

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY

How to construct two paper models showing the effects of  
glacial ice on a mountain valley

by

Tau Rho Alpha<sup>\*</sup>

Open-File Report 89-190A

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This report contains instructions and templates for preparing three-dimensional paper models of two features a mountain valley partly filled by a glacier and the same valley after the glacier has melted. Included are brief descriptions of how such glaciers form, how they erode the landscape, and what kinds of physiographic features they produce. The models are intended to help students and others visualize these features and understand how they formed.

The date of this Open-File Report is April 16, 1989.

OF89-190-A, paper copy, 19p. OF89-190-B, 3.5-in. diskette.

Purchasers of the diskette **version 2** of this report, which includes all of the text and graphics, can use HyperCard 2.0™ software (not supplied) to change the model (by adding geologic patterns, symbols, colors, etc.) or to transfer the model to other graphics software packages\*.

Requirements for the diskette **version 2** are: Apple Computer, Inc., HyperCard 2.0™ software, and an Apple Macintosh™ computer. If you are using System 7, we recommend using at least 3 MB of RAM with 1.5 MB of system memory available for HyperCard.

To see the entire page (card size: MacPaint), use the mouse to move the cursor to the menu "Go" and click on "Scroll".

If you are experiencing trouble with user level buttons. Bring up the message box. Type "magic" in the message box and press return. Three more user level buttons should appear.

The date of **version 2** of this Open File Report is Feb. 7, 1992. OF 92-200-A, paper copy, 22p. OF 92-200-B, 3.5-in.

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## Introduction

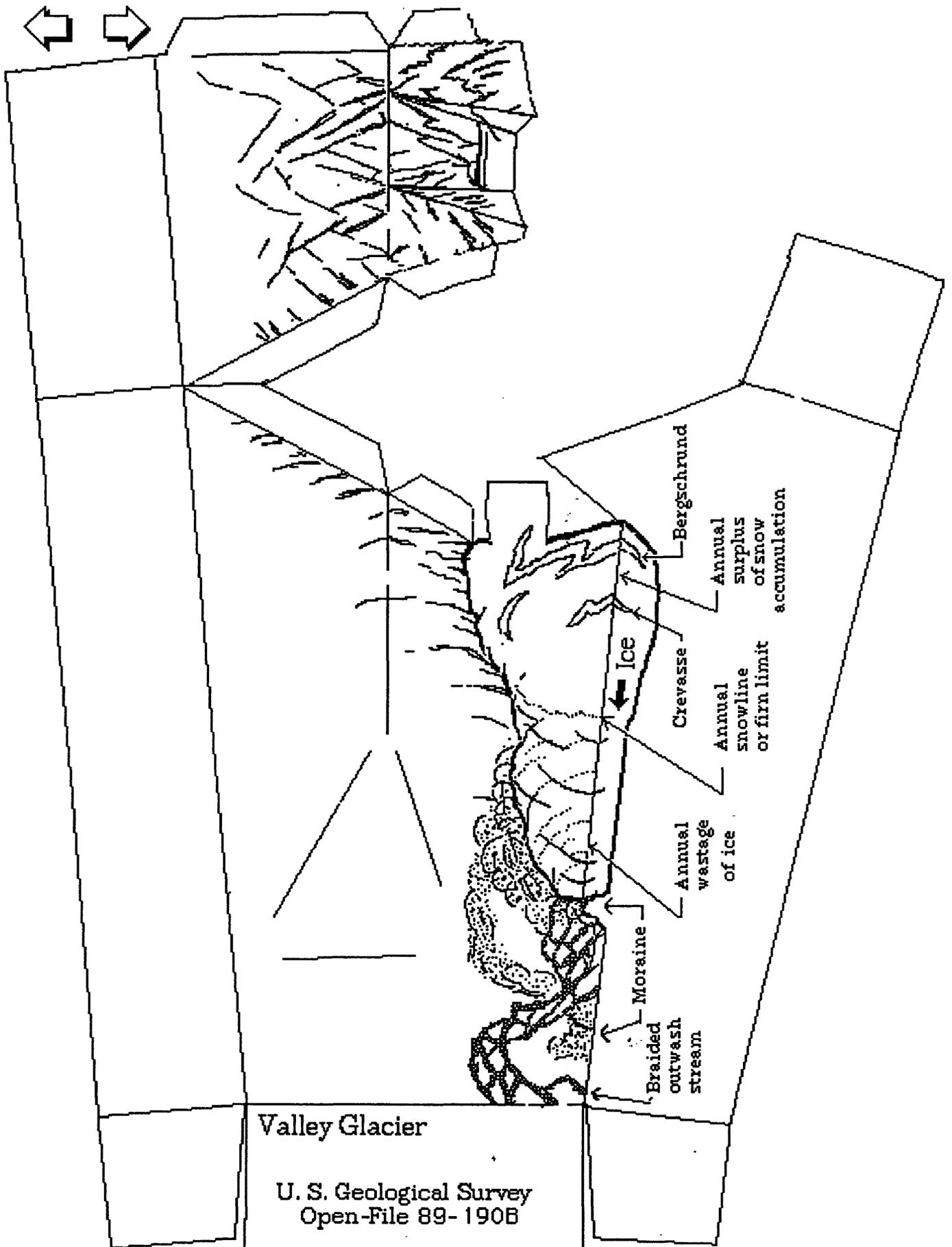
Without proper training, most observers have difficulty visualizing or interpreting the landforms shown on a topographic contour map. With a three-dimensional model, however, an untrained observer can visualize the topographic features and can more easily understand how they might have formed. With skillful portrayal of subsurface rock type or surface material, the model landforms appear even more realistic. Models can be used as effective teaching aids for students who are learning to sketch both broad landscapes and individual landforms.

