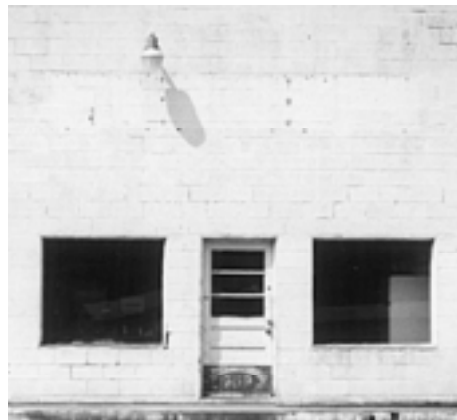


Observation and Light



Catherine Porzio

A design thesis submitted to the faculty of
Virginia Polytechnic Institute & State
University in partial fulfillment of the
requirement for the degree of
Master of Architecture
Blacksburg, VA December 1999

Assistant Prof. Hunter Pittman, Chairman

Prof. William Brown

Associate Prof. William Galloway



For Mom and Dad

Acknowledgments

Deepest thanks to my family for your love and support.

Thanks to my student committee for their criticism, inspiration and teaching:

Nasser Abulhasan
Doreen Ebert
Roberto Gardoni
Evelyn Strong

With infinite gratitude to Karen and Phil Amodeo (and their dog Copper) for their graciousness and patience.

Thank You: Jeff Mayfield, Jennifer McCarthy, Tim Castine, Jen McLeran, Paul Gehringer, Jeff Berghage, Don Flick, Misti Moser, Ruby Moser, Rose Moser, Kerry Ann Mullins, Koichiro Aitani, and the Larkin Family.

Abstract Our life experience can be enriched by observation; acknowledging this as a way of “seeing” can positively influence architectural design. This thesis records personal observation of light and looks to historical precedents in which natural light is revered as an element that both defines space and emphasizes importance of place. The culmination of this course of study is a project for light in which a monumental sundial becomes an amphitheater for the town of Newport, Virginia.

Contents	Abstract	ii	iii
	Introduction	iv	
	Observation of Light	1	
	Idea of Light	6	
	Path to Place	11	
	Project for Light	25	
	Conclusion	70	
	Image Credits	76	
	Endnotes	77	
	Bibliography	77	
	Vita	79	

An individual's approach to design is a product of accumulated experiences. Each experience enriches one's outlook; collectively the experiences become the basis of a thesis.

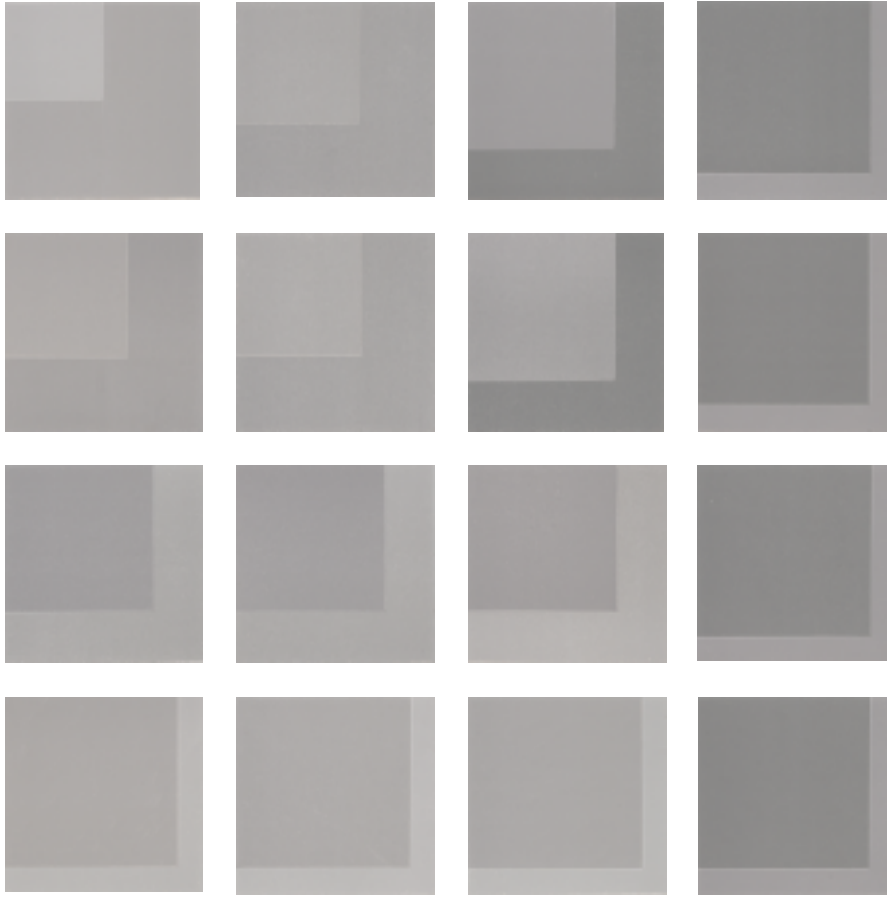
One beginning to a thesis study is memory from childhood where we learn a way of seeing from those who raise us. Taking something from its usual context emphasizes how the ordinary becomes the extraordinary. When I was a child, my father cut down a tree, placing a section of it on the coffee table; twigs and dried vines appeared on the walls when my mother came in from the woods. By eliminating the extraneous and removing the visual noise, the essential strength in everything can be revealed. I learned the importance of observation and how it is a means of marking time and creating memory.

Underlying all that I have achieved -such as it is- are the memories of my father's ranch where I spent my childhood and adolescence. In my work I have always strived to adapt to the needs of modern living the magic of those remote nostalgic years.

- Luis Barragán



Observation of Light



Making a tangible expression of seeing and discovery is difficult.

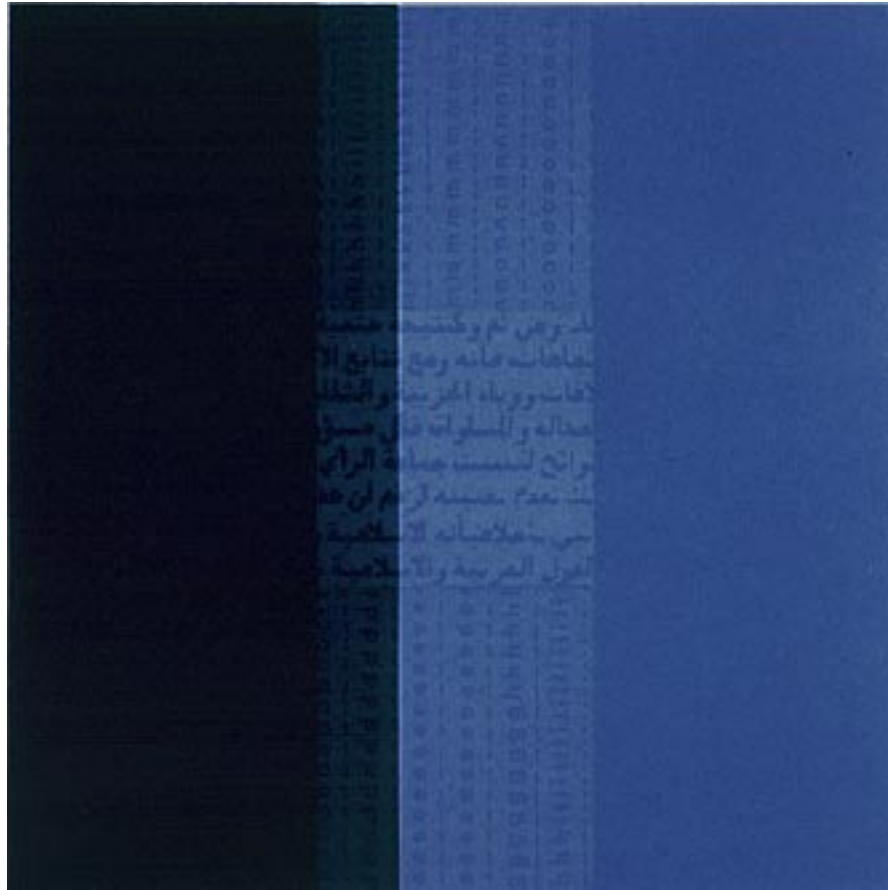
A first year studio project required making sixteen 8"x8" squares of color. I chose a monochrome scheme of five shades of gray to express my understanding of shade: You can remember how it was and you can see how it is, but the subtle progression of sunlight mirrors the nearly imperceptible movement of shade. This opposition in nature allows for the sense of time passing. Recognizing the importance of simple observations like this inspires you to see things ordinarily missed.

Brion Family Cemetery

I sat for a few hours facing the walls surrounding the cyprus-framed chapel. Slowly, within the interaction of sunlight and structure, a cross appeared for a moment and faded quickly. Changing light can reveal something new about a building.



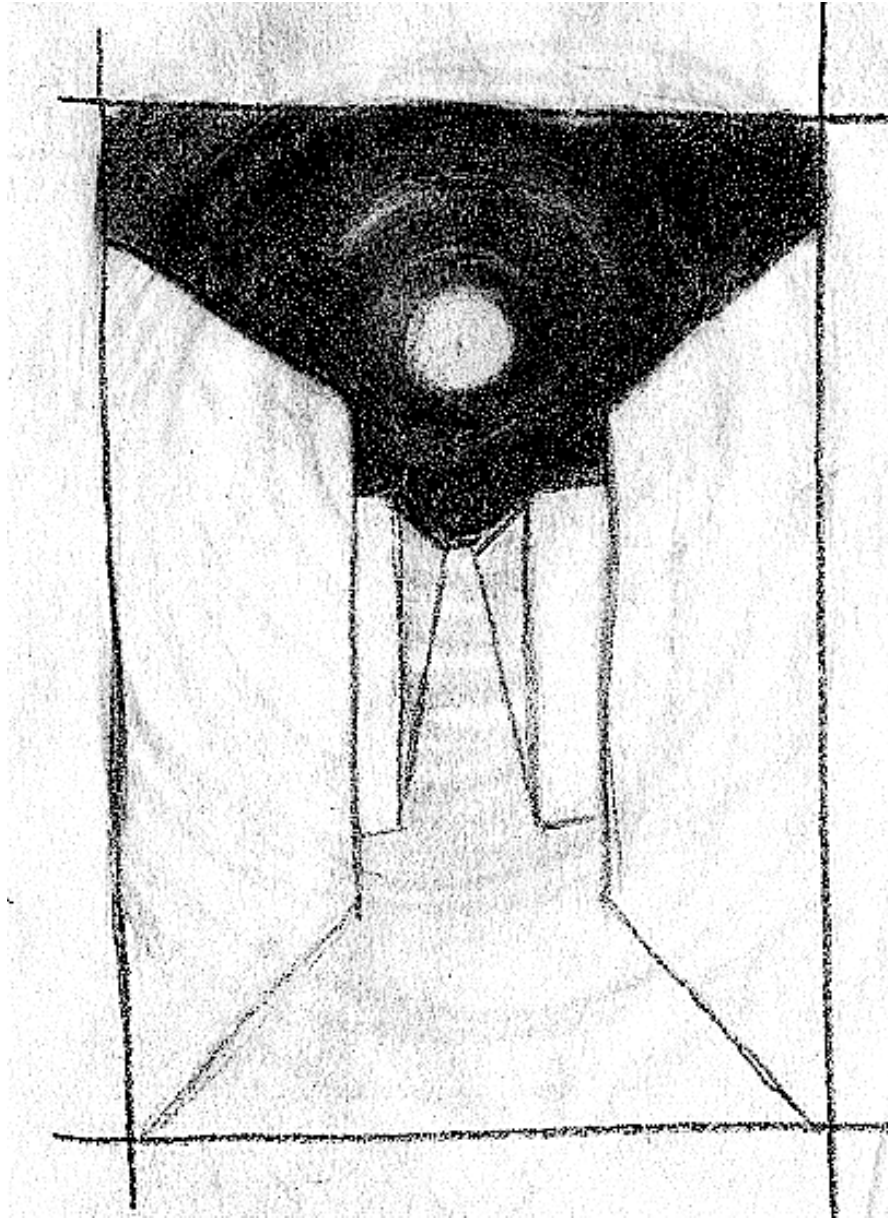




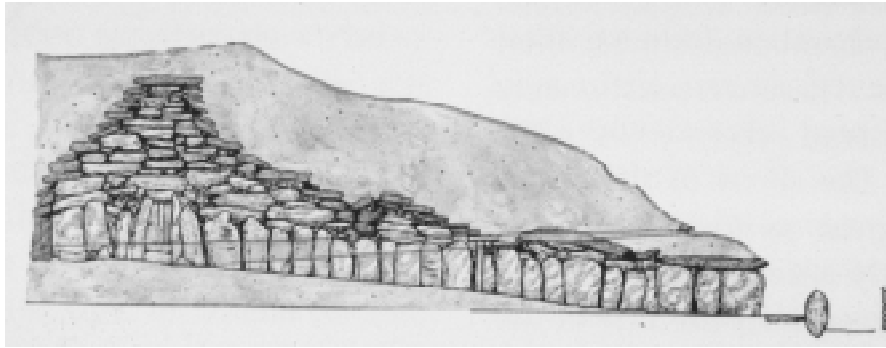
Discovery comes by chance and chance requires working with many tools. The etching print above shows how light, in this case white ink, can penetrate color and behave through a filter. On the facing page, a photograph of the light wells in the crypt of La Tourrette records a different quality of light. The cylindrical shape and the color of the wells diffuse the sunlight, changing its purpose from illumination to something more powerful. Working with a variety of media allows greater opportunity for learning something new.

There was a shallow foundation in the woods, never used and so nearly consumed by the trees and vines. We called the place Fungus Park and made up stories as we played there. The ever damp concrete was colored and cushioned by moss. I remember the feeling of being within the walls of the foundation, just a foot or two below the ground level. Being within the walls somehow enhanced everything in view. Sound was different, smells were different, and being surrounded by earth, the sky was different.

Idea of Light



A spiritual connection to the cosmos is strongest through the medium of earth. Carving into the earth eliminates the peripheral, making it a singular element, limiting the view to the depth of the sky.



Newgrange, Boyne Valley, Ireland (3000 BC)

Throughout history, alive in every culture was (and is) a desire to make a physical and spiritual connection among earth, human, and cosmos. The connection was sought for explanations of changes in weather, journey of life and death. In ancient times this connection most often associated rituals of sacrifice and burial with celestial events. More specifically, natural light is revered as an element that both defines space and emphasizes importance of place.

Light finds its way into the underground burial chamber at Newgrange only one day a year. An aperture on the hill is aligned with the midwinter sunrise allowing light to penetrate and slowly fill the chamber. In late morning as Earth continues to rotate, the beam of light ceases. This spare illumination emphasizes the importance of the place. ¹

Stonehenge, with its enormous stone elements and its exposure to the sky, is probably the most well known of astronomical structures. The arrangement of the site changed over two millennia. It began as an earth monument around 2900 BC, was later

built as a timber monument and used for the burial of cremated human remains. In the third phase, the megalithic stone monument was assembled and alignment of the entrance with the summer solstice sunrise was perfected. ²

Stonehenge, Amesbury, England (2900 BC-1600 BC)

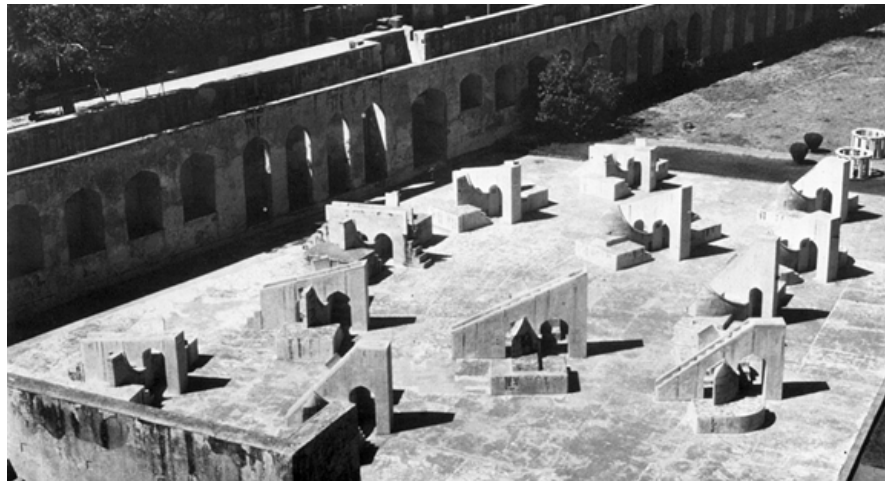


Newgrange and Stonehenge are structures in which light indicates sacredness of place. Later in history light becomes the key to the physical makeup of the universe. Around 1420 in the Mongol-Turkish capital of Samarkand, Ulugh Beg ('great prince' who was a mathematician and astronomer) ordered the construction of an enormous observatory to be part of an institute of higher learning. Housed in this observatory was the Fakhri sextant. The base of the sextant is built in a 2.5 m wide notch carved into the earth. The depth and curvature of the shaft indicate that the radius of the sextant was 40 meters.³

The Maharaja Jai Singh II built the largest of his five observatories between 1718-34 in Jaipur, India. The observatory contains monumental quadrants, sextants, a gnomon and tools for reading azimuths and altitudes. Each of these large scale instruments contain stairs from which visual readings can be recorded.⁴



Base of the Fakhri Sextant, Samarkand
(in present day Uzbekistan)



Observatory, Jaipur, India



The observatory within Roden Crater, designed by artist James Turrell, incorporates both the sacred-ness and scientific aspects of natural light. This observatory is made up of different spaces leading up to the fumarole. Each space is opened to the sky and aligned for a particular celestial event. Turrell elevates the experience of place by exploiting the height of the volcano above the plain: a space opens to the horizon which appears concave, optically creating a view similar to that of a pilot flying at a low altitude.⁵

These precedents illustrate how the occurrence of natural light ties together earth, structure, human and cosmos using three elements of design: path, place and event.

Movement
from urban to rural,
from constructed relief to that which occurs necessarily,
from definition to understanding.

