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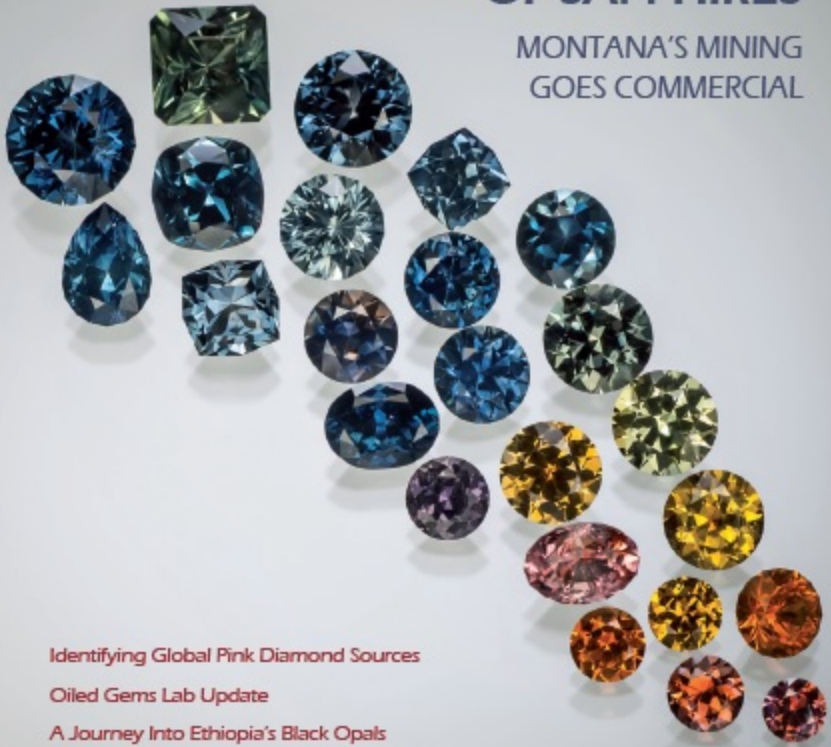
InColor

All About Colored Gemstones

A RAINBOW OF SAPPHIRES

MONTANA'S MINING GOES COMMERCIAL



Identifying Global Pink Diamond Sources

Oiled Gems Lab Update

A Journey Into Ethiopia's Black Opals

The Rock Creek Sapphire Mine of Montana - A New Era

By Dr. Keith M. Barron Ph.D., and Warren F. Boyd, BSc (Geology) & FGA (Gemmology)

Looking east from Dann Placer overlooking the meadows on the west fork of Rock Creek. In the valley are the abandoned cabins and offices from the old time miners of the 1920s to 1940s. Photo by Warren F. Boyd

The Gem Mountain or Rock Creek sapphire district is about 16 miles west of Philipsburg and approximately 60 miles northwest of Butte in west central Montana. The unique sapphire producing region of Gem Mountain only covers about five square miles, but according to the records preserved in the Montana Historical Society, it produced over 65 tonnes, or more than 325 million carats, of rough sapphire from the 1890s to 1930 (Berg, 2014).

This area of Rock Creek exceeds the sapphire production by volume of all other Montana sapphire mining locations combined. This incredible sapphire resource along with the abundant gold deposits throughout the state is the reason that Montana is rightly called the *Treasure State*.

Most historical mining has focused on a small number of gulches or ravines on the north side of the West Fork of Rock Creek, in the appropriately named Sapphire Mountain ranges, at about 6,500 feet above sea level. These famous gulches carry names such as Wild Cat Gulch, Last Chance Gulch, Queen Gulch, Sapphire Gulch, Fork Gulch, Black Pine Gulch, Mink Gulch, and Anaconda Gulch that reflect the western American history of the region (Figure 1).

The original discoveries of sapphire on Gem Mountain were made by prospectors looking for placer gold deposits which are common throughout western Montana. In 1899-1900, two miners working alone recovered an astounding 400,000 carats of rough sapphire from gravels in the dry streambeds of these gulches.

