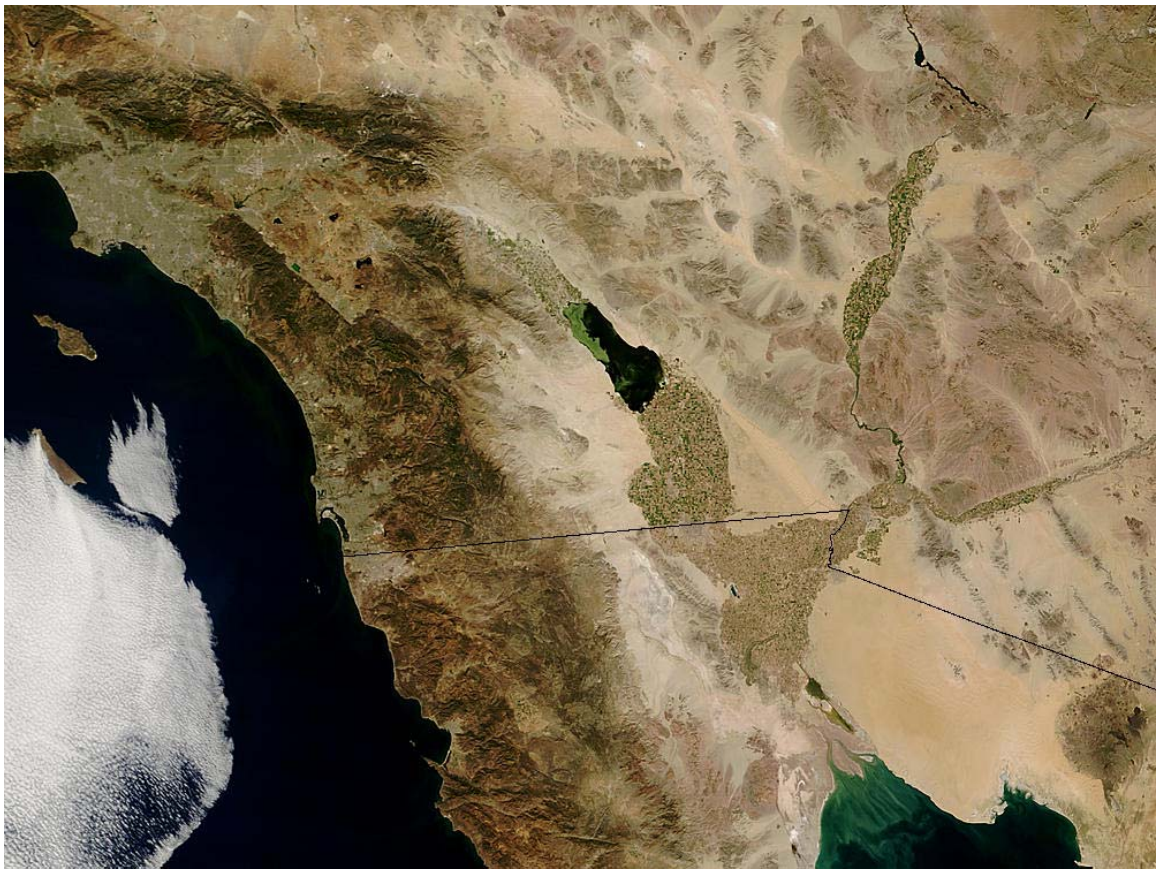
Origin of the Salton Sea

Southern California and the Salton Sea, October 9, 2003


Algal Bloom Close-up, October 11, 2003



The Salton Sea, shown in this series of Moderate Resolution Imaging Spectroradiometer (MODIS) images, is California's largest lake. The current Salton Sea formed in 1905 when an irrigation canal ruptured, diverting the Colorado River into the Salton Basin in southeastern California. The basin filled, resulting in the lake that exists today. At 227 feet below sea level, the basin has filled with flood water from the Colorado River many times in the past. Around 700 A.D., the Colorado River became clogged with silt and changed its course to flow into the Salton Basin. The lake that formed there, Lake Cahuilla, seems to have persisted until about 300 years ago. Since then, occasional lakes have filled the basin, and then evaporated away. Enriched by silt, the former lake bottom provides fertile farmland, and can be clearly seen as green against the tan of the surrounding desert in these true-color images.

Today, agricultural run-off from the Imperial, Coachella, and Mexicali Valleys supplies 90 percent of the inflow to the Sea. This water is rich with nutrients like phosphates and nitrates, which spur the growth of plants and algae in the Sea. Fish and other wildlife thrive on the veritable underwater forest that grows in the Salton Sea, but that same productivity can be lethal. Large algae blooms consume the oxygen in the lake as they die, killing large numbers of fish.

This series of MODIS images show the development and decay of several large algae blooms starting on May 28, 2003. The first bloom grows from a green fringe on the shores of the lake to a murky green swirl that covers much of the lake. Then, as the bloom dies, it fades to a dull brown, as seen on June 14, 2003. The Sea clears the next day, though traces of algae remain. Subsequent blooms develop and fade away on varying scales throughout the summer and into the autumn.

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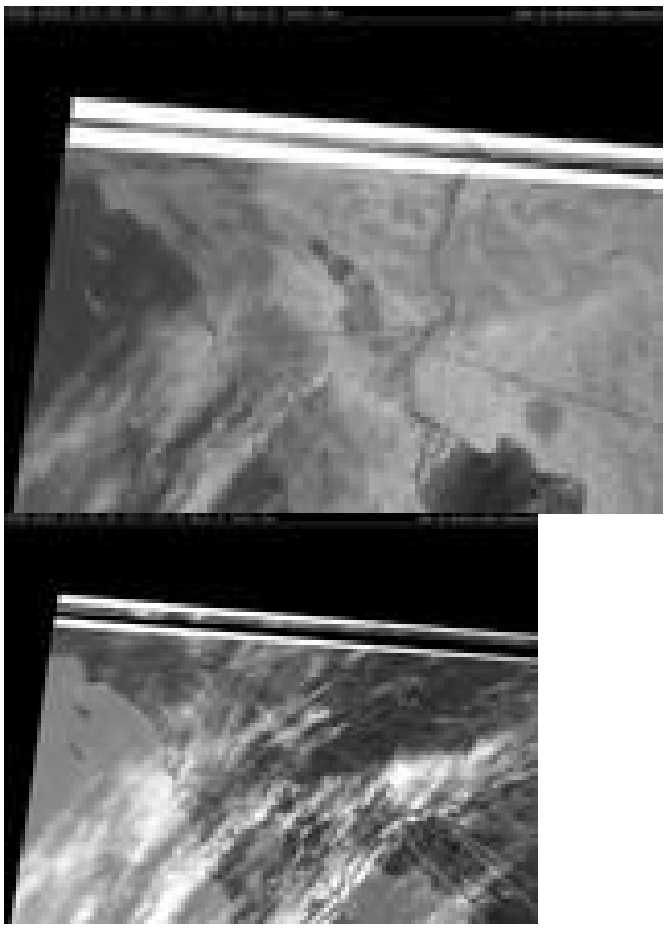
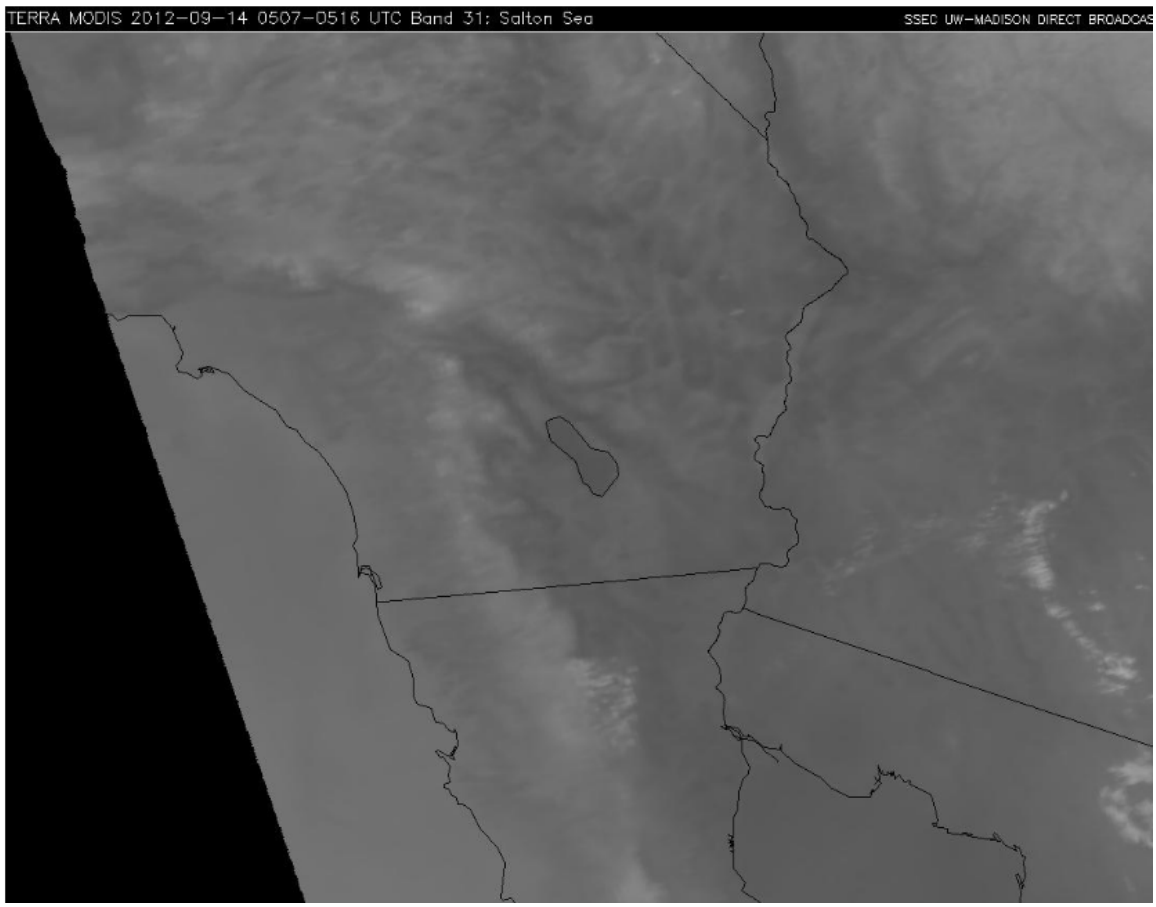
Salton Sea and Imperial Valley (NASA, International Space Station Science, 04/15/10)

Biot #505: March 14, 2008

The Salton Sea, California's largest saltwater lake (currently about 15 by 35 miles), is located in the Salton Trough, a 130-mile-long and 70-mile-wide below-sea level depression of concentrated tectonic activity on which ride the Coachella and Imperial Valleys of Southern California, and the western half of the Mexicali Valley and the Colorado River delta in Mexico. (1,2) The Salton Trough is divided into two parts by the Salton Sea--the Imperial Valley is to the south and the Coachella Valley is to the north. The Coachella Valley

includes the highly populated Palm Springs area, and the Imperial Valley is the largest area of desert irrigation development for growing crops in the US. Importation of water from the Colorado River to Imperial Valley has transformed 500,000 acres of desert into a fertile agricultural area. The Colorado River lies to the east of the Salton Trough. The mouth of the Colorado River, which is now mostly dry, is in Mexico where the riverbed merges with the Gulf of California (Sea of Cortez).

