LANDSLIDES OF TORREY PINES 2020

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Gravity always wins in the end!

Our coastal cliffs are exposed to the action of wind, water, waves and gravity. In most areas they are retreating about 6 inches a year, but as much as several feet in others. This is not a uniform loss year after year in most cases. Instead the cliff may be eroded only a few inches in 100 years and then have a failure 50 or 100 feet into the cliff with a very large landslide. North of Bathtub rock the landslides tend to be smaller. South of the Bathtub the formations are much more vulnerable to large slides.

Landslides occur when gravity, pulling the rocks down the slope, exceeds the pull perpendicular to the slope and the friction of the material. When the pull of gravity exceeds the hold, the object will slide or fall. The angle when this occurs is called the angle of repose. For vertical cliffs a failure may occur when the lower slope undercuts the upper slope leaving a cantilever or overhang or when an area of weakness develops in the rock formation. At some point the weight exceeds the strength of the rock and it drops. This is usually along a line of weakness, perhaps a crack or microfault. The Torrey Pines and Del Mar formations have many cracks and planes of weakness. The Ardath and Scripps formations are weaker.

Slope failure takes many different forms and we see many of them at Torrey Pines south beach.

Failures can occur in vertical walls with the forward rotation of a mass of rock. **Toppling** may be triggered by the weight of material over an undercut slope. Toppling of a rock mass onto the beach led to the recent fatalities on the beach in Encinitas.

Rockfalls are downward movements of rock detached from steep slopes or cliffs. The falling mass may break on impact but some fragments may roll or bounce away from the cliff. Fortunately most north Torrey Pines slides do not move very far out onto the horizontal beach.

However, a very small rockfall that fell free before hitting the lower slope bounced some rocks out more than 50 feet (September, 2019).

Perhaps the most common failure on the northern part of Torrey Pines beach is a **translational** landslide that moves down along the surface plane with little rotational movement or backward tilting. The material in these slides may range from large slabs to loose, unconsolidated material with small chunks. The recent arch landslide (July 2019) was a translational slide with a debris pile about 150 feet wide with some refrigerator sized blocks including two left on the landslide plane. The 2016 rockfall south of the first canyon on Torrey Pines beach was similar. Just before it fell, a jet of dry sand developed at one of the cracks. This may have led to the uncoupling of the mass. The debris pile from this landslide is about 100 feet wide.

South of Bathtub rock the Ardath Shale and Scripps formations are more vulnerable to larger **rotational** slides, These involve a surface of rupture that is curved upward where the displaced material rotates about an axis parallel to the slope. The head of the displaced material may drop almost straight down, and the upper surface of the displaced material may then tilt up or backwards toward the scarp further down the slope. The massive Torrey Pines slide was north of the glider port in the 1880s. This was 1,700 feet wide and extended several hundred feet landward. The debris pile pushed out into the ocean and can still be seen. This slide occurred after a very wet winter. The Black's Beach slide of 1982 was smaller, but still more than 600 feet wide and extending more than 250 feet into the cliff. Fortunately it occurred on a January morning. In about 1920 a similar slide 460 feet wide, 200 feet high and 250 feet deep also took place at Black's.

"**Iceplantalanches"** also occur at Torrey Pines but pose little threat to humans. The invasive non-native ice plants are very heavy when saturated with water and have very weak root systems. This leads to slope failures and several have occurred at the top of the cliff. You can recognize them with topsoil mounds on the beach and a smear of topsoil on the cliff. The heads of some of these failures have reached almost to the Guy Fleming Trail and it may be appropriate to consider moving that segment of trail further inland.

What can trigger a landslide?

Our landslides are usually triggered by erosion of the cliff faces leading to weakness and slopes steeper than the angle of repose. This is commonly related to undercutting by wave action, runoff or wind erosion. The last large slide on Torrey Pines beach was this summer, but slides are more likely in winter after heavy rains. A slide south of the first canyon happened in December 2016, following an adjacent slide in July. Rain water increases the weight of the material and can lubricate joints and reduce the strength of the sandstone.

Water from irrigation and urban runoff can also make cliff failures more likely. If you see brush growing along a seam in the cliff face it is a sign of moisture in the formation. Pine roots followed the damp cracks down as far as 100 feet on the arch slide site. As roots grow they can force the cracks open, allowing more water to move into the crack, increasing root growth and making a landslide more likely.

Earthquakes are fortunately rare, but will lead to many landslides. A careful look at the cliffs on Torrey Pines beach reveals many cracks, overhangs and perched materials just barely holding on to the slope.Even a small shake will set them free.

What can be done to reduce risk?

