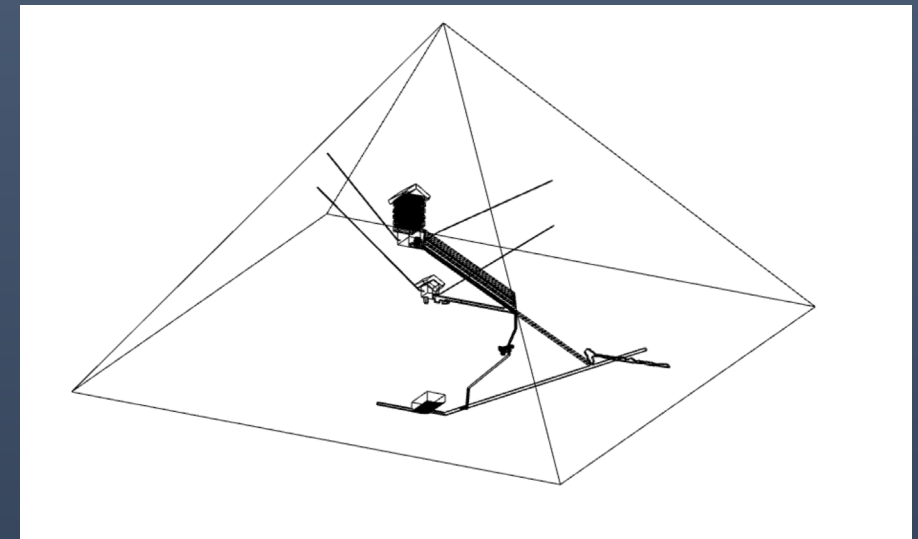
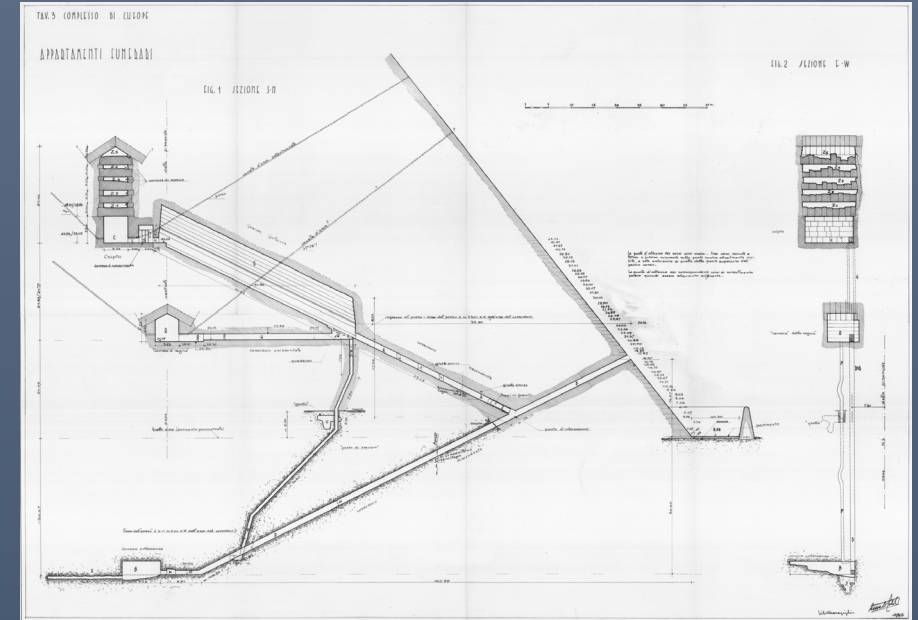


