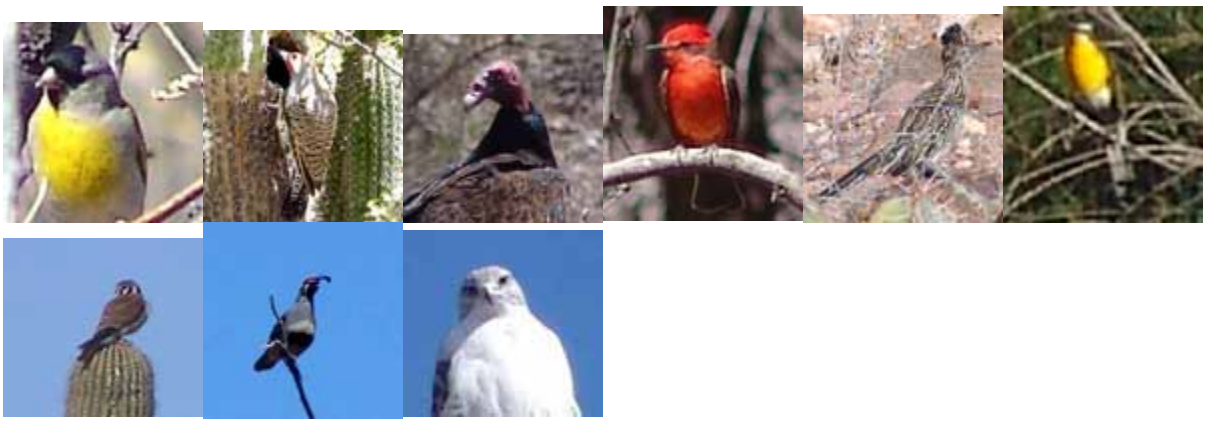
The San Pedro River Valley

http://www.sanpedrorivervalley.org/

Above: San Pedro River gallery forest, viewed from lower Soza Mesa near Cascabel, Arizona. Cottonwoods and willows are just leafing out in March 2003 (in the foreground, paloverde- and creosotebush-covered slopes, with scattered Saguaro cacti in the mid-distance).

"The riparian ecosystem along the unregulated San Pedro River is one of the most valuable in the Southwest, particularly for birds. " Robert Webb, Stanley Leake, & Raymond Turner 2007, *The Ribbon of Green,* Tucson: University of Arizona Press, p.223.



The San Pedro River valley is the most significant migratory flyway remaining in the Southwest. Nearly 400 species spend part of their life-cycles along the San Pedro, and during peak migration, between 1 and 4 million birds are found there. Part of the Madrean Sky Island Archipelago, the entire valley's exceptional species richness has complex causes, but

for birds it provides a well-watered, verdant corridor running from southern tropics toward northern tundra (and back), with stacks of diverse and accessible vegetation resources (for birds, anyway) rising up alongside it in the form of "Sky Islands" all the way to its confluence with the Gila River. For further details of the fragile ecological bases of this richness, see below.

Below: the flooding San Pedro River at Cascabel, Arizona in August 2005.

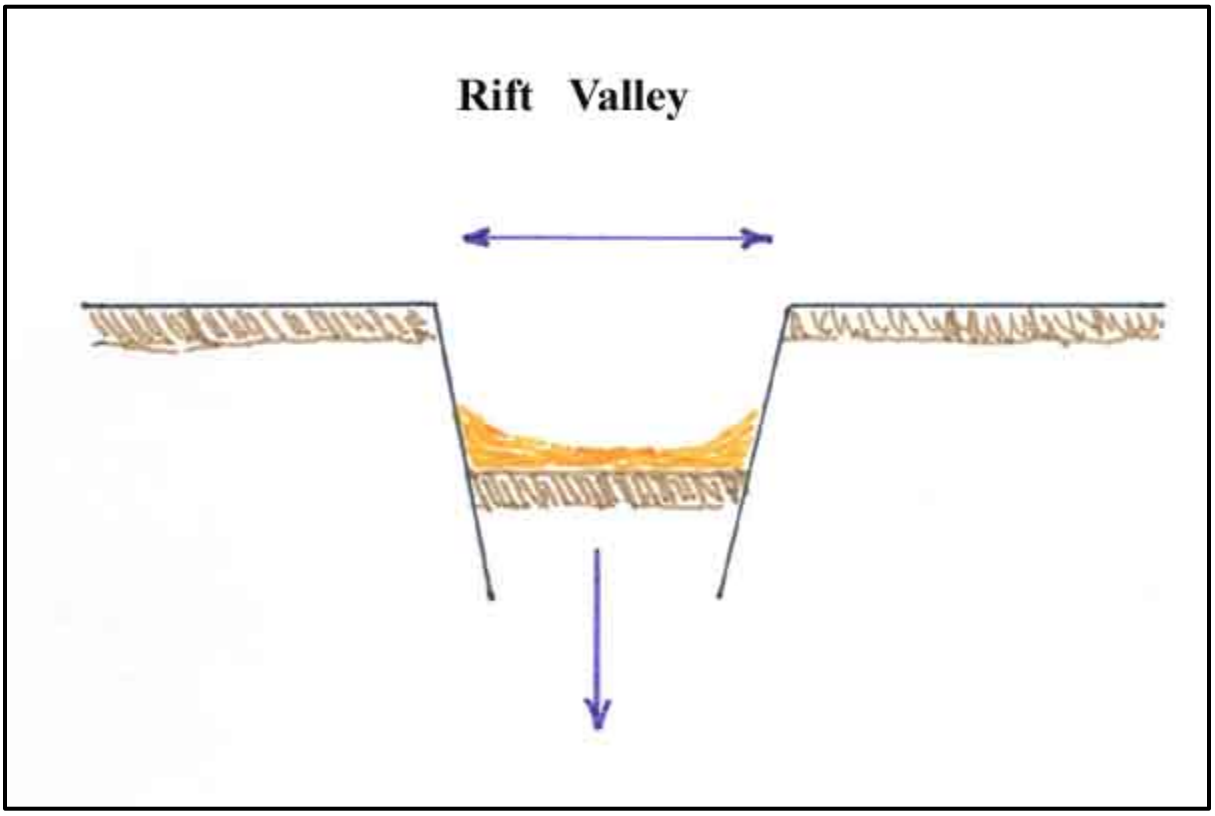
The San Pedro River **begins in Mexico** (some 30 miles south of the border in the Sierra Manzanal Mountains, not far from the city of Cananea in northern Sonora) and **ends at its confluence with the Gila River** near Winkelman, Arizona. A south-to-north-running river, it forms a **central corridor** of the **Madrean Archipelago**, the complex of "**Sky Islands**" scattered from the Sierra Madre of Mexico to the Mogollon Rim in Arizona.

For initial orientation, the map **below** shows the relationship of the river in our area to the Sky Islands which flank it on both sides:

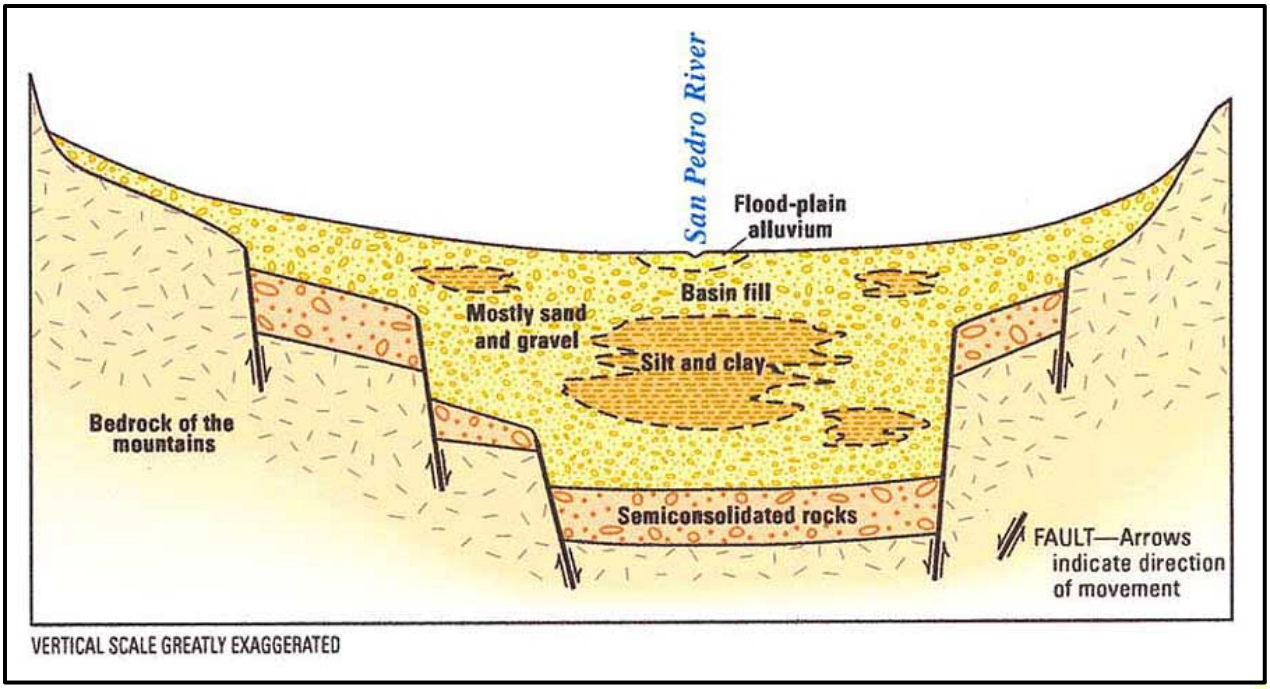
This relationship between river and flanking mountains reflects the fact that the **mountain ranges and river basins** of this part of the American southwest have been **produced by a geological process of crustal extension:**

A Brief Geological/Geographic Overview

The San Pedro Valley is geologically a great **trough**, a **rift valley**, resulting from the extensional southeast-to-northwest block-faulting of the earth's crust, looking crudely like this in an east-west cross-section:



The final phase of this rifting was part of the **Basin-Range Faulting** process that began some 15 million years ago (described on our Geology Pages at that link). However, the geological picture is considerably more complex than the simple diagram presented above. The diagram **below**, adapted from the 2006 USGS Report FS 2006-3034 by Thomas Blakemore, "Hydrogeologic investigation of the Middle San Pedro Watershed, Southeastern Arizona", shows the valley as the result of **a long series of pull-apart riftings** (the earliest of which may have occurred some 50 million years ago):



A series of fault-block episodes occurred, as the valley was incrementally enlarged, became deeper and, even as this trough was dropping, it was filled with erosion deposits from the fault-block mountains that flanked it (which rose as "**horsts**" or uplifted blocks while the trough or "**graben**" dropped). (See our **Geology** pages for further discussion.) The first point here is that what we see today as we go downstream in today's valley are flanking ranges of mountains located mostly well back from the riverbed on both sides, their long axes roughly parallel to the valley trough and their strata usually tilted away from the river, and very long "**bajadas**", or alluvial fans, that run out from the mountains toward the river. Today these bajadas form high terraces near the river, which has downcut through them during the past several million years. Note also: for a deeper and broader view of the geology of this area, see **Cochise College Geology of SE Arizona**. Second: note the scattered distribution of silt and clay in basin fill, which affects how deeply the water table sinks along the river, and thus (in our desert conditions) whether water will be present on the surface of the floodplain at a given location during dry spells -- a significant feature for wildlife.

The map **below** divides the watershed into two parts marked roughly by the city of Benson. South of Benson the sky islands are more distant from the river and the bajada terraces are broader. North of Benson the width of the valley constricts and the bajada terraces are narrower.

Major Divisions of the San Pedro River Watershed

The Arizona Department of Water Resources (**ADWR**) and the United States Geological Service (**USGS**) now designate **three distinct Watershed Areas** for the river:

- the ***Upper San Pedro*** (from the river's source in Mexico to the Tombstone Gaging Station, including the **Sierra Vista** Sub-Area),
- the ***Middle San Pedro*** (including the **Benson** and **Redington** Sub-Areas, from the Tombstone Station to the Narrows, and from the Narrows to the Redington Bridge Gaging Station),
- the ***Lower San Pedro*** (from Redington Bridge to the confluence with the Gila River).

While our interests in this website include the entire watershed, **our particular knowledge focuses our attention mainly on the Middle San Pedro**, and we will focus our discussion and illustrations mainly on that area. We will however say something about the others and provide links to sources that concern both the Upper and Lower San Pedro Watershed Areas.

.....

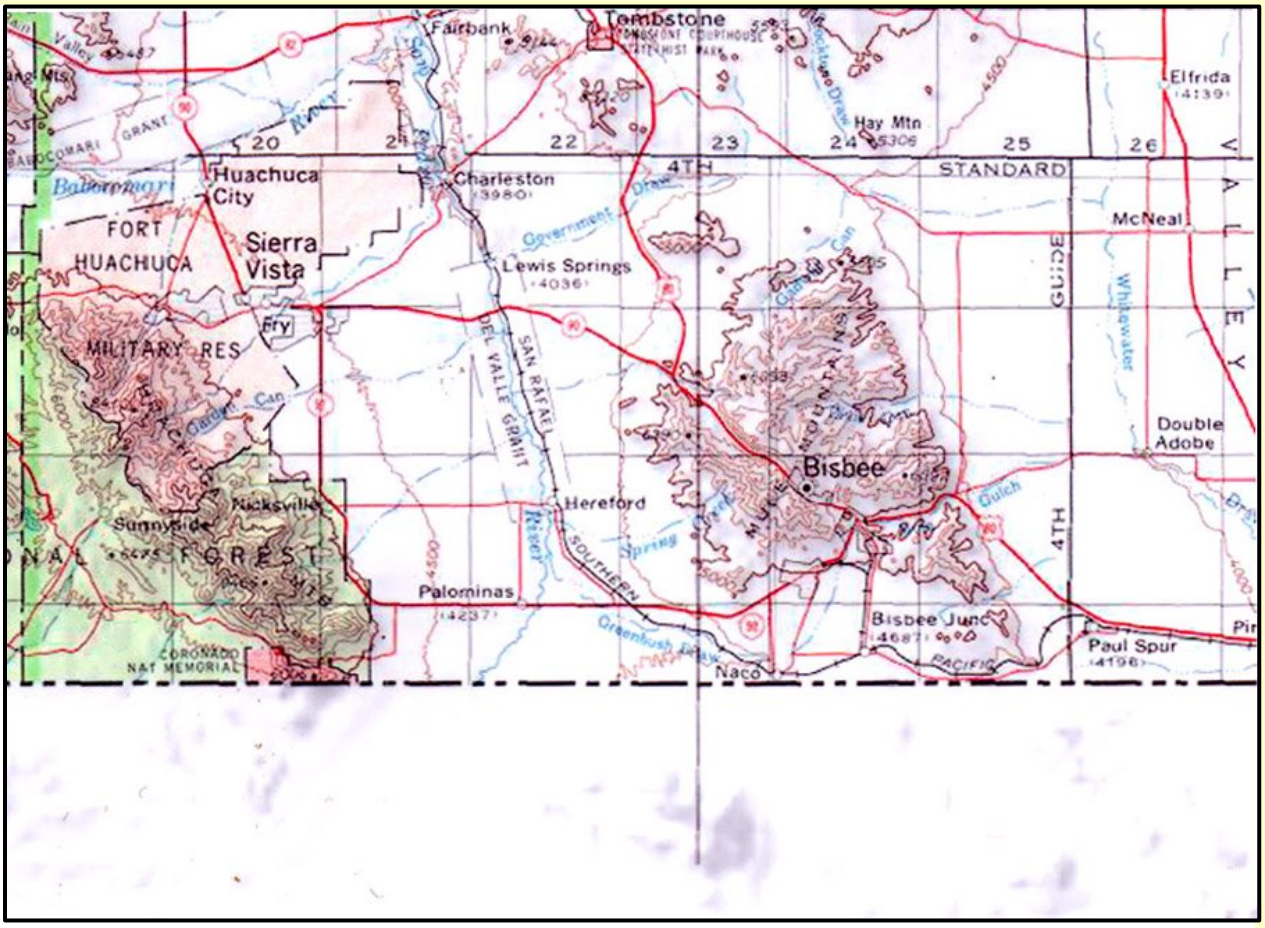
According to Webb, Leake, & Turner (2007, *The Ribbon of Green*, Tucson: UofA Press, p. 223), "Riparian vegetation has generally increased along the [San Pedro] river north of the U.S.-Mexico border.... [and] closely follows the alternating pattern of perennial-ephemeral flow that characterizes this watercourse along its greater than 150-mile length in Arizona " Moreover, "...the case of riparian vegetation change on the San Pedro River represents one of the largest increases in woody riparian vegetation in the Southwest. Many researchers have noted that this river, once swampy, now sustains a verdant forest."

For more in relation to this subject, see

From another perspective, the **early history of Spanish-colonial interaction with native people** along the river may be of interest to some. For a brief essay on that subject, see

The Upper San Pedro: including Sierra Vista Sub-area

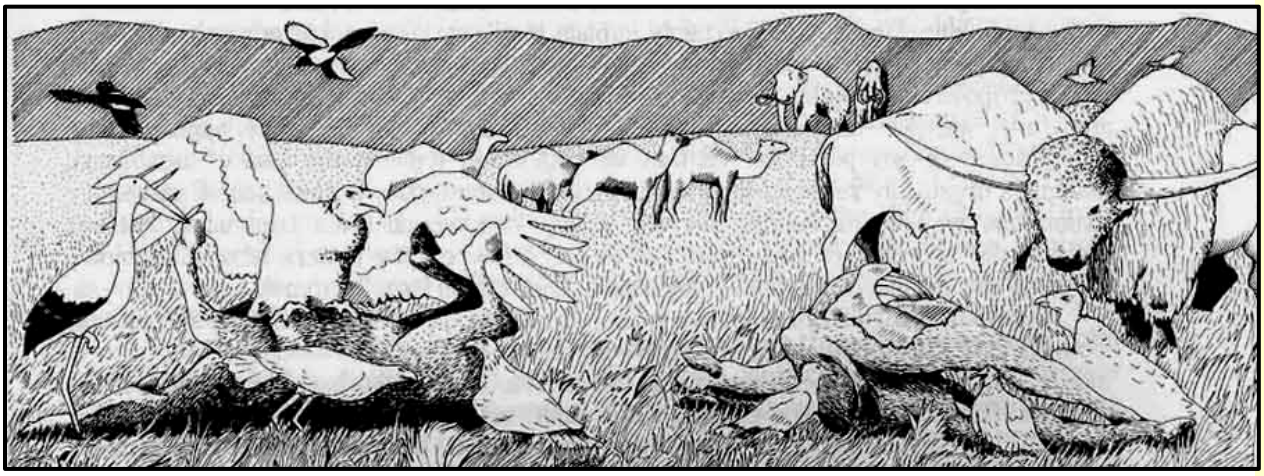
[From Mexico to the Tombstone Gaging Station near Fairbank]



In this part of the drainage, the immediate flanking Sky Islands are the **Huachuca Mountains** (much of which is National Forest) and the **Mule Mountains**. While we cannot pretend to detailed understanding of the Upper San Pedro Watershed (see below for links directing viewers to some relevant sources), we do intend to explore ecological relationships between the river corridor here and its main flanking Sky Islands. Toward developing that aim, see this link: **Huachuca Mountains** (and for the vegetation-stacking features of **Sky Islands**, see that link).

Part of this Upper (southern) area of the river was designated **The San Pedro Riparian National Conservation Area (SPRNCA)** in 1988. The SPRNCA straddles the northern end of the Sierra Vista Subarea and the southern end of the Benson Subarea. For some details on **bird conservation** activities in this part of the river valley, see this link: **Southeastern Arizona Bird Observatory (SABO)**. For an excellent overview of the many agencies concerned with the area, see this link: **Upper San Pedro Partnership (USPP)**. See also **Friends of the San Pedro (FSPR)**, a non-profit organization that supports the work of the SPRNCA.

