Development and Abandonment of Towns and Nearby Mines in Summit County, Colorado: An Analysis of Relationships

Abstract: This project was to determine through spatial analysis whether there is a relationship between mining activity and the growth or abandonment of a town. Colorado has over 1500 ghost towns, of which there are only about 640 that still visibly exist. Currently there are 271 municipalities within the state showing the dynamics that exist in settling of different areas. As we see in the current economic climate, many towns depend on the jobs provided by a local industry such as the towns that saw population explosions in North Dakota due to the oil boom in the Bakken Shale. As the price of oil plunged, exacerbated by a global pandemic, there can be seen a mass exodus of people looking for work and income elsewhere leaving many modern towns in a position where they become near ghost towns themselves. The question of did this happen to communities in mining areas then arises. Was the commodity being mined depleted, was infrastructure at the time not adequate enough to support a towns sustainability or was this just a generational development where the young left and never returned? According to the USGS Colorado has 302,591 records of mining claims on public lands managed by the BLM. There are 14,282 active mining claims and 288,309 closed mining claims. This is just a record of claims. There are many mines that, to this day, remain unknown to the authorities responsible for monitoring of these sites as many would have occurred during the gold and silver rushes that happened in the 1800's. Due to the large mining activity that has occurred in Summit County, CO, an analysis of the data may show a mines longevity, commodity and accessibility to a road or rail network may have helped a neighboring settlement grow. Results show a correlation between mines and presence of towns.

Introduction: Anyone driving along I-70 in the mountains of Colorado are greeted with signs to tour underground mines and can see the physical changes to the landscape that these mines of days past have done. There are the mine entrances, the tailings and the machinery used to get the ore out of the ground and processed for the desired commodities. With these mines came the prospectors followed by the settlers who would build towns to service the inflow of people who desired to make it rich in the gold and silver rushes. As these mines dried up there was no longer any need to stay and people moved on. Some of these towns died with the mines while others not only survived but thrived and continue to grow.

What were the factors that determined whether a town survived or not? Was it solely the mines themselves or was it the infrastructure present? Maybe it was access to arable land where these people could move from mining to farming and continue to generate revenue to keep the town alive? Maybe it was a completely unrelated. The town of Gilman, CO, founded in 1886 during the silver rush, was a successful mining town until 1984 (it was the most successful in Eagle County) when the EPA forced its closure due to high levels of arsenic and other toxins due to the decades of mining of lead and zinc. The area was designated a superfund site in 1986 and declared clean in 2000.

This is the story of just one of an estimated 1400 ghost towns in Colorado, of which upwards of 600 plus still exist in form or another. So, what of the other ghost towns? Can we tell their story by conducting spatial analysis by determining the location of a town in proximity of a mine? Was the mine abandoned before the town or did situations change where having a town in close proximity didn't make sense or wasn't feasible for other reasons? Maybe it was due to the change in infrastructure where a location started with a trail and ended with a major highway.

Using the results from this analysis we may be able to provide a bigger picture of human migration and settlement of the state as well as the activity. Depending on the source of information one is looking at you can see figures for abandoned mines ranging from 15,000 to nearly 50,000. Why is there such a big range? Because not all mines in Colorado have been identified. On a personal note, I almost tumbled down a shaft while hiking in the mountains because it was hidden by brush. The state of Colorado does it's best to record and secure these areas to prevent accidents or explorers who might otherwise get lost and/or injured without anyone knowing their whereabouts. These results could show the path of the known successful mines which could help in determining prospecting areas that have yet to be identified. It could also provide a source of historic significance by locating sites where mining camps were established, but never recorded.

Summit County has one of the most visible histories of mining within the state. Leadville, which sits at an altitude of 10, 151' above sea level, sits on what is known as the Colorado Mineral Belt. This belt "is a northeast-trending, ~500-km-long, 25-50-km-wide belt of plutons and mining districts that developed within an ~1200-km-wide magma gap". (Chapin, 2012) Oro City, one of the first mining camps founded in 1860 during the Colorado gold rush of the late 1850's, was set up about a mile east of where Leadville is now. This was the first of many mines in the area that would show activity up until 1999 when the last mine was closed.

Research Context: "The expectation of future resource depletion, moreover, has implications for the housing market in boomtown areas. Rents would be expected to be higher and housing durability lower, in some mix, since the going return to capital investment must be obtained in a smaller number of periods than is the case in more typical locations". (Graves, 2009) This tells us one of the more fundamental observations about a community which is if there is no income, there is no town. The reverse is also true as is seen in the oil and gas fields of North Dakota when there is a boom. "According to a recent survey from Apartment Guide, the region around the town of Williston, North Dakota has the highest average rent in the U.S., beating out other traditionally expensive areas such as the Washington D.C. and New York City metropolitan regions. A renter in Williston can expect to pay an average of $2,394 a month for a 700-square-foot, one-bedroom apartment — space that would cost $1,504 in New York and $1,411 in the Los Angeles area". (Valentine, 2014) "In the context of the unique factors influencing a boom/bust type of location, both firms and workers face distinctive combinations of wages and rents re-quired for equilibrium. As a result, wages and rents are a direct function of the amenity setting characterized by an extraction economy, where high variance of economic prospects are expected by both workers and firms". (Graves, 2009)

When these prospectors struck it rich and brought money into the camps, these camps then became bustling towns. "Despite Colorado's extreme terrain and harsh winters, prospectors quickly pushed deep into the mountains in search of gold. In August 1859, George Spencer along with 28 other men and one woman, crossed the continental divide and discovered rich gold placers in the Blue River Valley. The camp founded at these diggings would become known as Breckenridge, and over 160 years later the town of Breckenridge thrives. In 1860 placer miners pushed deeper into the mountains, and the settlement of Oro City was established among the gold fields of California Gulch. The settlement was mostly abandoned by 1865 as the placer gold ran out. A few years later, lode gold mining was attempted and the district limped along for years in obscurity. Ultimately it was discovered that the black sands that were so difficult to separate from the placer gold was actually rich silver ore. The bonanza that followed is the stuff of legends, and the new city of Leadville became one of the nation's richest mining

cities". (Colorado Mining Towns) "Settlers looking for precious metals were in the area as early as 1874. As the number of mining camps grew, Crested Butte thrived as a supply center, and the town was incorporated in 1880. As the gold and silver played out, the mining of nearby high-quality bituminous coal supported the economy. The Colorado Fuel and Iron Company and its predecessors developed coal mines and coke ovens, making the Crested Butte area the state's leading mountain coal operation by 1882". (CO History, 1974) This shows that it wasn't all about the mining but what the miners needed. Fuel to keep warm, timbers for the mine shafts, lumber for the construction of ore processors and buildings as well as the towns. There was also people who were willing to work these mines for little money in the hopes of a better life. "While English, American, and Northern European settlers arrived first, by 1900, Croatian, Italian, and Slavic miners made up the overwhelming majority of the labor force". (CO History, 1974)

