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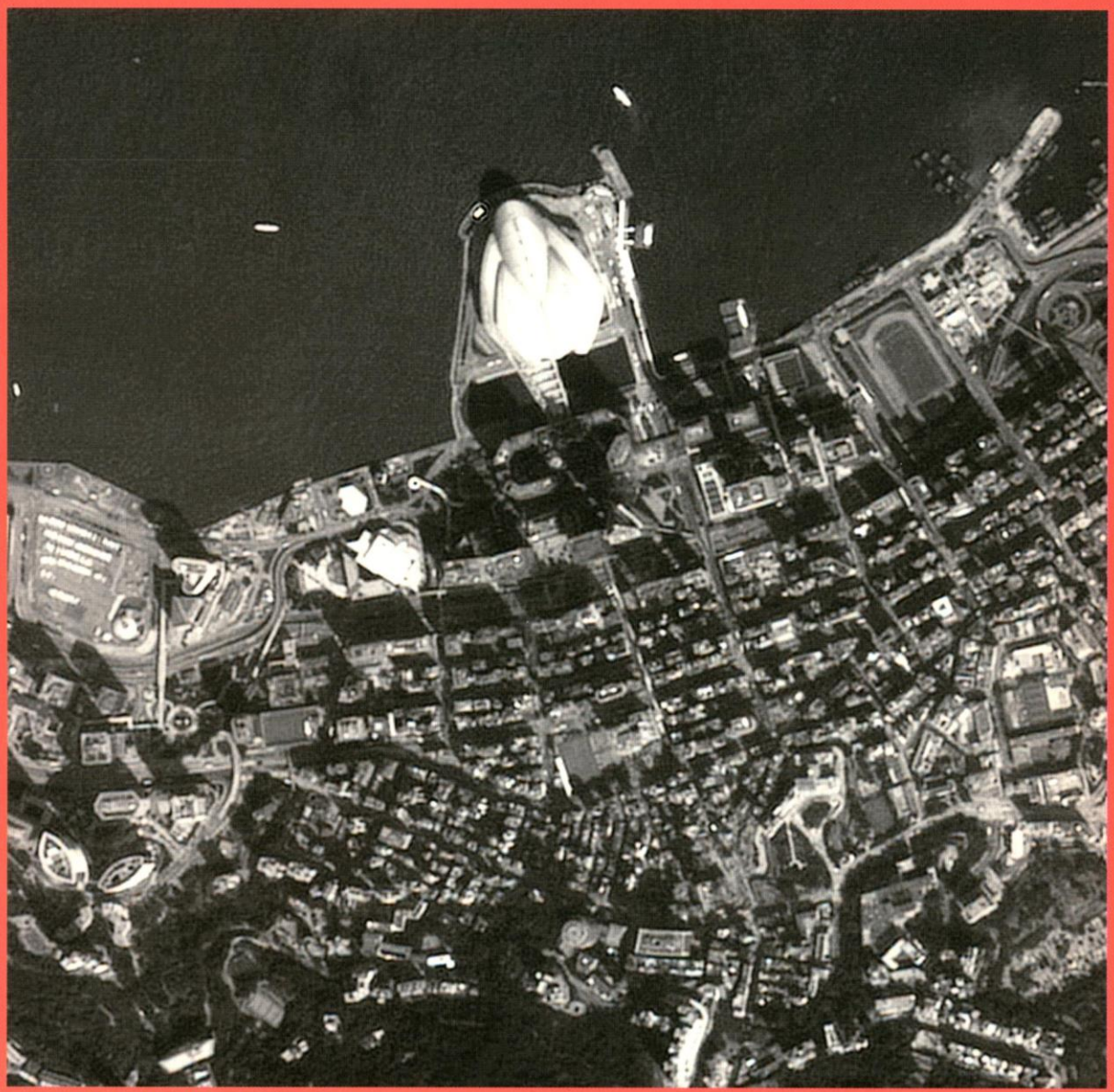


