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# What Is Geology and What Do Geologists Do?

The importance of geology and geologists to our society is often poorly understood and seldom considered. Geology is the body of knowledge that deals with the materials and structure of the solid earth and how it changes, and has changed, through time. By utilizing the technological knowledge obtained through geology, we are able to locate mineral and energy resources which are critical to our economic success, as well as minimize and prevent financial losses associated with natural disasters. It is the role of the geologist to research and assess the quantity, quality, availability, and recoverability of natural resources, and in conjunction with geological engineers, locate, evaluate, and develop cost-effective methods of extracting them. In addition, geologists collect data for use in environmental and resource conservation, land use and management, and global ecosystem research and testing.

When people think about geology, the first things that come to mind are rocks, earthquakes, and dinosaurs. Encompassing more than just these things, the realm of geology plays an essential part in manufacturing such varied and diverse products as paper, plastic, make-up, pharmaceutical supplies, and computer components. Natural resources, and therefore geology, are intrinsically linked to every nation's economy; the more natural resources a country possesses and is able to utilize, the more wealthy they will be on a global scale. The importance of the geologist within this economic perspective cannot be underestimated. Geologists are involved in every aspect of locating, removing, refining, and utilizing earthen resources, as well as responsibly managing the land where resources are found, both pre- and post-use. They develop a conceptual understanding of sites and potential processes that control the occurrence and transport of materials and contaminants for purposes of determining the stability and suitability of localities under consideration for urbanization and/or waste disposal. Geologists are also charged with considering and estimating the magnitude of effects that humans will have on the natural surroundings in which they reside.

The world in which we live is a very dynamic system. Many geologic activities, such as earthquakes, volcanic eruptions, floods, and landslides, can be hazardous to populations and property; through researching and studying the locations, frequencies, and concentrations of these events, geologists are able to pinpoint areas of increased incidence, and therefore advise against building in such zones, or suggest ways to prevent disasters from taking place at sites where development has already occurred. In addition to natural processes, human-induced problems can come about through industrialization via the removal, displacement, and cultivation of soils and rock materials, in the building of roads, cities, and pastureland. Geologists monitor the erosion and landslide potential of these activities before, during, and after land development initiatives in order to predict and prevent foreseeable problems.

An understanding of geology has led to our country's increased ability to productively locate, utilize, and manage our abundant natural resources, as well as reduce the risks posed by geologic hazards to both property and life. Technological need and advancement are for certain, and so geologists continue to develop more and more cost-effective and efficient methods of unearthing our planet's hidden potential. As long as we continue to depend upon natural resources for our economic, societal, and literal survival, there will be a need for geology and geologists.

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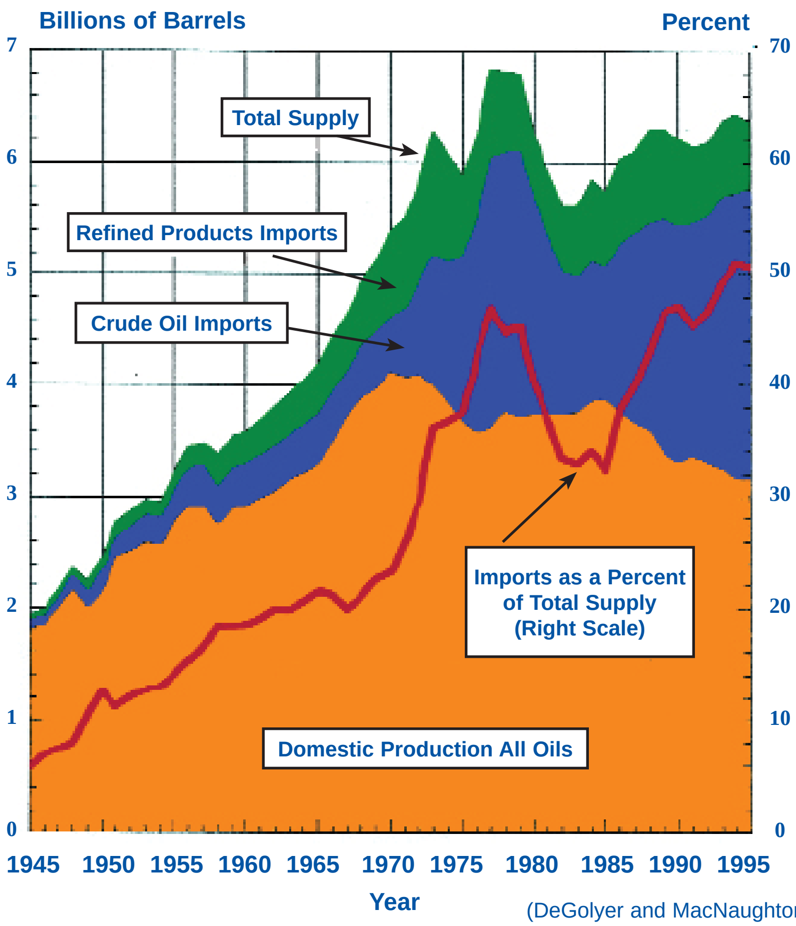
# The Value of Petroleum Resources to our National Economy

The United States depends on many mineral commodities which it once exported.[1] High costs of mining and production, and in certain instances, a lack of local supply, make it more economically sound to import many resources from countries where production is not so expensive. According to the United States Geological Survey, mineral imports exceeded exports by about $29 billion dollars in the year 2000.[1] In addition to industrial materials, the U.S. depends heavily on the foreign market for petroleum resources used in the production of energy. In fact, petroleum imports alone are responsible for generating 1/3 of the U.S. trade deficit.[2]

Most of the world's energy is produced by burning fossil fuels (coal, oil, natural gas), and so they are an invaluable resource in a global market. Fossil fuels cannot be reused or regenerated, and so are said to be non-renewable. With current estimates placing the complete exhaustion of *non-renewable* fossil fuels within the next 40 years, some effort has been made in looking at ways to efficiently and cost-effectively utilize those resources which are *renewable*, like solar, wind, and water. However, since in the year 2000, the United States only saw renewable energy use constituting 6.5 percent of total energy consumption, it is obvious that we have a long way to go.[2] We are still very much caught up in the "age of petroleum," and our immediate future demands an ample supply of coal, oil, and natural gas.

