

University of Nebraska - Lincoln

DigitalCommons@University of Nebraska - Lincoln

University of Nebraska Press -- Sample Books
and Chapters

University of Nebraska Press

Spring 2010

Mining Archaeology in the American West

Donald L. Hardesty

Follow this and additional works at: <https://digitalcommons.unl.edu/unpresssamples>



Part of the [Arts and Humanities Commons](#)

Hardesty, Donald L., "Mining Archaeology in the American West" (2010). *University of Nebraska Press -- Sample Books and Chapters*. 103.

<https://digitalcommons.unl.edu/unpresssamples/103>

This Article is brought to you for free and open access by the University of Nebraska Press at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in University of Nebraska Press -- Sample Books and Chapters by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

Mining Archaeology in the American West

[Buy the Book](#)

Historical Archaeology
of the American West

Series Editors

Rebecca Allen
Annalies Corbin

[Buy the Book](#)

Mining Archaeology in the American West

A View from the Silver State

Donald L. Hardesty

University of Nebraska Press
and the
Society for Historical Archaeology



[Buy the Book](#)

© 2010 by The Society for Historical Archaeology

All rights reserved

Manufactured in the United States of America



Library of Congress

Cataloging-in-Publication Data

Hardesty, Donald L., 1941–

Mining archaeology in the American West :

a view from the Silver State / Donald L. Hardesty.

p. cm.

— (Historical archaeology of the American West)

Includes bibliographical references and index.

ISBN 978-0-8032-2440-7 (cloth : alk. paper)

1. Nevada—Antiquities.

2. Archaeology and history—Nevada.

3. Frontier and pioneer life—Nevada.

4. Mines and mineral resources—

Social aspects—Nevada—History.

5. Mines and mineral resources—

Nevada—History.

6. Mining engineering—Nevada—History.

7. Industrial archaeology—Nevada.

8. Social archaeology—Nevada.

I. Society for Historical Archaeology. II. Title.

F843.H25 2010

979.3'01—dc22

2009033169

Set in Quadraat & Quadraat Sans by Kim Essman.

Contents

List of Illustrations	vii
List of Tables	xi
Introduction	xiii
1. Traveling into Nevada's Mining Past	1
2. The Archaeology of Mining Technology	29
3. The Social Archaeology of Mining	109
4. Conclusions	
<i>Understanding Variability and Change on the Mining Frontier</i>	179
References Cited	189
Index	203

Illustrations

Images

1. Miners at Cortez, early 20th century	2
2. Mining landscape, Bodie, California	9
3. Standard Mill at Bodie, California	13
4. Billie Mine Portal, Death Valley, California	14
5. Bullwheel at Bulwer Mill site, Bodie, California	16
6. An arrastra	17
7. Map of arrastra archaeological site	18
8. The Tenabo Mill in 1900	19
9. Lime kiln next to the Tenabo Mill	19
10. The Mayflower Mine site, Bullfrog Mining District, Nevada	24
11. Hoist engine at the Pioneer Mine site, Bullfrog Mining District, Nevada	25
12. Virginia City, Nevada, from Cedar Hill, 1870s or 1880s	26
13. House site at Shoshone Wells	27
14. Mine waste dump and tramway at Arctic Mine, Cortez Mining District	30
15. Cyanide vats, Bodie, California	30
16. The Tenabo Mill site	32
17. The “Nevada Giant Ledge” in the Cortez Mining District	33
18. Placer deposits, Malakoff Diggings, California	34
19. The “glory hole” at the Montgomery-Shoshone Mine, Bullfrog Mining District	35
20. Lavender copper pit, Bisbee, Arizona	37
21. Abandoned dredge between Tok and Eagle, Alaska	39
22. “Giant” water nozzle used in hydraulic mining at Malakoff Diggings, California	39
23. Illustration of Burleigh mechanical rock drill	40
24. Air compressor at Caledonia Mine, Gold Hill, Comstock Mining District	41
25. Mine shaft and collapsed headframe, Joshua Tree National Park, California	42

26. “Rat-holing” scene: miners, burro, and ore car	42
27. Underground workings at the Consolidated Cortez Mine, 1920s	44
28. Adit at the Arctic Mine, Cortez Mining District	45
29. An 1876 lithograph by T. D. Dawes of square sets on the Comstock Lode	46
30. Shrinkage stoping at Cortez, 1920s	47
31. Windlass at Rawhide, 1908	48
32. Underground at the Gold Bar Mine, 1905	48
33. Whim at Bodie	49
34. Gallows headframe at the new Gold Bar Mine, 1906	50
35. Gallows headframe at the Forman Shaft, Gold Hill, Comstock Mining District	51
36. Hoisting cages, Bullion Mine, Gold Hill, Comstock Mining District	52
37. Cornish pump at the Union Shaft, Comstock Mining District, 1879	54
38. The Gold Bar Mine site	54
39. Horse whim at the original Gold Bar Mine, 1905	56
40. The original Gold Bar Mine site	56
41. Map of the original Gold Bar Mine	57
42. Blacksmithing feature at the original Gold Bar Mine	58
43. The new Gold Bar Mine in 1908	58
44. The new Gold Bar Mine site	59
45. Map of the new Gold Bar Mine	60
46. The Homestake Mine in 1906	61
47. The Homestake Mine site	61
48. Map of the Homestake Mine	62
49. Concrete machine pads at the Homestake Mine	63
50. The main shaft at the Homestake Mine	64
51. An arrastra, Joshua Tree National Park, California	65
52. An 1860s lithograph of a stamp battery at Gould and Curry Mill, Comstock Mining District	66
53. Ruins of an 1870s stamp mill at Tuscarora, Nevada, in 1911	67
54. Illustration of a Blake rock crusher	68
55. Illustration of Krom rolls	68
56. Allis-Chalmers tube mill at Consolidated Cortez Mill, Cortez Mining District, 1920s	69

57. Frue vanners at the Kinkaid Mill, Virginia City, Nevada.	71
58. Illustration of Fagergren flotation cells	72
59. Elevation and flow sheet of Black Hawk Flotation Mill, New Mexico	73
60. Patios at the 1864 Gould and Curry Mill, Comstock Mining District	74
61. Elevation of the Taylor Mill, Mineral Hill	75
62. Illustration of Wheeler amalgamation pan	77
63. Illustration of settler.	78
64. Interior of California Pan Mill, Virginia City, Nevada, in 1882.	79
65. Ruins of 1871 Monte Cristo Mill near Rawhide, 1914	80
66. Illustration of Bruckner cylinders	81
67. Illustration of Stetefeldt shaft furnace	82
68. Remains of leaching vats at the Tenabo Mill site	85
69. Bruckner cylinders and furnaces at the Tenabo Mill site	85
70. Butters Mill on the Comstock Lode, 1906	86
71. Interior of Butters Mill, showing agitation tanks	86
72. The 1909 Sanborn fire insurance map of Montgomery-Shoshone Mill, Bullfrog Mining District	87
73. Milling flow sheet for Montgomery-Shoshone Mill	88
74. Montgomery-Shoshone Mill site	89
75. Illustration of Dorr thickening tank	90
76. Archaeological remains of Dorr thickener	90
77. Illustration of Trent agitation tank	91
78. The Homestake-King Mill site, Bullfrog Mining District	92
79. The Homestake-King Mill in 1908	92
80. Map of the Homestake-King Mill	94
81. The Consolidated Cortez Mill site, Cortez Mining District	96
82. Consolidated Cortez Mill in the 1920s	96
83. Allis-Chalmers ball mill at the Consolidated Cortez Mill, 1920s	97
84. Agitation tanks at the Consolidated Cortez Mill, 1920s	97
85. Merrill slime press at the Consolidated Cortez Mill, 1920s	98
86. Oliver filter at the Queen Mill in Rawhide, Nevada, 1912	98
87. Bullion furnace at the Consolidated Cortez Mill	99
88. Map of the Consolidated Cortez Mill site	100

89. Tailings flow at the Consolidated Cortez Mill site.....	101
90. Consolidated Cortez Mill powerhouse in the 1920s.....	101
91. Fairbanks and Morse generators at the Consolidated Cortez Mill powerhouse.....	102
92. The Consolidated Cortez Mill powerhouse site.....	102
93. Cyanide lid trash scatter at the Consolidated Cortez Mill site.....	103
94. Richmond Consolidated Smelter, Eureka, Nevada.....	104
95. Assaying artifact: crucibles.....	106
96. Assaying artifact: cupels.....	106
97. Assay trash scatter at the Consolidated Cortez Mill site.....	107
98. Rhyolite, Nevada, in 1905.....	114
99. Map of settlements in Cortez Mining District.....	118
100. Town of Cortez, Nevada, in early 20th century.....	119
101. Map of Shoshone Wells site.....	121
102. The Gold Bar Camp in 1908.....	126
103. Map of the Gold Bar townsite.....	127
104. The Gold Bar Camp in 1905.....	129
105. The Gold Bar Camp in 1906.....	129
106. The Gold Bar Camp in 1908.....	129
107. Residential locus at the Garrison Mine, Cortez Mining District.....	142
108. Chinese artifacts from Structure 22.....	150

