Physiographic Provinces and Surface Geology of Utah

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The physical features of Utah provide some of the most beautiful scenery anywhere. Utah is a land of stark contrast with high mountains, plateaus, ridges, uplands, plains, basins, and canyons. Elevations range from a low of 2,350 ft above sea level along the Beaver Dam Mountains in extreme southwestern Utah to 13,528 ft in the Uinta Mountains (Murphy 1981). Murphy (1989b) presents an informative discussion of these features, from which I have drawn much of the content of this paper. Table 1 is a reference to geologic eras, periods, and epochs providing some additional perspective on time that may be helpful in the discussions that follow.

Table 1. Eras, periods, and epochs through geologic time (adapted from Stokes 1986).

Geologic Time	Millions of Years Ago		Millions of Years Duration
	Begin	End	
Cenozoic Era	66	——	66
Quartenary Period	2	——	2
Holocene Epoch	.011	——	.011
Pleistocene Epoch	2	.011	1.989
Tertiary Period	66	2	64
Pliocene Epoch	5	2	3
Miocene Epoch	24	5	19
Oligocene Epoch	37	24	13
Eocene Epoch	58	37	21
Paleocene Epoch	66	58	8
Mesozoic Era	245	66	179
Cretaceous Period	144	66	78
Jurasic Period	208	144	64
Triassic Period	245	208	37
Paleozoic Era	570	245	325
Permian Period	286	245	41
Pennsylvanian Period	320	286	34
Mississippian Period	360	320	40
Devonian Period	408	360	48
Silurian Period	438	408	30
Ordovician Period	505	438	67
Cambrian Period	570	505	65
Precambrian Time	≈4,600	570	≈4,000

Four of the major physiographic provinces in North America extend into Utah, providing the wide variety of topography. The Great Basin Section of the Basin and Range Province encompasses western Utah and the Snake River-Columbia Plateau Province dips into a small area of extreme northwestern Utah. The Wasatch Range and the Uinta Mountains, in northern and northeastern Utah, are recognized subsections of the Middle Rocky Mountain Section of the Rocky Mountain Province. Almost half of the state falls within the Colorado Plateau Province, which is divided into three primary sections in Utah: the Uinta Basin, Canyonlands, and High Plateaus. Several subsections are recognized within these three divisions.

Wah Wah Mountains across Pine Valley, Great Basin Section of the Basin and Range Province, Beaver County, Utah.

Basin and Range Province-The Great Basin Section

The Great Basin is a region of north-south aligned mountain ranges separated by wide, sediment-filled valleys with mostly internal drainage. The mountain ranges were formed by faulting and were later modified by erosion. Paleozoic Era limestones, dolomites, shales, and sandstones are the dominant outcrops along the normal fault escarpments (Moyle 1981). The valleys are filled with recent sediments from the Cenozoic Era (Ash 1981). Large alluvial fans have formed at canyon mouths and in some areas the mountain ranges have eroded to the extent that they are all but buried by deposits of fan material.

The Pine Valley and Bull Valley Mountains of southwestern Utah are east-west mountain ranges that serve as a divide between the Great Basin and the Colorado Plateau. Extreme southwestern Utah is part of the Colorado River drainage system, not part of the interior drainage system of the Great Basin. The terrain of the area is not greatly different than Great Basin terrain and is usually mapped as part of the Great Basin.

The Great Salt Lake is a remnant of Lake Bonneville, the largest Quartenary (Cenozoic Era, Quartenary Period,

