

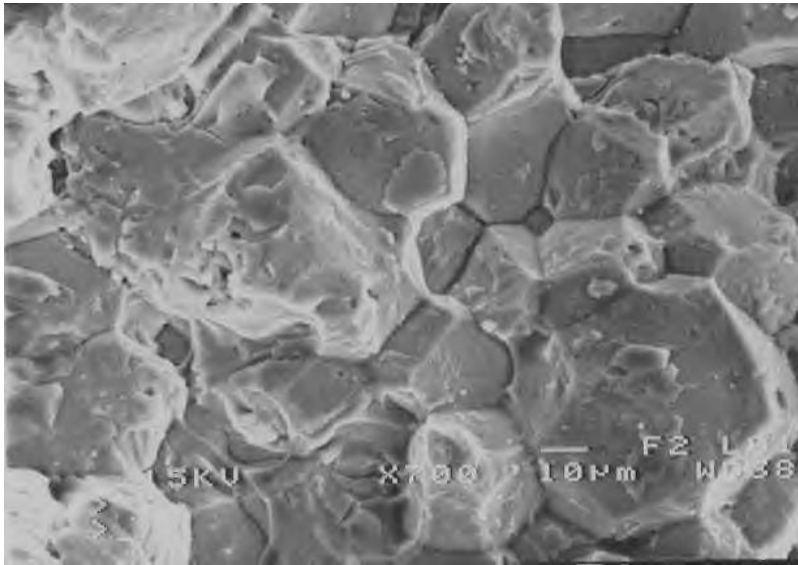
Mathematics and Science in Schools in Sub-Saharan Africa

MATERIAL SCIENCE



CORROSION

Corrosion



The degradation of a material due to a reaction with its environment.

Environmental Factors

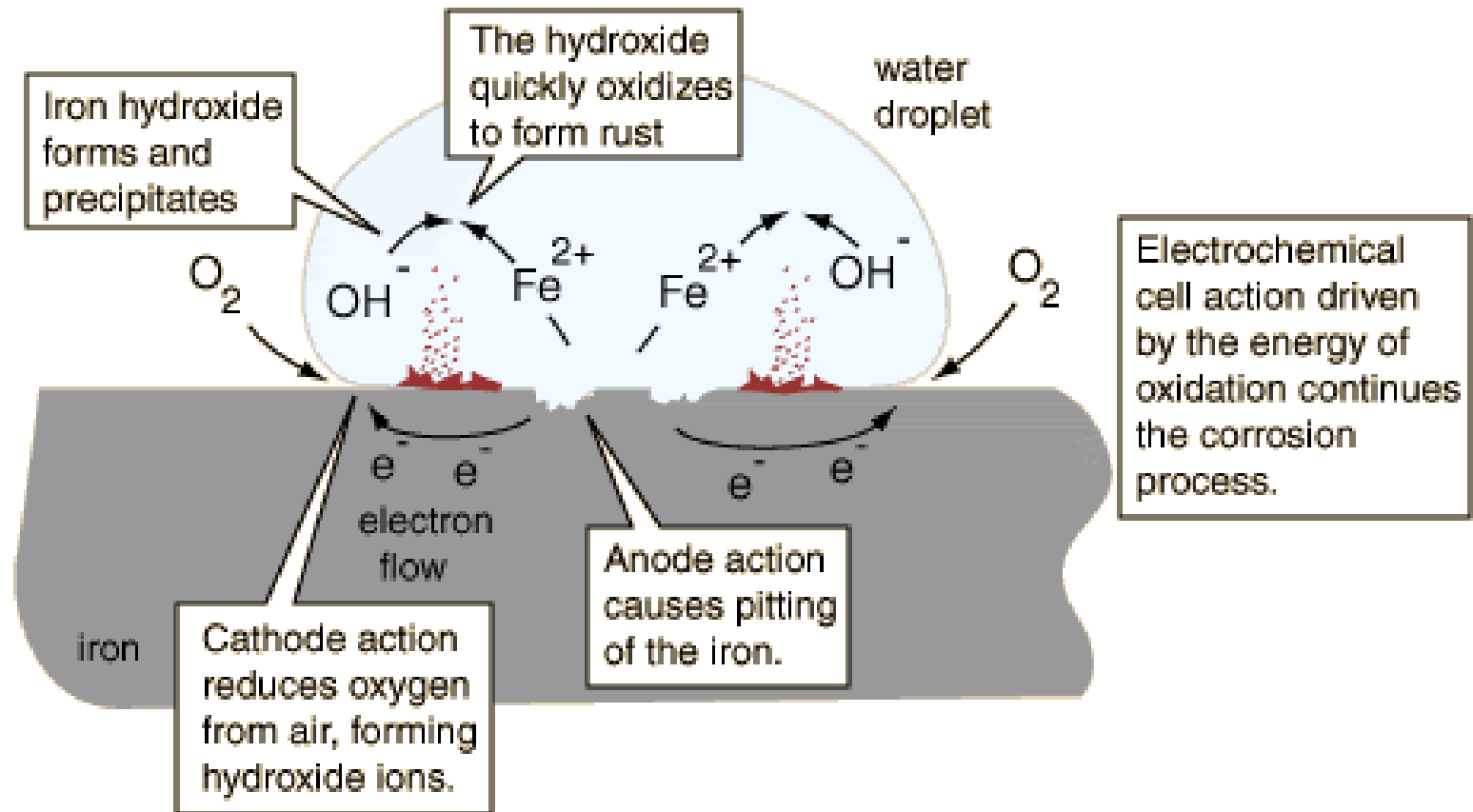


Corrosion



***Most metals are oxidized by the oxygen in air.
This process is called oxidation.***

Oxidization



Electrons leap from the metal to the oxygen molecules.

Oxidization



Leo the lion says “ger”

