

honeysuckle, side bells pyrola, round leaved violet, and northwestern sedge. Cool moist slopes exhibit grand fir, western larch, queen's cup beadlily, and prince's pine. The vegetation on drier slopes includes Douglas-fir, ponderosa pine, mountain maple, ninebark, pinegrass, elk sedge, and bigleaf sandwort. This forested landscape is used for logging, woodland livestock grazing, wildlife habitat, and recreation.

Elevations range from 4000 to 7000 feet. Local relief varies from 400 to 2500 feet. These areas are influenced by marine air coming through the Columbia River Gorge to the west. Mean annual precipitation ranges from 30 to 60 inches. This comes mostly in the form of snow and persists into late spring. Mean annual frost free days vary from 15 to 70.

The **Subalpine-Alpine Zone** includes high elevation, glaciated mountains with arêtes, cirques, mountain slopes, tarns, permanent snowfields, and a remnant glacier. The high gradient streams have boulder and cobble substrates. Surface geology includes volcanic ash and colluvial deposits from the Strawberry Volcanics and Picture Gorge Basalts. Intrusive formations of basalt and andesite are the result of magma pushing up through layers of older rocks that changed the rocks as they cooled. The area is dotted with rock. Surface geology includes remnant glacial deposits associated with glaciers from glacial Lake Missoula, e.g., about 2 million years ago. The dominant vegetation associations are western spruce–fir forest and alpine meadows–barren. Common species include subalpine fir, whitebark pine, Engelmann spruce, and lodgepole pine. Dry south-facing slopes have mountain big sagebrush and Idaho fescue. Wet meadows contain heather and Parry's rush. The treeline is vegetated by krummholz. Alpine meadows are marked by green fescue and Hood's sedge. The highest elevations consist of rock outcrops, rubble land, and snowfields. This expanse of forest, meadowland, and bare rock is used for recreation, and wildlife habitat. The land is used for summer livestock grazing. The Subalpine-Alpine Zone is an important water source for lower elevation areas.

Elevations range from 6500 to 9900 feet. Local relief varies from 600 to 3000 feet. Mean annual precipitation ranges from 35 to 80 inches and is mostly snow. Mean annual frost free days vary from 10 to 30.

The **Cold Basins** are cold, wet valleys and basins. Most streams have been channelized, but undisturbed reaches are meandering, with well developed floodplains. Surface geology consists of recent alluvium and lacustrine deposits. Older layers are formed from ash and sediment. The dominant vegetation associations are sagebrush steppe and wetlands. Common vegetation includes sedges, mountain big sagebrush, low sagebrush, and Idaho fescue. Wetlands and wet meadows are covered with tufted hairgrass, Baltic rush, and alien Kentucky bluegrass. The pastureland, shrubland, grassland, and wetlands are heavily grazed by cattle and elk. Meadow hay is harvested for winter livestock feed.

Elevations range from 3600 to 6000 feet. Local relief is mostly level. Mean annual precipitation ranges from 12 to 25 inches and is mostly snow. Mean annual frost free days vary from 20 to 50.

MINERAL RESOURCES

Much of the early history of the North, Middle and Upper John Day basins involves the search for the "motherlode." For a few the search continues even today. More common material, such as sand, gravel, and aggregate literally form the foundation of community and regional infrastructure. Modern roads and building foundations would not be possible without these common materials.

The BLM categorizes minerals as locatable, leasable, or saleable minerals. Locatable minerals are minerals for which mining claims can be located under the 1872 mining laws, as amended. These include precious and base metals and some non-metallic minerals. Saleable Minerals include common variety mineral materials such as sand, gravel, rock, and cinders. Leasable minerals include oil, gas, and geothermal and some solid mineral resources such as coal and oil shale. The distribution of mineral resources is described below.

LOCATABLE MINERALS

The potential for the occurrence of locatable minerals in the central and northern parts of the planning area is generally low because of the prevalence of relatively recent non-mineralized Columbia River Basalt flows in the Columbia Plateau Ecoregion and the northern portion of the Blue Mountain Ecoregion. The southern and eastern parts of the planning area generally have a moderate to high potential for locatable minerals due to scattered pockets of mineralization in the John Day and Clarno formations and in the accreted terrane rocks.

GOLD AND SILVER

Lode and placer deposits of gold and silver are present in the southern and eastern part of the planning area around Antone, John Day, Prairie City, Granite, and in the Greenhorn Mountains. Like most gold deposits, the gold found in the area is a naturally occurring alloy with silver (Lindgren, 1901). As a result, silver was produced as a byproduct of gold mining. Silver was also produced from ores including tetrahedrite, stephanite, and pyrrargyrite.

COPPER AND LEAD

Ores of Copper are found in the Spanish Gulch, Canyon, Greenhorn, Susanville, Granite, and Quartzburg Mining Districts (Brooks and Ramp, 1968). The copper ores are present in the same veins that were mined for gold and silver. Copper is also present in the Granite District, in the Quartzburg District.

