3.2 SOILS, GEOLOGY, AND MINERALS

This section is an overview of regional and site-specific geology, soils, and mineral resources. The region of influence (ROI) is the land within and adjacent to the potential drill sites. Figure 2-1, in the previous chapter, shows the topographic features of the study area described in this section. The ROI is in the Basin and Range geomorphic province, which is characterized by small north- and northeast-trending ranges and alluvium-filled valleys containing terminal lakes.

Physiography

The study area is in the western part of the Basin and Range physiographic province. The project area is southwest of Fallon Naval Air Station, including the northwestern edge of the Salt Wells Basin, the northern part of the Bunejug Mountains, and the eastern edge of Carson Lake. The highest elevation in the Bunejug Mountains, south of the project area is about 4,892 feet (1,491 meters) above mean sea level (msl). The land slopes down to the west and north to an elevation of about 3,910 feet (1,192 meters) msl.

Geology

Regional Geology

The faulting that formed the mountain ranges in the region began relatively recently in geologic time (about 16 million years ago) and resulted from extension and thinning of the earth's crust in the region between the Sierra Nevada and Rocky Mountains. The extensional tectonic regime caused vertical block faulting, in which small blocks of crust dropped downward to create small basins, while adjacent blocks of crust tipped upward and formed ranges. The crustal extension was accompanied by a large amount of volcanic activity, which has varied in character and intensity. Massive volumes of pyroclastic materials (e.g. volcanic ash) covered some areas of the Basin and Range province to depths of many hundreds of feet. The region remained enclosed, therefore, as the ranges eroded, the sediments filled the local basins. Many basins contain alluvial sediments thousands of feet thick. During the last 100,000 years, the basins contained large lakes ancient shorelines of which can still be seen high above the current valley floors in many basins.

The exposed rocks in the mountain ranges surrounding the Salt Wells Basin are mainly Tertiary volcanic rocks and sediments derived from them (Stewart 1980; Stewart et al. 1978). These relatively young rocks are underlain by Mesozoic sedimentary and volcanic rocks. The cores of the mountain ranges consist mainly of Mesozoic granitic rocks, which intruded older rocks. However, there are few exposures of these older rocks in the region. Mesozoic rocks are exposed on the east side of the basin. The Bunejug Mountains are primarily composed of Pliocene basalt. The Salt Wells Basin and Carson Lake and the surrounding margins are underlain by playa lakebeds.

Figure 3-1 is a geologic map of the CCFO, modified from the digital geologic map of Nevada (Stewart et al. 1978).

3-1 Geologic Map of the CCFO

The thin crust means that molten rock is relatively close to the surface, at depths of just a few miles or less. In many locations, especially near fault zones where the rock is highly fractured and heat and groundwater move more freely through the rock. Geothermal activity in the Salt Wells area is thought to be associated with the intersection of the Rainbow Fault Zone and the Wildcat Fault Zone. The bedrock fracturing and vertical offset resulting from the faulting allows both groundwater and heat to penetrate the bedrock to relatively shallow depths (less than 500 feet), enabling the heated water to be exploited as a relatively low-cost energy source.

Seismicity

Crustal extension and block faulting in the region are ongoing, making the region seismically active. Recently active faults are fairly common in the vicinity of the ROI.

The two largest nearby faults are the Rainbow Fault Zone, which has been mapped north of the Salt Wells Basin on the east side of the Rainbow Mountains, and the Wildcat Fault Zone at the foot of the ranges south of Carson Lake west of the Bunejug Mountains. The Rainbow Fault Zone may extend southward beneath the Salt Wells Basin (WESTEC 1988).

The most recent earthquakes on the Rainbow Mountain Fault Zone were two magnitude 6.8 events that occurred in 1954 and were centered about 15 miles (25 kilometers) north of the Salt Wells Geothermal leasing area (WESTEC 1988). These earthquakes reportedly caused extensive damage to nearby waterworks and roads. The US Geological Survey (USGS) estimates that there is about a 95 percent chance that peak bedrock acceleration in an earthquake would exceed 30 to 40 percent of the acceleration of gravity within the next 50 years in the project region (USGS 2002). This is a moderately high bedrock acceleration. Ground shaking could be more intense in areas underlain by unconsolidated basin fill materials. The project area is in Seismic Zone 4 (the highest zone rating) of the Uniform Building Code.

Mineral Resources

While the circulation of heated, mineral-laden groundwater (hydrothermal fluids) through fractured rock has also resulted in precipitation and concentration of economic minerals, including gold, silver, copper, zinc, mercury, and many others in the region, most of the study area is underlain by basin fill deposits and no significant metallic ore deposits have been identified. In addition, there are no active mining claims or oil and gas leases in the salt wells geothermal lease area (BLM 2007).

Soils

On the western slope of the Bunejug Mountains, the soils are dominated by the Labou-Rock outcrop complex and the Pirouette-Osobb association. Further down the slope, the Bangor sandy loam, and badlands grade into playa deposits on the eastern side of Carson Lake.

The Pirouette-Osobb association consists of nearly level to moderately steep soils in large areas of rolling uplands. The soils are generally shallow (about 20 inches), well drained, stony sandy loam to cobbley clay loam, derived from tuffs and basalts and including areas of rock

outcrop. Average annual precipitation is about five to seven inches. The soils are used for grazing and wildlife habitat.

The Bango soils consists of very deep, well drained to somewhat excessively drained soils with negligible to slow surface runoff and moderately slow to rapid permeability. They are formed in alluvium over lacustrine deposits. Bango soils are on smooth lake terraces and have a sandy loam surface layer, underlain by cobbley or gravelly sandy loam and by strongly alkaline sandy and silty loam. The soils are suitable for livestock grazing and wildlife habitat. The soils can produce alfalfa, pasture, and grains, if irrigated, but they are not classified as prime farmland (USDA 2006).

Badlands are large bands of moderately steep shorelines of ancient Lake Lahontan. The soils are severely eroded and highly alkaline and are generally barren of vegetation. Playa soils occur on nearly level basin floors and consist of clayey material that ranges from sand to clay and are strongly alkaline. Drainage is poor and water tends to pond on the soils. They are generally barren of vegetation (SCS 1975).

On the northern slopes the Biddleman association grades into the Isolde-Parran complex and further down slope, into playa deposits.

The soils belonging to the Biddleman association occur in broad bands bordering uplands on high shoreline terraces with slopes of 0 to 15 percent. The soils are about 60 percent Biddleman gravelly sandy loam. The Biddleman series consists of very deep, well drained soils with medium or high surface runoff and moderately slow permeability in the subsoil and very rapid permeability in the underlying sandy material. The soils are used for limited grazing and wildlife habitat (USDA 2006).

The Isolde series consists of very deep, excessively drained soils with negligible to low surface runoff and very rapid permeability. The soils formed in eolian sand derived from mixed rocks. Isolde soils are on dunes with slopes of 0 to 30 percent. The dunes are semi-stabilized by vegetation and are superimposed over various other landforms of intermontane basin landscapes. Isolde soils are used for rangeland and wildlife habitat (USDA 2006). Parran soils are very deep, nearly level, and somewhat poorly drained soils that formed in clayey alluvium. They occur on low lake terraces and in basins. The soils are used for limited grazing.