### United States Total Production, Imports and Annual Supply




(DeGolyer and MacNaughton, 1996)

## PETROLEUM – "Black Gold"

Both oil and natural gas are petroleum products, which are formed from decayed plant and animal remains. Petroleum is most commonly found in a liquid state, as *oil*, but it can also occur in a gaseous phase, which we call *natural gas*.

In the United States, petroleum accounts for more than 60% of total energy production, and over 96% of the energy used in all modes of transportation.[3] Even though the U.S. is ranked third in the world in oil production, a little more than half (52%) of the 17 million barrels of oil consumed in the year 2000 had to be imported.[2]

## THE BIG THREE

Oil, gas, and coal resources (in the ground) are classified in terms of *reserves*, those which have been positively identified, and *resources*, which include both reserves and probable supplies.

The volume of crude oil reserves worldwide is estimated at 1.1 trillion barrels (one barrel is equivalent to 159 liters).[3] In 2001, the United States had 22 billion barrels of proved oil reserves, twelfth highest in the world, primarily concentrated in 4 states: Texas, Alaska, California, and Louisiana. Most (nearly 65%) of the world's crude oil reserves are controlled by the Organization of Petroleum Exporting Countries (OPEC).[3]

Total proven natural gas reserves of the world are placed at around 4.9 trillion cubic feet.[3] Gas reserves in the United States are believed to exceed oil by nearly 380 percent.[2]

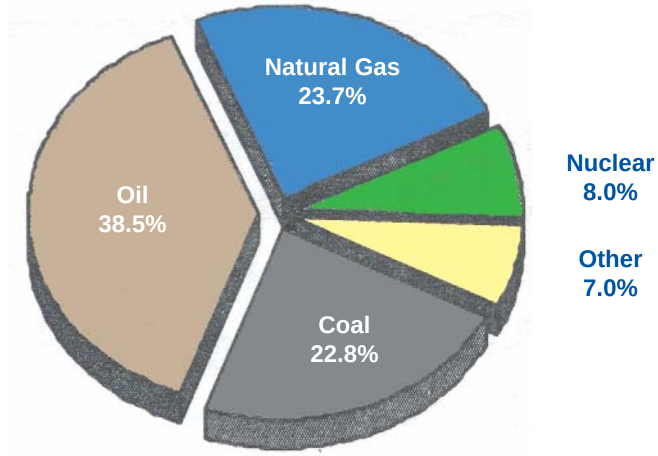
In the 1900's, coal was our Nation's major source of energy,[4] and although the cheapest source of power-fuel per million Btu today,[5] its use has declined considerably since the 1950's with the introduction of cleaner burning fuels like natural gas.[3] Even so, coal remains our Nation's leading mining industry (based on value of production), and in 2001, 1.1 billion tons were yielded, making it the only energy source for which exports are still greater than imports.[4]

The abundance of coal reserves in the world is hundreds of times greater than the present rate of annual consumption. In the U.S., the burning of coal accounts for about one-third of total energy production, used primarily for generating electricity.

Domestic production of crude oil in the United States peaked in the 1970's, and has been declining ever since.[3] The U.S. is presently the world's highest-cost oil producer because most of its low-cost, relatively easily accessible, reserves have been depleted; the remaining supplies are located in such small quantities, or in difficult and costly to access regions (like ANWR in Alaska), that it is much cheaper to import oil from the middle east.[3]

Concerns about the role of petroleum in the economic future of the United States continue to grow as trends in decreasing supply, increasing demand, and rising costs of production are seen.

## U.S. Energy Consumption by Source, 2000




*Source: DOE/EIA*

## REFERENCES

1. USGS, Increase Reliance on Imported Minerals, Oct. 15, 2002, www.usgs.gov/public/press/public_affairs/press_releases/pr1477m.html

2. COGA, 2001, Clean Energy for Colorado and America.

3. AIPG, 1999, Petroleum: Issues and Answers.

4. DOE, www.ela.doe.gov/cneaf/coal/-chron/chronc.html

5. NMA, Mineral Exports Sheet... www.nma.org

## OF INTEREST

1. www.minerals.nsw.gov

2. www.mii.org

3. www.eia.doe.gov/

# Identification and Mitigation of Geologic Hazards

An important and practical application of geology is identifying hazardous natural phenomena and isolating their causes in order to safeguard communities. According to the USGS, the average economic toll from natural hazards in the United States is approximately $52 billion per year, while the average annual death toll is approximately 200.[1] The primary causes are earthquakes, landslides, and flooding, but other events, such as subsidence, volcanic eruptions, and exposure to radon or asbestos, also pose considerable danger. Awareness of the potential hazards that persist in areas under consideration for both private and community development is critical, and so geological consultants and engineers are called in to survey land development sites and assist building contractors in designing structures that will stand the test of time.