There was also the risk that a prospector could come up with nothing. With stories of those striking it rich many abandoned the eastern states and moved west to take part of the fortunes to be had. So much gold that you can just pick it out of the river. There were to be lessons learned though. As it was in the 1970's during the American fuel crisis, oil companies were selling the government on new methods to retrieve bountiful reserves from oil shale and obtained massive subsidies to accomplish the goal. "The lesson: artificially high prices (a la OPEC's embargo), plus government subsidies designed under perceived emergency conditions, mixed with too-good-to-be-true, unproven technology, makes for both big booms and even bigger busts". (Limerick, Travis, Scoggin, 2002) Other issues that can contribute to a bust are when costs of production overtake the market price of the commodity.

With the boom-and-bust cycles experienced during these times there was also the need for infrastructure in the areas. Roads and rails had to be built to accommodate what was coming in and leaving the state. As a report by the USGS in 1926 states about the year 1871, "Lodes discovered in the Archean granite in Tenmile district, Summit County, but no development until 1879, and that in deposits in limestone. Denver & Rio Grande Railroad (now Denver & Rio Grande Western) built south from Denver to Colorado Springs. Ultimate destination the City of Mexico". (Henderson, 1926) As this shows, a find could be made but take years until any kind of development as done. Colorado Springs made sense as a place to build and expand the rail network as it was a result of the Pike's Peak gold rush.

There was a great need to ensure that these commodities could be brought out of the state and taken where it needed to go as well as to bring in supplies and labor to build up these new territories of the U.S. It was reported in 1880 that "Robinson-Kokomo district, in Summit County, produces $200,000 in silver and lead. Denver & Rio Grande Railroad reached Leadville" (Henderson, 1926) Within two years after building a railroad from Denver to Colorado Springs, a railroad was built that reached Leadville. $200,000 in 1880 is the equivalent of about $5.19 million today. This area was so rich in natural resources that helped fund the U.S. expansion to the west that it only made sense to help get these riches out. "Munson, the assayer in charge of the Denver Mint in 1887, estimated the yield of placer gold in Summit County from 1860 to 1869 as $5,500,000". (Henderson, 1926) This is the equivalent of nearly $102 million today.

Methodology of mining was tested and improved. According the USGS report, the Wilfley table was invented in the town of Kokomo, just outside of Leadville, in 1895 which helped to separate the heavier minerals from the sand increasing yield. In the same year an oil drill was used to test the gravels on the Swan River. By 1905 dredging operations were being conducted which proved fruitful as by 1914 four

dredges were in operation in Breckenridge. Over this same time period there was an increase of smelters and mills to process the raw ore before depositing it at the Denver mint.

Materials and Methods: Data on mines was obtained from the USGS Mineral Resources Data System. This data was last updated in 2016 and covers the entire U.S. Metadata for this source can be found at Mineral Resources Data System (usgs.gov). First published in 2005 the purpose of the dataset is as follows: "This digest of the complex mineral resources database is intended for use as reference material supporting mineral resource and environmental assessments on local to regional scale worldwide." Given the nature and time span covered, "The database is generally sparse; many records have no information for a given field. A few fields required for proper processing are complete throughout". The accuracy, due to the timespan covered and methodology over the decades, may lack in quality. The spatial reference was given in decimal degrees with the geodetic model WGS 1984 being used. 45 attributes are contained in this dataset. With the analysis being limited to Colorado and further limiting to Summit County, only 15 were used. These were site name, longitude, latitude, country, state, county, commodity 1-3, names (differs from site name as this is a name known in the past), year first produced, year last produced, discovery year and production years.

Historical census data from 1870 to 2010 was obtained from Colorado State Demography Office State Demography Office (colorado.gov). According the website, "The State Demography Office updates its population estimates and forecasts annually in the fall. The current estimates are based on 2010 Census count population totals and are re-benched each decade with the release of the decennial Census count". This dataset consists of 8 attributes. ID, area name, area type, incorporation year, county incorporation, population year, total population and name type. Attributes used for this analysis was ID, area name, area type, incorporation year, population year and total population.

City locations within Colorado was obtained from ArcGIS opensource created by Colorado Department of Public Health and Environment which was last updated in February 2019 Colorado City Point Locations - Overview (arcgis.com). This was created as a shapefile for general public use and used US census 2010 TIGER data for city point locations. Unfortunately, there is not much more information beyond this listed however a quick search of city points from other sources checked against this data proved that the data is reliable. This dataset consists of 8 attributes. Object ID, state, FIPS, Place Fips, Status (whether a town is county seat), latitude and longitude. Attributes from this data used in my analysis consisted of name, latitude and longitude.

Ghost Towns was created by myself incorporating data from above datasets and adding ghost towns and their known/probably locations. The base dataset used to create this new dataset was the historical census data. First, all area types were sorted to list only municipalities and deletion of city. Attributes added were ghost town (Y or N), longitude and Latitude. The names of ghost towns were taken from personal knowledge and various websites specializing in tourism, photography and hiking. Further research was conducted to locate these towns using Google to obtain the coordinates. If town was not found on google then a probable coordinate location was used based on available data.

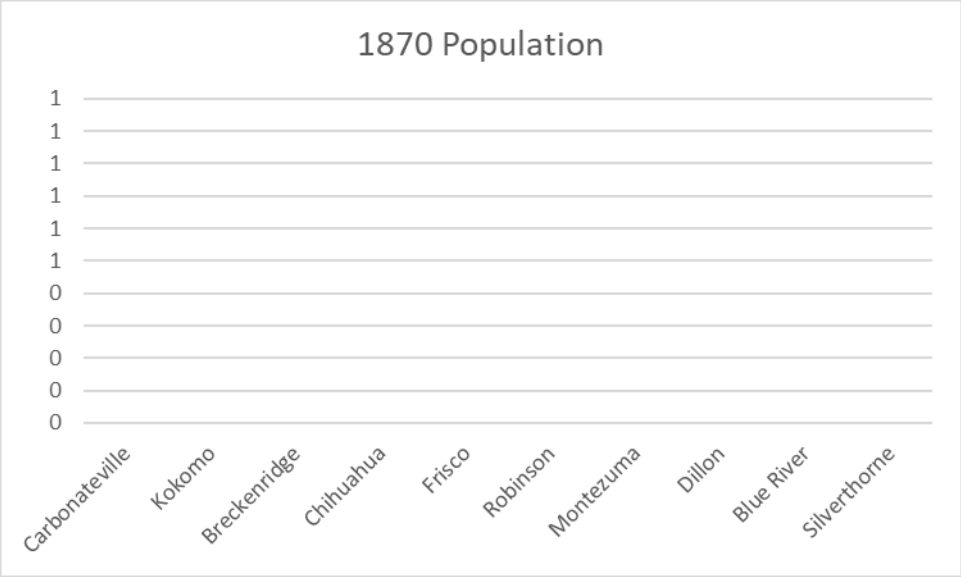
These datasets were used in order to determine the locations of current towns, known mines and ghost towns throughout Colorado. By using census data that spans from 1870-2010 we can see when the town was incorporated and if there was a population growth or decline. Population counts of less than ten could be regarded as a ghost town but for the purposes of this analysis, a population of zero was used in order to keep consistency in the analysis. In order to limit the amount of time it would take to