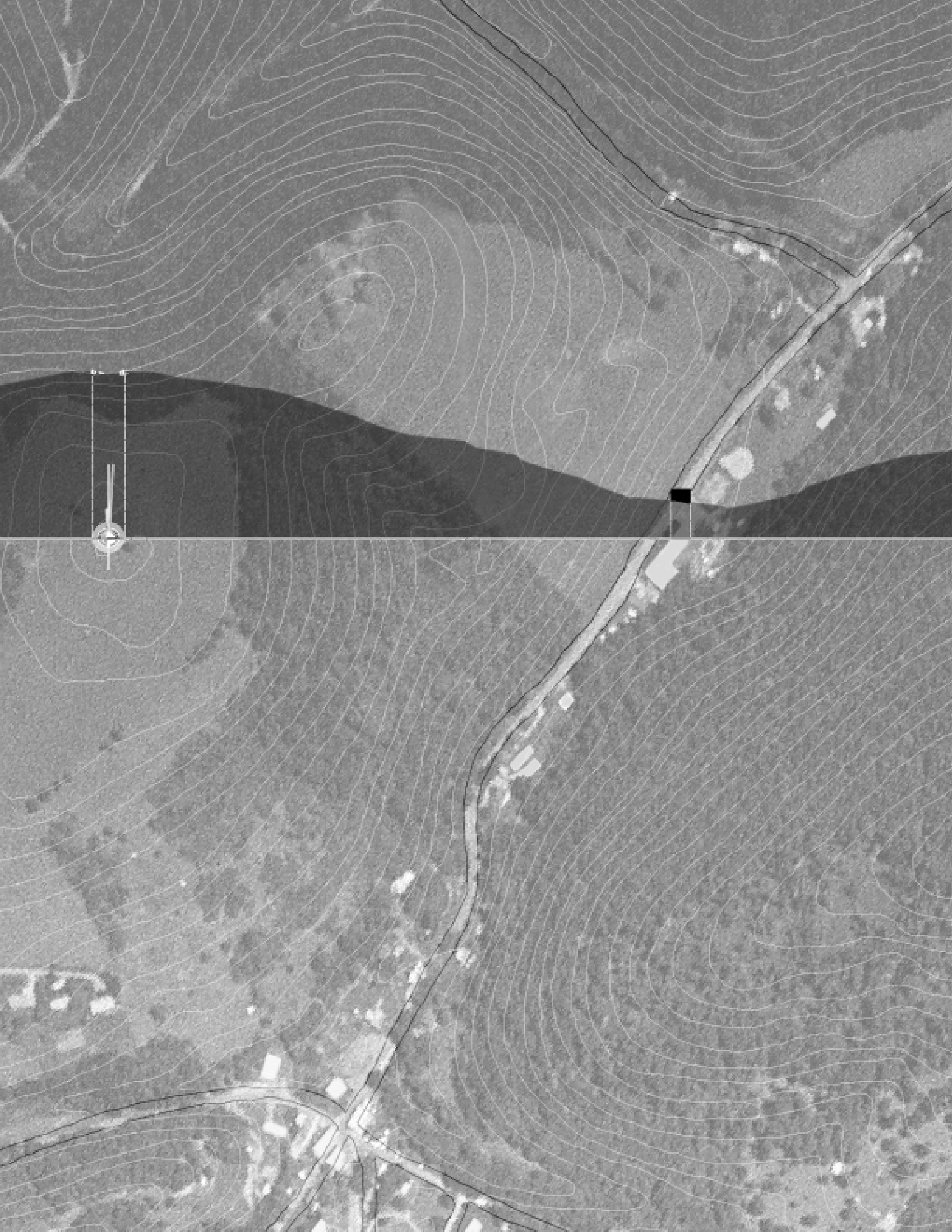
Path to Place











In the mountains of southwest Virginia lies the small town of Newport. Old white farm houses dot the landscape. The spaces between are pastures and growing fields with smaller houses, a few churches, and clusters of mobile homes appearing occasionally. Although the business center of Newport died long ago, the community survived and continues to grow. This is partially due to the town's willingness to use its largest building for a variety of purposes: the Newport Recreation Center is the only public meeting place in the area.

The NRC is proof of the vitality of the town and its residents. Interest in art, music, and education thrives. It is a community that would welcome a place of meditation.



Facing page: the NRC appears in section to the right of center.

Below: a group gathers to listen to music at a benefit to raise money for a member of the community.



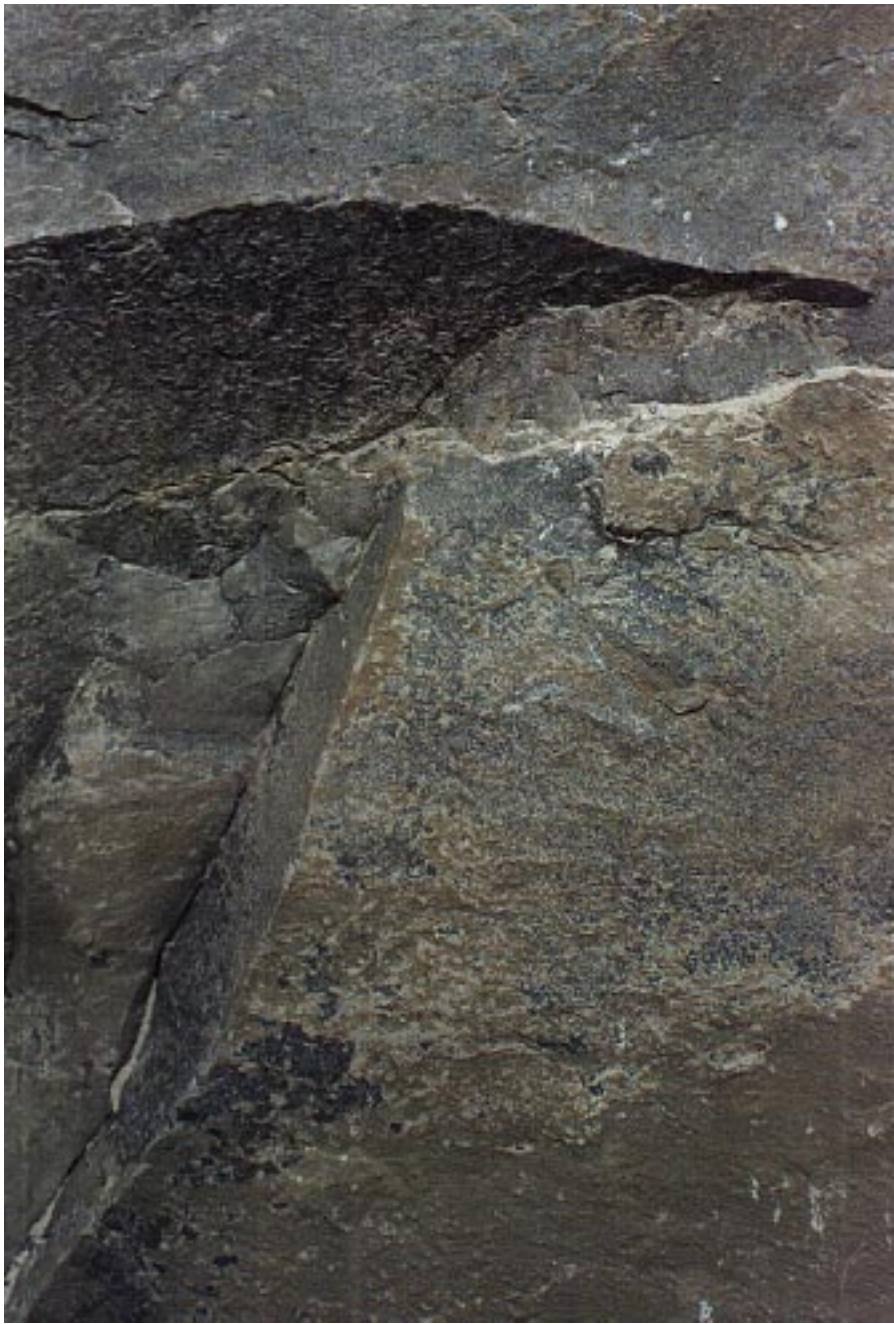




The landscape binds the people of Newport in work and in memory. The pastures, the abandoned gas station, the river and the softball field are all elements of the landscape. Located a few feet beneath this landscape is limestone. The following series of photographs studies this rock as it exists in a local quarry. All photographs were taken the same day. Each shows rock that appears to have been exposed longer than the previous.

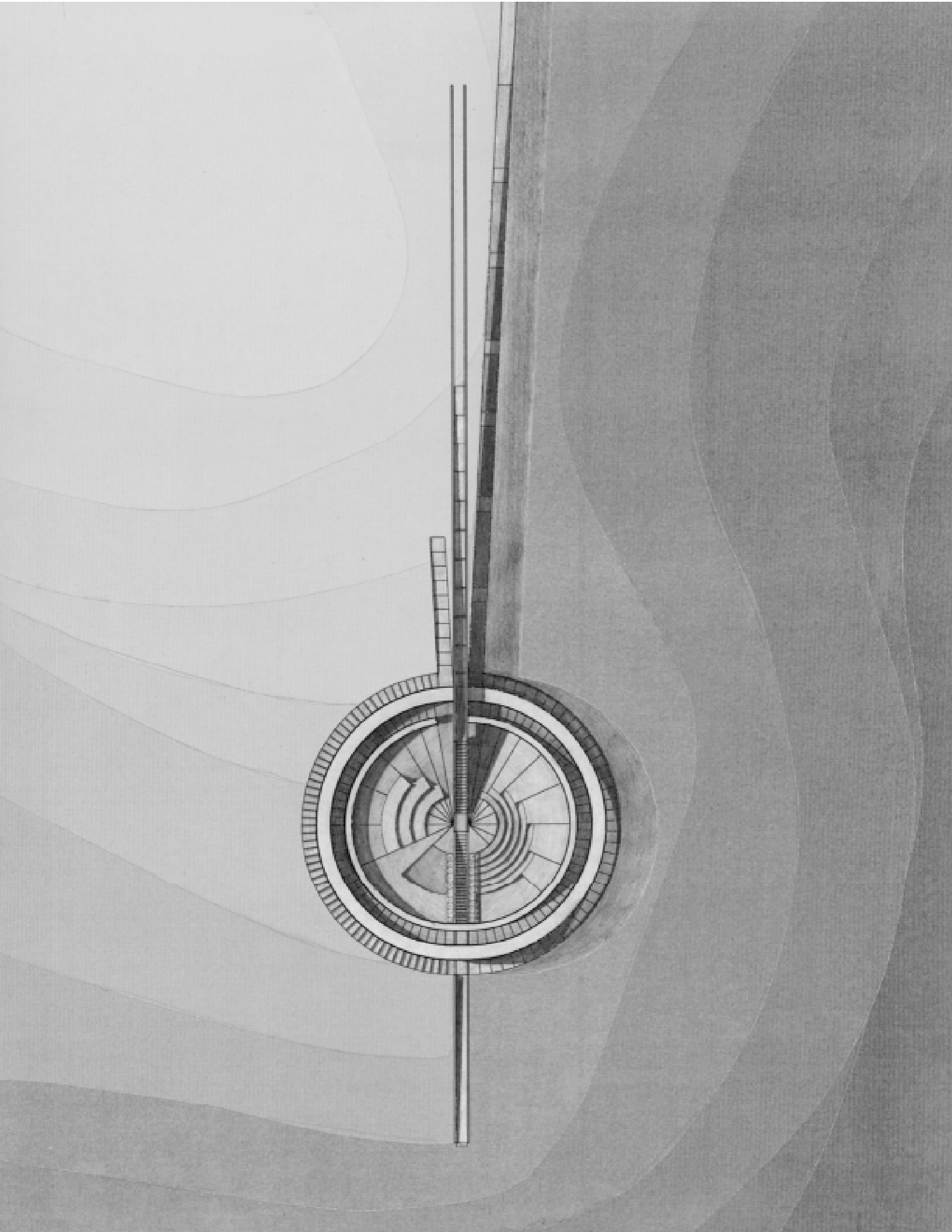






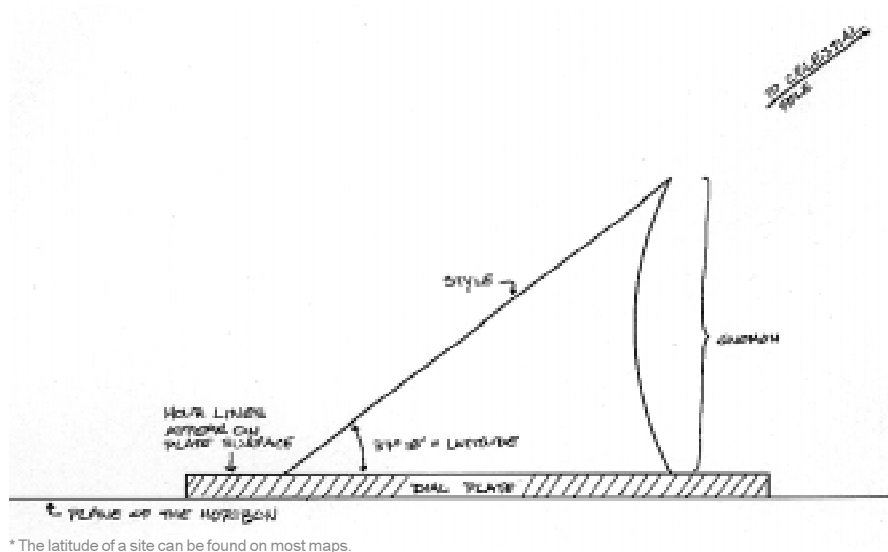






To see a world in a grain of sand
And a heaven in a wildflower:
Hold infinity in the palm of your hand,
And eternity in an hour.

- William Blake



Any object can be a sundial. If, on a sunny day, a vertical object casts a shadow northward or an object mounted to a vertical surface throws its shadow beneath itself, the sun is directly overhead indicating local apparent noon.

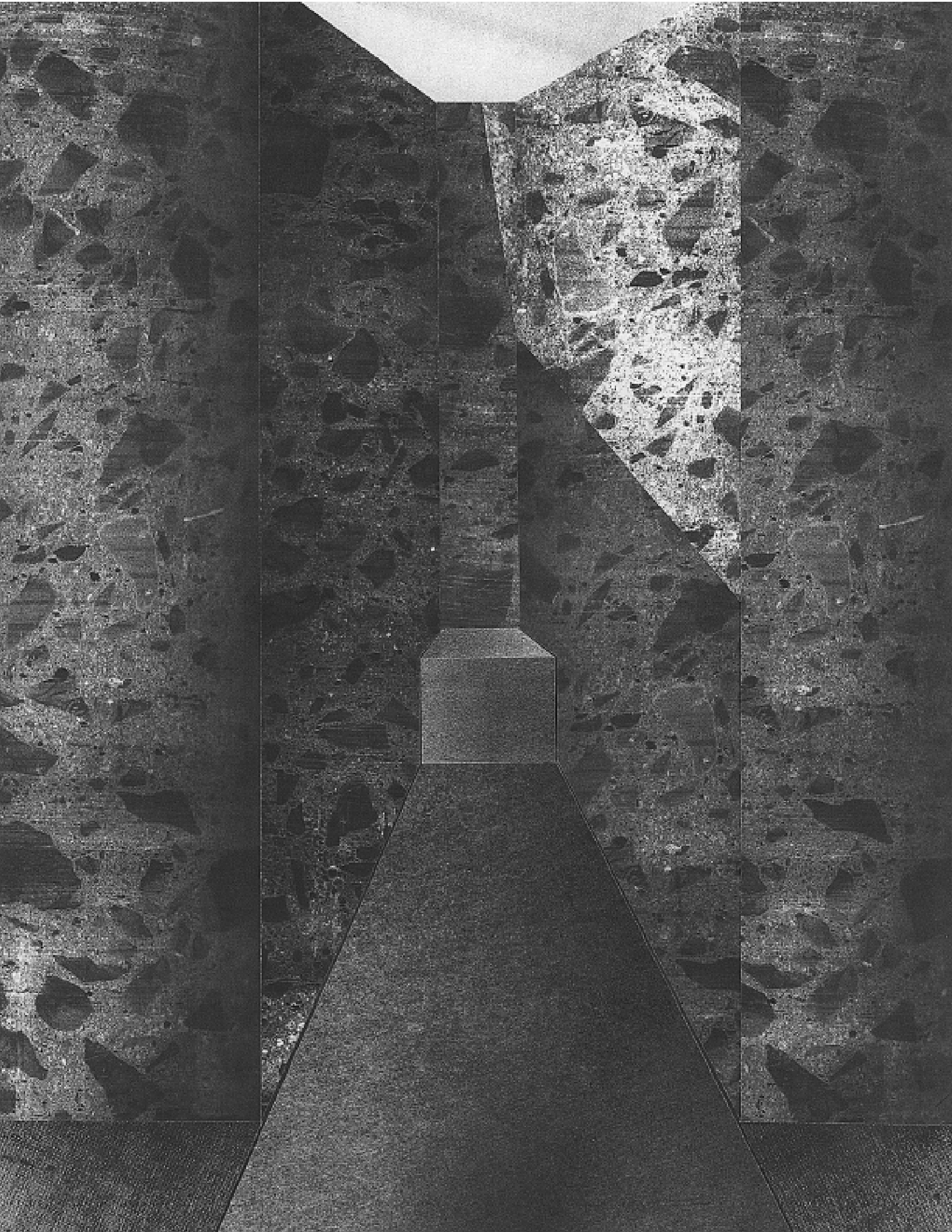
The basic principle of the horizontal sundial:

The dial plate, the surface on which hour lines are placed, is parallel to the plane of the horizon. The gnomon is the shadow casting element of the sundial. It can be thought of as a right triangle which lies on its longest side perpendicular to the dial plate. Its smallest angle equals the latitude of the site in which the sundial is placed and lines marking the hours of daylight radiate from the point of origin of that angle. The hypotenuse (known as the style) is aligned with the celestial pole. If the gnomon is of considerable width, the noon line splits in half to accommodate that thickness and thus separates the morning from the afternoon hours. ⁶

The design of the thesis project is based on the principle of the horizontal sundial. It is 82' in diameter and therefore monumental in scale allowing for a small amphitheater to be contained by its walls.



noon



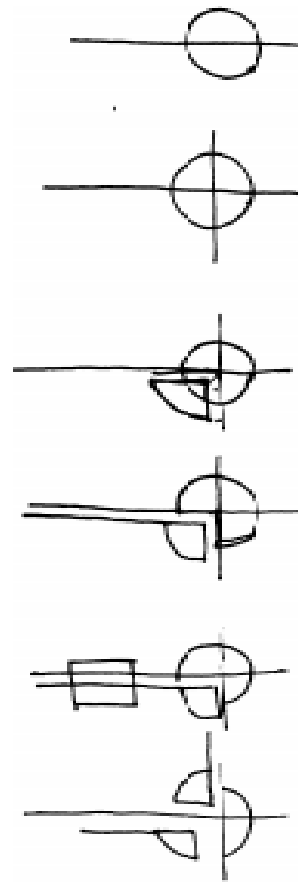
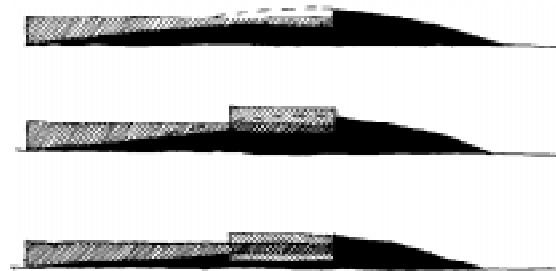
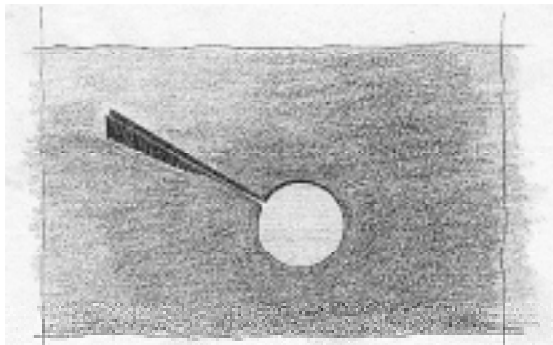
Diagrams of Program

A place that can be reinterpreted should support four possible conditions simultaneously:

- The individual seeking a place for meditation.
- The meeting of two.
- One with a group for instruction.
- Many meet for performance and entertainment.



