GEOLOGIC GUIDEBOOK 3 – HIGHWAYS OF ARIZONA
ARIZONA HIGHWAYS 85, 86 AND 386

by
Stanton B. Keith

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INTRODUCTION

Purpose and Scope

Persons traveling over Arizona highways encounter an ever changing variety of scenery, geologic features, climate, vegetation, wild life, and conditions for human habitation and industry. All of these have a close relationship to the physiography and geology of the particular area. In passing through the region, the viewer of the landscape, particularly if a stranger, may want to know more about what he is seeing and what has happened. This road guide to a part of the southwestern Arizona desert is designed to answer at least some of such questions, by keying brief descriptions to points of interest in a sequential manner. The amount that a traveler can see depends largely on the speed of his transit. This guidebook is planned primarily for those who wish to take time to observe the general geologic setting and physiographic features, and to understand their effects on life in the region.

The text, illustrations, and appendices are designed to provide a thumbnail sketch of what is there and what has, and is taking place. To those who wish to know more, the selected bibliography furnishes numerous references that may be explored.

It is hoped that this guidebook will increase the enjoyment and understanding of the area by the non-scientific public as well as whet the interest of both the non-scientific and scientific visitor in the unique character and history of this desert region.

Location and Extent

The routes covered in this guidebook are shown in figure 1. State Highway 85 extends from U.S. Highway 80 at Gila Bend, Maricopa County, southward into Pima County, through Ajo, to Lukeville on the United States-Mexico border, a distance of 81 miles. The route traverses the eastern side of the hottest and driest, large, desert area in the United States. Yet the term 'desert' is deceiving. The somber, but often colorful, steep-sloped mountains, plateaus and hills; and the broad, flat, and extensive plains and valleys present ever-changing types of vegetation adapted to the local geologic, physiographic and climatic environment. A surprising amount of wild life is present although it is seldom seen in the day-light hours. Outstanding features along the route are the large open pit copper mine and metallurgical installations at Ajo and the Organ Pipe Cactus National Monument.
Figure 1. Index Map showing locations of State Highways 85, 86 and 386, and locations of geologic cross-sections A-A', B-B', C-C', and D-D'. 
<table>
<thead>
<tr>
<th>Eras</th>
<th>Periods</th>
<th>Age</th>
<th>Million Years</th>
<th>Geological Events</th>
<th>Typical Rock Types</th>
<th>Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tertiary</td>
<td>Pliocene</td>
<td>1</td>
<td></td>
<td>Erosion of mountain ranges and sedimentation in intermontane basins.</td>
<td>Alluvial sand, silt, and gravel, mostly unconsolidated.</td>
<td>Development of modern man, animals, and vegetal forms.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No definite division recognized</td>
<td>Basaltic flows, agglomerates, and tuffs.</td>
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<tr>
<td>Cenozoic</td>
<td>Miocene</td>
<td>13</td>
<td></td>
<td>Strong renewed erosion of mountain ranges and thick accumulations of continental</td>
<td>Partly consolidated sand, silt, and gravel with local clay and marl.</td>
<td>Development and spreading of a large variety of mammals, vertebrates,</td>
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<td></td>
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<td></td>
<td>alluvium in intermontane basins. Strong local volcanism, largely basaltic flows and</td>
<td>Basaltic flows, tuffs, and agglomerates.</td>
<td>invertebrates, and plant life.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>tuffs, often interbedded with sediments.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>25</td>
<td></td>
<td>Intense erosion of mountains and deposition of sediments. Widespread, periodic,</td>
<td>Local conglomerates with intercalated lava, tuff, and breccia.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>local volcanism accompanied by faulting and folding or tilting.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>36</td>
<td></td>
<td>Basin and Range orogeny. Formation of fault-block mountains accompanied by</td>
<td>Conglomerate, sandstone, and siltstone with intercalated rhyolitic to andesitic flows</td>
<td>Extinction of dinosaurs.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>tilting, folding, and some volcanism. Local erosion and sedimentation.</td>
<td>and tuffs which locally may be of considerable thickness.</td>
<td></td>
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<td></td>
<td></td>
<td>58</td>
<td></td>
<td>Relatively quiescent period.</td>
<td>No diagnostic rocks recognized.</td>
<td>First appearance of mammals and ancestors of many present forms of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>70</td>
<td></td>
<td>Laramide Revolution. Widespread igneous intrusions of batholiths, stocks and</td>
<td>Large granitic to dioritic masses, pegmatite and other dikes, quartz veins,</td>
<td>vertebrates, invertebrates and plant life.</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>dikes accompanied by uplifts, faulting, folding, volcanic extrusions, and intense</td>
<td>rhyolitic to andesitic flows and pyroclastics.</td>
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<td></td>
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<td></td>
<td></td>
<td>local metamorphism of older rocks. Most metallic mineralization associated with</td>
<td>Intensely metamorphosed schist, phyllite and gneiss.</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>this period. Locally strong erosion and sedimentation.</td>
<td>Local shale, sandstone, and conglomerate, often intercalated with volcanics.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Prior to and during initial stage of Laramide Revolution, erosion,</td>
<td>Altered and mineralized intrusive and sedimentary rocks.</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>sedimentation and volcanism.</td>
<td>Arkose and red beds, often intercalated with rhyolitic to andesitic flows, tuffs,</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>and agglomerates. Locally the volcanic rocks predominate.</td>
<td></td>
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<tr>
<td>Era</td>
<td>Timeframe</td>
<td>Description</td>
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<td>-----------------------------------------------------------------------------</td>
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<tr>
<td><strong>Primordial Earth</strong></td>
<td>2000+</td>
<td>Origin of the earth, formation of the original crustal rocks, atmosphere, oceans and continents.</td>
<td></td>
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<tr>
<td><strong>Younger Precambrian</strong></td>
<td>1400</td>
<td></td>
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<tr>
<td></td>
<td>600</td>
<td>End of long erosional period (Grand Canyon Disturbance?). Probably long period of warping, structural disturbances, marine and continental sedimentation, erosion and peneplanation.</td>
<td></td>
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<tr>
<td></td>
<td>220</td>
<td>Permian Highland area in southern Arizona. Strong erosion furnishing sediments to Colorado Plateau to the northeast. Probably some volcanism.</td>
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<tr>
<td></td>
<td>270</td>
<td>Pennsylvanian Marine sedimentation, probably in a broad sea basin without any distinct sedimentary break. Minor uplift and temporary withdrawal of seas. Surface of low relief, minor erosion.</td>
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<tr>
<td></td>
<td>320</td>
<td>Mississippian Marine sedimentation, probably in a broad sea basin. Temporary withdrawal of seas. Period of nondeposition and local erosion.</td>
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<tr>
<td></td>
<td>400</td>
<td>Devonian Relative subsidence of land and invasion of seas. Probable period of quiescence with little or no erosion or deposition, with land surface at about sea level.</td>
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<td></td>
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<tr>
<td></td>
<td>490</td>
<td>Silurian Probably sedimentation along the shore of invading seas. No diagnostic rocks recognized.</td>
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</tbody>
</table>
| |          | Cambrian  
| | 600       | Older Precambrian Mazatzal Revolution. Igneous intrusions and extrusions, strong metamorphism, faulting and folding. Long period of erosion, sedimentation, and volcanism broken by periods of orogeny or revolution. |
| | 135       | Jurassic Ancestral Mogollon Highlands formed in southern Arizona. Local intrusions, volcanism, metamorphism, faulting and other deformation have been largely obscured by later geologic events. | Granitic to quartz dioritic intrusives. Metamorphic schist, phyllite, and gneiss. |
| | 180       | Triassic Locally some red beds and volcanics. | Development of reptiles. |
| | 220       | Carboniferous Limestones and shales. Only a few scattered occurrences preserved and recognized. | Luxuriant plant life and abundant marine life. |
| | 270       | Pennsylvanian Marine sedimentation, probably not widespread but only small scattered occurrences now found. Difficult to date due to lack of diagnostic features and affects of later deformation. | Abundant sea life and plants. Development of amphibians. |
| | 400       | Devonian Relative subsidence of land and invasion of seas. Probable period of quiescence with little or no erosion or deposition, with land surface at about sea level. | No diagnostic rocks recognized. |
| | 490       | Silurian Probably sedimentation along the shore of invading seas. | Quartzites. Found in small, scattered outcrops. |
| |          | Ordovician Primordial invertebrates and plants. Earliest life forms develop. | No diagnostic rocks recognized. |
| |          | Cambrian  
| | 600       | Older Precambrian Mazatzal Revolution. Igneous intrusions and extrusions, strong metamorphism, faulting and folding. Long period of erosion, sedimentation, and volcanism broken by periods of orogeny or revolution. | Metamorphic schists and gneiss, granitic rocks. |
| | 135       | Jurassic Ancestral Mogollon Highlands formed in southern Arizona. Local intrusions, volcanism, metamorphism, faulting and other deformation have been largely obscured by later geologic events. | No diagnostic rocks recognized. |
| | 180       | Triassic Locally some red beds and volcanics. | Development of reptiles. |
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| |          | Ordovician Primordial invertebrates and plants. Earliest life forms develop. | No diagnostic rocks recognized. |
State Highway 86 extends westward from U.S. Highway 89 from south of Tucson, Pima County, through the Papago Indian Reservation, to a junction with State Highway 85 at Why, Pima County, a distance of 120 miles. This route provides a cross-section of the Sonoran Desert section of the Basin and Range physiographic province, and is characterized by isolated, rugged, and precipitous mountain ranges separated by broad, gently-sloping desert basins. The highway passes numerous Papago Indian settlements and old ranches, stage stations, and mining camps. It is a scenic route with varied geology, physiography, life forms, and history.

State Highway 386 is a short spur leaving State Highway 86 at 38 miles west of Tucson. It climbs 3580 feet in a distance of 12 miles to the top of the Quinlan Mountains, altitude about 6800 feet. In addition to the exhibits at the Kitt Peak National Observatory, located at the top, the views from the road and the top present a spectacular panorama of this part of the Basin and Range Province.

For the convenience of the traveler the road logs of these highways are arranged so that the sequential descriptions may be followed in either direction that the traveler may take.

Geologic Setting

The basic textbook on geology is the earth itself. A careful interpretation of the topography and rock formations and structures provides a history of geological events. From years of study, geologists have constructed a world-wide time scale of geologic history. Table 1 is such a time scale adapted for this part of southwestern Arizona. On this table the principal rock units or types found along the highways are briefly described. Figures 3, 4, 5, and 6 are generalized cross-sections through various parts of the area, showing the relative positions of the rock units and the structures that affect them. The location of these cross-sections is shown on figure 1 and an explanation of the symbols used on figure 2.

Brief geologic descriptions of features seen along the highways are given in the Detailed Logs, supplemented by photographs. Only small parts of the area have been covered in any detail in published geologic reports and most of the geologic mapping has resulted from reconnaissance studies. Thus, the geologic knowledge of the area is as yet incomplete.

All three basic types of rocks—igneous, sedimentary, and metamorphic—are found along these highways. They cover a time span of some two billion years, from Early Precambrian to the present. Rocks classified as Precambrian—granite, gneiss, and schist—crop out as eroded basement formations along Highway 85 near Black Gap and in the Little Ajo Mountains. Parts of other granitic, gneissic, and schistose rocks in the region also may be of Precambrian age since these ancient basement formations underlie most, if not all, the region. Paleozoic rocks—mainly quartzites, limestones, and shales—are largely missing along
the routes. Small, isolated masses and fault-slivers of such rocks are seen at Snyder Hill and on the east and west sides of the Sierra Blanca Mountains. The engulfed blocks of metamorphic gneiss found in the Coyote, Baboquivari, and Comobabi Mountains probably include Paleozoic sediments, and scattered outcrops of Devonian and Mississippian limestones have been recognized at the south end of the Growler Mountains. Paleozoic rocks undoubtedly covered much, if not all, of the area prior to subsequent periods of uplift and orogeny. Either subsequent erosion stripped them away, or metamorphism, during later periods of orogeny, changed them to unrecognizable forms.

Most of the rocks seen along the route are of Mesozoic or later age and consist of igneous, sedimentary or metamorphic types. The history of these later eras is much clearer than that of the earlier ones. Periods of orogeny and vulcanism appear to have predominated into recent time. Large masses of granite intrusives invaded parts of the area during the Laramide orogeny and thick mantles of lava, agglomerate, and tuff were laid down over wide areas in successive volcanic pulses. Strong faulting, and some folding and tilting, accompanied and followed periods of orogeny, bringing about the present complicated structure of the exposed mountain ranges.

Some exposed ranges and hills are composed essentially of volcanic rocks (Tucson, Roskruge, Ajo, Pozo Redondo, Batamote, Crater, and Saucedo Mountains); some are of granitic and metamorphic rocks with only minor volcanics (Coyote and Baboquivari Mountains); and some are complex combinations of granitic intrusives, volcanics and sedimentary rocks (Comobabi, Quijotoa, Brownell, and Little Ajo Mountains).

Starting in late Tertiary time and extending to the present, the main geologic processes have been the degradation of the rocks exposed in the mountains and volcanic fields, and the deposition of gravel, sand, and silt in the deep intermontaine basins. Some of the latter have accumulations of alluvium in excess of 2000 feet in thickness.

Physiographic Setting

The routes covered in this guidebook all lie within the Sonoran Desert section of the Basin and Range physiographic province, characterized by relatively low, narrow, and widely-spaced mountain ranges which rise abruptly from extensive, aggraded basins. The mountains make up less than one-quarter of the total area. A few isolated peaks exceed 7000 feet in elevation but the main mountain ranges in general are less than 5000 feet high. The mountain masses are strongly dissected and their present surface configuration depends largely on their composition. Granitic and metamorphic rocks produce sierra-type mountain ranges with rounded or elongated, jagged, saw-tooth crests that slope away from high points. Their flanks are normally rough, irregular and steep. The volcanic moun-
tain ranges usually exhibit even, flat crests which are cut by faults and have been eroded into a cluster of plateaus, buttes, and pinnacles. At least one of these volcanic ranges, the Batamote Mountains, contains a central volcanic vent. The faulted flanks of these mountains are steeply terraced by the differential erosion of alternating, near-horizontal layers of lava, agglomeration, and tuff. Mountains composed of mixed extrusive and intrusive rocks show irregular topographic features.

The surface of the basins are formed by extensive, coalescing bajadas (alluvial slopes) which descend gently from a sharp break in the angle of slope at the foot of the mountains to an axial drainage line in the basins. There are no enclosed basins in the area and surface and underground water, when present, flows to the Santa Cruz-Gila drainage to the north or the Sonoita River drainage in Mexico to the south. All streams in the area are ephemeral, flowing only for short periods after the occasional rains. Definite channels in the basins are often lacking, because the water spreads out over wide, flood plains and disappears rapidly into the unconsolidated alluvium, or evaporates. The basin alluvium consists of imbricated lenses of sand, silt, and clay with gravel locally near the mountains or along main drainage washes. Scattered erosional remnants of bedrock may rise out of the basins in island-like hills. All the major valleys are of structural origin, having been depressed by faulting in relation to the mountain blocks.

The main cause of degradation in this desert region is the uneven expansion and contraction within the surface rocks due to the wide range in diurnal temperatures. Relatively rapid disintegration, lack of soil or vegetal cover, and gravity are factors in maintaining steep slopes and deep, high-gradient canyons. The infrequent, normally short but intense, rains wash the debris out into the basins. Wind action has little erosional or transporting effect in this region.

