DIAMONDS, KIMBERLITES, LAMPROITES AND RELATED ROCKS IN THE UNITED STATES

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ABSTRACT

Hundreds of diamonds have been found in the United States. The majority of the discoveries occurred during the 19th century as a by-product of placer gold mining. Most of these early diamond finds have no known source, and in many cases are situated in areas unfavorable for diamond exploration based on current models that require kimberlite or lamproite to be emplaced in a stable Archean craton or Proterozoic craton margin.

Diamonds have also been recovered *in situ* from lamproite at Murfreesburo, Arkansas,from kimberlite in the Lake Ellen region of Michigan, and in several kimberlites in the Colorado-Wyoming State Line district. Unverified reports also suggest that diamonds may have been recovered from other related intrusives at a number of localities in the United States.

Figure 1. Diamond, kimberlite, lamproite, and related rock localities in the United States (each locality may represent one or more reported occurrences).

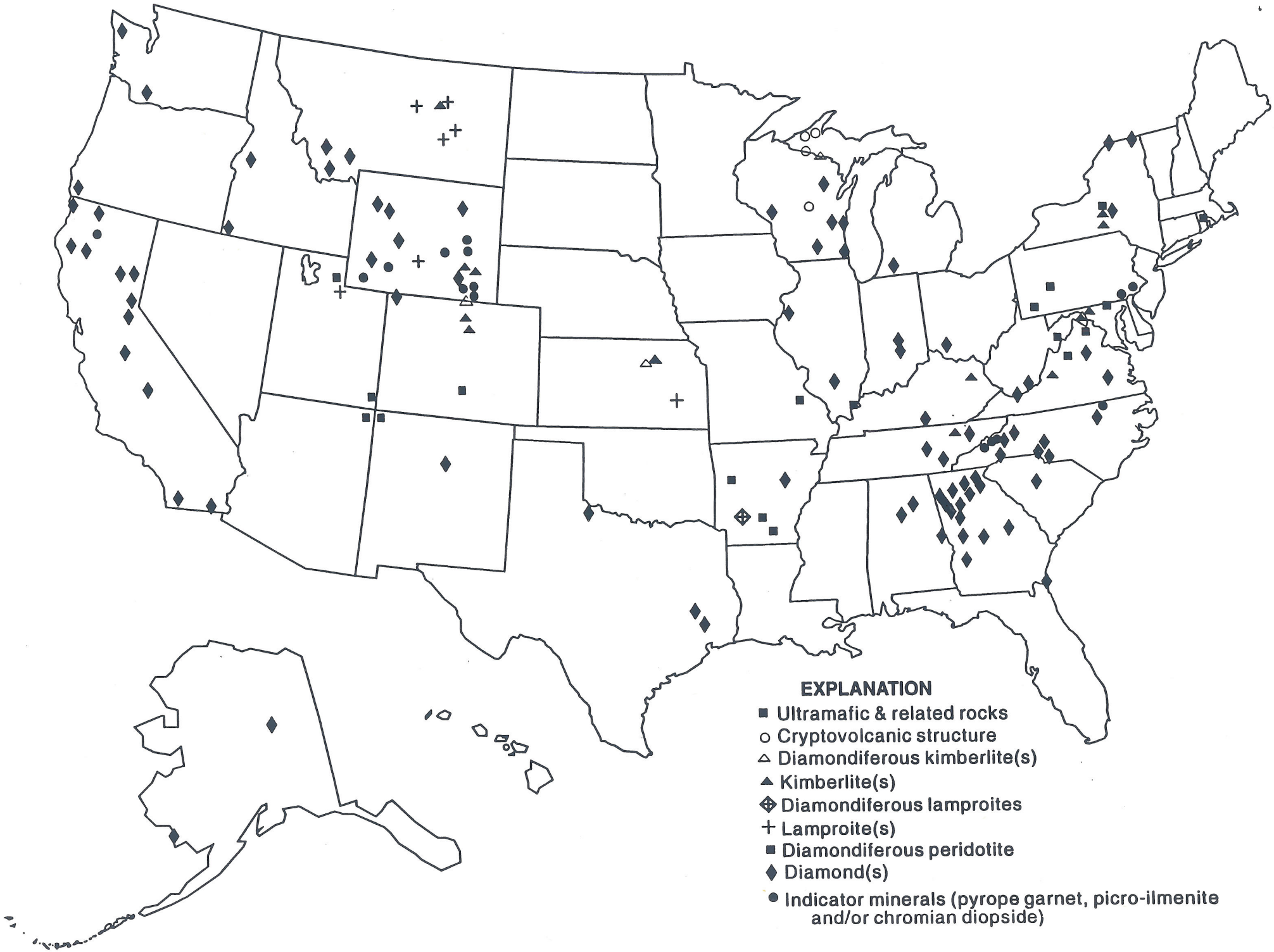
EXPLANATION
Ultramafic & related rocks
Cryptovolcanic structure
Diamondiferous kimberlite(s)
Kimberlite(s)
Diamondiferous lamproites
Lamproite(s)
Diamondiferous peridotite
Diamond(s)
Indicator minerals (pyrope garnet, picro-ilmenite and/or chromian diopside)

Table 1. Reported diamonds in the United States greater than 2 carats in weight.

Diamond	weight (carats)	State
Loyd	>100	Georgia
Uncle Sam	40.42	Arkansas
Punch Jones	34.46	West Virginia
Star of Murfreesboro	34.25	Arkansas
Doubledipity	32.99	California
Howell	27.31	Arkansas
Dewey	23.75	Virginia
Terresa	21.25	Wisconsin
Rock Flat	19.5	Idaho
Enigma	17.83	California
Amarill Starlight	16.37	Arkansas
Eagle	15.37	Wisconsin
Star of Arkansas	15.24	Arkansas
Serendipity	14.33	California
Kelsey Lake	14.2	Colorado
Lewis & Clark	14.0	Montana
Dowagiac	10.875	Michigan
Unnamed	8.82	Arkansas
Unnamed	8.61	Arkansas
Unnamed	7.95	Arkansas
Ashley	7.75	Illinois
French Corral	7.25	California
Shell Bluff	7.11	Georgia
Unnamed	6.75	Arkansas
Saukville	6.57	Wisconsin
Gary Moore	6.43	Arkansas
Unnamed	6.30	Arkansas
Unnamed	6.25	Arkansas
Unnamed	6.2	Arkansas
Kesley Lake	6.2	Colorado
Eisenhower	6.11	Arkansas
Unnamed	6.07	Arkansas
Williams Ferry	>6.0	Georgia
Milford	6.0	Ohio
Unnamed	5.9	Arkansas
Unnamed	5.76	Arkansas
Unnamed	5.63	Arkansas
Unnamed	5.58	Arkansas
Sloan	5.51	Colorado
Unnamed	5.19	Arkansas
Unnamed	5.15	Arkansas
Unnamed	5.08	Arkansas
Unnamed	5.0	Arkansas
Unnamed	5.0	Arkansas
Stanley	4.88	Indiana
Lee	4.61	Alabama
Shelby	4.37	Alabama
Dysortville	4.33	North Carolina

Daniel Light	4.25	Georgia
Skamania	>4.0	Washington
Brown County	4.0	Indiana
Peru	3.93	Indiana
Devine	3.87	Wisconsin
Jeopardy	3.9	California
Columbus	3.5	Georgia
Chicken Craw	3.15	Oregon
Salt Creek	3.06	Indiana
Little Indian Creek	3.0	Indiana
Union Crossroads	3.0	Tennessee
Chicken Park	2.6	Colorado
Malheur	2.5	Oregon
Prescott Siding	2.41	Alabama
McDowell	2.38	North Carolina
Gold Creek	2.28	Indiana
Mary	2.27	California
Moore	2.25	California
Burlington	2.11	Wisconsin

INTRODUCTION

To date, diamonds have been recovered *in situ* from kimberlite in the Colorado-Wyoming State Line district and from a kimberlite in Michigan. Additionally, diamonds have been recovered from lamproites in Arkansas. Diamonds have also been reported from kimberlite in Kansas, and from peridotite in New York and Maryland. However, these latter reports have not been verified.

Secondary diamond deposits are widespread in the United States. Diamonds have been reported in gravels from numerous gold placers and in glacial till. These secondary occurrences can be geographically separated into the following regions: (1) the Appalachian Mountains, (2) the Great Lakes region, (3) the Continental Interior, (4) the Gulf Coast, (5) the Great Basin, and (6) the Pacific Coast. Most notable of these regions are the Appalachian Mountains and the Pacific Coast where hundreds of diamonds, including the largest diamonds reported in the United States, have been found (Figure 1, Table 1). The source of these diamonds is unknown, in that much of this terrane is not conducive to diamondiferous kimberlite or lamproite.

DIAMONDS AND THEIR HOST ROCKS

Diamond is the hardest naturally occurring mineral on the surface of the earth. Diamonds have been found in a number of rock types, but commercial diamond deposits are for the most part restricted to kimberlite, lamproite, and secondary deposits derived from these intrusives. Diamonds have also been recovered from several unconventional host rocks. The reader is referred to the excellent overview of diamond source rocks by Helmstaedt (1993) for further discussions.

Diamonds

There are two basic forms of natural diamond: (1) isometric, and (2) hexagonal. Terrestrial diamonds, for the most part, are isometric. Hexagonal diamonds (lonsdalite) are rare, and appear to be restricted to meteorites.

Isometric diamonds occur in a number of forms and habits. The isometric diamond is an equal-dimensional mineral which in its simplest form produces six-sided cubes referred to as hexahedrons. However, the most common habit of diamond is the octahedron, or some modification of the octahedron. Octahedrons form eight-sided bipyramids, although some octahedrons may develop ridges on the octahedral faces producing crystals of trisoctahedral and hexoctahedral habit. Partial resorption of octahedral diamonds can result in a rounded dodecahedron (12-sided) with rhombic faces. Many dodecahedrons develop ridges on the rhombic faces producing a 24-sided crystal known as a trishexahedron. Additionally, four-sided tetrahedral diamonds are sometimes encountered; these diamonds are probably distorted octahedrons (Bruton, 1979).

Diamonds often enclose mineral inclusions that provide important scientific data on the origin of diamond, and some of these inclusions are used to date the formation of the diamond. Nearly every diamond examined, to date, has yielded a Precambrian age (3.3 Ga to 990 Ma), with one notable exception. The exception is a diamond from an unconventional source rock in New South Wales, Australia, which yielded a date of 300 Ma.

It turns out that the host rocks for the diamonds are significantly younger than the diamonds themselves. For example, most lamproite and kimberlite host rocks yield much younger ages (1.6 Ga to 1.0 Ma) than the diamonds (Helmstaedt, 1993). This age discrepancy indicates that most diamonds are xenocrysts.

The mineral inclusions in diamond are characteristic of either peridotites or eclogites. These diamonds are designated as P-type (peridotitic) or E-type (eclogitic). Peridotites are ultramafic rocks that contain pyroxene and more than 40% olivine, and are subdivided based on their pyroxenes. For example, lherzolites are peridotites that contain clinopyroxene and orthopyroxene; wehrlites contain clinopyroxene but lack orthopyroxene, and harzburgites contain orthopyroxene, but lack clinopyroxene. Thus P-type diamonds may contain inclusions of olivine, orthopyroxene, clinopyroxene, garnet, chromite, diamond, and/or sulfides which were derived from their peridotitic host rock.

Some peridotitic garnets have unique chemistries indicative of the diamond stability field. Since garnets are typically more abundant than diamond (especially in kimberlite), they are often used in the exploration of diamondiferous deposits. Some peridotitic (pyrope) garnets have been designated as "G10" which have been derived from low-Ca harzburgites, and "G9" derived from the more calcic lherzolites (Gurney, 1984). Most garnet inclusions in diamond are derived from low-Ca harzburgites. These garnets have relatively low Ca/Cr ratios compared to lherzolitic pyropes, and are interpreted to have been derived from the diamond stability field (Gurney, 1989).

Eclogite, another common mantle xenolith found in kimberlite, has an approximate chemical composition of basalt. Mineralogically, eclogites consist of omphacitic clinopyroxene and almandine-pyrope garnet, and may have accessory rutile, kyanite, corundum, coesite, and possibly diamond. Thus the mineral inclusions found in E-type diamonds are characteristic of eclogite.

Some ecologitic garnets also have unique chemistries indicative of the diamond stability field. Mantle garnets of eclogitic parentage have been designated as either Group I or Group II garnets. All diamond-bearing eclogites belong to Group I. The Group I eclogitic pyropes have Na_2O contents of $\geq$ 0.07%, low levels of Cr_2O_3 (typically <0.05 wt% Cr_2O_3), and CaO contents in the range of 3.5 to 20 wt%. Group II eclogitic pyropes are similar to the Group I garnets, but have <0.07% Na_2O. Low-Cr garnets with less than 3.5% CaO, are probably derived from crustal rocks (Helmstaedt, 1993).

Some of the nodules (or mantle xenoliths) found in kimberlite are very rich in diamond. For example, a hand-specimen of eclogite collected from the Sloan 1 diatreme in the Colorado-Wyoming State Line district yielded a minimum diamond grade of 2,100,000 carats per 100 tonnes (Schulze, 1992). Typical commerical kimberlite diamond ore may only average 10 carats per 100 tonnes.

Kimberlite

Kimberlite is considered one of the principal host rocks for commercial diamond deposits. However, not all kimberlites contain diamond. Typically, only about 10% are diamondiferous and less than 2% have commercial amounts of diamond in concentrations typically less than 1 ppm (Lampietti and Sutherland, 1978).

Kimberlite is a volatile-rich, potassic, ultrabasic hybrid igneous rock with variable mineralogy, that forms diatremes, dikes, and "blows". Blows are swells along dikes, and are considered to be the root zones of diatremes. In cross-section, a diatreme is a carrot-shaped pipe that grades upward from a root, to a diatreme, and further upward to a crater at the surface. The root zone developes at approximately 2 km below the surface, and is an irregular dike complex occupied by one or more intrusive phases of hypabyssal facies kimberlite.

