



**Teacher Notes-Slide1:** If you have time allow students to volunteer answers.



- Tens of Millions of years ago most of California was under the ocean. The edge of the continent was near Western Nevada.
- Subduction, when one plate sinks back into the mantle, was taking place.

**Teacher Notes-Slide 2:** Answers QUESTION #1 and #2. Pause for two to three minutes on this slide so that students have time to answer these questions. Also you may want to point out the white outline of CA current coastline, which is out in the ocean on this slide.



- The oceanic plate was subducting beneath the North American plate creating volcanoes. The magma chambers that fed these volcanoes would later become the Sierra Nevada Mountain Range.

**Teacher Notes-Slide 3:** This is a composite or strato-volcano. Composite volcanoes still exist in the Pacific north-west. Due to the subduction of the Juan de Fuca plate below the North American plate, examples of some of the composite volcanoes along the Cascade Range that the subduction creates are Mt. Saint Helens, Mt. Rainer, Mt. Hood, and California's Mt. Shasta.

- 30 million years ago, the area that would become the San Joaquin Valley was a shallow ocean.
- As ocean animals die, including microscopic organisms called **diatoms**, they would sink to the bottom and become part of the ocean floor sediment.

[www.bh.kku.net/archives/03/mar03.html](http://www.bh.kku.net/archives/03/mar03.html)

**Teacher Notes-Slide 4: Answers QUESTION #3.** Direct students to write “ocean” in the first blank and “diatoms” in the second.

- This is where shark teeth on Shark Tooth Hill come from!!!

**Teacher Notes-Slide 5: Shark Tooth Hill** is located across the river from Hart Park off of Round Mountain Road. Unfortunately, it is on private property and is a known location of Valley Fever spores.

- From 250 to 30 million years ago, the oceanic plate subducted and some of the sediment and pieces of the ocean floor scraped off on the continent to form part of the coast range.

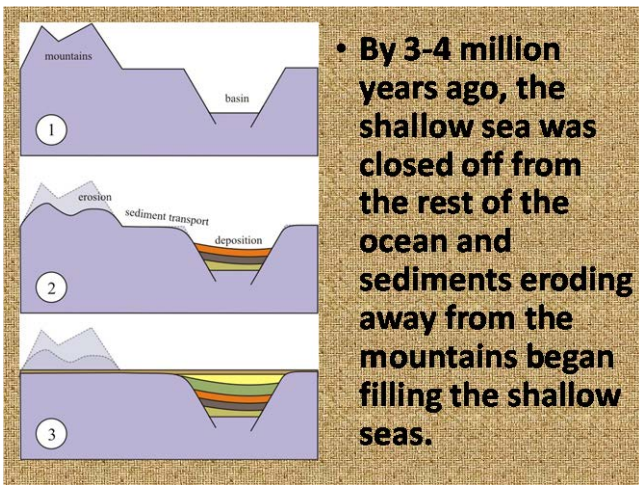
**Teacher Notes-Slide 6: The process of sediments and seafloor scraping off onto the continent is called accretion.** This land is referred to as accreted terrain and exists all along the West Coast. Point out to students that the inland sea in this slide is the future location of the San Joaquin Valley and the mountains to the East of it are the Sierra Nevada





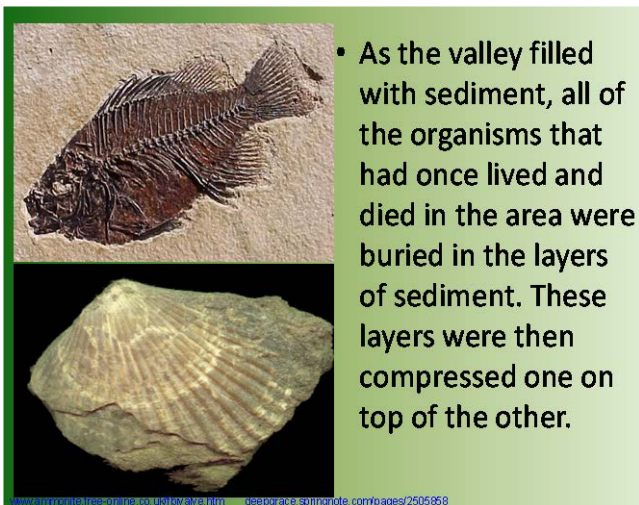
- 30 million years ago, the subduction along California's coast moved north as a transform boundary was formed. This transform boundary is now known as the San Andreas Fault.
- The Pacific Plate then began moving north carrying the mountains with it.