# Khufu's Great Pyramid: CAD Model Status

Sophie Dukes

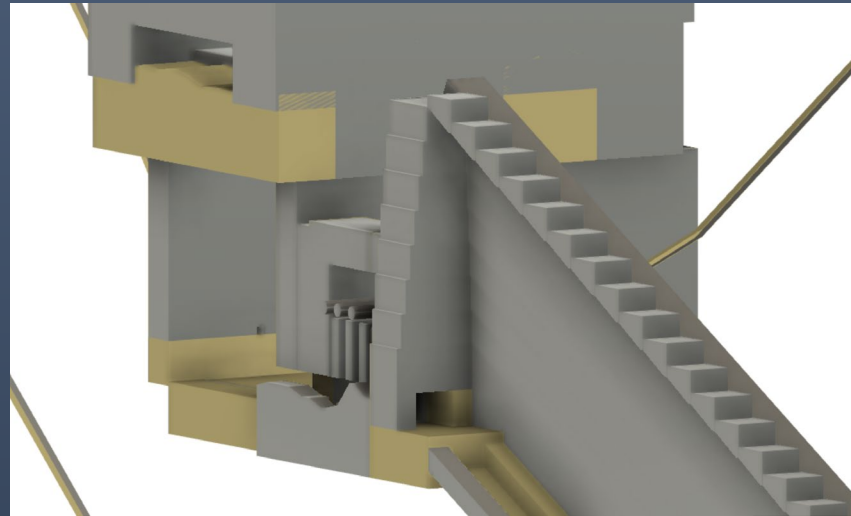
# The Project

- Accurate 3D CAD model of the Great Pyramid
  - Defining where voids/material changes are
  - Baseline to compare to the results to
  - Primarily using Rinaldi plans from 1965
- Using Fusion 360
  - Ready-to-use step file
  - To be imported to GEANT

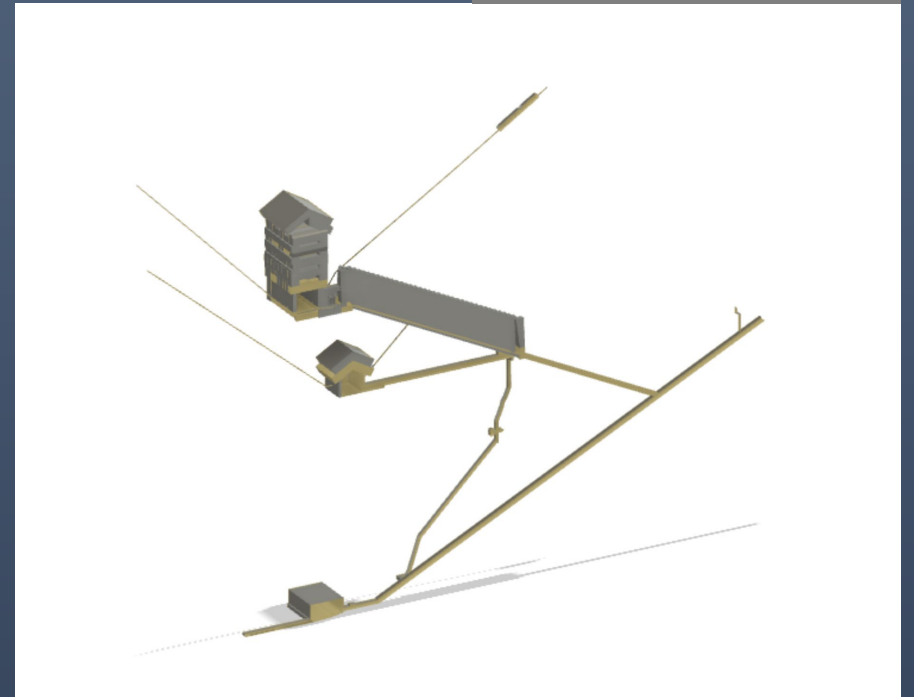


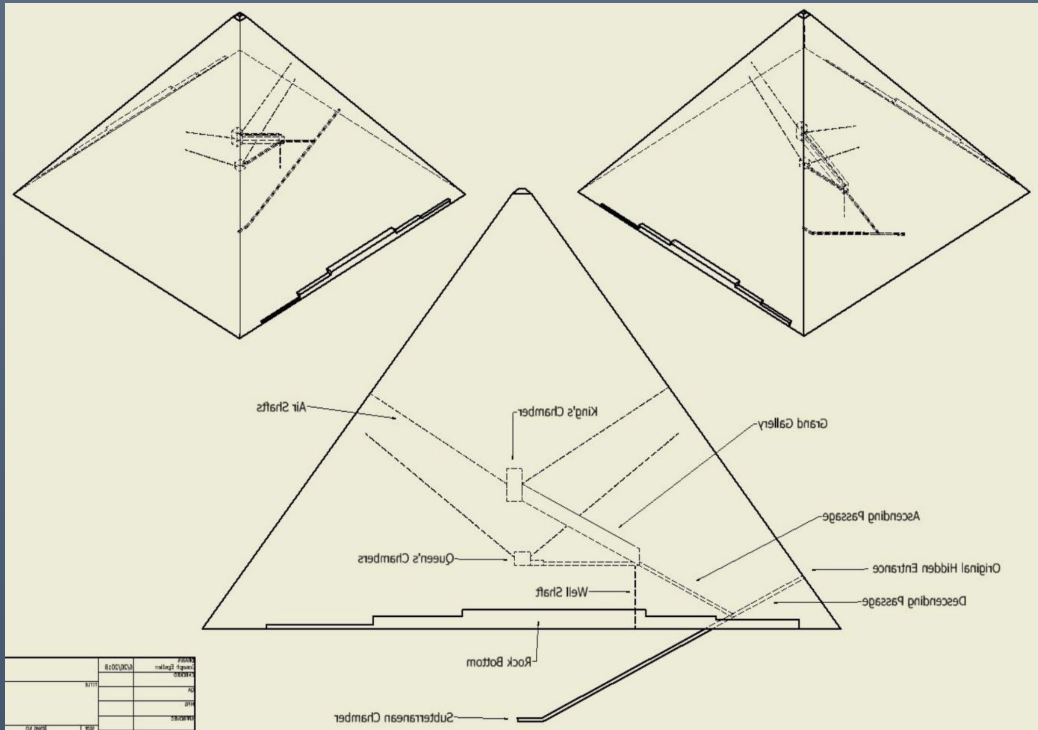
# Setbacks

- No modern dimensional resources (of interior) found
  - Are there none available?
- Accurate 3D CAD resources not found

