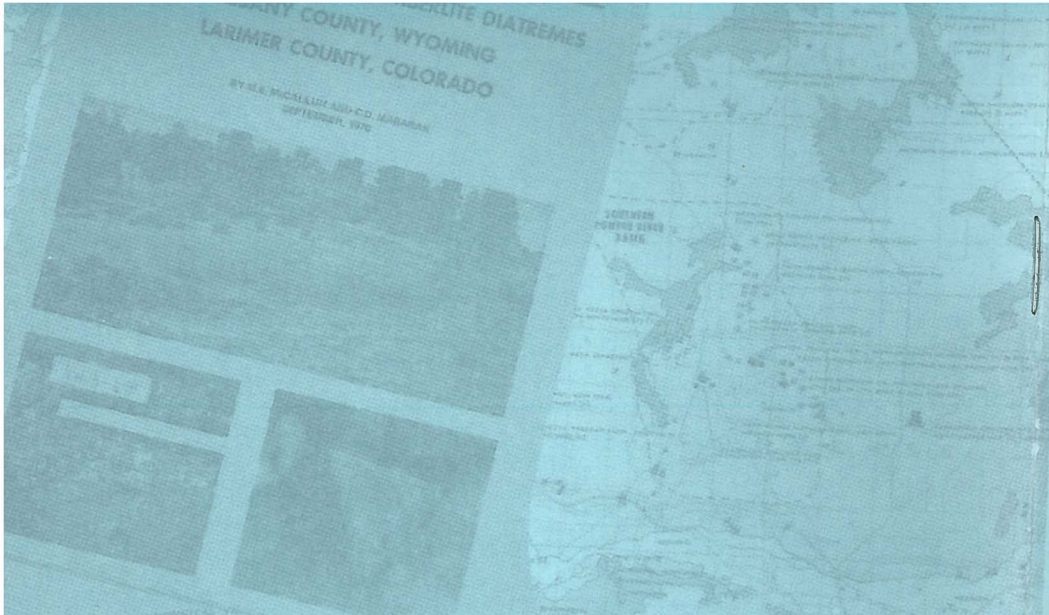

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[RI-12]

EXPLORATION FOR DIAMOND-BEARING KIMBERLITE IN COLORADO AND WYOMING
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GEOLOGICAL AND GEOPHYSICAL INVESTIGATIONS OF KIMBERLITES IN THE LARAMIE RANGE OF SOUTHEASTERN WYOMING
[PR-18]

WYOMING MINES AND MINERALS MAP (1:5000,000 — full color)
[MS-5]

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THE GEOLOGICAL SURVEY OF WYOMING
Gary B. Glass, State Geologist

DIAMOND-BEARING KIMBERLITE PIPES IN WYOMING AND COLORADO

by

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INTRODUCTION

Not many people are aware that Wyoming, as well as Colorado, has a number of diamond deposits similar to those in the famous Diamond State Park in Murfreesboro, Arkansas, and also similar to those mined in South Africa.

Actually, less than a decade ago, diamonds were accidentally discovered in the Colorado-Wyoming region in a rock called "kimberlite". Ever since this accidental discovery, there has been a fervor of activity to locate new deposits. Presently, about 100 separate kimberlite diatremes and dikes have been found in southeastern Wyoming and Colorado, including one placer diamond occurrence. Both gem and industrial quality diamonds, up to a carat in weight, have been recovered. Recent exploration and research activities by the Geological Survey of Wyoming, Colorado State University, and the Remote Sensing Section of the Department of Geology and Geophysics, University of Wyoming may lead to the discovery of several more deposits in the the future.

