## ABSTRACT

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| Title of Document: | GEOLOGY, CULTURE, AND THE BUILT ENVIRONMENT: AN INTERPRETIVE CENTER FOR THE BERKELEY PIT |
| | Emily Childs, Master of Architecture, 2010 |
| Directed By: | Professor Steven Hurtt, School of Architecture Planning & Preservation |

Many people are drawn to the scene of dramatic geologic events; the Grand Canyon, Old Faithful. Hikers traverse the remains of geologic events, such as the Appalachian Trail and the Pacific Crest Trail.

Occupying the surface of the earth, we live in the realm between the bowels of the earth and the limitless sky. As guests of this realm, we search the corners of the earth to learn more about the way it works. Our culture for centuries has been involved in this quest to know more.

How can architecture (and an architectural thesis) set up an experience of this cultural exploration?  This thesis will attempt to create an architectural narrative for the visitor by framing views of landscape, creating architectural experiences of geologic conditions, and setting up an architectural metaphor for geologic processes. I am ultimately connecting the public to ideas of geology and the natural world through carefully considered, deliberate design moves.

# GEOLOGY, CULTURE, AND THE BUILT ENVIRONMENT: AN INTERPRETIVE CENTER FOR THE BERKELEY PIT

By

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Thesis submitted to the Faculty of the Graduate School of the University of Maryland, College Park, in partial fulfillment of the requirements for the degree of
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Advisory Committee:
Professor Steven W. Hurtt, AIA, Chair
Professor Ralph Bennett, AIA
Professor Robert L. Vann, Ph. D.

## Acknowledgments

This thesis would not have been possible without the guidance, time, and effort of several individuals.

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# I. Geology as the Subject Matter

> *"Total immersion: this is the ultimate reason why the love of nature has been for so long accepted as a religion. It is a means by which we can lose our identity in the whole and gain thereby a more intense consciousness of being."* *- Kenneth Clark*

**Geologic Processes:**

Two areas of geologic study that are relevant to my thesis project are: plate tectonics and the rock cycle

The study of plate tectonics is a science that encompasses many segments of geologic study. The rock cycle describes how through a series of processes minerals are formed, broken down and then reformed into different types of rocks.

**General summary:**

- Convection currents in hot layers of the earth's mantle move the oceanic & continental plates. Colliding plates cause the lifting or subducting of continental crust which produces mountain ridges and island chains. This process produces ***metamorphic*** rock (i.e. through compaction and heat layers of rock become supple and bend, fold, and shear).
- Additionally as part of this same process hot magma finds its way to the surface of the earth. At times cooling very quickly forming ***igneous*** rock.
- Rock surfaces erode breaking down large masses of rock to smaller and smaller particles. This material is carried from its origin by water or wind and then deposited elsewhere. Layer upon layer of sediment are compacted

down, eventually creating ***sedimentary*** rock (i.e. limestone). These layers of rock eventually become shifted around as part of the tectonic plates that get lifted, sheared, and/or subducted.

Through these processes in conjunction with many different variables a vast variety of landforms are created.

**Geologic Threats to Life:**

Geology is not always something that we can simply take an academic approach towards. From tsunamis, to volcanoes and earthquakes, there have been several natural events recently that have been life threatening.

However, a *Washington Post* article by Dana Milbank from April 22, 2010- highlights the desire of our culture to be able to regard geologic processes as something that can be easily dealt with. Milbank writes:

> “"Volcanoes can really do more than just ruin your day’…you can't bomb them, you can't impose sanctions on them, and our drones are no match for their cones. But Congress can do to volcanoes what it does to everything else: It can spend money on them.
>
> Tom Murray, from the U.S. Geological Survey, detailed the enemy's strengths. It is stealthy: ‘Just because a volcano is quiet today, it may not be tomorrow.’ It catches us when our guard is down: ‘If you haven't experienced an eruption, your parents haven't and your grandparents haven't, you tend to forget that volcanoes can erupt.’ It is quick: ‘The stakes are just too great to be playing catch-up with a volcano about to erupt.’ **And it is evil: ‘We cannot depend that the volcano will be good to us.’**
>
> A representative of United Airlines, Leonard Salinas, found similarities between volcanoes and the terrorists of 9/11. ‘Just like the volcano, things happened very quickly, response times were very short,’ he said in response to a question from the audience. ‘I may have to divert, I may have to turn around, I may have to refuel.’

> Salinas, in a PowerPoint presentation, outlined a battle plan against the volcano, including such subject headings as 'long term strategic threat planning' and 'pre-tactical eruption planning'.
>
> So can we hit the volcanoes with a preemptive attack to stop them from erupting on us? 'The short answer,' the Geological Survey's Murray answered, 'is no.'"[1]

**Cultural Concepts of the Natural World:**

In the book *Architecture and Nature; Creating the American Landscape*, the authors give a description of how American culture has expressed views on Nature through design, some examples given were the Chicago World's Fair, the Architecture of National Parks, Tennessee Valley Infrastructure, California Housing types, and early sustainable design of the 60's.

**Views on the Natural World Expressed Through Art & Architecture:**

The Natural World has been a source of inspiration for thousands of years. Whether it be primitive architecture, classical architecture, or contemporary design. Leonardo da Vinci described how from studying nature a designer could find sources of inspiration: 'look into the stains of walls, or ashes of a fire, or clouds, or mud or like places, in which, if you consider them well, you may find really marvelous ideas'[2]

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[1] Milbank, Dana. *Now for the war on volcanoes.* Washington Post Online. http://www.washingtonpost.com/wp-dyn/content/article/2010/04/21/AR2010042104718_2.html?nav=rss_opinion/columns&sid=ST2010042105242. Accessed on 4.24.10.

[2] March Lionel & Steadman, Philip. *The Geometry of the Environment; An Intriduction to spatial organization in Design*. London: RIBA Publications Ltd. 1971. p.30.


Fig. 1. Concepts of space, movements and the natural world expressed in Art and Architecture [Drawing by Emily Childs. Images from various sources]

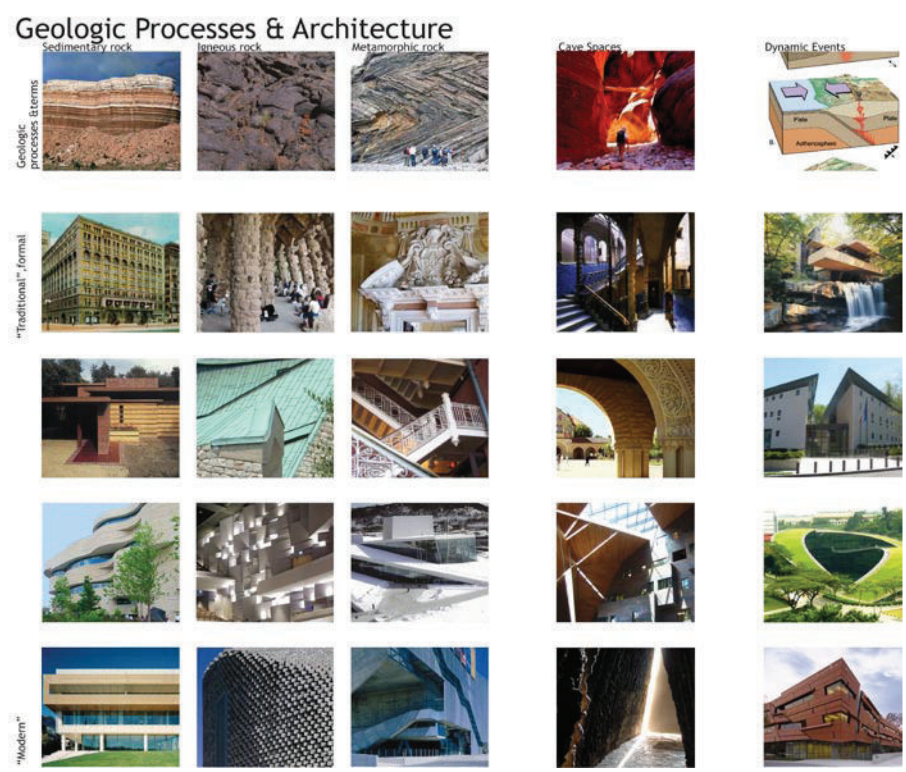


Fig. 2, Examples of architecture expressing ideas of geologic processes. [Drawing by Emily Childs. Images from various sources]

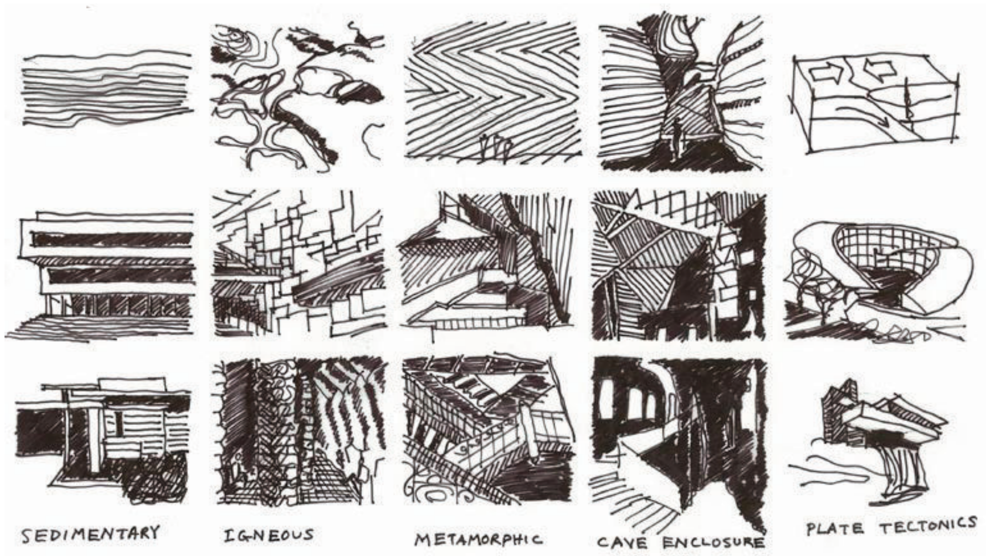


Fig. 3. Sketches of the geology-architecture connection [Image by Emily Childs].

## The "Value" and Role of Form:

'Meaning' or 'content', for the present generation of architecture students- like 'function' for the generation of the 50's and 60's, or like 'user needs' for the generation of the early 70's – is not a generative action."[3]

Form can be derived from any number of sources and processes: program, site, context, precedents, theories, stories, myths. The "form" of geology is expressive in and of itself. It speaks of time, motion, movement, solidity, permanence, and history. It speaks of "violent" movement, slow deformation (erosion), and slow accumulation through layering (sedimentation). Geologic formations are records of heat, temperature, depth, and pressure.

[3] Schumacher, Thomas. *A Thesis in the Thesis Project*. UMD Architecture School article.

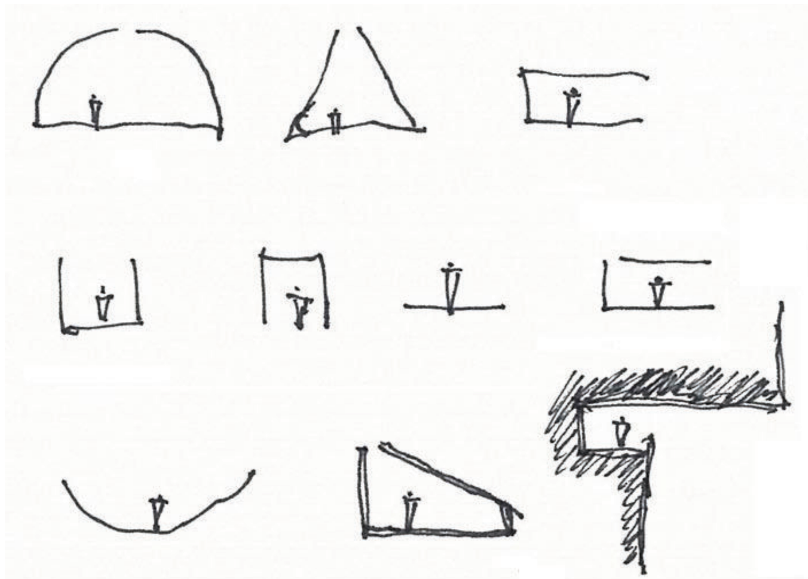

Fig. 4. Sketches of different types of spaces, each providing a different experience
[Image by Emily Childs]

Form in architecture gives shape to a building and can convey spatial ideas and might convey to visitors a point of view, story, or atmosphere. Adolf Hildebrand writes that: “Form becomes an expression of internal structure or of forms lying under the surface, as in the case of any organic body at rest or in action. We may also have the idea of a motive, a purposive action, or a process causing an alteration or movement of the form”[4].

In relation to this thesis project the intention is that architectural form can convey a sense of the dramatic geologic and cultural history of the selected site.

[4] Hildebrand, Adolf. *The Problem of Form in Painting and Sculpture*. New York, 1945. p. 101.

# II. Site Selection; Three Very Different Options

**Site Considerations:**

These are three sites with different considerations necessary for each site. The variables include but are not limited to:

1. Urban condition
2. Conceptual view of geologic subject matter & different levels and types of human interest and interaction with the geologic formations present
3. Notable geologic features at the site

**A. Golden, Colorado. Colorado School of Mines campus (National Earthquake Information Center)**

1. Urban condition: Small town/ semi urban campus (projected town population in 2010 = 18,955)[5]
2. Conceptual view of geologic subject matter: more abstract, dealing with the phenomenon of earthquakes (and related geologic processes, how are earthquakes connected to plate tectonics). The numerous recent large scale earthquakes are fodder for this exploration.
3. Notable geologic features at the site: Other than the mountains nearby there would not be geologic formations immediately present. This site does not allow you to build directly on the site of an earthquake (many locations in California experience earthquakes daily). Contained on a college campus, in

[5] Demographics of Golden, Colorado. From the website of the city of Golden, Colorado. http://ci.golden.co.us/Page.asp?NavID=214

comparison to the other sites, this would represent a more urbane example (although very far from the extreme of New York City).

The campus is located to the North West of the town proper. The National Earthquake Information Center exists on the campus; a visitor's center would be added to the existing Center.

Earthquakes are processes we must live with. The instability of the ground beneath your feet is a concept that is very foreign to those who live in areas that are relatively safe from such events. However, earthquakes are part of the larger picture of plate tectonics and therefore part of the larger picture of the rock cycle. How can architecture dramatize these events? This site is not directly connected to the exposed remains of geologic events. The campus is a center of earth sciences research and education and already has a museum of geology.

Fig. 5. Google satellite image of the National Earthquake Information Center and a possible adjacent site. [Aerial photo from Google Maps]

Fig. 6, School of Mines Museum of Geology, street approach - photo.
[Photo from http://illusion.mines.edu/UserFiles/Image/geomuseum.jpg]

Golden, Colorado has a substantial number of tourists visiting every year. "Approximately 2.5 million visitors are attracted to the Golden area each year; to destinations such as:

- Heritage Square (619,300 visitors)
- Golden Gate State Park (543,355 visitors)
- Buffalo Bill's Museum (526,900 visitors)
- Coors Brewery Tours (302,650 visitors)
- Colorado Railroad Museum (49,106 visitors)
- Mother Cabrini Shrine (90,000 visitors)
- Jefferson County Nature Center (9,078 visitors)
- Foothills Art Center (30,000 visitors)
- School of Mines Geology Museum (18,000visitors)" [6]

**B. Butte Montana, Berkeley Pit Mine.**

1. Urban condition: Small Town (Population 32,119). Butte had been a large prosperous mining town back in the early 1990's. There is an interesting commingling of geologic phenomena and the imprint of those phenomena on the built environment and culture.

[6] From the website of the city of Golden, Colorado.http://ci.golden.co.us/Page.asp?NavID=214

2. Conceptual view of geologic subject matter: There has been human destruction of a geologic landscape (creating an equally dramatic landscape) in order to mine for the mineral deposits. Our culture has demanded that we scar the earth to take advantage of the culturally valuable minerals. In the process we have obliterated the existing landforms in addition to areas of the town as well. The Berkeley Pit is part of the largest US Superfund site. The Super fund site also includes land in the town of Anaconda (25 miles from Butte) where the ore was processed.

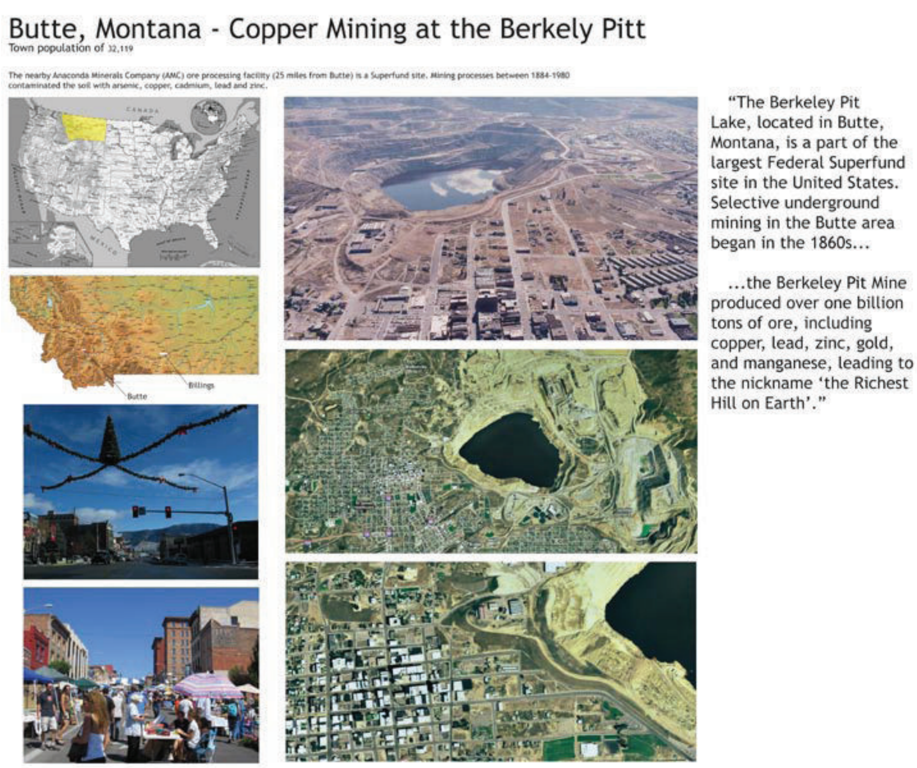


Fig. 7. Butte, Montana. Context Photos, Montana State map, and aerial photos (Drawing by Emily Childs. Images from various sources).

3. Notable geologic features at the site: 1000 plus feet of layers of rock revealed by the process of strip mining (see Fig. 8). Copper deposits underground resulted from the minerals that filled between cracks that formed in the granite batholith [7].

[7] Shovers, Brian; Fiege, Mark; Martin, Dale; and Quivik, Fred. *Butte & Anaconda Revisited; An Overview of Early-Day Mining and Smelting in Montana.* Published by Montana Bureau of Mines & Geology. 1991.p.3.

