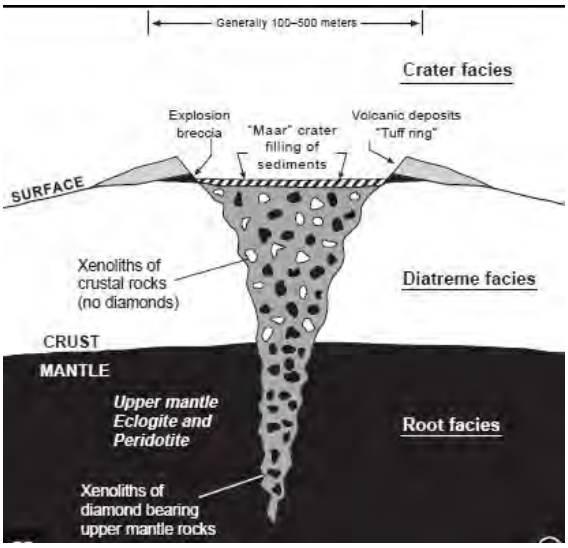
KIMBERLITES



Kimberlite is an ultrabasic olivine-rich igneous rock called peridotite. Peridotites occur at great depths in the earth in a layer called the mantle (100-135 miles below the surface). At this depth the combined temperature and pressure is high enough to partially melt the peridotite. When carbon dioxide and water are present (increase the buoyancy), they may propel the molten magma slowly to the surface (areas of lower temperature and pressure). As it reaches the upper mantle and overlying crust, minerals present begin to crystallize and the volatile gases expand and exert increasingly higher pressure on the surrounding rocks near the surface. This causes the surrounding rocks to fracture and incorporating it into the magma (xenoliths-“foreign rocks”). Reaching the surface the internal pressure of the magma and volatile gases causes the kimberlite to become explosive. Here the magma can rise at speeds of 1,200 fps, ripping up more of the surrounding rock to give the kimberlite its characteristic texture. Diamonds form at about 100 miles below the earth where the temperature and pressure is right to transform the carbon to diamonds, this may not always happen if the depth is not deep enough or the magma is not carbon-rich.

KENTUCKY KIMBERLITE FACTS

KGS Miscellaneous reports-Trap Dikes of Elliot County, A.R. Crandall and J.S. Diller
NOTES from the American Journal of Science, August, 1886

1. Found only in a small part of the valley of the Little Fork of the Little sandy River. Seven miles south-west of Willard.
2. Appears to extent in two diverging lines from Critche's Creek into the valley of Isom Creek, with one exposure near Isom's Mill.
3. All the rocks of this region including the beds up to coal No. 7 are cut by both arms of the dike.
4. Preliminary examination of the rock under a microscope indicates that it belongs to the peridotites, which by most petrographers as eruptive.
5. Peridotite is a compact dark greenish rock with a specific gravity of 2.781.
6. In it are embedded numerous grains of yellowish olivine, uniformly distributed throughout the mass.
7. Rarely it's a fine-granular and dense, like many dark colored basalts, but generally the grains of which it is composed are medium sized.
8. Occasionally the olivine grains wholly disappear and the deep green serpentine pervades the whole mass.
9. Besides olivine and serpentine, which together make up 75% of the rock, there are prominent grains of pyrope (deep yellow-red garnet-$Mg_3Al_2Si_3O_{12}$/SG3.5)) and ilmenite (accessory mineral in altered igneous rocks, FeTiO3, with appreciable quantities of Mg, Mn, along with minor biotite.

Primary minerals=	Olivine-40%	Secondary minerals=	Serpentine-30.7%
	Pyrope-8%		Dolomite-14%
	Biotite-1%		Magnetite-2%
	Enstatite-1%		Octahedrite-1.1%
	Ilmenite-2.2%		
	Apatite-trace		

10. Professor Carvill Lewis remarks that in accord with nature's method of manufacturing the diamond than it gives prospector's a valuable guide to examine these localities.