Diamonds in kimberlite

Kimberlite is a relatively rare rock that commonly occurs in conical-shaped diatremes (pipes) that typically merge into dikes at depth. These diatremes are quite small, usually measuring only a few tens of acres in surface area. The largest reported kimberlite occurrence in the world is a little more than one mile in diameter. Kimberlite is demonstrably of magmatic origin and contains nodules of material formed at a variety of depths in the earth's crust and upper mantle. For example, some mantle nodules and individual crystals in the Colorado-Wyoming kimberlites are believed to have been derived from depths in excess of 120

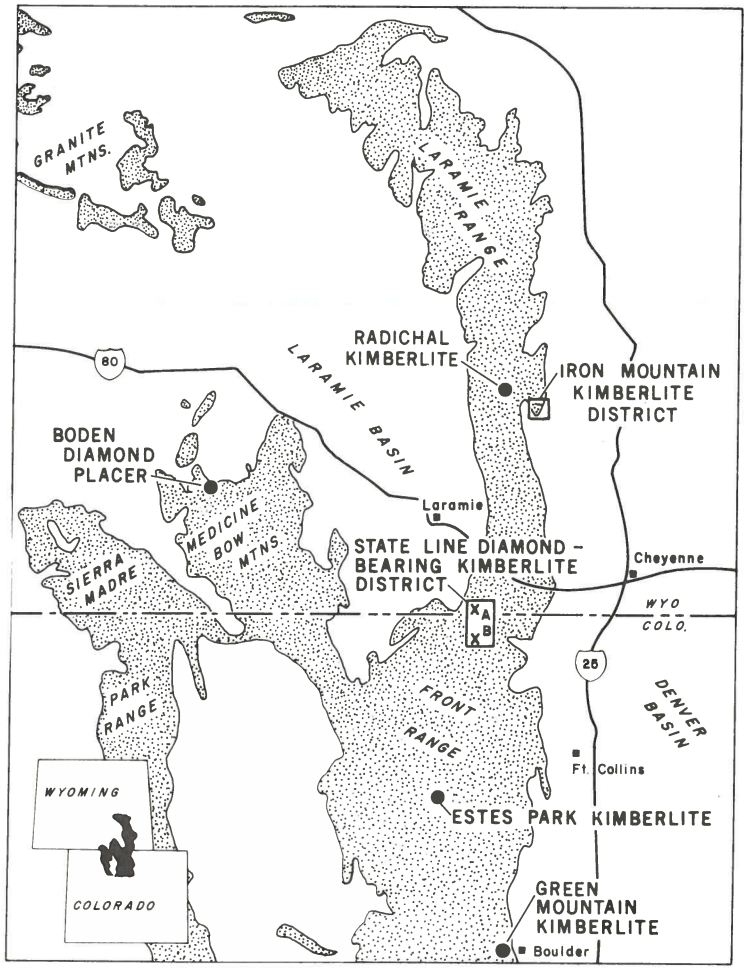

Figure 1. Location map of known kimberlite occurrences and districts. In the State Line District, locality A is the location of the two early Paleozoic outliers which were later identified as kimberlite diatremes. Locality A also includes the Schaffer 3 kimberlite where the first diamond-bearing rock was collected in 1975. Locality B is the location of the Sloan 1 kimberlite pipe where kimberlite was first recognized in 1964.

miles below the earth's surface, which provides evidence that the kimberlite magma originated from similar depths.

Some kimberlites are of great importance to the mining and industrial communities, in that they are the only known primary source rocks of economic concentrations of diamond; however, only a few of the world's kimberlites have produced diamonds. According to Lampietti and Sutherland (1978), less than 10 percent of all the known kimberlites are diamondiferous and less than two percent contain commercial amounts of diamond. In those kimberlites that are diamond-bearing, diamond concentration generally is considerably less than one ppm (part per million). Thus, the chances of finding a commercial diamond pipe are indeed small.

