GEOLOGICAL SURVEY OF WYOMING

PROSPECTING FOR KIMBERLITE IN WYOMING USING HEAVY MINERAL ALLUVIAL SAMPLING METHODS

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INTRODUCTION

Presently, twelve kimberlite pipes in the Colorado-Wyoming State Line District are reported as diamondiferous (McCallum, et al., 1977; 1979). This significant discovery of diamonds found in place, has led to several investigations by M. E. McCallum, and others, at Colorado State University, and to cooperative studies by personnel at Colorado State University with personnel at the Wyoming Geological Survey (Hausel and McCallum, 1980).

After the first diamond was identified in a serpentinized garnet peridotite nodule collected from the Schaffer 3 kimberlite pipe, in 1975 (McCallum and Eggler, 1976), it became necessary to assess the extent of kimberlite occurrences. Twelve pipes tested by McCallum, et al., (1977; 1979) proved to contain diamonds: seven of these pipes, and a portion of an eighth pipe lie within Wyoming. This present paper reports on recent geological mapping and alluvial-colluvial sampling investigations conducted by the Wyoming Geological Survey in the vicinity of these diamond-bearing diatremes. Geophysical prospecting within the district was previously evaluated in papers by Hausel, et al., (1979a and b), Puckett (1971), Puckett, et al., (1972), and Woodzick, et al., (1980).

Location and Accessibility

The Wyoming portion of the Colorado-Wyoming State Line District is located in the southeastern corner of the State, or about 32 kilometers south of Laramie, Wyoming, within the Sherman Mountains of Wyoming's Laramie Range. This district is named for its location straddling the Colorado-Wyoming border. The Wyoming portion of the district extends 4 kilometers north, and the Colorado portion extends about 19.2 kilometers south of the state line. Approximately 35 kimberlites are known within this district.

Road access to the district is good, and can be reached by U.S. Highway 287 between Laramie and Fort Collins, Colorado. From Highway 287, the district lies within 3.2 kilometers of the highway by private ranch road access. No public roads enter the district.

Land Ownership

The land and mineral estate of the Wyoming portion of the State Line District subdivides into a rough checkerboard pattern of State and private land. State sections within this pattern include section 32, T. 13 N., R. 72 W., and sections 4, 6, 8; W$\frac{1}{2}$ and the NE$\frac{1}{4}$ of section 10; W$\frac{1}{2}$, NE$\frac{1}{4}$ and the SE$\frac{1}{4}$ SE$\frac{1}{4}$ of section 14; section 16; W$\frac{1}{2}$ of section 18; and the N$\frac{1}{2}$ of section 20 in T. 12 N., R. 72 W.

ECONOMIC GEOLOGY

Near the turn of the century, the State Line area was prospected for base and precious metal mineralization. The best mineralization shows are reported on the Sherman Claims in section 23, T. 13 N., R. 71 W. Limonite-stained quartz veins with disseminated copper sulfides are reported with

assays as high as $2.00 per ton of gold (1907 prices) (Osterwald, et al., 1966).

To the north and west of the known kimberlite pipes, the Copper Float and King Solomon prospects were developed at the contact between Precambrian crystalline rocks and Pennsylvanian sedimentary rocks. The weakly mineralized arkosic conglomerates at the base(?) of the Fountain Formation in these prospects contain apparent supergene native copper with copper carbonates.

Several microcline-rich pegmatite exposures were mined in the 1940's for the potash feldspar (Osterwald, et al., 1966). A number of these pegmatites are found in the district, and several show above background radioactivity (Hausel, in prep.; Elevatorski, 1976; 1979; Osterwald, et al., 1966; Trexler, 1978).

The present interest in the State Line District results from the discovery of diamonds occurring in kimberlite pipes. Seven and part of an eighth pipe in Wyoming are classified as diamond-bearing kimberlites. The pipes are the Ferris 1, Aultman 1, and Schaffer 3, 10, 13, 15, 16, and 19 (McCallum, et al., 1977; 1979; Hausel and McCallum, 1980). The known recovered diamonds are small, with the largest reported stone from Wyoming State section 16 weighing only 0.0098 carat (McCallum, et al., 1977, 1979). However, enough interest has been generated by this discovery to entice a number of exploration groups to initiate exploration programs for additional diamond occurrences in the Colorado-Wyoming region. In addition, Cominco American Incorporated will test several Wyoming pipes for economical diamond concentrations over the next several years.

Structural Guides in the Wyoming Portion of the State Line District

During the mapping phase of this project, all structural features and fractures were identified for the purpose of developing an 'ore guide' or structural guide for kimberlite emplacement. McCallum and Mabarak (1976) noted that the plan of the kimberlite pipes on the Wyoming side of the district was linear and suggested possible emplacement along prominent joints or fractures related to the predominant joint pattern trend. These kimberlite lineaments dominantly trend along a maxima between N30° W to N40° W (Hausel, et al., 1979b). Approximately 750 joint sets were measured in the host granites resulting in a maxima trend between N10° W to N20° W, or several degrees off of the prominent kimberlite lineaments. This data suggests that the most favorable fractures and joints for undiscovered kimberlite pipes trend several degrees west of the joint set maxima developed in the Precambrian host granites. However, the close association of the Ferris 1 pipe to a Precambrian diabasic dike places an importance on all prominent fractures.

