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U.S. GEOLOGICAL SURVEY

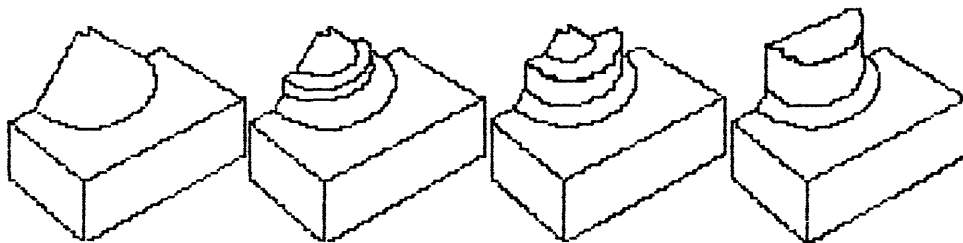


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How to Construct Four Paper Models  
that Describe Island Coral Reefs

By  
Tau Rho Alpha\*

Open-File Report 91 - 131A



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## Description

This report contains instructions and patterns for preparing a set of four, three-dimensional paper models that schematically illustrate the development of island coral. The first model is of a shield volcano that extends above sea level, making a volcanic island. The second model is of the original shield volcano and volcanic island that have developed a fringing reef of coral growing at sea level. The third model is of a lagoon and a barrier reef after a rise in sea level. The coral reef has grown, producing a lagoon between the volcanic island and the reef, (scientists call this a barrier reef). The fourth model is of an atoll. Most of the original shield volcano has disappeared because of the continual rise in sea level, as the growing coral kept pace with the rising water.

These models are intended to help students and others to visualize the growth of coral on an island and to learn some of the terminology used by earth scientists to describe coral reefs. By constructing and examining these model landforms, students will achieve a greater appreciation of the relations between volcanic islands, the growth of coral reefs, and atolls.

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

Requirements for the diskette version are: Apple Computer, Inc. HyperCard 2.0™ software, and Apple Macintosh™ Plus, Classic, SE, or II. The date of this Open-File Report is 2/22/1991. OF 91-131-A, paper copy, 20 p. OP 91-131-B, 3.5 in. Macintosh diskette.



## Island Coral

Coral landforms are unique because they are the only known landforms that are composed of living material. Coral attaches to any hard surface; it grows in large colonies and can develop reefs several thousand feet thick. Coral grows best on the coastline of continents and islands between Lat. 25° N. or S., with ocean temperatures above 68°F. in the western oceans, where its food supply (plankton) is brought in by the west-blowing trade winds and where the water is clear and free of suspended sediment. The coral reef develops from coral animals that secrete lime to form their skeletons, and from algae, plants that also make limy encrustations. Coral develops as large colonies of individual animals. As the coral colonies die, new colonies are built upon them, and so a coral limestone evolves, made up almost entirely of strongly cemented limy skeletons. During strong storms, the coral is broken up and transported to form beaches, spits, and bars, which later are cemented into limestone.

Island coral generally grows on volcanic islands built up by shield volcanoes. Shield volcanoes can evolve to be the largest of the Earth's landforms; are found on the continents as well as in the oceans. In the ocean environment, examples of island volcanoes are the Hawaiian volcanoes. The Hawaiian volcanoes are huge; their submerged base is 100 mi (160 km) across and they rise more than 25,000 ft (7,620 m), to an altitude of 13,000 ft. (4,000 m) above sea level. The summit crater of the shield volcano is a wide, steep-sided crater that may be 2 mi (3.2 km) or more across and several hundred feet deep. Island shield volcanoes continue to grow by repeated lava flows both above and below sea level that issue from cracks or fissures and flow down gentle slopes.



## Island Coral Cont.

These voluminous lava flows have low viscosities and spread out into thin sheets. With repeated lava flows, the island volcano grows, advancing a new shoreline. With time this shoreline is eroded by the ocean, and a wave-cut platform develops. As coral grows on this rocky wave-cut platform, it forms a fringing reef. Fringing reefs are coral reefs that are attached to the shore; they grow best where there is an abundant food supply and clean freshwater, and poorly near the mouths of streams where the water is muddy.

Gradually because the island is sinking, the reef grows upward along its outer margin and is called a barrier reef. Between the island and the barrier reef is a lagoon that is too deep to permit coral growth. Wave erosion of the growing edge of the coral produces fragments that are carried down the seaward slope as talus and toward the lagoon, where it forms a sediment apron along the lagoon margin. As the sinking of the island continues below sea level, the reef keeps growing, forming a ring of coral around the lagoon called an atoll. The upper surface of an atoll is a nearly flat surface called the reef flat, situated at or near low-tide level. Cracks are common on reef flats. Crescent-shaped segments fall away, possibly owing to submarine slides on the slopes of the shield volcano, or to collapse of the coral because of oversteepening. Breaking off of large blocks of the coral reef by storms can result in tens of feet of relief on atolls, but the highest hills are sand dunes.



Paper Models

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### Selected References for Additional Reading

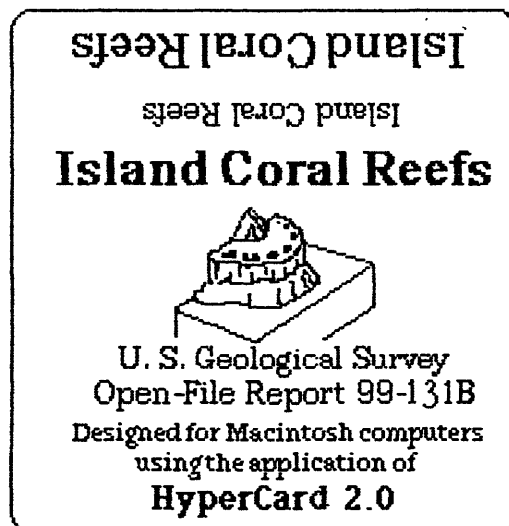
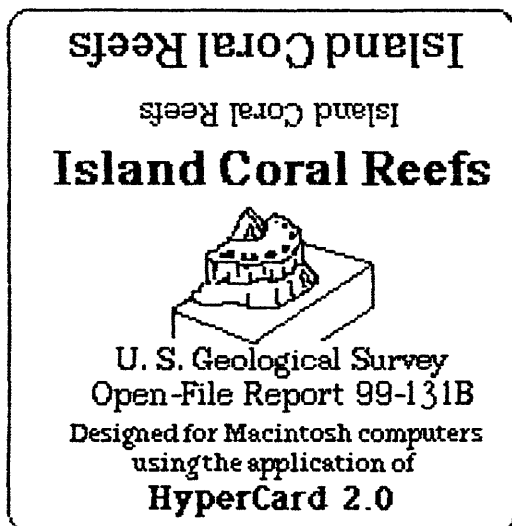
Darwin, Charles , 1898, The structure and distribution of coral reefs (3d. ed.): New York, D. Appleton and Co., 344 p.

Davis, W. M., 1928, The coral reef problem: New York, American Geographical Society Special Publication 9, 569 p.

Shepard, F. P., 1977, Geological oceanography: New York, Cane Russak and Co., Inc., 214 p.

