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# A History of Gold Mining in Oatman & Gold Road, Az

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## INTRODUCTION

Gold-bearing outcrops were discovered in 1862 by Union soldiers garrisoned at Needles, CA, near the northwest corner of the future State of Arizona. Sporadic mining began several years later, but engineered shaft sinking and mill construction were not adopted at Oatman and the neighboring camp of Goldroad until about 1900. Geological interpretations in 1915 enabled major production during the next decade. In the late-1930s, USSR&M built a new mine and mill in Gold Road and the District flourished until closure by Federal Order L-208 in October 1942. For about a decade, Oatman's mines were among the largest gold producers in the American West.

### 1850–1862

The following historical context was published by Donnell. The Territory of New Mexico was an incorporated territory of the United States from September 9, 1850, until New Mexico Statehood on January 6, 1912. The Territory of Arizona was a territory of the United States from February 24, 1863 until Arizona gained statehood on February 14, 1912.

Tensions between Mexico and the United States and the United States' need for a southern railroad route to California led to the Gadsden Treaty, or so-called "Gadsden Purchase." This agreement, finalized in 1854, resulted in acquisition of the southern portions of the New Mexico Territory.

When the Civil War officially began on April 12, 1861, turmoil resulted almost immediately in the New Mexico Territory as the Confederacy moved to claim part of the region. Motivations included access to mineral resources and a secure route to California where it was believed that sympathizers could be enlisted.

In July 1861, Jefferson Davis authorized Gen. H. H. Sibley to march to Fort Bliss and take over New Mexico Territory. There were a few skirmishes: The Battle of Glorietta Pass east of Santa Fe, March 26–28, 1862, was won by the Union, but the Confederacy won the brief fight at Picacho Peak north of Tucson on April 5, 1862. The matter was settled on July 8, 1862, when the Fifth California Volunteers led by Gen. J. H. Carleton drove the Confederates from the New Mexico Territory.

### 1862–1896

It was during Carleton's occupation of New Mexico Territory that gold was discovered in 1862 in what was initially named the San Francisco mining district. Many of the soldiers were experienced miners from the eastern US and they relieved the monotony of garrison duty by prospecting, as reported by Ransome. At the time of Ransome's survey (1922), a "dozen or more" stone cabins reportedly built by Carleton's troops remained on Silver Creek, about 4 miles north of the future town of Oatman.

Around 1863–64, John Moss discovered free gold in an outcropping vein one mile north of Silver Creek. Moss may have recovered as much as $240,000 (about 11,600 ounces). $20.67) from a pocket near the surface, but extensive subsequent development on the vein was disappointing.

Figure 1 is a map of Arizona showing the location of the Oatman district as a blue rectangle (not to scale) near the western edge of the state on old Highway 66. The district measured roughly 7 miles wide by 10 miles long in a north-south direction. It was 20 miles from Needles,

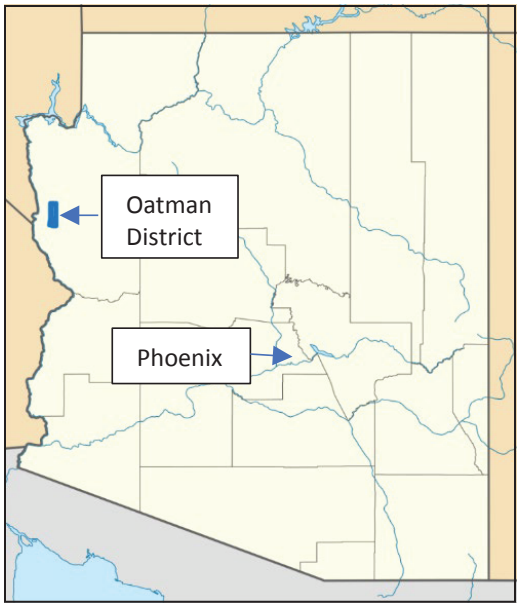


**Figure 1. Location of Oatman in Arizona**

CA, on the west bank of the Colorado River that forms Arizona's western boundary.

Discovery of the Hardy, Gold Dust, and Leland veins occurred soon after Moss's strike, but they apparently were unproductive and there was little activity in the area for at least another 30 years.

An uprising of the Hualpai people in 1866 may have been responsible for the decline in mining activity.[1] Through 1896, there was little activity in the district.