Loose

Electrons

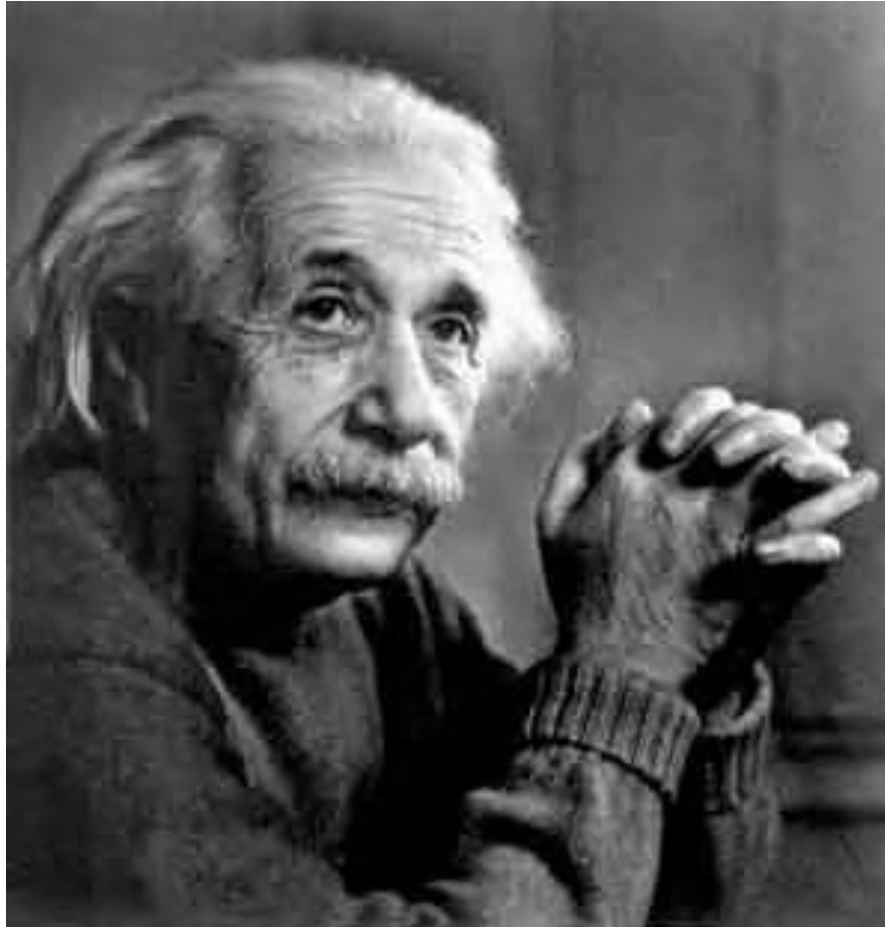
Oxidation

Gain

Electrons

Reduction

Lab: Oxidation & Reduction of Copper

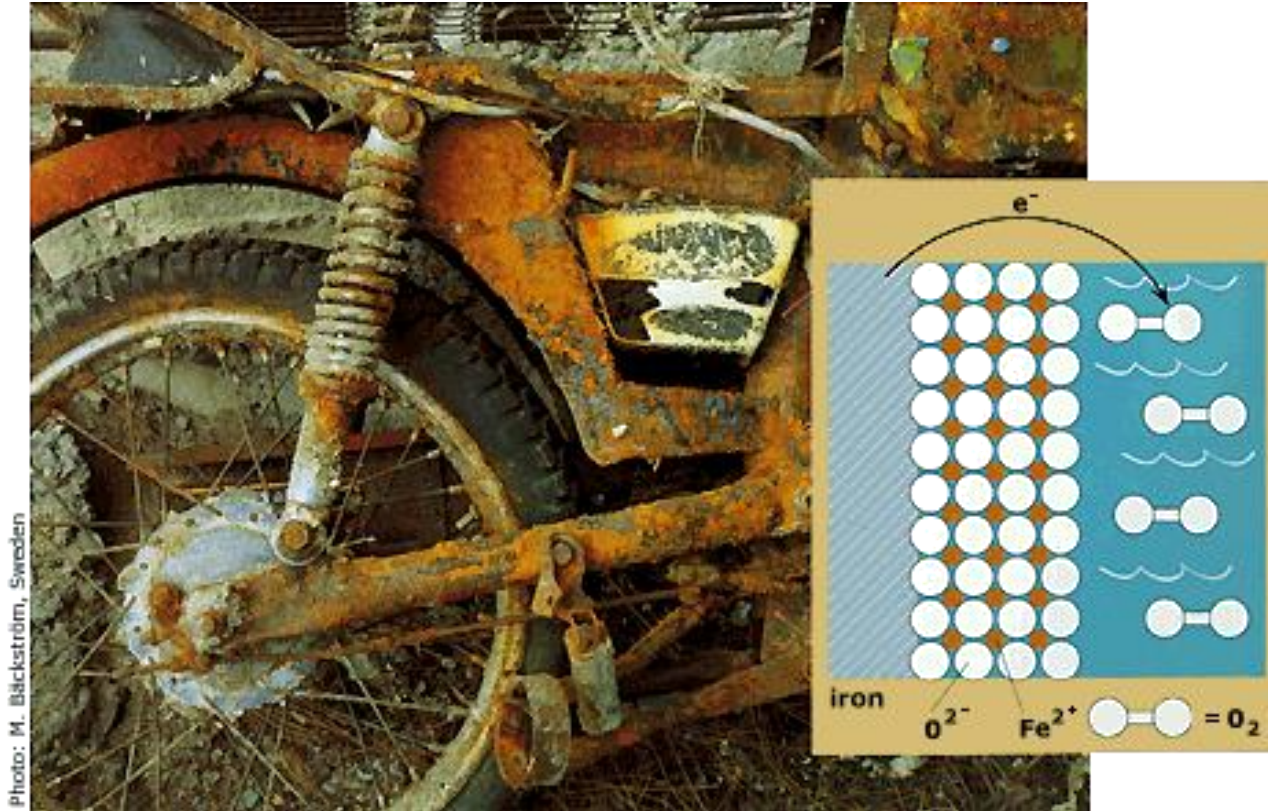


Lab: Oxidation & Reduction of Copper

Data Chart

Copper Before Heating	
Copper After Heating	
Copper After Adding HCl	
Copper After Adding Zinc	

Corrosion Chemistry



The negative oxygen ions which are thus formed penetrate into the metal, causing the growth of an oxide surface.

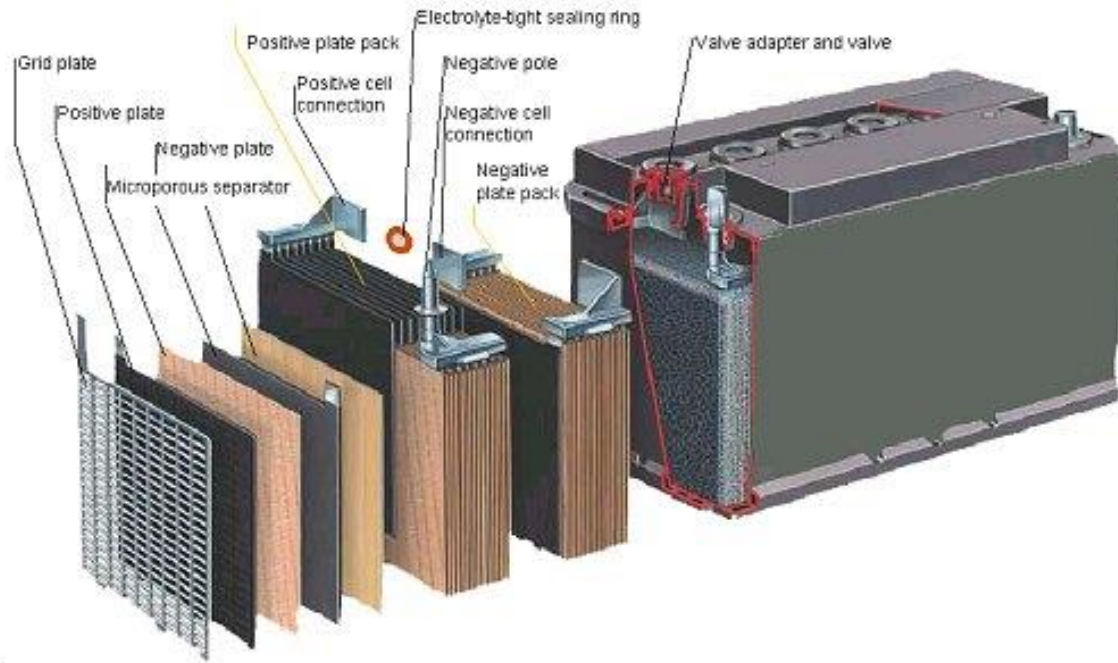
Corrosion Chemistry



As the oxide layer grows the rate of electron transfer decreases.

The corrosion stops and the metal is made passive.

Corrosion Can Be a Good Thing!



