H., 1951, Geology of the western Kentucky fluorspar district: U.S. Geological Survey Mineral Investigations Field Studies Map MF-2, scale 1:24,000.
Willman, H.B., and others, compilers, 1967, Geologic map of Illinois: Illinois State Geological Survey, scale 1:500,000.
Zartman, R.E., Brock, M.R., Heyl, A.V., Jr., and Thomas, H.H., 1967, K-Ar and Rb-Sr ages of some alkalic intrusive rocks from central and eastern United States: American Journal of Science, v. 265, p. 848-870.

Table 1.—*Summary of petrology, structural information, and primary references on alkaline igneous rocks, carbonatites, and peridotites in the northern Midcontinent area*
[Leaders (–), information not available]

Locality No.	Rock type	Feature or structure	Description	References
			ARKANSAS	
Greene County:				
GR 1	–	Magnetic and gravity anomaly.	Mafic or ultramafic intrusion iterpreted from magnetic and gravity anomalies.	Hildenbrand and others (1977).
			ILLINOIS	
Franklin County:				
FR 1	Mafic alkaline igneous rock.	Dike	–	Heyl and McKeown (1978).
Gallatin County, Omaha dome:				
GA 1	Mica peridotite	Dikes and sills	Igneous rocks penetrated by drill holes in Omaha oil field. Small dikes and sills near surface described as serpentinized mica peridotite. Two thick sills of monticellite alnoite at unspecified depth account for structural relief of the Omaha dome. Perovskite, melanite, and Cr-magnetite reported in alnoite.	Bickerman and others, (1982); Clegg and Bradbury (1956); English and Grogan (1948); Lewis (1982).
Gallatin County, Shawneetown dikes:				
GA 2	Igneous rock	Dike	–	Willman and others (1967).
GA 3	Igneous rock	–	Drill hole penetrating undescribed igneous rock	Clegg and Bradbury (1956).
GA 4	Igneous rock	–	Drill hole penetrating undescribed igneous rock	Clegg and Bradbury (1956).
GA 5	Igneous rock	–	Drill hole penetrating undescribed igneous rock	Clegg and Bradbury (1956).
GA 6	Igneous rock	–	Drill hole penetrating undescribed igneous rock	Clegg and Bradbury (1956).
Hardin County, Hicks Dome and nearby areas:				
HA 1	–	Diatreme or plug	–	Willman and others (1967).

HA 2	Igneous rock	Dikes and unclassified masses.	Two dikes and two igneous masses of uncertain form	Clegg and Bradbury (1956).
HA 3	Igneous rock	Philadelphia School dike.	–	Clegg and Bradbury (1956).
HA 4	Breccia containing igneous rock fragments.	Plug or diatreme of Sparks Hill.	Angular to subangular fragments of rock (chiefly sedimentary but some fragments of igneous and metamorphic rocks from basement and possibly from mantle) in highly altered matrix containing angular fragments of quartz, muscovite, plagioclase, and microcline. (N1/2NE1/4 sec. 13, T. 11 S., R. 8 E.)	Clegg and Bradbury (1956); A.V. Heyl, Jr. (oral commun., 1987).
HA 5	Breccia containing igneous rock fragments and igneous minerals.	Plugs or diatremes of Hicks dome.	Fragments of chert and silicified rocks in fine-grained quartz cement, and fragments of sedimentary rocks in matrix of finely ground rock and quartz. Contains apatite grains and rock fragments thought to be igneous. (Sec. 30. T. 11 S., R. 8 E.)	Brown and others (1954); Clegg and Bradbury (1956).
	Mica peridotite, lamprophyre.	Dikes of Hicks dome	–	Clegg and Bradbury (1956).
HA 6	Breccia	Plug or diatreme (Grants plug of Clegg and Bradbury, 1956).	Fragments of metamorphosed sedimentary rock and large pieces of hornblende and biotite (as long as 2.5 cm) and augite in matrix of calcite with angular quartz and feldspar. (NW1/4NW1/4 sec. 6, T. 12 S., R. 8 E.) K-Ar ages: hornblende 281±14 Ma, biotite 258±13 Ma.	Clegg and Bradbury (1956); Zartman and others (1967).
HA 7	Altered mica peridotite or lamprophyre.	Crystal dike	Fine-grained calcite with scattered apatite. Dike 15 cm wide in roof of fluorspar mine. (Shaft No. 4, Crystal Mine, SE1/4NE1/4 sec. 34, T. 11 S., R. 9 E.)	Clegg and Bradbury (1956).
Hardin County, Rosiclare dikes:				
HA 8	Breccia	Plug or diatreme (Soward plug).	Angular to subangular fragments of igneous and sedimentary rock in highly altered matrix. Altered fragments of mica, quartz, plagioclase, and microcline. (NE1/4SW1/4 sec. 31, T. 12 S., R. 8 E.)	Clegg and Bradbury (1956).
	Altered mica peridotite.	Argo dikes	Dikes, 3-60 cm wide, in fluorspar mine on Argo vein. Fine-grained, dirty calcite with abundant apatite and scattered, partly chloritized biotite. (NE1/4SW1/4 sec. 32, T. 12 S., R. 8 E.)	Clegg and Bradbury (1956).