## 1900–1912

In 1900, a prospector named José Jerez discovered rich surface float several miles northeast of Oatman. Jerez had often been grubstaked by Henry Lovin, a storekeeper in Kingman, 27 road miles to the east, so Jerez went to Lovin with samples. Jerez bought supplies and returned to his discovery, soon tracing the float to an exposed vein. He staked two claims and named them Gold Road and Line Road after nearby wagon roads. (The former claim was later renamed Goldroad.)[2]

Investors formed the Gold Road Mining and Exploration Company and mining began in 1902. A small mill sporadically treated approximately 290,000 tons of ore valued at $3,667,000 up to 1911, when the entire property was acquired by the United States Smelting Refining & Mining Company ("USSR&M") for $1,600,000.[3]

In 1901, the Gold Road Company sank the Tom Reed and Ben Harrison shafts to a depth of 100 feet on what became known as the Tom Reed vein.[4] This was the beginning of a revival in the Oatman part of the district.

In 1902, Col. Thomas Ewing bought the Leland and Mitchell properties, comprising eight patented claims, that had been discovered in the 1860s[5]. The next year, Ewing sold the Leland property to the Mohave Gold Mining Co. for an alleged $550,000.

Mohave then invested another $400,000 in improvements that included a mill, a pumping plant, and an 8-inch pipeline that delivered water about 5 miles from the Colorado River to the mill. Another $278,000 was invested in a 17-mile narrow-gauge railroad to supply ore to the mill. It terminated at a 12-chute loading station located at the mine.

Unfortunately, all this investment preceded any mining and the property closed after two years of operation with a total ore production of about 4,500 tons and gross revenues of $40,000.

Fred J. Eddy lived with his wife and children on a claim in a neighboring locale near Cottonwood Springs about 5 miles north of the Oatman settlement. Two of his "hired men," Ely Hilty and his brother, told Eddy about their claim just south of the future Oatman business district. The Hilty brothers had done a limited amount of work that revealed a gold-bearing outcrop, but they had no money and owed unpaid bills in Kingman.

Eddy visited the claims, liked the looks of the outcrop, and collected some rock chips from several locations along the outcrop. He pulverized the chips in a hand mortar and panned them, finding visible free gold in each pan's concentrate. He needed no more proof, paid off the Hiltys' debts, and obtained an option on their claim.[6]

Eddy hired a 10-man crew and began shaft sinking, encountering higher grades with depth, but more capital was soon needed. Returning to his former hometown of Pasadena, CA, Eddy formed the Pasadena Consolidated Company and sold stock to many local businessmen. Eddy became President and Manager and the Hilty brothers received stock in addition to a cash payment for their option.

Continued development increased the ore reserves and the share price increased from 10 cents to several dollars.

1. Wilson, E. D., Cunningham, J. B., and Butler, G. M. (1934), "Arizona Lode Gold Mines and Gold Mining," *The Arizona Bureau of Mines,* Bulletin 137, pp. 80-
2. Malach, R., (1975), "Oatman," *Arizona Bicentennial Commission,* p. 11.
3. Ransome, Ibid, p. 5.
4. Ransome, Ibid, p. 4.
5. Malach, Ibid, p. 7.
6. Malach, Ibid, p. 13.

Whereas Eddy wanted to finance expansion with cash flow, the other Directors wanted to borrow money and build a mill. Divergent views caused Eddy to resign from his positions. The mine was sold and a 10-stamp mill was constructed. However, the new owners failed to make payments and the property was reorganized in 1906 as the Tom Reed Gold Mines Company.

The Tom Reed and Gold Road mines produced ore steadily during the next decade and the settlement near the Tom Reed acquired its official name of "Oatman" in 1912. Its namesake was Olive Oatman, whose family had been massacred nearby in 1851. Olive had been a captive until her rescue in 1857.[7]

### 1913–1933

In 1913, a new shaft was sunk at the Tom Reed. A crosscut was driven, but it missed the vein. Two practical, but experienced miners, G. W. Long and T. L. McIver, studied the Tom Reed's underground workings and theorized about the structural controls of the vein. They noticed that the rock on the sides of the projected line of the vein differed slightly, suggesting existence of a fault fissure.[8]

They then bought claims on ground well to the northeast of the Tom Reed, incorporated the United Eastern Mining Co., and began sinking a shaft in November 1913. Their money ran out when the shaft reached 40 feet and work stopped. In June 1914, W. K. Ridenour bought stock in the new company at 25 cents per share and recommended the investment to friends. By December 1914, about $14,000 had been raised, but more was needed.to continue development.