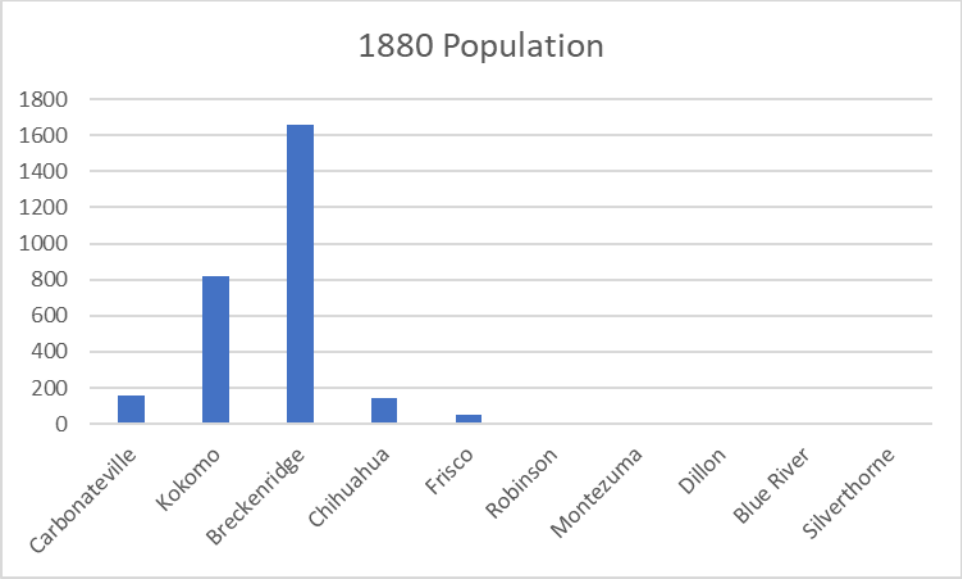
cover the analysis of the entire state on a county-by-county basis a choice was made to use Summit County as there is a record of different commodities being mined over the span of a hundred years. This time allows for boom/bust cycles and can be used to see if there is a correlation between town sustainability on activities outside of mining.

Ghost towns are abundant in Colorado and there are more than a few in Summit County. This allowed for the same analysis that is conducted on towns that are still inhabited. With available records, even if the exact location is not known, an approximate location was deemed sufficient in that analysis would cover miles of territory.

Mines data was used to not only determine its spatial location but also determine the commodity being mined. Gold is much more valuable than gravel so the commodity being mined is an important part of the dataset to determine what is more economically beneficial for a community. This dataset also provided year discovered and year last produced. Even though this data may be incomplete what is recorded can provide valuable information on the lifespan of mine. If we know when a mine is abandoned and compare that to the population of a nearby town then we can see what kind of impact is shown. If we know the discovery year and year of incorporation of a town then we can see what that relationship is as well.

Results:

