S A N T A C A T A L I N A M O U N T A I N S

BIOLOGICAL AND GEOLOGICAL

DESCRIPTION AND ROAD LOG

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SANTA CATALINA MOUNTAINS

GENERAL DESCRIPTION

BOTANY

The tour to the Santa Catalina Mountains is designed to examine the plant life of a typical mountain within the four-state area of New Mexico, Arizona, Chihuahua, and Sonora. The Santa Catalinas are the westernmost forested mountains of the region, being separated by some 480 km (300 mi.) of desert from the next forest-clad ranges to the west (the San Jacintos and San Bernardino Mountains of southern California). To the north, the east, and the south from the Santa Catalinas lie forested ranges with substantially the same sequence of vegetation zones as are to be seen on this tour.

If the Sonoran Desert climate were predominantly that of an arid rain shadow, the vegetation of the mountains would more nearly resemble that of the desert plain. Since the Sonoran Desert region is, in fact, not primarily the product of a rain shadow, the mountains are moist. The atmospheric moisture of the area falls upon the large elevated land masses as air flows up and over the mountain barriers. The desert plant communities on the basal plain of the Catalinas receive perhaps 300 mm (12 in.) of moisture while the fir forest at the summit, only 10 km (6 mi.) away, may receive more than 760 mm (30 in.). At the summit increased moisture in conjunction with lowered temperatures,

produces a biotic community with affinities far to the north. In ascending the mountain, the tour will observe changes in vegetation that are floristically equivalent to a span of several thousand miles from southern Arizona to Canada.

During the tour, emphasis will be placed on recognition and characterization of vegetation zones. The party will see the following: (1) Sonoran Desert, (2) Desert Grassland, (3) Oak Woodland, (4) Pine-oak Woodland, (5) Pine Forest, and (6) Fir Forest. The vegetation of the Santa Catalinas was described first by Shreve (1915) and recently has been intensively studied by Whittaker and Niering (1964, 1965). Terminology for the vegetation zones follows most closely that of the latter authors.

SONORAN DESERT: The Sonoran Desert, one of four regional deserts of North America, is itself divisible into seven subunits (Shreve 1964). We will see but one of these, the Arizona Uplands. This subdivision is one of the most complex within the Sonoran Desert, whether judged on the basis of life-form diversity or by the number of species making up its flora. This complexity arises in part by reason of the relative abundance of moisture received (175-300 mm/yr; 7-12 in/yr), and because the amount that does fall arrives in approximately equal amounts during two seasons, winter and summer. Thus species attuned to winter, to summer, or to both winter and summer rainfall regimes grow together here.

Although made up of many different communities, the portion of the Arizona Uplands seen on our tour will include but one of these, the paloverde-saguaro community. The luxuriance of the growth will not conform to the concept of desert held by many Europeans. The

green-stemmed paloverde (Cercidium microphyllum), the saguaro (Cereus giganteus), and many other conspicuous elements of the vegetation here form a cover through which it is difficult to see for more than a few tens of meters. Essentially the same plant assemblege seen less than 160 km (100 mi.) to the west, however, forms an open, low community that agrees with virtually any concept of desert.

The paloverde-saguaro community is best developed on the upper portions of the long, straight outwash slopes (bajadas) which characteristically skirt the desert mountains. On the warm, south side of the Catalinas, where bajada and steep slope meet at elevations below the desert's upper limit, desert vegetation extends well above its usual reaches. Thus at the beginning of our trip we will see a well developed paloverde-saguaro community at 1145 m (3750 ft) on the south slope. This is to be compared with an upper limit of about 915 m (3000 ft) for desert on the flat, slightly dissected terrain at the base of the mountain on the west.

DESERT GRASSLAND. This zone is a broad transitional band of vegetation lying between the desert and the Oak Woodland and is marked by the dominance of grasses and by the absence of such desert species as saguaro and paloverde. It reaches its best development between 1065 m and 1370 m (3500 ft and 4500 ft) on gently rolling terrain where soils are deep. Much of the land formerly occupied by this grassland has undergone conspicuous change during the last three

quarters of a century and today is dominated by a characteristic woody element that often far outweighs the importance of grasses (Humphrey 1958; Hastings and Turner 1965).

