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Ronald C. Surdam, State Geologist

SEARCHING FOR PLACER DIAMONDS

by

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Information Pamphlet 12

LARAMIE, WYOMING
2004

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Front cover: The Boden long tom and sluice placer operation on Cortez Creek. Long toms were once commonly used in the Medicine Bow Mountains. Two placer diamonds were recovered along with gold during this venture.

Introduction

A number of diamonds have been found in Wyoming and neighboring Colorado by prospectors, companies, and geologists. Geological and mineralogical evidence suggest that many more of these gemstones will be encountered by prospectors in the future. For example, in the Colorado-Wyoming State Line district and Wyoming's Iron Mountain district, kimberlites have been deeply eroded—as much as 2000 to 4000 feet of vertical rock column may have been removed during the geologic past. This pamphlet was prepared to help those prospectors identify diamonds.

Diamond recognition

To search for placer diamonds, the prospector first needs to become familiar with the commodity. Diamonds are extraordinary minerals with extreme hardness, making them useful in industrial applications. They also have inherent beauty that is sought for personal adornment. Genesis of this unique mineral requires extreme temperature and pressure generated at great depth within the earth, making diamonds rare. In fact, the environment for diamonds is so rare that diamond is one of the more valuable commodities on earth, and arguably, the most valuable based on price and size. Few commodities can match the value of a high-quality faceted diamond gemstone when based on comparable weight

Diamond habit

Diamonds are isometric and have high symmetry. In their simplest form, they occur as a *cube*, which is a 6-sided solid (**Figure 1a**). One of the more common habits for diamond is an *octahedron* (8-sided diamond formed by two pyramids attached at a common base, **Figure 1b**). Many diamonds have crystal habits that are modified octahedrons and may include such varieties known to the mineralogist as hexoctohedron, rhombic dodecahedron, trisoctahedron, and others.

Crystal faces are frequently rounded and may have distinct tiny triangles known as *trigons* which you may need a 10x hand lens to see. *Trigons* are triangular depressions (or growth plates) found on the octahedral crystal faces (**Figure 1b**). Cubic diamonds may show similar depressions with pyramidal morphology that appear as rotated squares or parallelograms (**Figure 1a**). Twinned diamond crystals often occur as a flattened triangular-shaped diamond known as a *macle*.

Partial resorption of the octahedron can result in a rounded *dodecahedron* (12-sided crystal) with rhombic faces (**Figure 1d**) along with some distorted variations (**Figure 1e**). Many dodecahedrons develop ridges on the rhombic faces producing a 24-sided crystal known as a *trishexahedron* (**Figure 1f**). Four-sided tetrahedral diamonds are sometimes encountered that are distorted octahedrons. A *tetrahedron* by definition is a four-faced polyhedron, in which each face forms a triangle. Diamonds can also occur in a variety of crystal habits (**Figure 1g**).

Fracture, hardness, and cleavage

Diamonds have conchoidal fracture, are brittle, and break from a mild strike with a hammer. Even so, they are considered the hardest of all natural minerals and are assigned a hardness of 10 on Mohs' hardness scale (Erlich and Hausel, 2002). Diamond exhibits a slightly different hardness in different crystallographic directions, which allows it to be polished with less difficulty in specific directions. For example, it is easier to grind the octahedral corners off a diamond than to grind parallel to the octahedral face, which is nearly impossible. Diamond has perfect cleavage in four