While the entire stretch of the river contains numerous historical and archaeological sites, this southern portion is internationally known for its **Paleoindian sites** dating to the end of the Pleistocene Epoch. See **Clovis** and **Murray Springs** for a few details. The plants and animals living here during late Pleistocene times were very different from those present today, as suggested by this image **below**. See **Pleistocene Megafauna extinctions**, and **The Clovis/Folsom Transition**.

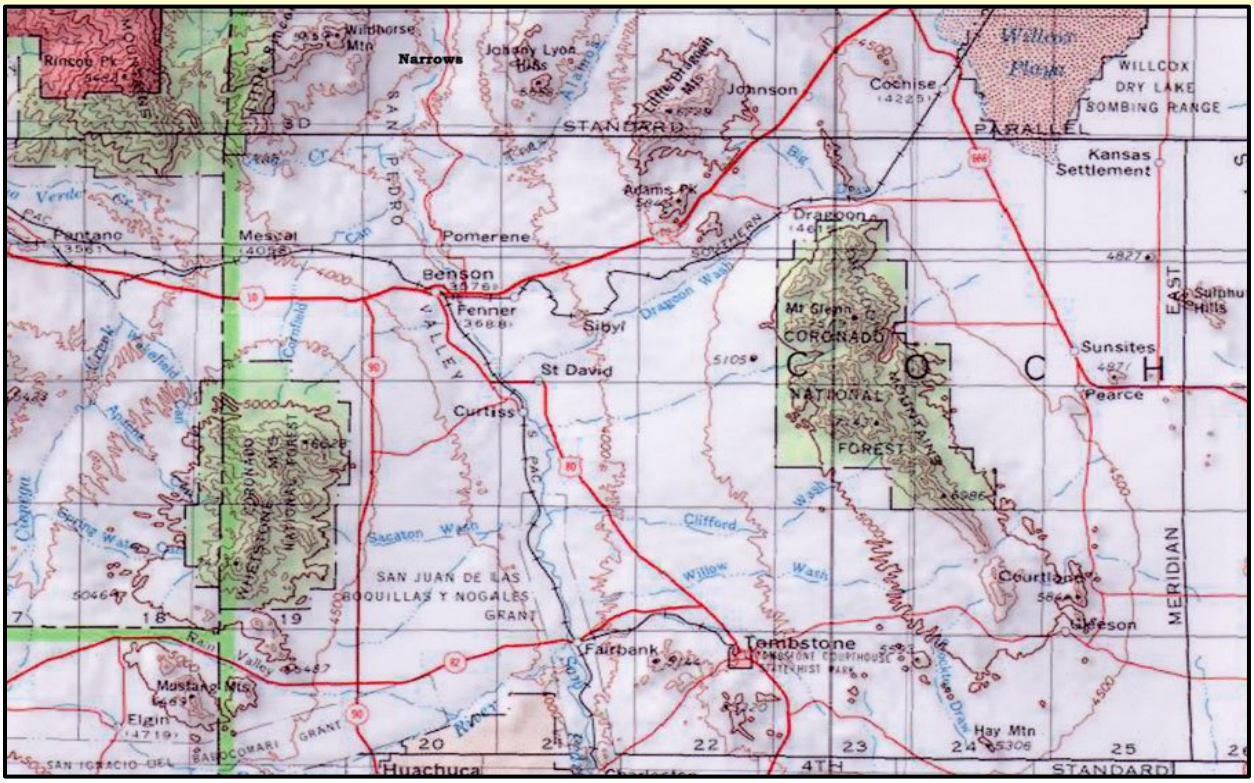


(Image adapted from Steadman, DW and Martin, PS, "Extinction of Birds in the Late Pleistocene of North America" In ***Quaternary Extinctions: A Prehistoric Revolution***, Martin PS and Klein RG. editors, Univ of Arizona press, Tucson, 1984.]

For a general outline of the archaeological history of the river, see **Archaeology of the San Pedro Valley**.

The Middle San Pedro: Benson Sub-area

From Near Fairbank to The Narrows including St David Springs and St David along SPRNCA

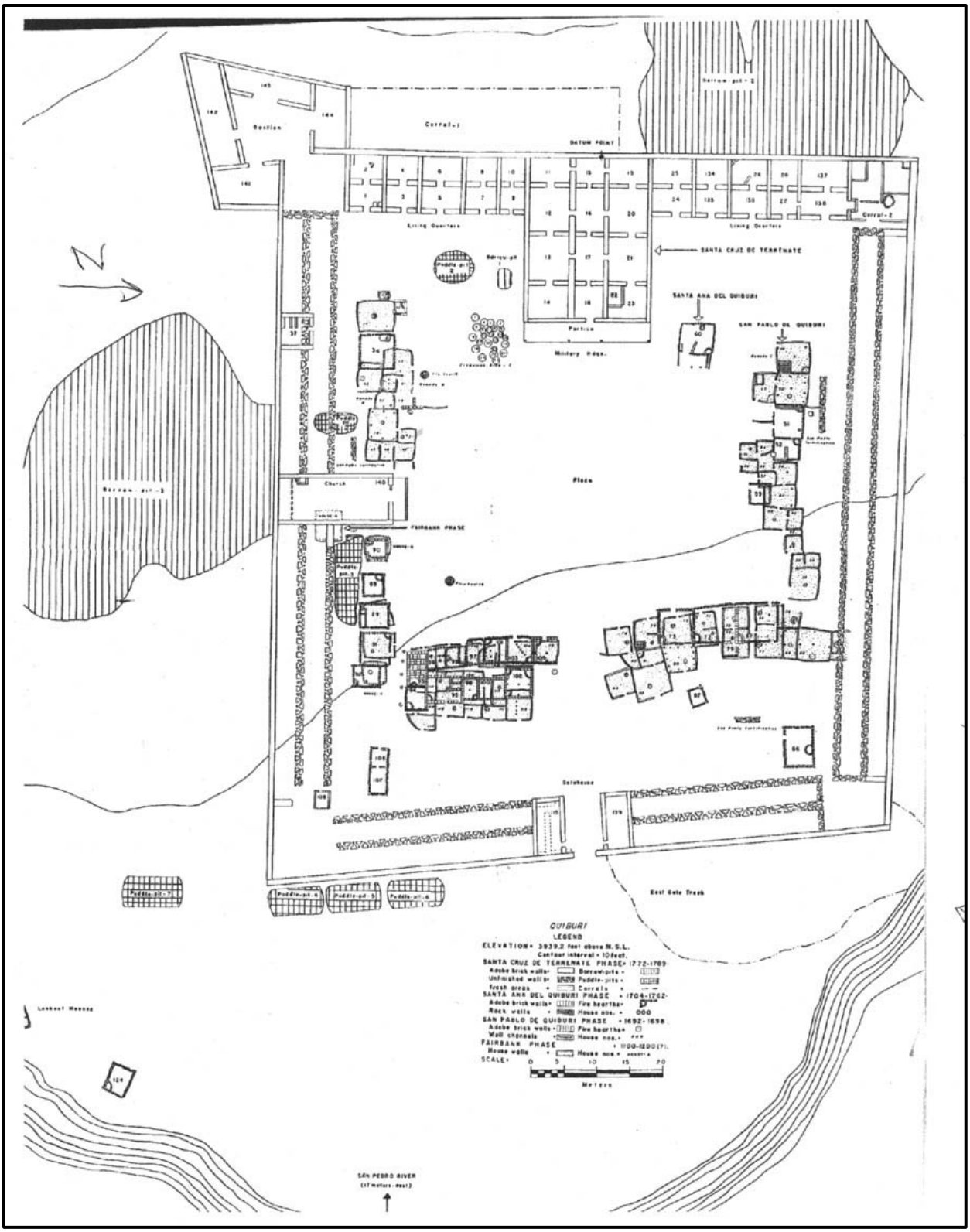


In this part of the drainage, the main flanking Sky Islands are the **Whetstone Mountains** and the **Dragoon Mountains** (both of which are mostly National Forest land). The **Little Dragoon Mountains** lie mainly to the north of the I-10 freeway. As you can see on the map, two substantial paved highways, AZ State 90 and US 89, run north-south paralleling the river corridor on each side. These are both high-speed motorways and therefore constitute significant barriers to between-mountain movements by terrestrial vertebrates.

Below: looking southeastward toward the **Mule Mountains** (and the location of Bisbee) from near Fairbank, Arizona: gallery forest of the Babocomari Stream drainage in the foreground, running from lower right to middle-left; San Pedro River Cottonwoods et al. in the farther distance, both rivers running from right to left. (July 2002) This image, which looks from the southern edge of the Middle San Pedro out into the northern portion of the Upper San Pedro, illustrates the very broad width of the valley south of Benson.

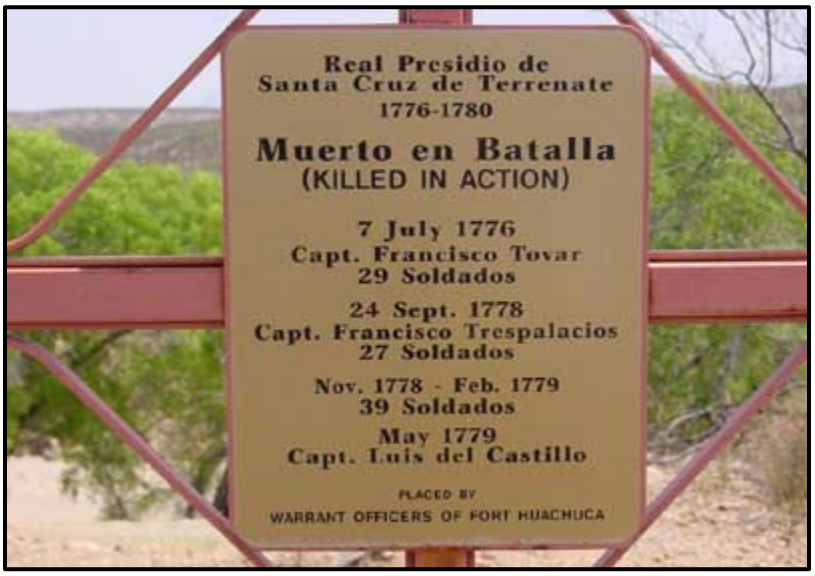
Below, the broad San Pedro River floodplain photographed (looking north) from a nearby location at the terrace site of the ruins of **Santa Cruz de Terrenate**, the Spanish Fort built here in 1775. (See that link for a brief history of this fort.) Archaeologist T.J. Ferguson (at left here) led our first tour here on July 17, 2002:

Note the faint adobe mounds marking the ruins of the "captain's quarters" in the middle distance. **Below**, a copy of the map of the fort prepared by Charles Di Peso, the archaeologist who originally surveyed and dug portions of the site in 1950.



As you can see, this complex was a substantial, high-walled enclosure (complete with both chapel and diamond-shaped bastion intended for cannon

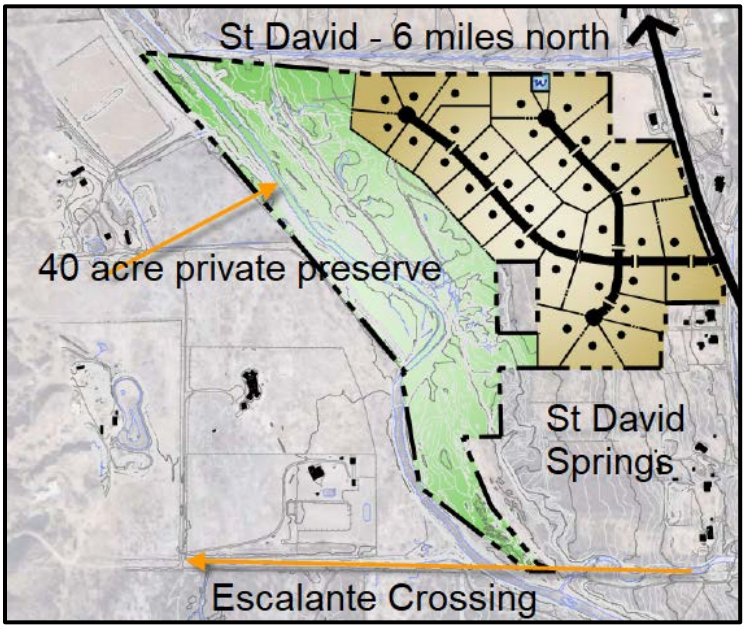
emplacements), a presidio which the Spaniards founded as a permanent base for subduing roving predatory Apache bands who were then dominating the area. Unfortunately for these medieval-fortress warriors, the Apaches routed them using guerrilla tactics without loss to themselves, forcing the Spaniards to abandon the entire post after only 4 years. Note **below left** in the foreground of the photograph (taken from the eastern fringes of the fort), the railway, which dates from the 1880s mining era, and the river floodplain a short distance beyond it and dry during this July visit.)



Further north, the western bajadas of the San Pedro River south of Benson stream out of the **Whetstone Mountains** in long straight lines of alluvium (see the image **below**, where the central horizontal strip marks part of a very long

bajada). This photo also nicely shows the tilted fault-block shape of these Basin-range mountains.

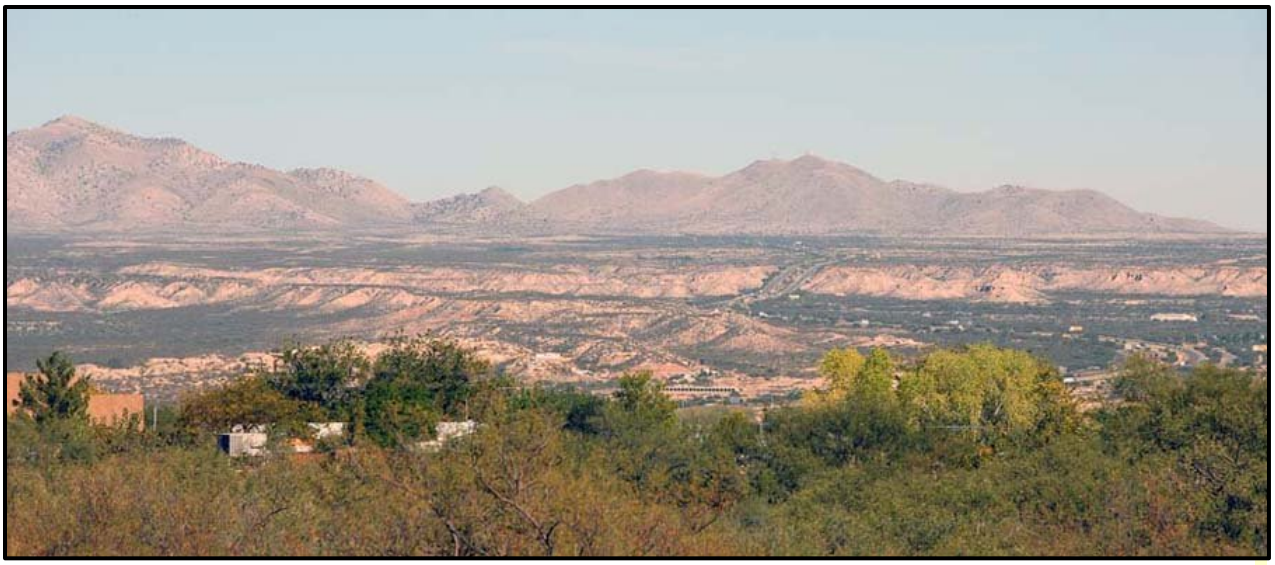
The picture **above** was taken from Kartchner Caverns State Park April 17, 2005, looking from the other side of the bajada toward the southwest, where the escarpment tilts down from its apex toward the west. Note the close grass cover in the foreground, part of the **Apache Highlands Grasslands**. An informative video presentation of the geological and hydrological history of this part of the San Pedro River Valley may be viewed at this link: **Kartchner Caverns Hydrology**. And see **Whetstone Mountains** for more details on this, a lesser (but by no means insignificant) Island in the San Pedro Valley portion of the Madrean Sky Island Archipelago. See the link just listed for more details on Island-Corridor relations here.



Left, 6 miles south of St David is St David Springs. A lush area along the farms that abut the San Pedro River. SPRNCA begins at the south point of **Escalante Crossing** and immediately above the crossing is a lush 5-layer vegetation habitat of natural ground cover to towering cottonwood trees…. A haven for birds and wildlife. This private preserve is a wildlife ecosystem that welcomes and protects the birds and mammals of the San Pedro

Below, a view of the **Dragoon Mountains** taken from the hills above Tres Alamos Wash on the San Pedro in August 2007, looking east-southeast. A complex mix of intrusive granitic rocks and faulted/folded metamorphosed sedimentary rocks, these mountains rise abruptly from their grassland plains and contain much chaotic terrain. This range rises up in an important part of the **Apache Highlands** and is an important part of Apache Indian history as well. See the "Dragoon" link above for more details on Island-Corridor relations.

Below: the "pink cliff" terraces that surround Benson, here viewed from the west-side terrace in the afternoon of October 26, 2008 looking east across the San Pedro River floodplain with the **Little Dragoon Mountains** in the background. (Note the multi-lane US I-10 Freeway rising over the terrace just right of mid-picture.

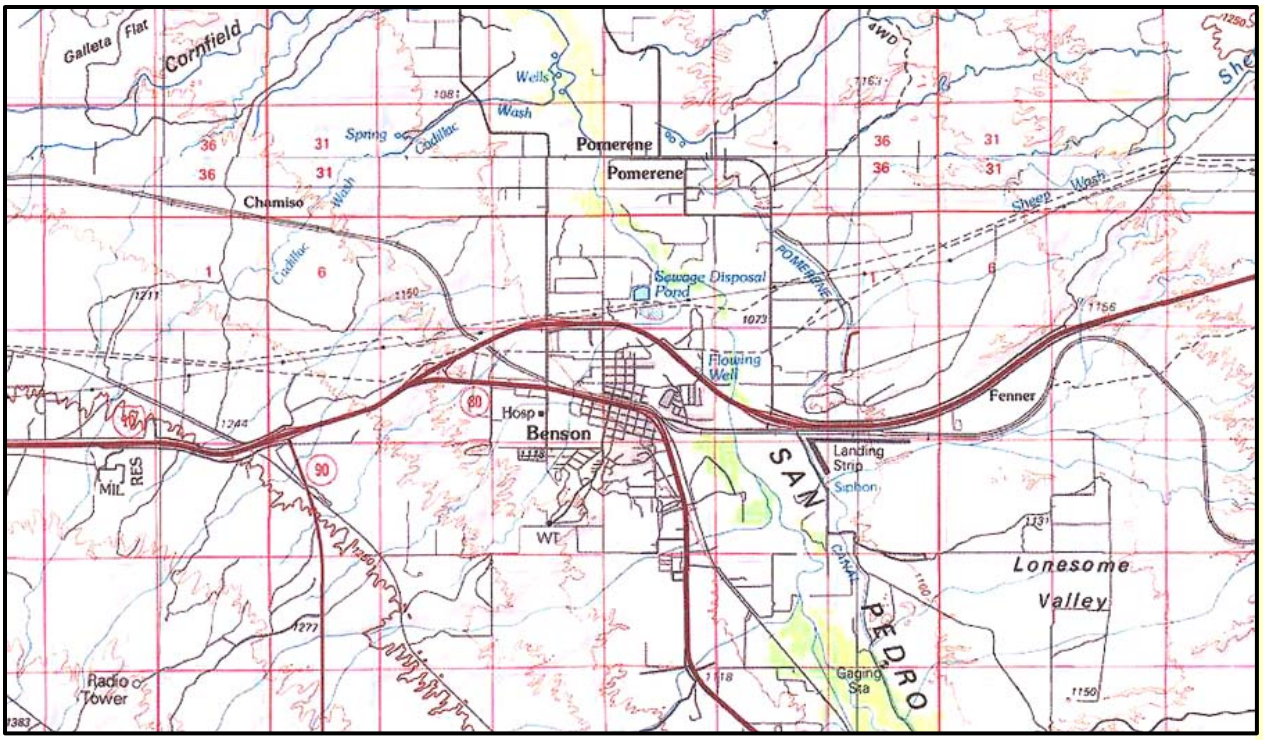


These pink cliffs are sedimentary remains of the **St. David Basin Lake of Pliocene times**: (before the Gila River captured the San Pedro Valley basins, which had previously contained several interior-basin lakes). **Below**, a closeup view of these old lakebeds from near the base of one terrace:

Below, a closer view of lakebed formation taken on March 21, 2008. Here exposed beds stand some 50 feet high along the large wash that drains the Dragoons Mtn. bajada just north of St. David:

The sediments originally deposited in this very extensive lakebed consist of as much as 900 feet of clays, silts, and freshwater limestone (see the "silt and clay" layers in the cross-section displayed in the USGS diagram further above), and they tend to confine the vertical movement of ground water in the basin, creating aquifer conditions that sustain the distinctive **artesian wells** found near the town of St. David. (See Thomas Blakemore, above and cited in **Geology Credits**.) These have of course proved advantageous to farmers here, who settled the area since prior to the 1880s.

