

Notes to accompany...

Transforming California

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(Note: The title slide and several other display lines are in yellow TremorITC TT font. I hope you are able to see this appropriate font. Images not taken by the author are so labeled.)

This presentation includes several challenges for student (viewer) participation, such as slide 30.

SLIDE 1 (TITLE SLIDE)

The title is “Transforming” because the San Andreas is a “transform” (strike slip) fault.

SLIDE 2

Please pardon the pun.

SLIDE 3

See the text below the image. Later in the show you’ll see more of the Parkfield USGS experiment.

SLIDE 4

This is a list of what’s to come.

SLIDE 5

Some Californians say they love their climate and landscape, but would prefer not to have earthquakes. The fact is, their climate and landscape are a direct result of plate dynamics. (earthquakes) The lines with arrows show the approximate trace of the San Andreas Fault.

In general, this program will follow the fault from south to north.

SLIDE 6

The San Andreas Fault is named after these lakes in the distance just south of San Francisco along interstate 280 near Stanford University. The fault extends into the near valley to the right. Should they experience a major seismic event....

SLIDE 7

The San Andreas is one of the few places in the world where an active plate boundary traverses a continent. It is a strike-slip (transform) boundary. This makes California an ideal laboratory for plate dynamics. This laboratory is, however, heavily populated by people who like vegetarian pizza and guacamole.

SLIDE 8

This journey begins along Baja Mexico on the Sea of Cortez. This is Isla Coronado near Loreto. The mainland of Mexico is in the far distance. The fault runs up this arm of the Pacific Ocean.

SLIDE 9

The San Andreas Fault crosses into the United States and the intensely agricultural area of the Imperial Valley. This fence is the international boundary. (In fact, the picture was actually taken about 150 miles to the east at Quitobaquito Spring in Arizona. Mexico is on the right side of this small fence. An unguarded break in the fence allows Mexicans to walk across the border to see the spring.

SLIDE 10

Here the All American Canal carries Colorado River water into the Imperial Valley “desert.” The vegetation is natural only on the near side of the canal. The history of this canal is interesting from both hydrologic and political points of view. The fault (between here and the distant mountains) is covered by a thick cover of sediment.

SLIDE 11

This steep San Jacinto Mountain front near Palm Springs is a testament to the fault block (graben) origin of this (below sea level) valley. The wind powered electricity generators are among hundreds at this location. Some say the wind farm is strategically placed in a windy corridor for California to supplement their energy needs. Others say it was constructed to blow the L.A. basin pollution into nearly Arizona. < ;) >

SLIDE 12

The San Andreas Fault passes along the far side of the San Gabriel Mountains as it bypasses Los Angeles by about 25 miles to the north. This photograph shows a jet descending into the smog at L.A. airport. The fault is on the far side of the mountains where the next image was taken.

SLIDE 13

The California Aqueduct is a major supplier of water to the Los Angeles basin. This segment runs directly along the San Andreas Fault at Palmdale. Local hummocky topography clearly shows fault wrenching. California growers prominently display (political) signs such as,
“Water grows our food and clothes.”

SLIDE 14

Should a major seismic event breach the aqueduct, gates such as these at Palmdale can be closed to minimize the spill. (We hope.)

SLIDE 15

This road cut along California Freeway Route 14 traverses the San Andreas Fault zone. It has excellent fault exposures. The next photo will show the distortion of layers originally laid down straight and horizontal.

SLIDE 16

(Again along Freeway 14 at Palmdale) Can you identify fault surfaces?

SLIDE 17

The geological “Times Square” of California. California landscapes are dominated by fault structures. Note the labels on the image. This is the narrow western corner of the Mojave Desert ecological and landscape province at Quail Lake and an unusually geologically active location. Tejon Pass (4144 ft/1263 m), the high point on Interstate 5 between L.A. and the central valley, is less than 5 miles (8 km) to the left. (Pronounced “tay HONE.”)

Quail Lake, visible here, is a part of the California Aqueduct that brings water to parched southern California from the northern part of the state. It all comes together here. (faults, highways, water supply)

SLIDE 18.

Time for a detour. From the geological intersection in the last slide (See the Tejon Pass label.) we travel east of the Sierra Nevada to see eastern parts of the fault system.

SLIDE 19

During World War II thousands of Japanese Americans were involuntarily relocated here in the name of national security, below the remote, faulted eastern slope of the Sierra Nevada Mountains. This is obviously a major fault scarp. The western mountain slope is far more gradual.

SLIDE 20

The volcanism at the Mammoth Lakes area is related to fault activity. In Devil’s Postpile National Monument is a classic example of columnar jointing of a lava flow. The shrinking of the magma as it cooled caused these columns. Similar columns can be seen along the Palisades cliffs north of New York City and Giant’s Causeway in Ireland. (This not a direct fault structure.) The next photo was taken at the top of this cliff.

SLIDE 21

The top of Devil’s Postpile shows the truncated 5 ad 6-sided columns at the glaciated top surface. These cracks extend straight down into the rock.