F. A. Keith became interested and approached Seeley W. Mudd and C. H. Palmer, Jr., respected Los Angeles mining engineers. Altogether, $50,000 was raised and in March 1915, a crosscut at 465 feet went through 25 feet of ore assaying $22.93 per ton (1.1 opt Au at a price of $20.67 and excluding minor silver credits).

### TOATMAN IN 1921

Figure 2 was photographed in 1921 from a location north of the United Eastern, looking south over the eastern part of Oatman. Near the center of the right-hand edge of the photograph, a tower supporting the aerial tramway from the Big Jim is visible.

By 1916, an orebody estimated to contain $6 million in gold had been blocked out. A 200-ton mill built and soon expanded to 300 tons, and a new shaft was sunk. Through 1920, the United Eastern had produced 37,138 tons of ore at an average gross value of nearly $22/ton with a total operating cost of about $8.50/ton. By the end of 1921, dividends totaling $3,959,700 had been paid!

Since the United Eastern orebody had been found without a surface outcrop, many miners and the inevitable promoters assumed that a shaft had to be sunk to 300–500 feet to gain access to new veins. A prospecting boom naturally followed with the sinking of numerous shafts, most of which had been abandoned by 1922.

Nonetheless, there were some successes during that period. Around 1914, the Tom Reed Company had begun developing its Black Eagle claim at the extreme southeast end of a long strip of surface that overlaid proven mining ground.

During this period, other mines in the district, including nearby Union Pass area, shipped ore to the Tom Reed and United Eastern mills. These included Arabian, Banner, Frisco, Gold Crown, Gold Dust, Gold Ore, Gold Trails, London, Midnight, Old Western, Orphan, the Pioneer Group, Oatman United, Ruth, Sheep Trail, Sunnyside, Telluride, United American, and Vivian.

The Big Jim claim was located on September 2, 1908, by S. S. Jones and others.[9] While it showed no indications of a vein, it was on unlocated ground near a producing mine (Tom Reed) and might therefore have some speculative value.

The Big Jim mine was developed in 1916 and the Big Jim and United Eastern Mining Companies jointly operated

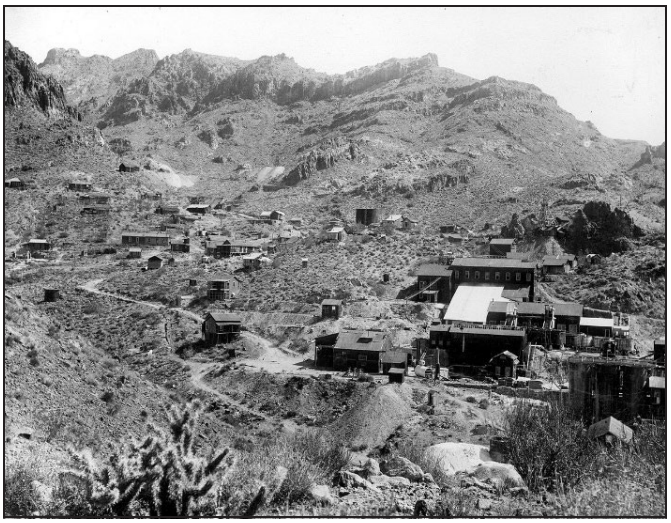

**Figure 2.**

7. Malach, Ibid, p. 15.
8. Ransome, ibid, p. 6.
9. Ransome, Ibid, p.6.

the latter's 300-ton mill to reduce expenses. An aerial tramway delivered the Big Jim ore roughly 50–100 feet above the town[10] for approximately 5,000 feet.[11]

Since the Big Jim mine was clearly related to the Tom Reed's Grey Eagle vein, at least geologically, it was inevitable that owners of the Tom Reed would sue. They did, but the suit was dismissed after appeals because the courts became convinced that the displacement ("throw") of the fault separating the vein members—about 400 feet—exceeded a reasonable interpretation of Apex rights.

Gold Road reopened briefly during 1922–1923, then closed (temporarily) after producing $ 6,654,000 in bullion during its sporadic 20-year life. There was a small cyanide mill on the property and some ore may have been hauled to the Tom Reed.

