Playas and Pleistocene Lakes – Buy One, Get One Free – By Paul Withers

Playas

As is typical in geology, there is no agreement on what a playa is. Roughly, a playa is what's at the bottom of an internal drainage system in arid regions. The regional shallow groundwater system does not connect with an ocean and the surface is dry for at least part of the year. Near-surface strata are typically sedimentary evaporites with characteristic coarse- to-fine facies change from edge to centre. They are good for racing on (Bonneville Salt Flats) and dropping bombs on (Willcox Playa). Playas vary in size from tens of metres to tens of kilometres across. The majority of the approximately 50,000 playas in the world are small. Fewer than 1,000 exceed 65 square km (25 square miles), and fewer than 100 exceed 520 square km (200 square miles). Most small playas are almost circular in shape, and the typical playa will have a length-width ratio of 2:1 or 3:1.

Willcox Playa

The Willcox basin, encompassing approximately 3900 km^2, is a topographically and hydrologically closed basin in the northern part of the semi-arid Sulphur Springs Valley, a NW-trending structural trough within the Basin-and-Range physiographic province. It is bounded to the east and west by mountains (Dragoons and Chiricahuas, and their extensions to the NW) formed during the mid-Tertiary that rise 1 - 2 km above the basin floor. Extensive alluvial pediments (bajadas) emanate from the mountains and circumscribe the basin, forming drainage divides to the north and south. The basin probably contains about 1 km of alluvial fill, though drills have only reached 300 m. Local annual rainfall is 30 cm, over half of which falls in July and August during the summer monsoons, which are caused by the arrival of warm, moist tropical air from the Gulf of Mexico. Winter rainfall comes from frontal storms moving east from the Pacific. Willcox Playa, elevation 1260 m, is in the lowest part of Willcox basin and covers an area of 130 km^2. Heavy rainfall creates a shallow (< 30 cm deep) lake in Willcox Playa that evaporates within a week, leaving white patches of NaCl and Na_2SO_4 that are dispersed by wind. The playa is not quite flat, it slopes down to the west-southwest by less than a metre. Dessication polygons (both 10 cm and 10 m across) and 10 cm-high transverse dunes can be found. Willcox Playa is said to be a landmark for astronauts.

About 15000 years ago, during the last glaciation, the local climate was much cooler and wetter (maybe twice as much annual rainfall and no monsoons) than it is today. Pleistocene mammoth and camel bones have been found nearby. As today, Willcox basin had no hydrologic outflow, and so the extra rainfall accumulated in a pluvial lake, Lake Cochise. Such lakes were then common in the Basin-and-Range province. At its greatest extent, Lake Cochise covered 190 km^2 and had a maximum depth of 11 m (shoreline at 1274 m elevation). Its level rose and fell with climatic changes, finally drying up completely either 4000 (Waters) or 10000 (Long) years ago and killing all the ostracods that had been thriving within it. It was slightly alkaline and its bottom water may have been oxygen deficient. Present day aeolian erosion of the playa means that we look out over a 15000 year old lake bottom.

Palaeoshorelines at Willcox Playa

Beach ridges border the playa on the east and west sides and are the major preserved shore features of Pleistocene Lake Cochise. The ridges stand out when viewed both from the ground and from the air because they support a good growth of mesquite trees and yucca. Of the 80 km of shoreline, only about 50 km are defined by this shoreline feature. At the north and south ends of the playa it does not appear that the ridges were ever built because these were the sites of the influx of fluvial sediments during the late Pleistocene. The ridges are a few metres high and as much as 100 m wide. The fore slope is about 3 times steeper than the backslope. Prior to actual beach ridge formation, beach sands and gravels were supplied by the streams entering Lake Cochise. Longshore drift and waves were responsible for sediment transport and mixing. Periodically storm waves built up the beach level more rapidly. Formation of a beach ridge is indicative of a gently sloping lake bottom. Hence, waves break far from the shore, building up a subaqueous bar which then grows by longshore drift. When the ridge pokes above the lake surface, further growth proceeds by the addition of wave-tossed sediments. Lagoons, which formed behind the bar, appear today as broad, flat areas behind the beach ridges. The uppermost portion of the beach ridge sediments, deposited subaqueously, are unstratified and unconsolidated, in contrast to the underlying bedded, calcium carbonate-cemented sediments, which were deposited subaerially. The beach ridge sediments range in composition from relatively mud-free gravelly sands to slightly gravelly sandy muds. For most of its length the beach ridge surface is gravelly because the fines have been washed away. Roller and disc shapes dominate the pebbles.