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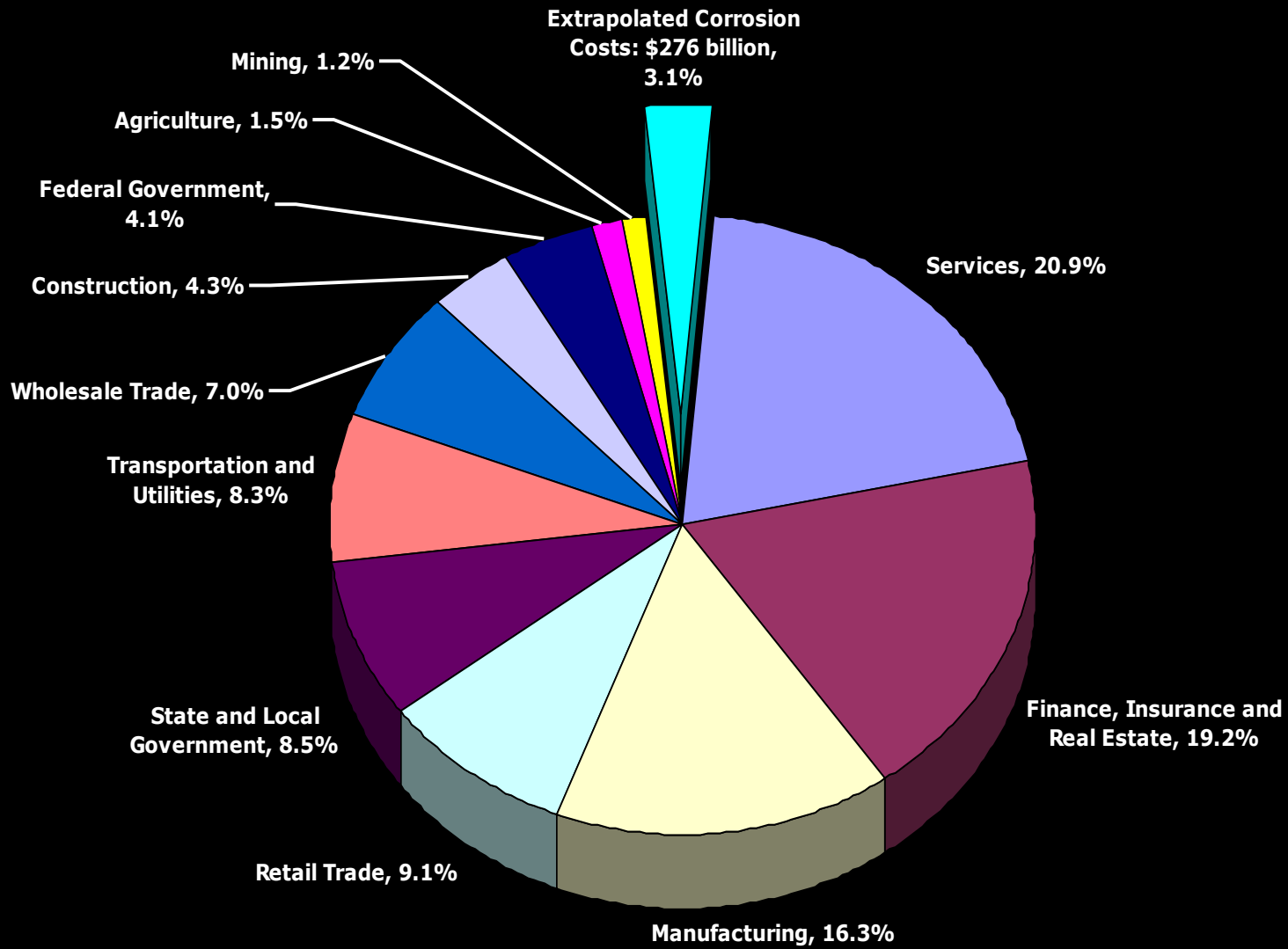
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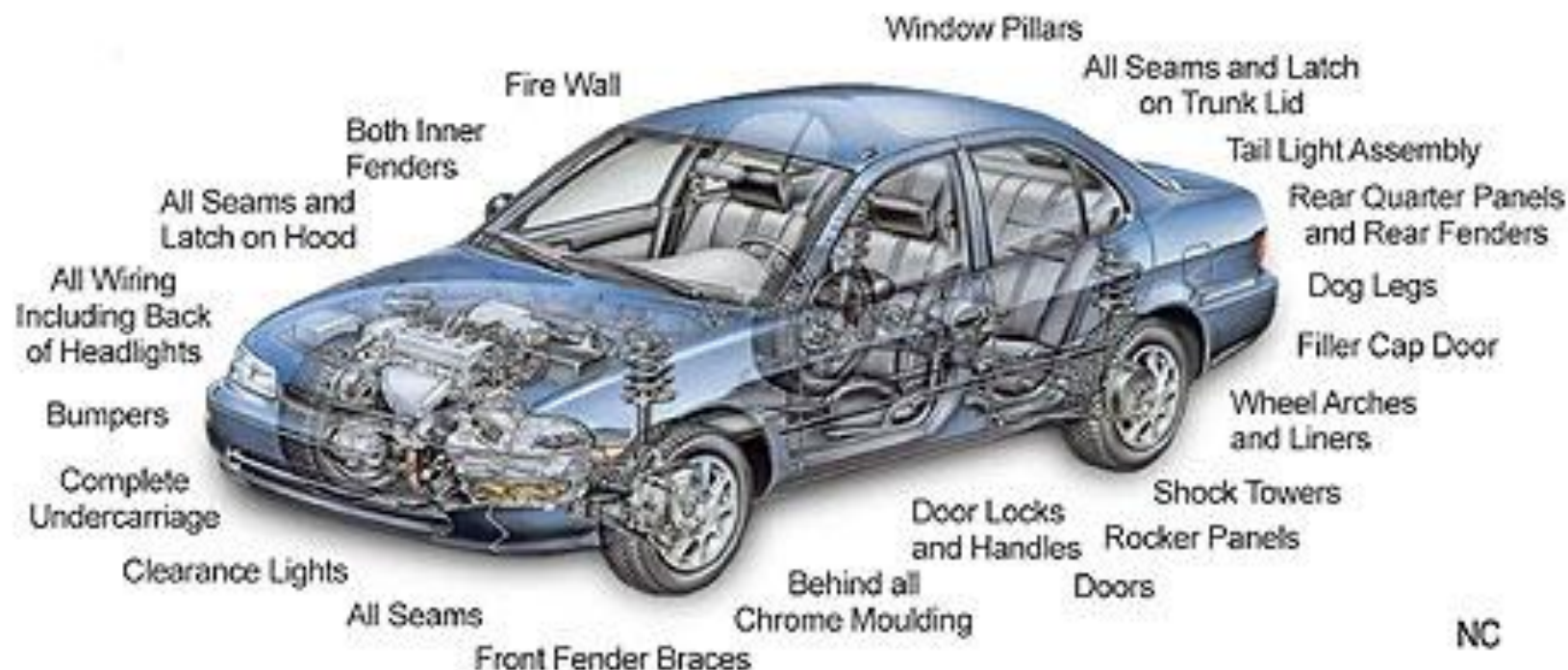
Hurricanes, floods, tornadoes and earthquakes total, on average, 17 billion each year.

\$276 Billion





Where corrosion can form



The Silver Bridge-1967



The bridge was dubbed the 'Silver Bridge' because it was the country's first aluminum painted bridge.

The Silver Bridge-1968



Along with fatalities and injuries, a major transportation route connecting West Virginia and Ohio was destroyed striking fear across the nation.

Rebar Corrosion



Rebar Corrosion



Concrete damage due to rebar corrosion is a common problem among bridges and other saltwater structures.

Bridge Corrosion



According to a 1997 report, of the 581,862 bridges in the U.S.A. about 101,518 bridges were rated as structurally deficient.



15% of almost 600,000 bridges in the USA are structurally deficient because of corrosion.