History of the diamond discovery

The historical events which led to the discovery of diamonds in Wyoming, and later in Colorado, began in 1960. During that year and in 1961, the discovery of two small outcrops of limestone in southeastern Wyoming presented problems to geologists familiar with the geological history of that part of the country. These two outcrops, located 20 miles south of Laramie, represented an enigma for a number of reasons. First of all, fossils found in these rocks were Ordovician and Silurian in age (400 to 500 million years old). The discovery of these rocks was difficult to explain because no rocks of similar age had been found in this region. The nearest Ordovician rocks are more than 90 miles away, and the nearest exposure of Silurian rock is more than 300 miles distant. Secondly, these lower Paleozoic limestone outcrops were chaotically distributed in oval shaped areas, 200 to 300 feet in diameter. Thirdly, the out-

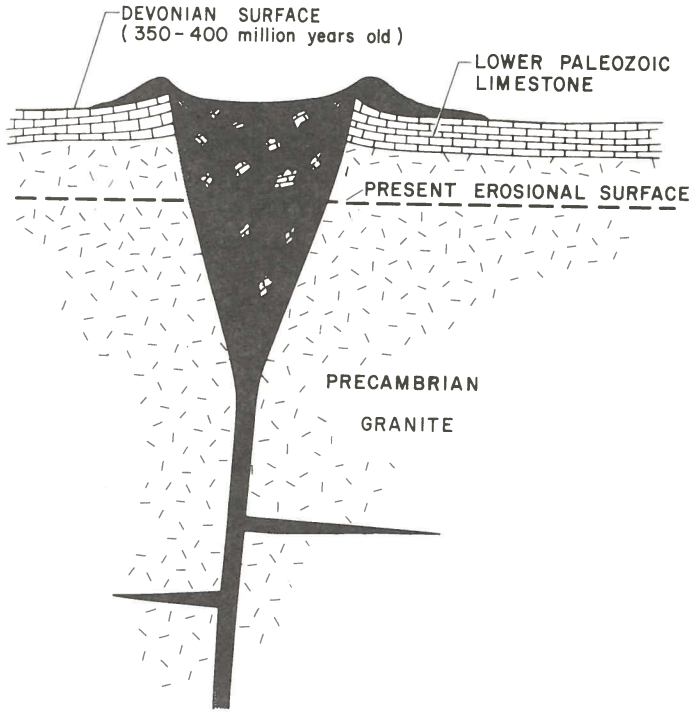

Figure 2. Cross-sectional view of a Wyoming kimberlite diatreme. During the eruption of these kimberlites some 350 to 400 million years ago, blocks of overlying lower Paleozoic limestone became trapped within the kimberlite and sank possibly a few hundred feet. Later, erosion removed all traces of the bedded limestone and portions of the kimberlite. Some of these kimberlites have been discovered because some of the trapped blocks of limestone are now exposed at the surface.

Kimberlites represent some of the fastest geological phenomena. The eruption of the kimberlite from depths as great as 120 miles below the surface may have been as rapid as three times the speed of sound (Mach 3), with gaseous emplacement temperatures as cold as 0° Centigrade (Hughes, 1982).

crops were located in the middle of Precambrian granitic terrain dated at 1.4 billion years old. It was as if someone or something had dumped these rocks at these localities for some unknown reason.

Two papers were written by Chronic and Ferris (1961, 1963) that speculated on the origin of the outcrops and termed them early Paleozoic "outliers". The actual origin, however, continued to elude researchers for some years.

In 1964, a similar limestone outcrop was discovered in Colorado, about 12 miles to the south of the first two. In addition to the limestone blocks, this outcrop (known as the Sloan 1 Pipe) contained greenish igneous rock. The green rock was identified by M.E. McCallum from Colorado State University as kimberlite (McCallum and Mabarak, 1976).

The presence of kimberlite in association with the limestone led to a viable explanation for these so-called "outliers." When the kimberlite magma erupted 350 to 400 million years ago, the region south of Laramie was covered by lower Paleozoic bedded limestones. The explosive eruption of the kimberlite fragmented the overlying limestone, and blocks of limestone became trapped and sank into the magma. Over the last several hundred million years, erosion has removed all traces of the bedded limestone in this region, and all that remains are these limestone fragments and blocks that were trapped within the kimberlite diatremes.