Figures

1. Milling flow sheet for the Taylor Mill.....	76
2. Milling flow sheet for Russell process at the Tenabo Mill.....	84
3. Milling flow sheet for the Homestake-King Mill.....	95
4. Histogram of “purple” bottle glass assemblages at Gold Bar.....	131
5. Histogram of house-site floor areas at Gold Bar.....	160
6. Histogram of artifact assemblage sizes at Gold Bar.....	161
7. Histogram of artifact assemblage diversity at Gold Bar.....	164
8. Simple linear regression of assemblage diversity on assemblage size at Gold Bar.....	165
9. Histogram of ceramic percentages at Gold Bar.....	166
10. Histogram of bottle glass percentages at Gold Bar.....	166

Tables

1. Shoshone Wells house-site classification	123
2. Statistical description of Gold Bar “purple” bottle glass	132
3. Tin can assemblage from Gold Bar townsite.	133
4. Artifact assemblage from Wenban’s house site	137
5. The 1900 household census for the Garrison Precinct	143
6. The 1900 household census for the Cortez Precinct	144
7. Shoshone Wells property owners with Chinese surnames	146
8. Artifact assemblage from Structure 22	149
9. Artifact assemblage from Structure 18.	151
10. Artifact assemblage from Structure 20.	154
11. Artifact assemblage from Structure 14.	157
12. Artifact assemblage from Structure 13.	158
13. Statistical description of Gold Bar house floor areas.	161
14. Statistical description of Gold Bar artifact assemblages	162
15. Statistical description of Gold Bar assemblage diversity	164
16. Statistical description of Gold Bar ceramics	167
17. Statistical description of Gold Bar bottle glass	167
18. Geographical origins of Cortez Store invoices, 1891–1893	172
19. List of suppliers to the Cortez Store, 1891–1893	173

Introduction

Mining and miners left an enduring legacy in the history and landscape of the American West (Smith 1987; Robbins 1994; Hine and Faragher 2000; Paul 2001; Isenberg 2006). Indigenous peoples mined minerals such as salt and turquoise in the region before the arrival of Europeans in the 1500s. Spanish explorers and settlers searched for the mythical El Dorado and opened mineral and metal mines in what is now the Southwest and Southern California. They introduced mining technologies and methods developed earlier in medieval Europe and other parts of New Spain. The discovery of gold in California in 1849 led to the first global mining rush in the American West (Holliday 1999). More mining rushes followed with gold strikes on the Fraser River in British Columbia and on Pikes Peak in Colorado in the late 1850s (Fetherling 1997). The discovery of the famous Comstock Lode in Nevada in 1859 spurred the industrialization of mining and revolutionized mining technology, society, and culture throughout the world (James 1998). Subsequent mining rushes took place during the next few decades in the Cariboo region of British Columbia; on Nevada's Reese River and Treasure Hill; in the Black Hills of South Dakota; at Bannack and Alder Gulch in Montana; at Leadville and Cripple Creek in Colorado; and at Idaho's Clearwater River, Boise Basin, and Owyhee Mountains, among other places. The end of the nineteenth century and beginning of the twentieth heralded the last of the famous global mining rushes in the American West: the Klondike Gold Rush in Alaska (Morse 2003) and the gold strikes at Tonopah, Nevada, in 1900 and at nearby Goldfield, Nevada, in 1902 (Elliott 1966; Zanjani 1992, 2002). Mining for base metals and minerals such as copper and iron played an equally prominent role in the history of the American West in the twentieth century (Hyde 1998).

Nevada's mining frontier is a microcosm of the western mining experience and is the focus of this book. Sporadic and small-scale mining took place in what is now Nevada before the expansion of the American state. In the late 18th century, Spanish Franciscan monks traveling on

an old Spanish trail in what is now southern Nevada mined gold placers, silver lodes, and turquoise (Horton and Lincoln 1964:2). Mormon expansion out of the Salt Lake Valley in the late 1840s and 1850s also introduced some mining activity to Nevada in the aftermath of the California Gold Rush (Arrington 1958, 1979; Davies 1984; Owens 2002). In 1855 Mormons established a mission in the Las Vegas Valley at what is known today as Mormon Fort (Arrington 1979). Brigham Young sent a party of prospectors led by Nathaniel V. Jones in April 1856 to search for rumored silver and lead deposits (Arrington 1958:127–129; Lingenfelter 1986:60–61). They failed to discover a “silver mountain” but did find gold and lead deposits in the Spring Mountains of present-day southern Nevada. Young opted to develop the lead deposit at Potosi Spring close to the Spanish trail (Arrington 1958:127–129). By January 1857 the Mormon miners had “opened the mine, built a small smelting furnace, and produced over 9,000 pounds of lead” containing significant amounts of silver, giving rise to legends about Mormons using silver bullets (Lingenfelter 1986:61). The mine became unprofitable, however, and the group began to search for new lead deposits (Arrington 1958:127–129). Young called the Mormons back to Utah later that year (1857), bringing the search and the Las Vegas mission to an end. In 1861 non-Mormons discovered silver deposits near the Potosi lead mine, and the Colorado Mining Company built another smelter, along with the townsite of Potosi, about one-half mile from the mine (Paher 1970:265–266). William O. Vanderburg (1937:11) noted that the first systematic mining in present-day Nevada began in 1857 with the discovery of gold and silver deposits in the Eldorado Mining District on the Colorado River just west of Lake Mead.

Mormon emigrants discovered placer gold at the mouth of Gold Canyon on the Carson River in 1850, culminating in the discovery of the Comstock Lode in 1859, the subsequent “Rush to Washoe,” and the global revolution of the mining industry. In 1860 prospectors found new silver deposits in the Esmeralda district in Mineral County and the Humboldt district in Humboldt County, soon leading to mining rushes in both places. The Reese River strike in 1862 and ensuing rush brought the mining industry to central Nevada, where production peaked between 1862 and the late 1880s (Abbe 1985). In 1867 excitement surrounding the Treasure Hill mines in central Nevada led to the establishment of the towns of Hamilton, Treasure City, and Shermantown as well as major British investment in the mines in the 1870s and 1880s (Jackson 1963). At one point, 200 mines and

23 mills operated on Treasure Hill. The Treasure Hill mines soon failed, however, with most closing down in the early 1870s. Eureka emerged in the 1870s and 1880s as a world-class smelting center for lead-silver ores mined in the region. Large-scale placer mining began in the Osceola district in northeastern Nevada during the 1880s and continued until 1900 through the use of hydraulic and sluicing mining technology. The Osceola Placer Mining Company constructed a large water conveyance system of ditches and flumes (Vanderburg 1936:168–169).

Tonopah and Goldfield emerged as early-20th-century centers of mining activity in Nevada in 1900 and 1901, respectively (Elliott 1966; Zanjani 1992, 2002). Secondary and short-lived booms also occurred in the Bullfrog district, Rawhide, and the Seven Troughs district (Ransome et al. 1910; Lincoln 1923:151, 216; Lingenfelter 1986). The western slopes of the Toquima Range were dominated by large-scale placer mining activities in the Round Mountain and Manhattan districts (Lincoln 1923:175). Using a variety of technologies ranging from hydraulic monitors to floating bucket dredges, both sites produced high yields of free gold between the first decade of the 20th century and the 1940s.

The purpose of this book is to explore the historical structure, characteristics, variability, and evolution of Nevada's mining frontier through the material remains of the technological systems, landscapes, and social formations associated with past mining activities. These physical expressions include standing buildings and structures, ruins and other archaeological remains, landforms, and historical documents. Toward this end, chapter 1 discusses how to travel into mining's past through the corridors of written and pictorial documents, landscapes, architecture, and the archaeological record and how to use these resources interactively to explore the Nevada mining frontier. Traveling through documents involves images of the past gleaned from personal diaries and letters, photographs, state and federal census records, tax assessments, company records, government publications, and the like. Mining landscapes are marked by images in landforms, vegetation patterns, land-use patterns, circulation networks, and cultural traditions. Another corridor passes through architectural images in the form of surviving buildings and structures associated with the extraction and processing of minerals and metals, mining infrastructures of transportation and communication, and the lifestyles and social organization of the miners. Traveling through the archaeological record of Nevada's mining past, one finds im-

ages of collapsed headframes and hoisting houses, foundations of pan amalgamation mills, remnants of arrastras, trash dumps, and the ruins of blacksmith shops and miner's residences.