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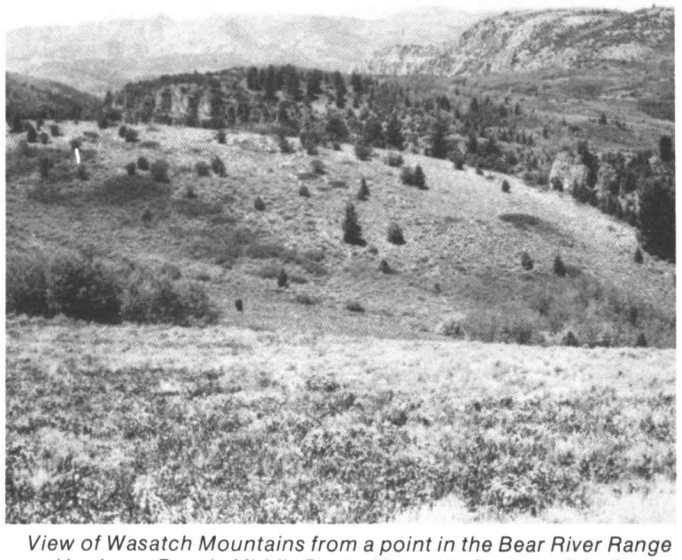
Pleistocene Epoch) lake in western North America. Lake Bonneville covered about 20,000 square miles and was more than 1,000 ft deep in the area of the present Great Salt Lake. The Lake Bonneville shorelines apparent today are a result of at least 10 major rises and falls of lake level over the last 100,000 years (Hintze 1975). The other terminal lake of the Great Basin in Utah, and also a former part of Lake Bonneville, is Sevier Lake. Now it is a playa which is dry most of the time. It is located in Millard County, in west central Utah (Murphy 1989a).

Rocky Mountain Province-Middle Rocky Mountain Section

Uinta Mountains. The Uinta Mountains are an east-west mountain range about 150 miles long and 30 miles wide. They were formed by anticlinal uplifting with sedimentary units outcropping on all sides and dipping outward. The core of these mountains is very old (Precambrian Era) quartzite and the outcrops on the flanks are ancient (Paleozoic and Mesozoic Eras) limestones, shales, and sandstones (Hintze 1975, Moyle 1981, Murphy 1989b). The Uinta Mountains were extensively glaciated in recent (Pleistocene Epoch, Quartenary Period, Cenozoic Era) times and glacial features dominate the landscape. Glaciation created many examples of horns, aretes, cirques, and glacial troughs. Subsequent deposition of moraine by ice and glacial-melt water has created many small high-mountain lakes across the region.



View of Wasatch Mountains from a point in the Bear River Range near Hardware Ranch, Middle Rocky Mountain Section of the Rocky Mountain Province, Cache County, Utah.

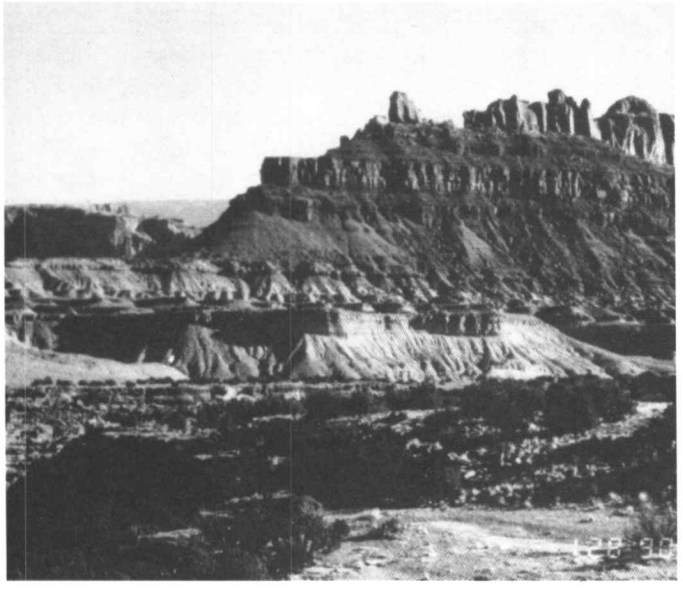
Wasatch and Bear River Ranges. The Wasatch and Bear River Ranges are similar except in extent. The Bear River Range is a relatively small mountain range of similar stratigraphy to the Wasatch Range, located between Cache Valley and Bear Lake. The Wasatch Range is a north-south oriented mountain range that extends from Idaho south to Salt Creek Canyon east of Nephi. The western flank is very steep and relatively straight as a result of displacement along the still active Wasatch Fault. The eastern flank rises much more gently. Like the Uinta Mountains, the Wasatch Range has a core of very old (Precambrian Era) quartzites, gneisses, and schists overlain by old (Mesozoic Era) sandstones, shales, mudstones, and limestones (Moyle 1981). Locally, more recent (Cenozoic Era) conglomerates and shales, interspersed with volcanic tuffs and breccias, form the surface layers of strata (Moyle 1981).