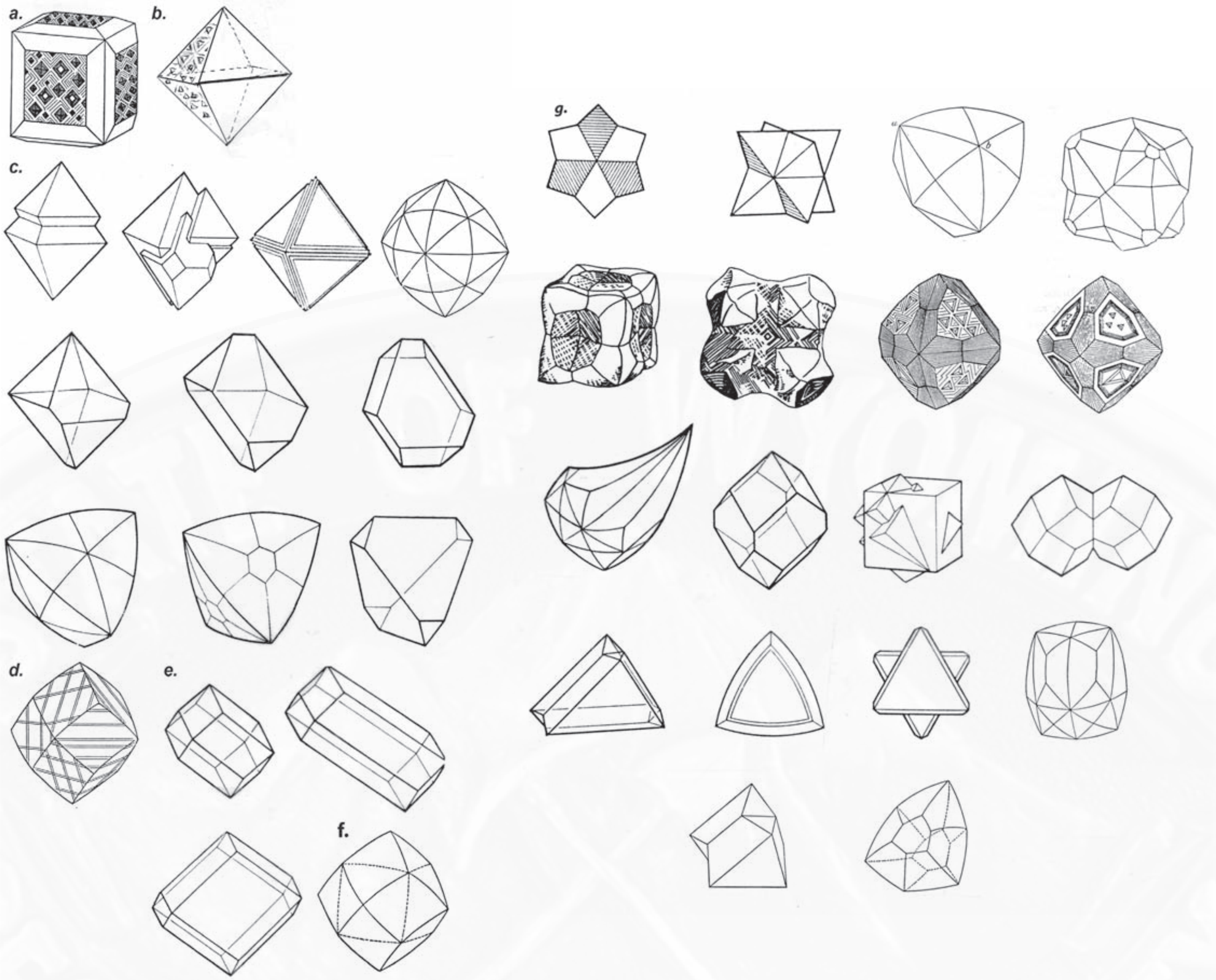

Figure 1. Some crystal habits of diamond include: (a) the cube—a relatively uncommon habit that is often reported in some placers in Brazil. Cubic diamonds often have several pyramidal depressions on the crystal faces. (b) Octahedral diamonds (8-sided) often have distinct triangular-shaped growths or depressions on the crystal surfaces known as trigons, which are useful in the identification of diamond. (c) Various modifications of octahedra are more common. Less common are (d) dodecahedral diamonds and (e) distorted dodecahedra. A trishexahedron (f) is a 24-sided crystal; numerous other crystal habits have been reported (g).

directions parallel to the octahedral faces; thus, an octahedron can be fashioned from an irregular diamond crystal by cleaving.

Appearance

The luster of diamonds is greasy to adamantine, appearing as if they are covered with a thin coat of grease. Diamonds are found in a variety of colors including the more common white to colorless and less commonly, shades of yellow, red, pink, orange, green, blue, brown, gray, and black. Those that are strongly colored are termed *fancies*; a 0.95-carat fancy purplish-red Argyle diamond recently attracted attention by selling for nearly $1 million (U.S.). A yellow-brown fancy diamond (the 545.7-

carat Golden Jubilee) is known as the world's largest faceted gemstone (Harlow, 1998). Possibly the most famous fancy diamond in the world is the 45-carat blue Hope Diamond.