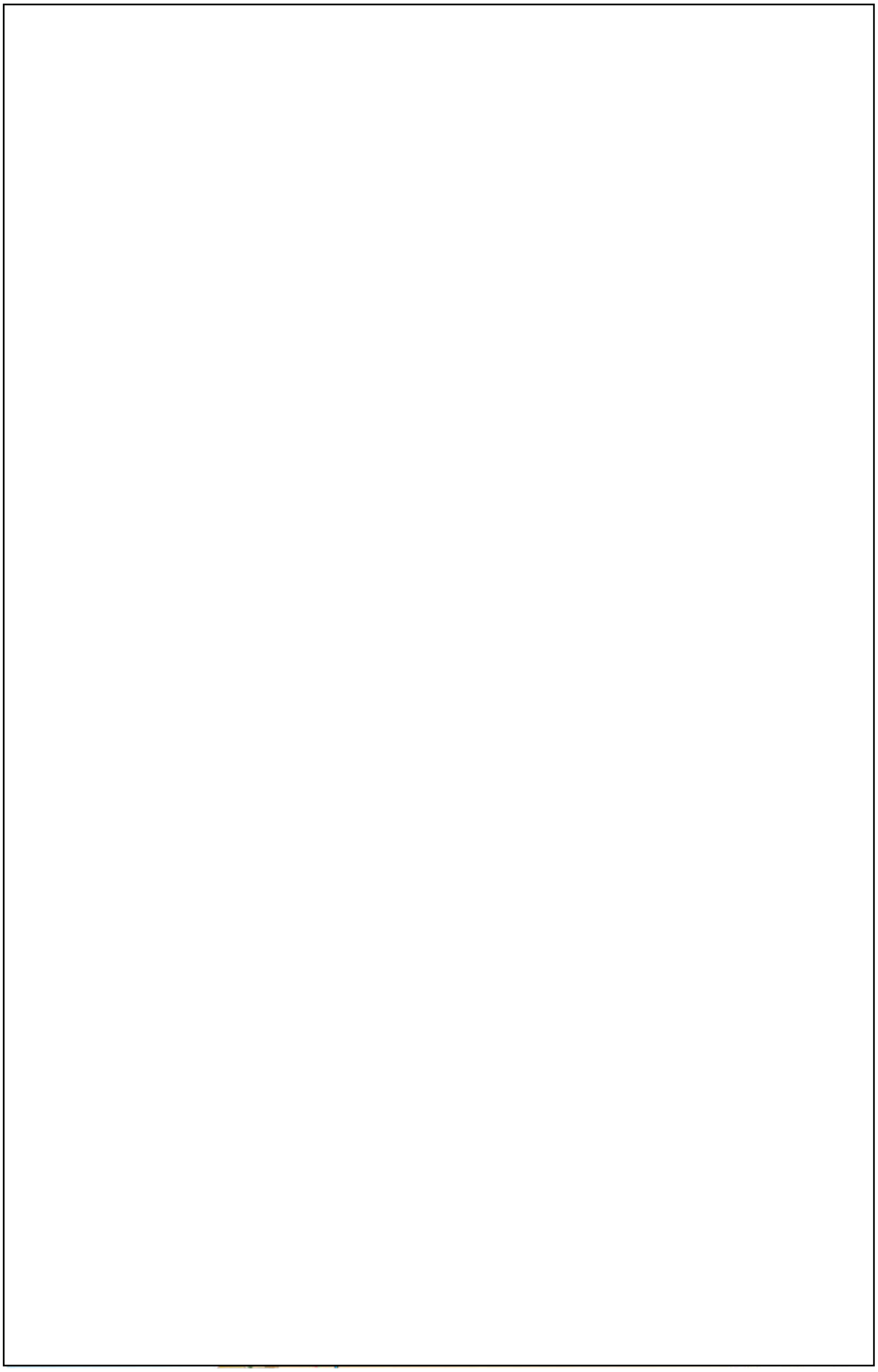

Fig 8. Summary of Pit info, distributed by Berkeley Pit Public Education Committee. [Image from http://www.pitwatch.org/water.html]

**C. Vasquez Rocks in Agua Dulce, CA**

1. Urban condition: Rural town, population of 4,000. There are exposed rock formations within a 932 acre County Park. A visitor's center is being designed/proposed for the site[8].
2. Conceptual view of geologic subject matter: Out of the three sites this one provides the romantic view of landscape, a relatively unscathed dramatic landscape containing exposed rock formations, the most untouched site. A place like this makes us feel like a small part of a much larger picture of which we see very little.
3. Notable geologic features/history at the site: This site is part of the San Andreas Fault running north to South along the coast of California. Scientists have studied this fault for a number of decades trying to determine how fast the fault is shifting. At this site you could relate the museum to the larger picture of plate tectonics on a global scale.

> “The sedimentary rocks are up to 25 million years old and consist mainly of sands eroded off of a nearby uplifted mountain… 25 million years ago the North American continental crust overrode the subducting Farallon Plate…(eventually coming) into contact with the Pacific Plate for the first time” resulting in the San Andreas fault system. “When the plate boundary changed, the Earth’s crust buckled and splintered to adjust to the new forces. Great blocks of crust were broken apart and jostled around, creating topography of high relief…” [9]

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[8] Eugener Tong. *Otherworldly Rocks; May Bet Learning Center Plans Move Forward For Vasquez Site.*
http://www.thefreelibrary.com/OTHERWORLDLY+ROCKS+MAY+BET+LEARNING+CENTER+PLANS+MOVE+FORWARD+FOR...-a0145244008. Accessed on 4.25.2010.

[9] Morris, Ron. Vasquez Rocks: A Geologic Overview. Ed. on 9/12/2009. http://www.cnsm.csulb.edu/departments/geology/VIRTUAL_FIELD/Vasquez/vasqmain.htm accessed on 4.19.10.

Fig. 9. Vasquez rocks, near Agua Dulce, CA, [Photo from http://planetrambler.com/150mph/090208_vasquezrocks/index.html]

Fig. 10 Vasquez Rocks, Exposed rock layers. [Photo from http://planetrambler.com/150mph/090208_vasquezrocks/index.html]

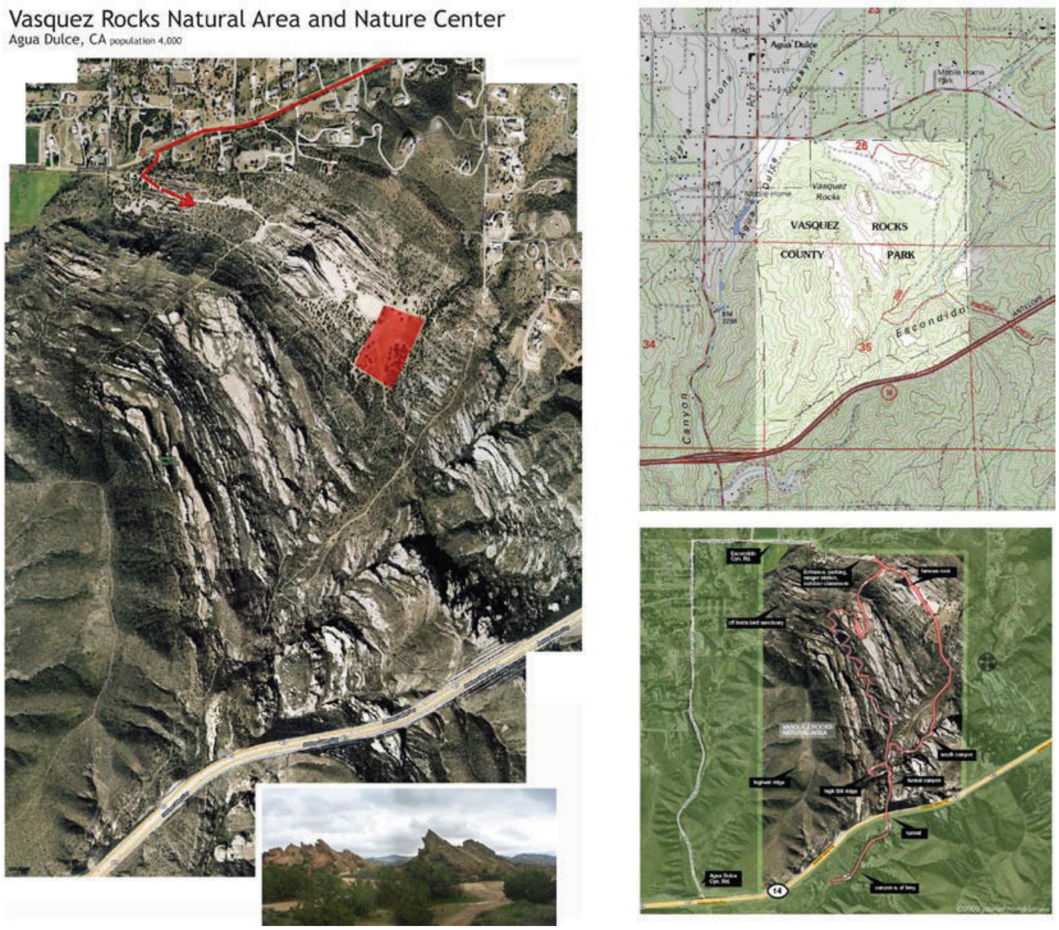


Fig. 11. Site image of the Vasquez Rocks Park. [Drawing by Emily Childs] Images from http://planetrambler.com/150mph/090208_vasquezrocks/index.html]

## III. Program Elements:

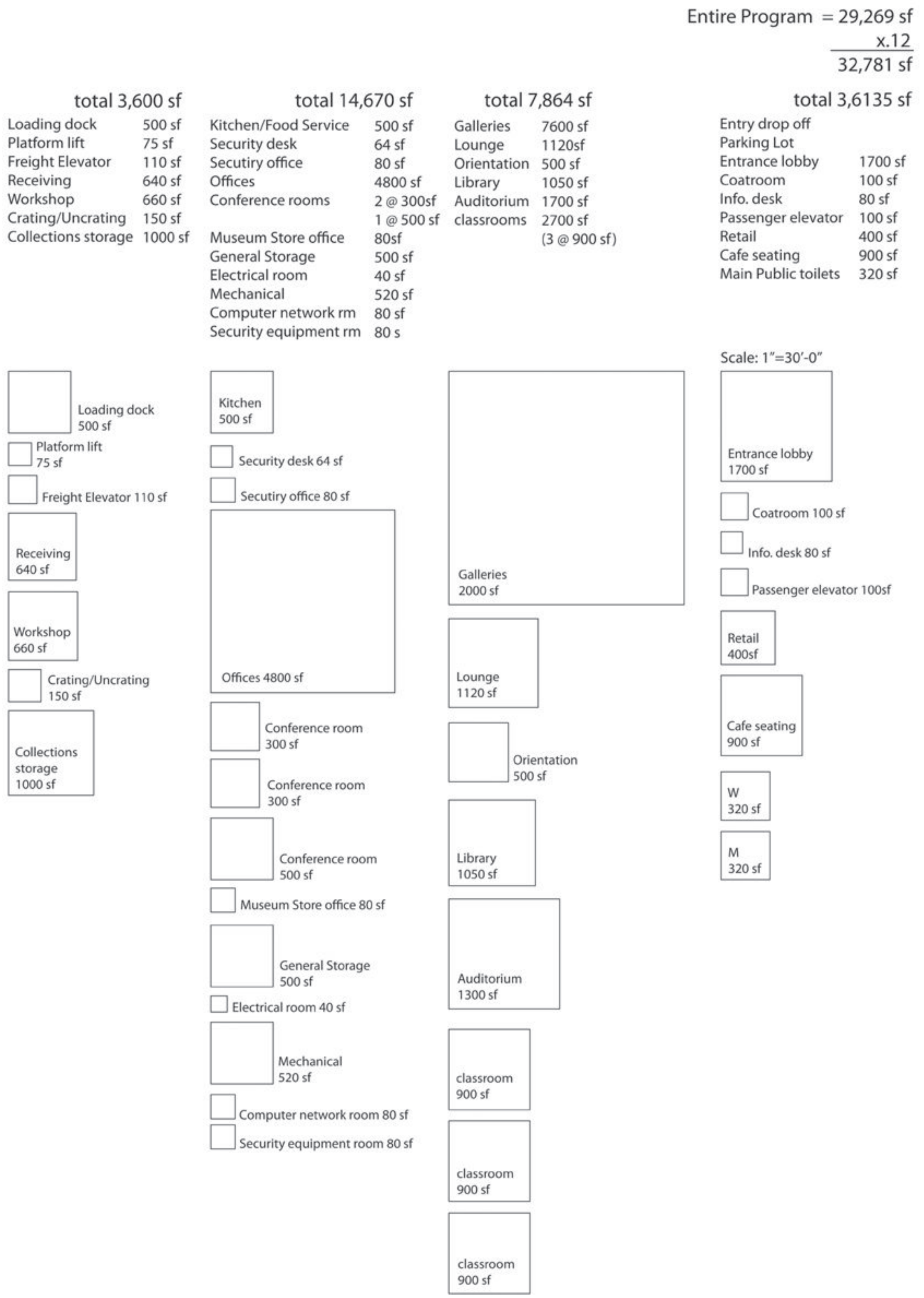


Fig. 12. Interpretive Center Program. Some program sizes were enlarged in the final design [Image by Emily Childs]

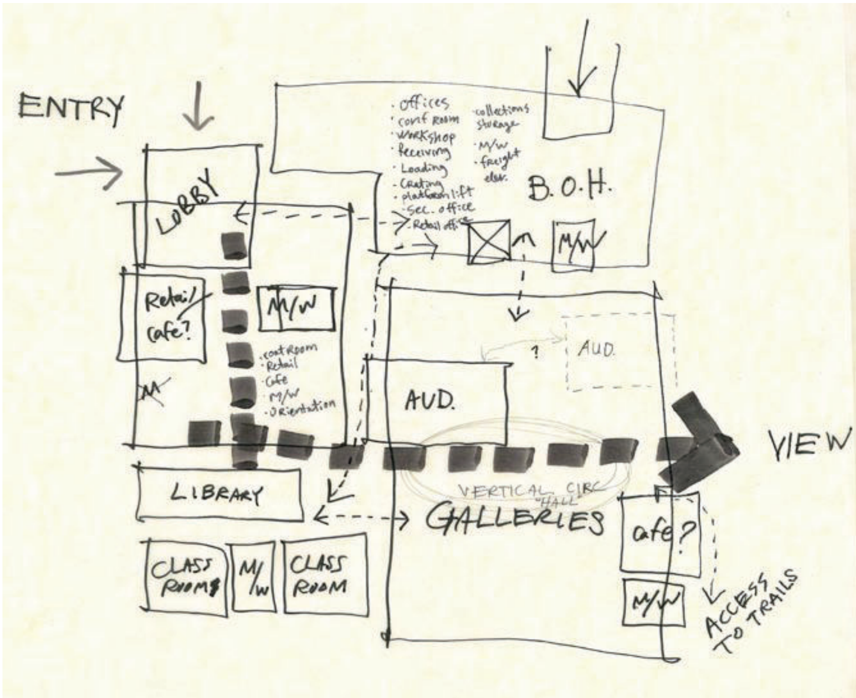

Fig. 13. Program diagram. Auditorium is buried within the sequence, not exposed at the entry or to the “view” [Drawing by Emily Childs]

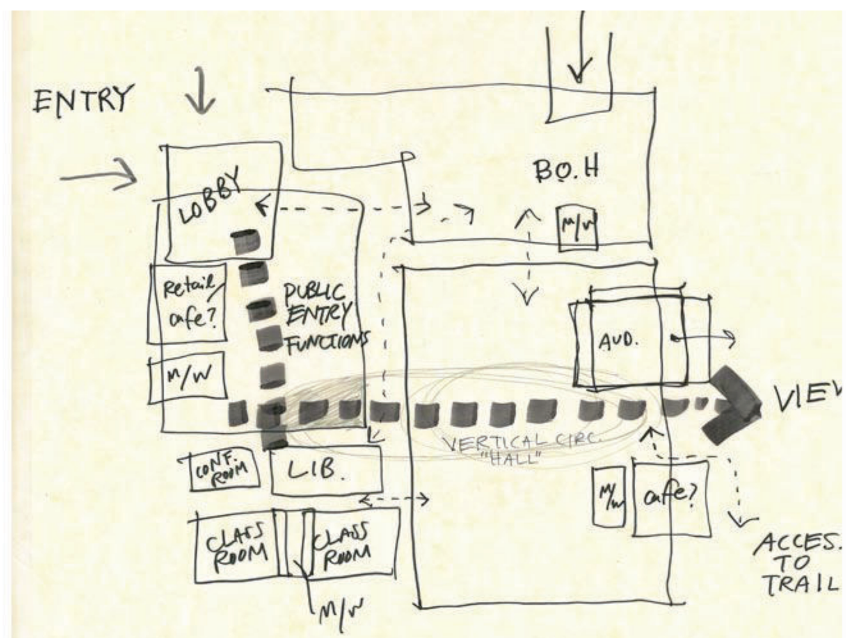


Fig. 14. Program diagram. The auditorium is part of the experience of the “view” to the pit. [Drawing by Emily Childs]

# IV. Precedent Analysis

**Programmatic precedents:**
[Photos from Architectural Record Building Types Study).

- Museum of the Earth
- James Clarkson Environmental Discovery Center
- Baldwin Hills Scenic Overlook

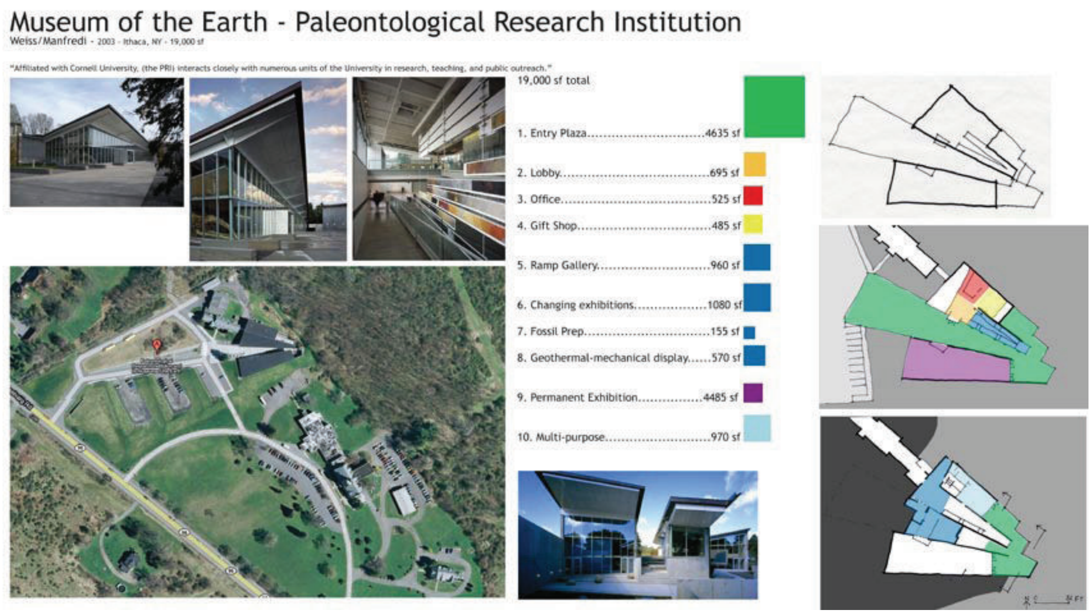


Fig. 15. [Drawings by Emily Childs] Photos from [http://archrecord.construction.com/projects/bts/archives/museums/0401_museumEarth/photos.asp. Aerial photo from Google Maps]