On all but the south side, the steep slopes of the Santa Catalinas rest on a bajada that extends up to elevations well over 915 m (3000 ft). On such high bajadas the Desert Grassland was well developed until recent changes, produced by the combined effects of cattle grazing and climatic change, resulted in the increased importance of shrubs and a reduction in grass cover. On the south side of the mountain, level terrain at the proper elevation for grassland is absent and desert extends above its usual level, to merge directly with Oak Woodland (Shreve, 1915:15).

OAK WOODLAND. When first encountered in passing upward from the Desert Grassland, the Oak Woodland appears on protected north-facing slopes or in ravines (at about 1220 m; 4000 ft). The grass cover common to both zones provides the matrix into which are set widely scattered oaks. Historically, much the same thing happened here as happened in the grassland: The combined effects of continued heavy grazing and altered climate have brought a series of changes marked by the encroachment of new woody occupants, such as mesquite (Prosopis juliflora var. velutina). In the woodland is added another symptom of desertification--the death of oaks. In effect, the new shrub-studded version of the Desert Grassland has expanded upslope at the expense of the Oak Woodland.

Upslope from this point there is a steady increase in broad-leaved woody evergreens and a proportionate decrease in grasses. These characteristics are typical of the zone next above, the Pine-Oak Woodland.

PINE-OAK WOODLAND. This typically Mexican woodland community is widespread southward in the Sierra Madre Occidental. In the Catalinas it extends from 1525 m (5000 ft) to approximately 2075 m (6800 ft). It is characterized by closely spaced broad-leaved evergreen shrubs and low trees (mainly species of oaks [Quercus]), by one or two species of juniper (Juniperus deppeana, J. monosperma), and by pinyon pine (Pinus cembroides).

On relatively moist northerly to easterly slopes at elevations above about 1738 m (5700 ft), Chihuahua pine (Pinus chihuahuana) is a conspicuous element. Its entrance changes the aspect from that of a predominantly broad-leaved evergreen community to one with tall pines as a discontinuous canopy over smaller trees and shrubs. Farther south, in Mexico, Chihuahua pine is joined by several other similar species and this phase of the woodland becomes the main mid-elevation vegetation separating open Oak Woodland from Pine Forest. Northward from the latitude of the Catalinas, Mexican types of vegetation yield their places on the slopes to predominantly Great Basin communities; the Catalinas are thus near the northern terminus of this vegetation type (Shreve 1942b; Marshall 1957).

PINE FOREST. Ponderosa pine (Pinus ponderosa) is the conspicuous element of this forest. First seen at about 1830 m (6000 ft) along moist ravines or in canyon bottoms, pine forest reaches its best expression on rolling terrain above about 2135 m (7000 ft). When first encountered the dominant is the 5-needle form of ponderosa pine. (Some authors regard this tree as the specifically distinct Pinus arizonica.) One or two species of evergreen oaks (Quercus hypoleucoides) extend upward from the zone below to form a low understory to the tall pine forest. On xeric sites with relatively deep soil, grasses (Muhlenbergia virescens, M. emersleyi) are the principal herbaceous plants.

As more mesic conditions are met (higher elevations, north-facing slopes), the 3-needle form of ponderosa pine becomes dominant and the deciduous Gambel's oak (Quercus gambelii) and Mexican white pine (Pinus strobiformis) are commonly encountered. Sheltered slopes or draws at these higher elevations support attenuated stands of Douglas fir (Pseudotsuga menziesii) and white fir (Abies concolor), characteristic conifers of the next zone.