When the overburden became too deep down the grade, the miners built diversions, ditches and flumes to carry water from nearby lakes and streams and used hydraulically pressurized water hoses to wash away the overburden to expose the sapphires concentrated in these gulches. One of these hand-built wooden diversion flumes was over 16 miles (26 km) long. Historical records indicate prodigious numbers of sapphires in all of these gulches. In August 1903, one cleanup from the sluices was 110 pounds (50 kg). In some cases there were so many sapphires in the sluice boxes that they were recovered using coal shovels (Anon, Montana DEQ).

At this time in the early 1900s the bulk of this production was used in industrial applications, with a vast majority of the production sold to Gübelin in Switzerland for the jewel movements in watch bearings. Unbelievably, the largest stones at the mine site, known locally as *doorknobs*, were tumbled in barrels with iron scrap to intentionally break them into smaller fragments so they could be more easily fashioned into jewel bearings.

Over time, the popularity of pocket watches waned and natural sapphire was replaced in jewel movements by synthetic corundum which had recently come on to the market. By the late 1930s, mining was once again reduced to a small band of prospectors (Figure 8). Except for a brief up-tick in 1943 when demand increased for jeweled bearings in air force bomb sights and other specialty instruments for the military, the area largely supplied the local jewelry and tourist trade and recreational fee diggers through the 1950s to the 1990s.

The Rock Creek locality not only has fine blue sapphires but also has an incredible variety of pastel hue colored stones. These include deep blues, light blues, purple, deep yellow, golden, orange, pink, lavender, magenta, colorless, natural rubies and parti-colored sapphires. Also the rare *padparadscha sapphire* is occasionally recovered from Rock Creek – one of the few localities in the world where such stones are found (Figure 2,3,6,& 8).

These pastel hues, or *fancies*, account for 8%-12% of the run-of-mine material. The majority of the sapphires are pale green, grey-green, pale blue, pale yellow or near colorless and historically they were not commercially desirable (Sinkankas, 1959). However, in 1993, an extensive study of over 75,000 sapphires from Rock Creek showed that 65%-75% of these weakly colored green and yellow sapphires could be processed by heat treating into well-saturated blues and yellows (Emmett and Douthit, 1993).

In the last 20 years, great advances beyond the technology used in the 1990s have substantially improved the results of heat treating (Emmett, pers. com). Thus, heat treatment technology has radically increased the percentage

Top: A cozy hand built log cabin at Eureka Gulch on Gem Mountain – wood fires and running water. Photograph by Warren F. Boyd

Bottom: Privately owned hunter's cabin in the idyllic forests on the top of Gem Mountain. A popular retreat for Elk hunters. Photo by Warren F. Boyd