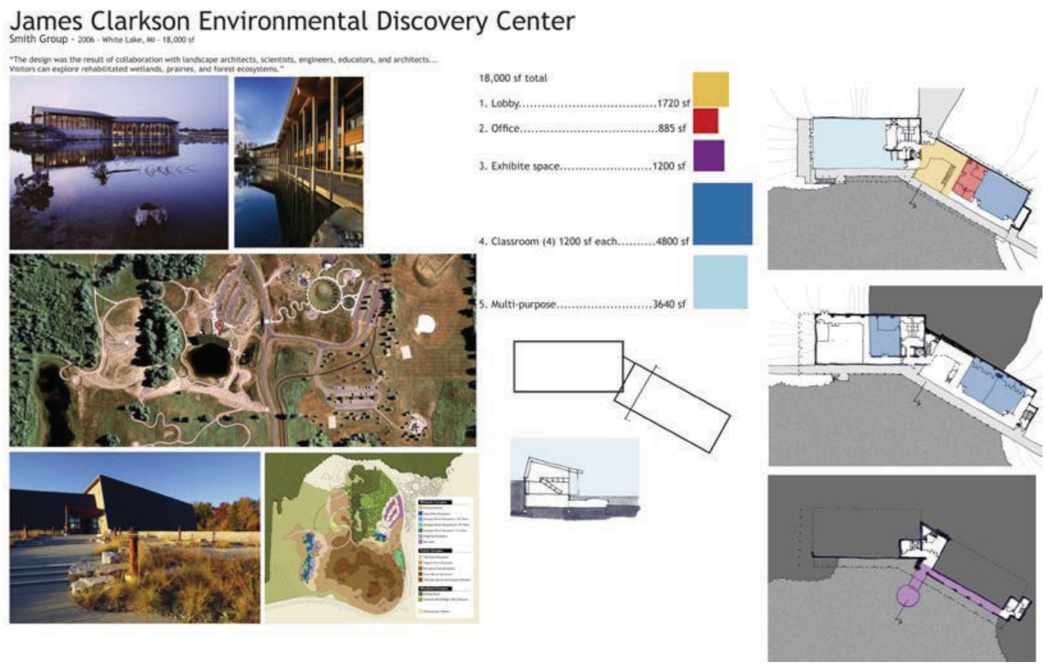


Fig. 16. [Drawings by Emily Childs] Photos from http://archrecord.construction.com/projects/bts/archives/civic/10Indian-Springs/default.asp?bts=CB]

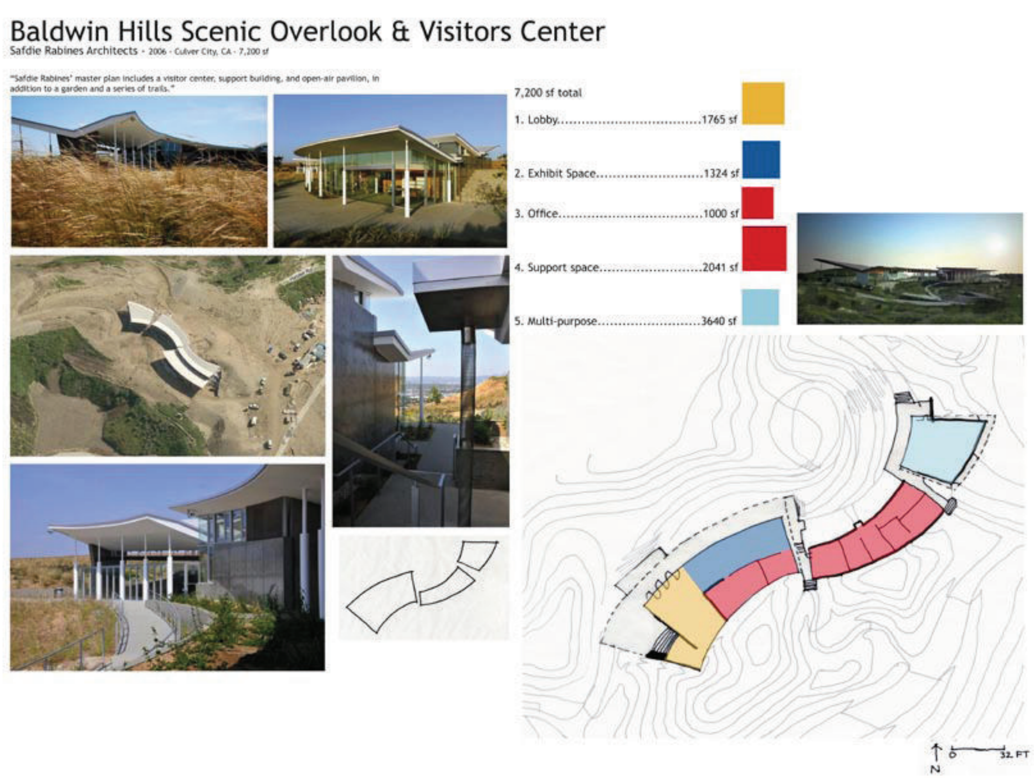


Fig. 17. [Drawings by Emily Childs. Photos from http://archrecord.construction.com/projects/bts/archives/civic/10Baldwin-Hills/default.asp?bts=CB]

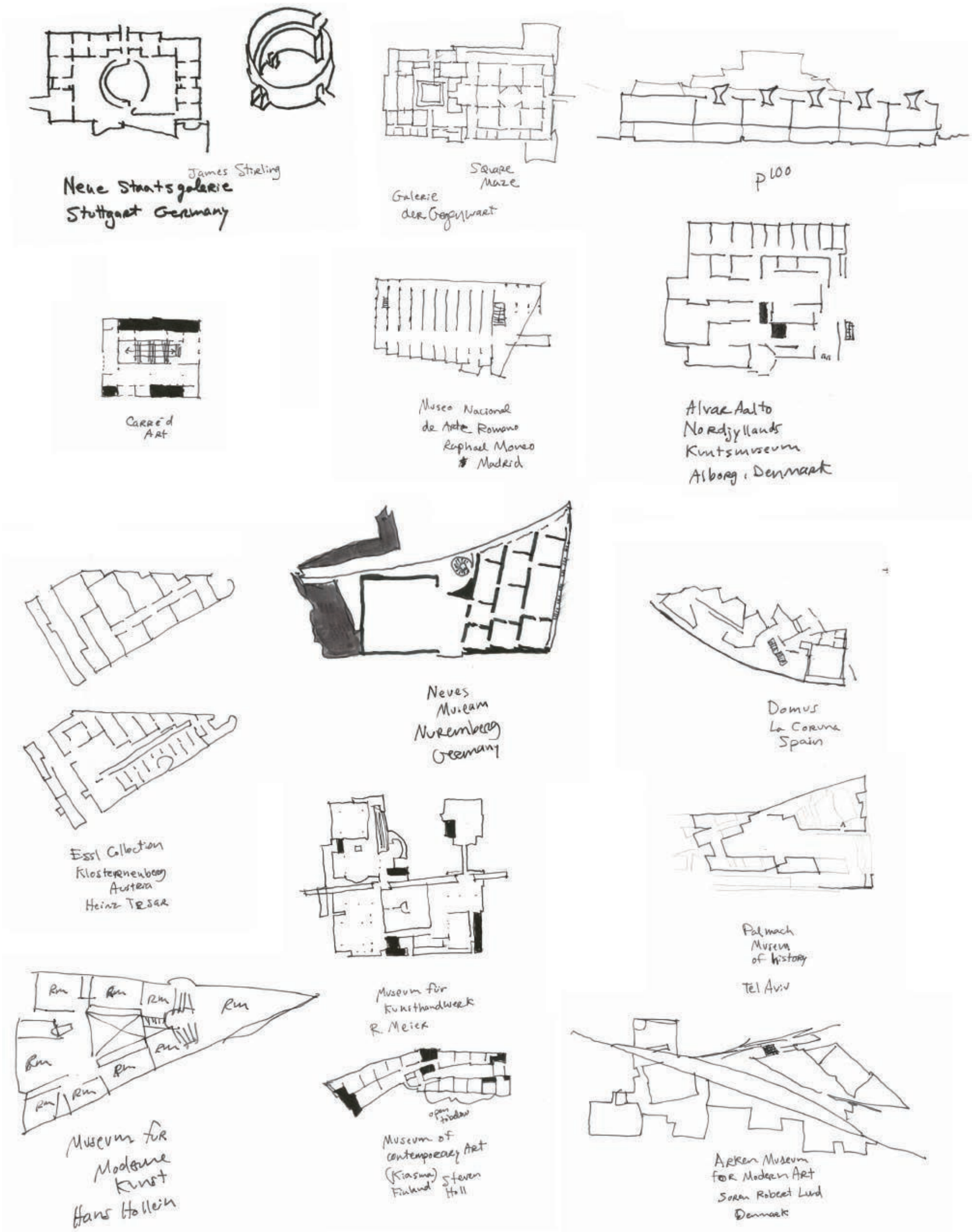


Fig. 18. In addition to the three specific projects shown previously, a survey was made of parti organizations of a number of different precedents [Drawings by Emily Childs].

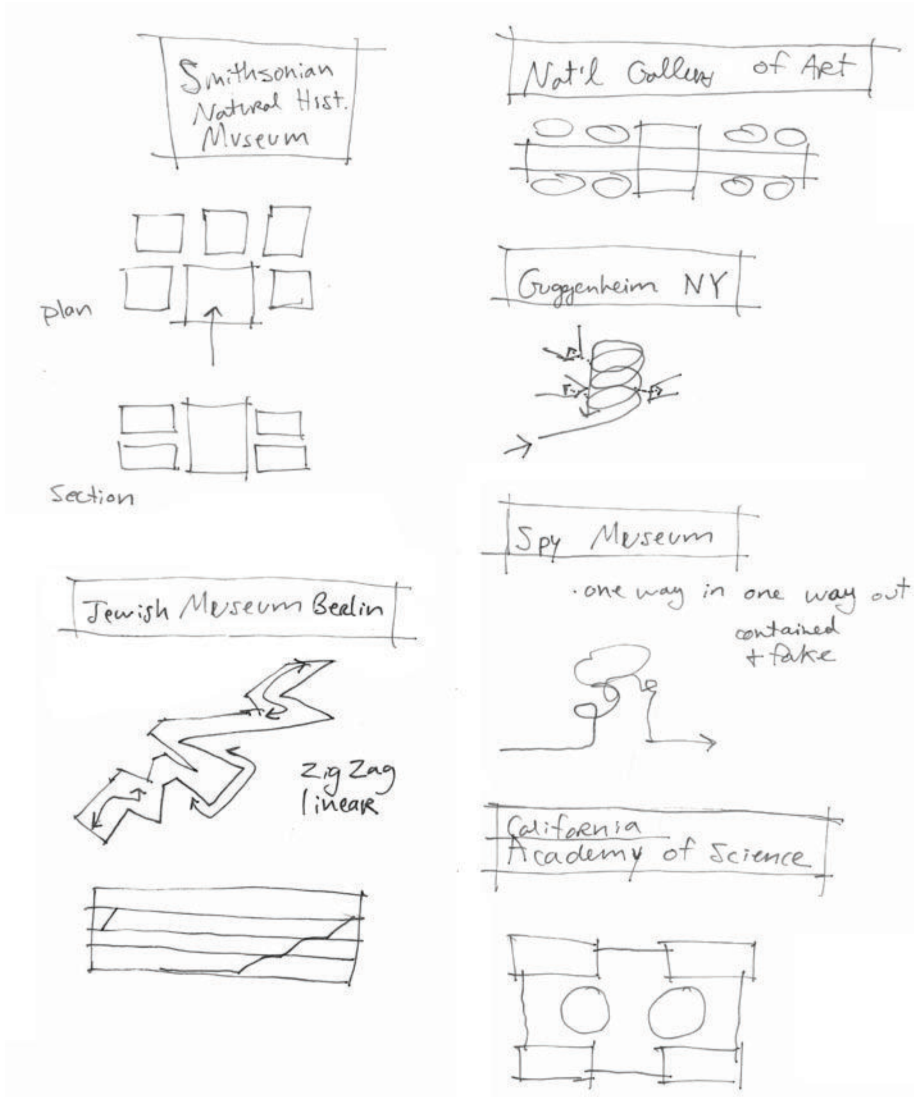


Fig. 19. In addition to plan organizations, sketches diagramming the circulation in several museum precedents [Drawing by Emily Childs]

In looking at precedents for style there are two that have been important to this process. Those are Sverre Fehn's Glacier Museum in Fjaerland Fjord, Norway and Thom Mayne's Cahill Ceneter at Cal Tech in Pasadena. These two precedents are seen as opposite ends of a spectrum. The Glacier Museum presents a visual metaphor in a more subtle form of expression. The Cahill Center is more expressive and abstract. To varying degrees both are sharing ideas of natural processes, that of glaciers and astrophysics.

Fig. 20. A view of the approach to the Glacier Museum. [Image from http://www.abitare.it/wp-content/uploads/2009/03/s00076-1.jpg]

Fig. 21. Street view of the Cahill Center for Astronomy and Astrophysics. [Imafge from http://latimesblogs.latimes.com/culturemonster/2009/02/thom-maynes-cah.html]

## V. Initial Parti Explorations/Speculative Design

Speculative designs include: two schemes for Butte, MT & two for Vasquez Rocks and several collage/perspectives.

The two schemes for Butte Montana present different ways of treating the rim of the pit. The first scheme focuses on how to negotiate the steep drop towards the water level (see fig.22). Through this scheme it would be possible to capitalize on the experience of descending into the earth, beneath the rim of this man made chasm.

**Butte, Montana, Berkeley Pit.**

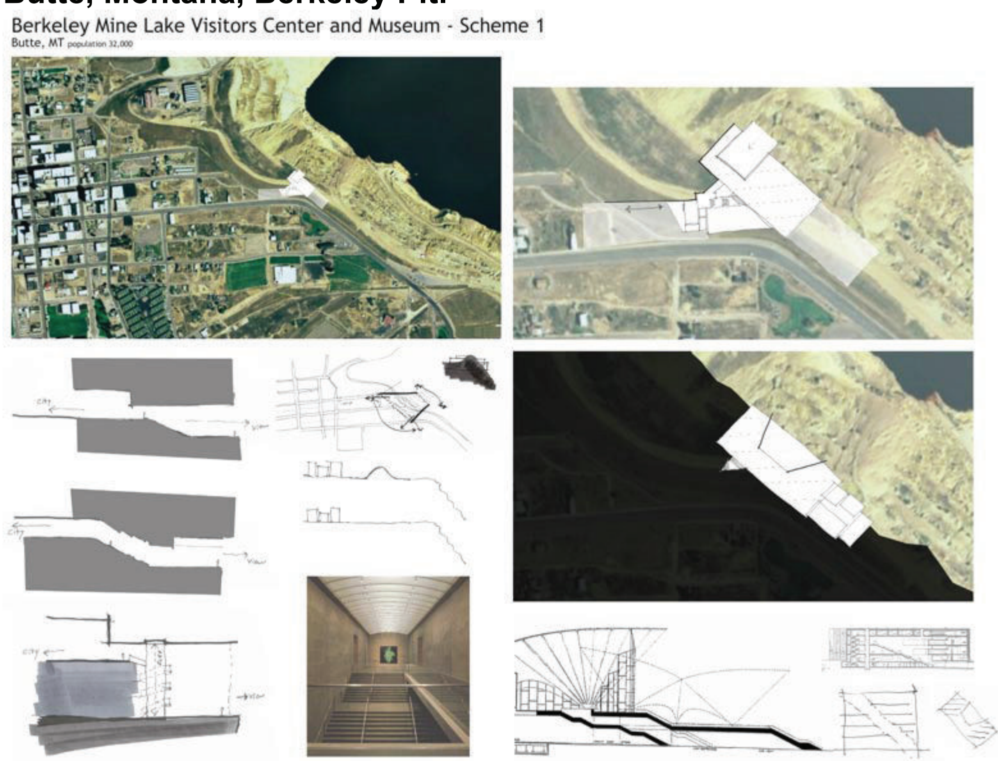


Fig. 22. This scheme gives more of a connection to the town and looks at how you descend into the pit. Precedents: the Modern Art Museum of Art, Ando; Sydney Opera House, Utzon; Jewish Museum, Liebeskind [Drawing by Emily Childs. Precedent images from various sources]

The second scheme for Butte provides an experience of clinging to the edge of a shelf like space carved into the walls of the pit (see fig. 23). This scheme would provide a series of views across the pit as you walk between exhibit spaces and a changing relationship to the rough rock wall as you walk in a hallway closed on one side by the rock wall and on the other side by the museum galleries.

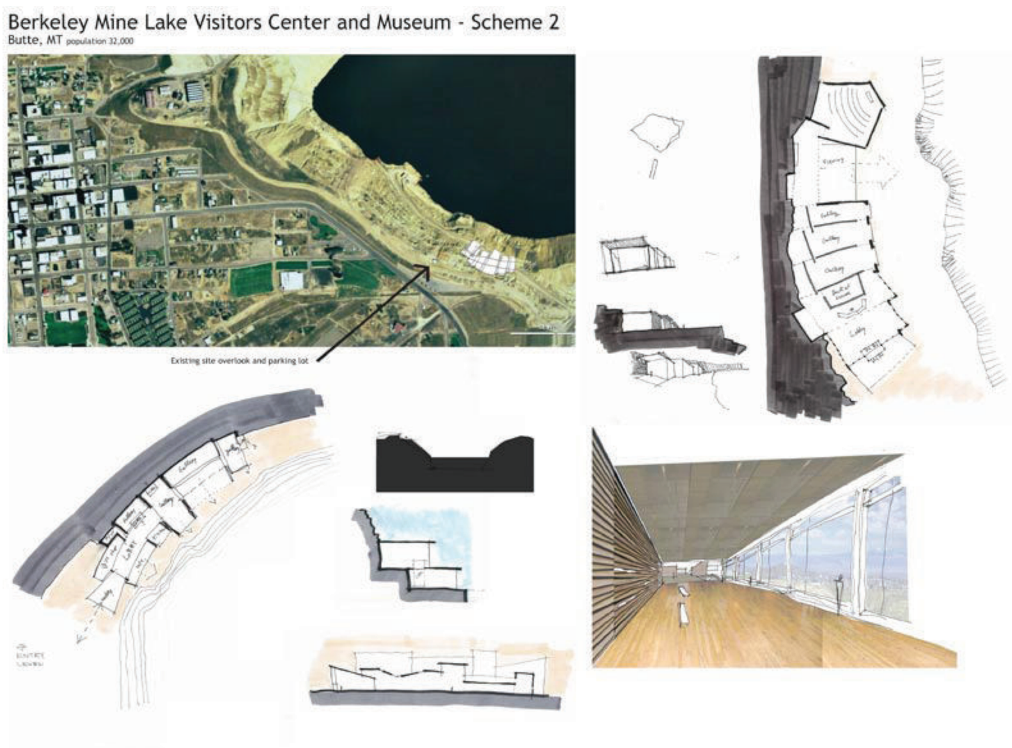


Fig. 23 Sunken inside of the rim of the pit, this scheme is more separated from the town. [Drawings by Emily Childs. Precedent images from various sources]

**Vasquez Rocks in Agua Dulce, CA**

The first scheme for Vasquez Rocks focuses on relating the building form to that of the exposed rock at the site (see fig. 24). This idea may be more apparent in the plan view rather than the exterior views. The second scheme was an attempt to abstract the experience of being in the canyon like crevices between the jagged rock faces (see fig. 25).

