# Finding Diamond Deposits With Your PC—Part I

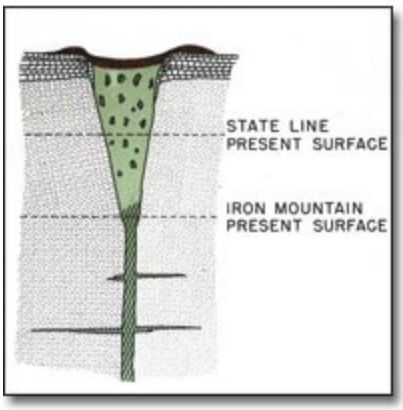
April 2009 by **W. Dan Hausel**

Kimberlites, lamproites and some lamprophyres are primary host rocks for diamond deposits. In addition to diamond, these often contain value-added gemstones such as pyrope and spessartine garnet (referred to as Cape Ruby), chromian diopside and enstatite (referred to as Cape Emerald), peridot, and rare rock specimens and nodules (rounded boulders and cobbles) of mantle-derived material accidentally trapped in the host magma. Finding these deposits is difficult and requires detective work.

The first kimberlite volcanoes discovered in Colorado and Wyoming were accidentally found by ranchers. In 1960 and 1961, two were identified near US Highway 287 south of Laramie and north of Ft. Collins as odd, out-of-place, rounded boulders and cobbles of limestone and sandstone. It was strange to find these in the middle of granite, but the mystery thickened when the rocks were dated based on fossils in the limestone—they were 400 million years old. This caused great interest in the geological community as no rocks of this age were known in this region, and no one knew how they got there. Furthermore, the odd rocks sat in small circular areas surrounded by granite and schist that were dramatically older and had dramatically different chemistry and genesis. The surrounding rocks were Precambrian in age and 1.4 to 1.8 billion years old. With a lack of explanation of how these small, circular outcrops ended up in this region, they were called Lower Paleozoic Outliers for a lack of a better term. Similar terms such as “cryptovolcanic structure,” “impact crater,” etc., have sometimes been used for deposits that were later reclassified as kimberlite.

In 1964, a third outlier was discovered in Colorado on the Sloan ranch. But this was a little different than the first two. This not only contained the odd boulders of limestone and sandstone, but it also had a distinct outcrop of green to black volcanic rock. The rock was identified as kimberlite by Dr. M.E. McCallum of Colorado State University and the enigma was solved. All three outliers were ancient kimberlite volcanoes that erupted 400 million years ago. These highly energized volcanoes disrupted layered limestone and sandstone and trapped blocks of these rocks in the old maar volcanoes.

Over the past 400 million years, considerable erosion removed all traces of the bedded sandstone and limestone. The only places where these rocks could be found were those that had been down-




*Cross sectional sketch of a kimberlite pipe (volcano) that erupted 400 million years ago through granite (radiating dashes) overlain by bedded sedimentary rock (horizontal lined pattern with rectangles) showing the current erosional surfaces (dashed lines) at the State Line district, Colorado-Wyoming and Iron Mountain district, Wyoming. The angular blocks in the grey diamond pipe represent pieces of sedimentary rock down-dropped in the pipe such that today, the only place these ancient limestones and sandstones can be found are in the kimberlite pipes.*

dropped in the throats of the maar volcanoes. In some cases, rocks were down-dropped 2,000 feet in the volcanic necks. Today, these fragments (known as xenoliths) are out of place. Over the years since 1964, approximately one hundred kimberlites were found in the State Line, Iron Mountain and Sheep Rock districts in Colorado and Wyoming. Nearly all that have been tested have contained diamond. Other kimberlites were found to the north in Montana and Alberta and to the east in Kansas.

Diamonds were also officially recognized in this area by accident in 1975. Material collected from a Wyoming kimberlite was polished for mineralogical tests by the US Geological Survey. The sample scratched the carborundum polishing wheel. The only thing harder than carborundum is diamond. Realizing this, the US Geological Survey dissolved the sample in acid and extracted several tiny diamonds.

Diamonds had been suspected in the region prior to 1975. Frank Yaussi, a prospector from Ft. Collins, searched Rabbit Creek in Colorado (adjacent to the Sloan pipe) for gold after picking up a mineral lease on the kimberlite. He was also interested in the green kimberlite rock for decorative stone and told me years later that he periodically found diamonds in Rabbit Creek prior to 1975, but no one would listen to him.

Material from the kimberlite was cut and polished by a terrazzo company in Cheyenne, Wyoming prior to 1975, and the polished tile was used in local buildings. But the decorative rock contained extremely hard material that scratched the carborundum wheel and put the company out of business.

