LAB EXERCISE 15 - RIVERS & EROSION

Introduction

Through millions of years of earth history, agents of erosion have been working to constantly reduce the land masses to the level of the oceans. Of these agents, running water is the most important. Every part of the surface of the earth either has running water in streams and rivers or else shows evidence of running water in the recent past (canyons and gullies in arid regions).

Stream valleys and even entire regions appear to pass through a series of stages as erosion progresses. This cycle of erosion provides us with a qualitative description of river valleys and of regions which can be divided into stages of youth, maturity and old age. Each of these stages has certain general characteristics, but it is impossible to draw sharp lines between stages in the evolution of a stream valley or of a region.

Stream Valleys

A youthful stream valley is rapidly eroding its channel. The valley floor is hardly any wider than the stream itself and the valley has a V-shaped cross-valley profile. The stream's gradient is steep and non-uniform, marked by falls and rapids sometimes alternating with pools or even lakes.

In mature valleys, less downward and more lateral erosion occurs as the valley approaches its base level. Mature streams have graded profiles without rapids and falls. Streams may meander across a narrow flood plain in the wide, flat-bottomed valley.

Old age streams flow in meanders across a broad flood plain which is much wider than the meander belt. The valley slopes are gentle and the stream is at or very near its base level of erosion. Oxbow lakes, meander scars and natural levees are more common now that they were during the stream's maturity.

The Regional Erosion Cycle

The cycle of erosion can be applied to the evolution of an entire region as well as to individual valleys. The controlling factor is base level which we can think of as a plane or surface extending inland from the ocean and rising very gently. Erosion of the land works down toward this imaginary surface, although it may never be actually reached. The regional cycle can be thought of as the beginning with rapid uplift of a land mass, followed by a period of stability during which running water, mass movement and other processes erode the land mass ever lower toward the regional base level.

During the youthful stage of a region, streams cut rapidly downward forming narrow, steep-sided valleys. Broad, flattish intervalley uplands may contain lakes or marshes in humid regions. Generally, less than one-third of the task of reducing the entire area to base level has been accomplished.

In the mature stage of a region, its valleys are youthful to mature and are separated by narrow ridges or rounded summits. There is a maximum amount of sloping land and the maximum total relief in this stage of erosion. The network of stream channels reaches all parts of the region which ordinarily has no lakes or ponds. In the mature stage the task of reducing the area to base level is generally from one-third to two-thirds accomplished.

The old stage of a region is characterized by gently rolling topography with old age streams meandering across very broad floodplains on which oxbow lakes and marshes are common. In the old age stage, the task of reducing the entire area to base level is more than two-thirds accomplished. The broad, gently rolling plain near the base level is called a *peneplain.*

Arid Regions

Arid regions undergo a cycle of erosion which produces different characteristic landforms because of the different characteristics of arid region erosion. There is a strong tendency toward parallel retreat of mountain fronts in arid regions. The gentle slope in front of the mountains is commonly an erosion surface which has a gradient similar to the longitudinal profile of mountain streams. This slope is called a *pediment* and is a surface coated with a relatively thin veneer of gravel. In retreat of the steep front of a range, segments of rock may resist erosion and stand above the surrounding pediment surface. These erosional remnants are known as *inselbergs.*

Instructions

Read the introduction to this lab exercise and the corresponding parts of your textbook. Then answer the following questions concerning the indicated aerial photographs and topographic maps.

Questions

Alma, Wisconsin/Minnesota (map #107)

1. In the topographically higher area east of the Mississippi River Valley, what general difference exists between the land surface *above 1200* feet in elevation and that *below 1200* feet in elevation? Please explain this difference.

2. Will the land surface above *1200* feet elevation increase or decrease in area as time goes on? Why?

3. Why does the Mississippi River appear different in the lower half versus the upper half of the map?

4. What separates Peterson Lake from the main channel of the Mississippi River in the upper part of the map?

5. In the southwest corner of the map, why are the swamps generally farther away from the river, with higher land along the river bank?