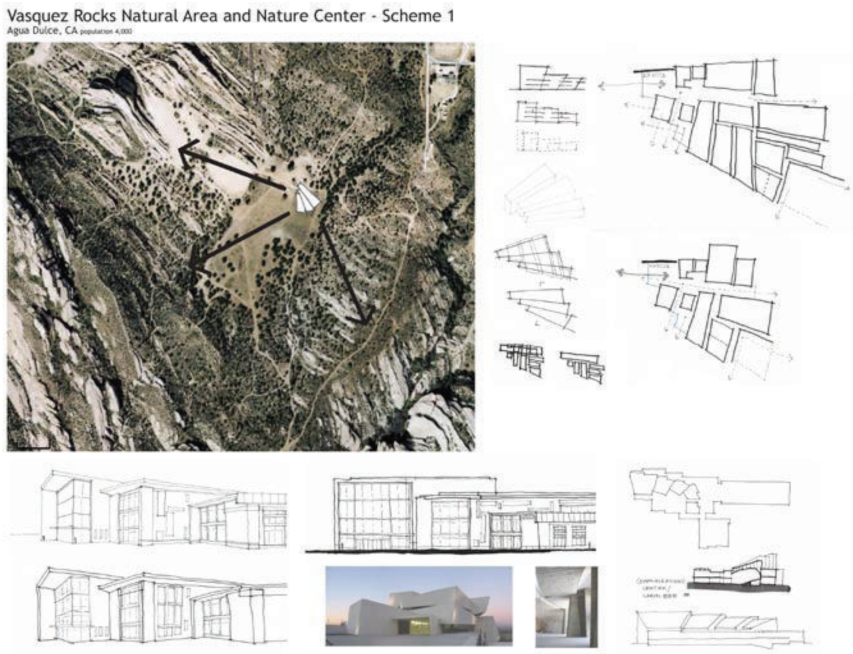


Fig. 24. Scheme 1 at Vasquez Rocks. Precedent: Bodegas Darien, Logrono, Spain; South Tenerife Convention Center, Tenerife, Spain. [Drawing by Emily Childs. Precedent images from various sources]

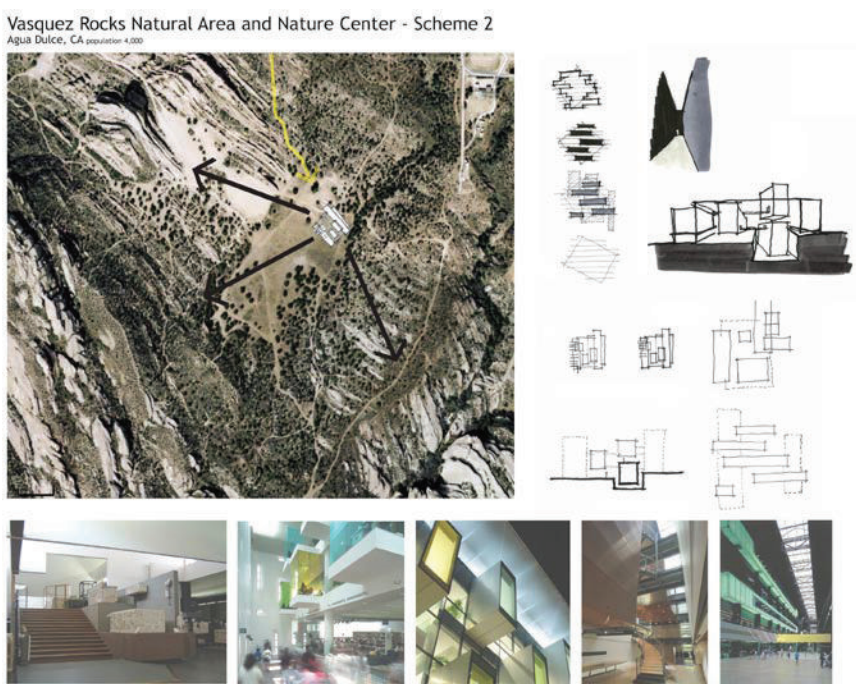


Fig. 25. Scheme 2 at Vasquez Rocks. Precedents: Museo Gregoriano Profano gia Lateranese, The Vatican City; Bishan Community Library, Bishan Singapore; Bishan Community Library, Bishan Singapore; Finish Embassy, Washington, DC; The Tate Modern, London, England. [Drawings by Emily Childs. Precedent images from various sources]

**Interior collage/perspectives:**

These images are early explorations into how the building might create varied interior spaces relating to the landscape beyond.

Fig. 26. Illustrative section through a Lobby, varying the ceiling plane, sources of natural light, and wall materials. [Image by Emily Childs]

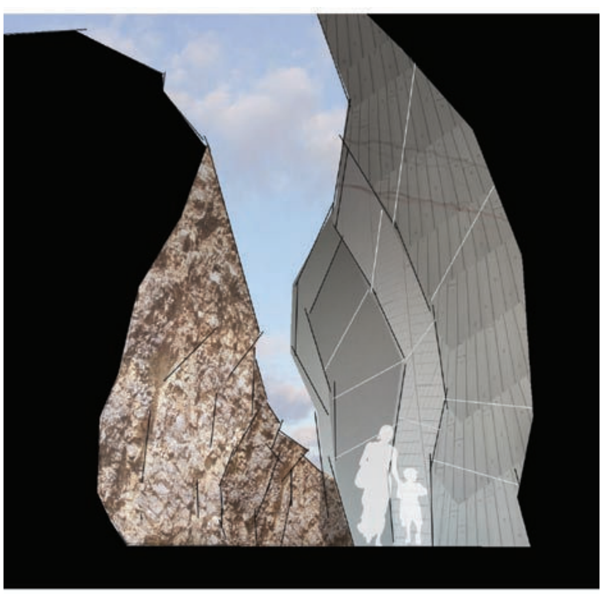

Fig. 27 Perspective image of a narrow space between a rough cut rock wall and an articulated wall surface, highlighting the contrast between the man made and the artificial. [Image by Emily Childs]

Fig. 28. A perspective image showing circulation/gallery space. [Image by Emily Childs]

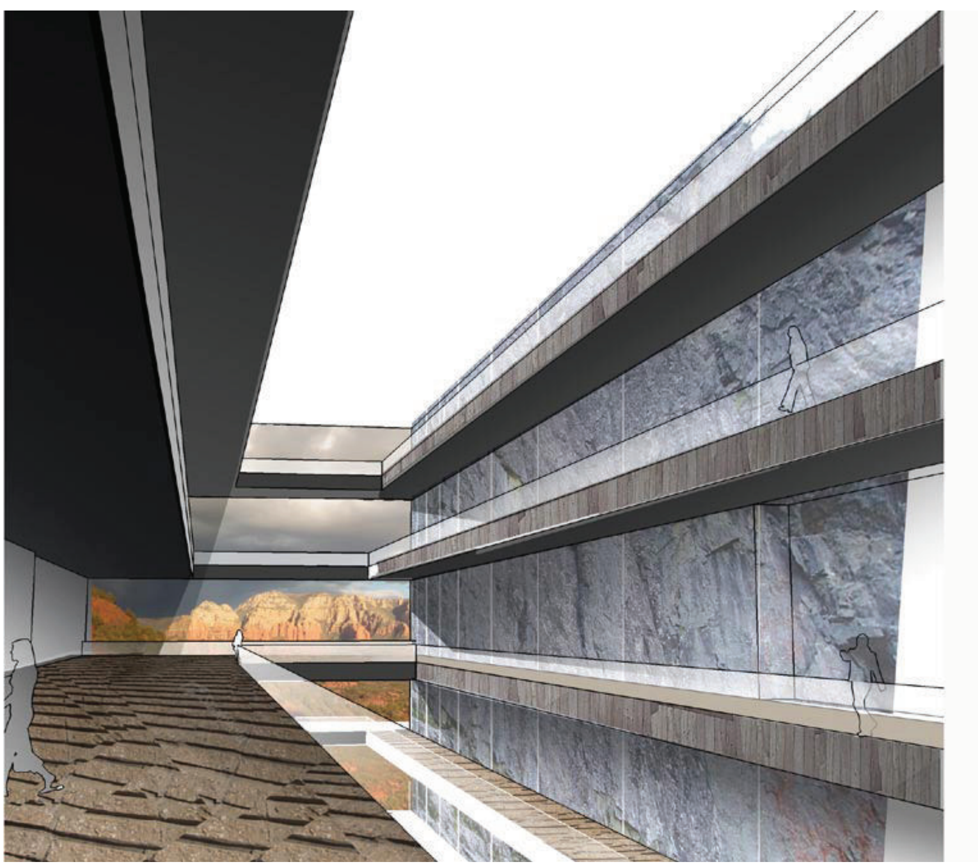

Fig. 29 An Image from a central vertical open space looking towards the exterior landscape. [Image by Emily Childs]

Fig. 30.  Perspective image of an open room meant to direct attention to the landscape framed between the wall, floor and ceiling surfaces. [Image by Emily Childs]

## VI. Choosing one Site; An Interpretive Center for the Berkeley Pit in Butte, Montana

Butte, Montana was selected as the site for my thesis investigation because of the combination of dramatic geologic history, the human intervention at the site, and our current cultural relationship to sites of this nature.

Butte was established as a mining town in 1860. The sought after veins of copper resulted from geologic processes from 80 million years ago;

> "the Butte hill is part of the Boulder Batholith, originally an underground molten mass which cooled to form granite 80 million years ago…As the rock fractured due to cooling and external pressures, mineral solutions filled the resulting cracks and solidified, forming the veins eventually followed by miners…The veins are nearly vertical, with the minerals extending to depth s of over 1 mile"[10]

Between 1955 and 1982 "320 million tons of ore and 700 million tons of waste rock were mined from the Pit"[11]. The metals mined from the ground in Butte (in order of quantity extracted) were copper, zinc, manganese, lead, silver, cadmium, bismuth, selenium, tellurium, and gold[12]. Such a dramatic scale of human intervention has revealed striking layers of the earth, spurred the local economy, and has been an engine of progress for various industries and cities across the country.

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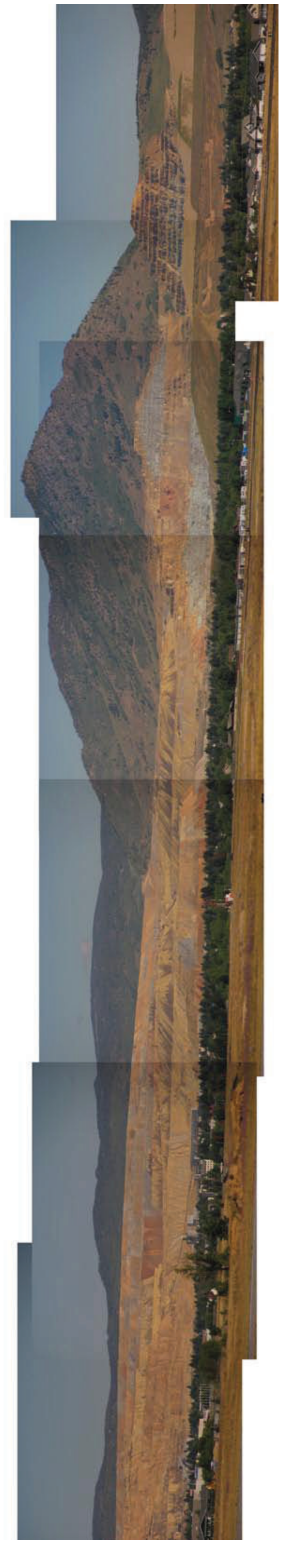
[10] Shovers, Brian; Fiege, Mark; Martin, Dale; and Quivik, Fred. *Butte & Anaconda Revisited; An Overview of Early-Day Mining and Smelting in Montana.* Published by Montana Bureau of Mines & Geology. 1991.p.3.
[11] http://www.pitwatch.org/
[12] Shovers, Brian; Fiege, Mark; Martin, Dale; and Quivik, Fred. *Butte & Anaconda Revisited; An Overview of Early-Day Mining and Smelting in Montana.* Published by Montana Bureau of Mines & Geology. 1991.p.3.



From left to right:
Fig 31. Historic panorama of the “Richest Hill on Earth” [Image from the World Mining Museum]
Fig 32 Panoramic photo from August 2010 from the Butte Visitors Center looking north towards the Pit. [Photo by Emily Childs]
Fig. 33 View from the Bert Mooney Airport looking north towards the pit. [Photo by Emily Childs]

Butte was established in 1860 as a mining town. Early mining produced silver and gold, but copper gave Butte a place in the history books. "In 1910, the Butte district produced over 284 million pounds of copper, making it the largest producer of copper in North American and second only to South Africa in world production of metals"[13]. The heyday of Butte was in the late 1910's when "Butte supported a population of nearly one hundred thousand. In the early twentieth century, Butte had more than twice the population of any other city in the five states of the northern Rocky Mountains and Great Plains"[14]. In 1955, as a result of the high price of copper and competition in the international market, open pit mining was initiated at the site of the Berkeley Mine. Otherwise known as strip mining, open pit mining was a more efficient means of extracting ore[15].

Mining took place in the Berkeley Pit from 1955 until 1982. Mining operations in Butte shut down in 1983. Mining of the nearby Continental Pit has been on and off since 1986[16]. They are still mining today in Butte, but at a much reduced scale than previously seen.

In addition to historic Uptown Butte, urban development spread south into the valley. Today in the valley there is generally a typical suburban style community with a commercial/mixed use district spread along an arterial road and with single family home neighborhoods just beyond the commercial area.

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[13] Shovers, Brian; Fiege, Mark; Martin, Dale; and Quivik, Fred. *Butte & Anaconda Revisited; An Overview of Early-Day Mining and Smelting in Montana.* Published by Montana Bureau of Mines & Geology. 1991. p.10.
[14] Ibid.
[15] Ibid. 13.
[16] http://www.pitwatch.org/2009.htm#2009timeline

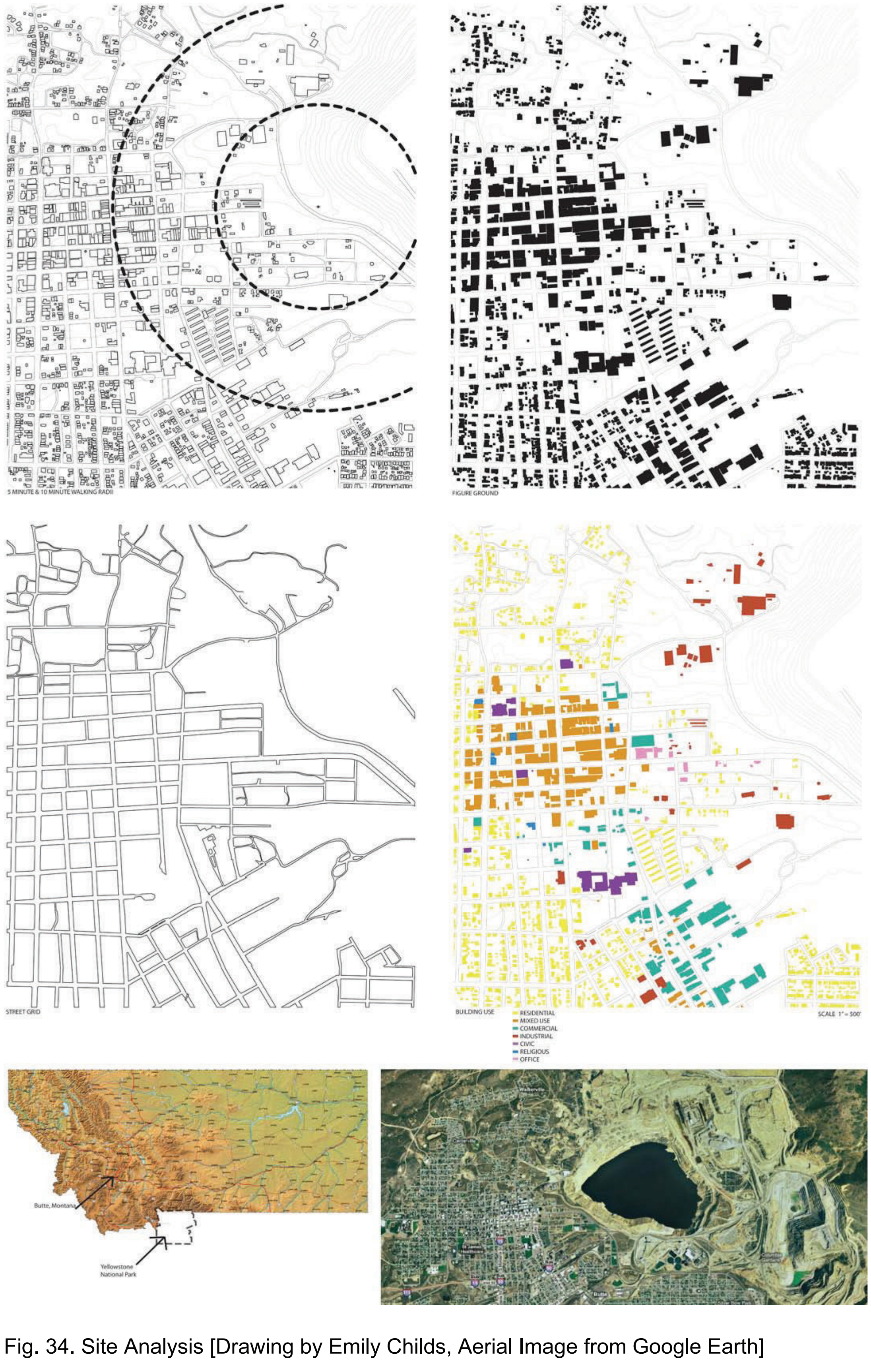



Fig. 34. Site Analysis [Drawing by Emily Childs, Aerial Image from Google Earth]

Uptown Butte is an early 19th century town with an intriguing history and interesting examples of 19th century architecture (see fig. 37-40). There are pleasant mixed use areas of town with shopping, dining, and dramatic vistas into the distant natural landscape (see fig. 34, 35). The town was designated a National Historic Landmark in 1962[17].

Fig.35 Photo from Uptown looking south into the valley. [Photo by Emily Childs]

[17] Ibid. 1.