Chapter 2 explores the archaeology of mining technology on Nevada's mining frontier. Miners and engineers developed technologies for exploration and extraction, processing, and building infrastructure. Extraction technologies included excavation, hoisting, ventilation, and drainage systems. Processing technologies involved mechanical crushing and grinding, simple collection, chemical methods for milling complex ores, and smelting. The technologies of mining infrastructure addressed transportation, power, and communication. Mining technologies have archaeological, architectural, and landscape expressions in mine waste-rock dumps, mill tailings, open pits and prospects, shafts and adits, mill foundations, concrete engine pads, tramways, hoist houses, air compressors, dredges, and headframes. Such remains reflect the tools, materials, operational sequences and skills, social coordination of work, and knowledge involved in the extraction and processing of metals and minerals, the key components of what has been called a "sociotechnical system." The chapter explores variability and change in the sociotechnical systems of mining.

Chapter 3 addresses the social archaeology of mining on Nevada's mining frontier in terms of settlement-systems, settlements, households, and the archaeology of gender, ethnicity, and class. Settlement-systems reflect the spatial arrangement of tools, operations, social formations, and coordination of work within mining-related sociotechnical systems. Such social relations are, in the words of Elizabeth Brumfiel (1992:551), "the composite outcomes of negotiation between positioned social agents pursuing their goals under both ecological and social constraints." Mining social systems can be conceptualized as a network of power relationships based on controlled access to resources like capital, ore deposits, labor, and water. Power relationships among individuals and groups are therefore situational: they are constantly being negotiated because of changing meanings or values of these resources. This chapter also explores local settlements as well as variability and change in households on the mining frontier. Local settlements formed the key nodes of mining-related settlement-systems, social networks, communities, and sociotechnical systems. They ranged from small social groups organized around mines or mills to large urban centers and company towns with a

wide range of activities and diverse social structures. Chapter 3 focuses on Gold Bar, a short-lived early-20th-century camp in southwestern Nevada, and the late-19th-century settlement of Shoshone Wells in central Nevada. These mining settlements were organized around households—groups of people sharing domestic activities such as consumption and production who may or may not have lived together.

Chapter 4 considers the theoretical frameworks and evolutionary models used to understand Nevada's mining past. The principles of evolutionary theory and evolutionary ecology are applied to explore variability and change in the distinctive social and cultural characteristics of mining frontiers in the American West. Mining frontiers reflect the mechanisms and processes of evolutionary plays taking place in unique ecological theaters. How miners used coping strategies to adapt to the boom-bust cycles and island structures of the frontier is discussed in the chapter. They include opportunistic strategies (such as geographical expansion, resource intensification, and pooling) and resiliency strategies (such as finding new markets, cutting costs, and geographical contraction). The chapter concludes with the development of a coevolutionary model of adaptive change on mining frontiers and its application to the Comstock Mining District.

1. Traveling into Nevada's Mining Past

Exploring Nevada's mining past involves traveling through the historical corridors revealed by documents, landscapes, architecture, and the archaeological record. Each pathway follows an independent source of information that can be combined and used interactively with the others to construct models of the past (Deetz 1988). One source of information, like written documents, can provide a preliminary model of a mining technology, household, or community. The archaeologist or historian can derive hypotheses from the model and test them with data acquired from new research into the archaeological record, architecture, landscapes, or documents. The new information helps modify the preliminary model, leading to the identification of new hypotheses that can be tested and used to revise the model further. In this manner, the construction of mining's past from several independent sources of information is cyclical and continuously evolving.

Documentary Images

One corridor into Nevada's mining past is through written and pictorial documents (image 1). Community plats, cartographic sources, iconographic and pictorial material, company records, records of social service workers, professional and technical journals, consultants' reports, governmental publications, newspaper accounts, census records, and city directories are the most common documentary accounts of mining (Alanen 1979).

Townsite Plats

The Townsite Surveys of the General Land Office are one of the most important sources of plats for mining camps. Plats are available for several Nevada mining settlements, including Esmeralda, Aurora, Washoe City, Austin, American City, and Mineral City (Reps 1975). In addition, Sanborn fire insurance maps of several mining towns, including the Comstock towns of Virginia City, Gold Hill, Silver City, and Dayton, are available



1. Miners at Cortez, early 20th century. (Courtesy of Nevada Historical Society.)

for different time periods. The maps give important information about town layout and the use and construction of buildings. Sometimes included are maps of mines and mills in and around the town, such as the Montgomery-Shoshone Mine at Rhyolite.

Cartographic Sources

The maps produced by the U.S. Bureau of Mines and the Nevada Bureau of Mines and Geology are useful sources of information about ore deposits. Researchers can also turn to the township and mineral patent survey plats and notes in the Nevada State Office, Bureau of Land Management.

Company Records

The availability of written accounts kept by mining companies in the state of Nevada varies greatly. Some records are in the Nevada State Historical Society; the Nevada State Archives; the county historical societies, archives, and museums; and the university libraries at the Reno and Las Vegas campuses of the University of Nevada. For the most part, however, the records are scattered. The Churchill County Museum and Archive as well as Special Collections at the University of Nevada–Reno Library, for example, hold ledgers and invoices from the company store of the Cor-

tez Mines Limited from 1889 to 1893. Ledgers and invoices for the company store of the Tenabo Mill and Mining Company for 1904, 1908, and 1909 are available elsewhere. The Adelberg and Raymond manuscript collection at the New York Public Library is another valuable source of company data, containing items like the 1865 report of the Manhattan Silver Mining Company in Austin, Nevada.

Diaries and Other Personal Reminiscences

Dan De Quille's (1876) *The Big Bonanza* is a newspaperman's account of the Comstock Mining District in its heyday. Mary McNair Mathews's (1985) *Ten Years in Nevada or Life on the Pacific Coast* is an account of 1870s Virginia City. Hubert H. Bancroft's (1889) multivolume series "Chronicle of the Kings" includes a biography of Simeon Wenban, a mine operator in Nevada. And John Ross Browne's (1871) *Adventures in the Apache Country: A Tour through Arizona and Sonora, with Notes on the Silver Regions of Nevada* is another classic.

Professional and Technical Journals

Two contemporary journals are the standard sources on mining technology and provide a wealth of information about the subject: the *Mining and Scientific Press* and the *Engineering and Mining Journal*. There are also several textbooks and handbooks, the most useful of which is Robert Peele's (1918) *Mining Engineers Handbook* (1st edition, with several later editions). Other key publications include Manuel Eissler's (1898) *The Metallurgy of Silver* (4th edition); Thomas Egleston's (1887) *Metallurgy of Silver, Gold and Mercury in the United States*; Carl A. Stetefeldt's (1895) *The Lixivation of Silver-Ores with Hyposulphite Solution*; John Dorr's (1936) *Cyanidation and Concentration of Gold and Silver Ores*; William Storms's (1909) *Timbering and Mining*; Guido Kustel's (1863) *Nevada and California Processes of Silver and Gold Extraction*; and Thomas A. Rickard's (1901) classic *The Stamp Milling of Gold Ores*.

Government Records

Government records provide another important source of information about mining in Nevada. Chester Naramore and C. G. Yale's (1910) *Gold, Silver, Copper, Lead, and Zinc in the Western States and Territories in 1908* is a standard source, as are James Hague's (1870) mining reports in the U.S. *Geological Exploration of the Fortieth Parallel*. The *Information Circulars* of the

U.S. Bureau of Mines provide a wealth of geological and engineering information about the mines of Nevada and elsewhere, as do the bulletins of the U.S. Geological Survey and the bulletins of the Nevada Bureau of Mines and Geology. Couch and Carpenter's (1943) *Nevada's Metal and Mineral Production*, for example, is an extremely useful source. Many of these works contain key information about mining districts, such as J. M. Hill's (1912) *The Mining Districts of the Western United States* and Francis Church Lincoln's (1923) *Mining Districts and Mineral Resources in Nevada*.

Another key government source is the series *Mineral Resources West of the Rocky Mountains*, later renamed *Mineral Resources of the United States*. Several authors wrote the reports in this series, which the U.S. Treasury Department issued beginning in 1866; the most important were those by J. Ross Brown (1866–1867), Rossiter Raymond (1868–1875), and S. F. Emmons (1893). Several of the reports were published as annual reports of the U.S. Geological Survey between 1882 and 1893. Specific reports can be located through the *Checklist of U.S. Public Documents*, prepared by the superintendent of documents.