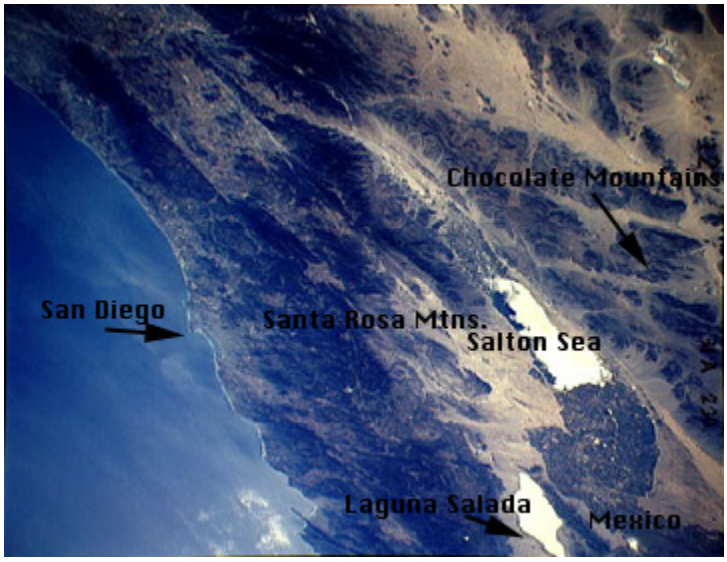




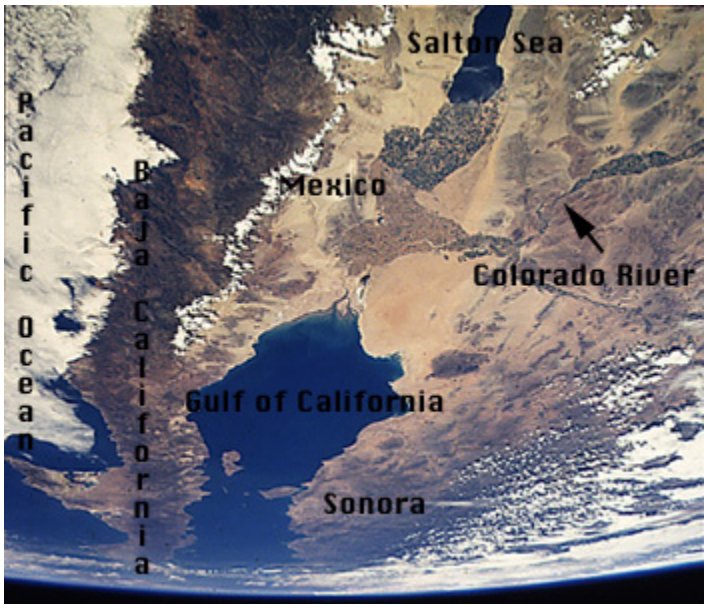
Satellite photo of Salton Sea, Imperial Valley, Colorado River, and Gulf of California. Source: www.ssec.wisc.edu/~gumley/modis_gallery/images/SaltonSea_20040108_2050_250m.jpg; accessed March 12, 2008.

The Salton Sea, located about 130 miles east of San Diego (in Imperial County), is a saline lake that was formed in a large basin (called the Salton Trough) created by a releasing bend of the San Andreas fault. In modern times, the Salton Trough, a desert basin whose center is 278 feet below sea level, became a lake in 1891, but dried up within a year. It began to form again in 1893. In 1905, the Colorado River flooded and was accidentally diverted into the Salton Trough, thus creating the Salton Sea. The Salton Sea was originally a fresh water lake. Because it is a closed system, with no outlet, water is lost only through evaporation. The salts from the surrounding environment have been concentrated in the sea for many years, and now it is more saline than the ocean. The sun evaporates 18% of the

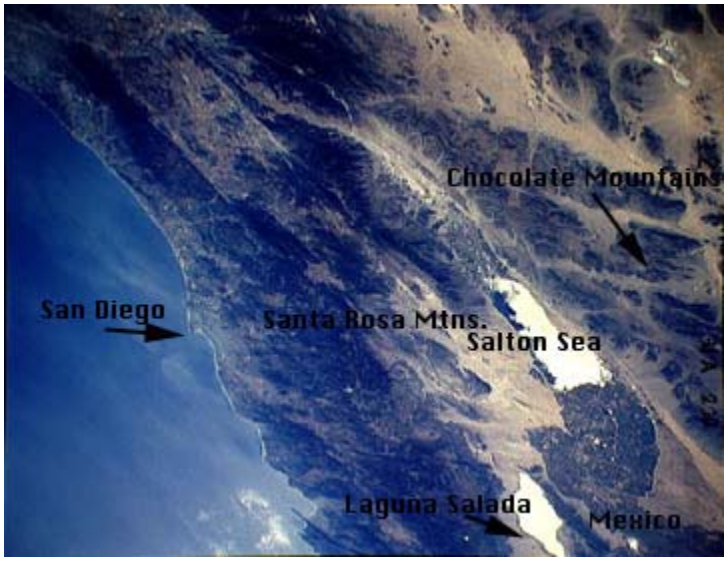
sea's volume every year, but the salt is left behind. Evaporation also concentrates pesticides and other pollutants.



This is image STS61A-0200-0122 taken from the space shuttle in October 1985. The Salton Sea is about 60 km long. Beneath it is the Imperial Valley, one of the major agricultural zones in California. The U.S./Mexico border runs about midway through the farmlands. The San Andreas fault is the linear feature that runs along the eastern (right hand) side of the Salton Sea. Notice that in this image, there is water in Laguna Salida, a large playa lake on the Mexican side of the International Border.

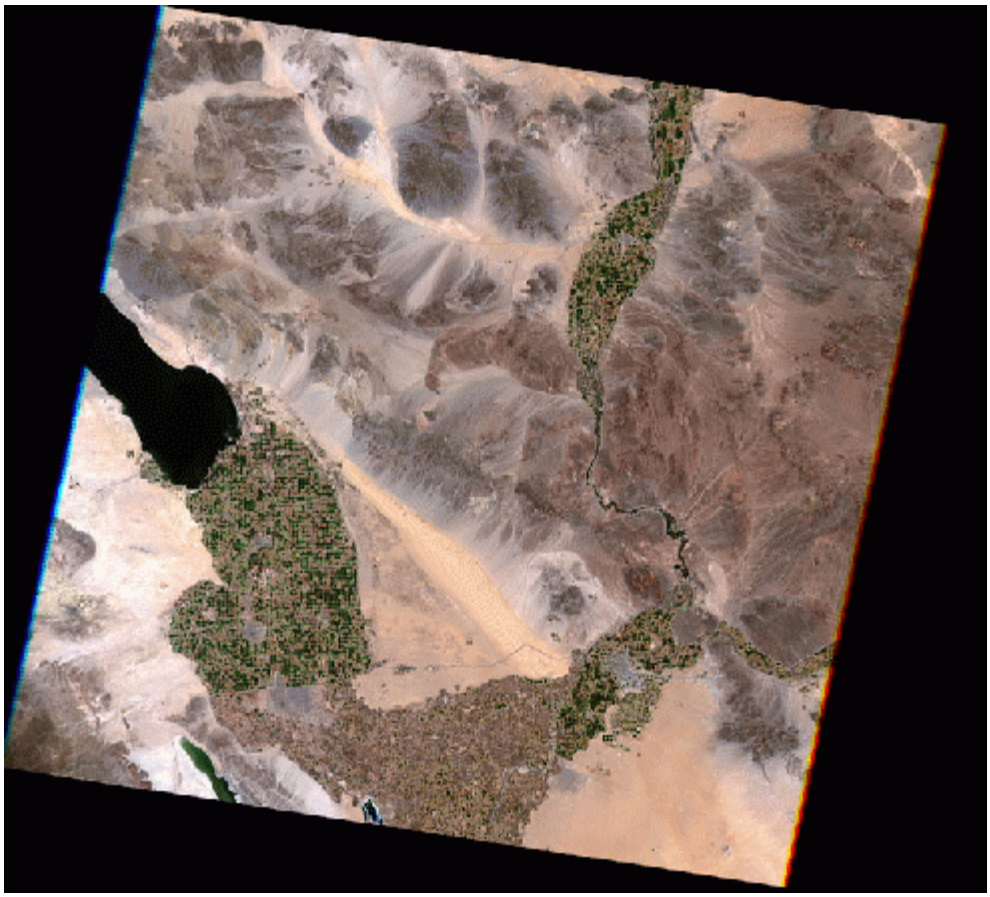


This is image STS040-0073-0054 taken from the space shuttle in June 1991. The Salton Sea is the small body of water in the north east quarter (top left) of the image. In this image you can clearly see where the US/Mexican border runs through the middle of the agricultural zone beneath the Salton Sea. Also, notice that in this image, there is no water in Laguna Salada.



Satellite view of Coachella and Imperial Valleys on the north and south ends of the Salton Sea. Source: content.answers.com/main/content/wp/en/thumb/6/6b/200px-Salton_Sea_from_Space_Shuttle.jpg; accessed March 12, 2008..

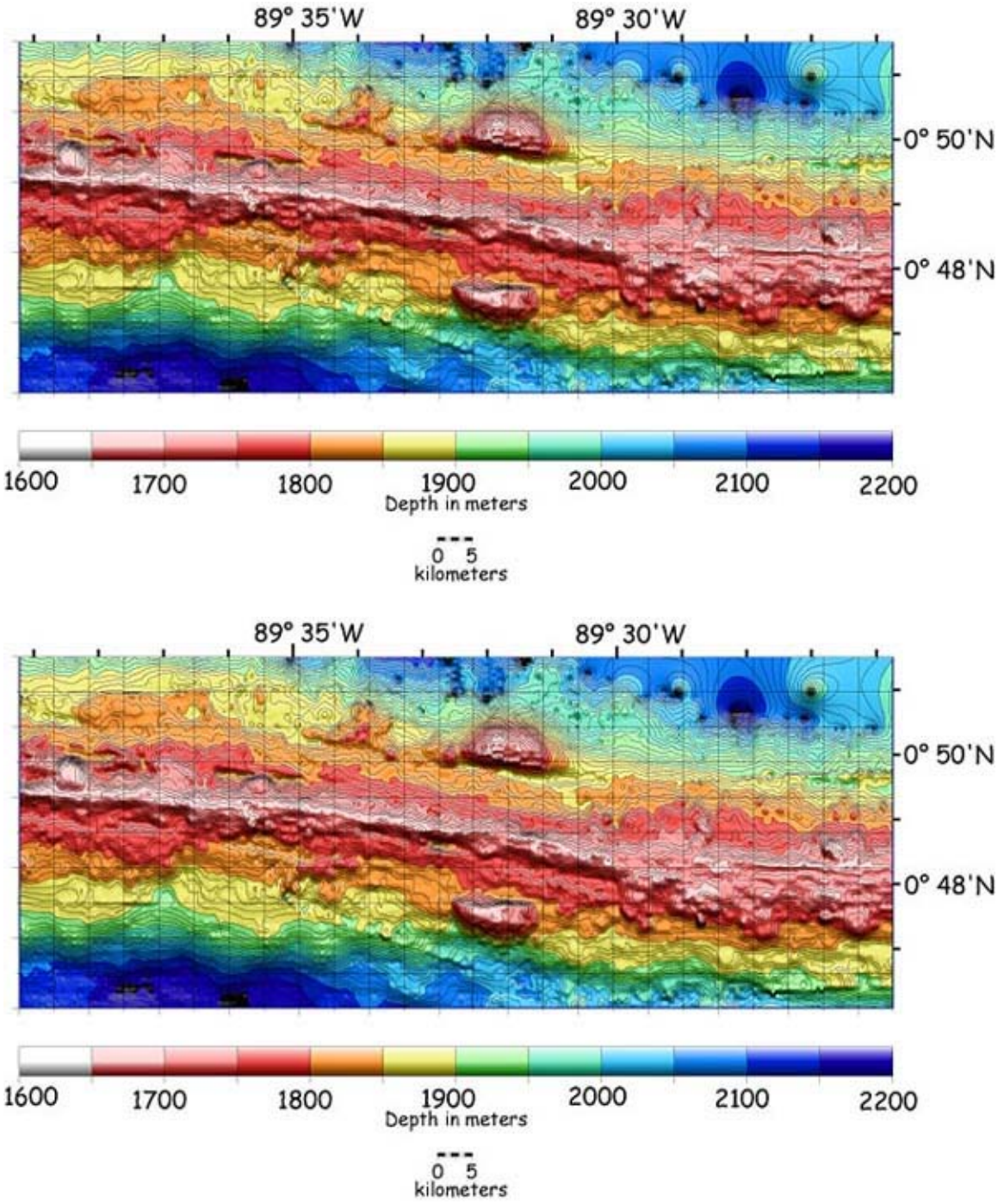
Jay Calderon, The Desert Sun cq'd jmc Energy from rising magma is still evident in geothermal hot springs that bubble up just beneath the shallow water's surface here at the south end of the Salton Sea. This aerial photograph was taken near geothermal power plants that capture the heat energy released deep underground.