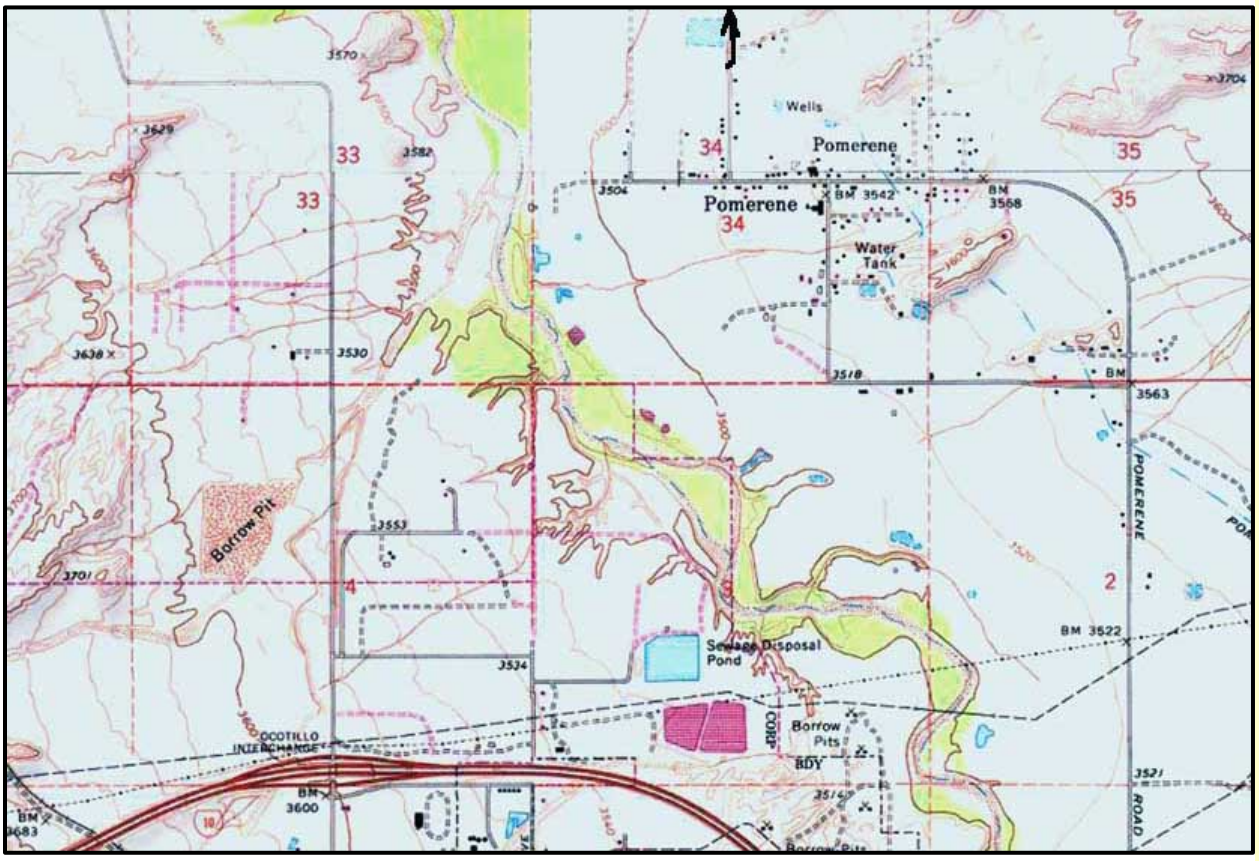
The city of **Benson** lies on the western edge of the river, and forms the main vehicular intersection of the area. The map **below** shows Interstate Highway 10 running east-west past the city, dropping from an **Apache Highlands Grassland** terrace elevation of more than 4160 feet to the west down to 3500 feet at the river crossing. The highway then rises in altitude toward the east, reaching 5,000 feet elevation at the Texas Canyon summit.



The largest city in the Middle San Pedro Watershed (with a population of ca. 4900 in 2005), Benson was established in 1880 when the Southern Pacific Railway made its San Pedro River crossing (the city name is that of a friend of the Railway's President at the time). Its numbers might well increase to more than 50,000 by 2025. San Pedro River groundwater is its primary source of water and hence anticipated increases in groundwater pumping will soon threaten quality of life around here (including riparian habitat). Sources of decline in streamflow of the San Pedro River here also include changes in upland land-cover and riparian vegetation. Quality of water remains good for domestic, governmental, and commercial uses (though there a 9-square mile area of contaminated ground water just SW of St. David (now designated as an EPA Superfund site). [See Blakemore cited above]. As in the St. David area, the basin fill around Pomerene contains clay deposits from the ancient lake, so artesian wells are found here too, and these are much used by local farmers.

The Town of Pomerene

On the map **below**, the black arrow at the top indicates the location of the **Cascabel Road**, the main roadway down the river valley, which stays on the east side of the river all the way north past Redington. (Another road follows the west bank, but it ends well south of Cascabel.) The Pomerene Road becomes the Cascabel Road about 5 miles north of the I-10 exit.



This hamlet, still substantially a farming community, is partly occupied by descendants of the **Mormon Battalion**, a nineteenth-century branch of the Iowa infantry mustered in 1846 during the Mexican War, who's soldiers marched up the San Pedro River on their way toward Tucson (then part of Mexico) and encountered the environmental wonders of the place. Near the **Benson Narrows**, they were accosted by a herd of stampeding wild cattle, with the reported result of ten to fifteen bulls killed, two mules gored to death, and three men wounded. (see "**The Battle of the Bulls**", which includes this beautiful picture taken somewhere near the site of the battle (south of the Narrows).

We mention this event to make the historical point that, as Webb, Leake, & Turner observe in their monumental book ***The Ribbon of Green*** (U. of AZ Press 2007), the episode reflected the introduction of large herds from Mexico by homesteaders in this area after 1832, which was followed by intensive raiding by Apache bands, causing the homesteaders to abandon their large ranches around 1840. Since the Apaches selectively culled cows, the large wild herds that remained in this area at the time of the Mormon Battalion were almost entirely bulls -- a very dangerous herd of wild animals indeed. (Webb, Leake, & Turner note that they were gone from the area by the 1850s. See p.223 in that source.)

We hope to insert more history of Pomerene into this space as becomes feasible, and would of course welcome Pomerenians to contribute credited essays to it.

Below, a view of the Benson/Pomerene valley taken in January 2007 from the top of a "pink cliffs" terrace located to the northeast along Cascabel Road, looking southward. The center of Benson lies roughly in the center of the image. Note the very broad bajada slope behind the city running from the

flanks of the Whetstone Mountains at the right all the way out of photo to the left. The river crosses the image laterally, running from south-southeast toward the lower left to north-northwest at lower right. (Its course is roughly visible in the scattered cottonwood trees running along it, whose seasonally gray crowns stand out from the darker background.)

Approaching the Heart of the Middle San Pedro Watershed:

Tres Alamos Wash

In the image **below**, the broad floodplain of **Tres Alamos Wash** runs from near lower-right to mid-left foreground, then bends sharply rightward against the high terrace which slants across the photo from above-mid-left to the upper center of our view. (This terrace formation dates largely from the time of the **St. David Formation Lake** of the Pliocene period).

The constriction of the valley may be seen at this point, where the terraces on the east side of the river reach down close to those on the west. Beyond the far lower end of the mid-left terrace, you can see a short horizontal strip of pale green, marking irrigated farmlands and buildings located on the San Pedro River floodplain. (A Hohokam ruin is located near this confluence, which is referenced in early Spanish accounts.) Across the valley, counterpart near-horizontal-appearing Pliocene terraces are visible, with the **Little Rincon Mountains** above them and a blue-cast **Rincon Peak**, at 8,482 feet the second highest peak in the **Rincon Mountains** complex, rising further behind. All of these mountains are part of the **Catalina-Rincon Metamorphic Core Complex**, largest example of this type of geological formation in the southwest. The bajadas on the far side of the river have remained part of the prehistoric **Apache Highlands Grasslands**. (See also **Apache Highlands Ecoregion**). Just upstream from and out of view to the left of the Pliocene terrace formation at mid-left, **Ash Creek** runs into the San Pedro from its source in **Happy Valley** in the shadow of Rincon Peak. And for an overview of our valley's vegetation, see **San Pedro River Valley Flora Today**.

These two converging washes -- Ash Creek running down from the high Rincon Mountains and Tres Alamos Wash draining the Winchester Mountains -- point to a typical feature of the entire valley, which will be remarked from this location northward: essentially, **the whole area is a crisscross** of **wildlife corridors** - routes by which plant and animal species may move, in this case from one "**sky-island**" and its foothills to another (and of course moving from

highlands to valley floor depending on the seasons), thus maintaining numbers and genetic diversity. But this life-sustaining movement greatly depends on the quality of that valley floor (here, the cross-cutting San Pedro River and its hinterlands). For details on the transitions and the ecological import of these complexes, see

Topo maps we present in our discussions below will illustrate only a few of these corridors, which are however multiple and connect both the **Santa Catalina** and the **Rincon Mountains** on the west to both the **Galiuro** and the **Winchester Mountains** on the east. Many of these washes contain springs, permanent streams in their upper reaches, including populations of fish, and mountain lions and bears purposefully walk down some of these washes following pools of water on their way to the river and beyond. Population pressures in one area may stimulate species recoveries in another.

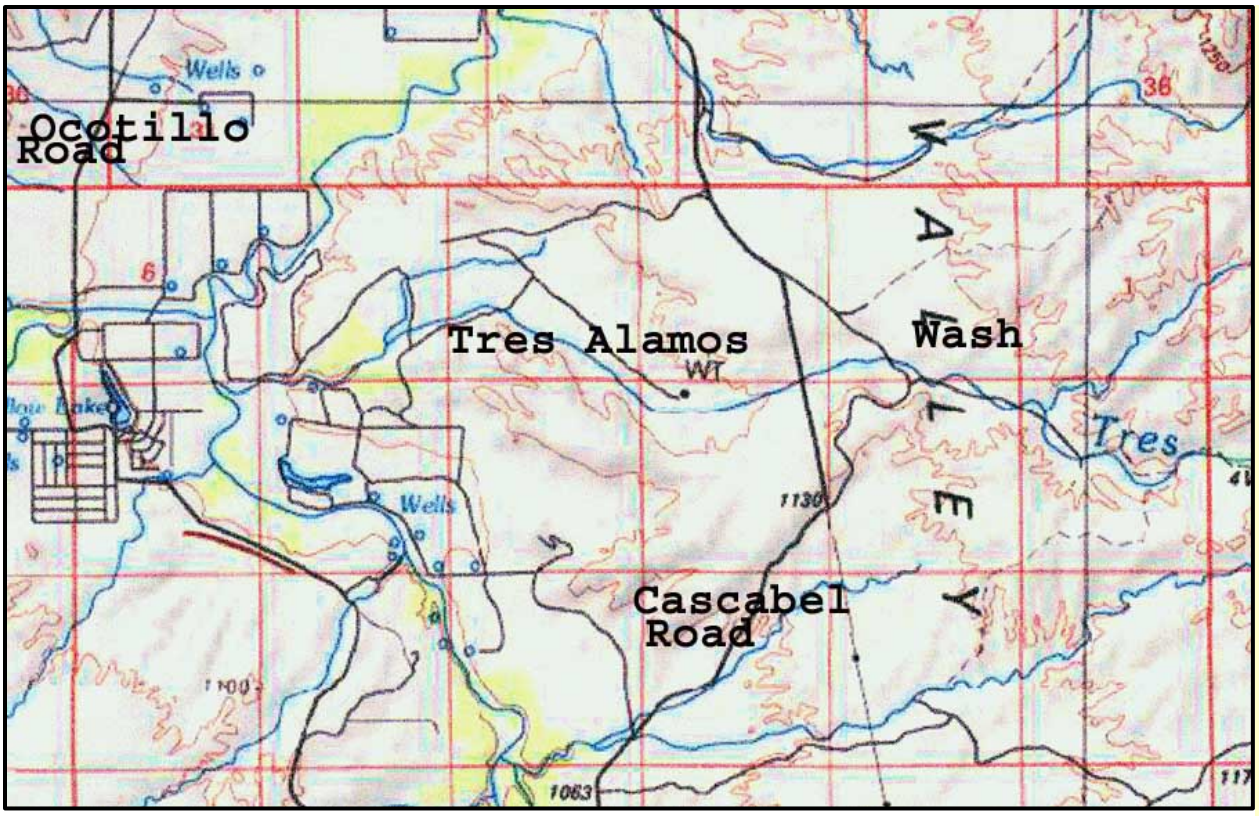
However, the ecological importance of the area has not prevented developers from trying to drive "improvements" through it in the past:

Any one equipped with a sense of the importance of history to our understanding of the present and future (not to mention the past) will appreciate that along what is now the **Cascabel Road** (the sole current route running up the east side of the river from Benson to San Manuel) one may see major evidence of previous human efforts to alter the landscape quite drastically. Follow briefly with us enroute toward Cascabel on this road in order to observe this historical evidence.

While the River flows in roughly a north-northwestwardly direction out of Benson, North of Pomerene Cascabel Road turns northeastward and rises fairly steeply out of the floodplain, past flat sedimentary layers of the St. David Lake Formation, where at the top of the highest terrace nearly 5 miles out of Pomerene it turns northwestward into a very large road cut. **Below**: In one of the two massive, freeway-like road cuts that bracket a very substantial bridge placed across Tres Alamos Wash (see more below!), you can observe a closeup example of the old St. David Lakebeds (between milepost 4 & 5.

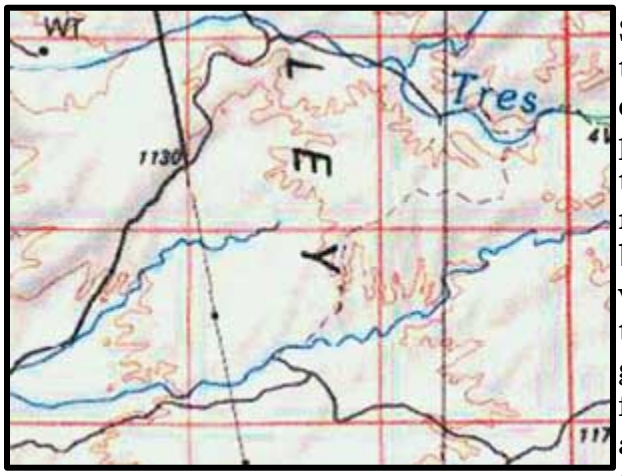
A Previous Effort by the Arizona Department of Transportation, aiming to Build a Very Large Road Here: The Aborted "Grand Roadway"

This map **below** shows how the Cascabel Road (at right-center of the image) bisects the Tres Alamos Wash (which runs from east to west into the San Pedro here, coming from its sources in the Galiuros and Winchester Mountains. **Note the unusually arrow-straight NNW-SSE line of the road along this stretch, and also the map-projected straight line extending that line further south-southeastward**. At the far left of the map you can also make out a portion of the Ocotillo Road, which runs generally northward from Benson along the west side of the River. [Maps in this text are adapted from *TOPO!*.]



In the late 1980s, the Cascabel Road was a dirt road where it crossed the Tres Alamos Wash, but incongruously it contained these very large road cuts shown **below**, associated with the large and rather expensive bridge which had been built across the Tres Alamos Wash. These images show, at **left**, a view of the bridge, the arrow-straight road and the two grand cuts taken from the north; at **center**, the southernmost cut viewed from the south end of the construction zone (the existing Cascabel Road enters the cut from the middle-left of the photo, turning sharply into the cut as you go north); at **right**, a view from the north looking toward the projected road's southern direction, which until recently had a sign proclaiming "Road Closed" (now only a remnant remains). (Photos taken in March 2004.)





Since beyond this sign toward the south the land drops away abruptly in a series of deep ravines running nearly perpendicular to the apparent target of the road -- U.S. Highway I-10 some 7 miles to the south -- the prospect of building a road further in that direction would seem very daunting indeed (not to mention that of cutting similar gashes through the various lands further north). One understanding (not at this point confirmed by us) relates that in the late 1970s some members of the ADOT pushed this project into construction in order to provide a better and shorter link between the San Manuel mine and smelter and other mines located along the Mexican border. The project foundered due to **conflicts over funding**, recognition of the **ruinous costs** that would be incurred in order to complete it, and "**issues of drainage**" -- the newly established **EPA's requirements rendered the plan untenable**. The lower portion of the topo map (**at left)** still indicates the wishful projected direction of a road extension aimed at I-10 in a straight line toward the south-southeast across what is on the ground an array of deeply cross-cutting, bridge-demanding washes. The expense of completing this project on this southern end alone would have been enormous indeed.

We who love Cascabel know that everyone owes the present relative wildness of the Cascabel portion of the San Pedro River Basin to the fact that the project was not completed at that time, since a road of this caliber of "creative destruction", though at the time conceived to be only two-lane, would surely have been thoroughly paved, and Cascabel would by now be a bedroom suburb of Tucson (not to mention drastically transformed as an alien presence from a wildlife point of view). But like Frankenstein, versions of this plan to "pave paradise" apparently refuse to die -- in 2007 ADOT studied the feasibility of a much larger (4-lane or more) highway to bypass Tucson enroute to Phoenix and points further west. Only strong and persistent active popular resistance forestalled this project.

