

# Science Camp #110808.2

8-10 August 2011 @ Nelson Cabin on Cedar Mountain  
and surrounding area

## Advisors

H. Roice Nelson, Jr. and Paul F. Nelson

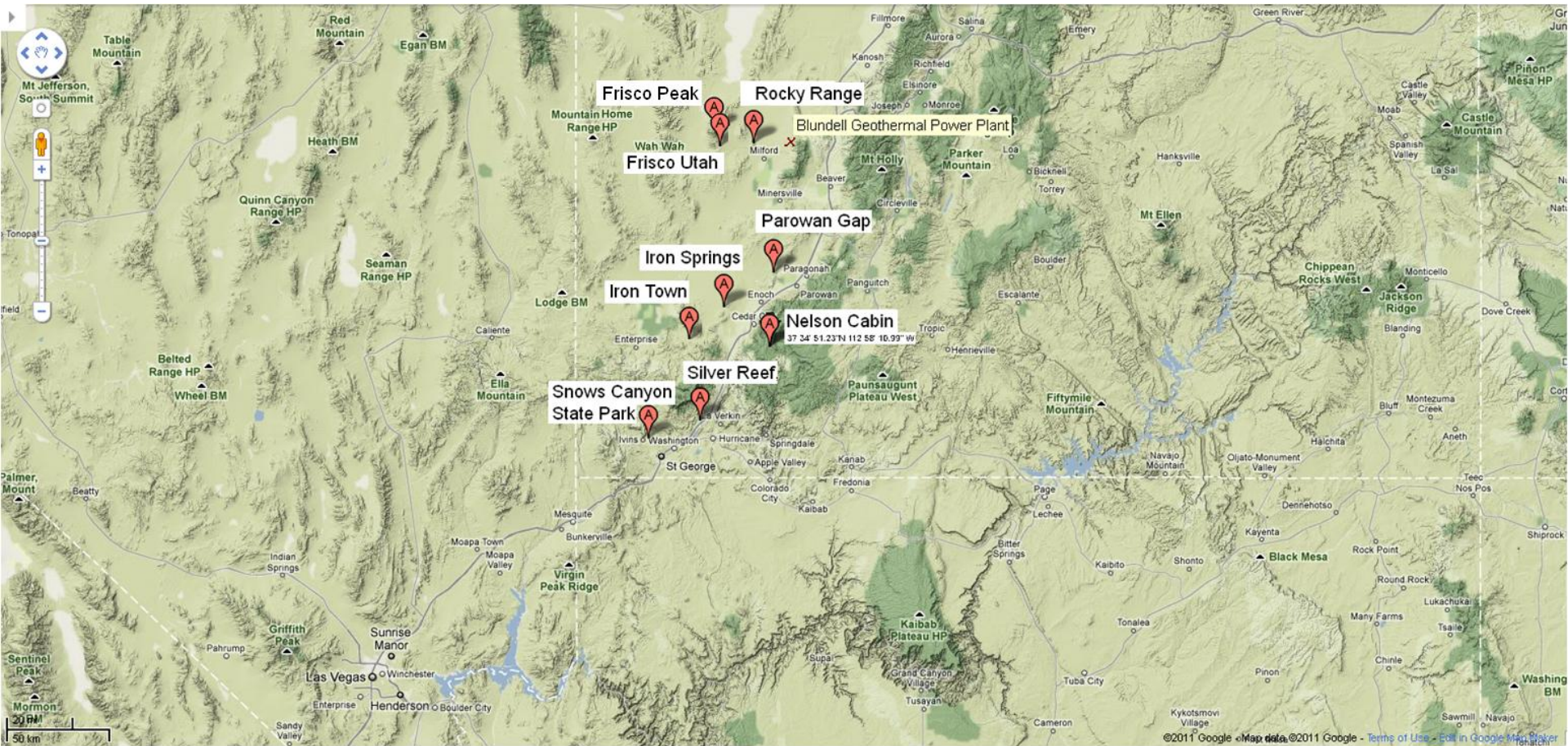
## Attendees

Ethan E. Nelson, Grant M. Nelson, Colby C. Wright

# A. Safety

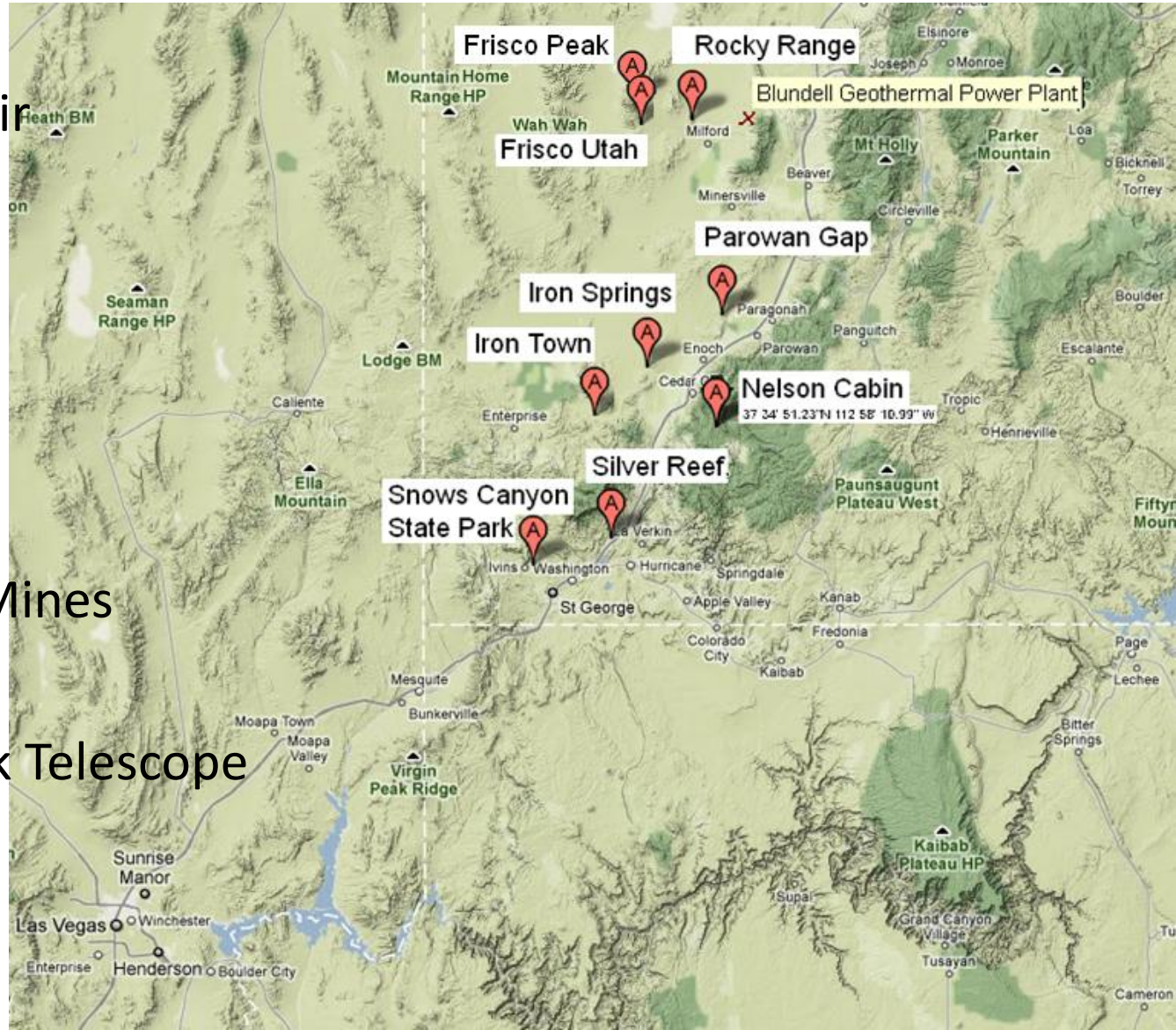
- Never go anyplace alone!
- Exception is if one of you is hurt, then:
  - One of you stay and help the person hurt.
  - The other one run and get help.
- If you get lost stay put, we will find you.
- If you hear a rattlesnake do not move quickly, just slowly move away from the sound.
- Do not run with a knife open. Use knife safety.
- If you cut yourself, apply pressure to the wound to stop bleeding, and send for help.
- Never point an arrow in a cocked bow at any person.
- Drink lots and lots and lots of water.
- Do not go swimming unless an adult is with you.
- Do not start branches on fire and swing them around where others can be hurt.
- Use common sense and think before you act.

# Mines in Southwest Utah



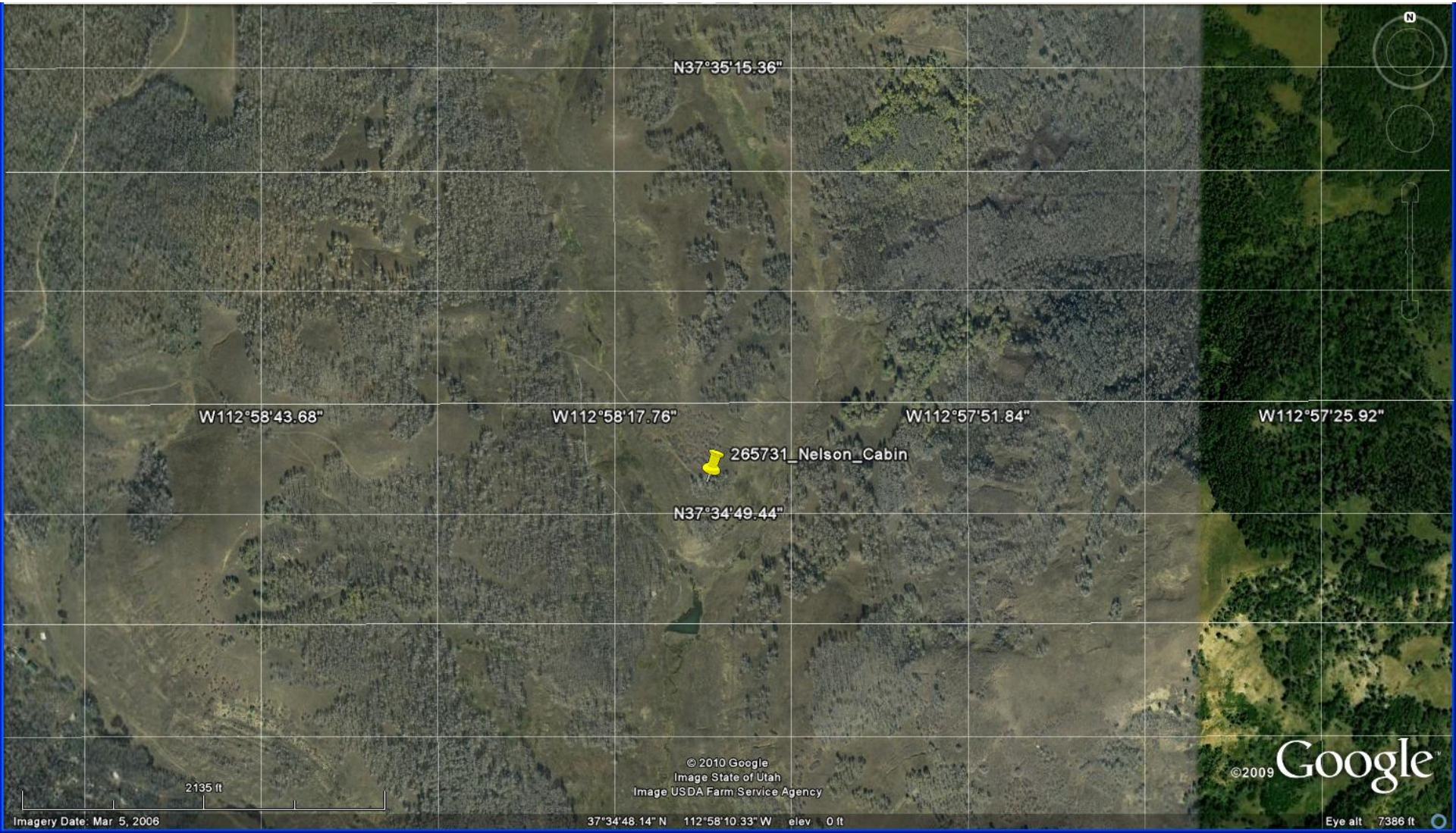
# B. Geographic Context

1. Nelson Cabin
2. Kolob Reservoir
3. Silver Reef
4. Snows Canyon
5. Volcano
6. Coal Mines
7. Parowan Gap
8. Rocky Range Mines
9. Frisco
10. UU Frisco Peak Telescope
11. Iron Mine
12. Iron Town