Infrastructure Repair



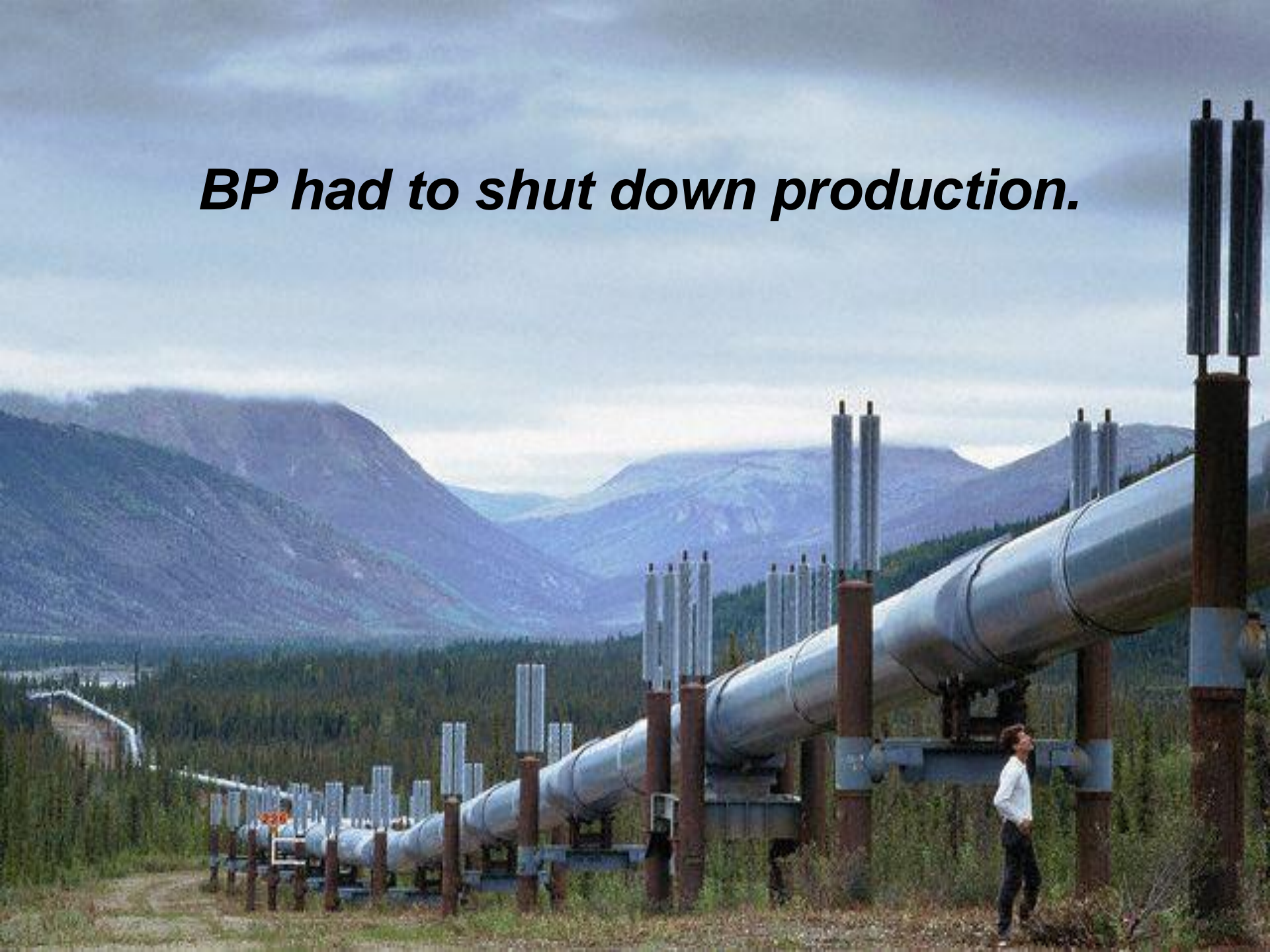
The estimated cost is ~\$78 billion, and it could increase to as much as \$112 billion, depending on the number of years it takes to meet the objective.



The BP pipeline at Prudhoe Bay.

Prudhoe Bay is the nation's largest oil field.

BP had to shut down production.





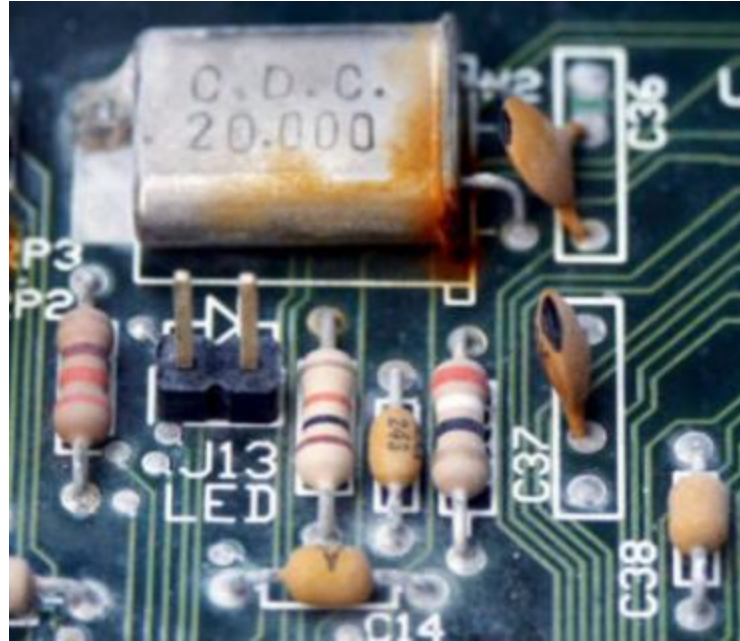
***A section of pipeline shows corrosion.
The pipe walls had thinned in 12 areas of the
pipeline.***



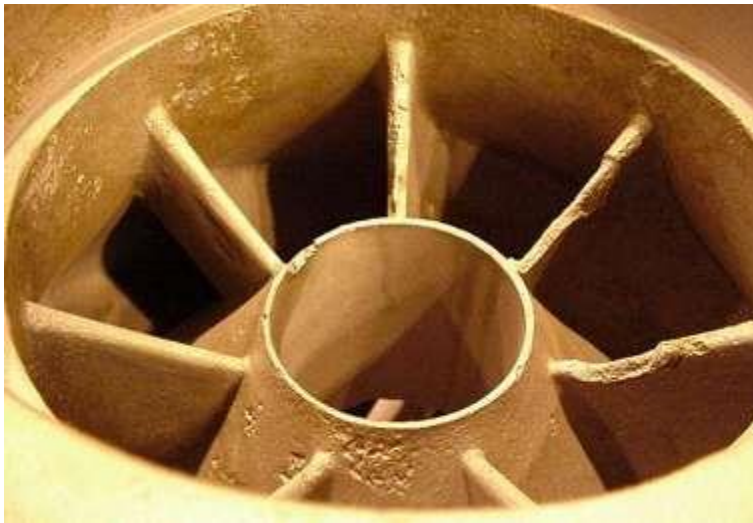
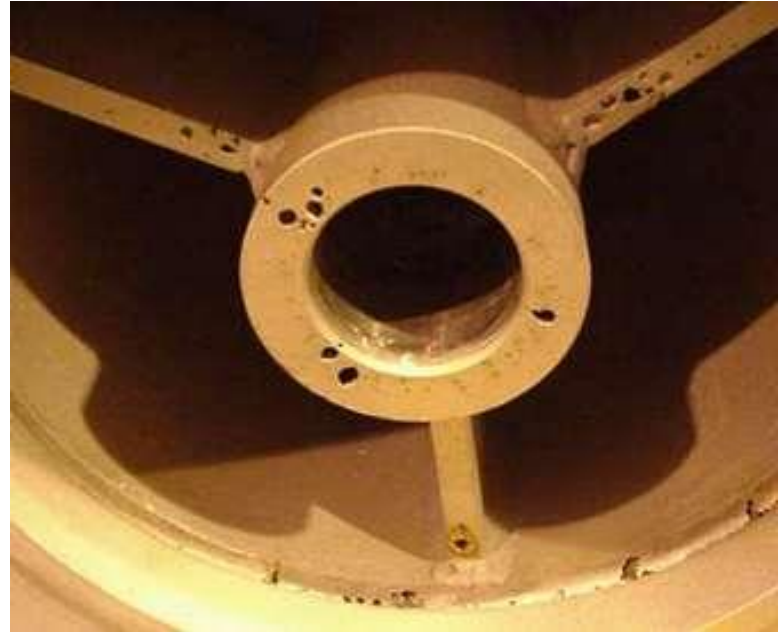
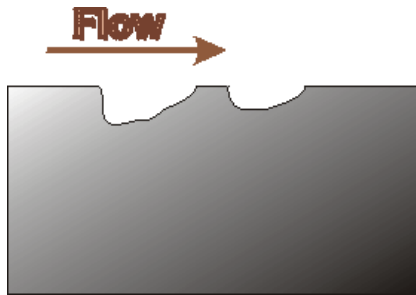
***Closing the pipeline will cut U.S. production
by 400,000 barrels daily.***