SPOT-5 Panchromatic Image of Hong Kong

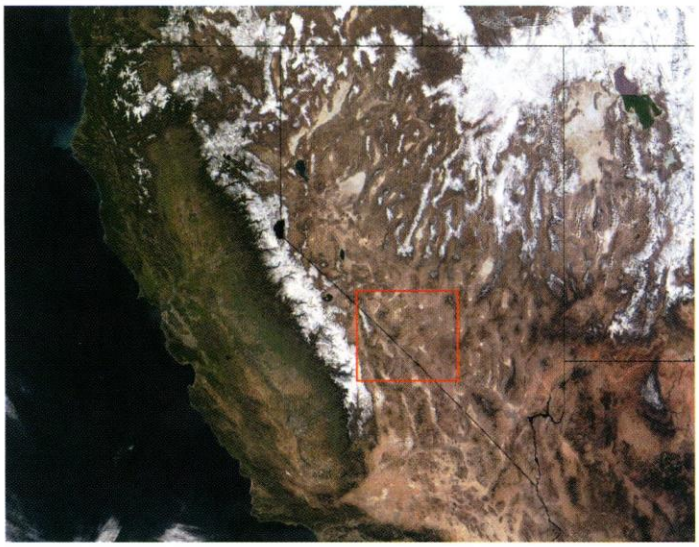
This 2.5 m resolution black and white image was collected by SPOT-5 satellite on November 3, 2002. The image features the Hong Kong Convention and Exhibition Centre in Wanchai District, Hong Kong.

The Earth From Afar: Image Review

Editor: Paul R. Baumann
Department of Geography
State University of New York at Oneonta
Milne Library 317
Oneonta, NY 13820
U.S.A.

Basin and Range Region of Nevada, U.S.A.

Paul R. Baumann and **Jean Palmer-Moloney**
State University of New York
College at Oneonta
Department of Geography
Oneonta, New York 13820 U.S.A.



Map Southwestern US, from March 3, 2002. Study area outlined in red. Image provided by Jacques Descloritres, MODIS Land Rapid Response Team, NASA/GSFC.

Generally speaking, the southwestern United States, seen in the image (Map) above, is a sparsely populated, arid region, which is rich in terms of mineral wealth and sunshine, but wanting in terms of water. The region's impressive fault block mountains, desolate salt playas, and small, resilient communities - backdrop to many a Hollywood "western" - are the foundation of America's collective cultural definition of the West. However, this region is dynamic, and regardless of the film-makers' attempts to immortalize and freeze the set, it is constant change.

The satellite image highlighted in this article was acquired by Landsat 7 on July 2, 1999. This Landsat scene (Figure 1) covers the region of the southwestern United States along the California/Nevada border. See the study area box on the Map image. Figure 1 is a false-color composite based on the bands 5-4-3 RGB. The four accentuated sections on this composite are areas that will be viewed in greater detail. In general, alkali surfaces such as playas appear white on the composite, basalt and andesites vary between black and dark gray, healthy natural vegetation is dark green; whereas, irrigated vegetation is bright green, iron-bearing rocks are reddish brown, and bleached rocks are light blue.

The absolute location of this Landsat scene is 37.4758°N and 117.4916°W based on the center of the image. Relatively speaking, the image includes all of Esmeralda County, Nevada and parts of Mineral and Nye Counties, also in Nevada, and parts of Inyo and Mono Counties in California. Las Vegas is approximately 135 miles (217 kilometers) in straight-line distance from the center of Esmeralda County.