Table 1.—*Summary of petrology, structural information, and primary references on alkaline igneous rocks, carbonatites, and peridotites in the northern Midcontinent area —Continued*

Locality No.	Rock type	Feature or structure	Description	References
			ILLINOIS—Continued	
Hardin County, Rosiclare dikes—Continued:				
	Altered mica peridotite.	Good Hope dike	Dike as thick as 30 cm on Good Hope vein in fluorspar mine. Chlorite and quartz with abundant apatite. (NE1/4NW1/4 sec. 5, T. 13 S., R. 8 E.)	Clegg and Bradbury (1956).
	Altered mica peridotite.	Dike of Orr's Landing.	Large crystals of calcite and less commonly of serpentine in fine-grained carbonate groundmass. Abundant apatite. (SW1/4NE1/4 sec. 33, T. 12 S., R. 8 E.)	Clegg and Bradbury (1956).
	Altered mica peridotite.	Unnamed dikes	Dikes in diamond drill hole at depths of 290-375 m. Mica and few large augite grains in groundmass of carbonate and minor serpentine. Abundant apatite. (NW1/4SW1/4 sec. 32, T. 12 S., R. 8 E.)	Clegg and Bradbury (1956).
	Altered mica peridotite.	Downey's Bluff sill	Thin anastomosing sill in limestone outcrop. Augite and mica crystals in carbonate groundmass. Abundant apatite. Biotite K-Ar age 269±13 Ma.	Clegg and Bradbury (1956); Zartman and others (1967).
Pope County, Hicks dome area:				
PO 1	Breccia	Diatreme or plug	–	Baxter and others (1967); Willman and others.
PO 2	Breccia	Diatreme or plug	–	Baxter and others (1967); Willman and others (1967).
PO 3	Igneous rock	Unclassified igneous mass.	Incompletely described. Shown as dike by Willman and others (1967). Test pit uncovered boulders of granitic rock.	Clegg and Bradbury (1956); Weller and others (1952); Willman and others (1967).
Pope County, Dikes:				
PO 4	Mica peridotite	Mix dike	Partly serpentinized olivine, mica, augite, and apatite present in boulders. (NE1/4NE1/4, sec. 18, T. 13 S., R. 7 E.)	Clegg and Bradbury (1956).