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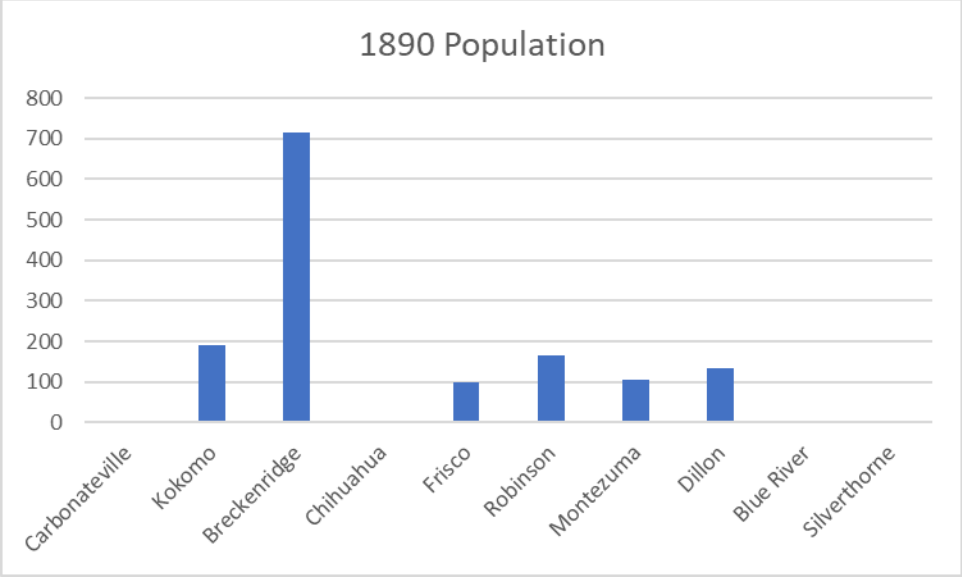
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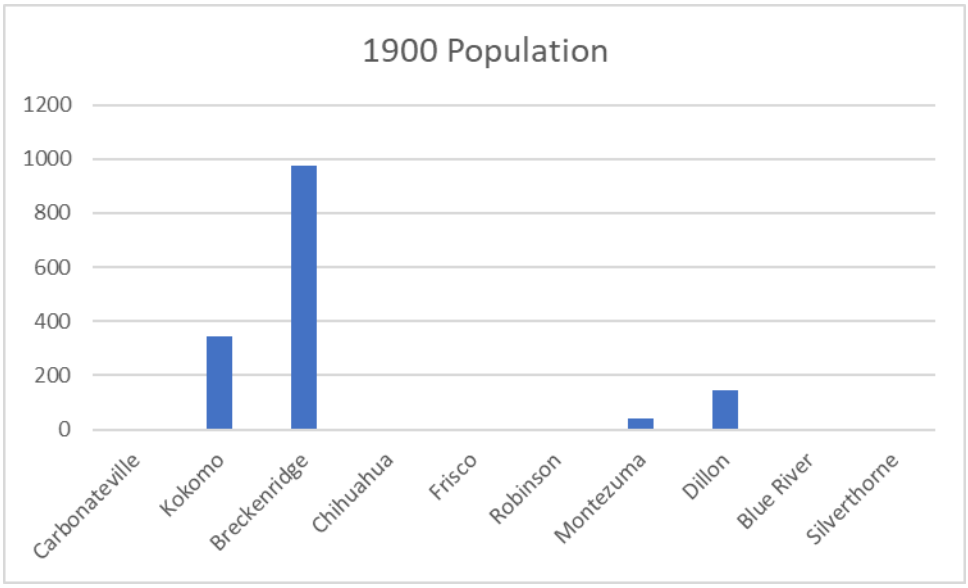
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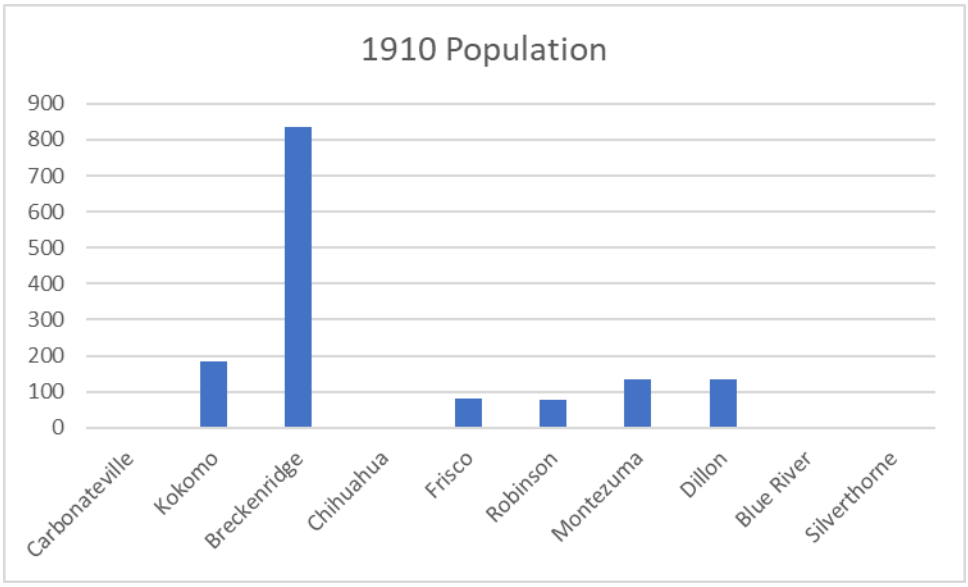
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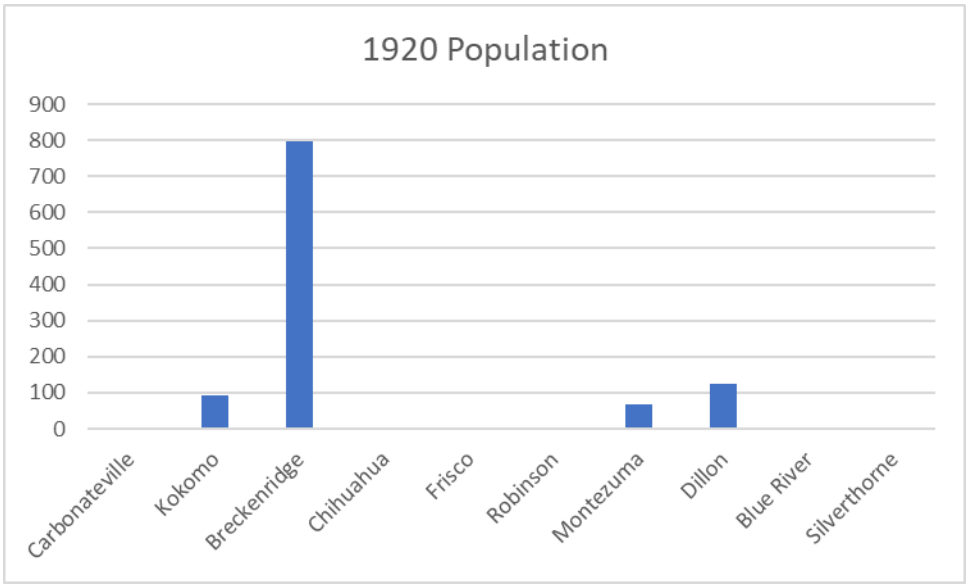
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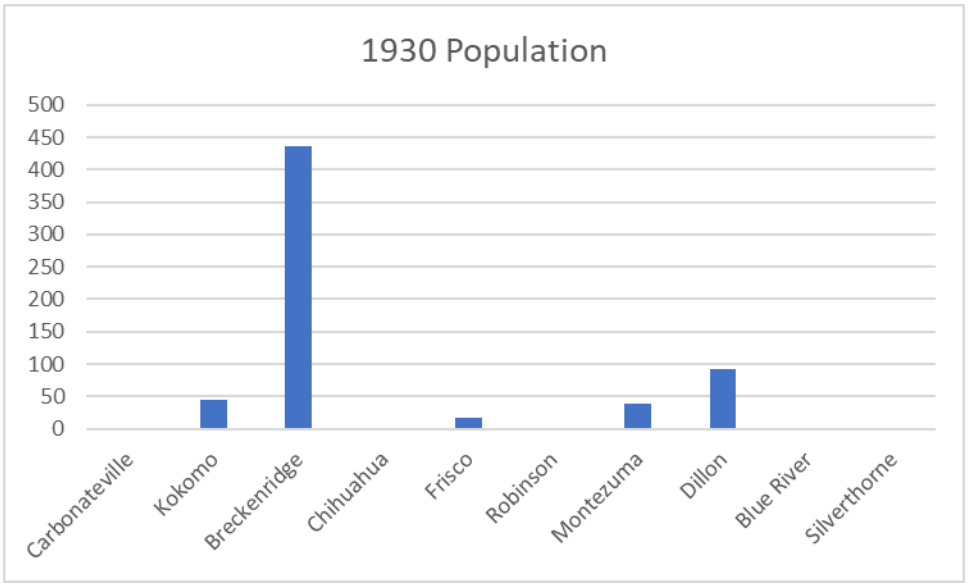