## EARTHQUAKES AND VOLCANOES

In the average year, some 12 million earthquakes occur worldwide but most of them are low in magnitude.[1] Earthquakes are generally concentrated along tectonically active plate boundaries where numerous faults exist (normally near the edges of continents, Fig. 1). As nearly half of the world's population resides in coastal areas, and because earthquakes are of such a scale that they can affect several communities si-multaneously, the risk to human life is obvious.[2] The largest recorded earthquake to hit the North American continent had a magnitude of 9.2, which occurred on March 27, 1964 in Anchorage, Alaska. It devastated the town and surrounding area, and could be felt over an area of half a million square miles.[2] Land-slides caused most of the damage, while a 30-foot high tsunami generated by an underwater quake leveled coastal villages around the Gulf of Alaska, killing more than 100 people.[2]

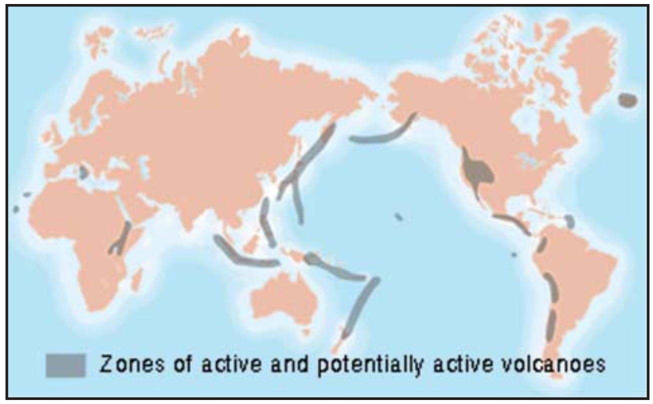



Figure 2. Volcano Zones

Less frequent, but just as destructive are volcanic eruptions. Approximately 700 potentially dangerous volcanoes are active in the world today, collectively initiating approximately 50 eruptions each year.[3] Surprisingly, the United States is ranked third most volcanically active country in the world, with most of the activity being concentrated along the Pacific coast (part of the Pacific Ring of Fire, Fig. 2). In addition to lava flows, other volcanic hazards include lahars, which are mud and ash flows (either hot or cold), and clouds of poisonous gas and dust.[3] Unlike most other natural disasters, volcanic eruptions can affect the entire planet; for example, the 1815 eruption of Tambora (in Indonesia) exploded with the energy of 10,000 atomic bombs, releasing a layer of ash that shrouded the earth and caused a lowering of the average global temperature by 2 degrees Fahrenheit for 2 years.[3]

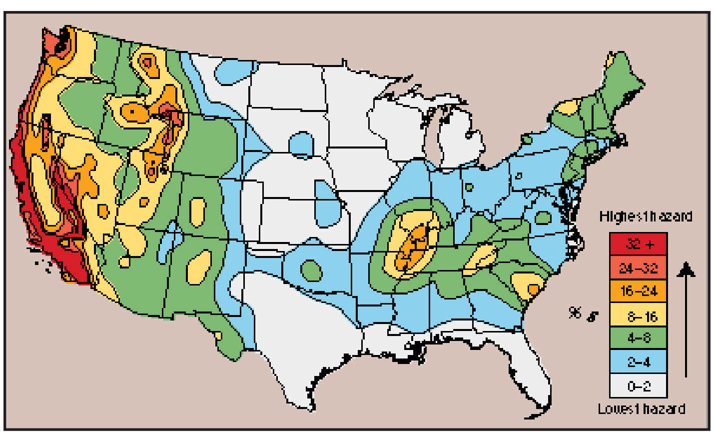



Figure 1. Quake Zones

The role of geologists in mitigating such hazards is difficult. While great progress has been made in predicting the incidence of volcanic eruptions, our ability to predict earthquakes is inadequate. Despite these difficulties, generalities can be made. Earthquake occurrence is concentrated around, but not confined to, the rim of the Pacific Ocean in an area known as the circum-Pacific belt; this also happens to be the area of greatest volcanic activity (the Pacific Ring of Fire). The geologic activity in this region is produced by the movement of the Pacific plate underneath the continents surrounding the Pacific Ocean. The understanding of plate tectonics within the field of geology explains how and why these earthquakes and volcanoes take place.

## LANDSLIDES AND SUBSIDENCE

Landslides are a group of hazards that include both fast- and slow-moving debris flows associated with the onset of other natural phenomena, such as earthquakes, volcanic eruptions, floods, and wildfires, as well as slope instability created by industrialization processes.[1] Landslides and avalanches produce over $2 billion in building and highway losses and about 25-50

Photo by J. T. McGill, USGS

deaths annually in the United States.[4] The vulnerability of future landslide occurrence is directly related to the location and frequency of past slide events.[5] The four most landslide-active locations in the United States are California, Alaska, Washing-ton, and Utah.[1]

Subsidence, or the localized sinking of the land surface, can be induced by a number of factors, including tectonic shifting, collapse of soluble rock (karst topography), removal of underground water supplies, earthquakes, and underground mines.[3] Soil expansion due to the absorption of water, can cause homes and buildings to heave or buckle, and in the United States, causes more than $2 billion in damages to highways and buildings annually.[3]

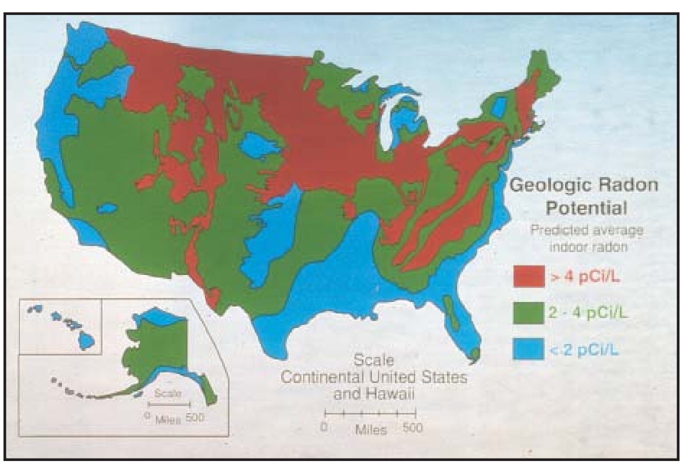
Field evaluation of slope stability through the examination of materials and processes that comprise and affect them, allows geologists to estimate their potential hazard and suggest ways to counteract or minimize their occurrence. Geologic maps already in existence can be used to detect areas where swelling soils, subsidence, and landslides may be problematic.