PO 5	Mica peridotite	Golconda dike	Serpentine and mica with minor pyroxene and apatite. Known from boulders from old prospect pit. (SW1/4NE1/4 sec. 25, T. 13 S., R. 6 E.)	Clegg and Bradbury (1956).
Saline County, Eldorado dikes:				
SA 1	Igneous rock	Dikes(?)	Several undescribed dikes or sills(?). One is 150 m long, about 10 m wide, and cuts Pennsylvanian rocks; another is more than 1,200 m long. K-Ar age 261±9 Ma.	Clegg and Bradbury (1956); John Nelson (written commun., 1987).
SA 2	Mica peridotite	Dering dikes	Dikes in coal mine. As thick as 5 m. Large grains of serpentine and partly chloritized mica in groundmass of serpentine and chlorite. Minor apatite. (SE1/4NE1/4 sec. 24, T. 8 S., R. 6 E.)	Clegg and Bradbury (1956).
SA 3	Igneous rock	Dikes(?)	Undescribed, numerous dikes and sills(?)	Clegg and Bradbury (1956).
SA 4	Mica peridotite	Dikes	Several dikes in coal mine. Large grains of serpentine in groundmass of chlorite and serpentine. Scattered clinopyroxene and mica. Abundant apatite. (SE1/4NE1/4 sec. 17, T.9 S., R. 6 E.)	Clegg and Bradbury (1956).
SA 5	Igneous rock	Dikes	Mainly undescribed dikes. John Nelson (written commun., 1987) reported mica peridotite dike, 5-6 m wide, in coal mine. Several small dikes parallel larger dike, which strikes about N. 35° W. A 30-cm-wide dike of carbonate rock strikes northeast. Magnetic survey suggests continuation of dike for about 3.2 km. (SE1/4 sec. 11, T. 20 S., R. 5 E.)	Clegg and Bradbury (1956); Willman and others (1967).
Williamson County:				
WM 1	Mica peridotite	Absher dikes	Two parallel dikes, 0.3-5.2 m wide, in abandoned strip mine. Phenocrysts of mica and partly serpentinized olivine and hypersthene in groundmass of biotite, chlorite, and apatite.	Clegg and Bradbury (1956); Clegg (1955).

Table 1.—*Summary of petrology, structural information, and primary references on alkaline igneous rocks, carbonatites, and peridotites in the northern Midcontinent area —Continued*

Locality No.	Rock type	Feature or structure	Description	References
			KANSAS	
Riley County:				
RI 1	Micaceous kimberlite	Diatreme or pipe	Circular structure 300 m in diameter with relief of about 15 m. Originally called Winkler crater and thought to be an astrobleme. Drilling and trenching revealed kimberlite mixed with fragments of country rock. Pyroclastic material indicates that kimberlite reached the Cretaceous surface. Minerals in kimberlite-bearing zones are: chloritized phlogopite, forsteritic olivine, kelyphitized pyrope, clinopyroxene, orthopyroxene, ilmenite, perovskite, magnetite-bearing serpentine, and apatite.	Brookins (1970a, b); Berendsen and others (1985).
RI 2	Lamprophyric kimberlite.	Diatreme or pipe	Randolph No. 1 kimberlite forms a 3-m-high knoll about 60 m in diameter. Limestone country rocks are upwarped at contact but show no contact metamorphism. Kimberlite shows minimum brecciation, is porphyritic, and contains as much as 25 percent phenocrysts. Phenocrysts are serpentine, calcite, hematite, and black oxides that formed from olivine and pyroxene. Groundmass is fine-grained lizardite, calcite, and iron oxyhydroxides. Contains few xenoliths.	Cullers and others (1982).
RI 3	Lamprophyric kimberlite.	Diatreme or pipe	Randolph No. 2 kimberlite forms a topographic high 15 m in diameter. Contacts with country rock were exposed by trenching and drilling. Pipe appears to have a mushroom-like cap indicating that kimberlite may have have intruded to the surface. Composition similar to kimberlite of the Randolph No. 1. Few xenoliths and few megascopic pseudomorphs of serpentine after olivine. Pyrope and phlogopite absent.	Cullers and others (1982); Brookins (1970b).