SLIDE 22

Death Valley, the lowest point in the Western Hemisphere, looks like a graben (down faulted block) but it it’s actually more likely created by hinge faults. (The Dead Sea in the Middle East is more than three times as far below sea level.) Death Valley is the site of the world’s second hottest authenticated air temperature; 134° F. (57° C) (The world record, in North Africa, is 136°F.) A new automated weather station has recently been installed just below this scarp at Badwater. How likely are the new instruments to establish a new world record?

SLIDE 23

Now we’re back to the main path of the San Andreas Fault. Some of the most spectacular fault landforms occur in this closed basin in between Los Angeles and San Francisco. The next dozen or so photographs are on the area of this map. A diagonal orange line shows the San Andreas Fault. (Roads are shown in red and black.)

SLIDE 24

At the southern end of the Carrizo Plain these dry slump ponds and the distant truncation of the spurs shows the trace of the San Andreas Fault. Note the fence.

SLIDE 25

This fence traverses the fault at the same location. Any future displacement of the San Andreas Fault at this location will probably offset the fence line.

SLIDE 26

The fault is visible in the distance at the base of the Tremblor Range.

SLIDE 27

As the fault moves, it pulverizes and weakens the rock allowing erosion to make these trenches that traverse across the main slope, which is downhill to the right.

SLIDE 28

The San Andreas Fault trace can be seen through this trench in the foreground, under the car and along the stream gully beyond.

SLIDE 29

Notice how this little stream jogs right at the fault. These offset streams are very common along this part of the fault and show the “right lateral” motion of the San Andreas Fault.

SLIDE 30

All these Carrizo Plain streams drain into Soda Lake, which is often dry. This is a closed basin so there is no outlet from this lake. The water escapes by evaporation.

SLIDE 31

This is an aerial photograph of the most famous offset stream on the Carrizo Plain, Wallace Creek. Below the “Y” confluence the stream jogs to our left. Notice the older path of the same stream even farther to the left. You will see more photos of this location at ground level. How much time do these two offsets of Wallace Creek represent? (The average slip rate can be calculated using slide 49 in this presentation. The problem can be solved by students as a rough estimation in the style of Fermi problems.)

SLIDE 32

This map shows stream offsets and sag structures near Wallace Creek. (on the left) Trenches dug here by Kerry Sieh and others at Cal Tech to investigate recent fault movements are reproduced in the Smithsonian Science & Technology Museum in Washington, DC.

SLIDE 33

This is the author in the same location where Wallace Creek crosses the San Andreas Fault. The present offset channel as well as the more distant older channel are both visible.

SLIDE 34

The offset of this smaller nearby stream is visible as you follow the tall grass in the shallow streambed. Notice that it does not extend to its own gully across the fault.

SLIDE 35

Further north along Bitterwater Road, this offset gully is deeply incised. Can you see where the fault is and the relative tight lateral motion along this plate boundary?

SLIDE 36

Dry sag ponds mark the fault to the north. The fault extends the length of the valley and to the right through the trees at the end of the sag structure.

SLIDE 37

Where utilities cross the fault the potential for damage increases. The fault runs from the left side of the tree toward the camera position. What engineering steps should be taken here? Does the cost of these modifications justify the increase in infrastructure security?

SLIDE 38

(Forces along the San Andreas Fault are hardly capable of tearing selected branches off trees. But it's a clever ruse!)

SLIDE 39

Such an obvious cleft in such an unlikely place is explainable only as a fault trace. Note the road (CA Route 25) to the left.

SLIDE 40

The truncated ridge in the distance is the fault trace. It continues roughly along the straight section of California Route 25..

SLIDE 41

The small grassy-topped ridge just to the right of the stream is a pressure ridge where the fault trace curves and compression pushes up the rock. (See the blue water in the small stream to the left of the pressure ridge.) Both are along the fault trace which runs diagonally down to our right.

SLIDE 42

The escarpment to the left is the fault trace. It marks a sudden drop off of the land surface. A sag pond is visible in the middle distance.

SLIDE 43

Unstable slopes along the fault (which is near the tree) are subject to mass wasting. The savanna climate makes such landforms readily visible.

SLIDE 44

This is the United States Geological Survey office in Parkfield. (The center of the hamlet is visible in the near distance.) Moderate seismic events with a regular periodicity of about 22 years led to the installation of this facility and nearby instrumentation in 1985. The last significant local tremor was in 1966. After 40 years since the last local

earthquake, we're still waiting for a significant ("22 year") seismic event. Patience.

SLIDE 45

The masts at the top of the hill just south of Parkfield are satellites receiving stations and laser telemetry instruments hooked into a network of measured locations to detect land shifts to an accuracy of millimeters.

SLIDE 46

This stream bridge straddles the San Andreas Fault. The sign says, "Now entering the North American Plate." A similar sign tells oncoming traffic, "Now Entering the Pacific Plate."

SLIDE 47

Note the railing of the same bridge. The distortion is caused by fault strain. The offset since the bridge was built is more than half a meter. Also notice how the supports have been constructed at an offset to anticipate movement along the fault.