Lake Animas and Alkali Flats

Just like Willcox, only in a different state. This is a little more complicated, with four sub-basins to the 6300 km^2 Aminas basin. The eastern boundary of this basin is the Continental Divide. Two Pleistocene lakes were present in this basin, Lake Cloverdale, to the south straddling the current border, and Lake Animas, to the north straddling the current I-10. Lake Animas had an area of 388 km^2, a depth of 20 m, and its highstand was at an elevation of 1280 m. The lake grew and shrank with Quaternary climate changes, probably in a similar fashion to Lake Cochise, giving it palaeoshorelines at several elevations. Like Lake Cochise, it also has beach ridge shoreline features. Two playas, North and South Alkali Flats, currently lie at the bottom of Lake Animas.

Martian Oceans

Were the northern plains of Mars covered by a late-Hesperian ocean? The northern plains are exceedingly flat and smooth, consistent with formation by subaqueous sedimentation. Outflow channels descending from the southern highlands tend to terminate at the same elevation, consistent with entry into an ocean. Tim Parker mapped two contacts between geological units at the southern boundary of the northern plains and suggested that they marked two separate highstands of an ocean. The outflow channels and "Contact 2" all lie close to the -3760 m equipotential. However, spectroscopy (TES) has failed to reveal any minerals indicative of aqueous alteration and proposed shoreline candidates do not look like oceanic landforms in either MOC imaging or MOLA topography.