This report could not have been published with out the help of Jim Pinkerton, William Glen and George Havach

### Disk Labels



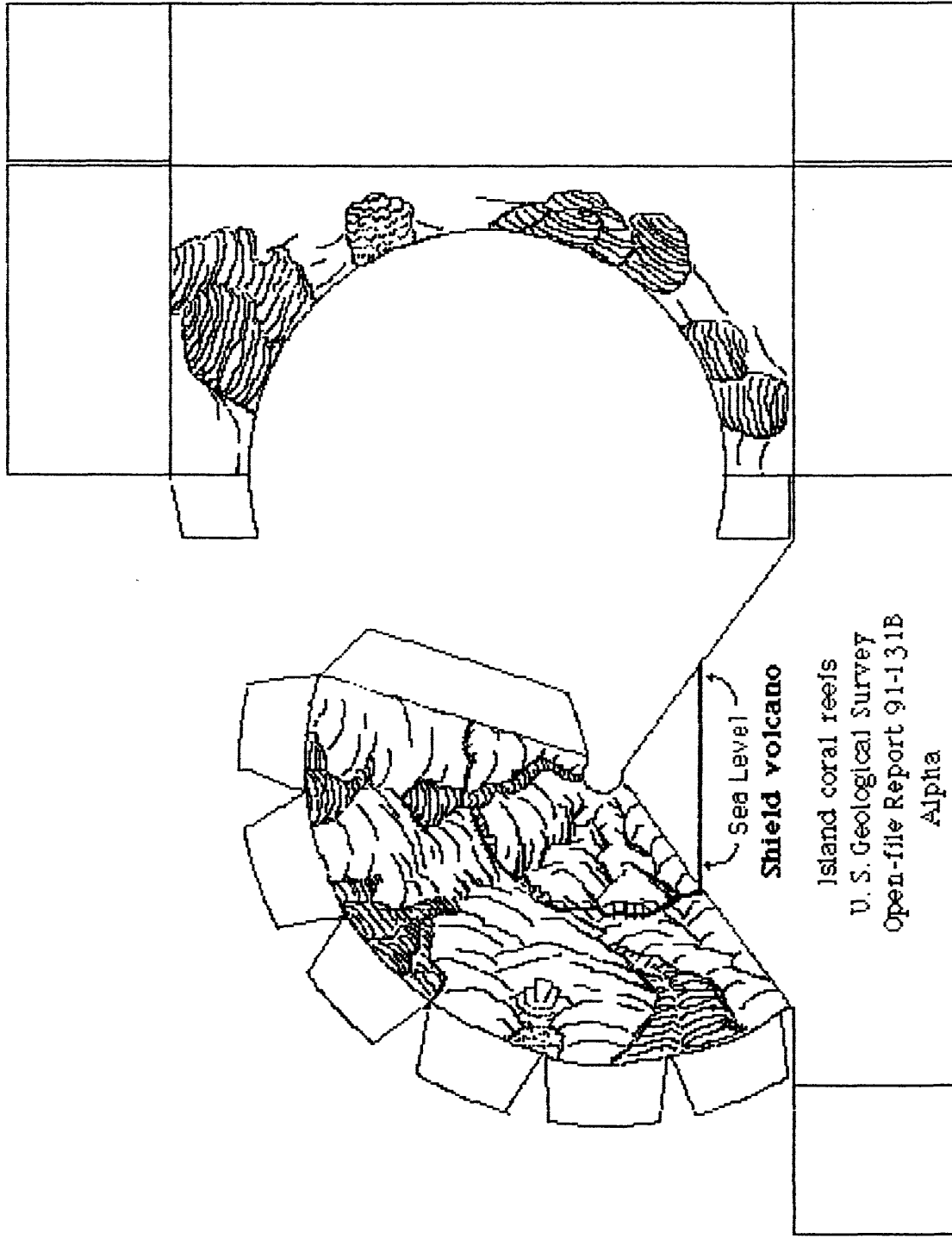


Shield volcano pattern

Paper Models



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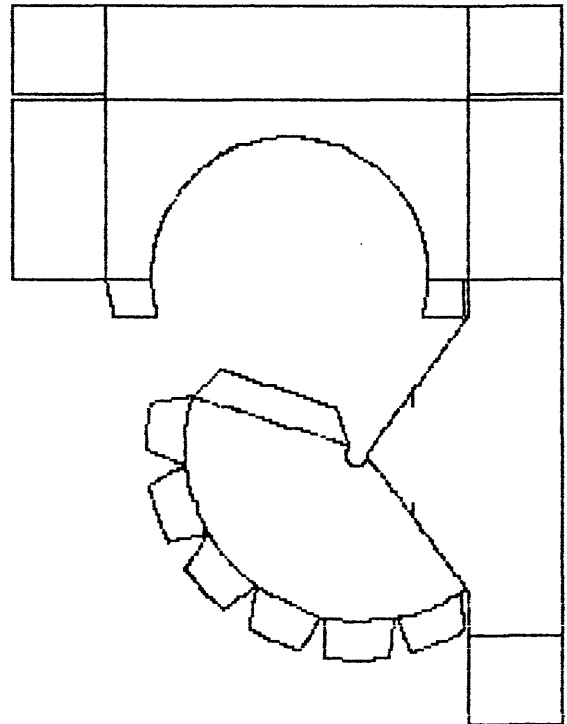
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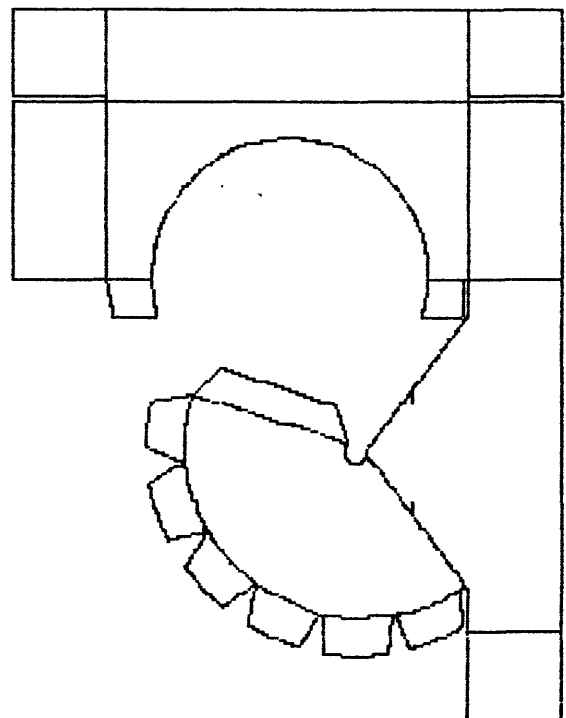
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Cut out the pattern of the paper landform by cutting along its borders.



### Step 2

Make creases and fold along the solid lines within the pattern, folding so the printed side faces outward.





## Shield volcano instructions

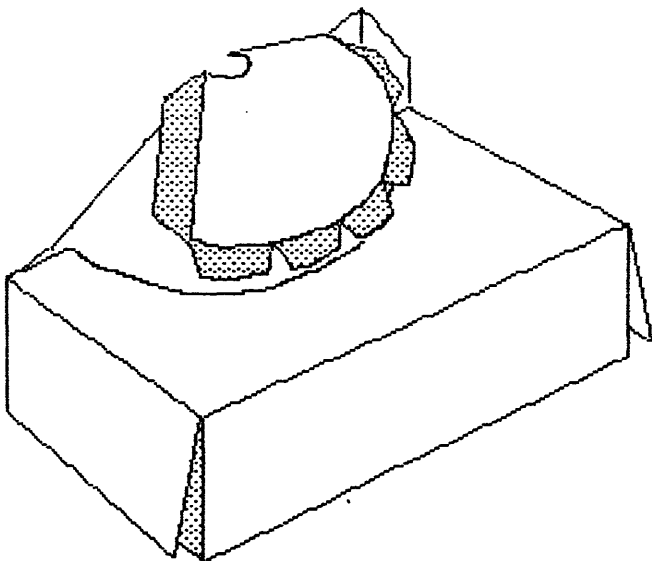
### Step 3

Glue the marked tabs.



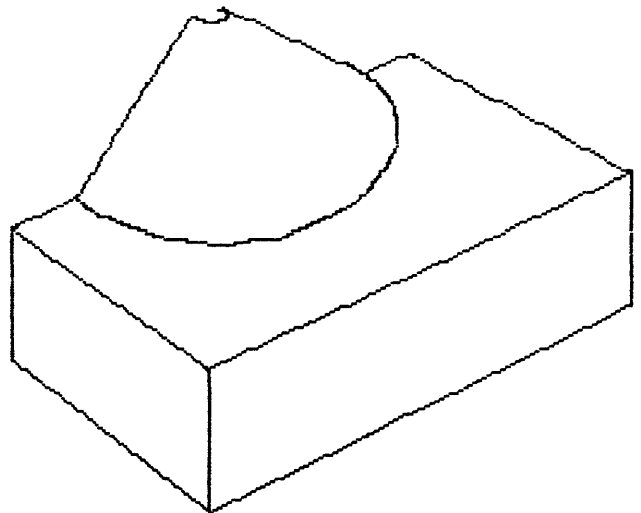
### Step 4

Assembling the model.



### Step 5

The assembled model should look like this.