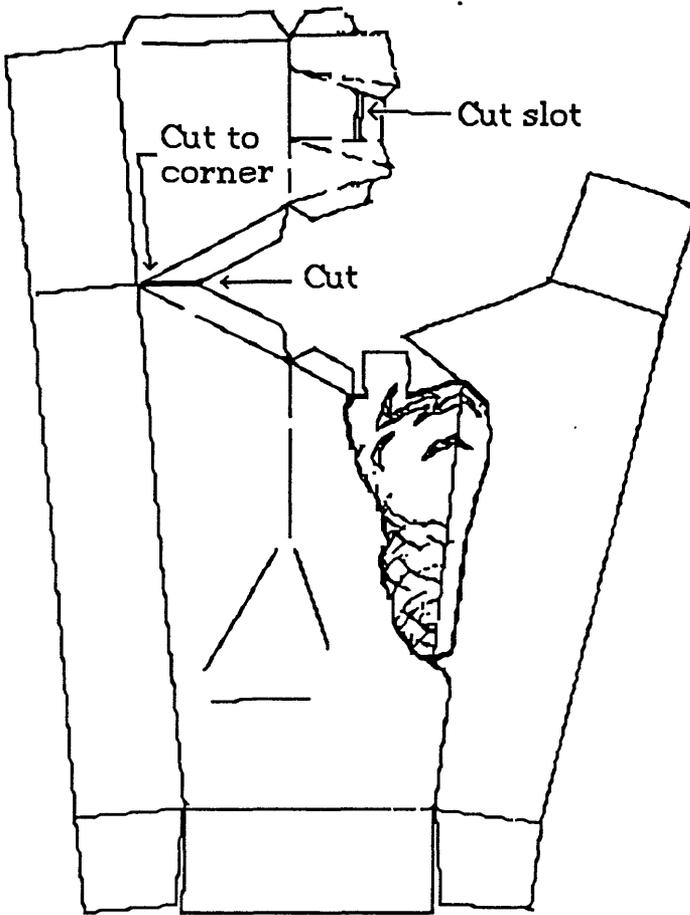
These two paper models, "Valley glacier" and "Cirque and glacial valley", enable an observer to visualize a mountain valley with and without ice, allowing a better understanding of the geologic structures associated with and produced by moving ice.

