

## **Multidisciplinary Collaboration for Exploration in Old Mining Districts: The Segregated Belcher, Gold Hill, Nevada**

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The Comstock Lode—discovered in 1859 beneath what is now Virginia City and Gold Hill, Nevada—is the most important nineteenth century mining strike made in the United States, and second only in historical significance to the 1848 discovery of placer gold in California. The staggering wealth extracted from the Comstock mines—equivalent to the modern impact of about \$600 billion dollars—helped stabilize the Union economy during the Civil War, establish Nevada as an independent state, and transform San Francisco from a Gold Rush seaport into the innovative financial and industrial powerhouse it still is today. The Comstock Lode gave birth to a more modern, mechanized mining industry in America, and the advancements in mining techniques, technology, and mineral processing made on the Comstock reverberate down to the present day. Every nineteenth century mining district in the American West between California’s Sierra Nevada and the Black Hills of South Dakota owes some degree of debt to the Comstock Lode.

The Comstock Lode is an intermediate-sulfidation epithermal system located along the eastern flank of the Virginia Range in Storey County, Nevada. The most prominent faults in the district are the NE-striking Comstock and Occidental faults, and the NW-striking Silver City fault. Many of the district’s faults and associated fractures were the sites of Miocene hydrothermal fluid flow and the deposition of quartz, calcite and gold-silver mineralization that comprise the veins or lodes. The faults generally dip from about 60° or more at the surface to 40-45° at depth. Ore minerals within the lodes include gold, electrum, native silver, and occasional acanthite. Andesite of the Silver City and Virginia City volcanic suites have long been considered the best-mineralized host rocks, but some ores have also been found in veins within the older

ash-flow units and pre-Tertiary wall rocks. The lode widths in the northern two-thirds of the district are noteworthy, varying from about 150m to as much as 300m in the near-surface environment.

The Comstock Lode's incredible economic significance has led to a wealth of historical material documenting its events. To keep track of what was going on in the West, including in underground mines, the United States Government commissioned several surveys to map the mines—among them Clarence King's Survey of the 40<sup>th</sup> Parallel, published by the US Geological Survey in 1870, and a subsequent geological study specifically of the Comstock conducted by George Becker in 1882. King and Becker mapped the Comstock's underground workings in excruciating detail and wrote descriptions of them in keeping with the geological norms of the day. The mines themselves published weekly and annual reports, many of which found their way into the archives of the University of Nevada and Nevada Historical Society. Contemporary newspapers like the *Daily Alta California*, the *San Francisco Chronicle*, and the *Mining & Scientific Press* religiously reported on mining events, and missing mine reports can usually be reconstructed from contemporary newspaper articles. Descriptive reports from journalists visiting the mines and sworn testimony provided in court cases add other important details. Although some reports are plainly promotional (they're easy to identify and discount), most of them are plain matter-of-fact reporting which we judge can be taken at face value. This extraordinary volume of data spans decades, and much of it can be corroborated through multiple eras and multiple companies, which greatly increases our confidence in reconstructing the Comstock's history. Painstaking attention to detail through many years of reports, articles, maps, and other sources has allowed us to create a complex, multi-dimensional picture of what happened in the Comstock mines.

Over the past couple of years, we've expanded our understanding of the district in many ways—we've come to better understand the metallurgy and milling, how mining costs varied with depth and mining method, how ore handling costs changed due to the complexity of the underground workings and ore body location, the costs of fuel, timber, and pumping, how mine ownership changed and why, how

bonanza strikes influenced the development of mines in other parts of the lode, what factors drove development of the great third line shafts, and much, much more.

The old Comstock was divided up into about two dozen small claims, and each one of those old claims has its own particular story. To give you an example of the gritty research and analysis we've poured into understanding the district over the last several years, we're going to tell you the story of the Segregated Belcher (or, Seg. Belcher), which consisted of only 160 feet of strike length along the lode. The Seg. Belcher is located between the Belcher to the north and the Overman to the south and is just north of where the Comstock Lode splits into two south-striking branches, the Silver City and American Flat spurs.

Although the Seg. Belcher had very little historical production, the mine's modern exploration potential caught our attention early on when we discovered annual reports from the late 1880s and early 1890s that documented significant mineralized material that hung just below the threshold of nineteenth century extraction grades. Those teasers prompted us to take a deep dive into the mine's history. What we soon discovered in other archives made those 160 feet even more attractive as a modern exploration target.

For the first two and a half decades of Comstock development, three competing claimants disputed ownership of the Seg. Belcher based on the overlapping Belcher, Apple, and Mides (sometimes Midas) claims. Indeed, those disputes likely motivated the Belcher Company to fence off the disputed ground from the rest of their claim. This was done for good reason, too, because those disputes curtailed mining of that section of the Comstock Lode for the next two decades. Without clear title, none of the three claimants was willing to risk major investments in mine development. Not until 1886, when the second bonanza strike at the Consolidated California & Virginia mine sparked another mining boom, did the three Seg. Belcher claimants bury their hatchets and do the obvious—consolidate. Thus, the Seg. Belcher missed the Comstock heydays in the 1860s and 1870s. Its recorded production from 1865-1898 is

9,911 tons and \$178,433 (State of Nevada records of Net Proceeds of Mines, Couch and Carpenter, 1943). Using the fixed price of gold in the nineteenth century of \$20.67 per ounce, this calculates to an average grade of about 0.9 oz AuEq/ton.

The consolidated ownership started exploring the Seg. Belcher mine by drifting over from the adjacent 1300, 1200, 1100, and 1000 levels of the Belcher mine, which had extracted their massive, deep bonanza ores from those levels in the early and middle 1870s. From the date of the Seg Belcher's earliest 1886 explorations and moving forward in time, we tracked down every published weekly mine report we could find and plotted their progress on a series of geologic level maps created in 1911. That allowed us to both graph the exact location of each mine report on the maps and to understand the logic of their prospecting. We followed their exploration of the best quartz bodies on different levels through lateral drifts and crosscuts, raises and winzes as they strove to follow "good indications" of a potential high-grade bonanza—which they never did find. However, from a modern exploration perspective, that news is good: abundant evidence of gold-bearing vein just below the threshold of nineteenth century extraction.

As far as we can determine, everything below the 850 level of the Seg. Belcher, the level of the "Merger Tunnel" built by United Comstock Mining in the 1920s, remains unmined. Large quartz bodies on both the footwall and hanging wall of the Comstock fault are attractive exploration targets that could return grades of between 0.2 to 0.5 opt of gold based on data published in historical archives. Other "streaks" and "seams" of quartz also strike us as interesting for follow up. What still remains a mystery is the significance of the many reports of "porphyry and quartz" or "porphyry with streaks and seams of quartz." In aggregate, there was no way that material was going to make the nineteenth century cutoff grade, so those miners generally didn't bother to assay it, but it seems at least possible that those reports described zones of stockwork veins or brecciated quartz associated with porphyry that might make attractive modern mining targets.

Historical mine and geological data, similar to that found for the Seg Belcher, were incorporated into a detailed 3D model that covers the Gold Hill and Middle Mines sections of the Lode. Analysis of these data in 3D as well in cross sections resulted in several prioritized exploration targets. The most promising targets are currently being drilled by Tonogold. Amazingly, this seems to be the first systematic modern exploration of the Gold Hill section of the Comstock Lode ever undertaken. Credit must be given to Tonogold's management team for being supportive of this unique approach to "de-risking" exploration—the process of conducting historical research on old mines is very time consuming and therefore expensive. However, if drilling results prove positive, this level of detailed analysis will have shown to be a powerful predictive tool for further exploration of the Comstock.