Following the discovery of kimberlite, a number of research projects were conducted by Colorado State University and the University of Colorado, and several more kimberlites were discovered. Then, in 1975, Dr. McCallum collected some nodules from a Wyoming kimberlite (Schaffer 3

Figure 3. Some Wyoming diamonds -- note the typical octahedral shape (scale divisions 1 mm apart).

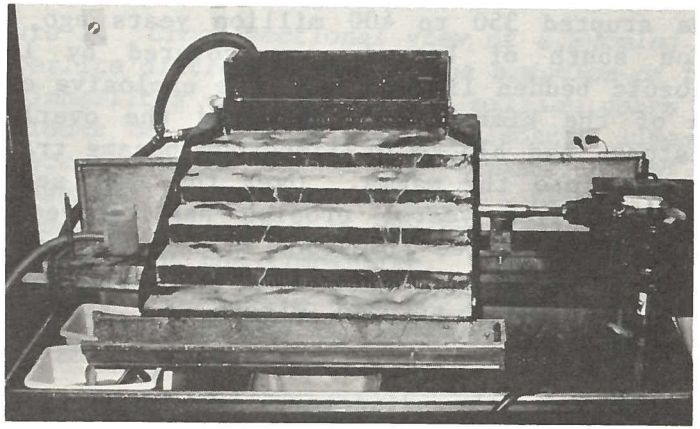

Figure 4. View of a side-shaking grease table in operation at the Geological Survey of Wyoming's diamond extraction lab.

pipe) for research studies. One of these nodules, while it was being ground on a carborundum plate, produced several deep scratches in the grinding wheel. This led to the immediate speculation that the rock fragment contained diamonds since diamond is the only known naturally-occurring substance harder than carborundum. The rock was dissolved in hydrofluoric acid, and several small crystals remaining in the residue were identified as diamond (McCallum and Mabarak, 1976).

This discovery led to cooperative exploration and research programs involving the Geological Survey of Wyoming, Colorado State University, and more recently the University of Wyoming Department of Geology and Geophysics. Today, we know there are nearly 100 occurrences of kimberlite in the Colorado-Wyoming region, and that 15 of these contain diamond (McCallum and others, 1979; Hausel, and others, 1979a, 1979b, 1981; Hausel, 1982).

Diamond extraction

The known kimberlites are found as far as 45 miles north (Sybille Canyon, Wyoming) and 90 miles south (Boulder, Colorado) of the Colorado-Wyoming border. Most of these intrusives are on private or State land, and some of the diamond-bearing ones are leased or otherwise held by mining firms, making access difficult, if not impossible. The one diatreme near Boulder, Colorado, is located in a park west of Boulder along the mountain front on the flank of Green Mountain.

The diamondiferous kimberlites in the State Line District were recently tested for commercial diamond concentrations by two separate mining firms. One company reported low-grade diamond mineralization averaging 0.005 to 0.01 carat per ton with diamonds up to one carat in size. The

second company reported grades as high as 0.2 carat per ton for two kimberlite pipes in Colorado. Gem quality to industrial quality diamonds were reported in similar ratios to many South African diamond mines. The results essentially indicated that the few kimberlites tested contained low-grade diamond resources.

The Geological Survey of Wyoming is also searching for diamonds. Unlike the mining firms, the State Survey is not interested in testing for commercial mineralization, but rather is only interested in determining the presence or apparent absence of diamonds in newly discovered kimberlites. The Survey's diamond extraction lab is very small and handles small samples. At the Survey, small samples of kimberlite (less than 500 pounds) are crushed and concentrated. The final concentrates are processed on a side-shaking grease table and a skin flotation separator (Hausel, 1982). These two diamond sorters make use of diamond's unique properties of being grease-attractive and non-wettable. Diamonds will stick to the grease on the table and will float on water in the skin flotation separator.

Many of the diamonds found to date are octahedral crystals with trigonal plates built up on the surfaces. The others are twinned octahedrons, macles (flattened octahedrons), and irregular-shaped crystals (McCallum and Mabarak, 1976; McCallum and others, 1979).

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