KGS Series 9, Bulletin 21, 1956, James B. Koenig, The Petrography of certain Igneous Dikes of Kentucky, excerpts taken only from the Elliott county portion.

1. Peridotite is a holocrystalline (mineral grains can be identified with the unaided eye-phaneritic) porphyritic (distinct difference in size of the crystals) with phenocryst as large as 2 to 15 mm and may reach 25 mm.
2. Phenocrysts being olivine, serpentine replacing olivine, pyrope garnet, and ilmenite.
3. Fresh samples ranges from olive-green to almost black where weathered peridotite has a distinctive yellow-brown color.
4. Extent of the intrusion is unknown.
5. Kelyphitic alteration rims are found on the garnets.

KGS Series 11 Thesis Series 2, Stephen L. Bolivar, Kimberlite of Elliot County, Kentucky

1. Kimberlite is defined as a porphyritic alkali peridotite containing abundant phenocrysts of Olivine and phlogopite in a fine-grained groundmass of calcite and second generation olivine and phlogopite, and with accessory ilmenite, serpentine, chlorite, magnetite, and perovskite.
2. Kimberlites in Elliott County were emplaced in a series of pulses as a mush magma of suspended crystals and xenoliths with CO2- and H2o-rich gas provided a fluidization agent for the mush.
3. Kimberlites contain a wide variety of minerals and are usually altered by secondary processes, with olivine completely or partially replaced by serpentine or carbonate:
    a. Magnesium olivine
    b. Ilmenite, with some grains reacting with the carbonate fluid which formed the groundmass to produce rims of perovskite
    c. Garnets surrounded by kepyphitic rims as a product of the reaction between garnet and the transporting fluid. The rim usually consists of spinel, enstatite, hornblende, micas, and chlorite, also some rims are magnetite, phlogopite, and enstatite. The garnets inside the reaction rims are highly fractured, and oval or rounded.
    d. Phlogopite, boundaries of phenocrysts are corroded by reaction rims of magnetite.

e. Pyroxene characteristic of Kimberlite, but is not abundant in samples in Elliott County, but may occur as fragmental ultabasic xenoliths. Total pyroxene is less than 1% and is surrounded by reaction rims of magnetite indicating early formation and subsequent travel in a iron-rich carbonate fluid.
f. Groundmass consists of calcite, serpentine, magnetite, with accessory minerals
g. Accessory minerals are pervskite, apatite, zircon, rutile, *diamond*, and graphite.
h. Rock fragments are cognate xenoliths that consists of ultramafic rock fragments and accidental fragments.

CONCLUSIONS

1. The igneous rocks in Elliot County are Kimberlites and are post-Pennsylvanian in age.
2. The exposures may represent one pipe or separate pipes.
3. The carbonate occur as rock fragments (medium-to-fine grained anhedral crystals in the groundmass. Carbon-oxygen isotope study prove that most of the carbonate is of primary igneous origin and amounts to about 12% of the whole rock.