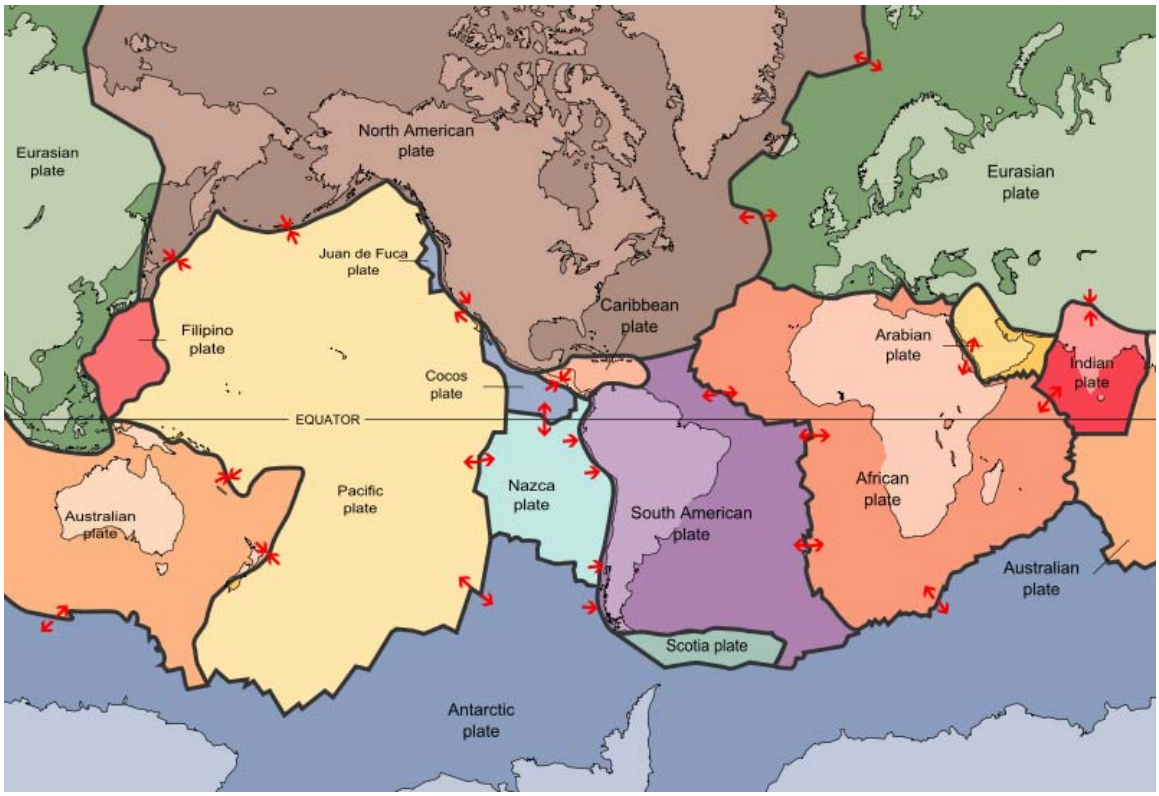
Satellite view of Imperial Valley and Colorado River. Source: landsat.gsfc.nasa.gov/education/compositor/graphics/salton_321.gif; accessed March 12, 2008.

I. Triple Plate Junction Beneath the Salton Trough

The Salton Trough area, incredibly, is the place where three moving tectonic plates meet a triple junction among the Cocos, Pacific, and North American tectonic plates.



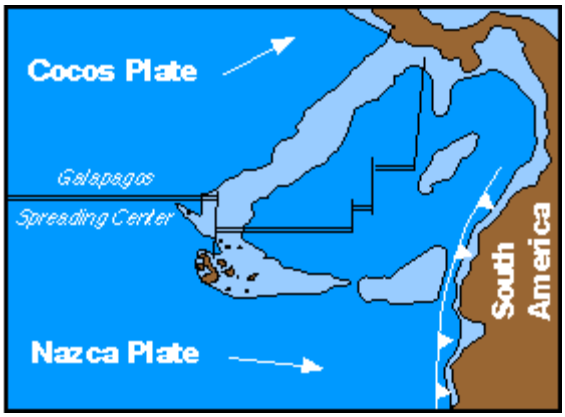
Global rift valleys. Can you locate the Cocos and Nazca plates? Source: www.photolib.noaa.gov/htmls/nur09764.htm; accessed March 12, 2008.



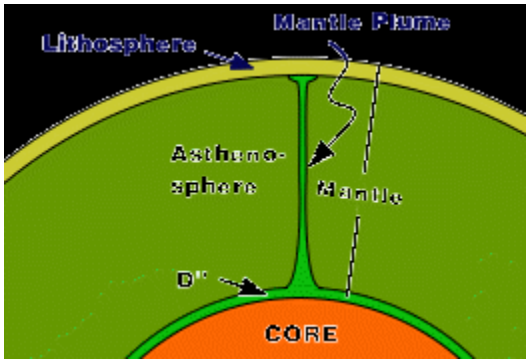
Earths tectonic plates. Source: en.wikipedia.org/wiki/Image:Plates_tect2_en.svg; accessed March 12, 2008.

Cocos plate (gray-blue in above figure) is an oceanic plate hugging the west coast of Mexico. Its name derives from Cocos Island, which rides on it. Seismic activity of the Cocos plate caused the 1985 Mexico City earthquake (8.1 on the Richter scale) described elsewhere. (3) Mexico City is located where the Cocos and North American plates rub up against one another.

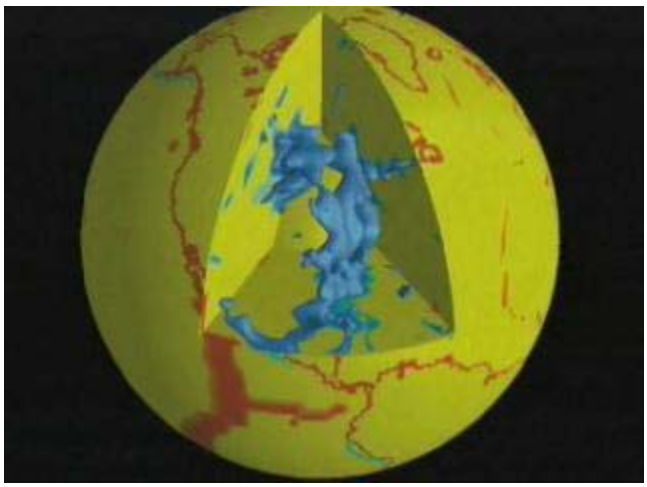
South of the Cocos plate is a larger oceanic plate called the Nazca plate (light blue in the figure above), named after the Nazca region of Peru. The Galapagos archipelago, a group of volcanic islands, signals the boundary between the Cocos and Nazca plates, which are spreading apart along their shared margin. (4)

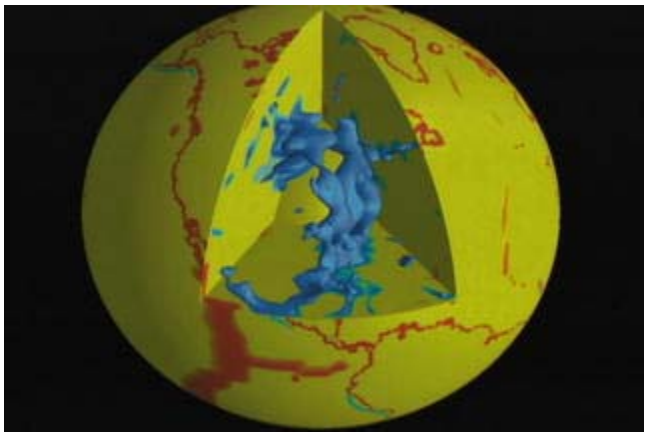


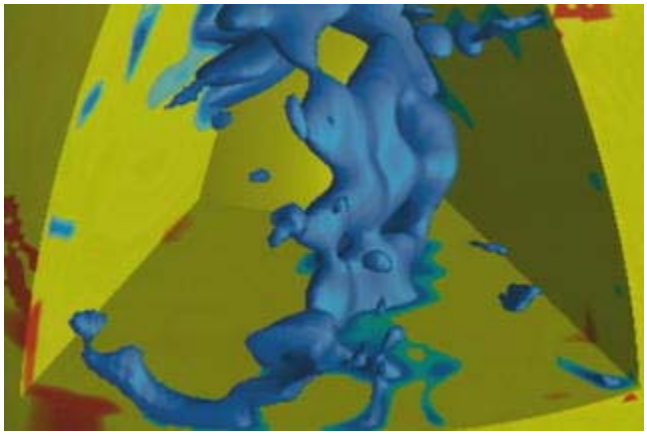
Galapagos Archipelago. Source: www.geo.cornell.edu/geology/GalapagosWWW/GalapagosGeology.html; accessed March 12, 2008.



Farallon plate inside the Earth. Source: svs.gsfc.nasa.gov/vis/a000000/a002400/a002410/; accessed March 12, 2008.







Farallon Plate Remnants

The Rockies are fifteen hundred kilometers, or one thousand miles, to the east. The cause must be the tectonic plate that built these mountains. Its name is Farallon. Farallon started off normally enough. It plunged beneath the North American Plate at a forty-five degree angle. This process sprouted volcanoes to form the Sierra Nevada in what is now California.

Next, mantle motions pulled North America westward over Farallon, and the plate scraped along the bottom of the continent - for fifteen hundred kilometers. As North America continued its westward trek, Farallon settled to the bottom of the mantle.

The image is output from a model run using the TERRA mantle software. To read more about Hans-Peter Bunge's work of that time (2000), visit the following story:

http://ct.gsfc.nasa.gov/insights/vol14/story1.htm.

To learn more about Bunge's more recent work, visit his web site at:
http://www.geophysik.uni-muenchen.de/Members/bunge.