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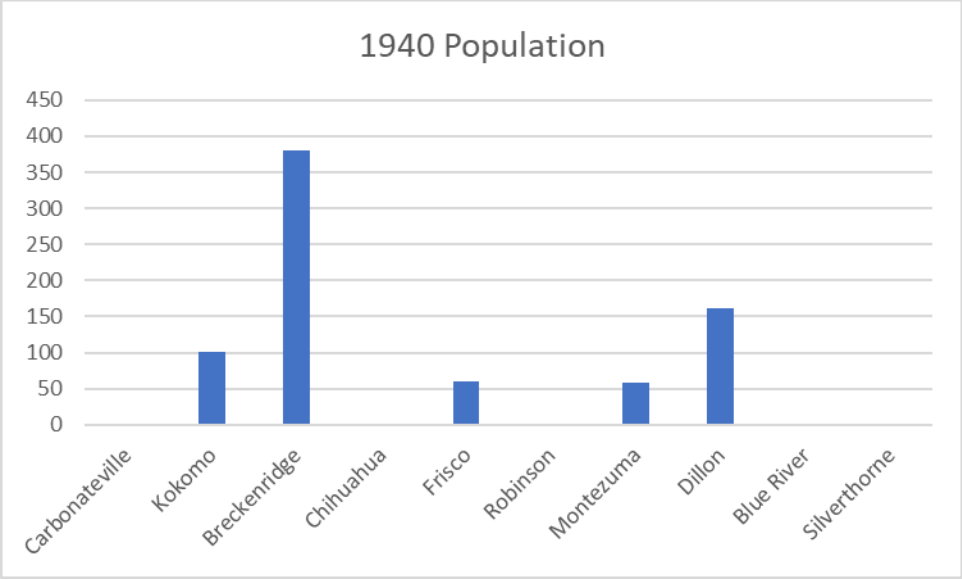
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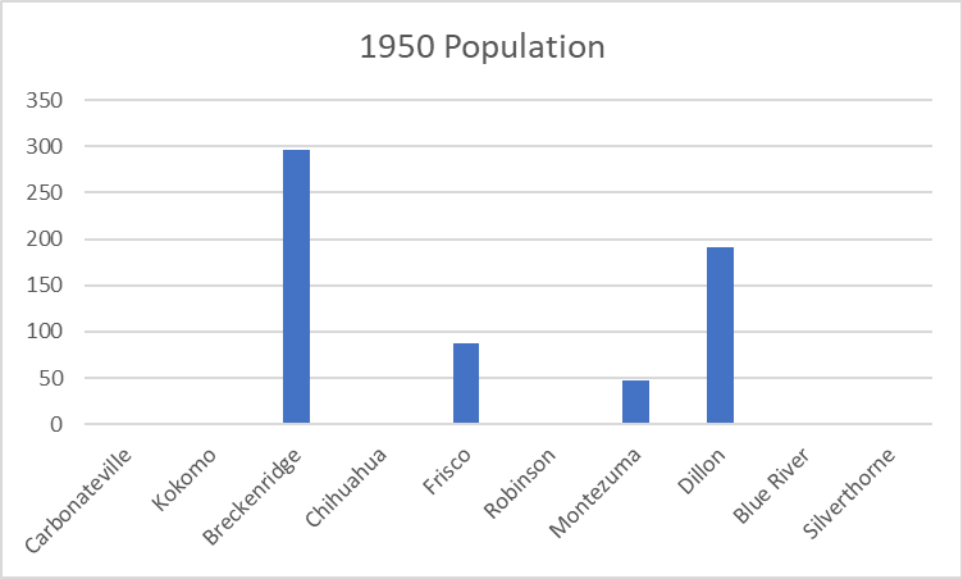
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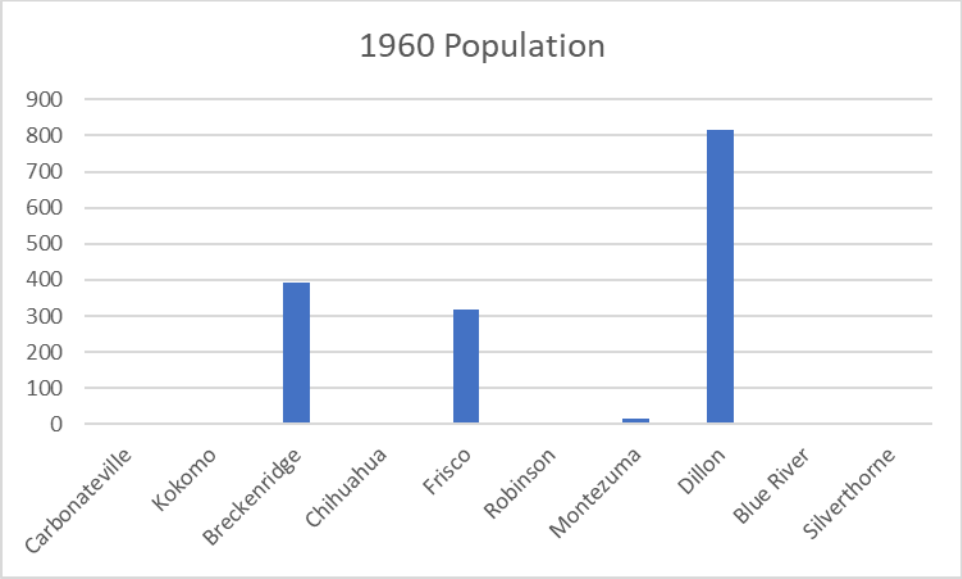
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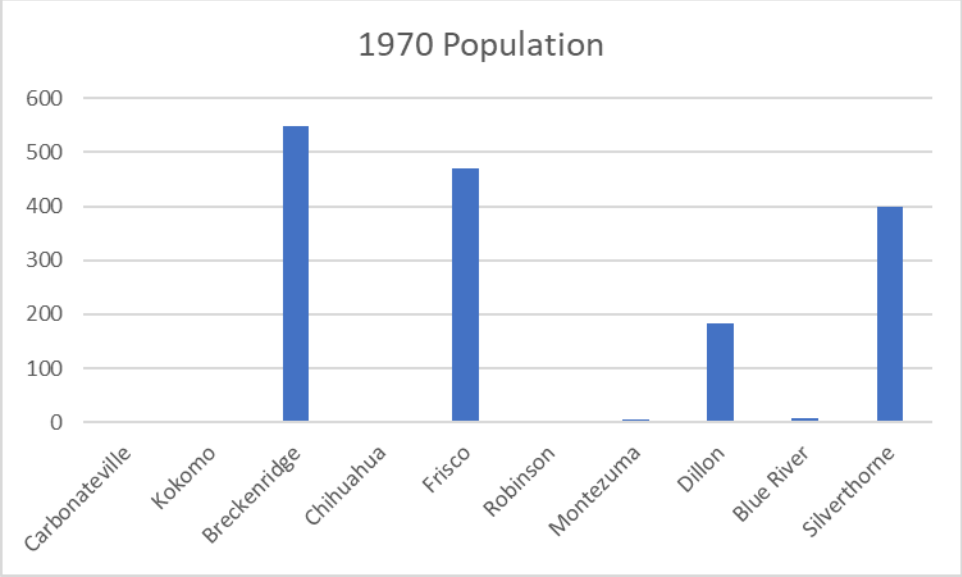