## Valley Glacier

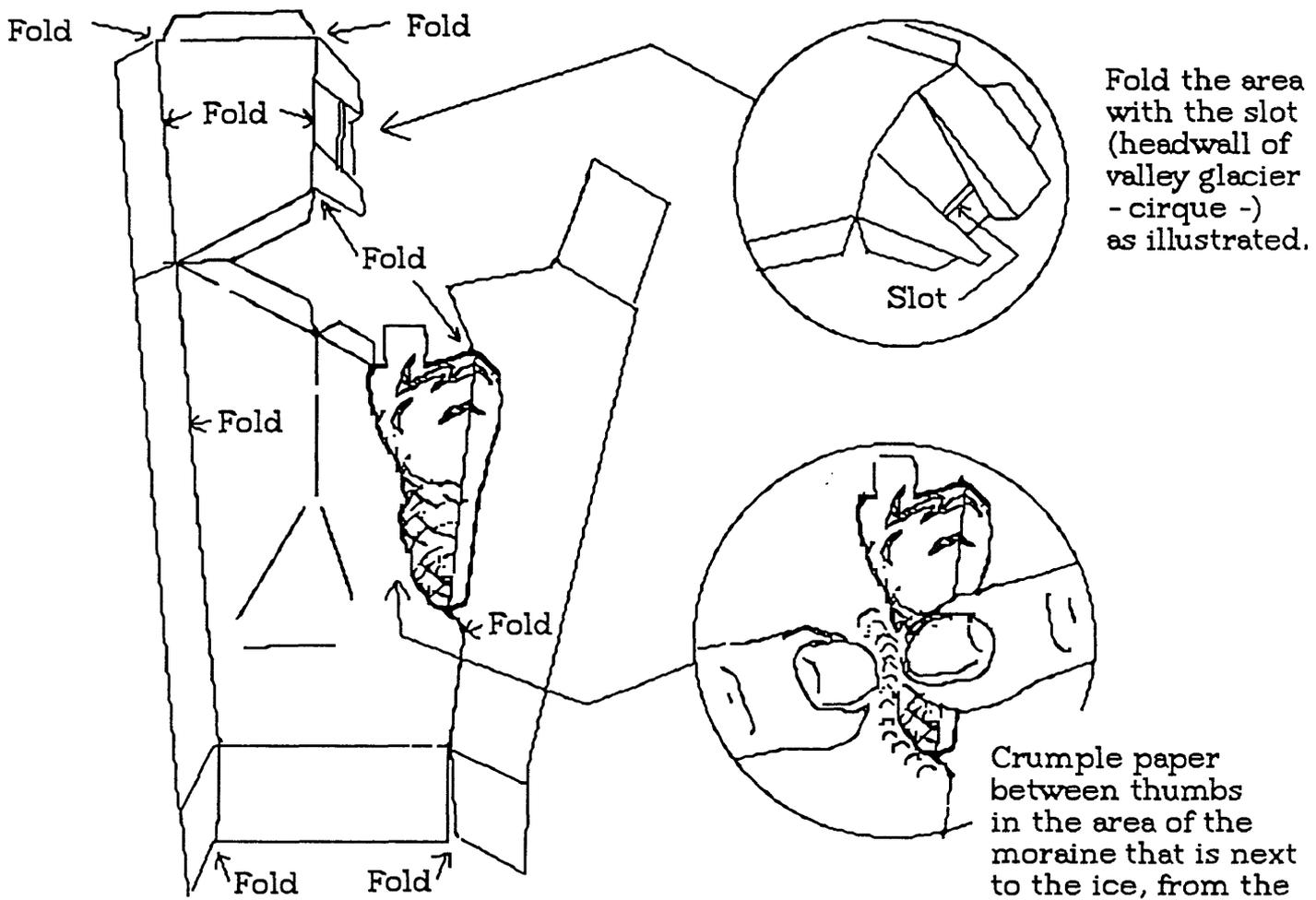
Glaciers start where the snowfall exceeds the amount of snow that melts. Snow that has laid on the ground for a long time is recrystallized into solid ice by the compaction and pressure from more fresh snow. When enough snow and ice have accumulated, the ice under the influence of gravity flows downhill. The part of a glacier that is at higher elevation is known as the area or zone of accumulation, and that part at lower elevations is known as the zone of wastage. The area between the zones of accumulation and wastage is called the firn limit or annual snowline, which is where the annual loss by evaporation and melting is greater than the annual accumulation of fresh snow. The glacier can exist below the annual snowline because of the pressure from the ice at the higher elevation in the zone of accumulation. Where the glacier stops, more ice is melting than is being pushed down from the zone of accumulation. When a glacier retreats, it does not flow back up hill, but simply melts away.

At the head of the valley glacier, meltwater pours down between the glacier and the headwall and down the bergschrund and into the joints and cracks in the headwall. As the water freezes and the glacier moves downhill, it plucks rock from the headwall and carries this rock debris down the valley. This removal of bedrock produces a bowl-shaped depression called a cirque. Some rock debris lies on the surface of the glacier, but most debris is frozen inside the glacier. This imbedded rock debris is what gives a glacier its ability to erode the underling material. When a glacier erodes a bedrock surface, it smooths and polishes the bedrock and may leave grooves or scratches called striations. Rock debris is pushed along the sides of the glacier and deposited on the valley slopes as lateral moraines; in front of the glacier, the rock debris is deposited as recessional or terminal moraines. In some areas such as the Alps in Europe, and the Rocky Mountains in North America, valley glaciers are the main erosional force responsible for the rugged relief and beauty of the mountain landscape.