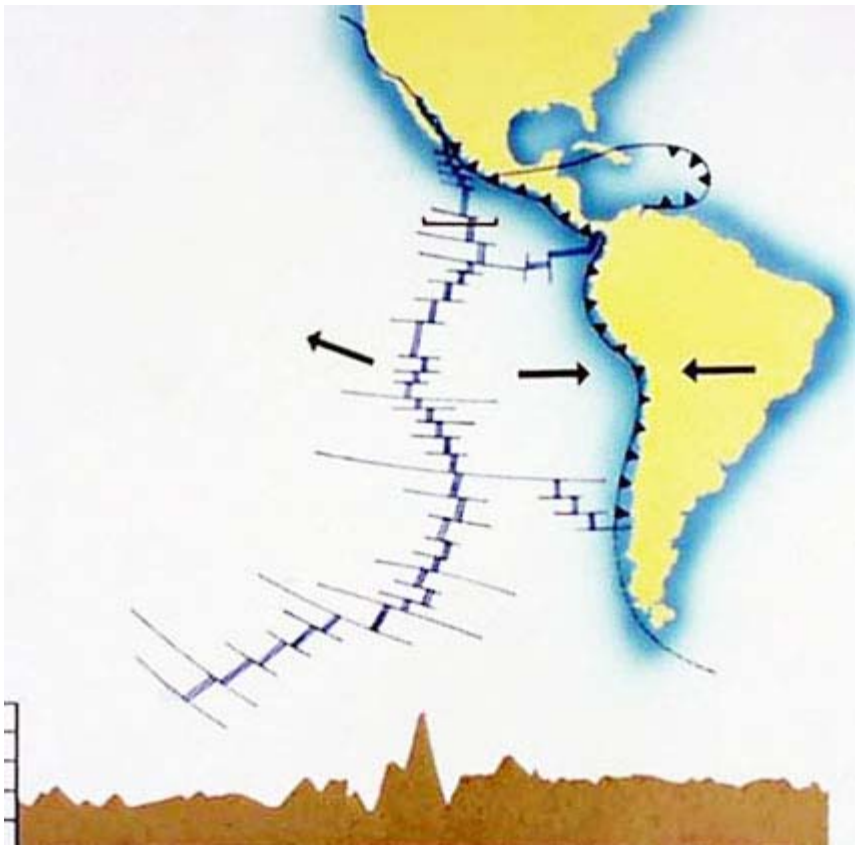
The Cocos and Nazca plates are remnants of the Farallon plate, the ancient oceanic plate that broke up and has been subducting under the North American plate since the Jurassic period 199 to 145 million years ago. (5) The Farallon plate, named after the Farallon islands off the coast of San Francisco that ride on it, has almost completely subducted beneath the western portion of the North American Plate. When the Farallon plate began its downward plunge beneath the North American plate in the Jurassic period, it probably lifted up the Rocky Mountains. The North American plate terminates at the San Andreas Fault system, which runs down the length of California. The San Andreas Fault system is also the point at which the North American plate rubs up against the Pacific plate.
The North American plate (brown in map above) is made of both continental and oceanic (Atlantic Ocean) crust.

The Pacific plate (light yellow in figure above) shares a boundary with the Cocos, Nazca, and North American plates. Indeed, the point at which the Pacific, Cocos, and North American plates meet the triple junction is beneath the Salton Trough.

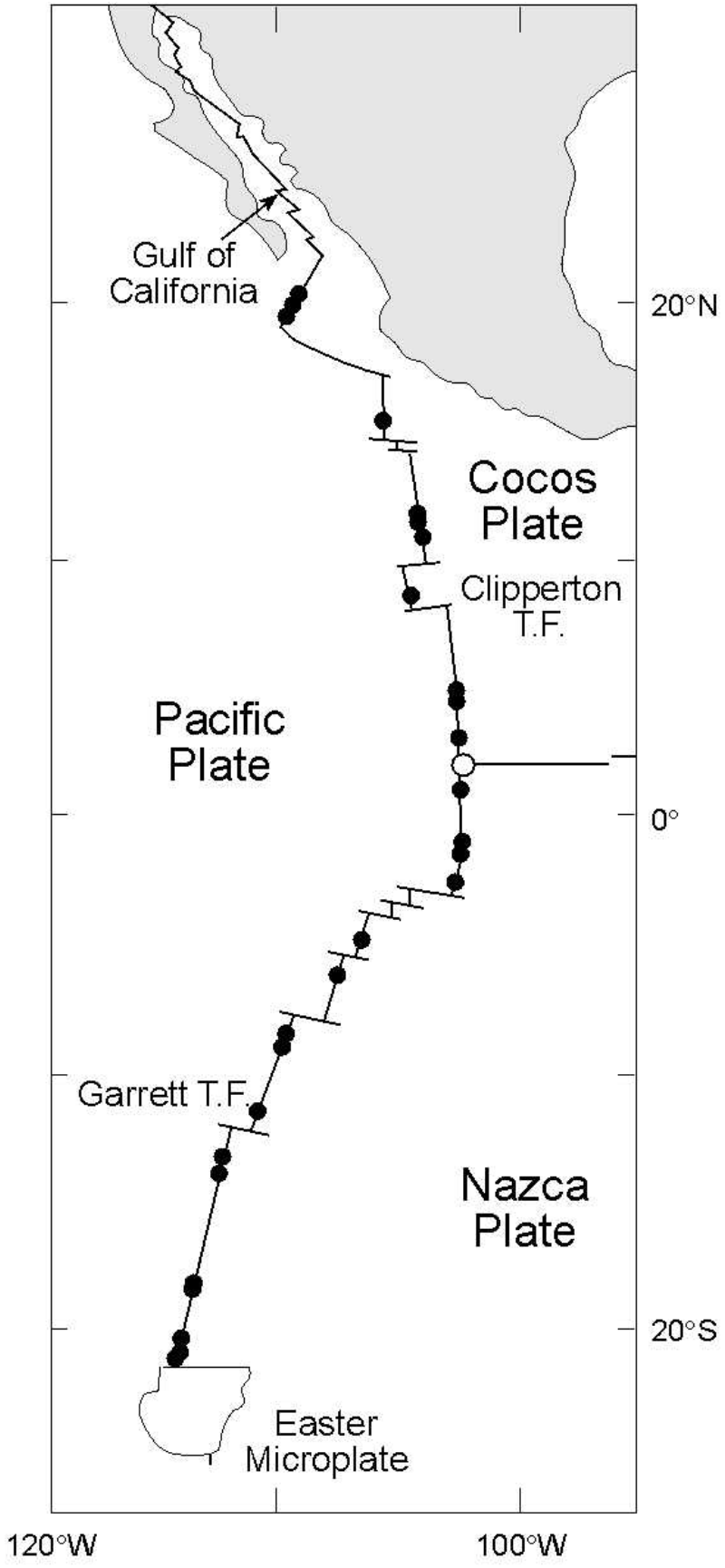
II. East Pacific Rise and the Gulf of California

The East Pacific Rise is a spreading rift valley that extends northward from the middle of the equatorial Pacific Ocean and disappears as a distinct bathymetric feature somewhere near the Gulf of California. (6,7) The East Pacific Rise connects with the San Andreas Fault system under the Salton Trough.

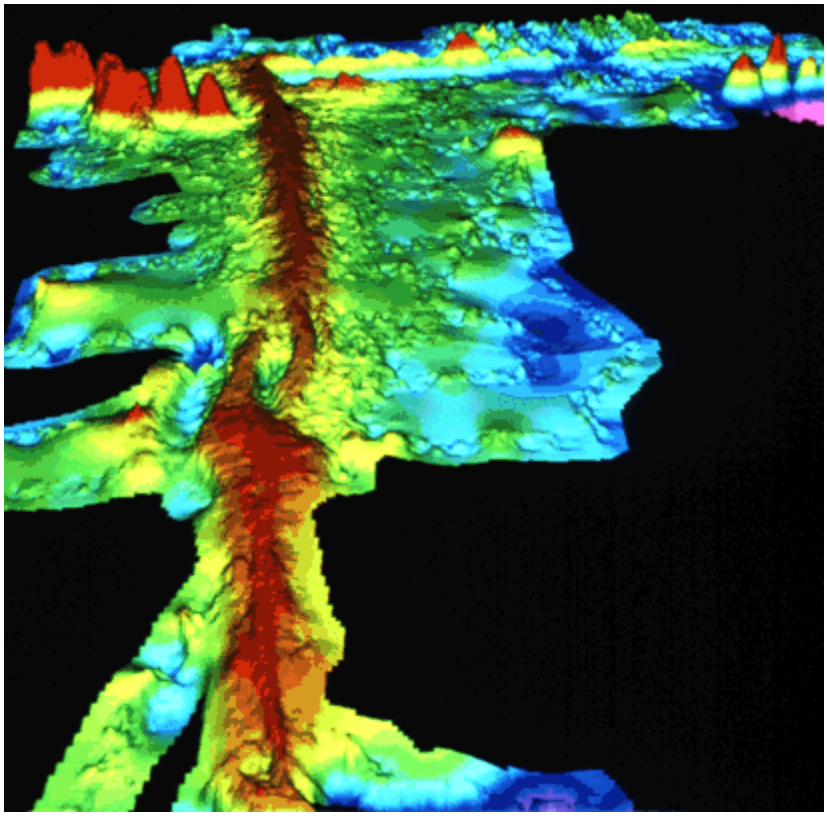
How did the Gulf of California and Baja California form? "About five million years ago, the East Pacific Rise split the Baja Peninsula from the mainland of Mexico", explains Alles. (2) "The waters of the Pacific then poured into the rift valley creating the Gulf of California. Since then, like a giant door swinging open, plate tectonic activity along the East Pacific Rise has moved the Baja Peninsula 162 miles (260 km) westward from the mainland at the southern end of the gulf. The northern 'hinge' point of this tectonic system is the Salton Trough". (2)



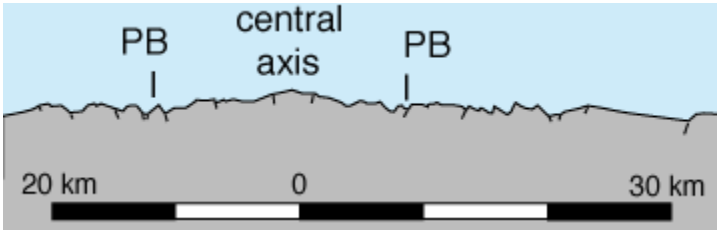
Map showing East Pacific Rise (left side of the photo). Source: www.dkimages.com/discover/previews/852/20118006.JPG; accessed March 12, 2008.


Gulf of
California
20°N
Cocos
Plate
Clipperton
T.F.
Pacific
Plate
0°
Garrett T.F.
Nazca
Plate
20°S
Easter
Microplate
120°W
100°W

Map showing course of East Pacific Ridge. Source: www.pmel.noaa.gov/pubs/outstand/bake1538/images/fig08.jpg; accessed March 12, 2008.



Computer-generated topographic map of the east Pacific Rise near 9 degrees north. Blues and greens represent lower elevations. Yellows and reds represent higher elevations. The narrow axis (red linear features) and narrow or absent axial rift, characteristics of fast-spreading mid-ocean ridges, are obvious. The spreading centers overlap near the middle of the image. The cones in the top-right corner of the image are a linear chain of near-axis seamounts on the Pacific Plate. The seamounts are greater than 200 m tall. View is to the north. Image courtesy of Stacey Tighe, University of Rhode Island. Image from U.S. Geological Surveys 'This Dynamic Earth Colorful bathymetry' . Source: volcano.und.edu/vwdocs/Submarine/plates/diverg/fast.html; accessed March 12, 2008.



http://volcano.oregonstate.edu/book/export/html/140

A similar interpretation of the formation of the Gulf of California by Elders, et al., is: "The northeast Pacific plate appears to be a flank of the East Pacific Rise modified by the westward boundary of the North American plate Marine geophysical studies both in the Gulf of California and in the adjacent ocean strongly support the interpretation that the gulf originated in the spreading apart of the continental crust. It appears that the Gulf of California is part of the active boundary between the North American and Pacific plates". (8)

Hydrothermal vents jetting water at 380 degrees plus or minus 30 degrees Celsius exist on the axis of the East Pacific rise. (9) Indeed, "the axis of the East Pacific Rise is marked by a zone of recent volcanism approximately 1000 meters wide. Near the center of the volcanic zone, there is a very narrow band of active hydrothermal ventsat least 25 vents along a strip 7 km long and only 200 to 300 meters wide", according to one group of researchers. (9)

If you look closely in the lower right-hand portion of the illustration you can see the East Pacific Rise, a portion of the Mid-Ocean Ridge that defines the eastern edge of the Pacific Plate. As the giant Pacific Plate encounters the North American Plate the two grind against each other with such force that they have caused a network of fractures, or faults, across the state of California. The San Andreas Fault is part of this fracture zone that extends for 700 miles from Mexico to just north of San Francisco, where it dives into the Pacific Ocean.

The stresses created along this fault are enormous and are responsible for the infamous San Francisco earthquake of 1906. Over 20 million people live along this fault, which continues to periodically rock the state. Actually, western California is considered part of the Pacific Plate and, over the next several million years, will break away from the mainland and drift steadily northward.