## FLOODING

More than 3 million miles of rivers and streams flow throughout the United States, resulting in nearly 10 percent of the land surface to be prone to flooding.[2] Average annual flood losses in the U.S. are more than $3 billion today, a substantial in-crease from the less than $100,000 at the beginning of this century.[2] This rapid rise can be attributed to population growth and an unawareness of the inherent dangers of building on floodplains and in flood-prone areas. Assessing the risk of large floods is very difficult because of the unpredictable nature of weather patterns.

The most intense form of flooding, called *flash flooding*, results from tremendous amounts of water raining down over a localized area in a short amount of time. Heavy runoff can pick up loose material and transport it quickly downslope in the form of mudflows, another geologic hazard.

Geologists look back through the rock record to determine where and when floods have historically taken place. Examination of landforms, types of soil and sediment, signs of erosion, and flood-scarring recorded in tree rings, allow the flood history of an area to be pieced together. Geologists combine this data with contemporary knowledge about the area in order to predict the likely-hood of future flooding.




Geologic Radon Potential

## ASBESTOS AND RADON

Two other hazards can be found inside the home; they are asbestos and radon gas. While presently on the decline due to recent public abatement, exposure to certain types of asbestos can result in severe and fatal lung disease. The term “asbestos” has evolved from being used to describe any fibrous mineral, to being reserved exclusively for use in describing a few fibrous minerals considered to be health hazards by federal statutes.[2] Most varieties of asbestos do not pose a major health threat, and those that do, require prolonged contact with the tissue of the lungs.[3] Inhalation and the body’s inability to break down certain types of asbestos fibers results in irritation and the eventual production of cancerous cells.[3] People living in older homes may be most at risk because of the types of materials used in the construction of the building.

Radon is a radioactive gas formed by the decay of the element radium from rocks that have a high uranium content, such as granites, shales, and metamorphic varieties of these rocks.[5] According to the EPA, radon is considered a carcinogen to humans, and its presence in indoor air is estimated to cause between 15,000-20,000 lung cancer deaths each year in the United States.[6] Radon can affect both new and old homes alike, as it is due to the infiltration of the gas through cracks in basements, or the transmittal of radon to the home in contaminated water, which has been in contact with high uranium-content rocks. Radon problems are solvable, and tests are available for its detection.

Today’s geologist is well trained for identifying those forms of asbestos that are considered hazardous to human health. As such, geologists are used to diagnose asbestos problems. Since only certain types of rocks containing high quantities of uranium are presently linked to most radon gas production, geologic maps can be used to identify areas of greatest risk.

## REFERENCES

1. USGS, FS-61-95, http://water.usgs.-gov/wid/html/HRDS.html#HDRO
2. Erickson, J., 1994, Quakes, Eruption, and other Geologic Cataclysms: New York, Facts on File, Inc.
3. AIPG, 1993, Citizens’ Guide to Geologic Hazards.
4. AIPG, 1996, Home Buyers’ Guide to Geologic Hazards.
5. USGS, http://energy.cr.usgs.gov-/radon/georadon.html
6. EPA, www.epa.gov/iaq/radon/radon-qa1.html

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# Finding and Producing Petroleum Resources

What sort of activities are necessary to isolate and extract the various non-renewable resources our society is economically dependent upon? Are these resources immediately ready for use, or are they in need of refinement?

Petroleum is formed when ancient plant- and animal-remains (primarily microscopic plankton), which have been buried for millions of years in anoxic conditions, decay. Over time, these organic materials fuse into a characteristically black hydrocarbon-rich mixture, which when combusted, will yield large quantities of energy. The fact that compaction resulting from burial must occur over relatively long periods of time, explains why it is usually necessary to drill deep wells in order to obtain the oil.

Contrary to popular belief, oil does not reside in underground lakes; rather, it is stored in the pore spaces of sedimentary rocks.1 Many of the largest reservoirs can be found in upward-facing folds between layers of impermeable rock, called anticlines (see Fig. 1). In such a reservoir, the petroleum products are able to separate into two distinct layers: an extremely light gas layer floating atop a denser layer of liquid oil. Drilling into these reservoirs breaks the impermeable rock seal, and the lowered pressure allows the petroleum to flow to the surface and be collected.2

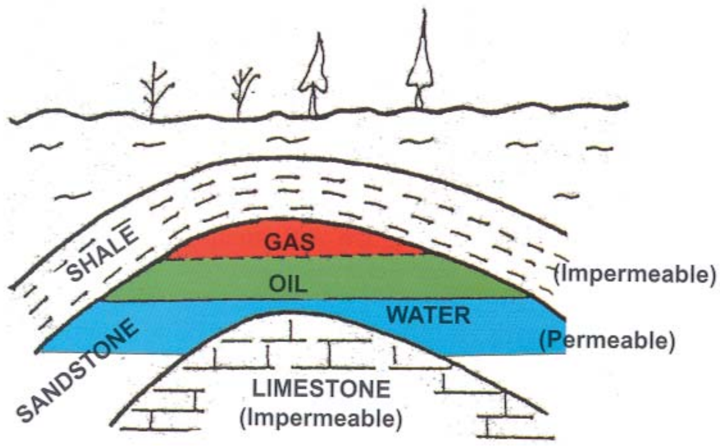


Figure 1. Anticlinal Trap

How do geologists locate areas that may contain petroleum? Initial exploration was based solely on surface indicators (for example, oil seeps or obvious anticlinal structures) and geologic maps. More recent techniques incorporate and utilize gravitational fluxes, wireline logs, and seismic information to develop subsurface computer models to identify areas of high oil potential.2 Once a suitable area has been located, drilling rigs are erected. A rotary bit attached to the end of a long chain of steel pipes is the typical method of boring modern oil wells.2 Lubricants, such as mud or water, are pumped down through the pipes to reduce frictional heat and wash rock cuttings back up to the surface along the outside of the pipes.2 Average drilling rates range between 30-60 feet per hour.1 In the United States, well depths can be more than a mile, with the deepest one approaching nearly seven miles.1 When the drill reaches oil-bearing rocks, natural pressure differences may force the oil to the surface, or it can be pumped.