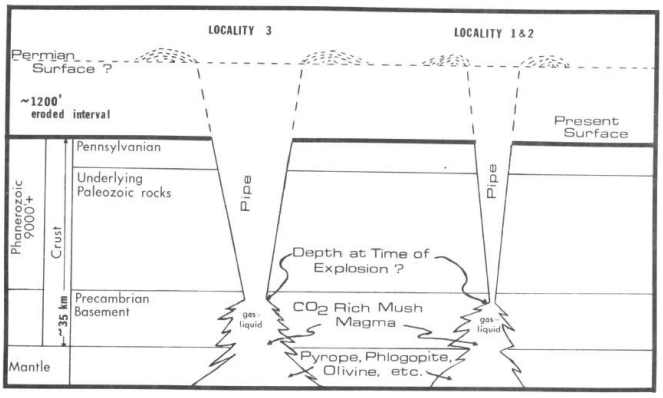


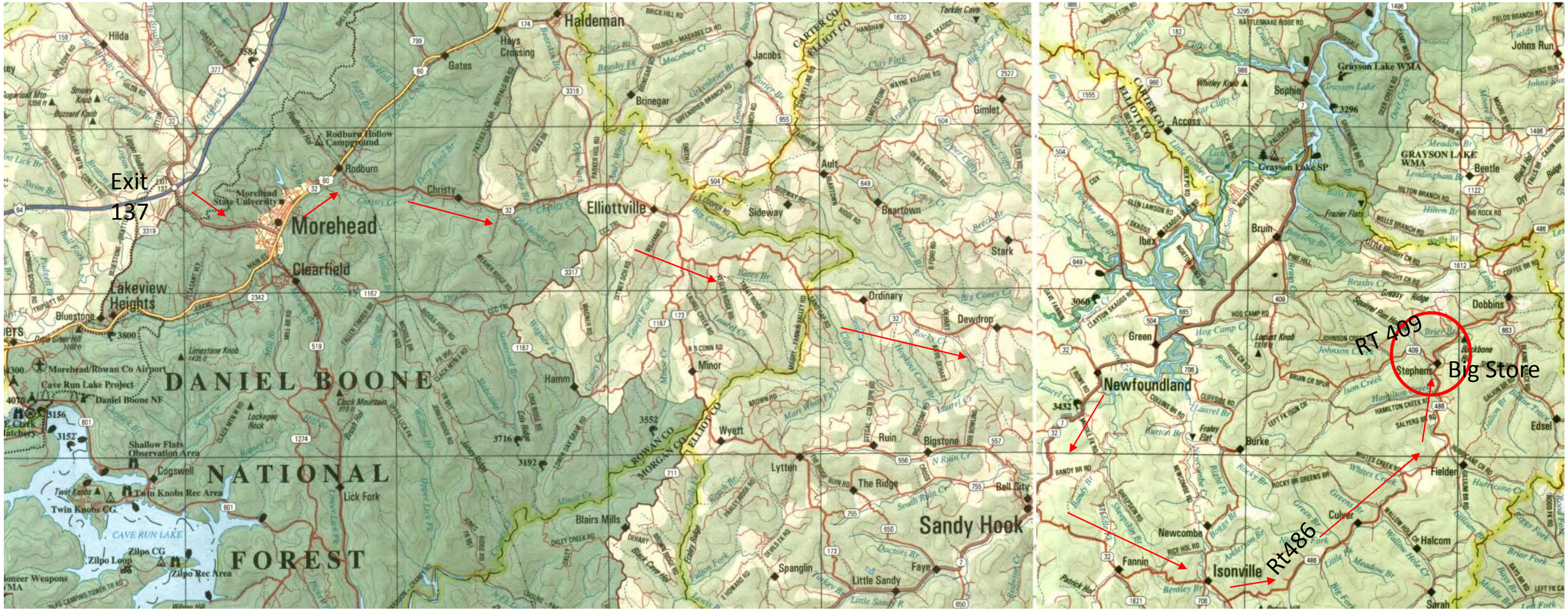
Figure 9. Diagrammatic sketch illustrating emplacement of kimberlites in Elliott County, Kentucky (modified from Dawson, 1960).