Several topographic features should be noted in this area. The mountain flanks slope from $15^\circ$ to $90^\circ$, depending on the local rock type, texture, and structure. The valley slopes rarely exceed $6^\circ$. This creates the sharp break in slope between the mountains and basins. On the valley side of this break, a relatively smooth rock floor, only thinly covered, if at all, by alluvium, may extend a considerable distance out into the valley. This rock floor, called a mountain or rock pediment, has been planed by the grinding action of water heavily laden with rock debris as it rushes off the steep mountain slopes.

The most common means of transportation of rock debris in the basin areas is by sheetwash or sheetflood. These broad movements of water, heavily laden with alluvial material, may be local or regional, may reach a foot or more in depth, and can travel considerable distances. They are short-lived but can be very destructive to any obstacles in their path. Their action in cutting and filling the irregularities in the basin floor produces

8
the level, gently-sloping bajadas and explains the general lack of deeply-
cut channels.

It will be noted that much of the undisturbed basin floor is free of
fine dust and is coated by a mosaic of pebbles that protects the finer
alluvium below. This pebble coating is called desert pavement and results
when the fine surface material has been swept away by wind.

The desert washes are normally dry and the highways in many places
pass through these “dips.” Heavy local showers can change such innocent-
looking washes within minutes into raging torrents, capable of carrying
away anything in their path. Travelers should not attempt to pass through
the dips at such times. Fortunately such flooding is normally short-lived
and usually only a short wait on the higher ground is necessary before the
wash can be safely crossed.

Climate

The climate of this desert area is affected by the topography and in
turn has a marked effect on the land forms and life. In summary, it is
generally hot and dry most of the summer and cool and dry most of the
winter. There are two periods when rain may be expected. The summer
rains occur from about late June to the middle of September in the form
of scattered, afternoon or evening thunderstorms. The winter rainy season
is from mid-December to mid-February when occasional, more general
and steady, light rains occur. The warm, dry days and cool, dry nights of
Spring and Fall, with very rare precipitation, are the most favorable times

<table>
<thead>
<tr>
<th>Altitude (feet)</th>
<th>Tucson</th>
<th>Gila Bend</th>
<th>Ajo</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,410</td>
<td>737</td>
<td>1,763</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Climatic Data Along State Highways 85 and 86

<table>
<thead>
<tr>
<th></th>
<th>Tucson</th>
<th>Gila Bend</th>
<th>Ajo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average maximum temperature °F (Year)</td>
<td>82.4</td>
<td>89.5</td>
<td>84.0</td>
</tr>
<tr>
<td>(Dec., Jan., Feb.)</td>
<td>66.3</td>
<td>70.5</td>
<td>73.8</td>
</tr>
<tr>
<td>(Mar., Apr., May)</td>
<td>85.1</td>
<td>88.4</td>
<td>83.4</td>
</tr>
<tr>
<td>(June, July, Aug., Sept.)</td>
<td>97.8</td>
<td>106.5</td>
<td>100.6</td>
</tr>
<tr>
<td>(Oct., Nov.)</td>
<td>79.9</td>
<td>85.8</td>
<td>80.8</td>
</tr>
<tr>
<td>Average minimum temperature °F (Year)</td>
<td>52.4</td>
<td>54.4</td>
<td>58.3</td>
</tr>
<tr>
<td>(Dec., Jan., Feb.)</td>
<td>36.3</td>
<td>38.4</td>
<td>42.6</td>
</tr>
<tr>
<td>(Mar., Apr., May)</td>
<td>47.9</td>
<td>50.7</td>
<td>55.4</td>
</tr>
<tr>
<td>(June, July, Aug., Sept.)</td>
<td>68.1</td>
<td>73.5</td>
<td>66.2</td>
</tr>
<tr>
<td>(Oct., Nov.)</td>
<td>46.9</td>
<td>49.5</td>
<td>55.0</td>
</tr>
<tr>
<td>Highest recorded temperature °F</td>
<td>112</td>
<td>121</td>
<td>115</td>
</tr>
<tr>
<td>Lowest recorded temperature °F</td>
<td>6</td>
<td>11</td>
<td>17</td>
</tr>
<tr>
<td>Average rainfall (inches)</td>
<td>11.21</td>
<td>5.69</td>
<td>9.10</td>
</tr>
<tr>
<td>Greatest daily rainfall (inches)</td>
<td>2.98</td>
<td>2.61</td>
<td>4.15</td>
</tr>
<tr>
<td>Average number of days 0.10 inches rain or more</td>
<td>27</td>
<td>13</td>
<td>20</td>
</tr>
<tr>
<td>Average number of days 90° or above temperature</td>
<td>147</td>
<td>190</td>
<td>156</td>
</tr>
<tr>
<td>Average number of days 32° or below temperature</td>
<td>39</td>
<td>21</td>
<td>4</td>
</tr>
<tr>
<td>Average range daily maximum relative humidity</td>
<td>32-57</td>
<td>23-51</td>
<td>31-49</td>
</tr>
<tr>
<td>Average percentage of days sunshine per year</td>
<td>86</td>
<td>90</td>
<td>88</td>
</tr>
</tbody>
</table>
for visiting the region. However, the average relative humidity is almost always low, tempering the effect of any extreme temperatures. Elevation and the nearness of high mountain ranges play a role in the local temperatures and amount of rainfall. Tucson, at an altitude of 2410 feet and surrounded by mountains, has cooler temperatures and twice as much rain as Gila Bend, at 737 foot elevation and located in an open plain. At Kitt Peak in the Quinlan Mountains, elevation 6800 feet, the summer temperature seldom exceeds 90°F, the winter temperature seldom falls below 10°F, and the average annual rainfall is 17 inches.

Table 2 summarizes some climatic data for Tucson, Gila Bend, and Ajo which is typical for the area as a whole.

**Water Supply**

The availability and supply of water is of critical importance in this desert area of low rainfall, low humidity, high temperatures, and lack of flowing streams and springs. About 95 percent of the scant rainfall evaporates rapidly and is lost from use or storage. Most natural or man-made surface-water storage in charcos or behind dams is short-lived, and the depth to ground water in most areas is several hundred feet. Plants and animals have had to adapt themselves to the dry environment and the early civilizations in the region learned how to use and manage the meager surface and near-surface water supply necessary for their existence. The Papago Indians raised staple crops during the summer rainy seasons along the flat, flood plains and harvested the balance of their vegetal food from native plant life. The early European and American miners, ranchers, and settlers dug wells to reach more assured supplies and these widely scattered wells acquired the names of those who dug them — Dobbs, Bates, Walls, Menager, etc. Some of these are still the main local source of water. The importance of sources of water to early travelers throughout the Sonoran Desert area led to the initiation of a hydrological reconnaissance and guide to desert watering places by the U.S. Geological Survey in 1917. Kirk Bryan’s (1925) U.S. Geological Survey publication is a classic study of the water conditions in the Papago Reservation area that resulted from that investigation.

With increasing agriculture, industry, mining and domestic use, the available water stored in the subsurface in many local areas is being depleted faster than nature can restore it. Likewise, the quality of the available water can be seriously affected by over-withdrawal. Conservation of available water supplies is a pressing problem of immediate concern in many parts of southwestern Arizona.

**Vegetation**

The native species of vegetation along State Highways 85 and 86 are classed as Sonoran Desert varieties, sometimes subdivided into microphyll-
type, found mainly in the hot, sandy basins, and the succulent-type, found usually in the rocky and relatively more moist mountain foothills and upper bajadas. In the higher mountains, such as on Kitt Peak, varieties of trees, shrubs and plants requiring cooler temperature and more moisture are found. There is no sharp division between these plant zones but they are recognized by the relative abundance of typical vegetal types.

The microphyll zone markers are creosotebush and bur-sage which are evenly-spaced in the basin areas. Along the washes mesquite and palo verde, with an occasional ironwood and smokethorn, are commonly present. The succulent desert vegetation is especially marked by the many forms of cacti, acacia, palo verde and various shrubs. The ever-present mesquite lines the washes. The higher elevation zone is marked by yuccas, live oaks, juniper, pinon, and many other shrubs and bushes. In all zones after substantial winter rains and sometimes after summer storms, the Sonoran Desert may be carpeted with short-lived grasses and a variety of colorful flowers.

Table 3 provides a selected list, with brief descriptions, of typical types of vegetation seen along the routes. All native vegetation is protected by law and should not be disturbed or removed.

Table 3. Typical Sonoran Desert Vegetation Found Along State Highways 85, 86, and 386

I. MICROPHYLL ZONE. Occurs in the low, dry, essentially flat, alluvial basins with ephemeral washes and deep water tables. Typical plant life has developed either small, often coated leaves, or root storage systems to conserve moisture. Overlaps succulent zone along washes and on upper slopes.

A. Shrubs or bushes

1. Coville creosotebush (*Larrea tridentata*), also called greasewood and hediondilla (little stinker); Caltrop family. A shrub, 2 to 8 feet high, branches spreading from the ground. Small, smooth, pale-green, waxy leaves give off resinous, creosote-like odor when wet. Pale-yellow flowers blossom in the Spring, develop into round, white, fuzzy seed balls. Insects produce a resinous lac on the branches that is used as glue by the Indians. Bushes occur in an even, well-spaced order on all basin floors.

2. White bur-sage (*Franseria dumosa*), also called burroweed and burrobush; Sunflower family. Low, up to a few feet high, ashy, irregularly-rounded shrub resembling and related to ragweed. Small, inconspicuous, petal-less, greenish flowers bloom from April to November. Fruit is small, irregular, sharply-barbed bur. Triangle bur-sage (*Franseria deltoidea*) is similar but with somewhat more regular, triangular leaves. Both varieties commonly associated with creosotebush in desert basins, but also found in foothill areas. Pollen is a cause of hay fever.

B. Grasses and flowering plants

Seasonal grasses, such as the several varieties of gamma, and numerous small flowering plants suddenly appear in the barren desert basins, sometimes carpeting the surface for short periods, after substantial winter rains or summer showers. The seeds may lie dormant, protected under surface pebbles, for several seasons until sufficient moisture becomes available to allow sprouting and growth.

II. SUCCULENT ZONE. Predominantly on the upper bajadas, mountain foothills, and along washes where soil is more rocky, or where more moisture is available.
from seasonal rain or showers. The characteristic plant life has developed moisture storage systems and/or either shallow spreading, or deep tap roots to reach and gather in water.

A. Cactus family — Large variety of predominantly green, spiny, leafless plants storing water, often in expansible, wax-covered trunks, branches, or joints, and in a few cases in tuberous root growth.

   a. Saguaro (*Cereus giganteus*). Largest of American Cacti, up to 50 feet tall, trunk up to 2 1/2 feet in diameter, and can be up to 200 years old. Trunk may develop one or more branches. Numerous ribs covered by spine clusters along the outer edge. Green trunk and branches shrink or swell with amount of available moisture. Flower tubes near crown of trunk or branch support relatively large, waxy, white, bell-shaped flowers (Arizona State Flower). Blooming at night, in April and May, they wither by next afternoon. Green, egg-shaped fruits develop by June and burst open when ripe, revealing scarlet, fleshy interior containing small black seeds. Saguars occur throughout south-central Arizona in rocky or gravelly soil of foothills, canyons, benches, and desert washes. Fruit is edible and important to wild life and Indians. Holes bored in trunks by flickers and woodpeckers furnish nesting places for many birds. Skeleton ribs of dead saguaros are used for many purposes.
   b. Organ Pipe Cactus (*Cereus thurberi*). Large saguaro-like plant but with numerous, clustered trunks rising up to 20 feet high from a base below ground level. Flower tubes near crown produce night-blooming, delicate, waxy, pinkish-lavender, tubular flowers in the late Spring that wither the following day. Red, fleshy, spine-covered fruits (pitahaya dulce) develop in late summer and early fall. Edible fruit is relished by wild life and Indians. Restricted in the United States to a small area in western Pima County near the Mexican border, in rocky, or sandy soil in low areas having a warm to hot climate.
   c. Senita (*Cereus schottii*), also called “wiskered cactus” and “old one.” Clustered clumps like Organ Pipe Cactus, up to 21 feet high, but distinguished by fewer and more widely-spaced ribs and smaller spine clusters. Long, draping, hair-like spines near crests give it its name. Nocturnal, small, pale pink flowers near crown in May and June have unpleasant odor. Relatively small, red, fleshy fruits ripen and burst open in the fall. Range very limited in the United States, restricted to few specimens along Mexican border in southwestern Pima County.
   d. Desert night-blooming cereus (*Cereus greggii*). Slender, inconspicuous, sprawling, widely-ribbed stems with abundant clusters of small spines on ribs, rise from large turnip-like root bulb. In late May into June, elongated, upright floral tubes develop from stems, and have nocturnal, white flowers with a strong sweet odor. Flowers wither quickly. Small, red, fleshy fruit ripens in late summer and is eaten by birds who scatter the seeds. Widespread occurrence but overlooked as it grows mainly under trees and shrubs in flats and washes.

2. *Opuntia*, Cholla. Cylindrical joints sometimes from trunks, and numerous tubercles, usually with barbed spines. Flowers and fruits often grow on last year’s growth forming chains. Segmented joints easily detachable when brushed by skin or clothing. Large, varied family.
   a. Buckhorn cholla (*Opuntia acanthocarpa*, var. major). Shrub or small tree, short dark trunk with long, branching, slender, green joints having clustered, sharp, but poorly barbed spines. Petalled red, purple, or yellow flowers. Dry, tan to brown fruit. Prefers sandy soil of flats and washes. Form resembles branching antlers.
Table 3. Continued

b. Cane cholla (Opuntia spinosior). Small tree or shrub with short, often thick trunk, long branches, and numerous tubercles covered with clusters of needle-like barbed spines. Red or yellow, petalled flowers and bright, persisting, lemon-yellow, fleshy, spineless, fruits. Spines are gray to purplish-gray and short joints are in whorls at right angles to tubercles. Dead trunk and branches are hollow cylinders of wooden mesh, used for walking sticks, lamps, and decorative purposes. Widely spread in valley alluvium and on grassy hillsides.

c. Staghorn cholla (Opuntia versicolor). Branching shrub or tree with short trunk; long, straggly branches; and numerous joints covered with reddish, poorly barbed, clustered spines. Multicolored flowers and spineless, fleshy, greenish fruits sometimes tinged with red or purple. Fruits are persistent, forming short chains, over several years.

d. Jumping cholla (Opuntia fulgida). Tree-type; up to 12 feet or more high; long, branching trunk terminating in clusters of easily detachable joints that take root wherever they fall, producing large clusters and forests. Barbed spines are densely clustered. Flowers are small, pink to white. Greenish, sterile, fleshy fruit persists in long chains. Widely spread. Name and reputation due to ease of detachment of joints at slightest contact.

e. Teddy bear cholla (Opuntia bigelovii), also Arizona Jumping or Silver cholla. Small tree with long blackish trunk, short and relatively few stout branches or joints covered by straw-colored to silvery barbed spines giving tree a soft, hazy appearance. Joints readily detachable and take root wherever they fall, often forming dense stands. Small pale green to yellow flowers and small, fleshy, yellowish, sterile fruit. Favors rocky or gravelly terrain on hillsides or in desert flats. Contact to be avoided.

f. Desert Christmas Cactus (Opuntia leptocaulis), also called Tesajo. A small, irregularly branched, low-growing, slender-stemmed cholla with short joints and relatively long single spines. Greenish to yellow blossoms in late spring, small scarlet-red, olive-shaped fruits in winter. Wide-spread but often inconspicuous under protection of larger trees and shrubs.