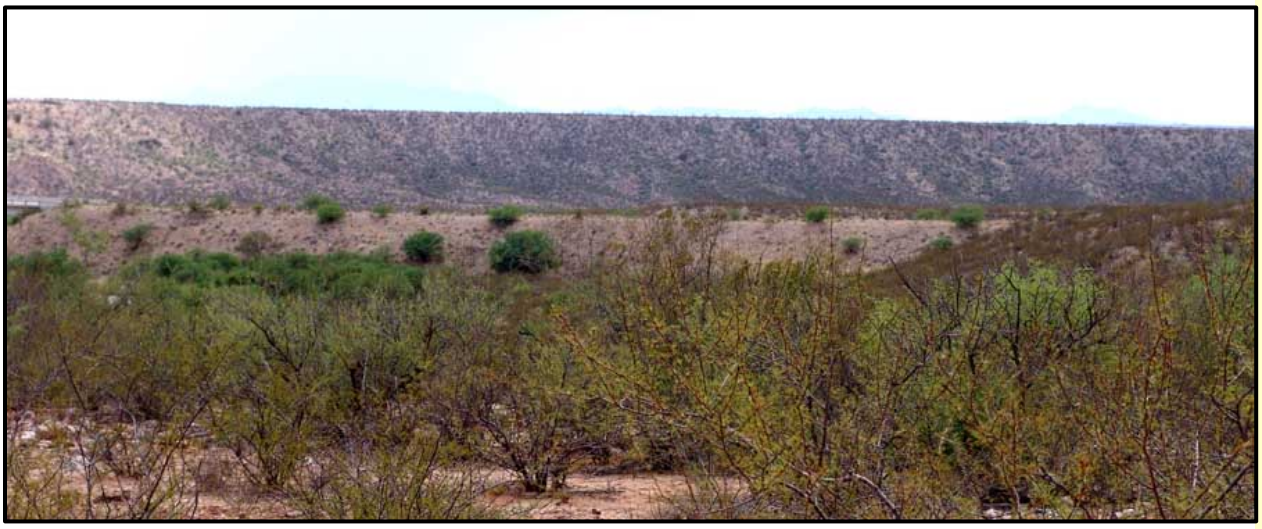
Some Low-Ground Details: the "Grand Roadway" of the 1970s

Only by approaching the roadway from beneath, that is from the position of the Tres Alamos Wash which it overruns, can we see the true expense that this construction entailed.

Below, massive pillars stand in mid-wash, supporting a very extensive span. Flanking them, the ramps which embrace and constrict the wash.

Below, the south ramp, employing no doubt materials from the Grand Cuts but some other materials as well.

Below, the north ramp, whose grounding materials would perhaps largely come from elsewhere.



Below, the view of this whole twentieth-century operation seen from the second terrace of the post-Quiburis (<7.5-5.5 Million years ago) wash. The high terrace at horizon view is composed of remains of Quiburis deposition. The first terrace is out of view below to the left, just above the floodplain. The north ramp of this Grand Bridge system merges with the third terrace at mid-right in the image.

This downstream constriction of the natural drainage has, over an approximately 30-year period, produced an "inland delta" just upstream by systemically slowing the wash's flushing processes.

Aside from the expense of construction, **such great side-dams significantly alter wash ecology**. Our point here is not that the change to be explored here is necessarily good or bad -- we do not know. But the fact is that the ecological changes were largely unintended, unconsidered, indeed (to the planners and

builders) probably for the most part unimagined, and they are without question real.

Our point in bringing this to you is not to bemoan the presence of this great, impressive Destructive Creation. The point is that further downstream along the Middle San Pedro river valley, this kind of earth-and-concrete-and-steel workswould have wreaked real havoc in the narrower, more intensely dissected, and -- yes -- biologically richer locations there. (And this was the avowed aim of the ADOT I-10 Bypass project we opposed from its inception in 2007 through its rejection in 2008. See the **Original sanpedrorivervalley.org** website linked here.)

For more on the hydrology and vegetation of the Tres Alamos Wash at this point, see

Ecoregional Features: Tres Alamos North

Beyond the Grand Cuts shown above, the road turns north-north-westward as you go downstream and drop down toward the River.

The old terrace flanking the Tres Alamos Wash displays a fine array of plants typical of the **Chihuahuan Desert Ecoregion**. ***Yucca elata*** (at **left**) are very prominent here, and they may be seen all the way downriver to Cascabel (though at that location they become limited to the river floodplain and near vicinity, while ***Yucca baccata*** replaces them in the uplands).

Yucca species and their relatives are important indicators of ecological conditions as well as valuable plants in their own right. For more on the subject, see **The Agaves and Nolinas**. (And for a broader reference guide to the vegetation of the area, see **San Pedro Valley Flora: Today**; for a comparison in deeper time perspective, see **San Pedro Valley Flora: in the Pleistocene**.

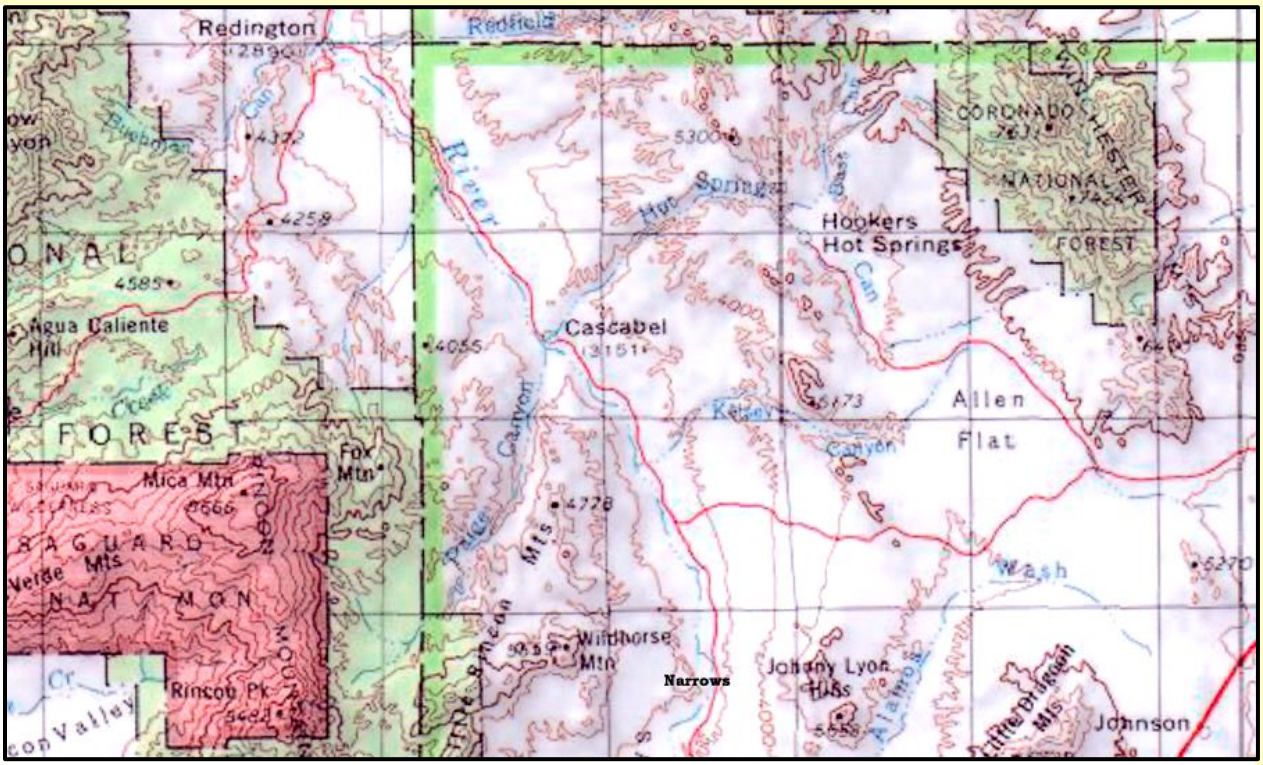
Note also the Desert Grasslands filling the ground in the image at left.

In March 2005, the gray hills of the Little Rincons foothills which approach the River at this point, **below**, were covered with **Mexican Spring Poppy** blooms.

A newcomer to the area may sense the diversity of wildflowers in our area by consulting the following link: **Wildflowers**.

The Middle San Pedro: Redington Sub-area

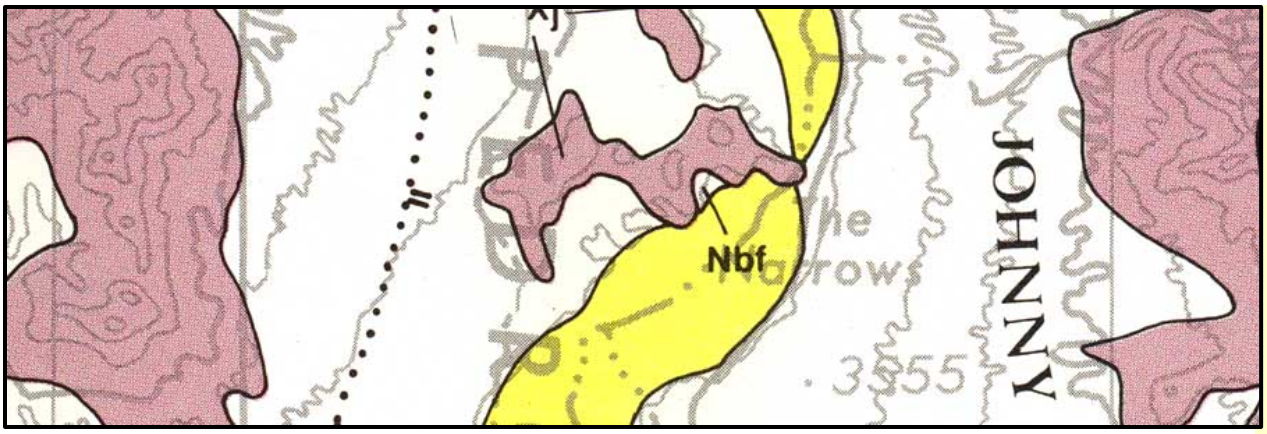
[from the Narrows to the Redington Bridge Gaging Station]



Below, see **the Narrows** -- or the "**Benson Narrows**", a sub-watershed designation that distinguishes it from the Narrows further downstream near Redington (see further below, the "**Redington Narrows**"). This Narrows (note the distinct rock-outcrop "edges" at both left and right) marks a geological (and hydrological) boundary between the upstream portion of the River and the part located further downstream. This view of the Narrows is from the **downstream** side looking toward the southwest. (May 2007)

Note in the image the distinctly riparian tree in the lower left, standing out among a stand of mesquite trees. Note also the strongly ascending slopes of the uplands beyond the west bank of the river here, uplands that rise to the nearby peak named Whitehorse Mountain in the Little Rincon's. This tree marks the forcing of groundwater to the surface by the impermeable underlying rocks.]

The basis of this hydrogeological separation lies in these distinctive rocks, which are part of the "Johnny Lyon suite of granodiorite... which may form a single composite pluton" forming the geological basement of this area, and which extend under the Narrows. These rocks are some **1.65 Billion years old**. (**Map below** and text adapted from Dickinson's monumental work of **1991**. The yellow Formation shown **below** is contemporary floodplain alluvium, while the rosy-brown color marks exposures of the Johnny Lyon suite. The white marks massive terraces of roughly Quiburis [7.5-5.5 Mya] age.)



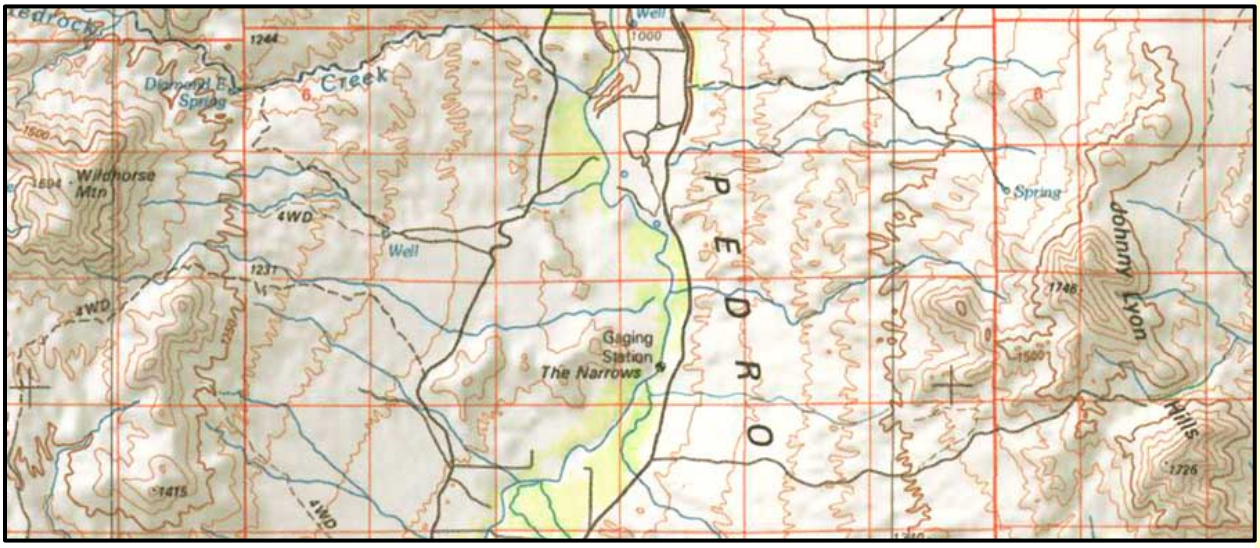
A few images of these extremely ancient rocks are perhaps in order. **Below**, an outcrop along the eastern hillside of the Narrows:

Below left, a closeup view of one of the rocks; below **center,** the crystalline structure of the granodiorite; below **right**, in contrast, the much more recent **St. David Lake-bed Formation** that overlies these basement rocks, visible just across the Cascabel Road at this same location.

These two images of the Benson Narrows **below** are from August 2002 (**left**) and January 2005 (**right**), both looking downstream through the Narrows from viewpoints just east of the Cascabel Road. In both images, Bassett Peak of the **Galiuro Mountains** is framed in the distant background --near the center horizon in the left image, and well to the right in the right image. In the **left**-hand view, taken from further upstream, **Sierra Blanca** is just visible in reddish brown behind the left edge of the Narrows, while in the **right**-hand view the image is pointed in a more northerly direction and is taken from a slightly higher hill.

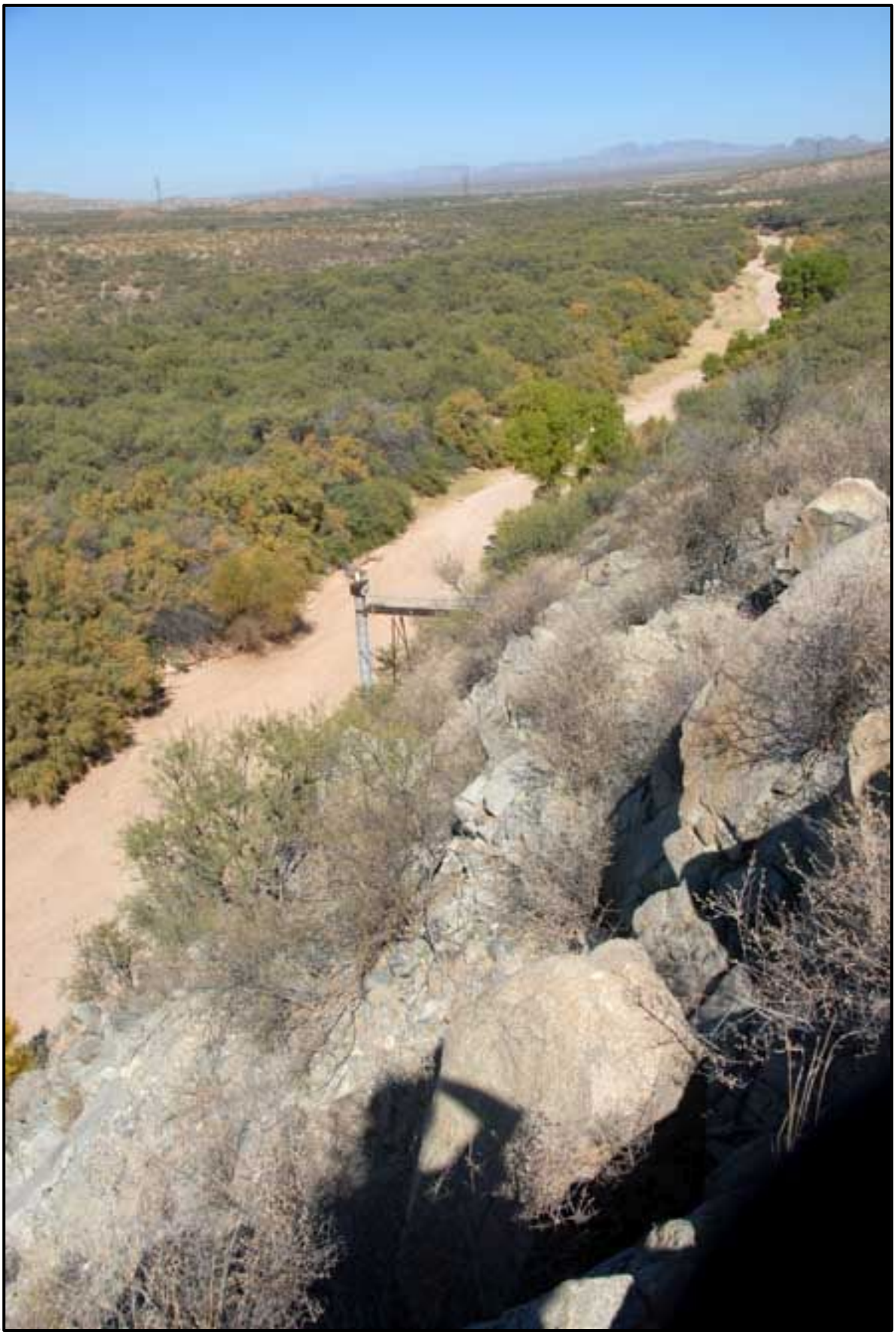
..

Below, a map of the Narrows showing its location relative to the Cascabel Road. The rock formations that straddle the Narrows are ancient (structurally similar to those of the **Johnny Lyon Hills**], but those bounding the roadway are much more recent, lakebed formations connected with the Pliocene St. David Formation further south. (Note the springs on each side of the watershed.)



Below, a view across the Benson Narrows looking west. The lip of the Narrows is in the near foreground, Wild horse Mountain in the distant far right.

Below left, a view in October 2007 from the lip of the Narrows looking upstream. Standing water is visible in the lower left quadrant of the image. **Below,** from the lip looking downstream, the wash is entirely dry at this time. The Gaging station is visible in mid-photo.



Below: the visually striking **Johnny Lyon Hills** rise above the San Pedro east of where it runs through the Narrows.

After passing the Narrows, the river course drops suddenly, and the valley vista greately widens. **Below**, near milepost 11, this drop becomes a striking feature of the road, and the floodplain below is far from the current course of the river. (Note **Sierra Blanca** at middle left, and the Red Peaks of the Western Range southern extension of the **Galiuro Mountains** at right. The much higher Eastern Range is here obscured by overflowing, cascade-descending clouds in the lower-left portion of the upper-right quadrant of the image. (April 2004)**.**

Below, a view taken on June 28, 2008 from near the same location, now looking in a more northerly direction toward the floodplain of the Three-links Farms.

Ecological Richness of this Sub-Area

From the Benson Narrows northward, we enter the Redington Sub-area of the Middle San Pedro Watershed. Over a four-mile stretch of the River straddling the Benson Narrows, the riverbed drops about 40 feet, a hydrological change where deep valley fill upstream encounters this bedrock outcrop that forces water to the surface.

Early 19th-century explorers reported that below the gorge at this point, the then-perennial stream spread out over the lower floodplain, forming sporadically extensive swamps running all the way past Cascabel and containing beaver dams and large fish. For more on the history of this area's hydrology, see this link on **Cienegas**.

From the Narrows, northward to Redington, the aquifer is narrower and thinner than that to the south, and for most of the area it lacks the clay beds found further south that confine the groundwater (though in several locations the flowing river water still rises to the surface).