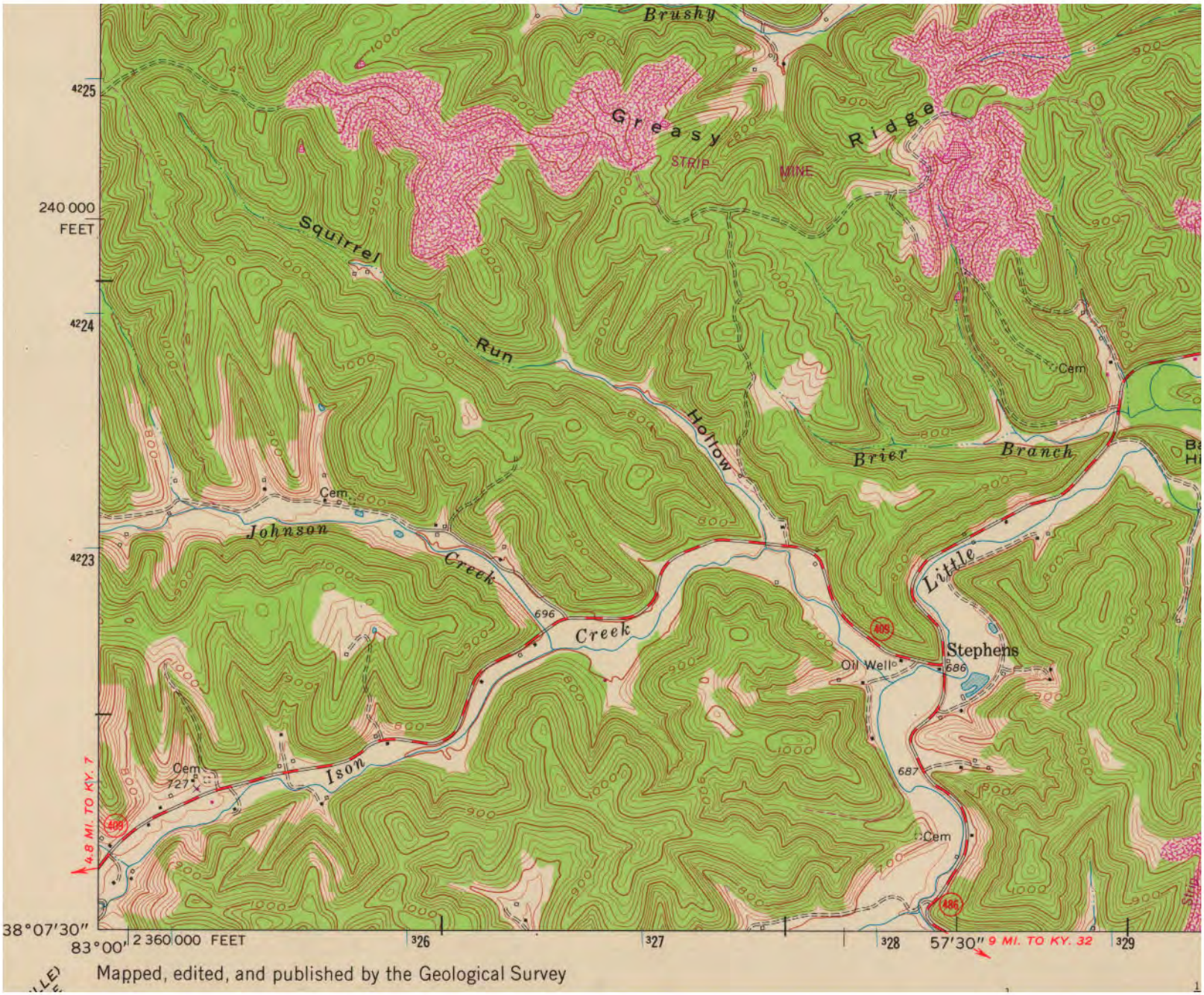
4. Variations in isotope analysis between kimberlite localities:
    a. Separate kimberlite pipes.
    b. Variations in temperature, depth of intrusion, and partial pressure of water pressure.
    c. Interaction with groundwater, and assimilation of rock fragments.

d. Partial melting of a peridotite rich mantle at a depth of about 125 to 250 km gave rise to abundant CO_2, H_2O, and a volatile fluid phase (more detail in the conclusions of the thesis series report).
e. The kimberlite pipes reached the earth's surface, resulting in some serpentization of late-generation olivine in the groundmass.
f. The temperature of the intrusion is believed to be less than 200^oC, causing very little alteration of the rock fragments in the kimberlites.
g. The fracture pattern of faults crossing central and eastern Kentucky provided the pathway for kimberlite magma.