Fig. 36. Photo taken from the middle of E. Granite St. looking towards the site location at the pit beyond [Photo by Emily Childs]

Fig. 37. Finlen Hotel, 1924,Shanley and Baker [Photo by Emily Childs]

Fig. 38. Metals Bank Building,1906,Cass Gilbert [Photo by Emily Childs]

Fig. 39, Architecture in Uptown Butte.
[Photo by Emily Childs]

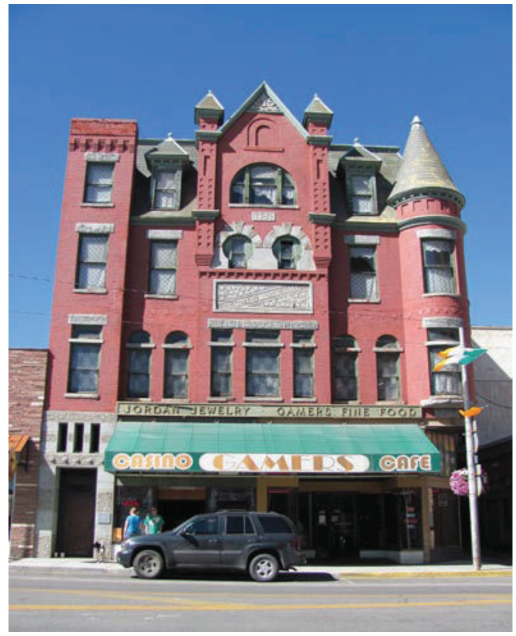



Fig. 40, Architecture in Uptown Butte.
[Photo by Emily Childs]

At the heart of the density there are several buildings which are nine stories tall (see fig. 37, 38). The heights of buildings taper off after a few blocks in each direction to neighborhoods with a density closer to that of single family housing (see fig. 35). While there has been reinvestment in the Uptown area, there are still some vacant store fronts which add to the allure of the Uptown area.

**Siting the building:**

The site selected for the interpretive center is on the rim of the pit, cutting through the berm. In this location the museum would be on an axis between the town and the pit (see fig. 41).

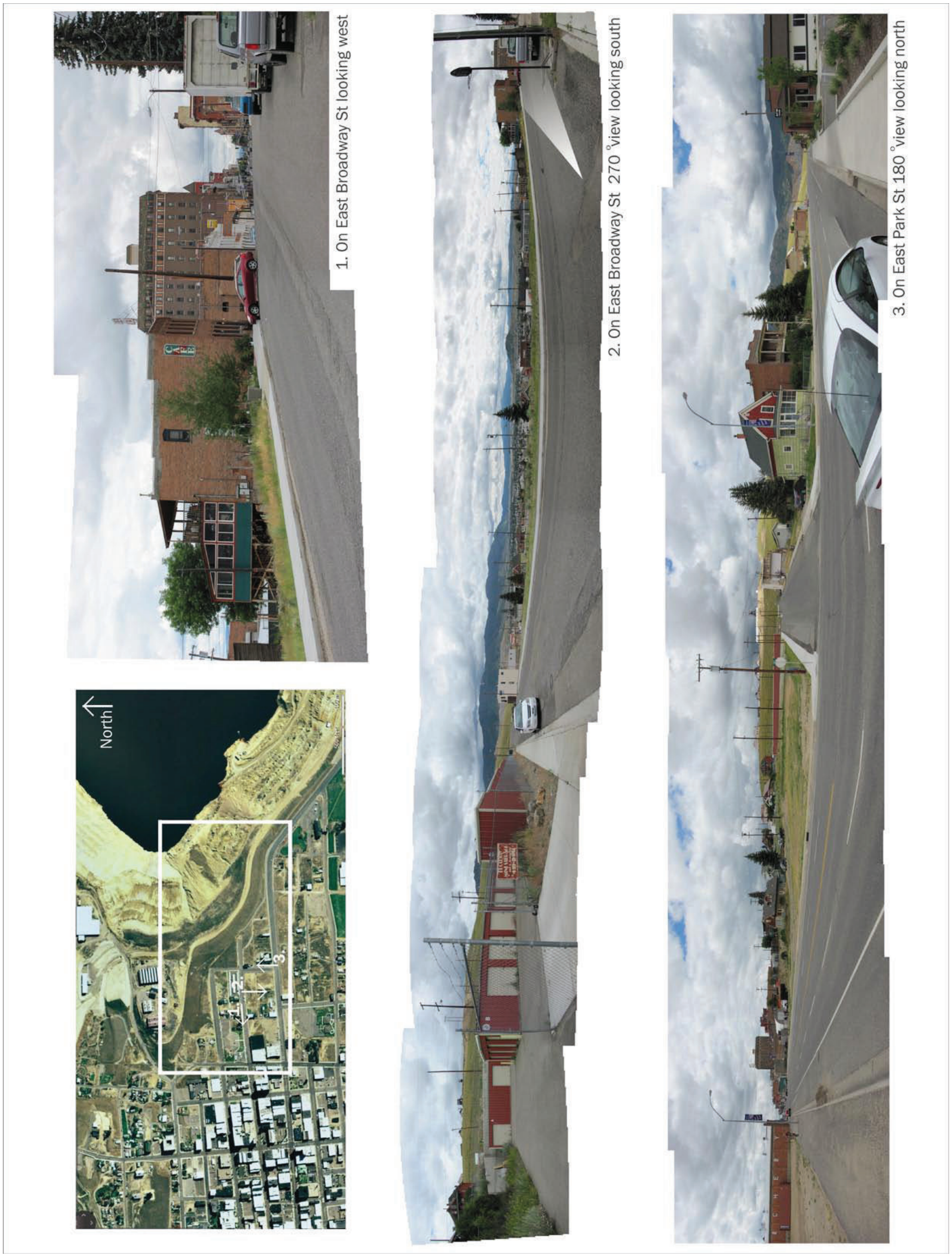



Fig 41. Site photos. [Drawing and site photos by Emily Childs. Aerial Image from Bing maps]

Currently the site is part of the land owned by the mining company Montana Resources (conducting the mine operations taking place at the Continental Mine and maintaining the Berkeley Pit). The density in immediate vicinity of the site is sporadic (see fig. 41, 53). There are unimproved open plots of land, various small manufacturers, several small commercial buildings, and several single family houses. Uptown Butte proper is only approximately 1500 ft to the west. Potentially there could be future development which connects the site of the museum to the more dense areas of Uptown Historic Butte. As part of the efforts to bring reinvestment to Uptown Butte the immediate blocks surrounding the site are part of a Tax Increment Financing zone[18].

The edge of the pit next to the town is protected by a berm. A rise of 40 feet prevents direct visual access into the pit from the immediate street level (see fig 36). However, there is a rise in slope as you go further into Uptown Butte. From this vantage point you can see over the berm and across the pit (fig. 36).

**Alternative Parti Organizations:**

Initially several parti's were investigated. The different options looked at a number of different ways of organizing the building including. Some of the approaches included: burying the building in the ground (see fig. 44, 45), creating a main axis perpendicular to the edge, or taking on a more irregular geometry (see fig. 42).

[18] Smitham, Jim. Executive Director of the Butte Local Development Corporation. Conversation dated 9-13-10.

A number of different variables were studied through these options. Some of those variables are: how secondary functional spaces would interact with a large ceremonial hall holding the main vertical circulation, how visitors would access the ceremonial hall, the connection between the lobby and the ceremonial hall, the connection of the galleries to the ceremonial hall, and the relationship of the galleries to the significant views from the building.

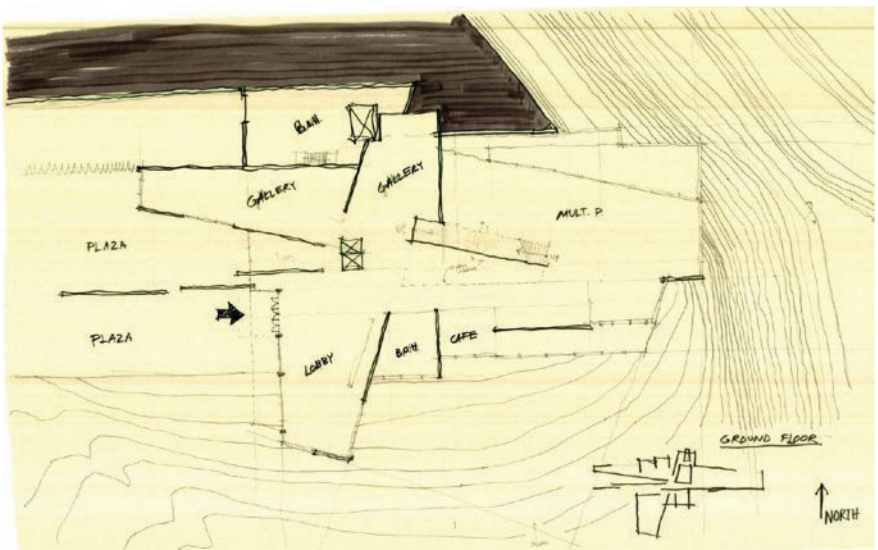



Fig. 42. Plan view speculative design 1, irregular geometry. [Drawing by Emily Childs]

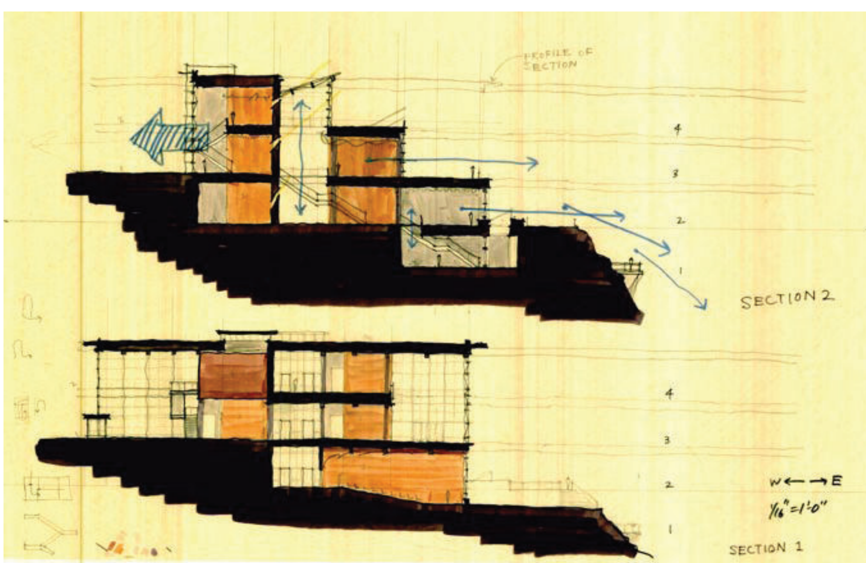



Fig. 43. Section view speculative Design 2. [Drawing by Emily Childs]

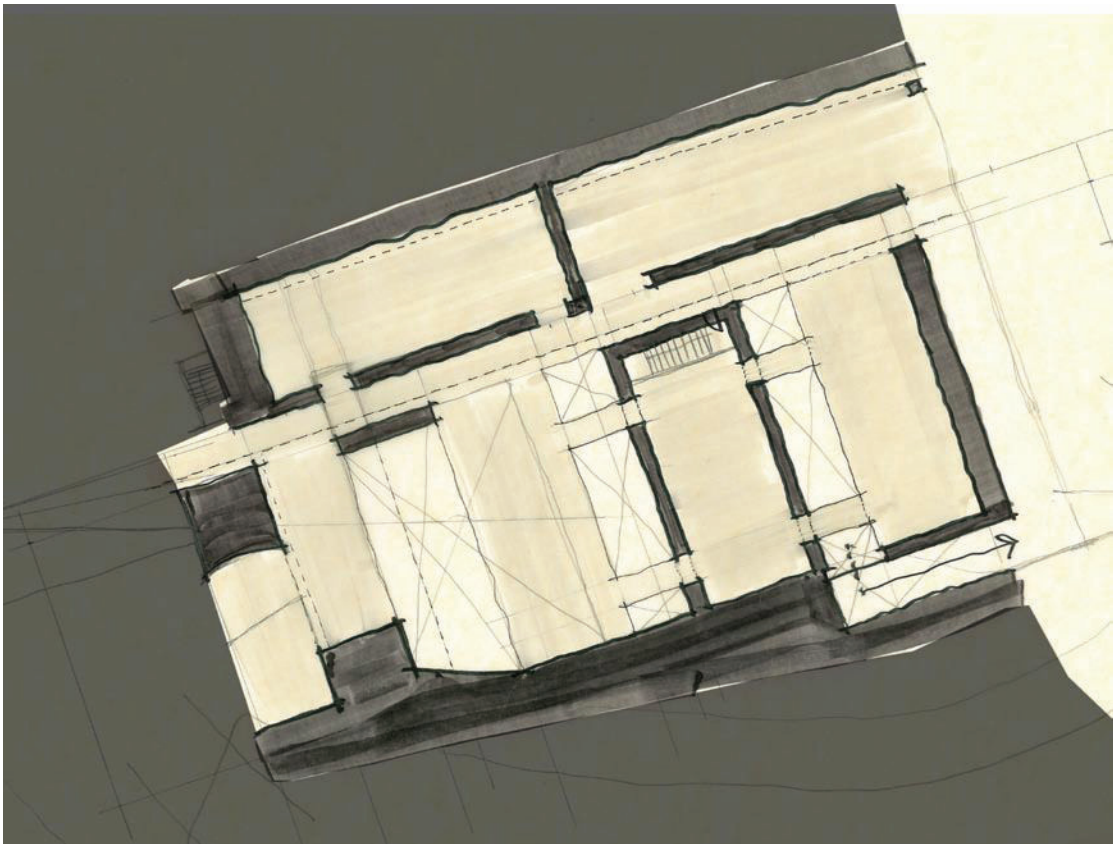


Fig. 44. Plan view speculative design 3. [Drawing by Emily Childs]

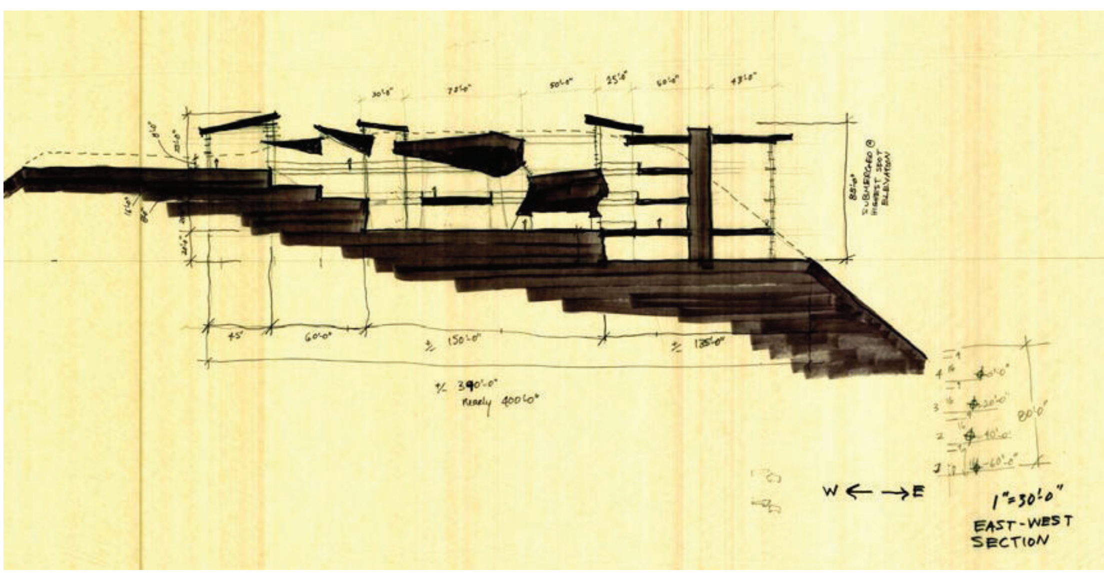



Fig. 45. Section view speculative design 3. [Drawing by Emily Childs]

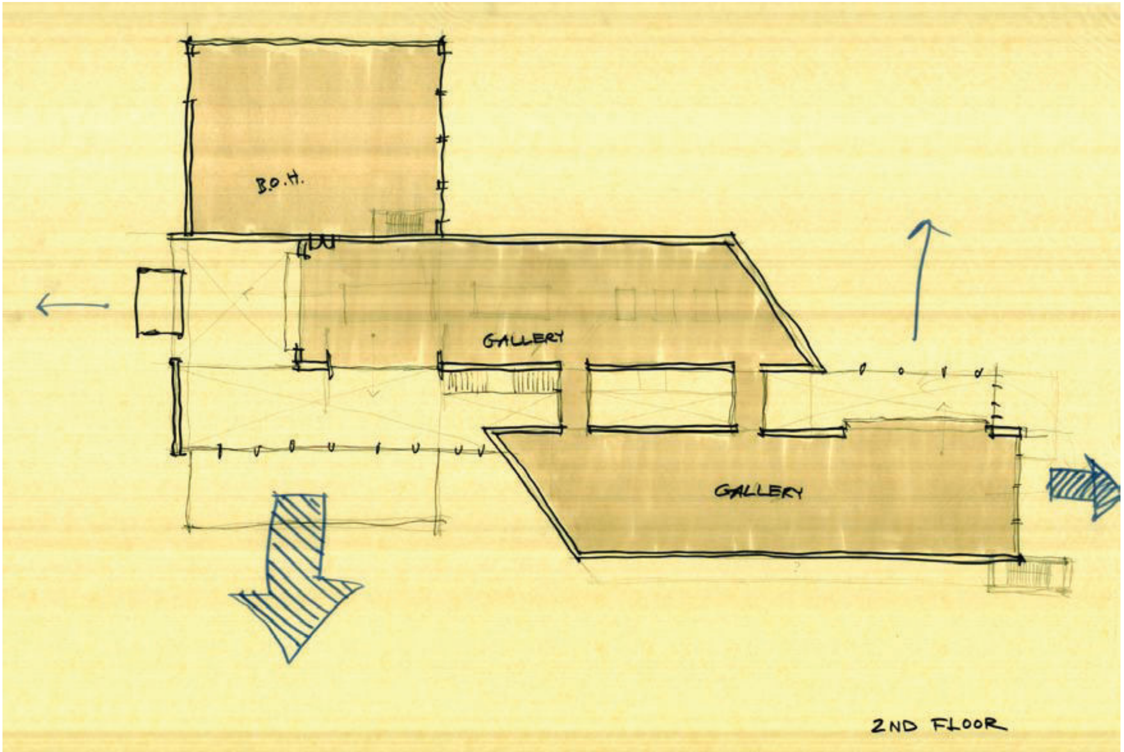



Fig. 46. Plan view speculative design 4. [Drawing by Emily Childs]