Colorado Plateau Province

Uinta Basin. The Uinta Basin Section of the Colorado Plateau Province is a synclinal as well as topographic basin with an east-west axis running near the south flank of the Uinta Mountains. The highest elevations are around 9,000 ft at the southern boundary along the top of the Roan Cliffs and the lowest elevations at the basin floor near Vernal are about 5,000 ft. The basin contains 20,000 to 25,000 ft of marine and continental limestones, shales, and sandstones of old (Paleozoic Era) to recent (Cenozoic Era) age (Moyle 1981). The Green River shales of recent (Cenozoic Era) origin contain vast deposits of oil shale and other hydrocarbons. Although the basin is gently rolling for the most part, there are areas like the Book and Roan Cliffs that have eroded and been cut by deep ravines and spectacular canyons.

View to the north down Willow Creek in the Book Cliffs, Uinta Basin Section of the Colorado Plateau Province, Grand County, Utah.

Canyonlands. The Canyonlands Section of the Colorado Plateau Province encompasses the southeast quarter of the state. It is dominated by essentially horizontally lying old (Paleozoic and Mesozoic Era) to recent (Cenozoic Era) sandstones and shales with minor amounts of limestone (Moyle 1981). Recent (Cenozoic Era) igneous intrusions of monzonites, syenites, and diorites form the domed highlands of the Henry, LaSal and Abajo Mountains (Moyle 1981). The Monument and Circle Cliffs uplifts and San Rafael Swell are predominantly arched and folded rock layers. The Great Sage Plain, south of the



San Rafael Swell, Canyonlands Section of the Colorado Plateau Province, Emery County, Utah.

LaSal Mountains, is an unusually wide and flat region unlike the surrounding area of deeply cut canyons and intrusive mountain ranges (Murphy 1989b). The Kaiparowits Plateau appears to be transitional between the Canyonlands and the High Plateaus Sections, but the marginal cliffs are erosion boundaries rather than faulted boundaries like those that define the southern High Plateaus (Murphy 1989b). The Mancos Shale Lowlands,

Mancos Shale Lowlands along Interstate 70 and south of the Book Cliffs, Canyonlands Section of the Colorado Plateau Province, Grand County, Utah.

south of the Book Cliffs and east of the High Plateaus, form a fairly flat region developed in weaker rocks.

High Plateaus. The High Plateaus Section of the Colorado Plateau Province consists of north-south oriented fault blocks of old (Mesozoic Era) to recent (Cenozoic Era) sandstones and shales capped by recent (Cenozoic Era) basalt, andesite lava flows, and glacial deposits. Faulting generally marks the boundaries of this section with the Great Basin Section of the Basin and Range Province and the Canyonlands Section of the Colorado Plateau Province. These Boundaries are marked with colorful badlands such as Cedar Breaks and Bryce

Cedar Breaks, High Plateaus Section of the Colorado Plateau Province, Iron County, Utah.

Canyon. The southern boundary of this section is marked by a series of cliffs known as the Grand Staircase. They include the Chocolate Cliffs, Vermillion Cliffs, White Cliffs, Gray Cliffs, Pink Cliffs, and Black Cliffs.

Snake River-Columbia Plateau Province

The Snake River-Columbia Plateau Province makes a very limited entry into Utah in the extreme northwest corner of the state. This small area includes one small basin draining north from the Goose Creek Mountains in Boxelder County to the Snake, and eventually, Columbia Rivers. The Goose Creek Mountains are composed of old (Paleozoic Era) to recent (Cenozoic Era) sedimentary rocks sometimes capped with volcanic ash and lava flows.