Below: **Fremont-Cottonwood-Goodding-Willow Gallery Forest** marks the zig-zag San Pedro River channel near the **3-Links Farm** near Milepost 13 (October 2002):

Today, the entire river basin contains long strips of this Cottonwood/Willow riparian gallery forest, which is one of less than 20 such riparian zones in the world. This forest sustains a highly diverse wildlife, including large numbers of migratory birds and a variety of vegetation forms. For a quick take on our birds, see this link: **Birds**; or see **Arthropods**; for accounts of terrestrial vertebrates, see for example **Mammals**, **Reptiles/Amphibians**;

Below, the "Ribbon of Green" seen from the Quiburis-formation terrace above at the 3-links Farm on July 6, 2007. The central, higher ribbon of somewhat brighter green is Fremont Cottonwood-Goodding Willow Gallery Forest; the lower, darker green flanking it is mesquite bosque.

Below: at the 3-Links Farm, the river becomes a perennial flow for a considerable stretch (cattle have been fenced off the immediate floodplain here for many years). When this picture was taken in February 2003, **Dace** were spawning in the streambed. Here we're looking upstream.

Recently, **The Nature Conservancy** bought this 3-Links part of the River, and ceased the agricultural pumping of river water (formerly done to grow alfalfa), and over several years the perennial stream has expanded more than a mile in length (though this varies depending on drought intensity).

For details on the current condition of our **native fishes**, see this link: **Native Aquatic Species (Gila River Basin AZ & NM).**

For more information and images showing the biological richness of the River along this 3-links stretch, we present this this side tour, well worth taking,

which shows a region as rich in biodiversity as (and in some ways richer than) the federally-designated SPRNCA of the Upper San Pedro Area, discussed briefly elsewhere in this account.

The Nature Conservancy 3-Links Tour, April 2005

On April 24, 2005, **Ralph Waldt, the Naturalist for then-TNC's 3-Links Farm**, led a Nature Walk along a portion of the stretch of San Pedro River which TNC has worked to restore. **Below**, Ralph introduces the subject to a group of ecotourists near the riverbank.

The group rested at several points along the river. Note the gallery forest cottonwoods, common throughout the area. This forest, characterized by a **Fremont Cottonwood-Goodding Willow** association, is unique among North American forests. According to Ralph, about 4 1/2 miles of perennial water now flows through the 3-Links lands, and considerably more may emerge depending on drought conditions. The San Pedro River is the last free-flowing river in the entire desert Southwest.

At one point in our walk, Ralph picked up some lengths of bark-stripped logs lying along the riverbank and observed that the San Pedro has again become a "beaver river". (See **Beavers along the San Pedro**.) The two images **below left and center** show the teeth marks made by a beaver in cutting the tree, while the one on the **right** shows those made when one consumed the bark.

According to Ralph, this beaver moved in from upstream (where a beaver population has been recovering for some time), and was in the area during 2004, but was presumably washed downstream with the seasonal flooding of

the River sometime last year. More will probably appear here from time to time (though so long as the river's periodic massive flooding pattern continues, their stays may be temporary).

At another point, people were discussing plants, birds, and other fauna seen along the stream way. Note the dark clay strip running horizontally along the lower portion of the cut-bank behind them.

Ralph suggests that these dark clay layers, which appear along the river at a number of points here, mark the presence of prehistoric swamps, or in some locations **Cienegas**, known to have been widely distributed along the River in this area prior to the 1890s, when the River began the downcutting which has led to today's typically fairly deep entrenchment in many places. In the photo

above, the dark deposits marking older swamplands are overlain by several feet of subsequent deposition prior to the entrenchment. As the group continued its tour upstream, we came upon other patterns of clay layering, as shown **below:**

Here the swampy deposits have a depth of fifteen feet or more, and continue right to the topmost layer, indicating that a swamp (or cienega) must have been present here immediately prior to the 1890s entrenchment, and must have existed here for hundreds, perhaps thousands of years before.

A short distance upstream, we saw **below** -- in a clay layer some 15 feet below the top of the old floodplain -- collections of **fossil freshwater molluscs** eroding out of the deposits**:**




In the images just **above**, at **left** the fossils are barely evident from a distance, but closeup a considerable variety of shells may be seen, and at **right** some have weathered out and now lie under the water in today's streambed, where they will eventually be deposited further downstream in a second sedimentary formation.

Further upstream, we encountered stands of **Coyote Willow (*Salix exigua* Nutt.),** a kind of willow tree infrequently seen in our area but an important riparian stabilizer, which is now spreading along the River at this point. In the image **below,** it is the relatively pale green, low and densely packed cluster at left center, in front of the towering lone cottonwood:

Coyote Willow pioneers flood deposits along a river's edge, and forms dense thickets which both retard erosion and provide both food and habitat for wildlife. It is a favored food for **Beavers**, and a critically important habitat for the **Willow Flycatcher**, an **endangered bird species** in our area. **Left**is a closeup of the foliage:

Another riparian plant which is rare in our area but found along the San Pedro River at 3-Links is the **BurrReed Sedge (*Carex sparganioides* sp.)**, shown **below.**

Members of the Sedge Family (Cyperaceae) resemble grasses and rushes, to which they are remotely related within the Order Poales (monocotyledonous flowering plants). They generally grow in wet locations. The inconspicuous flowers of the Burr Reed Sedge may be seen in the close-up image above.

We did not observe fish swimming in the river on this occasion, but they are plentiful and varied. For more details on the fish of one tributary in our area, see **Saguaro Juniper Fish**.

We encountered numerous Monkey Flowers (*Mimulus* spp) blooming alongside the river.

.....

We also saw numerous birds along our route, including Gray Hawks, and managed to obtain distant images of the following.

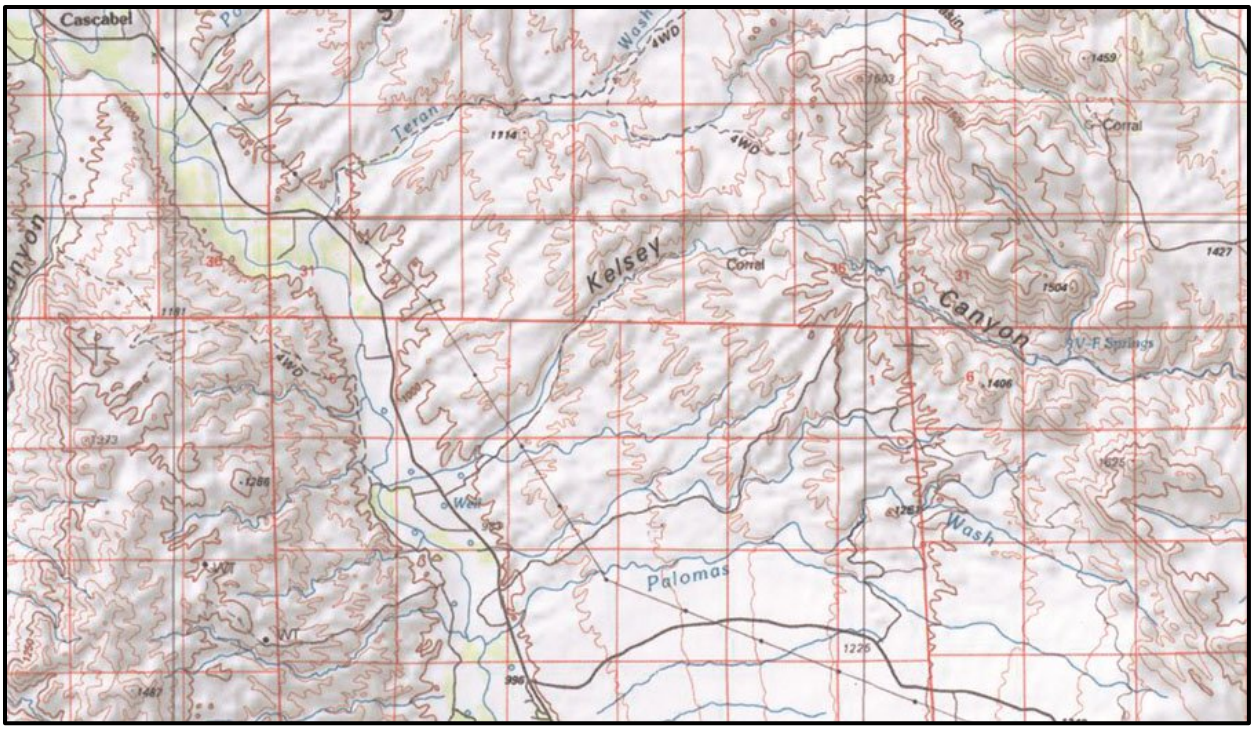
....

We walked much of the way in the river, especially where the banks are very densely vegetated, as shown **below**. Octogenarian John Wires, at right, leads the way in this photo.

The Valley Constricts: Kelsey Canyon Corridor

Around Milepost 15, the **Three Links Road** meets the Cascabel Road. the image **below** (taken in March 2005 from the terrace south of Kelsey Canyon, some miles uphill to the east from Cascabel Road on the Three-links Road and looking toward the southwest) draws attention to the tiered mountain structures west of the river and north from the latitude of the Benson Narrows:

Beyond the dark terrace structure in the foreground and directly above it lie two long stretches of the **Little Rincon Mountains**. In the lower middle foreground is the lower, eastern portion of the Little Rincon's, which extends roughly northward from the lower drainage of Ash Creek (fed by **Rincon Peak** and its high environs in the left background) all the way to Cascabel. We are looking here, in effect, from the lower flanks of one **"Sky Island"** to the summits of another. The map **below** shows the Three-Links Road entering the valley from the east. (While it looks like a fairly level route, it actually drops fairly steeply; the photo **above** was taken along that road.)



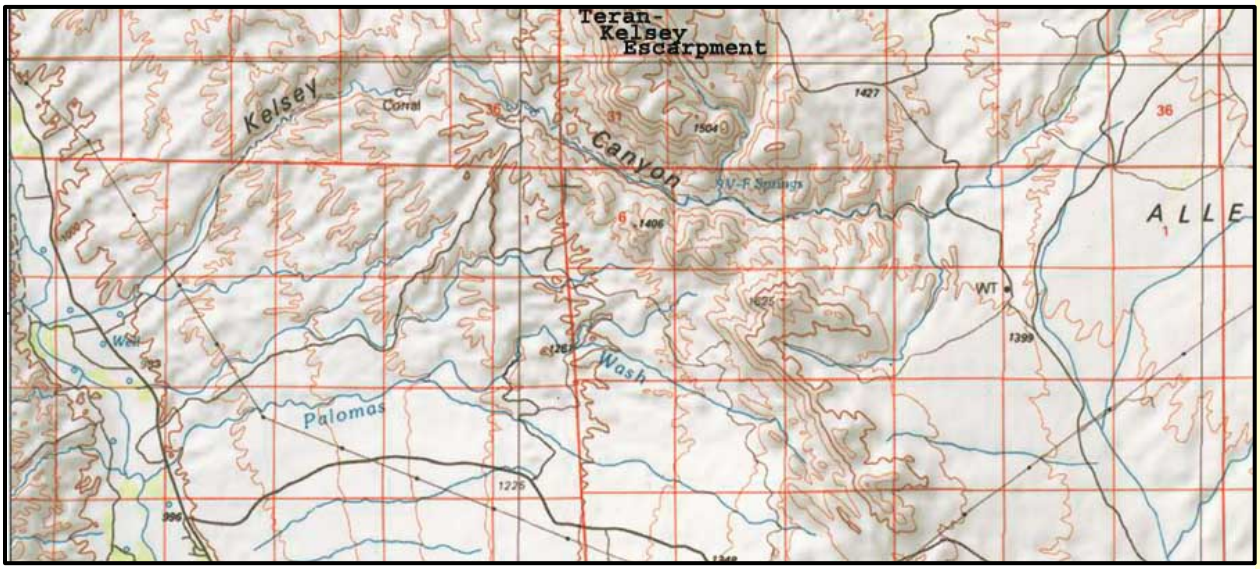
Near Milepost 16, a series of **hanging Quiburis-era terraces** flank the west bank of the River:

The surfaces of most of these terraces above the river are dominated by a major shrub of our three North American deserts: **Creosotebush** -- see this link for details on this very important plant [sacred to the O'odham, host to numerous distinctive other plants and animals, a prominent member of most plant communities in the Mohave, Sonoran, and Chihuahuan Deserts).

Below, near Kelsey Wash at Milepost 17, a series of pale misty-rose-colored vertical cliffs also flank the River. Judging from the geology map in **Dickinson 1991**, the vertical cliffs in this image are also members of the Quiburis Formation. (The hills rising above and behind them, however, are "Metamorphosed Paleozoic Strata".)

Below, looking down on the same cliffs (at lower right) from the Pool Wash Ridge Road near Sierra Blanca, a vantage point about 600 feet in altitude above the River. The Quiburis cliffs of the photo just **above** stand out prominently at lower middle-right, while the Three Links Farm flats are the green floodplain area at far middle-left of the photo. The **Huachuca Mountains**, which flank the Upper San Pedro River Valley on the west side where it emerges from Mexico, are hazy-blue at far upper left toward the south, the **Whetstone Mountains** the darker-blue forms at right-middle, flanking the valley to its west near Benson.

Kelsey Canyon does not appear large where it crosses the Cascabel Road, but it drains part of the large grassland area called the **Allen Flats**, located beyond the Galiuros Western Range (at **right** on the map below)and which form part of the western flank of the **Winchester Mountains**:



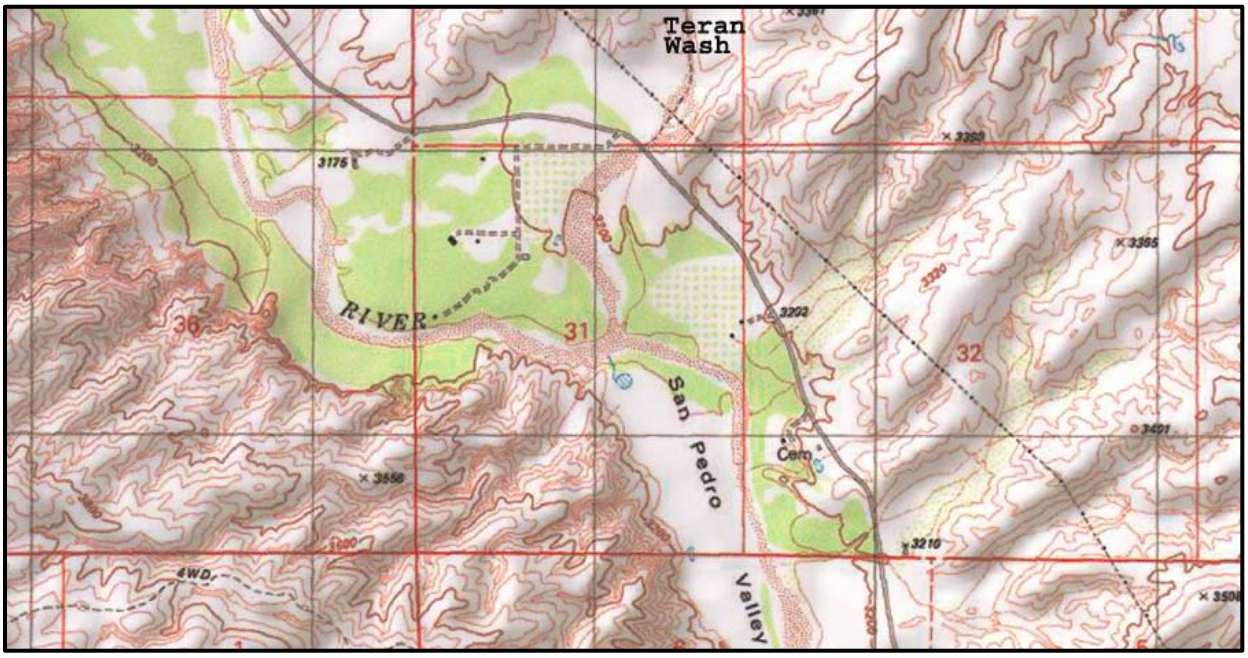
As can be seen on the map **above**, it has cut a deep and narrow canyon through the **Teran-Kelsey Escarpment** after draining the extensive Allen Flats (far **right**), and in flood it can carry very massive loads of rock as well as water.

Many washes that cross the Cascabel Road in this area present serious danger to traffic during and after rainstorms. **Below**, after a storm in late July 2005, **Kelsey Wash** runs modestly.

In this example, careful examination indicated the Wash was safe to cross for the high-centered, 4wd vehicle parked here. However, the Kelsey Wash is notorious for carrying down substantial boulders when it runs more strongly than this, and becomes too dangerous to cross even at moderate depth. Usually the strong pulses are fairly brief, but from the perspective of long-term Cascabel residents they are also legendary. For a note alluding to the likely old-historical significance of this aspect of Kelsey Wash.

The Teran Wash Corridor

Proceeding further north, the very broad (and, further upstream, multiply dissected) Teran Wash strikes into the river at Milepost 20.



The Teran Wash is a large one: note how the inflowing wash has in earlier times helped cut out the high cliffs evident at the lower-left (southwestern) bank of the San Pedro here (for a photo image of part of this cliff-face, see further below). Long-term resident Barbara Clark has old maps of the Teran Wash confluence from early in the 20th century, showing that Teran Wash apparently entered the River at the grade of the bosque at that time, so -- as can be seen directly below -- this marks a very considerable recent change, a drop of about 40 feet from near the current roadway to the floodplain.

This image of the Teran Wash road crossing shows Teran Wash in very modest flow in late July 2005, with some of the vehicles waiting for the flood to subside while a higher-centered vehicle begins a run across. (The problem in this instance was not rate of flow but the deep undercutting of the embankment in the foreground; much of the flow is out of sight because the embankment has been sharply cut on this side.) The depth of the wash below the main grade of the road here is on the order of 20 feet.

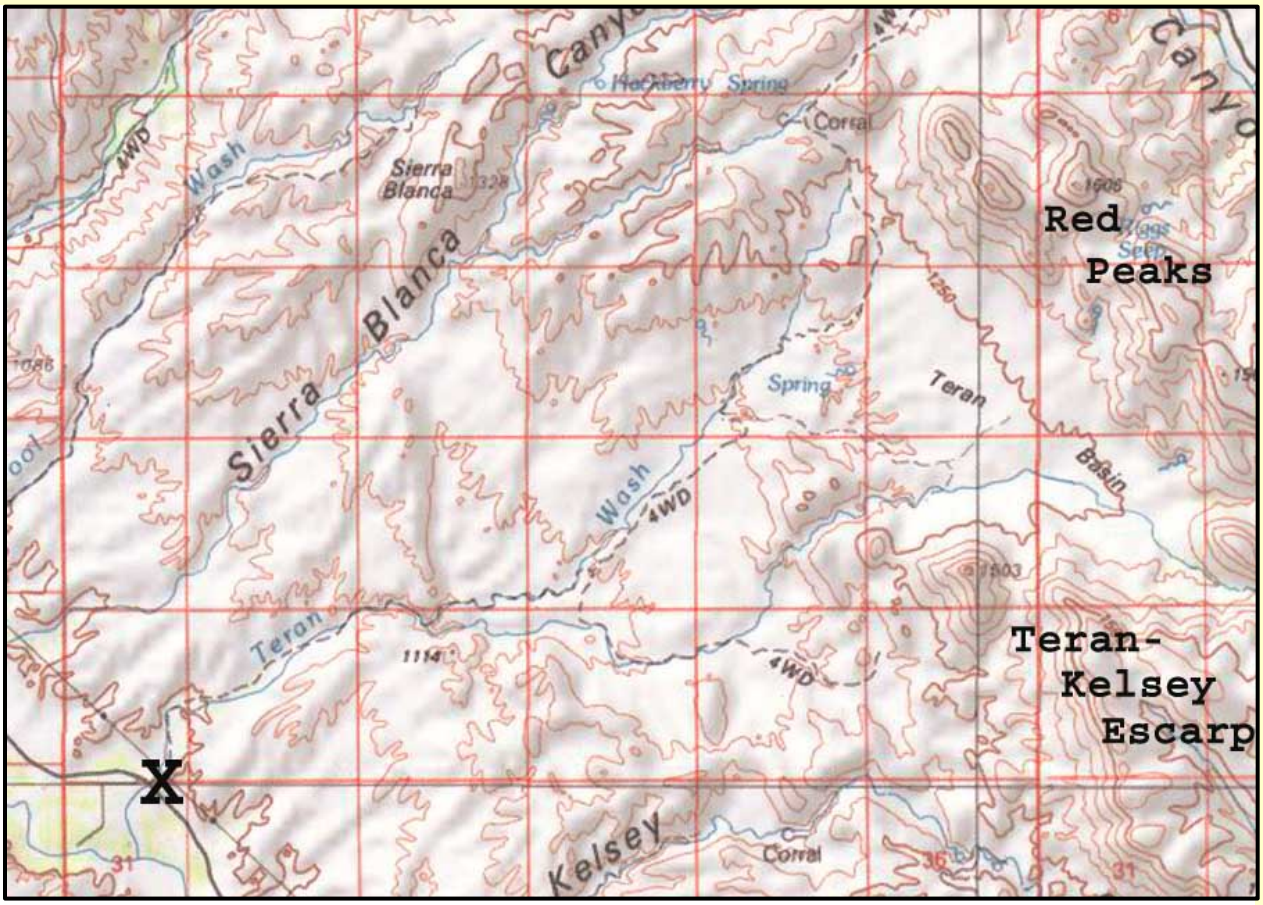
Note the power pole visible at mid-left top in the above photo. Across Cascabel Road from this spot is a single-lane road turnoff leading to the Oasis Bird Sanctuary, the Deacon's Cathedral, the La Margarita community meeting center, and the Cascabel Clay works.