3. Opuntia, Prickly Pears — Joints are flat pads more or less covered with single or clustered spines.

a. Purple Prickly Pear (Opuntia violacea). Sprawling, low-growing plant with short trunk, if any, and green pad-like joints tinged with reddish-purple. Relatively few, long, curving spines near upper edge of pad. Yellow flowers turning red near base. Red to purple, fleshy fruit. Several variety with or without spines.

b. Common Prickly Pear (Opuntia phacacantha). Wide variety including opuntia engelmannii. Generally large, low, sprawling plants; often forming large clumps with chains of green, pad-like joints extending outward along the ground. Usually spiny. Some varieties have long spines. Relatively large yellow flowers with reddish base. Purplish-red, fleshy fruits (tunas) are edible and used for jelly. Pads vary in shape from round to elongated (Cow tongue). Prefer sandy to rocky locations. Often eaten by wildlife and cattle. Spineless varieties used in desert landscaping.

4. Echinocereus (Hedgehog Cactus). Varieties are low growing, single, branched or clumped, elongated, often cucumber-shaped, cylindrical, ribbed plants. Clusters of spines along the ribs. Small purple to lavender, waxy flowers and red, often edible, strawberry-shaped fruits form just below the crown. Common in more rocky terrain but inconspicuous.
Table 3. Continued

5. *Mammillaria* (Pincushion and Fishhook Cactus). Low growing, single or clumped, rounded to slightly elongated, unribbed cacti. Some covered with matting of radial clusters of spines giving silvery appearance (Pincushion type). Others have larger curved and barbed, reddish spines emerging from clusters (Fishhook type). Small pink, lavender or white flowers and small, red to green, nipple-like fruits form near the crown. Widely scattered but common, particularly where protected by rocks, trees or shrubs.

6. Barrel Cactus, Ferocactus, Bismaga — Family of large, single trunk, unbranched, cylindrical to barrel-shaped, strongly ribbed cacti with clusters of spines along edge of ribs and usually a larger central, curved, pinkish and flattened, hooked spine emerging from the cluster. Very showy yellowish to bright orangy red flowers form on crown in summer. Yellow globular fruits develop in late fall and are relished by birds and rodents. Widespread in rocky and gravelly soils of foothills, canyons and alluvial slopes. Sometimes confused with young saguaros.

B. Trees and Shrubs

1. Ocotillo (*Fouquieria sprendens*); Ocotillo family. Long, whip-like, spreading, grayish-green, thorny branches up to 10 feet long, bearing leaves only for short periods after rains. Clusters of bright-red, tubular flowers form at ends of wands in April and May. Cut branches take root and are made into living fences. Dried branches used by Indians for construction of dwellings.

2. Palo Verde (*Cercis*); Pea family. Green bark trees, up to 25 feet high, with inconspicuous small, mimosa-type leaves, only after periods of rain. Foothill variety (*microphyllum*) has yellowish-green bark, is generally irregular and shrubby, and has a profusion of pale yellow flowers in April and May. It prefers the rocky foothill areas. Blue variety (*floridum*) is a larger, more evenly-branched tree with bluish-green bark, larger and longer leaves, and bright yellow blossoms in April and May. Blue palo-verdes prefer the warmer desert washes. Both varieties produce bean-like pods relished by many animals. The soft brittle wood is not a good fuel.

3. Desert Ironwood (*Olneya tesota*); Pea family. A spreading tall tree with dark, evergreen, broad, mimosa-type leaves and dark, thick trunk. Lavender and white, wisteria-like flowers bloom in May and June. Pea-shaped seed pods contain edible beans relished by wildlife. The wood is extremely hard when dry. Scattered trees present, but not common, in the warmer and frost-free desert washes.

4. Honey or Velvet Mesquite (*Prosopie juliflora*); Pea family. Shrubby to relatively tall, spreading trees with numerous thorned branches and elongated mimosa-type leaves that fold in during hot days to resist loss of moisture. Greenish-yellow, fragrant, catkin-like flowers bloom in the Spring and edible string-bean-like fruits have been important food for wildlife and Indians. Wood is aromatic and used for fuel. Dried gum-like sap can be used for glue and to make a black dye. Inner bark was used by Indians for fibre. Wide-spread along washes and sometimes on desert floor where deep root systems can tap water.

5. Acacias; Pea family. Shrubby plants with mimosa-type leaves and thorned branches. Catclaw (*Acacia greggii*), also called “tear-blanket” and “wait-a-minute” for good reason, has sharp, hooked thorns, pale yellow, catkin-like, fragrant flowers from April to October, and yellow to red, string-bean-like fruits. White thorn (*Acacia constricta*) is similar except for long, slender and straight, white thorns and yellow, puffball blossoms. Both varieties are wide-spread in desert washes and on rocky hillsides, often forming impenetrable thickets.

6. Jojoba (*Simmondsia chinensis*), also called Goatnut, Deernut, Wild-Hazel and Coffeeberry; Box family. Shrubby, plant with grayish, green, leathery, evergreen leaves, 2 to 5 feet high. Inconspicuous yellow-green flowers from
late winter through Spring. Small, acorn-like, edible nuts relished by deer and rodents. Favors alluvial fans and the mouths of canyons.


8. Desert Broom (*Baccharis sarothoides*); Sunflower family. Coarse, erect, branching, green-stemmed shrub with inconspicuous leaves. Winter blooming with small, yellowish flowers. Fruit is in form of masses of cottony seed threads that give plant a snow-covered appearance. Found along the sides of highways and in foothill areas.

9. American-Mistletoe (*Phoradendron californicum*); Mistletoe family. Conspicuous, dense, parasitic clumps in mesquite, palo verde, and ironwood trees, sometimes killing them. Small, scale-like, brownish leaves; tiny, yellowish-green blossoms in the Spring; and clusters of corral-pink berries. Spread by birds, particularly phainopeplas, which eat the fruit.

10. Tree Tobacco (*Nicotiana glanca*); Potato family. Often a tall, up to 12 feet, tree-like plant with large, smooth, green, ovate leaves and clusters of tubular, yellow flowers at the ends of the branches. Blossoms throughout the year. Favors moist locations at low elevations, and sometimes seen along the edge of highways where the road surfacing protects underlying moisture.

11. Desert willow (*Chilopsis linearis*); Bignonia family. An often inconspicuous, low-growing tree, related to the catalpa, with willow-like foliage and pinkish-lavender, tubular blossoms at the ends of the branches. Elongated, slender seed pods droop downward. Occurs scattered along desert washes, often hidden by other trees.

12. Flowers. Numerous desert flowers, often from inconspicuous plants, bloom in the early spring after good winter rains and to a lesser degree after heavy summer showers have soaked the ground. Blue lupine, purplish sand verbena, yellow Mexican goldpoppy, yellow desert sunflower, yellow desert marigold, orange desert globemallow, pink desert penstemon, and many others often line the highways, occur in extensive fields in the foothills, or on the upper bajadas, along with various grassy plants.

III. HIGHER ELEVATION ZONES. On the upper slopes of the mountain ranges and along State Highway 386, the vegetation of the Sonoran desert succulent zone gives way to species adapted to rocky terrain, more moisture, and somewhat cooler climate. Scrubby juniper, pinon, agave, yucca, scrub and live oaks, ferns, hackberry, sumac, buckthorn, mulberry, and many others cling to the rocky slopes wherever soil is available.

Wild Animal Life

Most wild life in the Sonoran Desert is nocturnal, especially in summer, but some species may be seen along the highways, particularly in the early morning or late afternoon. Almost all land animals and reptiles seek shelter in the ground or in the shade when the sun is high in order to conserve their body moisture. Some require water for their existence while others can acquire all necessary needs from the food they eat. Table 4 list the more common species of wild life that might be seen or encountered in the area.
Inhabitants

The area traversed by State Highways 85 and 86 is sparsely settled, Tucson at the eastern side of the area, is the only city; Gila Bend to the north, Lukeville to the south, and Ajo and Sells along the routes are towns and settlements where some services may be found. Trading Posts and/or service stations are located at Three Points, Quijotoa (Covered Wells), Hahak-Hotrontk (San Simon), and Why. A major portion of the

Table 4. Typical Sonoran Desert Wildlife Found Along State Highways 85, 86, and 386

<table>
<thead>
<tr>
<th>MAMMALS</th>
<th>BIRDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deer — Desert mule, Whitetail</td>
<td>Eagles — Golden</td>
</tr>
<tr>
<td>Javelina (collared peccary)</td>
<td>Hawks — Redtail, Cooper’s,</td>
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<tr>
<td>Fox — Gray, Kit</td>
<td>Sparrow, Swainson’s</td>
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<tr>
<td>Coyote</td>
<td>Vultures — Black, Turkey</td>
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<tr>
<td>Bobcat</td>
<td>Owls — Elf, Ferruginous,</td>
</tr>
<tr>
<td>Raccoon, Coati, Ringtail Cat</td>
<td>Great Horned, Screech</td>
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<tr>
<td>Skunks — Spotted, Striped,</td>
<td>Woodpeckers — Gila</td>
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<tr>
<td>Hooded, Hognose</td>
<td>Flickers — Gilded</td>
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<td></td>
<td>Roadrunner</td>
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<tr>
<td></td>
<td>Quail — Gambel’s</td>
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<td></td>
<td>Doves — White-winged,</td>
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<td></td>
<td>— Mourning, Inca</td>
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<td></td>
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<tr>
<td></td>
<td>Bats — Mexican freetail</td>
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<td></td>
<td>Thrashers — Crissal,</td>
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<td></td>
<td>Curve-bill, Bendire’s</td>
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<td></td>
<td>Cardinal</td>
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<td></td>
<td>Pyrrhuloxia</td>
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<td>Phainopepla</td>
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<td></td>
<td>Towe — Brown</td>
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<tr>
<td></td>
<td>Wrens — Cactus, Canyon, Rock</td>
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<tr>
<td></td>
<td>Sparrows — Black-throated,</td>
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<tr>
<td></td>
<td>White-crowned</td>
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<td></td>
<td>Finches — House</td>
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<td></td>
<td>Verdin</td>
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<td></td>
<td>REPTILES</td>
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<tr>
<td></td>
<td>Small Lizards — Zebra-tailed,</td>
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<tr>
<td></td>
<td>Collared, Checkered</td>
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<tr>
<td></td>
<td>Whiptail, Chuck-walla, Spiny,</td>
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<tr>
<td></td>
<td>Crested, Horned</td>
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<tr>
<td></td>
<td>Gila Monster — (Poisonous,</td>
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<td></td>
<td>(poisonous to dogs)</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>INSECTS</td>
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<tr>
<td></td>
<td>Scorpions — (Painful sting)</td>
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<tr>
<td></td>
<td>Centipede — (Painful sting)</td>
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<td>Millipede</td>
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<tr>
<td></td>
<td>Cone-nose — (Infectious bite)</td>
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<td></td>
<td>Vinegaroon</td>
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<td></td>
<td>Tarantula — (Bite only if</td>
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<td></td>
<td>aggravated)</td>
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</tbody>
</table>

NOTE: In the mountains, as at Kitt Peak, and near more permanent sources of water, other varieties of wildlife adapted to or preferring a cooler climate or a water environment may be found.
area is covered by the Papago Indian Reservation and small Indian settlements (rancherias) are scattered throughout the region. Outside the Reservation there are widely spaced ranches.

The Papago Reservation was the most recent permanent Indian reservation created in the United States, established in 1917, and enlarged subsequently to cover about 4,334 square miles. It is the second largest in the United States. The population of the reservation is about 4,400. The Tribe is governed by a tribal council under the supervision of the Bureau of Indian Affairs. The headquarters is at Sells.

The name “Papago,” meaning “bean people,” is a Piman Indian term given this branch of the Piman Tribe. In general they are a proud, intelligent, stocky, dark-skinned race with bold features. They are noted for bravery and endurance but also for friendliness and peacefulness. The Papagos developed remarkable skill as semi-nomadic agriculturists in the dry environment of the Sonoran Desert, moving back and forth from winter rancherias in the mountain foothills, where some water was available from springs, seeps and shallow wells, to summer rancherias in the flood plains, where summer rains made possible the raising of corn, beans, and other staple crops. Mesquite beans, cactus fruit, small game, and occasionally larger mountain animals supplemented the staple foods. Trips to the Gulf of California for salt and trade with the related Pima Indians in the Gila River Valley for other necessities fulfilled their needs. Until the coming of the Europeans and Americans, there were no domestic animals or beasts of burden to help in their semi-annual migrations, travels or farming. At best, life was precarious both from the uncertainties of food and water and from raids by hostile Indians.

Early Spanish explorers crossed or skirted the present reservation area, which at that time was called Papagueria or Pimeria Alta — extending northward from Sonora, Mexico to the Gila River and westward from the San Pedro River to the Colorado River and the Gulf of California. The first European to establish permanent contact and report on the Papagos was Father Eusebio Kino in 1691. Father Kino brought in horses, cattle, sheep, goats, and fowl for the Indian settlements, and thus initiated a change in the life of these inhabitants. Today ranching plays an important role for the Papagos. These people are also skilled artesans, particularly in basket weaving. Many have adapted themselves to modern living habits.

Visitors to the Indian settlements are generally welcome, but the Papagos naturally expect that their property and right to privacy should be respected.

**Industries**

For the region as a whole, ranching is the main industry, and relatively small scale farming is of secondary importance. The only active mining at present is connected with or tributary to the copper mining and
metallurgical operations at Ajo. Tourist travel over these highways has been increasing, using State Highways 85 and 86 as an alternative route between Tucson and Gila Bend and as access to the Organ Pipe Cactus National Monument, the Kitt Peak National Observatory, and to the beaches at Rocky Point in Mexico.

Acknowledgements

Grateful appreciation is extended to the staff members of the Arizona Bureau of Mines for their assistance, review, and suggestions and especially to Mr. Joseph LaVoie for his production of the maps, sections, and photographs.

Suggestions for using this Guidebook

It is helpful if the user reads the introduction, reviews the figures, tables and appendices, and familiarizes himself with the Detailed Logs prior to setting out on the trip along the highways. In this manner he can pick out the points of greatest interest and schedule his trip in relation to the time available.

At a starting point it is desirable to note the mileage on the odometer, preferably on a whole mile. Odometer readings on vehicles vary and a correction factor may be necessary. By use of the Highway Mileage Markers and the mileage given in the Detailed Logs over a distance of ten miles or more, the necessary correction factor can be calculated. Set features such as road junctions, bridges and cattle guards also help in tying in the descriptions in the Detailed Logs with the mileage.
This log, although recorded in a north to south direction, that is, from Gila Bend to the United States-Mexico boundary at Lukeville, is designed to be used equally as well from South to North.

Mileage for the southbound trip is given in the left hand margin as a cumulative mileage from the point of beginning to the point being discussed (Total). The Mileage Interval between each point of discussion is recorded in the center of the page.

Cumulative mileage for the north bound trip is tabulated in the right hand margin, starting at the end of the log and reading upward.

<table>
<thead>
<tr>
<th>MILES SOUTHWARD</th>
<th>MILEAGE INTERVALS</th>
<th>MILES NORTHWARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>0.0</td>
<td>80.5</td>
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0.0
North end of State Highway 85 which joins the north side of U.S. Highway 80 one mile west of the center of Gila Bend, Maricopa County. Elevation 722 feet.