Don't be afraid, but be aware. Unfortunately very little can be done except to educate the public on the risks of hugging the cliff—even if the shade looks appealing. Landslides, like earthquakes are hard to predict, but we know they can and will occur eventually on every part of the cliff. Educational material can help visitors make a more informed judgement of risk when they set up their chairs or decide not to walk on a narrow beach at high tide.

A smooth face with a debris pile is usually a sign that the cliff is more likely to be stable in this area, while a pocketed or rough cliff suggests it has been many years since the last slide and that it may be more risky. An arch feature can also be a sign of instability. Areas with obvious cracks, perched rocks and overhangs should simply be avoided. We watched a large boulder, "the rock of

Damocles," perched precariously on top of the cliff for several years before it finally fell to the beach below.

Landslides can and do occur at any time of the year. They give little warning and make little sound until they hit the beach. Even a small failure can cause injuries or worse. Massive landslides are more difficult to predict but are most likely in very wet winters. A regular review of the cliff face and the slope above the cliff would be a good idea. The geologists who were called in to review the risk at Black's Beach after cracks in the cliff top were seen in 1981 predicted a slide almost exactly as it occurred in 1982.

Railroads, parks and highway departments often hire skilled climbers to work on the cliff faces to remove hazardous rocks. These "scalers" reduce rockfall and landslide risk in vulnerable areas but it is dangerous work and expensive. It would provide limited protection on the Torrey Pines cliffs and is also not in keeping with the natural reserve designation. Armoring cliffs with riprap or concrete is simply not practical and would reduce the sand development that helps maintain the beach. Other "hard solutions" would be very expensive, and in the end, gravity will always win. Reducing the flow of irrigation water from the golf course (and landscaping and urban runoff in towns) into the cliffs can help reduce risk. Keep in mind it is more dangerous driving to the beach than it is to be enjoying the beach — but be wise and be safe.

More info:

Lynn M. Highland and Peter Bobrowsky. 2008. **The Landslide Handbook**. Reston, Virginia, U.S. Geological Survey Circular #1325.

Gerald G. Kuhn and Francis P. Shepard. 1984. **Sea Cliffs, Beaches, and Coastal Valleys of San Diego County: Some Amazing Histories and Some Horrifying Implications**. UC Press.

David Bainbridge graduated from UCSD with an earth sciences degree in 1970. He was team leader for the Geology section of the San Diego County resources inventory and worked on

projects for the U.S. Geological Survey, Association of Bay Area Governments, and other clients. He has taught earth sciences classes and workshops.

Geohazard evaluation—who do you call?