**Teacher Notes-Slide 7: Answers QUESTION #4.** Subduction still takes place along Northern California, Oregon, and Washington, creating the volcanically active Cascade Range.



- By 3-4 million years ago, the shallow sea was closed off from the rest of the ocean and sediments eroding away from the mountains began filling the shallow seas.

**Teacher Notes-Slide 8: Answers QUESTION #5.** The sea was closed off because the Pacific Plate was moving North carrying land. This land blocked the opening to the ocean and the valley has been filling with sediment ever since.



- As the valley filled with sediment, all of the organisms that had once lived and died in the area were buried in the layers of sediment. These layers were then compressed one on top of the other.

**Teacher Notes-Slide 9:** As sediment accumulates, it creates the pressure needed to turn the organic matter into oil.

- Over the next couple of million years, these marine plants and animals decomposed and turned into the oil we find in the San Joaquin Valley today.

[http://www.conservation.ca.gov/GOE/Kids\\_teachers/Seeps/Pages/Index.aspx](http://www.conservation.ca.gov/GOE/Kids_teachers/Seeps/Pages/Index.aspx)



**Teacher Notes-Slide 10:** As sediment layers stacked on top of the marine plants and animals, the heat and pressure from the weight of the sediment compressed the organic matter into oil.



- **Important!!!**  
**This oil was formed AFTER the dinosaurs all died !!!**

**Teacher Notes-Slide 11:** Answers QUESTION #6. Dinosaurs became extinct 65 million years ago. The process that formed the San Joaquin Valley oil began about 30 million years ago.

**Where do we find the oil?**

**Teacher Notes-Slide 12:** You met let students guess or share locations they know have oil wells on them.

**SUITABLE STORAGE ROCKS**

- California oil is found within **sedimentary rocks**. Sedimentary rocks are made from sediment, sand, gravel, mud or organic matter.
- The oil is formed in the pore spaces found between the rock grains.
- How much pore space (space between the rock grains) there is in a rock is called **porosity**.
- **Permeability** is the measure of a materials ability to allow fluid to flow through.

**Teacher Notes-Slide 13:** The first paragraph in this slide answers QUESTION #7. Students will need a minute for this because they will have to write down a longer answer. QUESTION #8 is in the last paragraph. You may need to help students with the definition for porosity.

- Oil producing sediment needs to be buried under 7,000-18,000 ft (2100 to 5500 m) of sediment and heated to 150°-300°F to form oil.

**Teacher Notes-Slide 14:** The Empire State Building is 1250 ft tall, so oil needs to be buried over five times deeper than the Empire State Building is tall or is deeper than Mt. Whitney is tall.

**Why isn't oil everywhere?**

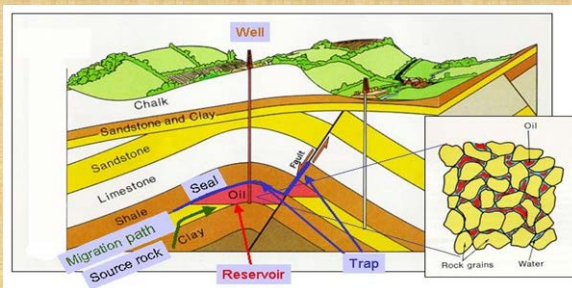
**Teacher Notes-Slide 15:** Let students suggest some reasons if you have time. Hopefully they will mention the shallow seas that became buried in sediment did not exist everywhere.



- Oil needs very specific conditions, such as the marine environment that eventually becomes buried in many layers of sediment.
- Oil exists in sedimentary rocks between sediment grains.
- Oil also needs four other things to exist in a location.

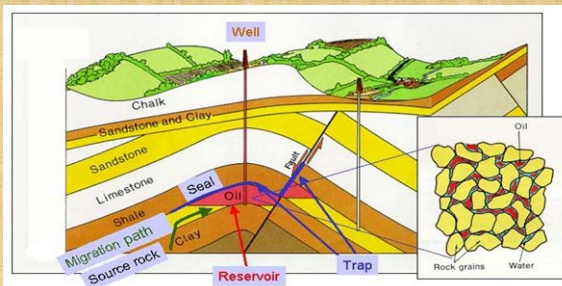
**Teacher Notes-Slide 16:** Use this slide to review the vocabulary for porosity and permeability. You can also compare the low permeability of the top picture (because the pores are not connected) to the high permeability (connected pores) of the bottom picture.

- reservoir rock:** any porous rock that holds oil or gas.
- source rock:** the geologic formation in which oil or gas originates.



