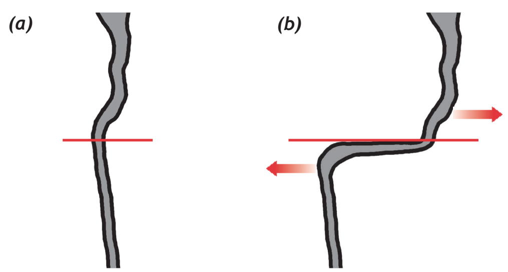
1 and 2 A creek with a "twist"

Post 1. Look northeast. Wallace Creek drains through the channel you see (the **channel** being the bed of the creek, which is dry most of the year), downhill from the Temblor Range toward the plain to the southwest. The creek is fairly straight until **Posts 1 and 2**, where you can see that it sharply bends. What causes these bends? Why doesn't the upstream half of the channel line up with its downstream half?

Observe that the San Andreas fault crosses Wallace Creek almost exactly through the two tight bends. The fault cuts across the surface of the Earth from northwest to southeast. Everything that lies southwest of the fault, including the low Carrizo Plain and the downstream half of Wallace Creek, has been sliding slowly to the northwest (toward San Francisco). Everything that lies northeast of the fault, including the Temblor Range and the upstream half of Wallace Creek, has been sliding to the southeast (toward Los Angeles).

When the "modern" channel of Wallace Creek first formed about 3800 years ago (see "Science in Action" on the back of this trail guide), it cut a path directly across the fault. There were no bends. Repeated motion along the fault, due to large earthquakes every few hundred years, caused the upstream half of Wallace Creek to break away from its downstream half. Geologists call this feature an **offset channel**.



Evolution of the modern channel of Wallace Creek:
(a) the modern channel when it was first cut across the fault, before it was offset by motion (earthquakes) along the fault;
(b) the modern channel today, after being offset 420 feet.

There is more to see here than the modern channel. Before the modern downstream leg of Wallace Creek was cut, Wallace Creek occupied another channel. As you walk back down the hill from **Post 1**, try to pick out the older channel. (Look carefully—it may not be that easy to see!) Can you connect what you can see to the San Andreas fault's history?

There is more to the story here! See "An Evolving Channel" on the right-hand flap of this trail guide.

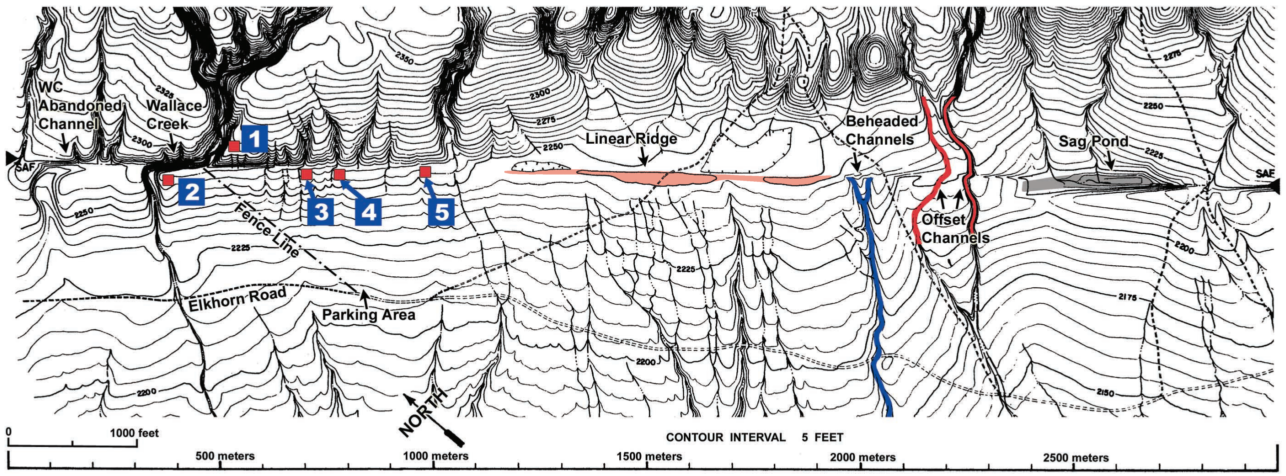
"A great earthquake shook the mountains, ripping a deep gash through the rock formations…" †