FIR FOREST. Nowhere within the Santa Catalinas do southerly slopes provide the necessary cool-moist conditions for this temperate Douglas fir-white fir forest. Beginning at elevations below 2375 m (7800 ft), this vegetation type, formerly confined to moist draws, begins to occupy all slopes of northerly aspect. Here it is joined by other plants of northern affinities such as quaking aspen (Populus tremuloides), big-tooth maple (Acer grandidentatum), and dwarf maple (Acer glabrum).

The last vestiges of the flora from lower reaches of the mountain (i.e., Pine-Oak Woodland downward) are eliminated in the special habitats of this coniferous forest. Instead, a contingent of Canadian, Alaskan, and Holarctic species takes over as subordinates along with a large number of less far-ranging western North America species (Whittaker and Niering 1965).

On north slopes near the summit of Mt. Lemmon (2791 m; 9157 ft), corkbark fir (Abies lasiocarpa) can be seen. About 96 km (60 miles) to the northeast from here lie the Pinaleno Mountains where this fir, with spruce (Picea emgelmannii), forms several square miles of spruce-fir Taiga. In the Catalinas suitable cool-moist habitat-types are lacking and this evergreen high latitude forest is not well developed.

GEOLOGY

The Santa Catalina Mountains are part of a larger geologic entity consisting of the Rincon, Santa Catalina and Tortolita Mountains. The Picacho Mountains may even be a member of this group since their rocks and structure appear to be similar.

The entity is best described as a domal complex in that the overall structure is that of a large, west-northwest oriented dome. The internal structure, however, indicates that the emplacement was as a series of lobes, each rising independently of the others. Field mapping indicates that the area of the Catalina Granite and the Mt. Kimball-Cathedral Peak area are centers of two of these lobes.

The fracture pattern gives no indication that the present relief of the Santa Catalinas is due to faulting. The Catalina frontal fault,

along the southwest edge of the mountain, has not been shown to exist to the satisfaction of all concerned. The Pirate fault, along the west edge of the range, appears to be the eastern fault of a graben forming the valley between the Tortolita and Santa Catalina Mountains. This structure was likely formed by the tensional forces developed during the emplacement of the Catalina Granite lobe. The Mogul fault, the Geesaman fault and the Romero Pass zone are members of a N70W trending set of fractures apparently related to the doming but not responsible for the development of any relief.

Topographically the Catalinas consist of a forerange separated from the main mountain mass by the Romero Pass zone. The forerange is essentially a N70W trending anticlinal structure upon which is superimposed a series of NE trending anticlines. The rocks of the forerange are primarily of banded gneiss with some granitic gneiss. The main mass is predominantly granitic gneiss with some banded gneiss, flanked on the north and northeast by Precambrian through Cretaceous sediments.

SANTA CATALINA MOUNTAINS ROAD LOG

Total Mileage	Point to Point	
0.0	0.0	At Sabino Canyon Road, going east on Tanque Verde Road.
1.0	1.0	Intersection with Pantano Road.
1.3	0.3	Tanque Verde Wash. Riparian species: Mesquite bosque (Prosopis juliflora) and cottonwood (Populus fremontii) at edge of wash.
2.3	1.0	Intersection on right with Redington Road.
2.5	0.2	Intersection on left, Bear Canyon Road. View ahead is of the foothills of the Santa Catalina Mountains. From this point to the Molino Basin, pegmatites and augen structures are characteristic of the Catalina Gneiss.
4.5	2.0	Road cuts ahead are of late Tertiary sediments that are dropping to the South. Considerable argument has occurred at times as to whether the steepness of the dip represents the initial dip of the inter-layered muds and sands that make up that particular outcrop.
4.8	0.3	Road cut of the same Tertiary sediments at a steeper angle.
5.8	1.0	At 9:00 are the south dipping slopes of the Santa Catalina Mountains. Following these layers to the higher elevations, the foliation can be seen to flatten in the vicinity of Mt. Kimball, Window Rock, and Cathedral Peak. This is the south side of the forerange anticline.
6.7	0.9	Road intersection, Soldier Trail to the right.
7.0	0.3	Soldier Canyon at first hairpin turn.
7.9	0.8	Entering Coronado National Forest.
8.1	0.3	Altitude 1098 m (3600 ft). Dense stand of saguaros many of which bear scars from damaging low temperatures in January 1962. Many saguaros were killed by the unusual event. (See Niering, Whittaker, and Lowe 1963). Note that at the base of the mountain scarred saguaros were missing.