Thanks to Bruce Heezen and Marie Tharpe.

<<< Back to Ocean Floor Map

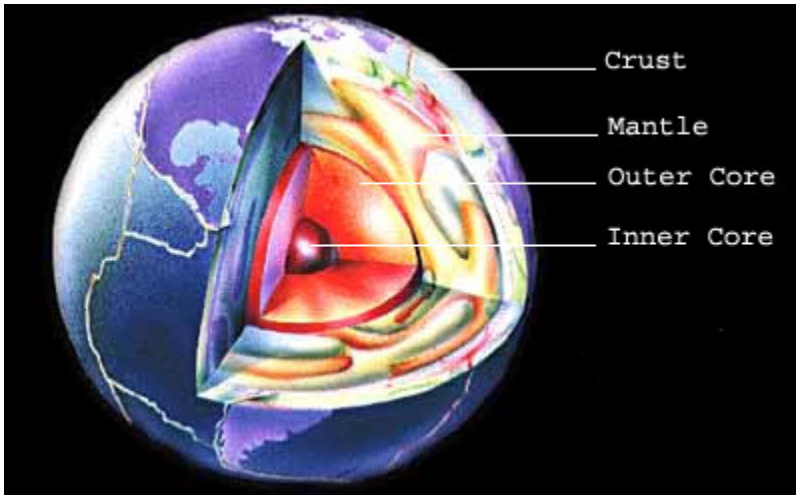
World Ocean Floors

Browse and Click the map for selected close-ups and commentary.

by Bruce C. Heezen and Marie Tharp

This amazing piece of work accurately illustrates the Tectonic Earth. Mid-ocean ridges, the sight of sea-floor spreading, girdle the planet like seams on a baseball. Behold the giant Pacific Plate, continental shelves, and undersea mountain chains.

Inner Strata



Over time the Earth cools and separates into several different layers. The matter with the highest density (mostly iron) sinks to form Earth's solid inner core. This inner core becomes enveloped by a less dense mixture of nickel and iron - the outer core. Surrounding the inner and outer core is the mantle (itself divided into several distinct layers), and over the mantle is the Earth's crust, a thin veneer of rocky material that covers the planet like the cracked, twisted, lumpy crust of an apple pie.

Tectonic Plates

Earth's outer shell, the lithosphere, long thought to be a continuous, unbroken, crust is actually a fluid mosaic of many irregular rigid segments, or plates. Comprised primarily of cool, solid rock 4 to 40 miles thick,* these enormous blocks of Earth's crust vary in size and shape, and have definite borders that cut through continents and oceans alike. *[Oceanic crust is much thinner and more dense than continental, or terrestrial crust]. There are nine large plates and a number of smaller plates. While most plates are comprised of both continental and oceanic crust the giant Pacific Plate is almost entirely oceanic, and the tiny Turkish-Aegean Plate is entirely land. Of the nine major plates, six are named for the continents embedded in them: the North American, South American, Eurasian, African, Indo-Australian, and Antarctic. The other three are oceanic plates: the Pacific, Nazca, and Cocos.

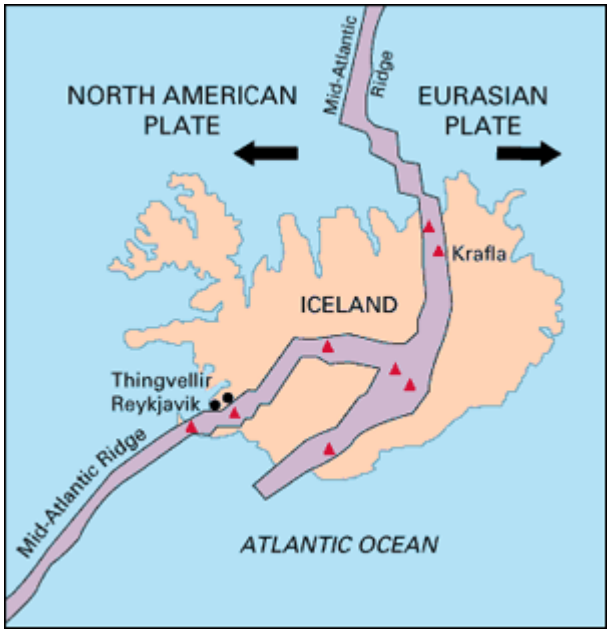
The relative small size of the numerous other plates neither diminishes their significance, nor their impact on the surface activity of the planet. The jostling of the tiny Juan de Fuca Plate, for example, sandwiched between the Pacific and North American Plate near the state of Washington, is largely responsible for the frequent tremors and periodic volcanic eruptions in that region of the country.

Plate Boundaries

There are 3 primary types of Tectonic Plate boundaries: Divergent boundaries; Covergent boundaries; and Transform boundaries. As the giant plates move, diverging [pulling apart] or converging [coming together] along their borders, tremendous energies are unleashed resulting in tremors that transform Earth's surface. While all the plates appear to be moving at different relative speeds and independently of each other, the whole

jigsaw puzzle of plates is interconnected. No single plate can move without affecting others, and the activity of one can influence another thousands of miles away. For example, as the Atlantic Ocean grows wider with the spreading of the African Plate away from the South American Plate, the Pacific sea floor is being consumed in deep subduction trenches over ten thousand miles away. **(All graphics courtesy of USGS.org)**.

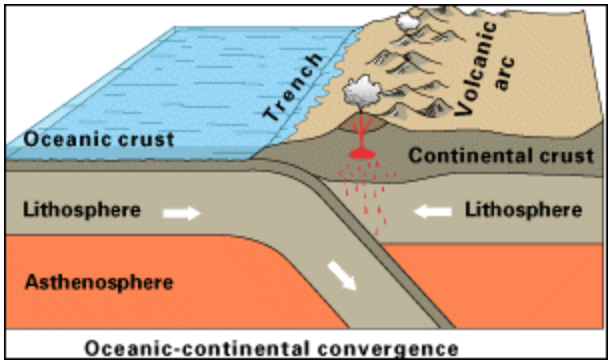
Divergent Boundaries: At divergent boundaries new crust is created as wo or more plates pull away from each other. Oceans are born and grow wider where plates diverge or pull apart. As seen below, when a diverging boundary occurs on land a 'rift', or separation will arise and over time that mass of land will break apart into distinct land masses and the surrounding water will fill the space between them. ***Jump to 'Birth of an Ocean'***



Iceland offers scientists a natural laboratory for studying - on land - the processes that occur along submerged parts of a divergent boundary. Iceland is splitting along the ***Mid-Atlantic Ridge*** - a divergent boundary between the North American and Eurasian Plates. As North America moves westward and Eurasia eastward, new crust is created on both sides of the diverging boundary. While the creation of new crust adds mass to Iceland on both sides of the boundary, it also creates a rift along the boundary. Iceland will inevitably break apart into two separate land masses at some point in the future, as the Atlantic waters eventually rush in to fill the widening and deepening space between.

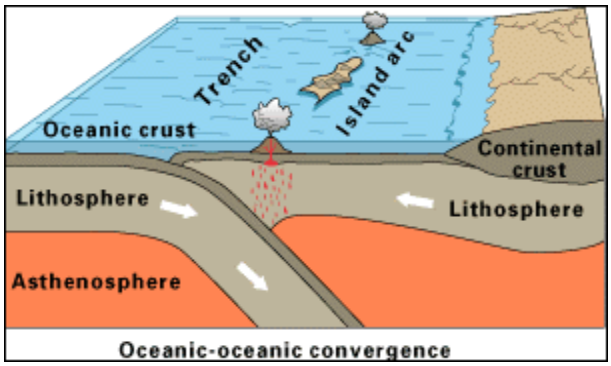
Convergent Boundaries: Here crust is destroyed and recycled back into the interior of the Earth as one plate dives under another. These are known as ***Subduction Zones*** - mountains and volcanoes are often found where plates converge. There are 3 types of convergent boundaries: Oceanic-Continental Convergence; Oceanic-Oceanic Convergence; and Continental-Continental Convergence.

Oceanic-Continental Convergence



When an oceanic plate pushes into and subducts under a continental plate, the overriding continental plate is lifted up and a mountain range is created. Even though the oceanic plate as a whole sinks smoothly and continuously into the subduction trench, the deepest part of the subducting plate breaks into smaller pieces. These smaller pieces become locked in place for long periods of time before moving suddenly and generating large earthquakes. Such earthquakes are often accompanied by uplift of the land by as much as a few meters.

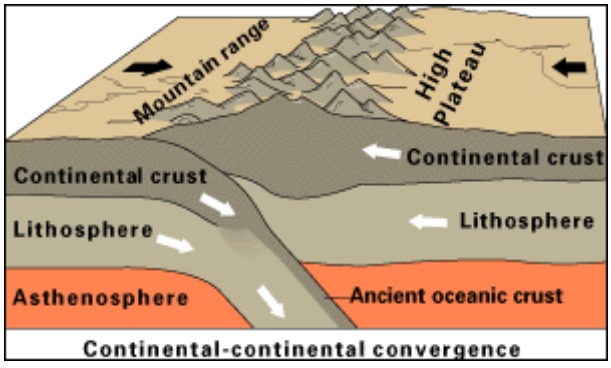
Oceanic-Oceanic Convergence



When two oceanic plates converge one is usually subducted under the other and in the process a deep oceanic trench is formed. The Marianas Trench, for example, is a deep trench created as the result of the Phillipine Plate subducting under the Pacific Plate.

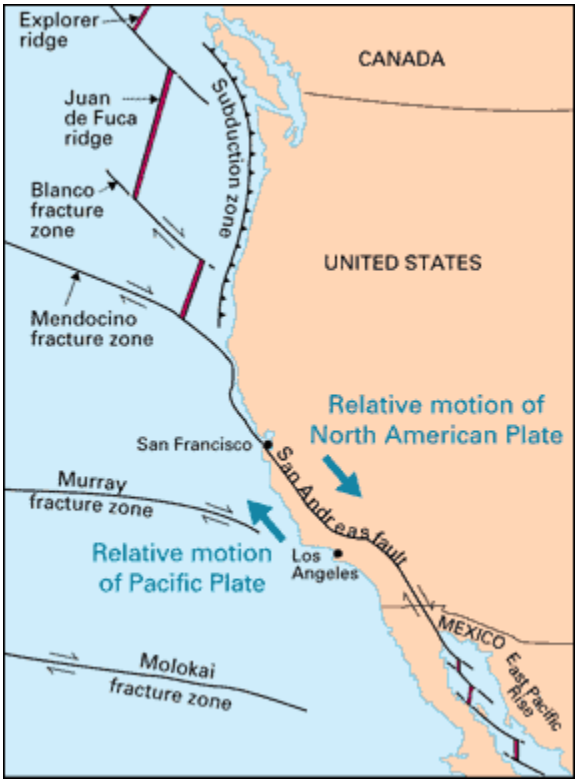
Oceanic-oceanic plate convergence also results in the formation of undersea volcanoes. Over millions of years, however, the erupted lava and volcanic debris pile up on the ocean floor until a submarine volcano rises above sea level to form an island volcano. Such volcanoes are typically strung out in chains called island arcs.

Continental-Continental Convergence

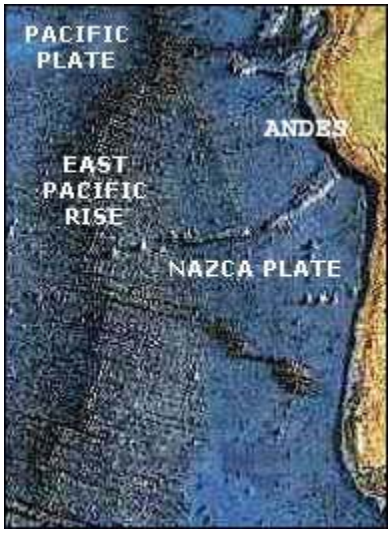


When two continents meet head-on, neither is subducted because the continental rocks are relatively light and, like two colliding icebergs, resist downward motion. Instead, the crust tends to buckle and be pushed upward or sideways. The collision of India into Asia 50 million years ago caused the Eurasian Plate to crumple up and override the Indian Plate. After the collision, the slow continuous convergence of the two plates over millions of years pushed up the Himalayas and the Tibetan Plateau to their present heights. Most of this growth occurred during the past 10 million years.

