PLATE TECTONICS & THE COASTAL ZONE

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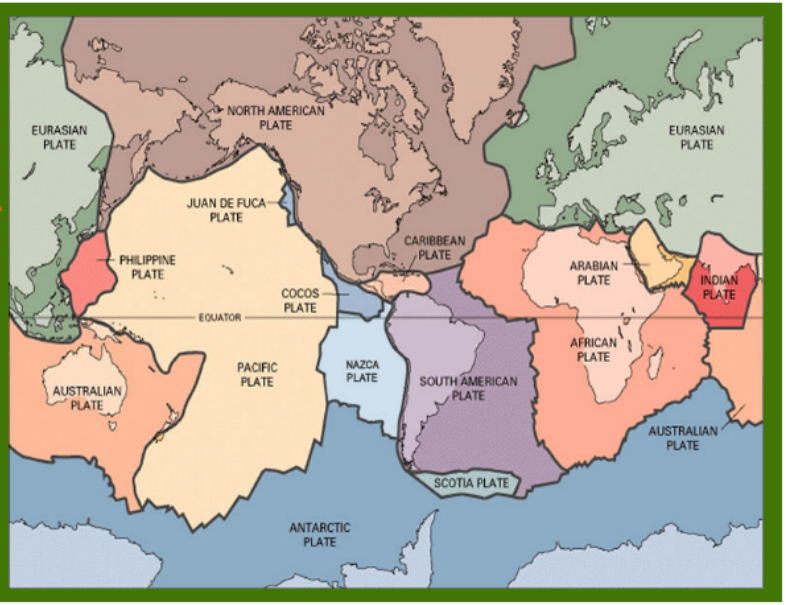
TAKE HOME MESSAGE

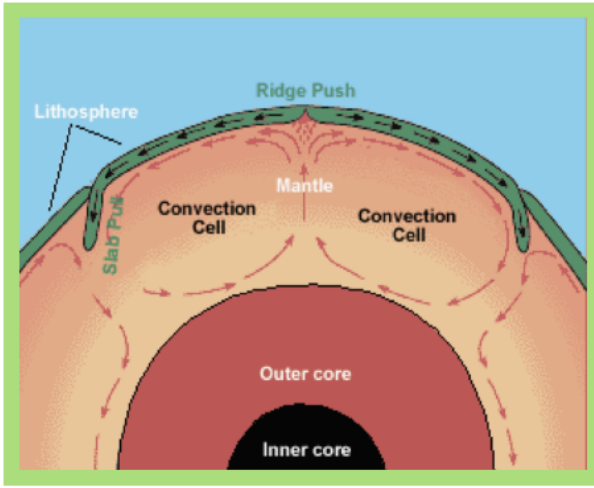
The Earth's surface is made up of rigid pieces called tectonic plates. The plates move due temperature and densities differences and due to convection currents in the molten layer underneath the plates (the mantle). Plate boundaries are divergent, convergent, or transform, and coastal zones are categorized as either active margins (convergent and transform boundaries) or passive margins (no plate boundaries). Active margins (U.S. West Coast) have narrow, steep continental shelves while passive margins (U.S. East Coast) are characterized by a wide, gently sloping continental shelf. Waves are impacted by their interaction with the continental shelf, and the steeper, narrower continental shelves of active margins create better surfing waves.

WHAT ARE TECTONIC PLATES? [1]

Earth's surface (the crust) is divided into ~15 rigid pieces, or tectonic plates. There are both oceanic and continental plates.

OCEANIC	CONTINENTAL
• Primarily basaltic rock • More dense, sink below sea level • Thinner (4-5 miles) • Younger (<200 million years old)	• Primarily granitic rock • Less dense, more buoyant • Thicker (average 25 miles) • Older (>1 billion years old)



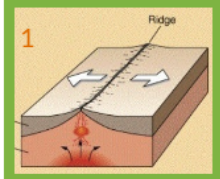


The Earth's tectonic plates "rest" on the layer below them called the mantle. The mantle is made up of molten rock, or magma, heated by the Earth's core. This magma moves in a circular pattern called a convection cell: as magma closest to the core heats up, it rises, then as it nears the surface it cools and sinks until it heats up again and the cycle continues.

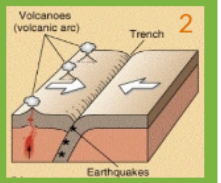
Slab pull: as cold/thick/dense plates sink into the mantle, the rest of the plate is pulled along with it. Ridge push: as warm/thin/less dense plate pushes to the surface in between two plates, it pushes the plates apart.

WHAT HAPPENS WHERE PLATES MEET? [3,4]

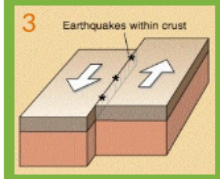
There are three types of plate boundaries based on the direction the plates are moving, and there are two types of margins:



1. Divergent boundary: two plates move away from each other - new crust is created as magma from the mantle pushes up in between the plates and cools.



2. Convergent boundary: two plates colliding. Result of collision depends on what kind of plates are colliding. When an oceanic and continental plate collide the more dense oceanic plate sinks below the continental plate into the mantle (subduction).



3. Transform-fault boundary: two plates sliding past each other in a predominantly horizontal direction.

ACTIVE MARGINS

Convergent & Transform Boundaries

Characteristics: tectonic activity (ie. earthquakes, volcanos, mountain formation), fairly short rivers, narrow continental shelf that drops off steeply.