Diatreme facies kimberlite is represented by volcaniclastic breccias consisting of clasts of country rock, fragments of hypabyssal kimberlite, and pelletal lapilli in a matrix of serpentine and diopside. Crater facies kimberlite, consisting of pyro- and epiclastic kimberlitic material (pyroclastics, tuffs, and lapilli pyroclastics), is preserved only in pipes that have undergone little or no erosion since emplacement. In general, the diamond grade of kimberlite will decrease with depth. Grades in crater facies kimberlite are significantly higher than diatreme facies (Helmstaedt, 1993).

Lamproite

In 1978, diamondiferous lamproite was recognized in the Kimberly block in Western Australia. Prior to this discovery, kimberlite was assumed to be the only commercial primary rock for diamond. Kimberlites and lamproites are distinctly different rock types, however there is an overlap in the chemical compositions of micaceous kimberlites and lamproites (Helmstaedt, 1993).

In general, lamproites are peralkaline ultrapotassic igneous rocks enriched in the trace elements Zr, Nb, Sr, Ba, and Rb relative to kimberlite. Lamproite, like kimberlite, is silica-poor and rich in MgO, FeO, K_2O, and volatiles (Kirkley and others, 1991). Lamproites may contain diopside, phlogopite, K-Ti richterite, leucite, sanidine, wadeite, priderite, and /or olivine, with minor apatite, perovskite, ilmenite, and spinel (Mitchell and Bergman, 1991). The typical kimberlitic "indicator" minerals (pyrope garnet, chromian diopside, and picro-ilmenite) are uncommon in lamproite.

Lamproite occurs as extrusive, subvolcanic, and hypabyssal facies rocks, and erupts from small volcanoes with restricted flows. Where mineralized, the diamonds are primarily restricted to the pyroclastics: the magmatic phases (and sills) are notoriously diamond poor. Thus, the available minable tonnage is somewhat limited to the vent facies rocks. Typically, diamond grades are higher in olivine-lamproites than in the leucite-lamproites.

The known diamondiferous lamproites in the world include the Argyle, and a few other lamproites in the Ellendale field of Western Australia; Kapamba in Zambia; Majhgwan-Chelima in India; a group of lamproites at Murfreesburo, Arkansas; Aldan in Russia; and Bobi in the Ivory Coast. The Argyle lamproite yields more diamonds per tonne (6.8 carats) than any other primary diamond deposit in the world. Currently, the Argyle mine produces 30% of the world's diamonds. Some rare pink diamonds from Argyle have recently become the most expensive gemstones in the world. Some Argyle pinks are valued at about $1 million Australian for a 1 carat brilliant cut (Rock and others, 1992).

Placers

Isometric diamonds are 6,000 to 8,000 times harder than any other mineral. Because of their extreme hardness and chemical inertness, diamonds can be stream transported over great distances. In some instances, diamonds are assumed to have been transported hundreds of kms from their original source rock.

Ultramafic lamprophyres and related rocks

Diamonds have been reported in lamprophyres, alkali basalts, and other unconventional host rocks. Certain types of ultramafic lamprophyres, notably alnöites, have yielded minor amounts of diamond. Alnöites lack the characteristic kimberlitic indicator minerals, and contain melilite and biotite mica (instead of phlogopite), and can be thought of as melilite-bearing mica-peridotites (Helmstaedt, 1993).

Diamondiferous picritic monchiquites have been reported in Western Australia, and diamonds have also been reported in lamprophyres in Quebec. Diamonds have also been reported in mugerarite, nephelinite, and alkali basalt from New South Wales (Jaques and others, 1986; Engineering and Mining Journal, 1994). One diamond recently recovered from New South Wales yielded a relatively young age date (300 Ma). This diamond is assumed to have formed at relatively shallow depths (80 km) in a cool, subducted, organic-rich oceanic slab (Engineering and Mining Journal, 1994).

Altered olivine-phlogopite lamproite dikes have also yielded diamonds from the Ivory Coast and NW Gabon. These rocks are devoid of the usual kimberlitic indicator minerals and appear as talc or phlogopite schists. The Bobi lamproite dike in the Ivory Coast is locally very diamond rich with grades up to 1,000 carats/100 tonnes.

Ultramafic complexes

Other primary diamond deposits that have recently been recognized are high-pressure alpine-type and ophiolitic peridotites. Such peridotites were discovered in the Ural, Caucasus, and Koryak Mountains of the former Soviet Union, after diamonds were traced from nearby placers. The initial discovery occurred in 1978, and resulted in the identification of diamonds in harzburgite bedrock in the Phanerozoic Koryak Mountains of northern Kamchatka. Diamond in alpine peridotites from the Koryak Mountains, as well as from Tibet, is thought to have formed during subduction and to have survived metastably during rapid tectonic uplift.

Diamonds have also been found in a metamorphosed, layered, mafic-ultramafic complex near Kaya, Burkina Faso, West Africa. This particular complex consists of metamorphosed dunite overlying a sequence of layered amphibolites, metaperidotites, metapyroxenites, and biotite-plagioclase gneiss.

Recently, a slab of oceanic lithosphere from a high-pressure metamorphic belt in Morocco, was shown to have been diamondiferous. The Beni Bousera peridotite massif contains numerous graphite pseudomorphs after diamond in garnet clinopyroxenite. The mineral inclusions in the graphite, and the carbon isotopic compositions of the graphite, are similar to E-type diamonds from kimberlite.

The graphite octahedra are confined to four garnet clinopyroxenite magmatic cumulate layers in the complex. Two of the layers are greater than 2 m thick, and contain orange pyrope-almandine garnet with compositions comparable to those found in

diamond-bearing eclogites (Na_2O concentrations up to 0.14%), and also contain omphacitic pyroxene porphyroclasts with minor plagioclase, spinel, and sulfides. The graphite-bearing garnet clinopyroxenite layers, along with wehrlites, lherzolites, and diopsidites, form an intercalated horizon up to 16 m thick at the apex of the massif (Pearson et al, 1989, 1993).

Although primary diamond was not preserved in the Beni Bousera slab, based on the concentration of the graphitized diamonds, the slab initially had about 15% diamond, or approximately 10,000 times as many diamonds per unit mass of rock than any known kimberlite intrusive (Pearson et al, 1993)! This deposit may not be unique, especially when it is realized that many detrital diamonds have been reported along plate margins near ophiolite complexes elsewhere in the world.

High pressure metamorphic rocks

Helmstaedt (1993) describes some interesting occurrences of metamorphic diamonds. For instance, microdiamonds (average 12.5 microns) were found as inclusions in garnets and zircons of metasedimentary garnet-biotite gneisses and schists in the Kokchetav massif of northern Kazakhstan. Diamonds have also been identified in inclusions in garnets in coesite-bearing eclogites, garnet pyroxenites, and jadeites in the Dabie Mountains of eastern China. These diamonds average only 10 to 60 microns across and include grains up to 240 microns.

Metamorphic diamonds were discovered northwest of the Ulaan-Baatar region of Mongolia in 1992 by the Central Institute of Exploration from Moscow. Initial bulk sampling tests recovered diamonds in the range of <0.1 mm to 1 mm in diameter at grades of 4,000 carats/100 tonnes to 10,000 carats/100 tonnes. This deposit is similar to the Kokchetav deposit in Kazakhstan (Ed Erlich, written communication, 1993).

Meteorites

Diamonds occur in some meteorites. As much as 1% diamond by weight has been found in stoney and iron meteorites. These include both isometric and hexagonal (lonsdaleite) diamonds. Lonsdaleite has also been reported from the Popigay Depression in northern Siberia. In this region, diamonds were mined for industrial purposes in the past. The Popigay structure has been described as a astrobleme, although some researchers suggest that this structure may instead have had terrestrial origins (Ed Erlich, personal communication, 1985).

DIAMOND, KIMBERLITE, LAMPROITE, AND RELATED ROCK LOCALITIES IN THE UNITED STATES

Diamonds, kimberlite, lamproite, lamprophyre, and peridotite have been reported at a number of localities in the United States (Figure 1). For discussion, these regions are divided into the (1) the Appalachian Mountains, (2) the Great Lakes region, (3) the Continental Interior, (4) the Gulf Coast, (5) the Great Basin, and (6) the Pacific Coast.

Appalachian Mountains, Eastern United States

Many diamonds have been reported in the Appalachian Mountains along the eastern coast of the United States. Diamonds have been reported from Alabama, Georgia, Kentucky, North Carolina, New York, Maryland, South Carolina, Tennessee, Virginia, and West Virginia. The authenticated diamonds in this belt range in weight from 0.25 carat to 34.46 carats. There are also various less well documented reports of diamonds weighing up to more than 100 carats. The great majority of the stones found in the Appalachians were recovered as a by-product of placer gold mining during the historical past.

The source of the diamonds is unknown. Several writers have suggested that the diamonds originated from a distant source and were transported by streams, glaciers, and even migrating birds from South America, or were the product of fraud. Some early writers even speculated that the diamonds were derived from nearby outcrops of Itacolumite (micaceous sandstone) (Bond and Hausel, 1994). However, kimberlite, ophiolite, micaceous peridotite, and diamondiferous(?) peridotite have all been reported in the Appalachians, thus it is more likely that the source of many of the diamonds was from nearby, mantle derived, host rocks. Many kimberlites in the Appalachians are reported to be localized at the intersections of reactivated faults with cross-structural lineaments (Parrish, 1984).

Alabama

Diamonds have been reported from three localities in Alabama (Sinkankas, 1959). These stones (2.41 carats to 4.61 carats in weight) are documented, and two of the stones ended up in the American Museum of Natural History. Two of the diamonds were found along the southern margin of the Appalachian uplift.

Lee County: A distorted octahedron was found in Lee County along the eastern margin of the State near the Chattahoochee River, and was placed in the American Museum of Natural History (Sinkankas, 1959). This diamond was reported by Blank (1935) to weigh 4.61 carats.

St. Clair County: In 1905, a greenish, 2.41 carat diamond was found near Prescott Siding about 1.25 miles east of Brompton in the northeastern portion of the State (Blank, 1935).

Shelby County: In 1900, a faint, yellow, octahedron was found near Birmingham in the northeastern portion of the State. The diamond was placed in the American Museum of Natural History (Sinkankas, 1959), and weighed 4.37 carats (Blank, 1935; Mather, 1941).

Georgia

Georgia is one of the more intriguing states in the Appalachians because of the number of diamonds reportedly found in the historical placer gold mines. The stones are poorly documented, thus the actual number of diamonds found could have ranged from several stones to dozens of diamonds. The great majority were reported from the Appalachian region in the northern portion of the state.

The diamonds are described to range from microdiamonds to possibly the largest diamond ever found in the United States. According to Cook (1978), diamonds have been

reported from several counties in the state including Banks, Bartow, Burke, Camden, Carroll, Cherokee, Clayton, Cobb, Dawson, Forsyth, Gwinnett, Habersham, Hall, Haralson, Lumpkin, Paulding, Twiggs, and White (Figure 1). Unfortunately, very few of the reported gemstones were verified. The first report of diamonds in Georgia was in 1843, when diamonds were recovered from gravels in placer gold mining operations in Hall and White counties (Sinkankas, 1959).

Burke County: A hexoctahedron weighing 7.11 carats was found at the old Shell Bluff post office along the eastern edge of the state (Cook, 1978).

Camden County: Two 50 mesh diamonds were identified in the heavy concentrates of samples from Camden County along the Gulf Coast. One stone was a colorless hexoctahedron (Cook, 1978).

Clayton County: In 1887, a 4.25 carat yellow octahedron (9 x10 x7 mm) with one dark inclusion, was found on the Daniel Light farm three-quarters of a mile northeast of Marrow station (20 km south of Atlanta) in the northern portion of the state. A second stone, possibly from Clayton County, was found in 1889 at an undisclosed location near Atlanta. This was a poor quality 2 carat stone (Cook, 1978).

Hall County: In 1843, a diamond was recovered at Winns or Williams Ferry at the mouth of a small creek that enters Muddy Creek about a half mile from its junction with the Chattahooche River in the northern portion of the state. The stone weighed more than 6 carats. The country rock was reported to consist of granite and pegmatite.

There is an intriguing story about diamonds being found in gravel along the Stockeneter Branch of the Glade Creek, 20 km northeast of Gainsville. The property was mined in the 1850s for gold, and diamonds were frequently encountered in the sluice box clean-ups. Several pounds of diamonds were reportedly saved by a Dr. Loyd and his family. The diamonds were reported to average 4 carats in weight and included three very large stones. The largest weighed more than 100 carats (Cook, 1978). A Mr. Stephenson also reported finding several small well-formed stones in the area of the Glade Gold Mine several years later (Cook, 1978). The U.S. Geological Survey also reported diamonds along Glade Creek (USGS, 1968).

Lee County: A diamond found in Lee County near Columbus in the southern portion of the state was sold to Tiffinys in 1901. The stone was a flattened hexoctahedron of 3.5 carats, and was white with a greenish tint (Cook, 1978).

Twiggs County: A number of diamonds were reported on the Nelson property located 17.5 km southeast of Macon, or about 2.5 km northeast of Pikes Peak Station in the center of Georgia (Cook, 1978).

White County: A diamond weighing 3 grains was recovered from a long tom in White County in the northeastern corner of the state. Three small diamonds (0.125, 0.15, and 0.5 carat) were found in the Horshaw gold placer in the Racoochee Valley near Loudsville. These diamonds were described as opaque with no definite shape. Another diamond was reported from Lot 10 on the Lumsden property (the Lumsden property may be part of the Horshaw mine according to Cook, 1978). Four small diamonds were also reported from gold placers from the Nachoochee Valley. Other reports indicate stones of good quality have been found in this region. For instance, a perfect diamond weighing nearly a carat was recovered from a gold mine in White County.

Kentucky

Kimberlite, mica-peridotite, and at least one diamond have been found in Kentucky. The kimberlites in eastern Kentucky have received a fair amount of interest in the past. Based on the chemistry of some megacrysts and nodules from the kimberlites, it appears the intrusives originated within the diamond stability field; however, there are no verified reports of diamond from the kimberlites.

Adair County: According to Sinkankas (1959), a yellowish, 0.766 carat diamond, was reported from a stream near Montpelier in southern Kentucky. This may be the same diamond that was reported in Russel County in the same general part of the state.

Crittenden County: Approximately 20 ultramafic igneous dikes (257 Ma, age from Zartman et al, 1967) occur near the town of Marion in western Kentucky. The dikes are part of a larger field of about 50 intrusives which extend into southern Illinois (Koenig, 1956).

