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Not My Fault: Plates boundaries aren't simple

Lori Dengler/For the Times-Standard
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Plate tectonics is introduced to many children in fifth or sixth grade. Students learn about plate boundaries and how earthquakes, volcanoes and mountain building occur along plate boundaries leaving the interior of plates deformation free.

In California, transform boundaries are given special emphasis with the San Andreas fault as the example close to home. Students might use simple models sliding blocks next to each other and be told that the plates move at about the rate their fingernails grow. They may look at photos or a Google Earth and be asked to pick out the great San Andreas scar that runs most of the length of the State.

It makes a nice story and engaging classroom activities. Unfortunately, it isn't quite correct. Plate boundaries are more complicated. If all deformation were constrained to the San Andreas, the central and eastern part of the California along with Nevada and Utah would be earthquake free. The 1992 M7.3 Landers earthquake, 1872 M7.8 Lone Pine earthquake and numerous other large historic earthquakes in California and Nevada would never have happened. And I wouldn't have spent space in recent columns about the recent spurt of activity in Utah, Nevada and Eastern California.

Plate boundaries are constantly evolving. The Pacific – North American plate interaction began about 30 million years ago when the Pacific plate and North American plate first made contact. The San Andreas transform boundary, where plates move horizontally, was formed to accommodate their relative motion. View UC Santa Barbara Professor Tanya Atwater's animation of how this might have happened https://www.youtube.com/watch?v=9F8AcDJq2QU.

The Pacific and North American plates are enormous pieces of real estate and once the new boundary formed, all did not go smoothly. The enormous pressures caused deformation across the western part of the continent. If you view the Atwater animation, you will get a feel for the distortion across the region.

Not only does stress change as the transform boundary grows, it is interacting with highly heterogeneous rock types. Continents have long, complicated histories. Our continent began to form at least three billion years ago. Over the intervening millennia, it grew as other crust collided into it and lost areas when extensional forces broke split land off. It's a giant evolving patchwork quilt of rock types with numerous fault and fracture zones of different ages and strengths.

Piecing out the history of this transform boundary has been the collective effort of generations of geologists. In the 19th and much of the 20th centuries, it was a boots-on-the-ground effort of mapping and analyzing rock units. In the 1970s, paleoseismology opened new ways of reading the recent history of tectonic movements. Paleoseismology has advanced in recent years with GPS studies that allow scientists to measure real time plate motions and LIDAR (laser imaging, detection, and ranging), exposing previously invisible faults.

The picture that has now emerged of the Pacific-North American plate boundary is one that extends all the way to Utah. Don't worry - the San Andreas is still important. The San Andreas and associated faults such as the San Jacinto in Southern California and the Hayward in Northern California accommodate 75 to 80% of the relative motion between the two plates. But that leaves nearly a quarter of the motion on fault systems to the east – in Eastern California, Nevada and Utah - enough to have a major impact on the landscape.

Flying over Nevada and Utah, I am struck by Basin and Range topography, the stark north – south oriented ridges and valleys unobscured by vegetation. Blame the Pacific-North American transform motion. To me they look like giant stretch marks reflecting how the crust thinned in response to the extensional forces. Every one of those ridges is bounded by faults, many capable of producing significant earthquakes. The March 18th M5.7 earthquake in near Salt Lake City, near the edge of the Basin and Range province, is a result of those stresses.

I find the faults and tectonics of Eastern California and Western Nevada even more interesting. Called the Walker Lane or the Eastern California shear zone, this zone extends from the Mojave Desert to just south of Idaho. GPS studies show that it accommodates 10 - 15% of the total motion between the North American and Pacific plates. Although the sense of motion is similar, Walker Lane is a very different type of beast than the San Andreas, consisting of many different discontinuous faults spread over a 125+ miles wide zone. It doesn't move

homogeneously as different units respond to the stress in different ways. Some blocks even rotate, like the section that produced the recent May 15th M6.5 where the causative fault is nearly perpendicular to the general trend of Pacific – North America motion.

A group of scientists from the University of Nevada, Reno speculate that Walker Lane may eventually kick the San Andreas aside and become the main contributor to the relative motion between the two plates. That might cut off most of California from the North American mainland. Don't hold your breath or start investing in Western Nevada real estate any time soon. It's not like to happen for another 7 to 8 million years. Read more at https://www.unr.edu/nevada-today/stories/walker-lane

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