If you were standing here in 1857, just after the last earthquake, you would have witnessed a large tear stretching across the land, as far as your eye could see. A casual observer today might conclude that erosion has covered up signs of the fault that broke with such great force—but the fact is, anyone can see it—*and so can you!*

How can you tell there is a fault here? Walk along the trail, read this guide and look at the unusual landforms and geological features. Figure out, just as a geologist would do, what happened in the Earth's past that formed the land you see now.

To preserve the fragile environment, please stay on the trail.

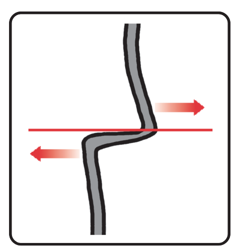
† *Spanish travelers describing the 1857 earthquake in the Carrizo Plain; from "The Legend of Los Temblores," in* Cuentos, *by Angus MacLean (Pioneer Publishing Co., Fresno, 1979, pp. 45-46).*



3 and 4 More clues to the past

Post 3. Look northeast (upstream). Follow the course of the small creek down to the fault where you are standing. Now look southwest (downstream), and see if you can find it. You might not see it at first. Where did the channel go?

From **Post 3**, walk northwest 30 feet (9 m) along the fault. Look again for the downstream channel. It is not as obvious as the upstream channel, but it is still a visible gully. Like Wallace Creek, this channel has been **offset** by motion along the San Andreas fault.

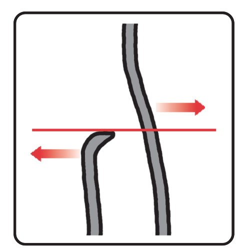


Now do the same at **Post 4**. If you can find the offset channel, you are doing the work of a geologist!

5 A channel with no source

Post 5. Look southwest (downstream). There is another channel here, although it is very subtle and may be difficult to recognize. Where did it come from? Look northeast (upstream)—there is no source for this channel, nothing to flow into it! There is only an "escarpment"—a steeply sloping hill. The downstream landform is called a **beheaded channel**.

A stream once flowed downstream into this channel, but motion across the fault has separated it from its original source. Where is that source now? The original upstream portion of this channel must lie somewhere to the southeast—this is because the upstream portion has been carried in that direction by plate motion.



Along the trail…

There are five numbered posts, which are also shown on the map. On each post are arrows indicating northwest (NW), northeast (NE), southwest (SW), and southeast (SE). Use these aides to help you locate the features described in this trail guide.

Beyond the trail…

Beyond the trail, there are more landforms to help you identify the San Andreas fault. They are colored on the map to correspond with the colored bars below:

A linear ridge…

A **linear ridge** is a long hill or crest of land that stretches in a straight line. It is possibly the result of fault motion (earthquakes) where there was prior uneven ground. Higher ground (southwest of the fault) may have been moved in front of lower ground. But there could be another explanation. The southwest side of the fault may have been pushed upward by earthquakes, which created the ridge.

Upstream from this ridge, water and soil deposits have collected (scientists call this process **ponding**). Ponding happens when all natural escape routes (or "drainages") for water have been blocked, as by this linear ridge. The area has more vegetation than surrounding areas because it is supported by the trapped water.

Beheaded channels…

You can see some dramatic examples of **beheaded channels** beyond the trail. Where is the upstream half (the source) of each channel? The sources lie to the southeast. But know what to look for! When the downstream part of a channel is "beheaded," the creek cuts a new channel across the fault. The source would now appear either as a stream cutting straight across the fault, or as an **offset channel**.

Offset channels…

You can see more **offset channels** beyond the trail. Are these offsets longer or shorter than the offset at Wallace Creek? Is there some way to tell whether the channels are older or younger than Wallace Creek? We know that if a stream has been offset a greater distance (say 60 feet instead of 30), it must have been through more earthquakes. Since these offsets are shorter than the offset at Wallace Creek, these channels must be younger than Wallace Creek.