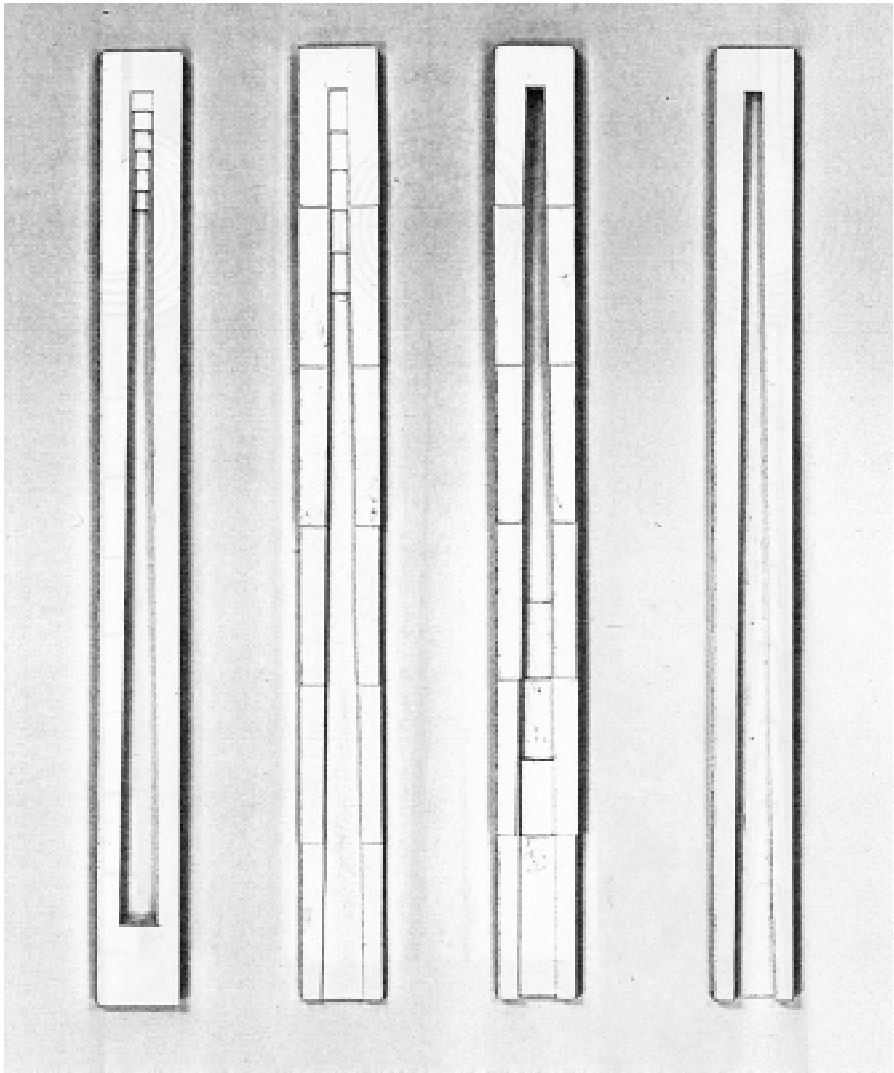
Path leading to place. Sketches below show place cut into the hill.



Diagrams of Plan

The lesson of the precedent study was that examples of spiritual architecture share the elements of path, place and event. An intuitive plan including these elements is a circle with two lines crossing.

The simple diagram grows more fragmented and complex with each alteration.

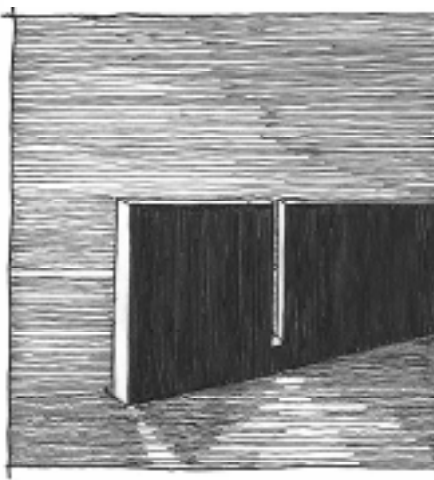


Preliminary models for path

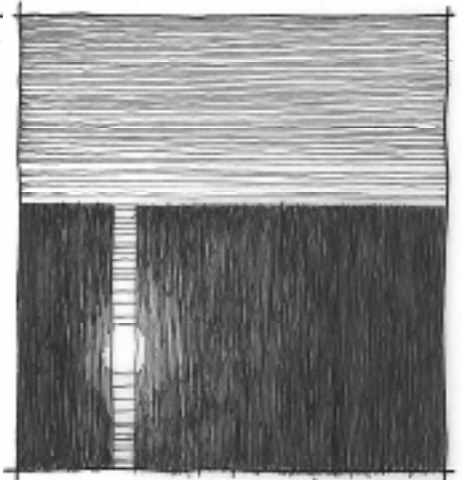




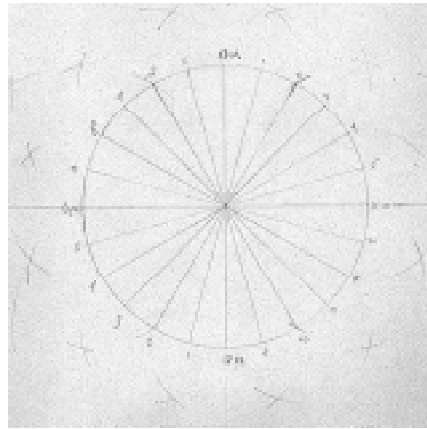
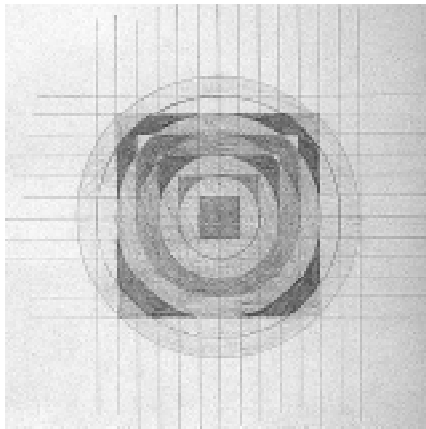
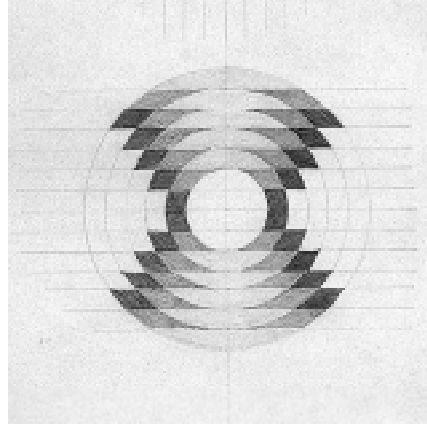
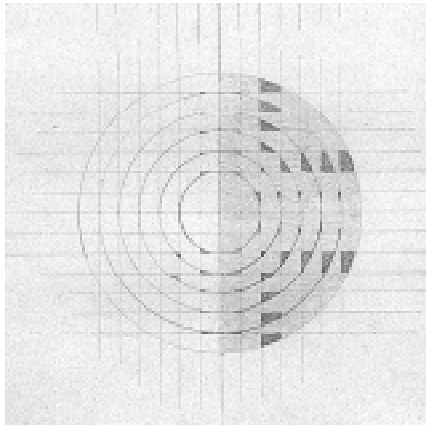
path



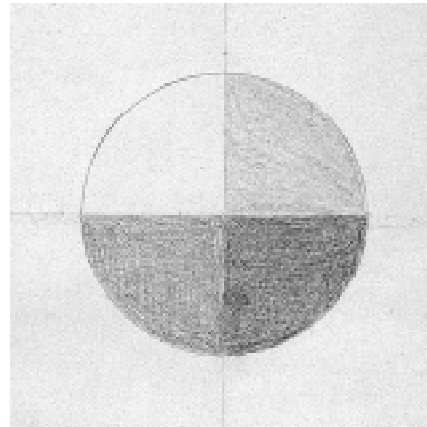
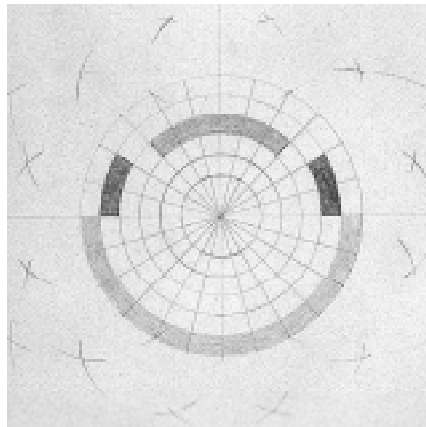
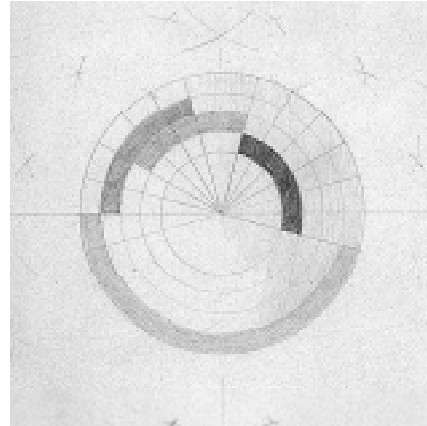
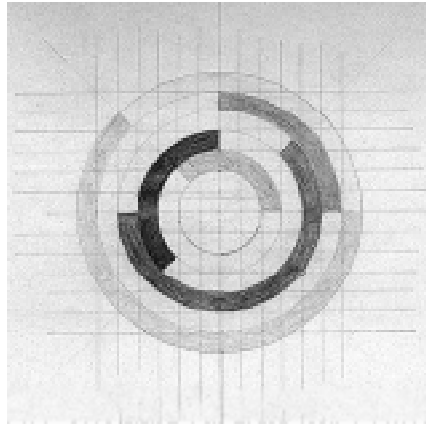
place



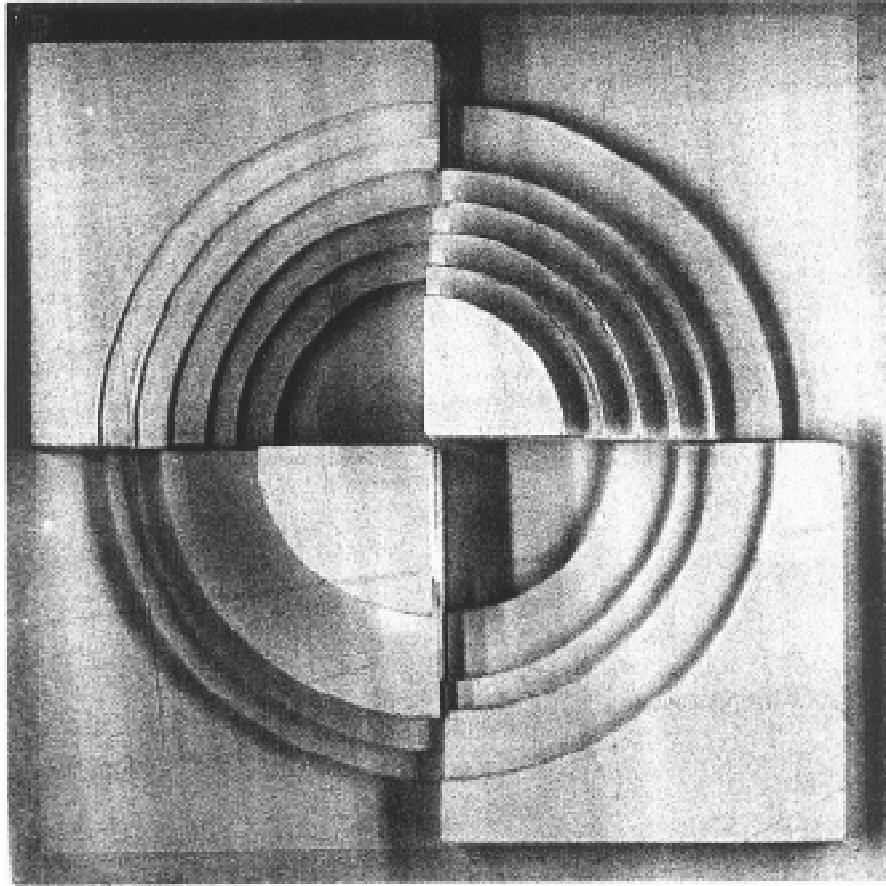
event



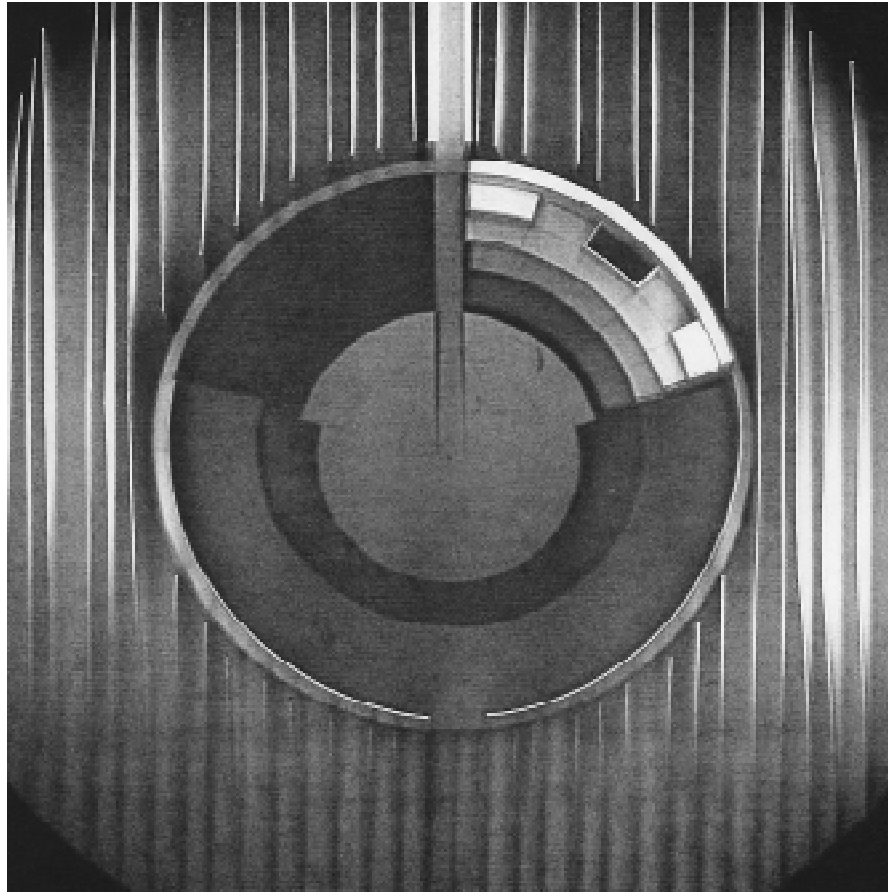
The circle is the strongest form to define or enclose a place. Attempting to differentiate the circle produces patterns that are suitable for a surface (above) or an arrangement of parts that lends itself to built form (facing page).



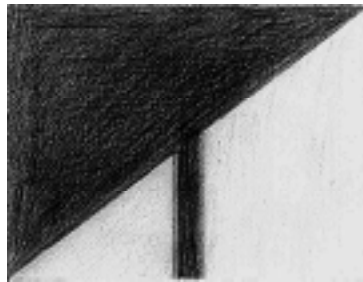
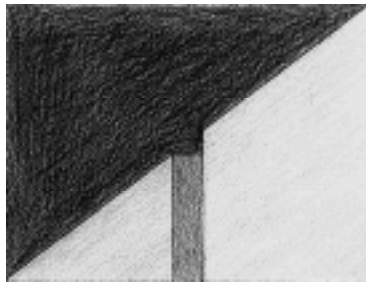
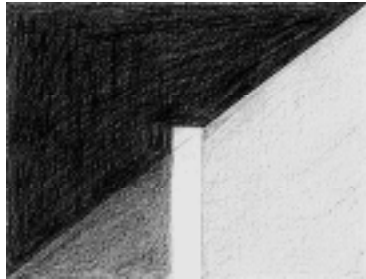
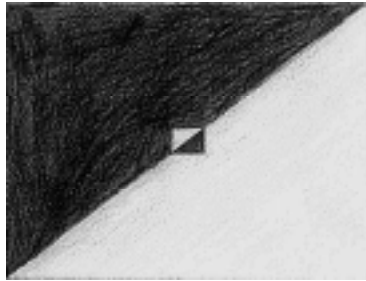
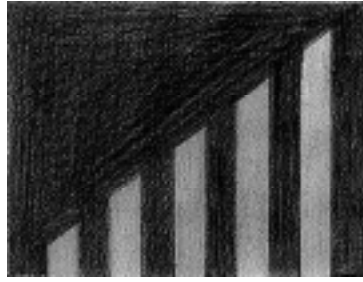
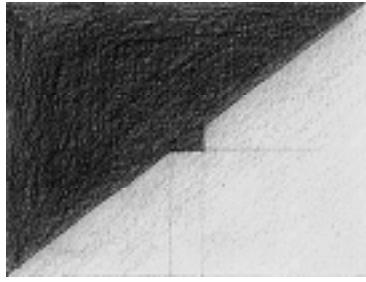
There is a tendency to begin with the complicated, but ultimately the design is reduced to a simple four part division. In this simpleness lies the strength of design in history associated with spirituality. For example, the Islamic garden and the Cloister garden are traditionally laid out in four parts.