The most common colored diamond is brown. Prior to the 1986 development of the Argyle mine in Australia, all brown diamonds were considered industrial stones, but due to Australian marketing strategies, these are now highly sought as gems. The lighter brown stones are labeled *champagne* diamonds and the darker brown referred to as *cognac* diamonds.

Yellow is the second most common colored diamond; these are referred to as *Cape* diamonds, after the Cape Province of South Africa. When the yellow color is intense, the stone is referred to as *canary*.

Pink, red, and purple diamonds are rare and bring high values. According to Harlow (1998), orange is the rarest color in diamond. There are many green diamonds because the color occurs as a thin layer of green on the surface of a white diamond. Faceted green stones, however, are rare. Black diamonds are thought to be the result of numerous inclusions of graphite, which also make diamond an electrical conductor. Such diamonds are difficult to polish due to the presence of abundant soft graphite, so black gem diamonds are uncommon.

Other traits

The distinct "fire" seen in faceted diamonds is the result of the high coefficient of dispersion (0.044). Diamond also has a high index of refraction (IR=2.4195) due to its density, and is responsible for the distinctive adamantine luster. The high density diminishes the velocity of light passing through the mineral to only 77,000 miles per second, whereas the speed of light in a vacuum is 186,000 miles per second (Harlow, 1998).

Approximately one-third of all gem diamonds will luminesce blue when placed under ultraviolet light. In most cases, luminescence will stop when the ultraviolet light is turned off, a property known as *fluorescence*. Many diamonds fluoresce in both long- and short-wavelength ultraviolet light. However, fluorescence is generally weak, and may not be readily apparent to the naked eye. In some cases, the light emission from the diamond will still be visible for a brief moment after the ultraviolet light is removed, which is known as *phosphorescence*.

Diamonds have tremendous thermal conductivity, i.e., diamond will feel cold to the lips when touched, since the gemstone conducts heat away from the lips. This is why diamonds are sometimes referred to as "ice" (Harlow, 1998). There are pocket-sized detectors (e.g., GEM® testers) that are available for a minimal price that are designed to measure the surface thermal conductivity of diamond. These will distinguish diamond from other gems and diamond imitations.

Diamonds are *hydrophobic* (nonwettable) and repel water. Because they are hydrophobic, diamonds attract grease (which will adhere to the surface of a diamond), providing an efficient method for extracting diamonds from waste material by the use of grease tables (Erlich and Hausel, 2002).

When heated in the presence of oxygen, diamond will burn to produce CO_2. However, when heated in the absence of oxygen, diamond will transform to graphite at 1900°C. Diamonds are also unaffected by acids.

Prospecting for placer diamonds

Diamonds have moderate specific gravity (3.5) and tend to concentrate with "black sands" in creek and riverbeds. A prospector should be able to pan for diamonds as they would pan for gold; Wyoming and Colorado provide excellent hunting grounds for stream-deposited *placer* diamonds.

When found in streams, diamonds may have been liberated from a kimberlite, lamproite, or related lamprophyric pipe or dike nearby, or may have come from diamond pipes hundreds of miles away. Because of their extreme hardness, some diamonds are thought to be able to resist stream abrasion over great distances.

The greatest diamond placers in the world occur within the Orange River basin of southern Africa and in beach sands along the Atlantic Ocean shoreline of western Africa. The Orange River basin drains some of the richest diamond pipes in the world and includes a region with more than 3000 barren and diamondiferous kimberlite pipes. Erosion of these pipes over the past several million years resulted in the liberation of millions of diamonds. The Orange River and its tributaries captured the diamonds and carried them hundreds of miles downstream to the Atlantic Ocean. River sediments from Kimberley to the Atlantic Ocean and beach sands extending from Port Nolloth, Namaqualand at the mouth of the Orange River northward to Luderitz, Nambia contain considerable placer diamonds eroded from the kimberlites. Although not of the same scale as Africa, there is little doubt that thousands of diamonds also occur in some streams and stream sediments in Colorado and Wyoming (**Figure 2**).

