

## Exodynamic Geology

### Text A

### Weathering and Erosion

1 Rocks exposed on the earth's surface are constantly being altered by water, air, changing temperature, and other environmental factors. The term "weathering" refers to the group of destructive processes that change the physical and chemical character of rock on or near the earth's surface. The tightly bound crystals of an igneous rock<sup>(1)</sup> can be loosened and altered to new minerals by weathering. Weathering can be a mechanical or a chemical process. Often, these two types of weathering work together.

#### Mechanical Weathering

- 2 Mechanical or physical weathering involves the breakdown of rocks and soils through direct contact with atmospheric conditions such as heat, water, ice and pressure.
- 3 Water seeps into cracks and **crevices** in rock. If the temperature drops low enough, the water will freeze. When water freezes, it expands. The ice then works as a **wedge**. It slowly widens the cracks and splits the rock. When ice melts, water performs the act of erosion by carrying away the tiny rock fragments lost in the split<sup>(2)</sup>.

- 4 Mechanical weathering also occurs as rock heats up and cools down. The changes in temperature cause rock to expand and contract. As this happens over and over again, the rock weakens. Over time, it **crumbles**.
- 5 Another type of mechanical weathering occurs when clay or other materials near hard rock absorb water. The clay swells with the water, breaking apart the surrounding rock<sup>(3)</sup> (Figure 3-1).

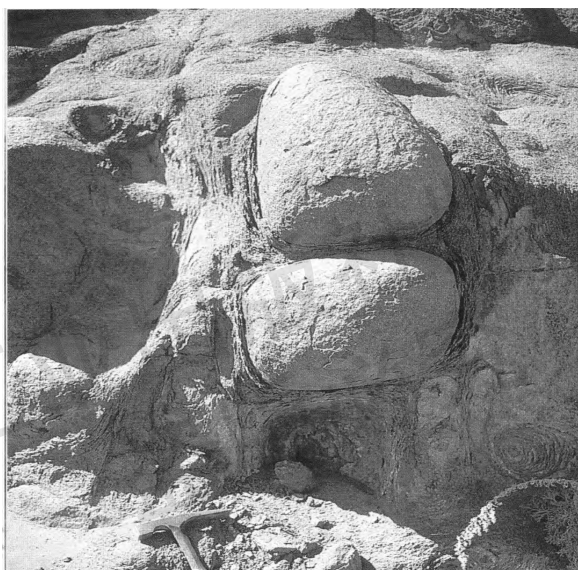


Figure 3-1 Spheroidal Weathering

- 6 Salt also works to weather rock. Saltwater sometimes gets into the cracks and pores of rock. If the saltwater **evaporates**, salt crystals are left behind. As the crystals grow, they put pressure on the rock, slowly breaking it apart.

### Chemical Weathering

- 7 The second classification, chemical weathering, involves the **decomposition** of rock from exposure to water and atmospheric gases (principally carbon dioxide and water vapor). As rock is **decomposed** by these agents, new chemical compounds form. Chemical weathering changes the materials that make up rocks and soil. Sometimes, carbon dioxide from air or soil combines with water. This produces a weak acid called carbonic acid<sup>(4)</sup>, which can dissolve rock.

- 8 Carbonic acid is especially effective at dissolving limestone. When the carbonic acid seeps through limestone underground, it can open up huge cracks or hollow out<sup>(5)</sup> vast networks of caves. Carlsbad Caverns National Park<sup>(6)</sup>, in the State of New Mexico, U.S.A, includes more than 110 limestone caves. The largest is called the Big Room. With about 1,200 meters long and 190 meters wide, it is the size of six football fields.
- 9 Sometimes, chemical weathering dissolves large regions of limestone or other rocks on the surface of the earth to form a landscape called **karst**. In these dramatic areas, the surface rock is **pockmarked** with holes, **sinkholes**, and caves. One of the world's most spectacular examples of karst is Shilin, or the Stone Forest, near Kunming, China. Hundreds of slender, sharp towers of limestone rise from the landscape.
- 10 Another type of chemical weathering works on rocks that contain iron. These rocks rust in a process called **oxidation**. As the rust expands, it weakens the rock and helps break it apart.
- 11 Erosion is the process by which soil and rock are removed from the earth's surface by **exogenetic** processes such as wind or water flow, and then transported and deposited in other locations.