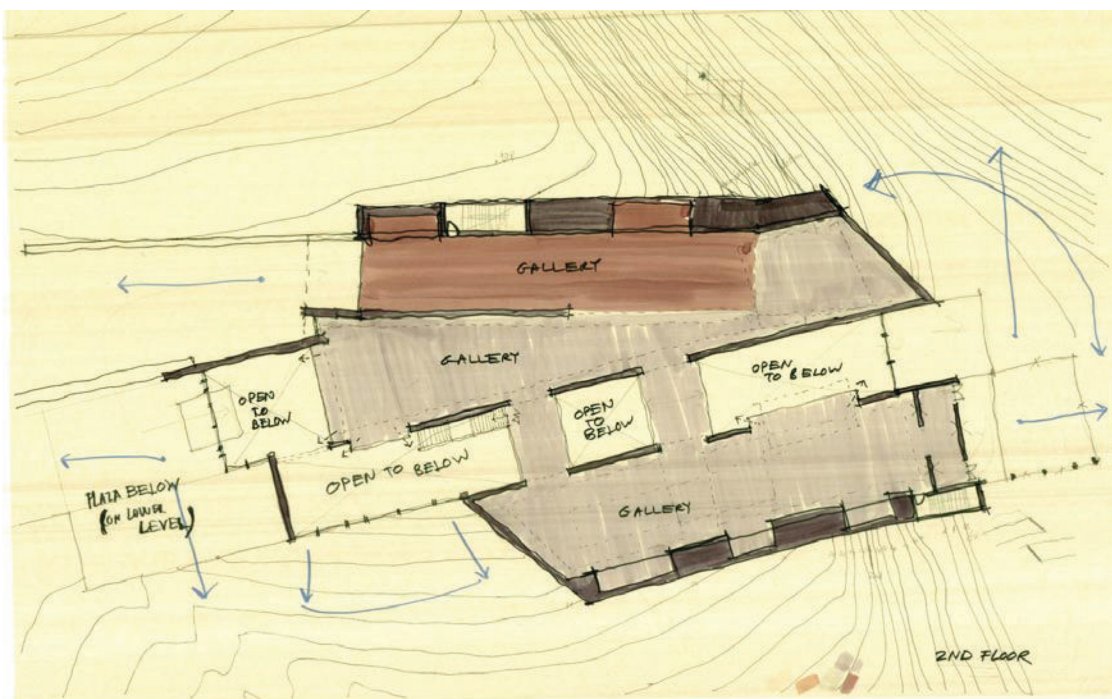



Fig. 47. Plan view modification to speculative design 4. [Drawing by Emily Childs]

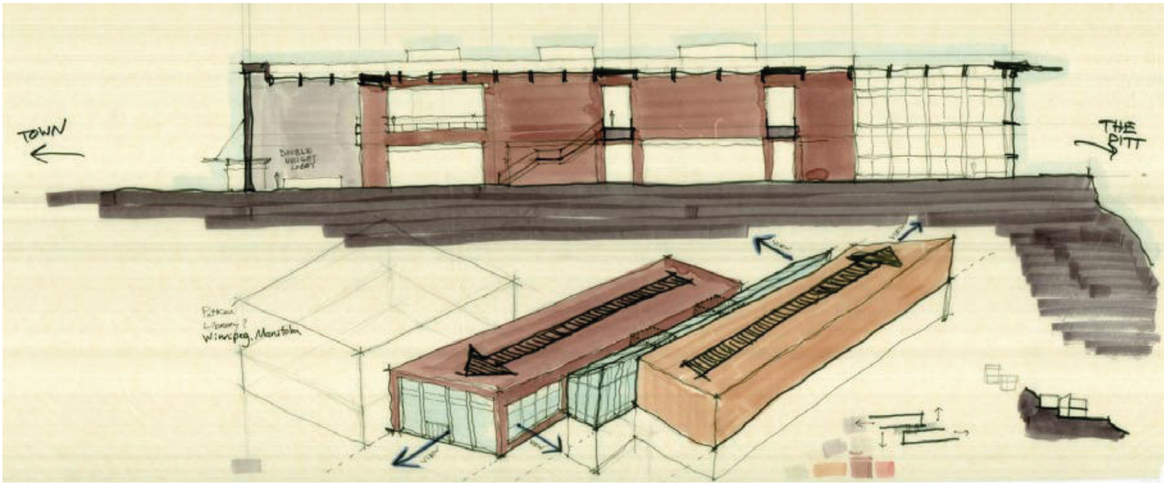



Fig. 48. Section and axon diagram; design 4. [Drawing by Emily Childs]

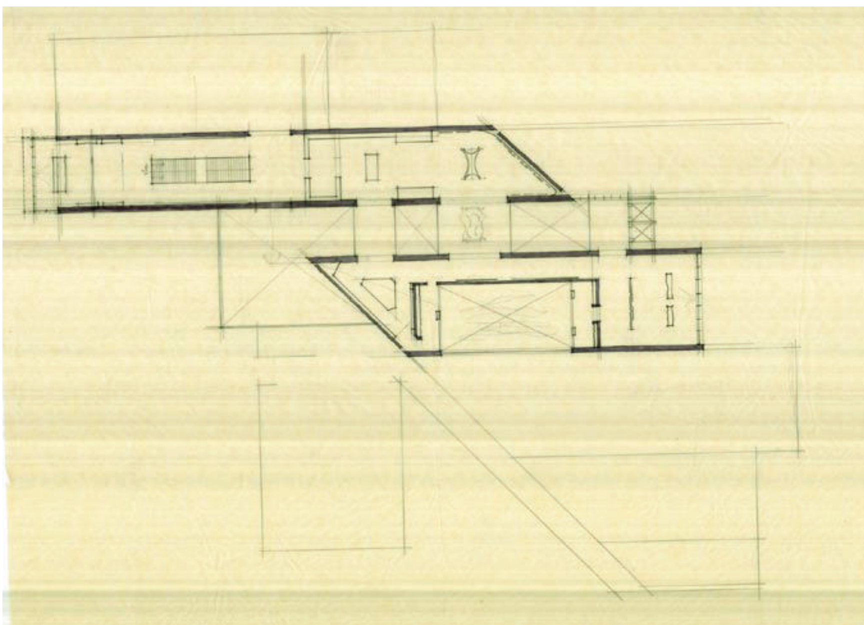


Fig. 49. Plan view; further development of design 4. [Drawing by Emily Childs]

In addition to plan and section iterations, a number of basic diagrams looked at site conditions in terms of how the building might cut through the berm (see fig. 50), whether the main axis of the building would be perpendicular to the rim of the pit or along the rim of the pit, and how the orientation of a main stair would be influenced by visual access to the pit (see fig. 50). Process models explored spatial relationships and materiality (see fig.51-52).

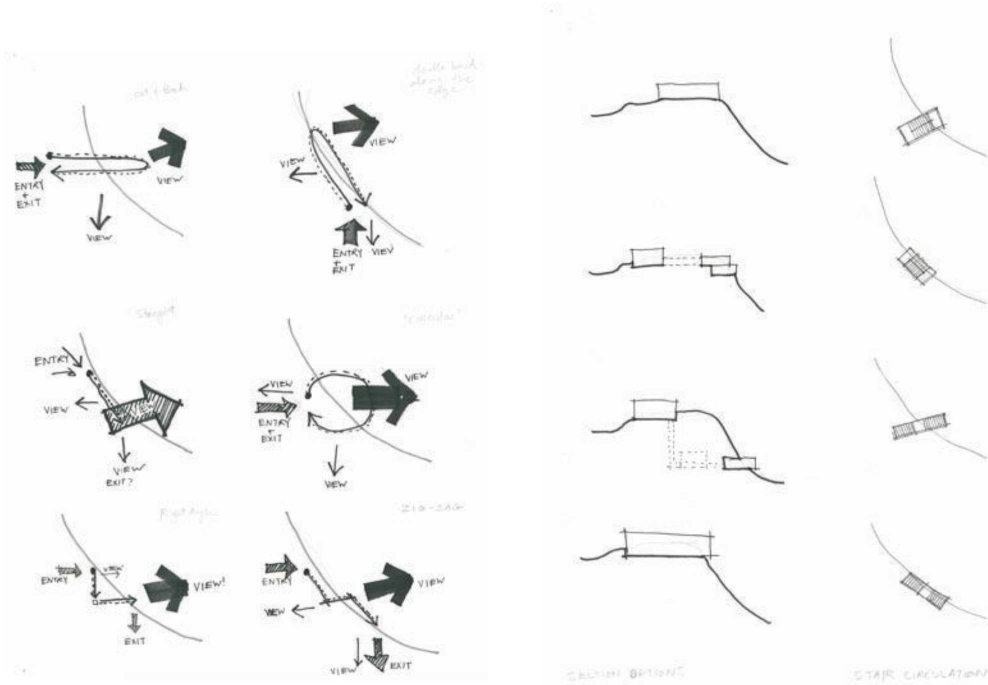



Fig. 50. Site diagrams [Drawing by Emily Childs]

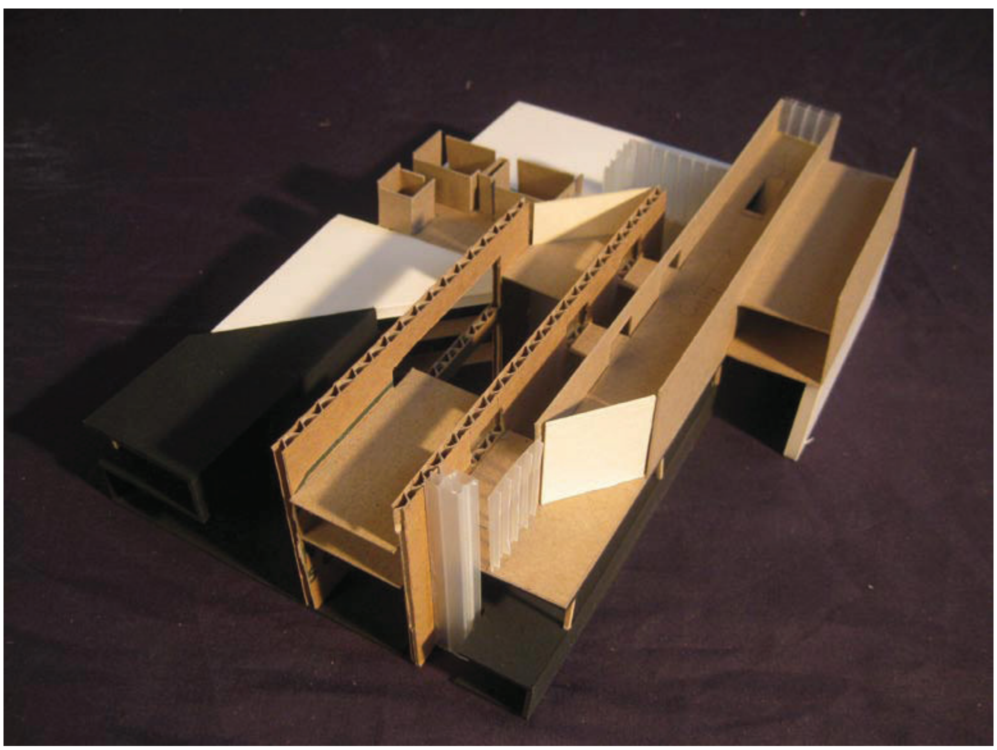


Fig. 51. Model [Photo by Emily Childs]

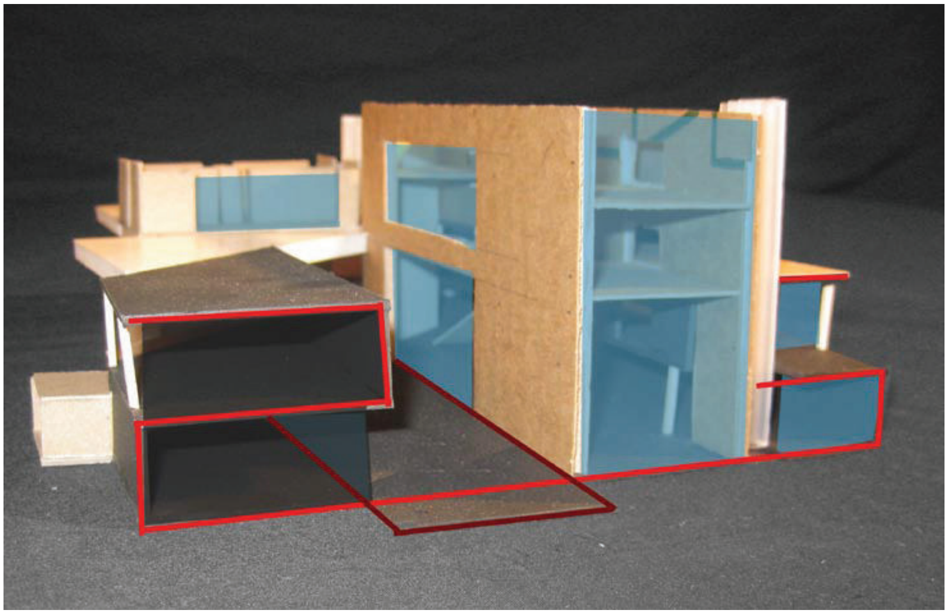


Fig. 51. Model [Drawing by Emily Childs]

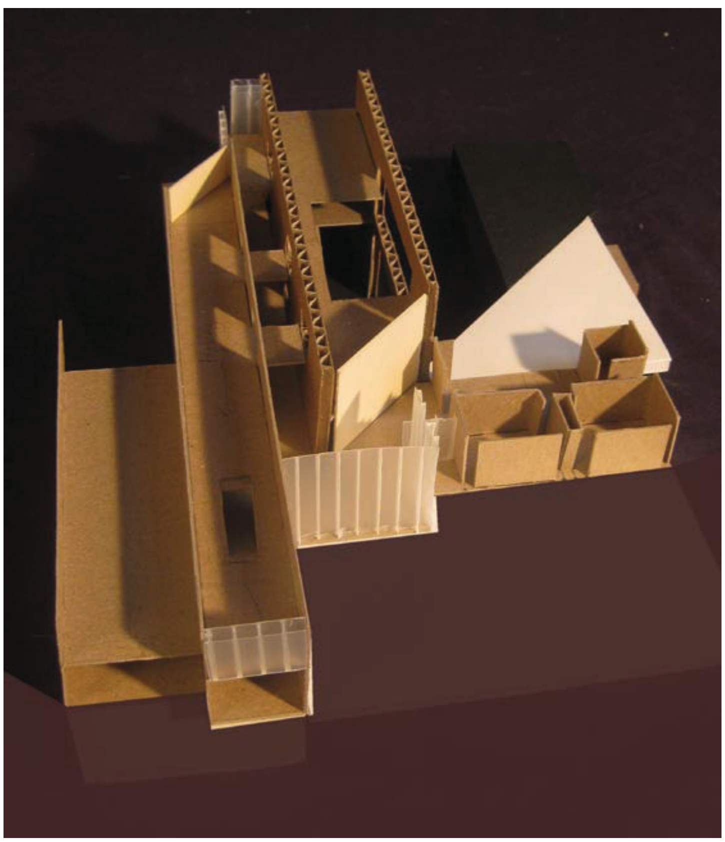


Fig. 52. Model [Photo by Emily Childs]

**The Design Solution:**

The final design was meant to highlight the contrast between the 2 very different marks left on the landscape and the underlying reason for those marks. On one hand, the manifestation of the town; built structures speaking of the progress inherent in the roughly 150 year history of Butte, and on the other hand, the destruction of the landscape; providing raw materials for the used in the growth of towns and industries all across the U.S, made possible by the roughly 100 years of mining at the site. Meanwhile underlying the reason for both the town and the pit is the geologic history that produced the mineral resources.

The selection of the structural system was important in relating back to the rock, minerals, and metals taken out of the ground. The exposed structural system was meant to be straightforward and systematic. Structural concrete walls and a system of bar joists were selected for the simplicity and directness. Additionally, in a town with a history of relying on efficient industrial structures; such as head frames, mine shafts, and tunnels, it was important that the structural system of the interpretive center reflect that type of performance.

Additionally the structural system relates to the geologic history of the site. The thick vertical concrete walls can be seen as a metaphor for the copper veins in the ground. The bar joists create a regular rhythm which is interrupted by the concrete walls slicing through.

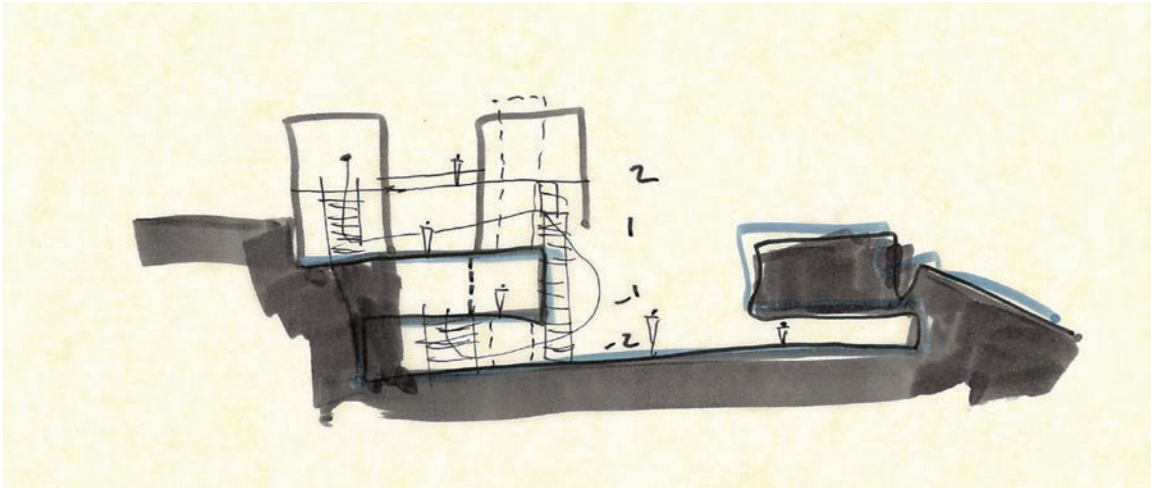



Fig. 53. Diagramatic process drawing of a section cutting North -South through the building looking East. This diagram shows the lobby space between the “town” gallery and ceremonial hall and the outdoor terrace between the ceremonial hall and the mining gallery [Drawing by Emily Childs].

Originally other more expressive forms were studied, however through engaging in multiple design options it seemed that in emphasizing the contrast between the construction and the town and the destruction of the landscape (in the form of the Berkeley Pit) that a more straightforward parti would be more direct.

The orientation of the building was chosen based on a few factors. The westward extent of the pit diagonally cuts off several streets. The rim of the pit cuts on a diagonal through the street grid. This prompted the question: should the building align itself with the town or with the pit? Orienting the building to the town would make the axis from the street be dominant. Whereas orienting the building to be perpendicular to the berm would have directed the main vista (towards the pit) away from the center of the pit. The angle chosen was based on the ideal angle to allow for a direct view of the center of the pit from the berm, this meant canting the main axis of the building between 10 and 17 degrees North of East (see fig. 54).