In the Colorado-Wyoming State Line district (**Figure 3**), 40 known diamondiferous kimberlites have been subjected to sporadic erosion that began as early as 600 million years ago for some of the Proterozoic (late Precambrian) kimberlites to 400 million years ago for the Devonion kimberlites. Hundreds of thousands (if not millions) of diamonds must have been eroded from these pipes and many were probably carried downstream from the State Line district. According to some early work by McCallum and Mabarak (1976), the State Line diamond pipes may have lost to erosion a vertical column of diamond-bearing rock 2500 feet thick. The diamond pipes at the Iron Mountain district to the north could have been eroded even more, possibly 4000 to 5000 feet. So the question is, where did all of the diamonds go? Many diamonds should still be found in nearby creek and riverbeds, waiting for someone to pick them up, yet few people have ever looked. I would suspect that a prospector has a much greater chance of getting rich by finding a valuable diamond by panning in these streams than by winning a lottery.

The placer diamonds could range from microdiamonds to macrodiamonds (**Figure 4**). For example, the largest diamond recovered from the Kelsey Lake mine weighed 28.3 carats, and another diamond fragment from that mine may have come from a diamond weighing as much as 80 carats (Howard Coopersmith, personal communication, 2002). So theoretically, one could find some large and valuable diamonds downstream.

A few placer diamonds have been reported in the State Line district. During some of the early testing of the Kelsey Lake kimberlites along the Colorado-Wyoming border, a 6.2-carat diamond was found in Fish Creek (Howard Coopersmith, personal communication, 1998 (**Figure 2**). Earlier, a prospector searching for gold recovered some diamonds on Rabbit Creek adjacent to the Sloan 1 and 2 kimberlites (Frank Yaussai, personal communication, 1982). Another prospector recently panned a diamond from the Poudre River (Vic Norris, personal communication, 2002).

Essentially, every kimberlite in the State Line district south of Laramie is diamondiferous. Some of the more significant kimberlites include the Kelsey Lake group, George Creek, and the Sloan group