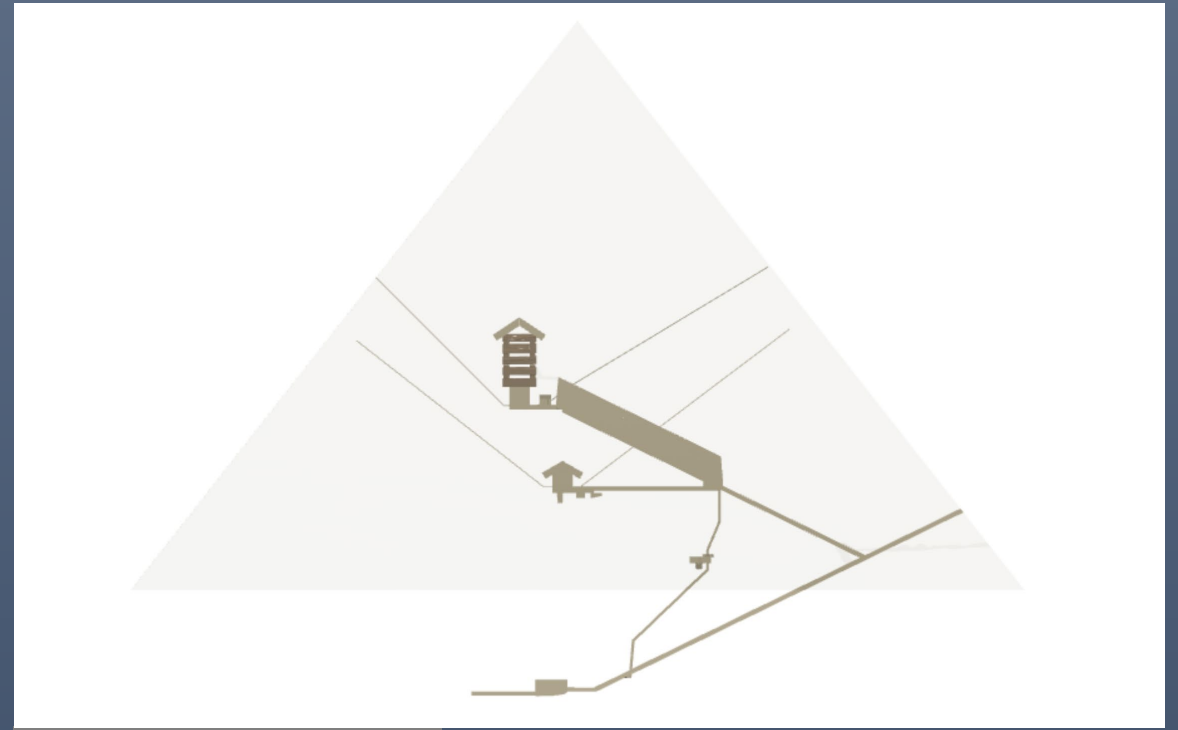


Model from GrabCAD





Graphic by Mary Blankemeier

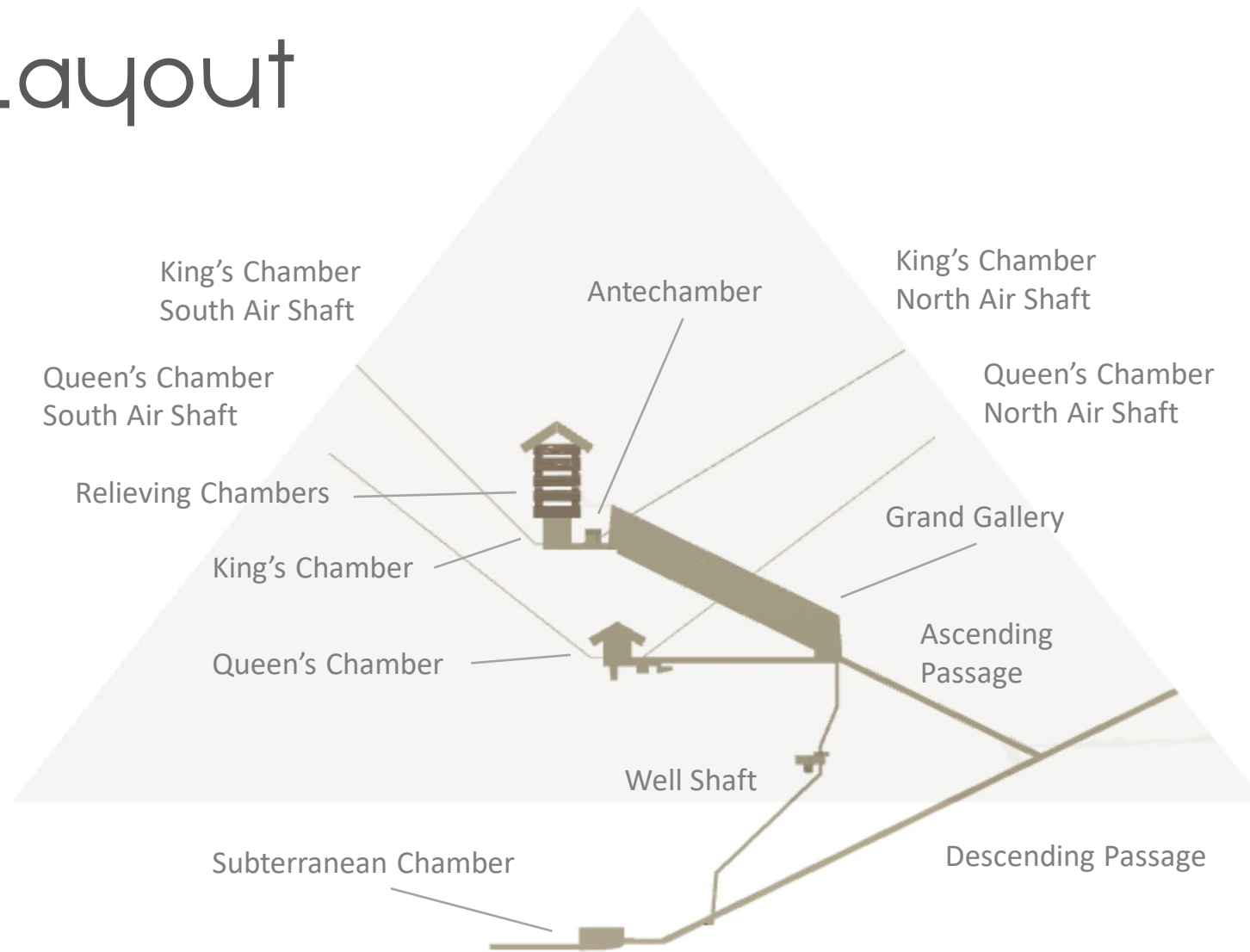


Graphic by Sophie Dukes