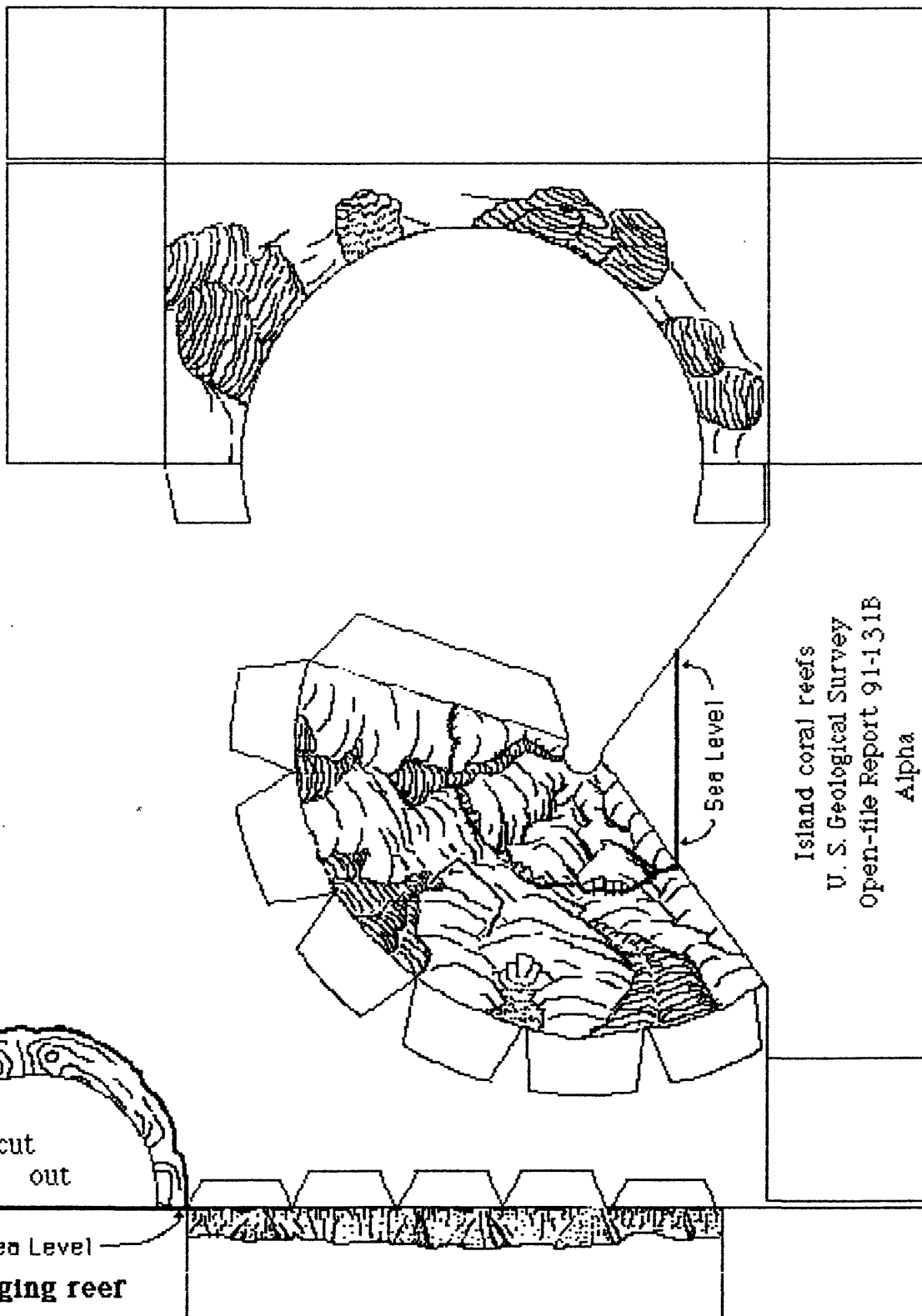
Fringing reef

pattern

Paper Models



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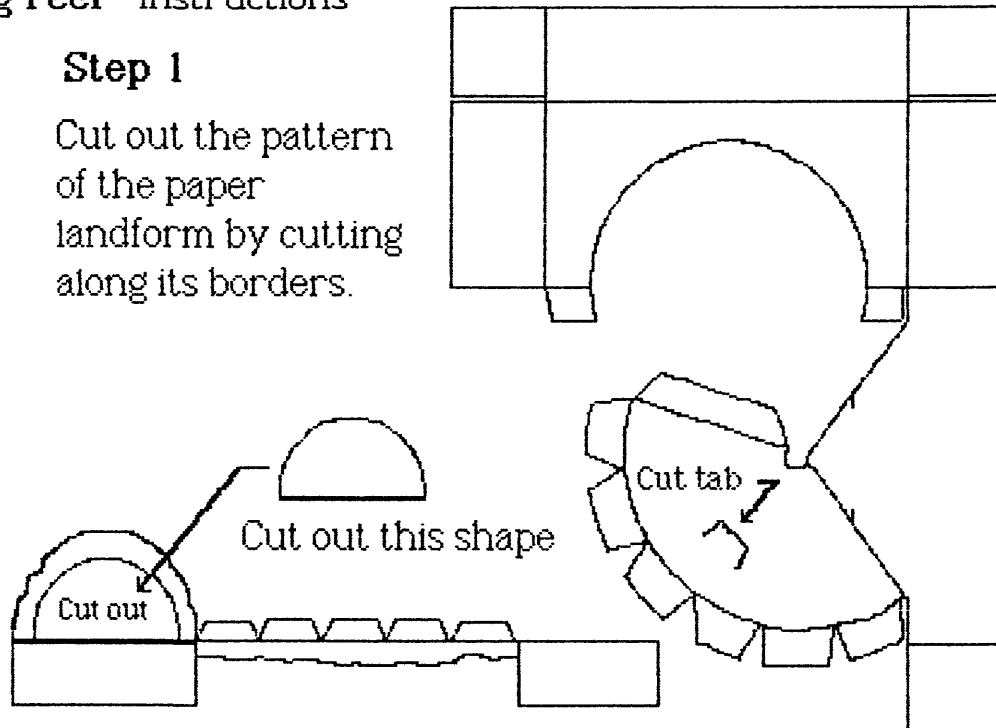
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## Fringing reef instructions

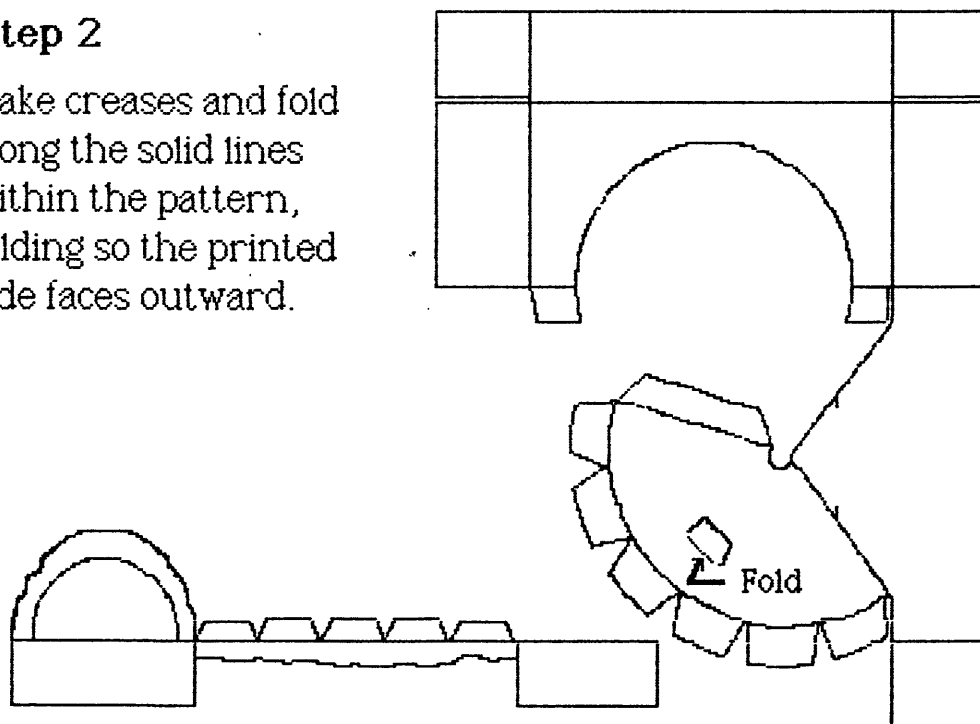
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Cut out the pattern of the paper landform by cutting along its borders.