### Erosion by Water

- 12 Moving water is the major agent of erosion. Rain carries away bits of soil and slowly washes away rock fragments. Rushing streams and rivers wear away<sup>(7)</sup> their banks, creating larger and larger valleys. In a span of about 5 million years, the Colorado River<sup>(8)</sup> cut deeper and deeper into the land in what is now the U.S. state of Arizona. It eventually formed the Grand Canyon<sup>(9)</sup>, which is more than 1,600 meters deep and as much as 29 kilometers wide in some places.
- 13 Erosion by water changes the shape of coastlines. Waves constantly crash against shores. They pound rocks into **pebbles** and **reduce** pebbles to sand. Water sometimes takes sand away from beaches. This moves the coastline farther inland.
- 14 The battering of ocean waves also erodes seaside cliffs. It sometimes bores holes that form caves. When water breaks through the back of the cave, it creates an **arch**. The continual pounding of waves can cause the top of the arch to fall, leaving nothing but rock columns. These are called sea stacks<sup>(10)</sup>. All of these features make rocky beaches beautiful, but also

dangerous.

### Erosion by Wind

- 15 Wind is also an agent of erosion. It carries dust, sand, and volcanic ash from one place to another. Wind can sometimes blow sand into **towering dunes**. Some sand dunes in some areas of the Gobi Desert<sup>(11)</sup> in China reach more than 400 meters high.
- 16 In dry areas, windblown sand blasts against rock with tremendous force, slowly wearing away the soft rock. It also polishes rocks and cliffs until they are smooth.
- 17 Wind is responsible for the dramatic arches that give Arches National Park<sup>(12)</sup>, in the U.S. state of Utah, its name. Wind can also erode material until nothing remains at all. Over millions of years, wind and water eroded an entire mountain range in central Australia. Uluru<sup>(13)</sup>, also known as Ayers Rock<sup>(14)</sup>, is the only **remnant** of those mountains.

### Erosion by Ice

- 18 Ice can erode land. In **frigid** areas and on some mountaintops, glaciers move slowly downhill and across the land. As they move, they pick up everything in their path, from tiny grains of sand to huge boulders.
- 19 The rocks carried by a glacier rub against the ground below, eroding both the ground and the rocks. Glaciers grind up<sup>(15)</sup> rocks and scrape away the soil. Moving glaciers gouge out<sup>(16)</sup> basins and form steep-sided mountain valleys.
- 20 Today, in places such as Greenland and Antarctica, glaciers continue to erode the earth. These ice sheets, sometimes more than a mile thick, carry rocks and other debris downhill toward the sea. Eroded sediment is often visible on and around glaciers. This material is called **moraine**.
- 21 It is important to distinguish between weathering and erosion. Weathering breaks down rocks that are either stationary or moving. Erosion is the picking up or physical removal of rock particles by an agent such as streams, wind or glaciers. Weathering helps break down a solid rock into loose particles that are easily eroded. Most eroded rock particles are at least partially weathered, but rock can be eroded before it has been weathered at all. A stream can erode weathered or unweathered rock fragments. Far more erosion occurs naturally, and a combination of weathering and erosion is responsible for

producing the soil from which earth's plants grow.

- 22 Weathering and erosion slowly **chisel**, polish, and **buff** the earth's rock into ever evolving works of art – and then wash the remains into the sea.
- 23 Working together, they create and reveal marvels of nature from tumbling boulders high in the mountains to sandstone arches in the **parched** desert to polished cliffs braced against violent seas.