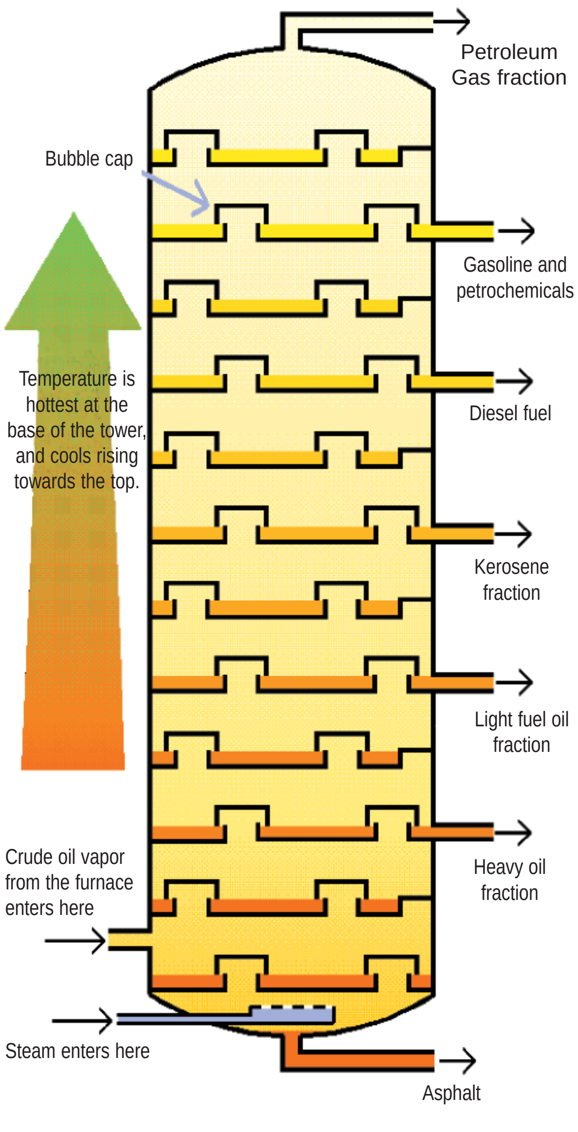


**Figure 2. The Fractioning Distillation of Petroleum**

## REFINEMENT

The process of refining separates crude oil into the various distinct petroleum products (fuel oil, diesel fuel, gasoline, petrochemicals, etc.) while at the same time removes any impurities that may be present.[1] The refining process encompasses several steps: fractional distillation, cracking, coking, and purification.[1] Fractional distillation makes use of boiling point differences between the various hydrocarbon-chain components in petroleum to separate them into "heavy" and "light" fractions, and residuals (Fig. 2). Light fractions consist of butane, gasoline, and petrochemicals, whereas heavy fractions include fuel oils and lubricants. Residuals are the leftovers from the fractional distillation process, and are used to make asphalt. Other steps in petroleum refinement include "cracking" heavier fractions to produce lighter ones through heat and pressure, and utilizing cokers to change light fractions into heavy ones through alkylation and polymerization.[1] One final step may consist of adding certain chemicals to the petroleum products to promote cleaner and more efficient burning.

## ENVIRONMENTAL CONCERNS AND LAND USAGE

Increased concern for the environment has led to more and better modes of transportation and maintenance of equipment used in the production of petroleum resources, as well as closer regulation of activities at extraction sites. Computerized cleaning devices, called "smart pigs" traverse pipelines checking for stress or damage, and underground storage tanks are monitored for leaks to prevent groundwater contamination.[1] Contemporary sea-faring oil tankers are routinely built with dual hulls to lessen the likely-hood of spills like that of the Exxon Valdez. At drill sites where petroleum under pressure has the potential to shower the surrounding landscape with toxic oils, carbon dioxide or water is pumped into the wells to maintain pressure.[1]

The petroleum industry is strictly regulated by state and federal agencies in order to ensure responsible usage and management of our natural resources and environment. In consultation with geological experts, these agencies have developed "field rules" relating to the treatment and disposal of wastes, spill management and cleanup, and safety and operational procedures, all the way from the drill site through distribution.[2]

## REFERENCES

1. Moldauer, B. Ed., 1998, All About Petroleum, American Petroleum Institute.
2. AIPG, 1999, Petroleum: Issues and Answers.

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# Water Resources

Water is the most important natural resource on the planet. Without it all life would perish and the earth would be nothing like it is today. According to the U.S. Geological Survey, many experts believe that we are transitioning from a mode of water-supply development to that of water demand management and conservation.[1] Why is there so much concern about a depleting water supply when 71% of our planet is covered by it?

Most of the water on the earth is found in the oceans, which contain a high concentration of salts (most notably NaCl) and other elements. Saltwater is not suitable for drinking because it actually induces dehydration Since only about 4% of the water on the entire planet is fresh, concerns over depleted water supplies become increasingly more obvious as population increases.[1] The real problem of having adequate water supplies, is having enough water available in populated areas.