### Step 2

Make creases and fold along the solid lines within the pattern, folding so the printed side faces outward.

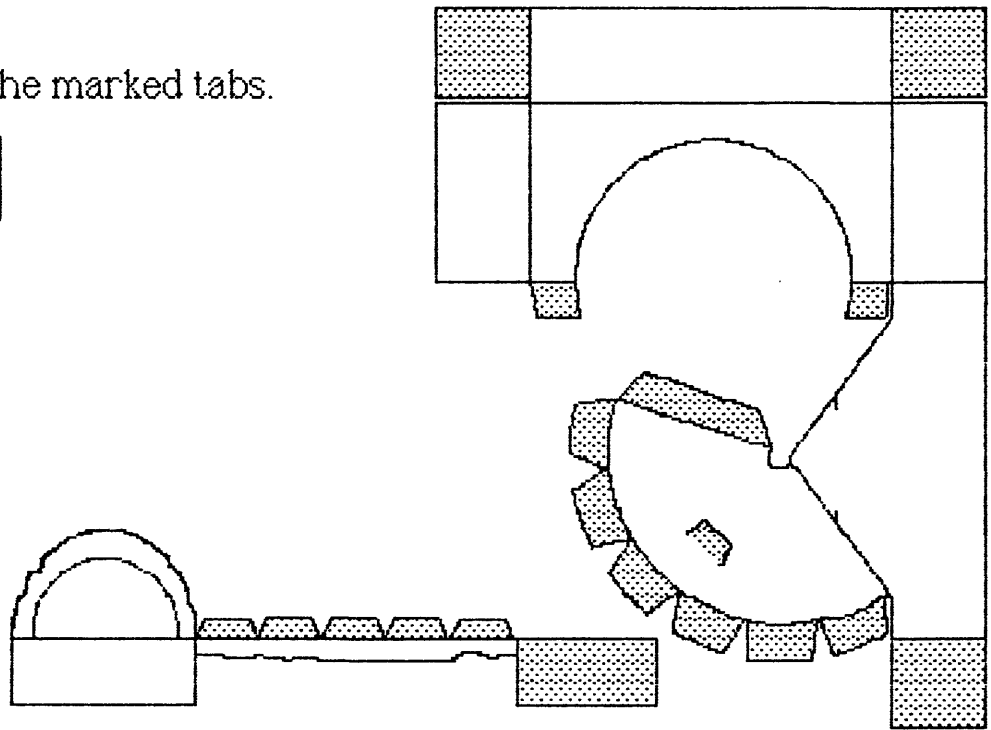




## Fringing reef instructions

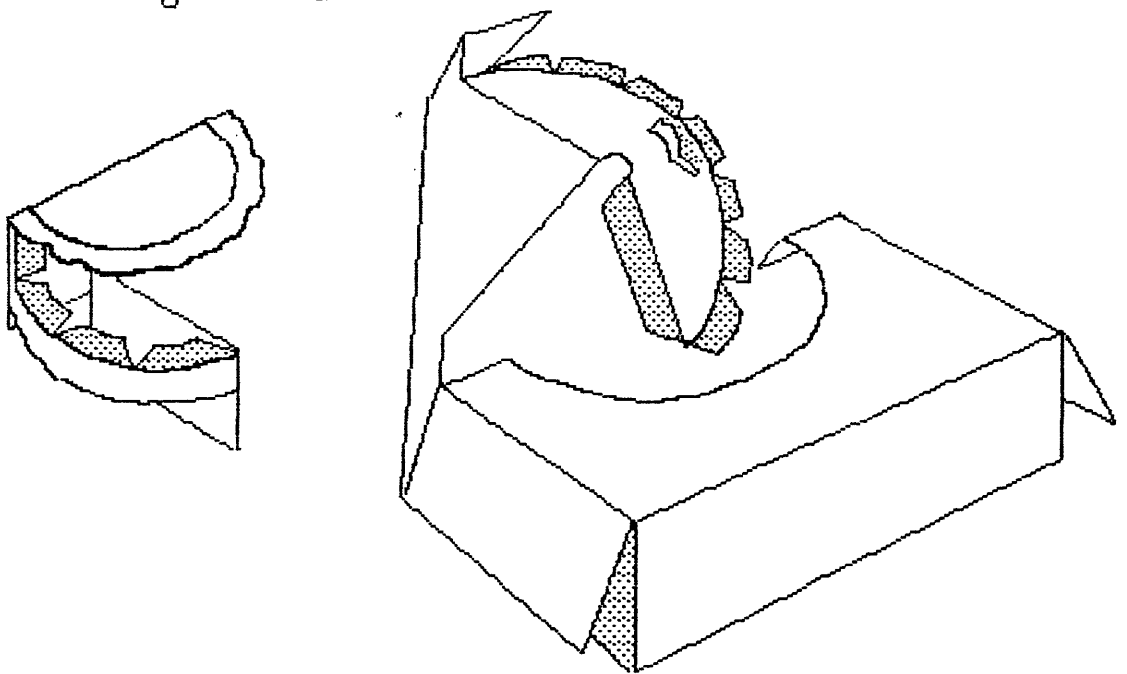
### Step 3

Glue the marked tabs.



### Step 4

Assembling the model.

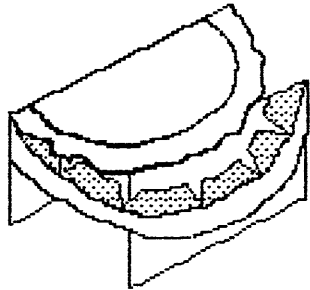




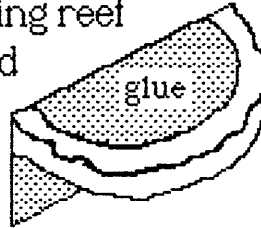
## Fringing reef instructions

### Step 5

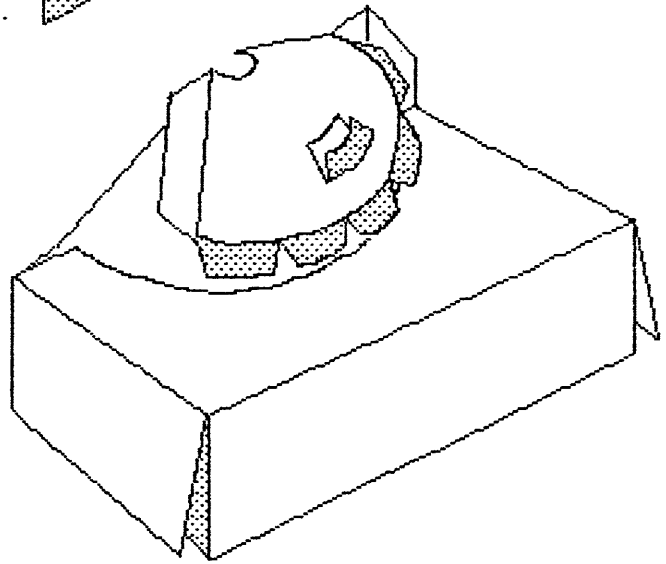
Assembling the model.



Finished Fringing reef should look like this.

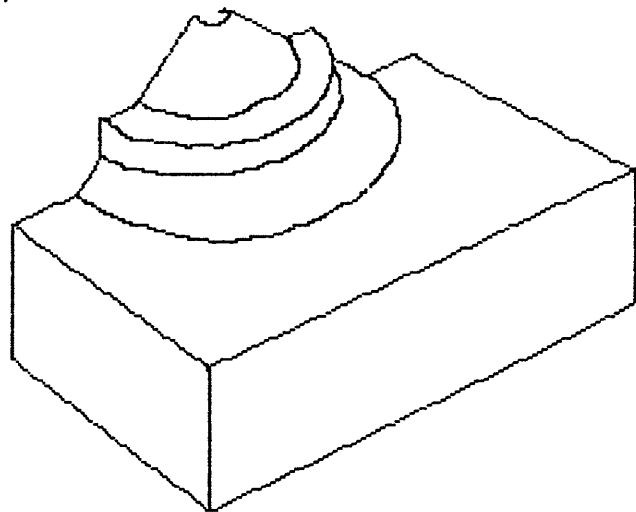


Now glue the inside of Fringing reef on the back.