Corrosion of Electronics



Erosion Corrosion



Prevention



Material Selection



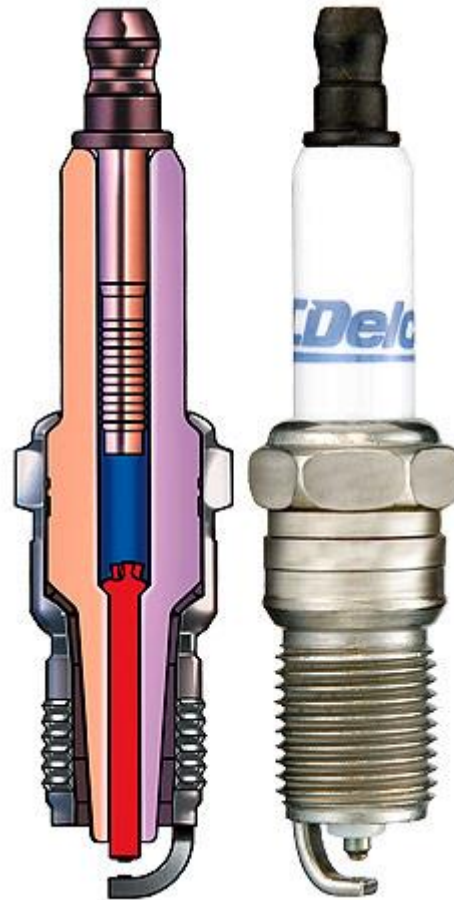
Stainless Steel

Material Selection



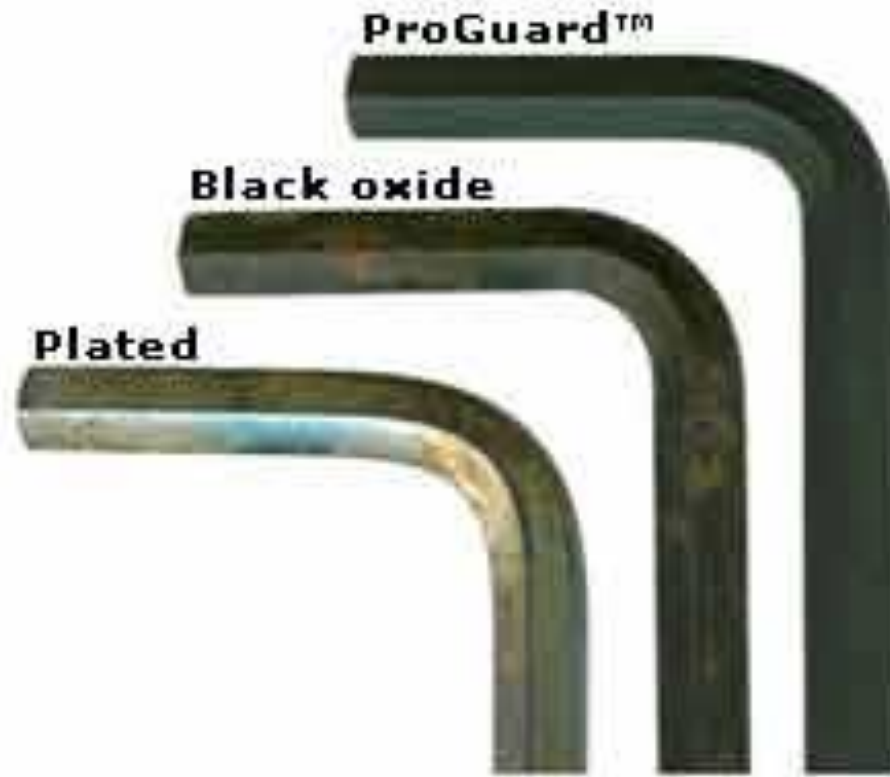
This large statue by Pablo Picasso in front of the Chicago city hall is made of weathering steel that does not need painting in many boldly exposed environments.

Iridium

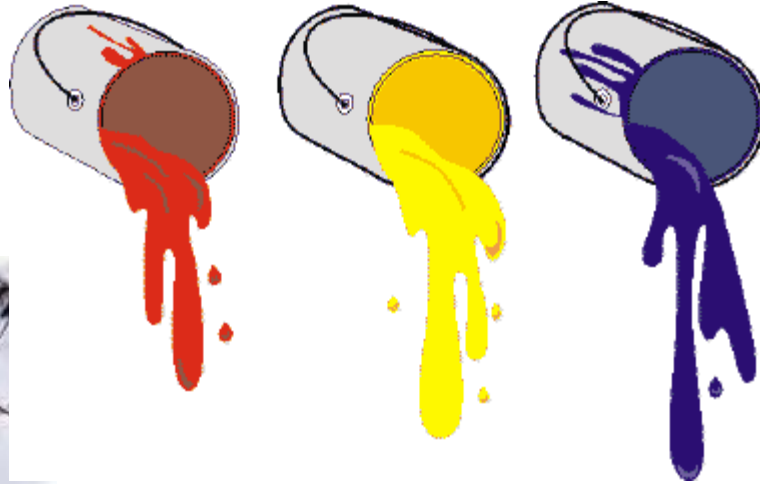


The most corrosive resistant element.