0.3
The road curves to the south and passes under U.S. Highway 80 and the Southern Pacific Railway line.

0.4
Bridge over Gila Bend Canal. This irrigation canal was designed to convey water from the Gillespie Dam on the Gila River, to the north of Gila Bend, to farming areas in the valley to the west. Since water storage behind the dam is usually inadequate, water is pumped directly into the canal from about 50 wells along its route.

This basin area is called the Gila Bend Plains, bordered by the Gila Bend Mountains to the north, the Sand Tank Mountains to the east, the Painted Rock Mountains to the west and the Sauceda Mountains to the south. Stream flow in the Gila River and tributaries in this region is for the most part ephemeral, flowing only after rare periods of heavy precipitation. The depth to ground water in the plains increases southward from Gila Bend, from about 150 to 300 or more feet, and is being lowered by heavy ground-water withdrawals. The depth to bedrock under the alluvium is estimated at up to 2,000 feet.
Figure 2. Explanation of geologic symbols used on geologic cross-sections.
Highway Mileage Marker 1, denoting the distance from the junction of State Highway 85 with U.S. Highway 80. These markers are useful checks on specific positions discussed in the log but the accuracy of their placement is sometimes questionable due to more recent realignment of the road.

Old Highway 85 into Gila Bend leaves the new route on the east side. The Tucson, Cornelia, and Gila Bend Railroad lies just east of the road for most of the way between Gila Bend and Ajo. This road intersection also marks the northern boundary of the Luke Air Force Range, a military reservation used for practice air bombing and gunnery. Except for designated highways, such as Highway 85, the range is not open to the public.

Junction with the road east to the Gila Bend Auxiliary Airfield of the U.S. Air Force.

Bridge over Quilotosa (Quiotosa) Wash, one of the main washes draining to the Gila River from the long valley between the Sand Tank and Sauceda Mountains. The incised stream bed indicates that the plain is being slightly dissected in this area. Note the vegetation along the washes where more moisture is retained from occasional stream flow.

Highway Mileage Marker 5. This marker was placed before the new shorter road into Gila Bend was constructed, thus the discrepancy in mileage.

Bridge over Sauceda Wash.

Rest area on the west side of the highway. An extensive, slightly northwest-sloping bajada (alluvial plain) extends outward from the Sand Tank Mountains in the distant east and the Sauceda Mountains to the south. The typical desert vegetation consists mainly of evenly-spaced creosote bush on the bajada and lines of palo verde and mesquite trees along the intermittent stream washes.

The Sand Tank Mountains are a broad, geologically complex, range of flat-topped plateaus formed on thick, faulted, and partly tilted Tertiary volcanics. The volcanics rest on an old erosion surface cut on Precambrian granite, gneiss, and schist. The small sharp-pointed peak near the center of the mountain chain is Jack-in-the-Pulpit.

The Sauceda Mountains to the south are a northwest-trending range sculptured out of dark-colored, Cretaceous, basaltic andesite
flows, tuffs, and agglomerates. The Spanish name “Sauceda” means “little willows” which reportedly grow along washes in the mountains. Looking southwest, toward the northwest end of the range, a light colored exposure of Precambrian schist and granitic rocks can be seen, giving these erosional remnants the name “White Hills.”

1.0 Blindman Butte and the adjacent, smaller hill on the east side of the highway are erosional remnants of nearly horizontal Quaternary basaltic flows that once covered a much larger area.

2.7 To the west, the rugged, sierra-type White Hills of Precambrian schist and granite rise abruptly from the desert floor. These hills are remnant high points in the eroded basement rocks that were later covered by Quaternary volcanic rocks of basaltic composition. The latter have been largely stripped away by subsequent erosion. Precambrian schist also is exposed in the low rolling terrain east of the road (figure 3, Section A-A’).

The high peak to the east is typical of many of the volcanic mountains in the area. It was once mantled with thick volcanic talus which subsequently was eroded by deep gullies and embayments, producing jagged collars of triangular, talus remnants on the slopes (Plate 1).

Plate 1. Mountain peak composed of Quaternary basaltic flows, at north end of Sauceda Mountains to the east of Black Gap. Note the collar of triangular talus remnants resulting from the erosion of a thick talus mantle. Light colored rock and alluvium in foreground marks basement Precambrian schist.
Black Gap, a low divide in the northwest extension of the Sauceda Mountains, was so named because of the bordering black buttes. Elevation 1,045 feet. The steep, rounded buttes to east and west of the highway are composed of Quaternary basaltic lava beds that have weathered to a black, blocky talus on the surface (Plate 2; Figure 3, Section A-A'). Note that the saguaros favor the rocky slopes in preference to the alluvial flats.

Highway Mileage Marker 20. The highway skirts a western prong of the Sauceda Mountains which are composed of banded Cretaceous volcanic flows, tuffs, and agglomerates of varying thicknesses and horizontal extent. These volcanics have been gently folded along a northwest striking anticline. From the highway, the crest of the range appears to be a plateau, rising southward to Hat Mountain, a 2,716 foot high, flat-topped mesa encircled by steep cliffs. Hat Mountain has been a prominent landmark for travelers in this region.

In the flat area to the west there is a U.S. Air Force practice bombing and gunnery range. Low flying planes often skim over the highway. Beyond the range the hills are part of a north-trending prong of the Crater Mountains, showing patches of lighter-colored Precambrian granitic basement rocks in contrast to the overlying, dark brown to black, Tertiary, basaltic andesite volcanics farther south (Figure 3, Section A-A').

The Sauceda Mountains to the east exhibit the apparent plateau-like crests with Hat Mountain, and farther to the southeast, Tom
Thumb, standing out as erosional buttes cut into the slightly dipping, thick Cretaceous and Tertiary volcanic sequence.

To the west are the Crater Mountains carved out of nearly horizontal basaltic andesite flows and tuffs of Tertiary age. This range is deeply and intricately dissected by erosion.

The valley between these mountain ranges has a relatively thin alluvial cover as shown in the well at Midway, in the center along the railroad, which encountered volcanics at 615 feet below the surface. The valley probably has formed along a downthrown fault block.

**Bridge over Midway Wash, one of the main intermittent drainage channels of the local basin.** The railway line veers to the southeast to pass through Deadman Gap, so named because a prospector reportedly died of thirst on one of the bordering hills.

**Bridge over wash at north edge of the “Crater.”** The Crater range received its name from the crater-like appearance of a circular erosional basin bounded by cliff-like walls and containing isolated pillars. It has been cut out of nearly horizontal Tertiary basaltic andesite flows and tuffs (Plate 3).

**Highway Mileage Marker 30.** This south entrance to the “Crater” has an elevation of 1,280 feet. To the west is Childs Valley, named for a prominent ranching family that moved into the area in the late 1800’s. A well located near the center of the valley encountered water in the alluvium at 460 feet below the surface and was used for water-

![Plate 3](image)
Plate 4. Looking east at the Batamote Mountains surmounted by the eroded Tertiary basaltic volcanic cone, one of the sources of the widespread volcanics of this area.

ing cattle until about 1919, when overgrazing denuded the available forage.

2.9

32.7 Bridge over Rio Cornez Wash, the main drainage to the northwest from the northern part of the Valley of the Ajo and from Childs Valley.

0.1

32.8 Border between Maricopa County to the north and Pima County to the south. The line of the Tucson, Cornelia, and Gila Bend Railroad veers to the northeast through Deadman Gap. The highway passes the western end of the Batamote Mountains which show a thick series of slightly dipping late Tertiary to early Quaternary basaltic volcanic beds.

1.0

33.8 The site of the Childs Ranch is to the east in the Rio Cornez Wash. Here the Batamote Well, named after a local, dense, green bush, encountered water at a relatively shallow depth in the veneer of alluvium covering volcanic bedrock. The well was an important watering place for travelers in earlier days.

1.3

35.1 Airport Road, to the east, leads to the Ajo Airport, the small settlement of Childs, and the shaft wells and pumping plant supplying the needs of the New Cornelia mining and metallurgical operations and the community at Ajo.

The Batamote Mountains to the east were a center of Tertiary-Quaternary volcanic activity. The dissected plateau of basaltic lavas and tuffs is surmounted by an eroded volcanic cone with a central intrusive plug. The original gentle slope of the volcanic beds has been modified by later warping, faulting, and erosion (Plate 4).
1.2  The road west leads to the facilities of the U.S. Air Force Ajo Station, part of which can be seen along the top of Childs Mountain. The latter is an eroded, asymmetrical, faulted and tilted ridge of Tertiary-Quaternary basaltic flows and tuffs. The western ridge rises abruptly some 2,000 feet above the valley floor. The broad prong extending northeastward forms a dissected plateau. The highway is passing over a gentle, north-sloping bajada extending out from the Little Ajo Mountains.

36.3  Southern boundary of the Luke Air Force Range, a military reservation in which public travel is restricted to the main highways and roads.

37.3  Bridge over a wash draining northward from the Little Ajo Mountains.

37.4  Northern edge of the city of Ajo.

38.4  The old site of Gibson, now a suburb of Ajo, is to the west.

40.7  Main Plaza of Ajo, an unincorporated city of about 7,000 inhabitants and the location of the open pit copper mine and metallurgical works of the New Cornelia Division of the Phelps Dodge Corporation. Elevation 1,750 feet. The name of the city may have originated from the Papago words “au auho” meaning paint since the Indians reportedly used the red iron-oxide over the copper deposit as a decorative paint, or it may have acquired the name from the Spanish word “ajo” meaning garlic since the ajo lily, having an edible onion-like root bulb, grows in the area.

The original settlement of Ajo was located on the site of the present open pit mine. Largely destroyed by fire in the early 1910’s, when the New Cornelia Company was planning the pit operations, the company built a new town at the present site, which it proposed to call Cornelia. The latter name was not accepted and the older name “Ajo” persisted. However, objections to a company-controlled town led to the establishment of the privately owned settlements of Clarkstown (or Clarkston) to the east, and Gibson to the north. In these locations the house lots were rented and each of these settlements established independent water supplies from local wells or shafts. In 1917, the inhabitants of Clarkstown tried unsuccessfully to change the name to Woodrow after President Woodrow Wilson and eventually the Post Office in Clarkstown bore the name “Rowood,” an inversion of Woodrow. That name subsequently was often used for the settle-
Figure 4. Generalized geologic cross-section B-B'.

- LITTLE AJO MOUNTAINS
- VALLEY OF THE AJO
- GROWLER MOUNTAINS
- SAUCEDA MOUNTAINS
- BATAMOTE MOUNTAINS
- SIKORT CHUAP MOUNTAINS
- VALLEY OF THE AJO
ment. More recently a destructive fire and the encroachment of tailings ponds and waste dumps led to the abandonment of Clarkstown as a townsit. Gibson has survived and is now a northern suburb of Ajo.

The city lies on the eastern edge of the Little Ajo Mountains, a maturely dissected and geologically complex mountain mass formed from tilted fault blocks of Precambrian gneiss, Mesozoic intrusive rocks, Cretaceous volcanics and Laramide intrusives (Figure 4, Section B-B'). This complex was eroded and later largely covered by alluvial conglomerate and andesite breccia, flows, and tuffs. Subsequent erosion has produced the present rough topography. The copper orebody occurs mainly in the mineralized apex of a prong of Laramide quartz monzonite which intruded the earlier rocks. The mineralized area is roughly oval, with an elongated northward dimension of 1¼ miles and a width of ¾ of a mile. Disseminated bornite and chalcocopyrite are the primary copper minerals but the deposit was oxidized and enriched by weathering to a considerable depth. The upper part, and first ore mined, contained chalcocite, malachite, and chrysocolla.

There is evidence that early Spanish prospectors tried to mine high grade native copper from the deposit as early as 1750. American interests did not try to mine the deposit until after the Gadsden Purchase of 1852 made the area a part of the United States. Early production consisted of a few high grade ore shipments in the 1850’s, which were hauled by pack animals and teams to either Yuma, Arizona, or San Diego, California, for transport in sailing vessels to Swansea, in Wales, England, for smelting. Prior to 1911, numerous unsuccessful attempts to exploit the deposit were made. Difficulties with high transportation costs, lack of water, and unsound and sometimes fraudulent metallurgical schemes brought about repeated failures. Except for the brief periods during these activities the population of Ajo seldom exceeded 50 inhabitants.

In 1911, a favorable preliminary examination by the prominent geologist Ira Joralemon, aroused the interest of John C. Greenway, manager of The Calumet and Arizona Mining Company. This company acquired rights to a large part of the orebody and carried out a thorough exploration program and study of the deposit. Several million tons of copper ore were outlined by drilling, ample water was found in shaft wells sunk 7 miles north of Ajo at Childs, and an economical and practical leaching process for extracting the copper from the oxidized carbonate ore was developed. The transportation problem was solved by building a railroad line to Gila Bend. As a result, the New Cornelia Company started open pit mining and leaching of the ore in 1917; it was the first such operation in Arizona and the second in southwestern United States. Adjoining properties were acquired and the company become the single operator on the orebody. The car-
Plate 5. The open pit copper mine of the New Cornelia Division of the Phelps Dodge Corporation at Ajo, looking south from the visitor's viewpoint. The central part of the pit is in mineralized, light-colored quartz-monzonite and quartz-diorite, the east and west walls in poorly mineralized Cretaceous rhyolite, and the south wall in darker, post-mineralized Tertiary conglomerate. The high peak to the south is Black Mountain, carved out of nearly horizontal basaltic flows of Tertiary age.
Plate 6. The New Cornelia Division metallurgical installations at Ajo, looking southeast from the road to the visitor's viewpoint. The flotation mill is to the right and the smelter, with tall stacks, is in the center.
bonate ore was mined out by 1930, but a flotation concentrator, originally built in 1924, was enlarged to permit continued operations on the deeper sulfide ore. The New Cornelia Company was acquired and made a division of the Phelps Dodge Corporation in 1931 and the present smelter was completed in 1950.

Production from Ajo has risen to over 15 million tons of ore per year with an average grade of about 0.7% copper (a content of 14 pounds of copper to one ton of ore). Nearly as much waste rock as ore has been removed. To date, over 337 million tons of ore containing more than 2.6 million pounds of copper (plus substantial amounts of by-product gold and silver) and some 374 million tons of waste have been mined from the pit, the bottom of which is now over 850 feet below the original surface.

Signs direct visitors to a viewpoint at the north end of the pit where the mining operation is described and can be observed (Plate 5).

42.2 Highway crosses railway tracks.
42.3 Well Road, branching to the north, leads to Childs, the Ajo Airport, and the shaft wells and pumping station supplying the water needs of the New Cornelia Division and the city of Ajo.
42.4 Road crosses tracks to slag dump where the melted waste from the smelter operation is discarded.

To the southwest are the metallurgical installations of the New Cornelia Division of the Phelps Dodge Corporation. The smelter and high stack are in the foreground and the flotation concentrator behind them on the slope of Concentrator Hill (Plate 6).

To the east are the tailings ponds where the discarded, finely ground waste is deposited. The copper minerals have been separated out by flotation in cells containing reagents that attach themselves selectively to the sulfide particles and make them float.

42.7 Road passes under pipe line conveying the tailings from the New Cornelia concentrator to the tailings ponds.
43.1 The remains of Clarkstown (Rowood) in a narrow pass between the tailings ponds to the north and the waste rock dumps to the south.
44.6 Darby Well Road, leading west from the highway, was an old, hazardous route to Yuma by way of Bates Well, in Growler Pass, and was also the older route to Sonoita, in Mexico, to the south. Darby Well, about 2 miles out on this road, was a source of water sold by vendors to the residents of Ajo in the early 1900's.
0.1 Bridge across Darby Arroyo which drains a large central part of the Little Ajo Mountains.