**Teacher Notes-Slide 17:** This answers QUESTION #10A and 10B. Reservoir Rock: most commonly a sedimentary rock, usually sandstone or conglomerate. Source Rock: The rock that carbon based life is initially deposited in and buried for oil to form. Because oil is less dense than water, it moves out of a source rock into a reservoir rocks above until it becomes trapped. Point out Reservoir rock and source rock on diagram.

- seal or cap:** a comparatively impermeable rock immediately overlying a reservoir. Impermeable means oil and water cannot pass through.
- trap:** a geologic feature that prevents oil or gas from escaping that location.



**Teacher Notes-Slide 18:** This slide answers QUESTION #10C and 10D. Give students a few minutes with this slide. You can also point out to students where the seal is and point out the fault trap (this trap will be discussed in a later slide).

# How does the oil get trapped?



Teacher Notes-Slide 19: Review with students that they just wrote the definition of a trap.

A 3D diagram of the Earth showing plate tectonic boundaries. Red lines represent faults and folds in the crust, illustrating how these structures can form traps for oil.

- As plate tectonic processes bend and break the Earth's crust, faults, anticlines and synclines form.
- The oil rises above water and becomes trapped.
- The following slides outline these different traps.

Teacher Notes-Slide 20: (Anticline and Syncline are defined two slides ahead.) Most oil is less dense than water so it will rise above any water in the reservoir rock.

**Unconformity Trap:**

The tops of earlier formations are eroded away and covered by an impermeable layer.

A geological cross-section showing an unconformity. The top of an older rock formation is eroded and covered by a new, impermeable layer. Below this layer, a dark area labeled "OIL" is trapped.

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Teacher Notes-Slide 21: Formation is a rock structure. In this case, sedimentary rock layers of different ages. The next five slides describe each the oil traps that answer QUESTION #11. Leave these slides up long enough for students to describe each trap and draw the oil on their pictures. This slide answers QUESTION #11D.



**Pinch out  
Trap:**

A layer of permeable sediment is pinched or squeezed between the layers above and below it.

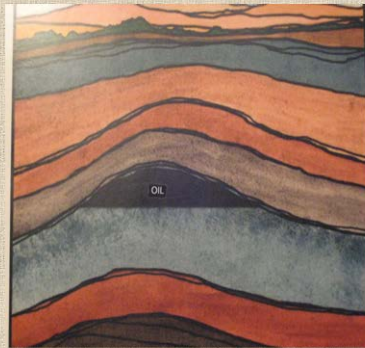


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**Teacher Notes-Slide 22:** Strata is a sedimentary rock layer. This answers QUESTION #11C.

**Anticline Trap:**

Layers of rock are squeezed creating an arch shape where oil gets trapped.



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**Teacher Notes-Slide 23:** Anticlines and Synclines usually exist together. They are created by the compression of Earth's crust. This answers QUESTION #11A.

**Fault Trap:**

When a fault moves rock layers, a reservoir rock can be lined up with an impermeable rock layer.



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**Teacher Notes-Slide 24:** A fault trap is created when the reservoir rock becomes lined up with an impermeable rock layer so that oil can no longer flow through. The fault plane can also act as an impermeable layer. This answers QUESTION #11B.





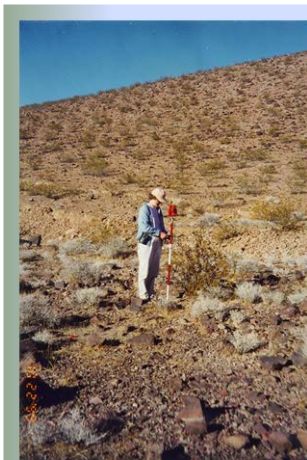
- Sometimes the cap rock is broken or does not hold the oil under ground.
- When this happens, the more fluid oil escapes to the surface, creating an oil seep.
- Eventually the heavier oil that is left behind creates a plug or seal to stop oil from seeping to the surface.

**Teacher Notes-Slide 25:** Oil seeps happen frequently in Kern County. Seeps can be seen near Taft and along Highway 58 near McKittrick. They can also be seen near Maricopa near Highway 166 and 33. This slide answers QUESTION #12.