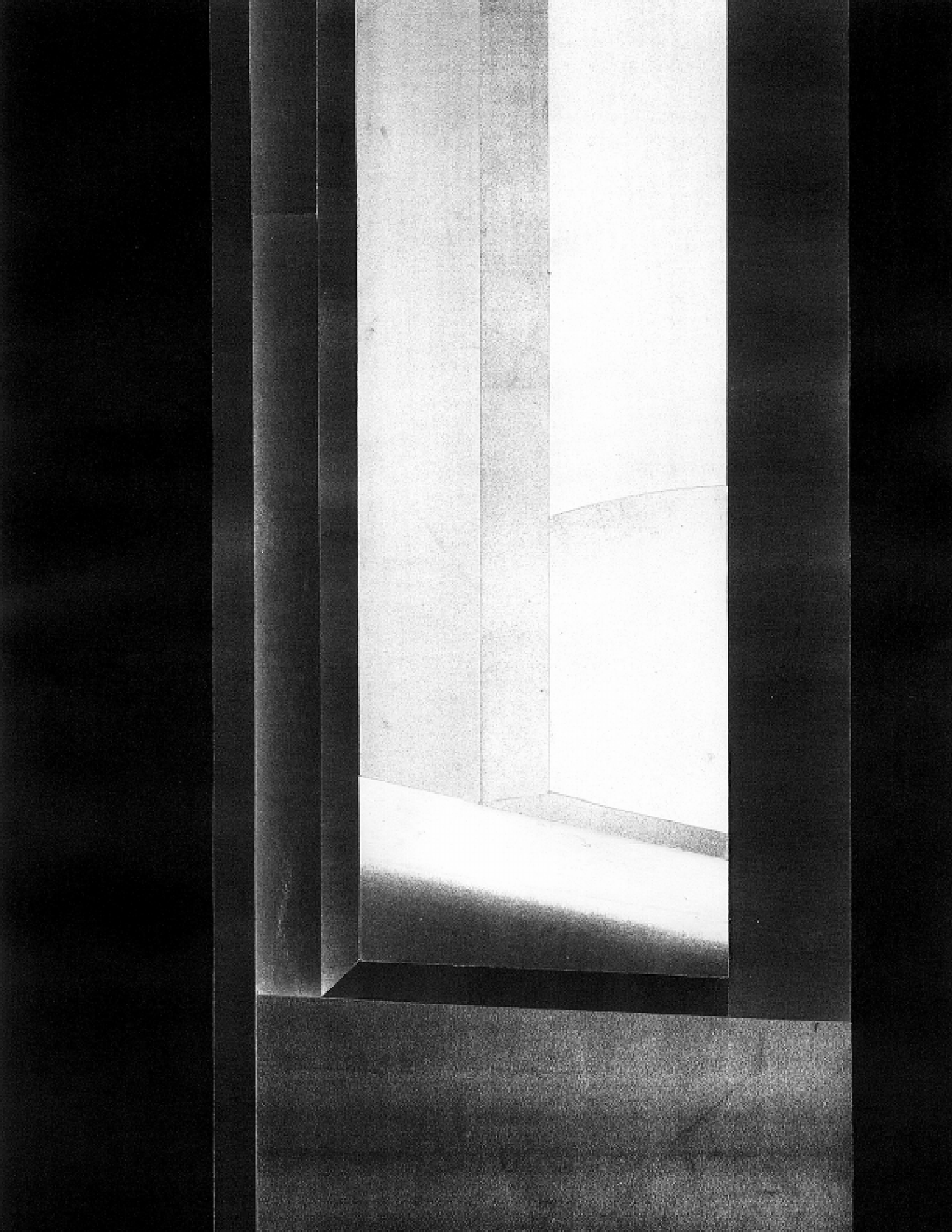
Plan view of an abstract model showing an extrusion of levels in search of a built form.

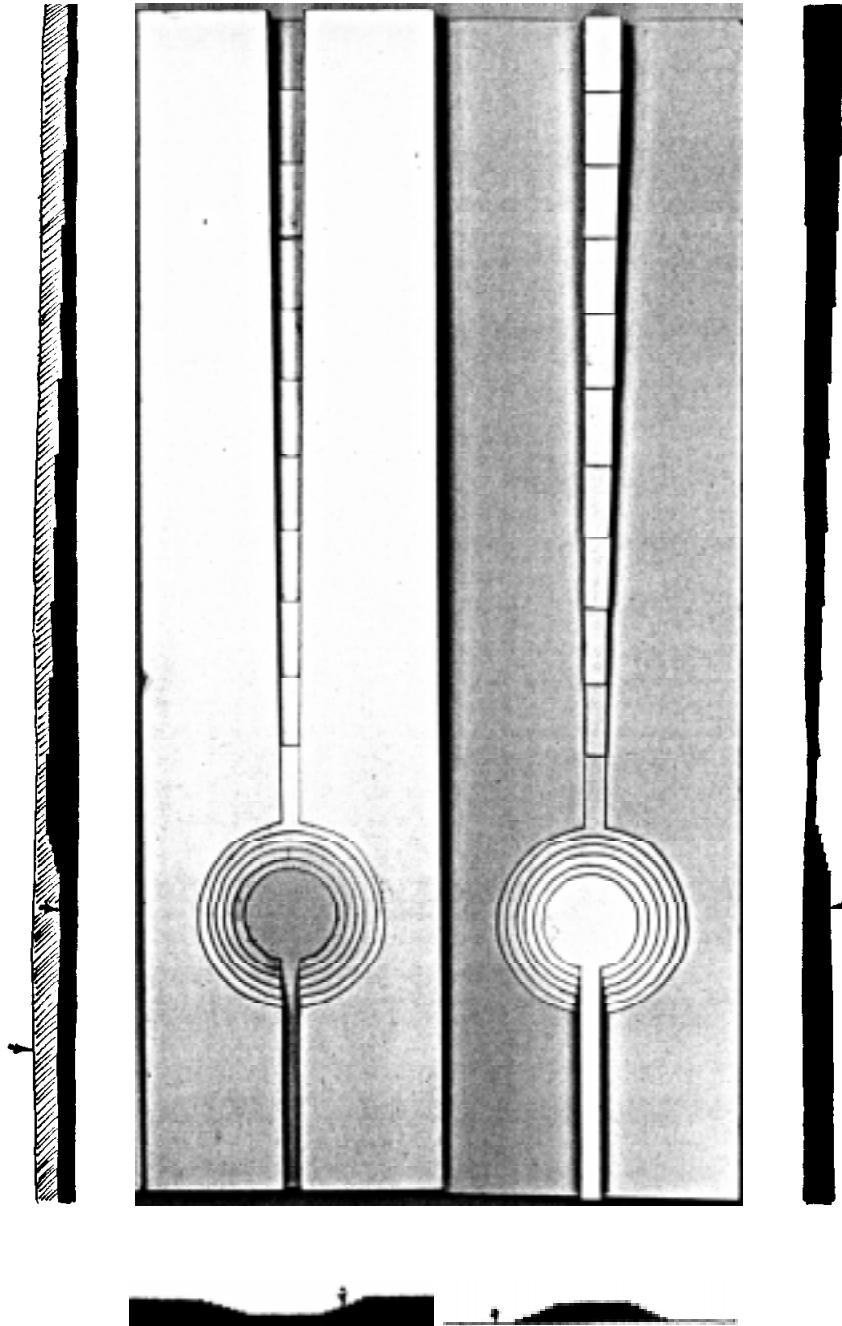


Plan view of another step towards inhabiting the circular place. The ring surrounding the circle begins to define a walkway. A ramp leads from the ring up to the center of the circle. Stepped seating in this plan could also contain space underneath.



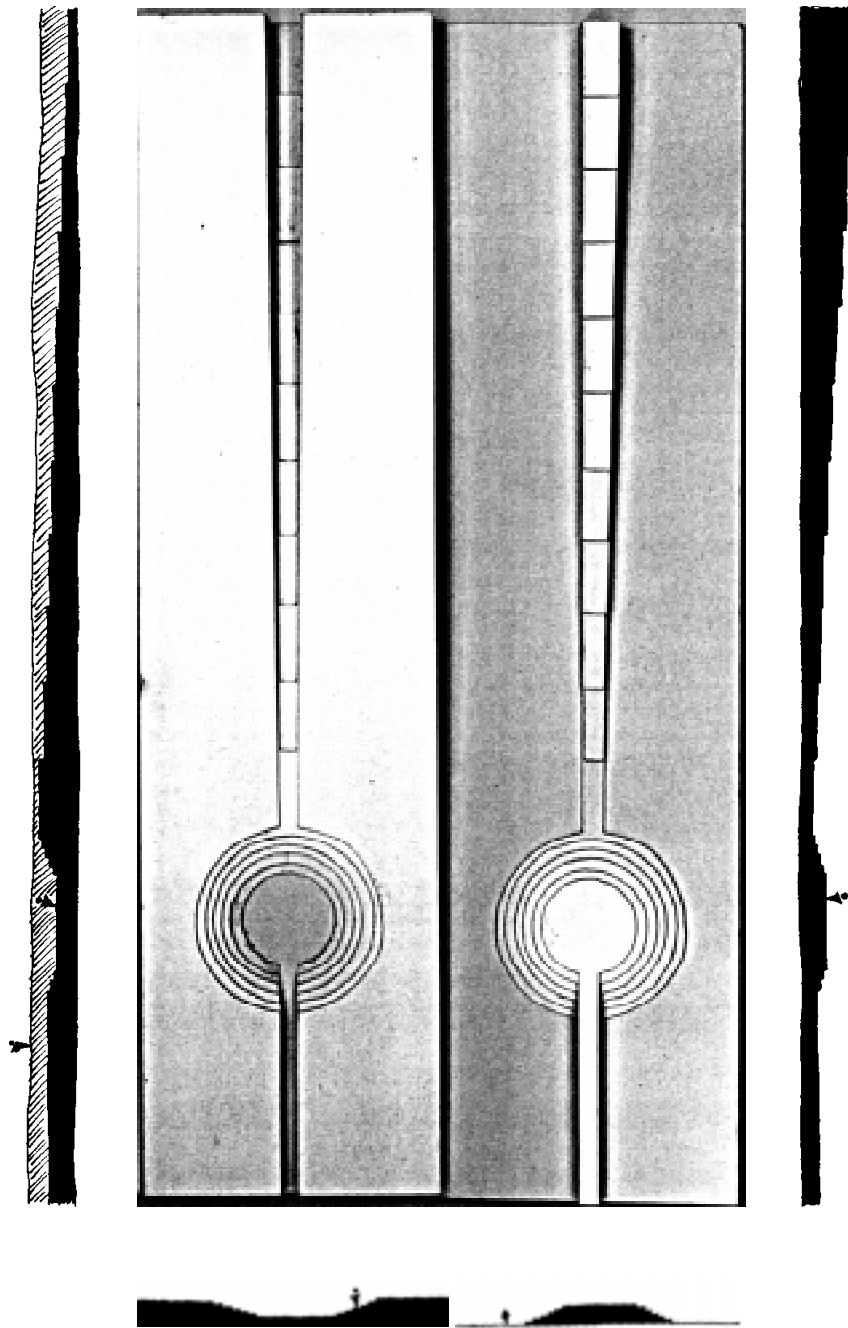
Above: Sketches studying the angle of the gnomon
 Right: Event (cut paper collage of shadow and light)