GEOLOGIC MAP OF THE WYOMING PORTION OF THE STATE LINE DISTRICT

A preliminary geological map of the Wyoming portion of the Colorado-Wyoming State Line District was prepared prior to and during alluvial-colluvial sampling for the purpose of showing the relationship of sample sites to known kimberlites, and to examine possible guides to additional diatremes (Plate 1). For example, during the mapping phase, the principal investigator discovered five new kimberlite occurrences; the Aultman 2, the Schaffer 5A, 5B, 5C, and 5D.

The base for the geological map was prepared from U.S. Geological

Survey topographic maps: Sherman Mountains quadrangle (Scale 1:62,500); Cherokee Park quadrangle (Scale 1:24,000); Diamond Peak quadrangle (Scale 1:24,000), and the Best Ranch quadrangle (Scale 1:24,000). The Sherman Mountains quadrangle was photographically enlarged to match the scale of the adjoining quadrangles. The geology was mapped on U.S. Forest Service color and U.S. Geological Survey black and white photographs and transferred to the topographical base map.

Major Rock Units

The nomenclature for the granitic, basic, and sedimentary rock units was retained from Eggler's (1967) geologic map of the Virginia Dale ring dike complex, Colorado-Wyoming. At that time, Eggler (1967) mapped two kimberlite diatremes within the Wyoming portion of the State Line District. Besides these two diatremes (Aultman 1 and Ferris 1) Eggler described six additional pipes (Eggler, 1967). More recently, McCallum and Mabarak (1976) located seven pipes on a topographic base of Wyoming State Section 16.

The petrography of the major rock units is discussed in detail by Eggler (1967), and only general hand specimen descriptions will be provided here. The interested reader should refer to Eggler's (1967) thesis for more detailed descriptions.

Trail Creek Granite and Inner Cap Rock Quartz Monzonite

The Trail Creek Granite and Cap Rock Quartz Monzonite are facies of the Sherman Granite, a calc-alkaline batholith (Eggler, 1967). In hand specimen, these units are primarily differentiated by texture. The Trail Creek Granite exhibits coarse-grained hypidiomorphic granular texture. Primary

minerals are subhedral microcline and plagioclase, anhedral quartz, subhedral hornblende with minor biotite. The ferromagnesian and oxide minerals are extensively replaced by epidote, chlorite, biotite, quartz, hematite and meta-ilmenite, respectively.

The Inner Cap Rock Quartz Monzonite is characteristically porphyritic. The dominant phenocryst is euhedral tabular microcline averaging about 2.5 centimeters in length. Plagioclase phenocrysts commonly are about 1.5 centimeters in length. In addition, representative samples contain nearly 25 percent quartz and 8 percent dark minerals. The main ferromagnesian mineral is partially chloritized biotite. Magnetite is partially replaced by hematite, however, the replacement is not as extensive as in the Trail Creek Granite. Secondary sericite and epidote replace plagioclase in both facies.

Granitic Dikes

The granitic dikes are principally hornblende quartz monzonites, biotite quartz monzonites, porphyritic alaskites, and alaskites. Granitic dikes in the Trail Creek Granite stand out as resistant linear ridges.

Diabasic Dikes

Diabasic (andesitic) dikes occur as linear features trending dominantly between N 10° W to N 30° W with a maxima occurring near N 20° W. These dikes cut across diorites, some pegmatites, and the granitic dikes, and are therefore younger. The diabases are predominantly dark brown to black porphyritic to diabasic andesites containing small plagioclase phenocrysts and biotite clots in an aphanitic groundmass.

Older Dioritic Rocks

The older dioritic rocks are predominantly feldspathized by metasomatic reaction with granitic rocks.

Devonian Kimberlites

Kimberlites occur as structurally controlled diatremes or pipes. They are recognized in the field by 'blue ground' (weathered kimberlite) abundant lower crustal and upper mantle nodules, Lower Paleozoic xenoliths, caliche, and vegetative changes.

Grus

Much of the Wyoming portion of the Colorado-Wyoming State Line District is covered by grus developed on the Sherman erosional surface. These grus fields were differentiated from areas of rock outcrops to show the vast regions that are hidden by the weathered granite.

ALLUVIAL-COLLUVIAL SAMPLES

Heavy mineral prospecting for kimberlite is a classical exploration technique used extensively in Africa and Siberia. In general, this technique requires the identification of heavy mineral indicators in stream sediment samples collected during prospecting. Once a heavy mineral is identified, the explorationist follows the heavy mineral 'trains' upslope from the sample site to the potential kimberlite occurrence.