A sag pond…

The depression in the earth you can see here is called a **sag pond**. This sag pond lies between two sections, or "strands" of the fault. Between these two strands, the ground is sinking as it is also being pulled apart by fault motion. Although it is dry most of the year, the sag pond fills with water quickly after a storm.

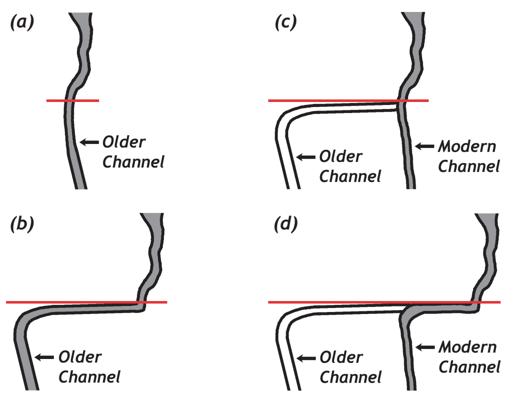
An Evolving Channel...

Wallace Creek did not always look the way it does today. Its shape has been constantly changing over time. If you study the present configuration of Wallace Creek and think about how the San Andreas fault behaves, you might be able to guess what the creek looked like in the past.

At **Posts 1 and 2**, you learned that when the modern channel was first cut, its path was *straight* across the fault. Since then, the shape of the channel has been changed by motion along the fault. What did Wallace Creek look like *before* the modern channel was cut?

Remnants of an older channel are still visible. If you look across the modern channel from **Post 2**, you will see another channel in the distance, draining toward the plain to the southwest. This is a much older downstream segment of Wallace Creek. It has been completely separated from the upstream portion. This is known as a **beheaded channel**. About 10,000 years ago, it lined up with the upstream segment of the creek.

Earth scientists can see what the original, older channel looked like by going backwards in time along the fault. By "sliding back" the fault, geologists imagine Wallace Creek evolving in this manner:



*Wallace Creek **(a)** when the older channel was first cut; **(b)** after the older channel had been offset some distance, but before the modern channel was cut; **(c)** just after the modern channel was cut; and **(d)** in its present form. The shaded channel is the active channel at the time depicted.*

In the future, Wallace Creek will erode a new path straight across the fault, and the downstream portion of the modern channel will become another beheaded channel.

Science in Action

One of the most important questions a geologist tries to answer about any active fault is *how fast* the fault moves. A fault's motion is not constant. Most faults do not move for tens, hundreds, or even thousands of years. Then they may suddenly break with an abrupt motion that we call an "earthquake."

Some time ago, geologists realized that if they could establish the date when Wallace Creek cut its modern channel, they could figure out the rate at which the fault has been moving since then: it would be the offset of the present channel—420 feet (130 m)—divided by the number of years that have passed.

They discovered that one way to establish when the creek cut its new channel would be to figure out the age of the youngest material in the older channel. This could be done by using a method called carbon-14 dating on charcoal samples that were deposited in the bed of the older channel.

After digging a series of trenches, geologists found that the youngest material in the older channel was about 3800 years old. The modern channel of Wallace Creek must have been cut just after the 3800-year-old material was deposited. Since Wallace Creek has been offset 420 feet (130 m) since then, the fault must be slipping at an average rate of about 1.3 inches (34 mm) per year.

Slip Rate on the San Andreas fault at Wallace Creek:

$$\frac{\text{offset}}{\text{time}} = \frac{\text{420 feet}}{\text{3800 years}} = \frac{\text{5040 inches}}{\text{3800 years}} = \text{1.3 inches per year}$$

Project Staff:
Jill Andrews (SCEC)
Robert de Groot (SCEC)
Aron Meltzner (Caltech)
Kerry Sieh (Caltech)

Special Thanks to:
Michael Ayers (BLM)
Johna Hurl (BLM)
Kathy Sharum (BLM)
Larry Vredenburgh (BLM)