RI 4	Micaceous kimberlite	Diatreme or pipe	Kimberlite near Leonardville is poorly exposed in two small mounds. Trenches expose a steeply dipping contact with country rock. Kimberlite is porphyritic and contains as much as 30 percent phenocrysts (as large as 5 mm) of olivine and pyroxene, altered to calcite, serpentine, or magnetite, with a few phenocrysts of pyrope, phlogopite, and magnetite. Fine-grained groundmass of serpentine with lesser phlogopite, opaque oxides, calcite, and garnet. As much as 10 percent xenoliths of shale containing finely disseminated calcite.	Brookins (1970b); Cullers and others (1982).
RI 5	Micaceous kimberlite	Diatreme or pipe	Kimberlite near Stockdale crops out in a stream bed and is thoroughly brecciated and porphyritic, with as much as 20 percent phenocrysts (as large as 2 mm) of serpentine (pseudomorphous after olivine and pyroxene) and phlogopite, in a fine-grained matrix of lizardite with minor calcite and black oxides. Contains about 20 percent altered xenoliths of dunite, eclogite, gabbro, amphibolite, granulite, lherzolite, phyllite, and shales.	Brookins (1970b); Cullers and others (1982); Meyer and Brookins (1976).
RI 6	Lamprophyric kimberlite.	Diatreme or pipe	Kimberlite at Bala forms a knoll 4-5 m high and about 60 m in diameter. It is porphyritic with as much as 30 percent phenocrysts (as large as 2 mm) of olivine and pyroxene (mostly altered to serpentine, calcite, and magnetite) and a few phenocrysts of pyrope. Groundmass is serpentine, calcite, opaque oxides, and hematite. Contains few xenoliths and is minimally brecciated.	Brookins (1970b); Cullers and others (1982).
RI 7	Kimberlite	Diatreme or pipe	Kimberlite mass, called Lone Tree A, is not exposed at surface. Sharply dipping contact with country rock was exposed by trenching. Located approximately 600 m northwest of kimberlite near Stockdale.	Berendsen and others (1985); Mansker and others (1985).
RI 8	Kimberlite	Diatreme or pipe	Kimberlite mass, called Lone Tree B, was exposed by trenching. Trenches reveal a steeply dipping contact with country rock. This mass is smaller than Lone Tree A mass, and is located about 250 m northwest of Lone Tree A mass.	Berendsen and others (1985); Mansker and others (1985).
RI 9	Kimberlite	Diatreme or pipe	Kimberlite at Swede Creek is a small mass and is not exposed at surface. Trenches exposed weathered kimberlitic material and a contact with country rock.	Berendsen and others (1985); Mansker and others (1985).
RI 10	Kimberlite	Diatreme or pipe	Kimberlite at Fancy Creek is exposed at surface, but is mostly covered by a farm pond. Kimberlite mass is about 100 m in diameter and has a roughly circular outline.	Berendsen and others (1985); Mansker and others (1985).

Table 1.—*Summary of petrology, structural information, and primary references on alkaline igneous rocks, carbonatites, and peridotites in the northern Midcontinent area —Continued*