Physical Characteristics

The physical landscape associated with the image consists of three major topographic components: mountains, alluvial plains, and valley floors (Baumann 1994, 3-4). It is part of the physiographic region known as the Basin and Range Province. The fault-block mountain ranges are oriented generally north-south with parallel ridges, typically 50 to 75 miles (80 to 120 kilometers) long and 10 to 25 miles (16 to

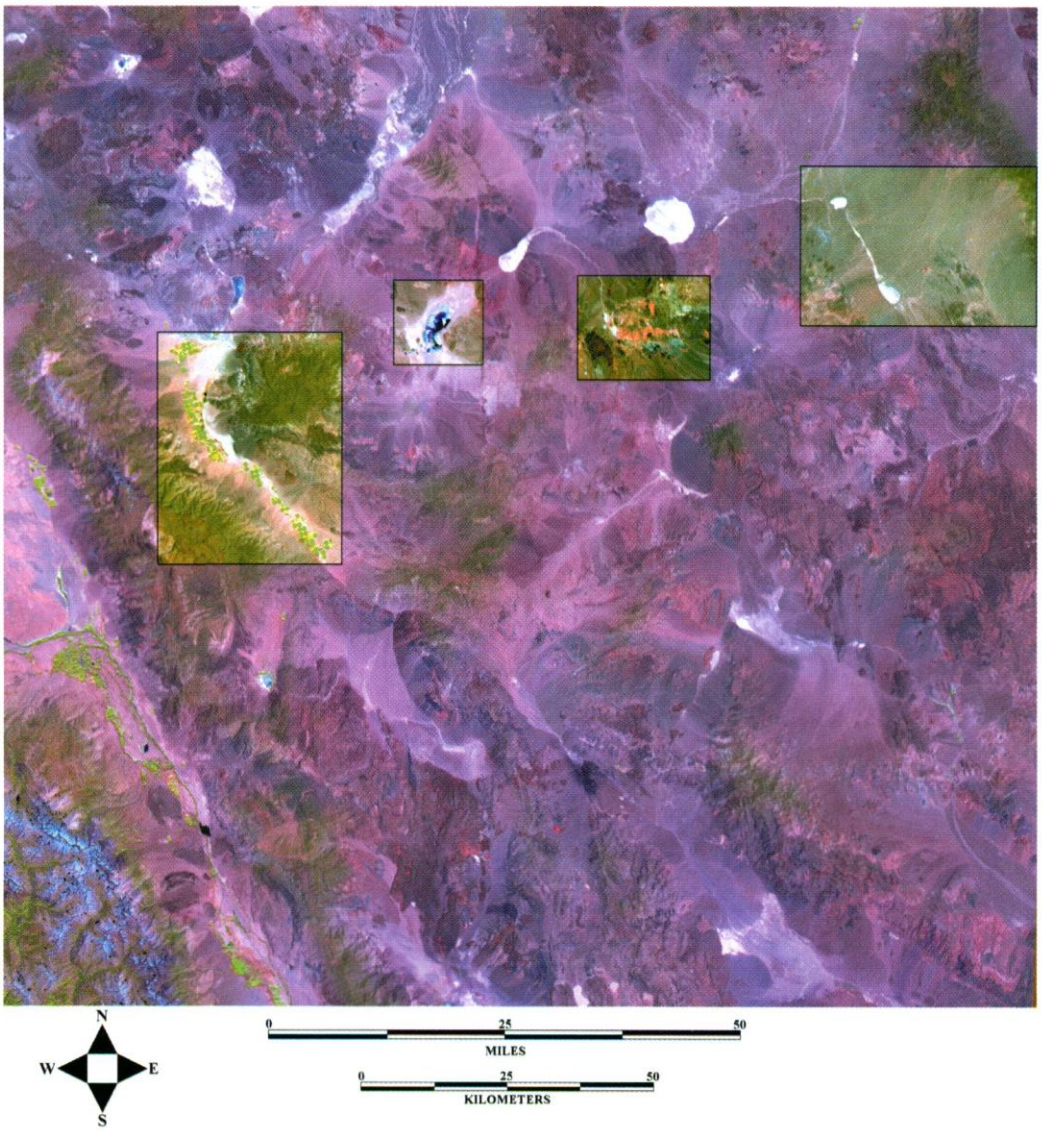


Figure 1 Landsat 7 color composite image with highlighted areas.