**What does this all mean for the oil industry?**

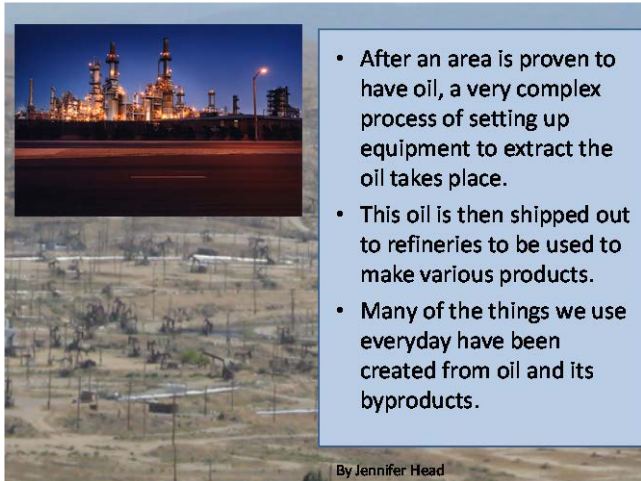
**Teacher Notes-Slide 26:** You may ask the students why there is such a big oil industry in Kern County.



- Geologists are able to use their knowledge of these different features and sediments to figure out where oil might be found.
- Geologists determine what areas are good for drilling and can take core samples for further study.



**Teacher Notes-Slide 27:** The features that Geologists study are the oil traps. Geologists use methods of “looking underground” using sound waves and other devices to locate these traps. There are many jobs in the field of geology in Kern County. California State University Bakersfield has an excellent program to train future geologists.



- After an area is proven to have oil, a very complex process of setting up equipment to extract the oil takes place.
- This oil is then shipped out to refineries to be used to make various products.
- Many of the things we use everyday have been created from oil and its byproducts.

By Jennifer Head

**Teacher Notes-Slide 28:** Pumps are frequently needed to bring oil to the surface. These pumps can extract anywhere from 1 to 150 barrels a day in Kern County. Oil is then shipped to a refinery to be processed into products we use every day. In some areas of the world, free flowing oil wells use a series of pipes and valves called a “Christmas Tree” (instead of a pump) to control the flow of oil.

**This is only a short list of some of the things made by the oil industry:**

Gasoline	Helmets	Telephones
Motor Oil	Toothbrushes	Cameras
Tires	CDs and DVDs	Lipstick
Ink	Balloons	Hair Dye
Skis	Crayons	Soap
Snowboards	Roller Skates	Aspirin
Umbrellas	Nail Polish	Carpet
Shampoo	Purses	Clothing
Toilet Seats	Deodorant	Paint
Candles	Sunglasses	Surfboards
Hand Lotion	Shaving Cream	Perfume



**Teacher Notes-Slide 29:** This slide answers QUESTION #13. Students need to pick at least four of these items that they use every day. The items will pop up on the screen one at a time, so you may read them off as they come up or let the students read for themselves.

- Please give a special thanks to the following sources for providing information for this presentation:
- Western States Petroleum Association (WSPA)
  - Dan Tuttle and Kern County Museum
  - Tim Elam and The Buena Vista Museum of Natural History
  - SJV Rocks!/ NSF Grant
  - California State University Bakersfield Geology Dept.

**Teacher Notes-Slide 31:** This page is for credits.



For further information involving the petroleum industry or the creation of oil, please do not hesitate to visit a few of the following websites:

- <http://www.conservation.ca.gov/dog/Pages/index.aspx>
- [www.api.org](http://www.api.org)
- [www.kcmuseum.org](http://www.kcmuseum.org)
- <http://www.adventuresinenergy.org/>
- <http://www.blm.gov>
- <http://www.nhm.org/site/>
- <http://www.eia.doe.gov/kids/>
- <http://www.wellsample.com/>
- <http://www.bp.com>

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**Teacher Notes-Slide 32:** This slide contains websites where you can get further information.

References used for PowerPoint, worksheet and modules:

- "Layer Cake Earth" by Rebecca Tedford and Sophie Warney,  
<http://educ-calvin2/lsu.edu/~dekuhne/20061114TedfordWarnyNSTA.pdf>
- "Project WET" Curriculum and Activity Guide,  
[www.projectwet.org](http://www.projectwet.org)
- "Nontechnical Guide to Petroleum Geology, Exploration, Drilling, and Production: 2<sup>nd</sup> Edition" by Norman J. Hyne, Ph.D.  
Copyright ©2001 by Penn Well Corporation, 1421 S. Sheridan Rd.  
P.O. Box 1260, Tulsa, Oklahoma 74112, [www.penwell.com](http://www.penwell.com)

**Teacher Notes-Slide 33:** This slide contains references for both the PowerPoint and the activities included in the module.