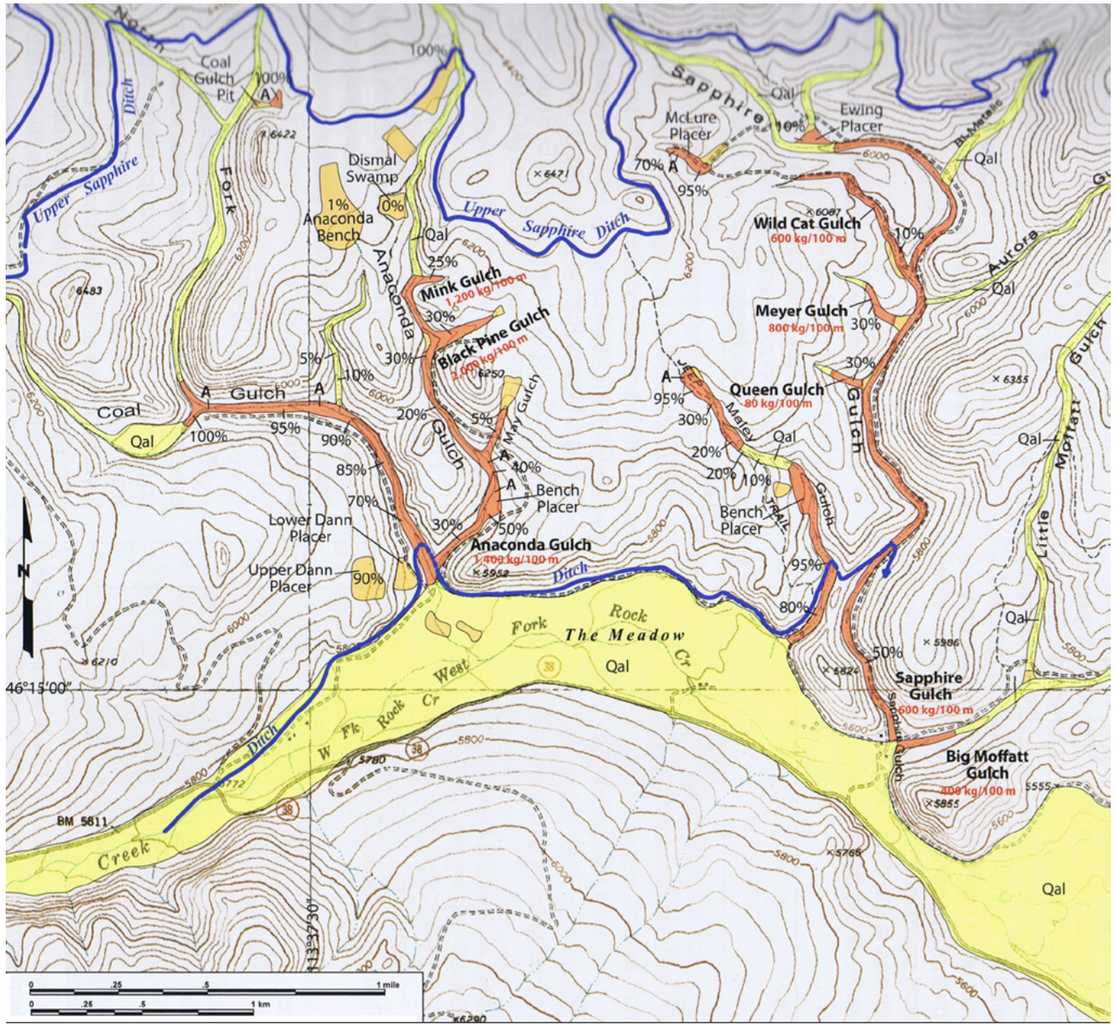


Figure 1: Map of Gem Mountain–Rock Creek Sapphire deposit showing the location of historical and more recent workings. From Berg 2014

of market acceptable colors to at least 80% of the run-of-mine production from Rock Creek.

American Gem Corporation – Sad History

American Gem Corporation (AGM) acquired the Dann Placer and Anaconda Bench claims and other areas within the gulches of Gem Mountain in 1993. American Gem Corporation (AGM) was a much promoted public company listed on the Toronto Stock Exchange. Within four years of the commencement of the AGM promotional campaign the company's shares sank to 4 cents from a high of $4.00.

AGM stated in public filings to have mined over four million carats (800 kilograms) between 1994 and 1996, but local knowledge indicates that many attics, basements and coffee tins were raided for caches of sapphires from older production. In one case, approximately one ton of small rough sapphires that was mined on Gem Mountain between 1920 and 1940 were subsequently purchased by AGM to bolster the sapphire reserve.

By 1999, AGM had changed course and their corporate name into an eCommerce entity and was thus completely out of the sapphire business. It is widely regarded that in its previous incarnation AGM was an unfortunate manipulation of investors' money, compounded by improper claim staking, environmental fiascos and litigation.