0.3 Highway Mileage Marker 45. Around the southern edge of the waste dumps, Ajo Peak and North Ajo Peak can be seen as tall separate spires at the southern edge of the Little Ajo Mountains. The somewhat lower Pinnacle Peak and behind it the more massive Cardigan Peak, the highest and largest of the group, are more to the north. The first three are carved by erosion out of tilted volcanic rocks and the last mainly from Laramide intrusive (Figure 4, Section B-B').

2.6 Bridge over Rio Cornez, the ephemeral stream draining the northern part of the Valley of the Ajo. Elevation 1,626 feet. A few miles south of here is the drainage divide between the north to northwest trending Rio Cornez and the westward draining Cuerda de Lena. (Spanish for “cord of wood”). The Valley of the Ajo is a structural valley bounded by fault block mountains and filled to an unknown depth by alluvium surfaced by dissected, coalescing bajadas which slope gently outward from a sharp break at the base of the steep mountain walls.

To the west of the highway is Black Mountain, an erosional remnant ridge of the Quaternary-Tertiary basaltic volcanics that once covered a more extensive area. The terraced, horizontal banding is due to the difference in erosional resistance between flows and tuffs and the brown-black color tinged with red is typical of the oxidized and weathered surfaces of such volcanic exposures.

To the east of the highway are the Pozo Redondo Mountains, composed of Tertiary basaltic and andesitic lavas and tuffs that have been faulted and tilted westward into a series of north-south, elongated blocks. Erosion has carved the blocks into a broken collection of steep walled mesas and plateaus of varying elevations.

3.9 Cattle guard.

1.4 Junction with the west end of State Highway 86 at Why. The shape of this intersection gave the small settlement its name but it also has been commonly known as Rocky Point Junction since the highway south through Sonoita, Mexico, leads to Puerto Penasco or Rocky Point, a popular beach and fishing area on the Gulf of California.

0.3 Cut-off road from Highway 86 curves in from the east.
Plate 7. Picnic area at mileage marker 55 along the south edge of Gunsight Wash. Note the fine specimen of a blue palo verde tree.

1.8

55.0 Bridge over Gunsight Wash. On the south side of the bridge, on both sides of the road, are picnic areas. Highway Mileage Marker 55 is also at the south side of the bridge. Note the large blue palo verde trees along the wash and at the picnic areas (Plate 7).

1.8

56.8 Highway skirts the northwestern edge of a long, narrow, irregular ridge of banded Tertiary andesite flows and tuffs, capped by Quaternary-Tertiary basalt. Erosion of the horizontal volcanics has produced a plateau-appearing top and steep walls. The predominant vegetation on the westward-sloping bajada is the evenly-spaced creosote bush. Saguaro and other cacti and desert flora prefer the more rocky slopes.

1.0

57.8 North boundary of the Organ Pipe Cactus National Monument.

1.9

59.7 Highway crosses the braided channels of Kuakatch Wash which joins Cuerda de Lena on the far western side of the Valley of the Ajo. To the west, in the distance, is a low divide, Growler Pass, between the Growler Mountains to the north and Bates Mountains to the south. The Growler Mountains are an extended, rugged range composed of eastward dipping, faulted, basaltic flows and tuffs of Quaternary-Tertiary age. At the southeastern end, however, the broken hills near the divide expose basement Precambrian gneiss; Paleozoic quartzites, sandstones, shales, and limestone; and Mesozoic granitic rocks. Some
mineralization occurs in these formations but mining generally has been unsuccessful. Bates Well near the pass has been a ranch area for many years and was one of the few watering places for travelers passing westward to Yuma by this inhospitable southern route.

Bates Mountains, capped by 3,197-foot Kino Peak, named after Father Kino, the noted Jesuit missionary and explorer of the late 1700’s, consist of deeply and intricately eroded, layered, Quaternary-Tertiary basaltic volcanics that are faulted and tilted.

Bridge over wash. The dirt tracks going southeast lead to a small isolated hill of weakly mineralized Laramide granitic rock rising out of the alluvial slope. It was prospected for copper prior to 1920 and is known as the Copper Mountain mine.

The high rugged mountains to the east are the north end of the Ajo Range and the isolated peak, shaped like a square-shouldered bottle, is Montezumas Head, elevation 3,634 feet. This range with numerous high peaks and deeply incised canyons is made up of Tertiary rhyolite and andesite lava flows and tuffs, at least 2,000 feet thick. They have been faulted and tilted to the northeast (Plates 8 and 9).

Highway passes through a divide, at an elevation just under 2,000 feet, in a series of northwest extending hills composed of Tertiary, rhyolitic, welded tuff and agglomerate.

Plate 8. North end of the Ajo Mountains, looking east, with Montezuma’s Head eroded out of Tertiary rhyolite capping Tertiary andesite.
Figure 5. Generalized geologic cross-section C-C'.
Plate 9. Looking east at the Ajo Mountains. Note the plateau-like top and terraced walls due to the differential erosion of alternating layers of Tertiary rhyolite capping basaltic andesite flows and tuffs.

4.3

Highway Mileage Marker 70. The narrow, steep-walled ridge to the east, capped at the south end by Tillotson Peak, with an elevation of 3,374 feet, is composed of bedded Tertiary rhyolitic and andesitic volcanic rocks. Mt. Ajo, elevation 4,808 feet and the highest peak in the area, caps the Ajo Range behind Tillotson Peak (Figure 5, Section C-C').

The Puerto Blanco Mountains, with 3,145 foot Pinkley Peak at the eastern end, are to the west and southwest. These mountains are a fault block range trending northwest and west and have a geologically complex composition of Tertiary lavas and tuffs, ranging from rhyolite and latite to andesite, that rest on Mesozoic intrusive and metamorphic rocks. The contrast between the light-colored rhyolite and Mesozoic rocks and the dark-colored andesite is well displayed on the steep northeast slope.

2.0

Highway Mileage Marker 72. The road cuts in this hilly area are in glassy, spherulitic and porphyritic volcanic rocks, ranging from rhyolite to latite, and from flows and tuffs to agglomerates, in an apparent gradational series.

The vegetation has changed from the creosote bush cover of the alluvial plains to a large variety of cacti, palo verde, ironwood, and other flora favoring the more rocky terrain. Occasional organ pipe cacti can be spotted from the highway.
To the west, the Twin Peaks area, at the eastern end of the Puerto Blanco Mountains, displays the eastward dipping dark porphyritic lava flows capping the light grayish Mesozoic metamorphic and intrusive rocks, particularly in the ridge extending southeastward.

Highway Mileage Marker 75. Northern entrance to the headquarters and visitors center of the Organ Pipe Cactus Monument.

This national monument, covering 516 square miles, was established in 1937 in order to protect and preserve the rare organ pipe cacti, and many other desert plants, animals and natural features of the Sonoran Desert area, some of which are not found elsewhere in the United States. At the visitors center there are exhibits and literature pertaining to the area and illustrated talks are given in the evenings during winter months. Scenic drives over graded dirt roads wind through the Monument to the east and west with picnic areas and marked points of interest along the way. A campground and picnic area is located a short distance south of the headquarters but no food or lodging is available within the Monument grounds.

The elevation at the headquarters is about 1,680 feet. During the late Autumn, Winter, and early Spring, the days are generally sunny.

Plate 10. Organ pipe, saguaro, cholla and other small cacti with ocotillo, palo verde and bur-sage in Organ Pipe Cactus National Monument.
Plate 11. Looking east at the south end of the Ajo Mountains showing differential erosion of volcanic flows and tuffs cut by dikes. Diaz Spire and Peak are to the right.
and warm, the nights cool to chilly, and there may be an occasional light rain in December through January. Summer days are very hot and nights warm with the chance of violent thunderstorms in the late afternoon or evening. Late Autumn or early Spring are the most favorable times for visits to this unique and interesting area (Plate 10).

South entrance to the Organ Pipe Cactus National Monument headquarters area and the north entrance to the Puerto Blanco Drive, a 51 mile trip through the western section of the Monument.

The road to the east is the Ajo Mountain Drive, a 21 mile trip over a one-way road along the foot of the Ajo Mountains.

The steep-walled and rugged Ajo Range, with 3,892-foot Diaz Spire and 4,024-foot Diaz Peak along its crest, provide the eastern backdrop. They are named after Melchoir Diaz, a Spanish Captain under Coronado who is believed to have passed through this area in 1540 on his way to the Gulf of Lower California. The terraced walls of the range are due to the varying erosional resistance between different volcanic beds and the irregular, sinuous ridges crosscutting the beds are andesite dikes (Plate 11).

To the west are the Sonoyta Mountains, a comparatively low, sierra-type range cut in Mesozoic metamorphic and igneous rocks. This north-south range forms a link between the Puerto Blanco Mountains and the Cuababi Mountains to the south in Mexico.

The broad, dissected, alluvial valley, called Sonoyta Valley, is to the east, extending southward to the Sonoita River in Mexico.

The south entrance to Puerto Blanco Drive is to the west.

Cattle guard at the southern border of the Organ Pipe Cactus National Monument. Rest area on east side of the highway.

Highway Mileage Marker 80. Entering Lukeville, named after a former owner, and also called Gringo Pass by the local inhabitants. Elevation 1,388 feet.

United States-Mexico International Boundary and southern end of Highway 85. U.S. Customs and Immigration Offices are on the border. The Mexican town of Sonoita is 2 miles beyond at the junction of Mexican National Routes 2, along the border, and 8 to Puerto Penasco, 64 miles farther south.
DETAILED LOG
Arizona Highway 86

This log, although recorded in an east to west direction, that is, from Tucson to Why, is designed to be used equally well from Why to Tucson. Mileage for the westbound trip is given in the left hand margin as a cumulative mileage from the point of beginning to the point being discussed (Total). The Mileage Interval between each point of discussion is recorded in the center of the page.

Cumulative mileage for the eastbound trip is tabulated in the right hand margin, starting at the end of the log and reading upward.

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<th>MILES WESTWARD</th>
<th>MILEAGE INTERVALS</th>
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<tbody>
<tr>
<td>Total</td>
<td>0.0</td>
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<td>0.0</td>
<td>East end of State Highway 86 (Ajo Way) at Junction with 6th Avenue (U.S. Highway 89-State Highway 93, Tucson to Nogales). Elevation 2,460 feet.</td>
<td>119.2</td>
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<td>0.6</td>
<td>Cross 12th Avenue.</td>
<td>118.6</td>
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<tr>
<td>0.4</td>
<td>Overpass across U.S. Interstate Highway 19 (Tucson-Nogales). To the north, Sentinel Peak (“A” Mountain) and Tumamoc Hill stand out as eastern erosional outliers of the Tucson Mountains. They form a faulted and slightly tilted block of rhyolitic agglomerate, tuff, and ash flows capped by basaltic andesite, all of Tertiary age (Figure 6, Section D-D’). Sentinel Peak was used by the Papago Indians and early settlers as a look-out point for hostile Indian raids. Tumamoc is a Papago name for “horned toad” and the hill was the site of the Carnegie Desert Botanical Laboratory in the early 1900’s. The buildings now are used by the Department of Geochronology of the University of Arizona.</td>
<td>118.2</td>
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<td>1.3</td>
<td>Bridge over Santa Cruz River. This ephemeral stream heads in southern Arizona and drains the Santa Cruz Valley northward through</td>
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Tucson to the Gila River Valley. Near Tucson the Santa Cruz Valley is a relatively flat, undissected flood plain covered by several hundred feet of unconsolidated alluvium which in turn rests on up to 2,000 feet of moderately consolidated alluvium consisting of lenses of sand, gravel, silt, and clay. There is strong evidence that the valley in the Tucson area is a downthrown fault block with the fault on the western side buried under the alluvium.

Historical records show that the Santa Cruz River was a permanent stream meandering on the surface as far north as Tucson as late as the early 1900's and that the ground water level was close enough to the surface of the plain to support a good grass cover and large stands of mesquite and cottonwood. Since that time the increased pumping from wells in the valley for irrigation, and for domestic and industrial use in Tucson have lowered the average groundwater level several hundred feet. The lowering of the water table has resulted in the loss of much of the original vegetation and the incision of the channel into the alluvium. The Santa Cruz River now flows only after occasional and seasonal heavy rains.

Cross Mission Road. To the north, Mission Road passes around the eastern foot of Sentinel Peak. To the south, Mission Road leads to the San Xavier del Bac Mission and to the open pit copper mines farther south. The Mission was originally founded in the early 1700's by the celebrated Jesuit missionary and explorer, Father Kino, who was the first European to extensively travel through the area covered by Highway 86.

Local headquarters of the U.S. Border Patrol.

Highway Mileage Marker 170. These markers indicate the road distance from Gila Bend and serve as useful orientation points along the logged route. Due to changes in the road location they may not always reflect the correct distance.

The surface cuts and dumps to the north result from an old clay quarry and, more recently, from the extraction of aggregate for road building. The hilly ridge to the south is composed largely of welded and unwelded, pyroclastic quartz-latite tuff (Cat Mountain Rhyolite). Some of this light-gray rock was quarried for building stone.

Road cuts are in Cat Mountain Rhyolite of Cretaceous age, dated radiometrically as about 68 million years old. This formation is the bottom member of a thick volcanic series capping a large part of the Tucson Mountains.
Robles Pass. Elevation 2,654 feet. This pass, through the southern part of the Tucson Mountains, was named after Bernard Robles who, around 1884, ran stage lines from Tucson to the booming mining camps at Quijotoa and Gunsight.

The main mass of the Tucson Mountains extends northwest for about 16.5 miles and is a block-faulted and uplifted range composed of a structurally complex, thick sequence of sedimentary, volcanic and intrusive rocks ranging from Paleozoic through Tertiary in age. The steep-sided, 3,854-foot peak to the north is Cat Mountain which lends its name to the pyroclastics of which it is composed.

To the west, from this pass, the traveler overlooks the Altar and Avra Valleys, extending from south to north, respectively. These valleys form a wide trough or basin between the bordering mountain ranges. On the east side, southward from the Tucson Mountains, are the Black Hills and Black Mountain, composed of basaltic rocks; and the Sierrita Mountains, a large circular mass of Laramide granitic rock that intrudes older intrusive, sedimentary, and metamorphic formations and in turn is intruded and partly covered by later rocks. A broad pediment and bajada (alluvial slope) extends outward into the basin area from this sierra-type range (Plate 12). On the western side, to the south, is the long, steep-walled, serrated ridge of the Baboquivari Mountains with the blocky tower of Baboquivari Peak near the center. At the north end of this range are the Quinlan Mountains, at the top of

Plate 12. Altar Valley, looking south from the rock quarry on Snyder Hill. An even, gently sloping pediment extends outward from the Sierrita Mountains on the left. The Baboquivari Mountains, with Baboquivari Peak, border the valley on the right. The vegetation is mainly creosote bush.
which are the white astronomical observatory installations at Kitt Peak. In front of the Quinlan Mountains are the Coyote Mountains. The ranges farther north, in sequence, are the Roskruge, Waterman, and Silver Bell Mountains. Altar Valley, in the southern part of the basin, is largely undeveloped and contains only scattered ranches. The northern part of Avra Valley is extensively developed by irrigated cotton farms.