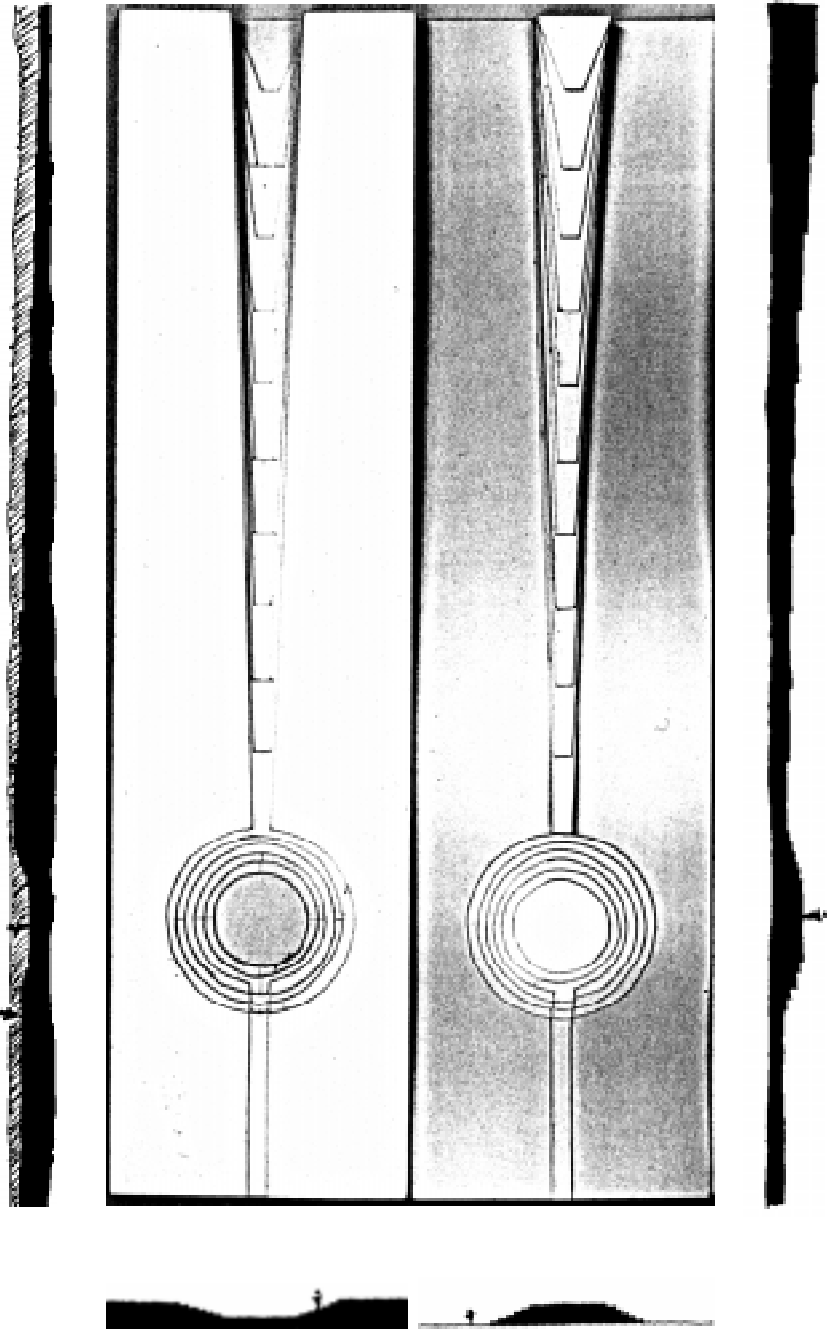


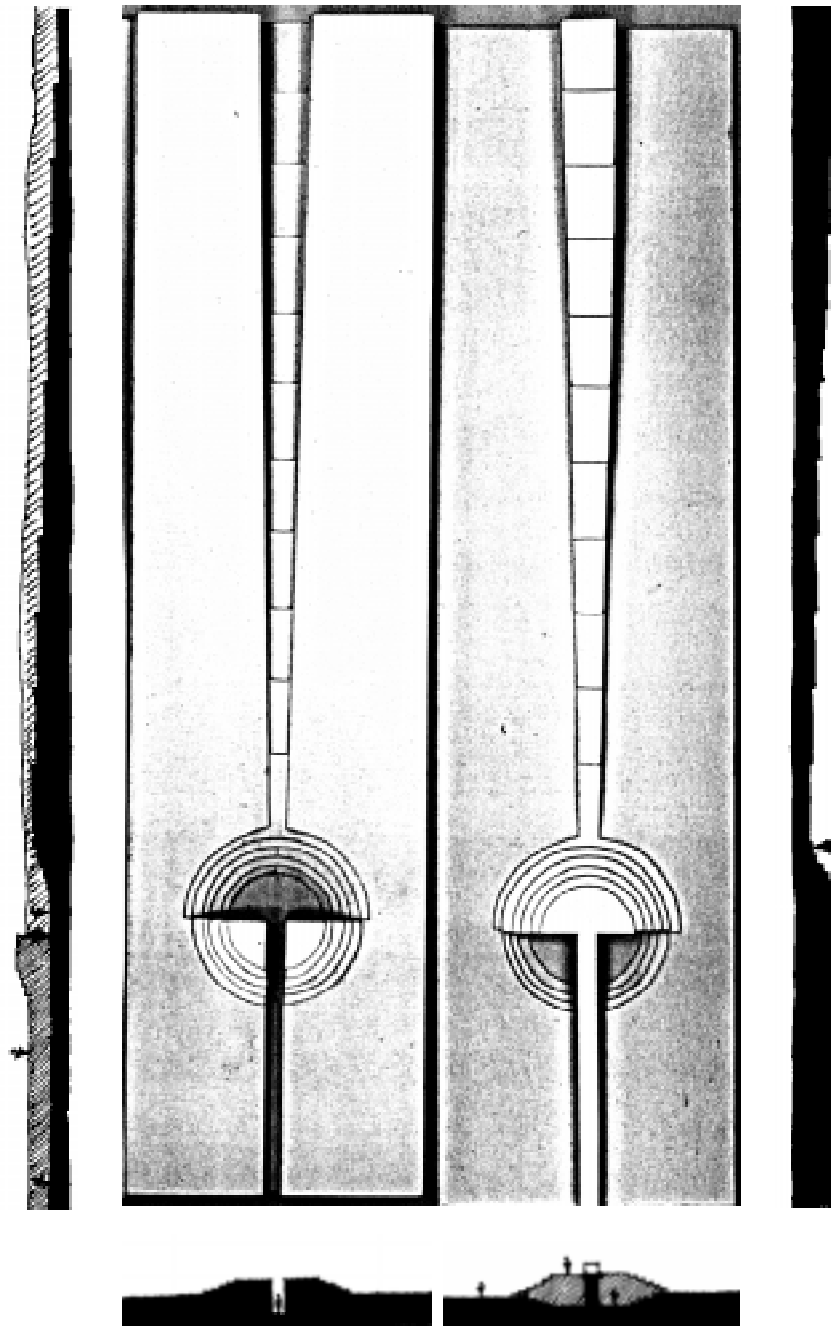


Opposites: Using What is Left Over

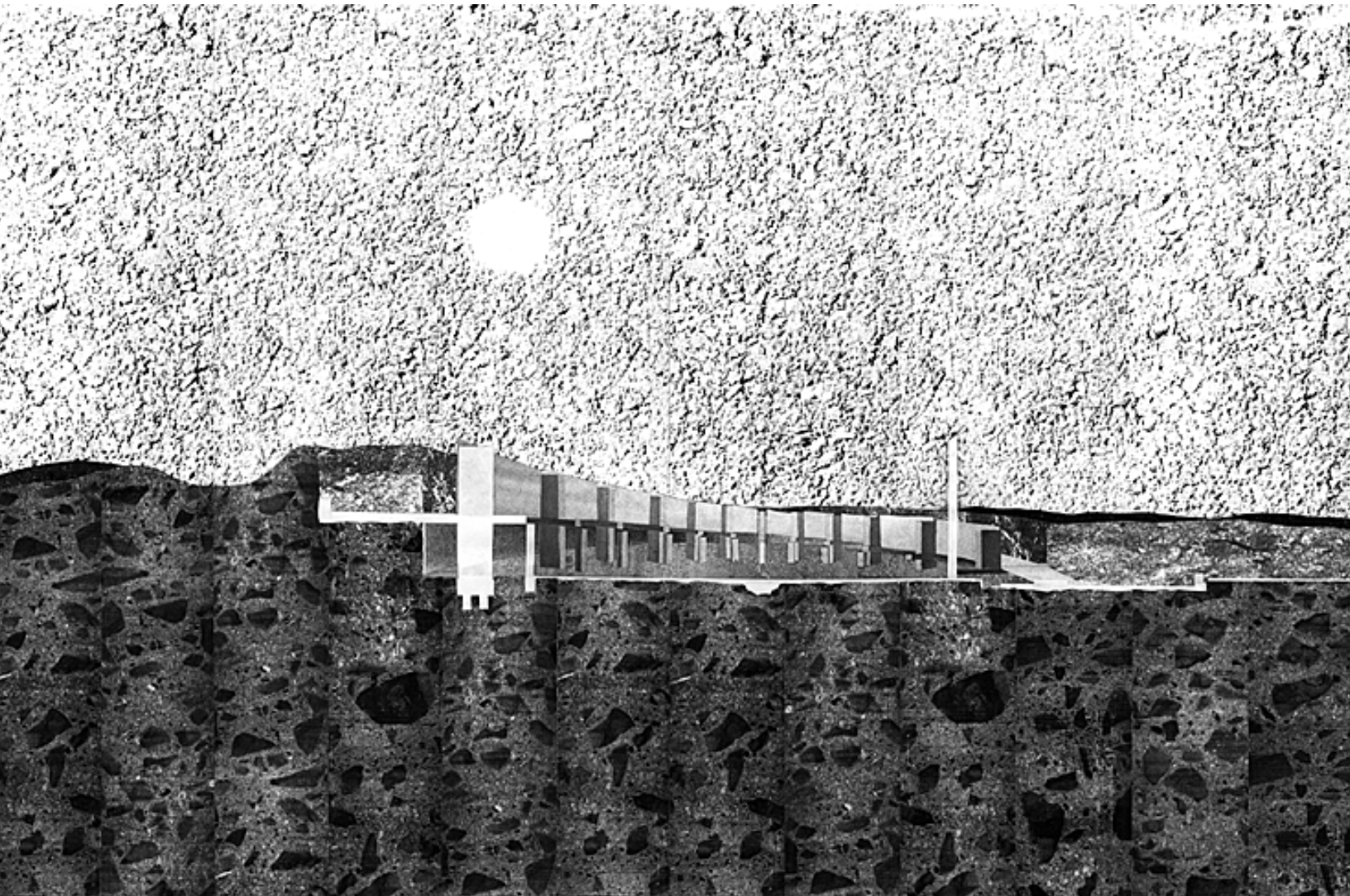
Usually when making a model the left over pieces are thrown away. When cutting layers for the following eight models, pieces left over were set aside in a stack. An important discovery was recognizing that the left-overs are also parts to a model. Two models are made at the same time, each containing a bit of information that leads to the next step and next set of models.

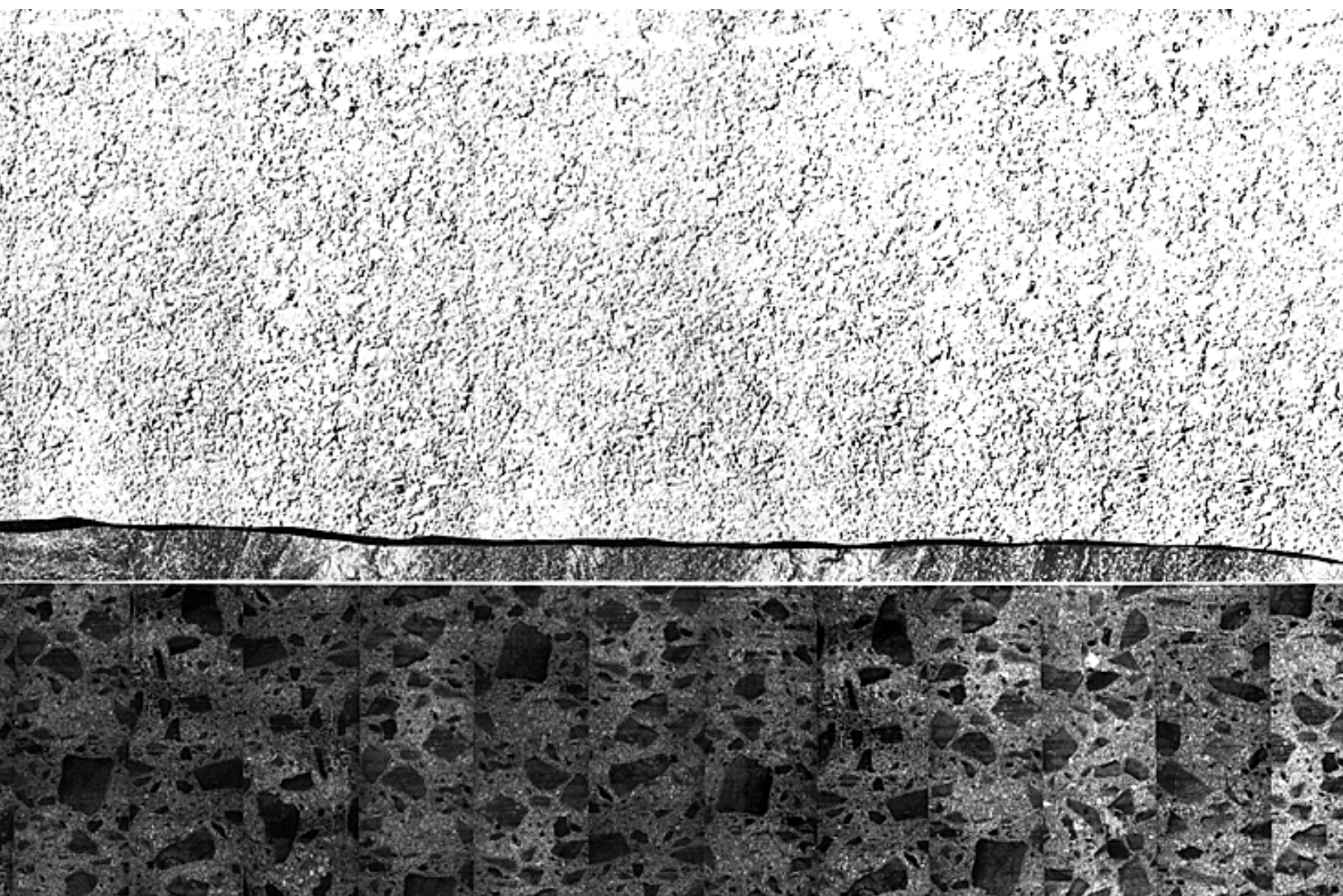


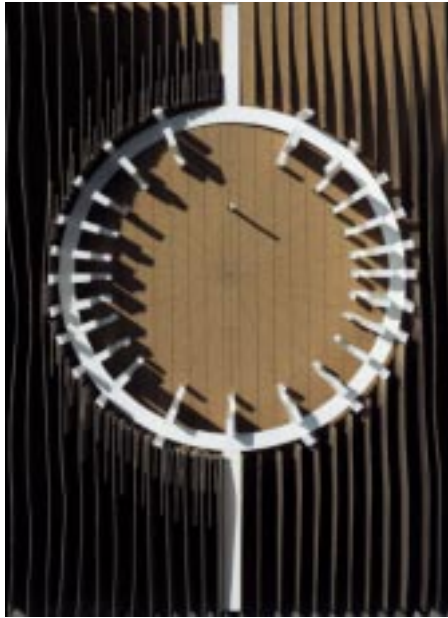




Section of second dial plan showing vertical gnomon, path from the north to the ampitheater, and walls marking the hours.



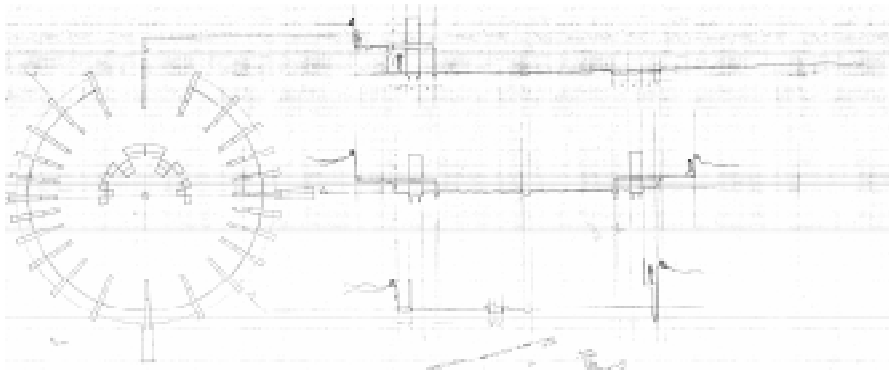




Left top: Plan view of model of the first dial design shows vertical gnomon and walls marking the hours and supporting the perimeter path.

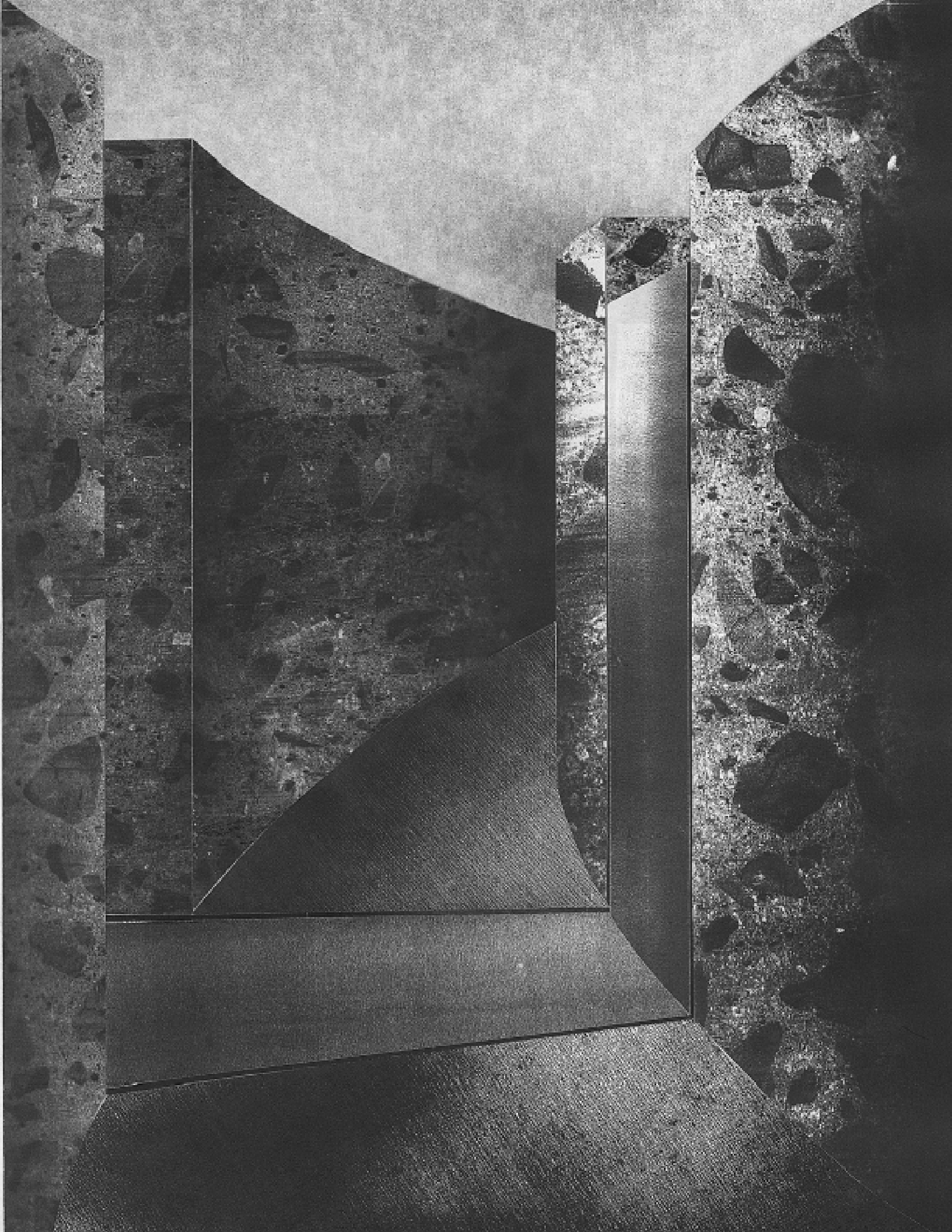
These models explore possibilities for the gnomon, the walkway, and the marking of the hours. The curvature of the path restricts sight to what is immediately ahead and behind, but it is open to the expanse of the sky. The path leads you back to where you began, allowing you to complete a cycle.

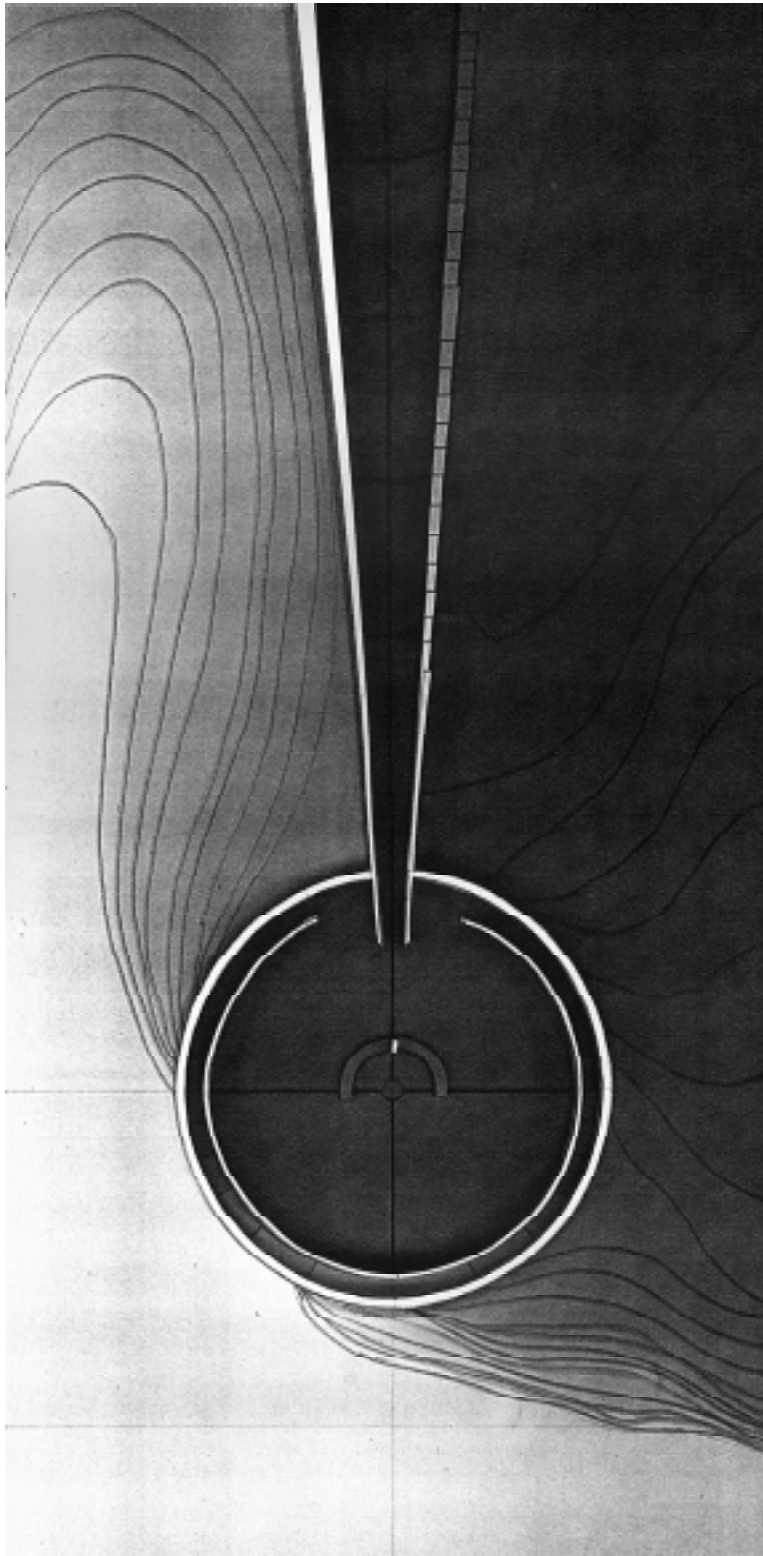
The path to discovery in design can be jagged. The models shown here strayed too far from the spirit and essence of the original thought. It was necessary to return to what was successful earlier in the investigation. The models of path and place were considered on a larger scale, the results of which appear on the next twelve pages.

