THE GEOLOGICAL SURVEY OF WYOMING

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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, diamonds were accidentally discovered in the Colorado-Wyoming region in a rock called "kimberlite" less than a decade ago. 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. 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 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 to the largest reported kimberlite occurrence in the world of a little more than one mile in diameter. Kimberlite is demonstrably of magmatic origin and contains xenoliths (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 miles below the earth's surface, which provides evidence that the kimberlite magma originated from similar depths (Hausel and McCallum, 1980).

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 of those contain commercial amounts of diamond. In those kimberlites that are diamond-bearing, diamond concentration generally is considerably less than 1 ppm. Thus, the chances of finding a commerical diamond pipe are indeed small.

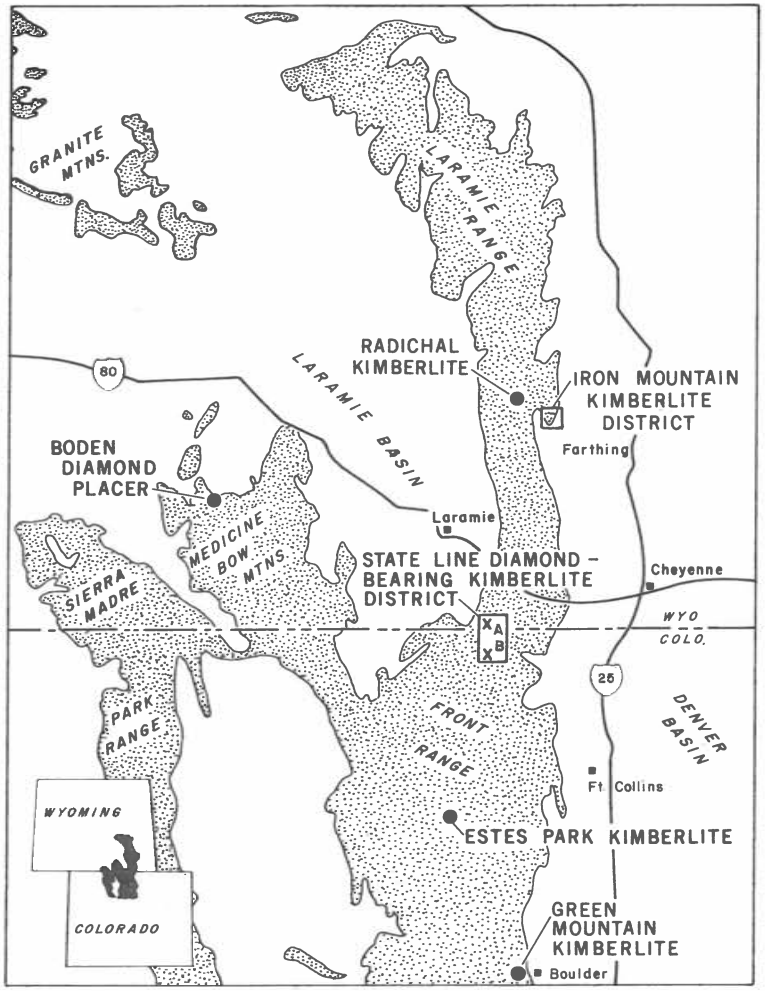

Figure 1. Location map of known kimberlite occurrences and districts. In the State Line District, locality A is the location of the two early Paleozoic outliers which were later identified as kimberlite diatremes. Locality A is also the Schaffer 3 kimberlite where the first diamond-bearing rock was collected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

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

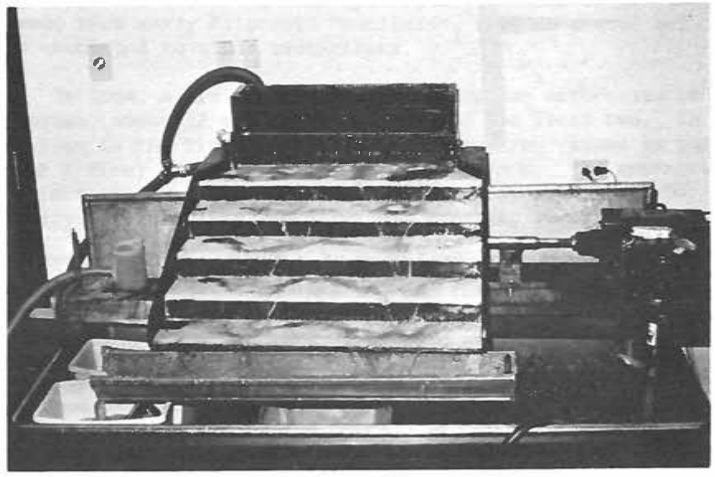

Figure 4. View of a side-shaking table in operation at the Geological Survey of Wyoming's diamond extraction lab.