To the east from the pass there is a restricted view of the Santa Cruz Valley and the Rincon Mountains.

The vegetation in the pass is typical of the succulent desert zone found in the higher, rocky areas of the Sonoran Desert. Saguaro, palo verde, acacia, cholla, and other small cacti and shrubs predominate.

The small hills and rocky slopes to the south are composed largely of Cat Mountain Rhyolite and Cretaceous and Tertiary volcanics and agglomerates that have been faulted and tilted. Saginaw Hill, the largest and most westerly hill, exposes a Tertiary porphyritic intrusive that has been prospected for copper.

Junction with Kinney Road which leads north to Old Tucson, the site for many western movies and television productions; the Arizona-Sonora Desert Museum, containing a collection of local fauna and flora; Tucson Mountain Park, a recreational area; and the western section of the Saguaro National Monument.
1.4 Highway Mileage Marker 165. To the north, standing out to the west of the Tucson Mountains, is Golden Gate Mountain, 4,288 feet in elevation, composed of Cat Mountain Rhyolite. The northward extension of the rugged Tucson Mountains is well seen from this point (Plate 13).

8.8 The highway skirts the north side of Snyder Hill, a low isolated hill exposing limestone and dolomite of Permian age. This outcrop probably resulted from faulting and folding of the bedrock. On the west side of the hill the carbonate rock was quarried for road construction material.

9.1 San Joaquin Road to the north. The vegetation has been changing to the mycrophyll type with evenly spaced creosote bush becoming the dominant shrub.

10.4 Bridge over wash. Mesquite and acacia line the washes where more moisture is available from the spotty rains. Drilling in this area down to about 500 feet, failed to find water or bedrock, suggesting a structural break between this point and the outcrops at Snyder Hill to the east.

10.6 Bridge over wash. Streams in such washes are ephemeral.

12.4 Highway Mileage Marker 160. Ryan Field, on the north side of the highway, was constructed as an air training base during World War II and is now used mainly as an auxiliary airfield for the Civil Air Patrol, Air National Guard and parachute jumping clubs. It is operated under the jurisdiction of the Tucson Municipal Airport.

12.8 West Valencia Road to the south. The highway is crossing the broad, gently-sloping bajada extending northward from the Sierrita Mountains.

15.8 Sandario Road leads northward into Avra Valley.

18.5 To the north of the highway is one of the missile sites built by the U.S. Department of Defense and serviced by the Air Force.

18.8 Sierrita Mountain Road goes south to ranching and mining areas.

21.8 Three Points (also called Robles Junction) at the junction with State Highway 286 which goes to Sasabe at the head of Altar Valley
on the U.S.-Mexico border. Father Kino and other early Spanish missionaries and explorers often used this route for access into Arizona territory. Bernard Robles sunk a deep well and established a ranch at Three Points in the 1880's. The ranch was a stage stop on the runs between Tucson and the mining camps to the west.

22.4 Highway Mileage Marker 150. The farms on each side of the road are irrigated by 700-foot wells penetrating permeable lenses of sand and gravel interbedded with clay and silt. The average ground water level is 200 feet below the surface and the depth to bedrock is believed to be about 2,000 feet. The relatively little pumping here has had small effect on the water table in contrast to the excessive pumping farther north in Avra Valley where the water table has been lowered critically by at least 70 feet in recent years.

23.0 Three bridges across branches of Brawley Wash, the corrupted name derived from Bowley or Bawley, which was the name of a ranch and stage station along the wash in the 1880's. Elevation 2,540 feet. This wash is the main drainage for Avra Valley, joining the Santa Cruz River to the north. The streams are ephemeral but can reach flood stage after heavy rainfall. The entrenchment of the stream bed is due to the channeling of the rapid flow when the streams are active. Mesquite trees favor the banks of such washes (Plate 14).

24.5 The Tucson Rifle Club firing range is to the north.

Plate 14. Looking south along the slightly-incised, main channel of Brawley Wash, filled with fine alluvium and lined by mesquite trees. Baboquivari Peak and Mountains in the distance.
Plate 15. The Coyote Mountains, with the Quinlan Mountains and Baboquivari Range behind, looking west from Brawley Wash. The peaks to the right are Martina Mountain and other volcanic hills. Note the difference in erosion between the jagged topography of the granitic and metamorphic mountain ranges and the smoother surface of the volcanic hills.

1.7

26.2 Highway passes the southern end of the Roskruge Mountains at an elevation of 2,644 feet. This range consists mainly of colorful volcanic flows and pyroclastic rocks of Laramide age which rest on folded and interbedded Cretaceous sedimentary and volcanic rocks. The Laramide rocks are capped in part by Tertiary basaltic andesite. The formations have been faulted, warped, and tilted. The rounded hills near the highway are outcrops of the basaltic andesite (Figure 6, Section D-D’).

1.1

27.3 Highway Mileage Marker 145. The cattle guard and fence mark the eastern boundary of the main Papago Indian Reservation. In this area there is a mixture of the microphyll-type desert vegetation (principally creosote bush and bur-sage), which is typical of the low-lying broad alluvial plains, and the succulent-type desert varieties (various cacti such as saguaro, cholla, and barrel; ocotillo; and palo verde) where there is more moisture and a rocky soil.

0.4

27.7 Bridge over small wash.

3.0

30.7 Coleman Road goes south to ranches along the east side of the Coyote Mountains. To the north is the conical, 4,041-foot peak called Martina Mountain, formed by erosion from a thick sequence of pyroclastic ash flows and volcanic breccia of Laramide age. This peak and others farther north and west are collectively called Dobbs Buttes, after a local stage driver and ranch owner of the 1800’s. Most of these buttes are eroded, tilted, fault blocks displaying the light-colored ash bands interbedded with darker volcanic flows and breccia (Plate 15).
1.1 Road north to Viopuli (also called San Pedro), a long established Papago winter rancheria where a good water supply is available. The Indian name means “wild tobacco,” which was grown and used by the Indians.

1.0 Road south to Nawt Vaya (Papago for “pampas grass well” and also called Alamo), a winter rancheria established at a well dug by early prospectors. Prior to having this well, travelers obtained water from Aqua la Vara, a small spring in the fractured granitic rock higher up on the north slope of the Coyote Mountains.

Bell Mountain, one of Dobbs Buttes, lies to the north and displays the tilted, interbedded ash flows and volcanics of Laramide age (Plate 16).

0.1 An old section of the Tucson-Ajo road veers off to the northwest. It passed the Roadside Mine, a low grade copper prospect in interbedded clastic sediments and andesitic volcanics of Cretaceous age. Considerable underground development from a 800-foot shaft and several subsequent surface exploration programs failed to disclose economic mineralization. The mine camp, when operating, was a source of water and supplies for travelers in the early 1900’s.

Plate 16. Bell Mountain from the south, showing the tilted, interbedded, light-colored ash beds and darker lava flows of Laramide age.
Highway Mileage Marker 139. Road cuts show Cretaceous pyroclastics with interfingering conglomerates and abundant caliche. Palo verde, cholla, ocotillo, and some yucca thrive in the rocky terrain. Sharp eyes may spot the top of the headframe of the old Roadside Mine above the vegetation about one-half mile to the north.

Road cuts in Cretaceous volcanic agglomerate.

Bridge. Reddish purple agglomerate and conglomerate are exposed in the deep wash.

Roadside rest area. From here there is a good view of the Coyote Mountains to the southeast. They are composed mainly of Laramide granitic and gneissic rocks with some engulfed metamorphosed limy and sandy Paleozoic (?) and Mesozoic sediments. The intrusive mass is cut by swarms of quartz pegmatite dikes and by strong faults. The trace of one fault passes along the north face of the mountains accounting for the steep erosional wall and the sharp break between the intrusive mass and the Cretaceous volcanic rocks to the north. Another fault marks the sheer western wall of the mountain mass.

To the southwest are the Quinlan Mountains marked by the large white dome housing the 150-inch astronomical telescope on Kitt Peak, elevation 6,875 feet. The Quinlan Mountains, at the north end of the Baboquivari Range, also are made up of Laramide granitic rocks with some scattered pegmatite and black lamprophyre dikes and dark segregations and inclusions. James Quinlan had a stage station at the northern base of the Quinlan Mountains. Kitt Peak may have been named after an Indian or after the relative of an early surveyor.

The amount of rainfall is somewhat greater in this area, accounting for the increase in vegetation.

Bridge over wash.

Road north to Pan Tak (Papago for "coyote sits" and often called "Coyote"), an Indian winter rancheria below a spring in fractured granitic rock on the west flank of the Coyote Mountains. This watering place was known to travelers as early as 1864.

Junction with State Highway 386, the road to Kitt Peak. This well-maintained, paved road climbs and circles the Quinlan Mountains for 12 miles at a maximum grade of 6 percent, from an elevation of 3,220 feet at the highway junction to about 6,800 feet where the Kitt
Peak National Observatory installations are located. (See detailed log of Arizona Highway 386 and Plate 17.)

The Kitt Peak National Observatory is operated by the Association of Universities for Research in Astronomy, Inc. (AURA) under a contract with the National Science Foundation. AURA was created in 1957 as a non-profit organization of seven universities, now increased to nine. Kitt Peak, a sacred Papago Indian spot, was selected and leased from the Papago Tribe after a thorough investigation. Except for restricted areas, the road, observatory grounds, Astronomical Museum, and picnic area, are open to the public daily from 10:00 A.M. to 4:00 P.M.

0.4 to 1.1

Road cuts in reddish-brown Tertiary rhyolite. The low hills to the south were prospected for soft manganese oxides which occur as thin coatings and in narrow fractures in the shattered rock. The hills to the north display granitic rocks.

The small dirt basin just south of the road is a typical "charco" where run-off rain water is collected for watering livestock.

0.7

Bridge over wash. From the highway in this section there is a good view to the north of the Aguirre Valley (named after Pedro Aguirre, a rancher and stage line operator in the mid-1800's). This valley is flanked on the west by the South and North Comobabi Mountains and further north by the Santa Rosa Mountains with Gu Achi Peak (Papago for "big narrow ridge"). The distant low, dark, basaltic

Plate 17. Kitt Peak at north end of the Quinlan Mountains from the intersection of State Highways 86 and 386. The white dome of the 150-inch astronomical telescope building surmounts the mass of eroded, Laramide, granitic batholith.
andesite hills rising out of the valley floor are the Vaca Hills. The east side of the valley is bordered by the Roskruge, Waterman and Silverbell Mountains.

1.7
Road north to Schuchk, (Papago for “black”), the Santa Rosa School, the old Santa Rosa Ranch, and the Indian settlement of Sil Nakya (Papago for “saddle hanging”). The latter is located at the north end of the North Comobabi Mountains. Father Kino reportedly visited this area in 1693.

The dirt road to the south was a part of the old Tucson-Ajo road, leading to San Vicente, an old settlement where early-day travelers could obtain water and supplies.

2.1
Highway skirts the northwest extension of the Quinlan Mountains. The granitic rocks of Laramide age intrude the Cretaceous volcanics and coarse arkosic sediments. All the formations are blockfaulted.

1.6
Road cuts in Quaternary gravel.

0.6
Cross roads. The road north leads to Haivana Nakya (Papago for “crow hanging”), an Indian village on the drainage divide between the Santa Cruz-Gila basin to the north and the San Simon-Sonoyta basin to the southwest. The depth to water here is over 400 feet. This road also goes to Comobabi (also spelled Comobavi, a Papago term for “hackberry tree well”), one of the oldest Indian rancherias known. The old route through the pass between the North and South Comobabi Mountains was a recommended alternate road between Tucson and Ajo in the early 1900’s, avoiding the difficult desert washes of more southerly routes.

The road south is a foothill truck trail along the western flank of the Quinlan and Baboquivari Mountains, serving numerous Papago rancherias and mining prospects.

1.0
Bridge over Sells Wash.

0.5
Highway Mileage Marker 125.

2.6
The well visible to the north of the highway is in Sells Wash and the depth to water is reported to be about 300 feet.

2.2
Highway Mileage Marker 120. The Indian settlement of Chiawuli Tak (Papago for “barrel cactus sits”), extends along the north side of the highway. From this area there is a good view to the
Plate 18. View of the Baboquivari Mountains from the west, showing Kitt Peak in the Quinlan Mountains with the road cuts and white observatory towers to the left, and towering Baboquivari Peak in the center.

east of the Quinlan Mountains with the white observatory towers on Kitt Peak and the road cuts leading to the top. Extending south from Kitt Peak is the steep-sided Baboquivari Range capped by box-like Baboquivari Peak, elevation 7,730 feet, believed by the Indians to be the sacred home of a Papago god. The peak has long been an important landmark. The sharp break from the steep rock slope of the mountain to the gentle westward sloping bajada of Baboquivari Valley is well marked.

The Baboquivari Mountains form a sinuous, elongated, narrow, high, rugged range. Block-faulted Laramide granitic and metamorphic rocks make up most of the mountain mass (Plate 18; Figure 6, Section D-D').

1.0

The road south leads to Ali Chuk Shon (Papago for “foot of little black hills”) and to other small Papago settlements. The dark-colored hills are a northeast extension of the Artesia Mountains and have been eroded out of Tertiary andesitic lava flows.

3.5

A large charco, a collecting basin for run-off surface water, is on the north side of the road.

0.1

Road cut in Tertiary basaltic andesite.
Old road into Sells veers to the south from Highway 86.

Highway Mileage Marker 114. The road to the south is the eastern access to the business district of Sells. Sells is the headquarters for the Papago Indian Reservation. The meeting hall, the offices of the tribal council, the offices of the Bureau of Indian Affairs, a school, and the tribal Rodeo Grounds are located there. Also there are Trading Posts and a Post Office.

Sells, originally called Indian Oasis, had its beginning in the early 1900's when Joseph Meneger dug a well and established a trading post at this location. An Indian settlement grew around the post and in 1918, after the selection of Indian Oasis as the tribal headquarters, the name of the Post Office was changed to Sells, after the then Commissioner of Indian Affairs. In spite of local opposition at the time, the new name persisted.

From Sells, a road leads south through the Artesia Mountains into the Baboquivari Valley, and on to the Mexican border. The Artesia Mountains, as well as the Comobabi Mountains to the north, are composed of Laramide intrusive granitic rocks that invaded Cretaceous rocks, and later were largely covered by Tertiary volcanics and sediments. Block faulting and erosion have produced their present shape. Several small mines and prospects were opened up around the south end of the Comobabi Mountains but none became sustained economic operations.

Bridge over Sells Wash.

Hill with water tank on the south side of highway is composed of Tertiary andesitic volcanics.

The road to the south is the western entrance to the Sells business district. Elevation 2,360 feet. The offices of the Indian health service and the hospital of the U.S. Public Health Service can be seen to the south. The road to the north is an old alternate route of the Tucson-Ajo highway, which passed through the old Cobabi mining district in the Ko Vaya Hills, on the west side of the South Comobabi Mountains.

Highway Mileage Marker 112. The graded road to the west descends the broad, alluvium-covered, westward sloping bajada into the “Great Plain,” drained by San Simon Wash. One of the early routes from Sells to Ajo crossed this valley through several Indian summer rancherias. The predominant vegetation is creosote bush and cholla with occasional saguaro and palo verde.
Highway Mileage Marker 109. Highway passes through the Etoi-Ki Hills (derivation unknown) which are erosional remnants of andesitic volcanic flows, agglomerate, and some welded tuff of Tertiary age.

The erosional hills to the east are made up of basaltic agglomerates, tuffs, and flows.