Murbach Geotech
3130 N Evergreen Street
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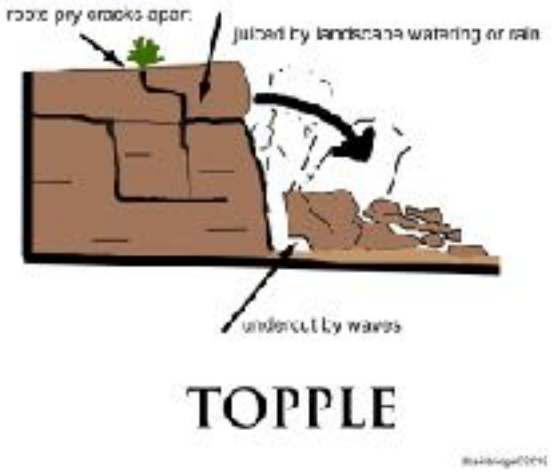
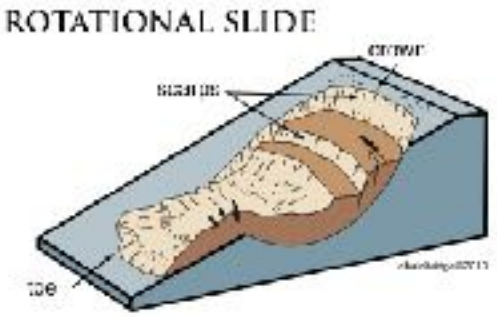
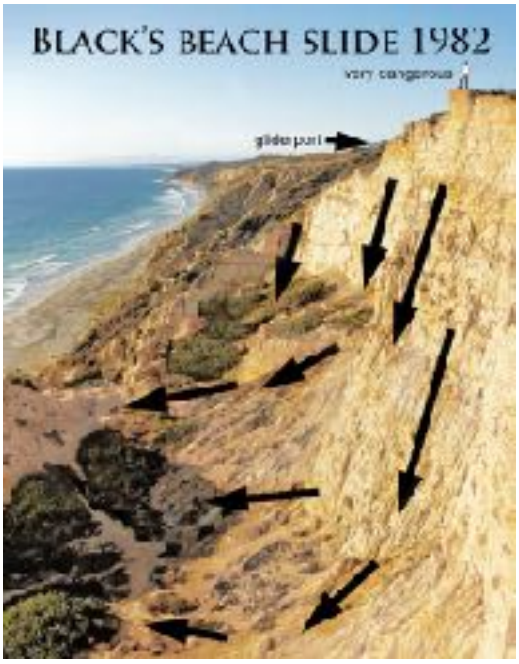
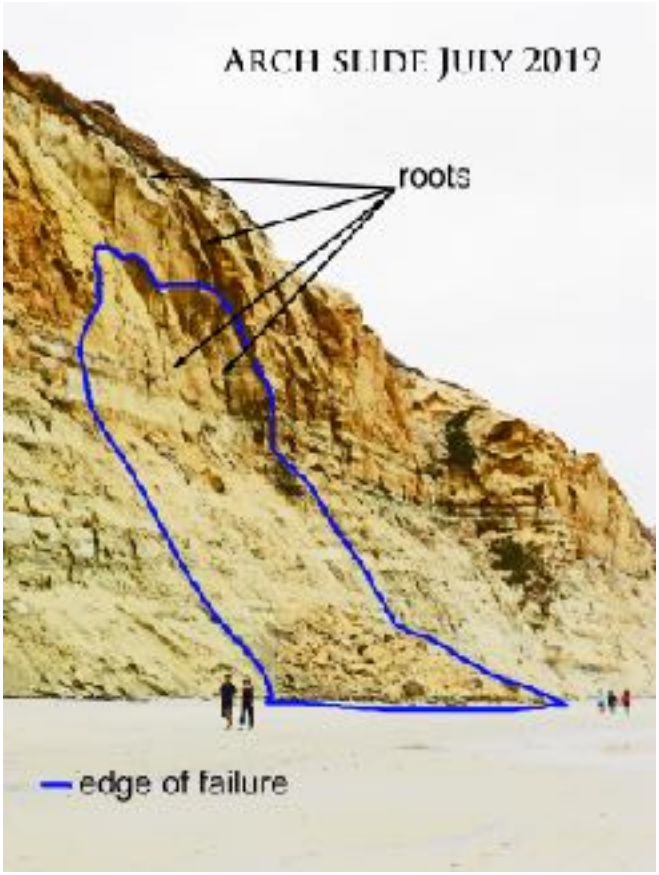


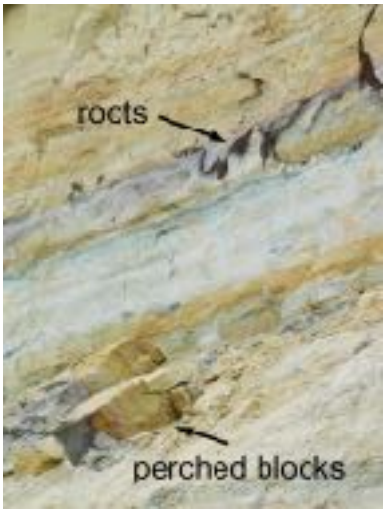




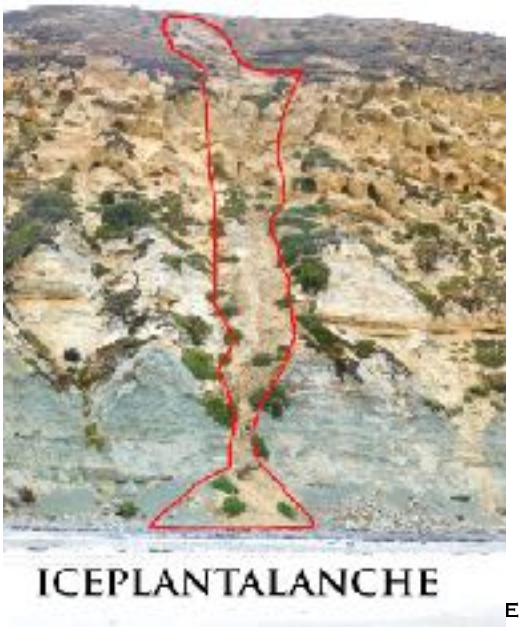
Glider port trail goes down old slide

Canyon south slide
Dec 2016





Arch slide blocks, roots at 100 feet behind the slab that fell



Highly weathered rough face likely to fail sooner

Smooth face after recent fall (2016). More likely to be stable—but no guarantee

Overhang from recent rock fall, flake to left will go soon - then the cliff face above

Torrey Pines Crack 2014 -this flake fell the following year

Undercut by waves - eventually will lead to slope failure

Scaler working on a road cut. Workers become very skilled at this dangerous work. In some cases they haul compressors up the slope to power jackhammers or use dynamite to remove bigger rocks.