8.8	0.7	Approximately in this area we cross over the axis of the front range anticline.
9.8	1.0	Notice the outcrops on the east side of the stream. The pegmatites appear to be folded. Whether this represents actual folding or just movement along shear planes after the formation of the pegmatite is still to be determined.
11.9	2.1	The abundance of dark material at this point of Molino Basin is not characteristic of the whole forerange but is concentrated in this area.
12.1	0.2	Molino Basin. Altitude 1317 m (4320 ft). Oak Woodland vegetation. A few saguaros occur above us on south slopes overlooking the valley. Several dead oaks can be seen on these same hillsides. Note the open areas above on the left. Several years ago a fire burned over much of the hillside removing most of the woody plants.
12.3	0.2	Road intersections to the left and right lead into Molino Basin picnicking and camping areas. We are about to pass the Romero Pass zone and the rocks on the right reflect the structure of the north flank of the forerange. You will see dips of approximately 40-50^{o} to the north within the banded gneisses.
16.0	3.7	Excellent viewpoint of the north slope of the forerange of the Santa Catalina Mountains with Cathedral Peak straight West at 12:00, Window Rock at 11:30. Thimble Peak separating Sabino Canyon and Bear Canyon is at 10:30. The trail along the ridge at 11:00 is the Forest Service Trail from Bear Canyon to Sabino Canyon. The Romero Pass zone occupies the valley that moves from left to right from 11:00 to 9:00. The zone is fractured with many of the fractures being filled with brick red material. The rock foliation that you see has the same altitude (NW10^{o}N) into the Romero Pass Zone. The foliation is not present or cannot be detected across the zone but immediately on the other side of the zone the foliation is trending NW and dipping 45^{o} to vertical to the north. The rocks immediately underlying Thimble Peak are essentially horizontal and essentially on the axis of the forerange fold. The general tendency for the rocks to dip to the south toward Tucson, to become horizontal near the crest of the forerange and then dip to the north can be seen on close inspection of the rocks surrounding Cathedral Peak. The gneisses that are on the immediate right (east) side of the road show a peculiar structure that some people have referred to as cross-bedding. It is this type of structure that has led some people to postulate that the Catalina Gneiss has been formed from sedimentary units of early Mesozoic age. They maintain that the gneisses have undergone little or no mixing between layers

and that many of the structures within the gneiss are relic in nature. In many places, however, the gneiss shows an intense folding producing overturned and recumbent folds. Movement along fractures as the plastic limit was exceeded would produce shear surfaces that would look very much like these features. As we proceed past this point notice the decrease in the percentage of dark bands within the gneiss.

16.3 0.3 The rock foliation is very well developed in this area.

16.7 0.4 Note black bands appearing in the Catalina Gneiss to the right of the road. They are also apparent in the cliff walls across the stream on the left (west) side of the road and gradually decrease in number as we go from the banded gneiss into the granitic gneiss.

16.9 0.2 The tall conifer on the north slope to the right is Arizona cypress (Cupressus arizonica). This tree is usually found as scattered individuals in ravines and on north slopes between the elevations of 1525 m to 1830 m (5000 to 6000 ft). Conditions on this steep hillside are obviously well suited to reproduction and growth of this tree. Note the abundance of small trees.

17.2 0.3 Large sycamore trees (Platanus wrightii) in riparian situation.

18.4 1.2 Bear Canyon. Altitude 1814 m (5950 ft). Ponderosa Pine Forest.

18.5 0.1 Road intersection on left. Bear Canyon picnic area.

18.8 0.3 Road intersection on right. Hitchcock picnic area.