**Step 1** Cut out the paper landform by cutting along its borders. Cut one slot in the upper part of the model.

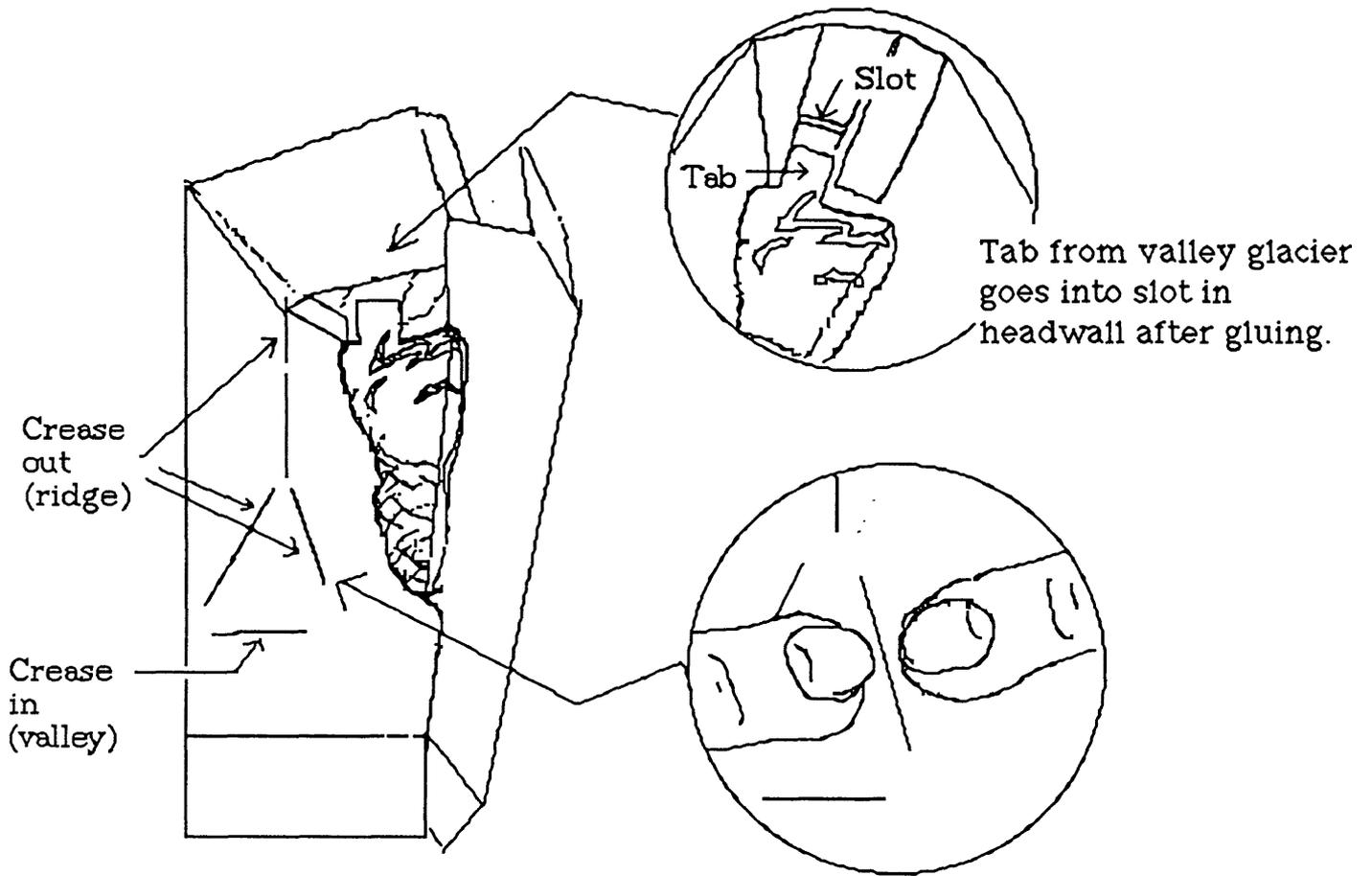


Fold the area with the slot (headwall of valley glacier - cirque -) as illustrated.

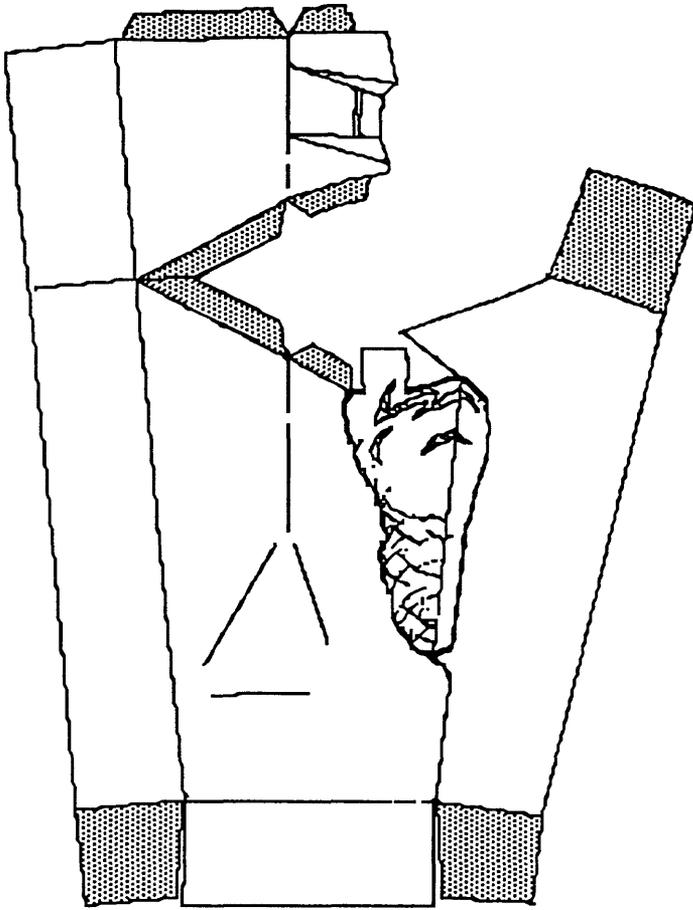
Slot

Crumple paper between thumbs in the area of the moraine that is next to the ice, from the end of the moraine to the edge of the model.

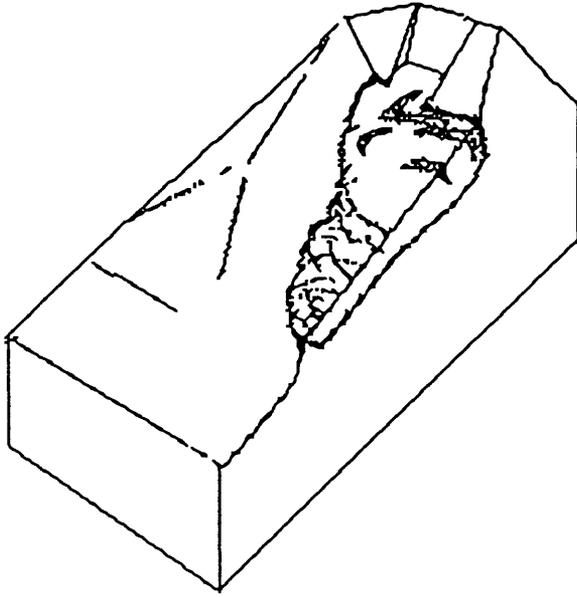
**Step 2** Fold the paper landform along the marked lines so the printed side faces outward.