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Vegetation Types of Utah

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Utah is a land of contrast. Elevations range from 2,350 ft in extreme southwestern Utah to 13,528 ft at King's Peak in the Uinta Mountains in northeastern Utah (MacMahon 1988). The wide variety of physical features that occur, linked to the diversity of plant and animal communities, produces many kinds of rangeland ecosystems. Although many vegetation maps have been produced over the years, Küchler (1964, 1970) compiled maps showing the potential natural vegetation of the conterminous United States with 20 subdivisions shown for Utah. One of these, desert, occurs primarily on old lake bottoms that are now salt flat and is essentially devoid of vegetation. Küchler's map subdivisions for Utah give adequate detail and are recognizable, making them appropriate vegetation units for discussion in an overview (MacMahon 1988, West 1989). This paper summarizes information presented by West (1989).

Alpine Zone

Alpine ecosystems in Utah occur in mountainous areas above timberline, usually above 11,000 ft. The 498,000 ac classified as alpine meadows and barrens (Yorks and McMullen 1980b) in Utah is located in the Uinta Mountains. Small alpine areas occur on other Utah mountain ranges.

Vegetation of this zone is called tundra and is dominated by mosses and lichens, low-growing, perennial herbaceous and prostrate shrubby vascular plants. Tree species present grow along the ground and appear as shrubs. Usually, fewer than 200 alpine plant species are present on any given mountain range. Grasses and sedges are widespread and species of the mustard, rose, saxifrage, buckwheat, and pink families are common. Tufted hair grass, alpine avens, and sedge are prevalent on many dry and wet meadow sites. Water sedge is common in bog communities, and shrub thickets are often dominated by willows: Drummond willow, grayleaf willow, or plain-leaf willow.

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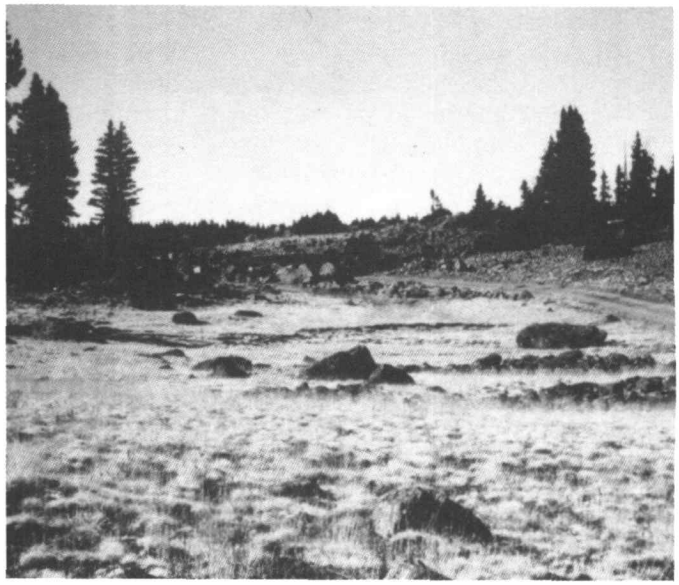

Subalpine Zone vegetation on the Aquarius Plateau of southcentral Utah.

Domestic sheep grazing has been the primary human use of the alpine zone in Utah since the mid-nineteenth century. However, it has steadily declined over the past 40 years. Much of the alpine zone is inherently low in productivity yet relatively high in ecological condition.

Subalpine Zone

The subalpine zone runs down slope from the alpine zone to approximately 9,000 ft. The subalpine zone in Utah is estimated to be 1,250,000 ac. The largest areas of this zone occur in the Uinta Mountains and cap the Wasatch, Paunsagunt, Markagunt, Aquarius, and Tavaputs Plateaus. Small areas occur on other Utah mountain ranges.

Undisturbed forested sites within the subalpine zone are dominated by conifers such as Engelmann and blue spruce, and subalpine and white (true) firs. Intermingled