Chapter 10 The Deserts

In this brief introduction we will discuss the geographical location of deserts, some of their main physical features, flora and fauna, effect on climate and human use.

Main locations and types of Deserts

A desert is a landscape or region that receives an extremely low amount of precipitation, less than enough to support growth of plants. Deserts are defined as areas with an average annual precipitation of less than 250 millimetres (10 in) per year or as areas where more water is lost by evapotranspiration than falls as precipitation.

Deserts are part of a wide classification of regions that, on an average annual basis, have a moisture deficit (i.e. they can potentially lose more than is received). Deserts are located where vegetation cover is sparse to almost nonexistent and make up about one third (33%) of the Earth's land surface. This brief introduction shall concentrate on hot deserts. Hot deserts usually have a large diurnal and seasonal temperature range, with high daytime temperatures, and low nighttime temperatures (due to extremely low humidity).

In hot deserts the temperature in the daytime can reach 45 °C/113 °F or higher in the summer, and dip to 0 °C/32 °F or lower in the winter. Dry desert air is incapable of blocking sunlight during the day or trapping heat during the night. Thus, during daylight most of the sun's heat reaches the ground, and as soon as the sun sets the desert cools quickly by radiating its heat into space. Urban areas in deserts lack large (more than 14 °C/25 °F) daily temperature variations, partially due to the urban heat island effect.

Many deserts are formed by rain shadows; mountains blocking the path of precipitation to the desert (on the lee side of the mountain). Deserts are often composed of sand and rocky surfaces. Sand dunes called ergs and stony surfaces called hamada. Exposures of rocky terrain are typical, and reflect minimal soil development and sparseness of vegetation. The soil is rocky because of low chemical weathering.

The largest hot desert is the Sahara in northern Africa, covering 9 million square kilometres and 12 countries. Other large hot deserts include the Arabian Desert, Kalahari Desert, Great Victoria Desert, Great Basin Desert and the Syrian Desert.

Deserts are also classified by their geographical location and dominant weather pattern as trade wind, mid-latitude, rain shadow, coastal, monsoon, or polar deserts. Former desert areas presently in non-arid environments are paleodeserts e.g Nebraska Sand Hills.

Montane deserts are arid places with a very high altitude; the most prominent example is found north of the Himalaya especially in Ladakh region of Jammu and Kashmir, in parts of the Kunlun Mountainsand the Tibetan Plateau. Many locations within this category have elevations exceeding 3,000 meters (10,000 ft) and the thermal regime can be hemiboreal. These places owe their profound aridity (the average annual precipitation is often less than 40 mm or 1.5 in) to being very far from the nearest available sources of moisture. Montane deserts are normally cold.

Rain shadow deserts form when tall mountain ranges block clouds from reaching areas in the direction the wind is going. As the air moves over the mountains, it cools and moisture condenses, causing precipitation on the windward side. When that air reaches the leeward side, it is dry because it has lost the majority of its moisture, resulting in a desert. The air then warms, expands, and blows across the desert. The warm, desiccated air takes with it any remaining moisture in the desert. An example of a rain shadow desert is Death Valley which lies in the rain shadow of the Pacific Coast Ranges of California and the Sierra Nevada Mountains.

Main Physical Features

Sand covers only about 20 percent of Earth's deserts. Most of the sand is in sand sheets and sand seas—vast regions of undulating dunes. In general, there are six forms of deserts: 1) Mountain and basin deserts 2) Hamada deserts, which consist of plateau landforms 3) Regs, which consist of rock pavements 4) Ergs, which are formed by sand seas 5) Intermontane Basins and 6) Badlands, which are located at the margins of arid lands comprising clay-rich soil

Nearly all desert surfaces are plains where eolian deflation—removal of fine-grained material by the wind—has exposed loose gravels consisting predominantly of pebbles but with occasional cobbles.
The remaining surfaces of arid lands are composed of exposed bedrock outcrops, desert soils, and fluvial deposits including alluvial fans, playas, desert lakes, and oases. Bedrock outcrops occur as small mountains surrounded by extensive erosional plains.