These intrusives were initially described as mica-peridotite and occasionally referred to as kimberlite. However, the overall mineralogy, especially the paucity of garnet and pyroxene, is not consistent with kimberlite (Meyer, 1976). The rocks are more appropriately classified as mica-peridotite or lamprophyre depending on the presence of absence of olivine or olivine pseudomorphs.

Elliott County: Three kimberlite intrusives (two diatremes and one dike) occur in Elliott County, eastern Kentucky. The intrusives cut Lower Pennsylvanian sediments and have been dated at 279 and 270 Ma (Zartman and others, 1967). The two diatremes consist of multiple phases of diatreme and hypabyssal facies kimberlite dominated by kimberlite breccia with less common massive kimberlite. Sparse stream sediment sampling in the area suggests the intrusives are either more widespread than previously reported, or that an undiscovered intrusive (or intrusives) occurs nearby (James E. Bond, personal communication, 1994).

The intrusives consist of phlogopite-poor, ilmenite- and pyrope-rich kimberlite containing some mantle and crustal xenoliths, xenocrysts, and megacrysts (Schultze, 1985). The host kimberlite is inequigranular in nature, with common phenocrysts and metacrysts of serpentinized olivine, pyrope garnet, picro-ilmenite, phlogopite, and minor pyroxene. Studies indicate the ilmenite contained appreciable magnesium (Meyer, 1976), which may be favorable for diamond preservation. One published ilmenite analysis yielded 9.39% MgO and 0.21% Cr_2O_3 (Garrison and Taylor, 1980). The groundmass is serpentinized and carbonatized and consists of serpentine and calcite, with accessory perovskite, apatite, and chlorite (Bolivar, 1982).

Equilibration temperatures and pressures determined for some metacrysts and garnet lherzolite nodules from the Kentucky kimberlites fall within the diamond stability field (Taylor, 1984). In other words, the chemistry of these metacrysts and nodules suggest these intrusives sampled the diamond stability field.

The intrusives were explored for diamond shortly after their discovery, and a 22.5 m shaft was sunk on the southernmost intrusive. Later exploration occurred in 1907, when the Kentucky Kimberlite Diamond Mining Company was established in Catlettsburg, Kentucky. Between 1965 and 1970, additional trenching was completed and a washing operation tested colluvium near the southern end of the southeastern-most

intrusive by Kentanna Minerals from Henderson County, Kentucky (Brown, 1977). At least one of the kimberlites was also tested by Cominco American Incorporated in the early 1980s. There are no verified reports of diamond being recovered from the intrusives.

Russel County: There is at least one verified report of a diamond in Kentucky. This diamond was recovered from Cabin Fort Creek in Russel County in southern portion of the state. The diamond weighed 0.776 carat and was incorporated into the U.S. National Museum's collection (Holden, 1944). There are no known ultramafic intrusives near this site.

Maryland

Kimberlite and diamondiferous peridotite have both been reported in Maryland. The report of diamondiferous peridotite in Maryland is intriguing, in that no recent reports on this occurrence is known.

Baltimore County: Diamonds were reportedly discovered *in situ* in an altered serpentinized peridotite at Bare Hills in northern Maryland (Mather, 1941). No other information was found on this occurrence.

Washington County: Parrish and Lavin (1982) report kimberlite occurs near Clear Springs of northwestern Maryland. The Clear Springs intrusive appears to lie on a northeasterly-trending structure which also controlled the emplacement of the Mt. Horeb, Virginia, and Norris, Tennessee kimberlites to the southwest. This belt of kimberlites parallels a second belt of kimberlites further to the west which includes kimberlites in Kentucky, Pennsylvania, and New York. Both of these belts should provide excellent targets for additional kimberlites.

New York

Kimberlite occurs in the southern portion of New York in the Ithica field south of Syracuse, and kimberlite is also reported near Syracuse. In addition to these intrusives, a diamond was reportedly found *in situ* in a peridotite near Syracuse. It is not known if the find was verified, nor is it known if this particular peridotite is the same intrusive as the kimberlite reported near Syracuse by Parrish and Lavin (1982). Diamonds have also been reported from three other counties in the state.

The Ithica field lies along a major trend with kimberlites in Pennsylvania and Kentucky (Parrish and Lavin, 1982). This trend supports several known kimberlites, including one or more with favorable mineral chemistries for diamond. The possibility of additional discoveries of kimberlite and diamond along this trend is considered good.

Clinton County: Diamonds have been reported in glacial drift at Plattsburg in the northeastern corner of the state (Mather, 1941). No details were given.

Onondaga County: Blank (1934) reported that a microscopic diamond was found in peridotite near Syracuse, New York, north of Ithica. The diamond apparently was described in 1921 after a microscopic study of the peridotite by a geologist at Syracuse University (Mather, 1941). Kimberlite is also reported to occur near Syracuse (Parrish and Lavin, 1982).

Putnam County: A diamond was reportedly recovered from a chicken at Cold Spring, New York, near the southeastern corner of the state (Mather, 1941). No other details were given.

Tompkins County: The Ithica kimberlite field south of Syracuse is comprised of kimberlite dikes and one diatreme (Martens, 1924; Kay and others, 1983). The exposures are described as narrow dikes of kimberlitic affinity that range from a few centimeters to 5.3 m wide, and are found in stream and road cuts in folded Devonian sediments (Martens, 1924). Emplacement of the intrusives was controlled by a prominent set of N-S trending joints.

More recent work by Kay and others (1983) expanded the Ithica field to 82 dikes and one small diatreme known as the Poyer Orchard diatreme. Kay and others (1983) examined three of the intrusives and suggested the kimberlite magmas originated from depths of less than 150 km. Both G9 pyropes and chromian diopside were recovered from the kimberlites. Another garnet in the kimberlites is described as iron-rich variety (probably almandine).

The dikes range from relatively fresh kimberlite with visible red garnets and chromian diopside to highly altered rock (Kay and others, 1983). The altered dikes consist of mica and serpentine with rare phenocrysts of olivine. The groundmass consists of perovskite, apatite, and magnetite with ubiquitous serpentine, chlorite, and calcite. Martens (1924) recorded the presence of small amounts of chromite, picotite (chromian spinel), graphite, red garnet, and bright green diopside.

The presence of melilite in some of the dikes led Martens to refer to these rocks as alnöites. However, later work by Kay and others (1983) disproved the presence of melilite. Foster and Reitan (1972) suggest most of the dikes are kimberlitic based on texture, composition, and mineralogy. The three intrusives examined by Kay and others (1983) were reported to have mantle xenocrysts and rare xenoliths. Clinopyroxenes of mantle origin yielded compositions >0.5% Cr_2O_3, and 0.5 to 2.0% Na_2O.

St. Lawerence County: A diamond was reported from the Grass River near Massena by Sinkankas (1959). The report is unconfirmed.

North Carolina

Diamond, chromite, pyrope, and menaccanite [according to Sinkankas, 1964, menaccanite is ferroan geikeilite (picroilmenite?)] have been reported at several localities in North Carolina suggesting that kimberlite, or a similar undiscovered intrusive, may occur in the state.

North Carolina has also produced several diamonds, some of which were of probable gem quality. Several of the diamonds have been found in the Upper Piedmont region of North Carolina. This region is underlain by Precambrian schists (Proterozoic?) and includes a peridotite belt west of the known diamond localities (Blank, 1934). Whether or not the peridotites contain mantle material, is unknown.

Diamond was first discovered in North Carolina in 1843 associated with placer gold mining activities, and other diamonds periodically were found until 1893. The exhaustion of auriferous gravels, and the sharp reduction of placer gold mining, led to the decline of the diamond discoveries (Sinkankas, 1959).

Burke County: In 1843, an octahedral diamond was discovered at the ford of Briddletown Creek in the Appalachian region in the western part of the state. This was followed by the discovery of a second diamond nearby. In total, at least three diamonds were discovered near Briddletown, and two near the Briddle Creek ford (James E. Bond, written communication, 1987).

Diamonds ranging from 0.5 carat to over 2.0 carats in weight were reported at the J.C. Mill gold mine. According to Blank (1934), the Mill diamonds were all questionable and may have instead been quartz or zircon. Kunz (1907), however, reported one of the diamonds to be an octahedron (unlike quartz or zircon). Diamonds were also found nearby at Dyortsville in McDowell County. One diamond (0.31 ct) from this region, was incorporated in the State Museum at Raleigh (Sinkankas, 1959).

It may be significant that ilmenite and chromite were also reported from the Mill gold mine. Pyrope garnet has also been reported in the gold washings of Burke County (Kunz, 1885). Ilmenite was also reported from the Linnville Mountain area.

Cleveland County: Blank (1934) reported that a small, bright, canary yellow stone weighing 0.75 carat was found in 1893 near Kings Mountain in southwestern North Carolina.

Franklin County: Two diamonds were found at the Portis mine in northeastern portion of the state. One was described as a beautiful octahedron (Blank, 1934; Kunz, 1885).

Lincoln County: A greenish elongated hexoctahedron, approximately 0.5 carat in weight, was found in 1852 near Cottage Home in the southwestern portion of the state. This diamond was transparent with a greenish hue (Sinkankas, 1959).

Madison County: Kunz (1885) reported purple almandine to red pyrope garnets were found four miles from Marshall in Madison County in western North Carolina (*author's note: almandine is generally red to reddish-brown and pyrope is typically purplish-red, lavender, and yellow orange. Kunz may have reversed the descriptions of the garnet colors*).

Chromite and ilmenite (menaccanite) were also reported from the Carter's mine in the County and ilmenite was reported from the Big Laurel and from the Haynie mine (USGS, Bulletin 74).

McDowell County: Two or three small diamond crystals were discovered in the headwaters of Muddy Creek in western North Carolina (Blank, 1934). Sinkankas (1959) also reported that several diamonds were recovered from this locality.

Three diamonds were recovered from a placer gold mine at Dysortville (USGS, 1968). One was a "fine stone" that was picked up at Dysortville on the Bright farm in 1886. This specimen was a distorted, twinned, 4.33 carat hexoctahedron, and was described as transparent with a grayish-green tint. The diamond was placed in the Tifanny-Morgan collection of the American Museum of Natural History (Blank, 1934). In 1877, another stone was reported from this same region that weighed 2.38 carats. This diamond was flawed, white, irregular, and flattened (Blank, 1934). Pyrope and ilmenite (menaccanite) have also been reported in the gold washings of McDowell County (USGS, Bulletin 74).

Mecklenburg County: In 1852, a perfect, white, one carat stone was found at Todd's Branch in southwestern North Carolina. At the same locality, a "beautiful stone as large as a chinquapin" was found (Holden, 1944) (*author's note: a chinquapin is a small nut*). According to Sinkankas (1959), a black crystal of good size was reported from this same locality. This diamond was smashed by hammer in the mistaken belief that diamond was indestructible.

Rutherford County: A distorted, yellow, clear, and flawless, 1.33 carat hexoctahedron, with curved faces was found in 1845 in the gold washings at Twitty's mine in western North Carolina (Blank, 1934). At about the same time, another diamond was reported from this same locality (Sinkankas, 1959). Nearby, a 0.835 carat stone was found in a placer mine on the Levinthorpe property. This diamond was incorporated into the U.S. National Museum (Holden, 1944). Another poor quality diamond was also described from the Levinthorpe placer by Kunz (1885). Ilmenite (menaccanite) is also reported in the gold placers of the county (USGS, Bulletin 74). A diamond was also found in Cane Creek (USGS, 1968).

Warren County: Pyrope was reported in the gold washings of Warren County in northern North Carolina. The pyrope locality lies north of a reported diamond discovery in Franklin County.

Pennsylvania

Mica-peridotite, kimberlite, and possibly pyrope have been reported in Pennsylvania. Koenig (1956) also reported that several peridotite dikes were found in the southwestern portion of Pennsylvania, where they intruded Pennsylvanian age sedimentary rocks. Parrish (1984) suggested that the Vozoff gravity high in north-central Pennsylvania was related to kimberlite magmatism. There are no known reported diamond occurrences in Pennsylvania.

Chester County: Kunz (1885) reported that a purplish-red garnet with *"sharp angles"* was found in the Avondale quarry in Chester County in the southeastern portion of the state. The color is suggestive of pyrope, however, the sharp angles suggest the garnet had dodecahedral habit, and was probably not a mantle megacryst.

Delaware County: A dark red variety of garnet, similar to pyrope in color, was found in Darby Creek near Lazaretto in Delaware County in southeastern Pennsylvania (Kunz, 1885).

Fayette County: A mica-peridotite dike was recognized by Kemp and Ross (1907) near Masontown, Fayette County, in southwestern Pennsylvania. This dike intrudes a coal seam along a northwesterly trending fault. Sosman (1938) concluded the dike had an emplacement temperature of approximately 500°C based on the coking affects on the coal. Parrish (1984) implied this intrusive to be kimberlite.

Taylor (1984) also reported kimberlite in the county. The dike was described to contain a well-preserved megacryst suite typical of kimberlite.

Indiana County: A second mica-peridotite occurrence similar to that in Fayette County, is reported near Dixonville in Indiana County 35 miles to the north. This peridotite forms a dike that varies from 1 and 50 feet wide, and intrudes Pennsylvanian age rocks, including coal. The rock has porphyritic texture with phlogopite, calcite, and ilmenite phenocrysts (Honess and Graeber, 1926). Olivine is not abundant, but when present

shows varying degrees of serpentinization. Perovskite, green diopsidic pyroxene, titanium magnetite, spinel, and garnet all occur in minor amounts (Meyer, 1976). Parrish (1984) indicated the intrusive was a kimberlite. The contacts between the intrusive and coal are sharp and shows little evidence of metamorphism (Deines, 1968). An apparent K-Ar date of 185 Ma is consistent with the geology (Meyer, 1976).

Rhode Island

Peridotite is reported near Cumberland (Blank, 1935).

South Carolina

According to Sinkankas (1959), unsubstantiated reports indicated diamonds were found in gold placers in some of the northern counties of the state. Another report indicated that a white diamond was found in a South Carolina placer. No specifics were given.