Transform-Fault Boundaries: Transform-Fault Boundaries are where two plates are sliding horizontally past one another. These are also known as transform boundaries or more commonly as faults.



Most transform faults are found on the ocean floor. They commonly offset active spreading ridges, producing zig-zag plate margins, and are generally defined by shallow earthquakes. A few, however, occur on land. The San Andreas fault zone in California is a transform fault that connects the East Pacific Rise, a divergent boundary to the south, with the South Gorda -- Juan de Fuca -- Explorer Ridge, another divergent boundary to the north. The San Andreas is one of the few transform faults exposed on land. The San Andreas fault zone, which is about 1,300 km long and in places tens of kilometers wide, slices through two thirds of the length of California. Along it, the Pacific Plate has been grinding horizontally past the North American Plate for 10 million years, at an average rate of about 5 cm/yr. Land on the west side of the fault zone (on the Pacific Plate) is moving in a northwesterly direction relative to the land on the east side of the fault zone (on the North American Plate).



Growing Mountains

As an underlying oceanic plate tips down, its ocean-floor sediment is scraped off along

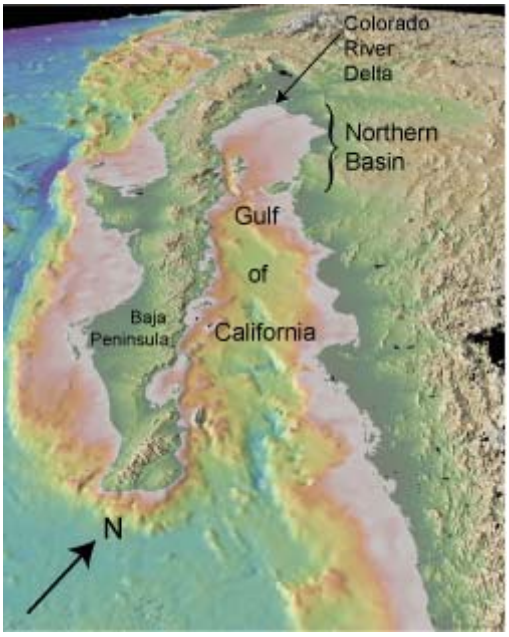
the front edge of the overriding continental plate. The result is an increase in the width and thickness of the overriding plate. This could be why the Andes, a long mountain range bordering the west coast of South America, appears to be growing higher. Perhaps sediment from the Nazca Plate, which is diving under South America in the Peru-Chile Trench, is scraping off on the roots of the Andes. This scraping adds thickness and buoyancy to the mountains so that they float upward more rapidly than their peaks can be eroded by wind and rain.

Interconnectedness of the San Andreas Fault and the East Pacific Rise. Source: www.platetectonics.com/book/images/Transformfaults.gif; accessed March 12, 2008.

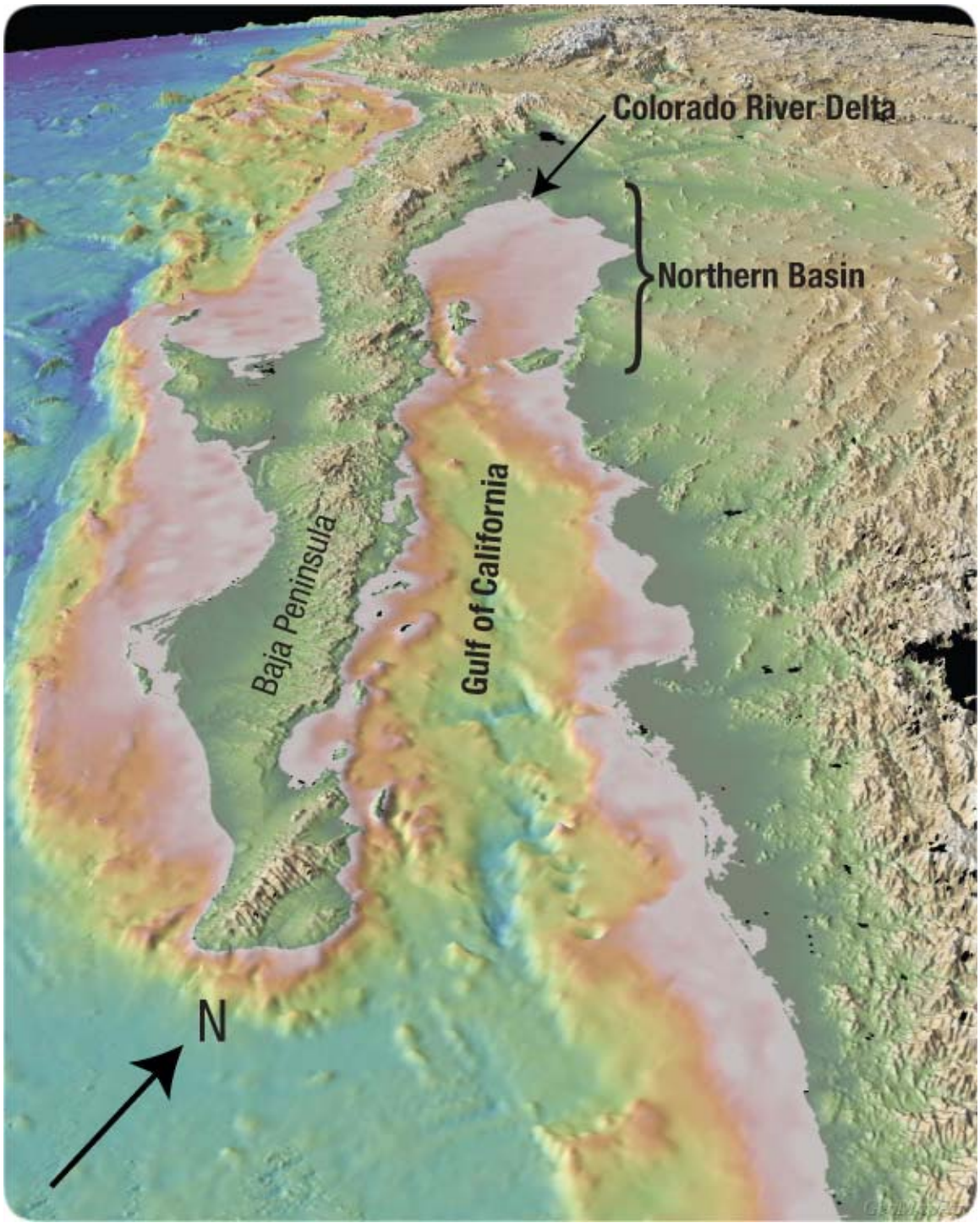
Figure 130: Algodones Sand Dunes (California's Imperial Sand Dunes). Where did all this clean, pure sand (2.5 cubic miles worth) come from? Why is it here in a 45-mile-long and 5-mile-wide valley?

America, covering 200 square miles and containing about 2.5 cubic miles of sand. It extends 45 miles up the Imperial Valley between Yuma, Arizona and the Salton Sea.

In his geology textbook, Richard Flint estimates that wind slowly blew all that sand in over "at least 160,000 years."[62] He does not identify the source of the sand, why wind concentrated it there, or why little dirt was blown in. Others say that an extinct lake they call Lake Cahuilla (ka-WEE-ah) was fed by the Colorado River and provided the sand. Lakes, however, rarely have the energy to break up rock to produce that volume of sand, and even if they could, they couldn't separate much sand from the mud and clay that is also produced. Here is the explanation:



Looking northward up the Gulf of California to the Salton Trough. Source: www.creationscience.com/onlinebook/webpictures/gulf_california; accessed March 12, 2008.



III. Salton Trough

The Mexicali-Imperial Valley is the northern extension of the Gulf of California. "It is a broad structural trough partly filled with lacustrine [lake] and deltaic [Colorado River

delta] silts, sands, and gravels of late Tertiary age, and by great thicknesses of Quaternary alluvium and lake sediments", notes Elders, et al. (8) They continue:

"The trough has "steep, step-faulted margins and a broad, relatively flat basement floor. This trough is comparable in shape and size with the deeper submarine basins of the southern part of the Gulf of California, but it is partly filled [in the Imperial Valley] by the vast accumulation of sediments of the Colorado River Delta". (9)

Elders, et al., believe that "the Salton trough formed by a combination of tensional and right-lateral strike-slip movements associated with the opening of the gulf as Baja California was transferred from the North American to the Pacific lithospheric plates. The details of how Baja California was transformed from the American to the Pacific plate remain enigmatic", they opined. (9)

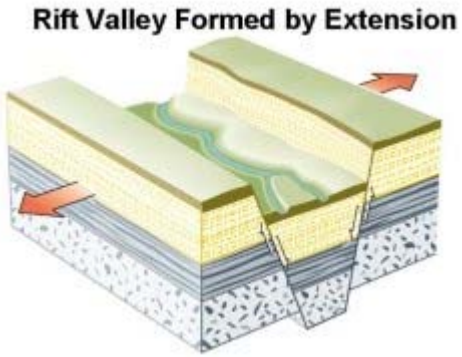
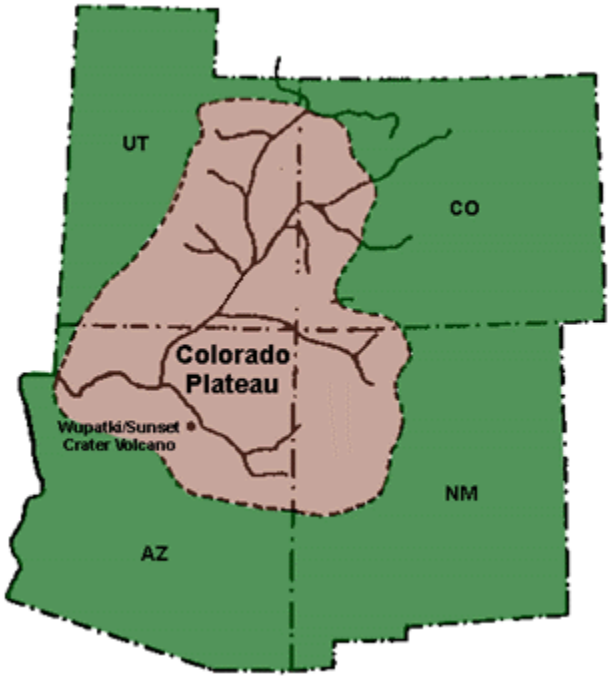


Diagram of rift valley structure. Source: www.daviddarling.info/encyclopedia/R/rift_valley.html; accessed March 12, 2008.