Several different types of dunes exist. Barchan dunes are produced by strong winds blowing across a level surface and are crescent-shaped. Longitudinal or seif dunes are dunes that are parallel to a strong wind that blows in one general direction. Transverse dunes run at a right angle to the constant wind direction. Star dunes are star-shaped and have several ridges that spread out around a point. Oases are vegetated areas moistened by springs, wells or by irrigation. Many are artificial. Oases are often the only places in deserts that support crops and permanent habitation.

Flora and Fauna

Deserts have a reputation for supporting very little life, but in reality deserts often have high biodiversity, including animals that remain hidden during daylight hours to control body temperature or to limit moisture needs. Some fauna for example in the Mojave desert includes the brush mouse, cactus mouse, gray fox, porcupine, kangaroo rat, coyote, jack rabbit and many kinds of lizards. In the Australian deserts we have the Bilby, Perentie, Thorny Devil, Bearded Dragon, Red Kangaroo and Dingo as examples. These animals adapted to live in deserts are called xerocoles. Many desert animals (and plants) show especially clear evolutionary adaptations for water conservation or heat tolerance, and so are often studied in comparative physiology, ecophysiology and evolutionary physiology. One well-studied example is the specializations of mammalian kidneys shown by desert-inhabiting species.

Many examples of convergent evolution have been identified in desert organisms, including between cacti and Euphorbia, kangaroo rats and jerboas, Phrynosoma and Moloch lizards.
Some flora includes shrubs, Prickly Pears, Desert Holly, and the Brittlebush. Most desert plants are drought- or salt-tolerant, such as xerophytes. Some store water in their leaves, roots, and stems. Other desert plants have long taproots that penetrate to the water table if present, or have adapted to the weather by having wide-spreading roots to absorb water from a greater area of the ground. Another adaptation is the development of small, spiny leaves which shed less moisture than deciduous leaves with greater surface areas. The stems and leaves of some plants lower the surface velocity of sand-carrying winds and protect the ground from erosion. Even small fungi and microscopic plant organisms found on the soil surface (so-called cryptobiotic soil) can be a vital link in preventing erosion and providing support for other living organisms.

Deserts typically have a plant cover that is sparse but enormously diverse. The giant saguaro cacti of the Sonoran Desert provide nests for desert birds and serve as "trees" of the desert. Saguaro grow slowly but may live up to 200 years. When 9 years old, they are about 15 centimeters (6 in) high. After about 75 years, the cacti develop their first branches. When fully grown, saguaro cacti are 15 meters tall and weigh as much as 10 tons. They dot the Sonoran and reinforce the general impression of deserts as cactus-rich land. Although cacti are often thought of as characteristic desert plants, other types of plants have adapted well to the arid environment. They include the pea and sunflower families. Cold deserts have grasses and shrubs as dominant vegetation.

Biodiversity Case Study - The Atacama

Atacama is the driest place on Earth and is virtually sterile because it is blocked from moisture on both sides by the Andes mountains and by the Chilean Coastal Range. The cold Humboldt Current and the anticyclone of the Pacific are essential to keep the dry climate of the Atacama. The average rainfall in the Chilean region of Antofagasta is just 1 mm per year. Some weather stations in the Atacama have never received rain. Evidence suggests that the Atacama may not have had any significant rainfall from 1570 to 1971. It is so arid that mountains that reach as high as 6,885 meters (22,590 feet) are completely free of glaciers and, in the southern part from 25°S to 27°S, may have been glacier-free throughout the Quaternary, though permafrost extends down to an altitude of 4,400 meters and is continuous above 5,600 meters.

Some locations in the Atacama do receive a marine fog known locally as the Camanchaca, providing sufficient moisture for hypolithic algae, lichens and even some cacti. But in the region that is in the "fog shadow" of the high coastal crest-line, which averages 3,000 metres (10,000 ft) m height for about 100 kilometres (60 mi) south of Antofagasta, the soil has been compared to that of Mars. Due to its otherworldly appearance, the Atacama has been used as a location for filming Mars scenes. The desert was also primarily featured in the 2008 James Bond film Quantum of Solace.