Most of earth's freshwater supply is locked up in the form of ice in remote areas, and so is unavailable for use. As a result, we rely on surface and ground sources of water. The most important source of water is that which is contained in the pore spaces and cracks of rocks and soil, which geologists call aquifers. Aquifers are found in basins where the water table is exposed (lakes and ponds), or in streams of moving water especially in the arid west (see Fig. 1).

## THE HYDROLOGIC CYCLE

Our supply of fresh water is constantly being renewed through the cycle of evaporation and precipitation scientists call the "hydrologic cycle." In this process, energy from the sun evaporates water from the ocean and land turning it into a vapor which enters the atmosphere and leads to formation of clouds.[3,6] During the evaporation process, solid particles such as salt and dirt are left behind. Precipitation from the clouds in the form of rain and snow falls on land and see where it is collected and stored in oceans, lakes, streams, and the ground.

The United States receives enough rain annually to cover the entire country to a depth of 30 inches. Unfortunately, the water is not evenly distributed.[2] The problem is that due to population increases, rising living standards, and industrial and economic growth, we are depleting surface- and ground-water supplies at a much greater rate than they are being replenished.[2]

The EPA estimates that each person in the United States uses 80-100 gallons of water for normal household activities in a 24-hour period. In 1995, 341 billion gallons of fresh water per day were withdrawn for domestic, agricultural, and industrial uses; roughly 75% from surface sources, and 25% from ground water sources.[3] Of the amount of water consumed each day, 2/3 was returned to the environment after use.[3] Many of AIPG members are actively involved in protecting, develop-ing, and understanding our water resources.