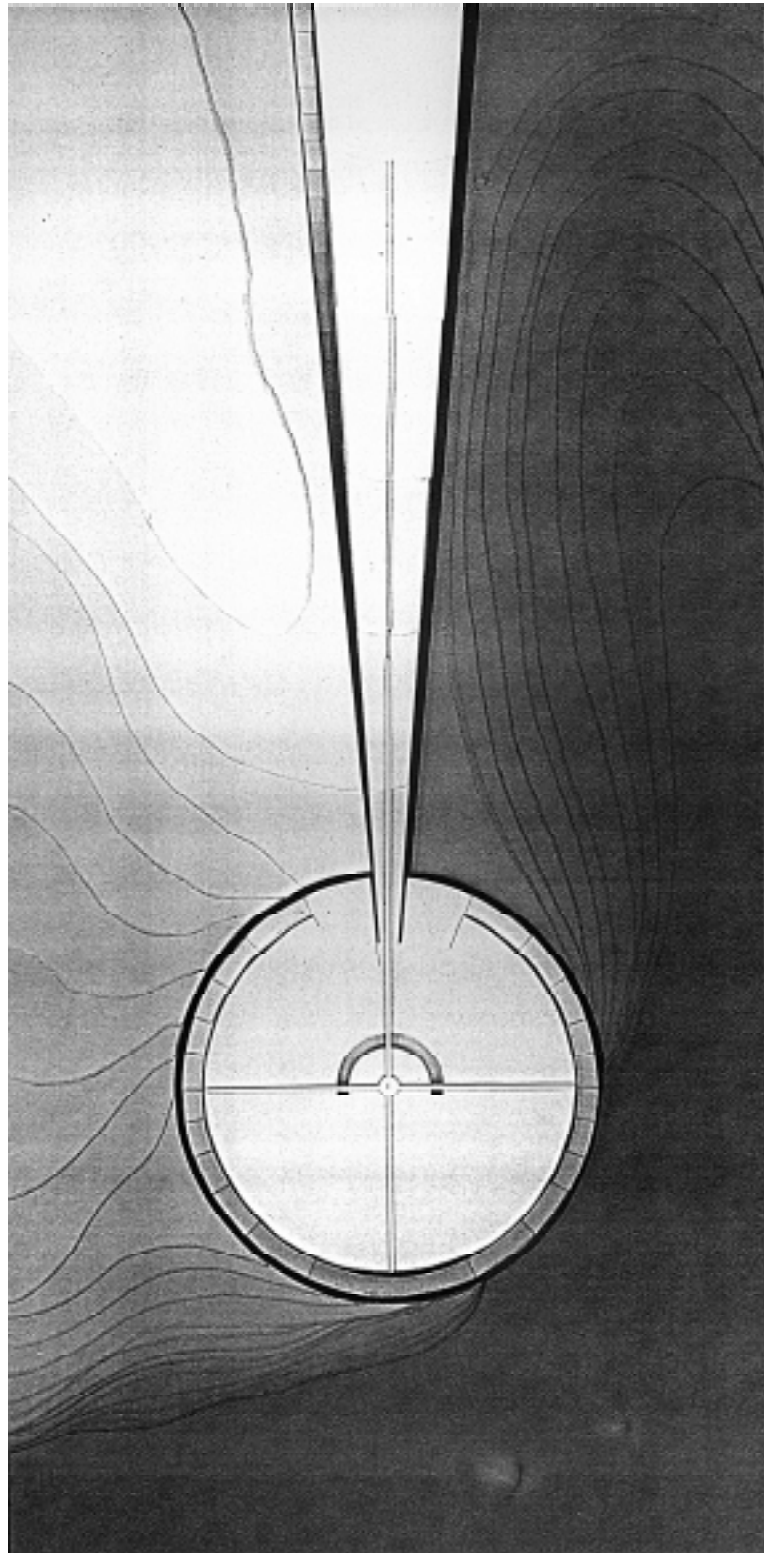


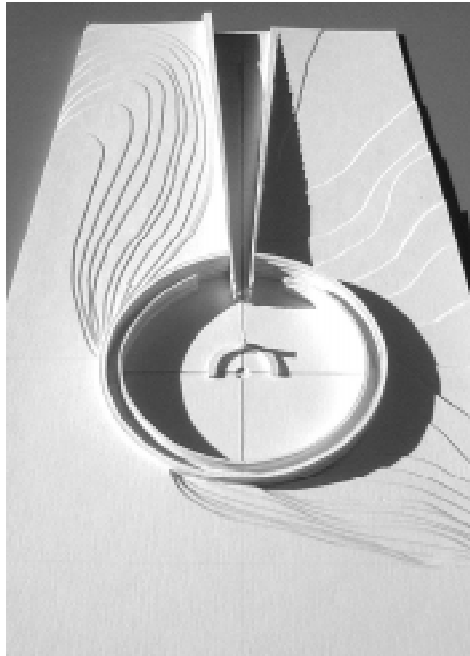
Left bottom: Model of the second dial design shows the development of the enclosure of the perimeter path. A section of this plan appears on the previous page.



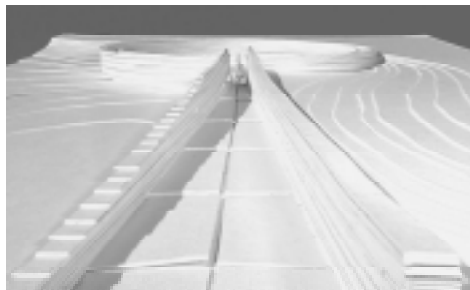








View from south



Path leading from the north to the amphitheater

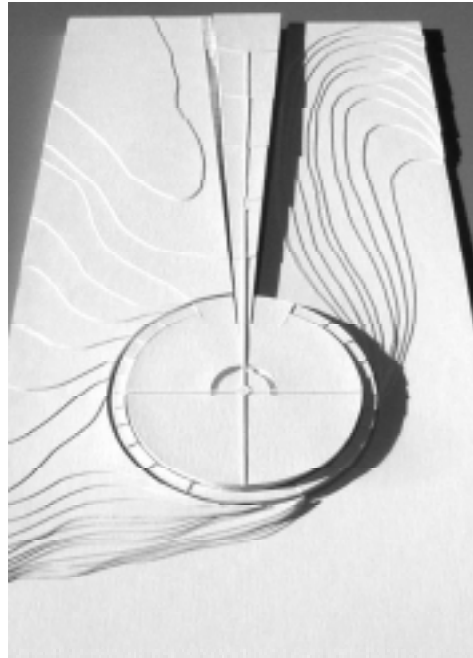
East elevation



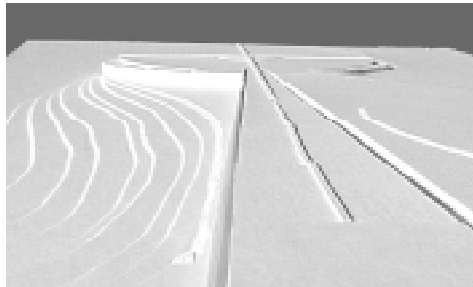
The diagram study shown on pages 40 to 43 begins to evolve into built form in this series of study models. Walls placed at an angle to the north/south axis define the northern path to the amphitheater. This visual and physical focus becomes the entry to a circular room made of arcing walls and sky. These walls also enclose the walkway introduced in the previous set of models. The gnomon appears as a single vertical element perpendicular to the arc of a circle on which hour lines would be incised. Although this type of gnomon will function properly, its design seems to emphasize a sense of the entire plan being an instrument placed in the earth rather than something of the earth.

This first set of sketch models led to the discovery of the relationship of the sundial to the earth. The opposite model shows new characteristics of the northern path and the walk encircling the room. Working with horizontal layers allowed the design to grow from the site and be bound to it rather than placed on it.

As with the diagram models, these studies were made simultaneously. Cutting layers for one produces layers for another. This results in opposite models and provides a concrete form for that which is either left to the imagination or not considered at all. In other words, this type of model making uncovers the possibilities of one design.



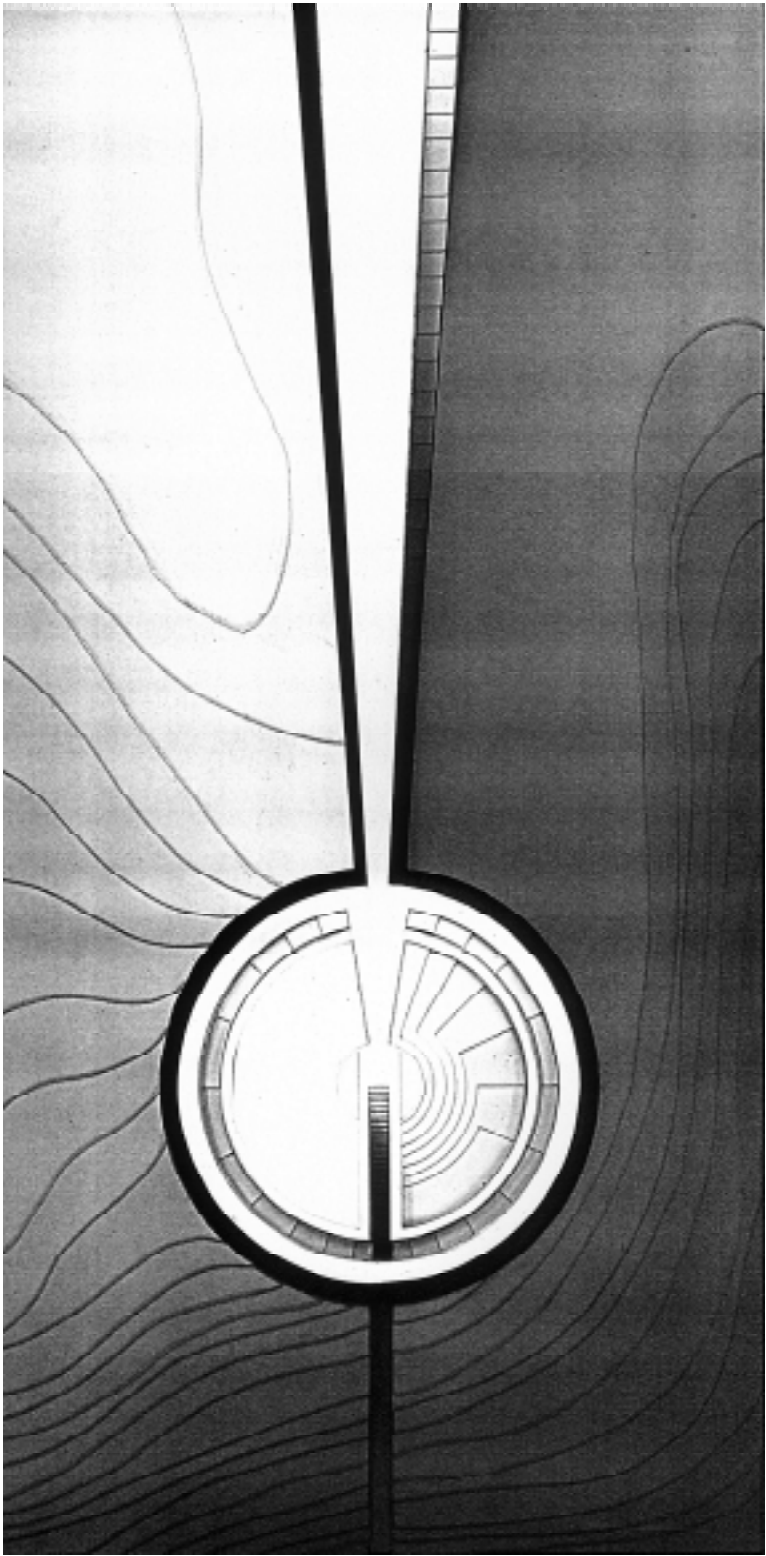
View from south

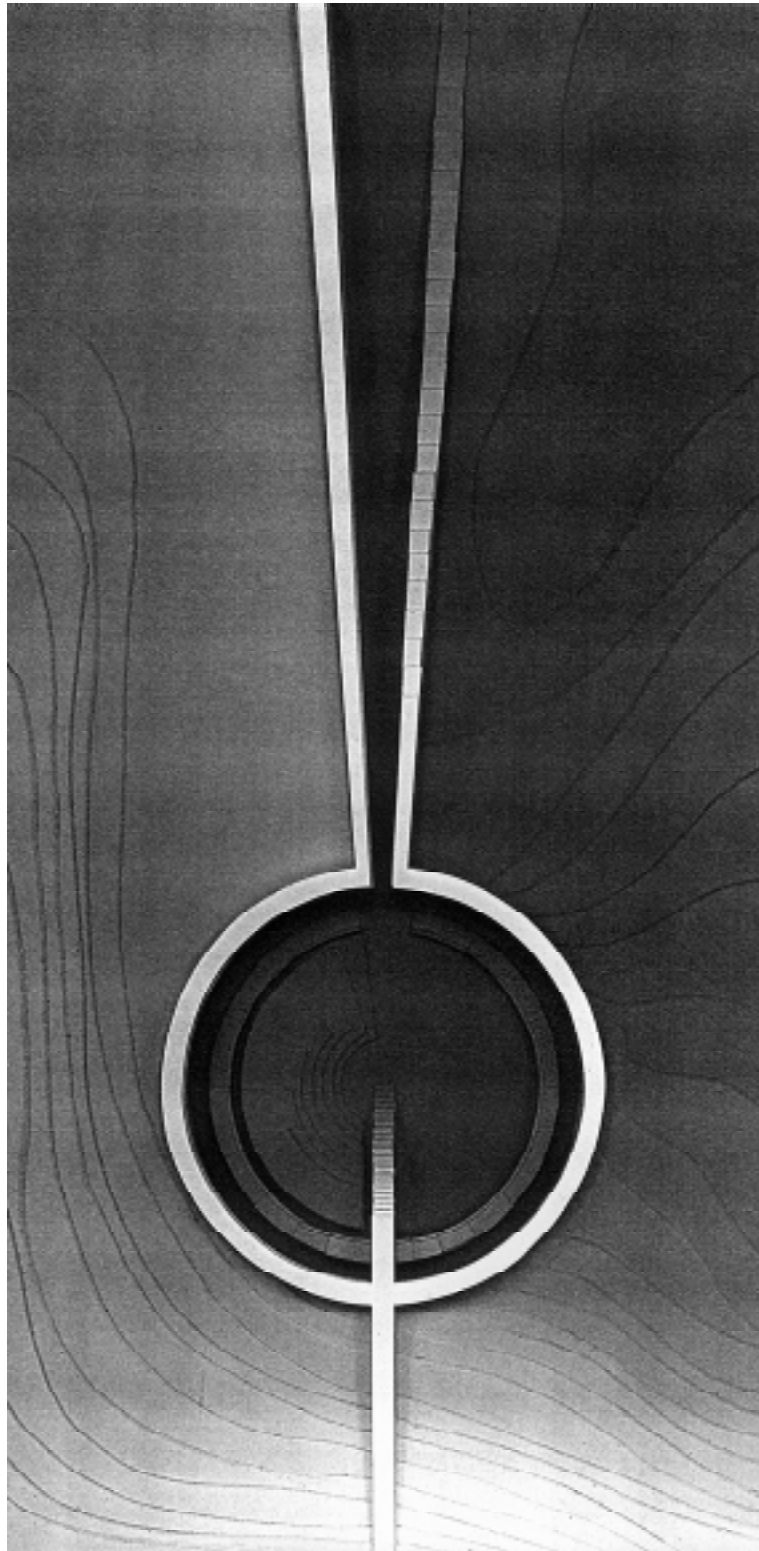


Paths leading from the north to the amphitheater



West elevation

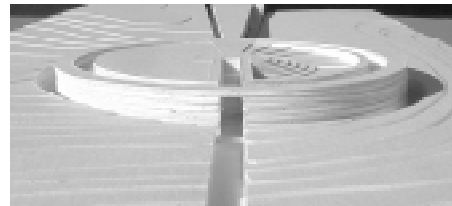






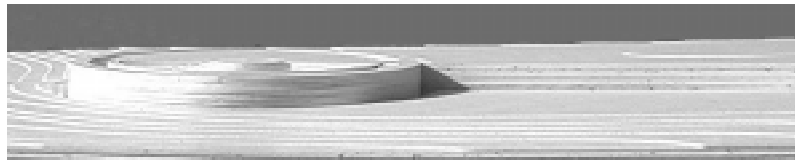
View from south

The first of the second set of models shows the development of the southern entry and the marking of the hours on the amphitheater floor. Seating is carved out of the floor in concentric steps, each intersecting a radian representing an hour line.