**Step 3** Crease the paper landform along the marked lines.



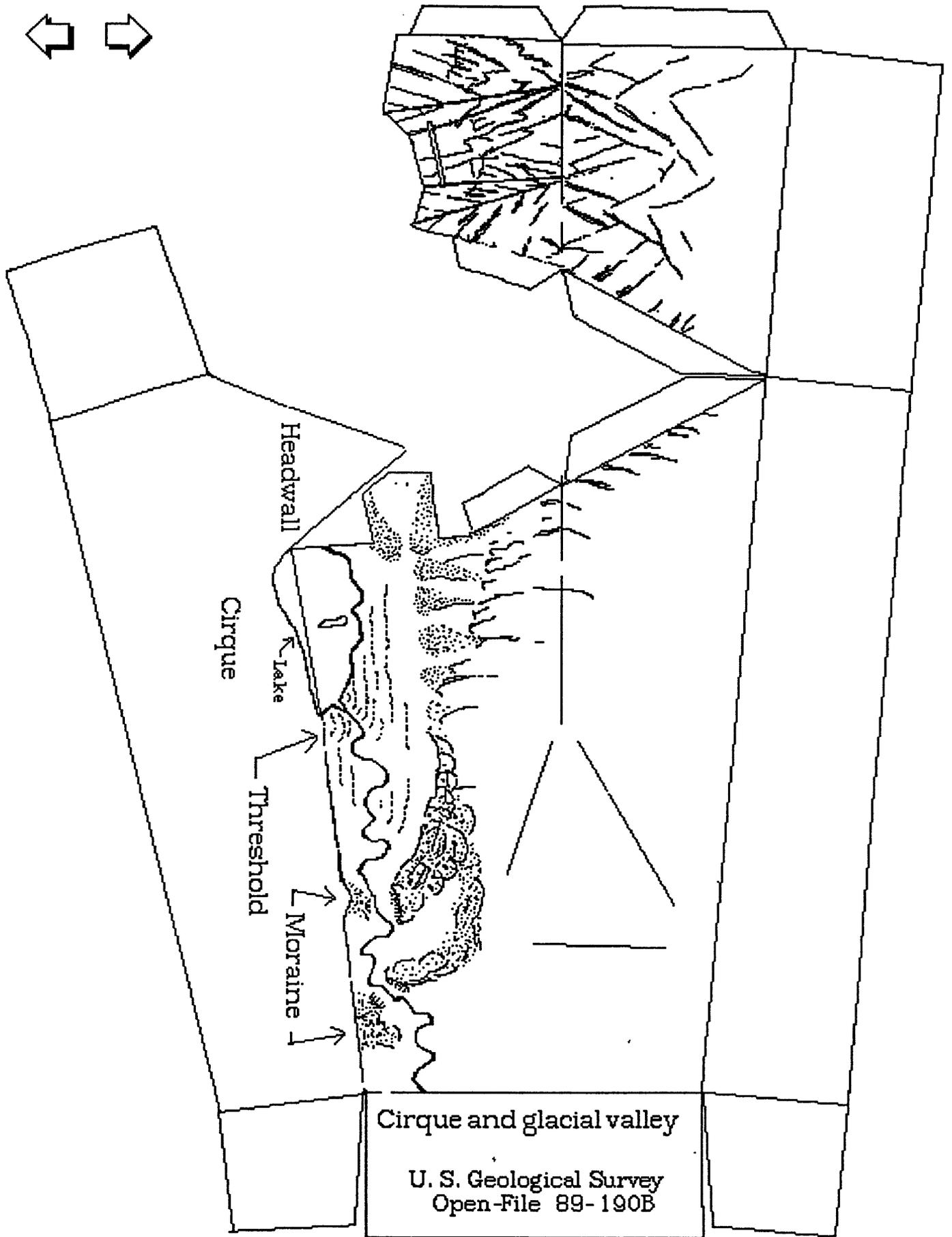
**Step 4** Glue the paper landform by applying glue to the gray tabs.