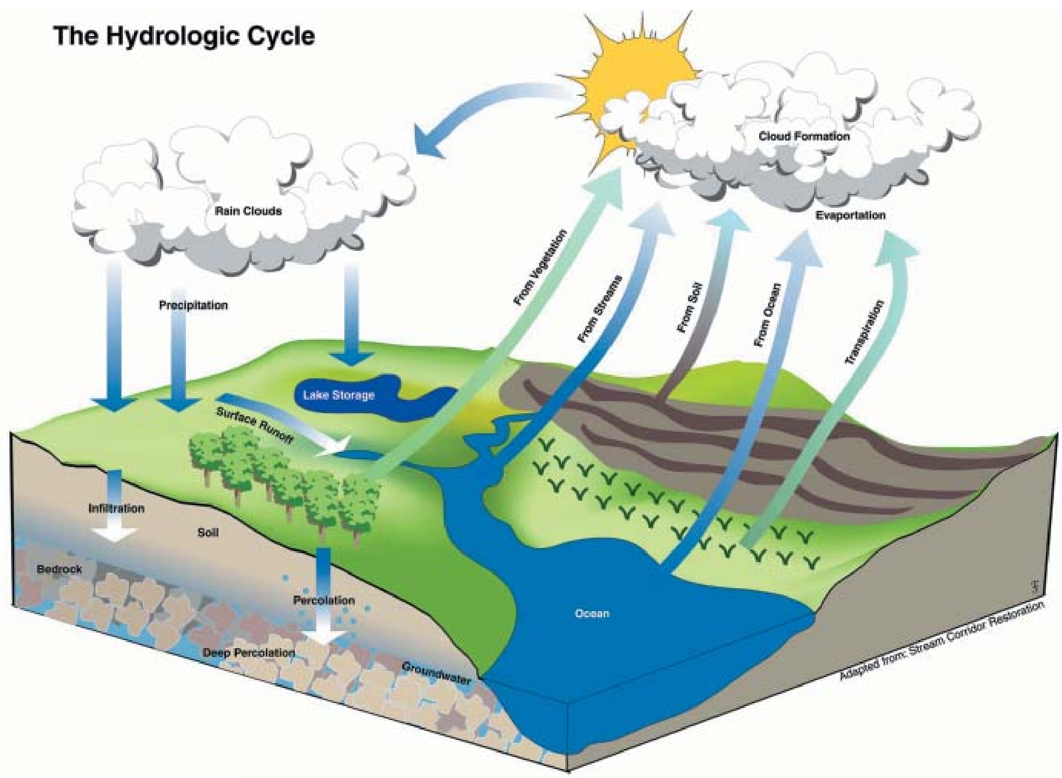


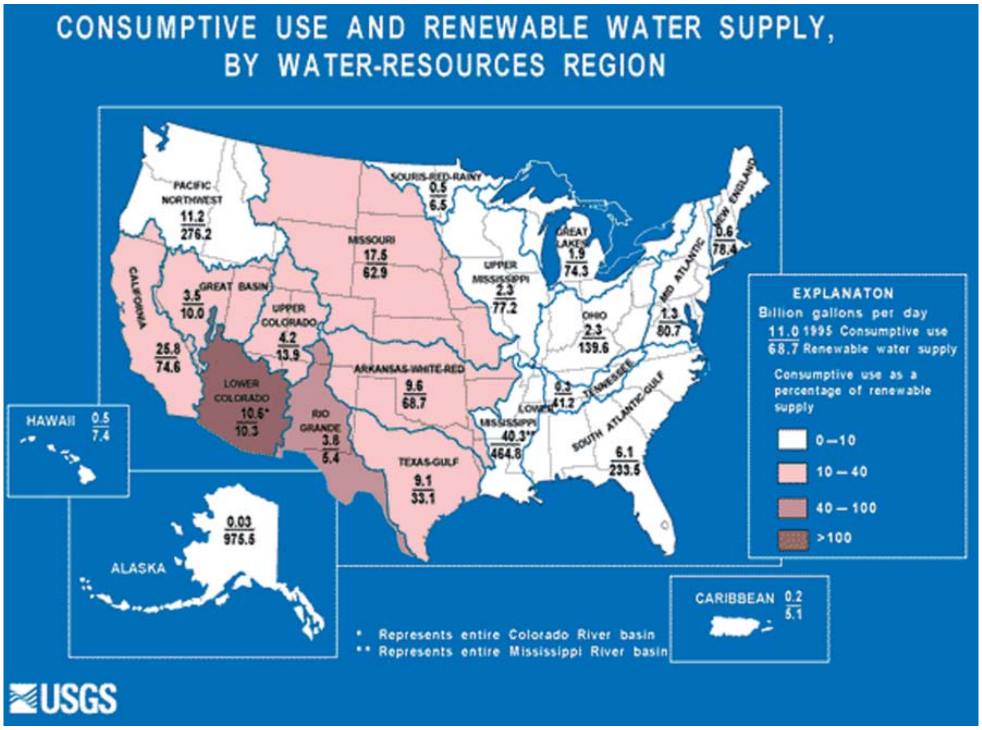

Figure 1.

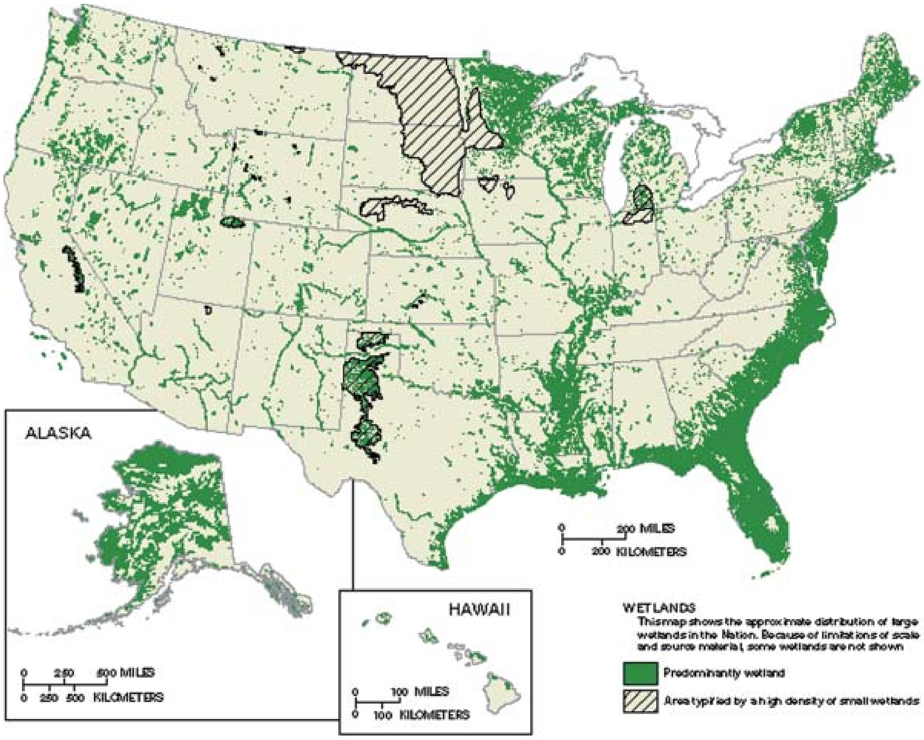
## WATER CONSERVATION AND WETLANDS

Wetlands are special areas where surface water collects or ground water discharges, saturating the area for an extended period of time, but not necessarily indefinitely. Some common examples of wetlands are marshes, swamps, and bogs. Of the 221 million acres of wetlands that existed when the first European colonists arrived, only 103 million acres remain today.[4] Wetlands have been drained or changed to accommodate the development needs of our ever-growing and expanding population. Wetlands improve water quality by filtering harmful polutants from ground water and surface water; they are an important spawning and nursery habitat for fish and other wildlife; they provide recreational opportunities including hunting, fishing, bird watching, and nature photography; and they provide effective natural flood control.

The formation an dlocation of wetlands are due to geologic factors including underlying soil type, topography, geomorphology, and hydrology. Throughout geologic time (measured in millions of years) wetlands have formed, migrated, and disappeared as a result of natural processes. In recent years, artificial wetlands have been constructed to treat water either from remediation systems used to clean up environmentally contaminated sites, or as a component of waste-water treatment systems, or to restore a hydrologic regime.

Geologic understanding is essential to the accurate assessment and evlauation of existing wetlands and to the effective design and construction of artificial wetlands. A realization of these benefits has prompted increased interest in their regulation. Section 404 of the Clean Water Act (1972) affords the Federal Government some control over wetland activity and alteration.[5] The American Institute of Professional Geologists (AIPG) believes that qualified geologists with the appropriate training and experience must be included in an interdisciplinary approach to drafting legislation, regulations, or policies regarding the definition, conservation, or drafting legislation, regulations, or policies regarding the definition, conservation, or construction of wetlands, as well as the actual investigation, design, and construction of wetlands.




## REFERENCES


1. USGS, http://water.usgs.gov (accessed on April 28, 2003).
2. EPA, www.epa.gov/seahome/groundwater/src/supply.htm#budget (accessed on April 28, 2003).
3. USGS, 1984, The Hydrologic Cycle (pamphlet) also http://water.usgs.gov/pubs/circ/circ1139/htdocs/natural_processes_of_ground.htm (accessed April 28, 2003)
4. Dahl, Thomas E., 1990, Wetlands losses in the United States 1780's to 1980's. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/-othrdata/wetloss/wetloss.htm (Version 16JUL97) (accessed April 28, 2003).
5. Wetlands, http://wetlands.fws.gov
6. http://www.epa.gov/seahome.groundwater/src/cycle.htm#cycle (accessed on April 28, 2003).