Vermiculite deposits in the Enoree district, west of the Kings Mountain belt (see Cleveland County, North Carolina), were examined by Bergman (1987) and interpreted to represent metamorphosed lamproites. Mineralogically, these rocks consist of phlogopite, diopside, tremolite (or talc), K-spar, apatite, sphene, monazite, and zircon. If these were originally lamproties, only a few minerals characteristic of lamproite have been preserved. Although the mineralogy was modified by metamorphism, the geochemical charateristics of these rocks are nearly identical to the average lamproite. If these are altered lamproites, it opens up several vermiculite deposits in this region for diamond exploration. For example, Bergman (1987) reports that Late Proterozoic to Early Paleozoic vermiculite deposits occur throughout the Appalachian Mountains and Piedmont.

Tennessee

Diamonds and kimberlite have been reported in Tennessee. Koenig (1956) reported two "good quality" diamonds were found in 1904 in gravels immediately downstream from the Norris kimberlites. Kunz (1907) reported three diamonds were found on Koko Creek, at the headwaters of the Tellico River in eastern Tennessee. The exact locations of these diamonds were not given, but were reported to have been derived from the bench lands of the Smoky or Unaka Mountains.

Monroe County: Several diamonds were reported from Monroe County about 80 to 90 km south of the Norris kimberlite in southeastern Tennessee (Holden, 1944).

Roane County: A diamond was reported at Union Crossroads in eastern Tennessee, about 50 to 60 km downstream (southwest) from the Norris kimberlites (Holden, 1944). According to Sinkankas (1959), the diamond was found on the south bank of the Clinch River. The diamond weighed 3 carats and was cut into a 1.25 carat gem.

Union County: Two kimberlite intrusives, known as the Norris kimberlites, crop out along the northern shore of Norris Lake reservoir, 50 km north of Knoxville in northeastern Tennessee. One of the intrusives lies under the reservoir waters, and is only exposed in the winter when the reservoir is low. The second intrusive is located above the water line, and is exposed as a foliated serpentine mica schist. The intrusives were first recognized in 1869 and were later classified as mica-peridotite in 1927 (Meyer, 1976). Later work by Meyer (1975) showed them to be kimberlite.

The intrusives trend northeasterly for nearly 950 m. Based on aeromagnetic data, they are interpreted as near vertical plugs intruding Silurian and Devonian strata. And nearby geophysical anomalies may indicate the presence of additional kimberlites (Tim Neal, personal communication, 1994). The rock is heavily weathered and altered, and consists of mica, hematite, ilmenite, and serpentine. Phlogopite is abundant and is altered to vermiculite. Carbonate is ubiquitous. Ilmenite and red and orange pyrope garnet occur as uncommon rounded xenocrysts. The ilmenite is picroilmenite and contains approximately 8 to 15% MgO (Taylor, 1984). Xenoliths recovered from the intrusives include crinoid-bearing limestones and a garnet-pyroxenite nodule. Based on geologic relationships, the intrusives are early Mississippian to Permian in age (Meyer, 1976).

A shaft was sunk in one of the intrusives sometime during the historical past. The results of the venture are unknown. However, two alluvial diamonds were reportedly found in the near vicinity of the Norris kimberlites. One diamond was purchased by a jeweler from Knoxville in 1889. The diamond weighed 3 carats. The second diamond was purchased by the same jeweler in 1900 and was described as a white, flawless, 1.69 carat stone [Sinkankas (1959) reported this diamond to weigh 1.81 carats]. The stone was found on the bank of Flat Creek near Hickory Creek Shoals about 4 to 5 km downstream from the kimberlites (Holden, 1944; Hall and Amick, 1944).

Virginia

Kimberlite, diamonds, mica-peridotite, and other ultramafic rocks have been reported in Virginia. One of the largest stones recovered in the United States, the Dewey diamond (23.75 carats), was found in the James River valley of Virginia.

Augusta County: Within the Paleozoic sedimentary sequence of the Appalachians are a large number of igneous dikes in Augusta County near Staunton in northwestern Virginia. These dikes have alkalic affinity and include teschenites, camptonites, and nepheline syenites. Johnson and Milton (1955) also list mica-peridotite. The dikes appear to be associated with a northwest trending joint trend, and are considered to be Jurassic in age. The mica-peridotites had not been adequately characterized according to Meyer (1976), however, Parrish (1984) reported the presence of a kimberlite in the Staunton area. Possibly, Parrish was referring to the same intrusives described earlier by Meyer.

Henrico County: Diamonds reported from Virginia include the famous Dewey diamond. The Dewey diamond from Manchester (Richmond), eastern Virginia, was found in 1885. It consisted of a slightly rounded trigonal trisoctahedron weighing 23.75 carats that was cut into a 11.69 carat gemstone, with a faint greenish-white color and perfect transparency (Kunz, 1885). The stone was believed to have been transported by the James River from the Virginia gold fields during spring flooding (Blank, 1934).

Orange County: A diamond was found in 1847 in the Vaucluse gold mine in north-central Virginia (Sinkankas, 1959). Details are lacking.

Rockbridge County: An intrusive, known as the Mt. Horeb intrusive, was initially classified as mica-peridotite. The intrusive is located 55 km north of Roanoke in western Virginia (Sears and Gilbert, 1973). More recently, the intrusive has been classified as kimberlite based on its mineralogy, structure, and lack of thermal metamorphism of the sedimentary xenoliths in the rock. The rock is altered to

montmorillonite, vermiculite, and chlorite, and contains some Cr-spinel, pyrope garnet (2% Cr_2O_3), green diopside (2% Cr_2O_3), and Mg-ilmenite. Sedimentary xenoliths include sandstone, limestone, and chert. The age of the kimberlite is unknown but based on geological evidence, it is believed to be post Middle Ordovician (Meyer, 1976). The intrusive is about 220 by 375 m across.

Tazewell County: In 1913, a beautiful, blue-white diamond was reported from Tazewell County in western Virginia (Holden, 1944). The gem cut from the original stone weighed 0.83 carat (Sinkankas, 1959).

Warren County: The most northerly of the known ultramafic intrusives in Virginia lies near Front Royal near the West Virginia border. This rock was initially described as a mica-peridotite dike, and more recently Southworth and others (1992) refer to this intrusive as kimberlite.

West Virginia

Peridotite, kimberlite, and one of the largest diamonds found in the United States are reported from West Virginia. Parrish (1984) reported kimberlite in West Virginia, although no location was given.

Berkeley County: A kimberlite dike is reported near Martinsburg in eastern West Virginia (Southworth and others, 1992). The dike was initially classified as a pyroxenite.

Monroe County: According to the Washington Post (Feb. 6, 1964), the Punch Jones diamond, which weighed 34.46 carats, was found in Peterstown, West Virginia near the Virginia state line. Peterstown is located about 130 km southwest of Pendleton County along the Virginia-West Virginia state line. The diamond was found in 1928, but was not identified until 1943 (Sinkankas, 1959). The Punch Jones was a hexoctahedron that was slightly greenish-gray in color (Holden, 1944; Sinkankas, 1959). The diamond exhibited several possible impact features suggestive of great transportation distances according to available sources. It was placed in the U.S. National Museum along with other American diamond crystals.

Pendleton County: Peridotite is reported in Pendleton County near the Virginia-West Virginia state line (Blank, 1935; Southworth and others, 1992).

Great Lakes Region

Several diamonds (including some fairly sizable stones) have been recovered from the Great Lakes region. Historically, these diamonds were thought to have been transported from Canada by continental glaciers during the last ice age. This assumption has recently come under fire following the discovery of several kimberlites in Michigan. Most probably, many of the diamonds found in glacial till in the Great Lakes region originated from nearby kimberlites.

Illinois

A group of lamprophyric dikes and some diamonds have been found in Illinois. Diamonds found in Illinois were assumed to have been transported by glaciers.

Hardin County: A dike swarm of more than 50 ultramafic rocks occur in southern Illinois near Elizabethtown and continue south into western Kentucky. These were originally described as mica-peridotite or lamprophyre and occasionally referred to as kimberlite, although their mineralogy does not support a kimberlitic classification (Meyer, 1976). Several of the intrusives were discovered during drilling in southern Illinois for Missouri Valley-type fluorite-sphalerite-galena mineralization (Koenig, 1956).

The dikes appear to have intruded Mississippian to Pennsylvanian sedimentary rocks and have a general northwesterly trend. Some of the dikes intrude coal. The thermal effects on the coal suggest a maximum intrusive temperature of 600°C (Meyer, 1976). The dikes rarely exceed 7 m in width. They are porphyritic and contain abundant phlogopite. Olivine is replaced by serpentine and calcite, and forms much of the groundmass. Pyroxene is uncommon. Magnetite, ilmenite, garnet, perovskite, apatite, and chromite are minor constituents of some dikes. Many of the dikes are associated with magnetic anomalies. Zartman and others (1967) report Permian (257 Ma) ages for some of the intrusives.

Jefferson County: A 7.75 carat stone was reported 5.6 km east of Ashley in southern Illinois. The discovery was not confirmed (Sinkankas, 1959).

McDonough County: A 1911 report indicated that 22 diamonds were found in the vicinity of Macomb in western Illinois. The report was not confirmed (Sinkankas, 1959).

Indiana

Several diamonds were found by prospectors panning for gold in Morgan and Brown counties near central Indiana (Blank, 1934). The source of these diamonds is unknown, but it has been assumed that the diamonds were transported by glaciers originating from Canada. However, with the recent discoveries of diamondiferous kimberlite in Michigan, the source of the Indiana diamonds should be re-evaluated.

Brown County: Several diamonds were discovered in Brown County of south-central Indiana, including a 4 carat stone (Blank, 1934). One of the Brown County diamonds examined by Holden (1944) weighed 1.69 carats and is part of the U.S. National Museum's collection. In 1916, a 1.48 carat, yellowish rounded dodecahedron was recovered from Lick Creek about 24 km southeast of Martinsville. Another 3.06 carat diamond was found in Salt Creek in the northeastern Brown County (Sinkankas, 1959).

Miami County: In 1949, a 3.93 carat flattened and distorted octahedron was discovered near Peru in north-central Indiana (Sinkankas, 1959).

Morgan County: A 3 carat stone was found near central Indiana in 1878, in Little Indian Creek by prospectors panning for gold. Another diamond, called the Stanley diamond, was found in a branch of Gold Creek. The Stanley diamond weighed 4.88 carats and was a greenish-yellow octahedron.

Other reported stones weighed from less than 0.13 carat to 1.66 carats and consisted of dodecahedral and hexoctahedral crystals of white, yellow, bluish, and pink colors (Blank, 1934). These stones were recovered from gold pan concentrates with some ruby, sapphire, and zircon (Sinkankas, 1959).

According to Sinkankas (1959), a 1.0 carat diamond was found in 1908. This was followed in 1911 by a discovery of a 0.135 carat diamond at the junction of Gold and Sycamore creeks. The same locality, produced a 2.28 carat diamond in 1912. In 1913, five diamonds were washed from Gold and Highland creeks. These diamonds included a greenish 0.2 carat diamond, a colorless 0.73 carat diamond, and a yellowish, twinned 0.69 carat diamond.

Michigan

One large diamond was found in a glacial moraine in Michigan. Debris from this glacier also yielded several diamonds in Wisconsin. Until recently, all of these diamonds were assumed to have originated from Canada. However, the recent discovery of diamonds in a kimberlite near Crystal Falls, Michigan, suggests that some of these diamonds may have had a nearby source.

To date, more than 20 post-Ordovician kimberlites have been discovered in Michigan (Carlson and Floodstrand, 1994). Michigan also has some Paleozoic outliers that are completely surrounded by Proterozoic age rocks. These outliers are interpreted as cryptovolcanic structures possibly related to kimberlite.

Baraga County: Sherman Hill (section 7, T51N, R34W) in Baraga County along Lake Superior, is an outlier of deformed Paleozoic dolomite surrounded by Proterozoic sandstone. The outlier occurs as a semi-circular ridge of possible cryptovolcanic origin (Cannon and Mudrey, 1981).

Cass County: The Dowagiac diamond was found in Michigan near the Indiana border. The diamond was a rounded hexoctahedron that weighed 10.875 carats (Sinkankas, 1959). According to Blank (1934), this stone, as well as the Burlington and Saukville stones from Wisconsin, were recovered from the Lake Michigan moraine.

Houghton County: Limestone Mountain, located about 1.9 km southwest of Sherman Hill, is another outlier of Paleozoic rocks located in sections 13, 14, 23, and 24, T51N, R35W. The outlier is surrounded by Proterozoic sandstone and consists of dolomite which forms a prominent bluff 103 m above the surrounding topography. The structure may be cryptovolcanic. Another outlier occurs along the Michigan-Wisconsin border in section 27, T42N, R35W about 8 km south of Iron River, Michigan. This outlier is about 10 m in diameter and surrounded by Proterozoic metavolcanic rocks (Cannon and Mudrey, 1981).

Iron County: Kimberlite was discovered near Crystal Falls, Michigan, 1.6 km west of Lake Ellen (SW section 27, T44N, R31W) near the Wisconsin border. The intrusive, known as the Lake Ellen kimberlite, is poorly exposed but produces a strong positive magnetic anomaly indicating it is circular in plan and about 200 to 300 m in diameter. The kimberlite was emplaced in volcanic rocks of the Hemlock Formation (Proterozoic age) and contains abundant Ordovician(?) dolomite xenoliths, and consists of diatreme facies kimberlite composed of olivine, pyroxene, mica, pyrope, and magnesian ilmenite in a fine-grained serpentine matrix (Cannon and Mudrey, 1981). The kimberlite covers a surface area of about 20 acres. Small diamonds have been recovered from the Lake Ellen intrusive by Dow Chemical. Currently, Dow Chemical in conjunction with Crystal Exploration and Ashton Mining maintains a diamond extraction plant in Crystal Falls (Carlson and Floodstrand, 1994). Another kimberlite, known as the Michgamme kimberlite, lies a short distance northwest of the Lake Ellen kimberlite along the Lake Michigan shoreline (Carlson and Floodstrand, 1994).

Ohio

Clermont County: A 6 carat diamond was found at Milford near Cincinnati in 1897 (Blank, 1934). The diamond was found in the "Kettle moraine". Another diamond was reported from Cleveland (Mather, 1941).