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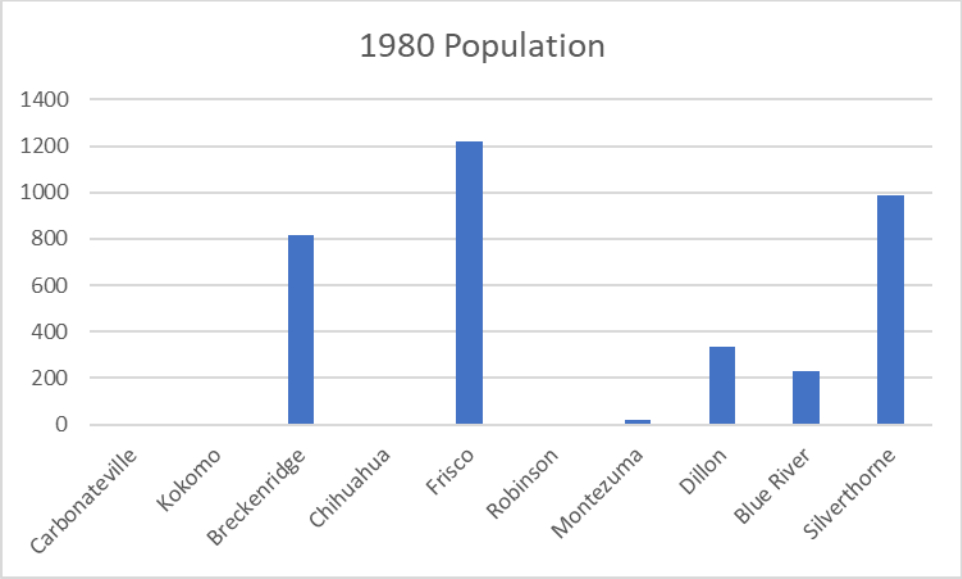
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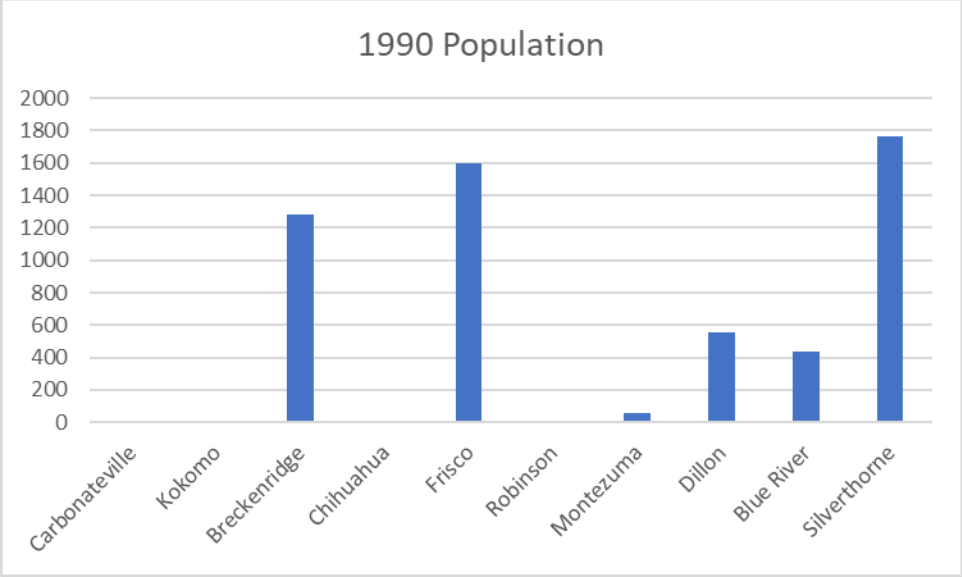
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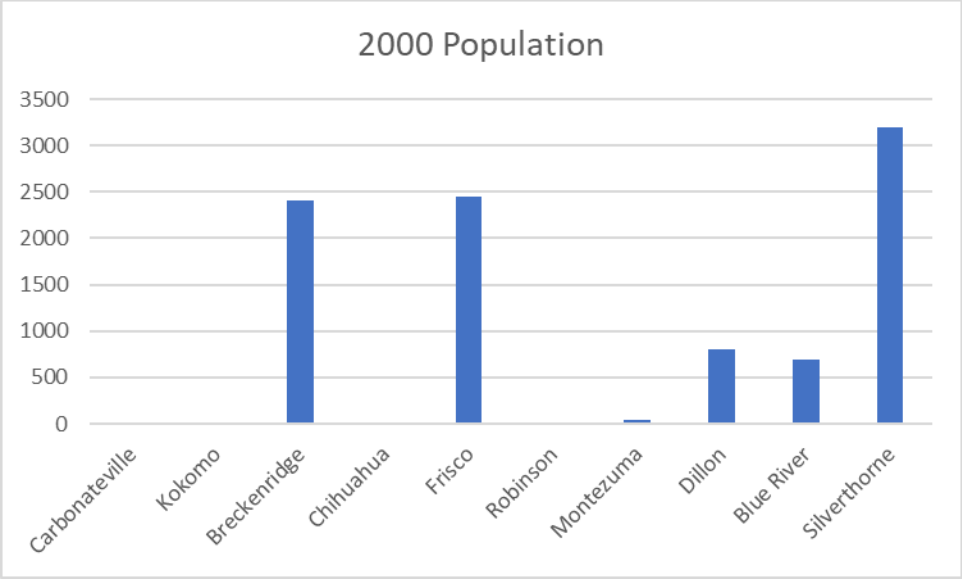
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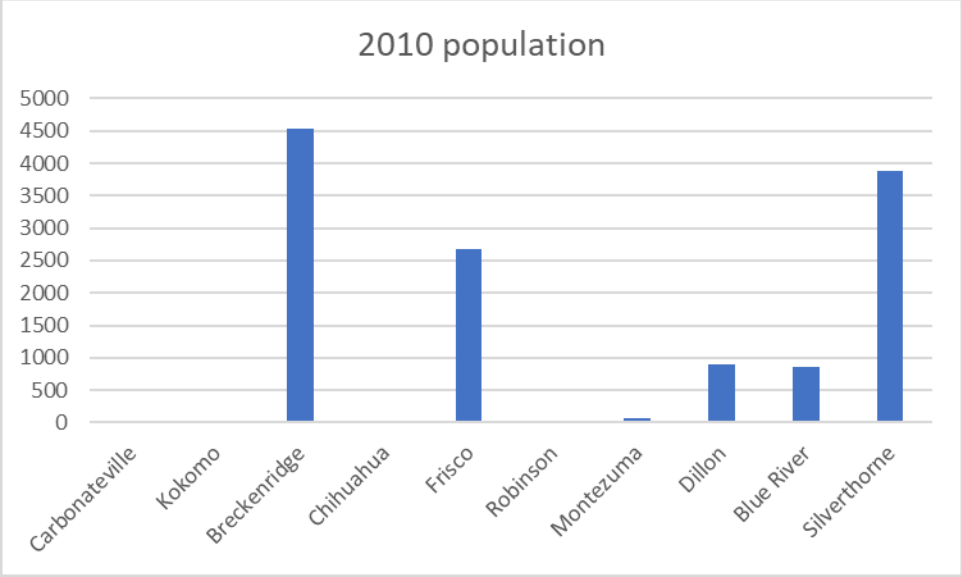
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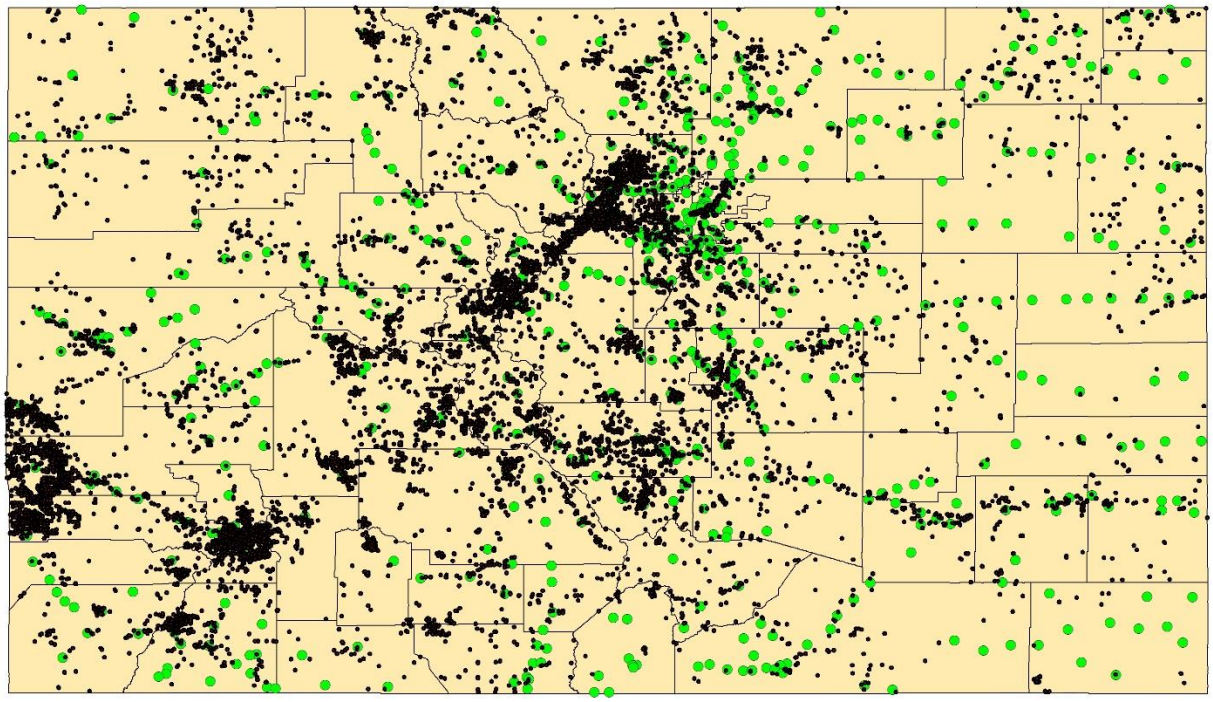
Mines in Colorado