40 kilometers) wide. Characteristically, the mountains are rugged, steep-sided, and deep-canyoned. The canyons and gullies, which drain the mountains, contain intermittent streams, that are usually dry, receiving water from an occasional rain or from snow melt off higher mountain peaks. When a stream reaches the base of the mountain, the change in gradient makes it difficult for the stream to transport the boulders, gravel, and sand that it flushed out of the highlands. As the gradient of the streambed decreases, deposition occurs. This disposition generally forms a fan shaped pattern (called an alluvial fan), with the apex or stem of the fan located at the point where the stream leaves the mountain. The deposition fans out along a gentle slope. The upper portion of the fan generally contains large amounts of boulders and gravel, while the lower portion consists of sand and finer grained materials. When several streams occur along a mountain front, more than one alluvial fan develops. As the fans increase in size, they coalesce creating a piedmont alluvial plain, also known as a bajada (from the Spanish word for "gentle slope"). At the outer edge of these plains, very flat bolson floors form, known as playas (from the Spanish word for "beach"). The intermittent streams that start in the mountains and cross the alluvial fans create temporary, shallow lakes in the playas. When the water in these lakes evaporates, alkali flats or saltpans occur.

This part of the desert southwest of the United States receives an average of 3-5 inches (75-125mm) of rainfall per year. Most of the precipitation is orographic in nature coming from southwest winds that collect moisture over the Pacific Ocean. As these winds are forced to rise over the mountains, they release some of their moisture in the form of precipitation. Since most of the precipitation comes during the winter months, the higher mountain peaks are often covered in snow. Average summer temperature is 92°F

(33.3°C) during the day and 76°F (24.4°C) during the night. In winter, the average daily temperature hovers around 47°F (8.3°C), and falls to an average nightly low of 2°F (-16.6°C). These averages are lower in the mountains. Also, the higher temperatures associated with the lower elevations produce higher levels of evaporation and evapotranspiration. Due to these conditions, vegetation found on the alluvial fans and around the playas is sparse and xerophytic in nature. In the mountains where less evaporation occurs and more moisture exists, the vegetation is more dense and greener. The dark green colors on Figure 1 correspond to evergreen forests in the higher elevations.

Human Characteristics

Esmeralda County typifies the general human landscape associated with the image and is the only county completely incorporated within the image. Thus, the information provided below is generally limited to Esmeralda County. According to the 2000 US Census, Esmeralda County's total population of 971 decreased by 27.8 percent from the 1990 US Census. Research of historical US Census population counts reveals that the county has experienced fluctuations in the past. The US Census recorded a 1910 population of 9,369, a 1920 population of 2,410, a 1980 population of 777, which spiked back up to a total of 1,344 in 1990. The 2000 populations for the other four counties that are partially within the image area are higher than Esmeralda County's population but their population densities are only around 2 people per square mile (.7 km^2). Esmeralda County's population density is .3 people per square mile (.1 km^2).

Economic land use in this landscape is rather restricted. The three economic activities displayed on the image deal with agriculture, mining, and military endeavors. Even these activities are confined to certain small sections of the image. Agriculture and mining are considered to be primary economic activities. There is no indication of secondary (manufacturing) or tertiary (services) activities that are associated more with industrial/urban environments. The military activity found in this area is based on the landscape being isolated, a condition which does not promote growth. Due mainly to the physical landscape, few people have shown a great desire to remain for a long time in the area. This lack of interest in the area has resulted in the U.S. Federal Government owning, by default, 82.9% of the land in Nevada. No other state comes near to having so much of its land under the control of the Federal Government. Thus, it is not surprising that the military has elected to use large sections of Nevada to conduct secretive tests. These three economic activities are discussed below in greater detail as to how they are shown on this image.