Wisconsin

Since 1876, approximately 25 diamonds have been found in seven regions in southern and central Wisconsin. All were found in Pleistocene glacial deposits or in Holocene river gravel. With the discovery of cryptovolcanic structures in Wisconsin and kimberlites in nearby Michigan, the possibility that some of these diamonds were derived from nearby kimberlites, must be considered.

Dane County: In 1893, a white diamond was discovered near Oregon, Wisconsin, on the Johnstown moraine in southern Wisconsin. The diamond was found on the Judson Devine's place 2.5 miles southwest of Oregon (Blank, 1934). The stone weighed 4.0 carats (Cannon and Mudrey, 1981). Sinkankas (1959) reported this diamond as a grey-green distorted and rounded octahedron that weighed 3.87 carats, and was found in the Kettle moraine.

Langlade County: In 1984, Al Falster, an amateur mineralogist, found 5 diamonds near Antigo in northeastern Wisconsin (Bendheim, 1984).

Manitowoc County: Several uncut diamonds were found in a coffee pot belonging to an old hermit who lived in Collins, eastern Wisconsin. The diamonds were discovered by some neighbors following the death of Peter Zagloba. The diamonds may have originated from gravel in the Collins area (Cannon and Mudrey, 1981).

Marquette County: Cannon and Mudrey (1981) suggested that Glover Bluff structure (SW section 3, T17N, R8E) in Marquette County, south-central Wisconsin, could possibly be related to a diatreme. The structure is roughly circular in diameter (500 m). The enclosed Cambrian and Ordovician strata are fragmented and down-dropped 62.5 m. The structure lies near a prominent west-trending positive magnetic anomaly and lies within an area surrounded by a positive Bouguer gravity anomaly. The anomalies could be the result of a mafic intrusive lying about 2 km below the surface.

Ozaukee County: A diamond discovered near the Milwaukee River in 1881, known as the Saukville diamond, was a beautiful white, flattened trisoctahedron of 6.57 carats (Cannon and Mudrey, 1981). The diamond was found 4.8 km north of Saukville (Blank, 1934), and only 1.6 km from the lake Michigan shoreline.

Pierce County: Between 1880 and 1887, approximately ten small diamonds were recovered from the gold-bearing gravels along Plum Creek in the Rock Elm Township in western Wisconsin (Blank, 1934; Cannon and Mudrey, 1981). The diamonds weighed less than a carat each. In 1889, three greenish-grey stones were recovered from the west branch of Plum Creek. These crystals were hexoctahedral, and weighed 0.8, 0.44, and 0.03 carats (Sinkankas, 1959). These latter diamonds may have been part of a fraud (Cannon and Mudrey, 1981).

Racine County: In 1903, a 2.11 carat stone was discovered near Burlington in southeastern Wisconsin. The stone was a twinned, flattened, tetrahedron of faintly greenish-grey color, and was found in glacial drift (Blank, 1934).

Washington County: The Terresa diamond was discovered at Kohlsville in 1883 in southeastern Wisconsin. This diamond weighed 21.25 carats (reported as 21.5 carats by Cannon and Mudrey, 1981) and was found near the Green Lake moraine. The diamond was nearly spherical with a flaw or cleavage plane which separated the diamond into a colorless crystal on one side, and a cream-yellow crystal on the opposite side (Cannon and Mudrey, 1981). The diamond was cut in 1918 and resulted in a total of 9.27 carats of finished stones, the largest being 1.48 carats (Sinkankas, 1959).

Wauesha County: According to Kunz (1885), a 15-carat diamond (reported as 16.25 carats by Cannon and Mudrey, 1980) was dug from a 19 m deep well in glacial drift at Eagle, near central Wisconsin in 1883. The diamond was slightly off color (warm yellow) (Kunz, 1885). According to Sinkankas (1959), the Eagle diamond was a dodecahedron that weighed 15.37 carats, and was found in the Kettle moraine in 1876. The diamond was recovered from hard yellowish ground in the well. Two other diamonds were also found in this same area that weighed less than 0.5 carat each.

Continental Interior

Kimberlites, lamproites, and some related ultramafic rocks are found in the mid-continent region of the United States. Diamonds, however, are uncommon. The abundance of kimberlite and lamproite in eastern Kansas, in particular, suggests that similar intrusions will be discovered in Kansas in the future.

Kansas

Eleven kimberlite intrusives and several lamproites intrude sedimentary strata in eastern Kansas. Other than two small diamonds recovered from one of the Kansas kimberlites (William Mansker, written communication, 1994), no other diamonds have been reported in Kansas. The overall lack of any other reported diamonds in Kansas could be in part due to the lack of historical placer gold activity.

Riley County: To date, eleven kimberlite intrusives have been recognized in Riley County of northeastern Kansas. These were emplaced at about 120 Ma (Brookins, 1970a). The intrusives have not been subjected to a large amount of erosion and crater facies, diatreme facies, and hypabyssal facies kimberlite are all present in some intrusives. The preservation of crater facies kimberlite is uncommon and has only been reported at a few localities in the world. The known intrusives in Kansas include the Stockdale, Randolph 1, Randolph 2, Leonardville, Bala, Winkler, Swede Creek, Lone Tree A, Lone Tree B, Fancy Creek, and the Baldwin Creek (Mansker and others, 1987). Reports of pyrope garnets recovered from water well cuttings about one-half mile west of the Winkler crater may indicate the presence of an undiscovered kimberlite pipe or sill in that area (Brookins, 1970a).

The Stockdale kimberlite (NE and SE sec 23, T8S, R6E) is poorly exposed but consists of diatreme facies kimberlite that intrudes Lower Permian sedimentary rocks. This intrusive is described by Rosa and Brookins (1967) as consisting of olivine, pyroxene, ilmenite, pyrope, chloritized phlogopite, magnetite, and calcite in a highly serpentinized and carbonated matrix. A variety of xenoliths have been recognized in the kimberlite, some of which are deep seated. Cognate nodules include eclogites, lherzolites, pyroxenites, magnetites, and granulites (Brookins and Woods, 1970a). Nodules from the Stockdale are similar to those recovered from the Monastery Mine,

South Africa, and according to Brookins and Woods (1970b), establishes a minimum depth of genesis of 120 km and perhaps much greater depths. Brookins (1970a) suggests depth of formation of the Riley County kimberlites to be approximately 120 to 150 km.

Nodular ilmenite-pyroxene intergrowths from the Stockdale kimberlite are assumed to have formed at depths as great as 300 km, although other researchers have placed a minimum depth of formation at 120 km (Brookins, 1970a). Diamond is assumed to be stable at depths of 160 km at 1500° C, although some researchers suggest stability at depths of 120 to 180 km and temperatures of 1,000°C to 1,400°C.

Accidental xenoliths of Paleozoic sedimentary country rock are common in the Stockdale, Leonardville, Bala, and Winkler kimberlites. These xenoliths consist of shales, limestones, and cherts. Lower crustal xenoliths include granite, adamellite, quartzite, diorite, gabbro, and schist.

Other kimberlites in the region include the Swede Creek, Lone Tree A and B, Fancy Creek, and Baldwin Creek. The Swede Creek kimberlite has an apparent diameter of 69 m and consists of hypabyssal facies kimberlite. The Lone Tree A and B intrusives are similar to the Stockdale and consist of diatreme facies kimberlite. The Fancy Creek kimberlite is similar to the Winkler intrusive and appears to contain highly brecciated crater facies kimberlite. Two diamonds were reportedly recovered from the Fancy Creek intrusive (Jim Marin, personal communication, 1994). The Baldwin Creek intrusive is interpreted as a kimberlite based on its magnetic signature; however, it is not exposed at the surface (Mansker and others, 1987). Magnetic data indicates that several of the kimberlites possess mushroom-like caps caused by the lateral spreading near final sites of emplacement. Six of the kimberlite intrusives in Riley County yielded strong positive magnetic anomalies.

Woodson County: Lamproite sills and vents occur in the southeastern part of the state. The Hills Pond and Rose Dome lamproites occur 136 km east of Wichita, and a few km south of Yates Center in Woodson County (37.667N, 95.750W). These lamproites are 88 to 91 Ma, and intrude Precambrian granite and flat-lying Pennsylvanian shales and limestones that are part of a broadly domed Late Paleozoic stable platform. The sediments of the stable platform overlie stable Proterozoic age (1.3 to 2.0 Ga) cratonic rocks. The Hills Pond intrusive is exposed in scattered outcrops and is currently mined by Microlite and used as a fertilizer additive. The Rose Dome lamproite is not exposed at the surface, and was discovered by drilling. Several other unnamed lamproites occur in the vicinity (Cullers, and others, 1985; Markezich, 1985).

The Hills Pond lamproite is a coarse-grained, porphyritic, olivine-phlogopite-richterite-diopside-madupitic lamproite, and the Rose Dome (Silver City Dome) is an altered and carbonated olivine-phlogopite madupitic lamproite ('mica peridotite'). These lamproites are olivine lamproites and consist of Ti-phlogopite, serpentinized olivine, K-richterite, and Ti-diopside, in a fine-grained groundmass of serpentine, perovoskite, apatite, and chrome spinel. Fresh samples were obtained by drilling, however, the rocks at Hills Pond are intensely altered to form a vermiculite body (Bergman, 1987).

There are seven other known significant occurrences of olivine lamproite in the world. All of them, with the exception of the Woodson County lamproites, are diamondiferous (Rock and others, 1992) and the geochemistry of the Woodson County lamproites are identical to the diamondiferous lamproites from Ellendale, Argyle, and Prairie Creek (Bergman, 1987). However, bulk sampling of the Hills Pond and the

Rose Dome intrusives by Cominco American Incorporated yielded no diamonds (Coopersmith and Mitchell, 1989). The Hills Pond and Rose Dome lamproites are unfavorable for diamond preservation, since they are sills which tend to cool slowly promoting diamond resorption.

Missouri

At least 100 small diatremes and associated dikes occur in a region around St. Genevieve and St. Francois Counties of southeastern Missouri south of St Louis. Early studies indicated one of these intrusives to be peridotite, although a 1930 study classified the same intrusion near Avon as alnöite based on the presence of abundant melilite in the groundmass. This intrusion was hot enough to metamorphose the surrounding Cambrian dolomite for a distance of about 6 m from the contact. The presence of Devonian fossils in limestone xenoliths in some of the intrusions were used to date the time of emplacement as post-Devonian.

Mansker (1973) examined the petrology and mineralogy of one pipe near Avon, Missouri. The rock included olivine, clinopyroxene, phlogopite, and chromian spinel. Notable was the absence of pyrope and picroilmenite, although the earlier study by Kidwell (1947) on 50 of the intrusions, identified garnet as an accessory: melilite was found in only one intrusion contrary to the 1930 study. Mansker (1973) also identified xonolite, which due to its low thermal stability would suggest a low temperature of emplacement. The intrusions yielded radiometric ages of 377 to 399 Ma (Early to Middle Devonian) (Erlich and others, 1989).

Gulf Coast

The Murfreesburo, Arkansas, area along the edge of the Ouachita Mountains occurs within the Gulf Coastal region. This area has been one of the two most productive areas for diamond in the United States. Diamonds from Arkansas have included gems up to 34.25 carats.

Arkansas

Diamonds were first discovered in Arkansas in 1906 near the mouth of Prairie Creek, 4 km southeast of Murfreesboro in the southwestern portion of the state. These diamonds were traced to the host intrusive which is now incorporated in the Crater of the Diamonds State Park. The host rock was initially referred to as peridotite and later as kimberlite. The whole rock chemistry and mineralogy, however, is typical of olivine lamproite.

Peridotite has also been recovered from drill core in Scott, Cleveland, and Ashley County, to the north and to the east of Murfreesburo (Bolivar, 1984, 1988). No diamonds have been reported from these intrusives.

Howard County: Gravel lenses in Mine Creek, four miles north of Nashville (section 2, T9S, R27W) in southwestern Arkansas, contain pebbles of quartzite, novaculite, grit, syenite, tinguaite, as well as fourchite (an olivine-free lamprophyre). The gravel was tested for diamonds with negative results (Miser, 1914).

Pike County: Diamonds were discovered in olivine lamproite at Prairie Creek near the town of Murfreesburo on August 8, 1906. Olivine lamproite from the Crater of the

Diamonds State Park (Prairie Creek) located near Murfreesburo (sections 21 and 28, T8S, R25W), has been one of the two most productive regions in the United States for diamonds with an estimated 90,000 to 100,000 diamonds recovered from the pipe. These diamonds included 30% gemstones and 70% industrial stones, and no attempt was made to recover microdiamonds (Sinkankas, 1959). The recovery was estimated at 11 carats/100 tonnes with an average diamond size of 0.26 carat.

Some of the larger diamonds recovered from this pipe include the Uncle Sam (40.42 carats), the Star of Murfreesboro (34.25 carats), the Amarill Starlight (16.37 carats), and the Star of Arkansas (15.24 carats) (Table 1). Most of the diamonds are white, yellow, or brown. The most common form is a distorted hexoctahedron with rounded faces (Bolivar, 1984; Kidwell, 1990).

The Prairie Creek olivine lamproite lies marginal to the Ouachita orogen within the Gulf Coastal Plain which is characterized by Cretaceous age sedimentary rocks that dip gently to the south (Meyer and others, 1977). This region of Arkansas, including parts of Texas and Oklahoma, appear to have been subjected to considerable alkalic igneous activity during the Cretaceous. The Prairie Creek lamproite intrudes rocks of the Cretaceous Trinity Formation.

The pipe covers approximately 73 acres and contains breccia, tuff, and hypabyssal lamproite (Miser and Ross, 1922a; Bolivar, 1984). Nearly all of the diamonds have been recovered from the breccia at Prairie Creek. The rock contains diopside, olivine, chrome spinel, phlogopite, potassium richterite, perovskite, pyrite, pyrrhotite-pendlandite, and uncommon pyrope and almandine. Much of the olivine is altered to serpentine. Country rock xenoliths include shale, limestone, and sandstone. No upper mantle xenoliths have been found in the intrusive. The age of the pipe, based on geological evidence, is Late Cretaceous which agrees with a 106 Ma K-Ar age date on phlogopite (Gogineni and others, 1978).