Barrier Protection



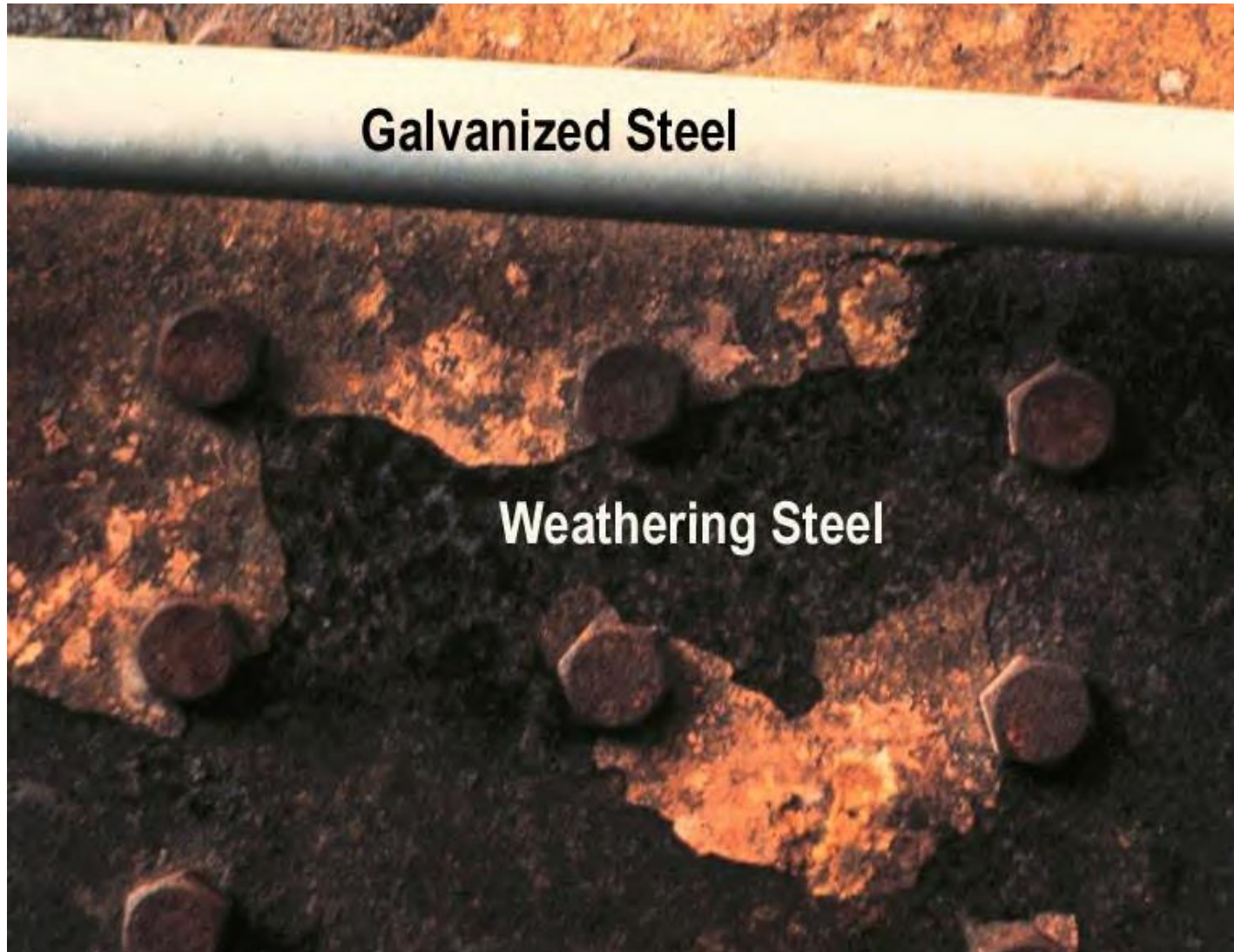
Protective Organic Coatings



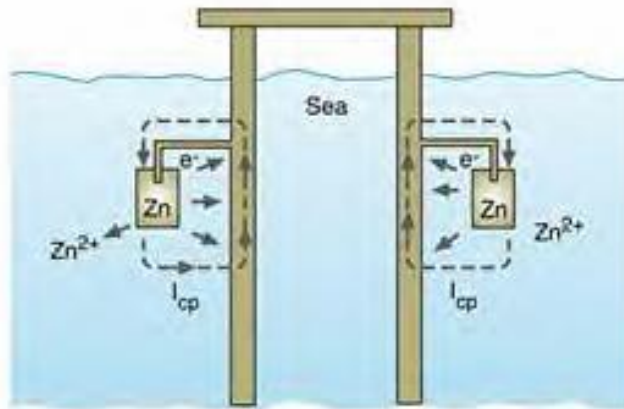
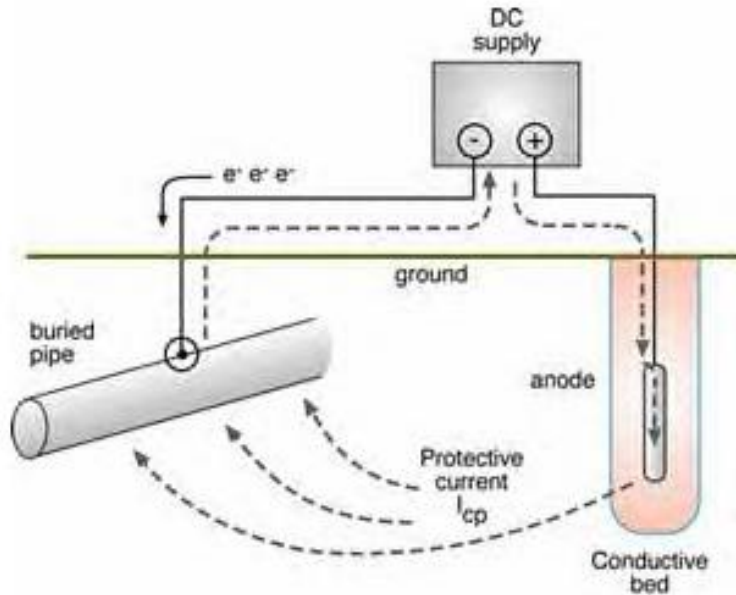
Rebar Protection



Protective Metal Coatings



Cathode Protection



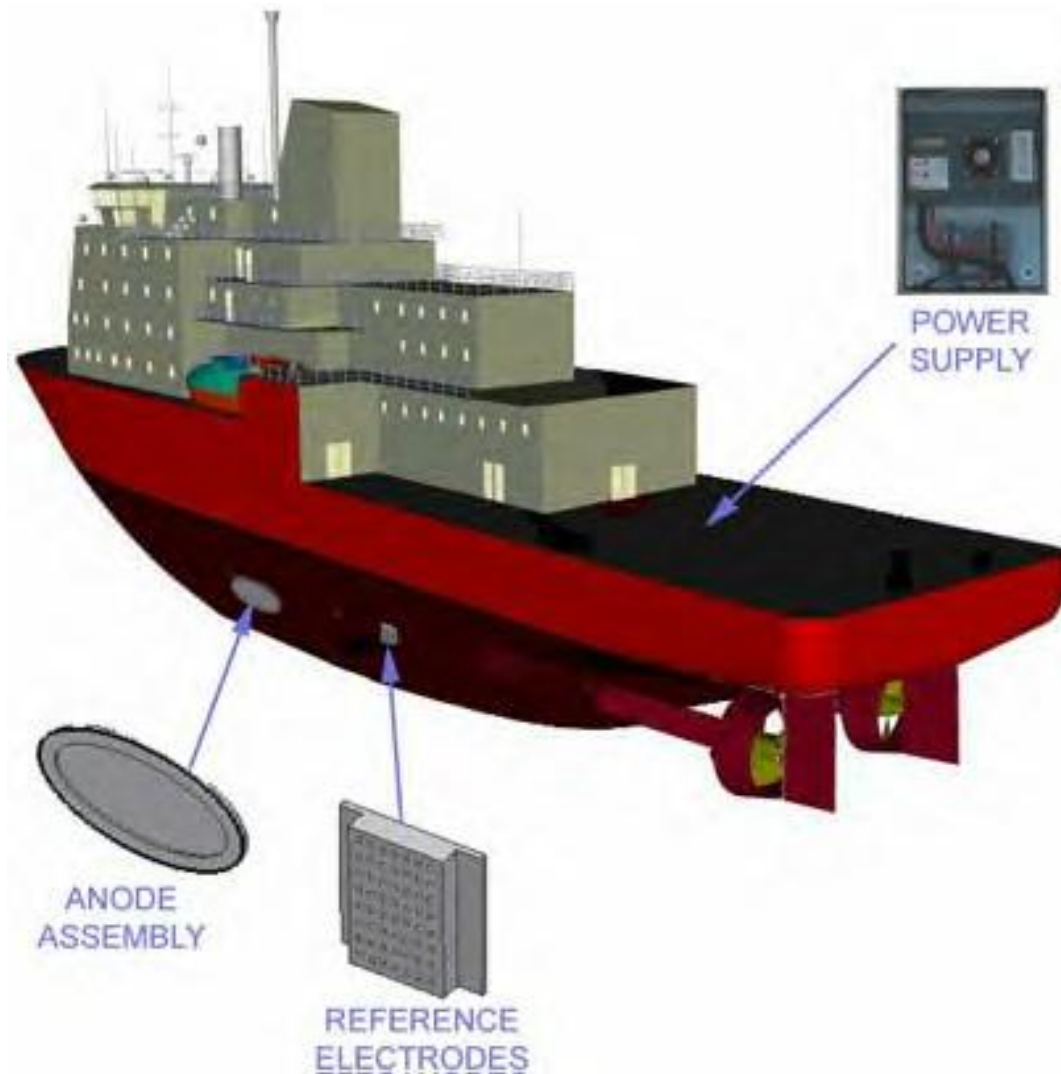
The rate of corrosion reactions may be controlled by passing anodic or cathodic currents into the metal.

This process is called cathode protection.



This technology can provide a long-term solution to corrosion issues for both steel and steel reinforced concrete structures and concrete highway pavement subjected to premature failure as a result of exposure to marine or deicing salts.

Cathode Protection

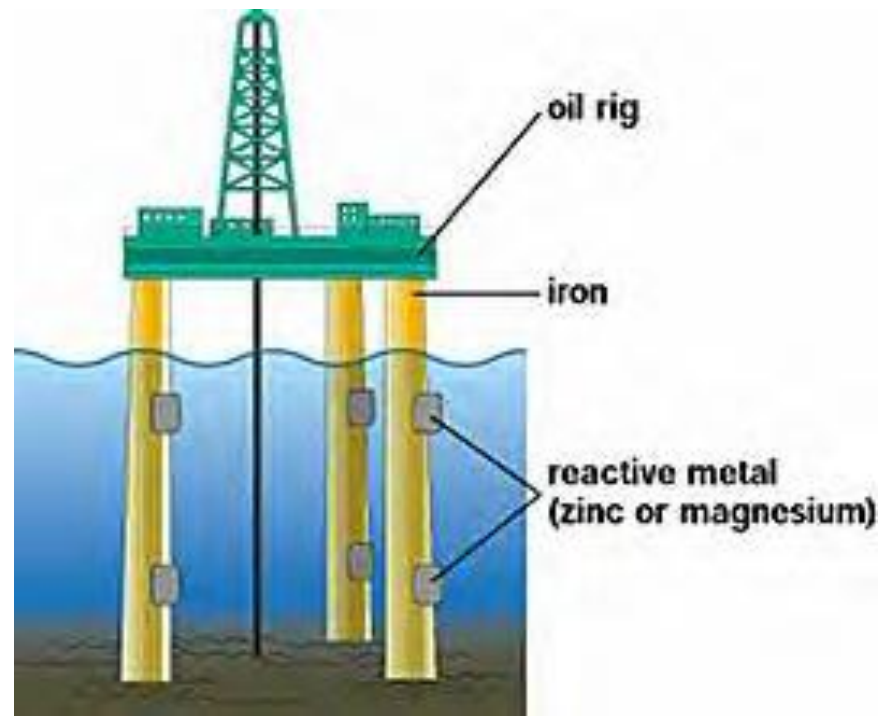


Cathode Protection



This can only be applied if there is a suitable conducting medium such as earth or water through which a current can flow to the metal to be protected.