Teran Wash drains a large basin lying eastward and southeastward from milepost 20. The extensive, high-angled **Teran-Kelsey Escarpment** bounds this basin on the southeast side, as shown **below:**

Like the other portions of the West Range of the Galiuro Mountains bounding the San Pedro River in this area, the Teran-Kelsey Escarpment shows strong block-fault tilting away from the River Valley. For more detailed views of this

piece of the Galiuros, see this link: **Teran-Kelsey Escarpment,** and for geological context see **Basin-Range Faulting**

The Teran Wash Watershed



"X" marks the spot where the wash crosses the Cascabel Road. Note the broad expanse of the Teran Basin at right-central in the map above. Teran Wash receives not only waters from the Teran-Kelsey Escarpment but even more extensively from the Red Peaks complex further to the north (both of these ranges are part of the Western Range of the Galiuro Mountains). Moving upstream, wash-roaders rapidly encounter multiple dendritic side-washes, each one tending steeper upstream than the last. For some minor hints of the situation, see this

Along many parts of the River basin in our area, severe downcutting of the river's channel has occurred, a process which accelerated along the river during and after the 1890s drought (see discussion of this process in **San Pedro Changes**). For example, a difference from the early years of this century

has been noticeable near the Teran Wash confluence, where one side of a downcut channel is shown **below**: (in July of 2006)

The channel here is about 20 feet deep, with the old pre-20th century floodplain (with its mesquite bosque) at the top of the embankment. **Below**, a March 2007 view from the edge of the mesquite bosque looking down into the River at this point:

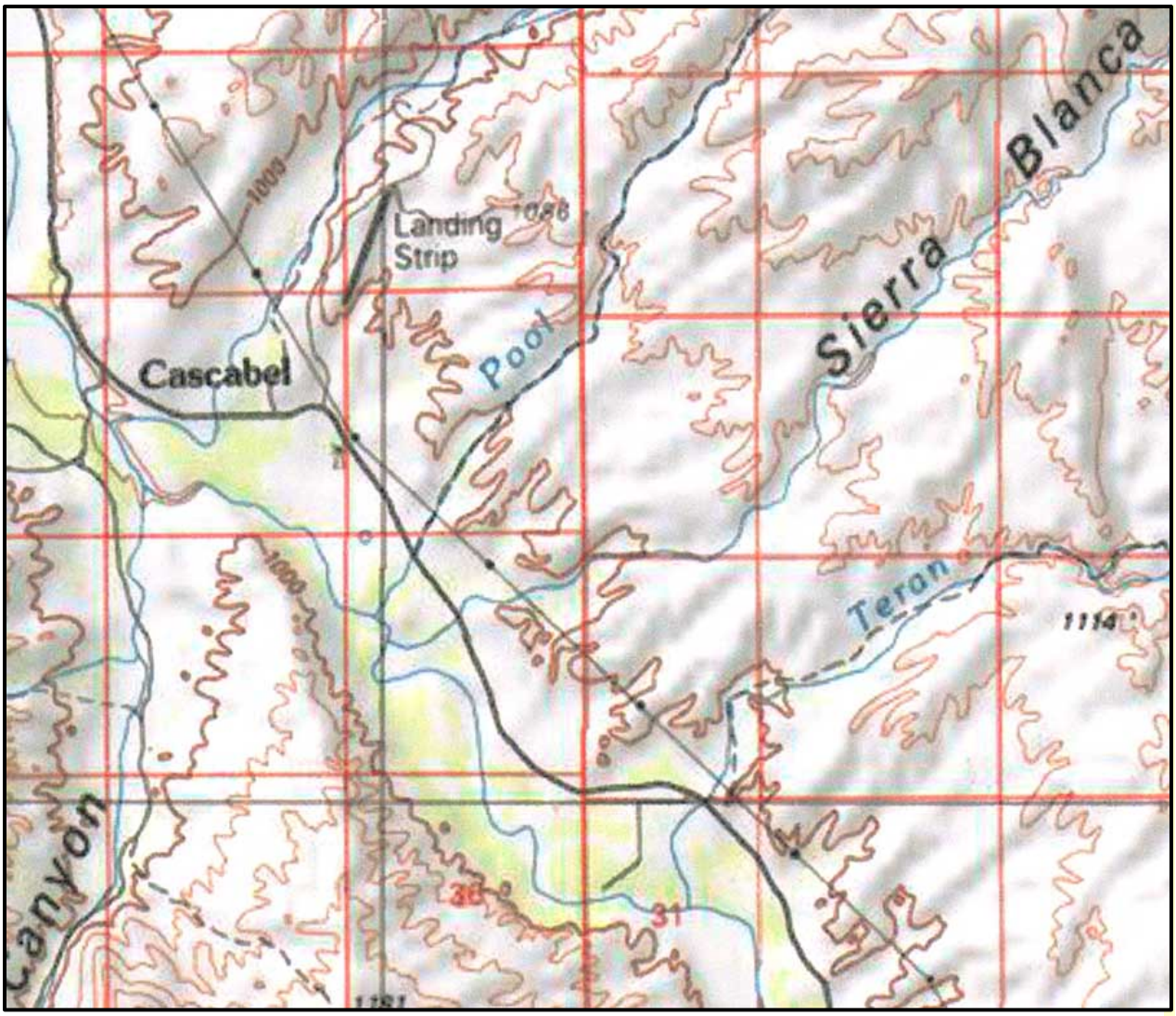
Note the precariously situated mesquite tree hanging over the river at left-center of the photo. **Below**, vivid evidence of the continuous loss of this bosque to riverbank erosion:

While downcutting during the twentieth century has lowered the water table at this point, some 6 miles further downstream perennial stream reappears in a number of places, and there the riverbed is not so channelized. Entrenchment is a prominent but not continuous feature of the River in our area. For a wide-ranging discussion of changes in the vegetation of this area, see **Changing Sonoran Desert Vegetation**.

Below, the river in moderate flood, August 2005:

At some points along the River in this area, some geologic facies of the San Manuel Formation rise behind the bosque on the west side of the River, occasionally forming erosional flumes of striking beauty. **Below,** just upstream from the confluence of Paige Wash with the San Pedro, these remarkable gray sedimentary hills erode down to the river in many fingers (they are post Basin-Range, flanking-mountains-erosional formations of Quiburis age -- 7.5 to 5.5 Million Years old):

These rapidly-eroding "badlands" provide many a cleft/flume refuge for nesting birds of various kinds. And note the bird guano visible in that closeup image.) This "Paige Formation" facies can be seen ending in a pointy triangle whose apex juts toward the icon "Cascabel".)



Sierra Blanca Canyon (shown flowing to the river from far upper-right in the map just **above**) is a large and dissecting corridor throughout its length.

The Central Geo-ecological Constriction along the San Pedro River:

Paige Wash Meets Hot Springs Canyon

Below: **Lower Hot Springs Canyon Wash** and its mesquite bosque, running westward (lower left to middle-right in the image) toward its **confluence with the San Pedro** in the middle distance, July 2002. The bosque-scouring floods of October 1983 and January of 1991 and 1993 have left their marks here in the lighter-colored portions of the floodplain. Previously most of that (now more open) ground was filled with thick bosque. (Note Rincon Peak in top-center background, and Mica Mountain (the other most prominent peak of the **Rincon Mountains**) rises mostly beyond view at far upper right.

Below: a view from the Quiburis Terrace (middle left in the photo **above**) looking across lower Hot Springs Canyon at the bosque that mostly fills the floodplain. (April 23, 2008)

Below, the bosque viewed from the first terrace above floodplain, in late afternoon sun (5:32 pm, April 23, 2008).

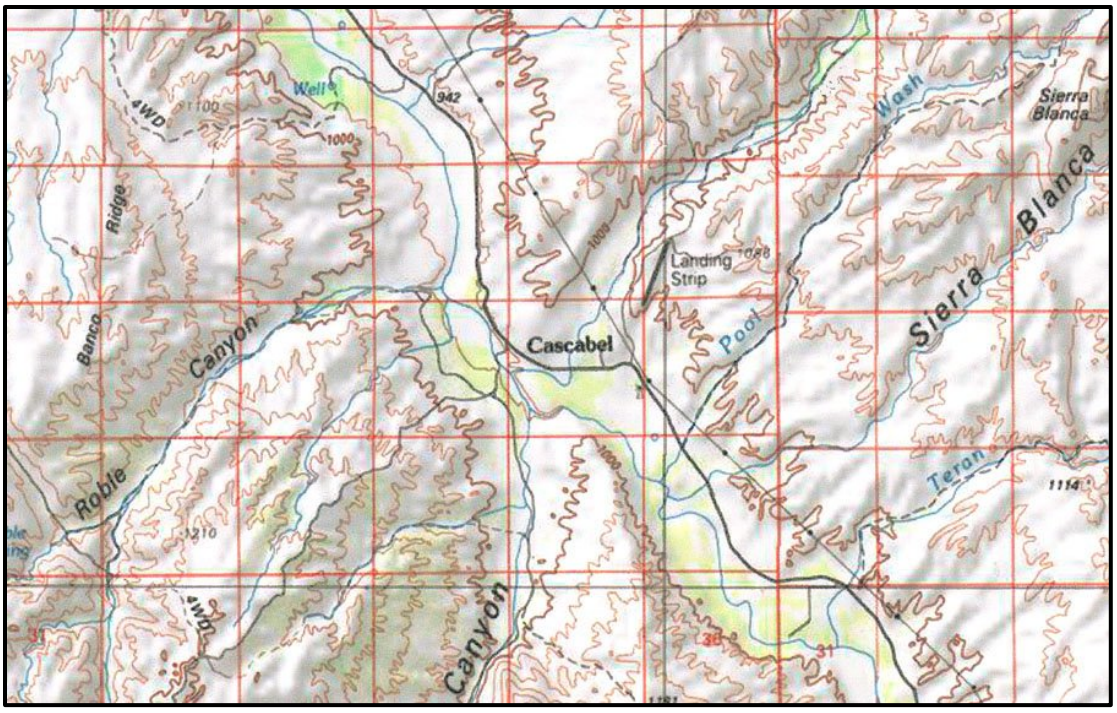
Below: The confluence of Hot Springs Canyon Wash (foreground gallery forest) with the San Pedro River (the River wash cut can be seen running horizontally at right central) and Paige Wash (its bosque just visible beyond the left-central ridge terrace at dead center in the photo) -- Rincon Peak in the right background, Little Rincon's dominate the mid-distance: (May 2002).

Below, another view of this triple confluence from higher up on the east bank terrace of lower Hot Springs Canyon. (Note that the saguaro fruits are ripe on this day, June 30, 2002. This would have been a great day for **saguaro fruit harvesting**.) Here the San Pedro River gallery forest shows in a horizontal green strip running from just to the right of the left-hand cluster of Saguaros, while **Paige Canyon's bosque** shows more clearly beyond the horizontal terrace at dead center of the photo. Paige Wash cuts back across the base of the strong, high ridge that dominates the upper left portion of the photo at mid-distance, then runs to its confluence at far right mid-photo. Hot Springs Canyon confluence is just to the left of it.

We are here viewing the nexus of the **Cascabel-Paige Wildlife Corridor**, running from the lower flanks of the Galiuro Mountains (where the photographer stands, i.e. the lower flanks of Soza Mesa) to the Rincon Mounts at far mid-left . In the map **below**, **Hot Springs Canyon** enters this central point from far-upper right along the high terrace marked near the roadway by the indicated "landing strip".

This watershed has perennial streams in its upper reaches and is a major wildlife refuge for the region. (For initial visual details, see **Hot Springs Canyon**, and for much broader ecological detail see the entire **Saguaro Juniper Corporation** webpage.)

Below, in August 2010 Confluence-dweller Sue Newman took this picture of two children of a friend playing (with Sue's mighty dog Sammy) in the mud of Hot Springs Canyon Wash (at left) where it merges with the San Pedro River (at far right, the latter still running strong after Monsoon rains). Hot Springs Canyon mud is apparently great fun to smear all over one's body (but the warning we cited above about **flash-flooding** should be borne in mind throughout the Monsoon season).



In the **map above**, **Paige Canyon** enters this constriction at bottom-center, hauling its water resources down from the perennial springs of the Happy Valley Basin in the Rincon and Little Rincon watershed. **Roble Canyon** joins the cluster running out of the Little Rincon's from lower left, and it too has perennial springs in its upper reaches. **Pool Wash**, running from the upper right corner to its confluence with the San Pedro just east of the Cascabel icon, is also a significant wildlife corridor, and the **Sierra Blanca Canyon Wash**, shown here at the right, also contains perennial springs. These corridors together form dynamic intersections of wildlife activity -- we have already emphasized the birds, and speaking personally we regularly observe bears, deer, javelina, coatimundis, and numerous other mammals crossing the webbed fingers of this crossroads (not to mention other non-mammalian forms like the sometimes seemingly ubiquitous Gila Monster, who definitely finds Cascabel to be a paradise).

Below, a view up lower Paige Wash from the San Pedro River terrace above the Community Center, looking a tad east of southward on February 22, 2008. In the lower left portion of the upper right quadrant of this image, **Paige Creek Wash runs** right-to-left through a gap between two Little Rincon peaks, then swings around toward the viewer to join the San Pedro River at a point roughly mid-picture (though largely out of sight here). The San Pedro runs into the picture from the far left. (The light-colored streak running across mid-picture on the right-hand side of the image is Cascabel Road).

This striking peak at the northern end of the Little Rincon's (photographed **below** on May 20, 2008) apparently has no name, though it is a very noteworthy feature of this scene, looking here like a crouching multilegged monster with pointy backbone, paws held forward and head down, apparently drinking its fill in Paige Creek (normally dry at this point at least on the surface).

Below, HSC confluence resident Sue Newman took this zoomed picture of the lower reaches of Paige Wash from the northside terrace above HSC in August 2010. Here you see the monster (clearly some kind of Paleozoic Amphibian) with its muzzle buried deep in the Wash, and definitely possessing an eye that keeps alert lookout toward the viewer.

Another salient aspect of this vicinity derives from the fact that the slopes above the river mark an ecoregion boundary where different vegetation zones intermingle and enrich each other. While the more southerly portion of the valley uplands we have passed through further upstream is generally considered part of **Apache Highlands** and/or the **Chihuahuan Desert**, by the time we reach Cascabel the vegetation becomes more dominated by **Sonoran Desert** plants. (See that link) **Below**, a view of the south-facing slope of lower Hot Springs Canyon (taken from the opposite terrace in the early morning of January 2005.

All of the obviously upright, sunrise-highlighted plants evident here on this slope are Saguaro Cacti, prime real actors among the distinctive plants of the **Sonoran Desert**. See **The Arizona Uplands** on the most characteristic features of our immediate area, and see **Saguaros** for details on the significance of this dominant plant in this ecosystem.

The pioneering plant ecologist Forrest Shreve called our Arizona Uplands a "**stem succulent** desert", referring to the prominent role played in it by Saguaro, cholla, and other cacti. For more details on these plants, see **Cacti**.

Below, a view of part of the **above** hillside taken in February 2008. Note the venerable age of many of these Saguaros. Somewhat surprisingly, immediately across Hot Springs Canyon toward the south, the frequency of these trees declines quite sharply, and they nearly disappear further south beyond Kelsey Canyon.

(For a more extended [if somewhat out-of-date] discussion of Ecoregions, see **Ecoregions in Our Area**.) Thus, the Cascabel locale has another quality of distinctiveness: as a **multi-transitional zone**, it intermingles life-forms from all three (or more) zones, and thus possesses an intensified diversity. Again, see also **San Pedro Valley Flora Today**.

Satellite Imagery (courtesy of Europa Technologies Inc. by way of Google Earth) intensifies our point regarding the distinctiveness of this **still-dirt-road-protected** location:

Dirt-Road Daddy-Long-legs Central Core

Even the lesser ridge/ravine dendrites you see here are not small. Cascabel as defined here (see the purple dot on the satellite photo) is the **central point of a multi-corridor system of bio-communication**. To repeat some references regarding Eco diversity here: For a quick take on our birds, see this link: **Birds**; or see **Arthropods**; for accounts of terrestrial vertebrates, see for example **Mammals**, or **Reptiles/Amphibians**.

And for the critical importance of preserving this river valley as a BRIDGE between its flanking Sky-Islands (rather than becoming a BARRIER), see this link:

Daniel Baker (2008) on the Value of Dirt Roads for Conserving Wildlife Habitat

All along this portion of the valley, the volcanic fault-block-tilted escarpment of the **Galiuro Mountains, below,** parallels the San Pedro Valley on its eastern side:

Its peaks rise high above the surrounding terrain (and have done so for a very long time, once much higher), and the fronts of the range are fairly close to the river at this point. Today, this intensifies runoff when monsoonal rains occur, and very massive flooding can result at many locations along this bottleneck corridor of the river. Since the southeastern slopes of the Galiuros drain ultimately into Hot Springs Canyon, and contain permanent streams, the " wildlife-corridor" significance of this striking "sky-island" lies as much on its far-eastern side as the one more visible to us here. See **Galiuro Mountains** for more details (both visual-geographic and ecological) on this very long and very important array of habitats: the wildest mountain range in southeastern Arizona.

To the west of the valley lie the grandest of its flanking mountains, geologically a single system called the **Catalina-Rincon Metamorphic Complex**, which arose in the form of intrusions of granite ("Plutons") from some 5 to 7 km below the surface. To illustrate this grand complex requires two images. First, viewed from lower Hot Springs Canyon, see the southeastern portion of the complex, the Rincon Mountains, **below** running from Rincon Peak in the south (at left) to Mica Mountain in the north (at right):

The second part of the complex is visually more remote from the vicinity of Hot Springs Canyon. Here **below** the **Santa Catalina Mountains** require a 10 X zoom **below** to show them looming high over the northern portions of the Middle San Pedro River valley:

In this image, taken February 22, 2008 as early morning light hit a lower flank of the mountain, snowy Mount Bigelow at 8,400 feet elevation is the most prominent form, but the Catalina range reaches many miles further toward the northwest and rises significantly higher, to 9,157 feet at Mount Lemmon, an

altitude that at this latitude supports mixed conifer forest of Merriam's "**Canadian Life Zone**". The Catalinas are ecologically the richest of our flanking **Sky Islands**, and its slopes form numerous wildlife corridors reaching into many portions of the Middle and Lower San Pedro. For details and implications of the relevant transitions in this area (as well as its historical role in the definition of ecologically important features), see this

From the vantage point of high parts of the Pool Wash ridge road, one can see a panorama of sky-islands along the west bank of the river ranging out to the south.