Other lamproites have been identified in the area. These lie about 3.2 km north of the Prairie Creek intrusive, and include the Kimberlite (section 14, T8S, R25W), the American (section 14), the Black Lick (section 23), the Twin Knobb 1, and Twin Knobb 2 intrusives (Krol, 1988). Other ultramafic rocks of lamproitic or lamprophyric affinity have been reported a few km east of Prairie Creek and about 5 km south of Corinth.

Diamonds were also recovered from the Kimberlite and American lamproites (Miser, 1914; and Miser and Ross, 1922a). The Kimberlite deposit is a hypabyssal facies porphyritic olivine lamproite. The American deposit is exposed at the surface as "yellow ground" with a small outcrop of olivine lamproite at its center. Miser (1912) reported that several diamonds were recovered from a washing operation on the lamproite. The Black Lick is a porphyritic olivine lamproite exposed at the surface as "black ground". Currently, Texas Star has constructed a pilot plant at Murfreesburo with the intention of testing several of the lamproites for diamond.

Scott County: Two mica-peridotite dikes were found 40 km southwest of Danville, Arkansas, in sections 3 and 4, T3N, R26W. The dikes contain aggregates of serpentine and phlogopite phenocrysts in a matrix of serpentinized olivine and phlogopite, with accessory calcite and magnetite. The dikes average 1.5 m and 0.3 m in thickness. One dike was traced 156 m on the surface. According to Miser and Ross (1922b), the dikes are similar to the diamond-bearing intrusive at Murfreesburo. However, tests yielded no diamonds.

White County: A perfect, virtually flawless, hexoctahedral diamond was found in 1925 on the Pellie Howell farm at Searcy in eastern Arkansas. The diamond weighed 27.31 carats and was sold to Tiffany and Company of New York (Sinkankas, 1959).

Texas

A few diamonds have been found in Texas, however, the source of the diamonds is unknown.

Foard County: A diamond was found in 1911 from section 64, Block 44 in the northern part of the state (Sinkankas, 1959). No details were given.

Montgomery County: Several stones were reported in 1911 in Montgomery County in southeastern Texas. The stones were reported to weigh between 2.5 and 3.5 carats (Sinkankas, 1959).

Walker County: A 1.7 carat diamond was reported from Huntsville of southeastern Texas (Blank, 1935).

Great Basin

The Great Basin contains many known kimberlites, lamproites, and related rocks. The Colorado-Wyoming kimberlite province within this region, has been one of the two most productive regions for diamond in the United States. Much of this region is underlain by the Wyoming craton which extends from Wyoming into Utah, Idaho, Nevada, and Montana, providing a favorable basement for diamondiferous kimberlite.

Arizona

Reports of diamonds in Arizona are uncommon. Other than diamonds of extra-terrestrial origin in the Diablo Canyon meteorite (Blank, 1935), the only other reported diamonds in Arizona is a one carat brown diamond found near Philadelphilos, Arizona, and diamonds found in the Santa Maria River (Mather, 1941).

Ultramafic rocks in Arizona include 30 Ma minettes in the Colorado Plateau. The time of emplacement of these rocks coincided with uplift of the Colorado Plateau (Anderson and Perkins, 1975).

Apache County: Several minette and monchiquite intrusives occur in northeastern Arizona. These include Buell Park, Fort Defiance, Garnet Ridge, Coliseum, Hoskietso, Hopi Buttes, and Hunters Point (Naeser, 1971). The Garnet Ridge intrusive consists of four small intrusives within 5 km of each other. The largest is about 312 m across (Meyer, 1976), and consists of tuff and lapilli tuff. Both chromian diopside and pyrope garnet are found in the rock (Allen and Bulk, 1954).

Colorado-Wyoming kimberlite province

The Colorado-Wyoming kimberlite province in the western United States, includes more than 100 kimberlite intrusives, one of the largest lamproite fields in the world, and dozens of unexplored geophysical, remote sensing, and heavy mineral anomalies. One district within the province, known as the Colorado-Wyoming State Line

district, consists of about 35 early Devonian kimberlite dikes and diatremes (many of which are diamondiferous). The district extends 7 km north into Albany County, Wyoming, and 20 km south into Larimer County, Colorado.

Total diamond production from the district amounts to more than 112,000 gem and industrial diamonds. The recovered diamonds range from microdiamonds to a 14.2 carat, flawless octahedron. Overall, the gem to industrial quality ratios are favorable, with some deposits reporting as much as 50% gemstones.

Kimberlites in the district consist predominantly of hypabyssal and diatreme facies, although some crater facies kimberlite has been identified at Kelsey Lake intrusives, along the state line. Estimates suggest the known kimberlites are deeply eroded with as much as 50% of the original pipes having been removed. Thus, some potential for placer diamonds should lie downstream.

An airborne INPUT survey over the Wyoming portion of the district in 1981, identified conductivity anomalies that were not associated with any known kimberlite. The survey also detected several weak to strong magnetic anomalies. One group of prominent magnetic anomalies along the northern edge of the district was interpreted to be the manifestation of undiscovered pipes (Paterson and MacFadyen, 1984). Several remote sensing anomalies were also outlined in the district (Marrs and others, 1984).

The province extends many miles north and south of the Colorado-Wyoming State Line district. Kimberlites have been found as far south as Boulder and Estes Park, Colorado, and as far north as the Iron Mountain and Middle Sybille Creek areas of Wyoming. To date, only the State Line kimberlites have yielded diamonds, although sub-calcic G10 pyropes from the Iron Mountain district suggest those kimberlites also tapped the diamond stability field.

North of the State Line district, nearly 300 kimberlitic heavy mineral anomalies have been identified over a 1,200 mi^2 area in the Laramie Range (Hausel and others, 1988). Heavy mineral anomalies have also been identified in the Seminoe Mountains greenstone belt of central Wyoming, and in the Medicine Bow Mountains and the Green River Basin of southern Wyoming. The anomalies in the Green River Basin are scattered over a few hundred square miles in ant hills and in road cuts. Most of these anomalies remain unexplored. The Green River Basin also hosts one of the three major lamproite fields in the world, known as the Leucite Hills. Much of this region lies within the boundaries of the Archean Wyoming Province.

Colorado

Boulder County: A single 40 m diameter diatreme, known as the Green Mountain pipe, intrudes Boulder granite in the Boulder City Park along the edge of the Front Range in north-central Colorado (Meyer and Kridelbaugh, 1977; Hausel and others, 1985). Similar material was reportedly identified 10 to 13 km west of the diatreme (Whitaker, 1898).

Custer County: Peridotite was reported to occur near Querida in Custer County of southern Colorado. The peridotite forms a small oblong outcrop on the north bank of Cottonwood Gulch above the Mountain Boy mine. The rock consists of hornblende, hypersthene, and olivine (Blank, 1934, 1935).

Larimer County: Several kimberlites occur in the southern portion of the State Line district in Larimer County, northern Colorado (Braddock and others, 1989; Coopersmith, 1991). These intrude Proterozoic age rocks south of the Wyoming craton. The basement rocks in this area were cratonized at about 1.7 to 1.9 Ga. These include the Kelsey Lake kimberlites (sec 20, T12N, R72W), the George Creek dikes (secs 28, 29, T11N, R74W), the Chicken Park kimberlites, the Sloan 1 and 2 pipes (sec 10, T10N, R72W), the Sloan 3 (sec 9, and 16, T10N, R72W), Sloan 5 and 6 (sec 3, T10N, R72W), the Sloan 4 (sec 12, T10N, R72W), the Moen intrusive (sec 31, T12N, R71W), the Nix kimberlites (sec 14, T11N, R72W), the Maxwell pipes (sec 24, T12N, R73W), and the Diamond Peak kimberlites (secs 26 and 35, T12N, R73W). A single kimberlite dike (1 to 2 m wide) lies nearly 64 km south of the State Line district, and south of the town of Estes Park south. Preliminary testing of the dike yielded no diamonds (Hausel and others, 1985).

Some of the more important deposits in Larimer County include the Kelsey Lake, George Creek, Chicken Park, and Sloan diatremes. The Kelsey Lake kimberlites consist of eight intrusives near the Wyoming border, that are irregular-shaped pipes and fissures of diatreme facies kimberlite with some zones of hypabyssal facies and minor crater facies kimberlite (Coopersmith, 1993). These have produced several diamonds larger than 1 carat. One parcel of diamonds recovered from the Kelsey Lake kimberlites and associated alluvium, in 1993, yielded 268 diamonds, 25% of which were larger than one carat, and 60% of which were gem quality. The largest was a 6.2 carat gemstone (Hausel, 1994). A more recent test recovered several additional stones including a 14.2 carat gemstone.

The George Creek intrusives, southwest of Kelsey Lake consist of three narrow dikes. These dikes were relatively diamond-rich and yielded more than 86,000 diamonds at an average grade of 136 carats/100 tonnes. The nearby Chicken Park kimberlites consist of four small intrusives. The largest diamond recovered from Chicken Park was a 2.6 carat industrial stone.

Farther south and east are the Sloan kimberlites. Four of the six Sloan kimberlites have been bulk sampled. The Sloan 1 and 2 kimberlites consist of both hypabyssal and diatreme facies kimberlite. The Sloan 1 intrusive has an areal extent of 156 by 563 m and the Sloan 2 is 63 by 625 m. The Sloan pipes have yielded a significant number of subcalcic G10 harzburgitic pyropes, and the $MgO:Cr_2O_3$ contents of picroilmenite from the intrusives suggest that the magma was reducing and thus favorable for diamond preservation (McCallum and Waldman, 1991). Currently, Royalstar Resources is exploring the diatremes. The ore is being processed at the nearby Diamet plant rated at 35 tonnes/day.

The Sloan 1 intrusive is estimated to contain a resource of 15.3 million tonnes of ore at an average grade of 6.1 carats/100 tonnes. The Sloan 2 intrusive is estimated to contain a resource of 8.4 million tonnes at an average grade of 17.1 carats/100 tonnes. Production from the Sloan 1 and 2 diatremes amounted to 21,546 diamonds in the 1980s (Oliver, 1990). The largest diamond recovered from the Sloan 1 and 2 pipes was a 5.51 carat gemstone (Bernie Free, personal communication, 1994).

The Sloan 5 intrusive lies north of the Sloan 1 and 2, and was bulk sampled in 1982. In total, 474 diamonds totalling 9.09 carats were recovered from 904 tonnes (average grade of 1.0 carat/100 tonnes). Bulk sampling of the nearby Sloan 6

intrusive resulted in the recovery of 215 diamonds (total weight of 6.72 carats) from 500 tonnes for a grade of 1.3 carats/100 tonnes.

Moffat County: Diamonds, rubies, sapphires, emeralds, and pyrope garnet occur on a sandstone outcrop in Diamond Field Draw in the northwestern corner of Colorado, a short distance south of the Wyoming border. In 1986, the author recovered 4 diamonds, 17 rubies, and 24 pyrope garnets from this deposit. The deposit was actually part of an elaborate fraud which took place in 1871, known as the 'Great Diamond Hoax'. The gemstones were purchased in London and Arizona by two enterprising individuals and were then scattered on the surrounding sandstone outcrops (Hausel, 1994b).

Idaho

Kunz (1885) reported that a few small diamonds had been found in placers in Idaho. According to Shannon (1926), the only authenticated diamonds in Idaho were derived from the Rock Flat gold mine in Adams County at the head of Little Goose Creek Canyon five miles east of the New Meadows along the west-central border of the state.

Adams County: Three small crystals were found in heavy concentrates from several cubic meters of gravel in 1913. The largest diamond was a greyish colored octahedron with greasy luster that weighed 0.33 carat. Ilmenite, chromite, zircon, magnetite, garnet, monazite, and corundum (ruby) were found associated with the diamond (Shannon, 1926: Sinkankas, 1959). A 1947 unconfirmed report stated that a 19.5 carat diamond had been found at Rock Flat four miles west of McCall (Sinkankas, 1959).

Owyhee County: Diamonds were reported in gold placers along the Owyhee River in the southwestern corner of the state (Blank, 1934). Microscopic diamonds were also reported in the black sands of the Snake River. The diamonds were greyish-white, and more or less opaque. A few stones of greenish color have also been reported. Most of the crystals were described as fragments of larger diamonds (Blank, 1934).

New Mexico

New Mexico hosts a group of minettes that are part of the same field in the four corners region that extends into Colorado and Arizona. There is only one known report of a diamond in New Mexico.

San Juan County: The Greens Knob intrusive in the northwestern corner of the state consists of lapilli tuff and is about 0.8 km in diameter (Meyer, 1976). The rock was initially classified as kimberlite, but more recently has been recognized as a minette (Mitchell, 1986). Minettes have also been identified at nearby Fluted Rock, Outlet Neck, the Beast, Beelzebub, and Black Rock (Allen and Bulk, 1954).

Santa Fe County: A diamond was reported from gravels near Santa Fe in north-central New Mexico (Blank, 1935).

Montana

Alnöites, monticellite peridotites, carbonate-rich mica peridotites, lamproites, and kimberlites are found in a stable cratonic setting in the Missouri River Breaks in north-central Montana (Hearn, 1989). This region is underlain by rocks of the Wyoming Province (Archean). A few diamonds have also been reported in the state. The presence of a cratonic basement, kimberlites, and lamproites, make Montana a favorable region for diamond exploration.

Beaverhead County: A diamond was reported from Grasshopper Creek in the southwestern corner of the state (Sinkankas, 1959). No specifics were given.

Cascade County: In 1990, a jogger reportedly discovered a 14 carat diamond near Great Falls in west-central Montana. The stone, named the Lewis and Clark diamond was sold for $80,000 (Anonymous, 1990). A few other diamonds have been found in along the Missouri River to the south near Helena.

Deer Lodge County: In 1883, a 12 grain diamond was discovered in the placer workings near Nelson Hill of Blackfoot, Deer Lodge County, southwestern Montana (Kunz, 1885). The stone was described as a colorless dodecahedron with triangular markings (Kunz, 1885). In 1894, a 0.22 carat flawed stone was also reported from the county (Sinkankas, 1959).

Garfield County: A lamproite complex, known as the Smoky Butte lamproite (27 Ma), lies 11 km west of Jordan in northeastern Montana. The complex consists of several lamproite exposures along a N30°E trend. The lamproites are exposed at Radial Dike Butte, Bull Snake Knob, Half Sediment Butte, Smoky Butte, Instrument Butte, Ship Rock, and Wall Rock.