Agriculture

Since most of the area's surface water is ephemeral, most of its natural vegetation is xerophytic, adapted for life and growth in desert and arid steppe environments. Farming of crops is limited. According to the *Soil Survey of Esmeralda County Area, Nevada* (Fisher 1991), agriculture is limited to Fisher Lake Valley where irrigation water comes from perennial streams flowing from the White Mountains (Figure 2). Water availability for irrigation throughout the remainder of the county is severely limited.

In the 1991 *Soil Survey* the aerial photographs of Fisher Lake Valley show rectangular irrigated fields. In contrast, the 1999 Landsat image (Figure 2) indicates that the majority of the fields are irrigated using center-pivot sprinkler systems. Rectangular fields are irrigated using siphon tubes to carry water from an irrigation ditch to furrows throughout the field. It is difficult under this method of irrigation to provide an even distribution of water throughout the field. The center-pivot system with its drop line sprinklers is a more efficient and economic methods than the siphon method. The center-pivot type fields are typical in places where agriculture is dependent on underground water sources. Groundwater is mined from underlying aquifers by pumps. An irrigation pipe reaches out from a pump, located in the center of the field, and moves on wheels in a circle, spraying the field with water; hence the circular pattern on the landscape. The fields are clustered at the edge of the piedmont alluvial plain where the groundwater can be tapped with relative ease.

The center-pivot system uses water more effectively, and thereby, decreases the amount of water needed. With less water, less alkalization of the soils occurs. The amount of extra water required to remove alkali is less than found with siphon irrigation. However, the price of electricity to run the electric pump wells used to operate the sprinkler systems is becoming a major drawback. It is apparent that the farmers in Fisher Lake Valley are trying to make the best use of their limited water resources. The rectangular fields are 160 acres in size but the circular irrigated areas cover only 127 acres, a loss of 33 acres per field. However, water cost savings and better yields due to better water distribution within fields have resulted in greater production on less land.

In 1997, Esmeralda County had 15,925 acres of irrigated land, most of it in Fisher Lake Valley. Alfalfa was grown on 7,687 acres and the remainder was used for pasture. The farmers are using the irrigated land to produce a better quality of grass to fatten their cattle faster and better for the market.

Mining

Mining has been the major industry in the study area since the 1860s when the first mineral discoveries were made (Fisher 1991, 1). In his book *Roughing It*, a narrative of his travels through the American West, Mark Twain notes that "[D]uring the great flush year of 1863, Nevada [claims to have] produced $25,000,000 in bullion....which is very well, considering that she was without agriculture and manufactures" (1972, 278). Esmeralda County government reports that since 1902, more than $100 million of gold has been produced in the area.

A close examination of the study area reveals numerous mining districts that have been developed to recover deposits of gold and silver. These precious metals resulted from