### New words

crevice /'krevɪs/	<i>n.</i> 裂缝; 裂隙
wedge /wedʒ/	<i>n.</i> 楔形物
crumble /'krʌmbəl/	<i>vi.</i> 崩溃; 破碎, 崩解 <i>vt.</i> 崩溃; 弄碎, 粉碎
evaporate /ɪ'væpəreɪt/	<i>vt.</i> 蒸发; 使……脱水; 使……消失 <i>vi.</i> 蒸发, 挥发; 消失, 失踪
decomposition /,di:kəmpe'zɪʃən/	<i>n.</i> 分解, 腐烂; 变质
decomposed /,di:kəm'pəuzd/	<i>adj.</i> 已腐烂的, 已分解的
karst /kɑ:st/	<i>n.</i> 喀斯特(石灰岩地区常见的地形); 岩溶
pockmark /'pɒkma:k/	<i>n.</i> 麻子; 凹坑 <i>vt.</i> 使留下痘疤; 使有凹坑
sinkhole /'sɪŋkhəʊl/	<i>n.</i> 落水洞; 灰岩坑
oxidation /,ɒksɪ'deɪʃn/	<i>n.</i> [化] 氧化
exogenetic /'eksəʊdʒɪ'netɪk/	<i>adj.</i> 外生的; 外因的; 外源性的
pebble /'pebl/	<i>n.</i> 砾石, 鹅卵石 <i>v.</i> (用卵石等) 铺
reduce /rɪ'dju:s/	<i>vt.</i> 缩减; 简化; 还原
arch /ɑ:tʃ/	<i>n.</i> 弓形, 拱形; 拱门 <i>vt.</i> 使……弯成弓形; 用拱连接 <i>vi.</i> 拱起; 成为弓形
towering /'tauəərɪŋ/	<i>adj.</i> 高耸的; 卓越的; 激烈的
dune /dju:n/	<i>n.</i> (由风吹积而成的) 沙丘
remnant /'remnənt/	<i>n.</i> 剩余部分

frigid /'frɪdʒɪd/	<i>adj.</i> 剩余的
moraine /mə'reɪn/	<i>adj.</i> 寒冷的, 严寒的
chisel /'tʃɪzəl/	<i>n.</i> 冰碛; (熔岩流表面的) 火山碎屑
	<i>vt.</i> 雕, 刻; 凿; 欺骗
	<i>vi.</i> 雕, 刻; 凿; 欺骗
	<i>n.</i> 凿子
buff /bʌf/	<i>vt.</i> 软皮摩擦; 缓冲; 擦亮, 抛光某物
parched /pɑ:tʃt/	<i>adj.</i> 焦的; 炎热的; 炒过的; 干透的
	<i>vt.</i> 烘干; 使极渴 (parch 的过去分词)

### Notes to the text

- (1) igneous rock: 火成岩
- (2) When ice melts, water performs the act of erosion by carrying away the tiny rock fragments lost in the split.  
译文: 当冰融化时, 水便带走留在裂缝中的细小岩石碎片完成侵蚀作用。
- (3) surrounding rock: 围岩
- (4) carbonic acid: 碳酸
- (5) hollow out: 挖空
- (6) Carlsbad Caverns National Park: (美) 卡尔斯巴德洞窟国家公园
- (7) wear away: 磨损; 消磨; 流逝
- (8) the Colorado River: (美) 科罗拉多河
- (9) the Grand Canyon: (美) 大峡谷
- (10) sea stacks: 海蚀柱; 海柱
- (11) the Gobi Desert: 戈壁沙漠
- (12) Arches National Park: (美) 拱门国家公园
- (13) Uluru: 乌鲁鲁 (澳大利亚艾尔斯岩, 世界最大的单体巨石)
- (14) Ayers Rock: (澳) 艾尔斯巨石
- (15) grind up: 磨碎
- (16) gouge out: 挖出; 凿槽

**Understand the text**

Answer the following questions according to the passage you have read.