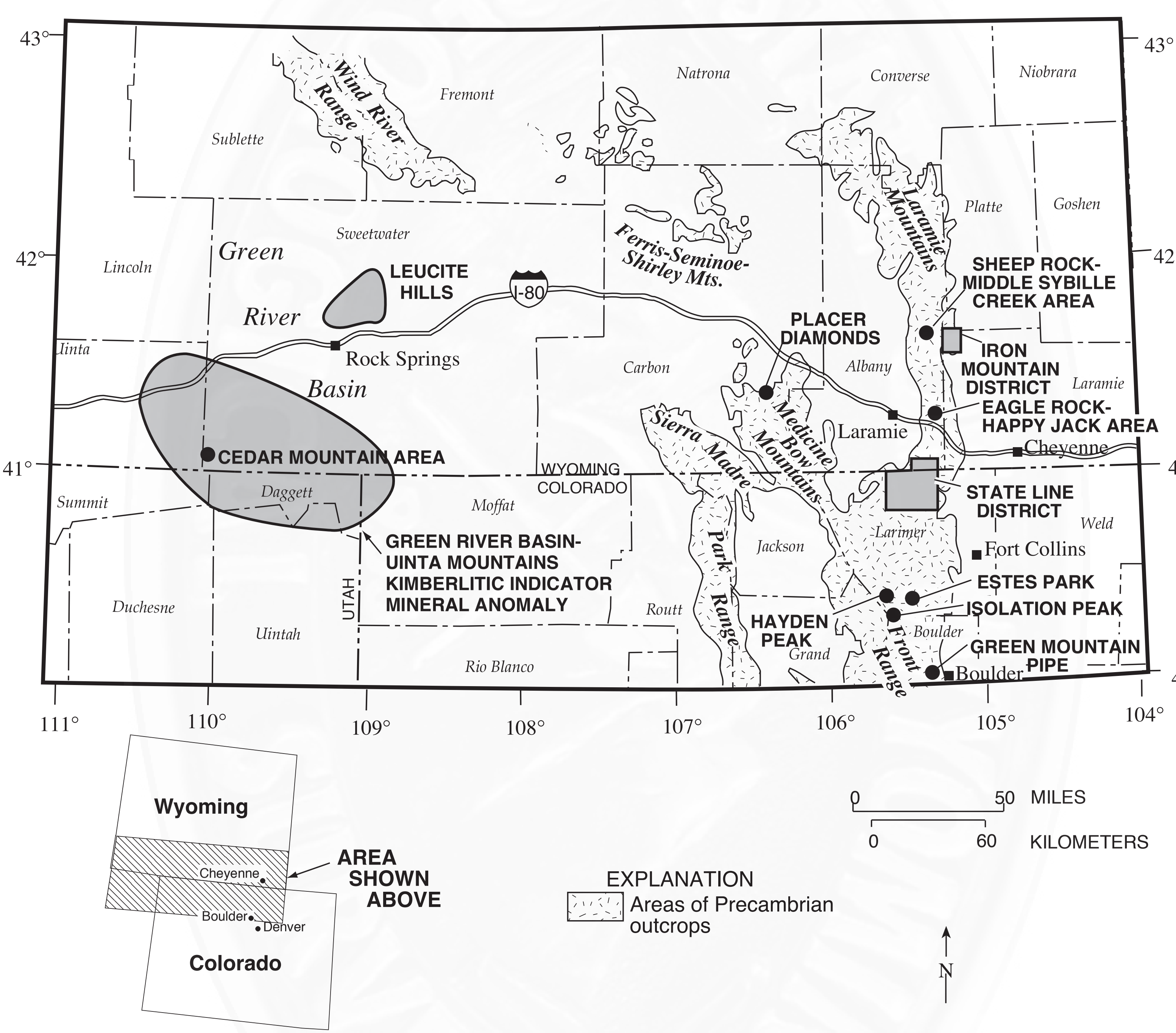

Figure 2. Location map of the Colorado-Wyoming kimberlite province and adjacent anomalous areas (modified from Hausel and