Whatever the political problems involved, Nevada's unique status of having 86% of its land in the public domain has created an unusually large body of written accounts. The Bureau of Land Management (BLM), which formed in 1812 as the General Land Office to administer public lands, maintains detailed records of land transactions. Jane F. Smith (1975:291) has classified these records into four groups, each of which contains different kinds of information: (1) *identification records*—mostly surveyors' field notes and plats containing information about topography, vegetation, and resources; (2) *status records*—tract books or ledgers and status plats giving a legal description of public lands and resources and detailing their ownership, size, purchase price, and use; (3) *case records*—land entry papers, especially related to homestead, desert land, and mineral claims, with information about dates, locations, and improvements to mining properties and settlements; and (4) *legal records*—mostly land patents and deeds. Many of these records are kept in the state and district offices of the BLM in Nevada, although some are located in the National Archives. Two categories of documents are especially important. After 1880 townsite survey files were separated from other land entry documents, and today they provide an important source of information about mining camps, both planned and actually built. Indeed, John W. Reps (1975) has made a case for early “urban planning” in western min-

ing camps using the town plats from the Townsite Surveys, General Land Office, National Archives. And, second, the passage of the U.S. Mining Law in 1866 (Act of July 26, 1866, 14 Stat. 251) opened up public lands to mining and led to the “mineral entry” documents, which are located in the General Land Office section of the National Archives. The mineral entries contain field notes and plats, the bylaws of mining districts, records of litigation surrounding mining claims, mineral contest dockets, and much more (Smith 1975:302).

Historically, the Nevada Legislature has convened every two years and continues to do so. A published report of its activities appeared in the year following each session. From 1864, when Nevada was admitted to the union, to 1879, the “Biennial Report of the State Mineralogist of the State of Nevada” was included in an *Appendix to the Journals of the Senate and Assembly*. Each report contained detailed information about mining production in the state, usually arranged by county. The 1877 report, for example, noted that the Garrison Mine in the Cortez Mining District produced 492 tons of ore with a market value of \$21,273.49 for the year 1875 (p. 197). And the 1873 report observed that the Cortez Mill was operating with 13 stamps (p. 67). From 1879 to 1911 the reports continued under the title “Biennial Report of the Surveyor-General and State Land Register of the State of Nevada.” In addition to mining statistics, the reports included litigation. The 1891 report, for example, discusses the dispute between Lander and Eureka counties over the Cortez Mining District, which was bisected by the county line (pp. 106–110). Construction of a new mill by the Tenabo Mill and Mining Company in 1886 instigated a lawsuit by Eureka County to recover taxes paid by the company to Lander County. In a 22 September 1890 decision, the Nevada Supreme Court reversed a lower court decision and gave the new mill to Lander County. Since 1911 the reports have appeared under the title “Annual Report of the State Inspector of Mines.”

The most important county records are those of the mining districts, which are usually stored in the vaults of the county recorder’s office. Nye County, for example, has a large number of volumes on the Tonopah Mining District, including the Index to Mining Locations (26 volumes), the Index to Tonopah Mining District Records (2 volumes), the Tonopah Mining District Records (12 volumes), and Mining Locations (122 volumes) (Elliott 1966:315). Another important source of information about mining camps are the county tax assessment rolls, which are stored mostly

in courthouses and administrative offices. (The Lander County rolls are currently stored in the Nevada State Archives in Carson City.) The rolls give especially good information about households. In the Cortez Mining District, for example, a detailed study of the rolls between 1865 and 1900 yielded several kinds of information. One kind is the estimated value of the household, including land, improvements, and personal possessions. The rolls between 1886 and 1888 show that the vast majority of the residents of Cortez had the same wealth, ranging from less than \$100 to about \$400; however, Simeon Wenban's household was valued at \$2,000, and his total wealth, including mines and the mill, had grown from \$20,000 to \$30,000 by 1888. Another kind of information is the location and uses of buildings. According to the 1886 Lander County tax assessment rolls for Shoshone Wells, Antonio Montare owned the "stockade house at Shoshone Wells being opposite to the store of Yung Look, also a frame stable south and adjoining Young Look." And in 1899 Joe Frasseti was listed as owning a "stone cabin at Shoshone Wells, back of A. Montroses house," while Hing Wah and Company owned an "adobe house at Shoshone Wells known as Hop Sing's house."

Secondary Accounts

Researchers can consult several histories of mining in the American West for a general background. Of these, the best are Rodman Paul's (2001) *Mining Frontiers of the Far West, 1848–1880*; Otis Young's (1970) *Western Mining*; Mark Wyman's (1979) *Hard Rock Epic*; Douglas Fetherling's (1997) *The Gold Crusades*; Duane Smith's (1987) *Mining America*; Colleen Whitley's (2006) *From the Ground Up: A History of Mining in Utah*; and Ronald Brown's (1979) *Hard-Rock Miners: The Inter-mountain West, 1860–1920*. Others are more limited in scope, like Clark Spence's (1970) *Mining Engineers and the American West: The Lace Boot Brigade, 1849–1933*; Arthur Todd's (1967) *The Cornish Miner in America*; J. S. Holliday's (1999) *Rush for Riches: Gold Fever and the Making of California*; and Andrew Isenberg's (2006) *Mining California: An Ecological History*. Perhaps the best general history of mining in Nevada is Russell Elliott's (1966) *Nevada's Twentieth-Century Mining Boom*. Others include W. Turrentine Jackson's (1963) *Treasure Hill*; Eliot Lord's (1883) *Comstock Mining and Miners*; and Sally Zanjani's (1992, 2002) *Goldfield: The Last Gold Rush on the Western Frontier and The Glory Days in Goldfield, Nevada*. Two other useful sources on Nevada mining history are Myron Angel's (1881) *History of Nevada* and Don Ashbaugh's (1963) *Nevada's Turbulent Yesterday*.

Newspaper Accounts

Mining town newspapers, although often short-lived and sometimes prone to embellishment, provide the most detailed and current information about mining activities. They include the *Reese River Reveille* from Austin, the *Territorial Enterprise* and the *Virginia Evening Chronicle* from Virginia City, the *Gold Hill News*, the *Goldfield News* and the *Goldfield Daily Tribune* from Goldfield, the *Manhattan Post*, the *Wonder Mining News*, the *Bullfrog Miner*, the *Rhyolite Herald* from Rhyolite, and a large number of others too numerous to list here. In addition, accounts of mining in Nevada often appeared in the major San Francisco newspapers, including the *Chronicle*, the *Bulletin*, the *Alta California*, and the *Call*. The *Sacramento Union* is yet another source.

Census Records

Federal and state census records often provide key historical information about mining populations in the American West. The composition of some mining populations in the state of Nevada, for example, can be glimpsed through the federal census records of 1860, 1870, 1880, 1900, 1910, 1920, and 1930 as well as through the state of Nevada census of 1875. The federal census records through 1920 are now available on-line on the Nevada State Historic Preservation Office Web site (<http://nevadaculture.org/shpo>). Household data are especially useful. Census records list individual occupations, ethnicities, and places of birth as well as information on households—the names and number of household members, their age and sex composition, and the number of families. The records, however, are somewhat spotty. The census records for the Cortez Mining District are missing for 1880 and 1890, when it reached its peak population growth. And mining settlements often do not appear at all in the federal censuses. Many were so small that they were grouped together with other settlements in the district or simply overlooked. Thus, inhabitants of the mining camp at Shoshone Wells in the Cortez Mining District fell into the larger town of Cortez under the Cortez Precinct; they have no separate visibility. And many of the settlements had such short life spans that they grew up and died between censuses, becoming invisible in documentary history. The mining camp at the Gold Bar Mine in the Bullfrog Mining District, for instance, lasted from 1904 until 1909 (Hardesty 1987a), too early for the 1900 census and too late for the 1910 census.

Other Documentary Records

Other documentary sources are too numerous and varied to be discussed in detail. Two additional ones, however, should be mentioned. Pictorial documents are quite common. Many illustrations of mining on the Comstock Lode, for example, appeared in *Harper's New Monthly Magazine* during the 1870s. The illustrations from the prospectus of the Gould and Curry Mill in Virginia City are another example. City directories give useful demographic information about the occupations and addresses of people and businesses.

Mining Landscapes

Another pathway into Nevada's mining past is through landscapes (Francaviglia 1997; Goin and Raymond 2004). Mining landscapes are among the most dramatic in the American West (image 2).

Some are "cut-and-pit" landscapes created by hydraulic mining and river diversion cuts, others large-scale open pits and strip mines. Deep industrial mining, like that on Nevada's Comstock Lode, as well as large-scale placer mining reservoirs and tailing systems form still other dramatic mining landscapes. Some are landscapes organized around "engineer-designed mine complexes" that integrate mines, processing plants, settlements, and transportation networks. Others reflect the ideology of corporate paternalism, such as company towns and outlying "satellite" settlements. The key components of mining landscapes are landforms such as mine waste-rock dumps, vegetation related to land use, buildings and structures, archaeological sites, transportation or circulation networks, boundary markers, and small-scale elements like mining claim markers (Noble and Spude 1992; McClelland et al. 1999). Mining landscapes are material expressions of the history of human-environmental interactions and reflect a wide variety of social, cultural, and environmental processes that include patterns of land use (like open-pit mining), ecological interactions, patterns of spatial organization, and cultural traditions.