20.9 2.1 Windy Point Vista. BOTANY: Altitude 2027 m (6650 ft). The vegetation is typical Pine-Oak Woodland on this southern exposure. The canyon below (Bear Canyon) supports a stand of Pine Forest although it is 213 m (700 ft) below our present position. The usual sequence of vegetation zonation is inverted because moist-cool conditions typical of higher elevations are carried to lower levels in the canyon due to cold air drainage. GEOLOGY: Excellent exposure of Catalina Gneiss. The foliation and lineation are both well developed at this point. The foliation is almost flat with a general NE strike and 10-15^{o} dip to the SE. The lineation is made up of stringers of quartz, feldspar, and mica and exists in the plane of the foliation. The reservoir that can be seen in the lower reaches of Bear Canyon is the water supply for the former Federal Youth Detention Camp. This reservoir lies along the Romero Pass zone that separates the forerange of the Santa Catalina Mountains from the main mountain mass. With this reservoir at 12:00, Cathedral Peak

		is at 2:00 and Window Rock at 1:30. Thimble Peak of Sabino Canyon is beyond the reservoir at 12:00. The ridge from 9:00 to 10:00 in the Rincon Mountains is Tanque Verde Ridge. This is a large anticlinal structure plunging to the southeast.
21.3	0.4	Geology Vista. Excellent view of geographic features of southeastern Arizona.
21.6	0.3	Note Mt. Bigelow TV towers at 10:00.
21.8	0.2	Goosehead Rock.
22.4	0.6	Excellent view of Agua Caliente Hills and Rincon Mountains at 3:00. The canyon immediately below is Upper Bear Canyon. The joint sets in this area have led to the development of the picturesque rock formations that you have just been driving through.
22.8	0.4	Road intersection on left to picnic area.
23.0	0.2	Road intersection on left to picnic area.
23.9	0.9	Road intersection to left. Rose Canyon Campground.
24.3	0.4	San Pedro Vista. Excellent view of the San Pedro Valley and the Galiuro Mountains. Map mounted at viewpoint shows location of geographic features. The Catalina Gneiss to the right of the road shows faint foliation. The structure is elusive and requires considerable attention if it is to be observed. At 10:00 from the viewpoint the steep side of the Paleozoic escarpment is visible. They are limestones of upper Paleozoic age and continue from 10:00 to 2:00 across the viewpoint.
25.4	1.1	Road intersection to left.
25.9	0.5	Excellent exposures of Apache Group geologic formation in contact with the underlying Catalina Gneiss. The contact is well exposed as well as the rocks on both sides of the contact. The contact can be seen on both sides of the road but the exposures to the right are best.
26.5	0.6	Organization Ridge road on left.
26.6	0.1	Palisades Ranger Station and trail up Mt. Bigelow.
27.6	1.0	Road on right to Mt. Bigelow.
27.7	0.1	Road to Spencer picnic area on left. The rocks here have a better developed foliation than those seen previously but are still of the granitic gneiss. The foliation strikes N70E and dips gently to the east at some 20°.