**Step 5** The assembled glued paper landform should look like this.

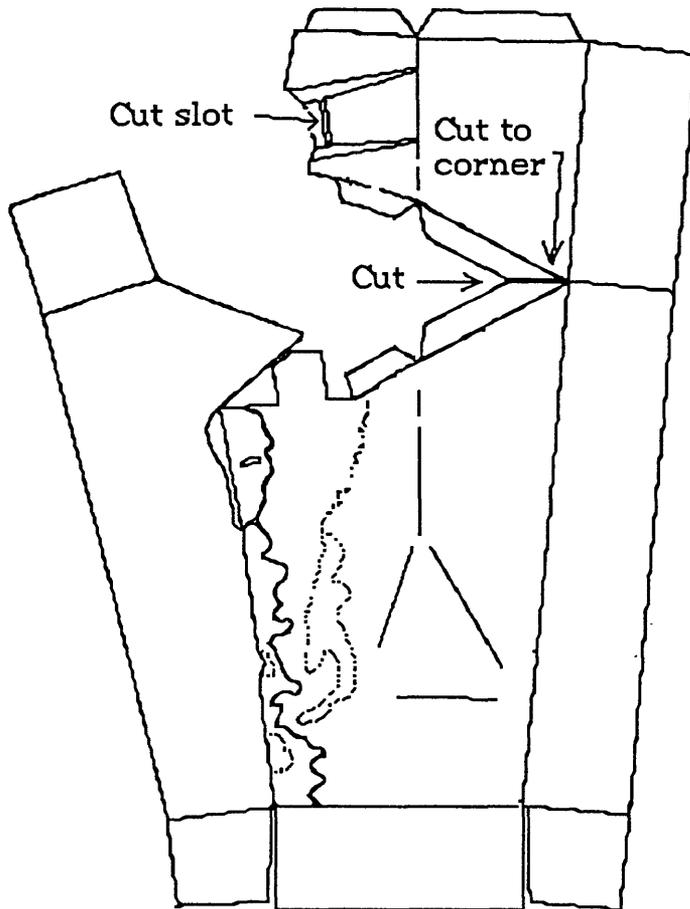
## Cirque and glacial valley

When a valley glacier melts, the valley shows the effects of the glacier. At the head of the valley, a bowl-shaped depression called a cirque has developed. Cirques range in diameter from a few hundred meters to several kilometers. Cirques are composed of a headwall, a concave floor, and a threshold. The threshold may be composed of bedrock or glacial till, and behind it a lake or tarn may form. Cirques are best developed in mountainous terrains in shadow areas protected from the sun, facing northeast in the northern hemisphere and southeast in the southern hemisphere. Below the cirque, some of the side spurs that formerly extended into the valley have been truncated, and the valley is straighter. The valley's former "V" shape has been eroded to a "U" shape. Smaller tributary valley glaciers may connect with a main valley glacier. The smaller tributary glaciers erode shallow valleys that are left "hanging" on the steep side of the main valley after the ice melts. These hanging valleys are commonly the site of spectacular waterfalls such as those found in Yosemite and Waterton-Glacier National Parks.



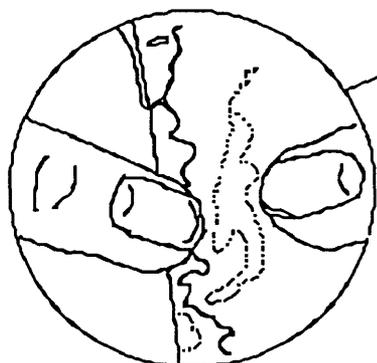
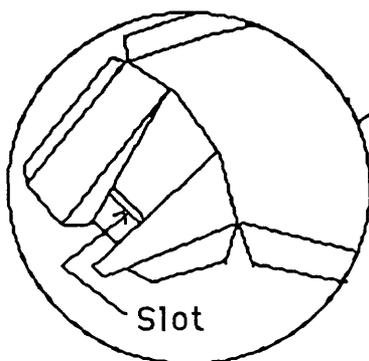
Cirque and glacial valley

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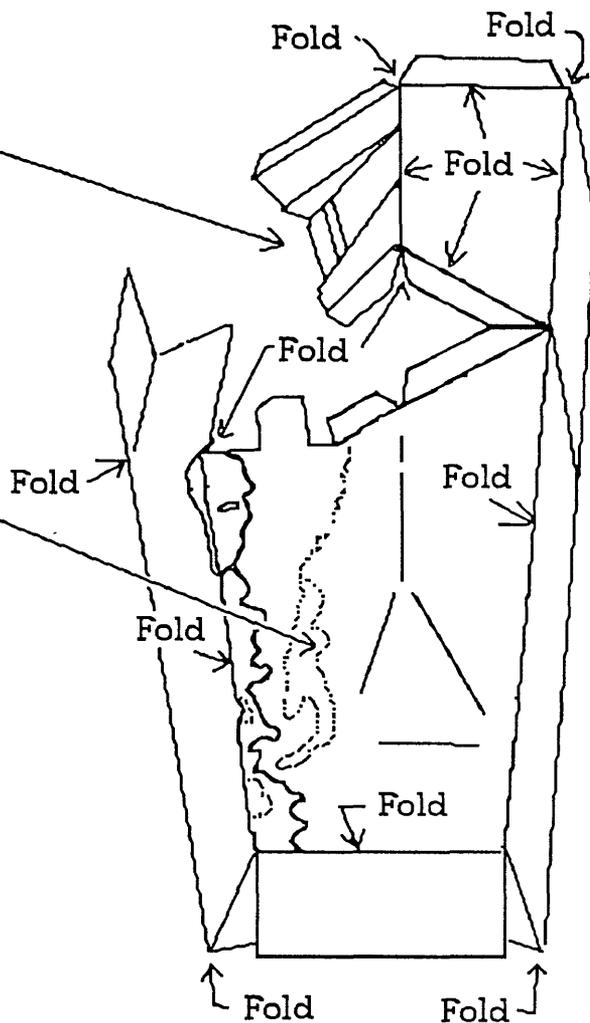