### Step 6

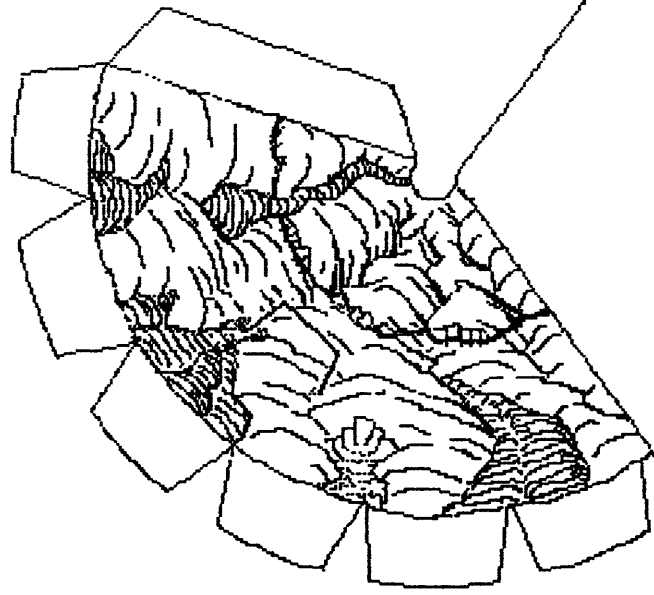
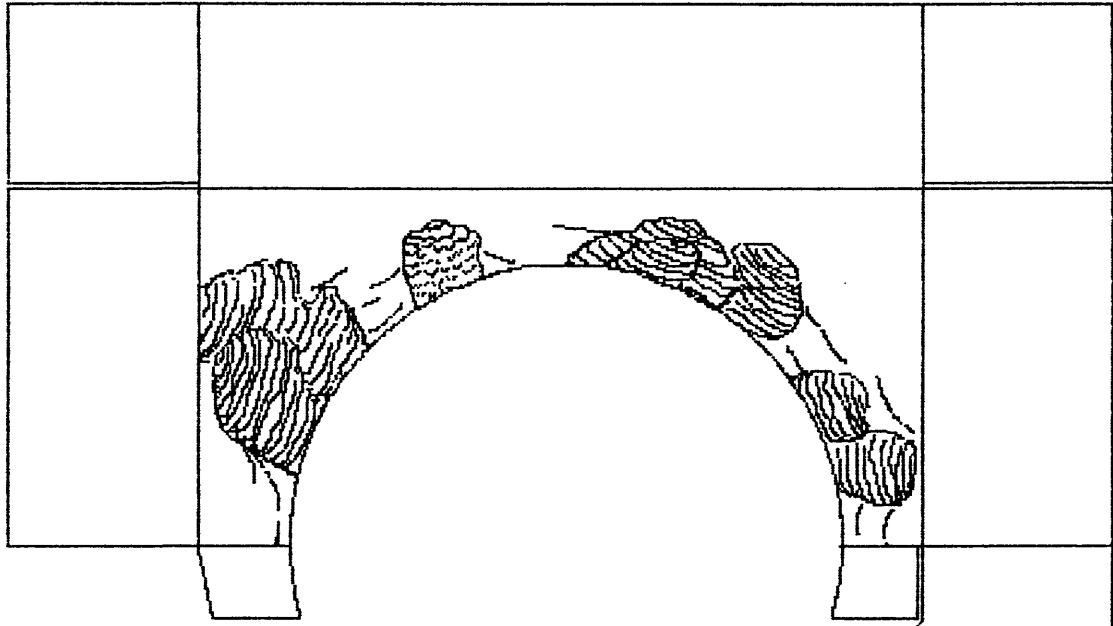
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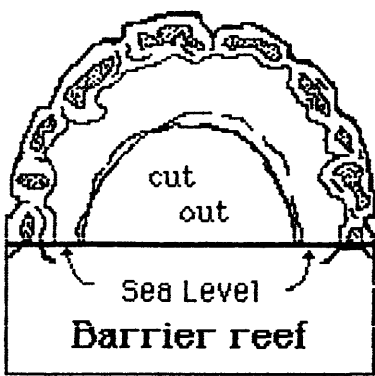


Barrier reef pattern

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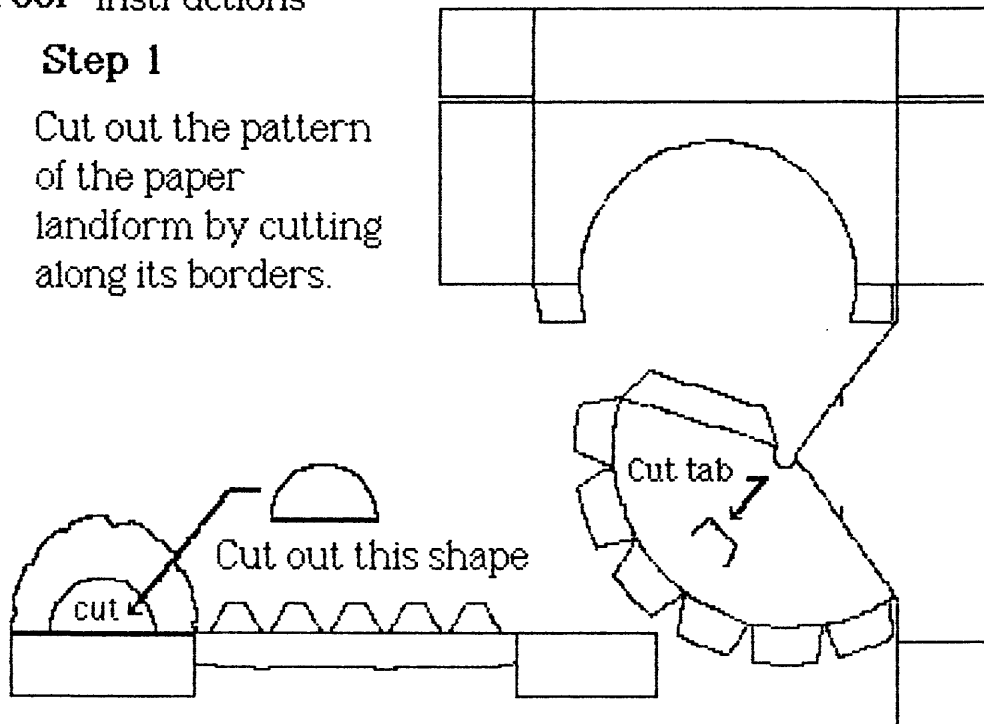




## Barrier reef instructions

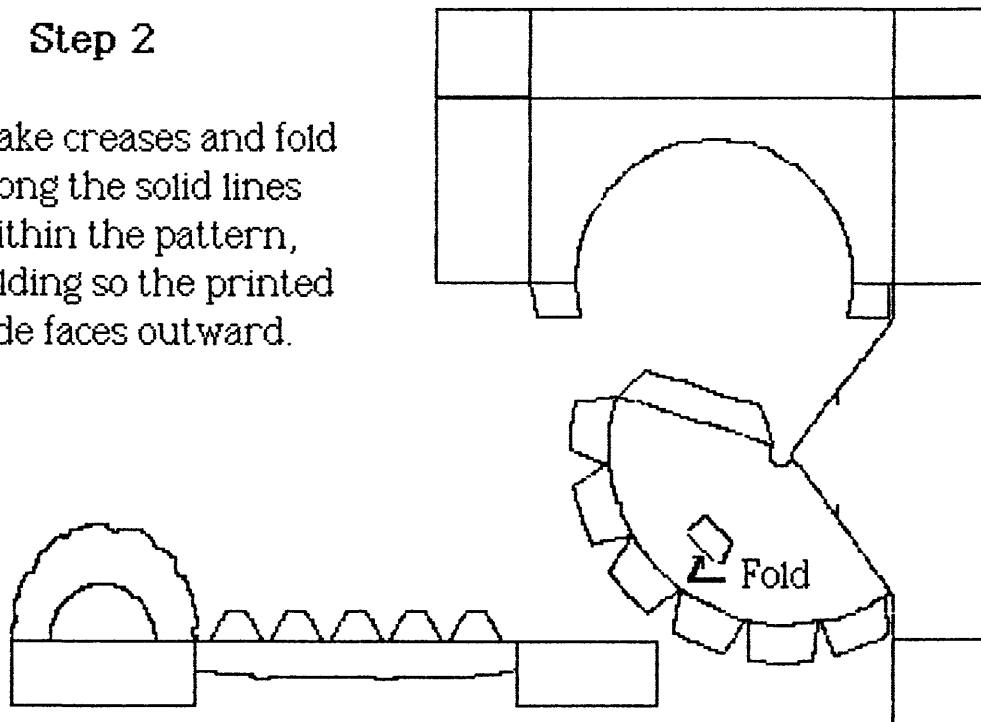
### Step 1

Cut out the pattern of the paper landform by cutting along its borders.