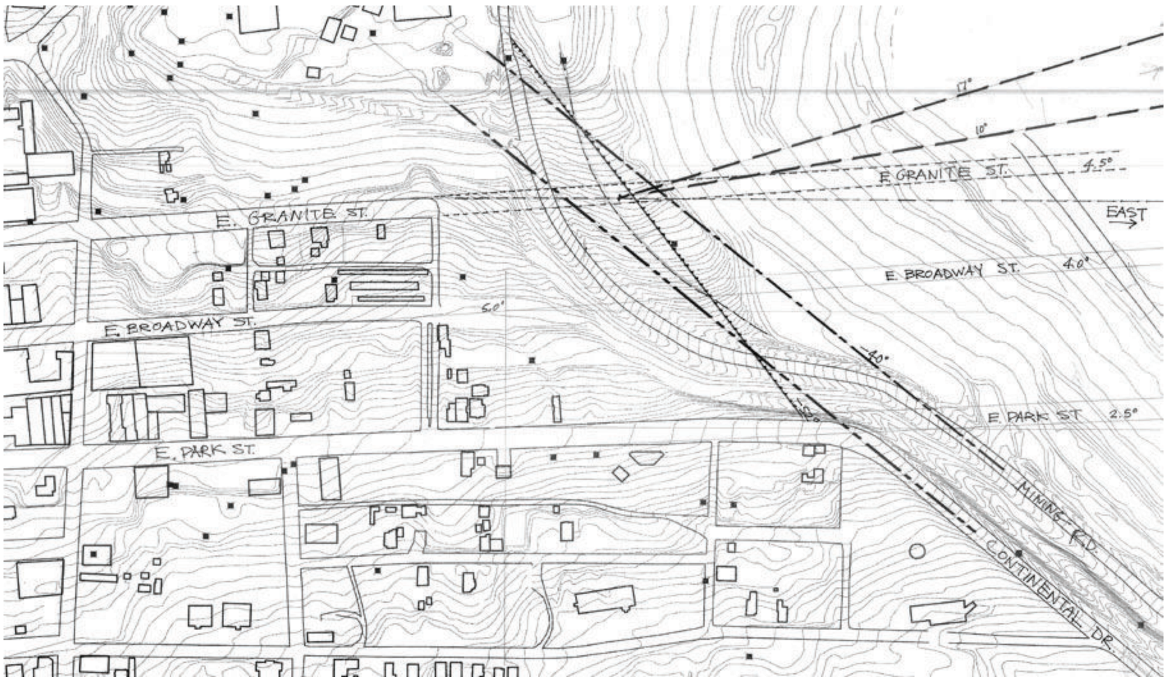



Fig. 54, Relevant angles based on site conditions [Drawing by Emily Childs]

There are several reasons for the parti organization. One of those reasons was to find bring attention to the pit and the town. Originally there were 2 linear bar shaped volumes, open on only one end. The open glazed end of one volume is directing attention to the town and the other is focusing on the pit. Between the first two volumes is the entry lobby hall and access to elevators. As the design developed a third volume was added that enabled the enclosure of an outdoor terrace providing views into the pit and another volume to hold exhibit spaces.

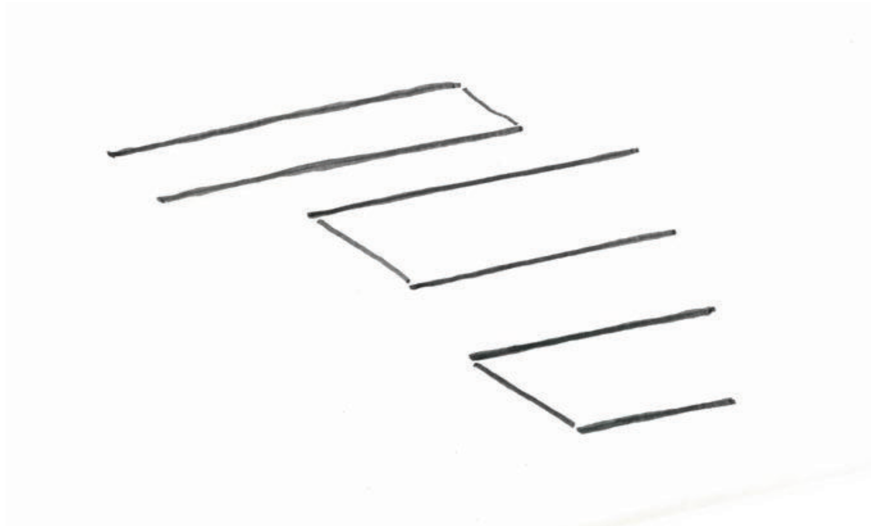


Fig. 55. Parti sketch of main volumes [Drawing by Emily Childs]

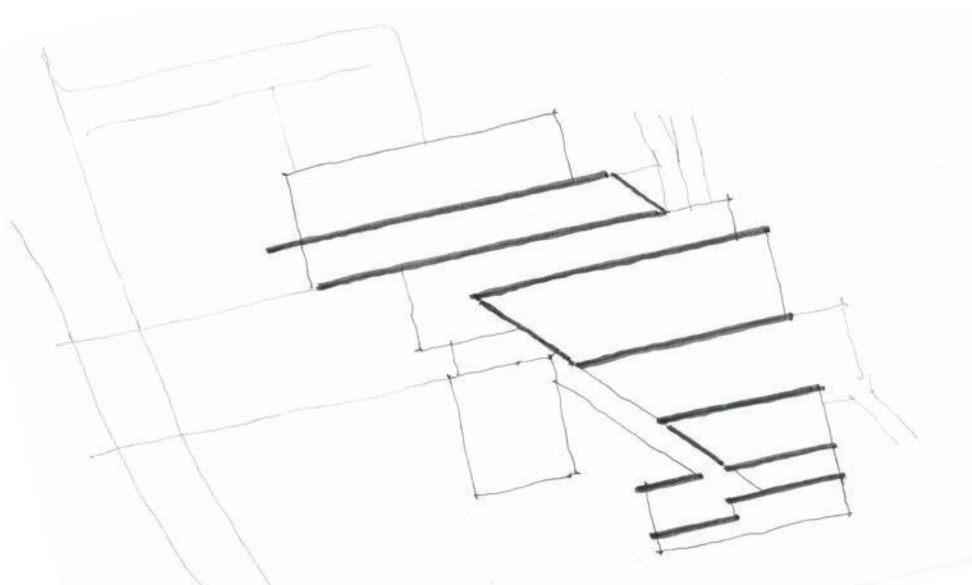


Fig. 56. Parti sketch including entry plaza, back of house, classroom/library volumes. [Drawing by Emily Childs]

The parti also relates to how sedimentary layers of rock are transformed when they are under pressure. Depending on the characteristics of the layers, they will undergo a number of possible different transformations, for instance bend, fold, or shearing (see fig. 57).

Fig. 57 Geologic cross section diagram. [Diagram from http://www.cypressdevelopmentcorp.com/images/maps/Geologic_Cross-Section.jpg]

The diagonal copper walls closing the volumes help relate to the angle of rim of the pit, and provide directionality to the volumes, while the strong demarcation of the concrete walls related to the street grid; but as mentioned earlier, is intentionally not the same as the street grid.

**Visitor approach and experience:**

At the street level there is small parking lot. A series of ramps allow visitors to walk from the street level to the open plaza in front of the building. There is also vehicular access to a larger parking lot which gives on grade, ADA access to the main plaza. From this plaza you can enter the main lobby (see fig.71).

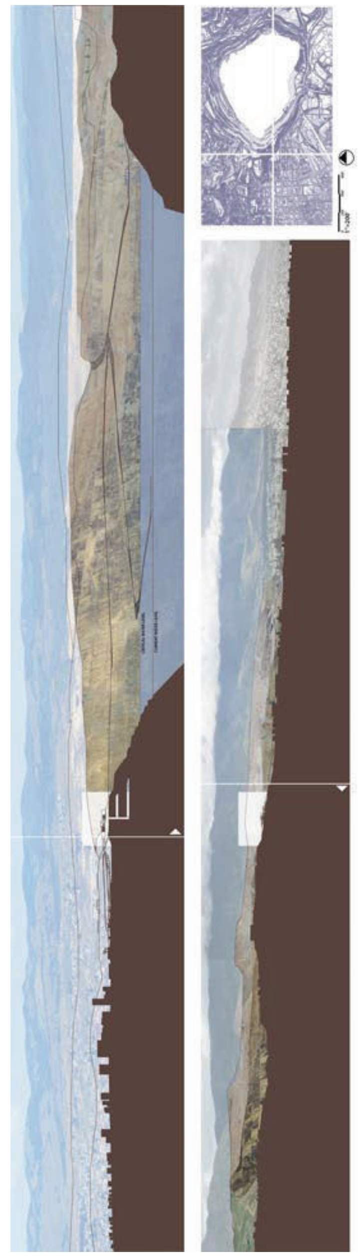
Once inside the main entry hall, on the left you can access the introduction gallery, stairs up to the “town” and “market trends” galleries, classrooms, library and back of house/service areas. From inside the main entry hall, straight ahead are glass elevators. Beyond these glass elevators is a view of the pit (see fig.72).

These elevators either take the visitor up to the "town" gallery (see fig. 73) and "market trends" galleries or down to the "mining" and "geology" galleries, the café, auditorium and elevator lobbies for overlook access. Adjacent to the entry hall and glass elevators is the large ceremonial hall, which has visual access from the main entry hall and can be accessed directly from the main entry hall. Once inside of the ceremonial hall there is an exhibit space providing a large open vista looking into the pit and the terrace to the south (enclosed on the other side by the mining gallery).

From this exhibit space there is a wide grand stair leading to lower levels of the museum. This ceremonial hall holds a 4 story copper sculpture, resembling a near life size representation of a copper vein. This sculpture would mimic the type of models of copper veins that were made for court hearings. One of these models is on display at the Montana Tech Natural Resources Building, located in Butte (see fig.58 & 74). This ceremonial hall has a 4 story glass curtain wall on the south face.

Fig. 58. Models of copper veins, on display at the Montana Tech Natural Resources Building, located in Butte. [Photo by Emily Childs]

From the 4 story hall the visitor can take a hallway to the mining gallery and the elevator access for the two levels of overlook terraces. One side of this hallway you are adjacent to a rough cut rock wall. The other side of the hallway is glazed and gives a long vista across to the far side pit (see fig.74).

From left to right
Fig. 59. Site plan showing Uptown,the building location, and the pit. Additionally there is a proposal for development to fill in the blocks adjacent to the site. [Drawing by Emily Childs]
Fig. 60 Two site sections, the first one is cut East-West looking North the second on is cut North South looking East. [Drawing by Emily Childs]

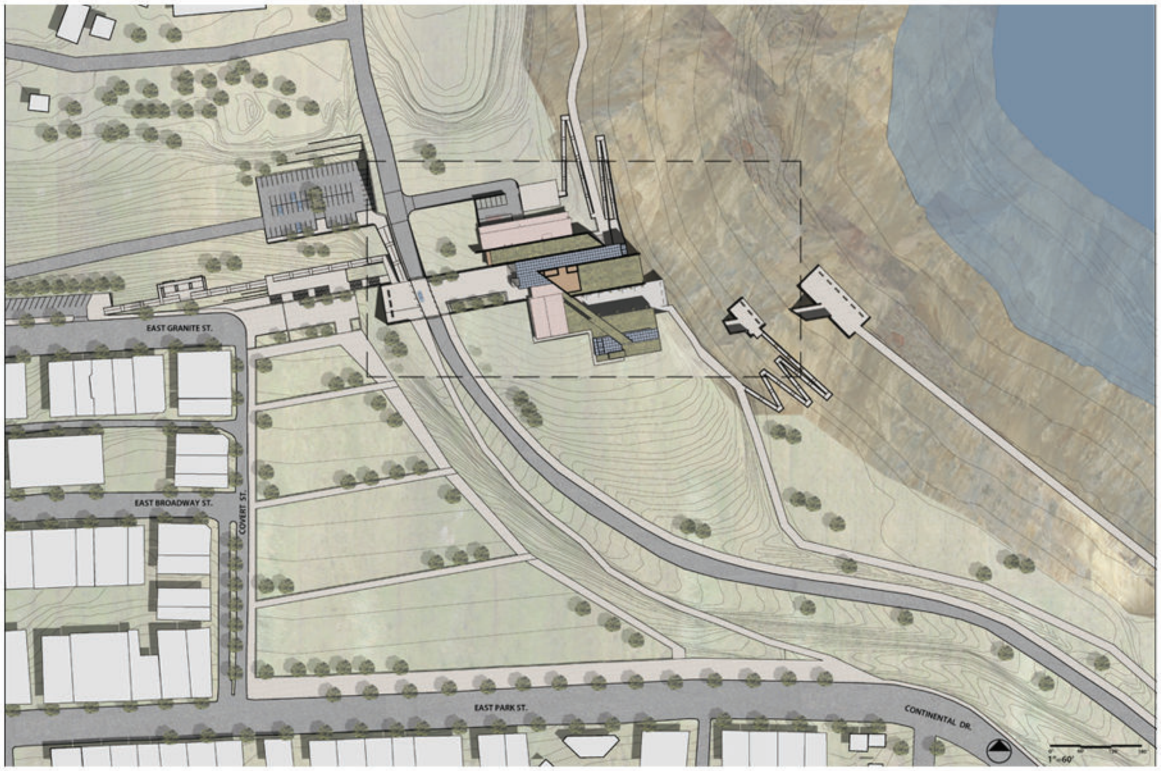



Fig. 61. Site Plan showing the roof. [Drawing by Emily Childs]

Fig 62. Two site sections, (left) one is cut (roughly East-West) through the two overlook terraces. the second (right) is cut (roughly North-South) through the park space and the ramps . [Drawing by Emily Childs]


Fig 63. Building Elevation, Western Facade [Drawing by Emily Childs]

Fig 64. Building Elevation, Eastern Facade [Drawing by Emily Childs]

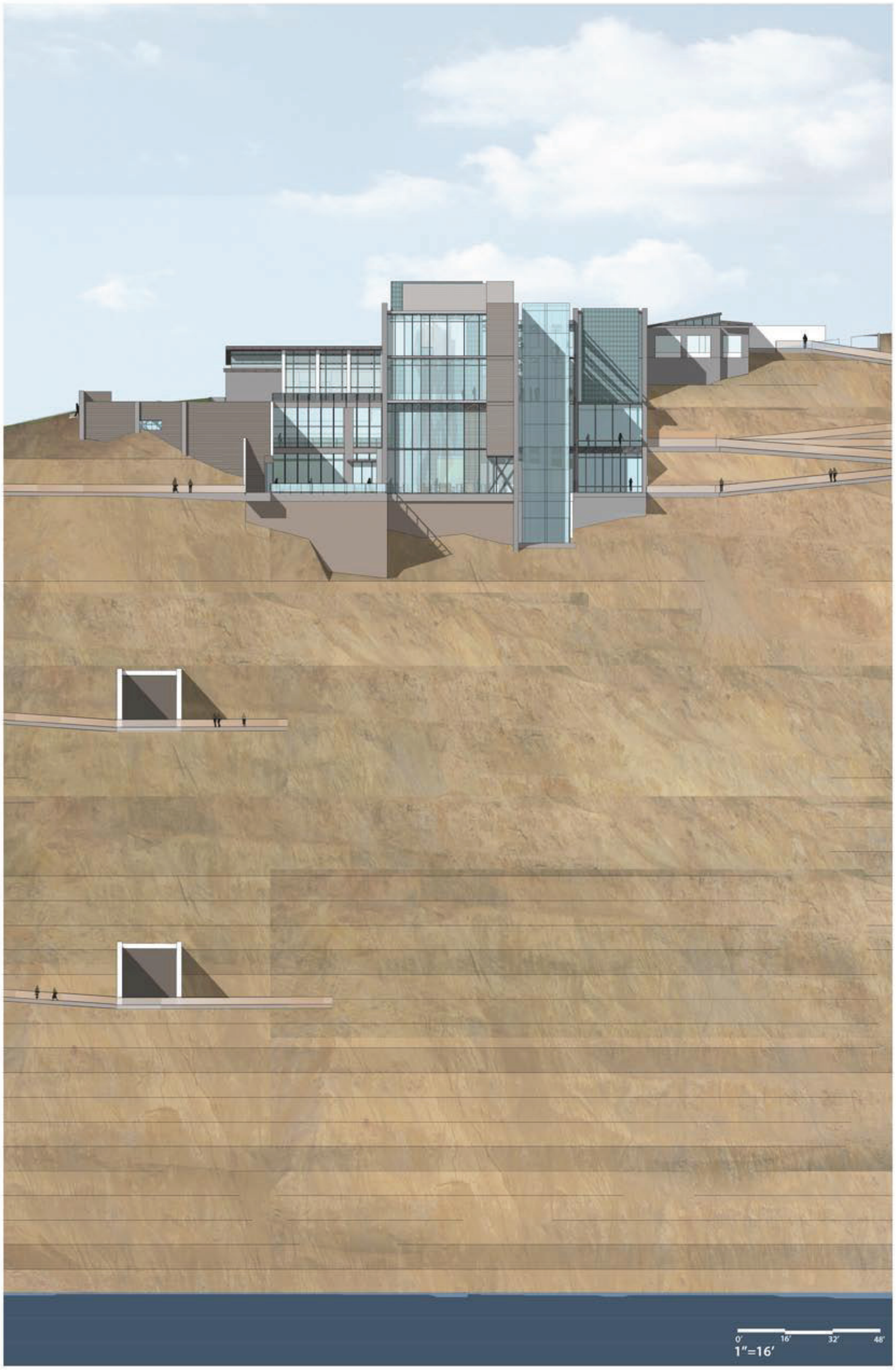



Fig 65. Building Plan second floor [Drawing by Emily Childs]


Fig 66. Building plan, first floor, main entry level [Drawing by Emily Childs]

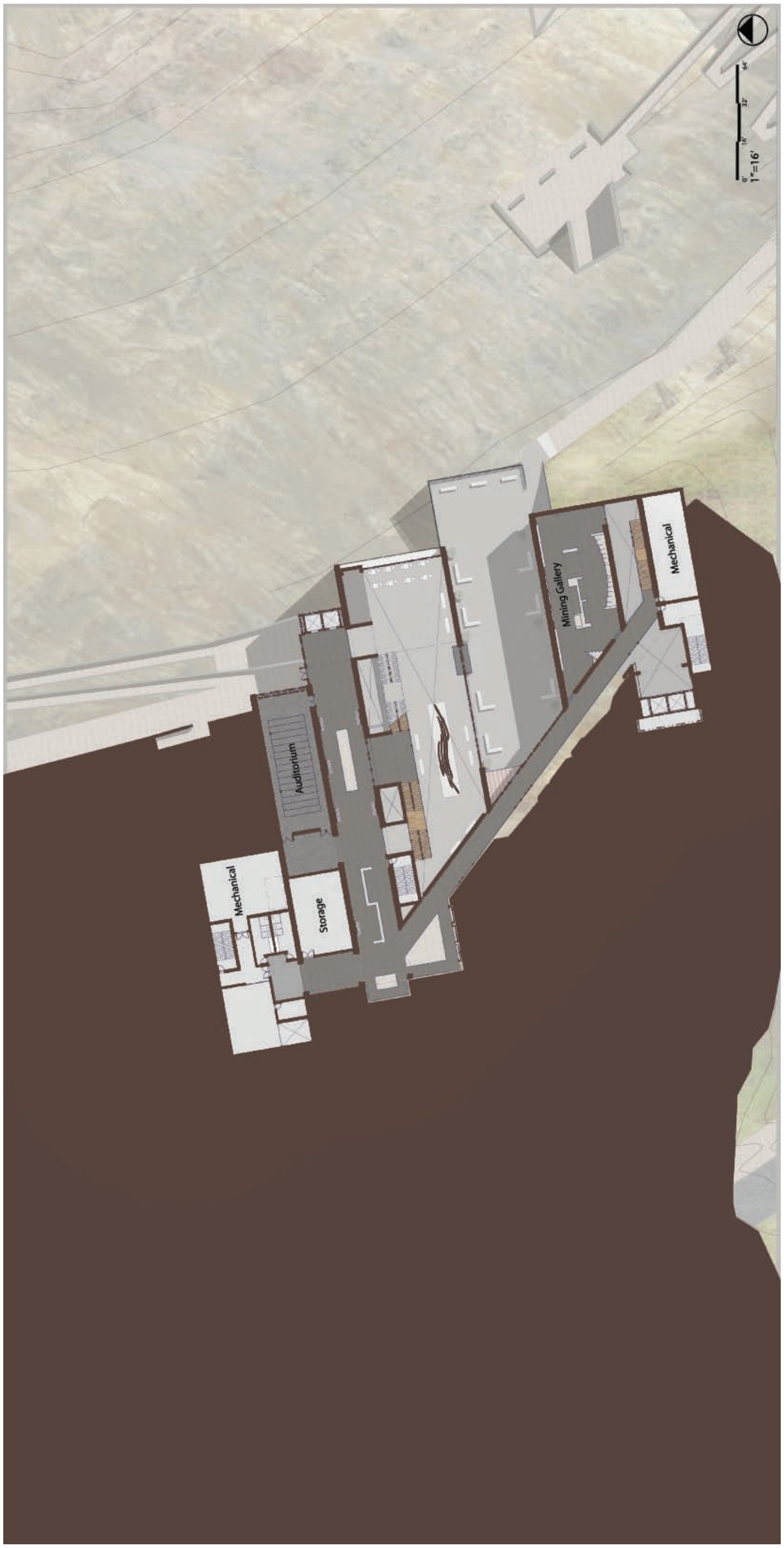


Fig 67. Building plan, first level below the main entery [Drawing by Emily Childs]