Apparently no one paid attention to the fact that only diamond was hard enough to scratch the wheel. A short time later, a geologist from South Africa (Dr. Arnold Waters, Jr.) visited the State Line district and collected a small sample of kimberlite that was shipped to a DeBeers mill in South Africa. Dr. Waters told me that he tried to lease the property from Yaussi, but the two could not come to terms. So it is likely that diamonds were found by DeBeers in the early 1970s, but due to restrictions, no information was released, particularly since DeBeers was not allowed to explore the US at this point in history due to an lack of settlement of an antitrust suit.

The possibility that commercial diamond deposits might occur in the area was proposed by Dr. Dan Miller, Jr. of the Wyoming Geological Survey. Dr. Miller hired me to conduct the research on the Wyoming diamond deposits. I began searching for additional kimberlites, and it turns out that Dr. Miller may have been a visionary, as myself and others found evidence for hundreds of kimberlites over large regions in Wyoming and Colorado, as well as evidence for diamonds in lamproite and lamprophyre.

Other geologists found evidence for kimberlite in Montana and Kansas. Over the years, four diamond mills were constructed to test for diamond in Colorado, but poor mill designs resulted in

very poor recovery. To this day, we do not know what the real potential of the area is due to these blunders, except there remain dozens, if not hundreds, of untested diamond pipes and anomalies. Of those that were tested, the results left more questions than answers, and it is likely that all of the mills rejected as many if not more diamonds than they recovered. At least one mill was so poorly designed it rejected all diamonds >40 carats as well as many smaller stones.

*Blue ground exposed in a badger digging in Wyoming. (Photo by the author.)*

More kimberlites were discovered during later geological mapping projects. When a kimberlite was discovered, we typically walked along the fracture that controlled the emplacement of the kimberlite, and more often than not, other kimberlites were found hidden along these fractures. (This is a very important fact to keep in mind when hunting for diamond pipes.) Most were so poorly exposed that the only reason they were found was because: (1) a badger exposed traces of blue ground and kimberlitic indicator minerals (KIMs) during burrowing; (2) a high stand of grass was found in a treeless park surrounded by forest; (3) a slight depression was found with no trees, or (4) the soils looked a little different and reacted to dilute hydrochloric acid. Other kimberlites on these fractures were later found because of ground penetrating geophysics (electrical magnetic and electrical resistivity).

Many kimberlites were recognized by “blue ground” and any diamond prospector needs to become familiar with blue ground.

Blue ground is just what it refers to. It is decomposed kimberlite replaced by light gray-blue clay known as montmorillonite and calcium carbonate. When seen in the field, it has a distinctive blue-gray color. If one were to go into the State Line district today, examples of blue ground can be found with little effort only because past mining operations exposed the material. When the kimberlites were initially discovered, few had any exposed blue ground. Often, the geologist crawled around on all fours until a trace of blue ground was found, or a rare pyrope garnet was discovered. More than one pair of pants were worn out by crawling around looking for the subtle evidence of kimberlite.

One Canadian company flew part of the State Line district with airborne geophysics and this method discovered hidden kimberlites in the middle of the diamond district. But to this day, none of these have been drilled!

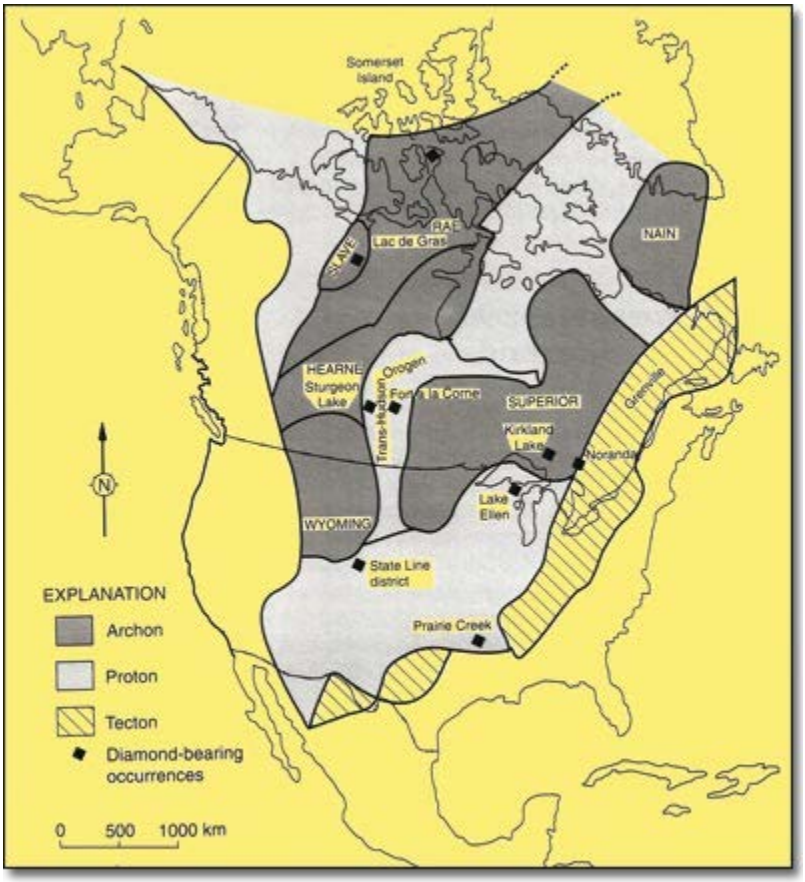
In addition to diamond, kimberlites contain other rare minerals from the earth’s mantle. During erosion, these minerals with moderate specific gravity are carried downstream with black sands where they can be recovered in gold pans. During panning in the Laramie and Medicine Bow Mountains, we identified more than 300 sites with these minerals. Nearly all of these anomalies remain unexplored, as does an extensive conglomerate with both gold and KIMs along the northern edge of the Seminoe Mountains in central Wyoming north of Sinclair.