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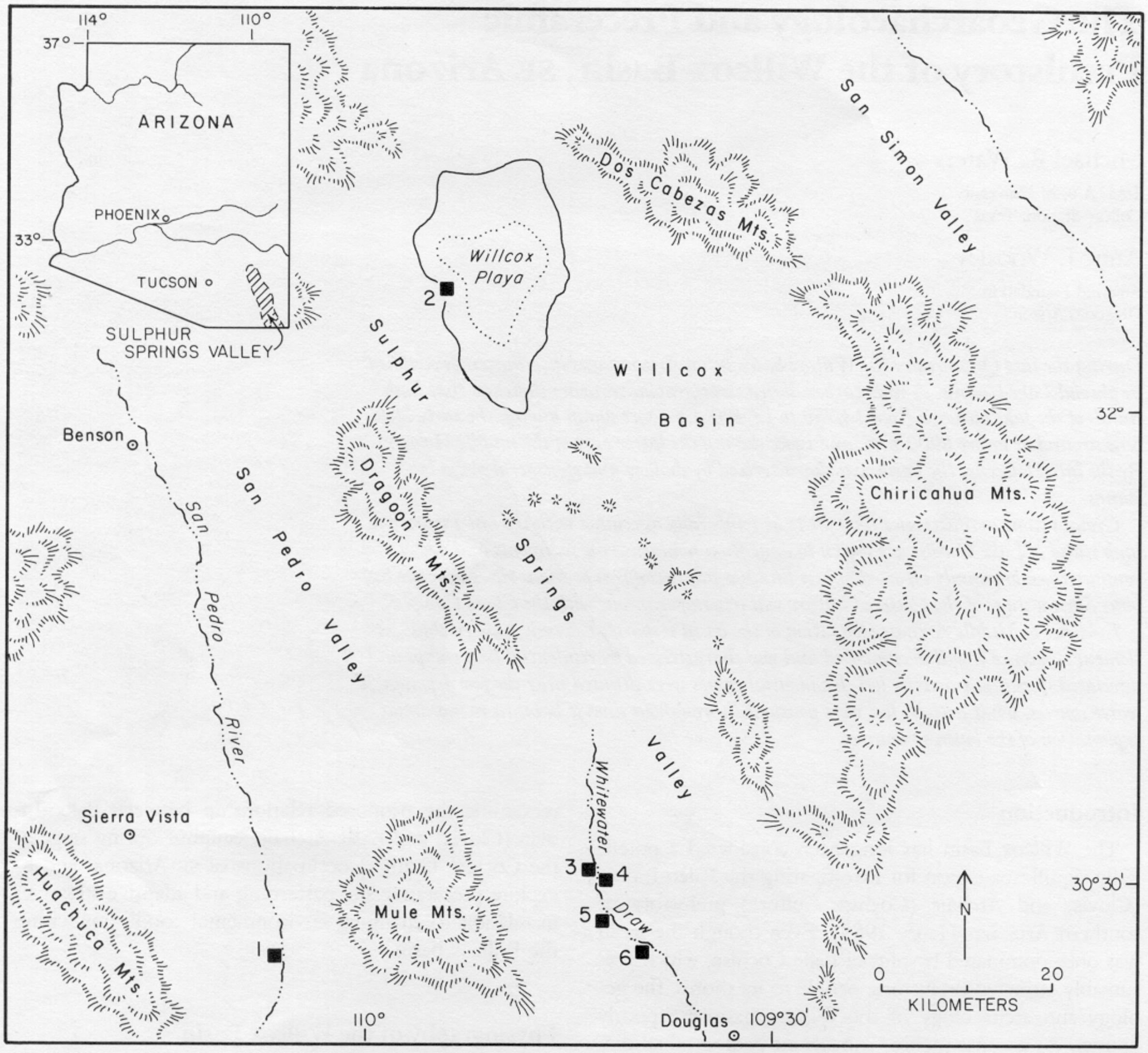

Figure 1. The Willcox basin, with towns, geological and archaeological sites, and physiographic features mentioned in the text. The Willcox Playa (dotted line) and the 1274 m shorelines of Pleistocene Lake Cochise (solid line) are indicated. 1: Lehner Clovis site; 2: Sites AZ CC:13:3, AZ CC:13:5, AZ CC:13:66, and gravel pits along Lake Cochise shoreline; 3: Sulphur Spring site AZ FF:6:9; 4: Sulphur Spring site AZ FF:6:8, 5: Sulphur Spring site AZ FF:10:1 (Double Adobe); 6: Sulphur Spring site AZ FF:10:14. Hatched area on the inset indicates position of the Sulphur Springs Valley in SE Arizona.

The topographically lowest portion of the basin is now occupied by the Willcox Playa, a barren depression covering approximately 130 sq km (FIG. 2; Meinzer and Kelton 1913; Schreiber 1978; Schreiber et al. 1972). The Willcox Playa is dry for most of the year but will fill with water after heavy rainfall, when runoff from the mountains and surrounding alluvial piedmont collects in the playa. This water creates a shallow lake that, if not recharged, disappears via evaporation within a few days to a week.