### 1934–1941

Many mines and mills closed in the early years of the Great Depression when the gold price was $20.67/troy ounce. However, the price was increased to $32.32 in 1933 and $35.00 in 1934[12] and the improved economics allowed re-opening of furloughed operations. Other improvements included better roads and cheaper electricity.[13]

A complete record requires mention of a 50-ton cyanide mill built by the Telluride Company owners for ore from the Old Western mine.[14] It is unclear how successful the small mill was, but Ransome's production summary shows Telluride ore being shipped to the larger local mills in 1923 and 1930.

According to Huttl,[15] the Tom Reed was operating as a custom mill in 1936 and the Gold Road mine was the largest shipper at 1,500 tons per month, followed by 1,000 tons from Oatman Eastern, 800 tons from the Pioneer Group, and 800 tons from leasers of Tom Reed Company mines. Altogether, there were "…about 100 shippers," according to Huttl.

In pursuit of improved economics, USSR&M constructed a 300-ton/day mill at Goldroad (renamed ca. 1936) and operation began on February 15, 1937.[16] Figure 3 is a photograph taken by the author's mother in 1941. North is at the top of the photo and Highway 66

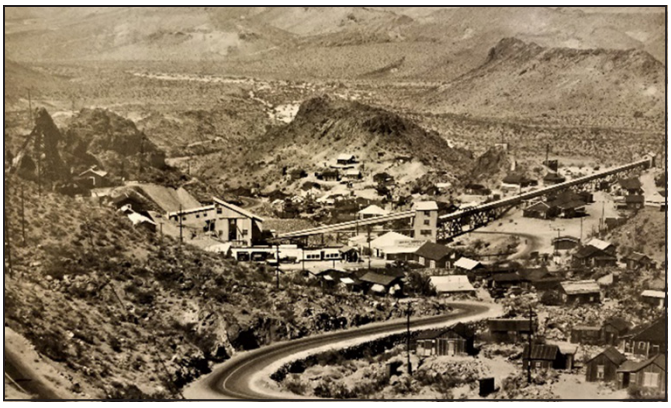

**Figure 3. Goldroad Mill in 1941**

is in the foreground as it wound into town and passed beneath the conveyor that delivered run-of-mine ore to the primary crushing and screening plant.

In October 1942, War Production Board Order L-208 closed all domestic precious metal mines to release workers for mining and processing of copper, lead, and zinc for the military use. The Goldroad mine headframe, mill, and all employee housing were dismantled and trucked to Vanadium, New Mexico, the site of the new Bullfrog lead/zinc mine and mill that was being completed by USSR&M.

Many employees were transferred to Vanadium with the same jobs, including Leo Duriez (manager), Paris Brough (mill superintendent), Ivan Lee (Chief Chemist), Don Johnson (Surveyor), and John McNulty (Fire Assayer).

## DISTRICT GEOLOGY

Geology of the gold deposits remained a mystery until 1916 when exploration by diamond drilling began[17] and systematic interpretation of host rock and vein geology began. Ransome's 1920–1921 investigation was prompted by extensive diamond drilling late in the second decade of the 20th century.[18]

A decade after Ransome's investigation, Lausen[19] completed a detailed geologic map with structure sections. The following brief summary is based on Lausen's report.

The southern portion of the Black Mountains is a strongly dissected eastward-dipping block of Tertiary volcanic rocks resting on a basement of pre-Cambrian gneiss and granite. The Oatman district is in rugged foothills at the western base of the mountains between 2,000- and 3,200-feet elevation. Eastward, the mountains rise to 5,000 feet.

10. Personal observation in 2005.
11. Ransome, Ibid, p. 8 and Plate X, p. 41.
12. "Annual Commodity Statistics," *U. S. Geological Survey*
13. Huttl, J. B. (1936), "Renewed Mining Interest in Oatman," *Engineering & Mining Journal,* Vol. 137, No. 5, p. 251.
14. Huttl, Ibid, pp. 250–251.
15. Huttl, Ibid, p. 251.
16. Staff (1937), "Notes on Arizona," *Engineering & Mining Journal,* August, p. 429.
17. Ransome, Ibid. p.1 ff.
18. Ransome, Ibid., p. 1ff.
19. Lausen, C. (1931), "Geology and ore deposits of the Oatman and Katherine districts, Arizona," *Arizona Bureau of Mines Bulletin* No. 131.