Eventually, the Rock Creek sapphire properties, formerly controlled by AGM, were sold to RY Timber, a privately owned logging company. Through a land exchange agreement with the US Forest Service, the land position was combined into sectional blocks that resulted in a large consolidated land position covering virtually the entire area north of Rock Creek, shown in Figure 1.

Over the following 13 years, the land was clear-cut of all trees and approximately 22 miles of logging roads were built, allowing unprecedented access to Gem Mountain. Parts of the property were leased by RY Timber to a small family team who produced minor amounts of rough sapphire for a few seasons. An area known as Anaconda Bench was reserved to feed a family-friendly tourist operation which currently operates down the Rock Creek valley during the summer

Dr. Keith Barron on an ATV showing easy access roads on Gem Mountain. Photo by Warren F. Boyd

Dr. Keith Barron standing in one of the gulches on Gem Mountain showing the stacked coarse boulders from the old timers workings on Gem Mountain. Photograph by Warren F. Boyd

Figure 2: Padparadscha, orange, golden and fancy sapphire colors: a selection of fancy colored Rock Creek sapphires. Both natural and heat-treated. Polished sapphires from 0.65 carat to 1.60 carat – Kenneth Lutz collection. Photography by Jeffrey Scovil.

months, well away from *Potentate*'s mining operations. The rest of the Rock Creek's historically producing sapphire properties have been idle with no production since the 1990s AGM fiasco.

Sapphires in Debris Flows

In 1993, the senior author visited and completed an informal geological survey on part of the Gem Mountain property known as the Dann Placer, which at the time was incorrectly regarded by local miners as a perched alluvial bench above the Rock Creek valley. Dann Placer is known for phenomenal mining grades, often over 1,000 carats per cubic meter, but mining exposures showed no evidence of sorting and concentrating of the gravels and sapphires by rivers or streams.

The host material was a random mixture of rounded and angular rock fragments in a muddy and clay-rich matrix with the sapphires distributed throughout this matrix. There was only rudimentary bedding, unlike the typically well-bedded and sorted alluvial gravel deposits. Thus the author has determined that the sapphire rich deposits are actually colluvium, or debris flow deposits, produced by a geological process known as mass wasting (Figure 4).

Mass wasting is effectively the formation of overlapping deposits from mudslides and landslides during humid events. Anything in the landslide's path is caught up in the mudflow and so when it comes to rest it is a hodgepodge of everything that slid off the mountain.

The gullies and gulches throughout Gem Mountain have been subsequently reworked through the geological time frame and this colluvium was washed and sapphires naturally concentrated in the drainages as alluvial placer, producing the phenomenal grades that the old-timers worked.

In 1993, except for Dann Placer, the district was incorrectly considered as mined out with the resource effectively depleted in the gulches. As a result of testing due to the improved road access, it has become apparent that the areas between the gulches contain very significant concentrations of sapphires that were, and remain, virtually untouched. These areas between the old drainages are completely virgin ground which the old-timers had ignored for three reasons.

Firstly, because it was thought worthless; secondly, for the practical reason that a supply of water with sufficient hydraulic pressure was unavailable on the hill tops to process the colluvium for testing and sluicing; and thirdly, and most importantly, this was formerly US Forest Service land and out of the purview and ownership of the miners.

Almost all of the historic mining, even up to the 1990s, was only in the drainages and gulches of Gem Mountain. It was not until the consolidation of the ground by RY Timber, with the above mentioned land exchange agreement, that these hilltops were released from US Forest Service control and thus became private property.

Potentate Mining Acquires Gem Mountain

In 2011, Potentate Mining LLC, the senior author's private mining concern, purchased the Eureka Gulch property on the north side of Gem Mountain and put it into production. Eureka Gulch is a gold and sapphire producing gulch that produces the full range of sapphires in smaller concentrations along with a significant and economic gold component in the form of nuggets and fine placer gold (Figure 5).