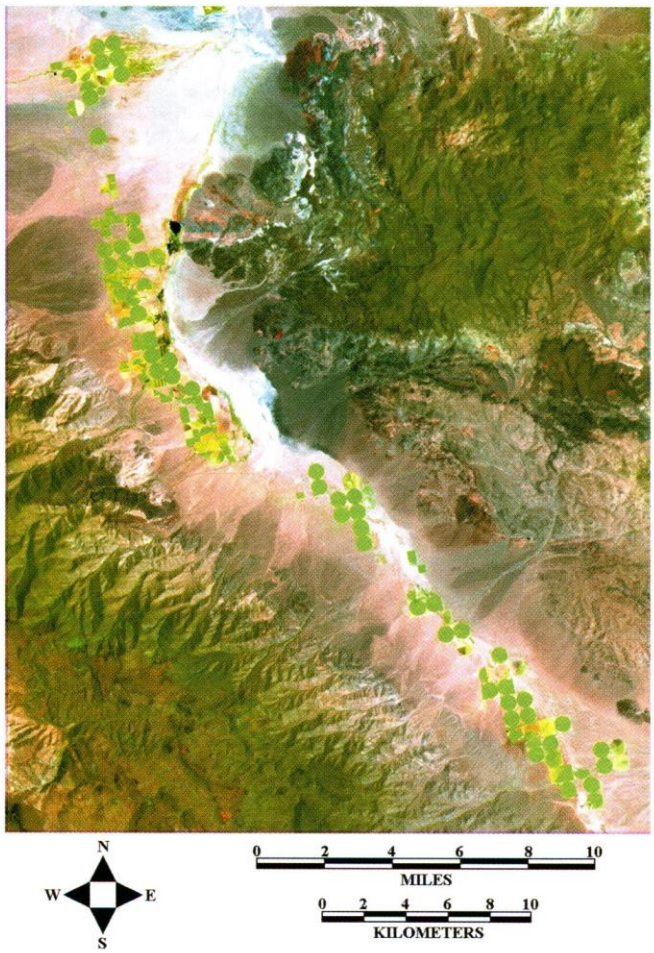


Figure 2 Centre-pivot irrigation in Fish Lake Valley, NV.

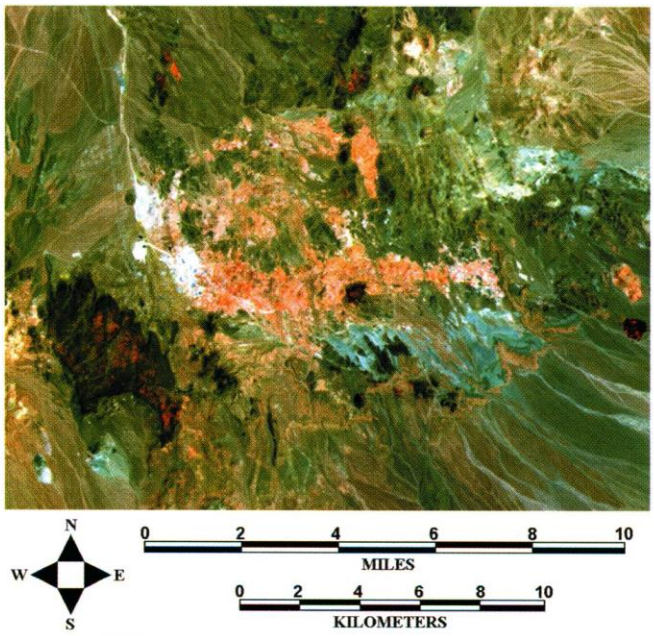


Figure 3 Goldfield mining area in Nevada.

major volcanic events that occurred mostly during the geological period referred to as the Tertiary. One of the more famous mining districts is Goldfield, now the county seat of Esmeralda County. Figure 3 shows the Goldfield mining district as well as the nearby Cuprite mining district. The Goldfield is one of a group of large epithermal precious-metal deposits in Tertiary volcanic rock.

According to Francaviglia, "[T]here are two major types of mining — underground and surface mining — both of which affect the earth's surface through extraction and deposition" (1992, 93). Both types are found in desert Southwest. Tailings result from the pulverization and solution recovering of metals. These features, along with ore dumps and waste piles, can be seen in most underground, hard-rock mining districts. Francaviglia goes on to say that "scars" of mining are confined to the areas immediately surrounding the underground mines (1992, 93). This is the case with the Goldfield mining district (Figure 3). The disturbed areas, shown in pink, blue, and white colors, around the mines stand out as distinctly different from the natural basin and range topography.

On the human side, silver and gold were discovered near Goldfield in 1902. Like many silver and gold discoveries, Goldfield's population exploded from a few grub stake prospectors in 1902 to over 30,000 inhabitants in 1906. It became Nevada's largest city. It contained dozens of saloons, banks, a railroad, a courthouse, and the most luxurious hotel between Kansas City and San Francisco. Some of the choice building lots sold for $45,000, a very high price for the early 1900s. At its peak in 1907, $10,000 a day in ore was mined. A total of $86,765,044 worth of metal were mined from 1903-1940. As late as 1997, American Resource Corporation, who operates one of the mines, recorded still producing; 1,376 oz. of gold and 435 oz. of silver. However, by 1911, the ore became harder to find, and the town had started to decline. Today, Goldfield has around 360 residents, 10 of whom work for the American Resource Corporation. The county government employs most people. Typical of many mining communities, Goldfield experienced rapid growth and equally rapid decline.