The lamproites are sanidine-diopside-richterite-phlogopite-lamproites. These lie along a dike that swells to 38 m in width. The rocks include vesicular, massive, glassy, hypabyssal breccias, and include minor tuffs and pyroclastics. Smoky Butte is a vent (Mitchell and Bergman, 1991).

Madison County: Diamonds have been reported from Greenhorn Gulch of southwestern Montana (Sinkankas, 1959).

Petroleum and Fergus Counties: A belt of ultramafic lamprophyres occur 4.8 to 9.6 km south of Winnet, central Montana, in the vicinity of Yellow Water Reservoir. The belt is formed of ultramafic lamprophyre diatremes and dikes (including alnöites), the Elk Creek Butte lamproite, and Yellow Water Butte lamproite (Mitchell and Bergman, 1991).

The lamproites at Yellow Water Butte consist of altered and carbonated massive to brecciated olivine-phlogopite-diopside-lamproite and massive hypabyssal olivine lamproite. The Elk Creek vent-dike complex consists of intrusive breccia and lapilli tuffs (Mitchell and Bergman, 1991). Some other, less extensive lamproites, occur in the area.

Phillips County: The Williams kimberlites are a group of four closely spaced diatremes in the eastern part of an east-northeast trending swarm of ultramafic alkalic diatremes, dikes, and plugs (46 to 51 Ma) in the Missouri Breaks area of north-central Montana. These rocks preceded the intrusion of the 27 Ma Smoky Butte lamproite located 112 km to the southeast. The rocks contain a host of xenoliths including garnet-bearing lherzolites, harzburgites, and dunites. The Williams 1 diatreme is about 235 to 313 m in diameter and contains the typical kimberlitic indicator minerals pyrope garnet, chromian diopside, and magnesian ilmenite.

The Williams 2 kimberlite is about 40 by 117 m, and has a zone of kimberlite breccia with abundant Paleozoic limestone and dolomite xenoliths. The Williams 3 diatreme is about 30 by 40 m and consists of kimberlite breccia. The Williams 4 is a

dike-like diatreme 380 m long and up to 38 m wide and consists of massive kimberlite with desultory zones of fragmental kimberlite (Hearn and McGee, 1983).

These intrusives include xenoliths of the Precambrian basement, the upper crust (schist, gneiss, amphibolite), the lower crust (granulite, mafic granulite, amphibolite), and the upper mantle (spinel peridotite, dunite, garnet peridotite, garnet megacrysts), as well as xenocrysts of kimberlitic indicator minerals. According to Hern and McGee (1983) neither diamond or eclogite has been found in these intrusions.

The available analyses of peridotitic garnets from the Williams kimberlites indicate compositions are equivalent to G-9. None of the garnets analyzed by Hern and McGee (1983) fell within the G-10 (sub-calcic pyropes) field.

Treasure County: Lamproite of the Froze-to-Death Butte occurs 14 km northwest of Hysham in southeastern Montana. Another lamproite is reported near Gold Butte, about 40 km northeast of Froze-to-Death Butte. The rocks are massive hypabyssal intrusive breccias consisting of altered olivine-phlogopite-diopside-lamproite. Froze-to-Death Butte is a multiple vent complex (Mitchell and Bergman, 1991).

Utah

Lamproites, minettes, and mica-peridotites occur in Utah. No diamonds are known from the region.

San Jaun County: Three ultramafic diatremes are recognized in the Colorado Plateau of southern Utah, to the southeast of Mexican Hat. These are the Mule Ear, Moses Rock, and Cane Valley intrusives. The rocks were originally described as kimberlite, but are currently considered to be related to minettes (Mitchell, 1986).

The Moses Rock dike is exposed over a 6.4 km strike length and reaches a maximum width of 950 feet. The dike is brecciated and intrudes Permian sandstones and siltstones of the Cutler Formation. The dike is 30 Ma (Brookins, 1970a).

A detailed investigation by McGretchin (1968) suggested that the 'kimberlitic' minerals in these minettes were derived by mechanical disaggregation of mantle rocks (spinel peridotite and garnet peridotite) from a depth of 50 to 300 km. The minette includes a variety of xenoliths from the surrounding country rock, as well as crustally derived igneous and metamorphic rocks, and a small number of eclogite, pyroxenite, and rare peridotite nodules (Meyer, 1976).

The Cane Valley intrusive is a collapse structure about 0.8 km in length that contains both kimberlitic and carbonatitic dikes. The Moses Rock diatreme in Utah, and the nearby Garnet Ridge diatreme in Arizona, contain abundant G9 garnets with relatively low Cr_2O_3 (1-5%). A temperature histogram based on the nickel thermometer for the garnets shows that all of the garnets were derived from shallow depths, within the graphite stability field (Griffin and Ryan, 1993).

Summit County: Lamproites and mica peridotites are found 64 km east of Salt Lake City near Kamas. The Moon Canyon lamproites (40 Ma), located a short distance southeast of Kamas, consist of hypabyssal olivine-sanidine-diopside-richterite-phlogopite lamproite flows and sills. The Whites Creek lamproites (13 Ma), located northeast of Kamas, include a series of small orendite dikes which have penetrated upper Cretaceous shales nearly 3.2 km northwest of the Uinta North Flank Fault Zone. The Whites Creek

lamproites contain chrome spinel, phlogopite, and olivine. Compared to the Moon Canyon lamproites, the White's Creek have less SiO_2 and approximately twice the MgO content.

Mica-peridotite was intersected in the Silver King tunnel of the Park City mining district. Another mica-peridotite is reported along the Erickson Basin Fault in Smith-Moorehouse Canyon, northeastern Utah (Henage, 1972). The latter peridotite (39 Ma) contains melilite and biotite suggesting this rock to be an alnöite.

Wyoming

Much of Wyoming is underlain by a stable Archean craton. Within the Proterozoic terrane along the Archean craton margin is the largest kimberlite field in the United States. Nearly 80 diatremes, blows, and dikes occur in southeastern Wyoming, in three districts. Surrounding these districts, are several kimberlitic heavy mineral indicator anomalies in stream alluvium, which suggests that the districts may be more widespread (Hausel and others, 1988). Wyoming also has the largest lamproite field in the United States located in the Leucite Hills of southwestern Wyoming. And a large area south of the Leucite Hills in the southern Green River Basin contains widespread 'kimberlitic' indicator minerals in ant hills.

Albany County: The Colorado-Wyoming State Line district extends 20 km south into Colorado, and 7 km north into Wyoming. On the Wyoming side of the border, 20 intrusives known as the Schaffer group, Aultman 1 and 2, and the Ferris 1 and 2, contain hypabyssal and diatreme facies kimberlite (McCallum and Mabarak, 1976; Hausel and others, 1981). These occur as dikes, blows, and diatremes. Surface geophysical surveys show the known kimberlites to be good conductors with weak to strong magnetic anomalies (Hausel and others, 1979, 1981). Only the Ferris 1 and 2 kimberlites have not been tested for diamonds, to date. All of the remaining diatremes are diamondiferous. No effort has been made to search for placer diamonds in the district.

Diamonds recovered from bulk samples of the Schaffer and Aultman kimberlites by Cominco American, yielded a small number of stones. The largest recovered stone was 0.86 carat in weight, and 50% of the recovered diamonds were gemstones (Hausel, 1993). The grades of the tested kimberlites were low and ranged from 0.5 to 1.0 carat/100 tonnes.

A stream sediment sampling program by the Wyoming Geological Survey in southeastern Wyoming, identified more than 300 kimberlitic heavy mineral anomalies. The anomalies were identified in the Laramie Range north of the State Line district, and a few were identified in the Medicine Bow Mountains to the west of the State Line district (Hausel and others, 1988).

Three highly anomalous areas identified in the Laramie Range included the Eagle Rock area, the Middle Sybille Creek area, and the Elmers Rock greenstone belt (Hausel and others, 1988). In the Eagle Rock area, 35 stream sediment samples collected over 30 mi^2 yielded pyrope garnet, chromian diopside, and picroilmenite. One small circular structure (the Eagle Rock anomaly) was discovered in the region. The Eagle Rock anomaly may be a small cryptovolcanic structure, however, it is soil covered and contains no rock exposures at the surface. One pyrope garnet was recovered from the soils in the structure. More recently, a peridotite nodule was recovered 100 m north of the structure (Larry Clark, personal communication, 1993).

The Middle Sybille Creek area lies near the center of the Laramie Mountains. A single blow, known as the Radical kimberlite, is comprised of hypabyssal facies kimberlite (Hausel and others, 1981). Stream sediment sampling in the vicinity of the intrusive produced 32 samples with 'kimberlitic' heavy minerals. These anomalies extend as much as 8 km upstream from the Radichal kimberlite suggesting the presence of several undiscovered kimberlites (Hausel and others, 1988). Samples collected in Grant Creek northeast of the Middle Sybille Creek area were also highly anomalous. Twelve stream sediment samples, collected over a distance of 1.6 km in this area, yielded dozens of pyrope garnet, chromian diopside, and picroilmenite.

Stream sediment samples collected in the Elmers Rock greenstone belt to the north of Grant and Middle Sybille Creeks also yielded dozens of anomalous samples (Hausel and others, 1988). Some of these indicator minerals lie downstream from a distinct 0.8 km diameter, circular structure of unknown origin. There is also one report of an unverified diamond from the Bluegrass Creek area of the Elmers Rock greenstone belt (Hausel, 1981).

In the Medicine Bow Mountains to the west of the Laramie Range, pyrope garnets were recovered from a sample (section 28, T16N, R78W) near Centennial Ridge (Hausel and others, 1988). The source of the garnets is unknown.

Campbell County: Microdiamonds were found in a coal seam near Gillette in the Powder River Basin of northeastern Wyoming (Finkelman and Brown, 1989). Some garnets were also recovered from the sample (R.B. Finkelman, personal communication, 1989).

Carbon County: Two diamonds were recovered from a gold placer on Cortez Creek in the northern Medicine Bow Mountains of southeastern Wyoming, in 1977. The Boden diamonds weighed 0.1 and 0.03 carat (Hausel and others, 1985). Some kimberlitic indicator minerals were found in the vicinity of Iron Creek, a tributary of South French Creek, a few km south of Cortez Creek (Tom McCandless, personal communication, 1991).

Several pyrope garnets and four chromian diopsides were also recovered from a gold paleoplacer along the northeastern flank of the Seminoe Mountains greenstone belt north of the Medicine Bow Mountains (Hausel, 1993). The source of the indicator minerals is assumed to be from the northwestern margin of the Seminoe Mountains.

Fremont County: A diamond was found in the late 1800s in the Beaver placers of the South Pass-Atlantic City district of the southern Wind River Mountains (Hausel, 1991). The diamond was apparently sold for $1,000.

Laramie County: Fifty-seven kimberlite dikes and blows occur in the Iron Mountain district of the Laramie Range in the northwestern corner of Laramie County. A few intrusives were tested by Cominco American Inc., but no diamonds were found. Some pyropes from the intrusives were chemically equivalent to G9 and G10 pyropes. The presence of G10 pyropes suggests the kimberlites tapped the diamond stability field, however, ilmenite analyses suggest the kimberlites were emplaced under oxidizing conditions implying that diamond preservation was unlikely (McCallum and Waldman, 1991).

Sublette County: A diamond (about one inch in diameter) was found by Snook Moore in the vicinity of Tourist Creek west of Gannett Peak in the Wind River Mountains. The diamond was later destroyed in a ranch fire (J.D. Love, personal communication, 1981).

Sweetwater County: One of the largest lamproite fields in the world is located in Sweetwater County in southwestern Wyoming. The Leucite Hills north of Rock Springs, Wyoming, are formed from several leucite lamproite and minor olivine lamproite volcanoes. These volcanoes are dominated by 1.0 Ma flows with only minor volcaniclastics. Small samples of olivine lamproite breccia (less than 1 tonne) were tested by the Wyoming Geological Survey. No diamonds were found.

South of the Leucite Hills, pyrope garnet and chromian diopside have been recovered from numerous anthills in the southern portion of the Green River Basin (McCandless, 1979). This anomaly covers hundreds of square miles and has been traced as far north as Granger, as far east as Sage Creek Mountain, and as far south as the Wyoming-Utah border. A few circular structures of unknown origin have also been identified along the western edge of the anomaly (Gordon Marlatt, personal communication, 1994).

The Green River Basin is a Tertiary age basin filled with thick lacustrine sediments, overlying the Wyoming craton. Within these lake sediments (and within the anomalous area) talc and chlorite schist of unknown origin, was intersected in two separate drill holes. The schist is unusual in this sedimentary basin. Four diamonds were also reportedly found in anthills in the Butcherknife Draw area along the western margin of the anomalous area by a prospector from Green River (Paul and Jean Miller, personal communication, 1994). The diamonds have not been authenticated.

Teton County: A 7 to 9 carat blue-white gem quality diamond was reportedly found in a prospect pit in the Gros Ventre range (J.D. Love, personal communication, 1981).

Pacific Coast

Diamonds have been reported from several locations along the Pacific Coast of the United States. The source for the hundreds of diamonds from this region has not yet been identified.

Alaska

In 1982, diamonds were discovered in a placer gold prospect on Crooked Creek within the Circle mining district northeast of Fairbanks near central Alaska. The diamonds included a 0.3 carat stone, a 0.83 carat stone, and a 1.4 carat stone. No 'kimberlitic' indicator minerals were recovered from the gravels (Forbes and others, 1987). The lack of indicator minerals suggests the diamonds either originated from lamproite or a similar intrusive, or that the diamonds had a distal origin.

In the southwestern corner of the state, two diamond inclusions were found in a native platinum nugget at Goodnews Bay. Another microdiamond was recovered from a core sample of bottom sediments in the Bay (Forbes and others, 1987).

California

California has been one of the most productive regions in North America for diamonds. But because this region does not fit any classical exploration model for diamondiferous kimberlite emplacement, it has been historically neglected by geologists.