FACTS FOR DIAMOND OCCURRENCE IN KIMBERLITES

1. G10 garnets (Pyropes), harzburgite, has a Cr_2O_3 content of 3-8%, deep red-purple-almost black
2. High chromium (chromite) >6%, dark green chromium diopside
3. Low in calcium <4%
4. Unoxidized iron usually indicates diamonds as long as there is G10 garnets, highly oxidized most likely no diamonds, maybe vaporized. The illmenites usually mirrored the heat and available oxygen in erupting kimberlites.
5. Iron-rich kimberlite illmenites usually form above or below


Exit 137
Morehead
Clearfield
Lakeview Heights
Bluestone
Rodburn
Rodburn Hollow Campground
Morehead State University
Christy
Haldeman
Hays Crossing
Gates
Hilda
Brinegar
Jacobs
Gimlet
Ault
Beartown
Sideway
Elliottville
Stark
Ordinary
Dewdrop
Minor
Hamm
Wyett
Ruin
Bigstone
Lytten
The Ridge
Bell City
Sandy Hook
Blairs Mills
Spanglin
Faye
Little Sandy
Lick Fork
Cogswell
Twin Knobs Rec Area
Twin Knobs CG
Zilpo CG
Zilpo Loop
Zilpo Rec Area
Shallow Flats Observation Area
Morehead/Rowan Co Airport
Cave Run Lake Project
Daniel Boone NF
DANIEL BOONE NATIONAL FOREST
CAVE RUN LAKE
Johns Run
Grayson Lake WMA
Sophie
Access
Grayson Lake SP
GRAYSON LAKE WMA
Beetle
Bruin
Ibex
Frazier Flats
Dobbins
Green
Newfoundland
Stephens
Big Store
RT 409
Burke
Edsel
Fielden
Culver
Halcom
Newcomb
Fannin
Isonville
Rt486
Sarah
ROWAN CO
MORGAN CO
ELLIOTT CO
CARTER CO



WILLARD, KY.