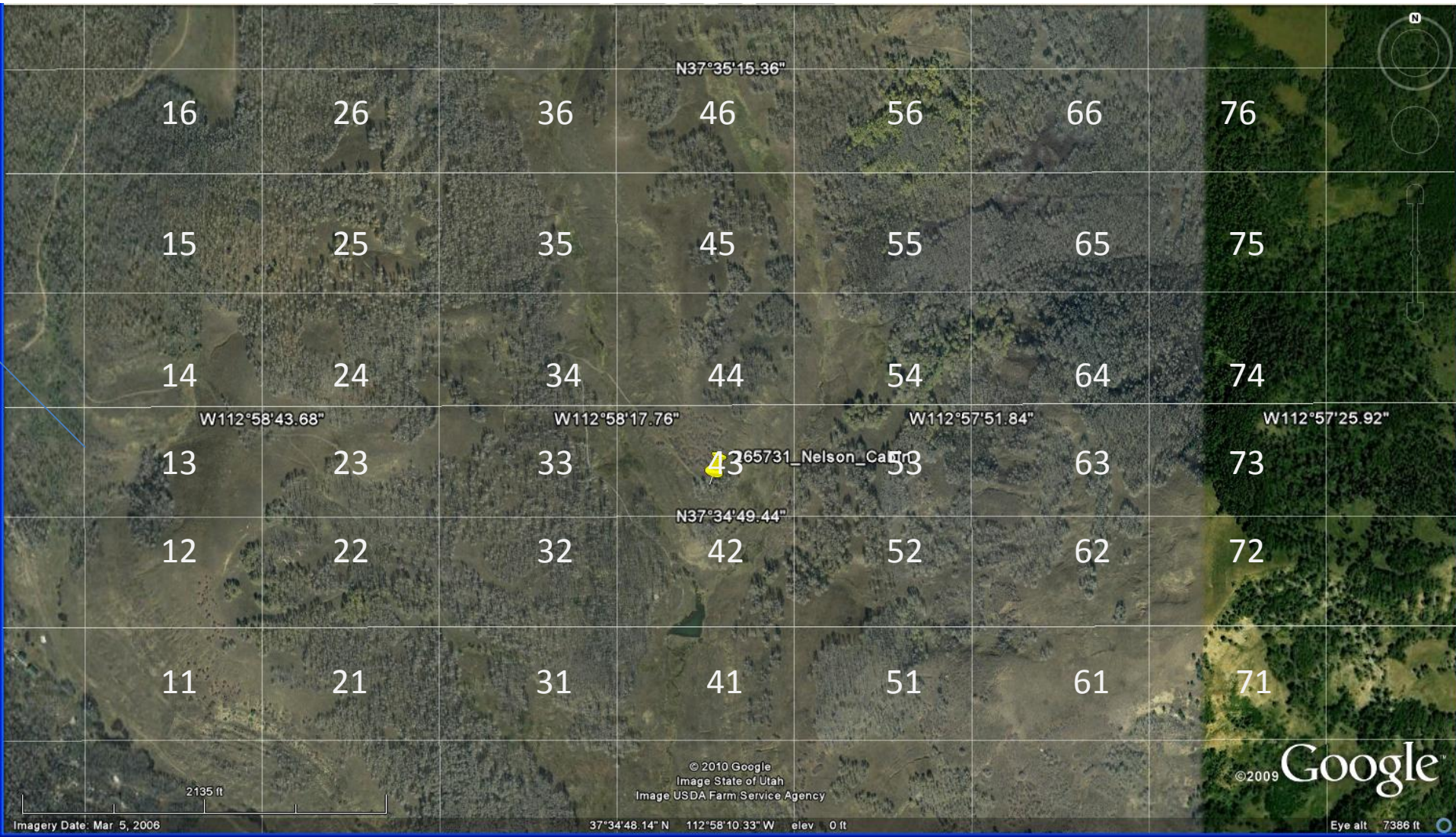




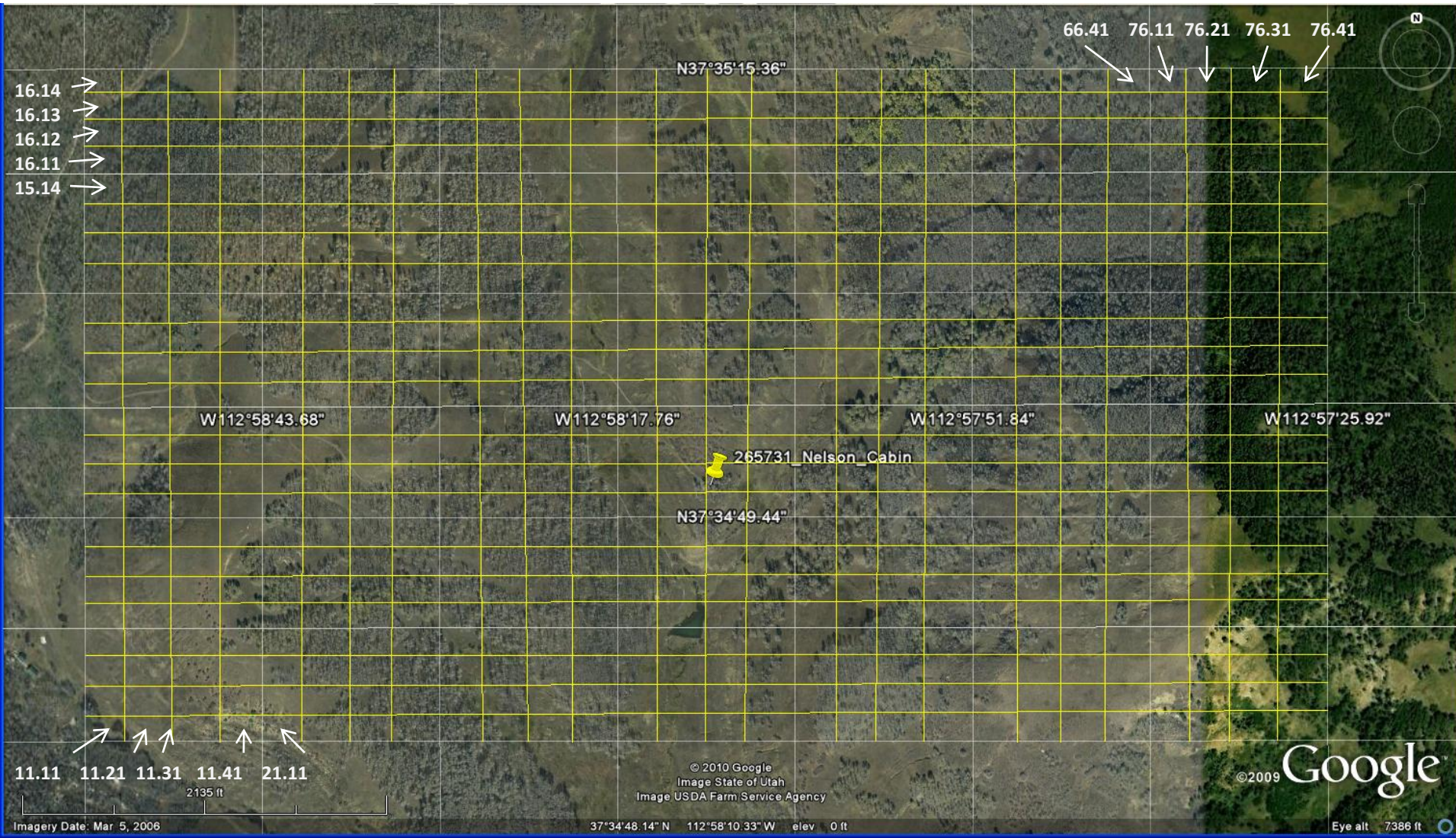
# B.1. Nelson Cabin Map



# B.1. Reference Grid



# B.1. More Detail Reference Grid





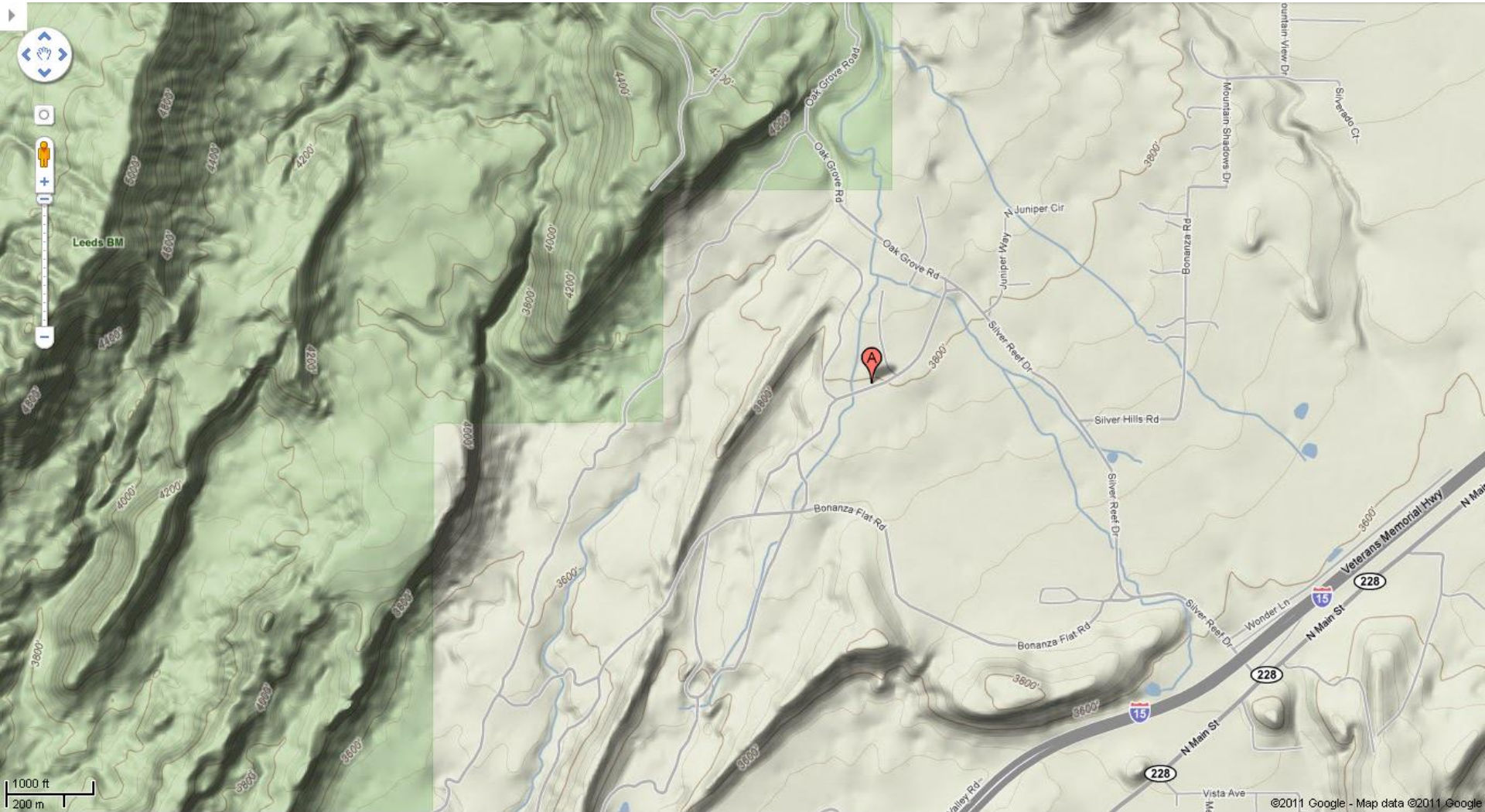


# B.2. Kolob Reservoir





# B.3. Silver Reef



# B.3. Silver Reef, a Mining Ghost Town

## SILVER REEF

**NAME:** Silver Reef

**COUNTY:** Washington

**ROADS:** 2WD

**Grid #:** 7

**CLIMATE:** Cool winter with possible snow, warm summer.

**BEST TIME TO VISIT:** Anytime. **COMMENTS:** A few current residents.

**REMAINS:** Many old buildings. Silver Reef was discovered between 1866 and 1870 (There are many different stories about the founding of this town) However in 1874 a man named William T Barbee is credited with getting the mining going. In 1875 he had 22 claims here. In 1876 Silver Reef became an established town. Main street was over a mile long. Silver Reef had over 2000 people living here. There were hotels, 9 stores, 6 saloons, a bank, several restaurant, a hospital, 2 dance halls, 2 news papers, a china town and 3 cemeteries. In 1891 the last mine shut down, about 25 million dollars worth of ore had been taken from the mines here. Between 1891 and 1901 another \$250,000 of ore was taken out of the area. The old Wells Fargo Express office is on the National Historical Register and is now a museum. The old bank is now a gift shop. Some of the area has been preserved for its history and is worth visiting. A lot of the surrounding areas of the old town are now homes and housing developments and are restricted to public access. Submitted by Bob Bezzant.

<http://www.ghosttowns.com/states/ut/silverreef.html>



Silver Reef  
Courtesy Bob Bezzant



Silver Reef  
Courtesy Bob Bezzant



Silver Reef  
Courtesy Bob Bezzant

# B.3. Silver Reef



Silver Reef  
Courtesy Dolores Steele



Silver Reef  
Courtesy [Uwe Fischer-Wickenburg](#)



Silver Reef  
Courtesy Dolores Steele



Wells Fargo Express office - faced Main Street  
in the center of town



Silver Reef  
Courtesy Bob Bezzant



Rice Bank - 1876  
Courtesy Dolores Steele



Silver Reef  
Courtesy Dolores Steele

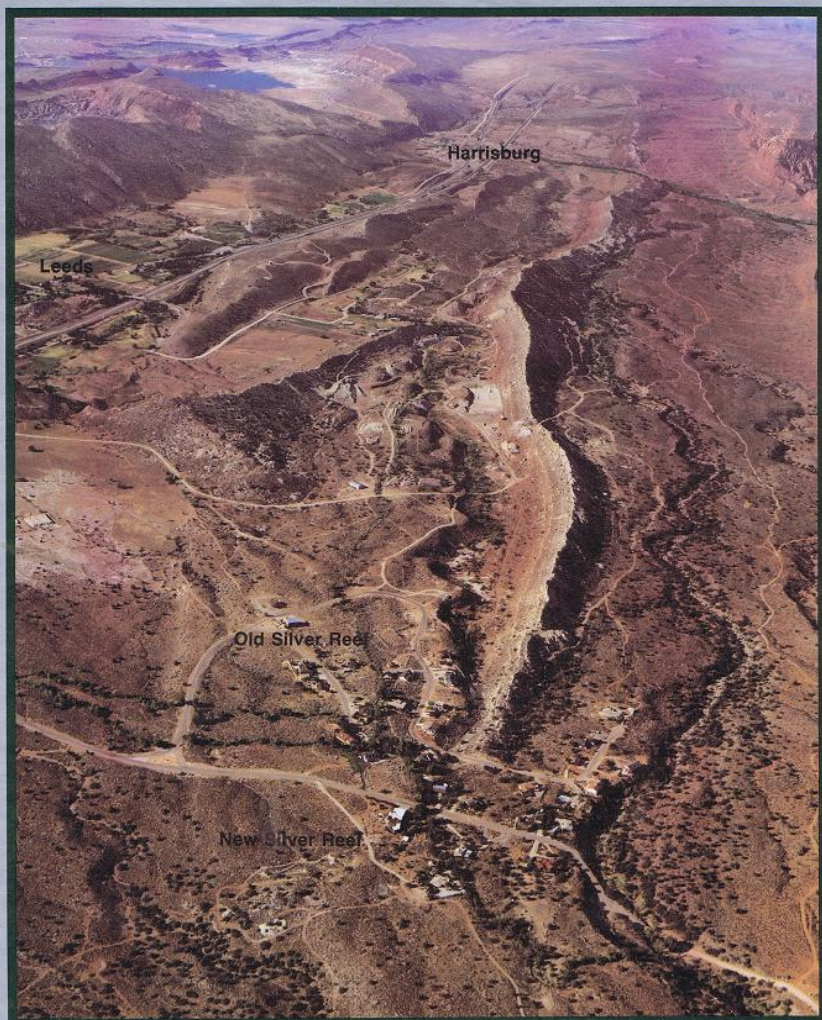


Old mine at Silver Reef  
Courtesy Wendi Epps

# Grandma's Dad's First Historical Book

## *Silver, Sinners and Saints*

A History of Old Silver Reef, Utah



Paulmar, Inc.