Ants also collect KIMs to armor their hills. Work by Dr. Tom McCandless years ago at the University of Utah identified hundreds of KIMs in anthills in the Green River Basin in Wyoming. A few rock hounds reported finding some diamonds in these anthills in Butcherknife Draw in this region. Similar KIMs were found in the State Line district as well as in anthills in the Bighorn Basin near Thermopolis.

One method used to explore for kimberlite pipes is aerial photographs. If a kimberlite can be found

on aerial photography, there are likely more nearby that can't be seen on photographs. Over the years, myself and others found several hundred, if not thousands of potential kimberlites pipes that are currently classified as cryptovolcanic structures. Many are likely kimberlites, but few have been investigated.

I found 9 new clusters in Colorado, and began looking elsewhere in Colorado and Wyoming and then found large numbers in Wyoming suggesting that a very large diamond province occurs in the US. Similar anomalies were identified in the Medicine Bow Mountains in Wyoming. In the Laramie Mountains, they are found as far south as Boulder Colorado and as far north as Wheatland, Wyoming.




*Sketch map showing the outline of the North American Craton.*

With today's technology, anyone can use the Internet to find cryptovolcanic structures on their PC. Aerial photographs are available at a number of sites on the Internet including NASA, US Geological Survey, Google Earth, Virtual Earth, BLM Geocommunicator, Flash Earth, Yahoo Maps and others. As you look for these anomalies, keep certain geological concepts in mind.

Kimberlite typically is found in very old geological crust (rocks >1.5 billion years) that are referred to as cratons.

For the greatest success, search exposed Precambrian rocks. If you have a geological map of the area, look at the legend for those units that are labeled as Precambrian. These are the better areas to look for diamond pipes.

Much of North America is favorable for diamonds, and much of this favorable terrain is hidden under younger sedimentary rock that was deposited on the old Precambrian rocks. So a prospector needs to find windows in these sedimentary rocks where the old cratonic rocks are exposed. In Colorado, Montana and Wyoming, look in the mountains. This doesn't mean that the adjacent basins and plains will not contain kimberlite or related diamond-bearing rock, as they do. Kimberlites have been identified in basins and plains in Kansas, Montana, and Wyoming, but these are much more difficult to find.

As you scan aerial photos, look for circular features that give an impression of an impact crater. If you use Google Earth, I recommend starting at an eye altitude of 25,000 feet and look for depressions and circular lakes that line up with fractures. When you find an interesting anomaly, zoom to 15,000 feet or closer. The cryptovolcanic structures are a few hundred feet to 0.5 mile in diameter. (Keep these sizes in mind as anything larger is likely a ring dike or impact feature and may

have little to do with kimberlite.)

Next, note if the circular features sit on a fracture. A fracture will be apparent the further you are from the surface. So when using different media, zoom in and out on all targets. In some cases, you may come across a group of circular anomalies that all line up—this is usually a good indication of a controlling fracture that connects the depressions.

When you find a group of depressions, look for vegetation anomalies (open parks with no trees), standing water in the depression, etc. Many diamond pipes in Canada occur as depressions filled with water. Usually the rock underlying a depression is softer than the surrounding country rock and erodes faster. Kimberlite is considerably softer than granite, and will erode much quicker.

Next month we will discuss cryptovolcanic structures, anomalies to look for, and some specific tests you can conduct with dilute hydrochloric acid.