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A HISTORY OF THE SALTON SINK

The story of the Salton Sea has three distinct beginnings, each of which paints a different portrait. From a geological standpoint, we can view the long history of the Salton Trough from its connection with the Gulf of California during the Tertiary period (Blake 1914, Durham and Allison 1960) to the existence of the mammoth Lake Cahuilla beginning some 40,000 years ago (Setmire et al. 1990). By most accounts the entire Salton Trough was once merely the head of the Gulf of California (Fig. 3; Durham and Allison 1960). Massive deposition of silt from the Colorado River eventually accumulated along the southern edge of Gravel Mesa to form a barrier between the erstwhile head and the current one (Fig. 4; Blake 1914, Kennan 1917, Loeltz et al. 1975, *cf.* Free 1914). The enclosed sea subsequently dried, but reminders of the saline environment in the form of "oyster-shells and other form of marine life" are strewn across the base of the Santa Rosa and San Jacinto Mountains at ±100 m elevation.

The resulting depression, further honed by uplift of the surrounding mountains (Blake 1914), formed a deep basin generally called the Salton Trough (Sykes 1914). In rough terms, this trough includes the Coachella Valley, Salton Sink, Imperial Valley, Mexicali Valley, and southern portion of the Río Colorado delta. The Peninsular Ranges, Anza-Borrego Desert, and Sierra Juarez and various other ranges in northeastern Baja California border it to the west. The Orocopia and Chocolate Mountains, Algodones Dunes, and Gravel Mesa form the eastern boundary. The northern terminus lies at the base of the great rift known as San Gorgonio Pass.

Much of this trough lies well below sea level, forming an area known as the Salton Sink (United States Geological Survey 1906) or, sometimes, the Cahuilla Basin (Setmire et al. 1993). The sink lies in an actively spreading rift valley (Setmire et al. 1993). Low-lying alkaline flats of little topographic relief typify this region, although there are a few rocky outcrops and hills, mostly volcanic in origin, such as Travertine Rock, Mullet Island, Red Hill, Obsidian Butte, Mount Signal, and Cerro Prieto (Loeltz et al. 1975). Tremendous geothermic activity not far below the earth's surface sprouts mudpots and "mud volcanoes" (Blake 1914, Nelson 1922) that further shape the terrain in subtle ways around the southeastern shoreline of the Salton Sea and the former Volcano Lake (now dry and occupied by Campo Geotérmico Cerro Prieto). Even so, this flat, low-lying sink is decidedly featureless compared to most of the Sonoran Desert. It is the Salton Sink that is the biogeographical region covered in this book (Figs. 1, 4). Thus, the title might well have been "Birds of the Salton Sink."

Lake Cahuilla

The next chapter in the story of the Salton Sea is that of Lake Cahuilla. The existence of this lake was first recorded for posterity during surveys for potential rail routes through the Southwest (Blake 1858). For this season, early literature often refers to the ancient lake as the "Blake Sea." The moniker "Lake LeConte" was applied widely too, until Blake himself insisted on his original dubbing (Gunther 1984). The name Lake Cahuilla has been used ever since. The still shoreline can be seen along the eastern flank of the Santa Rosa Mountains (e.g., Schoenherr 1992:421), especially in the vicinity of Travertine Rock, and there is evidence of the "heavy assaults of surf for some considerable period" along the northeastern shoreline, south of Mecca (Sykes 1914). Furthermore, the Algodones Dunes and presumably dunes around the Supersition Mountains are the remnants of beaches from this forerunner of the Salton Sea (Norris and Norris 1961) and it is clear that the central Coachella Valley was historically an area of playas and shallow lakes, similar to but commonly larger than the Salton Sea (California Department of Water Resources 1964).

Early forms of Lake Cahuilla, with a shoreline peaking at 50 m above sea level, date to 40,000 years ago (Setmire et al. 1990). More recent versions had a lower surface elevation, reaching a mere 12 m above sea level. In either form, this mighty lake dwarfed the present Salton Sea (Fig. 5), being 160 km long and 56 km wide, covering an area of ±5,400 km^2, and reaching a maximum depth of nearly 100 m. By comparison, the Salton Sea is 72 km long by 27 km wide, covers an area of ±1,150 km^2, and reaches 25 m at its deepest point (Blake 1914, Woerner 1989). Indeed, the entirety of the Salton Trough, that great northward extension of the

Gulf of California, is scarcely larger than was Lake Cahuilla, being 208 km by 112 km (Loeltz et al. 1975).