Mining landscapes have variable boundaries. Sometimes the boundaries overlie those of mining districts, which are legal or quasi-legal organizations that regulate mining claims. The boundaries of mining districts reflect perceptions of the geological distribution of the metals or minerals being mined or social networks that regulate access to land. But mining landscapes are not necessarily the same as mining districts. In



2. Mining landscape, Bodie, California. (Photograph by author, 2007.)

some ways, the “real” boundaries are easy to identify; the cultural landforms created by mining activities such as mine waste-rock dumps, mill tailings, and open pits are often highly visible and mark where the lines should be drawn. Visual images or viewsheds drawn from paintings, photographs, or narrative descriptions are also useful in drawing culturally meaningful boundaries around mining landscapes.

The boundaries of mining landscapes typically reflect the geological distribution of metal or mineral deposits. But contemporaneous geological knowledge plays a key role in determining the relationship between geology and mining landscapes. Consider, for example, how preexisting ideas about the geology of ore bodies affected the perception of environment by prospectors searching for new discoveries. The discovery of the Comstock Lode led prospectors to search for “true fissure veins” within 500 feet of the surface for decades afterward, and the geographical pattern of mining settlements basically followed this model (Tingley et al. 2001). They completely overlooked precious metal deposits in non-vein silica ledges weathered to knobs. After the discovery in 1900 of this geological context at Goldfield in south-central Nevada, however, a new mining settlement pattern emerged during the following decades.

The boundaries of mining landscapes often contain more than just the place where the ore is mined. Mining landscapes must also include “outliers”—geographically separated places where mines, mills, settlements, and supply operations took place. The Comstock mines in Virginia City, Nevada, and its immediate environs defined a mining landscape on a local scale. The Comstock Lode, however, served as a control center for a much larger region. It encompassed the pinyon-juniper woodlands of the Virginia Range, the Carson River, woodlands in and around the Lake Tahoe Basin, and the farmlands of the Carson Valley—localities all several miles away from the Comstock mines. These local ecosystems, each with distinctive histories and ecologies, were linked together into a regional ecosystem by Comstock industrial mining. Mining landscapes are therefore often best understood at different scales with geographical boundaries that vary accordingly.

Mining landscapes can also be viewed as cultural representations that convey ideas and meaning through signs and symbols. As signs, the components of mining landscapes communicate messages, like the stone cairns that prospectors used to mark the boundaries of mining claims. Such markers

represent not only miners' knowledge of where ore bodies should occur but also legal concepts in mining law. The geographical distribution of settlements, buildings, and structures on mining landscapes reflects some combination of “ideal” concepts of settlement and community and “real” determinants, such as topography, water availability, transportation routes, and mine locations. Thus, miners coming from the eastern United States typically carried with them cultural concepts of settlements laid out in a grid pattern. (Hardesty and Fowler 2001:83–84)

As symbols, the components of mining landscapes “spontaneously and unintentionally evoke emotions deeply embedded within a specific historical and cultural context” (Hardesty 2001:23), bringing to mind culturally based images or past personal experiences. Ghost towns in the American West, such as Bodie, California (Delyser 1999), have this power, as do individual places or landforms in mining landscapes that have “traditional cultural properties” for particular tribal groups. Similarly, arsenic or mercury-contaminated mine waste or open mine shafts provoke a human survival response toward the “toxic” and “hazardous.” Mining landscapes as places with signs and symbols may also have significant educational and market value as ecomuseums, outdoor muse-

ums of science and industry, sites for community-based archaeology, or cultural tourism.

Additionally, mining landscapes capture the ecological life histories of individuals or short-lived social units (like domestic households or companies) as networks or mosaics of microenvironments (Hardesty and Fowler 2001:80). Consider, for example, the evolution of the mining landscape associated with the Cortez Mining District (Hardesty 2006). Prospectors created the first microenvironment in 1863 in the Cortez Mountains after finding silver in what became known as the Nevada Giant Ledge. A few miles away, they added another microenvironment the following year in Mill Canyon by constructing a mercury amalgamation mill to process the ore from the ledge, later adding furnaces to heat the ore before processing. Significant environmental changes followed. Miners discharged mercury-contaminated sediments into the canyon and harvested wood from the surrounding pinyon-juniper forests to produce the charcoal necessary to fuel steam boilers and furnaces, creating a new microenvironment. Finally, yet another microenvironment became connected to the landscape with the extraction of salt from deposits in the Pleistocene-aged Lake Gilbert in nearby Grass Valley for use in the mill's amalgamation technology.

This network of microenvironments changed substantially about 15 years later with the construction of an innovative Russell leaching mill at the mouth of Arctic Canyon in 1886. Because it required lime for the leaching process, the mill was connected to a new limestone microenvironment nearby with an outcrop that could be quarried and processed into lime with kilns. Water for the mill came by pipeline from an aquifer seven miles away at the other side of Grass Valley. And as the demand for wood as fuel greatly increased, clear-cutting and thinning of the pinyon-juniper woodlands intensified. Wenban's mill closed in 1892, bringing the second episode of landscape transformation to an end.

The next mining episode began in 1908, when a new mining company refitted Wenban's abandoned mill with cyanide technology, enabling the extraction of low-grade ores and the reworking of old mill wastes. The new mill brought about a distinctive change in landform patterns. Cyanide technology continued to transform the landscape after the mill burned down in 1915. The Consolidated Cortez Silver Mines Company built and operated another cyanide and flotation mill further up Arctic Canyon from 1923 to 1929. Tailings from the mill eventually formed

a large tailings flow downslope about one mile to the valley floor. Afterward, small-scale mining continued sporadically in the Cortez district until the 1980s, when high gold and silver prices once again reestablished large-scale industrial mining, this time as an open-pit operation that still continues.

Mining Architecture

Perhaps the most imposing material expression of mining's past comes from the surviving buildings, structures, and objects associated with technology, social formations, and culture (image 3).

The Historic American Engineering Record (HAER) of the National Park Service has played an important role in recent years in documenting many of these remains. In 1980, what was then the National Architectural and Engineering Record registered surviving buildings and structures as the Virginia City National Historic Landmark. Other mining-related HAER projects included the Kennecott Copper Mill in Alaska, the Bodie Standard Mill in California, the Wall Street Mill in Joshua Tree National Park, the Keane Wonder Mill in Death Valley National Park, and the Mariscal Quicksilver Works in Texas's Big Bend National Park.

The architectural expression of mining falls into the categories of extraction, beneficiation, infrastructure (related to transportation, power, and communication), residential, and social architecture. Extraction architecture includes buildings, structures, and objects used in the activities of mineral or metal exploration and extraction. Buildings associated with extraction include hoisting houses, storage warehouses, machine shops, offices, air compressor buildings, air ventilation buildings, water drainage, and powder houses for storing explosives. Structures and objects associated with extraction include headframes used for hoisting; bucket and dragline dredges; scoop trams (muckers); jammers; continuous miners (rock-cutting machines); air drills; pumps (like the Cornish pumps used on the Comstock); surface fans; minematic self-contained drilling machines; generators; lifts; and hydraulic nozzles, monitors, or "Giants." Miners used bulldozers, dump trucks, graders, wheel loaders, man-carriers, and locomotives for transportation and excavation activities. And dams, ponds, and ditches were some of the water conveyance and storage structures used in hydraulic and dredge mining of placer deposits.



3. Standard Mill at Bodie, California. (Photograph by author, 2007.)

By way of example, consider the architectural expression of extraction at the Billie Mine portal just outside the boundaries of Death Valley National Park in California (Hardesty 2007). Several buildings, structures, and objects associated with the underground extraction of borates deposits and their transportation to a processing facility mark the mine portal (image 4).

The cluster is dominated by the multiple-story headframe hoist and conveyor used to transport borates ore, miners, and supplies to and from the underground extraction chambers. Nearby is an escape hoist for use as an emergency manway. Other structures at the mine portal include a double drum skip hoist, loadout tower, headframe bin, fill-hole bin, hose station, water storage tanks, fuel storage tanks, stockpile area, mine-water holding pond (sump), waste dump, parking lot, and storage yard. Buildings at the mine portal include the headframe hoist house, escape hoist house, office, powerhouse, shop, warehouse, dry building, maintenance shop, compressor building, and guard house.