### Step 2

Make creases and fold along the solid lines within the pattern, folding so the printed side faces outward.

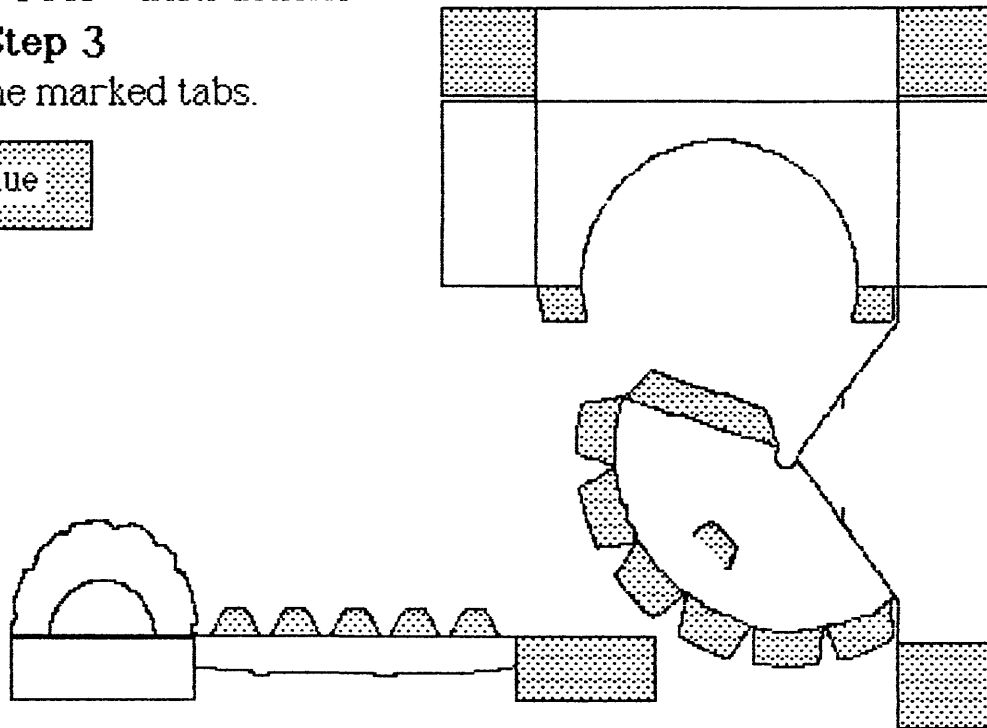




## Barrier reef instructions

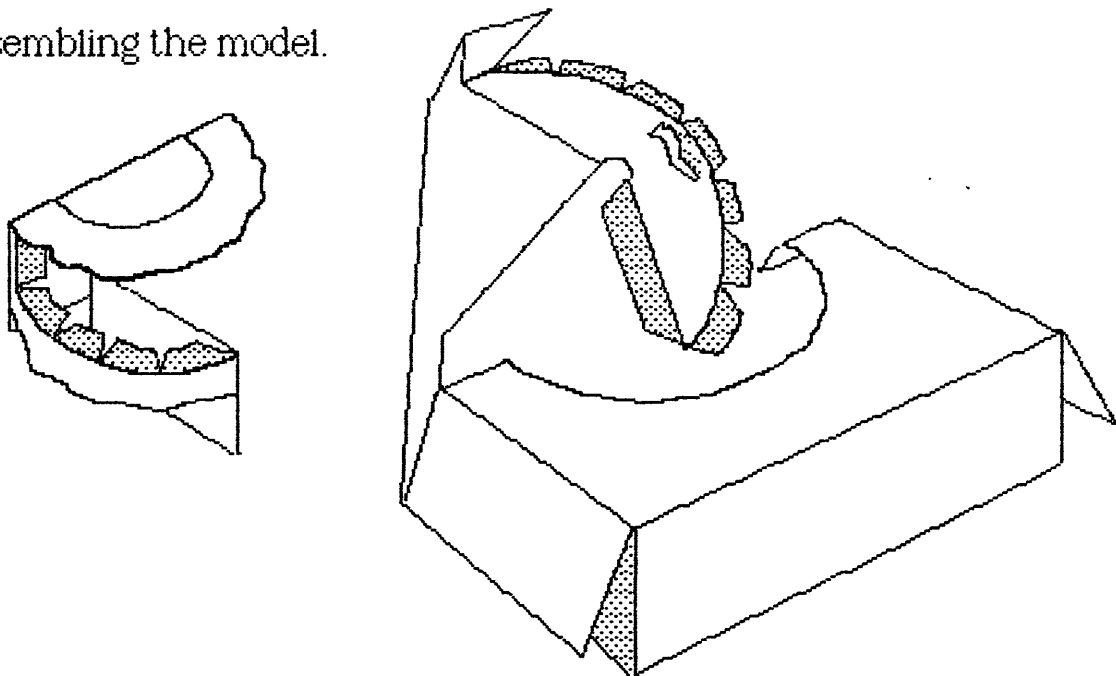
### Step 3

Glue the marked tabs.



### Step 4

Assembling the model.

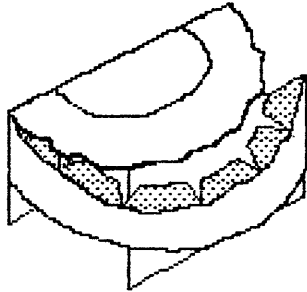




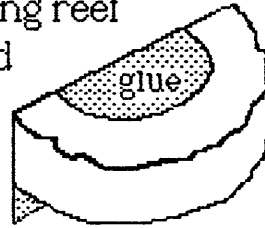
## Barrier reef instructions

### Step 5

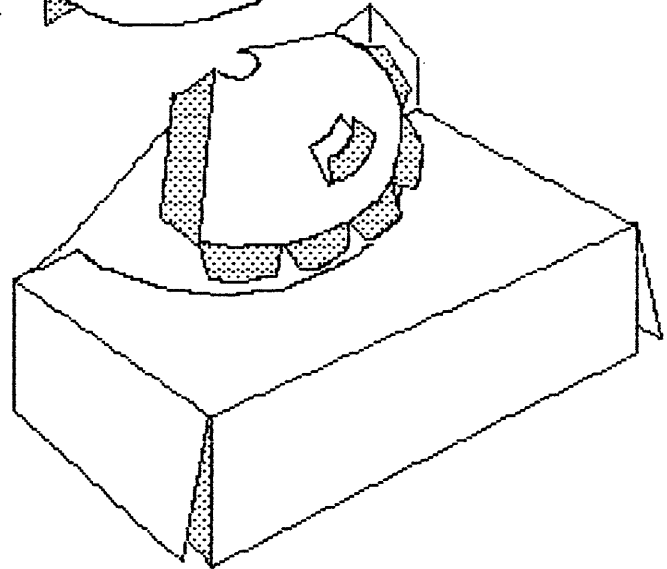
Assembling the model.



Finished Fringing reef should look like this.

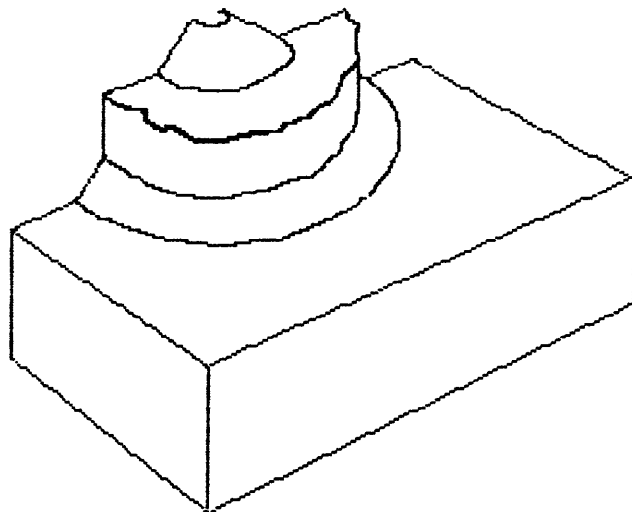


Now glue the inside of Barrier reef on the back.