The principal formations are patches of gneiss and granite overlain by a thick series of igneous rocks with feldspar stringers along original lava flow lines (trachytes), andesite, latite (the extrusive form of monazite), tuffs, rhyolite, and basalt. Parts of this series are intruded by monzonitic, granitic, and rhyolitic porphyrys. The dominant ore-bearing formation is the greenish Oatman andesite.

Ore veins occur within fissures along which faulting has occurred before, during, and after vein formation. Some of the veins are tabular, but the larger ones are stringers with complex structures. Few of the veins exceed widths of 50 feet.

The gangue within the veins is mainly quartz and calcite, either of which can dominate. Gypsum and kaolin are locally abundant in the oxidized zone above the historic water table.

The metallic minerals are limited, consisting of free gold with rare pyrite and chalcopyrite. The gold is very fine-grained and visible only in high-grade ore. Nuggets were uncommon and efforts at placer mining were unproductive.

## MINING METHODS

Ore veins throughout the district were irregular and unpredictable. They could be 20–50 feet in width, pinch out with the next round of blasting, then resume at original width if the mine foreman had the right instincts. Therefore, mining was opportunistic and selective. The most common method was shrinkage stoping, which minimized dilution while allowing high recoveries of gold mineralization.

Nearly all mines had competent ground with extensive timbering needed only in the vicinity of faults. Dewatering requirements usually increased as shafts approached the water table, but perched aquifers occasionally dictated temporary suspension of mining. For many years, extending as late as the 1990s, the Tom Reed supplied potable water to the town of Oatman.[20]

## METALLURGY

Gold was almost exclusively very fine, defying efficient gravity concentration and amalgamation. Discrete silver minerals were not common, so the silver that was recoverable may have existed primarily as the gold/silver alloy, *electrum.* Some bullion was 30 percent silver.

Consequently, recoveries of both metals were very low until the advent of cyanidation.

The cyanidation circuit at the Tom Reed was typical and consisted of a primary jaw crusher, a Merrick-type belt scale, and two stages of Allis-Chalmers grate-discharge 6-foot by 6-foot ball mills in closed-circuit with Dorr rake-type classifiers.

The 2nd stage classifier overflow at typically 60–90 percent minus 200-mesh was thickened and leached in a series of three 40-foot high by 12-foot diameter Pachuca-type agitated leach tanks. Following a 50-hour leach, the residual slurry was washed by countercurrent decantation in two rows of four 30-foot diameter by 10-foot Dorr thickeners. (Polymeric flocculants had not yet been invented, so the thickeners seem large compared with current practice for a 300 ton/day CCD circuit.) Thickener underflows were advanced with Frenier pumps and overflows advanced by gravity.

CCD overflow solution was settled in a 40-foot diameter by 12-foot Dorr thickener, filtered, and treated with zinc dust in a conventional Merrill-Crowe circuit. The precipitate was melted in a tilting furnace and cast into bullion bars. Overall recoveries from ore to bullion were approximately 90–92 percent.

The Vivian mine was a significant producer, beginning in the 1860s, but little information is available, except that it was moderately productive in the early-1930s.[21] The owners built a mill but, whereas all other mills that were built after 1900 used agitated cyanidation, there is a Daily Mill Report form for the Vivian Mining Company for July 27, 1940, that contained blanks into which entries could be made for flotation reagent and frother addition rates,[22] clearly indicating that flotation, not cyanidation was being used or considered.

### 1943–1985

There is no well-documented record of gold production during this period. However, it is doubtful that there was significant production, as cost inflation after World War II was serious and the gold price was not allowed to float until 1968. Furthermore, it did not exceed $100 per troy ounce until 1974.[23]

### 1985–PRESENT

After significant gold price appreciation that occurred during 1975–1985, interest was gradually renewed in the old Oatman-Goldroad District. It is possible that earlier exploration and property transactions occurred, but the

20. Personal communication (1992) with Chris Sawyer, President, Mojave Mining & Milling Company.

21. Wilson, Ibid, see table titled *Production, Oatman District,* facing p. 80.

22. Personal collection.

23. USGS, Ibid, "Annual Commodity Prices"

most serious effort was reported by Silver,[24] as summarized below.

Addwest Minerals began investigating Goldroad in 1991 and acquired the property for $1 million paid over 4 years with a 2% net smelter return. A feasibility study was completed in June 1993 and a 500 ton/day cyanidation/carbon-in-pulp mill was constructed. The first gold was poured in January 1995. Capital investments, respectively, in mine and mill were $10.0 and $7.2 million, for a total of $17.2 million, an overrun of nearly 63 percent versus the $10.5 million budget.