Locality No.	Rock type	Feature or structure	Description	References
			KANSAS—Continued	
Wilson and Woodson Counties:				
WI 1	Lamproite	Silver City dome, sills.	Sills of mica peridotite as much as 9 m thick intrude Pennsylvanian shales. Rock is porphyritic, consisting of euhedral to subhedral phlogopite, diopside, potassic richterite, anhedral serpentine pseudomorphs after olivine, and chrome spinel in a groundmass of mostly serpentine. Accessory minerals are perovskite, apatite, and magnetite. Sills contain a few granitic xenoliths. Ultramafic rocks of Wilson and Woodson Counties differ from those of Riley County in that they are not extensively microbrecciated and contain less than 5 percent xenoliths. Biotite K-Ar ages about 90±5 Ma.	Knight and Landes (1932); Bickford and others (1971) Zartman and others (1967) Wagner (1954); Franks (1959); Snyder and Gerdemann (1965); Culler and others (1985).
Woodson County:				
WO 1	Lamproite	Rose dome	Rocks discovered by drilling are petrographically similar to those of Silver City dome. Mass intrudes Pennsylvanian shale and contains a few granitic xenoliths dated at about 1,200 Ma. Minerals in ultramafic rocks include 25 percent or more euhedral to subhedral phlogopite and less than 5 percent each of anhedral olivine, euhedral to subhedral diopsidic augite, and pleochroic euhedral to subhedral amphibole phenocrysts in dolomitized, serpentinized groundmass. Rock contains minor apatite, magnetite, and iron-rich chromite. Biotite K-Ar age 88±4 Ma.	Knight and Landes (1932); Bickford and others (1971); Zartman and others (1967); Snyder and Gerdemann (1965); Cullers and others (1985).
WO 2	–	Neosho dome	Drilling in 1927 revealed an elliptical dome in Mississippian sedimentary rocks, but no igneous rocks were found. Highly siliceous recrystallized rocks not normally found in local section suggest a deeper igneous mass. Quartzite, magnetite, pyrite, chalcopyrite, and chert were noted in drill cuttings.	Knight and Landes (1932); Snyder and Gerdemann (1965).
WO 3	–	Dome	Small, well-defined dome. Highly silicified drill cuttings, similar to those from Neosho dome, contained magnetite. Dome has closure of about 8 m and structural relief of about 18 m.	Knight and Landes (1932).

KENTUCKY				
Crittenden County, Hardin Knob dikes:				
CR 1	Lamprophyre	Dikes	Based on generalized description of dikes on cited maps. Dark-gray, fine- to medium-grained, holocrystalline lamprophyre, abundant biotite, dolomite, and calcite, and minor magnetite, leucoxene, marcasite, fluorapatite, andradite, perovskite, and goethite. Many dikes contain abundant chlorite and serpentine. Quartz is present in and associated with veins. Dike locations on area geologic maps and in other reports are not consistent.	Englehardt (1973); Heyl and McKeown (1978); Koenig (1956); McDowell and others (1981); Trace (1966); Weller and Sutton (1951).
Crittenden County, Caldwell Springs dike:				
CR 2	Peridotite	Dike	Weathered peridotite, about 1.5 m thick	Koenig (1956).
Livingston County:				
LI 1	Lamprophyre	Dikes	Based on generalized description of all dikes on cited maps. Dark-gray, fine- to medium-grained, much-altered, holocrystalline lamprophyre. Bulk of altered rocks is calcite with abundant chlorite and serpentine, altered, dark-brown biotite, and abundant needles of apatite; some magnetite and ilmenite. The three north-trending dikes are from north to south, Sunderland dike, Lasher-Robinson dike, and Hutson dike.	Amos (1967); Englehardt (1973); Koenig (1956); McDowell and others (1981); Trace and Amos (1984); Weller and Sutton (1951).
MISSOURI				
Crawford County:				
CF 1	Brecciated sedimentary rocks.	Crooked Creek structure.	Synclinal ring graben with deformed, elliptical, uplifted, central area. Extensive brecciation of post-Precambrian rocks in brecciated zones, but no basic or ultrabasic igneous rocks. Shatter cones common in central area. Located at intersection of Cuba fault and Palmer fault zone. Snyder and Gerdemann (1965) interpreted structure as diatreme; Hendriks (1965) interpreted structure as astrobleme.	Hendriks (1965); Offield and Pohn (1979); Snyder and Gerdemann (1965).