**Step 1** Cut out the paper landform by cutting along its borders. Cut one slot in the upper part of the model.

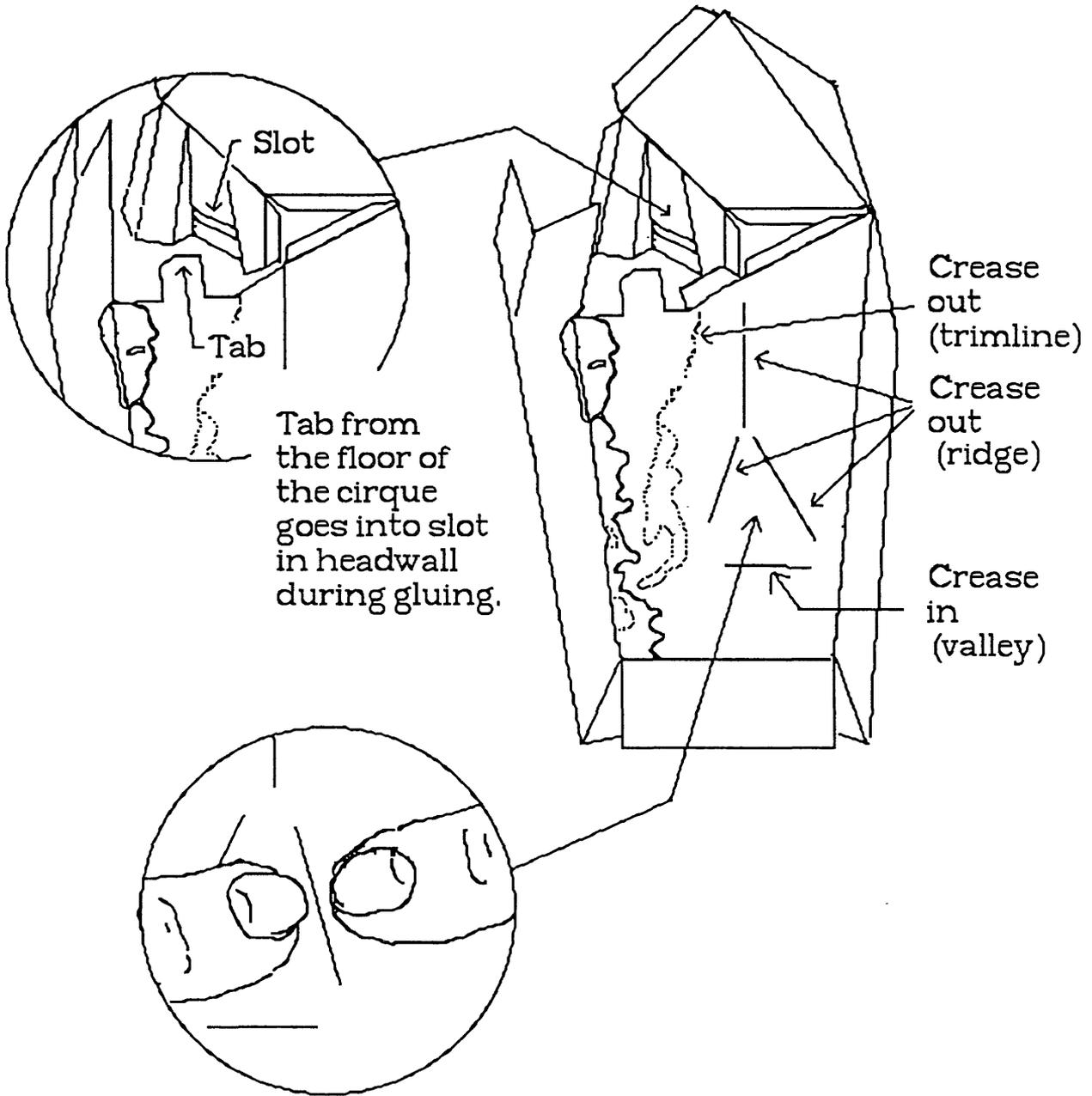
Fold the area with the slot (headwall of valley glacier - cirque -) as illustrated.