Paul Dean Proctor  
Morris A. Shirts

## Chapter Two

### SILVER IS WHERE YOU FIND IT

*"He reported (the sandstone) contained over \$200 of silver to the ton. Some say he was hanged on the spot—others that he was tarred and feathered"*

*Tradition—Silver Reef*



In the latter part of the 1800's and the early part of the 1900's, the laws governing mining activities in the United States were gradually developed and refined. Emerging governmental regulations based on a philosophy of encouraging private discovery of precious metals greatly assisted in the development of the mining industry through private enterprise and offered legal protection to those who had located mining claims. During this period the Silver Reef episode unfolded. Some definitions of mining terminology will lend a better understanding of the Silver Reef story.

#### Prospector/Prospecting

Major discoveries of precious metal deposits in the early days of mining in the western United States were by prospectors. Some looked for unusual geologic formations such as a distinctive colored outcrop different from the surrounding rock terrain. White rocks in a field of black volcanic-type rocks, or red or rust-colored rock masses among more subdued tones were good signs for possible mineral sources. The more experienced prospectors examined hill slope materials or sediments in the bottoms of stream beds for unusual materials. Glistening or reflective minerals within the sediments usually caught their sharp eyes. Float, or material of value, usually outside the stream deposits, were traced upstream or upslope in an attempt to find

the source from a lode, ledge or reef from which the float was derived. The latter terms were somewhat synonymous with "reef," borrowed from the English sea-faring society, which referred to an underwater or near surface ledge or a series of them, such as the "Great Barrier Reef" along the eastern Australia coast line. In some cases, the ledge or reef might be totally or partially exposed, or it might be hidden under the surface cover.

When covered or partly covered, shafts or downward mined openings, or tunnels (a more horizontal opening into a slope) were cut to determine the potential of the metal-bearing lode. Usually the average prospector was not a miner. His aim was to discover a rich deposit, then sell it to a mining company, another individual, or a speculator, and then go on to find an even bigger bonanza. He thrived on optimism—the big discovery was always just over the hill, or would be found in the next shaft, drift, or in the next powder round fired.

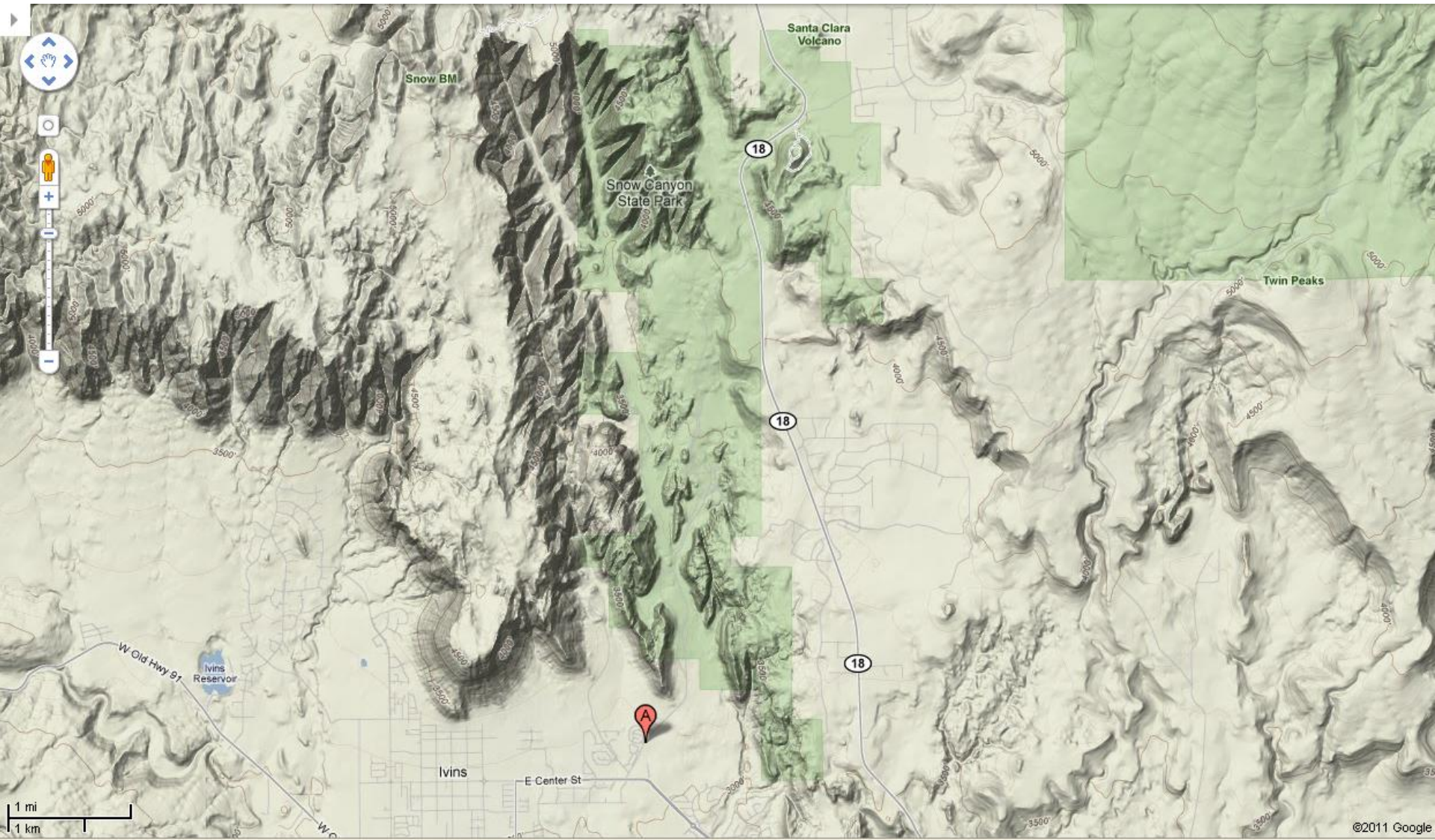
#### Field Assay

Some of the more successful prospectors used an elementary "field assay kit" to identify various ore minerals and to estimate the metal content in the enclosing rock. The kit usually consisted of a spade, pick, hammer, tube mill or small section of pipe closed at one end and fitted with a bolt to be used as a plunger to crush small





# B.4. Snows Canyon

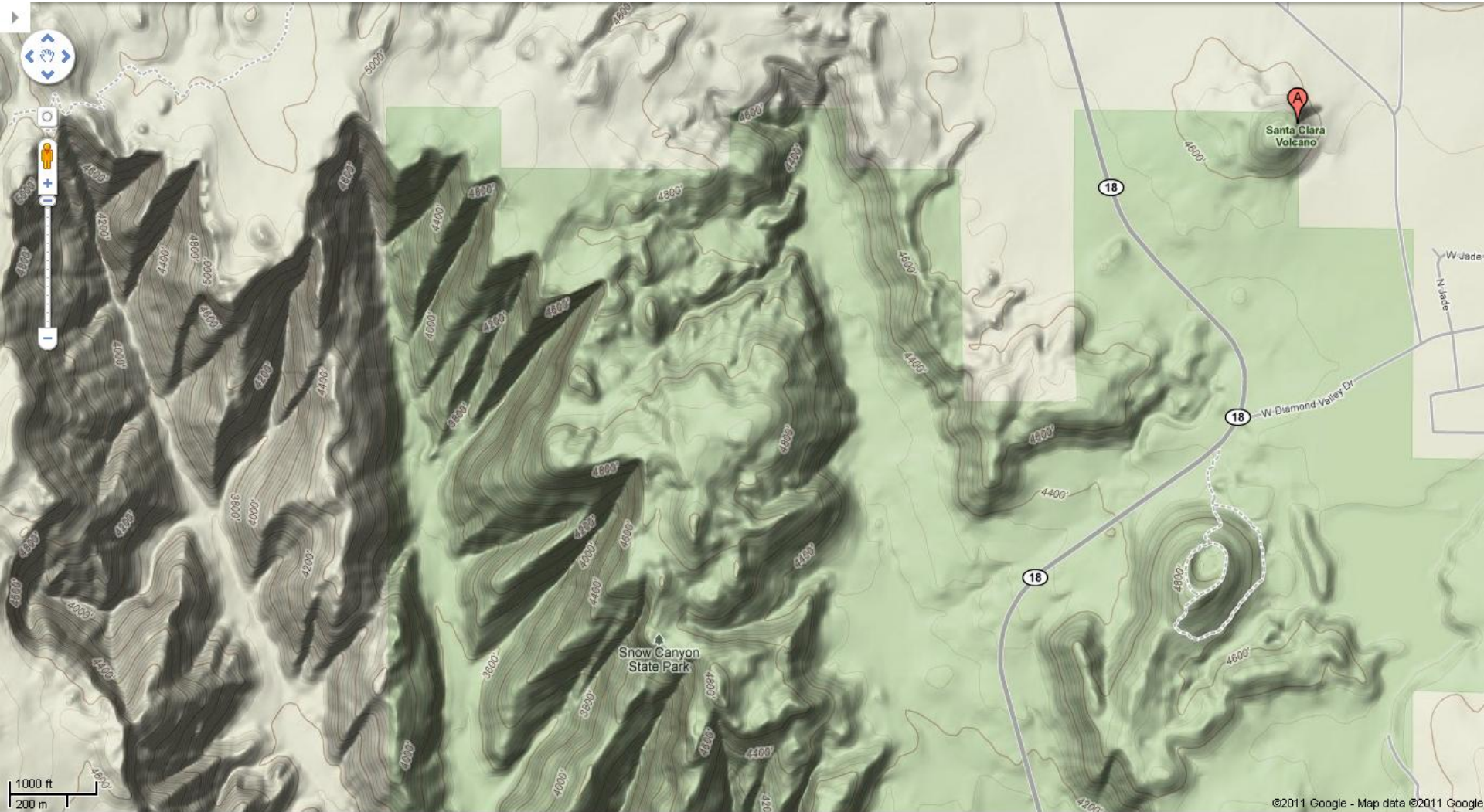


## B.4. Snows Canyon State Park





# B.5. Santa Clara Volcano



# from **NEW AGE FOR THE SANTA CLARA (SNOW CANYON STATE PARK) BASALT FLOW** by **Grant C. Willis, Robert F. Biek, and Janice M. Hayden**

In the fall of 2005, we finally found the charcoal we had been looking for – a short woody branch preserved in loose sand just below the lava flow that appeared to have been burned by the advancing lava. The lab (Beta Analytic, Inc.) struggled with the sample, probably because of the high temperature to which it had been subjected, but finally obtained an age of  $27,270 \pm 250$  radiocarbon years before present. We feel confident that this age is reliable, but we hope we can someday confirm or refute the results by finding another sample and using another dating method.

Is the Santa Clara flow the youngest lava flow in Utah, as some have suggested? No – not even close. Though other young flows are poorly dated for similar reasons, we are confident that some flows in the Fillmore-Black Rock Desert area in central Utah, and on the Markagunt Plateau north of Zion National Park, are much younger. The Ice Springs flow near Fillmore may be less than 1000 years old (C.G. Oviatt, UGS Special Studies 73).