Table 1.—*Summary of petrology, structural information, and primary references on alkaline igneous rocks, carbonatites, and peridotites in the northern Midcontinent area —Continued*

Locality No.	Rock type	Feature or structure	Description	References
			MISSOURI—Continued	
Laclede County:				
LC 1	Volcanic ash(?)	Beds	Volcanic rocks of Hazelgreen may consist of ash and detritus interbedded with shattered Upper and Middle(?) Cambrian Lamotte Sandstone. Knowledge of occurrence based on single drill hole. Intrusive event thought to have occurred during Late Cambrian, contemporaneous with deposition of the Lamotte.	Snyder and Gerdemann (1965).
New Madrid County:				
NM 1	Micaceous lamprophyre.	–	Igneous rock encountered in drill hole	Grohskopf (1955); Heyl and McKeown (1978).
New Madrid and Dunklin Counties:				
ND 1	–	Magnetic and gravity anomaly.	Buried mafic or ultramafic intrusion inferred from magnetic and gravity surveys.	Hildenbrand and others (1977).
Pemiscot County:				
PM 1	Alkaline igneous rock.	–	Alkaline igneous rock penetrated in two drill holes	Brock and Heyl (1961); Hey and McKeown (1978).
St. Clair County:				
SC 1	Faulted and brecciated sedimentary rocks.	Weaubleau crypto-explosion structure.	Zone of intense faulting and brecciation approximately 11 km long and 5 km wide. Faulting includes normal faults but is chiefly low-angle thrust faults. No intrusive igneous rocks known in area. Feature partially covered unconformably by undisturbed Pennsylvanian rocks.	Snyder and others (1965); Snyder and Gerdemann (1967).

St. Francois and Ste. Genevieve Counties:

SF 1	Peridotite	Avon diatremes	Intrusive material consists of primary and secondary calcite, chiefly secondary quartz, pleochroic biotite, magnetite, potassium feldspar, and plagioclase. Biotite is commonly altered to chlorite. Accessory minerals include apatite and garnet. Calcite is pseudomorphic after olivine and pyroxene or amphibole. Lapilli reported. Biotite ages: K-Ar 377±19 Ma, Rb-Sr 399±23 Ma (dated material from S1/2NW1/4SW1/4 sec. 18, T. 35 N., R. 8 E.).	Kidwell (1947); Zartman and others (1967).
SF 2	Peridotite	Outcrops(?)	Isolated outcrops of peridotite	Heyl and McKeown (1978).

Ste. Genevieve County:

SG 1	Peridotite	Saline Creek dike	Dark-greenish-gray peridotite with phenocrysts of altered olivine, augite, and biotite. Inclusions of granite, quartzite, and dolomite usually less than 15 cm in diameter. Chlorite is common alteration product. Accessory minerals include magnetite, apatite, and garnet. Secondary quartz present. Dike is 1.5 m wide, approximately 0.4 km long, and believed to be intruded along east-west-trending fault. Biotite ages: K-Ar 388±19 Ma, Rb-Sr 396±28 Ma. Located at SE corner sec. 12, T. 35 N., R. 7 E., in bed of Saline Creek west of road. Location shown on figure 2.	Kidwell (1947); Zartman and others (1967).

Stoddard and New Madrid Counties:

ST 1	–	Bloomfield pluton	Mafic or ultramafic intrusion interpreted from magnetic and gravity fields.	Hildenbrand and others (1977).

Reynolds County:

RE 1	Lapilli tuffs, altered volcanic material.	Diatremes(?)	Volcanic rocks at Bee Fork, delineated by 50 or more drill holes, consist of lapilli tuffs, which grade laterally into bedded volcanic ash and volcaniclastic facies in Upper Cambrian Bonneterre Dolomite. Lapilli tuffs contain altered volcanic material with relict olivine, phlogopite, and pyroxene phenocrysts. Evidence for five eruptive centers in vicinity of Bee Fork. Maximum known thickness of volcanic rocks is 45 m.	Heyl and McKeown (1978); Kisvarsanyi and Howe (1983a, b, c, d, e); Kisvarsanyi and others (1981).

