

**The Atacama Desert: A Physiographic Dissection of the
Hyper-Arid Desert Region of Chile**

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Abstract

Exclusive of the largest mountain ranges and oceans, earth's most well-known physical features are its great desert regions. The word desert often conjures up ideas of open expanses of sand and towering dunes blown by perpetual wind and dust storms. Moreover, deserts are often categorized as being strictly sandy, hot, and extremely dry. Only part of this assumption is correct. Furthermore, the categorizing of deserts as such illustrates how little knowledge many people in fact have of desert regions of the earth.

The notion that all deserts are hot and sandy is especially erroneous. The surrounding landforms, air temperature, and soil composition have no bearing on whether or not a climate region is classified as a desert. The sole characteristic used in classifying climate regions as a desert is aridity; a lack of moisture (Cressy 390). Deserts can be defined as regions where less than 10 inches of liquid equivalent precipitation falls each year. A better definition is any climatic region where evaporation substantially exceeds precipitation for most of the year (Cressey 390). Thus, based on this definition it is clear that deserts are not regulated to hot low latitude regions of the earth.

Deserts are found at all latitudes, and encompass all air temperature ranges found on earth. Deserts types range from hot hyper-arid deserts such as the Sahara to less known and rather unusual cool coastal deserts such as the Atacama. Although the Atacama does embody hyper-arid characteristics, the Atacama Desert is generally classified as a cool coastal desert. The remainder of this paper will focus specifically on the physical characteristics of the Atacama Desert.

Topography

Located in northern Chile and extreme southern Peru, the Atacama Desert is located in perhaps the most unique physiographic location on earth. (Clarke 101) Many topographic features of northern Chile are exclusive to the Atacama Desert; that is they are found in no other place on earth. The Atacama Desert lies between two mountain ranges on the west coast of South America, the Coastal Cordillera and the Andean Cordillera. The Coastal Cordillera ranges in elevation from 500 to 3000 meters (Boa, Jenkins, Khachatryan, and Diaz 577), and the Andean Cordillera ranges in elevation from 5000 to 6000 meters.

Between the two mountain ranges lies what is called the Central Depression (Boa, Jenkins, Khachatryan, and Diaz 577). The Central Depression is a valley, not unlike the central valley of California. The Central Depression is void of hydrologic processes (Boa, Jenkins, Khachatryan, and Diaz 577), and is where the Atacama's hyper-arid conditions occur. At an elevation of 2300 meters (Dransart 304), the Central Depression is also the site of the Salar de Atacama. The Salar de Atacama (salt flat) is a large salt-covered basin floor lying between the Coastal Cordillera and the Andean Cordillera at the north end of the Atacama Desert (Dransart 304). To the east of the Salar de Atacama the excessively high elevations of the western Andes is called the Puna region.

While the Atacama is hyper-arid, meaning it is nearly void of all moisture, there is one source of surface water in the desert. The River Loa is the only surficial water source to pass through the Atacama (Barfield 93). The Loa runs from the Andes, through the Atacama Desert, and finally drains into the Pacific Ocean (Barfield 93). In such an arid region it should be noted that the water that is found in much of the Atacama actually has a very low rate of evaporation. This slow evaporative process is due to the concentrated

salts in the Atacaman soil entering the surface water, thus giving the surface water an excessively high salinity (Kampf 236).

Tectonics

The Atacama Desert is located on the west side of the Andes Mountains. The Andes are a thin, linear range of mountains known as a cordillera. The west side of the Atacama is bordered by the Coastal Cordillera (Lamb 792). The Coastal Cordillera is caused by subduction, and is where the Nazca Plate directly contacts the sub aerial South American crust (Allmendinger 89). The Andes, farther to the east, are one of only a few mountain ranges that form hundreds or thousands of miles from the main subduction point, in this case at the Coastal Cordillera.

The Atacama Desert, even with its close relation to an active subduction zone, is strikingly “free of large earthquakes or active volcanoes” (Lamb 792). This lack of earthquakes is likely due to the nature of the South American lithosphere (Lamb 792). The South American lithosphere is weak and nonridgid (Lamb 792). Therefore when the Nazca and South American plates collide, the South American lithosphere is easily faulted upward, thereby creating the Chilean Coastal Cordillera and the Andean Cordillera (Lamb 792). In the center of these two mountain ranges lies the Central Depression of the Atacama Desert.

Soils

The Atacama Desert floor is composed primarily of salts and volcanic basalts. At the center of the desert, at an elevation of 2300 meters, lies an expansive salt-covered basin floor (Dransart 304). Other types of sand and gravel are interspersed though out the desert. Due to the unusual amount of basalts and the acutely barren landscape, the

Atacama is often described as looking similar to the surface of Mars. In fact, much Martian research takes place in the Atacama.