<http://geology.utah.gov/surveynotes/snt38-3.pdf>



From: [http://en.wikipedia.org/wiki/Santa\\_Clara\\_Volcano](http://en.wikipedia.org/wiki/Santa_Clara_Volcano)



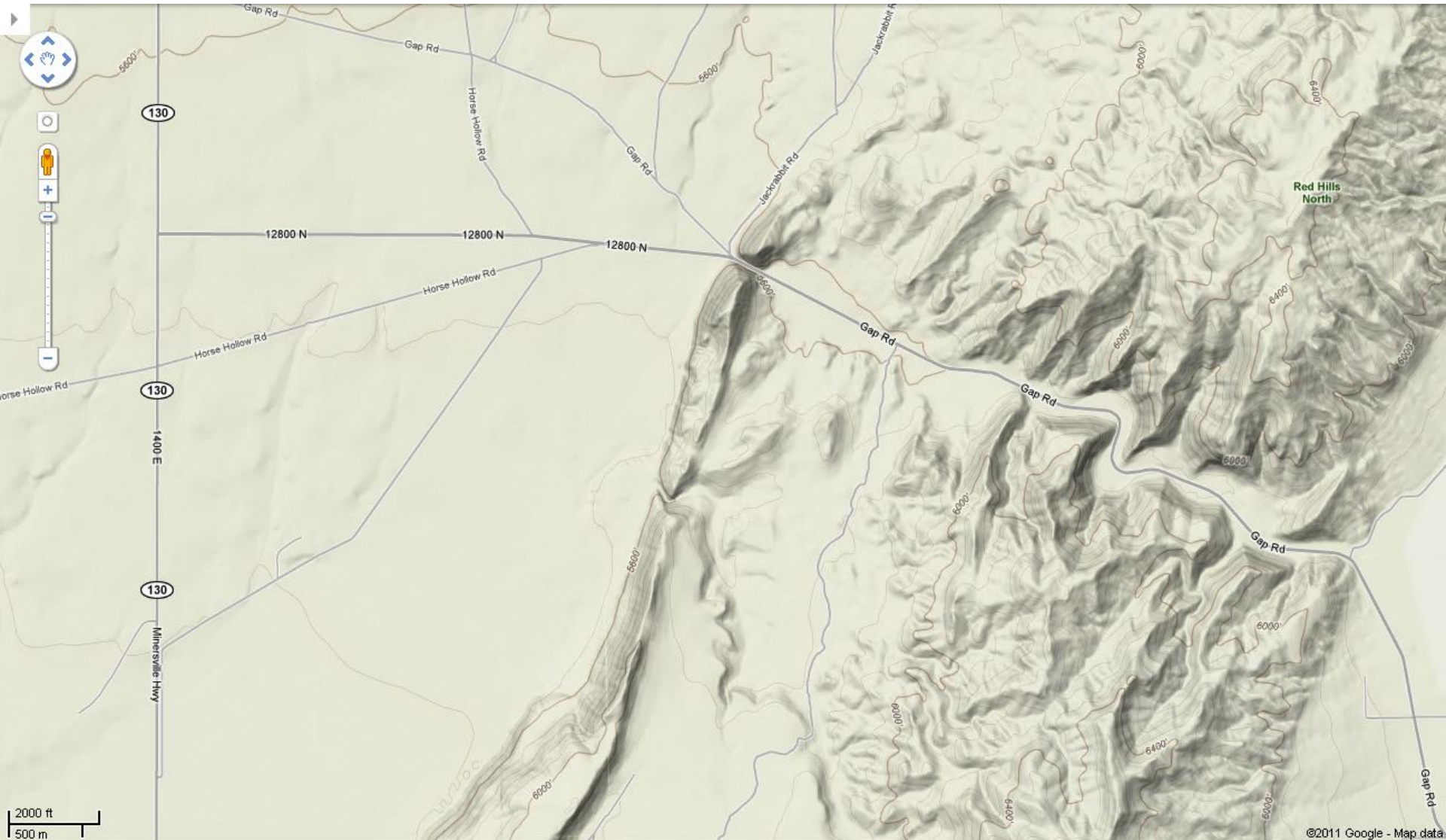
# B.6. Coal Mines Cedar Canyon





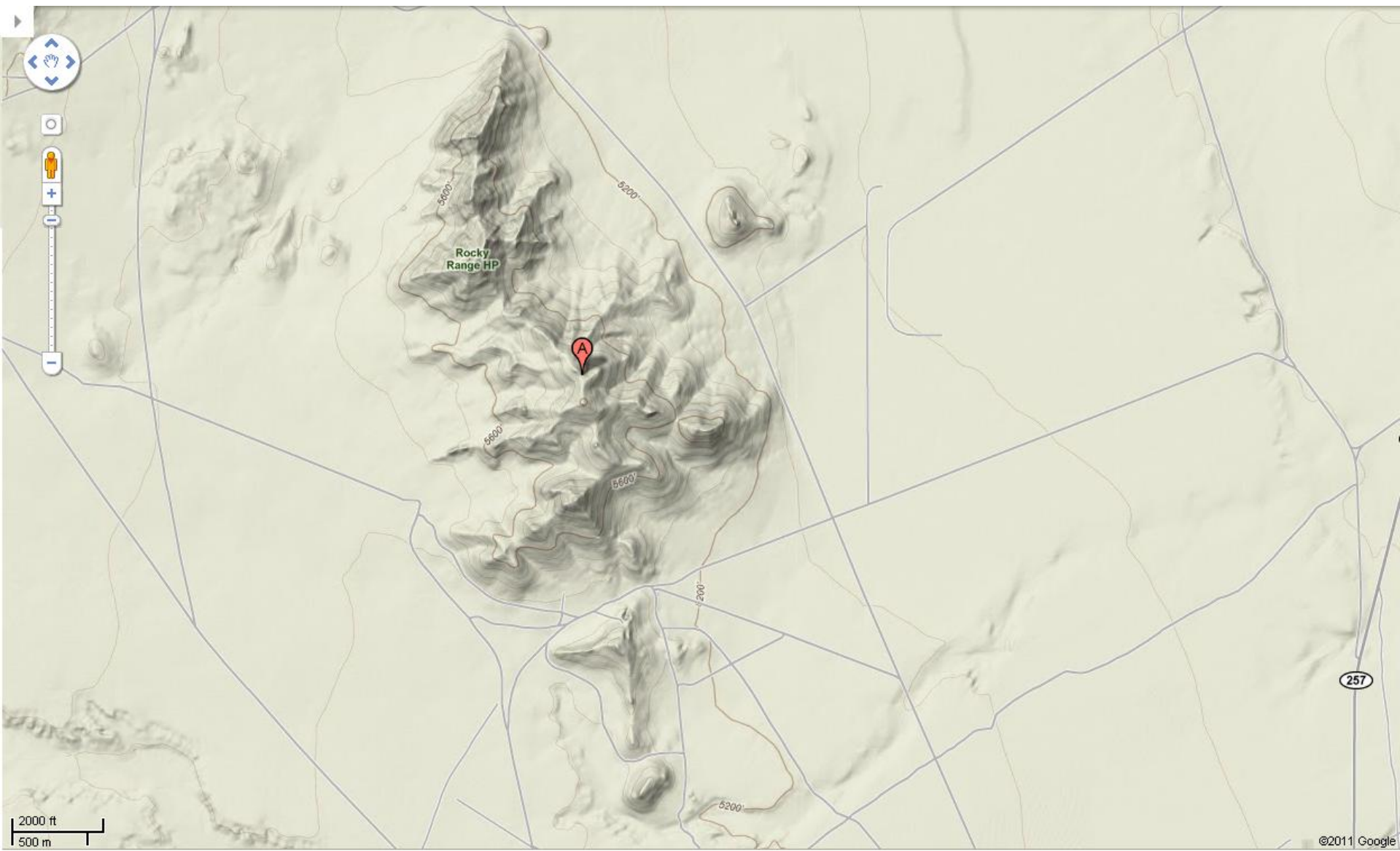


# B.7. Parowan Gap





# B.8. Rocky Range Mine



# Topographic Overview & Type Log Rocky Range, Beaver County, Utah



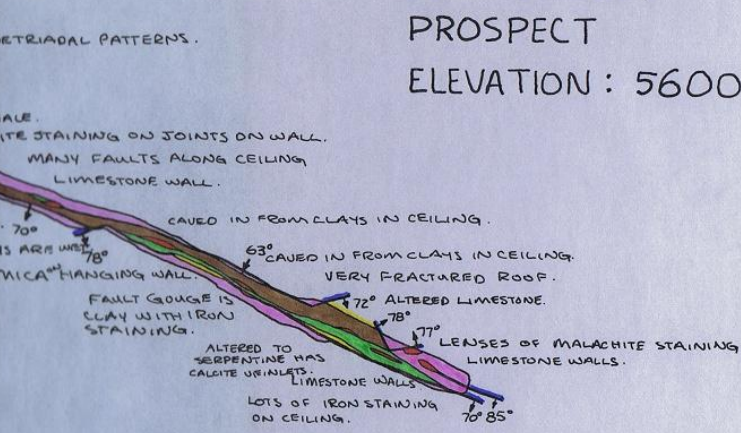
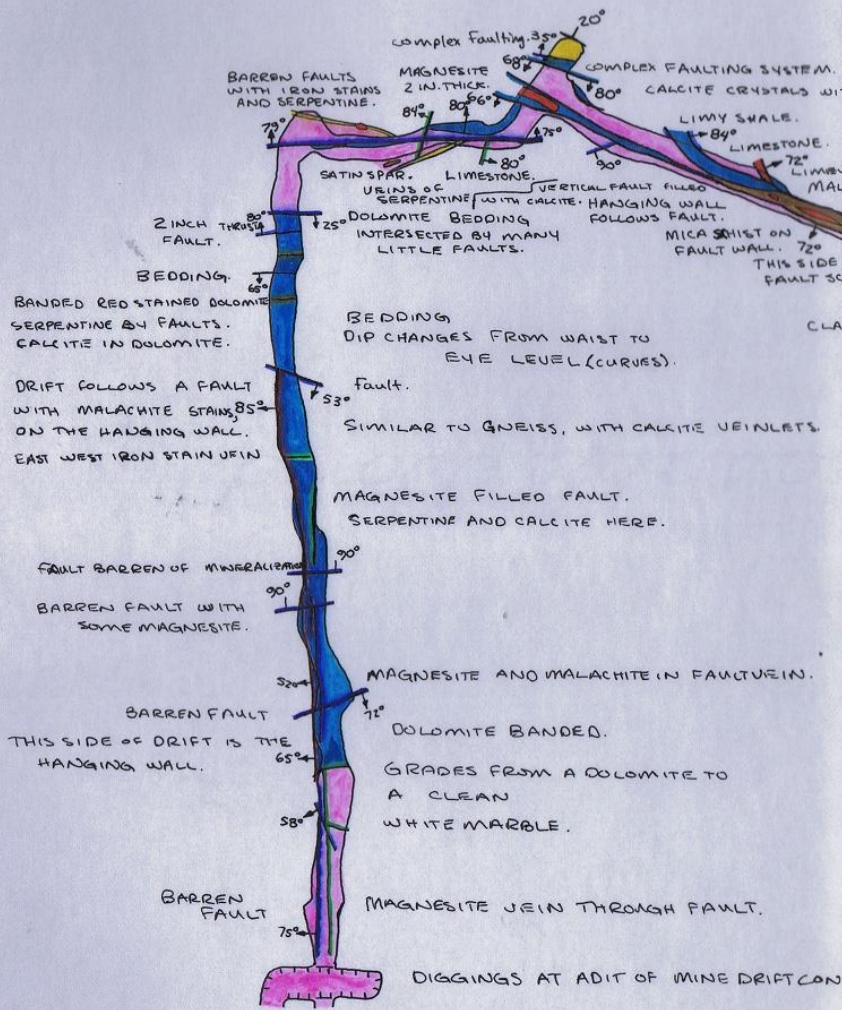
MEASURED SECTION T29S R11W (STAKE RANGE) M. ROICE NELSON 7 MAY 1974 35

AGE	FORMATION SECTION	DESCRIPTION	THICKNESS (feet)	CUMULATIVE (feet)
PERMIAN	Qal ALLUVIUM	VALLEY ALLUVIUM.		
	P <sub>kp</sub> KIABAB PLYMPTON	LIMESTONE, SANDY, DARK GRAY, WEATHERS DARK BROWN TO BLACK.		
		SANDSTONE OUTCROP, CALCAREOUS, REDDISH- PURPLE COLOR, WEATHERS DARK, CONTAINS BRACHIOPODS.	251.4	
	TOROWEAP	LIMESTONE, SANDY, DARK GRAY, CONTAINS SMALL CALCITE VEINLETS, WEATHERS DARK BROWN & BLACK. NO CHERT.	112.7	
		GYPSUM, WHITE TO YELLOW CLAYS SANDSTONE, LIMY, LIGHT BROWN FINE. (OFFSET 100 FEET SOUTH TO GET ABOVE TWO BEDS).	20.0	389.7
	Pt <sub>o</sub>	LIMESTONE, DARK GRAY, CHERTY. WEATHERS TO BROWN OR BLACK LEAVING CHERT NODULES AS SCABS. FOSSILS INCLUDE CRINOIDS, GASTRO- PODS, BRACHIOIDS, ETC.	203.7	
		VALLEY FILL. ROAD IN VALLEY.	151.9	
	TALISMAN Pt <sub>a</sub>	VALLEY FILL.	58.8	
		LIMESTONE, CHERTY, GRAY WEATHERS BROWN, STAGNO BRYOZOES, CONTAINS CHERT NODULES AND FOSSILS. OFFSET 200 FEET SOUTH LIMESTONE, AS ABOVE.	25.6	
		LIMESTONE, VERY SANDY GRABING TO SANDSTONE, CALCAREOUS, VERY FINE GRAIN, LIGHT GRAY WEATHERS BROWN.	9.8	
	QUARTZITE, CREAMY WHITE WITH BLACK SPECKLES. WEATHERS BROWN TO BLACK. FORMS SCREE SLOPES.	23.0	472.8	
			TOTAL THICKNESS 865.5	

SCALE (FEET)  
0  
100

Figure 1. Topographic Overview of the Rocky Range.