NW/4 WERRVILLE 15' QUADRANGLE

SCALE 1:24 000

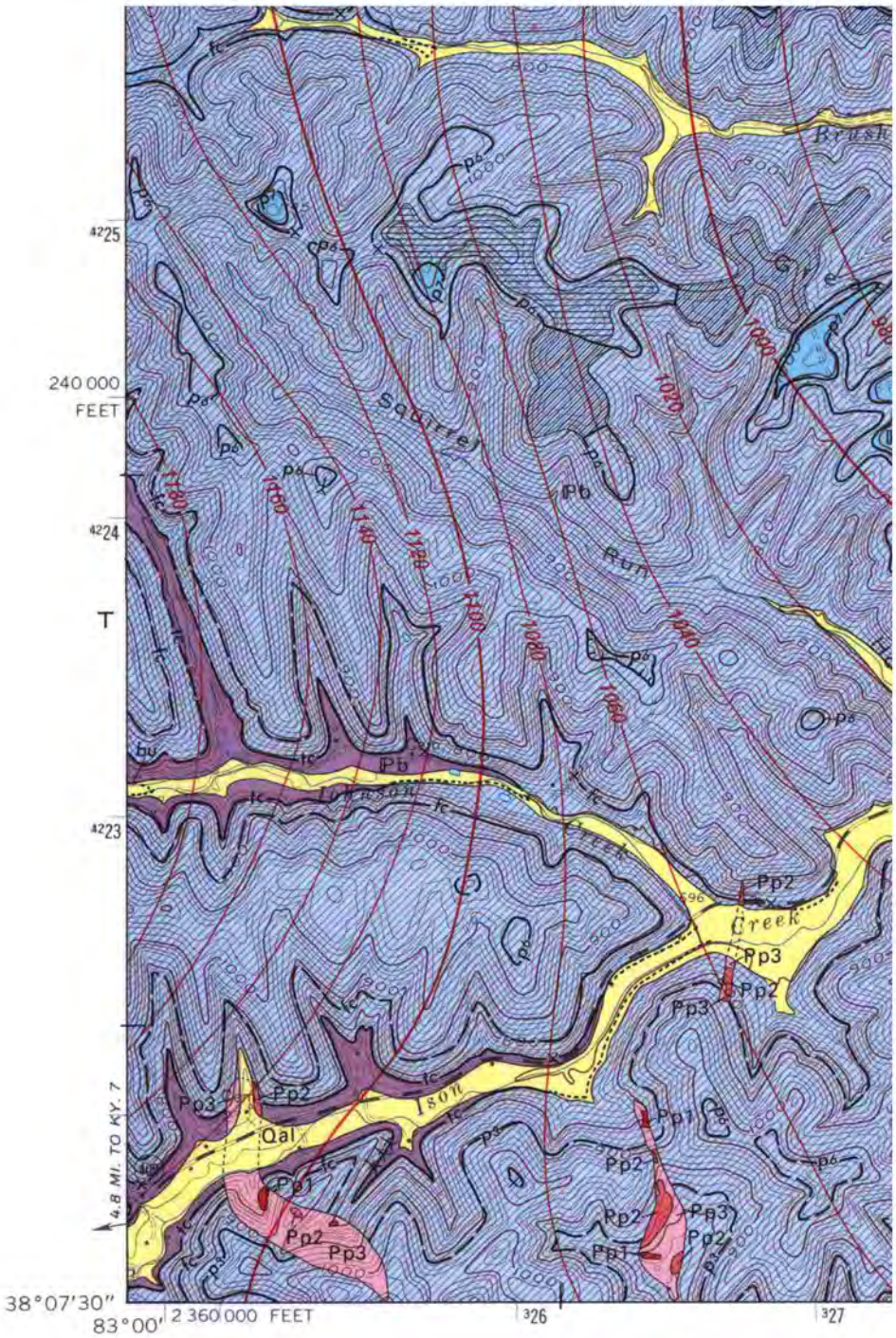
1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET

NATIONAL GEODETIC VERTICAL DATUM OF 1929



Qal

Alluvium

QUATERNARY

Upper Pennsylvanian

Pc
b

Conemaugh Formation

b, *top of Brush Creek Limestone Member*

Lower and Middle Pennsylvanian

Pb
p7
p6
vp
p5
c
p3
Pb
m
mb
fc
c
tc
Pb
bu
gr

Breathitt Formation

p7, *Princess No. 7 coal bed*
p6, *Princess No. 6 coal bed*
vp, *Vanport Limestone Member*
p5, *Princess No. 5 coal bed*
c, *unnamed coal bed*
p3, *Princess No. 3 coal bed*
m, *base of Magoffin Member*
mb, *Moore Branch coal bed*
fc, *Fire Clay coal bed*
tc, *Tom Cooper coal bed*
bu, *Bruin coal bed*
gr, *top of Grayson sandstone bed*

Lower Pennsylvanian

(Pl)

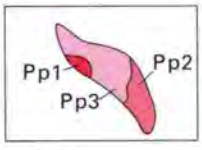
Lee Formation

Exposed only at low stages of Grayson Lake

PENNSYLVANIAN

Unit symbols in parentheses where covered by water at high stages of Grayson Lake

INTRUSIVE ROCKS OF PERMIAN AGE



Pp1, *unweathered peridotite*
Pp2, *yellow ground (oxidized and hydrated peridotite)*
Pp3, *areas of soil containing crystals of ilmenite and garnet, and foreign rock fragments*

GEOLOGIC QUADRANGLE MAP
WILLARD QUADRANGLE, KENTUCKY
GQ–1387

SCALE 1:24 000

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL