Chapter 2
Physical Geography of China and the U.S.

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China and the U.S. receive currently a lot of attention in the mass media as well as in the academic literature. A comparative physical geography of both countries is an important step to better understand their complex relationships. Landforms, climates, river basins and vegetation patterns of China and the U.S. are respectively introduced, as well as their natural regionalization which is based on the above mentioned factors. The following section focuses on natural disasters including earthquakes, hurricanes/typhoons, floods and droughts. Further, environmental issues and problems are discussed. Finally, all the physical geography features for both countries are compared to show the similarities and differences.

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2.1 Physical Geography

2.1.1 Landforms

2.1.1.1 Topography and landforms of China

The most obvious topographic feature of China is the higher elevation in the west and the lower elevation in the east, which could be visualized in form of steps of a stairway (Fig. 2.1). On top of the stairway—the first topographic step—is the Qinghai-Tibet Plateau in the southwest of China, a mountainous plateau with an average elevation of more than 4,500 m. Here are found a series of east-west or northwest- southeast trending mountain ranges, whose elevation are more than 5,000–6,000 m, including mainly the Hoh Xil Mountain, the Bayan Har Mountain, the Tanggula Mountain, the Gangdise Mountain and the Nyainqentanglha Mountain. The Qaidam Basin, known as a "treasure basin", is embedded inside these mountains. The plateau is surrounded by numerous towering mountains. In the south rises the highest mountain range in the world, the Himalayas Mountains, with an average elevation of more than 6,000 m. The Kunlun Mountains, Altun Mountains, Qilian Mountains in the north, and the Longmen Mountains, Minshan Mountains, Hengduan Mountains in the east form the boundary between the first and the second topographic step (Wang, 2007).

The second topographic step consisting of mainly plateaus and basins, is between the outer margins of the Qinghai-Tibet Plateau and the Daxing'an Ranges, Taihang Mountains, Wushan Mountains, and Xuefeng Mountains. This region contains a series of high altitude mountains from 1,500 to 2,500 m, such as Yinshan Mountains, and Qinling Ranges etc., as well as plateaus from 1,000 to 2,000 m including the Inner Mongolia Plateau, the Ordos Plateau, the Loess Plateau, and the Yunnan-Guizhou Plateau from north to south. The largest basin (Tarim Basin), the second largest basin (the Junggar Basin) and the basin with the lowest elevation (the Sichuan Basin) in China are located here.

The third topographic step consists of plains and peneplains, which extend along the boundary between the Daxing'an Ranges and the Xuefeng Mountains. From north to south, the Northeast Plain, the North China Plain, and the Middle-lower Yangtze River Plain are located with elevations mostly below 200 m. The vast area to the south of the Yangtze River consists of mainly hills with elevations of less than 500 m. To the east of these plains and hills, narrow and long mountains which are north-east trending are found. These mountains include the Changbai Mountains, Central-Shandong Mountains, Xianxia Mountains, Wuyi Mountains and so on, ranging from 500 to 1,500 m. To east of the coastline is a broad continental shelf. Many Islands are distributed here; and the most famous are the Hainan Island and the Taiwan Island.

China contains five kinds of landform types, including mountain, plateau, hill, basin, and plain. Among the five landform types, mountains and plateaus are most

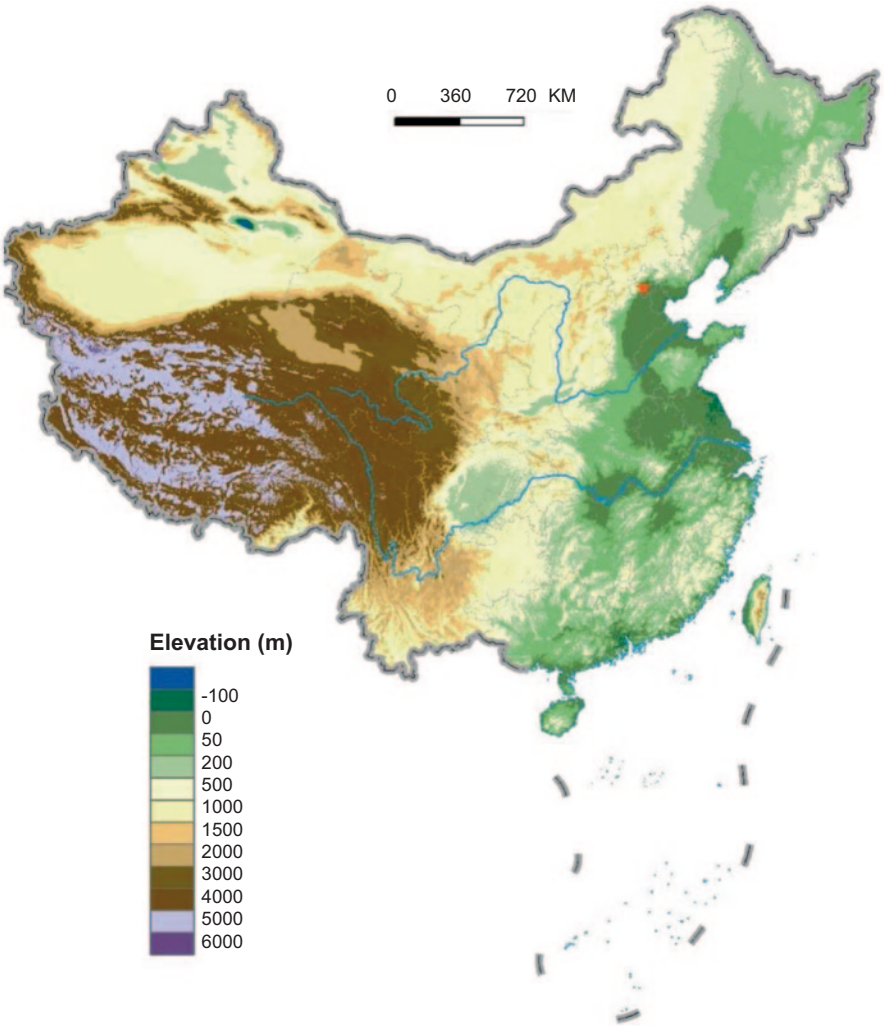

Fig. 2.1 The topography/landforms of China

extensive, accounting for 59% of the total China land area followed by basins (19%), plains (12%), and hills (10%) (Chinese Academy of Sciences, 1985).

China is a mountainous country, where the mountainous regions account for about 65% of its total land area. The crisscrossing mountains constitute the backbone of the landscapes of China and have an impact on the spatial distributions of other landscape types in China. (1) The south-north trending mountain ranges include the Helan, Liupan, and Hengduan (transverse) mountain ranges. These north-south running mountains divide China into an eastern and a western half. In the West, most of the mountains which are northwest or northwest-west trending are

above 3,500 m high, while most of the northeast-north trending mountains in the East are below 3,500 m. (2) There are three major east-west trending mountains, including Yinshan Mountains-Tianshan Mountains, Kunlun—Qinling—Huaiyang Mountains and Nanling Mountains from north to south. The latitudinal distance between them is almost equally 8°. The Qinling Mountain is not only the watershed of the Yellow River, Yangtze River, and Huai River systems, but also an important natural geographical boundary between northern and southern China. (3) The north-west trending mountains are mainly distributed in the western part of China, including the Altay Mountains, Qilian Mountains, Karakorum Mountains, Hoh Xil Mountain, Tanggula Mountain, Gangdise Mountains, Nyainqentanglha Mountains and so on. The western part of the Himalayas in the north of Qinghai-Tibet Plateau is also north-west orientated; however, its eastern portion gradually shifts into east -west orientation, forming an arcuate mountain belt bulging southward. Most of these mountains are high and steep with a frigid climate and generally are covered by glaciers. (4) The north-east trending mountains are mainly distributed in eastern China. They are arranged in form of a West row, an East row, and an outer row respectively from west to east. The West row includes Daxing'an Range, Taihang Mountains, Wushan Mountains, Wuling Hill, Xuefeng Mountains etc. The East row starts from the Changbai Mountains in the north, through Qianshan and the low hills in Luzhong, and then reaches to the Wuyi Mountains in the south. The Outer row consists of the Taiwan Mountains on the island of Taiwan.

The Qinghai-Tibet Plateau, the Inner Mongolia Plateau, the Loess Plateau, and the Yunnan-Guizhou Plateau are the four biggest plateaus in China. The Qinghai-Tibet Plateau lies to the north of the Himalayas Mountains, to the south of the Kunlun, Altun, and Qilian Mountains, and to the west of the Minshan—Qionglai—Jinping Mountains. It is the largest and highest plateau with a frigid climate and glaciers. The Inner Mongolia Plateau, the Loess Plateau, and the Yunnan-Guzhou Plateau, are located in the second topographic step and divided by the Yinshan Mountains, the Qinling Range, and the Dalou Mountains from north to south. Due to the differences in the composition of the materials and the exogenic processes, there are obvious differences among the morphotypes of the landforms on the plateaus. The Inner Mongolia Plateau located in the northern interior, where the climate is dry with little rainfall, is less impacted by fluvial forces but dominated by eolian forces. The plateau surface is relatively well preserved. Covered by soils of loose texture and affected by a strong fluvial process, the surface of the Loess Plateau was severely cut into pieces full of gullies and ridges everywhere. The Yunnan-Guizhou Plateau, also known as the "karst plateau", has a full set of karst landforms with a subtropical humid climate, widespread carbonate rocks, and very well developed karst processes.

The Tarim Basin, the Junggar Basin, the Qaidam Basin and the Sichuan Basin all located in tectonic fault zones, are the four biggest basins in China. The Tarim Basin that contains the largest desert in the country, the Taklimakan Desert, is the biggest basin in China. It has obvious Aeolian denudations and erosions with a closed terrain, an extremely drought prone climate, and a sparse vegetation cover. The second largest basin in China, the Junggar Basin, is a semi-closed basin with a slightly

increased precipitation and a relatively denser vegetation cover. It has vast areas of grasslands and a very developed livestock sector. Due to the abundant water from the melting snow and ice, agriculture thrives in the oases at the edges of the Tarim Basin and the Junggar Basin. In addition, there are many oil and natural gas fields in southern and northern Xinjiang Province. China's third largest and highest basin, the Qaidam Basin, has a dry climate, long hours of sunshine, abundant solar energy resources, and it is rich in salt, metal ores, oil and natural gas resources. The smallest basin in China, the Sichuan Basin, also known as the "land of abundance", is surrounded by many mountains. It has a warm and humid climate, numerous rivers systems, fertile soils, rich natural resources, a dense population, and a developed economy.

China's three largest plains, the Northeast Plain, the North China Plain, and the Middle-Lower Yangtze River Plain, are all concentrated in the third topographic step, among the east-west or north-east trending mountain ranges. With the vast land areas, low and flat terrains, easily accessible by transportation, dense population, and developed cities and towns, they are the nation's major agricultural bases and densely urbanized areas. The Northeast Plain is the biggest plain in China. It is formed by the alluvial deposits of such rivers, as the Heilong River, Nenjiang River, Songhua River, and Liaohe River, and is characterized by the large area of black soils and the widely distributed marshes. The North China Plain is the second largest plain, mainly formed by the alluviums from the Yellow River, the Huaihe River, and the Haihe River. The lands are low lying and flat with gentle slopes where many river beds are above the plains on both sides of the rivers. The phase distribution of the above-ground rivers and the depressions is a unique feature of the North China Plain. The third biggest plain, the Middle-Lower Yangtze River Plain, includes the Dongting Lake Plain, the Poyang Lake Plain, the Jiangsu and Anhui plains along the rivers, and the Yangtze River Delta, distributed like a string of beads from east to west. The Yangtze River Basin, a famous "Land of Abundances" in China, is characterized by a low lying and flat terrain, dense lakes and canals, and large areas of connected rice paddy fields.

China's hills, generally called the "Southeast Hills", are mainly distributed in the third topographic step, and are particularly concentrated in the vast areas to the east of the Xuefeng Mountain and to the south of the Yangtze River. Among them, the hills to the south of the Yangtze River and to the north of Nanling Mountain are called the "South Hills"; whereas the hills to the east of the Wuyi Mountain and within Zhejiang and Fujian provinces are called the "Zhejiang-Fujian Hills". To the north of the Yangtze River, there are not many hills except the Shandong Hills and the Liaodong Hills. The Southeast Hills are largely distributed on the two sides of a series of north-east trending mountains with middle to low altitudes; inside the mountains are many different sizes of scattered red rock basins. Because of the differences in lithological features, the Jiangnan Hills are covered with thick, red sandstones or conglomerates. Zhejiang-Fujian contains extensive granite and rhyolite. The Shandong Hills and Liaodong Hills consist of metamorphic rocks and granite which have been severely cut with a cursive coastline, and numerous bays and islands.

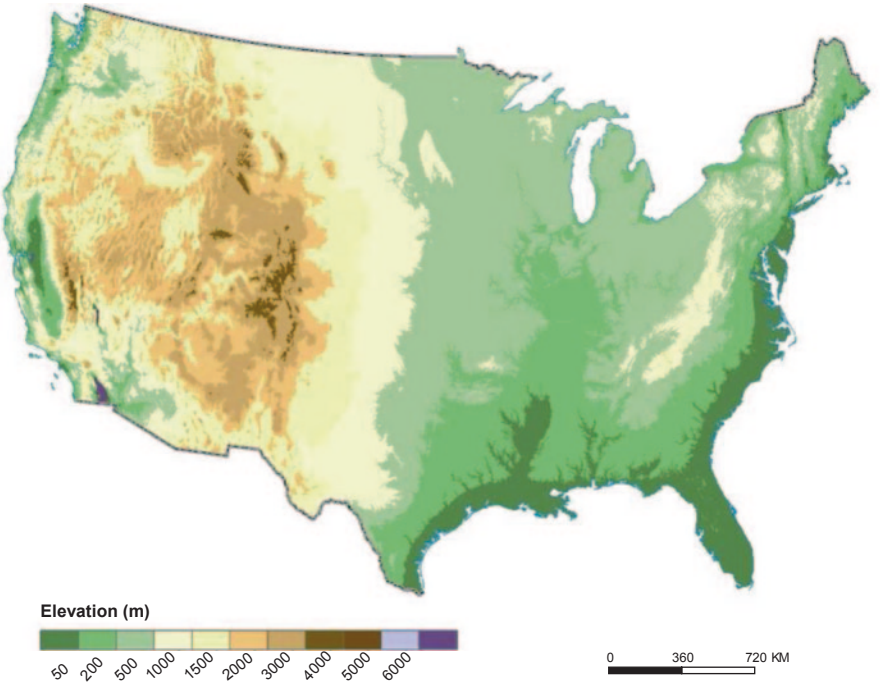

Fig. 2.2 The topography/landforms of the conterminous U.S.

2.1.1.2 The Topography and Landforms of the United States

The most obvious topographic feature of the conterminous U.S. is the higher elevations on the east and west sides and the lower elevations in the vast central plains. In addition, all of its major mountain systems have a north-south alignment. Its terrain can be roughly divided into three zones (Fig. 2.2):

The Western Cordillera System The Western Cordillera starts from Alaska in the north and extends all the way to the American Isthmus in the south, stretching the entire north-south extent of the western conterminous U.S. It is composed of a series of high and wide (usually 2,000–3,000 m high, 800–1,600 km wide) mountain ranges, plateaus, intermountain basins, and valleys that cover approximately one-third of the U.S. land area. Its components are arranged in a series of three large north-south trending bands, with the Rocky Mountains on the east separated from the pacific coastal mountains and valleys on the west by a series of high, heavily dissected intermountain basins plateaus.

The Rocky Mountains in the east, generally high and rugged, stretch more than 4,830 km (3,000 miles) from the Yukon plateau in the western Canada to the Rio Grande River in New Mexico in the southwestern United States. This bulky north-south trending mountains are about 4,830 km (3,000 miles) long; they run through

almost the entire north-south extent of the U.S. This range serves as an important continental divide of the drainage systems. All major rivers in the US, including the Columbia, Colorado, Missouri, and Rio Grande Rivers, originate from the Rocky Mountains and eventually drain into three of the world's Oceans: the Atlantic Ocean, the Pacific Ocean, and the Hudson Bay and eventually Arctic Ocean. The water supply feeding into the rivers and lakes from the runoff and snowmelt off the peaks of the Rocky Mountains accounts for one-quarter of the entire freshwater resources in the United States. The zone of the Intermountain Basins and Plateaus includes, from north to south, the Columbia Plateau, the Central Great Basin, and the Colorado Plateau. This region contains a series of high altitude plateaus ranging from 1,219 to 2,134 m (4,000–7,000 feet) trenched by canyons or hundreds of linear ranges separated by basins of varying size, making it the most complex area in the western United States in terms of its geological structures. The western Pacific Mountains and Valleys are composed of two mountain ranges parallel to the Pacific coast, the Coastal Mountains along the eastern coast of the Pacific and the western Cascade—Sierra Nevada Mountains and the narrow lowlands in between.

The Appalachian Mountains System Running almost parallel to the coastline, the Appalachian Mountains stretch from Alabama in the United States in the south all the way to the Newfoundland and Labrador area of Canada in the north, about 2,600 km in total length and usually 1,000–1,500 m above sea level. Mountains in this region are heavily folded and dissected by the down cutting rivers, forming many parallel ridges, plateaus, and valley topography. In the south, it consists of several parallel mountain ranges that vary gradually southward from 100 to 500 km in width. The system has five unique topographic units, the Piedmont, the Blue Ridge and Great Smokey Mountains, the Ridge and Valley area, the Appalachian Plateau, and the New England section. The Blue Ridge—Smoky Mountains is the system's "backbone", with the highest peak of the entire system at Mount Mitchell at an elevation of 2,037 m. Between the Blue Ridge—Smoky Mountains and the Atlantic Coast is the narrow Piedmont, with general widths between 50–350 km and heights between 50–300 m. Due to the big altitudinal differences between the mountains and the plains, when the rivers flow from the steep slopes of the higher inlands down to the plains, many waterfalls and rapids are created along the edges of the piedmont, which is commonly known as the fall line. The Atlantic Coastal Plain contains many beaches, lagoons, swamps, and mud flats. It has a north-south extent of about 600 km, west-east width of less than 200 km, and local relief of mostly between 30–90 m. The nation's largest peninsula, the Florida Peninsula is located here. Glacial moraines are widely distributed in the Ohio and New York areas, due to the invasion of the glaciations during the Quaternary. The Atlantic Coastal Plain is America's most developed industrial area.

The Great Plains of the Central Area Between the Rocky Mountains and the Appalachian Mountains lie America's vast interior plains, which extend from the border between the U.S and Canada to the Gulf of Mexico. Its north-south extent covers the entire central US, east-west spans 5,000 km, and accounts for one half of the total US territory. It is composed mainly of three physiographic regions: the

Eastern Plain, the Western Plain, and the Southeastern Coastal Plain. The boundary between the Eastern Plain and Western Plain is roughly along the 100 °W meridian. Located north of the Missouri River and the Ohio River, the Eastern Plain contains mainly undulating terrains with lakes and basins of various sizes that were significantly shaped by the past glaciers. Its altitudes are normally below 500 m, with a slightly higher elevation in the southwest. Near the Great Lakes is the Lawrence Plain that is characterized by the low rolling hills and moraines left behind by the retreating glacier. It is the drainage divide between the Gulf of Mexico and the Arctic Ocean. Rivers north of the watershed flow into the Hudson Bay; rivers south of it drain into the Mississippi River and then eventually into the Gulf of Mexico. The Western Plain, also known as the Great Plain, is located between east of the Rocky Mountains and west of the Eastern Plain, with its north-south extent reaching the Canadian and Mexican borders. Its terrain rises gradually from east to west, with elevations at around 500 m near the 100 °W to 1,500 m at the foothills of the Rocky Mountains. It is a high elevation plateau. Although being cut deeply by the east-west trending canyons, its surface remains very flat with very little relief changes, except for the gullies formed by the river erosion. The glacial moraines and tills are widely distributed in the north part of the plain. With flat terrains, fertile soils, and lush grasses, the Great Plains are America's most important agricultural area, also known as the Prairie. The Atlantic Coastal Plains include two parts, the Atlantic Coastal Plain and the Mexico Coastal Plain. This zone is mainly composed of low rolling alluvial deposits from the Mississippi River. Its southern margins are the Mexico Coastal lowlands (below 200 m), including the Mississippi Delta, the world's largest delta with black oily and fertile soils. Many swamps are distributed in the Mississippi River mouth area. Since located in the rising area of the Gulf of Mexico coast, a bird's foot delta was formed at the mouth of the Mississippi River, extending about 100 meters into the ocean every year.

The US contains various kinds of landforms, including mountains, valleys, hills, plains, and plateaus etc. There are many classification systems of land-forms, but the system from the United States Geological Survey (USGS) is the most commonly used one. It divides the landscapes in the US into eight different types, with each of them being further divided into sub types.

The Laurentian Uplands Located near Wisconsin and Minnesota, the Laurentian Uplands is the largest outcrop of the oldest core in North America continent, the Canadian Shield, in the United States. It consists mainly of low altitude hills and mountains that are made of Precambrian igneous rocks or metamorphic rocks. These highly metamorphosed rocks are important sources of iron, copper and other important industrial minerals in the United States.

The Atlantic Coastal Plain The Atlantic Coastal Plain stretches over 3,500 km from Cape Cod in the northeastern U.S to the border with Mexico, and is one of America's flattes areas. The coastal plains from New Jersey to Texas are composed of the Late Cretaceous to Holocene sedimentary rocks that were mainly deposited in the marine environment. A large portion of the deposit is still sands or clays that

have not been hardened into shale or sandstone yet. After several rounds of uplifts, those rocks formed a series of terraces tilting toward the ocean.

The Appalachian Highland The Appalachian Highland, stretching southwest from southeastern Canada to central Alabama in the U.S, is a highland of 2,400 km length and160–480 km width. It consists of a series of mountain belts at an average height of about 900 m. The highest peak of the system, also the highest point in the United States east of the Mississippi River, is Mt. Mitchell (2,037 m) in North Carolina. The landforms include low foothills, hillsides in the Blue Ridge Mountains formed by the metamorphic and granite rocks from the Precambrian to Paleozoic periods, valleys and ridges formed by the folded Paleozoic sediments, the St. Lawrence River valley covered by the glaciers and lake sediments, the gently rolling Appalachian plateau, and the low hills formed by the Paleozoic Cambrian igneous and metamorphic rocks in the New England region.

The Inland Great Plain The Great Plain is an immense inland area that is over 1,600 km long in its east-west extent from the Appalachian Mountains to the Rocky Mountains and north-south extent stretching from the U.S-Canada border to the coastal plain along the Gulf of Mexico. It was once a shallow inland sea. However, over millions of years, it has been gradually covered by the glacial deposits from the Canadian Shield in the north, and the sediments eroded away from the Rocky Mountains in the west and the Appalachian and the Ozark/ Ouachita Mountains in the east. Most of the fluvial sediments came from the marine and rivers during the Mesozoic and Cenozoic periods.