Sacrificial Protection



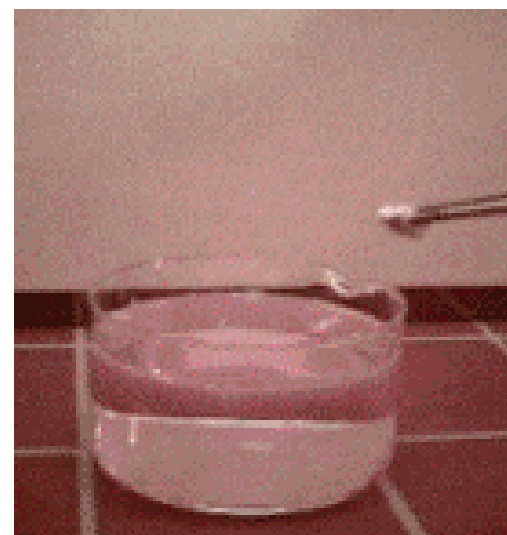
~~Pt~~ ~~Au~~ ~~Ag~~ ~~Cu~~ ~~Pb~~ ~~Sn~~ ~~Fe~~ ~~Zn~~ ~~Al~~ ~~Mg~~ ~~Ca~~ ~~Li~~ ~~Na~~ ~~K~~ ~~Rb~~ ~~Cs~~

Reactivity



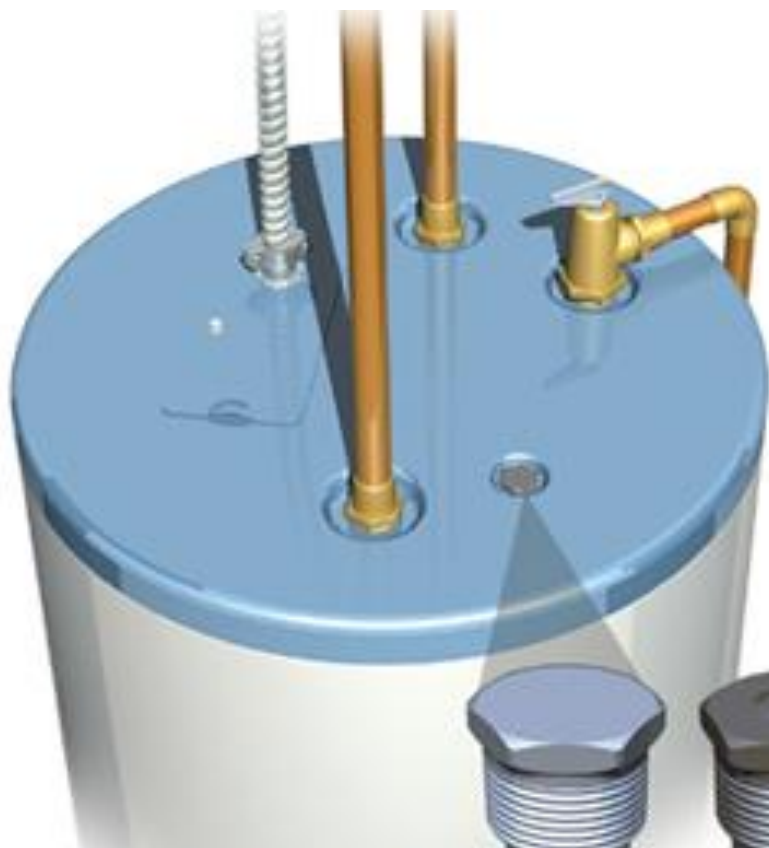
K	Potassium	↑
Na	Sodium	most
Ca	Calcium	reactive
Mg	Magnesium	
Al	Aluminium	
C	<i>Carbon</i>	
Zn	Zinc	
Fe	Iron	
Sn	Tin	
Pb	Lead	
H	<i>Hydrogen</i>	
Cu	Copper	
Ag	Silver	least
Au	Gold	reactive
Pt	Platinum	↓