- (1) What is the definition of weathering?
- (2) How do atmospheric factors affect the process of mechanical weathering?
- (3) In what ways does chemical weathering work on rocks?
- (4) How many agents of erosion are mentioned here? What are they?
- (5) How does erosion by water change the shape of coastlines?
- (6) What forms sand dunes in some areas of the Gobi Desert?
- (7) How can ice erode the land?
- (8) How do you distinguish between weathering and erosion?

**Translation**

1. Translate the following sentences into Chinese.

- (1) The tightly bound crystals of an igneous rock can be loosened and altered to new minerals by weathering.

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- (2) The changes in temperature cause rock to expand and contract. As this happens over and over again, the rock weakens. Over time, it crumbles.

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(3) Carbonic acid is especially effective at dissolving limestone. When the carbonic acid seeps through limestone underground, it can open up huge cracks or hollow out vast networks of caves.

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(4) The battering of ocean waves also erodes seaside cliffs. It sometimes bores holes that form caves.

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(5) Weathering and erosion slowly chisel, polish, and buff the earth's rock into ever evolving works of art—and then wash the remains into the sea.

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**2. Translate the following passage into English.**

全球变暖，世界各地的温度升高，正在加快侵蚀的速度。气候的变化也与更频繁、更剧烈的风暴联系起来。伴随着飓风与台风后的风暴潮可能侵蚀数英里的海岸线和沿海栖息地。这些沿海地区有家园、企业，以及经济上重要的产业，比如渔场。温度的升高也迅速融化着冰川，这就造成了海平面上升的速度超出了生物可以适应的程度。上升的海平面会更迅速地侵蚀沙滩。据估计，海平面上升 8~10 厘米引起的侵蚀将足以威胁到建筑物、下水道系统、道路和隧道。





viewpoints to consider?

**WHERE** is your topic important: at the local, national or international level? Are there specific places affected by the topic?

**WHEN** is/was your topic important? Is it a current event or an historical issue?

### **3. Analyze the chosen topic**

A manageable topic is a topic that isn't too broad or too narrow. If the topic is too broad, you need to narrow down the scope of topic and make it specific. Many of the research topics you find through internet search are too general and could involve many different aspects. For example, "Weathering and Erosion", the topic of Text A in Unit 3 is an appropriate topic for an expository writing about popular science, but it may be an extremely broad topic for a study of academic writing. It is unclear whether you need to write about the phenomena of weathering and erosion around the world, or you should focus on the phenomena of weathering and erosion in a particular country, or you attach much attention to the effects of weathering and erosion bring about on geologic formation. You also need to indicate the domain in which the two phenomena you are demonstrating fall. Therefore, you may narrow down your topic as "A Study of Weathering and Erosion of Rock Slope in Chengdu". It is narrow enough, but this topic is also problematic since the addition of a location to this topic may result in very few results, which means the topic is too narrow to extend further. Depending on the type of research you are conducting, you may focus your study on a larger geographic limit. A better choice would be "A Study of Weathering and Erosion of Rock Slope in Sichuan Basin".

### **4. Read and research more about your topic**

Once you have chosen a topic, find relevant information about it. You can browse through some current journals in your subject discipline. You only need one to be the spark that begins the process of wanting to learn more about a topic. List the key words describing your topic and do the search. Summarize the background information about

your topic and note down the important people and the important works in the field. When all your criteria fail, go back and generate other topics. Don't give up easily. There are lots of topics within your niche. In addition, make sure there are adequate sources available on the topic. Even when your topic is appropriate, if there are no materials on it, it will be impossible to write about.

**Writing practice**

You may try to find out some research topics based on Text A.