Where the Cascabel Road crosses Hot Springs Canyon, **below**, the substantial rains of July 2006 produced a fairly strong stream flow photographed here by Susan Newman on July 29, looking southward. Although the roadway now has a belt of concrete surfacing that runs from side to side to stabilize the crossing at this very large wash, these vehicles are prudently waiting for the pulse to decline further. The strip of rocky alluvium sitting across the roadway shows that the previous flow of this particular flooding was much stronger than what you see here.

Think about an Interstate Freeway-prospect here, as we have had to contemplate the prospect in the recent past: the bridge would have to extend well beyond the position of the photographer, far beyond and above the height of the vehicle seen waiting on the far side, and at three-to-four times the current roadway width. Such a Highway would make unliveable Elna Otter's house and home (where Sunday Quaker Meetings are often held; the place is off to the left in the trees beyond the far parked vehicle), and we've not even mentioned residents on the downstream side of the wash at this point. For example, there are small but significant archaeological ruins, dwelling places of the ***O'Odham people of southern Arizona*** (whose ancestors lived here from pre-Columbian times until 1762) located near the present roadway. These ruins would surely be obliterated by any further Highway construction along this road.

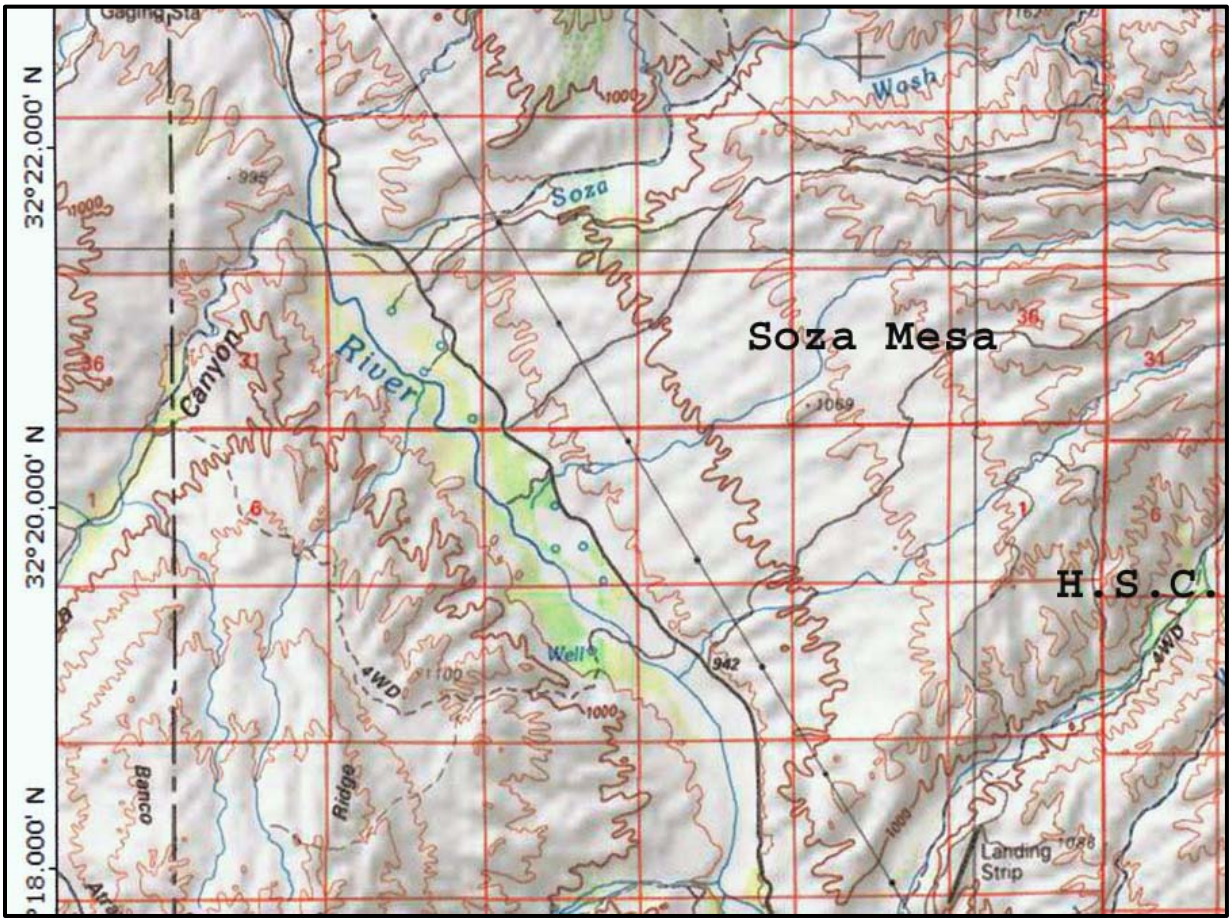
To summarize for the Central Core of this ecosystem so far, then:

In terms of "Central-place" theory, Cascabel Central meets every criterion of indispensibility from a desert ecosystem point of view, a fixed-location, global-species-endangered eco-spider.

Hot Springs Canyon is an unpredictable, dynamic -- and on occasion quite dangerous -- water-and-debris carrier, which sometimes displays highly destructive power. On the western side of the constriction, Paige Canyon can (and just a few years back, did) dump a temporary dike across the entire river floodplain, causing the San Pedro River to back up for days until rising floodwaters cut through the dike.

The Soza Mesa-Soza Canyon-Soza Wash Constriction

Just downstream and north of Hot Springs Canyon, a very large mesa looms high over the river floodplain (its long flat top visible in the image **above**). See its far-western naked shingles on this map:



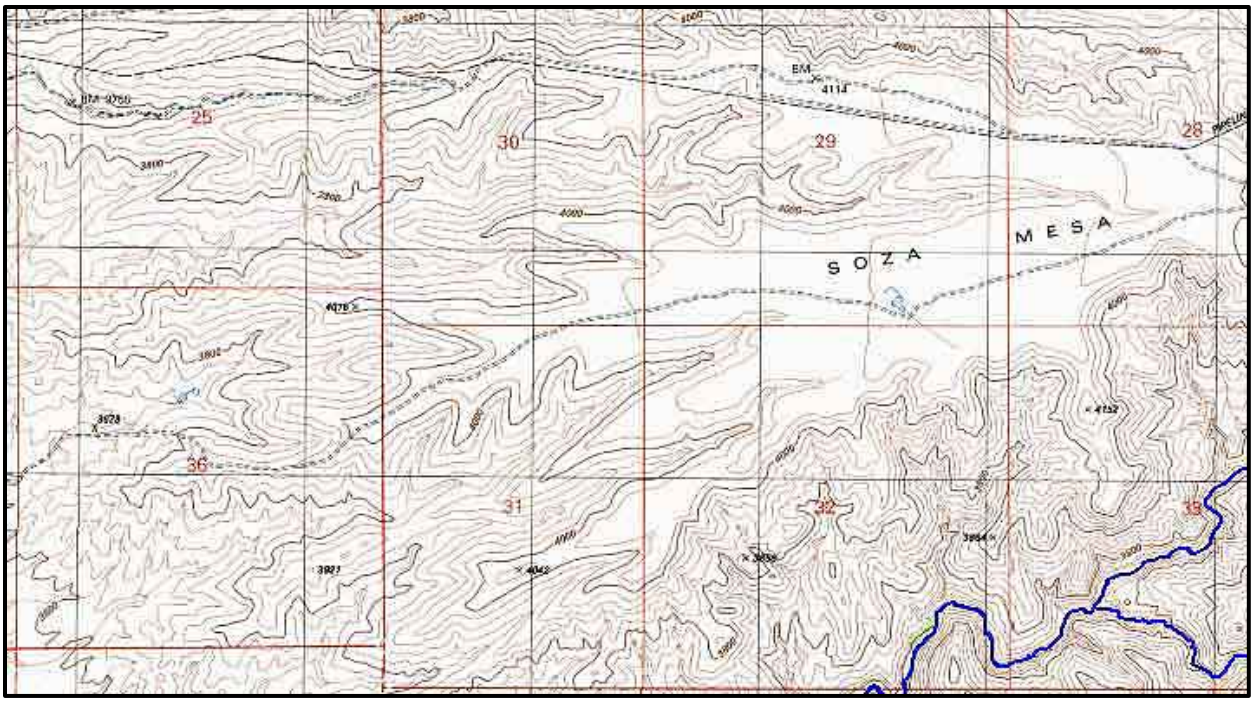
Soza Mesa is a greatly elongated Pliocene terrace (7.5-5 Million years old, see **Geology: more recent patterns**), built by long-sustained erosion of the formerly much-higher Galiuro Mountains. Note how it forms "fingers" of

descending slopes that fall down to the river. On this map, it perhaps appears a somewhat bland structure, and it is not visually much evident from the roadway below, but in fact the levels shown here give little hint of its size. Its elevation at the top, where it forms a very extensive tableland, stands at 4200 feet at its highest northeast elevation near Wildcat Peak, and it remains almost tabletop-level for miles until reaching its western finger-edges at 4000 feet, then declines at somewhere near the angle of repose until it reaches the river at around 3000 feet elevation. The amount of eroding materials that descend to river (and roadway) during flood occasions can be (and often has been) huge. This has very daunting implications for roadway construction here.

SOZA MESA

Soza Mesa is one of the most remarkable landmarks (and habitats) of our San Pedro Valley. Viewed from the south toward its furthest Eastern (up-slope) end from across Hot Springs Canyon (as in the banner photo **above**), it forms a striking horizontal edge to the Canyon itself. Viewed as **below**, again from the south across-Canyon looking toward the northwest, it gradually begins to decay more strongly at its Western edges, dropping down toward the San Pedro River (with the Catalinas standing far behind it on the other side of the River):

Viewed from overhead it appears to spread out from its headlands like a long flat hand with many, pointed fingers (ridges which descend for some 5 miles toward the San Pedro River, well out of view to the Left):



From the air, flying near the Cascabel Road and looking Eastward toward the Galiuros in January 2003 (**below**), Soza Mesa's perennial tabletop carpet of green (overwhelmingly composed of **Creosotebush**!) sets it off from the more broken array of hills located on each side of it. The "root" of the great (now remnant) alluvial fan may be seen at the center of the upper-left quadrant of the photo, where the massive Quiburis-era deposition of sedimentary gravels distributed the Bajada gradually downward and outward from the Galiuro Mountains of 7.7 to 5.5 Million years ago. Later, the upstream cutting of the San Pedro River drainage from the Gila River produced massive erosion of the fan at its edges.

Here, **below**, is a view of it from a different angle and considerably lower aerial elevation, taken in January 2003. Here the mesa top is a strikingly horizontal line running across the middle of the image, standing well above the Yellow Cliffs and other visible features of Hot Springs Canyon (lower-center). The cutting of this Canyon several million years ago tore away the superficial layers of Quiburis Formation to expose the Galiuro Volcanics, San Manuel, and Willow Canyon Formations you can see flanking the wash below:

We of Saguaro Juniper however much more typically view Soza Mesa from below and/or among its fingers, as the images which follow illustrate. (These next three images were taken in February of 2004, hence their overall drabness.)

From the standpoint of the bottoms of Soza Mesa Washes, each wash is **relatively wide and sandy**, and this holds true at the upper reaches as well as the lower ones. **Below**, we are looking upstream from a position near the Western bottom of the Soza Mesa fingers (not very far from the San Pedro River). At this point, two large washes, running out of the upper-left and upper-central part of the photo, converge toward the right, meeting at the lower right of the photo, with a low (but very long) ridge dividing them upstream (marked with a small roadway running up it from below). These are very wide washes indeed.

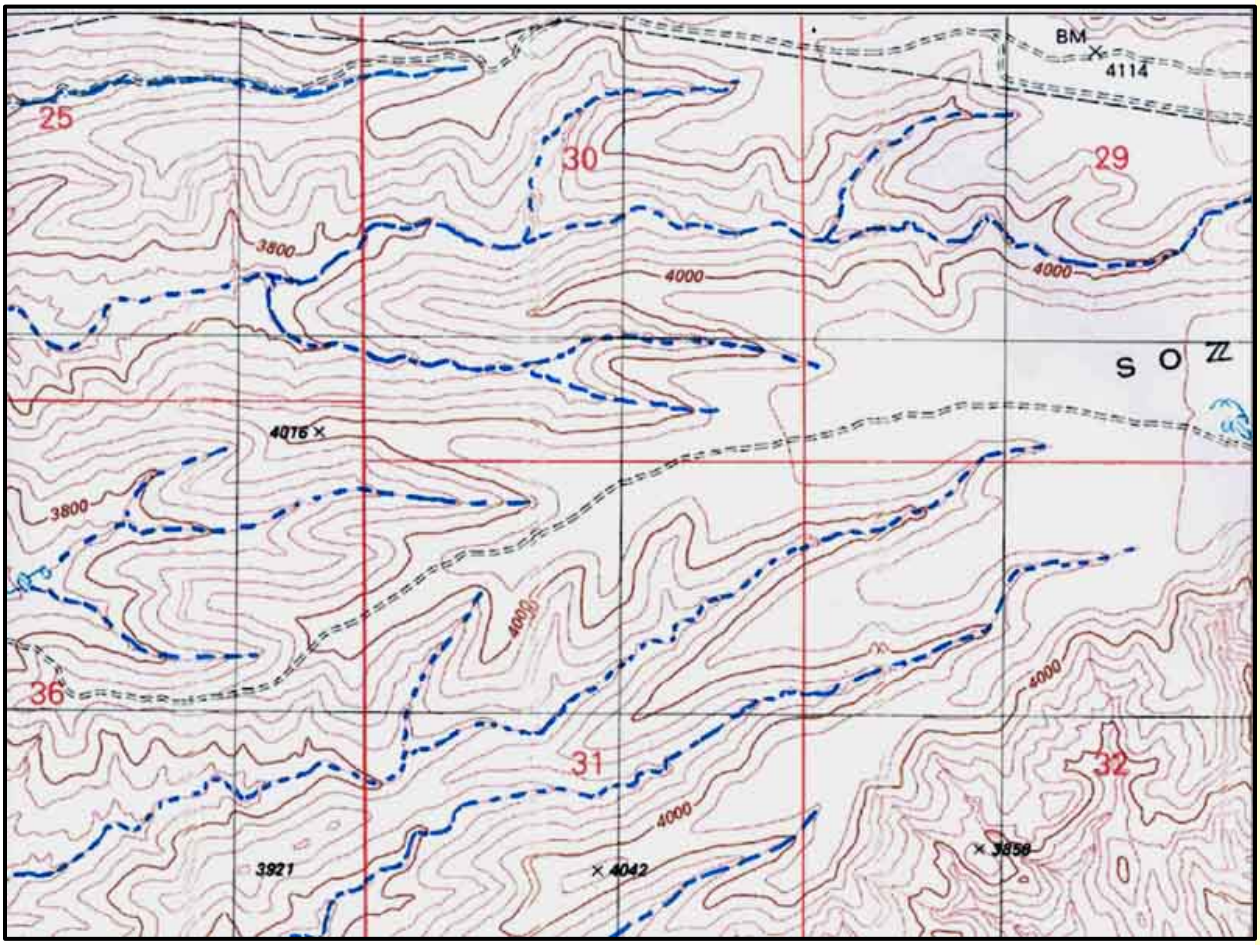
Below, a view from a more northern finger, the Jack Murphy Wash, which is huge even at this very substantial distance from the San Pedro River confluence (the very light green strip barely visible in the center of the upper-left quadrant of the photo). This is one of the washes whose runoff devasted parts of Cascabel north of Hot Springs Canyon during the July 2003 floods. We photographed here in February 2004 while repairing fences.

Below, a smaller wash also at a long distance from the San Pedro, running down from the Mesa toward the viewer, then curving sharply to the right at the bottom of the photo. Even here the wash is wide and sandy. Note that at right-center its flow has exposed bedrock of the **Quiburis Formation**, which is present all along these mesa fingers. Note also the large old Saguaro at middle-left, standing right in th

e middle of the wash in February 2004.

Following the strong summer rains of 2006, we found this massive saguaro entirely toppled:

A significant ecological feature of the Soza Mesa drainage is the prevalence of east-west-running washes, as you can see clearly in the map **below**, where the giant tableland adopts the aspect of a great octopus extending its tentacles out towards the river valley below it:



Along these washes, the ridge slopes are either **south-facing** or **north-facing**, which conditions very different vegetation growth on these two types. **Below left**, looking upstream, both kinds of slopes are evident, with the south-facing slope at upper left and the north-facing one at mid-right. The main contrast you can see in this image is a darker reddish color on the south-facing side.

Below a view of this south-facing slope from a standpoint directly opposite to it. Note the virtual absence of grasses, with only scattered shrubs and trees established along the slope.

...

Below left, the north-facing slope at the same location is packed with various annual plants and perennial grasses (including clumps of Bush Muhly). A short distance further downstream, grasses continue, along with a *Yucca elata* plant, found in our uplands only where moisture is relatively good.

...

This contrast in vegetation is consistent throughout these east-west drainages, though the differences are more striking following good monsoon rains than they are after drought.

These relatively large (and big-flooding) washes are not the only formations in the lower reaches of Soza Mesa. Some of the smaller side-washes may boast what becomes in good monsoon seasons a rather lush vegetation. For example, in August of 2004, parts of the West Wash (a tributary of Hot Springs Canyon) display the kind of richness seen **below** -- in the foreground, a substantial stand of **Bush Muhly**; and below a variety of perennial grasses share the ground with a rich array of flowering annuals and cacti:

..

Soza Mesa is named after the descendants of a Spanish soldier whose family moved from Tubac to Tucson in the late 18th Century, some of whom proceeded into the San Pedro River Valley in the 19th Century. There they established an extensive domain and a quite prominent dynasty. For more information, see **Edward Soza**.

Lower Portions of the Redington Sub-Area:

From Milepost 31 to the Redington Narrows

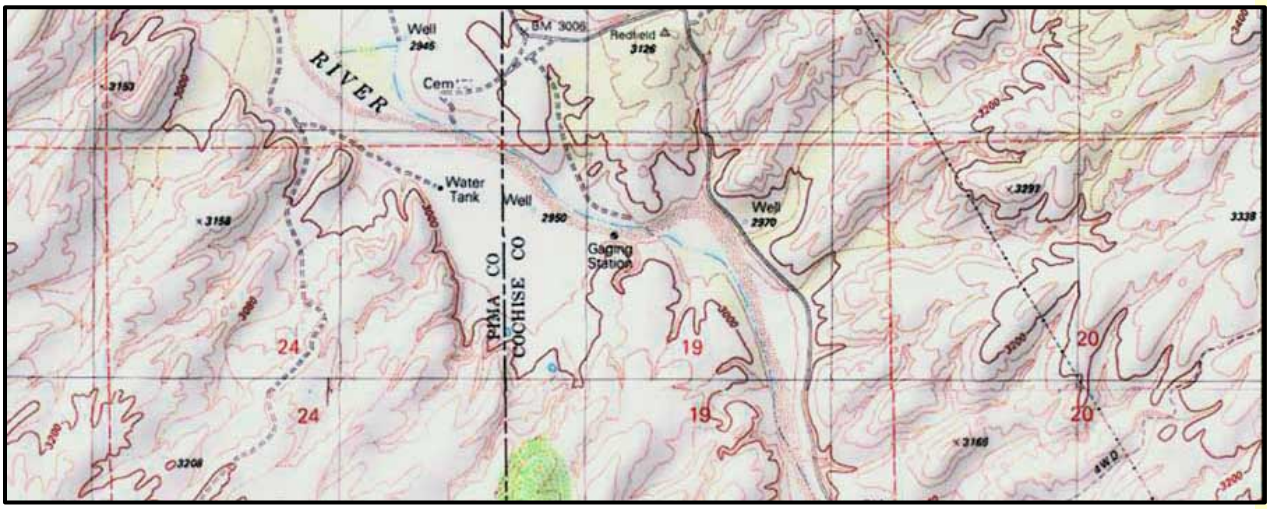
At Milepost 31, the cottonwood/willow gallery forest stands out in another stretch of perennial stream, shown in April 2005 **below**, first looking upstream and then (at **right**), looking across:

Between Milepost 31 and 32, the road runs past the Redington Narrows, shown at **below** when the river was running in flood in August 1998. (the lower photo was taken on the same day near the location shown above.)