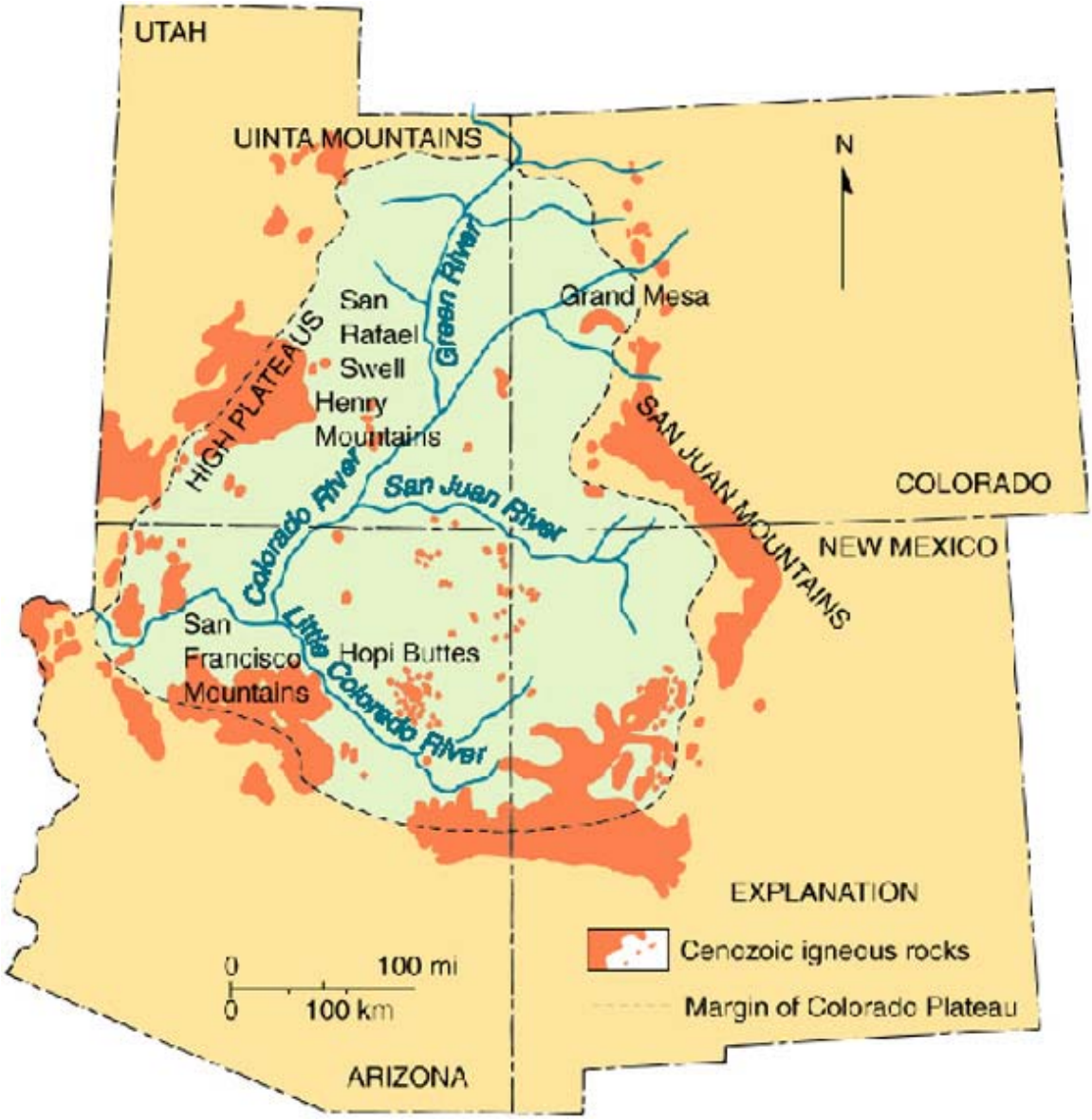
IV. Brief History of the Colorado River and its Relation to the Salton Trough
Upper mantle processes caused a broad regional uplift of the Colorado plateau about 20 million years, according to Atkinson and Leeder. (10)

The uplift of the Colorado plateau also initiated the Grand Wash Fault at the western edge of the Colorado Plateau where the Colorado River of 20 million years ago poured over this growing step on its way westward. (10) Recent work by Polyak, et al., shows that the Colorado River cut a deep gorge as it propagated upstream to create the Grand Canyon. (11)

The Colorado River drains the western slope of the Rocky Mountains. Its natural course is to flow to the Gulf of California. A diversion canal built (the "All American Canal") from the Colorado River to the Imperial Valley to irrigate crops has resulted in desiccation of the river before it reaches the gulf.



Extent of Colorado plateau. Source: en.wikipedia.org/wiki/Image:Colorado_Plateaus_map.png; accessed March 12, 2008.



Colorado plateau showing course of Colorado River. Source: higheredbcs.wiley.com/legacy/college/levin/0471697435/chap_tut/images/nw0345-nnc.jpg; accessed March 12, 2008.

Extent of Colorado River in the Southwest. Source: en.wikipedia.org/wiki/Colorado_River; accessed March 12, 2008.

Map showing All American Canal providing water from the Colorado River to Imperial River. Source: www.iid.com/Media/All-American-Canal-Map.jpg; accessed March 12, 2008.

V. Inadvertent Creation of the Salton Sea

The current Salton Sea is manmade that was a catastrophe by some accounts. (12) It formed over two years between 1905 and 1907, while an anxious Teddy Roosevelt was president of the United States. What happened? President Roosevelt said it well: "Briefly stated, the conditions are these: The Imperial Valley, so called, in San Diego County, Cal., includes a large tract of country below sea level. Southeast of the valley and considerably above its level is the Colorado River, which flows on a broad, slightly elevated plane, upon which the river pursues a tortuous course, finally entering the Gulf of California. The lands in Imperial Valley are 200 feet or more below the level of Colorado River. Down as far as the international border they are protected from inundation by low-lying hills. South of the boundary in the Republic of Mexico the hills cease abruptly, and only the broad, low mud banks of the river protect the valley from being converted into an inland sea or lake. In order to protect it from too much water, works of supply or of protection must be built in Mexico, even though they may tap the

river in the United States. The United States can neither aid nor protect the interests of its citizens without going upon foreign soil

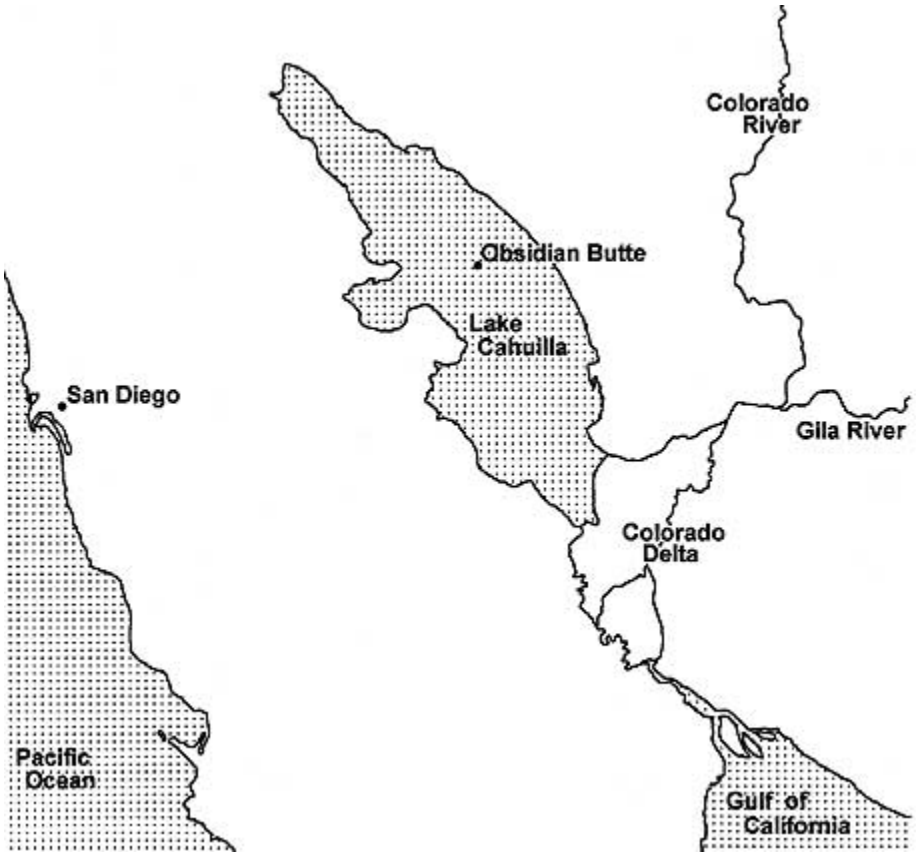
"Many schemes have been discussed either to convert the Salton sink area into a lake or to irrigate the desert lands below sea level by making a cut in Mexico through the west bank of the Colorado River. It was well understood that if the cut in the bank was not carefully guarded the river would quickly get beyond control. Finally, after many plans had been tentatively tried, the California Development Company, a New Jersey corporation, actively undertook the work.

"To insure the safety of Imperial Valley, the head of the canal on the river was first placed on United States territory near where the river was bounded by hills. The canal then swung southwest and west away from the river through Mexican territory to connect with natural depressions leading to the valley and back into the United States. The organizers of this company, in order to carry on the work in Mexico, caused to be created a subsidiary company in Mexico, acting under Mexican laws

"The company entered upon its construction work with large plans, but with inadequate capital. All of its structures for the control and distribution of water were temporary in character, being built of wood and of the smallest possible dimensions. Through the efforts thus made a large amount of land was brought under cultivation, and at one time it was reported that over 100,000 acres were being more or less irrigated.

"The first heading of the canal of the California Development Company was in the United States immediately north of the Mexican border. It was found, however, after a time that the heading on the United States side of the line did not give a grade to furnish sufficient flow or water, and after headings had been opened at other points without successful results a cut in the river bank was made four miles further south in Mexican territory. This gave the water a shorter and steeper course toward the valley.

"The making of this cut in a bank composed of light alluvial soil above a depression such as this without controlling devices was criminal negligence. This short cut on Mexican soil was made in the Fall of 1904. It was gradually eroded by the passage of the water, and in the Spring of 1905, the floods of the Colorado River entering the artificial cut rapidly widened and deepened it until the entire flow of the river was turned westerly down the relatively steep slope into the Imperial Valley and then into what is known as Salton Sin, or Salton Sea.



Lake Cahuilla. Source: soap.sdsu.edu/Volume1/LakeCahuilla/cahuilla.htm; accessed March 12, 2008.

"After the mischief became apparent strenuous efforts were made by the California Development Company to close the break, but these were without success. Finally the Southern Pacific Company, finding its tracks imperiled and traffic seriously interfered with, advanced money to the California Development Company, received as security a majority of the shares of the company, and thus took charge of the situation.

"By means of the facilities available to the Southern Pacific Company the break in the west bank of the Colorado River was closed on Nov. 4, 1906. A month later, however, a sudden rise in the river undermined the poorly constructed levees immediately south of the former break, and the water again resumed its course into the Salton Sea". (13) Eventually, the Southern Pacific Company was able to put the Colorado River back into its pre-levee-break channel. The damage, however, was done. The Salton Trough was filled with watera sea 45 miles long and 20 miles wide, equaling 110 miles of shoreline.

Flooding Colorado River through wooden levees, 1905, Provided courtesy of University of Wisconsin-Madison Space Science and Engineering Center, source: www.ivpressonline.com/content/articles/2004/02/23/anniversary/news09.jpg

Flooding Colorado River through wooden levees, 1905. Source: www.ivpressonline.com/content/articles/2004/02/23/anniversary/news09.jpg; accessed March 12, 2008.

The Salton Trough has been filled with water before its accidental filling in 1905. Prehistoric "Lake Cahuilla" formed when the Colorado River shifted its course within its delta, and flowed northwest instead of south around 300 years ago. The area was also briefly flooded in 1891. Both of these collections of water eventually evaporated. (14)

VI. Activity of the San Andreas Fault in Salton Trough

"The part of the San Andreas [fault system] called the Coachella Valley segment has always been one of the most worrisome along the entire fault", notes Kerr. (15) "Indeed, the first comprehensive evaluation of earthquake hazard in California, released in 1988 by a working group of the USGS, rated it the most dangerous of all [italics added]. The geologic record of this segment, which runs southward from near Palm Springs 100 kilometers to the eastern shore of the Salton Sea, shows that it experienced repeated earthquakes, at intervals of 200 to 300 years, until about 300 years ago. Since then, it has been eerily quiet, steadily accumulating strain that must eventually be

released.. The USGS working group gave it a 40% probability of producing a magnitude 7.5 quake by 2018 that would rip as far north as Palm Springs". (15)

VI. Summary

The Salton Sea Trough area is an exceedingly complex geological, riverine and lacustrine area underlain by the junction of three giant moving tectonic plates. Historically, the Imperial Valley and the Coachella Valley are one of the most, if not the most, seismically active regions in the State of California. (16) Twelve significant seismic events have occurred in Imperial County during the period April 1906 to October 1987. (16) The Salton Sea Trough is overdue for a big earthquake.