28.4	0.7	Road on left to Spencer picnic area. Rocks on right are granitic gneiss.
28.5	0.1	This is the beginning of this particular outcrop of the Apache Group. Box Camp Canyon Trail starts here.
29.0	0.5	Note folding in Dripping Spring Quartzite to the right. Rocks go from a vertical position to a horizontal position to a steeply dipping position in a very short distance. Folding in this case appears to be of the passive nature since the folds pay little attention to the layering within the rock mass. Rock masses to the left and right of the road are of the Dripping Springs Quartzite. Close inspection of these rock units will reveal the intense folding that has taken place.
29.1	0.1	Bear Wallow Forest Camp, road to the right.
29.2	0.1	Bear Wallow on left.
29.3	0.1	Continuation of the Dripping Spring Quartzite. Although the rocks look horizontal they are intricately folded. Many of the quartzite layers form recumbent folds.
29.5	0.2	Soldier Camp Road on right. Summer home area. Outcrops on the right are in the Dripping Spring Quartzite of the Apache Group. Butterfly Trail head.
30.3	0.8	Inspiration Rock picnic area road on left. At this point the Apache Group ends. The contact with the Leatherwood Quartz Diorite is covered. The rock is intricately folded showing both overturned and recumbent folds. Note that the material is cut by pegmatite dikes.
30.8	0.5	Loma Linda Extension summer home area. This road proceeds down to and intersects with the Marshall Gulch road.
31.4	0.6	Intersection with the road to Oracle is to the right. BOTANY: Altitude 2408 m (7900 ft). The forest of pines has an understory of evergreen oaks (mainly silverleaf oak). Note the occasional Gambel oak (Quercus gambelii), the only deciduous oak in the Catalinas. The dominant pine is ponderosa pine (Pinus ponderosa). Bracken fern (Pteridium aquilinum) is abundant beneath the pines in some areas. GEOLOGY: Outcrop on the left is Leatherwood Quartz Diorite with pegmatites. The small drill holes in the Leatherwood crossing the pegmatites were place there by Dr. Philip Matter who in the late sixties wrote a Ph.D. dissertation on the origin of the pegmatites in this area. In was his conclusion

that these pegmatites were replacement in origin since he was able to show that as he approached the pegmatites certain minerals would decrease in abundance and would increase in abundance in the pegmatite. This led him to postulate the movement of elements such as potassium into a fracture which eventually became the pegmatite that we see.

31.6 0.2 Ski area road. Turn right. (Summerhaven is straight ahead.)

31.9 0.3 Approaching contact between Leatherwood Quartz Diorite and Cambrian Abrigo Formation. The road parallels the contact for a short distance at this point. The contact is very strongly sheared as noted by the badly broken condition of the rock that you see in this interval. The road cuts were steepened several years ago and the winter snows have saturated the shattered material giving rise to the land slides that have produced the scars along this stretch.

33.0 1.1 Mt. Lemmon Ski Area and Lodge. BOTANY: Altitude 2561 m (8400 ft). The vegetation of north slopes is representative of the Fir Forest. Douglas fir (Pseudotsuga menziesii) and white fir (Abies concolor) are dominant trees. Mexican white pine (Pinus strobiformis) will also be seen in the Fir Forest although it occurs equally frequently on south slopes at this elevation with ponderosa pine. Ponderosa pine is absent on north slopes. Typical shrubs of the Fir Forest include snowberry (Symphoricarpos oreophilus) and mountain spray (Holodiscus dumosus). Small clumps of quaking aspen (Populus tremuloides) are scattered among the dominant conifers of this community, first successional species after a burn.
GEOLOGY: Bolsa Quartzite of Cambrian age underlies this area.

33.1 0.1 Cambrian lime silicates on the left.

33.2 0.1 Oracle Ridge and the back side of Marble Peak at 2:00. Notice the Paleozoic limestones outcropping along the ridge.

33.3 0.1 Outcrops to the summit are members of the Abrigo Formation.

34.1 0.8 Altitude 2683 m (8800 ft). On the slope of northerly aspect at this point, corkbark fir (Abies lasiocarpa) can be seen. The fir can be readily recognized by its smooth, grey bark which contrasts sharply with the rough, deeply furrowed bark of older trees of both Douglas fir and white fir.

35.5 0.2 Closed access road to transmission equipment.

35.6	0.1	Road to the left proceeds to Romero Pass, Cargadero Canyon, and Samaniego Ridge trails.
35.7	0.1	Summit. Altitude 2789 m (9150 ft). The Pine Forest is carried to the summit on the south-facing slope and onto the dry ridge-tops nearby. North slopes support Fir Forest. Installation on top of the mountain, formerly Mt. Lemmon Radar Station, an installation for the Air Defense Command for the southwestern United States. It is now University of Arizona and United States Government Infrared Laboratory.