Atacaman soil can be very profitable due to its abundance in many valuable minerals. In fact, “from the discovery of the Chinarcillo silver lode in 1832, minerals became an economic mainstay whose economic importance increased in the 1840s and 1850s, when large deposits of silver and copper ores were discovered in the Norte Chico and Santiago regions” of the Atacama (Oppenheimer 55). The world’s largest body of Copper Ore can be found in the Atacaman town of Chuquicamata (Rudolph 557). Moreover, much of the soils in the Atacama are high in Nitrates (Rudolph 557) used to make fertilizers around the world. Furthermore, there are fairly high concentrations of other salts in the Atacaman soil such as sulfate, chloride, iodate, and perchlorate (Boa 577).

The soils of the Atacama can be extremely, biologically inhospitable. However, some plant and animal species have found a way to thrive in an otherwise barren region. Small shrubs and grasses do grow where rare summer showers occur (Rudolph 553). A number of species of camelids also are native to the Atacama Desert region.

Climate

Due to its unusual topography, general physiographic characteristics, and spatial location on earth, the Atacama Desert is climatologically unique. Parts of the Atacama Desert are precipitation wise the driest places on earth (Clarke 101). In fact, on average, the northern Atacama towns of Arica and Iquique both receive less than .6millimeters of precipitation per year (Clarke 101). This average precipitation statistic is somewhat deceiving. Generally speaking, it actually does not rain in the Atacama Desert each year.

The average precipitation amounts may come from a single thunderstorm after many years with no rain at all (Right 527). The average yearly rainfall in Iquique, Chile, mentioned above, was calculated over 20 years, and includes a single year in which 15 millimeters of rain fell (Right 528).

Although most of the Atacama is hyper-arid, it does occasionally experience intense but short durations of rainfall. In 1927 the town of Copiapo, in the Atacama, received six days of rain totaling 95 millimeters (Right 528). After receiving such copious rains, portions of the Atacama may go forty or more years with no rain at all. This variability in precipitation amount is typical of all desert regions of the earth (Right 528).

The unique Atacaman climate is caused by several factors: a strong subtropical high-pressure zone, proximity to the cold Humbolt current along Chile's Pacific coast, offshore wind patterns, and topographic features causing the Atacama to be greatly effected by a precipitation shadow (Right 528). The Humbolt current is a cold ocean current that flows in a northerly direction along the western South American coast. This cold current hampers evaporation and thus prevents precipitation along the immediate coast of Chile and Peru (Hartley 421). Furthermore a nearly stationary subtropical high-pressure zone makes it nearly impossible for low pressure storm systems to reach the western coast of South America.

The climate of the Atacama Desert is additionally greatly impacted by its location in relation to the Andean Cordillera. The Andes Mountains lie on the eastern edge of the Atacama Desert. As air flows from the east, across the South American continent, and up the east side of the Andes, orographic precipitation is the result. The air flowing up the

Andes expands, cools, condenses and eventually precipitation occurs. As the air comes down the western side of the Andes it compresses, heats up, and dries out. On the western side of the Andes, the Atacama Desert lies in a precipitation shadow. Therefore the air has little moisture left by the time it arrives to the Atacama Desert (Hartley 421). The coastal cordillera is an extremely thin, linear mountain range on the immediate west coast of Chile. On rare occasions that the subtropical high-pressure lessens and winds become westerly, the coastal cordillera creates the same precipitation shadow effect that the Andes Cordillera does when winds are out of the east (Hartley 422).

Further compounding of the hyper-aridity of the Atacaman climate is caused by the continentality effect (Hartley 421). The continentality effect occurs when rain-bearing trade winds from the east cannot reach the interiors of the continent (Hartley 421). Essentially, when the air reaches the Atacama Desert it is starved of moisture due its extended traverse across South American continent.

Cultural Impact

There is little evidence of major civilizations in the Atacama before 5000 years ago. However, archeological findings suggest that a pre-Columbian Indian civilization likely flourished in the Atacama after 5000 years ago. Many of the people that currently live in the region today are decedents of the pre-Columbian Indians (Barfield 93).

Due to the extreme climate of the Atacama, it is rare to see large tracks of sustainable agriculture. However, in the few areas of the Atacama where there is healthy vegetation, there are large communities of nomadic cultures whose lives revolve around herding camelids (Dransart 305). Llamas and other camelids of the Atacama Desert have been semi domesticated, not unlike bovine species in North America (Dransart 305). The

Atacama Desert is one of the most inhospitable places on earth for human existence.

Therefore aside from small pockets of concentrated mining towns, primarily in the north of Chile, most towns and therefore cultural centers are relegated to the far eastern regions of the Atacama where rain is somewhat more prevalent.

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