Table 1.—*Summary of petrology, structural information, and primary references on alkaline igneous rocks, carbonatites, and peridotites in the northern Midcontinent area —Continued*

Locality No.	Rock type	Feature or structure	Description	References
			MISSOURI—Continued	
Washington County:				
WA 1	Tuffaceous siltstone and lapilli tuffs, carbonatite.	Bedded pyroclastic rocks, diatreme(?).	Pyroclastic rocks at Dent Branch consist of phlogopite, altered olivine and pyroxene, garnet, amphibole, ilmenite, magnetite, and perovskite. No melilite noted in groundmass. Crystalline calcite of possible carbonatitic origin is present. Small amount of millerite identified in tuffs. Pyroclastic rocks crop out in ditch about 100 m west of intersection of State Supplementary Highway C and Dent Branch, (sec. 3, T. 35 N., R. 2 E.) and extend for about 0.8 km south and 2.5 km north of Highway C along Dent Branch. Pyroclastic material thought to have been deposited in shallow-marine environment and reworked into bedded sedimentary rocks. Inferred to be Late Cambrian age.	Heyl and McKeown (1978); Kisvarsanyi and others (1981); Wagner and Kisvarsanyi (1969).
WA 2	Tuffisite	Diatreme(?)	Volcanic rocks at Furnace Creek, discovered in drill holes, consist of lapilli of highly altered green to black basic igneous rock, along with fragments of granite, rhyolite, sandstone, and sandy dolomite. Lapilli contain chlorite, carbonate, phlogopite, magnetite, and quartz. Drilling indicates funnel-shaped crater with diameter of 2.4 km in Upper and Middle(?) Cambrian Lamotte Sandstone. Upper Cambrian Bonneterre Dolomite lies undisturbed on top of volcanic rocks, indicating emplacement during Late Cambrian.	Kisvarsanyi and Howe, (1983a); Snyder and Gerdemann (1965); Kisvarsanyi and others (1981).
			NEBRASKA	
Johnson and Pawnee Counties:				
JO 1	Carbonatite	Plug	Carbonatite near Elk Creek discovered by drilling over positive gravity and magnetic anomalies. Typical Pennsylvanian sedimentary rocks underlain by iron-rich carbonatites, which contain dolomite, ankerite, hematite, chlorite, phlogopite, barite, and quartz, with lesser amounts of pyrite, chalcopyrite, galena, and serpentine. Geophysical data indicate a cylindrical mass with radius of 1.6 km near top. Average uranium content of carbonatite is 11.54 ppm.	Harlem (1982); Treves and others (1982); Brookins and others (1976).

Richardson and Nemaha Counties:

RN 1	–	Gravity and magnetic anomaly.	North-south-trending elliptical gravity anomaly of 5-km^2 area and 4 milligals relief. Vertical magnetometer survey revealed circular negative anomaly of about 200 gammas.	Sayeed and others (1972).

TENNESSEE

Lake County:

LA 1	Alkaline igneous rock.	–	Drill holes penetrating alkaline igneous rock	Brock and Heyl (1961); Hey and McKeown (1978).

WISCONSIN

Marathon County:

MA 1	Nepheline syenite, syenite, fenite, granite.	Composite batholith.	Syenite complex at Wausau. Concentrically zoned plutons consisting of (1) outer zones of fenitized volcanic rocks, (2) discontinuous zones of gneissic nepheline syenite, (3) inner zones of syenite, and (4) two plutons having cores of granite that invade rocks of zones 1-3. About 1,500 million years old.	Greenberg and Brown (1985); LaBerge and Myers (1983); Lockwood (1967, 1970).

Pierce County:

PI 1	Faulted sedimentary rocks, breccia pipe.	Rock Elm breccia pipe or crypto-explosion structure.	Rock Elm structure is nearly circular feature with diameter of about 6.5 km. It has ring boundary fault, uplifted central area, and sediment-filled ring basin. Central area has apparently been intruded by breccia pipe containing quartz, felsite porphyry, and potassium feldspar with minor granite, chert, and amphibolite. No associated shock metamorphic features found. Gold and diamonds have been found within Rock Elm structure, which is of Middle to Early Ordovician age.	Cordua (1985).