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# Mineral Resources and Exploration

Have you ever asked yourself, "where does *that* come from," or "how do they *make* that?" As an example, consider the ingredients necessary to build the typical home: gravels for driveways and landscaping, cement and concrete for the foundation, glass for windows, metal for nails, screws, hinges, and wiring, glass for lightbulbs, drywall or sheetrock for interior walls, and paper, rubber, and plastic for various other components. All of these materials, and most of the materials we use on a daily basis, come from the ground in one way shape or form.

## Minerals

Any economically valuable resource which is removed from the ground is referred to by the mining industry as a *mineral*. An approximation of the contribution of nonfuel minerals to the economy of the United States in the year 2002 was around $10.4 trillion.[1] Mineral resources obviously play an important role in our economy, and based on the home-building example above, they are also very important to industry and society in general. Minerals are the materials manipulated to build or make everything. Cement and concrete are made by mixing together lime (hardening agent produced by heating limestone), clay or shale, sand or gravel, and water. Glass is made by melting feldspar and quartz sand. Steel is produced by mixing iron with other metals. Tungsten, because it has the highest melting point of any known element (at 3422° C), is used for filaments in incandescent lightbulbs. The drywall used for interior walls is made primarily of the mineral gypsum. The mineral talc is used in the manufacture of everything from paper to plastic to baby powder. Other minerals, like rubies, diamonds, sapphires, gold, and silver, are garnished for purely aesthetic reasons.


Iron Ore


Gypsum


Quartz


Potash


Open Pit Mine

Even the synthetic materials made in laboratories must unclude mineral ingredients; plastic and rubber, for example, are ultimately produced from oil.

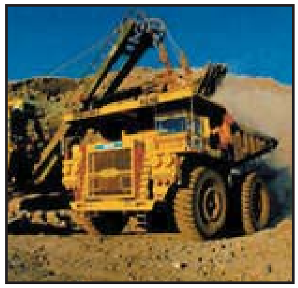
Some materials, like clay, gravel, and stone, often go unrecognized as economically significant resources. Because of their capacity for being molded into shapes when wet, and hardened into impermeable structures when baked, clays have marketable properties which allow them to be used in pottery, bricks, cements, heat-resistant kilns, paper, porcelain, and as a "glue" for sticking iron ore pellets together.[2] Gravels, in addition to all of their landscaping uses, are included in the production of concrete and asphalt. Granite, sandstone, and marble slabs are used as both decorative and durable building materials. The collective group of minerals known as potash are mined for fertilizer, certain medicines, and to make explosives.[2] Soda ash (trona) is one of the most widely used and important commodities in the United States, being used in the manufacture of fiberglass and specialty glass, liquid detergents, and for photographic processes. In fact, because of its use in so many industries, monthly soda ash production information is one of the pieces evaluated in determining the condition of the U.S. economy.[2]

## Exploration and Recovery

The journey from raw material (from the ground) to commercial or industrial product (refined) involves many steps. Starting at the very beginning, before the raw material can be extracted, it must first be located. This usually requires geological reconnaissance of rocks and soils in the field or examination of geologic maps. By looking at soil, water, and vegetation types, geologists can determine the minerals present in the local rock types. Additionally, seismic methods, gravity irregularities (indicative of large concentrations of heavy metals, such as iron), and Geiger counters (for detecting radioactive materials) can be used to isolate other sites of probable mineral concentration.

Mineral exploration requires different methods for different materials. Gravels, for example, are amply found in the moraines and outwash deposits of glaciated regions. Nickel, used in the manufacture of stainless steel, corrosion-resistant coatings, coins, and batteries, can be found concentrated in what are called *laterite deposits* just below the ground surface in areas of high-percentage nickel-bearing rocks.[2] The mineral graphite, composed exclusively of carbon, is used as a dry lubricant and for brake linings and pencil lead, and forms when organic-rich beds interspersed within large masses of limestone are compressed and reoriented by heat and pressure. In order to locate deposits of graphite, a geologist would look in regions of metamorphic rock where ancient seas once existed.

Once a suitably large mineral deposit has been identified, the building of a *mine* ensues. The purpose of a mine is to extract a marketable material at the lowest possible cost, and with the least possible disturbance to the natural environment. Upon depletion of the resource, the mine is closed and the surrounding area is returned to its pre-mining condition as closely as possible. Mining is an expensive operation, and this is why large concentrations of minerals must be present before mining can be profitable.



Mining Truck

Underground Mine

Many different types of mining exist: open pit mining, surface strip mining, hard and soft rock mining, and solution mining. *Underground* mining requires the construction of a shaft large enough to allow miners and their equipment to enter. From this shaft, a series of tunnels can be excavated horizontally into layers of valuable mineral, such as coal or potash. The ore is then transported via conveyor belt to the shaft where it is hoisted to the surface. *Surface* mining is reserved for mineral deposits that are found near the earth's surface. In this process, overlaying material is removed until the valuable resource is encountered and subsequently continues progressively deeper until the material of value runs out. *Solution* mining is used to mine minerals (sodium chloride and sodium sulfate – salts) which dissolve in water. In this method, a number of wells are drilled through which hot water is pumped down into layers of profitable salt content. The salt-bearing solution is then pumped to the surface and placed into evaporators which remove the water, allowing the minerals to crystallize out into a marketable form.

Potash Mine

Geologists are present in every aspect of mining: from predicting the locations of likely mineral concentrations to cost effectively and safely removing them from the ground. More than simply filling the role of a scientist, the geologist is often an integral part of the management team that operates a mine. His or her knowledge of minerals and the earth is an invaluable national resource that not only makes American industry possible, but successful too.

## References


1. USGS, Mineral Commodity Summaries 2003, http://minerals.usgs.gov/minerals/pubs/mcs/2003/mcs2003.pdf
2. Mineral Information Institute, www.mii.org/commonminerals.php


## Of Interest

http://webmineral.com/

www.infomine.com