The Willcox Playa is also the former bed of a much

Waters and Woosley

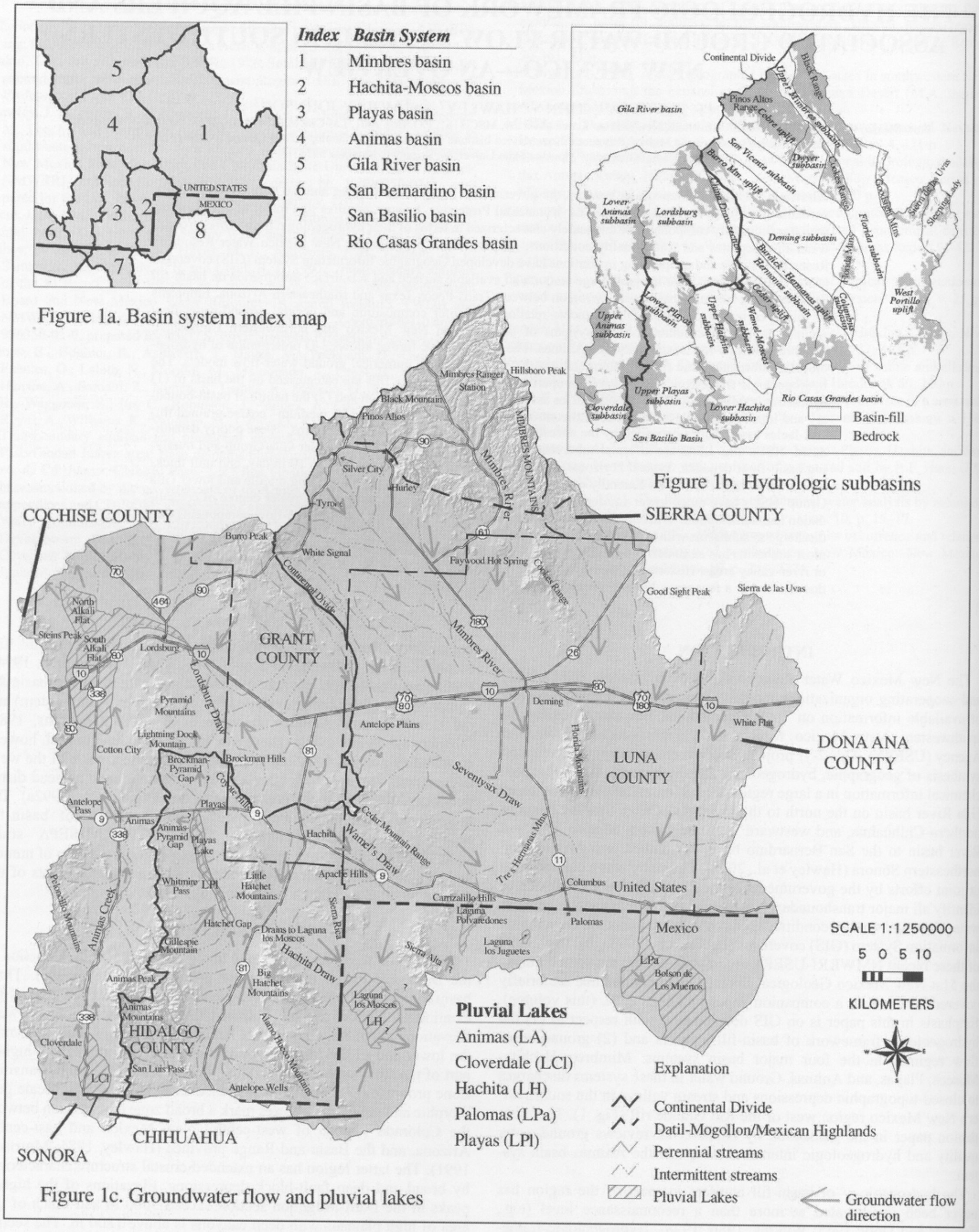

FIGURE 1. Location of the study area in southwestern New Mexico. The locations of the following basin systems are shown on Figure **1a**: (1) Mimbres, (2) Hachita-Moscos, (3) Playas, (4) Animas, (5) Gila River, (6) San Bernardino, (7) San Basilio, and (8) Rio Cases Grandes. Each basin system is comprised of numerous subbasin units (Fig. **1b**). The following pluvial lakes are listed on Figure **1c**: Animas (LA), Cloverdale (LCl), Hachita (LH), Palomas (LPa), and Playas (LPl).