In 2003, a team of researchers published a report in Science Magazine titled "Mars-like Soils in the Atacama Desert, Chile, and the Dry Limit of Microbial Life" in which they duplicated the tests used by the Viking 1 and Viking 2 Mars landers to detect life, and were unable to detect any signs in Atacama Desert soil. The region may be unique on Earth in this regard and is being used by NASA to test instruments for future Mars missions. Let us take a closer look at some of the biology of a particular region of the Atacama - the nearby Pan de Azucar National Park.

Pan de Azúcar NP is divided into two ecosystems: the coastal desert of Taltal and the steppe desert of the Sierra Vicuna Mackenna. There are more than 20 cactus species in the area, mainly of the genus Copiapoa The Guanaco is the main mammal found in the park. Other mammals include Culpeo Fox, Chilla Fox and European Hare. The shoreline area is home to marine mammals, such as the Marine Otter and the South American Sea Lion. Among the birds are the Humboldt Penguin and Peruvian Pelican. Also reptile species of the genera Tropidurus and Callopistes inhabit the park.

Human Uses

Mineral resources

Deserts may contain great amount of mineral resources over their entire surface. This occurrence in minerals also determines the color. For example, the red color of many sand deserts is a result of the occurrence of laterite. .Some mineral deposits too are formed, improved, or preserved by geologic processes that occur in arid lands as a consequence of climate. Ground water leaches ore minerals and redeposits them in zones near the water table. This leaching process concentrates these minerals as ore that can be mined.
Evaporation in arid lands enriches mineral accumulation in their lakes. Lake beds known as playas may be sources of mineral deposits formed by evaporation. Water evaporating in closed basins precipitates minerals such as gypsum, salts (including sodium nitrate and sodium chloride), and borates. The minerals formed in these evaporite deposits depend on the composition and temperature of the saline waters at the time of deposition.

Significant evaporite resources occur in the Great Basin Desert of the United States, mineral deposits made famous by the "20-mule teams" that once hauled borax-laden wagons from Death Valley to the railroad. Boron, from borax and borate evaporites, is an essential ingredient in the manufacture of glass, enamel, agricultural chemicals, water softeners, and pharmaceuticals. Borates are mined from evaporite deposits at Searles Lake, California, and other desert locations. The total value of chemicals that have been produced from Searles Lake substantially exceeds US$ 1 billion

The Atacama Desert of Chile is unique among the deserts of the world in its great abundance of saline minerals. Sodium nitrate has been mined for explosives and fertilizer in the Atacama since the middle of the 19th century. Nearly 3 million metric tons were mined during World War 1. See our group Chile Mining and Power on www.chronosconsulting.com and our other mining articles on Articles Base.

Valuable minerals located in arid lands include copper in the United States, Chile, Peru, and Iran, iron and lead zinc ore in Australia; and gold, silver and uranium deposits in Australia and the United States. Nonmetalic mineral resources and rocks such as beryllium, mica, lithium, clays, pumice, and scoria also occur in arid regions. Sodium carbonate, sulfate, borate,nitrate, lithium, bromine, iodine, calcium, and strontium compounds come from sediments and near-surface brines formed by evaporation of inland bodies of water, often during geologically recent times. The Green River Formation of Colorado, Wyoming, and Utah contains alluvial fan deposits and playa evaporites created in a huge lake whose level fluctuated for millions of years. Economically significant deposits of trona, a major source of sodium compounds, and thick layers of oil shale were created in the arid environment.

Some of the more productive petroleum areas on Earth are found in arid and semiarid regions of Africa and the Mideast, although the oil fields were originally formed in shallow marine environments. Recent climate change has placed these reservoirs in an arid environment. It's noteworthy that Ghawar, the world's largest and most productive oilfield is mostly under theEmpty Quarter and Al-Dahnadeserts. For more oil information please check out www.chronosoil.com

Other oil reservoirs, however, are presumed to be eolian in origin and are presently found in humid environments. The Rotliegendes, a hydrocarbon reservoir in the North Sea, is associated with extensive evaporite deposits. Many of the major U.S. hydrocarbon resources may come from eolian sands. Ancient alluvial fan sequences may also be hydrocarbon reservoirs.