Highway skirts the western foot of a basaltic volcanic hill. To the far west the gneissic Kupk Hills (Papago for “dike”), rise out of the Great Plain with the ragged ridge of the volcanic Mesquite Mountains behind them.

Road east to Nolia (corruption of “novia,” a Spanish word for “well”), Ko Vaya (Papago for “badger well”), Comobabi, and Sil Nakya; all of which are Indian settlements. The Ko Vaya Hills to the east consist predominantly of strongly faulted andesitic flows and tuffs. On their eastern side is one of the oldest mining districts in southwestern Arizona. The Picacho (Cobabi) mine was worked for silver by the Indians and early Spaniards in the 1700’s, and in the mid 1800’s produced about $40,000 in silver ore. There has been no active mining in recent years.

Road east to Nolia, Ko Vaya, Comobabi, and Sil Nakya.

Highway Mileage Marker 102. Picnic area on west side of the highway under a large blue palo verde tree just south of the bridge. Relatively thick vegetation occurs in this area with mesquite, palo verde, acacia, and other trees along the numerous washes. Creosote bush, bur-sage, and cactus are also seen, mainly in the alluvial soil between washes.

The dirt road to the west leads to Vainom Kug (derivation unknown), a small Indian summer rancheria in Gu Oidak (Papago for “big field”) Valley. Beyond the valley are a series of mountains named from south to north, South Mountain, Ben Nevis Mountain, and the Quijotoa Mountains. South Mountain rises to an elevation of 4,158 feet and has been carved by erosion from thick flows of andesitic lava showing strong horizontal parting and vertical columnar jointing. Ben Nevis Mountain even more strikingly rises sharply in a narrow, cliff-bordered ridge to an elevation of 4,013 feet. It is an eroded fault-block mountain made up of Cretaceous to Tertiary rhyolitic to andesitic volcanic flows, tuffs, and agglomerates, with intercalated sediments (Plate 19). Several short-lived mines around this ridge —
Plate 19. South Mountain on left and Ben Nevis Mountain on right, looking west from the picnic area at Highway Mileage Marker 102. Note mixed microphyll and succulent types of vegetation.
the Weldon, Ben Lomond, and Quijotoa — were worked in the late 1800's and early 1900's for gold and silver. The rich ore pockets were discovered by Albert Weldon, J. A. Roark, and Alex McKay and optioned to the same capitalists who made fortunes in the Comstock Lode in Nevada. The “boom” led to the construction of stamp mills, a tramway, a 1,000-foot deep well, and several townsites grouped under the name Quijotoa. The population grew to some 1,500 persons and stage lines between Quijotoa and Tucson were kept busy. After the initial mining of small rich pockets in quartz veins and hematite breccia zones near the surface, the development results were very disappointing and within two years the “boom” was over. A small production was made in 1887 and from 1891 to 1892 from the mines and from the dry placers in the consolidated gravel beds below the deposits. The total production and returns were small, up to $500,000, while an estimated several million dollars were invested or spent. As late as 1932, attempts to mine gold and silver ore in the district were still being made.

0.8 to 3.6

71.0 Highway crosses numerous dry washes draining westward on the broad gently-sloping bajada extending out from the Comobabi Mountains.

73.8

0.7

74.5 Highway crosses Sikul Himatk Wash (Papago for “whirlpool”), elevation 2,111 feet, that drains southward through Gu Oidak Valley. A short distance to the north is the drainage divide between northward and southward flow at an area where the bajadas from the mountains to east and west coalesce. The valley alluvium at the wash is at least 1,000 feet thick and the depth to ground water is estimated at 400 feet.

1.0

75.5 Cattle guard.

0.5

76.0 Inactive radar station.

2.0

78.0 Historical Marker “Quijotoa” on west side of highway. The dirt road to the west leads to the old mining areas in the Quijotoa Mountains and Ben Nevis Mountain (Plate 20).

The Quijotoa Mountains are a large fault-block range of Laramide granitic rock. The lighter color of these rocks contrasts sharply with the dark volcanics of the mountains farther south.

0.4

78.4 Graded road running southeast is the old Tucson-Ajo road through the Comobabi Mountain area, either to Sells or to the north end of the Baboquivari Range.
Road to west leads to Indian settlements and mining prospects in the northeastern foothills of the Quijotoa Mountains. To the east the bajada slopes into the Santa Rosa Valley.

Tertiary rhyolitic volcanic hills are east of the highway.

Junction of Highway 86 with a paved, unnumbered road running north to Casa Grande, a distance of 61 miles. Elevation 2,430 feet. An excellent stand of saguaros can be seen in the rocky terrain to the south of the highway.

Cross Quijotoa Wash. Papago Indian settlements are scattered along both sides of the highway.

Indian cemetery on south side of highway.

One of the main Indian settlements, Maish Vaya (Papago for "Covered Wells") is to the south. The townsite and wells were originally planned and constructed by early American miners to service their activities in the area. When mining declined, the Indians took over the facilities. The bedrock on both sides of the highway is Laramide granitic intrusive.

Plate 20. Historical marker for "Quijotoa," the short-lived mining boom camp. The granitic Quijotoa Mountains are in the background.
Remains of an old trading post on north side.

Andesitic volcanics are exposed in the road cuts.

Highway crosses Quijotoa Wash.

Western settlement of Maish Vaya (Covered Wells) with mission school and church to the south. To the north are two of the original wells.

The Quijotoa Mountains to the south are composed mostly of Laramide granitic rocks that intruded older rocks that are no longer present. Some overlying Tertiary rhyolitic volcanics crop out near the highway. The Brownell Mountains to the north are a complex fault block showing Laramide granitic intrusives along the east side and Cretaceous and Tertiary volcanics in the western half (Figure 5, Section C-C’). Brownell Valley to the west of the mountains has been eroded out of Tertiary sediments interbedded with andesite flows, producing a dissected mountain pediment with little alluvial cover. Several short-lived gold and silver mines and prospects were active in the past in the Brownell Mountains.

Quijotoa Pass, elevation 2,800 feet. The road cuts are in weathered Laramide granitic rocks. Just east of here the highway crosses a strong northwest striking normal fault which marks a contact between the Laramide granitic rocks to the west and the Tertiary sediments and interbedded volcanics to the east.

Cattle guard.

Highway Mileage Marker 85. About here the alluvium of the valley laps up onto the granitic bedrock. The Sierra Blanca Mountains to the north are a fault block extension of the Quijotoa Mountains and consist of granitic gneiss of Laramide age. The Black Prince Mine, along a fault zone on the eastern side, has been prospected sporadically for copper, lead, and silver since the mid-1800’s.

Road south to Pisinimo (Papago for “bison head”), a large and long established Indian summer rancheria in San Simon Valley. The dark outlying hills to the south are erosional remnants of Tertiary to Quaternary basaltic flows, tuffs, and agglomerates that formerly covered a much larger area.

Road north to silica quarry in Paleozoic quartzite, possibly
Abrigo Formation, in a small fault sliver on the western edge of the Sierra Blanca Mountains. Paleozoic limestone also crops out in the fault zone. The workings and dumps of this operation, which furnished smelter flux for Ajo, can be seen in the saddle between the outlying hills and the main mountain mass.

92.1 Highway Mileage Marker 80.

92.3 Picnic area on south side of highway along a small wash lined with large palo verde trees and mesquite. The highway is descending a broad dissected bajada extending westward to San Simon Wash.

92.5 Highway crosses the Gila and Salt River Meridian, the main north-south base line precisely surveyed by the U.S. Coast and Geodetic Survey in order to establish the land divisions (township and range) in Arizona. Elevation 2,051 feet.

93.5 Abandoned radar station to the south.

94.9 Road south into San Simon Valley. Creosote bush is the principal type of vegetation.

95.3 Indian Village of Wahak Hotrontk (Papago for "road dip"), or more commonly called San Simon, which is located in San Simon Wash. The alluvium, consisting of fine sand with lenses of gravel, silt, and clay is more than 800 feet deep. This broad basin, formed by the coalescing bajadas extending out from the bordering mountains, has numerous intersecting and shifting washes and often becomes very wet and muddy after the occasional hard rain. Because of the retained moisture in the soil, the wash has been an important summer farming area for the Indians (Plate 21).

To the north, the volcano-shaped Cimarron Peak, elevation 3,376 feet, is an erosional remnant of a mound of thick basaltic volcanics.

95.6 A trading post and Highway Maintenance yard are on the south side of the highway.

97.2 Highway Mileage Marker 75. Due to the construction of the highway, which was first laid out prior to 1920, stream drainage is held to the north side of the road, accounting for the dense stand of mesquite trees and brush on that side.

99.6 Cattle guard. In the distance to the south are the Mesquite Mountains with a distinctive corrugated crest. This range is composed
mainly of eroded, folded and faulted Tertiary rhyolitic flows, tuffs, and agglomerates. More to the southwest are the basaltic Gu Vo (Papago for “big charco”) Hills and behind them the higher and more rugged Ajo Mountains.

The west-east ridge to the south of the highway is an eroded outcrop of Laramide granitic rock. The alluvial cover is relatively thin in this area, forming a veneer on the granitic bedrock pediment which slopes eastward.

The white patches in front of the hills to the south are the dumps of the Little Chief Mine where quartz veins cutting granitic and gneissic rocks are quarried for silica flux used in the Ajo smelter. The hills to the north are outcrops of light-gray, gneissic rocks of Laramide age capped by dark-colored, Tertiary, basaltic andesite volcanics.

Highway Mileage Marker 67. The highway skirts the north side of Ninemile Peak, so named because it marks the eastern end of a nine mile straight stretch of the highway. It and other hills to the south are the erosional remnants of a thick series of late Tertiary basaltic andesite volcanics which rest on Laramide granitic basement rocks.

Road north to Hickiwan (Papago for “jagged cut”) and other Indian settlements in upper San Simon Valley. Father Kino visited this area in 1699.

The road to the south goes to Gu Vo (Papago for “big charco”). This large and long established Indian settlement lies along Gu Vo Wash, where it cuts westward through the eroded Gu Vo hills of Laramide granitic rocks. It has been dammed up to form a large ephemeral
pond. Father Kino visited Gu Vo in 1701 and the old southern route (from Tucson to Ajo) ran by this settlement.

The low discontinuous hills south of the highway are eroded remnants of basaltic andesite volcanics. Behind them are ragged ridges of Laramide granitic rocks and in the distance the high Ajo Range is marked at the north end by Montezuma’s Head, a block-like peak sculptured out of volcanic flows and pyroclastics (Plate 22).

3.5

The road to the north goes to Hotason Vo (Papago for “rock base charco”), an Indian settlement at the south end of the Sikort Chuapo (Papago for “round spring”) Mountains. This gently folded but sharply faulted range has been eroded out of basaltic andesite and basalt volcanics of Tertiary age.

2.7

The road south to Gu Vo is the route of the old southern Tucson-Ajo road of the 1910’s and 1920’s which passed through Gu Vo and Pisinimo to Sells. A branch of the road also goes south to Menager’s Lake near the Mexican border. This lake was made by a dam across a wash in a divide between basaltic andesite hills. Joe Menager homesteaded some six square miles here about 1915 and completed the dam in 1920. The homestead was sold to the Papago Tribe in the 1930’s.

The low, broken line of the Gunsight Hills to the south of the highway are erosional remnants of Laramide granitic rocks exposed by the stripping away of overlying Tertiary volcanics (Plate 23). The
origin of the name “Gunsight” is in dispute. One story relates that an early prospector noticed a hammered-silver gun sight on an Indian’s rifle and learned that the silver came from this locality. Another story suggested the name originated because the main flat ridge reportedly resembled a gun barrel. Prospecting in the late 1800’s disclosed some small pockets of lead-silver ore in these hills. Sporadic mining and prospecting continued until 1928 but the total production probably did not exceed $150,000. The dumps of the old Gunsight (Surprise) Mine, patented in 1874, can be seen on the northern slope of the main ridge. Farther south in the Laramide granitic rocks other small prospects and mines were worked for base and precious metals and tungsten.

The road north leads up Pozo Redondo Valley between the Sikort Chuapo and Pozo Redondo Mountains.

0.7

114.5 Road south to Schuchuli (Papago for “many chickens”). The old Gunsight Ranch was located here at a well dug in the 1800’s and was one of the few available watering places for travelers between Sells and Ajo in the early 1900’s.

0.9

115.4 The highway passes the south end of Pozo Redondo (Spanish for “round well”) Mountains made up of westward-tilted basaltic andesite volcanics broken by faulting into ragged north-south trending ridges.

Plate 23. Gunsight Hills, erosional remnants of Laramide granitic rocks, with old mine dumps on the lower slopes. The north end of the volcanic Ajo Mountains, with Montezuma’s Head, are behind.
Plate 24. South end of the Pozo Redondo Mountains showing tilted and broken basaltic andesite flows.

(Plate 24). To the southwest there is a twisting, narrow ridge with a horizontal top. Basaltic flows rest unconformably on tilted and discontinuous andesite flows. The road cuts along the highway are in andesitic volcanics.

1.9

Cattle guard and fence marking the western boundary of the Papago Indian Reservation. To the northwest, the mining and metallurgical complex at Ajo can be seen on the eastern side of the Little Ajo Mountains. To the west, in the distance across the Valley of the Ajo, are the Growler Mountains.

1.6

Highway Mileage Marker 53. A branching road curves to the west to join State Highway 85. The small settlement is Why (Rocky Point Junction), named because of the shape of this road junction.

0.3

Western end of State Highway 86 at the junction with State Highway 85 which runs from Gila Bend to Lukeville. (See detailed log of Arizona Highway 85.)
DETAILED LOG
Arizona Highway 386

This log is recorded from the junction with Arizona State Highway 86 southward to the end of the highway at the Kitt Peak National Observatory at the top of the Quinlan Mountains. However, it is designed to be used equally well for the descent.

Mileage for the upbound trip is given in the left hand margin as a cumulative mileage from Highway 86. The Mileage Interval between each point discussed is recorded in the center of the page.

Cumulative mileage for the descent is tabulated in the right hand margin, starting at the end of the log and reading upward.

<table>
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0.0  Junction of Arizona Highway 386 (Kitt Peak Road) with Arizona Highway 86 at 38 miles west of Tucson. Elevation 3,220 feet. This road is open to the public from 10:00 A.M. to 4:00 P.M. daily. It climbs some 3,580 feet in 12 miles with a maximum grade of six percent. It is a good paved road, but the traveler is advised to drive carefully, observing all road signs and stopping only at the frequent, well-spaced, designated turn-outs and view-points.

Kitt Peak, elevation 6875, is the highest point in the Quinlan Mountains, at the northern end of the Baboquivari Mountain Range. The large, white, observatory tower visible at the top of the mountain houses the 150-inch telescope (Plate 25).

1.0  Pan Tak (Papago for “coyote sits” and also frequently called Coyote) lies to the east at the foot of the Coyote Mountains. This old Indian rancheria acquired water from natural springs on the steep slope above. These springs probably lie along the trace of a north-south, high angle, reverse fault which is responsible for the steep mountain wall and the divide between the Coyote and Quinlan mountains. The watering place was known to travelers in the 1850’s.