Long-hole stoping was initially tried, but mining soon transitioned to shrinkage stoping to minimize dilution. A comparison of the methods revealed that shrinkage stoping nearly doubled both ore grade and percent ore recovery.

A rough startup was followed by a successful operation that produced 92,500 ounces of gold. However, high production costs and a soft gold market led to closure in 1998.[25]

## PARTIAL PRODUCTION STATISTICS

Table 1 summarizes production from the larger mines in the Oatman District. The ore tonnages are only available for some of the properties and the stated values represented only gold in bullion after milling. Silver contributed less than 2% to the total values in bullion.

These statistics are a composite of data provided by Ransome (USGS), the Arizona Bureau of Mines, and D. B. Silver.[26] Tons have been rounded to the nearest thousand from data that were reported to the nearest ton, but probably were less precise. Tons and values have intentionally not been totalized.

It is important to note that the production in Table 1 all occurred while the gold price was still fixed at $20.67 per troy ounce. Therefore, the amount of gold associated with the total stated value of $34.61 million totaled about 1,674,000 ounces. The actual number of ounces would have exceeded this figure because there were scores of smaller mines.

Also, significant production occurred after 1931 up to October 1942. It is likely that the Tom Reed mined and milled another 600,000 tons of ore. Silver reported that Goldroad had mined a total of 1.7 million tons through 1942, over double the tonnage reported through 1931.

**Table 1. Partial Pre-1932 Production Statistics**

| Mine | Years | Tons Ore | Value, $MM |
|---|---|---|---|
| United Eastern | 1917–1924 | 697,000 | 13.67 |
| Tom Reed | 1907–1931 | 984,000 | 13.10 |
| Gold Road | 1903–1931 | 738,000 | 7.25 |
| Moss | Pre-1900 | — | 0.25 |
| Telluride | 1922–1931 | — | 0.20 |
| Hardy | 1870–1906 | | 0.10 |
| Pioneer | 1896–1906 | — | 0.04 |

24. Silver, D.B. (1997), "Gold Road Mine: Anatomy of a turnaround," *Mining Engineering,* August, pp. 28–32.
25. Short, H. (2008), "Adopt-A- Mine," *WorldWide Drilling Resource,* November, p. 72.
26. Silver, Ibid., p.29.

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# A Holistic Vision for a Systems Approach to Resource Governance

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## ABSTRACT

Global public mineral reporting codes have driven strong governance of public disclosures of minerals information. Recently, we have seen an increase in disclosure of information related to Environmental, Social and Governance (ESG) issues, and governance of ESG information in mining companies has arguably reached a similar level of governance and diligence afforded mineral reporting. We define Resource Governance as the conjunction of environmental, social and minerals governance. A modern systems approach to Resource Governance, which combines mineral and ESG information, would provide not only reporting and governance capability, but also has the potential to sense/respond, predict, and manage ESG risks.

## INTRODUCTION

The intent of this paper is to point out that there is a plethora of data that exists, is inter-related, is siloed, can be managed better in a more integrated way and in that world a company will be able to manage risk, see planning and operational performance better and as a result be *confidently transparent* with public disclosures. The intent is not to focus on sustainability or minerals reporting per se, but on the vision of value generation that a modern systems approach offers in this domain.

Public mineral reporting codes around the globe like S-K 1300 (2021), JORC (2012), SAMREC (2016), CIM (2014), PERC (2021) and CRIRSCO (2019) have driven strong governance of public disclosures of minerals information and the data that underpins those disclosures. These codes also require companies to disclose ESG matters that are material to the value proposition of their projects. In more recent years we have seen an increase in expectations of transparent public disclosure of information related to ESG issues, driven by investors and supply chains. Governance of these types of information in mining companies has arguably reached the same maturity as information that supports mineral reporting, which opens opportunities for a broad-based approach across all these domains. See Rowland et. al. (2023) for a summary of standards that relate to ESG reporting.

To further improve ESG and minerals reporting mining companies must overcome challenges related to disparate sources and quality of data, large numbers of stakeholders, siloes in the organisation, varying levels of technical and social competence, and the strength of mechanisms for business process control including approval of public disclosures. These challenges are non-trivial but can be overcome, and exciting opportunities for improvement realized, by taking a holistic systems view of "Resource Governance."