The architecture of beneficiation is another category of mining buildings, structures, and objects. Beneficiation is the process of upgrading the economic value of the extracted ore through mechanical or chemi-



4. Billie Mine Portal, Death Valley, California. (Photograph by author, 2007.)

cal methods. Buildings, structures, and objects are associated with mechanical crushing, concentration, and chemical recovery processes (like amalgamation, leaching, flotation, cyanide, chlorination, and smelting). Arrastras, stamp mills, ball mills, and rod mills are structures used in the mechanical crushing of hard rock ores. Concentration structures like Wilfley tables and amalgamation plates upgrade hard rock ores after crushing. The mechanical concentration of placer deposits with free gold particles involves the use of structures such as pans, rockers, Long Toms, and sluices. Structures used in the chemical recovery of ores include cyanide and lixiviation leaching vats, flotation tanks, Freiberg barrels, Washoe amalgamation pans, blast furnace smelters, and patios. Patios are rock pavements or rock-lined pits upon which crushed ore is mixed with salt, iron, and copper; stirred by burros walking around the pit; and heated with sunlight to transform silver sulphides into silver chlorides, which can be amalgamated, with silver removed by treating it with mercury. Other buildings and structures associated with the activities of beneficiation and recovery are assay houses, kilns (like those used to produce lime for the chemical process of lixiviation), foundries, and blacksmith shops.

The buildings and structures associated with the activities of transportation, power, and communication needed in mining operations comprise the architecture of mining infrastructure. Perhaps the most visible are roads and railroads such as the Virginia and Truckee Railroad from Reno to Virginia City, the Eureka and Palisade Railroad from Eureka to Central Pacific, the Nevada Central Railroad from Ely to Central Pacific at Battle Mountain, and the Geiger Grade Road on the Comstock. Associated railroad buildings and structures included depots, water towers, trestles and bridges, worker's houses, and warehouses. Other buildings and constructions involved in transportation include tipples and similar structures for loading and transporting extracted ores. Tramways—for example, the aerial tramways at the Keane Wonder Mine in Death Valley National Park—and funiculars like the one at Lake Tahoe, which transported wood from the basin up to the crest of the Carson Range and into flumes for transport down to Washoe Valley, are also a part of the transportation infrastructure. In order to produce and transmit electrical power, mining companies set up powerhouses, power substations, power lines (like Bodie and Cortez), and hydroelectric plants such as the Nevada-California Power Company facility near Bishop supplying Rhyolite. The production and transmission of steam power is also expressed architecturally at many mining operations in the form of boilers, fireboxes, and wood storage yards. Communications buildings and structures include telephone and telegraph lines and radio towers.

Residential architecture is expressed in dwellings such as boardinghouses, single-household buildings, duplex or multiple-household buildings, and bunkhouses. Other common buildings and structures in the category are cookhouses, privies, and wells. Social architecture is a category of buildings and structures associated with commercial, governmental, civic, and institutional activities in mining settlements (James 1994; Nicoletta 2000). It may include hotels and lodging houses, governmental buildings such as courthouses and post offices, fraternal organizations, stores and mercantile buildings, saloons and bars, warehouses, laundries, morgues, barber shops, banks, barns and stables, recreational facilities such as racetracks and baseball fields, cemeteries, churches, fraternal organizations, school houses, hospitals, and jails.

The Archaeological Record of Mining

The archaeological record offers another pathway to the mining past through the observation of things like the remains of buildings, trash



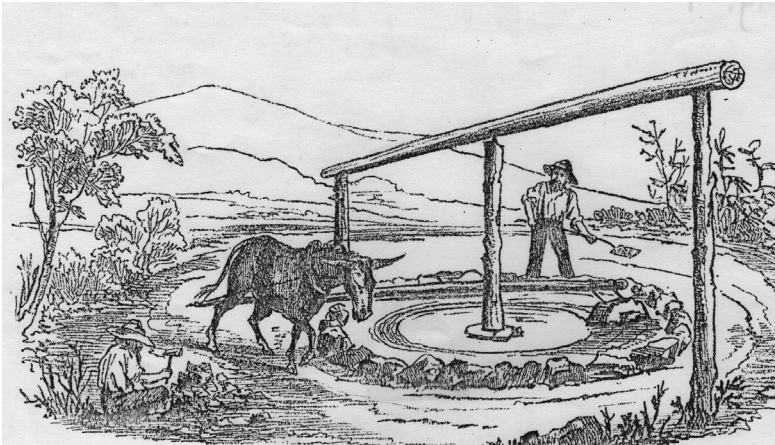
5. Bullwheel at Bulwer Mill site, Bodie, California. (Photograph by author, 2007.)

dumps, adits (horizontal passages into a mine), and machinery and their arrangement in three-dimensional space (image 5).

Observers can only view frontier social interactions indirectly, through the “morphology” or form of things that have been left behind. The morphology of the archaeological record is defined by (1) where the thing is found, (2) what is found next to or around it, and (3) its physical characteristics. All other information must be inferred. The strongest arguments regarding morphology do not stray far from these basic observations; indeed, simple inferences about time and activity are the most secure. For this reason, the analysis used here stays as close as possible to the most direct observations of the archaeological record’s morphology. At the same time, it employs observations about morphology and activity in the documentary record. The description and analysis of feature systems is the cornerstone of this approach (Hardesty 1987c).

Feature Systems

A feature system is a group of archaeologically visible features and objects that are the product of a specific human activity. Constructing models of feature systems lie at the interface of history, archaeology, and ethnography. Identification of the feature system begins with documentary



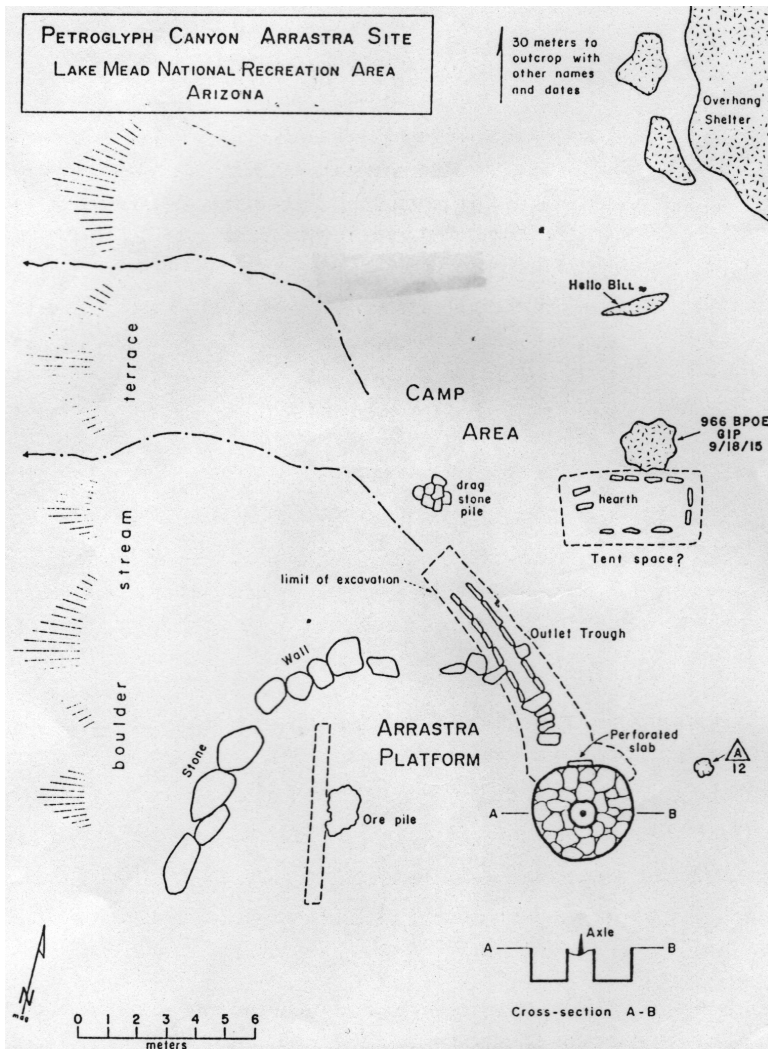
6. An arrastra. (Egleston 1887, figure 104.)

and ethnographic accounts of the morphology and activity of mining. Roger E. Kelly and Marsha C. Kelly's (1983) description of the arrastra, for example, illustrates how a feature system is defined. The arrastra, a cheap and simple technology for grinding free milling ores, is a circular platform over which a heavy stone slab is pulled by animal or water power (image 6).

Introduced into the silver mines of Mexico from Spain in the 1500s, the arrastra was a staple of small-scale mining operations in the American West until the 1940s (Kelly and Kelly 1983:85,90; Van Bueren 2004). The documentary record of arrastra technology includes not only written accounts but also photographs. From these sources, the Kellys were able to construct a "historical model" of arrastra morphology and activity (Kelly and Kelly 1983:85–87). They then used the model to search archaeological sites for observable remnants of the arrastra mill, several of which they identified in the Lake Mead Recreation Area in Arizona (Kelly and Kelly 1983:90–92). Image 7 illustrates one of these arrastra sites.

The archaeological morphology of the arrastra feature system consists of several associated structural features—like the circular platform, the drag-stone pile, and the outlet trough—along with objects such as a perforated slab.