Legend

- Mines
- Cities and Towns

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Kilometers 0 95 190

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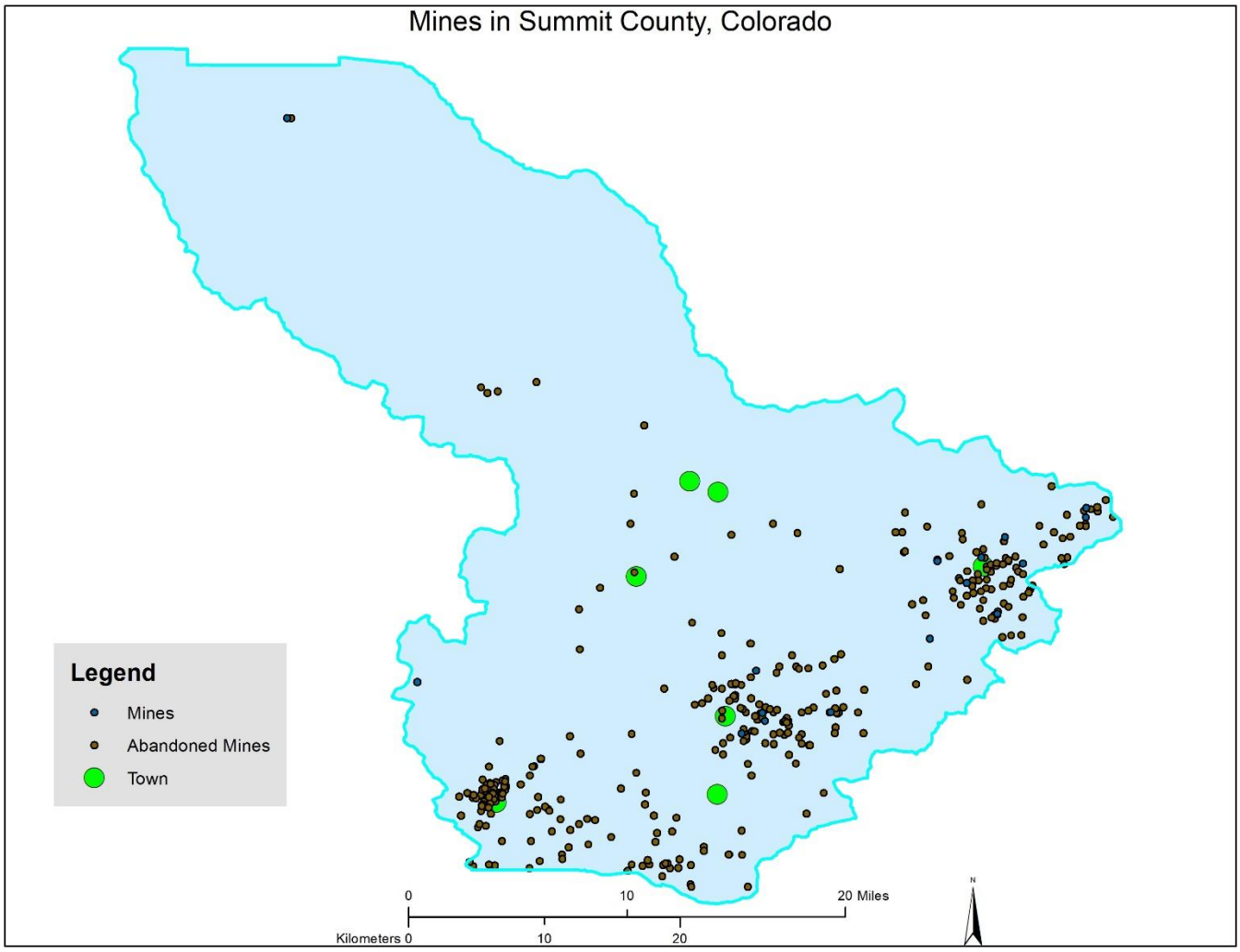