Eventually, in February, 2014, most of the south side of Gem Mountain was also purchased by Potentate from RY Timber. These purchases of land, representing approximately 3,000 acres, are now private property owned by *Potentate* and thus *Potentate* has the largest ground position of sapphire producing territory in the western hemisphere.

As *Potentate* advances mining, the water used is recycled to avoid the contamination of local streams, and any disturbed ground is fully rehabilitated once the mining has been completed. No chemicals are used in the exploitation process and Potentate works closely with the Montana Department of Environmental Quality (DEQ).

In the summer of 2014, Potentate completed encouraging bulk sample testing on the south side of Gem Mountain on the high ground between Mink Gulch and Wild Cat Gulch (Figure 1) and returned favorable values of in excess of 50 carats per cubic meter of gravels with some spectacular sapphires being recovered (Figure 6). Test mining, sampling and geological mapping will continue in 2015, and future seasons, especially in pursuit of the higher grade zones of sapphire occurrence.

Top, Figure 3: Two Kilograms of Rock Creek Mine-run production from test pit showing from 0.25 carat to +20 carats – no treatment and unsorted. Photo by Warren F. Boyd.

Bottom Right, Figure 5: Several days' sapphire and gold production from Eureka Gulch on Gem Mountain recovered in the 2013 season during testing operations. Photo by Keith Barron.

Bottom left, Figure 4: Detail of a trench dug into the sapphire rich colluvium on the top of Gem Mountain showing poor sorting, rudimentary bedding and a mud matrix. Note that the rock fragments are mostly very angular and unlike that found in stream deposits. Photo by Keith Barron.

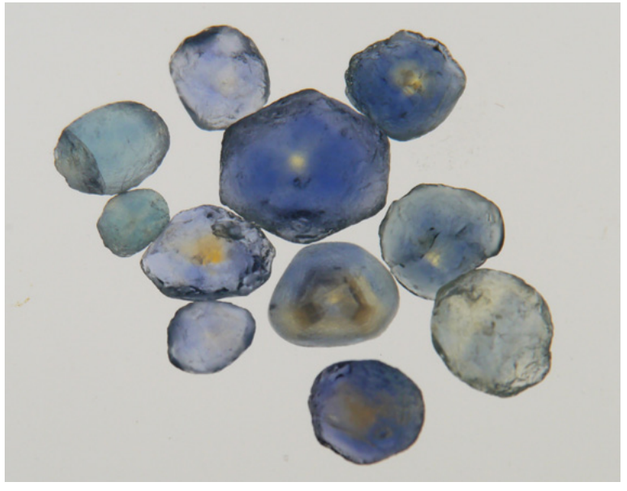


Figure 6: A selection of high-yield rough Rock Creek sapphire recovered from testing ranging in sizes from 4 to 18 carats. Transmitted light table under immersion. No heat treatment. Photo by Warren F. Boyd.

The entire area of Gem Mountain is fortunate that it has never been subjected to alpine or continental glaciation, thus the mantle of sapphire-bearing residuum has not been removed. No convincing examples of sapphire in the matrix have been found to date, however we may speculate as to their likely origins.

There has been much said over the years about the possible origins of these considerable quantities of sapphires. Berg (2014) mentions that the source rocks, that are found to outcrop at Gem Mountain, may be volcanic rocks but there has been no *bona fide* occurrence of the sapphires having being found in-situ. Currently, the sapphires are found solely in colluvium and alluvial secondary concentrations in unsorted and high energy mud flows (Figure 4). It is clear from the sapphire distribution geographically that these debris flows of colluvium, and the secondary alluvial deposits in the gullies, have transported the sapphires only a short distance.

Geology of Gem Mountain

Unpublished microprobe studies by the authors have shown the presence of niobian rutile inclusions within the sapphires. In addition, niobian rutile megacrysts as large as 0.5 to 1 cm are often found in the jig concentrates along with the sapphires. The sapphires recovered in the jigs are typically rounded and resorbed-looking, much like the look of a candy that has been sucked, in a similar way to diamonds and pyrope garnets from kimberlite.