The northern section of the Coyote Mountains is composed
Plate 25. Coyote Mountains from Kitt Peak, looking northeast, showing horizontal banding in the gneiss in the central part in contrast with the more homogenous intrusive at the northern nose. This western wall of the mountains is along a major fault. In the distance are the Santa Catalina and Rincon Mountains.
mainly of granitic to dioritic intrusives of Laramide age. Farther south along the mountain wall the rock is a gneiss showing horizontal banding. This gneiss is probably of Laramide age and derived from the metamorphism of older Paleozoic to Cretaceous rocks by the intrusive. Quartz pegmatite and lamprophyre dikes cut both the intrusive and metamorphic rocks (Plate 25; Figure 6, Section D-D').
From here to the top the road cuts are in the weathered, jointed and sheeted granitic to dioritic intrusive. All intrusive phases are from the same general magma invasion of Laramide age, differing in appearance because of slight changes in composition. The more granitic phases are lighter gray than the more dioritic phases. All phases contain patchy segregations of black ferromagnesium minerals and are cut by irregular white quartz veins and large and small irregular, dark greenish-gray to black lamprophyre dikes.

Turn-out. Elevation 4,000 feet. The weathered intrusive shows coarse, granular quartz and feldspar with black mica (biotite) as the major dark mineral. Note the quartz veins and stringers and the sets of joints sometimes coated with the greenish mineral, epidote.

As the amount of cacti and succulent desert type of vegetation diminishes, live oak, agave, yucca and various shrubs increase.

Turn-out. View of Aguirre Valley to the north and northwest, bordered on the west by the South Comobabi, North Comobabi, and Santa Rosa Mountains in sequence from south to north (Plate 26). Note the dark greenish-gray lamprophyre dike and the jointing of the intrusive rock in the road-cut.

Plate 27. Looking west over the Boboquivari Valley, from the Kitt Peak Road, towards Sells which lies between the low Artesia Mountains to the left and the South Comobabi Mountains to the right.
Plate 28. View of Alambre Valley, in foreground, leading out to Altar Valley. The Sierrita Mountains and Santa Rita Mountains are beyond.

5.2 Turn-out. View to the northwest to Comobabi Mountains. The 150-inch telescope observatory is directly above to the south, up the steep, broken north wall of Kitt Peak.

6.2 Turn-out. View to north of Aguirre Valley and the Comobabi Mountains. The road up the valley to Santa Rosa Ranch and Schuck is clearly marked. The road-cut in the intrusive shows strong jointing and sheeting.

6.4 A nearly vertical, thick, black lamprophyre dike cuts through the intrusive on the road-cut wall.

7.0 5,000 foot elevation marker.

7.5 View-Point, looking west over the northwest prong of the Quinlan Mountains and across the northern part of Baboquivari Valley towards Sells, located between the low Artesia Mountains and the higher South Comobabi Mountains. The ridges of the Mesquite and Ajo mountains are in the distance across the “Great Plain” that slopes gently southward into Mexico.
Plate 29. View to the south, from the Kitt Peak road, along the Baboquivari Mountains with Baboquivari Peak standing out along the skyline.

The intrusive rock in the road-cut exhibits strong jointing, sheeting, and fracturing with some irregular white quartz stringers and black lamprophyre dikes. Note the rounding and spalling of the granitic rock where it has been exposed to weathering.

1.0

As the road winds toward the south, there are views of the Baboquivari Mountains with blocky Baboquivari Peak, 7,730 feet in elevation, towering in the center of the range

0.7

9.2 Turn-out. View of Baboquivari Valley and the “Great Plain” to the west and the series of fault block mountains to the northwest (Plate 27).

0.4

9.6 6,000 foot elevation marker.

0.1 to 0.5

9.7 There are numerous small turn-outs from which there are views of Alambre Valley, directly below, leading out into the broad Altar Valley. Beyond are the Sierrita Mountains, and Mt. Wrightson in the Santa Rita Mountains (Plate 28). Note the juniper and piñon trees along the high slopes.

Looking south along the rugged Baboquivari Mountain chain, with Baboquivari Peak standing out against the skyline. This peak is considered sacred to the Papago Indians, who believe it is the home of their god (Plate 29).
Numerous white observatory towers, which are scattered around Kitt Peak, can be seen along the ridges above the road.

10.6 Side road to the west leads to a well-maintained picnic area amid a grove of live oak trees.

10.7 View Point from which the valleys and mountains to the east and south can be seen.

0.3 to 0.7

11.0 Turn-outs along the west side of the road with views to west and north-west.

11.4 View-point on the north nose of Kitt Peak. (DO NOT CROSS OVER ON ASCENT). From here there is an excellent panorama of the typical basin and range topography. To the east, in succession, are Altar Valley, the Sierrita Mountains, Santa Cruz Valley and the Santa Rita Mountains. To the northeast, overlooking the Coyote Mountains, are the Roskrugge Mountains, Altar Valley, the Tucson Mountains, the Santa Cruz Valley and the Santa Catalina and Rincon Mountains (Plate 25). More to the north are the Waterman and Silverbell Mountains, the latter marked by the light colored dumps of the Silverbell open pit copper mines. To the north is the broad Aguirre Valley formed from coalescing bajadas sloping in from the surrounding mountains. To the west and northwest, from south to north, are the Comobabi Mountains and Santa Rosa Mountains. Directly above this view point is the 150-inch telescope building.

11.6 6,750 foot elevation marker.

11.7 Parking area for the Kitt Peak National Observatory, operated by the Association of Universities for Research in Astronomy, Inc. (AURA) under a contract with the National Science Foundation. The facilities include an Astronomical Museum containing many exhibits concerning the sun and stars, the methods used in obtaining information about the universe, and a description of the observatory equipment and activities. Some installations may be open to the public, and well-marked roads and paths permit limited public access through the observatory grounds and to viewpoints overlooking the surrounding country. The various types of trees and shrubs growing on this mountain have been labeled for identification.

The Kitt Peak site was selected for the observatory after an exhaustive search and leased from the Papago Tribe, who had held it as a favorite dwelling place for Ee-Ee-Toy, their god. The Indians
have played an important role in the construction and maintenance of the observatory grounds in which they take justified pride. Visitors should follow all posted regulations and neither disturb nor mar the natural beauty of the site.
APPENDIX

GLOSSARY OF SELECTED GEOLOGIC TERMS

(Descriptions of geologic eras, periods and epochs are given in Table 1)

Agglomerate. Volcanic fragments of coarse to fine texture, generally unsorted, and more or less firmly cemented.
Aggradation. The building up of a land surface by sedimentary deposition.
Alluvium. Sand, gravel, and silt transported and deposited by stream or surface water action in relatively recent time.
Andesite. A volcanic rock, generally of dark-gray color, and intermediate in composition between rhyolite and basalt.
Anticline. An up-fold or arch of bedded or layered rock in which the limbs dip downward in opposite directions from an axis.
Arkose. A sedimentary rock composed of material derived from disintegrated granitic rock.
Bajada. An even, gently-sloping, alluvial plain extending outward from the base of a mountain range, often formed by coalescing alluvial fans.
Basalt. A common lava of dark color and of great fluidity when molten.
   It is much less siliceous than rhyolite and contains much more iron, calcium, and magnesium.
Basaltic andesite. A basaltic appearing andesite.
Batholith. A huge mass of intrusive igneous rock, several tens of square miles in area.
Bornite. A copper iron sulfide having a reddish-brown color but tarnishing readily to an iridescent purple.
Breccia. A mass of naturally-cemented, angular rock fragments.
Butte. A small isolated hill or mountain with cliff-like walls.
Caliche. Deposit of porous calcium carbonate along near-surface fractures or cementing alluvial sand and gravel in the subsurface.
Chalcocite. A copper sulfide of gray to black color most commonly resulting from the oxidation and enrichment of other copper sulfides.
Chalcopyrite. A copper iron sulfide having a bronze-yellow color, but tarnishing to a bronze, or iridescent hue.
Chrysocolla. A hydrous copper silicate of green to blue-green color usually occurring in noncrystalline masses in oxidized copper deposits.
Clastic. Formed from fragments of rocks.
Conglomerate. A sedimentary deposit of poorly sorted, subangular to rounded pebbles and boulders, more or less firmly cemented.

Continental deposits. Sedimentary deposits laid down within a general land area and deposited mainly by streams.

Deformation. Any structural change in the original shape of rock masses, such as by folding, jointing, and faulting.

Degradation. The general lowering of the earth's surface by erosion.

Dike. A vertical, or nearly vertical, tabular body of igneous rock cutting across adjacent rock.

Disturbance. Deformation on a large scale but of lesser scale than in a revolution.

Dolomite. A mineral or rock composed of calcium and magnesium carbonate.

Ephemeral. Short-lived.

Epicontinental. Situated on a continental land mass.

Extrusive. An igneous rock that when molten poured out or was ejected at the earth's surface.

Fault. A fracture or fracture zone along which one side has been displaced relative to the other. In normal faults, the hanging wall (upper wall) has been depressed relative to the footwall (lower wall). In reverse faults the opposite movement has taken place.

Fault-block. A large rock mass bounded on one or more sides by faults which may have elevated, depressed or tilted the block in relation to adjoining rock masses.

Geology. All phases of earth science.

Geosyncline. A large regional trough in which products of erosion and vulcanism have accumulated.

Gneiss. A coarse-grained metamorphic rock resembling a granite but with crude granular and schistose banding.

Granite. A light colored, granular intrusive rock composed mostly of quartz, sodium and potassium feldspar, and mica.

Igneous. Derived from hot, mobile rock material.

Imbricated. Overlapping.

Intrusive. Igneous rock that while molten invaded other rocks and solidified below the earth's surface.

Lamprophyre. A dark, fine-grained, dike rock made up largely of iron- and magnesium-rich minerals.

Latite. An extrusive igneous rock intermediate between a quartz-deficient rhyolite and andesite.

Lava. Molten rock material extruded and solidified at or near the earth's surface.

Limestone. A sedimentary rock composed mostly of calcium carbonate.

Malachite. A hydrous copper carbonate having a bright green color. A common alteration product in copper deposits.
Mesa. A flat-topped hill or mountain bounded on one or more sides by cliff-like walls.

Metamorphic. Changed in character within the earth by heat, pressure, solution, or gases.

Mineralization. Processes by which minerals of economic interest are added to rocks.

Ore. Mineralized rock from which a substance of value can be economically extracted.

Orogeny. The process of mountain building by folding and faulting of the earth’s crust.

Pediment. A gently-inclined, relatively flat surface carved on bedrock by erosion at the foot of mountain ranges.

Pegmatite. A coarse-grained igneous dike usually of granitic composition and associate with large granitic intrusions.

Peneplain. A land surface eroded down to a nearly-flat plain.

Phyllite. A metamorphic, fine-grained, indurated rock with rough platy structure. More compact than schist but less so than slate.

Physiography. A branch of geology dealing with physical features of the earth’s surface.

Physiographic province. A region of similar physiographic features.

Pinnacle. A high tower or spire-shaped pillar of rock.

Plateau. A relatively high, flat surface generally underlain by horizontal rock layers.

Porphyry. An igneous rock having well-developed crystals enclosed in a finer-grained ground-mass.

Pyroclastic. Volcanic material ejected explosively or aerially from a vent.

Quartz latite. An extrusive igneous rock equivalent to quartz monzonite.

Quartz monzonite. A granitic-appearing, intrusive, igneous rock having somewhat less silica, and sodium and potassium feldspar than granite. Often associated with Arizona’s large copper deposits.

Quartzite. A dense, hard, quartz-rich rock.

Red beds. Red sedimentary rocks, usually sandstones and shales, colored by abundant iron oxide.

Revolution. A period of major crustal deformation often accompanied by igneous intrusions.

Rhyolite. An extrusive equivalent of granite; usually light-colored, very siliceous and fine-grained or glassy.

Rock. Any naturally formed aggregate or mass of mineral matter, whether or not coherent, constituting part of the earth’s crust.

Schist. A metamorphic rock characterized by an irregular thin platy structure due to layering of micaceous minerals.

Sedimentary. Formed from rock fragments transported and deposited mainly by water and wind, precipitated from solutions, or deposited by organisms.
Shale. A weakly-consolidated, laminated, fine-grained sedimentary rock.

Sierra. A rugged mountain range with serrated or irregular outline; often formed by erosion of granitic-rock masses.

Spherulitic. An igneous rock texture exhibiting small, radiating, concentrically-arranged, crystal spheres in a rock mass. Most often found in glassy lavas.

Stock. An igneous, intrusive body smaller than a batholith.

Talus. Rock fragments, generally relatively coarse, accumulated on a slope or at the foot of a slope from the disintegration of solid rock.

Trough. An elongated, structural depression in the earth’s crust.

Tuff. A rock composed of relatively small, compacted volcanic fragments.

Unconformity. An extensive surface of erosion or major period of non-deposition between successive rock units, indicating a break in sedimentation or a missing record of geologic events.

Volcanic. Pertaining to features or rocks resulting from surface or near surface eruption and solidification of molten rock material.

Water table. The upper surface of the zone of water-saturated alluvium or rock.

Welded tuff. A tuff indurated by heat and hot gases.

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SERVICES AVAILABLE FROM ARIZONA BUREAU OF MINES

THE UNIVERSITY OF ARIZONA, TUCSON, ARIZONA

The ARIZONA BUREAU OF MINES was created and placed under the authority of the Arizona Board of Regents in 1915 by an act of the State legislature. The Bureau is directly charged with developing, maintaining, and disseminating to the people of Arizona information relating to geology, mining, metallurgy, and earth sciences generally. The Bureau's primary functions, therefore, are scientific investigation and public service activities comparable to those conducted by geological survey agencies and mineral experiment stations in other states. These primary functions are achieved through the following continuing programs:

1. Prepare and publish bulletins and circulars containing authoritative information on a wide range of topics of interest to prospectors, miners, and others concerned with the development of Arizona's mineral resources and industries. The bulletins are distributed free of charge to residents and at cost to nonresidents of Arizona upon request.

2. Classify mineral and rock specimens. Besides identifying rocks and giving the composition of minerals, the Bureau makes qualitative tests for important elements and answers inquiries concerning the probable market for and the economic value of material similar to samples submitted. This service is furnished free of charge providing the specimens originate within the State of Arizona; a charge of $2 per specimen is made for samples submitted from outside the State. Spectrographic analyses and detailed microscopic determinations are furnished at established rates, a schedule of which will be submitted on request.

3. Conduct laboratory and pilot-plant metallurgical testing of mineral substances in cooperation with industries and individual mine operators in the State. Such tests are conducted on the basis of nominal charges to compensate for wear and depreciation of equipment needed in the experimentation.

4. Make geologic investigations and compile geologic maps and reports. Geologic maps of each county, on a scale of 1:375,000, have been issued and geologic reports on numerous mining districts have been made available as bulletins. In addition to maps and reports on counties and mining districts, comprehensive studies of basic problems in the geology of Arizona are being carried out in order that the maximum benefits may be derived by the people of the State by having a more complete knowledge of its geologic setting.


6. Develop well-log storage facilities and a library of data pertaining to oil and water wells drilled in Arizona.

7. Conduct state-wide commodity studies as to modes of occurrence and potential industrial value of various mineral materials.

8. Collect and file items relating to Arizona mines and minerals that appear in Arizona newspapers and in many technical periodicals.

The basic philosophy which obtains in the operation of the Arizona Bureau of Mines is that of providing for the people of Arizona educational services in the earth sciences which cannot be readily secured elsewhere, and furnishing advice and service about mineral occurrences which cannot be obtained conveniently from commercial sources.

An inquiry addressed to: Director, Arizona Bureau of Mines, University of Arizona, Tucson, AZ 85721, will bring a prompt response if further information is desired about the services which are available.