Presently, however, the most important mineral products in the area are lithium and diatomite (Fisher 1991, 1). Water in the playa pictured in Figure 4 near the community of Silver Peak was not introduced by natural occurrences. The evaporation ponds, showing up distinctly in the image, were constructed by the Cyprus Foote Mineral Company to extract lithium carbonate from the playa. The darker blue/black color corresponds with areas of relatively deep water; whereas, the lighter blue areas are shallower with higher mineral concentrations. The town of Silver Peak is located uphill from the playa, in an area where the soil is less susceptible to salination.

Military Landscape

Nevada with its sparse population, varied desert

environments, and large amount of government owned land is an ideal area for the military, especially the air force, to test different weapons and other military equipment. Figure 5 shows a portion of the Tonopah Test Range (TTR), which is located at the north end of the Nellis Military Complex. TTR consists of a special air base, shown on the left side of Figure 4, and a secret electronic combat range, known as Site Four, which is located 12 miles (19 kilometers) east of the air base.

TTR covers an area of approximately 525 square miles (1360 km^2) and lies about 32 miles (51.5 kilometers) southeast of Tonopah, Nevada. First opened in 1957, the year the Soviet's sent Sputnik into orbit, TTR has been a major test facility for the Department of Energy funded weapons programs. Starting in 1984, the F-117 Stealth fighter squadron was based at Tonopah before being moved to Holoman AFB, New Mexico. Several years later the aircraft was publicly acknowledged. Around 1976, the original runway at the air base was only 6,000 ft. (1829m) in length but by 1990 it had been lengthened to 11,000 ft. (3353m) and 48 hangers constructed, the exact number of F-117 originally produced. See Figure 5 enlargement. The hangers concealed the planes from military satellites from other countries. The airspace over TTR is restricted; all non-military air traffic is denied flight pattern clearance.

Site Four is a component of the Tonopah Electronic Combat range, operated by the 554th Range Squadron. This range is used to assist in the training of pilots participating in exercises simulating encounters with various potential adversarial radar and electronic threats. Site Four contains a number of towers with various antennae, including steerable microwave dishes. Figure 6, a 1984 U.S. Geological Survey image, shows Site Four. A number of earth-covered bunkers exists. The 554th Range Squadron Operations and Maintenance headquarters is visible. No airstrip is evident at Site Four.