This implies that the sapphires are xenocrysts from a deeply-derived igneous host rock that on ascent and emplacement has plucked the sapphires from the lower crust or potentially even the upper mantle. About five kilometers from Gem Mountain there is a prominent outcrop of alkali basalt. Though this occurrence is not sapphire-bearing, alkali basalt is a known source rock for sapphires in Shandong, China, Queensland, Australia, and in Nigeria.

We can speculate that a basalt flow or sheet containing sapphire was entirely weathered away, possibly during a tropical regime, to leave only the resistant minerals behind. A ground magnetometer survey performed last year has isolated several anomalies which may be feeder dikes or blows of an alkali basalt or lamprophyre intrusive. These magnetometer surveys are clearly not caused by the rhyolite nor the quartzite country rock. The geophysical anomalies will be further tested in the summer of 2015. Once the elusive source rocks are defined using geophysics and trenching then it is anticipated that these areas may generate higher concentrations of sapphires to increase the sapphire resource on Gem Mountain

Figure 7: Conchita Montana Sapphire Butterfly donated to the Smithsonian Institution by Robert E. Kane (Fine Gems International) and Paula Crevoshay (Crevoshay, Inc). Photo by Harold and Erica Van Pelt – courtesy of Robert E. Kane.

Figure 8: A selection of natural blue, heat-treated blue, and blue-green Rock Creek sapphires. Natural and heat-treated polished sapphire from 1.50 carats to 5.70 carats – Kenneth Lutz collection. Natural color rough sapphire from 0.50 carat to 18.00 carats. Photography by Jeffery Scovil.

Very comprehensive sampling and size distribution analysis completed on the sapphires recovered at Rock Creek was performed in the past by AGM for all stones down to less than 2 mm and it was determined that the vast majority would be less than 3.5 mm in dimension (Emmett, pers.com). Since the market for large quantities of sapphires of such small dimensions is limited, Potentate anticipates recovering only stones in excess of 3.5 mm. This would be accomplished by setting the screens in the jigs to 1/8 inch or approximately 3.5 mm (Figure 9,10,11).

Thus, sapphires under 3.5 mm would not be recovered and the size distributions would be skewed to a much larger size fraction. Potentate has found from its own testing program that, of the recovered sapphires from the heavy mineral concentrate, approximately 27% range in dimensions from 2.5 mm to 4.4 mm, and 65% from 4.4 to 8.5 mm. Large sapphires greater than 8.5 mm represented an astonishing 6.4% of the sampled areas, thus Potentate expects to produce a highly market acceptable product of larger blocky (high cutting yield) clean sapphire rough greater than 0.50 carats and up to 25 carats in size (Figure 8).

Rock Creek Sapphire Jewelry

Since the discovery of the Rock Creek sapphire deposit in 1899, many pieces of fine jewelry have been created by jewelers and artisans around the world from the pastel colored sapphires recovered from the Rock Creek deposit. So many fine pieces have been designed and made over the last century from Rock Creek sapphire that they are almost too numerous to mention.

In 1901, George F. Kunz, the U.S. Geological Survey special agent for precious stones, and the mineralogist for which the gemstone Kunzite was named, described jewelry that was on display at the 1900 Paris Exposition made by Tiffany & Co.

Kunz's words were as follows (Clabaugh 1952): "*At no known locality, however, has there ever been found so great a variety of rich colors in corundum gems as here (Rock Creek). At the Paris Exposition of 1900, there was shown a brooch of over 200 of these stones, ranging from 1.25 to 3 carats each, every one of a different tint or shade. Although the deep-red ruby and the velvet blue or cornflower sapphire were lacking, yet the richness and variety of the other kinds were unequaled; pale rubies, pink, salmon, passing into yellow, pure yellow, yellow brown, and deep brown, pale blues and greens, blue-green, etc. Often a single stone would show two or three distinct shades of one color. Many of the colors have never been observed at any other locality. All were of unusual brilliancy, and improve greatly in artificial light. The butterflies and other rich jewels made from these stones possess almost the beauty of natural insects.*"

Another piece incorporating Rock Creek sapphire is on

Top, Figure 9: An overview of the wash plant and excavations in the gulch on Gem Mountain showing excavators, bulldozer, ore dump truck, and wash plant. Photo by Warren F. Boyd.