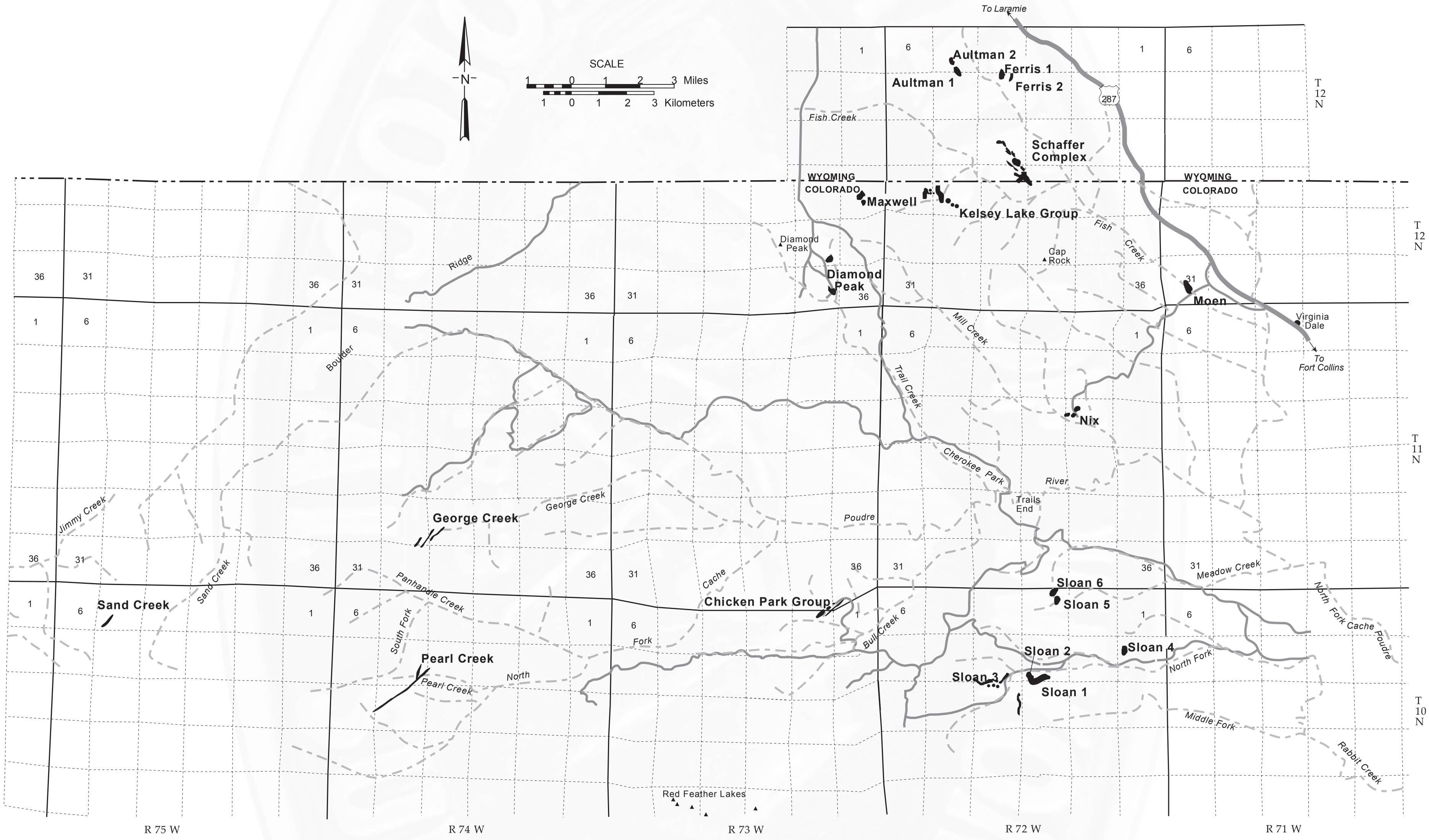

Figure 3. Generalized location map of the State Line kimberlite district, Colorado and Wyoming, showing locations of known kimberlites, nearby streams, and roads (modified from Hausel, 1998).