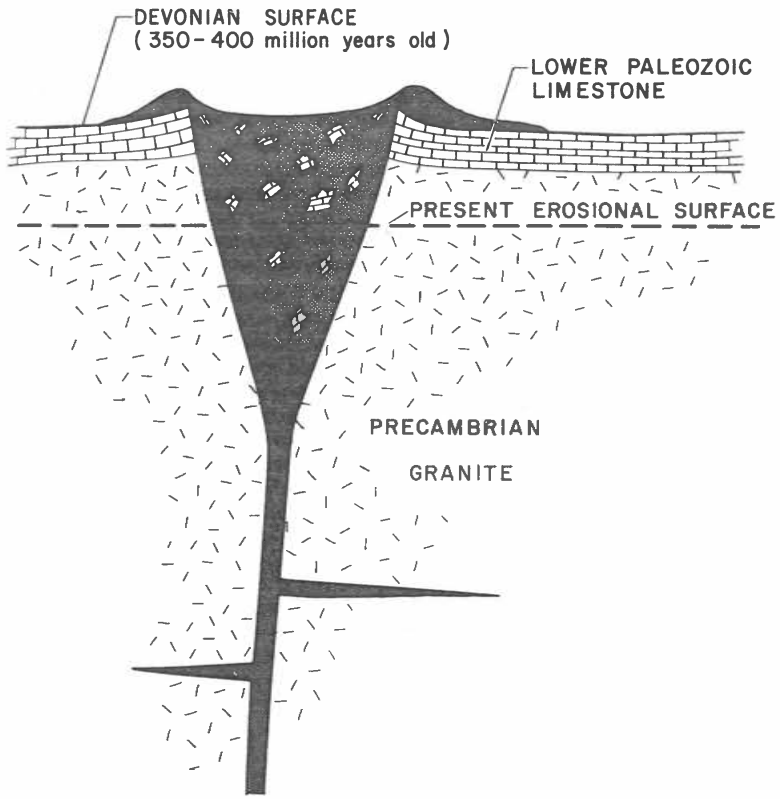

Figure 2. Cross-sectional view of a Wyoming kimberlite diatreme. During the eruption of these kimberlites some 350 to 400 million years ago, overlying lower Paleozoic limestones became trapped within the kimberlite and sank possibly a few hundred feet. Later, erosion removed all traces of the bedded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

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, two small outcrops of limestone were discovered in southeastern Wyoming that 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 outcrops 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 thousands of years, or more, ago.

For the next few years, the origin of these two outcrops remained unexplained. Two papers were written by Chronic and Ferris (1961, 1963) that speculated on their origin and termed them early Paleozoic "outliers", but the actual origin continued to elude researchers.

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 Dr. 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 with 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 pipe) for research studies. One of these nodules, while it was being ground on a carborundum wheel, 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 Geophyscis. Today, we know that there are nearly 100 occurrences of kimberlite in the Colorado-Wyoming region, and more than one dozen 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 80 miles south (Boulder, Colorado) of the Colorado-Wyoming border. Most of these intrusives are on private or State land, and 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 are presently being tested for commercial diamond concentrations by two separate mining firms (Cominco American Inc., and Superior Minerals Co.). It may be several years, however, before the commercial possibilities are known.

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. Because of the rarity of diamond, testing for commercial amounts of diamond requires the processing of approximately 100,000 tons of rock, or more. 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 property of being grease attractive and nonwettable.

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. A few of the crystals are twinned octahedrons with some macles (flattened octahedrons) and a few irregular-shaped crystals (McCallum and Mabarak, 1976; McCallum and others, 1979).

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