Sodium & Water



Examples

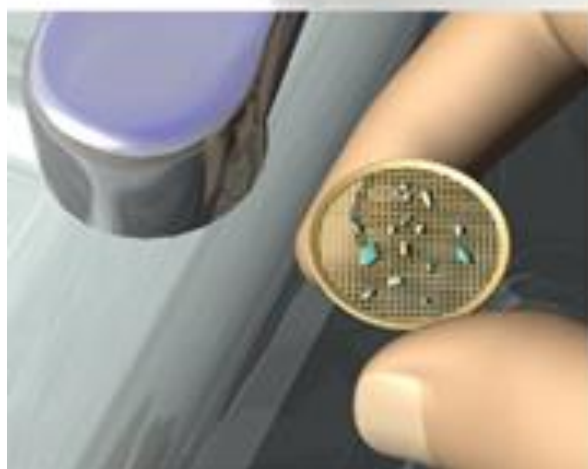




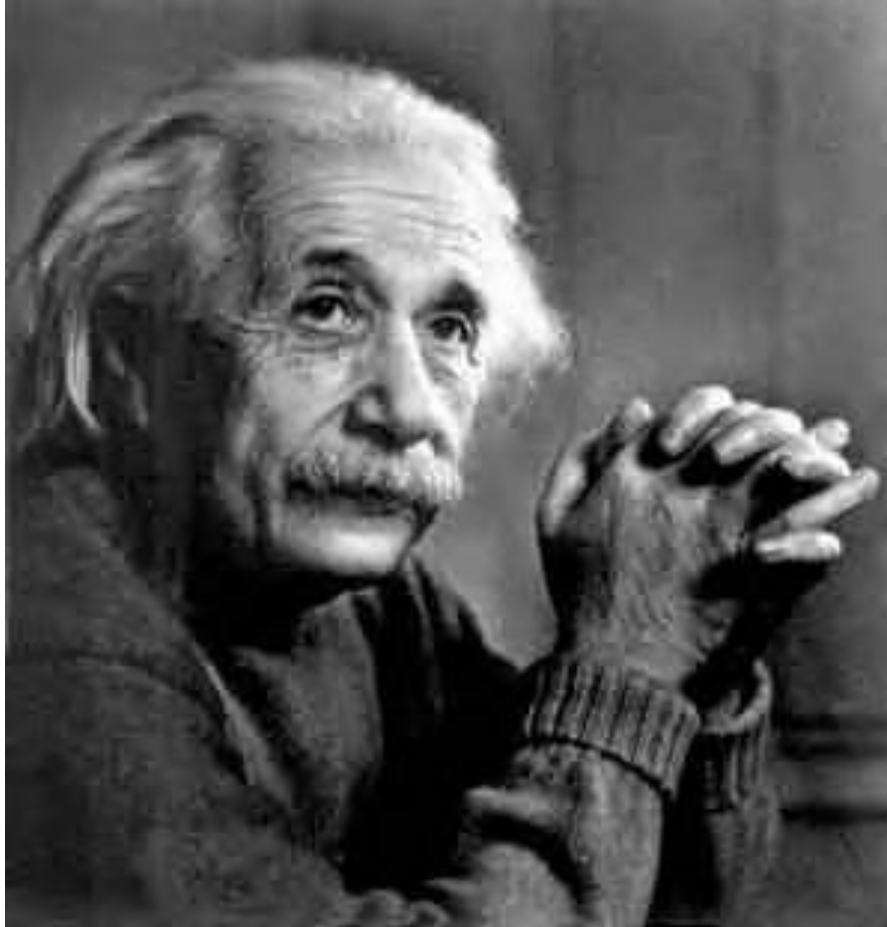
ALUMINUM
ANODE ROD

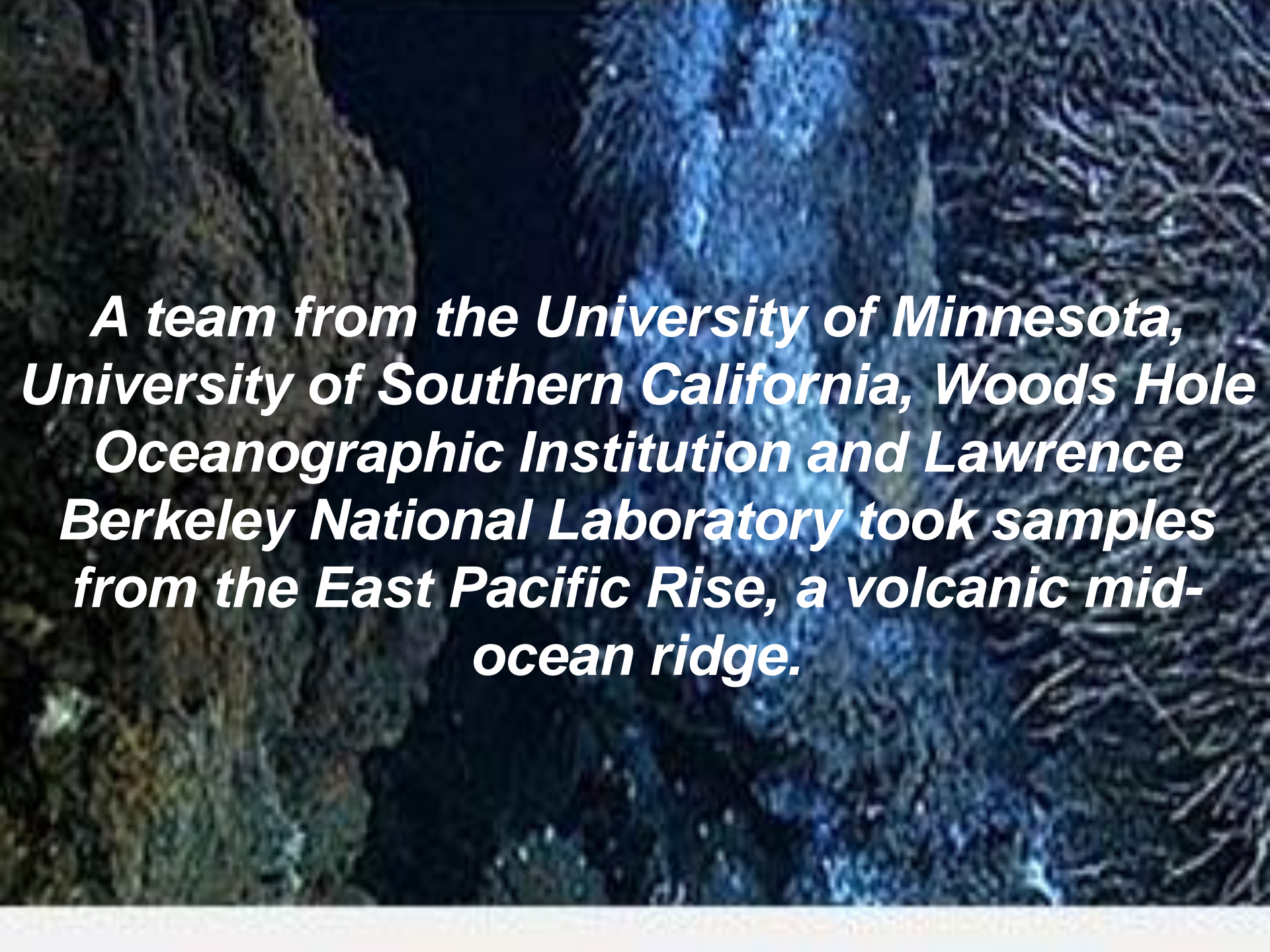


MAGNESIUM
ANODE ROD

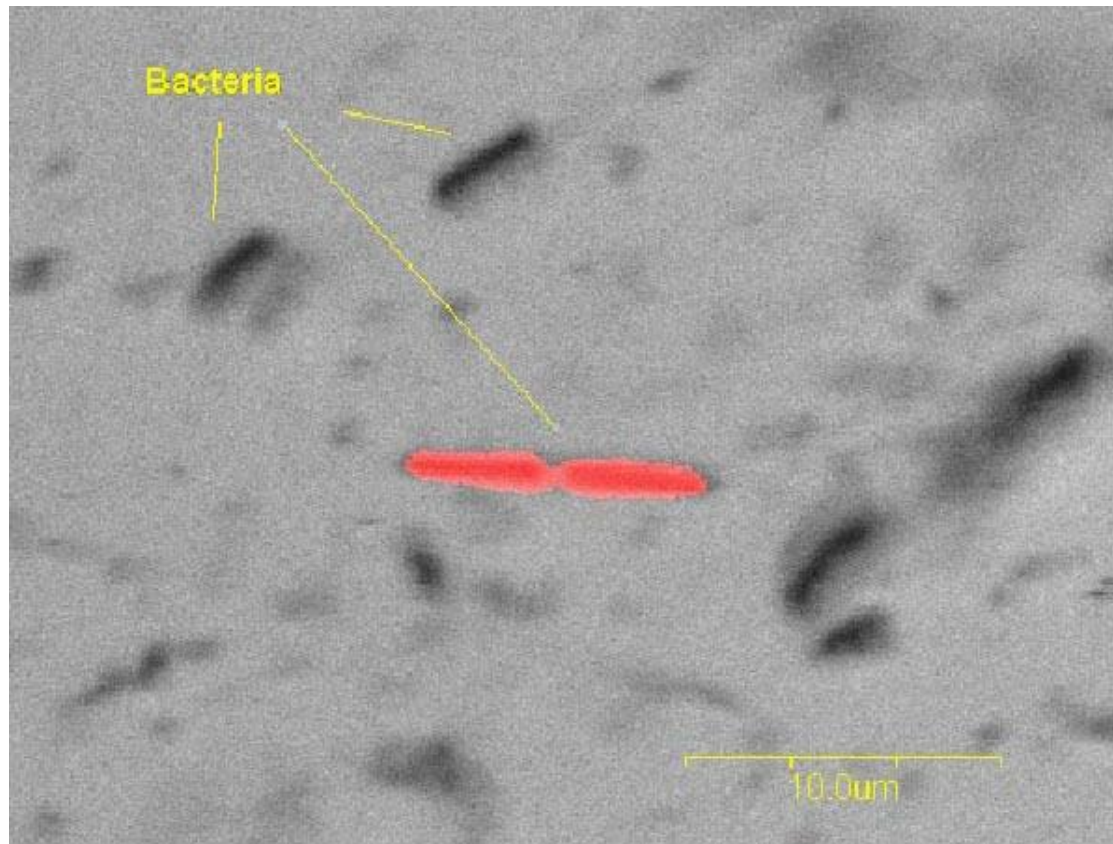


Lab: Activity Series



The background image is a deep-sea photograph showing a volcanic mid-ocean ridge. On the left, there is a dark, rugged rock formation. To the right, a hydrothermal vent is visible, emitting a bright blue, mineral-rich plume that rises into the dark water. The overall scene is dimly lit, with the primary light source being the vent's emission.

***A team from the University of Minnesota,
University of Southern California, Woods Hole
Oceanographic Institution and Lawrence
Berkeley National Laboratory took samples
from the East Pacific Rise, a volcanic mid-
ocean ridge.***



They found that organic compounds capture some iron from hydrothermal vents, enabling it to be carried away in seawater.

Iron trapped in this way does not rust.

For the scientists, discovering shiny iron in the ocean was like fishing a dry sponge out of a pool.

Iron is the limiting nutrient in most parts of the oceans, meaning that its scarcity is the only thing standing in the way of faster growth.