Discussion: With an area of 619 mi^2, Summit County has only ten towns with three of these being considered ghost towns. The county itself has roughly 39 mi^2 of land being used for farming showing how mountainous the area is.

We know that with that the reported first sighting of gold in Colorado being in 1758 it took some time before prospecting became a common occurrence in the state. The first of these gold and silver rushes started in 1859 and the first mine in Summit County being in 1860 just outside of Breckenridge. From the records that we have we know that there are 419 mines in the county alone. 261 of these are gold and 111 are silver or a combination thereof. Other commodities mined in the area include zing, lead, copper, bismuth and molybdenum.

As noted earlier, these mines brought in millions of dollars' worth of ore over their lifetimes. Population data is spotty during the early days Colorado mining but looking at the populations from decade-to-decade we see that there was a large population increase in 1880. We probably do not see data for 1870 due to travel conditions and remote locations of the sites were difficult at best and near

impossible during the winter months. The current route between Denver and Breckenridge is I-70 along Clear Creek which was probably only traversable by horse during this time. Many of the locations were just camps at best and trying to accurately count people as they came and went from these places must have been challenging.

The first of our three ghost towns, Carbonateville, had a very short life with only 157 people being counted in the 1880 census. This town was located near the present-day Climax mine between Leadville and Breckenridge. After this we do not see a repopulation of the town.

Our second ghost town, Kokomo, was located where the present Kokomo district is located in the south western part of the county. With a peak population of 818 in the 1880 census we begin to see a decline in the population over time with the lowest count being in the 1930 census of 44 people. There was a rebound in the 1940 census where the count was 101 people but has since remained unpopulated.

Our last ghost town, Robinson, recorded 164 people in the 1890 census. It dropped to 0 by the 1900 census and was later repopulated with a count of 78 in 1910. Since then, the town has remained unpopulated.

Looking at the rest of the populations for the remaining cities over time we see that populations actually remained quite low with no town recording over 1000 people until the 1980 census. By this time the population may have altered due to a change from mining to tourism.

When we begin to look at the mines in the area it is hard to imagine that so much could have been completed with these local populations. One question this result raises is if mining was a seasonal venture with residence being outside the county resulting in this offset. Using a radius of 5 miles from the towns located in the three clusters of mines we see in southern part of Summit County we can see there is a total of 103 mines in the south western part where the town of Kokomo once existed. In the south-central location, we have the town of Breckenridge which has 94 mines within this radius. At the eastern portion of the county lies the town of Montezuma which has 135 mines.

Using this data and comparing it against the population of Breckenridge we see that the town has always had populations numbering at least in the hundreds. Montezuma has always had a low population count and as of 2010 numbered only 65 people. Even with all of this mining activity we see one ghost town, one near ghost town and another that is booming.

Limitations of knowing the seasonal populations or where the majority of miners actually lived leaves the question of how much money was actually passing through these towns and if they were paramount to survival. Many of the ghost towns we know existed did not have coordinates due to the expansion of large-scale mining which overran these points erasing any signs of where it might have actually existed. This is true of the town Kokomo where now exist tailings ponds. The actual boom/bust cycle would also need to be compared with the annual incomes of residents during this time as it would show if the residents were employed. More research would be needed in finding records of employees of these mines to find residence which would also help answer a bulk of these questions.

Future analysis would require more detailed data showing the actual discovery date and date production ceased. The reason for the closing would also be a great help to determine if it was due to the economics of the time or whether the commodity was mined out and nothing remained. More detailed information on the road and rail network would be of great importance to help determine if

travel was impeded by terrain or other factors limiting the amount of people who would settle in these towns.

Conclusion: We can say that there is some correlation between the founding of a town and mining activity which was part of the original question but becomes more difficult to say with any certainty if a town didn't survive due to a mines' activity. Looking at our map of Summit County we see that there is only a total of 2 mines in the most northern part of the county but no towns. Where the Colorado Mineral Belt is located is where all of our towns are located.

One of the surprising elements found was the cluster of mines rather than a continuous band of mines. This did make it easier to perform a nearest neighbor calculation but makes one wonder why these clusters exist. It could have been due to the way the igneous intrusions occurred in these areas but more research is needed.

Populations were not as expected as I thought I would see a large influx of people during the 1870 and 1880 census across the board but instead we see more of a migration from town to town over time. Other than a one-time population above 1600 in Breckenridge during the 1880 census we do not see any town exceed 1000 people again until 1980. During my research I came across sources that stated some of these areas would see populations exceed 10,000 people but we do not see anything close to these numbers in the official counts so great care is needed in validating data.

Many of these mines operated for decades and produced millions of dollars and processed tons of ore. The minerals mined helped build the nation as well as fund it and provided the materials needed for the war efforts during WWI and WWII. Due to the massive amounts of manpower needed for the war efforts we cannot say that populations increased to help mine the commodities needed for these wars or that populations declined due to the draft or men volunteering for the military.

We also cannot say that the mines are what kept the towns alive since we do not have the necessary data to conclude this. Breckenridge is now a popular tourist destination with a ski resort immediately off the interstate. This begs the question of when a town was no longer dependent on the mines for survival if it ever was in the first place. There are many towns in Colorado that actually use some of these old mines as tourist attractions meaning that the mine is making money even if it is not active.

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