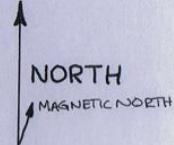
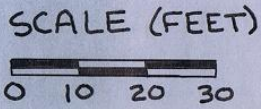
H. ROICE NELSON  
 22 MAY 1974  
 PROSPECT  
 ELEVATION: 5600 FEET



NO ORE IN THIS MINE, TO SPEAK OF.  
 NO TIMBER IN THIS MINE.  
 THE AIR WAS GOOD TO THE  
 BACK OF THE ORIFT.  
 ONE BAT WAS SEEN.  
 MAPPED 26 APRIL 1974 BY H. ROICE NELSON & RILEY C. SKEN

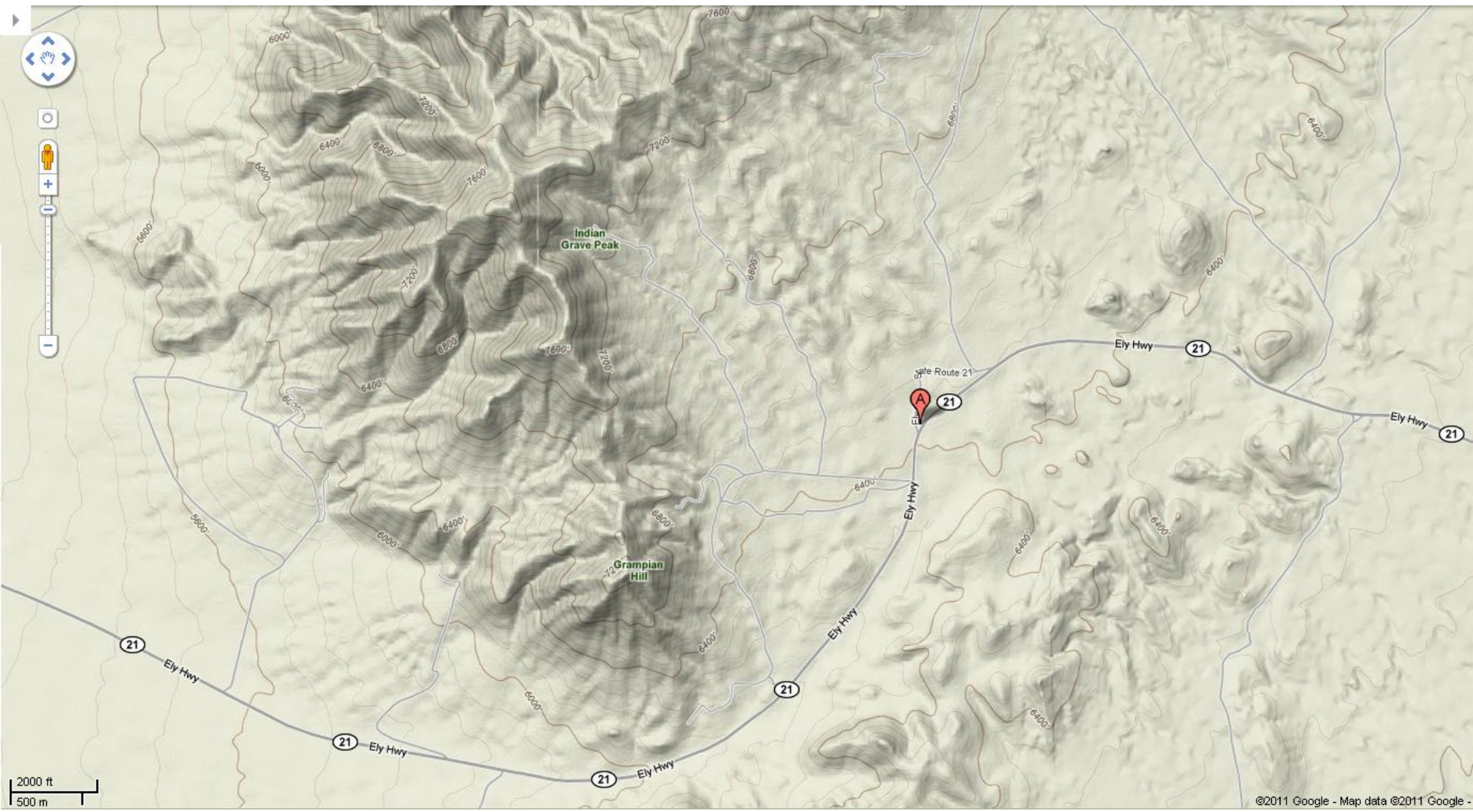
- ORE (MALACHITE STAINS)
- BARREN FAULT
- BARREN VEIN
- IRON STAIN
- MAGNESITE
- SERPENTINE, DUNITE
- DOLOMITE
- LIMESTONE

UNDERGROUND MAP  
 T27S R11W CEN. NE 1/4 SEC. 22





# B.9. Frisco



# B.9. Frisco, Utah a Mining Ghost Town

## FRISCO

**NAME:** Frisco

**COUNTY:** Beaver

**ROADS:** 2WD [Frisco, Utah](#), is just off route 21, 15 miles west of Milford.

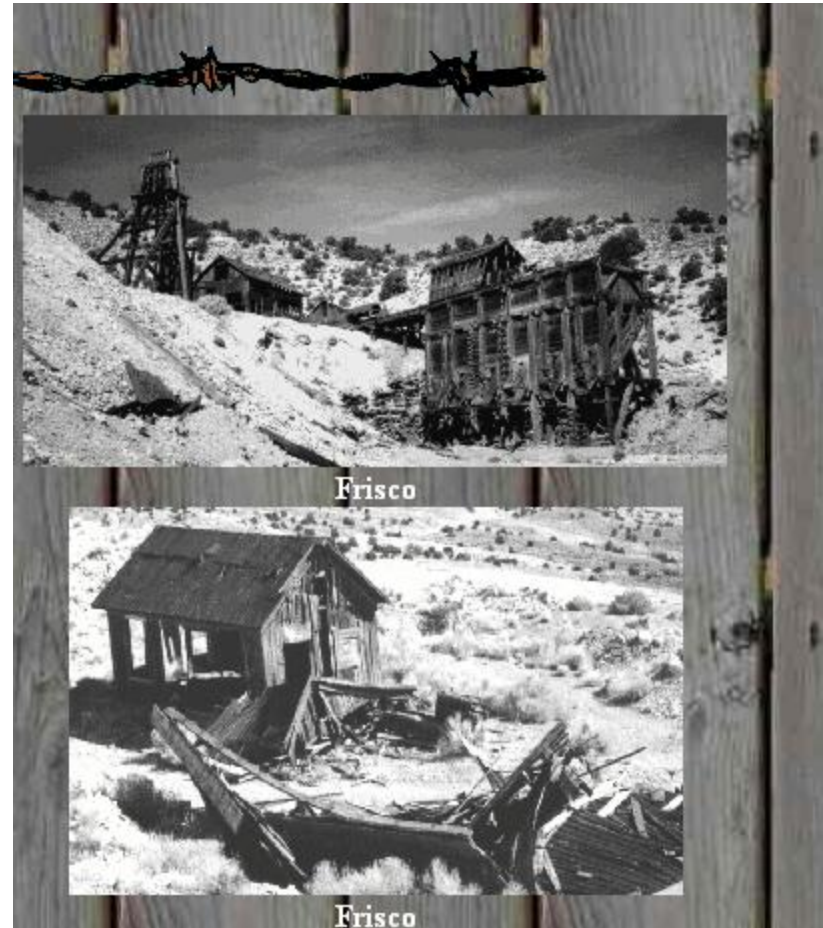
**Grid #:** 7

**CLIMATE:** Cool winter with possible snow, warm summer.

**BEST TIME TO VISIT:** Anytime. **COMMENTS:** Right off the highway. Some land is marked no trespassing.

**REMAINS:** Too much to list, make sure to see the 5 Beehive Kilns. Silver ore was discovered here in 1875. The town of Frisco soon followed and was named Frisco after the San Francisco mountains where the mine is located. A smelter was built here and charcoal ovens were built to make fuel for it (see photo). The town had 23 saloons. Gun fights and killings were common. Water was scarce here and had to be hauled in. In 1880 the railroad built to the town. The population of Frisco was around 6000 people. There was a hospital, hotels, churches, school, news paper and many stores. In 1885 the mine caved in and the town soon all but died. (No one was killed in the cave in). Up to the time of the cave in the mine had produced 54 million dollars worth of ore. A few people stayed and dug new shafts after the cave in but most was gone and only a couple stores stayed open. The mine made another 20 million dollars by 1913. By 1920 everyone had moved away and the town was dead. Submitted by Bob Bezzant.

(<http://www.ghosttowns.com/states/ut/frisco.html>)





# B.9. More About Frisco, Utah

Located in Beaver County, Utah are the silent remains of the once booming mining camp of Frisco . Though, its life was short, it was filled with history, from millions of dollars in ore taken from the Horn Silver Mine to shoot-outs in its dusty streets. Today its crumbling foundations, charcoal ovens, and silent cemetery speak eloquently of its rich and varied past.

Frisco's story starts with two prospectors by the names of James Ryan and Samuel Hawks in September, 1875. The pair worked at the Galena Mine in the San Francisco Mining District, which embraced approximately seven square miles on both flanks of the San Francisco Mountains. One day while on their way to work, they stopped to test a large outcropping for ore. When they found a solid ore body, they immediately staked a claim. Fearing that the mineral body was not very large, they decided to sell their claim rather than work it. Sadly for Ryan and Hawks, the new owners extracted some 25,000 tons of ore with high silver content by the end of the 1870s.

Near the mine, the town of Frisco soon sprouted up, named for the San Francisco Mountains. Another mine called the Horn Silver Mine was also discovered in 1875, and would soon become largest producer in the area. With the success of the Horn Silver Mine, the Frisco Mining and Smelting Company expanded its workings in July 1877 by constructing a smelter that included five beehive charcoal kilns. Frisco soon developed as the post office and commercial center for the district, as well as the terminus of the Utah Southern Railroad extension from Milford, some fifteen miles to the east.

Other mines located in the district included the Blackbird, Cactus, Carbonate, Comet, Imperial, King David, Rattler, and Yellow Jacket, but the Silver Horn was bar far the largest.

By 1879 the United States Annual Mining Review and Stock Ledger was calling the Silver Horn Mine "the richest silver mine in the world now being worked." Frisco was bustling and on June 23, 1880, the Utah Southern Railroad Extension steamed into town, allowing the mines the opportunity for less expensive shipping.

Though there were a number of roaring mining camps in the San Francisco district, Frisco soon gained a reputation for being the wildest. Like many boomtowns, its streets were lined with over twenty saloons, gambling dens and brothels. Reaching a peak population of nearly 6,000, vice and crime became prevalent in the town. One writer described it as "Dodge City, Tombstone, Sodom and Gomorrah all rolled into one."

Murders were said to have been so frequent that city officials contracted to have a wagon pick up the bodies and take them to boot hill for burial. Eventually, a lawman from Pioche, Nevada was hired and given free reign to "clean up the town." When the tough marshal appeared on the scene, he allegedly told the town that he had no intentions of making arrests or building jail. Instead, the lawless element had two options – get out of town or get shot. Apparently, some of the wicked did not take the new marshal seriously as he reportedly killed six outlaws on his first night in town. After that, most of the lawless moved on and Frisco became a milder place for its citizens.

On the morning of February 12, 1885, when the miners reported for duty, they were told to wait as tremors were shaking the ground. Taking precautions, as several cave-ins had previously occurred, the night shift came to the surface, and the day crew waited. Within minutes a massive cave-in occurred, collapsing tunnels down to the seventh level and shutting off the richest part of the mine. The cause of the collapse was blamed on inadequately timbered tunnels bearing the tremendous weight of the rain and snow soaked ground above. The collapse was so great that the cave-in was felt as far away as Milford, where some windows were reportedly broken. Fortunately, no one was killed, but cave-in spelled the eventual demise of Frisco .

By 1885 over \$60,000,000 in zinc, copper, lead, silver, and gold had been hauled away from Frisco by mule train and the Utah Southern Railroad.

After the collapse of the mine, it began to produce again within a year, but never on the scale of its fabulous past.

By the turn of the century only fourteen businesses were still alive in Frisco and its population had decline to 500. By 1912, only twelve businesses existed in the dwindling town of 150. By the 1920s, Frisco was a ghost town.

In 1982, Frisco's kilns were placed on National Register of Historic Places.

In 2002, a mining company began to rework the mines of Frisco , so only the charcoal kilns and cemetery are accessible today.