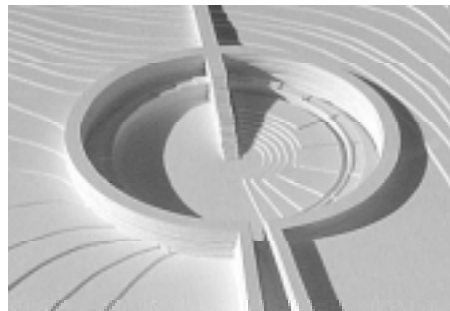
South entry

East elevation: the place grows from the site

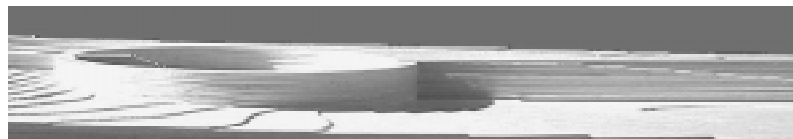




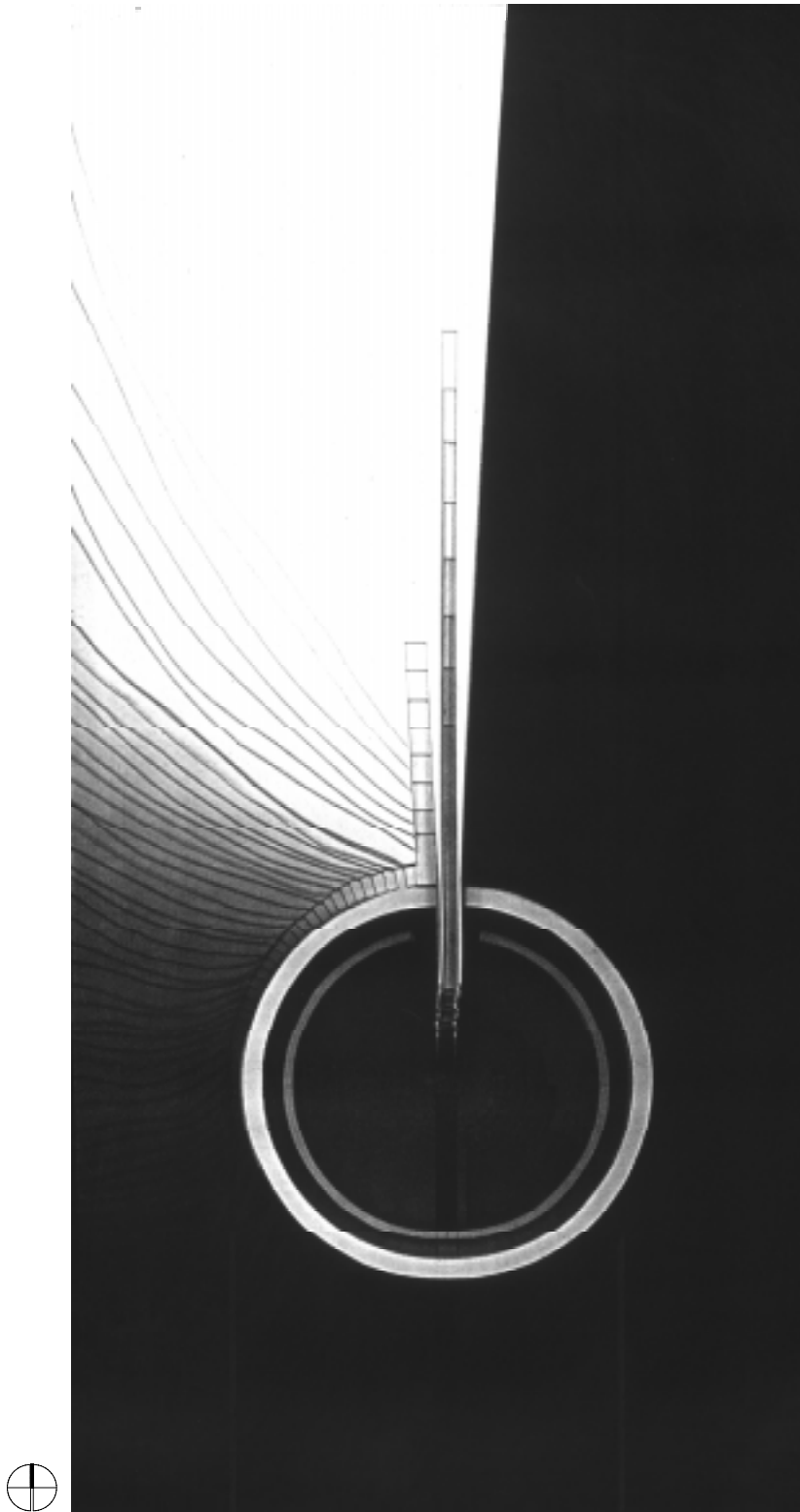
View from south

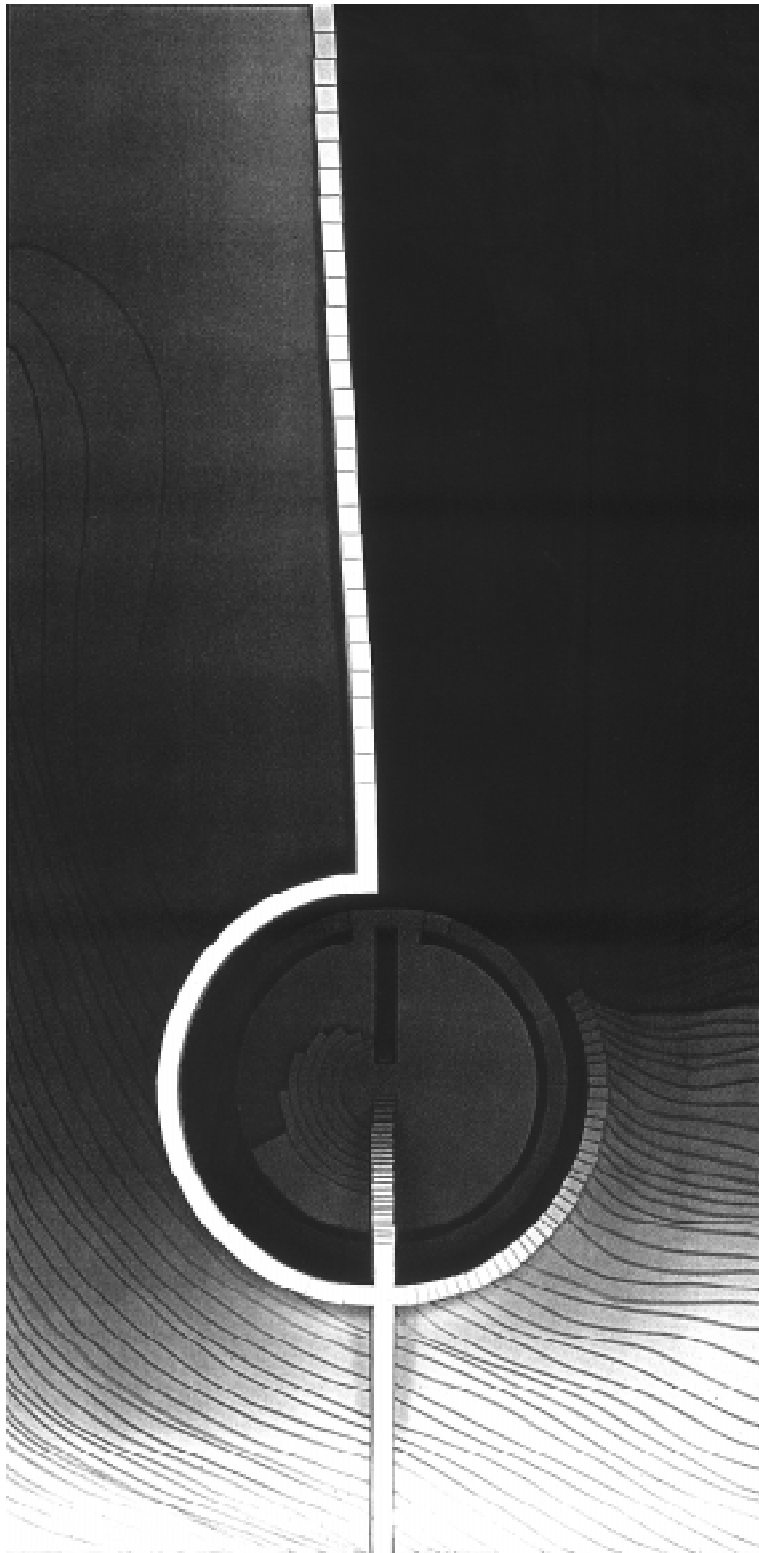


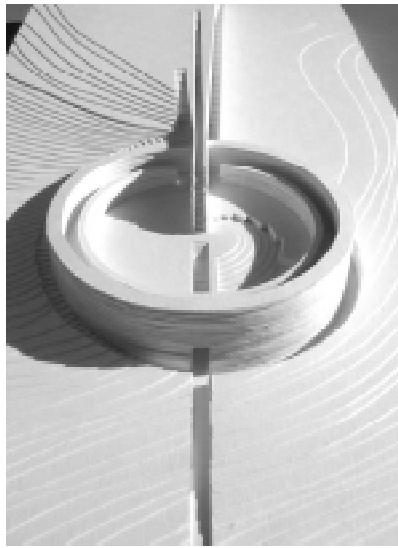
East elevation



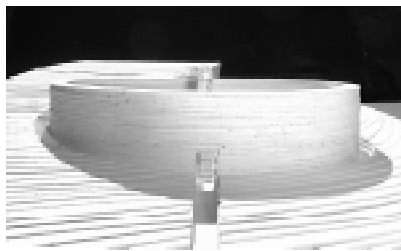
The solution of the gnomon appeared when this second model was assembled and a shadow was cast by the element that leads to the center of the circle. The gnomon became the entry to the place.







Southern axonometric view



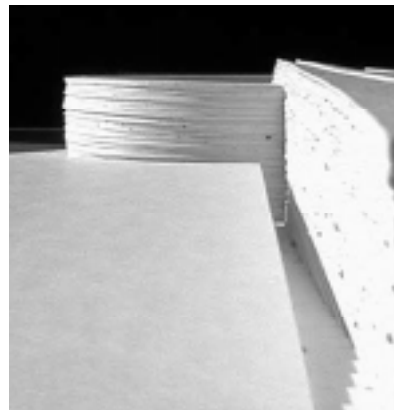
Elevation showing south entry

Axonometric view from the north



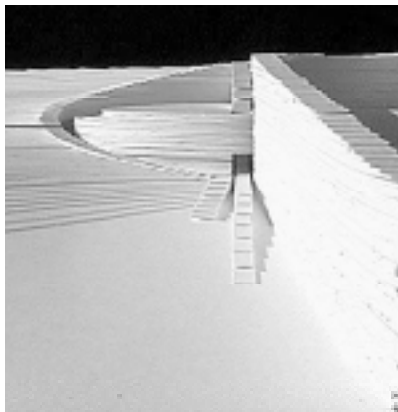
The third set of study models shows solutions suggested by the previous two sets. The gnomon has become a northern stepped entrance to the amphitheater. In order to cast the correct shadow, walls are placed on either side of the stone steps. The upper edge of the walls are the style of the gnomon and so descend towards the floor of the amphitheater at an angle of $37^{\circ}18'$ (the latitude of the site) relative to the horizontal floor.

Ramp leading down to the path surrounding the amphitheater



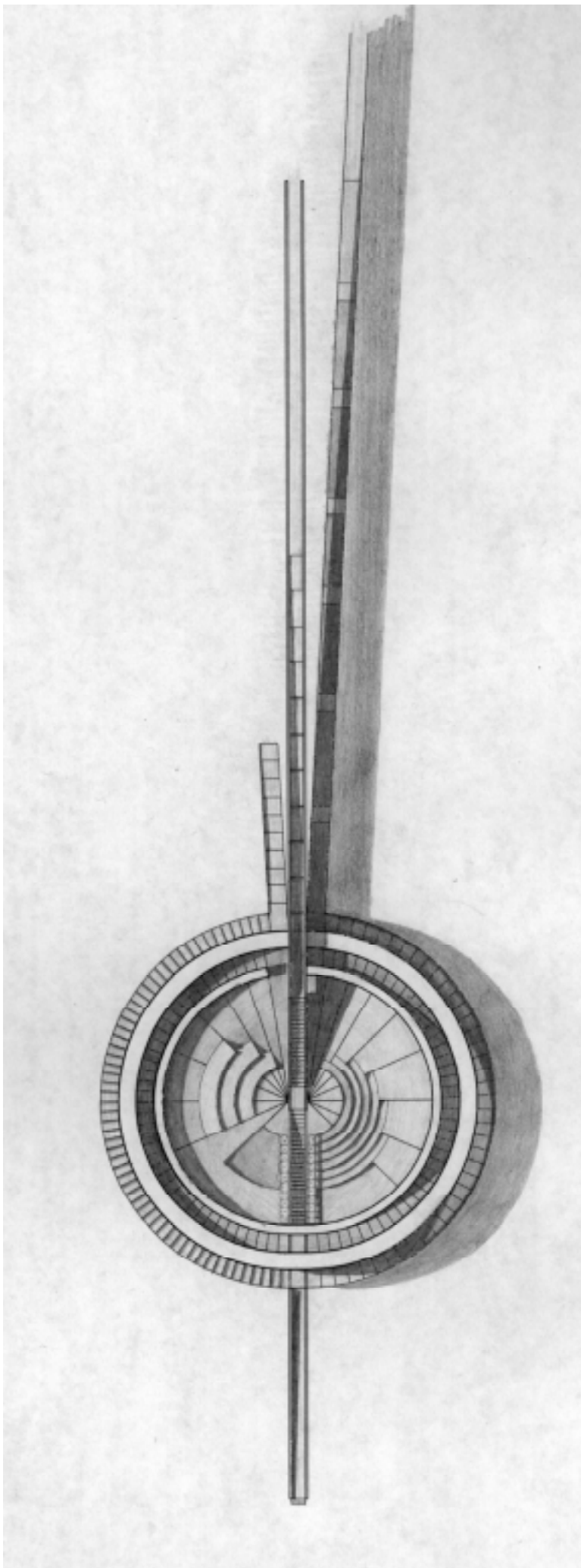


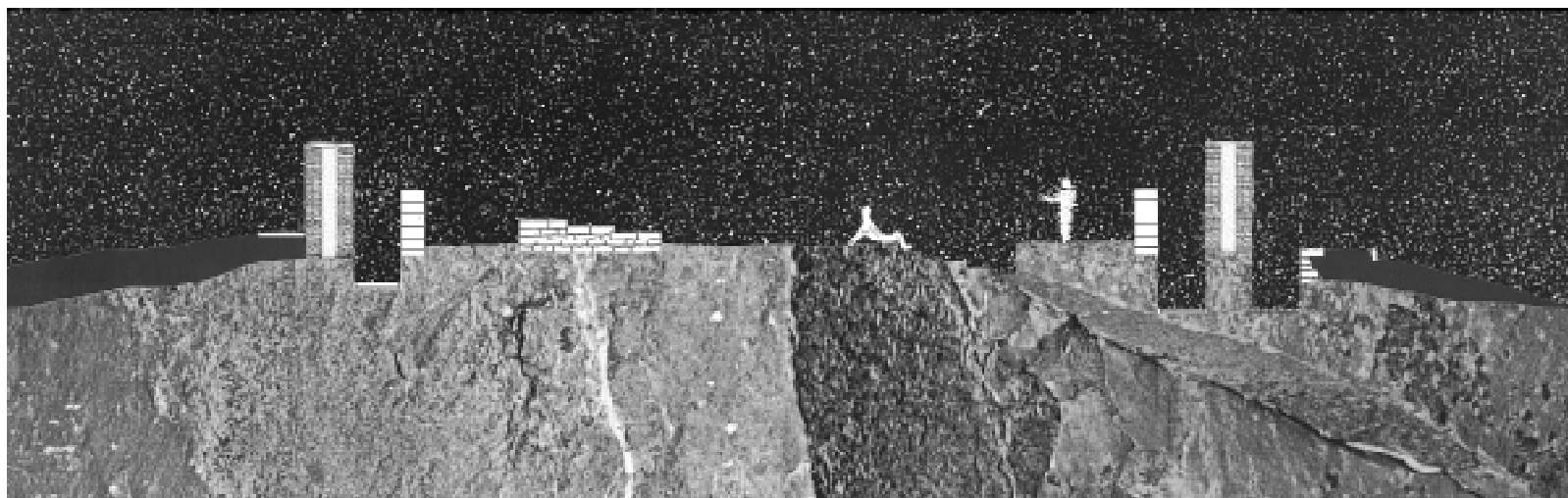
This model, which is opposite of that on the facing page, begins to show some ideas that are worth studying in the future: passage through a form.





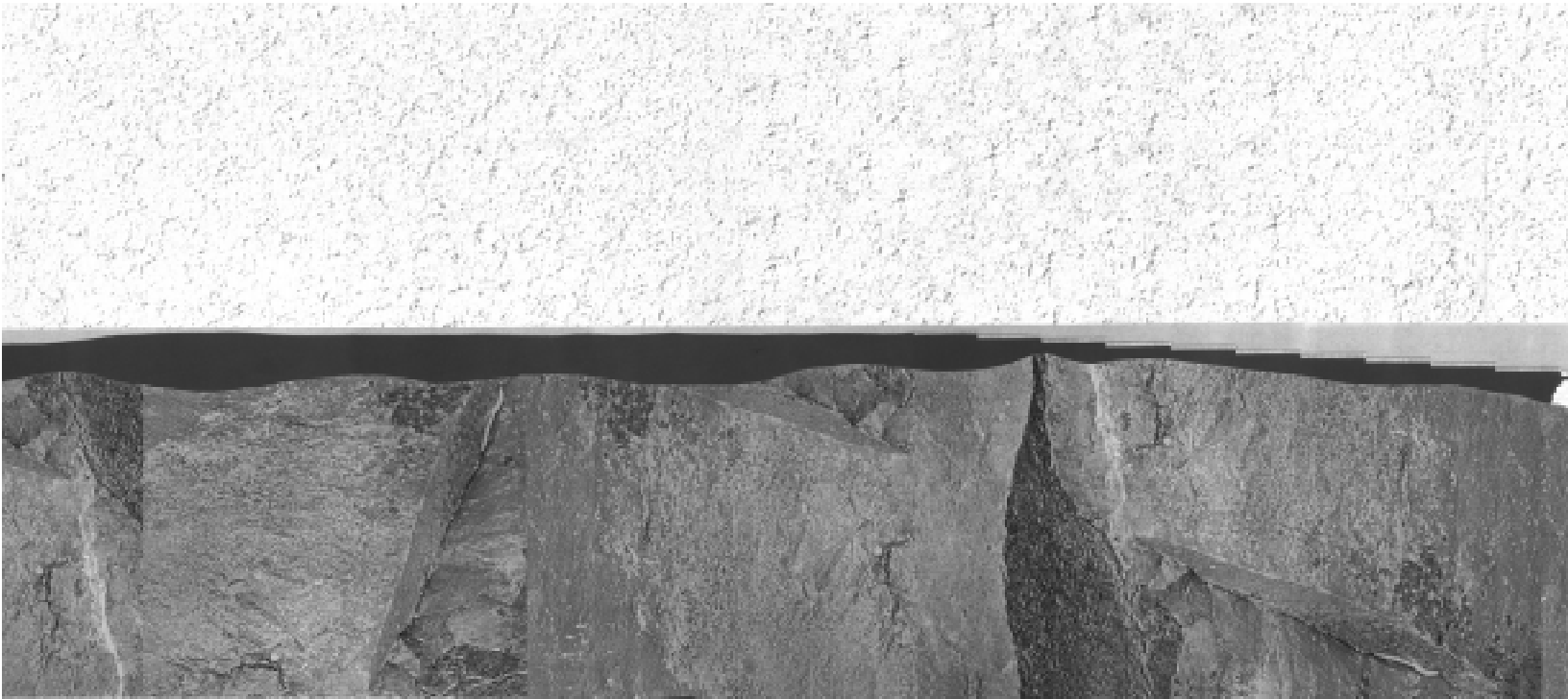
1/32":1'

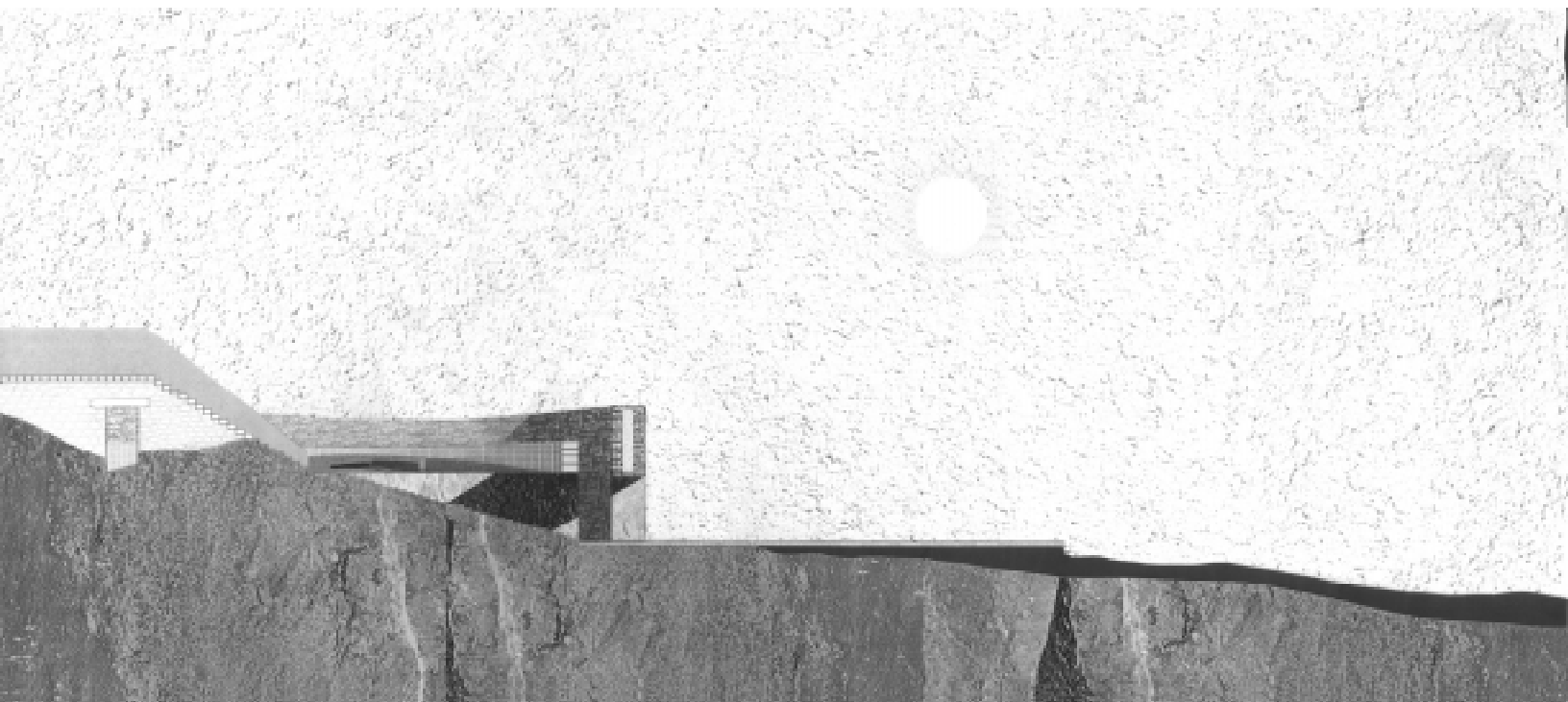




1/16"=1'

Section of final plan



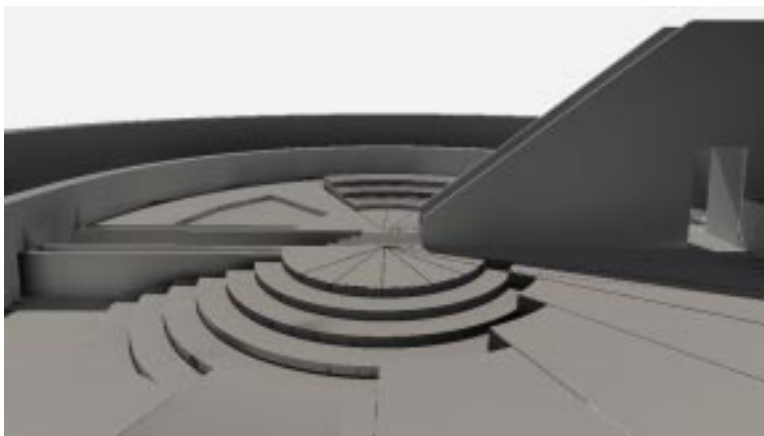




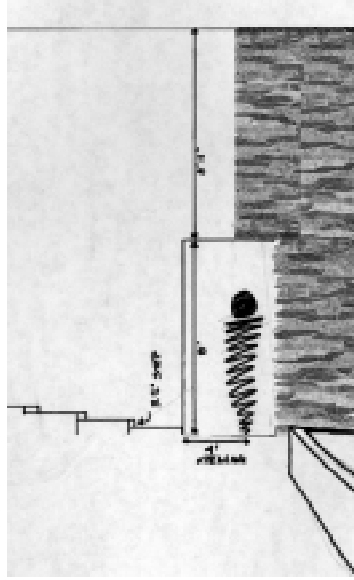
South entry looking up to the gnomon steps.



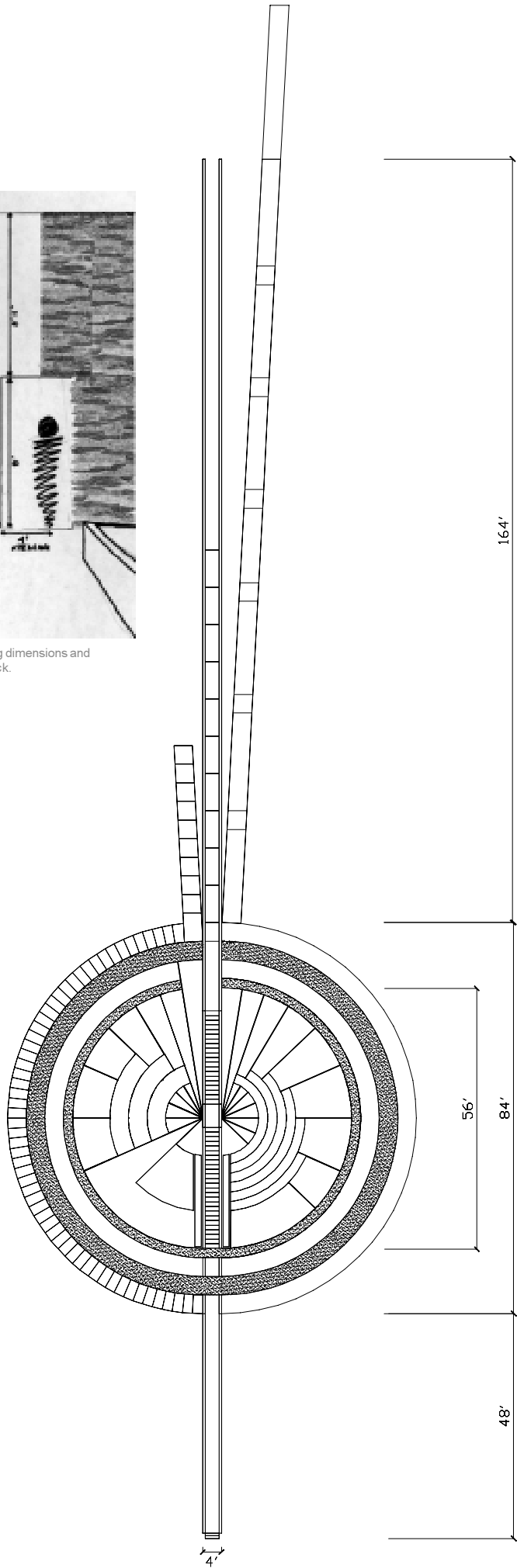
Long troughs for planting defines the boundary of the southern entry.

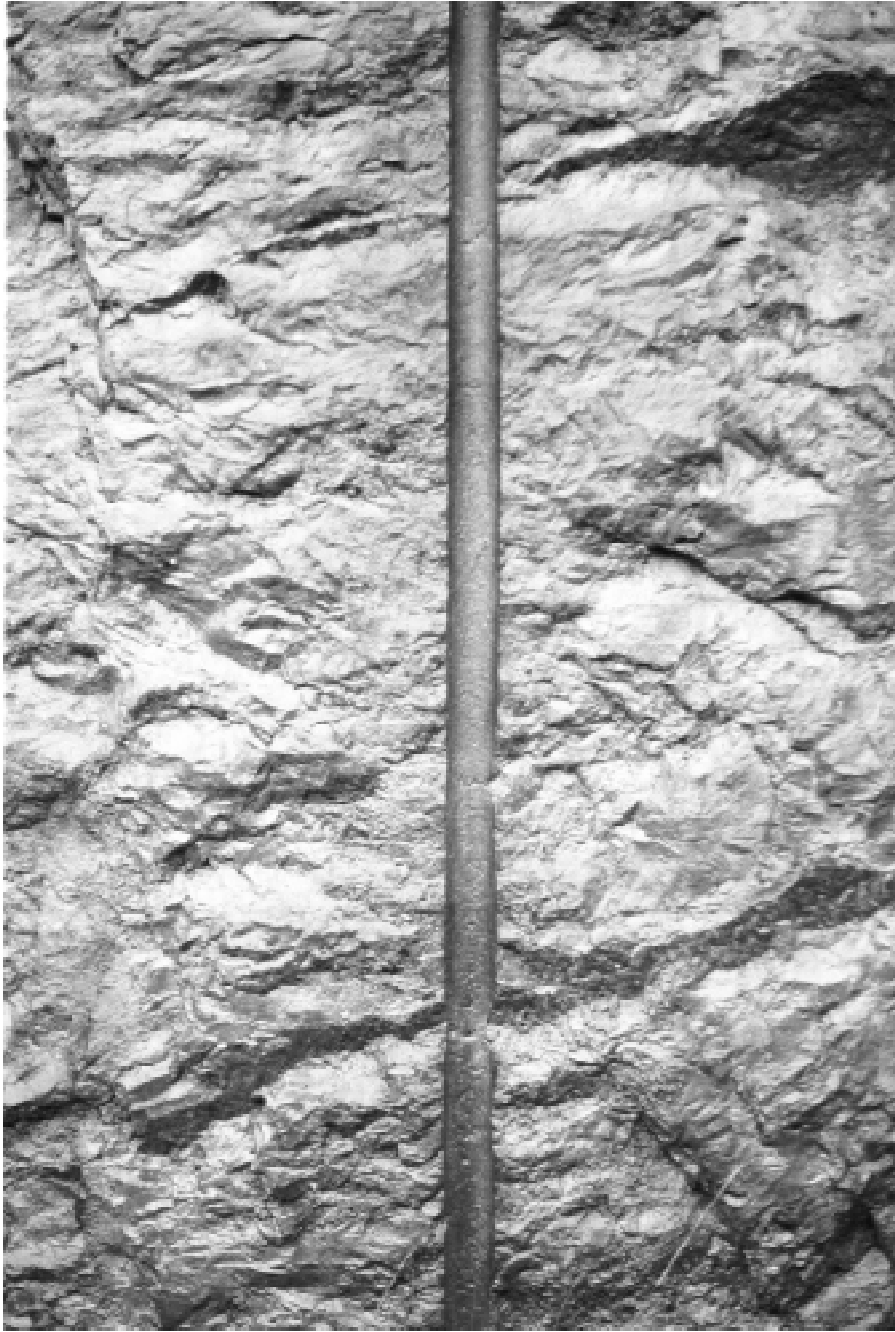


Hours are marked by shallow grooves in the dial surface



South entry detail showing dimensions and horizontal layering of rock.





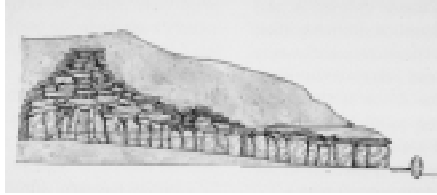
Excavation of the hilltop is necessary to expose the existing rock. Where possible, this living rock remains. That which must be removed is finished and placed back as filler for the floor of the amphitheater or as paving stones for the steps and ramp. Both the interior and exterior walls are also constructed with rock from the site. Stacked large "chips" of rock make up the exterior wall which is four feet in width. The interior wall is smaller in scale, however its larger rocks are Ashlar finished.

We seem to lose our curiosity for the world as we grow older. My father once said that the truly brilliant are those who are able to maintain their child-like wonder of the world. Wonder is the energy of discovery. Einstein believed that "discovery could not originate with experiments, but rather as the 'free invention of the the human mind' [after which the mental invention would be tested with experiment]." ⁷

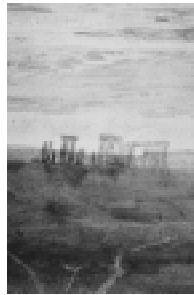
The fuel of that free invention is observation: seeing, hearing, and touching. Understanding observation, learning the difference between looking and seeing, leads to a more powerful architecture.



Image Credits



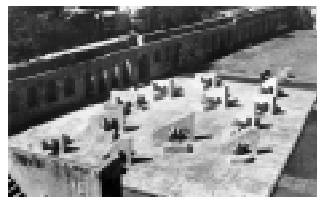
*The Secret Language of
the Stars and Planets*
p. 130



Watercolor by Turner
Stonehenge Revealed
p. 141



Kalenderbauten
p. 12



Kalenderbauten
p. 44



Mapping Spaces
p. 108

All other images appearing in this book were produced by the author.

Endnotes

1. Geoffrey Cornelius and Paul Devereux, *The Secret Language of the Stars and Planets* (San Francisco: Chronicle Books, 1996) 130-131.
2. David Souden, *Stonehenge Revealed* (New York: Facts On File, Inc., 1997) 30-39.
3. Kevin Krisciunas, *Astronomical Centers of the World* (Cambridge: Cambridge University Press, 1988) 27-31.
4. George Michell, *Monuments of India* (London: Viking, 1989) v. 2 376.
5. James Turrell, *Occluded Front* (Los Angeles: Lapis Press, 1985) 102-25.
6. Albert E. Waugh, *Sundials. Their Theory and Construction*. (New York: Dover Pub., 1973) 35-51.
7. Alan Lightman, *Ancient Light* (Cambridge, MA: Harvard Univ. Press, 1991) 18.

Bibliography

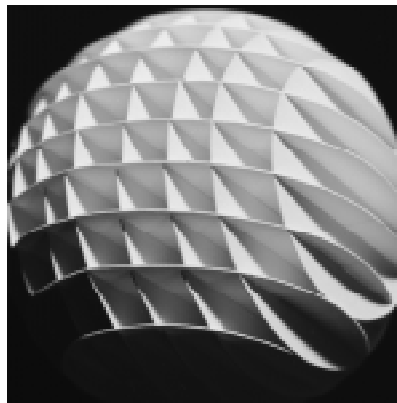
- Cornelius, Geoffrey and Paul Devereux. *Secret Language of the Stars and Planets*. San Francisco: Chronicle Books, 1996.
- Johnson, Mary Lynn and John Grant, ed. *Blake's Poetry and Designs*. New York: WW Norton & Co., 1979, p. 209.
- Kern, Hermann. *Kalendarbauten: Frühe Astronomische Grossgeräte aus Indien, Mexico und Peru*. Munich: Die Neue Sammlung, 1976.
- Krisciunas, Kevin. *Astronomical Centers of the World*. Cambridge: Cambridge University Press, 1988.
- Lightman, Alan. *Ancient Light*. Cambridge, MA: Harvard Univ. Press, 1991.
- Mayall, R. Newton and Margaret W. Mayall. *Sundials: How to Know, Use and Make Them*. (2nd ed.) Cambridge, MA: Sky Publishing Corp., 1973.
- Michell, George. *Monuments of India*. (v. 2) London: Viking, 1989.
- Rohr, Rene R.J. *Sundials: History, Theory and Practice*. Toronto: Univ. of Toronto Press, 1970.
- Saito, Yutaka. *Luis Barragán*. Balderas, Mexico: Noriega Editores, 1994.
- Souden, David. *Stonehenge Revealed*. New York: Facts On File, Inc., 1997.
- Turrell, James. *Mapping Spaces. A Topological Survey of the Work*. New York: Peter Blum Edition, 1987.
- Turrell, James. *Occluded Front*. Los Angeles: The Lapis Press, 1985.
- Waugh, Albert E. *Sundials. Their Theory and Construction*. New York: Dover Pub., 1973.

Vita Catherine Porzio

1991 B.A. Art History
 Douglass College, Rutgers University
 New Brunswick, NJ

1992-95 Office Manager
 Oudens + Knoop, Architects, PC
 Chevy Chase, MD

1999 M.A. Architecture
 College of Architecture & Urban Studies
 Virginia Polytechnic Institute & State University



Sphere: Spring 1997