Copper deposits are also found on the Strawberry Range crest between the summit of Canyon Mountain and Indian Creek Butte; a few other deposits occur just outside the western boundary of the Strawberry Mountain Wilderness (Thayer et al., 1981). Chalcopyrite, malachite, and chrysocolla are the primary copper-bearing minerals and occur mainly in lenticular quartz veins placed in gabbro host rock. All known copper deposits in the area are either too small or have an insufficient grade for production under current economic conditions. Occurrences of galena (ore of lead) are similar to that of copper in the planning area mining districts.

CHROMIUM

Deposits of chromite (ore of chromium) are located in the southeast part of the planning area in Grant County. Most of these deposits are in the Strawberry Range though a few also occur in the Greenhorn Mountains. Individual chromite deposits, ranging from a few hundred kilograms to 115,000 tons, occur as pods and lenses in peridotite, dunite, and serpentinite (Thayer, 1940; Thayer et al., 1981). At least 100 chromite deposits are recognized but most occurrences contain less than 100 tons.

MERCURY

Cinnabar (ore of mercury) was discovered in eastern Jefferson County in 1933. Small, isolated cinnabar deposits occur on the east and west sides of Canyon Creek in the southern part of the planning area. A notable mercury deposit was discovered in 1963 near the confluence of the East Fork of Canyon Creek and Canyon Creek (Thayer et al., 1981) where cinnabar occurs as fracture fillings and replacements in greywacke host rock. Cinnabar is also present in the Greenhorn Mining District (Brooks and Ramp, 1968).

BENTONITE

Bentonite clay is another locatable mineral found within the planning area. Active mining claims are located in the area about 1.5 miles northwest of Clarno.

OTHER MINERALS

Deposits chrysotile asbestos, nickel, and platinum-group metals (platinum, palladium, and rhodium) are found in the Strawberry Range and surrounding areas (Thayer et al., 1981). Zinc, lead, iron, arsenic, antimony, cobalt, bismuth, molybdenum, and manganese are all present in one or more of the mining districts in the planning area (Brooks and Ramp, 1968). Like copper and lead, these minerals are present in the same veins that contain gold and silver. Thus, minor amounts of these metals were produced from the gold and silver mines.

SALEABLE MINERAL MATERIALS

Most of the planning area has a moderate to high potential for the occurrence of mineral materials. The high potential areas are in and around existing mineral material quarries and in rock deposits with known value for aggregate uses. Most of the high potential areas occur in alluvial deposits of sand and gravel, the Columbia River Basalt flows and other volcanic rock units known or likely to have a sufficient quality for use in asphalt.

LEASABLE MINERALS

Leasable mineral resources include oil, gas, and geothermal and some solid mineral resources such as coal and oil shale. Owing to the prevalence of volcanic and volcanoclastic sedimentary rocks in the planning area and the lack of any discoveries, coal, coal bed methane, oil shale and tar sands are considered to be absent from the planning area and are not addressed.

OIL AND GAS

The potential for oil and gas ranges from low to high across the planning area. The presence of oil and gas has occurred in exploratory wells drilled near the NE-SW trending axis of the Blue Mountains anticline. This fold represents a potential trap for oil and gas and is therefore considered to have a high potential for oil and gas accumulation. Farther away from the fold axis, the oil and gas potential falls to moderate and then to low.

GEOTHERMAL

The potential for the occurrence of geothermal energy is moderate to high across the planning area. Available information on existing geothermal resources comes from 8 natural hot springs and 18 exploratory geothermal wells in the planning area. Data from other wells adjacent to the planning area were used to interpolate the geothermal energy potential to the planning area boundaries.

All of the hot springs are scattered throughout the southeast part of the planning area. Each hot spring is a surface indication of geothermal energy. All but 2 of the hot springs have temperatures exceeding 40° C (104° F).

The geothermal exploratory wells are somewhat evenly distributed across the planning area. Temperatures encountered in the wells range from 20° C (68° F) to 45° C (113° F). Only four of these wells have temperatures exceeding 30° C (86° F); all of the other wells have temperatures of 23° C (73° F) or less.

SOILS

Soils are defined by the processes that form them including climate, topography, parent material, and organisms living in the soil. Through time, these processes form unique soil types and influence what plants grow.

CLIMATIC FACTORS

Climatic influences are reflected by soil temperature and moisture. In the planning area, we have two soil moisture regimes: dry and moist. Common soil temperature regimes in the planning area include warm and cool.

Soils play an integral part in vegetation community development. Plant communities are most noticeably influenced with extremes in soil texture and thickness of soil horizons, depth to restrictive layers including abrupt soil horizon boundaries, and by soil drainage or depth to water table.

TOPOGRAPHIC FACTORS

Deep to very deep soils occur in alluvial drainages, floodplains and river terraces of the John Day River, and on North and Northeast facing slopes influenced by leeward soil deposition from the prevailing winds, and on colluvial (rockfall) foot slopes from water and gravity deposition. Shallow and very shallow soils occur on flat basalt table lands, and on upland ridge top and shoulder slopes.

PARENT MATERIALS FACTOR

The soils in the Columbia Plateau are derived from weathered basalt and some wind deposited silt. Silty soil textures occur in the Umatilla Plateau and Pleistocene Lake Basins. At higher elevations, the deep loess soils become thinner. The John Day Canyons have a higher rock fragment content than the surrounding areas. High rock fragment content helps protect the soil from erosion.