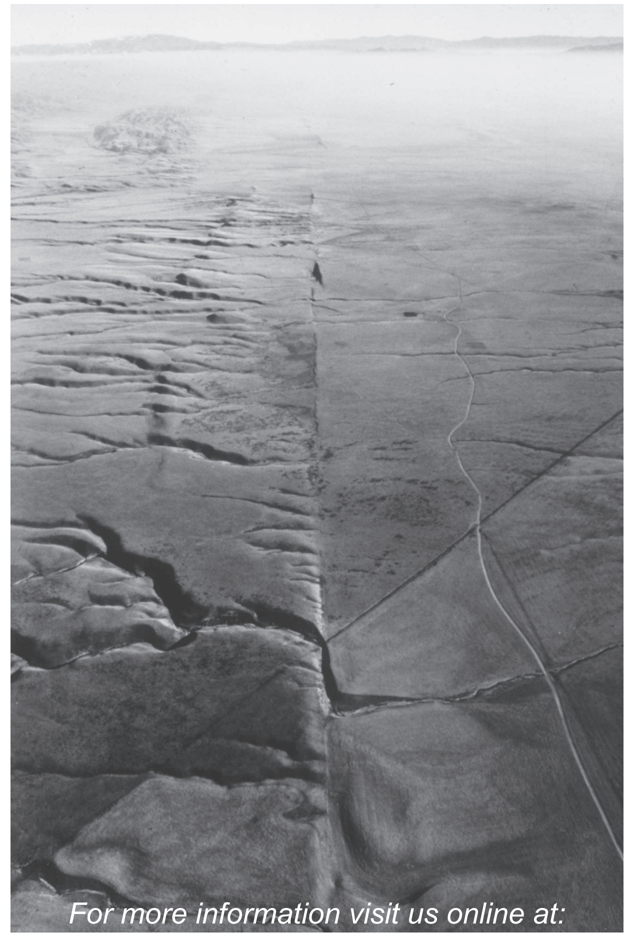
Acknowledgments:
The Wallace Creek map was adapted from K. Sieh and R. E. Wallace, "The San Andreas fault at Wallace Creek," in *Geological Society of America Centennial Field Guide, Cordilleran Section* (1987).
The map of California was adapted from K. Sieh and S. LeVay, *The Earth in Turmoil*, © 1998, W. H. Freeman and Company. The aerial photo is used courtesy of and with permission of G. Gerster.
The 3-D fault drawing (under "What is the San Andreas fault?") is adapted from a drawing by J. Marquis / SCEC. All channel sketches by A. Meltzner. Trail guide design by A. Meltzner and R. de Groot.

Additional copies of this trail guide and further information are available online at **http://www.scec.org/wallacecreek** or from the Bureau of Land Management, 3801 Pegasus Drive, Bakersfield, CA 93308.

Wallace Creek

INTERPRETIVE TRAIL

a geologic guide to the San Andreas fault at Wallace Creek



For more information visit us online at:
www.scec.org/wallacecreek

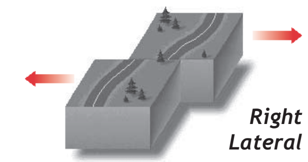
Project Sponsors:

Southern California Earthquake Center—
a National Science Foundation (NSF) Science and Technology Center
U. S. Geological Survey
California Institute of Technology
Bureau of Land Management

What is a fault?

A **fault** is a fracture in the Earth's crust whose sides have moved in relation to each other.

What is the San Andreas fault?



The San Andreas fault is a **lateral** fault. Lateral movement occurs when rock on one side of the fault slides horizontally past rock on the other side, with very little vertical motion. The San Andreas is a **right-lateral** fault. Geologists use the term right-lateral to describe the *direction* the fault moves. If you were standing on one side of a right-lateral fault and facing the fault, a person standing on the opposite side would move to your right during an earthquake.

The San Andreas fault is also the boundary between the Pacific and North American tectonic plates. The fault is about 700 miles (1100 km) long, stretching from Cape Mendocino to the Salton Sea. On average, the Pacific side is moving horizontally past the North American side at a rate of 1.3 inches (34 mm) per year—about as fast as a fingernail grows. But the fault here is not moving every single minute—it only moves during large earthquakes, which happen once every few hundred years. At Wallace Creek, it moved 30 feet (9 m) on January 9, 1857.