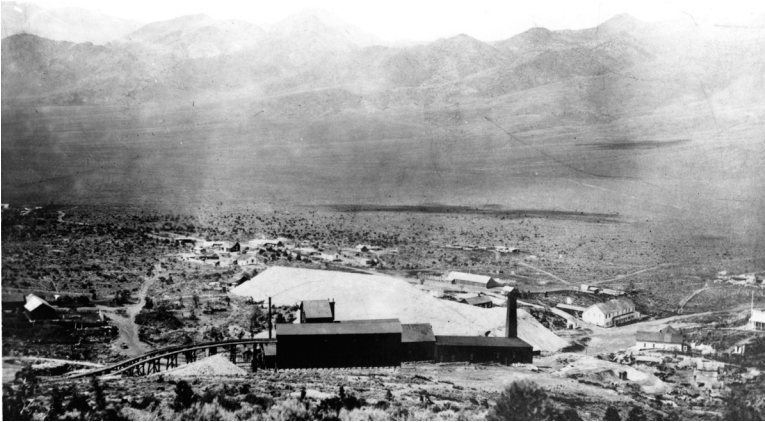
Feature systems may include archaeological features that are widely dispersed geographically. The Russell leaching technology first installed in 1886 at the Tenabo Mill site in the Cortez Mining District, for example, has an archaeological record that includes features placed over sev-



7. Map of arrastra archaeological site. (Reprinted from *Historical Archaeology* 17(1), figure 8.)

eral square miles (Bancroft 1889:16; Hardesty and Hattori 1982:7–10). Much of the feature system is clustered in and around the mill building (image 8), but the rest of the archaeological record of the technology is elsewhere.

The limestone quarry and kiln for making the lime needed for the Russell process were several hundred yards away (image 9). Workers gathered



8. The Tenabo Mill in 1900. (Courtesy of Nevada Historical Society.)



9. Lime kiln next to the Tenabo Mill. (Photograph by author, 1983.)

salt several miles distant at Williams salt marsh in upper Grass Valley, piped water from a spring seven miles across the valley, and manufactured charcoal for fuel in the timbered uplands above the mill site.

A single archaeological feature may play a role in more than one feature system. If both domestic trash and industrial waste are in a dump,

the trash dump may be part of both a household feature system and an industrial technology feature system. The Consolidated Cortez Mill site in the Cortez Mining District, for example, includes a trash dump that contains not only domestic trash such as tin cans and glass bottles but also cupels, crucibles, and other waste from assaying. The implication is that the associated house site was used both for assaying and as a residence by the assayer. In addition, features and objects from more than one feature system may appear at the same site. The Tenabo Mill site consists of two separate feature systems: one including the archaeological remains of the original 1886 Russell Leaching technology, the other with the remains of the “new” cyanide leaching technology installed in 1908 (Weight 1950; Gilluly and Masursky 1965:98).

Mining Site Formation and Structure

At the grassroots level, mining sites are geographical clusters of building ruins, trash dumps, privies, roads, milling structures, and mines organized into feature systems. The feature systems, however, may come from different time periods. Mining and milling technologies, for example, were imported, used for a short time, and then dismantled, either replaced by a new technology or abandoned along with the district. Cycles of occupation and abandonment within the mining district created “layers” of feature systems. The layers, or “components,” consist of one or more feature systems from the same time period.

The second distinctive characteristic of mining site structure is “horizontal stratigraphy.” Site components are often separated horizontally rather than vertically. To take one example, trash dumps from different time periods are not piled on top of one another but are arranged geographically. And house sites typically do not show evidence of vertically stratified archaeological deposits, with each layer representing a different house occupation. More often, the buildings once placed on a house site were moved or torn down at the time of abandonment, and the next occupation then occurred at a different place. As a result, mining camps tended to be separated into geographical clusters, each representing a different time period or component.

The third characteristic of mining site structure is mutilation. Because of the typical mining cycles of occupation, abandonment, and reoccupation, later components tended to destroy partly the earlier components of mining sites. In many cases, only one or a few features, strata, or objects

from the earlier feature system remain. For this reason, the “mutilation effect” must be taken into consideration. Furthermore, the “relic” features or strata may occur in any part of the site, either on the edge or in the center. Discontinuous surviving remnants of multiple occupations and feature systems, not a continuous accumulation of historic debris, define the structure of mining sites. As a result, it is essential to conduct good field searches for surviving feature systems as part of the survey and site evaluation plan; the approach is similar to searching for early man sites in “old dirt” rather than using a simple random sampling method.

Finally, the underground structure of mining sites must be reconstructed (Hardesty 1987c). In a sense the problem is similar to the one faced by geologists trying to understand the sedimentary history of large basins warped and twisted by mountain-building events. What remains is only an image of what actually happened, consisting of isolated fragments of sedimentary deposits. And it is precisely these fragmentary “clues” that geologists must locate and date in order to identify large-scale patterns and thereby reconstruct sedimentary history. New mining episodes have a similar kind of impact on the archaeological record of underground workings. Preexisting features, such as drifts, stopes, raises, and the like, are partly destroyed, reworked, or survive untouched, and new ones are created. The archaeologist observes the last image. But each successive image is actually a montage containing “warped and twisted” images of earlier mining episodes. The archaeologist can reconstruct every image in the montage from surviving “fragments”—drifts, stopes, raises, shafts, and other deeply buried features from the earlier mining episode. The actual reconstruction, of course, combines images from documentary history and surviving archaeological images of each mining episode.

Locating Mining Sites

Documenting the archaeological record of mining begins with the location of mining sites in the field. Perhaps the best place to start is with a simple “location model” that incorporates historical documents. The model gives preliminary information about what kind of archaeological sites are expected and where they are most likely to be located. Work on inventory models of several mining districts in Nevada has suggested that the best predictor of mining site pattern is the geographical distribution of the ore body, while secondary determinants are water, gravity

centers such as towns and roads, and supporting resources like timber stands. In the Comstock Mining District, for example, documentary images provide evidence that land-use patterns mostly followed the location of ore-bearing faults, placer gravels, and water (Hardesty and Firby 1980; Rodman 1985). The two major faults in the district (the Comstock and the Silver City) and several minor ones had been mineralized during the late Miocene period. An erosional episode in the late Tertiary transported some of the ore-bearing rock downward to what is now the Carson River, creating placer gravel deposits in Gold Canyon, Six-Mile Canyon, American Flat, and the Carson River valley. How miners used the ore-bearing faults and placers varied from one time period to another, partly because of technological changes. They constructed mills in the two canyons near water sources, but after 1873 they also built them at the lower edge of Virginia City to take advantage of a new pipeline delivering water from the Carson Range. Gravity centers around settlements, roads, and railroads were focal points for domestic activities and those related to transportation.

Locating mining sites requires a combination of documentary and archaeological surveys. Any survey strategy should begin with a search for documentary accounts. Historical documents provide an important source of information about the possible locations of existing cultural resources and what activities took place there. Photographs, maps, newspapers, tax assessment rolls, and the like provide data that help build a documentary model of cultural resources. This model does not necessarily reflect historical reality. Newspaper and other accounts of local mining activity were often thinly veiled attempts to attract investors and get people to move to the mining area, not accurate reports. At the same time, historical models provide the takeoff point for conducting intensive searches for archaeological sites in the field. Researchers can use the places mentioned in written documents to define a set of “sampling strata” for archaeological surveys. The photographic record is also especially useful.

The first step in developing a field survey strategy involves the field identification of sites mentioned in historical documents. Some cultural resources are quite visible today but may not be mentioned in the written documents, however. These often include mine shafts, adits, prospects, roads, house sites, outhouses, and trash scatters, among other things. Most of these show up in aerial photographs and can be readily

identified. The researcher can treat the archaeological evidence for each type of feature system, such as households or mines, as a separate sampling stratum and survey it accordingly. The second step in developing a field survey strategy, therefore, is the incorporation of these archaeologically visible features.

Between these sites of major activity is a “no man’s land” with no clear documentary or archaeological visibility to guide the pedestrian surveys. These areas should be treated as separate sampling strata and surveyed with “random” methods. Probably the best approach is to divide the area into linear strips or transects, randomly select a percentage of these, and completely survey each transect selected. Scale is a key problem in doing archaeological surveys of mining sites, one that extends to industrial sites generally (Teague 1987:200–202). Mining features may cover a large geographical area, often well beyond the boundaries of a single site. Charles Zeier (1987), for example, found that the archaeological remains of charcoal ovens feeding the smelting mills in Eureka, Nevada, clustered around a single residential settlement. He could not have reconstructed the charcoal production system without an understanding of the large geographical area containing the remaining archaeological record. The Tenabo Mill in the Cortez Mining District is another example of the type of large-scale technological system likely to be encountered on the mining frontier. The system included not only the mill site itself and a nearby limestone quarry and kiln but also a salt marsh, a pipeline to a spring, and a sulfur mine several miles away (Hardesty and Hattori 1982). And railroads are linear transportation systems that may cover even greater distances.