6. The town of Kellogg lies almost entirely west of the Chicago-Milwaukee-St. Paul and Pacific railroad track. Why aren't there more houses on the vacant land east of the tracks?

7. What would happen to Buffalo River and its valley if the Lock and Dam No. 4 (7 ft. high) were removed?

Kettle Creek, Pennsylvania (photo #5)

8. What is the geomorphic name of the high, rather flat surface in this area? (see introduction)

About what elevation is it?

9. Explain using sketches how Oxbow Bend was formed, giving all the stages leading to its present configuration.

Susquehanna River, Pennsylvania (photo #6)

10. What type of rock probably underlies this area (igneous, sedimentary or metamorphic)?

Why do you think so?

11. Are the rocks in this area simply tilted or are they tilted and also folded? (Note the oblique ("at an angle") photo)

12. Before the present stage of erosion, this area was a broad peneplain. Part of this uplifted peneplain is still preserved although most of it has been eroded away. What is the present elevation of these remnants of the old peneplain?

About how high are the peneplain remnants above the present valley floor?

13. Do you think that the present course of the Susquehanna River was established on the old peneplain and has simply eroded down during the present stage of erosion, or do you think: it was established more recently, when the erosion surface was similar to what it is today?

Why?

P*romontory Butte, Arizona (map #14)*

1. The Mogollon Rim in the middle of this map marks the southern edge of the upwarped Colorado Plateau. Notice that streams north of the Mogollon Rim flow north and that those to the south flow southward. Measure the gradients (foot/mile) of 3 streams on the north side and 3 streams on the south.

   North: _____ _____ _____

   South: _____ _____ _____

   On which side are the gradients steepest?

15. Will the drainage divide move generally toward the north, toward the south, or remain more or less fixed with the passage of time? Explain your answer.

16. Give the elevations of the following springs:

    Tonto Spring _____

    Horton Spring _____

    Nappa Spring _____

    See Spring _____

    How could you explain the similarity in elevation of all these springs?

Menan Buttes, Idaho (map #33)

17. Based on their shapes and locations, how do you think the closed depressions in section 12 originated?

18. What does the blue pattern in the north center of section 11 indicate?

19. What does the pattern on the inside of the river bend in Southeast 1/4 section 35 indicate?

20. What type of rock is present in section 3?

    What type of rock underlies section 12?

21. What is the origin of the closed depression in section 3 and section 10?

Ennis, Montana (map #58) - This map shows a well-developed alluvial fan deposited at the foot of the mountains.

22. Why are the lines on the alluvial fan so evenly spaced?

23. What are the slight irregularities seen on each of these contour lines?

24. Why does the main creek branch into several different channels flowing in different channels flowing in different directions near Lawton Ranch?

25. What is the purpose of the *Cedar Creek aqueduct* and the ditch in sections 30 and 32 in the top center of the map?

26. What would you call the flat surface in the southwest corner of the map?

How was it formed?

East Brownsville, Texas (map #91)

27. What type of lakes are those at Fort Brown Resaca, Los Tomates Banco, etc.?

28. What is the elevation (above sea level) of the water table just east of the sewage disposal plant?

29. Exactly how far would you have to dig to reach the water table at the intersection 4/10 mile east of Four Corners on Boca Chica Highway?

What type of material would you have to dig through to make this well?

Do you think this well could need a casing to prevent the walls from caving in? Why?

Antelope Peak, Arizona (map #12)

30. In the east-central part of this map the uniform contour spacing is interrupted by several isolated hills that rise 100 to 200 feet above the level of the erosional surface. What is the origin of these features?

31. Starting in the center of the map, what is the gradient (in feet per mile) of the pediment between the southwest corner section 34 and the northeast corner section 26?

Arrow Canyon Range, Nevada (photo #35)

32. What type of rock underlies the flat parts of this area?

    What type of rocks underlie the mountains in this area (note the north edge of the main range and the hills in the upper right hand comer)?

33. What are the small dark dots in the upper parts of the canyon in the mountains?

34. Please explain why the lower parts of the canyons (in the valley) are braided.