Bottom left & right: Long abandoned log cabins built in the1920s by old-time miners on Gem Mountain. Photo by Warren F. Boyd.

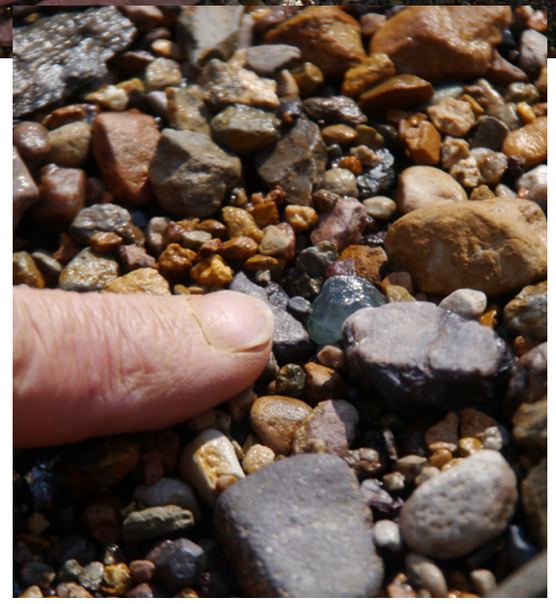


Figure 10: Ken Lutz kneeling on top of the jigs in the first stages of the clean out of the heavy mineral concentrate including sapphires and gold. Also mixed in the concentrates are old lead bullets, scrap iron, garnets and other heavy minerals. Photo by Warren F. Boyd

display in the Smithsonian Institution in the National Gem Collection in Washington. It has been entitled the *Conchita Montana Sapphire Butterfly*. Made by famous American jewelry designer Paula Crevoshay of Crevoshay Inc, it was donated by Robert E. Kane of Fine Gems International. Most of the pastel colored sapphires incorporated in these exquisite designs were recovered from Gem Mountain (Figure 7).

New Era Begins at Gem Mountain

With the reactivation of commercial mining of the Rock Creek sapphire deposit, the ownership of the majority of Gem Mountain by a private entity, and the work of a committed group of geologists, gemologists, mining engineers, and placer miners, it is clear Potentate will be able to provide a regular and consistent supply of American sapphires to

Figure 11: Approximately 8 carat blue sapphire still in the jig during clean out of the heavy mineral concentrate. Photo by Warren F. Boyd.

the global markets for the foreseeable future. Thus a new era of Rock Creek sapphire jewelry designs will be entering the markets over the following years.

For the first time in its 125 year history, the Rock Creek - Gem Mountain sapphire area is being systematically surveyed, sampled and mined using sophisticated and modern exploration and mining techniques.

At no other time in its history has the majority of Gem Mountain and the sapphire producing ground it contains been consolidated into an integrated privately owned land package available for mining and exploitation. A big part of responsible mining by Potentate will be cleaning up the old rock dumps and hydraulic cuts from 80 years ago and re-contouring and reseeding the mined out areas.

The authors have seen elk grazing in restored meadows and moose browsing on water weeds in the retention ponds. Though the Potentate property itself is closed to tourists due to safety and insurance concerns, the general public with an interest in sapphires is invited to visit the town of Philipsburg and its numerous sapphire-focused businesses.

Potentate's wider ambitions are to provide the American and international colored stone markets with a regular and

consistent supply of desirable American sapphires. Potentate's operations will supply US-produced pedigreed sapphires with a fully documented chain-of-custody from mines to market.♦

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