# B.9. Frisco Photos



Frisco  
Courtesy Dolores Steele



Frisco  
Courtesy Bob Bezzant



Frisco  
Courtesy Bob Bezzant



Frisco  
Courtesy Dolores Steele



Frisco  
Courtesy Dolores Steele



Charcoal Ovens  
Courtesy Dolores Steele



Frisco  
Courtesy Bob Bezzant



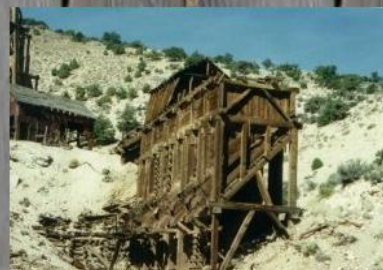
Frisco  
Courtesy Dolores Steele



Frisco  
Courtesy Dolores Steele



Frisco  
Courtesy Dolores Steele



Frisco  
Courtesy Bob Bezzant



Frisco  
Courtesy Bob Bezzant

# B.9. More Frisco Photos



Frisco  
Courtesy Bob Bezzant



Frisco  
Courtesy Bob Bezzant



Frisco  
Courtesy Stacy Aiken

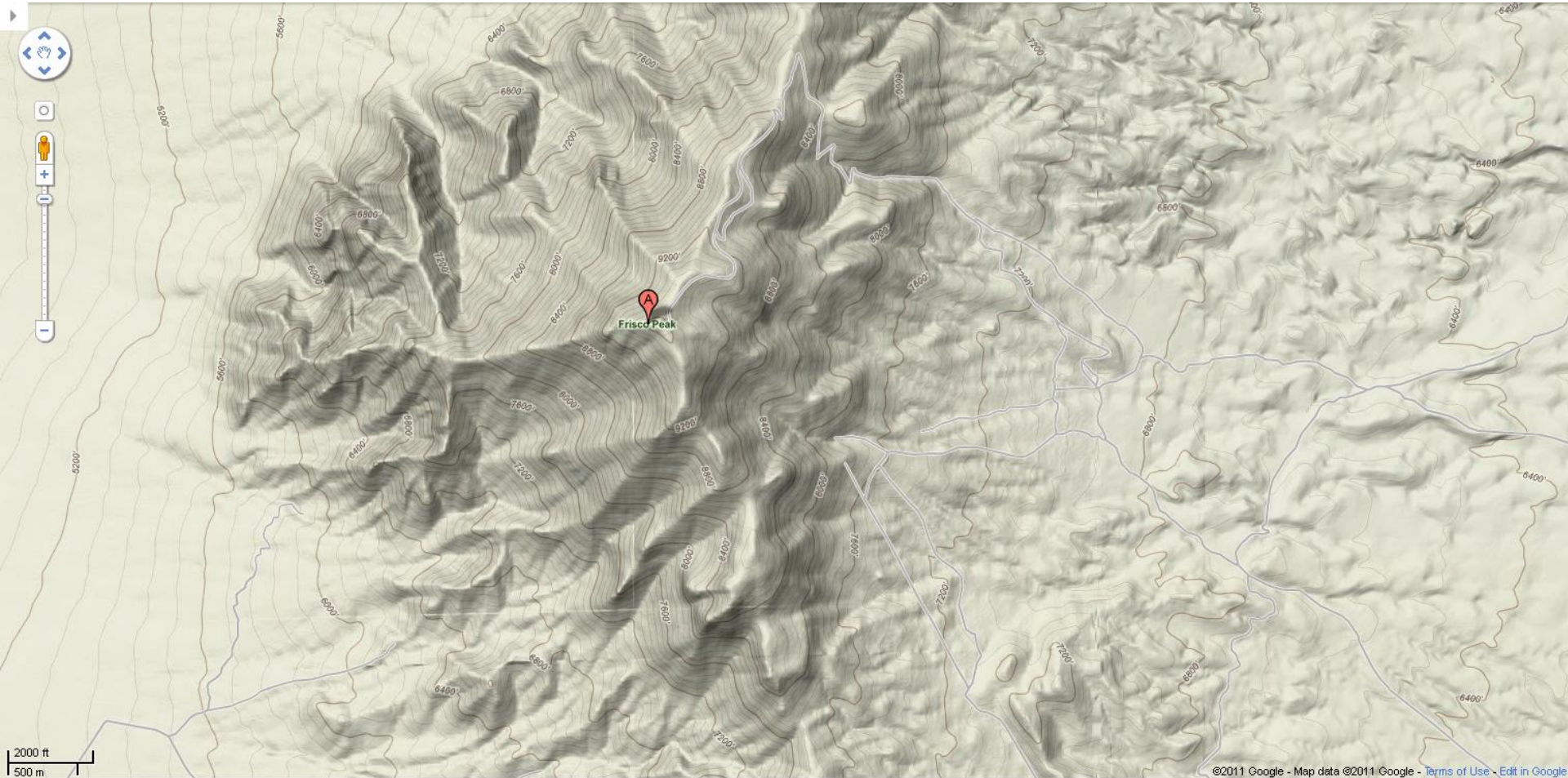


Frisco  
Courtesy Stacy Aiken





# B.10. University of Utah Observatory Frisco Peak





# B.11. Iron Mountain / Iron Springs



# Grandma's Dad's Second Historical Book

water. Our cattle almost exhausted for want of food and water. The cold was intense. Every man froze his feet more or less.<sup>28</sup>

In the comparative respite of Little Salt Lake Valley (present-day Parowan Valley), Pratt decided to let the exhausted oxen recuperate while an advance party went on, riding the mules and horses that were still fit. He and 20 men left the day after Christmas to go over the south rim of the Great Basin while the others established a base camp at the mouth of the canyon, where feed and fuel were more abundant. Continuing on a few miles, Pratt's forward company traveled through the area where the city of Parowan is now located, judging it to be a favorable place for a settlement because of its rich soil and water. On 27 December the group camped 20 miles further southwest, on the banks of the Little Muddy (or Coal Creek), the future site of Cedar City. In the official report to the territorial legislature, Parley P. Pratt and camp clerk Robert Campbell enthusiastically observed:

But the best of all remains to be told, near the large body of good land on the Southwestern borders are thousands of acres of cedar contributing an almost inexhaustible supply of fuel which makes excellent coal. In the centre of these forests rises a hill of the richest Iron ore.<sup>29</sup>

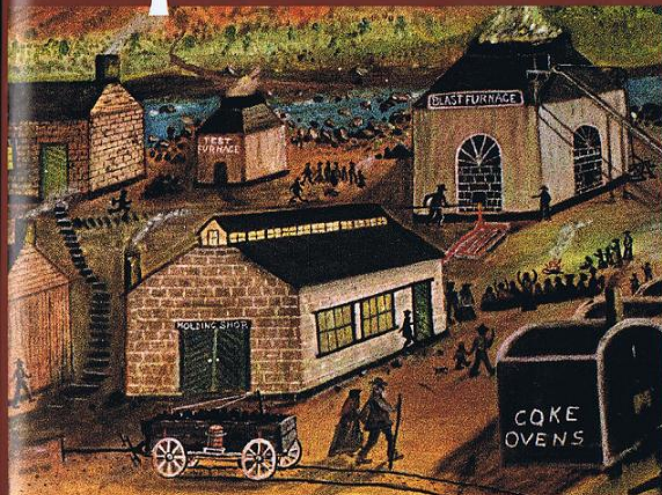
Pratt and Campbell estimated that the combined resources of Little Salt Lake Valley and the land to the southwest could support 50,000 to 100,000 people.<sup>30</sup>

Although the group did not explore the "hill of iron," the forward party collected ore samples (described as "first rate" and "beautiful") over the next few days.<sup>31</sup> They then continued on to the area just south of present-day St. George. Advised by Native Americans from a village on the Santa Clara that the country further south was not suitable for settlement, they returned to the main camp in Little Salt Lake Valley.

Arriving on 8 January 1850, the men raised a liberty pole and prepared a feast. According to Isaac Haight, they picnicked on a wagon cover on the ground, "enjoying roast beef, mince and pumpkin pie, apple pies, sauce, coffee, etc."<sup>32</sup> The next day, he wrote:

I shall leave this place with regret. It is one of the most lovely places in the Great Basin. On the East high towering mountains covered with evergreen forests and one of the most beautiful creeks running from them. On the west and south a large valley of the most beautiful lands. Little Salt Lake bordering the valley on the west and beyond a range of hills covered with verdure and backed with high towering mountains covered with eternal snows, all of which contributed to beautify the scenery and

## A TRIAL FURNACE



The Thomas Gilcrease Institute of American History and Art, Tulsa, Oklahoma

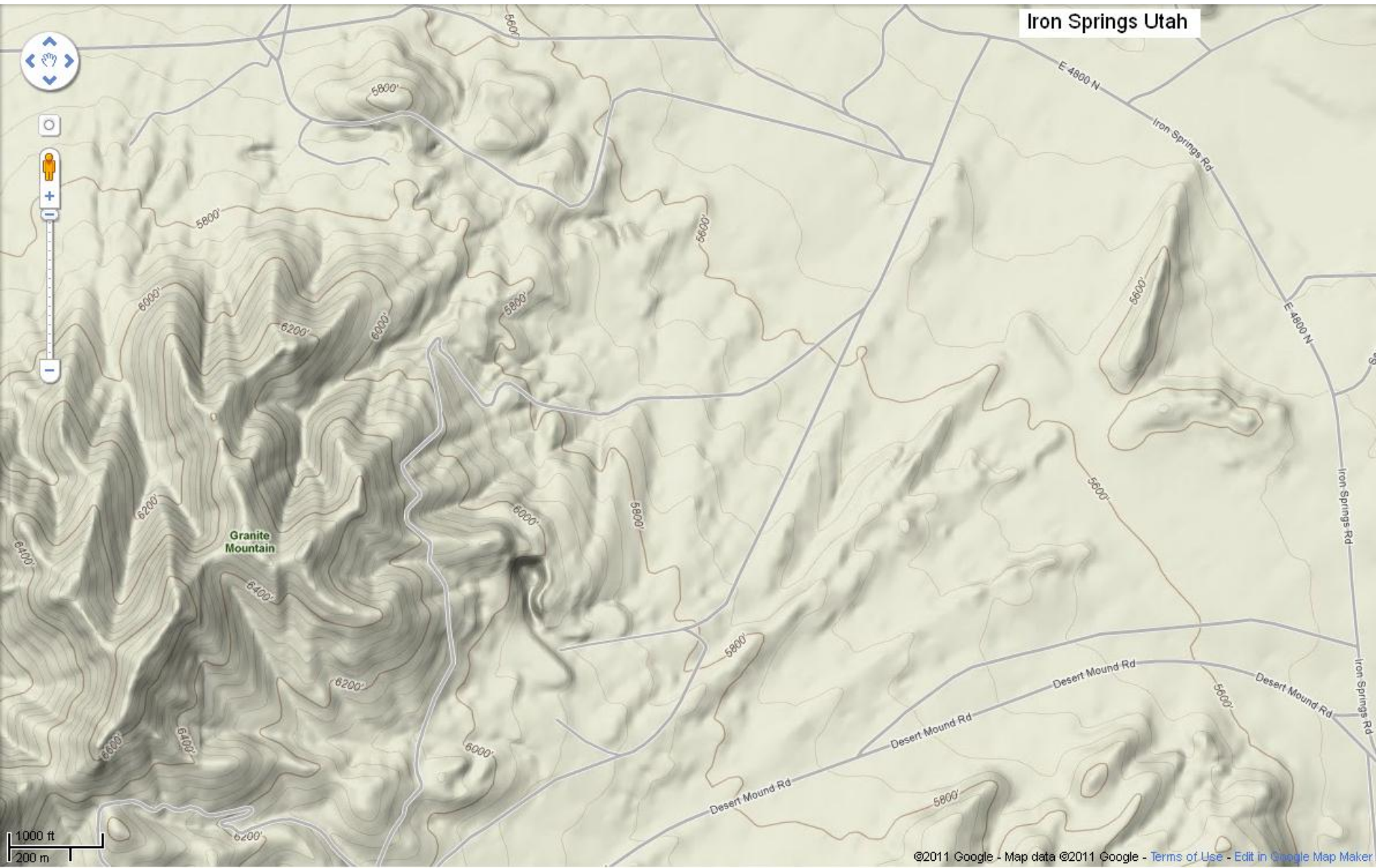
Illus. 1-4. Wakara (c. 1815–55) was chief of the Ute Indians based in the Sanpete Valley.