After desiccation, Lake Cahuilla was periodically filled by floodwaters from the Colorado River; it was thus a largely fresh-water lake (Walker 1961), although it may have been somewhat brackish at times, especially during early inundations (Blake 1914). The river deposited copious sediments and created the rich soil that supports abundant agriculture in the Coachella, Imperial, and Mexicali Valleys (Blake 1914, Cory 1915, Setmire et al. 1990). At least four major floods occurred during the past four millenia, each reforming this vast lake (Fig. 6). The oldest flood event was between 6,670 and 1,000 years ago (Waters 1983, Gurrola and Rockwell 1996), but the other three were much more recent. The second oldest event was between 720 and 1,180 years ago and the third oldest about 650 years ago (Wilke 1978, Waters 1983, Gurrola and Rockwell 1996). Importantly, Lake Cahuilla was last filled to capacity only about 400 years ago, meaning it was present during the late 1500s and early 1600s (Norris and Norris 1961, Gurrola and Rockwell 1996, Laylander 1997). The appearance and evaporation "*poco-a-poco* (little by little)" of this lake was well known to the Cahuilla Indians (Blake 1914), providing further evidence of its recent history in the Salton Trough.

Since Lake Cahuilla was last filled, periodic small floods have inundated the Salton Sink, creating smaller lakes/seas in 1840, 1842, 1852, 1859, 1862, and 1867 (Sykes 1914). Most flooding is through the New River, "so named for its unexpected appearance flowing into the desert in the year 1849" (Blake 1915, *contra* Schoenherr 1992). The last major flood was in 1891 (Sykes 1914), when a lake formed with a surface area roughly half that of the current Salton Sea (Chase 1919). Sykes (1914) noted that some water "found its ways down the channel of the New River toward the Salton every year since the inundation of 1891," demonstrating the capacity of natural Colorado River floods to fill the Salton Sink. This seemingly esoteric point should be borne in mind when pundits decry the Salton Sea as non-natural. While true the sink may have flooded never more after the turn of the twentieth century, this result would have been achieved only through the continuous damming and diking of the great river, not because the capacity to flood was lost. Humans have taken and given to this ecosystem, punctuated by a fortuitous engineering blunder that brought back a reminder of the former Lake Cahuilla.

Formation of the Salton Sea

The engineering accident that led to the inundation of the Salton Sink, thus forming the Salton Sea, has been chronicled in detail (Cory 1915, Kennan 1917, Burns 1958, Dowd 1960, de Stanley 1966, Skrove 1986, Woerner 1989), so only a general summary will be presented herein. Readers interested in more in depth information are referred to lively accounts by Kennan (1917), which set the standard for subsequent efforts, and Woodbury (1941), which takes a broader geographic perspective. The more technically inclined are referred to Cory's (1915) account, which goes into excruciating detail about every engineering aspects of the initial irrigation project and the various efforts to stop the flooding of the Salton Sink.

Importantly, what most accounts fail to mention is that 1905 was a major flood year and that were it not for the extensive channelization and draining of the Colorado River, the Salton Sink likely would have been inundated anyway. Copious inflow of irrigation water has kept the Salton Sea alive, sparing it the desiccatory fate of Lake Cahuilla. Blake (1914) calculated that at an evaporation rate of ±2.4 m per annum, the 25 m "of water now covering the Desert, and known as the Salton Sea, will require ten and a half years for its complete evaporation." So, aqua-engineering of the region has been a decidedly mixed blessing. Through the engineering debacle that formed it and the agricultural runoff that maintains it, the largest inland body of water in California has been dubbed "in essence manmade [with] a manmade ecosystem" (Setmire et al. 1993). Yet once one considers the long history of flooding in the Salton Sink and its long history of waterbird use, it is more proper to view the Salton Sea as merely the latest in a series of lakes that have occupied the basin.

As with the story of Lake Cahuilla, in many ways the story of the Salton Sea begins with William Phipps Blake. Showing remarkable insight on near-prophetic level, Blake (1858) opined that routine flooding by the Colorado River accumulated extremely rich fluvial and silty clay soils in the Salton Sink that would produce bountiful crops if sufficiently irrigated. Clearly a man before his time, this seemingly wild notion was ignored for decades, save for another intrepid visionary, Oliver Wozencraft. Quite independently of Blake, and some half-decade earlier, Wozencraft saw that the rich soils Imperial Valley might be irrigated by diverting water from the Colorado River through the Alamo River. Blake had warned that any calamity associated with irrigation attempts could flood the Salton Sink, because it was some 100 m lower in elevation than the Colorado River at Yuma. Wozencraft was less concerned about such potential problems and was undetered by skeptics noting the sand dunes between the Colorado and the Salton Sink that rose a few hundred meters in elevation. Instead, he pursued his vision with vigor for several decades, but ultimately failed to gain needed support.