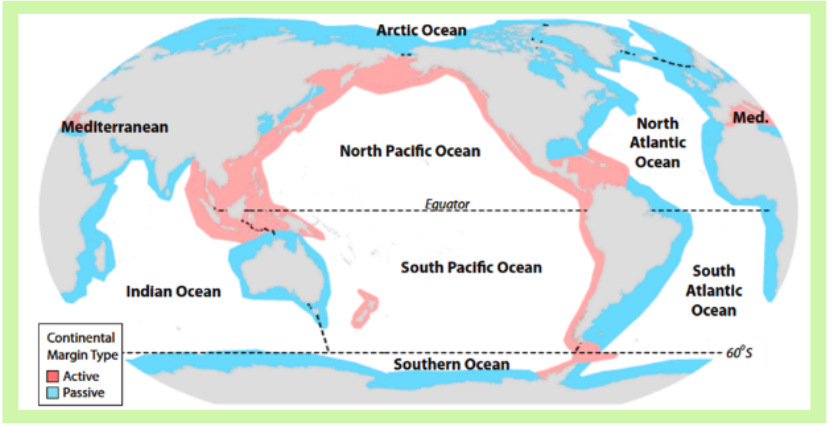
PASSIVE MARGINS

No Plate Collision Taking Place

Characteristics: minimal tectonic activity, longer rivers, flatter land extending from coast, and wide, gently sloping continental shelves.

WHY DO PLATES MOVE? [2]

WEST COAST MARGIN



The U.S. West Coast is an excellent example of an active margin. With multiple transform and convergent boundaries between the North American, Pacific, Juan de Fuca, and Cocos plates, there is significant tectonic activity and a narrow continental shelf with a steep drop off.

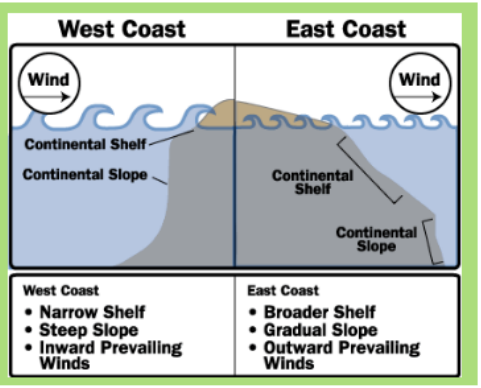
The U.S. East Coast is an excellent example of a passive margin. The North American Plate extends well beyond the east coastline, so there is no plate boundary along this coast. Consequently, there is little tectonic activity, a prevalence of barrier islands and a wider, more gently sloping continental shelf.

EAST COAST MARGIN

Waves are created by three main factors:

- Prevailing winds
- Ocean fetch
- Continental shelf topography

In terms of prevailing winds and ocean fetch, the West Coast of the U.S. has the upper hand over the East Coast. Prevailing winds on the West Coast blow onshore, meaning they are behind the waves. The Pacific Ocean is also much larger than the Atlantic, so there is greater ocean fetch on the West Coast. Finally, the West Coast also has a continental shelf that is more conducive to creating big, surf-able waves thanks to its passive margin. As waves move toward the shore on the East Coast, they hit the wide, sloping continental shelf. Friction from this interaction causes the wave to diminish as it travels. On the West Coast, the wave has more time to build energy before suddenly hitting the steep, narrow continental shelf, creating a larger wave break and some of the best surfing waves in the world!



COASTAL TOPOGRAPHY & WAVES[5]

EDITORIAL NOTE[6]

If you think a quick internet search would reveal the total number of tectonic plates that make up the Earth's surface, you are sorely mistaken. Though ultimately a small detail, I found the lack of clarity on this detail interesting. Most websites say 8 major plates and 7 minor plates for a total of 15 plates (which matches the plates illustrated in the map). However, other websites say 13, 14, or even 20 total tectonic plates. Wikipedia lists 7 major plates and 10 minor plates for a total of 17, and then also lists 60 microplates that together make up the major and minor plates. The most recent review article I could find settled at 159 plates in total. It appears that an entire 2-pager (or more) could be written on how plates are discovered, characterized, and counted!

RESOURCES

CONTENT

1. Bennett, D. (2018, April 5). Difference Between Continental & Oceanic Plates. Retrieved January 19, 2019, from https://bit.ly/2Df3IAB

2. Windows To The Universe. (2008, March 21). How Do Plates Move? Retrieved January 19, 2019, from https://bit.ly/2HkOAAD

3. Strickler, M. (n.d.). Ask GeoMan: What's the difference between an active and passive continental margin? Retrieved January 16, 2019, from https://bit.ly/2QTkdGi

4. USGS. (n.d.). Understanding plate motions. Retrieved January 16, 2019, from https://on.doi.gov/2hVWeWG

5. HowStuffWorks.com (2018, June 28). Why are the waves on the U.S. West Coast larger than the waves on the East Coast? Retrieved January 16, 2019, from https://bit.ly/2FFdPAv

6. Harrison, C. G. (2016). The present-day number of tectonic plates. *Earth, Planets and Space*,*68*(1). doi:10.1186/s40623-016-0400-x

MAPS & IMAGES

- Tectonic Plate World Map: https://geology.com/plate-tectonics.shtml
- Plate Movement Illustration: same as #2 above
- Plate Boundary Illustrations: https://hi-static.z-dn.net/files/d64/eba6400ada3e44543ccb9a6c730b3f37.jpg
- Active & Passive Margin World Map: http://www.geol-amu.org/notes/bl8-1-2.htm
- Aerial West Coast & East Coast Images: google.com/maps
- Wave Illustration: same as #5 above