

The San Andreas: What makes it shake?

By Mark Wheeler / Hi-Desert Star

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People who live in Southern California know the San Andreas. Famed, fabled and feared, its name is spoken whenever discussion turns to earthquake disaster. We heard its name in 1992 when Landers shook with a homewrecker of 7.3 magnitude. Again, its name was mentioned when in 1994 Northridge made catastrophe-news with its broken freeway and casualties.

Of course, the Landers quake was attributed to its own Emerson Fault, and Northridge was tossed on the heaving back of a fault that hadn't even been detected. Everyone knew, though, the San Andreas was probably involved, somehow. Someway.

San Andreas Fault Zone

Actually, the San Andreas Fault is not the singular earthen feature its name implies, at least it isn't over its entire 700-plus mile length, which stretches from south of the Salton Sea to north of San Francisco. As Michael Collier points out in his book, "A Land In Motion," the fault, in many places, "is more precisely referred to as a fault zone, where movement is taken up across a series of parallel fault segments that may spread out over a mile or more."

Seismologist Susan Hough says the same thing in "Earthshaking Science." In praising California as an ideal location for seismic research, she describes the San Andreas Fault as "one of the most significant plate boundaries anywhere on the planet."

Collier writes about this plate boundary, too, noting that in the San Andreas Fault zone: "The San Andreas is only one of many faults in California that accommodate movement between the Pacific and North American Plates."

This is the key to the San Andreas, the key to why it is so often implicated in earthquake activity seemingly far from its own geographical location, and why distant earthquakes are implicated in increasing its own probability for cutting loose someday, maybe in the near future.



Twentynine Palms Highway follows the Pinto Mountain Fault down the hill into Morongo Valley.

Not just any crack in the ground

The San Andreas is called a right-lateral, strike-slip fault. This describes its motion, which is sideways, and to an observer on either side of the crack during an earthquake, the opposite side will be seen to move to the right.

More crucial to understanding the true meaning of that sideways movement, though, is to know also that the San Andreas Fault is a "transform fault." In simple terms, it is the contact zone between the margins of two huge and independent portions of the Earth's crust called "tectonic plates." It is a plate boundary.

A crack in the crust is one thing; a transform crack between large plates of crust is something else. Both of them can quiver, shiver and quake, but the transform fault, especially if it is as extensive as the San Andreas Fault, can have complex relationships with all the other faults within miles. It can powerfully affect the strain accumulated in the land-mass, and under certain circumstances, such as if it is locked like the southern San Andreas Fault is locked, it will typically slip only rarely compared to other faults - but when it goes, "Look out!"

An important discovery

Last week, an article in this paper elaborated on a recent prediction for a large quake to occur before Sept. 5 of this year somewhere in the vicinity of the southern San Andreas. A complex mixture of statistical analysis and geophysics, the prediction is hard to understand in all its detail. However, its most fundamental premise is easy to understand and, fortunately, that premise is what explains why something like the San Andreas moves at all. San Andreas authorities Kerry Sieh and Simon LeVay explain it with a bit of history in their book, "The Earth in Turmoil."

After the big 1906 quake in San Francisco, they write, an engineer named Harry Reid, upon comparing land surveys made in the 19th century with surveys made after the quake, discovered a change in bearing between landmarks on either side of the San Andreas. A lighthouse on the Farallon Islands offshore from Golden Gate and west of the fault, had moved north by 4 1/2 feet with respect to Mount Diablo on the fault's east side over a period of 46 years.

Further records searches and measurements showed that the Pacific Plate and North American Plate actually move past one another. The Pacific Plate travels generally northwest, while the North American goes generally south.

Ultimately, these measurements, combined with many other advances and revelations, led to the formulation of the plate tectonics theory in the 1960s, which dominates the field of seismology today.

Reid gets much-deserved credit for his early, landmark observations. However, in the course of his further study over the years, he made another contribution to seismology called the "elastic rebound theory." Said by Sieh and Le Vay to be the basis of all subsequent thinking about earthquakes, this theory provides the most vivid description for how the earth manages to accumulate the force it needs to shatter so suddenly and destructively.

Elastic rebound theory

If for some reason, the motion of the two crustal plates is resisted at a contact point, strain will accumulate there. In the 10-mile-deep San Andreas, there is, indeed, resistance. It is the result of contact between the rocky faces of the two plate margins.

Some of the stress is dispersed to adjoining landmass, and it continues to accumulate steadily because, even though the fault is locked, the plates don't stop moving.

What Reid's theory says is that as the plates continue to move, and as the movement is resisted at the boundaries, something has to give. What gives, is the earth itself. It actually bends.

In the same way a board will bend if one end is locked in a vice and a sufficient force is applied somewhere along its axis, the earth bends when the plates continue moving but the movement is resisted at the margins. This causes strain to be stored, and we can detect the storage of it in a strained (bent) land mass.

Considering the magnitude of forces involved, it's not difficult to understand that, at some point, the friction at the plate margins is overcome by the ever-increasing strain generated by the plates' continued movement. The margins at the San Andreas Fault break free, and merely "rebound" to catch up with the rest of their plates.

A branched system

The San Andreas Fault can only take so much strain before it goes. Trench studies of historic earthquake events, read in the earthen record as distortions in the trenchside stratification, show there is some pattern to its

actions over time. Unfortunately, the pattern is difficult to interpret, and the reason is the San Andreas doesn't operate like a simple, single crack in the ground.

In terms of its dynamics, the fault is the primary joint in a highly unstable system of other joints, and strain connects them in very complex ways. We can live a long ways from it, but the San Andreas can still reach us, somehow. Someway. When it's ready to deliver a message, there's no telling where its quake-mail will likely turn up. It could be on anybody's doorstep. We can only hope the news won't be too bad.