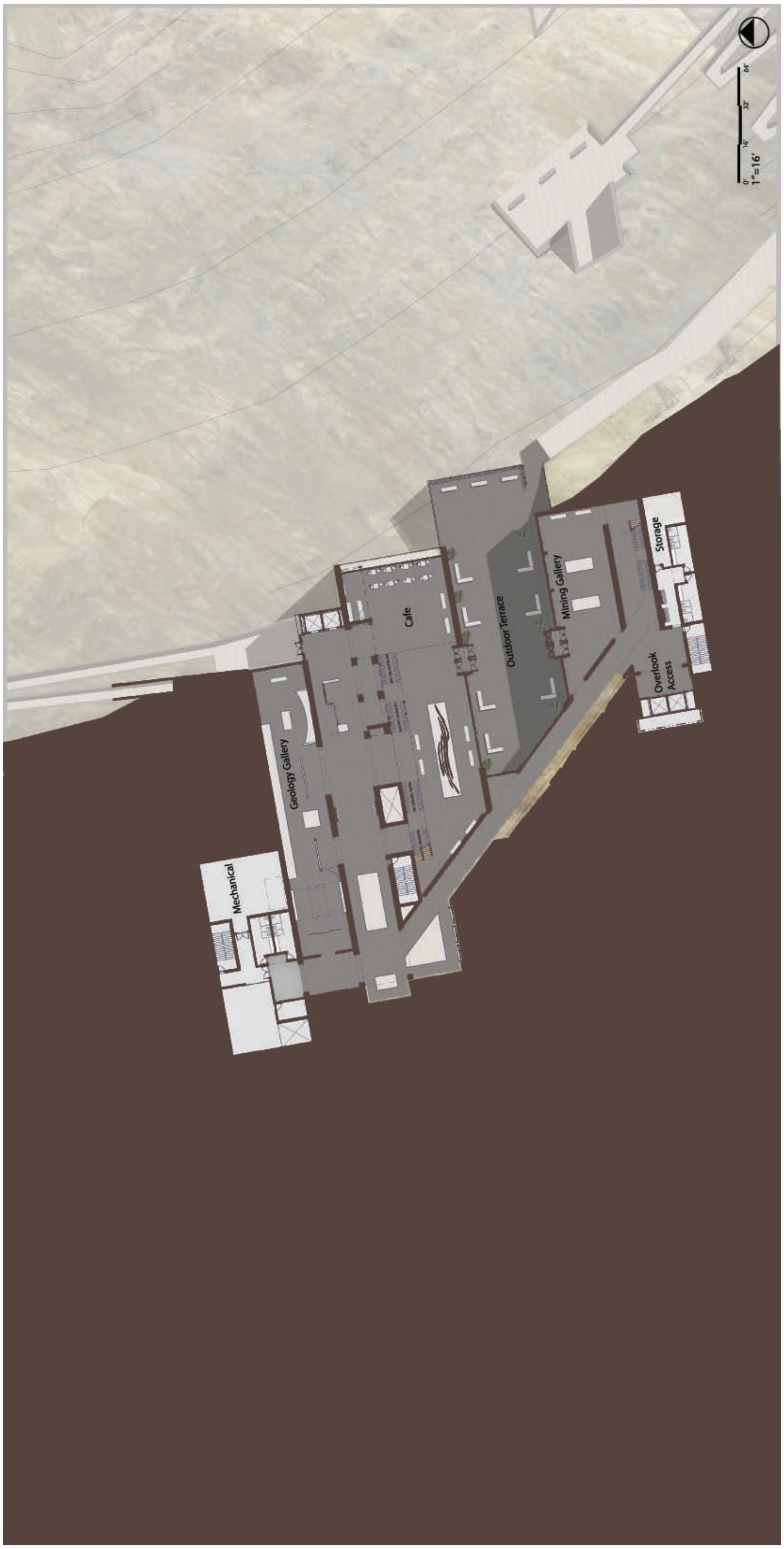


Fig 68. Building plan, second level below the main entry [Drawing by Emily Childs]

Fig 69. Building section (roughly East-West), through the main entry and the 4 story hall [Drawing by Emily Childs]

Fig 70. Building Section (roughly North-South) [Drawing by Emily Childs]

Fig 71.Frontal perspective of main entry, showing the approach to the buildiong [Drawing by Emily Childs]

Fig 72. Perspective image inside the entry lobby hall, looking towards the main elevators and the pit. [Drawing by Emily Childs]

Fig 73. Perspective image in the town gallery looking toward Uptown Butte [Drawing by Emily Childs]

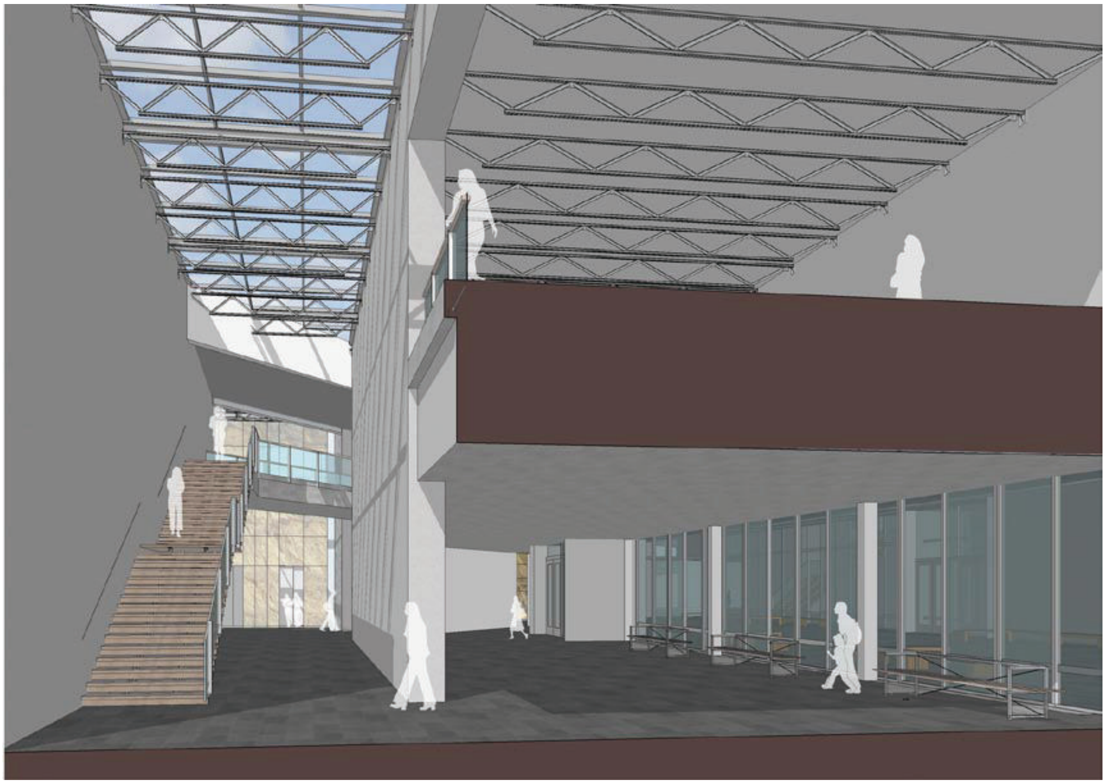


Fig 75. Section perspective looking west towards the elevator access to the overlook terraces and cut through the mining gallery. Through glazing to the right is the terrace that has a view into the pit. [Drawing by Emily Childs]

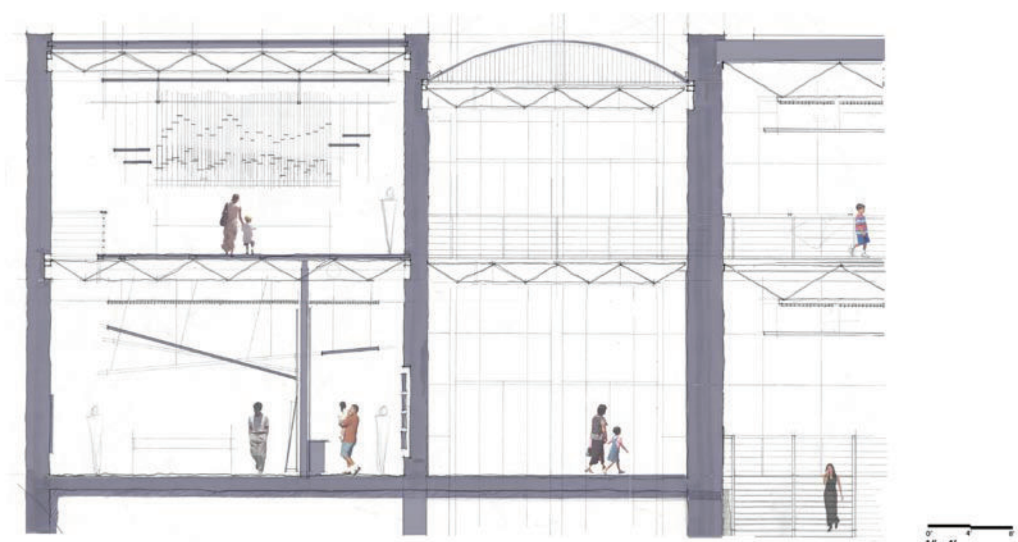



Fig 76. Section cut through the town and introductory galleries (left) main entry/lobby hall (center) and the top two floors of the 4sotry hall. [Drawing by Emily Childs]

# VII. Conclusion:

### Our Interaction with Geology

Except for violent events such as earthquakes and volcanoes, geologic events took place eons ago that have shaped the landscape we see. These events happen so slowly that it is difficult to record and convey these changes to the earth's surface in a fashion that enables the information to be conveyed to the public in a meaningful format.

During the thesis process I became more and more interested in the interaction between culture and geology. How do we currently relate to the natural world?

### Geology and the Built Environment:

For many people our lives are situated in relatively urban areas where our only connection to nature is watching leaves fall from the trees in autumn and then grow back again in the spring. On a daily basis we are not reminded of the much larger picture of the interconnected aspects of the natural world. Are we part of that natural world or separate from it? Either way, many people hold very different views about our current relationship with and views toward nature.

Butte, Montana provided 320 tons of ore used in the growth and development of national and international infrastructure and industry. Towns like Butte and their various deposits of minerals influenced not only the physical development of streets, cities, war ships, technology, and buildings, but the character and expression of these different elements of our built environment during different periods of time periods.

**Architecture Derived from Nature:**

Part of what drew me to this thesis project was that between a number of precedents (whether or not they were intentionally alluding to the dynamic forces of nature) some did so in an exaggerated very direct manner and others were more poetic and subtle. This thesis meant to determine what manner of building might relate to the existing architecture of the town, while still presenting itself as different, and convey ideas and concepts of geology? The intention of this design was to be subtle in the connection to geologic processes while not directly adopting a conventional parti.

If throughout the museum and its exhibits I am directing attention to the minerals brought out of the ground in Butte, Montana, then it was important that the materials used in the building were being employed in a manner that was consistent with the efficiency expected from such materials in a town that relies on expedient, reliable, functional structures.

It was important that visitors would be able to relate to the tectonics of the materials that were used. I had looked into having much more expressive forms, but found that in emphasizing the contrast between the construction and evolution of the town and the destruction of the landscape (in the form of the Berkeley pit) that a more straightforward clear parti would be more direct.

**The Public Review:**

The final review was very helpful. It was great to see how invited jurors responded to my design. Overall my design was well received by the jury. The main comments made by the jury are outlined in italics, with my responses underneath.

*1. There was a suggestion that given the story being told in the museum, the choice of poured in place structural concrete walls was wise. The concrete walls represent a man made replica of how sedimentary rock is formed.*

I wanted the bar joists spanning between the walls to be seen as a regularized pattern providing a backdrop for the concrete walls and the intermittent dropped ceilings (helping with acoustics in the galleries).

*2. There is a nice clarity in the original diagram, but that clarity has been lost in the final composition.*

I agree. There are possibly too many things going on in the final composition of spaces. There is ambiguity in how the system of walls was altered for the mining galleries and the elevator lobby for the overlook access. This should be simplified to more closely relate to the clarity of the 2 original volumes.

I might be able to further simplify the design by revising the back of house and library/classroom volumes to allow the main gallery volumes to be more prominent.

Originally the classroom/library volume in my design is perpendicular the main axes at the site, between Uptown and the pit. To decrease the attention to this volume I could possibly move the classroom/library volume to be in between the town gallery volume and the back of house volume. As the slope of the berm rises to the north and drops into the pit on the eastern side, these volumes could be sunken further into the ground. Natural light would come from skylights and an open end facing towards the pit. Additionally, if these volumes took on the same architectural vocabulary as that of the galleries the diagram of the building would be clearer.

*2. There was a suggestion that the oblique direction of the hallway that brings visitors to the overlook access lobby might be unnecessarily complicating the plan.*

Originally this move was made in order to emphasize the connection back to the nature of the shearing condition that might happen at a fault line and also to relate back to the two main gallery volumes. The same diagonal shapes the closed ends of the town gallery volume and the volume containing the large copper sculpture (the volumes on either side of the lobby hall). However, the experience of the concrete walls might be more easily discernable if the path of circulation to and from these walls was more consistent. Although this move was made in part to relate to processes in plate tectonics, in general, the diagonal closure to the 2 main volumes might complicate the design rather than adding value.

3. *Where the concrete walls are the most expressive (as seen in the perspective of the approach from the town) is where they extend past the glazed enclosures and into the landscape.*

It would be possible to extend the concrete walls in selected locations. The galleries would then be accentuated as being held between the concrete walls.

4. *The visitor is not properly oriented upon entering the museum.*

From the lobby entry hall the visitor has access to the stair going up to the town gallery and access to the grand stair going down to the lower levels, in addition to visual connection through the ceremonial hall to the terrace and the mining gallery.

**Relating to Ideas in Geology:**

Through this museum I have attempted to bring into contrast the vast interdependencies of different forces involved in creating the mineral wealth underground, the human activity that has extracted these mineral resources, and the role of these resources in the national and global economy. In addition to creating a metaphor for the interaction of geology and culture in Butte, Montana I wanted the architecture to dramatize the experience of the landscape and creating a memorable experience of the museum exhibits and the Berkeley Pit.

These goals were achieved through the siting of the building, the selection and manipulation of the structural system, the relationship between spaces created in sections of the building, the arrangement of the overall parti of the design, and the strategic framing of views from the building into the landscape.

**Glossary** (Unless otherwise noted these entries are from Press, Frank and Siever, Raymond. *Earth, Fourth Edition*. W.H. Freeman & Company. United States: 1986.)

Batholith- A very large intrusive igneous rock mass that has been exposed by erosion and with an exposed surface area of over 100 square kilometers. A batholith has no known floor [19].

Epeirogeny: Large-scale primarily vertical movement of the crust. It is characteristically so gradual that rocks are little folded and faulted.

Fault- A planar or greatly curved fracture in the Earth's crust across which there has been relative displacement.

Geologic Cycle- The sequence through which rock material passes in going from sedimentary form, through diagenesis and deformation of sedimentary rock, then through metamorphism and eventual melting and magma formation, then through volcanism and plutonism to igneous rock formation, and finally through erosion to form new sediments.

Igneous rock- A rock formed by the solidification of magma.

Metamorphism- The changes of mineralogy and texture imposed on a rock by pressure and temperature in the Earth's interior

Ore- The naturally occurring material from which a mineral or minerals of economic value can be extracted profitably or to satisfy social or political objectives. The term is generally but not always used to refer to metalliferous material, and is often modified by the names of the valuable constituent; e.g., iron ore. See also: mineral; mineral deposit; ore mineral [20].

Sedimentary rock- A rock formed by the accumulation and cementation of mineral grains transported by wind, water, or ice to the site of deposition of by chemical precipitation at the depositional site.

Tectonic(s) (in geology): The study of the movements and deformation of the crust on a large scale, including epeirogeny, metamorphism, folding, faulting, and plate tectonics.

Tectonic (in architecture) - "Greek in origin, the term tectonic derives from the word *tekton*, signifying carpenter of builder… The poetic connotation of the tern first appears in Sappho, where the *tekton*, the carpenter, assumes the role of poet…In the fifth century B.C. this meaning undergoes further evolution, from something specific and physical, such as carpentry, to a more generic notion of

[19] http://geology.com/dictionary/glossary-b.shtml.
[20] http://www.webref.org/geology/o/ore.htm

making…'Tectonic becomes the art of joining." The term is used as related to art or aesthetics and to the goal of "utility". The term was used by a German architect in 1830 referring to utilitarian objects "on one hand, due to their application and on the other due to their conformity to sentiments and notions of art." Tectonic represents a synergy between utilitarian aspects, usefulness, aesthetics, joinery, and craft. [21] (Craft- a thing embodies the time spent making it; it looks like it took time, care, thoughtfulness, find Zumthor quote[22]).

## Appendix

Fig. 77, Rock Cycle diagram [Image from http://www.okaloosa.k12.fl.us/technology/WOWLessons/WOWResources/RockCycleDiagram.gif ]

Fig. 78. Rock Cycle diagram overlaid onto a landscape [Image from http://www.gemselect.com/other-info/graphics/rock_cycle_01.jpg]

[21] Frampton, Kenneth. *Studies in Tectonic Culture: The Poetics of Construction in Nineteenth and Twentieth Century Architecture.* The MIT Press. Chicago: 1995. p. 3-4.
[22] Zumthor, Peter. Thinking Architecture. Birkhauser. Germany: 2006. p.11.

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