SLIDE 48

This drainage ditch is documented in many textbooks. The break where the whole ditch is shifted right is a result of movement along the San Andreas Fault. The ditch was quite overgrown and required considerable removal of vines. The next two images show the same location

SLIDE 49

In these images, taken many years apart, the result of subsequent fault movement is very evident. This movement is responsible for the wrenching of a warehouse across the road formerly owned by Almaden and now by the DeRose Winery. Notice the small spring house in both photographs. The spring is a result of groundwater blockage by fault gouge clay. (Cienga Road about 10 miles south of Hollister, CA.) How far has the ditch (San Andreas Fault) shifted in this time period? What is the average annual relative motion? Can student calculate the rate of fault shifting here? (That data can be used for the student problem in slide 31.)

SLIDE 50

The drainage ditch in the past two images is just out of the picture on the right. Note the elbow bend in the utility pipe to accommodate fault slippage. Also notice the patch on the road required by ongoing fault slippage. Workers can be seen constructing a new building next to the fault.

SLIDE 51

This is the north wall of the DeRose Cienga Winery building. The San Andreas Fault runs north-south directly under the building. The outside wall damage is caused by fault motion. The U.S. Geological Survey has installed instruments inside the building to record wrenching motion.

SLIDE 52

Park Hill, Hollister, California. The Calaveras Fault, along the slope in the foreground, is a splay fault several kilometers east of the San Andreas Fault. The Calaveras Fault runs directly through the intersection where the two vehicles can be seen. In fact, the next 15 images show the exact trace of this fault through the town.

SLIDE 53

As small retaining wall was built straight across the Calaveras Fault in Hollister. Slow but steady creep along the fault is progressively bending the wall and cracking the sidewalk. The public works department in town is constantly repairing curbs and sidewalks that cross the fault. What is the future of this wall? Note the large tree behind the author.

SLIDE 54

This tree, visible in the last image, shows evidence of rotational motion as it has grown. Carefully look at the roots and bark pattern. In the estimated 100 years of the life of the tree, the fault has probably moved on the order of 10 feet. (3 meters) Note the restoration work on the house behind the tree. Fortunately, this house does not sit directly on the fault. (It passes under the house next door to the right.)

SLIDE 55

The workmen who built this curb were neither partying nor hung over. (...to my knowledge.) Rather, fault creep has distorted the curb. This curb is adjacent to the bent wall in slide 53..

SLIDE 56

The telephoto view (equivalent to about 350 mm on a 35mm camera) emphasizes the bending of this curb caused by fault creep. Like the other images, this one shows right lateral movement.

SLIDE 57

This building at Hollister High School has obvious roof damage caused by wrenching action of the underlying Calaveras Fault. It appears that the asphalt pavement is more ductile in its response.

SLIDE 58

(Note that this is a "discrepant event" image.)

Can you explain why this is a **left** lateral offset on 4th Street in Hollister? (LEFT lateral!)

(Answer...The Calaveras Fault is a right lateral offset. Clearly this is not fault offset. Perhaps it's just an error in road alignment.)

SLIDE 59

This is where the Calaveras Fault crosses 5th Street. The fault, as you will see, crosses the road here and passes directly under the center house. Some road damage is evident. At the time the photograph was taken the right house was for sale. The brochures given out at the house made no mention of the fault.

SLIDE 60

Note the shape of this door transom. Related damage has led to severe structural problems in many houses along the fault. Some have been torn down over the years.

SLIDE 61

Notice how the wrenching action has caused the gutter trough to break free of the eaves. This is the house shown in the last to images.

SLIDE 62

Same location. If this were located in a colder climate, the break would be identified as a frost heave. But here it's fault warping.

SLIDE 63

Note the way the top step has separated from the lower steps. This is one city block from the last three images. Again, Calaveras fault creep damage.

SLIDE 64

Believe it or not, this sidewalk was initially built straight in front of the front steps on Locust Avenue. The walkway has been repaired repeatedly with fresh concrete, but not moved back to the left to its original perpendicular location.

SLIDE 65

This is the same wall you saw in the last image. This is at the north (left) end of the property. Notice the offset under the bushes.

SLIDE 66

This garage is next door to the south of the last location. It was constructed in 1929. Its foundation has been slowly distorted by fault creep in subsequent years. Also notice the tilted utility pole.

SLIDE 67

The nearby curb clearly shows the fault trace. Again, notice the tilt of the street sign pole. Hopefully, the operation fire hydrant is checked often.

SLIDE 68

100 km (about 65 miles) to the north is the western office of the United States Geological Survey at Menlo Park, California. Scientists here study the San Andreas Fault which is in the San Francisco peninsula hills about 10 km to the west.

SLIDE 69

The San Andreas Fault passes under the San Andreas Lakes and several kilometers west (left) of the Golden Gate Bridge, shown here.

SLIDE 70

The ridge at Point Reyes, from which the picture was taken, is a fault structure. From here the San Andreas Fault runs to the left into the North Pacific Ocean.

SLIDE 71

These are some of the fault-related products sold in a Home Depot in Gilroy California. (Quake Hold is a putty like product to hold fragile objects on shelves.)

SLIDE 72

That's California transformed.

Thanks for your interest.