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## Text B

### Fluvial Process

- 1 Fluvial<sup>(1)</sup> processes comprise erosion and transportation of sediment or deposition on river bed.
- 2 Fluvial erosion is the removal of rock and other mineral particles from channel beds<sup>(2)</sup> and banks by stream flow. There are various types of erosion. Abrasion<sup>(3)</sup> is the grinding effect of a channel caused by sediments in the process of being transported. The material being transported undermines<sup>(4)</sup> river banks and valley slopes. However, the sediment itself is eroded by colliding with other pieces of material, which is known as attrition<sup>(5)</sup>. Hydraulic action<sup>(6)</sup> is the erosive effect of flowing water without assistance of rock particles. The shear force of the flow causes erosion to occur. This type of erosion is most effective in areas of channels which consist of incoherent materials, such as sand and gravel. Cavitations<sup>(7)</sup> occur when tiny bubbles of air implode<sup>(8)</sup> in fissures<sup>(9)</sup> and cracks in channel banks. The tiny shock waves result in the weakening of river banks and the collapse of landforms. Corrosion<sup>(10)</sup> is a chemical action of stream water, which dissolves carbonate rocks such as chalk and limestone.
- 3 A river has three main stages: sediment supply zone, sediment transport zone and sediment storage zone. Within these three stages various erosions occur at each stage.
- 4 Within sediment supply zone, erosion is mainly directed vertically and headward, which is due to the river not having a lot of spare energy as it is using 90% of its energy to overcome obstacles such as large rocks and boulders. This erosion leads landforms such as rapids<sup>(11)</sup>, small waterfalls and steep river bed to form (Figure 3-2) .
- 5 Within sediment transport zone, it is mostly corrosion and attrition that occur due to the sediment being transported and colliding with both the channel bed and with each other. However, there is little hydraulic power and corrosion still taking place at this stage. Due to the river having fewer obstacles to overcome, it has more spare energy to erode more laterally rather than vertically, widening the river channel. This erosion leads to the

development of landforms such as rapids, small meanders<sup>(12)</sup>, small floodplains<sup>(13)</sup>, pools and riffles<sup>(14)</sup>.

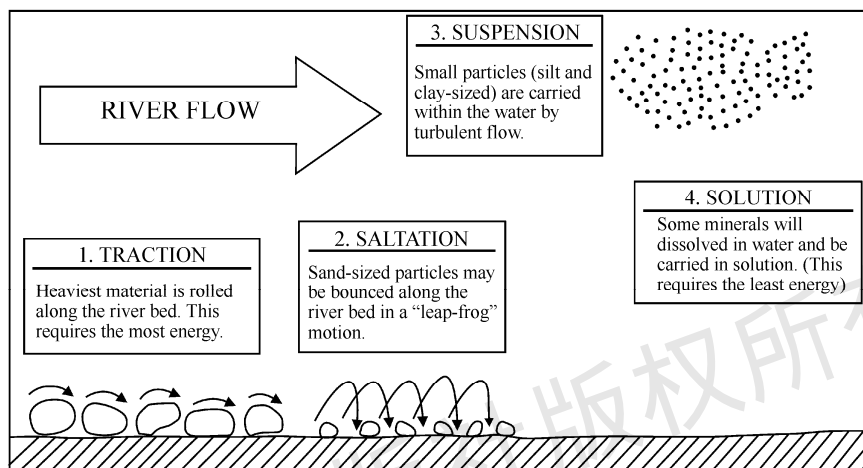


Figure 3-2 River Processes: Transportation

- 6 In sediment storage zone, less even no erosion occurs besides some lateral erosion<sup>(15)</sup> on the outside bends of meanders. This leads to the development of larger meanders and floodplains.
- 7 Solid and soluble particles eroded from channel, together with materials input by mass movements and weathering from valley slopes, are transported down the stream (from the upper stage to the lower stage). The material transported by a river is carried as either bedload<sup>(16)</sup> – the coarser particles that move near to river bed or suspended load<sup>(17)</sup> – the smaller particles which are carried in water. Another material which is carried by river in fluvial processes is dissolved material.
- 8 Material may be transported by a river in four main ways: solution, suspension, saltation<sup>(18)</sup> and traction<sup>(19)</sup>.
- 9 The type of transport taking place depends on the size of sediment and the amount of energy that is available to undertake the transport. In the upper course of the river there is more traction and saltation going on due to the large size of the bedload; as the river enters its middle and lower course there is a lot of finer material eroded from further upstream which will be carried in suspension.
- 10 River deposition is where the material carried by river is dropped. A river is continually

picking up and dropping solid particles of rock and soil from its bed throughout its length. When the river flows fast, more particles are picked up than dropped. When the river flows slowly, more particles are dropped than picked up. Areas where more particles are dropped are called alluvial<sup>(20)</sup> or flood plains, and the dropped particles are called alluvium<sup>(21)</sup>.