## SOUTHERN UTAH'S IRON MISSION

Morris A. Shirts  
Kathryn H. Shirts



# B.11. Iron Springs Mine

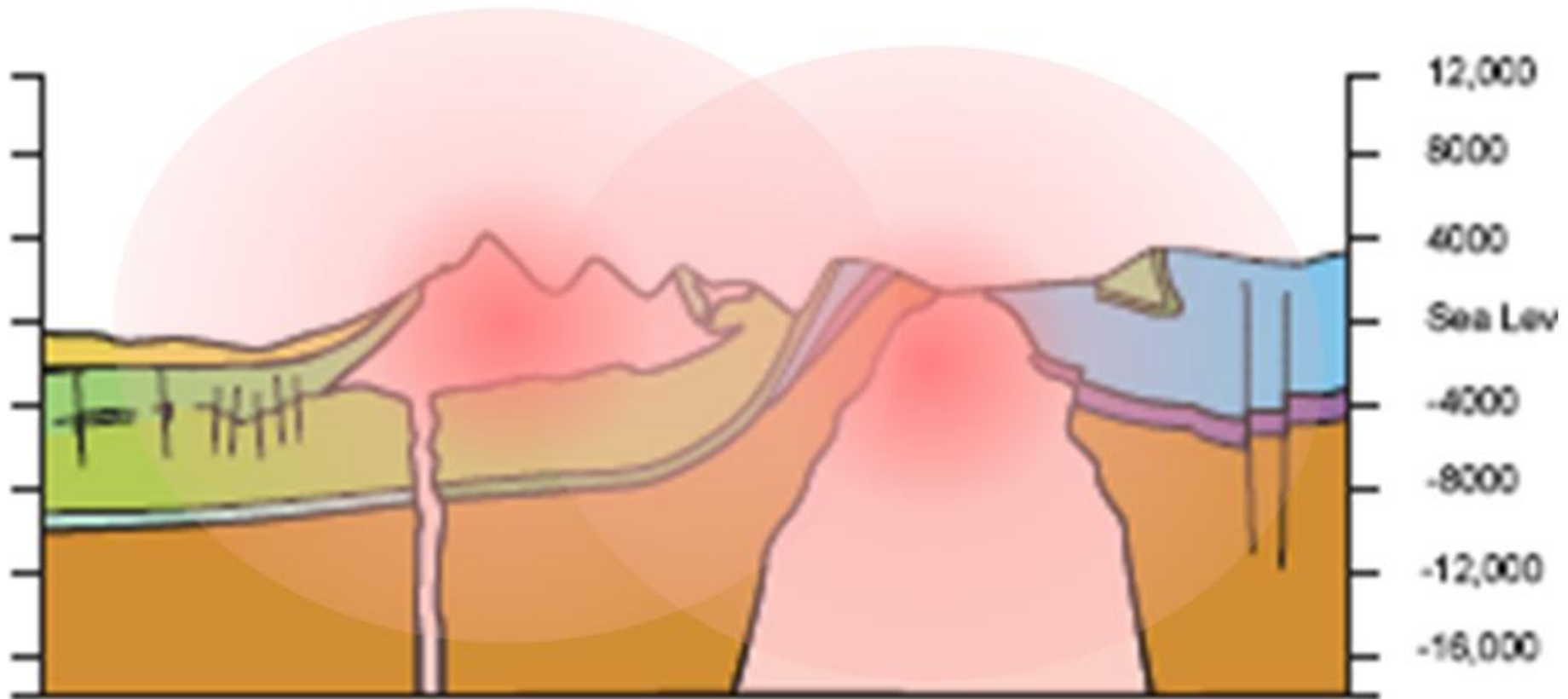




# B.11. Iron Town, Iron Mountain, & Iron Springs



# Why are there mines?

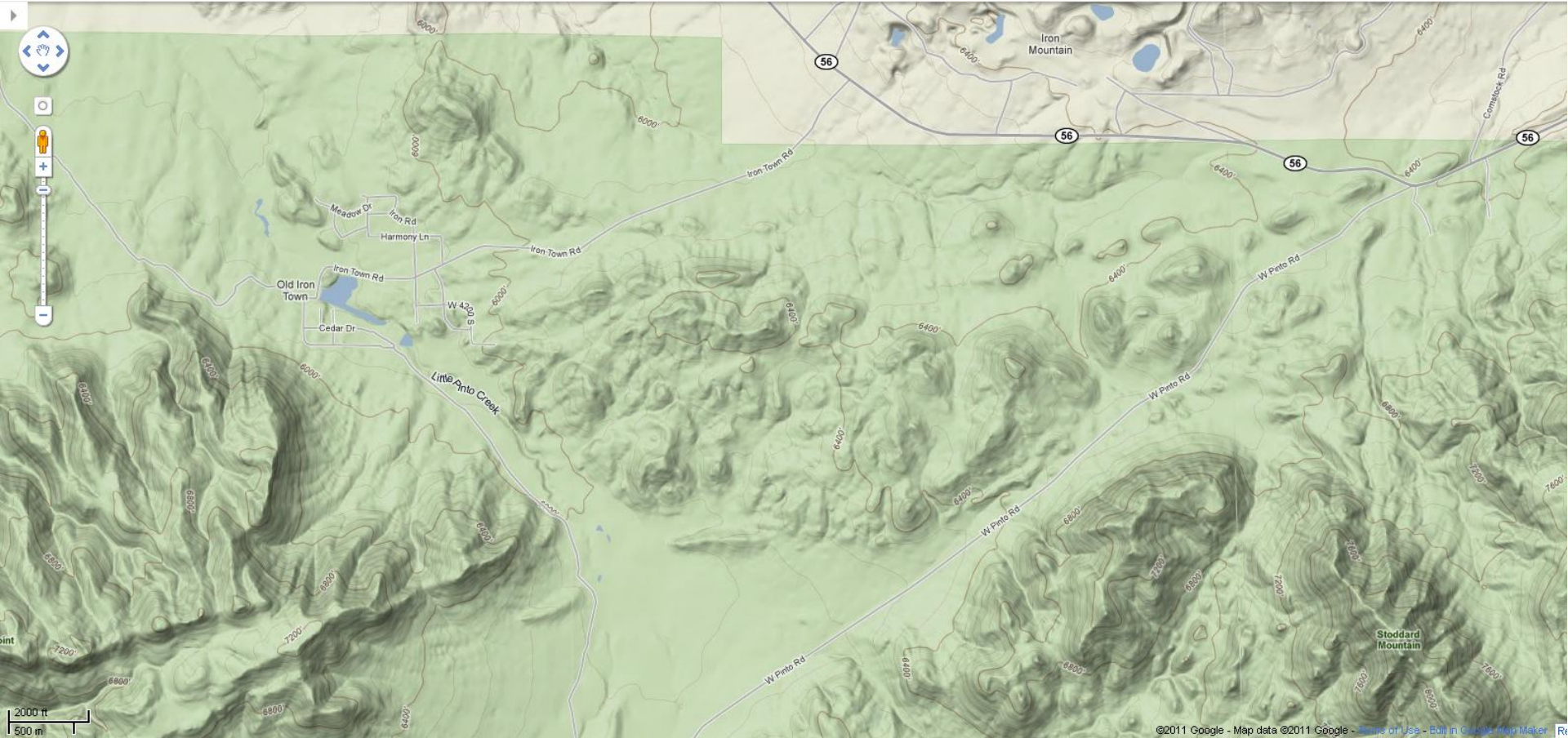


Temperature Anomalies from Intrusive Rocks



Mineralization Occurs in Heated Fluids in Faults

# B.12. Iron Town



# Friend's History of Iron County

A HISTORY OF

## Iron County

*Community Above Self*



Janet Burton Seegmiller

UTAH CENTENNIAL COUNTY HISTORY SERIES

new businesses and manufacturing plants to bring new jobs and diversify the economy. In tandem with record-setting enrollments at Southern Utah University, the city population grew from 6,106 in 1950 to 17,811 in 1996.

### *Chloride*

In 1890 silver chloride was discovered in Chloride Canyon on the western slope of the Antelope Range, twenty-three miles west of Cedar City, and the resulting mining camp was named Chloride. Mining operations continued off and on from 1890 to 1910. Near the mouth of the canyon to the south is Sand Spring, used by travelers on the Spanish Trail.

### *Desert Spring*

A stagecoach inn and freighter's camp was built at Desert Spring at the junction of roads from Beaver, Iron Springs, Mountain Meadows, and the Nevada mining camps. Ben Tasker, cattle rustler and outlaw, used Desert Spring as his headquarters. The Desert Spring cemetery is three miles north of Modena on the west side of the road going to Hamlin Valley. Ruins of the stagecoach stop are opposite the cemetery on the east side of the road. Tasker sheltered rustlers and other outlaws at his hideout, which was complete with a trap door leading to a stable under the house where horses were kept ready for a quick getaway.

### *Enoch*

Enoch was first called Elk Horn Springs by travelers along the Spanish Trail. After 1851 it was known as Johnson's Ranch or Springs for Joel H. Johnson, who established a herd ground and stockade there to protect the cattle of Parowan and Cedar City. Abandoned during the Indian troubles of 1853, as its seven families moved to Parowan or Cedar City, the community was reestablished in May 1854. A fort was built one-quarter mile west of the springs by Johnson. Thereafter, the community was known as Johnsons Fort.

John Pidding Jones and his sons moved to Johnsons Fort about 1869. Jones built and operated an iron foundry for twenty years while his sons engaged in farming and dairying. Joseph Armstrong bought half of the fort in 1880. When a post office was requested in 1884,

another community was already named after Johnson, so the Jones family, organized in a Mormon United Order, or Order of Enoch, suggested the name of Enoch.<sup>6</sup>

When Enoch was incorporated in 1956, the old settlements (Enoch, Grimshawville, Stevensville, and Williamsville) came together in name, but the town remained a spread-out rural community of farms and scattered homes. The population remained under 250 until the 1970s when several subdivisions were developed. Pastures and fields still dominate the landscape, as townspeople actively work to maintain a rural atmosphere. Population in 1996 was 2,576 and growing.

### *Fiddlers Canyon*

Fiddlers Canyon originates on the Markagunt Plateau at Jones Hill, five miles northeast of Cedar City, and drains northwest into Cedar Valley. The story is told that among men building the coop road up the canyon were four who played fiddle in camp—Joseph Hunter, John L. Jones, Edward Parry, and Elliot Wilden—and so it became "Fiddlers Canyon."<sup>7</sup> CCC workers in the 1930s built a dam and irrigation reservoir in the canyon that were later washed out by a flood. The mouth of the canyon was annexed to Cedar City in 1979 and developed as Fiddlers Canyon subdivision by Frank Nichols.

### *Ford*

Ford was a railroad siding and sheep-shearing station five miles southwest of Lund.

### *Gold Springs*

A mining camp on the Utah-Nevada border seventeen miles northwest of Modena opened about 1897. The spring on the Utah side is named Gold Springs, and gold and silver are found in the mining district. Population in 1910 was forty-five. Telephone service and electric power from Dixie Power Company were established in 1917-18. The buildings and deserted homes at present-day Gold Springs were built or renovated and lived in when the mine was open during the 1930s.<sup>8</sup>

# B.12. Iron Town Zoom



# B.12. Iron Town, a Smelting Ghost Town

Pretty rock formations and boulders like this are along the route to Iron Town. The area was discovered in 1868 by Peter Shirts. The area then was known as Iron City. Later Ebenezer Hanks invested in the iron ore mine under the name of the Union Iron Company, later known as the Great Western Iron Company. In 1870 there were 97 people living in Iron City.

More of the walls and foundations of the foundry building. A chimney still stands in the back. A lot of this was vandalized and the walls and artifacts are gone. This area is still one of the richest iron ore deposits in the United States.

The old furnace here could process 2,500 lbs of ore a day. The original mine closed down in 1876. Columbus Steel took over and in 1923 the Union Pacific railroad ran a spur into the mine sending over 500 tons a day to Northern Utah. By the mid-1980's the mine was shut down again due mostly to foreign prices being too low to keep producing ore here in the US.





# B.12. Town

The old furnace here could process 2,500 lbs of ore a day. The original mine closed down in 1876. Columbus Steel took over and in 1923 the Union Pacific railroad ran a spur into the mine sending over 500 tons a day to Northern Utah. By the mid-1980's the mine was shut down again due mostly to foreign prices being too low to keep producing ore here in the US.

To the right is an old BuCyrus Erie shovel that was once part of the Iron Ore Mine. This old shovel is at the entrance to the landfill.

<http://www.in-the-desert.com/irontown.html>





# C.1. Rare Earths

## THE SECRET

(Chinese)

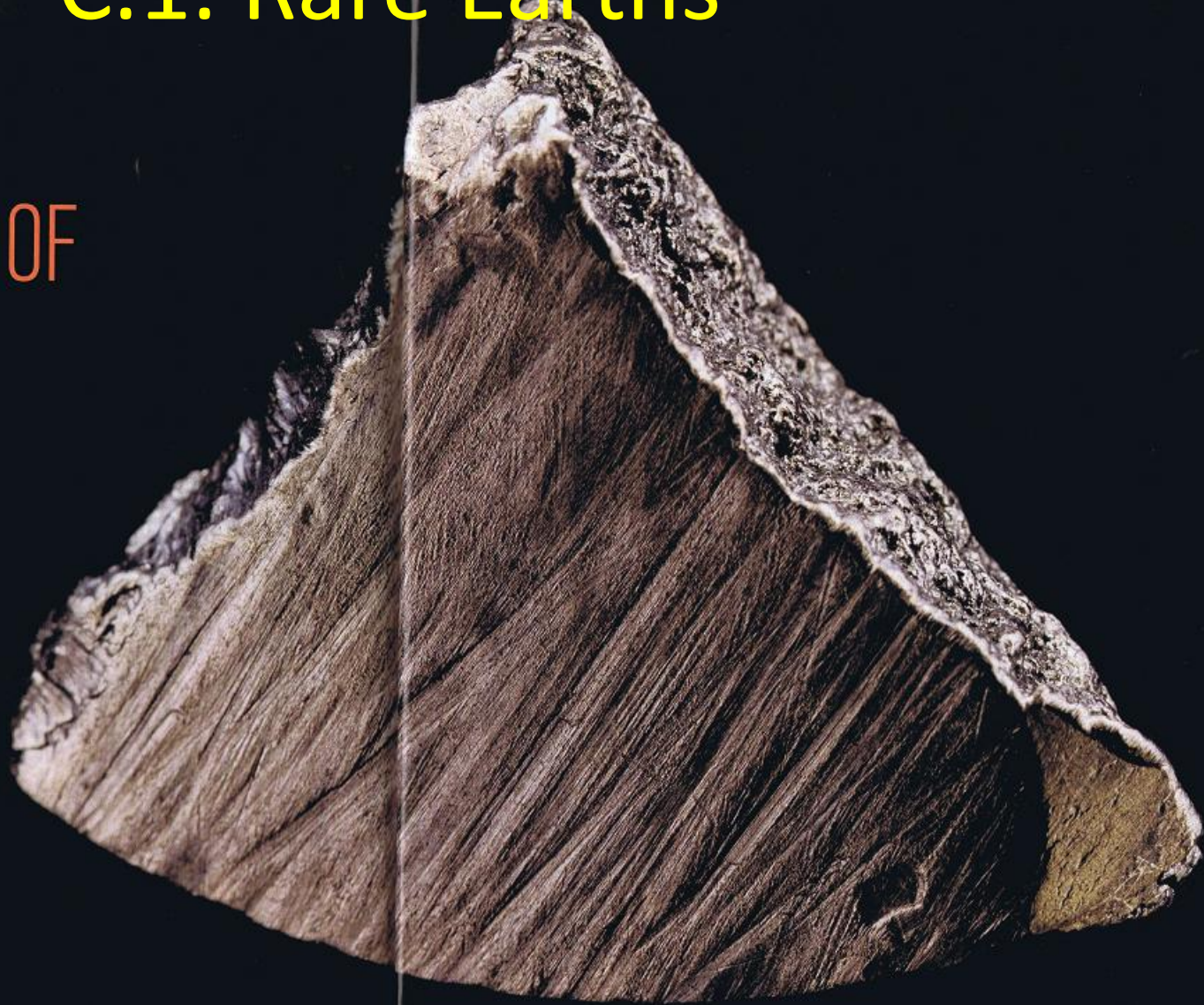
## INGREDIENTS OF

(almost)

## EVERYTHING

□□□□□□□□□□□□□□□□

*From smart phones to hybrid vehicles to cordless power drills, devices we all desire are made with a pinch of rare earths—exotic elements that right now come mostly from China.*



Samarium, one of the 17 rare (but widely useful) earths, helps convert sound into electricity in the magnetic pickups of electric guitars. It is also in the control rods of some nuclear reactors.



Actual size

# C.2. Rare Earths

By Tim Folger

M

ost of us would be hard-pressed to locate Inner

Mongolia, Jiangxi, or Guangdong on a map. Yet many of the high-tech devices we depend on—cell phones, laptops, and hundreds of others—would not exist without an obscure group of elements mined, sometimes illegally, in those three and other regions of China.