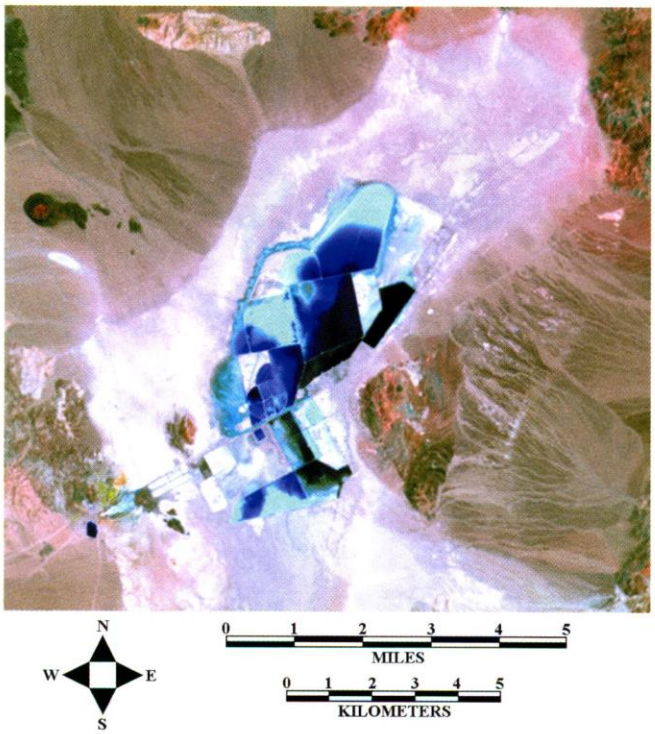


Figure 4 Evaporation ponds constructed by Cyprus Foote Mineral Company

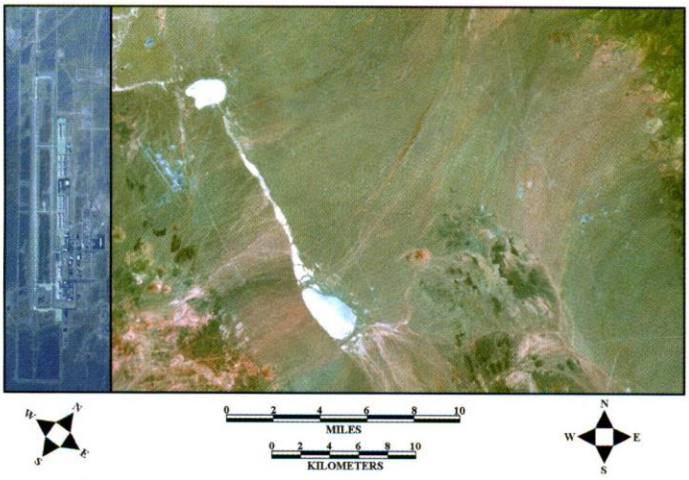


Figure 5 Tonopah Airbase and Test Range.

Suggestions for Classroom Use

The landforms, soils, climate, and vegetation are woven together in ways that distinguish this desert southwestern region from other regions in the United States. The physical geography of the area clearly fits within the curricula of Earth Science and Physical Geography. The visible landscape, shaped by volcanic activity, plate tectonic movement, wind action, and

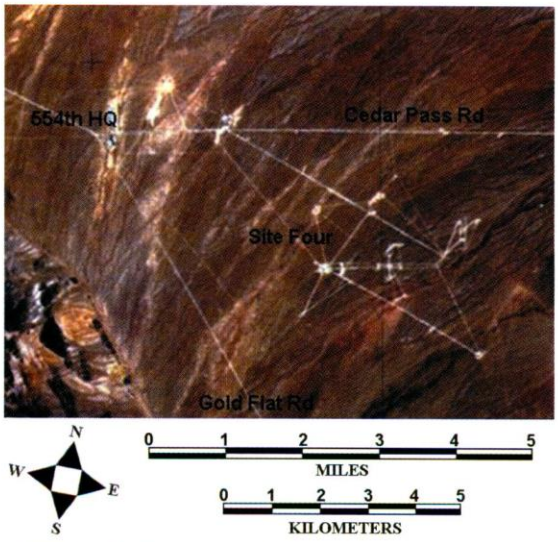


Figure 6 Site Four at Tonopah

water erosion, could enhance lessons on these topics. From the perspective of human geography, these physical characteristics of the landscape can help explain why the human population in the region is so limited.

The presence of precious metals and minerals brings together the physical and the human geography of the place. If not for the unique physical characteristics of the region, the minerals and precious metals would not be present. Consequently, if not for the precious metals and minerals, humans would have limited interest in the region.

Water is a critical component in support of human settlement. This is evident in trying to establish agriculture in a dry region. Though the image offers many examples of water erosion (as seen by the many dry stream beds and there associated alluvial fans), the number of perennial water sources is few. The circular agricultural fields and evaporation ponds give some indication of "cost" and "benefit." In relative terms, it must be worth the money and effort to acquire water to operate these economic activities, or they would not be there.

Those teaching about settlement in the western United States, beyond the 100th meridian, may use this information to illustrate the "null set." If there are push and pull factors of migration that lead people from some areas and toward other areas, what has kept the total population of the study area so low?

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