Solar energy resources

Deserts are increasingly seen as sources for solar energy. The Negev Desert and the surrounding area, including the Arava Valley, are the sunniest parts of Israel and little of this land is arable, which is why it has become the center of the Israeli solar industry. David Faiman, a world expert on solar energy, feels the energy needs of a country like Israel could be met by building solar energy plants in the Negev. Faiman also feels the technology now exists to supply all of the world's electricity needs with 10 per cent of the Sahara. Solel has nine fields of solar collectors in the Mojave Desert of California It recently signed a contract to build the Mojave Solar Park, which will be the world's largest solar generating plant.

Human life in deserts

A desert is a hostile, potentially deadly environment for unprepared humans. In hot deserts, high temperatures cause rapid loss of water due to sweating, and the absence of water sources with which to replenish it can result in dehydration and death within a few days. In addition, unprotected humans are also at risk from heatstroke. Humans may also have to adapt to sandstorms in some deserts, not just in their adverse effects on respiratory systems and eyes, but also in their potentially harmful effects on equipment such as filters, vehicles and communication equipment. Sandstorms can last for hours, sometimes even days. This makes surviving in the desert quite difficult for humans.

Despite this, some cultures have made hot deserts their home for thousands of years, including the Bedouin, Tuareg and Pueblo people. Modern technology, including advanced irrigation systems, desalinization and air conditioning have made deserts much more hospitable. In the United States and Israel for example, desert farming has found extensive use and locations such as Las Vegas owe much to air conditioning.

In cold deserts, hypothermia and frostbite are the chief hazards, as well as dehydration in the absence of a source of heat to melt ice for drinking. Falling through pack-ice or surface ice layers into freezing water is a particular danger requiring emergency action to prevent rapid hypothermia. Starvation is also a hazard; in low temperatures the body requires much more food energy to maintain body heat and to move. As with hot deserts, some people such as the Inuit have adapted to the harsh conditions of cold deserts.

Most traditional human life in deserts is nomadic. It depends in hot deserts on finding water, and on following infrequent rains to obtain grazing for livestock. In cold deserts, it depends on finding good hunting and fishing

grounds, on sheltering from blizzards and winter extremes, and on storing enough food for winter. Permanent settlement in both kinds of deserts requires permanent water and food sources and adequate shelter, or the technology and energy sources to provide it.
Many deserts are flat and featureless, lacking landmarks, or composed of repeating landforms such as sand dunes or the jumbled ice-fields of glaciers. Advanced skills or devices are required to navigate through such landscapes and inexperienced travellers may perish when supplies run out after becoming lost. In addition sandstorms or blizzards may cause disorientation in severely reduced visibility.
The danger represented by wild animals in deserts has been featured in explorers' accounts but does not cause higher rates of death than in other environments such as rain forests or savanna woodland, and generally does not by itself affect human distribution. Defence against polar bears may be advisable in some areas of the Arctic, as may precautions against venomous snakes and scorpions in choosing sites at which to camp in some hot deserts.

However, it is hard to overestimate the importance of deserts in our cultural and historical background. Three of the World's largest religions Christianity, Islam and Judaism began and are set against a desert backdrop. All three religions are monotheistic, and today have enormous geopolitical influence extending far beyond their area of origin -see articles on Christianity here on Articles Base and Biblon www.biblon.com. Deserts are also now a major source of tourism and travel interest e.g. Joshua Tree, Death Valley National Parks as well as vital to the movie industry.

Deserts are also vital areas for scientific interest. - specific examples include Deep Canyon on the western edge of the Colorado Desert is associated with the University of California, Riverside located in the P.L. Boyd Deep Canyon Desert Research Center. It receives a variety of visiting scientists and students and, in addition to research, addresses conservation issues of the surrounding environment such as the fate of the fringe-toed lizard. Another desert centre established by one visionary biologist, the Gobabeb Training and Research Centre, is located in Namibia within the driest part of the coastal Namib Desert in the Namib-Naukluft Park.
As the United Nations Environment Program concludes "People have lived in deserts for millennia, as hunter-gatherers, agriculturalists and pastoralists, and some people continue to do so today. But other people now live in urban developments situated in deserts, or enjoy deserts temporarily for tourism or recreation. Yet others are extracting profits from mining or other non-renewable resources. Deserts are a large and probably growing environment globally and their future will be best supported if it is based on a thorough understanding of their structure and function, and the influence of people's activities in the past, present and future."