### Step 6

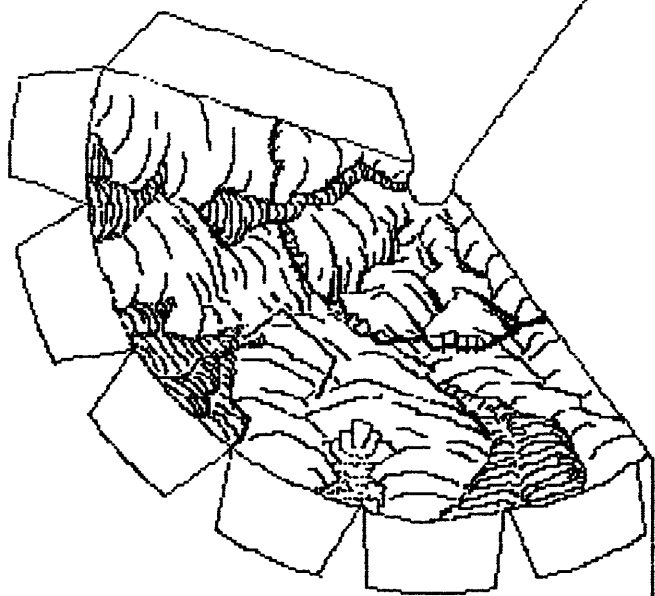
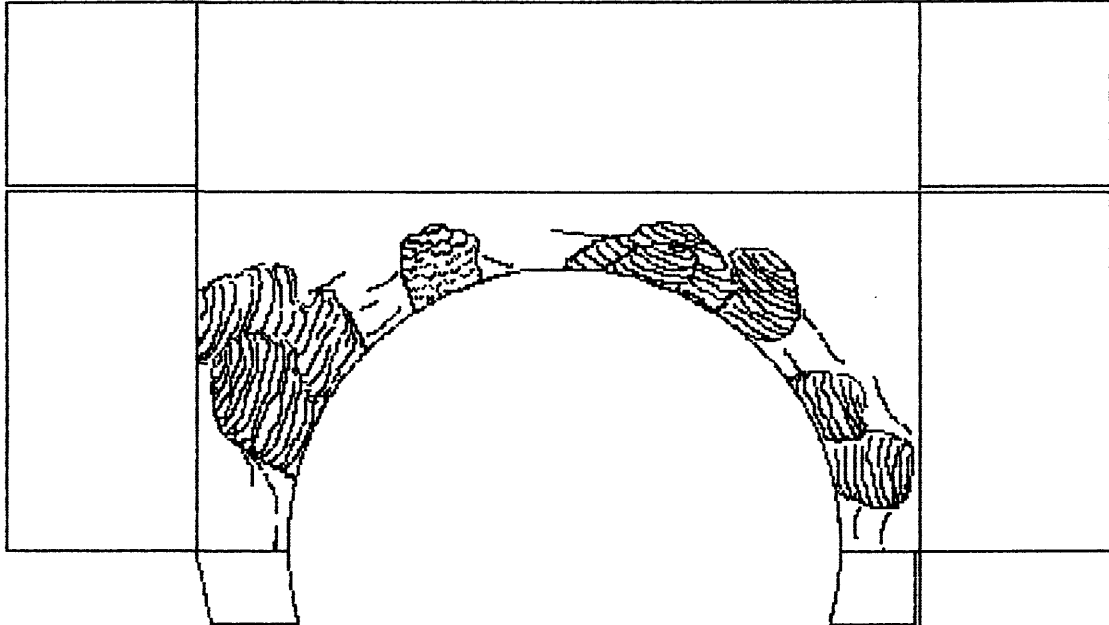
The assembled model should look like this.



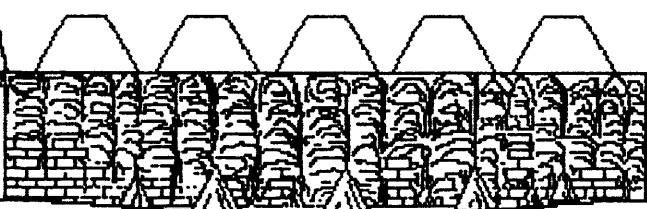
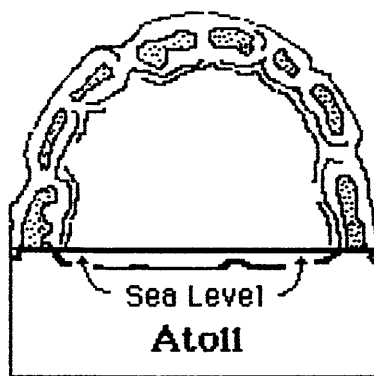


← Atoll → pattern

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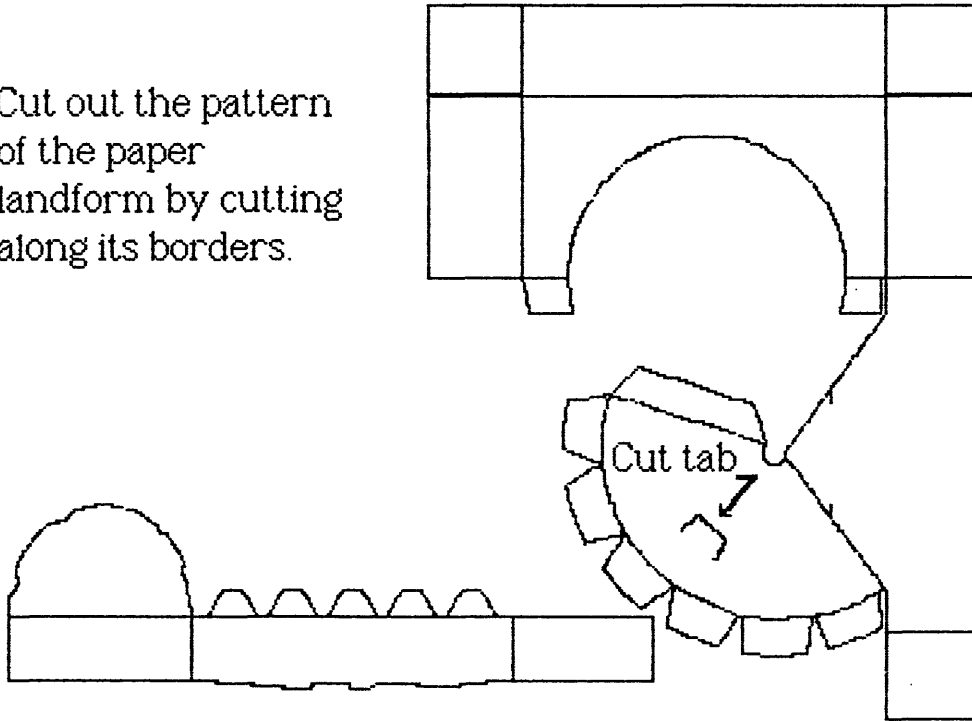