Combining Multiple Images of Mining’s Past

The study of mining’s past is most effective when multiple images can be used. Consider, for example, the combined and interactive use of documentary, architectural, archaeological, and landscape images in studies of mining technology, the residential settlement, and the household.

Technology

Perhaps the most visible features in mining sites today are the remains of mining technology (image 10). Waste dumps from mines, mill tailings, shafts, adits, mill foundations, concrete engine pads, tramways, head-



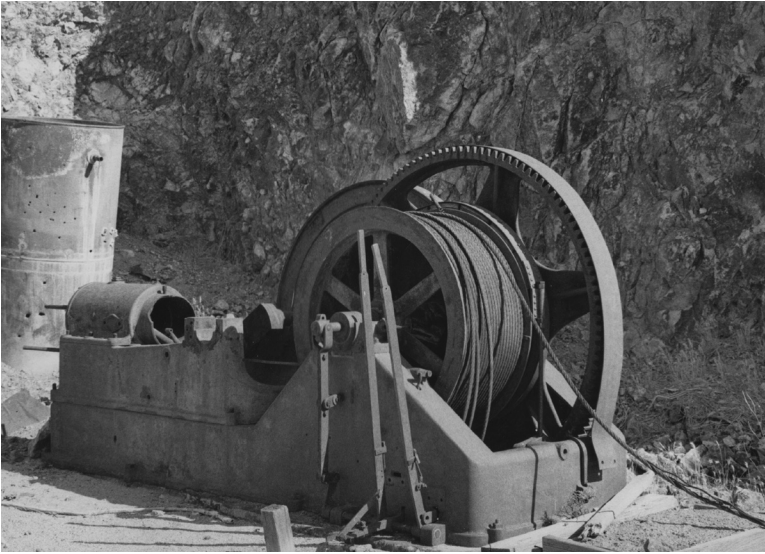
10. The Mayflower Mine site, Bullfrog Mining District, Nevada. (Photograph by author, 1987.)

frames, and other structures are a part of the archaeological record that is often documented in written accounts (image 11).

Much of the documentary record of mining technology exists in technical and scientific journals and textbooks, especially the *Mining and Scientific Press*, the *Engineering and Mining Journal*, the *Information Circulars* of the U.S. Bureau of Mines, and the bulletins and professional papers of the U.S. Geological Survey. Otis Young's (1970) *Western Mining* is a good, basic introduction to mining technology but does not offer much detail. Textbooks tend to describe basic industrial processes and equipment without regard to the locally adapted technology that was actually used in many mines. The archaeological record does contain information about these adaptive variants. Much of the machinery, however, disappeared from mines because of traditional scavenging on the western frontier as well as the scrap metal drives during the Second World War. For this reason, the archaeological record of mining technology often seems rather impoverished.

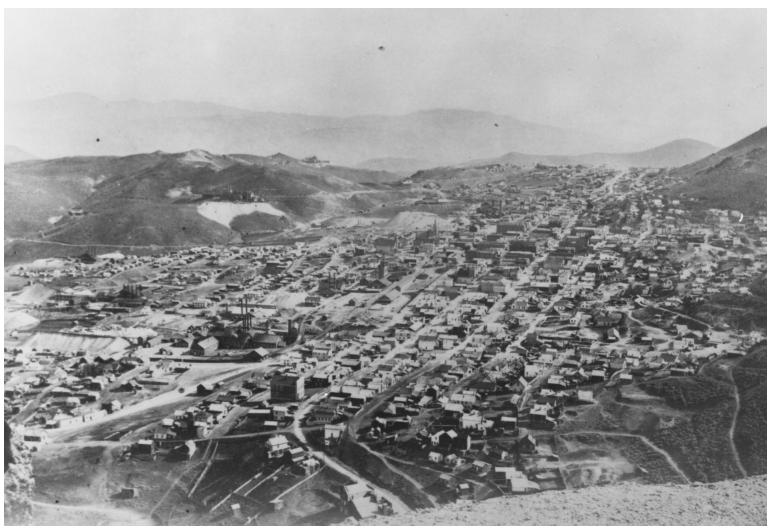
Settlements

The mining camp or residential settlement is another point at which documentary and archaeological records overlap. For purposes here, the set-



11. Hoist engine at the Pioneer Mine site, Bullfrog Mining District, Nevada. (Photograph by author, 1987.)

tlement is the material expression of Murdock's (1949) "community," a group of people who live in the same place and interact daily with one another. As such, the settlement is a focal point of social information about the mining frontier. The social interactions that take place within the sphere find expression in the morphology and the activity of settlements. Combining documentary and archaeological records is the most effective approach to the study of mining camps. Small, short-lived settlements are most likely to be invisible in the usual documentary sources of demographic information, such as the federal population census, tax assessment rolls, and city directories. The size, age, and sex composition of such camps is more visible in the archaeological record. At the Original Bullfrog camp in Death Valley National Park, population size was estimated from the floor area of house sites (Hardesty 1981). Here, Cook's (1972:13–15) argument that no more than six people will live in a house with less than 350 square feet of floor space formed a key assumption. His calculation is important for the simple reason that many mining camp house sites have floor areas between 300 and 400 square feet. Archaeological indicators of age and sex, such as toys, cold cream jars, and a hair curler, were used to define the other demographic characteristics of the Original Bullfrog settlement.



12. Virginia City, Nevada, from Cedar Hill, 1870s or 1880s. (Courtesy of Special Collections, University of Nevada–Reno Library.)

John W. Reps (1975, 1979) illustrates how to use written records to understand mining settlements. Some townplats suggest that the growth of mining camps in Nevada followed a simple grid pattern. Virginia City was laid out in a grid on the steep eastern slope of Mount Davidson (image 12).

The main north-south streets through Virginia City were built on leveled terraces and were closely spaced; the east-west cross streets running up the slope were short, steep, and widely separated (Reps 1975:276–277). The town was famous for its hillside social stratification (De Quille 1876; Reps 1975:277). On the upper streets of the town were the large and luxurious houses of mine and mill owners and wealthy merchants. The commercial and governmental districts were on B and C streets just below, along with working-class residences. Below C Street in descending social and geographical order were the red-light district and Chinatown. And at the very bottom, scattered around the mill tailings, were the Native American residences.

Only the archaeological record shows the layout of most of the smaller mining camps on the Nevada frontier. And from these remains, it is clear that the grid pattern was not all that common. Many small settlements were linear strips along roads or convenience clusters around mills and



13. House site at Shoshone Wells. (Photograph by author, 1983.)

mines. The settlements with a lot of ethnic diversity were often partitioned into several “neighborhoods,” each occupied by a different ethnic group and each with a somewhat different layout. Shoshone Wells in the Cortez Mining District, for example, has four or five visible clusters of house sites that may represent ethnic neighborhoods (image 13).

Excavations revealed Chinese material remains in the house sites in the ravine cluster and the road cluster; the hillside cluster provided some archaeological evidence of an Italian occupation; and the mine owner’s family, representing a Victorian culture, occupied the Wenban cluster.

The Household

How the household should be defined has generated a lot of discussion and controversy among anthropologists and historians (Goody 1958; Buchler and Selby 1968; Laslett and Wall 1972; Hammel and Laslett 1974; Netting et al. 1984). Here, however, the household is considered to be a group of people sharing domestic activities such as consumption and production (Carter 1984:45; Wilk and Netting 1984:3). Such a definition does not require that the group actually live together under the same roof, although coresidence is a frequent characteristic of households. The least understood aspect of the household is the relationship between its morphology or form (such as size and geographical location) and its activities (such

as reproduction or consumption) (Wilk and Netting 1984). Some authorities, though, view both the morphology and activity of households as controlled by a set of ideological rules or strategies that vary and change as part of a larger cultural process such as adaptation (Buchler and Selby 1968; Hammel 1972; Carter 1984).

Both documentary and archaeological images of the mining frontier household are strongly biased toward morphology. Census schedules, tax assessment rolls, and similar governmental records, for example, give information about household size, the sexes, ages, and occupations of its members, and the like. And the archaeological record of the household contains data on the location and size of house sites along with artifact assemblages that may include age and sex indicators such as toys and sex-specific clothing. But the identification of household activities is more difficult. The most consistent information probably arrives by reconstructing activities from the archaeological record of house sites. House site reconstruction gives indirect information about what were most likely coresidential groups: people who live under the same roof. "House-site groups," of course, are not necessarily households. Documentary sources may help considerably in understanding how house-site groups should be combined into mining households. Newspaper accounts of events at the Gold Bar Mine in Death Valley National Park, for example, identified bunkhouse, boarding house, and family households at the settlement.

Quite clearly, combining documentary and archaeological information is the most effective way of reconstructing households in mining camps. The activities that were most characteristic of the mining household were distribution and consumption. Production, reproduction, and inheritance, which are the important functions of most households, were not nearly as important to mining communities. Household morphology, however, varies for each of these activities.