...

Below, this map shows the Narrows near dead center, with a Gaging Station marked as located in the midst of it. The two arms of the Narrows, pointed toward one another in a northeast-southwest orientation, are clearly visible here. Assuming an Interstate Highway running near the floodplain here, considerable blasting would be required to enlarge the roadway that swings north away from the floodplain at this point. (See images of the "Soza Canyon facies" further below.)

On the other hand, should routes follow the adjoining uplands, a series of rugged cross-cutting washes would require another extensive series of bridges along this stretch.



Following are two more comprehensive views of the Redington Narrows photographed from further upstream in April 2005, when the riverbed was dry at this point**.**

...

From the vantage point **above**, the effects of the 1983 and 1991 floods on the river floodplain can be seen. Beyond the first terrace above the floodplain (which is visible in the near foreground of each image), the floodplain was almost entirely scoured of vegetation here, including the whole expanse from left to right upstream from the bottleneck of the Narrows.

As you can clearly see, a band of hard reddish-gray rock straddles the river at this point. This is a Lower Miocene deposit of sedimentary rock called the San Manuel Formation (see **Geology of Hot Springs Canyon** for more details on this Formation); at this particular location it is distinguished as the "Soza Canyon facies", and contains a high frequency of volcanic clasts in its tilted sediments, as can be seen **below**: at a broad view of the strata; and a closer view of its components**.**

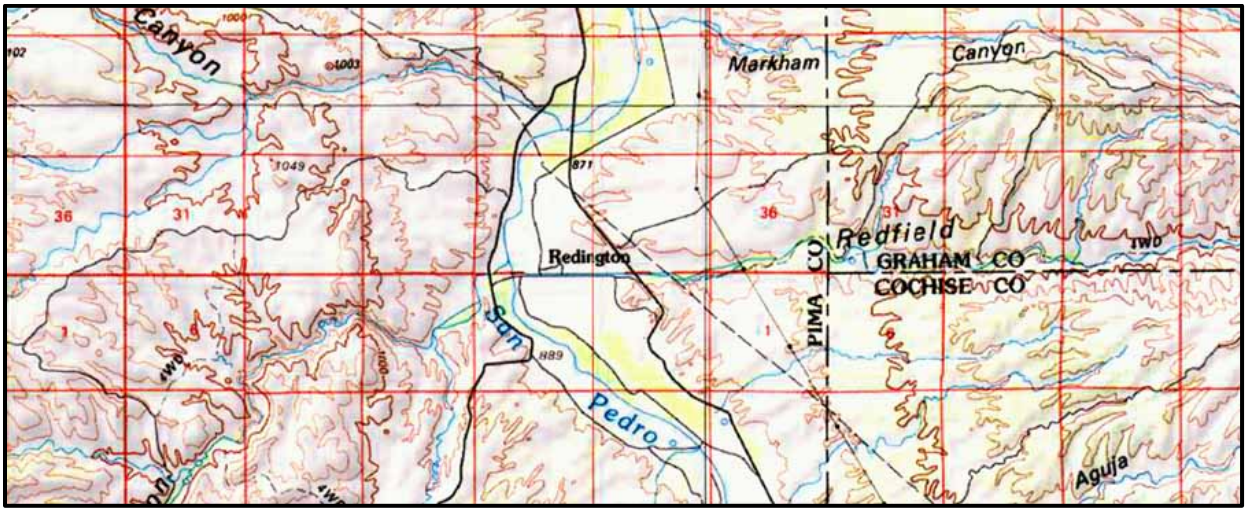
...

Further downstream, near Milepost 32, right at the Cochise County-Pima County line, the old, high terrace above the River has produced a remarkable vegetation:

On this high and dry terrace, the dominant vegetation (aside from the grasses) all the way to the terrace's cliff edge is **Jumping Cholla**. For more details, see **Cacti** and/or scroll down to **Cholla**.

Redington: the Buehman-Redfield Corridor, and Redington Pass

At **Redington** (see map **below**), two large wash corridors meet the San Pedro to produce a wildlife crossroads -- **Buehman Canyon** running from the Catalinas and **Redfield Canyon** from the Galiluros. These both form deep canyons in their higher reaches and have perennial waters upstream.



The **Bingham Cienega Nature Preserve**, located in this **significant wildlife corridor** in upstream portions of Buehmann Canyon, contains a spring-fed marsh which supports distinctive riparian plant communities and serves as an important oasis for migratory birds. Redfield Canyon is a deep, narrow red-walled vertical gash through **Galiuro Volcanics rocks.** Perennial waters may be found in its side-canyons, and the 6,600-acre **Redfield Canyon Wilderness** is centered in the area where the Canyon makes its westward bend descending from the high Galiuros further north.

Redfield Canyon is a geological gash of stunning beauty. Red Galiuro volcanics are on display with a stark vividness probably not seen elsewhere.

According to long-time Cascabel resident **Mary Taylor** and later resident **Nathan Sayre**, the first documented Anglo-American settlement occurred here in about 1875, when Henry and Lem Redfield established a residence, as did Mexican-American **Antonio Soza** at about the same time. These representatives of two distinctive American cultural traditions both drew other settlers (the early majority was Mexican-American) and eventually gave their names to major locales in the vicinity. Both groups pursued mainly subsistence farming/ranching and traded their produce occasionally over the **Cebadilla Pass** to Tucson. (The Cebadilla Pass was later renamed Redington Pass.)

Aerial photography of the Redington corridors (**below)** shows both similarities to the Cascabel Core (the multiple long-legs spiralling in-and-out) but also differences (the broader, more open floodplain and the lesser depth of dendritic wash-cutting running in from the uplands).

There is quite a lot of private land in the Redington corridor, and land as comparatively open and flat as this would be a tempting location for an off-ramp connecting truckers to rest stops, gasoline stations, cafes, etc., and this would stimulate a township development.

The **Redington Pass Road,** which crosses the saddle linking the two great granitic pillows (plutons) of the **Catalina-Rincon Metamorphic Core Complex** renown to contemporary geologists, can be seen running out of the bottom-left-central portion of the aerial photo **above** from its connection with Cascabel Road some distance north of Redington Central. The massive **Redington Bridge**, the northern counterpart of the "Grand Roadway Project" discussed in this page above, is located a short distance south of the intersection. A few

images of it **below** on May 25, 2008 (from the Redington Pass cutoff road that leaves the main road just south of the bridge, to the right) illustrate its close similarity to the Tres Alamos version:

On the same day, this view **below** was taken from some miles westward along the Redington Pass road:

and this view **below** shows the remarkably long earthen ramp built to accommodate this northern end of the projected "Grand Roadway", a structure which obviously alters the drainage patterns here.

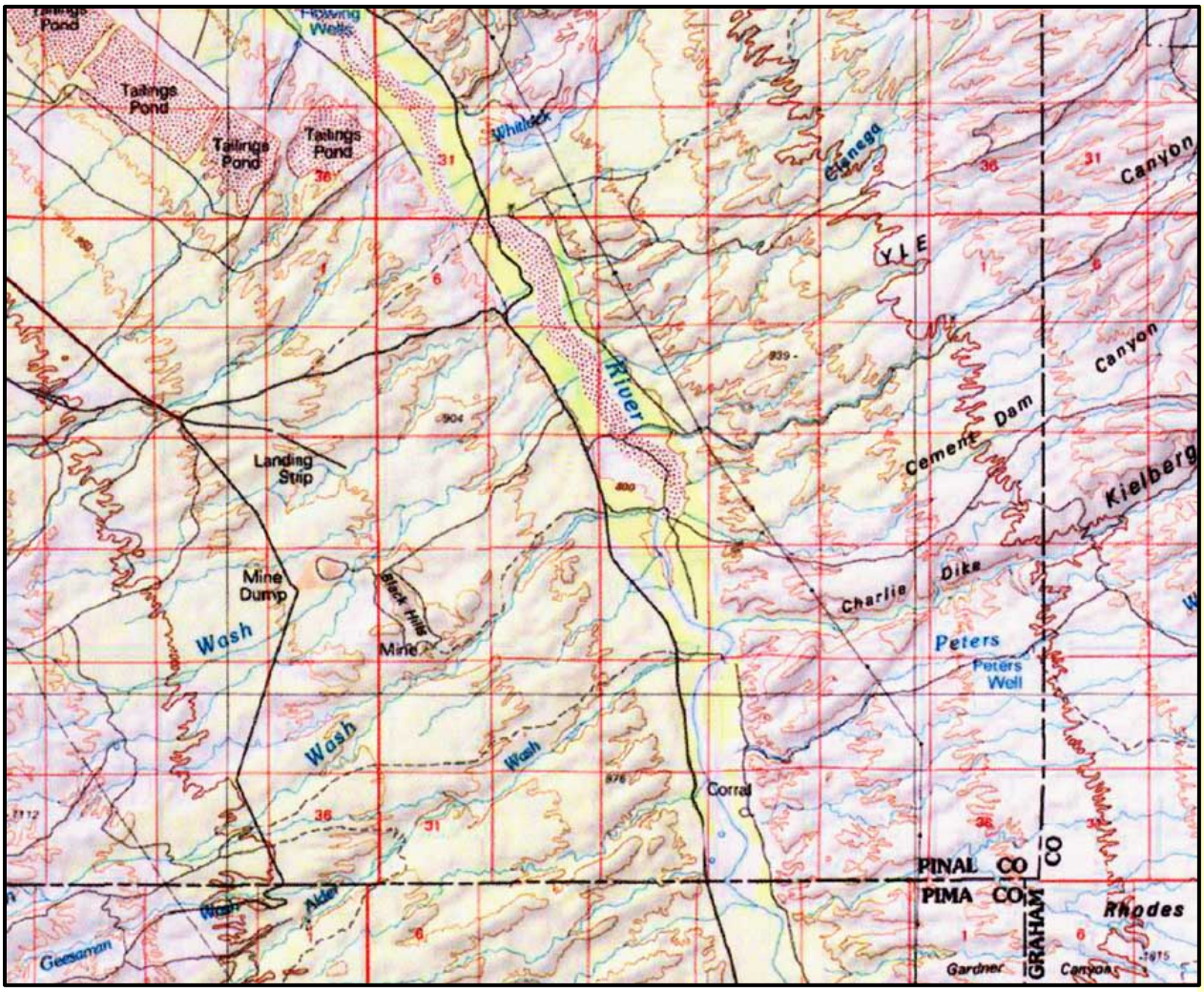
The Redington Pass Road is now a little-traveled if scenically unforgettable dirt-road linking this corridor crossroads with the Tanque Verde Road at the western edge of the Rincon Mountains in the eastern outskirts of Tucson. If a major Interstate Highway were to pass through Redington, strong pressure would no doubt arise to provide that off-ramp, and then to pave this rural dirt road (with major consequences for the distinctive biome to be found here.) This particular corridor, we should remember, runs between two **Sky-Islands** on each side: the **Rincon's** and the **Santa Catalinas**. and **at present** it's a bridge for just about all forms of wildlife that may want to pass from one to the other. Converting that into a barrier would be a sad side-story to the larger consequence of making the San Pedro River Valley a barrier between these two Sky-Islands and their longer partner to east, the **Galiuros**.

The Lower San Pedro Area

from Redington Bridge to the confluence with the Gila River

The San Pedro floodplain broadens considerably downstream from the Pima County line. North of Redington, looking toward the northwest from a terrace near the Davis Ranch. Some major archaeological sites from the Hohokam Classic period (A.D. 1200-1450) are found in this part of the valley. Some of these sites show cultural connections with the Hopi and other Puebloan peoples far to the north. (For more details, see the article by **Jeffrey Clark & Patrick Lyons**.)

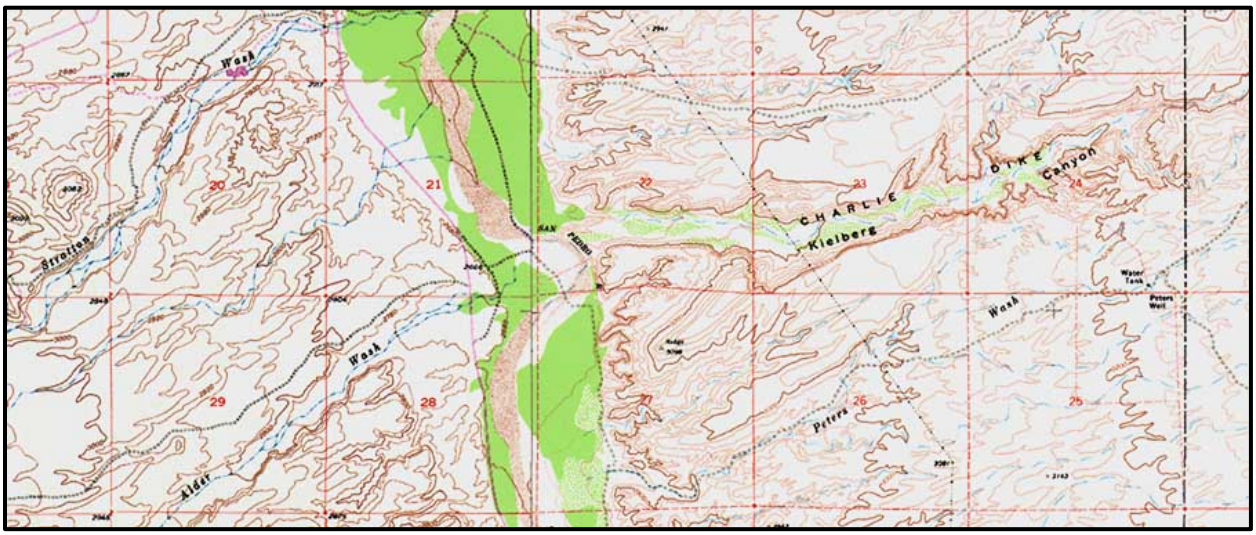
Below, the San Pedro runs from right to left, with the northern Galiuro Mountains in the background. As usual, substantial, high terraces continue to flank the floodplain at many points along this part of the river, but the mountains rise further away. (December 2002)



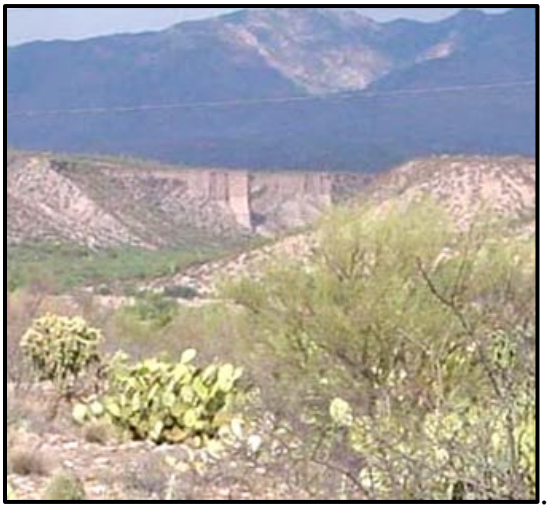
Alder Wash runs down from its source near Loma Linda at the top of Mount Lemmon and hence occasionally carries a lot of water (and, after the fire, organic debris). While it looks fairly modest on the above Topo map, it is a deep, rugged canyon in its upper reaches and a very expansive structure down below. Witness the following image: from the Cascabel/San Manuel Road we look out westward at the broad expanse of lower Alder Wash. The wash is running down toward the viewer, from its source in the central Catalinas (note by the way the big stand of very old Saguaros located on the terrace at far right):

This wash would require very massive bridging to build a large highway through here, and it is only one of a series of paralleling Mount-Lemmon-draining washes here, including Stratton Wash, Catalina Wash, and Peppersauce Wash.

On the map **below**, see Alder Wash running down from the Catalina Mountains. Directly across from it lies a much deeper wash, in Kielberg Canyon, a remote drainage (very difficult to traverse) which drops to the River from the closer slopes of the Galiuros. Together the two washes form a continuous wildlife corridor connecting the Catalinas and the northern Galiuros.

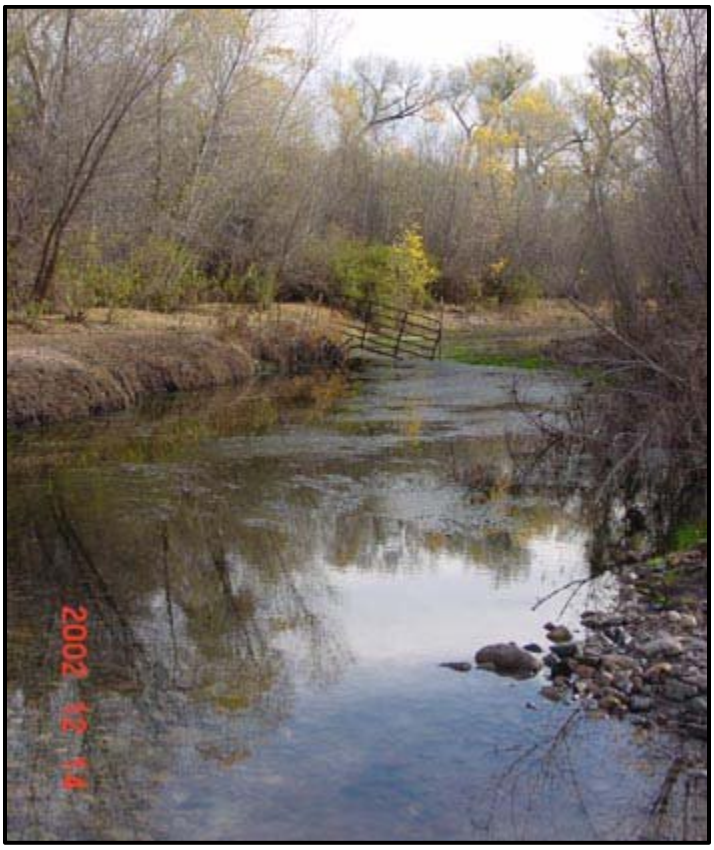


Below left : lower Kielberg Canyon viewed from Alder Wash, looking East; China Peak of the Galiuros rises in the background (July 2002): **below right**: Kielberg Wash looking upstream from High Mesa:



This wash (**above**) runs past Pliocene lakebed-deposit cliffs (see "**Quiburis Basin Geology**") which are visible on both sides of the Canyon, to its confluence with the San Pedro, where the floodplain is very broad and sandy (**right)**, looking eastward toward the outflow of Kielberg Wash):

Further downstream, near Whitlock Wash (and near San Manuel), the waters of the San Pedro surface again at a road crossing:



At this point we have come very close to the tailings ponds of the **San Manuel Mining** operation.


ROAD
CLOSED