Nearly 100 alluvial-colluvial samples were collected within a six-square mile region known as the Wyoming portion of the Colorado-Wyoming State Line District. The sample location sites were identified by T.R. Stephenson and

collected by Stephenson and G. L. Reavis. Each sample weighed approximately 15 to 20 pounds. The samples were transported to the laboratory at the Wyoming Geological Survey, and processed. The processing procedure required panning (more recently sluicing the samples has taken the place of panning) to remove the finer light minerals and organic debris. Each sample was sieved into size fractions, and magnetic minerals were removed by a hand magnet. The size fraction concentrates were examined under a binocular microscope for the appropriate heavy minerals (pyrope garnet, chrome diopside, magnesian ilmenite). The physical and optical properties used in the identification of the heavy minerals are listed in Appendix A.

Sample Results

The following sample station numbers are located on the attached geological map. Samples 9, 18, 39, 49, 62, 64, 74, 83, 86, and 87 were not collected because of insufficient time. All other samples gave negative results with the exception of the following samples:

Sample Number	Heavy Minerals Identified
1	Chrome diopside, pyrope and almandine garnet, and ilmenite
10	Pyrope and ilmenite
17	Pyrope and almandine garnet
20	Pyrope, almandine, and ilmenite
53	Pyrope
93	Pyrope

Discussion

Sample number 1 was collected in a drainage that drains the Schaffer 19, and 10 pipes. Retrieving abundant heavy minerals in this sample was of no surprise in that a number of large pyrope and ilmenite megacrysts (up to 10 cm) were collected in this drainage during geological mapping.

Sample number 10 was collected in a west to east running drainage just north of the Schaffer 19 pipe. Runoff from Schaffer 19 drains to the sample site location.

Sample number 17 is in a location that receives runoff from both the Schaffer 16, and 15 pipes.

Sample number 20 was collected in a drainage running to the southeast. Identification of heavy minerals in this sample is interesting in that no kimberlite has yet to be identified in the basins draining to sample site 20. A recent reconnaissance survey of these basins revealed no indication of the presence of kimberlite. To complicate the situation, the sample was collected near the drainage where sample 19 was collected, and this drainage carries runoff from the Schaffer 3, 16, 17, and 18 pipes. Although no indicator minerals were isolated in sample 19, it is known that this drainage contains an abundance of heavy mineral indicators. In fact, several heavy mineral megacrysts were found on a low lying, 2 to 3 meter high, barrier dividing the drainage in which samples 19 and 20 were collected. However, this barrier is granitic and suggests that possible flash floods carried the kimberlitic minerals over the top of the barrier to where sample site 20 was located. More field work and

sampling will be necessary to fully explain sample 20.

Sample number 53 lies in a drainage that drains both the Aultman 1 and 2 pipes.

Sample number 93 drains from no known kimberlite and will require extensive field work to identify the source of the pyrope garnets collected in this sample. Follow-up reconnaissance surveys led to several small animal burrows containing caliche-stained grus. Samples of this material were processed, but no indicator minerals were identified. Geophysical surveys over this area are presently planned.

CONCLUSIONS

Stream sediment sampling for kimberlitic satellite minerals revealed the presence of several previously known kimberlites on the Wyoming side of the Colorado-Wyoming State Line District. Only one sample (Sample #93) came from a region where no previously known kimberlite was found. Follow-up field surveys in this region led to caliche-stained grus. Because of winter conditions, the field investigations had to be abandoned until next spring. At that time, the State Survey plans to take additional alluvial samples to be positive that the garnets found in sample 93 are not the result of laboratory contamination, and also plans to conduct geophysical surveys in the vicinity of the caliche.

The Ferris 1 and 2 pipes were not revealed in the stream sediment survey primarily because no samples were taken near these pipes. These two pipes lie on private land and no samples were collected at the owner's request.

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PRELIMINARY GEOLOGICAL MAP OF THE WYOMING PORTION OF THE COLORADO-WYOMING STATE LINE DISTRICT

geology by W. Don Hausel

RECENT

- Stream Sediments & Alluvium
- Grus (alluvial-colluvial-eluvial grus derived from weathering of granitic rocks)

DEVONIAN PENN

- Pf — Fountain Formation

PRECAMBRIAN

- FERRIS 1 — Kimberlite Pipes
- peg — Pegmatites
- Diabasic Dikes
- Granitic Dikes (biotite quartz monzonite, hornblende quartz monzonite & alaskite dikes)
- Icm — Cap Rock Quartz Monzonite
- Tcg — Trail Creek Granite
- Pcg — Older Dioritic Intrusives

Fault or alteration zone

D / U — Fault with upthrown and downthrown side indicated

Island of predominate rock outcrop surrounded by grus.

Geologic contact- dashed where approximated and dotted where projected

Strike and dip of joint

Shear zone

Joint with vertical dip

Prospect pit

Strike and dip of foliation

Abandoned mines

Earthen dam

Alluvial sample collection site.

230 kv transmission line

TN MN 14½°

0 1/2 1 Miles

SCALE 1:24,000

The Wyoming Geological Survey, 1979