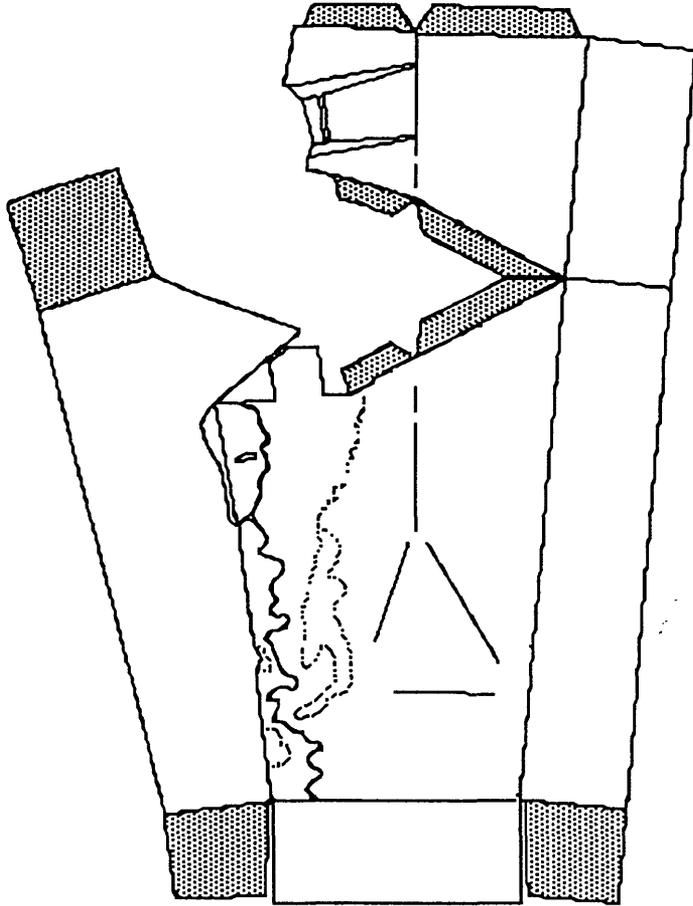
Crumple paper between thumbs in the area of the moraine.



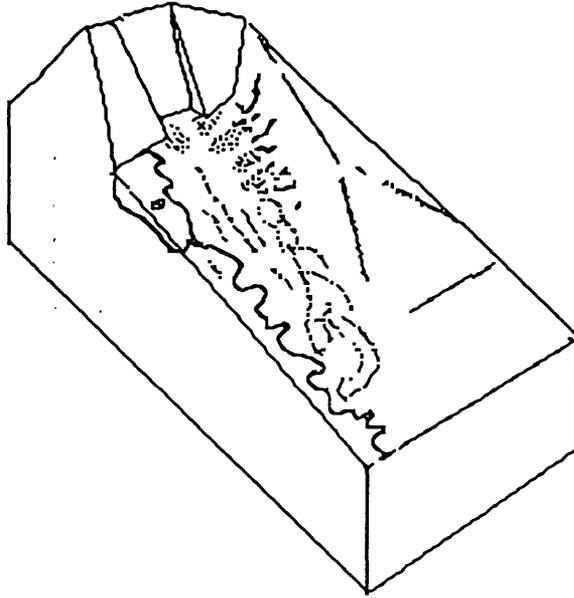
**Step 2** Fold the paper landform along the marked lines so the printed side faces outward.



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**Step 4** Glue the paper landform by applying glue to the gray tabs.



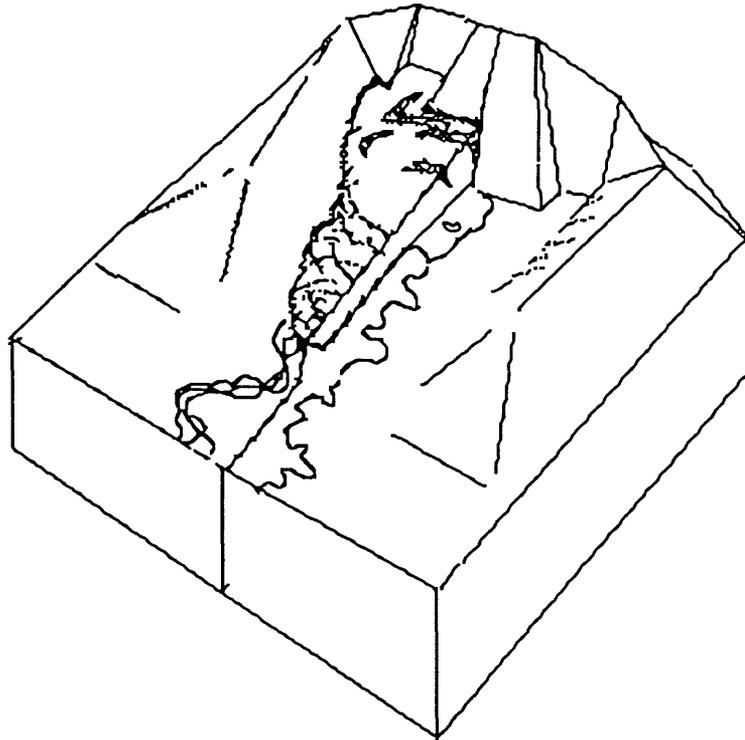
**Step 5** The assembled glued paper landform should look like this.

## Summary

The two paper models can be edge-joined to form a complete valley. One side contains half of a glacier and shows some of the glaciers features, and the other half shows how the valley might look after the glacier has melted away.

To represent themes such as geology, vegetation, or culture, the models can be colored with water colors (which are best applied before the models are constructed). Black-and-white patterns can be applied to the models with the SuperPaint software.

By constructing and examining these models, students may learn how to visualize these particular landforms and have a better understanding of how the natural landscape evolves.

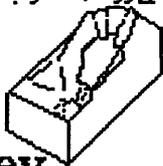




Effects of ice on a mountain valley

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Designed for Macintosh computers  
using the application of  
**HyperCard 2.0**