.....

**Rare earths**, as the elements are called, were discovered beginning in the late 18th century as oxidized minerals—hence “earths.” They’re actually metals, and they aren’t really rare; they’re just scattered. A handful of dirt from your backyard would probably contain a smidgen, maybe a few parts per million. The rarest rare earth is nearly 200 times more abundant than gold. But deposits large and concentrated enough to be worth mining are indeed rare.

The list of things that contain rare earths is almost endless. Magnets made with them are much more powerful than conventional magnets and weigh less; that’s one reason so many electronic devices have gotten so small. Rare earths are also essential to a host of green machines, including hybrid cars and wind turbines. The battery in a single Toyota Prius contains more than 20 pounds of the rare earth element lanthanum; the magnet in a large wind turbine may contain 500 pounds or more of neodymium. The



**Smart phones**  
Rare earths help phones (and MP3 players) emit sound and light. Neodymium magnets animate the speaker, the vibrating motor, and the tiny earbuds. LCD screen colors are produced by europium (reds) and terbium (greens).

HUGH TURVEY (X-RAY, HAND-TINTED)

# C.3. Rare Earths

**"They're all around you.** They're hidden unless you know about them."

—Karl Gschneidner, metallurgist



## Military vision

The U.S. military also depends on China's mines. Night-vision goggles (above) require lanthanum, gadolinium, and yttrium. Samarium magnets, which can withstand intense heat, help control Predator drones and Tomahawk cruise missiles.

## Medical scans

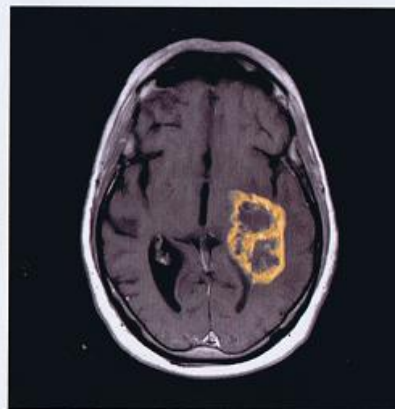
Gadolinium also serves as a contrast agent in magnetic resonance imaging, or MRI, helping surgeons distinguish diseased from healthy tissue. In the scan at right it highlights a brain tumor (colored orange for clarity).

## Green machines

Hybrid cars would not exist without rare earth elements—lanthanum for their batteries, neodymium magnets for their electric motors. A wind turbine may contain hundreds of pounds of neodymium; a compact fluorescent lightbulb, much smaller amounts of yttrium and terbium.

## And much else ...

such as protecting eyes and beverages from ultraviolet radiation. Praseodymium, erbium, and neodymium tint sunglasses; cerium in wine-bottle glass promotes absorption of UV light. Some power tools rely on neodymium or dysprosium magnets to shrink their motors.



# C.4. Rare Earths

## SEVENTEEN ESSENTIALS

The rare earths are 17 metals that cluster together on the periodic table—15 of them, from lanthanum to lutetium, form a continuous series—and in ore deposits too. Malleable, reactive, magnetic, refractive, they're small ingredients of many big things.

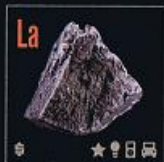


21 SCANDIUM

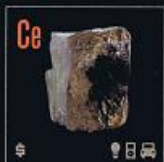


39 YTTRIUM

Scandium and yttrium lie outside the rare earth series but are chemically similar.



57 LANTHANUM



58 CERIUM



59 PRASEODYMIUM



62 SAMARIUM



63 EUROBIUM



64 GADOLINIUM



67 HOLMIUM



68 ERBIUM



69 THULIUM

### Wide-ranging uses and prices

Lanthanum and cerium—catalysts in refining oil to gasoline—are cheap and abundant. Lutetium, one of the rarest and most expensive, is in PET scanners. Low-cost erbium is in optical fibers.

### Metal price per pound

As of March 1, 2011

- ☛ \$60-199
- ☛☛ 200-999
- ☛☛☛ 1,000 and above

NORTH AMERICAN PRICES ARE SHOWN, BASED ON STANDARD PURITIES AND COMMONLY ORDERED QUANTITIES.

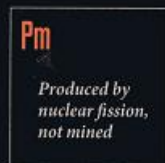
### Use

- ★ Military
- + Medical
- 💡 Energy
- 📺 Consumer products
- 🚗 Transportation

ALL POSSIBLE USES AND APPLICATIONS MAY NOT BE SHOWN.



60 NEODYMIUM



61 PROMETHIUM

*Produced by nuclear fission, not mined*



65 TERBIUM



66 DYSPROSIUM



70 YTTERBIUM



71 LUTETIUM

### Who produces them

As rare earth mining took off in China, U.S. and other producers could no longer compete. The world market now depends on China, which already uses most of its output to supply its own booming factories. But other countries still have large minable reserves of rare earths.

Rare earth production, metric tons

- China
- United States
- Other



GRAPHIC: LAWSON PARKER AND KAITLIN M. WAINALL, NGM STAFF  
SOURCES: USGS, HEFA RARE EARTH CANADA. PHOTOS: NICK MANN

U.S. military needs rare earths for night-vision goggles, cruise missiles, and other weapons.

"They're all around you," says Karl Gschneidner, a senior metallurgist with the Department of Energy's Ames Laboratory in Ames, Iowa, who has studied rare earth elements for more than 50 years. "The phosphors in your TV—the red color comes from an element called europium. The catalytic converter on your exhaust system contains cerium and lanthanum. They're hidden unless you know about them, so most people never worried about them as long as they could keep buying them."

Now a lot of people are worried.

China, which supplies 97 percent of the world's rare earth needs, rattled global markets in the fall of 2010 when it cut off shipments to Japan for a month during a diplomatic dispute. Over the next decade China is expected to steadily reduce rare earth exports in order to protect the supplies of its own rapidly growing industries, which already consume about 60 percent of the rare earths produced in the country. Fears of future shortages have sent prices soaring. Dysprosium, used in computer hard drives, now sells for \$212 a pound, up from \$6.77 eight years ago. Over just two months last summer, prices on cerium jumped more than 450 percent. World demand will probably exceed supply before the end of 2011, says Mark A. Smith, president and CEO of Molycorp, an American company that reopened a rare earth mine at Mountain Pass, California, last year.

"We're in a supply crunch right now, and it's a pretty severe one," says Smith. "This year the demand will be 55,000 to 60,000 tons outside of China, and everyone's best guess right now is that China will be exporting about 24,000 tons of material. We'll survive because of industry inventories and government stockpiles, but I think 2011 will be a very, very critical year in terms of supply and demand."

*Tim Folger wrote about the changing climate of Greenland in the June 2010 issue.*

#### Concentrated force

A neodymium-based magnet is many times stronger than a conventional ferrite magnet of the same size; this one is holding a foot-long, one-and-a-half-pound wrench. Rare earths "channel" the inherent magnetism of iron and other elements, amplifying their power to attract.

The demand shows no signs of abating. In 2015 the world's industries are forecast to consume an estimated 185,000 tons of rare earths, 50 percent more than the total for 2010. So with China holding tightly to its reserves, where will the rest of the world get the elements that have become so vital to modern technology?

Although China currently monopolizes rare earth mining, other countries have deposits too. China has 48 percent of the world's reserves; the United States has 13 percent. Russia, Australia, and Canada have substantial deposits as well. Until the 1980s, the United States led the world in rare earth production, thanks largely to the Mountain Pass mine. "There was a time we were



# C.5. Rare Earths

If you own a smart phone, it may contain **contraband rare earths** from southern China.

producing 20,000 tons a year when the market was 30,000 tons," says Smith. "So we were 60-plus percent of the world's market."

American dominance ended in the mid 1980s. China, which for decades had been developing the technology for separating rare earths (not easy to do because they're chemically so similar), entered the world market with a roar. With government support, cheap labor, and lax or nonexistent environmental regulations, its rare earth industries undercut all competitors. The Mountain Pass mine closed in 2002, and Baotou, a city in Inner Mongolia (an autonomous region of China), became the world's new rare earth capital. Baotou's mines hold about 80 percent of China's rare earths, says Chen Zhanheng, director of the academic department of the Chinese Society of Rare Earths in Beijing. But Baotou has paid a steep price for its supremacy. Some of the most environmentally benign and high-tech products turn out to have very dirty origins indeed.

Rare earth mines often also contain radioactive elements, such as uranium and thorium. Villagers near Baotou reportedly have been relocated because their water and crops have been contaminated with mining wastes. Every year the mines near Baotou produce about ten million tons of wastewater, much of it either highly acidic or radioactive, and nearly all of it untreated. Chen maintains that the Chinese government is making an effort to clean up the industry.

"The government has already made strict regulations to protect the environment and weed out the backward techniques, equipment, and products," Chen wrote in an email. "Those factories without abilities of environmental protection will be closed or merged with bigger companies."

The Chinese government may eventually be able to regulate the large rare earth mining

industry around Baotou. But some of the smaller mines in southern China will be more difficult to control—because they're operating outside the law to begin with. Violent criminal gangs run dozens of heavily polluting—and profitable—rare earth mines in Jiangxi and Guangdong Provinces. Xinhua, the official Chinese news agency, has reported that criminals smuggled 20,000 tons of rare earths from the country in 2008, nearly a third of the total rare earth exports for that year. If you own a smart phone or a flat-screen television, it may contain contraband rare earths from southern China.

"People don't understand how totally corrupt the system in China is, with local party people aiding and abetting criminals in a very substantial way," says Alan Crawley, CEO of Pacific Ores Metals & Chemicals, a trading company in Hong Kong. Crawley speaks from experience. One of his colleagues was murdered 11 years ago by Guangdong gangsters. "The Hong Kong police can't do anything," he says. "The killers fled back to the mainland."

The world is now scrambling to find other sources of supply; the development of rare earth mines in the U.S., Australia, Russia, and other countries may eventually cut into the smugglers' business. Molycorp intends to produce 3,000 to 5,000 tons of rare earths from stockpiled ore at its Mountain Pass mine this year and has big expansion plans. "The current U.S. demand is somewhere between 15,000 and 18,000 tons per year," says Smith. "In principle, Mountain Pass could eventually make the United States independent in rare earths." According to Chen, China's present dominance of the market is not in its own long-term interests. "This situation is obviously not sustainable," he noted, "for China's rare earth industry and for the world's high-tech industry." □

# Rare earths export quota unchanged

Move eases global fears as country committed to providing stable supply

By ZHANG QI, DING QINGFEN AND FU JING  
CHINA DAILY

BEIJING — China, the world's largest producer of rare earths, maintained its export quota at almost the same level as last year, a move analysts said will ease global supply fears.

The Ministry of Commerce said on its website on Thursday that rare earth export quotas for 26 companies in the second half year of 2011 will be 15,738 tons. That means the full-year export quota will be 30,184 tons, almost unchanged from last year's 30,258 tons.

The announcement was made as top trade officials from China and the European Union held talks in Beijing. A World Trade Organization (WTO) expert panel ruled, two weeks ago, that China's export restrictions were inconsistent with its WTO obligations.

The raw materials cited in the WTO ruling did not include rare earths.

Some countries raised concerns about China's export restrictions on rare earths. The government has promised to keep the export quota at reasonable levels to conserve the precious resources and protect the environment.

China produces more than 90 percent of the world's supply of rare earths, even though it has just 36 percent of global

reserves. Rare earths, a group of 17 minerals vital for high-tech industries, are used in electronics, defense and renewable energy.

Export quotas were reduced by 11 percent for the first batch of rare earths this year, after they were slashed 30 to 40 percent in 2010, in a bid to protect sustainable development.

The country is committed to providing a stable supply for the international market, said Wang Caifeng, a former official at the Ministry of Industry and Information Technology and a key player in establishing a rare earths industrial association.

She said the export quota is in line with the country's production plan.

China produced more than 120,000 tons of rare earths last year, with 87,000 tons for domestic use and 34,600 tons for export. The production quota this year is expected to grow by 5 percent, she said.

Su Xinying, deputy general manager of Belgium-based Arpadis Polyurethanes, a company that specializes in the supply and sale of raw materials, said: "China's export quota for rare earths has boosted our confidence."

Although rare earths were not in the nine materials covered by the WTO ruling, analysts believed the case could serve as a precedent to take China's restrictions on rare earths exports to the WTO.

European Union Trade

**China's export quota for rare earths has boosted our confidence."**

SU XINYING  
DEPUTY GENERAL MANAGER  
OF BELGIUM-BASED ARPADIS  
POLYURETHANES

Commissioner Karel De Gucht said on Thursday that the EU wants to see the principles that guided the WTO panel in making the judgment on raw materials also applied to rare earths.

However, Chen Deming, minister of commerce, said at a joint news briefing with De Gucht that he was not concerned about possible WTO challenges to Beijing's policy on rare earths.

The extraction of rare earths has caused environmental damage in China and rampant mining has diminished supplies.

This led to the introduction of policies to guard against over-exploitation and since 2009 export quotas have been cut.

Prices for the minerals on the international market have started to rise recently and "will remain high as demand is there," Wang Caifeng said.

China's rare earth consumption stood at 87,000 tons in 2010, up 19.2 percent from 2009. Demand is expected to grow by at least 3 percent this year, she said.

## C.6. Rare Earths





# D. Music and Genealogy

- Activities:
  - Learn to play your harmonica.
  - Review Grandpa's book of songs, select one of the songs to sing with him around the campfire, and write about your feelings in your notebook.
- Learn about and think about the sacrifices of those who provided you with your DNA:
  - Write something you learned about one of your ancestors in your notebook.



# 2011 Science Camp

- What was best about 2011 Science Camp?

- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_

- What would be your ideal 2012 Science Camp?  
(remember, Ella and Taylor will join us in 2012)

- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_