The dream may have died were it not for Charles Rockwood and George Chaffey, the "main players . . . in 'The Great Imperial Valley—Colorado River' play" (Woerner 1989). They resurrected Wozencraft's dream, designing an elaborate scheme to bring irrigation water to the Imperial Valley (a name that Chaffey himself coined). They, too, chose the Alamo River as the most reasonable channel by which to convey water. A short canal and an inflow site (with a headgate) was need to convey water from the Colorado to Alamo. The headgate was placed near Yuma and construction began on it and the canal in August 1900 (Cory 1915, Kennan 1917, Woerner 1989). By June 1901 water was being diverted into the Alamo, allowing irrigation and agriculture to begin. The canal worked smoothly for several years until it was clogged a deposit of heavy silt, disrupting inflow. Having carved the Grand Canyon and other glorious rock formations in the Southwest, the Colorado River was famous for carrying a massive load of silt. Thus, dredging to unclog the canal was a ceaseless task. In spite of this problem, ±150,000 acres (±620 km^2) of the Imperial Valley succumbed to cultivation by 1904.

The rapid establishment of an important agricultural economy increased pressure for adequate water delivery. The fateful decision was made in September 1904 to dig a temporary intake in hopes of improving water delivery to the Alamo River (Kennan 1917, Woerner 1989). The project was finished quickly, amounting to little more than a ditch 15 m wide and 2 m deep dug at river level without a headgate some 6 km south of the main headgate. This ditch soon silted, requiring constant dredging, but water levels in it could not be controlled because a headgate was never constructed. Flooding on the Colorado River in the winter of 1904/1905 rushed down this ditch, bringing a vast excess of water to the Imperial Valley, far more than was needed for irrigation of crops. The excess was carried by the Alamo and New Rivers to the Salton Sink, which slowly began to fill . . . just as Blake had warned decades before.

Water in the sink was rising at a rate of about 1 cm/day by October 1905 as water gushed through the ditch, widened by floods to a gaping 200 m and deepened to 8 m! Almost all river water was now flowing to the Salton Sink, with little to none continuing on to the Gulf of California (Cory 1915, Kennan 1917). Panic soon set in, as rising waters claimed not only farms and ranches, but the saltworks and Southern Pacific Railroad tracks. Nearly every solution imaginable, from pilings to sandbags to dynamiting, was thrown at the problem, but each failed as the raging torrent of water further widened the channel. By 1906 hope was nearly lost, spawning sarcastic features to appear that publicized Indio as a new seaport for the gulf (Woerner 1989). A grand effort in August 1906 nearly halted flow, as 200 railcar loads of rock, gravel, and clay were dumped into the channel, plugging the break by November. But the solution was short-lived. By December floodwaters again rose, destroying the newly constructed dam and carving a channel nearly a kilometer wide that dumped ever more water into the Salton Sea, now a vast lake. Another dam was completed by February 1907, this one successful. The level of Colorado River rose some 4 m and water levels dropped drastically in the Alamo and New Rivers.

Once the 1907 dam blocked inflow, the Salton Sea had a surface elevation of -60 m below sea level and was thus larger than it is today. Surface elevations fluctuated dramatically during the first two decades of the sea's rebirth (Fig. 7), reaching a low of -75 m in 1925 (Holbrook 1928). Irrigation effluent ditches constructed in 1922 and after restored the level of the sea to about -68 m (Holbrook 1928); indeed, were it not for the vast repository that is the Salton Sea, the rich agriculture of the Imperial, Coachella, and even Mexicali Valleys would not be possible. The water level is now much more stable, although it is slightly higher in spring and lower in fall (Setmire et al. 1990).

And thus the Salton Sea was born (Fig. 8). Lest anyone wonder why it is called the Salton Sea rather than Lake Cahuilla, given that the current lake was formed by the same flooding processes that created the vast prehistoric lake, we once again turn to Blake (1914). He noted that the Salton Sea is but a vestige of a lake of much vaster proportions, such that each deserved its own name, one for the current body of water and one for the distinct ancient body. In this sense the relationship between the Salton Sea and Lake Cahuilla parallels that between the Great Salt Lake and Lake Bonneville, as in each case the latter was a vastly larger precursor to the former (Blake 1914, Jehl 1994).