Diamonds were discovered in 1849 near Placerville in El Dorado County of central California. A few years later in 1852, diamonds were discovered in the Cherokee hydraulic gold placer mine 14.5 km north of Oroville in Butte County, California. Diamonds have also been reported in several other placer gold deposits in Amador, Nevada, Plumas, and Trinity Counties. In total, more than 600 diamonds (both gem and industrial stones) have been documented from placer gold operations in California.

Most Californian diamonds were found north of the 36°N latitude. And nearly all of the diamonds have been found in the Sierra Nevada and the Klamath Mountains downstream from serpentinized ophiolite complexes and melanges. Less than one percent have been found in beach sands.

The close association of the placer diamonds with serpentinized ophiolite suggest possible preservation of diamonds in an obducted Beni Bousera-type mantle slab (Hausel, in preparation). This is further supported by the discovery of pyrope garnet and chromian diopside in some Californian placers, and the discovery of chromian-diopside-bearing pyroxenite and peridotite in northern and in central California by the author. Possibly, diamondiferous garnet serpentinite may have contributed diamonds to the placers.

Amador County: Five different localities south of Placerville in central California, have produced diamonds. At three of the localities, diamonds were produced from ancient river channels. More than 60 diamonds (the largest weighed about 1.5 carats) were recovered from Jackass Gulch at the town of Volcano from an old channel about 12 m below a bed of volcanic ash.

At Fiddletown, diamonds were recovered from gravels underlying volcanic ash from Loafer Hill (the largest was approximately 1.33 carats). Indian Gulch, east of Amador City is also cited as a diamond locality, though few facts are available. According to Kunz (1885), four diamonds were recovered from grey-cemented gravel underlying a layer of lava flows or ash.

The pale colored Evans diamond, weighing about 1 carat, was found on the surface of gravel at Rancheria (6.4 km northwest of Volcano) in 1883. The diamond was recovered in the SW NW section 18, T7N, R12E. In 1934, The Echols diamond, a stone weighing about 2.5 carats was found near Plymouth, about 32 km south of Placerville.

Butte County: The most productive district for diamonds in California was the hydraulic gold placer mines immediately north of Oroville in the Round Mountain area of Butte County. Between 1853 and 1918, more than 300 diamonds and about 600,000 ounces of gold were recovered from the historical mining operations in this area situated near the Feather River.

The district is dominated by Round Mountain which forms a prominent flat top mountain north of Oroville. Round Mountain is capped by the propylitically altered, Miocene age, Lovejoy Basalt. The basalt overlies a Tertiary (?) age, gold-bearing, diamondiferous conglomerate which is the reported source of the majority of the diamonds recovered from the Oroville area.

Diamonds were initially washed from the conglomerate along the north end of Round Mountain at the Cherokee placer. In 1866, diamonds were also found in gravels along the west bank of the Feather River about one mile north of Oroville. Diamonds

were also recovered from conglomerates at Thompson Flat, Yankee Hill, and Morris Gulch (Hill, 1972).

In 1885, Kunz reported that 15 diamonds from the Cherokee flats were derived from a 3 foot thick layer which was part of a larger 8 m thick unit of gravel. Kunz (1885) indicates that a few diamonds were of possible gem quality.

In 1906, the U.S. Diamond Company sunk a 56 m deep shaft in what was claimed to be kimberlite. The shaft reportedly intersected a rich pocket of diamonds, although it is questionable as to whether or not any diamonds were recovered from the deposit (Rosenhouse, 1975). Presently, kimberlite is not known in the area, but serpentinized amphibolite schist has been described (Heylum, 1985).

The largest recorded diamond found in the Oroville area was found in 1868. The stone, known as the Moore diamond, weighed 2.25 carats. However, local folklore claims that the largest diamond from the area weighed 6 carats and was found outside the entrance of the Spring Valley mine at Thompson Flat (Rosenhouse, 1975). The color of the recovered stones included pure white, rose, and yellow colored diamonds (Hill, 1972).

At Thompson Flat, 3.2 km north of Oroville, diamonds were found in placer diggings in an old Tertiary channel, and a few stones were recovered from nearby modern drainages (Hill, 1972). Diamonds from the Oroville area have been surprisingly good quality being relatively free of flaws and possessing good brilliance. However, many have a yellowish tinge which detracts from their value (Heylum, 1985).

In 1931, another diamond which weighed 0.5 carat, was found in the Cherokee mine by a prospector. Another resident reported finding a diamond in the same year that weighed 2 carats and 27 points (Blank, 1934). Kunz (1885) reported that the diamondiferous gravels at Cherokee flats also included platinum, almandine garnet, epidote, gold, iridosmine, limonite, magnetite, pyrite, quartz, rutile, topaz, and zircon.

Del Norte County: Kunz (1885) reported that in all of the northern Counties drained by the Trinity River, in the vicinity of Coos Bay, Oregon, and on the banks of the Smith River of Del Norte County, diamonds may be found. Sinkankas (1959) reiterated that microdiamonds had been found on the Smith River.

El Dorado County: Records of diamonds from El Dorado County are the most complete due to the efforts of a Judge Carpendar who kept notes on the recovered diamonds. Diamonds from the Placerville region included stones from Live Oak Mine on Reservoir Hill, Smiths Flat, Spanish Ravine, White Rock Ravine, Webber Hill, Wisconsin Flat mine, Texas Hill, Newtown, Fairplay, and Prospect Flat (Hill, 1972). At least 50 diamonds were recovered from this region. Diamonds described by Judge Carpendar were white, canary yellow, greenish, and blue, weighing from 0.1 carat to 1.82 carat. Of the 50 diamonds described by Carpendar, at least 13 stones weighed more than 0.95 carat (Hall, 1972). Some of the diamonds may have been gem quality in that Kunz (1885) indicated some of the stones had been cut and mounted in rings.

A diamond from Forest Hill was described to weigh 1.5 carats and was of good color. The diamond was found in a tunnel driven into the auriferous gravels (Kunz, 1885). The diamondiferous gravel was described to be capped by a bed of lava ranging from 50 to 450 feet thick.

Fresno County: Small diamonds have been reported a few km north of Coalinga (Blank, 1934).

Humboldt County: Diamonds were reported in the Trinity River in Humboldt County (Sinkankas, 1959).

Imperial County: A diamond was reported near the Mexican border. The discovery was never authenticated (Sinkankas, 1959).

Nevada County: One of the largest diamonds found in California was a 7.25 carat stone recovered from French Corral (Heylum, 1985). A second stone from this area weighed 1.33 carats. A stone described by Kunz (1885) weighed 1.25 carats, was remarkably free of flaws, and slightly yellowish in color.

Plumas County: Diamonds ranging from microscopic to about 2 carats in weight have been reported at four localities in Plumas County. These include Gopher Hill, Spanish Creek, Sawpit Flat, and Nelson Point. At the latter two localities, the diamonds were recovered from Tertiary fluvial gravels.

San Diego County: Diamonds have been reported from Ramona. It was reported three diamonds were recovered from a sluice box on Hatfield Creek in the flats of the Little Three Mine. The stones were reported to be 1/8th inch in diameter (Sinkankas, 1959).

Siskiyou County: Diamonds were reported in the placer gravels of the Hamburg bar (Blank, 1934).

Trinity County: Five large diamonds were recovered from a tributary of the South Fork of the Trinity River known as Hayfork Creek. One of these diamonds, named the Doubledipity, weighed 32.99 carats, and was found in 1987. This was the forth or fifth largest diamond ever found in the United States (Table 1). The Doubledipity is a yellowish brown diamond and lacked the typical adamantine luster commonly associated with diamond. It is opaque except on the edges where it is translucent and does not fluoresce. The stone is an aggregate of seven interpenetrating cubes in random crystallographic orientation (Kopf and others, 1990).

In addition to the Doubledipity, at least four other large diamonds were recovered from Hayfork Creek in the Klamath Mountains in northern California. These included the Enigma (17.83 carats), the Serendipity (14.33 carats), a poorly documented diamond discovered in the 1860s that was about a half inch in diameter estimated to weigh between 10 to 15 carats, and the Jeopardy diamond (3.9 carats).

These large stones all exhibit an overgrowth of a multitude of tiny crystal faces of diamonds which coat the underlying crystal or crystal aggregate. The recognized forms are both cubes and octahedrons. The morphology of the crystals suggest that they were subjected to disequilibrium conditions within the diamond stability field. The diamonds, being industrial, coated with encrustations, and forming aggregates suggest minimal transport distance from the source rock.

The Enigma diamond is a greyish-brown industrial stone that is semi-translucent to opaque as a result of microscopic black specs scattered throughout the diamond. The stone is triangular in shape and bounded by two cleavage surfaces indicating the stone was originally larger (Kopf and others, 1990).

In addition to these large diamonds, countless numbers of small diamonds have been reported in the black sands of the Trinity River. Kunz (1885) reported that in all of the northern counties drained by the Trinity River in the vicinity of Coos Bay Oregon and on the banks of the Smith River of Del Norte County, California, diamonds were found. Sinkankas (1959) reported microdiamonds were found in the black sands of the Trinity River near its junction with the Klamath River.

The placers in this region also carry significant gold, coarse-grained platinum-group metals, and chromite. Recently, pyrope garnet and chromian diopside (heavy mineral indicators of mantle material) were also reported from the Trinity River area. The combination of these heavy minerals suggest an ultramafic or ultrabasic source terrane or terranes.

The reported presence of pyrope garnet and chromian diopside in the placers is especially significant in that these minerals are indicators of mantle-derived material and suggest a possible nearby source terrane for the diamonds. Both of these indicator minerals tend to disaggregate during stream transportation over short distances.

Tulare County: A single crystal was found in 1895 from Alpine Creek. The diamond was never authenticated (Sinkankas, 1959).

Oregon

Kunz (1885) reported diamonds were found in the black sands in the vicinity of Coos Bay, Oregon, and in placer gold gravels of southwestern Oregon (Anonymous, 1981). The number of recovered diamonds was estimated to be about 100 stones, and most were yellowish in color. The stones include some good quality diamonds up to 3 carats in weight, and some larger stones of inferior quality (Blank, 1934). One interesting report indicated that a 3.15 carat gemstone had been found in the craw of a chicken in Oregon (Birdsall, 1986). The diamonds have all been found in placers downstream from alpine and ophiolitic peridotites.

Curry County: A diamond found near Wedderburn near the mouth of the Rogue River, was reported to weigh 0.60 carat. The diamond was a flattened hexoctahedron with minor carbon inclusions (Anonymous, 1981). The diamond was incorporated into the U.S. National Museum's collection (Holden, 1944).

Microscopic diamonds were reportedly found in beach sands along the coast of Oregon at several places. The diamonds were thought to have originated from peridotite rocks in that region (Anonymous, 1961).

Josephine County: A diamond was recovered from a gold placer in the county. The diamond weighed nearly 3 carats (Anonymous, 1961). Two additional poor-quality yellow diamonds were reported from Josephine Creek (Birdsall, 1986).

Malheur County: A 2.5 carat diamond was found in 1870 in a gold placer. The diamond was dark in color and described as bort (Anonymous, 1961; Birdsall, 1986).

Washington

Microscopic diamonds have been reported in black sand deposits along the coast in the northwestern part of the state (Blank, 1934).

Skamania County: In 1932, a diamond of a little more than 4 carats was found in a gold placer. The stone was a pale yellow octahedron (Blank, 1934).

CONCLUSIONS

After reviewing all of the known diamond occurrences in the United States, some areas stand out as highly anomalous. These are: (1) the Appalachians, (2) the Great Lakes region, (3) Kansas, (4) Arkansas, (5) the Colorado-Wyoming province, and (6) the Pacific coast.

Numerous diamonds and some kimberlites have been found in the Appalachian Mountains. The emplacement of kimberlite dikes and diatremes in this region are controlled by intersections of reactivated faults with cross-lineaments (Parrish, 1984). Although exploration in this region would be hindered by heavy vegetation, the potential for discovery of additional kimberlites is considered to be high. Exploration should include mapping lineaments, stream sediment sampling surveys, airborne geophysical surveys, as well as following up on the historical reports of indicator minerals and diamondiferous peridotite.

The Great Lakes region is underlain by cratonic basement rocks, several kimberlites and some cryptovolcanic structures have been identified in the area, and several diamonds have been found in the region. These factors make the Great Lakes region one of the better exploration targets for diamond in the United States.

Kansas is also considered to provide a good exploration target. Although reports of diamonds are uncommon, this could be due to the lack of historical placer gold mining in the state. However, the presence of several kimberlites and lamproites in eastern Kansas suggests there is a good possibility for the discovery of additional pipes. Like the Appalachian Mountains, Kansas is covered by thick stands of grass and trees. Stream sediment sampling in conjunction with airborne geophysics would provide the best exploration program in this region.

Thousands of diamonds have been recovered from a small group of lamproites in Murfreesburo, Arkansas. Arkansas is also heavily vegetated, thus there is potential for discovery of additional diamondiferous lamproite in this region.

Based on the number of anomalies identified, the Colorado-Wyoming Province stands out as a potentially important diamond province. To date, the diamondiferous kimberlites that have been identified, are considered marginal because of their small size, and marginal grades of ore. However, this region contains numerous anomalies that need to be examined in greater detail, and in many cases, many of the anomalies have not even been examined, to date. The abundance of kimberlite, lamproite, and 'kimberlitic' indicator mineral anomalies in this region should make the Province one of the highest priority regions for diamond exploration in North America.

The Pacific coastal region (northern California and southern Oregon) provides an entirely different opportunity for the exploration geologist. This region is virgin ground for diamond exploration, yet it may offer the greatest potential for a world class deposit in the United States. More than 600 diamonds have been recovered from this region that range in size from microdiamonds to one of the 4 or 5 largest diamonds ever found in the U.S. Many of these diamonds were recovered under very unfavorable conditions (i.e. hydraulic mining) that was not conducive to diamond recovery.

Possibly, hundreds of diamonds reported to the tailings during the historical gold mining operations.

California is tectonically unstable, and the diamond fields of northern California are underlain by a Phanerozoic basement, conditions that have in the past been considered antipathetic to diamonds. However, the discovery of diamonds in ophiolite and in alpine peridotite in the former Soviet Union and in Tibet, the discovery of diamonds in alkali basalt in New South Wales, and the recent discovery of abundant graphitized diamond in ophiolite in Morocco all emphasize the Californian diamond fields as a potentially important region for future diamond exploration.

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