## Atoll instructions

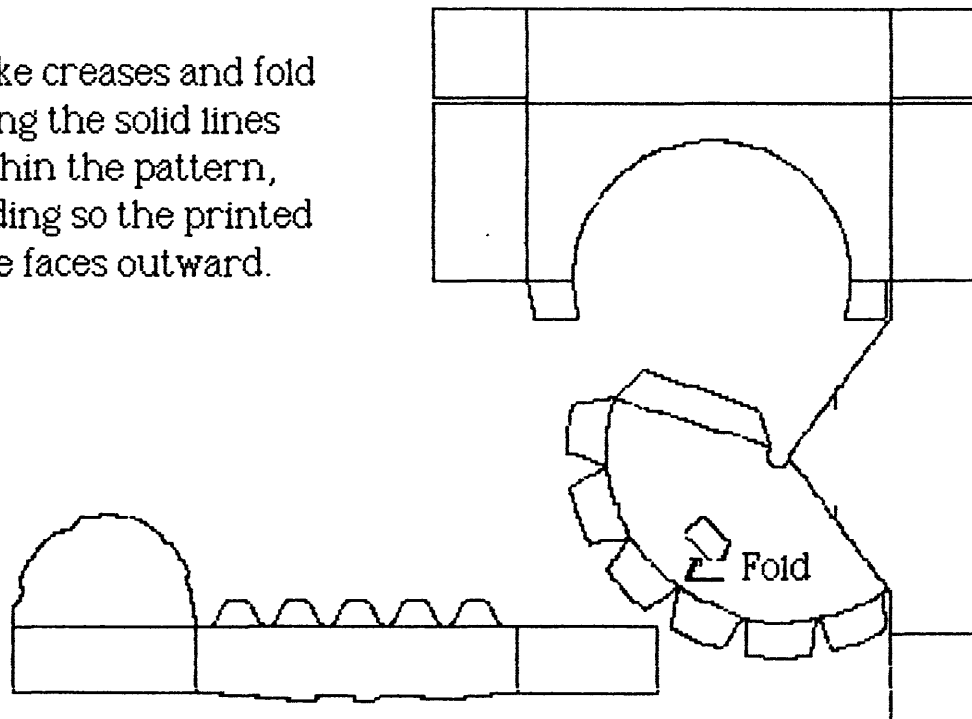
### Step 1

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### Step 2

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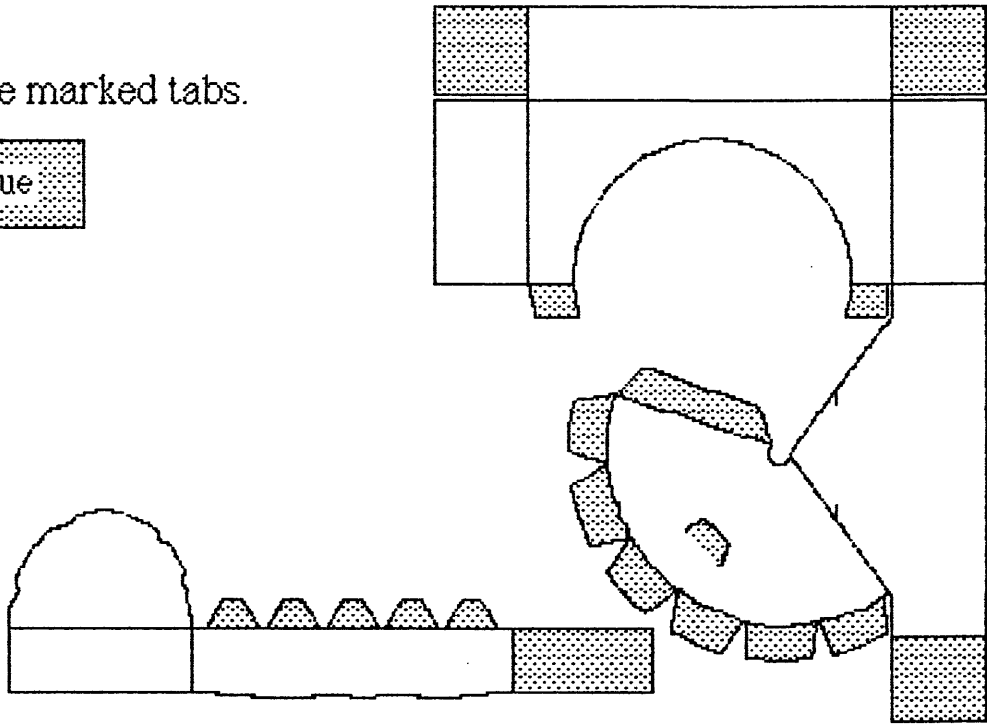


Atoll

instructions

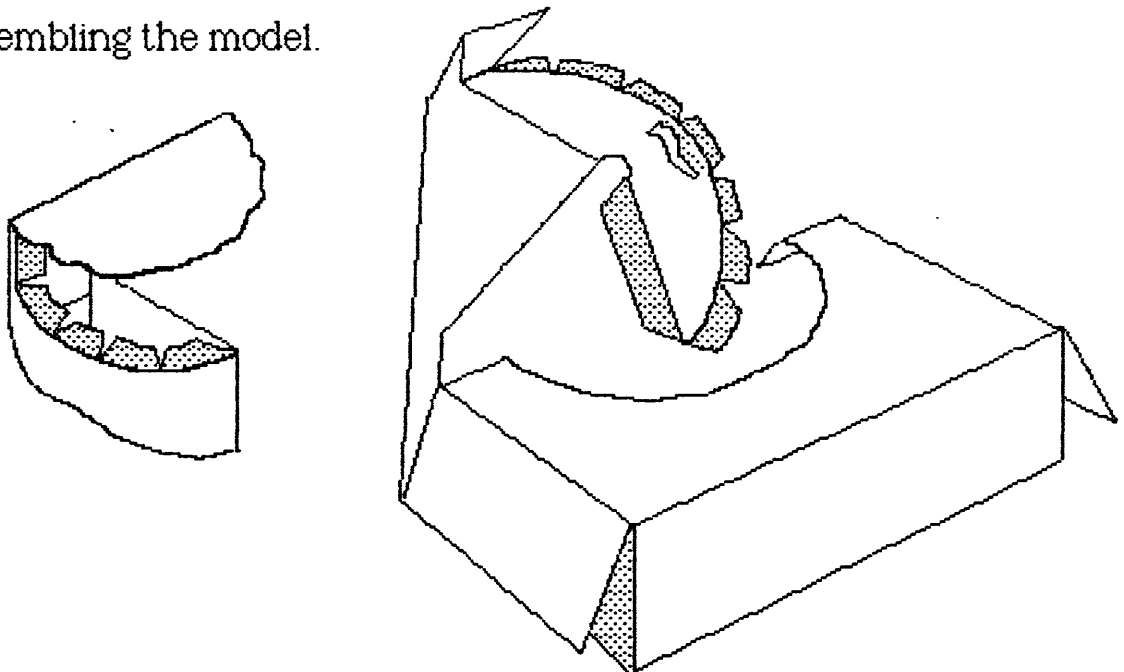
### Step 3

Glue the marked tabs.



### Step 4

Assembling the model.

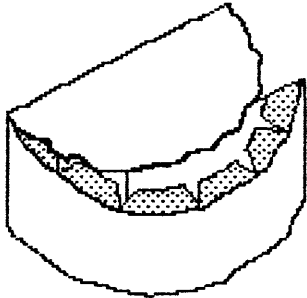




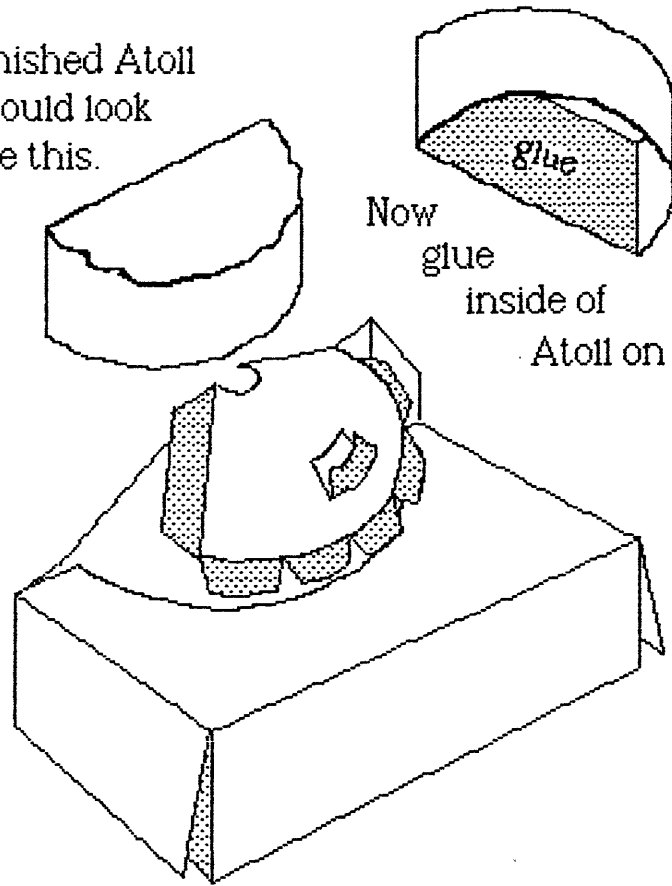
## Atoll instructions

### Step 5

Assembling the model.



Finished Atoll should look like this.



### Step 6

The assembled model should look like this.