The Inland Highland The Inland Highland is a mountainous area with rugged terrains. It encompasses a large area including eastern Oklahoma, western and northern Arkansas, southern Missouri, and the southeastern corner of Kansas. It is the only main plateau between the Rocky Mountains and the Appalachians and is composed of the Ozark Plateau and the Ouachita Plateau.

The Ozark Plateau is covered by Paleozoic Cambrian igneous and metamorphic rocks, and by the Paleozoic sedimentary limestone or dolomite rocks. In the middle of the plateau, the mountain ridges are mainly about 300–400 m wide and 30–100 m high, gradually increasing toward the south. The Ouachita Plateau is composed of folded sedimentary layers formed in the Paleozoic period. The ridges extend parallel from the east to the west, with elevations generally about 600 m.

The Rocky Mountains The Rocky Mountains, a product with many faults and folds from the orogenies from the Precambrian to the Cenozoic periods, are the major mountains in the western United States. They extend more than 4,830 km from the border with Canada to New Mexico in the southern United States. Its highest peak with an elevation of 4,400 m is Mt. Elbert in Colorado. The eastern edge of the Rocky Mountains rises above the central plains; its western edge includes ranges such as the Wasatch near Salt Lake City and the Bitterroots along the Idaho-Montana border. The Great Basin and Columbia Plateau separate them from the other mountain ranges further west. The Rocky Mountains are the drainage divide of the conterminous United States.

The Intermountain Plateaus The intermountain Plateaus are located west of the southern Rocky Mountains. The linearly structured landforms are a combined result of the great thickness of nearly horizontal rock layers from the Paleozoic, Mesozoic, and Tertiary periods and the dry climate. Due to the continued uplifts and rifts of the crust during the geological history, the plateaus were cut into large rugged horsts and grabens along the fault lines. They are composed of the Colombia Plateau, the Colorado Plateau, and the Basins and Ranges. The plateaus are characterized by a flat surface and many canyons formed from deeply down cutting rivers.

The Pacific Mountain System The Pacific Mountain System is composed of a series of mountain ranges that extend from the US-Canada border along the west coast all the way to the US-Mexico border. It is the youngest and the most active structure in the geological history of the United States. Those folded mountain ranges with steep slopes reflect the ongoing orogenic activities. The major ranges include the volcanically active Cascade Mountains, the young and steep Pacific Borders, and the Sierra Nevada Mountains which are mainly made of granites. The Cascade Mountains form curved north-south belts that extend parallel to the Pacific coastline.

2.1.2 Climates

2.1.2.1 The Climate of China

China is located between the 3° 52'N and 53° 31'N bordering the largest continent (the Eurasia Continent) in the west and facing the world's largest ocean, the Pacific Ocean., in the east. The average annual precipitation is about 650 mm which decreases from the southeast to the northwest. The seasonal distribution of the rainfall is uneven, with most of the precipitation concentrated in the summer and very little in the winter. Due to the impact of the mountain surfaces, the up-lifts of the Tibetan Plateau, and the coastal currents, the climate of China has the following characteristics:

First, the monsoon climate is significant. Under the influence of the seasonal variation of the global wind belts and the land-sea heating sources, the world's most famous monsoon region is formed in the southeast of China. Compared with the east region of the North America at the same latitude in the same Northern hemisphere, the monsoonal effect here is much more noticeable. The boundary of the monsoonal influence is along the Daxinganling—Yinshan Mountain—Helan Mountain—Wushaoling—Bayan Har—Tanggula—eastern Gangdise Mountains. Due to the control of the cold high pressure system in the land surface during the winter, this region is dominated by the northerly wind and the cold and dry climate. On the other hand, during the summer, this region is controlled by the warm low pressure system. Consequently, the southerly wind prevails and brings warm and moist weather conditions to this area. The monsoons influencing China in the summer are classified as the southeastern and southwestern monsoons. The southeastern monsoon originates from the North Pacific Subtropical High pressure system,

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