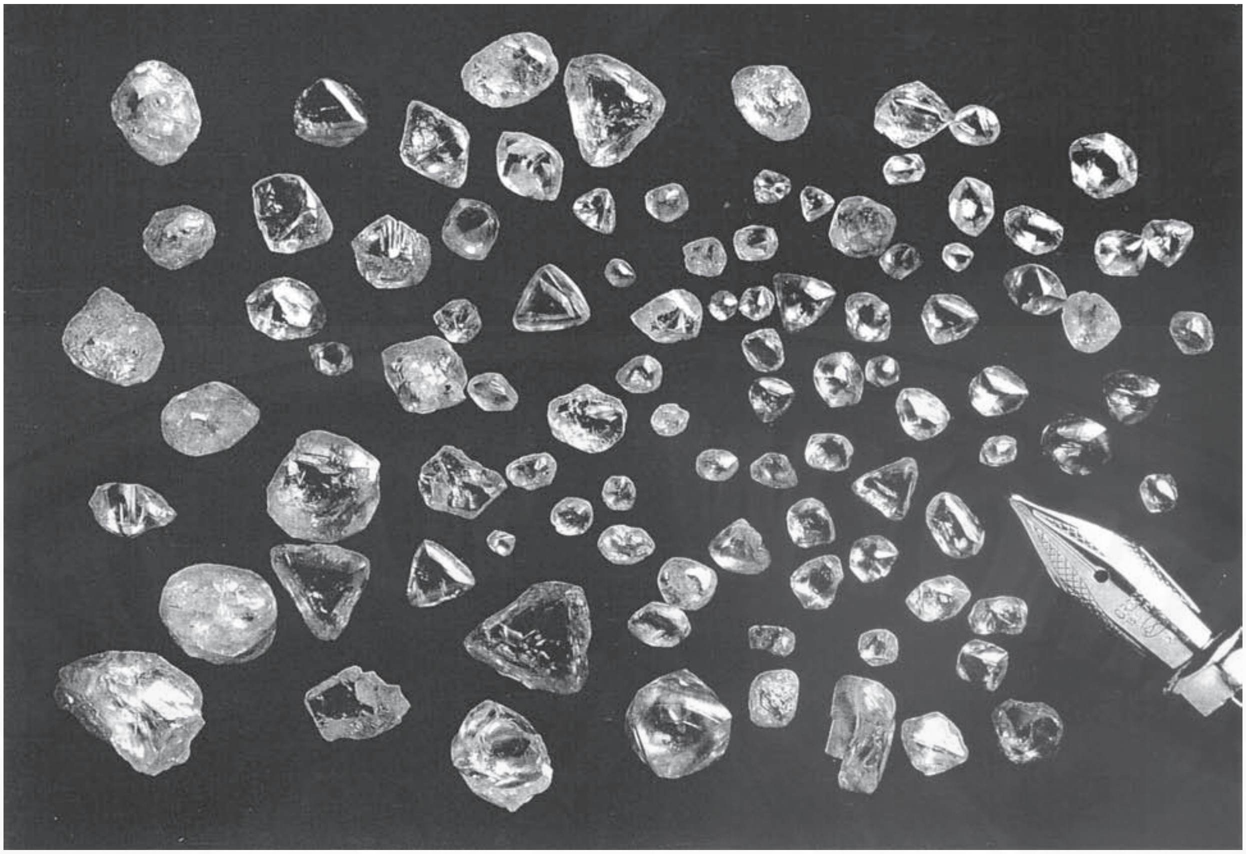

Figure 4. Some diamonds mined from the Kelsey Lake mine, Colorado (photograph courtesy of Howard Coopersmith).

(**Figure 3**). The George Creek kimberlites have yielded the greatest number of diamonds to date, producing more than 89,000 diamonds from bulk sample tests in the 1980s. These diamond-rich dikes undoubtedly supplied tens of thousands of diamonds into George Creek and the adjacent tributaries over the geologic past. Another good source for placer diamonds should be the Sloan kimberlites adjacent to Rabbit Creek. These yielded about 40,000 diamonds during bulk sampling tests in the early 1980s, including gemstones as large as 5.51 carats.

Historical placer diamond discoveries in Colorado and Wyoming have been rare. In 1977, a prospector from Saratoga, Wyoming recovered two gem-quality octahedral diamonds (**Figure 5**) on Cortez Creek in the Medicine Bow Mountains west of Laramie (**Figure 2**) (Paul Boden, personal communication, 1977). Other than that discovery, there are very few reports of placer diamonds in this region. This may be because most prospectors are not trained to recognize diamond.

Diamonds have never been reported in any of the drainages downstream from the State Line district, yet it contains 40 known diamondiferous kimberlites. Some geophysical and mineral anomalies suggest there are several

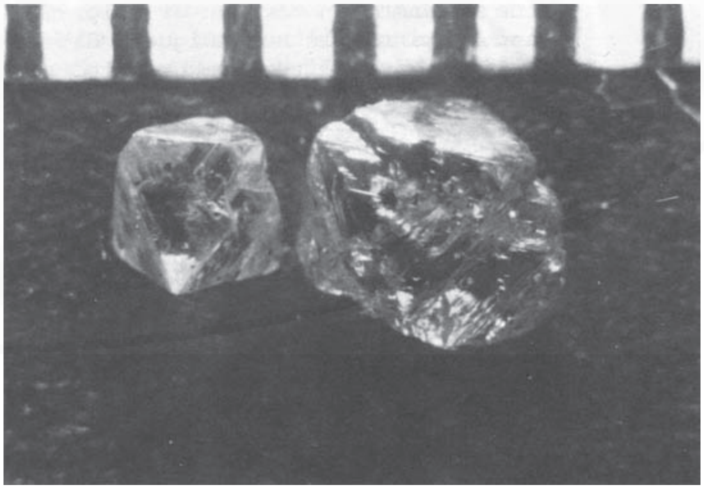

Figure 5. Two gem-quality octahedral placer diamonds found in a placer gold deposit on Cortez Creek, Medicine Bow Mountains, Wyoming.

more undiscovered diamondiferous kimberlites in this district. Thus, the total diamond budget in the streams should be significant. So why didn't gold prospectors of the past find gold and diamonds in this region? The answer is simple—the diamondiferous kimberlites occur in a region that is essentially barren of any significant gold veins and there are few indications of gold, so the past prospectors never spent much time prospecting for gold in this region. However, if gold had been found in this district, the prospectors would also have found some diamonds. Even so, many diamonds would still have gone unrecognized because most people didn't know how to identify diamonds.

Conclusions

Streams draining the known diamond districts in Wyoming and Colorado undoubtedly contain thousands of diamonds eroded from nearby diamond pipes. By becoming familiar with the characteristics of rough diamonds, a prospector will be better prepared to find these elusive gemstones. For further information on diamonds, feel free to contact the author at the Wyoming State Geological Survey.

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