Notes:

1. The Salton Trough is also called the Salton Sink, the Salton Basin, and the Salton Sea Trough.
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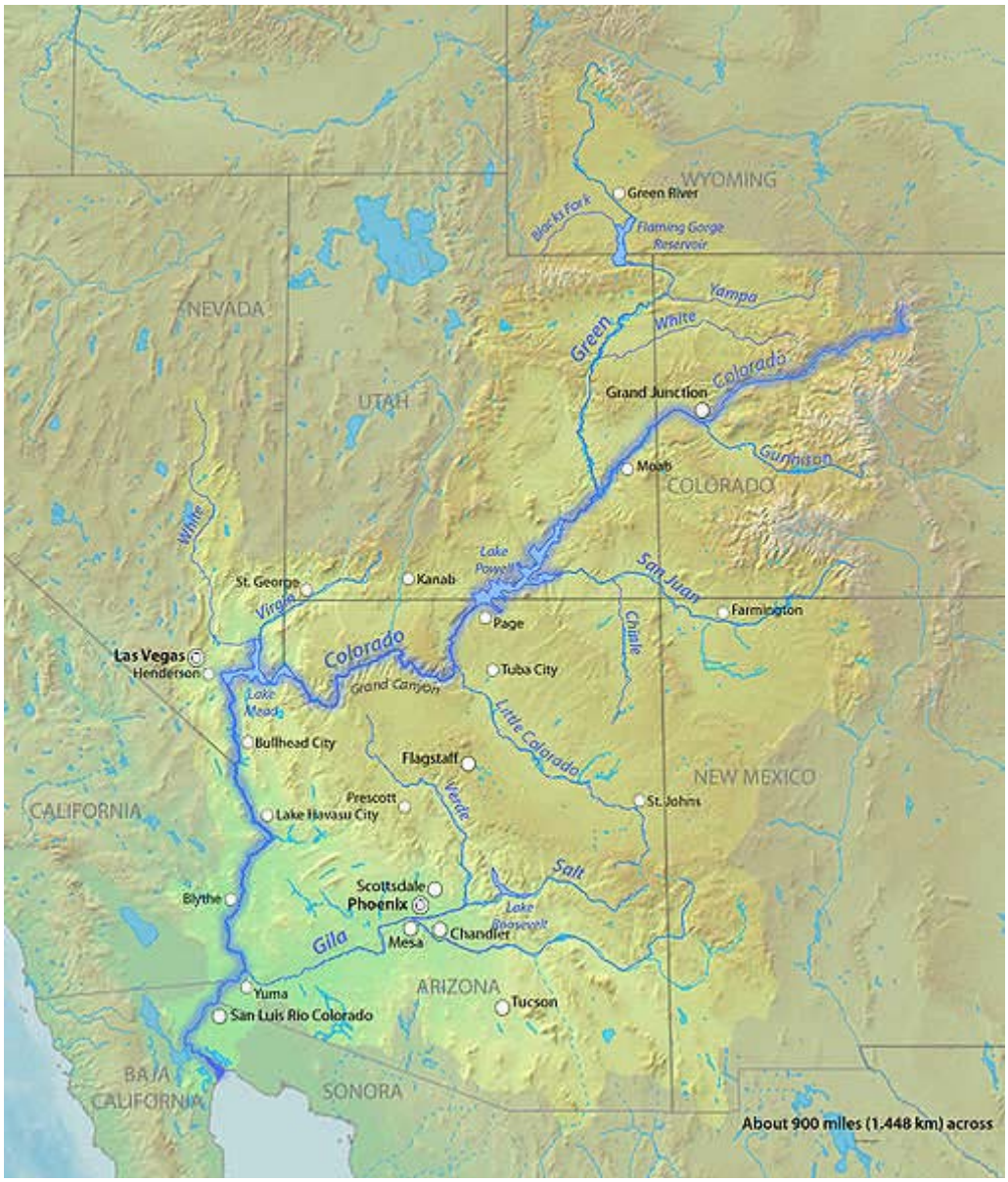
4. Martin Mesched and Udo Barckhausen: "Plate Tectonic Evolution of the Cocas-Nazca Spreading Center". In EA Silver, G. Kumra and TH Shipley (eds.) Proceedings of the Ocean Drilling Program, Scientific Results, January 2000, Volume 170. Available at www-odp.tamu.edu/publications/170_SR/VOLUME/CHAPTERS/SR170_07.PDF; accessed March 12, 2008.
5. "Farallon plate remnants". NASA/Goddard Space Flight Center Scientific Visualization Studio. Available at svs.gsfc.nasa.gov/vis/a000000/a002400/a002410/; accessed March 12, 2008.
6. Roger L. Larson, HW Menard, and SM Smith: "Gulf of California: A result of ocean-floor spreading and transform faulting". Science, August 23, Volume 161, 1968, p. 781.
7. Ronald L. Larson and Fred N. Spiess: "East Pacific Rise Crest: A near-bottom geophysical profile". Science, January 3, 1969, Volume 163, p. 68.
8. Wilfred A. Elders, Robert W. Rex, Tsvi Meidav, et al.: "Crustal spreading in Southern California". Science, October 6, 1972, Volume 178, Number 4056, p. 15.
9. RISE Project Group: "East Pacific Rise: Hot springs and geophysical experiments". Science, March 28, 1980, Volume 207, Number 4438, p. 1421-1433.
10. Tim Atkinson and Mike Leeder: "Canyon cutting on a grand time scale". Science, March 7, 2008, Volume 319, pp. 1343-44.
11. Victor Polyak, Carol Hill, and Yemane Asmerom: "Age and evolution of the Grand Canyon revealed by U-Pb dating of water table-type speleothems". Science, March 12, 2008, Volume 319, pp. 1377-1380.
12. Doug Sharp: "The Salton Sea Catastrophe". Available at www.rae.org/salton.html; accessed March 12, 2008.

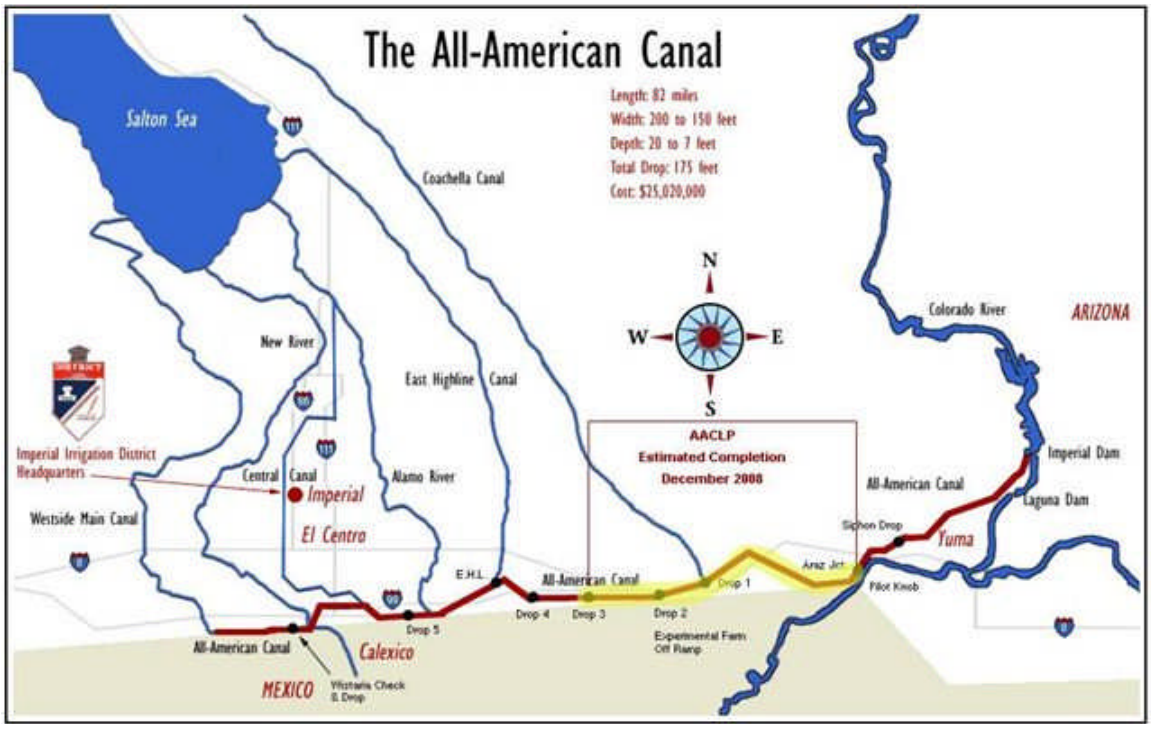
13. "President asks action to curb the Colorado. Tells Congress that 700,000 acres are menaced by river". The New York Times, January 12, 1907. Available at query.nytimes.com/mem/archive-free/pdf?_r=1&res=9C00E61130E233A25750C1A9679C946697D6CF&oref=slogin; accessed March 12, 2008. See also "The problem of the Salton Sea". The New York Times, January 20, 2907.. Available at query.nytimes.com/gst/abstract.html?res=9D00E0D9153EE033A25753C2A9679C946697D6CF&scp=1&sq=problem+of+the+salton+sea&st=p; accessed March 12, 2008.
14. Don Laylander: "The regional consequences of Lake Cahuilla". The San Diego State University Occasional Archaeological Papers. Available at soap.sdsu.edu/Volume1/LakeCahuilla/cahuilla.htm; accessed March 12, 2008.
15. Richard Kerr: "Ominous pattern looms in California earthquakes". Science, July 10, 1992, Volume 247, p. 155.
16. Imperial County Emergency Management Plan, revised July 2007, pp. 80-81.. Available at ; accessed March 12, 2008.

Posted by ABDSP Paleontology Society at 9/23/2010 2:50 PM
Categories: News
Tags: Salton Sea Imperial Valley Colorado River Gulf of California


WYOMING
Green River
Black's Fork
Flaming Gorge Reservoir
Yampa
White
Green
Colorado
Grand Junction
Gunnison
Moab
COLORADO
NEVADA
UTAH
White
Lake Powell
St. George
Virgin
Kanab
San Juan
Farmington
Page
Chinle
Las Vegas
Henderson
Colorado
Grand Canyon
Tuba City
Lake Mead
Little Colorado
Bullhead City
Flagstaff
NEW MEXICO
Prescott
Verde
St. Johns
CALIFORNIA
Lake Havasu City
Salt
Scottsdale
Phoenix
Blythe
Lake Roosevelt
Gila
Mesa
Chandler
ARIZONA
Yuma
Tucson
San Luis Rio Colorado
BAJA CALIFORNIA
SONORA
About 900 miles (1,448 km) across

6

Ancient shoreline in Salton Basin, located at http://www.saltonsea.ca.gov/histchron.htm, and Salton Sink area before turning into Salton Sea, at http://forum.treasurenet.com/index.php?topic=145089.0


The All-American Canal
Length: 82 miles
Width: 200 to 150 feet
Depth: 20 to 7 feet
Total Drop: 175 feet
Cost: $25,020,000
Salton Sea
Coachella Canal
N
W
E
S
Colorado River
ARIZONA
New River
East Highline Canal
AACLP
Estimated Completion
December 2008
Imperial Irrigation District
Headquarters
Central Canal
Imperial
Alamo River
El Centro
Westside Main Canal
Imperial Dam
All-American Canal
Laguna Dam
Siphon Drop
Yuma
Araz Jct.
E.H.L.
All-American Canal
Drop 1
Pilot Knob
Drop 4
Drop 3
Drop 2
Drop 5
Experimental Farm
Off Ramp
All-American Canal
Calexico
MEXICO
Wistaria Check
& Drop