- 11 Even small streams make alluvial deposits, but it is in the flood plains and deltas<sup>(22)</sup> of large rivers that large, geologically-significant alluvial deposits are found.
- 12 The amount of matter carried by a large river is enormous. The names of many rivers are derived from the color that the transported matter gives the water. For example, the Huang He in China is literally translated as “Yellow River”, and the Mississippi River in the United States is also called “the Big Muddy.” It has been estimated that the Mississippi River annually carries 406 million tons of sediment to the sea, the Huang He 796 million tons, and the Po River in Italy 67 million tons.

### Notes to the text

(1) fluvial /'flu:vɪəl/ *adj.* 河流的; 冲积的

(2) channel bed: 河床

(3) abrasion /ə'breɪʒn/ *n.* 磨蚀, 海蚀, 浪蚀, 研磨

(4) undermine /ʌndə'maɪn/ *vt.* 渐渐破坏

(5) attrition /ə'trɪʃn/ *n.* 摩擦; 磨损

(6) hydraulic action: 水力作用

(7) cavitation /,kævɪ'teɪʃ(ə)n/ *n.* 成穴; 空化作用; 气蚀; 空穴现象

(8) implode /ɪm'pləʊd/ *vt.* 向内破裂; 内爆; 突然崩溃; 向心聚爆; 向内坍塌

(9) fissure /'fɪʃə(r)/ *n.* 裂缝; 裂沟 (尤指岩石上的)

(10) corrosion /kə'rəʊʒn/ *n.* 腐蚀

(11) rapids /'ræpɪdz/ *n.* [水文] 急流; 湍流

(12) meander /mi'ændə(r)/ *n.* 曲流 (常用复数); 河曲

(13) floodplain /'flʌdpleɪn/ *n.* 泛滥平原, 漫滩, 洪积平原

(14) riffle /'rɪfl/ *n.* 浅滩

(15) lateral erosion: 侧蚀; 旁蚀

- (16) bedload /'bedləud/ *n.* 推移质
- (17) suspended load: 悬移质
- (18) saltation /sæl'teɪf(ə)n; sɔ:-; sɒ-/ *n.* 突变; (水中砂粒) 跃移; 不连续变异
- (19) traction /'trækʃn/ *n.* 拖拉, 牵引; 拉曳
- (20) alluvial /ə'lu:vɪəl/ *adj.* 冲积的
- (21) alluvium /ə'lu:vɪəm/ *n.* [地质] 冲积层, 冲积土
- (22) delta/'deltə/ *n.* (河流的) 三角洲

### Questions for review

- (1) The sediment itself is eroded by colliding with other pieces of material, which is known as \_\_\_\_\_.
- A. hydraulic action
- B. cavitations
- C. corrosion
- D. attrition
- (2) Within the sediment transport zone, the river has more spare energy to erode more \_\_\_\_\_.
- A. vertically
- B. laterally
- C. headward
- D. backward
- (3) In the sediment storage zone, which one of the following landforms does the erosion lead to?
- A. Rapids.
- B. Small waterfalls.
- C. Larger meanders.
- D. Pools and riffles.
- (4) The \_\_\_\_\_ material transported by a river is called bedload.
- A. coarser
- B. smaller

- C. dissolved  
D. bigger
- (5) When a river enters its middle and lower course there is a lot of finer material eroded from further upstream which will be carried in \_\_\_\_\_.
- A. solution  
B. suspension  
C. saltation  
D. traction
- (6) Why is the erosion mainly directed vertically and headward within the sediment supply zone?
- (7) What kinds of landforms can be developed when corrosion and attrition occur?
- (8) What does the way of material transport in a river depend on?

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