## Initial model

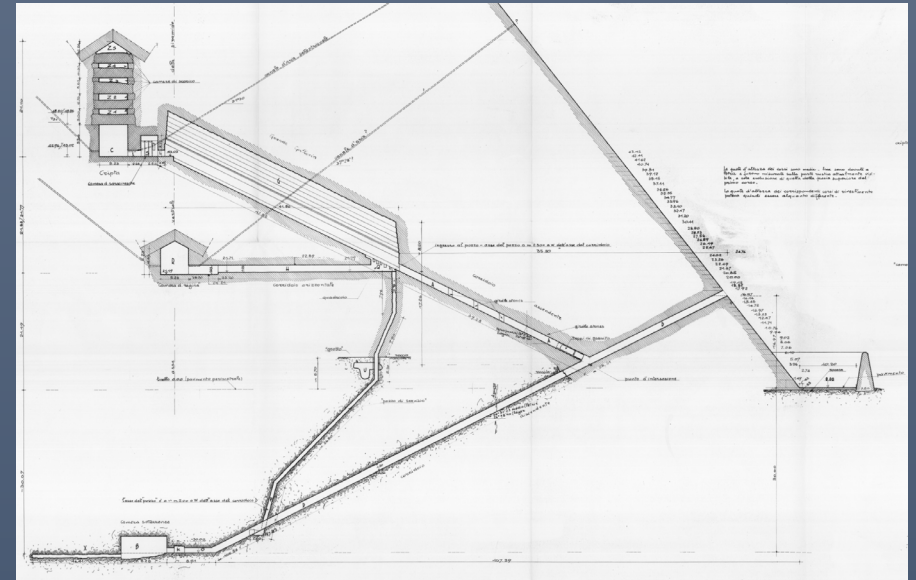
- Diagrams usually show the North side on the right
- (Flipped Mary's image)
- Created new model

# The Layout



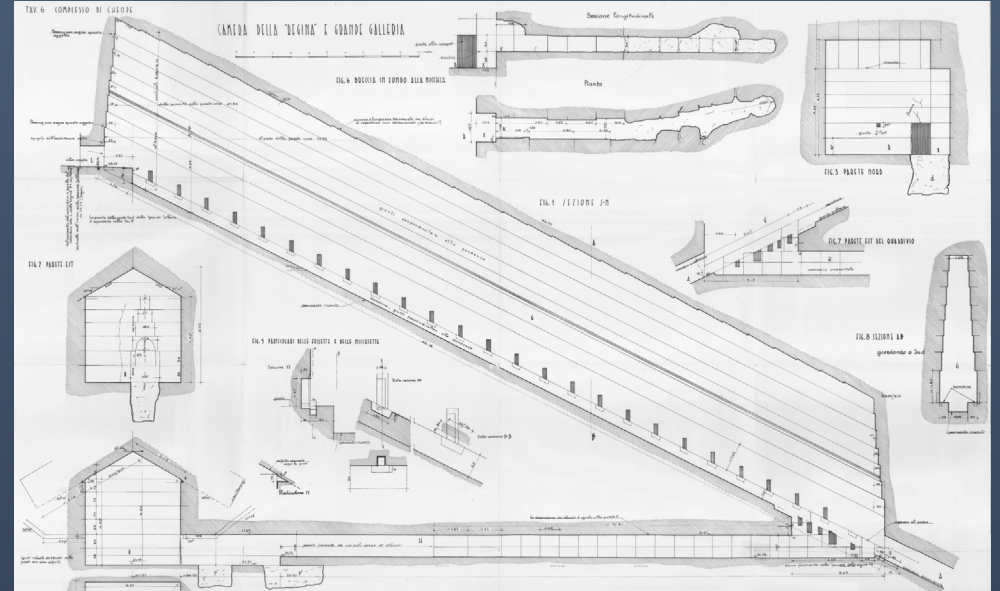
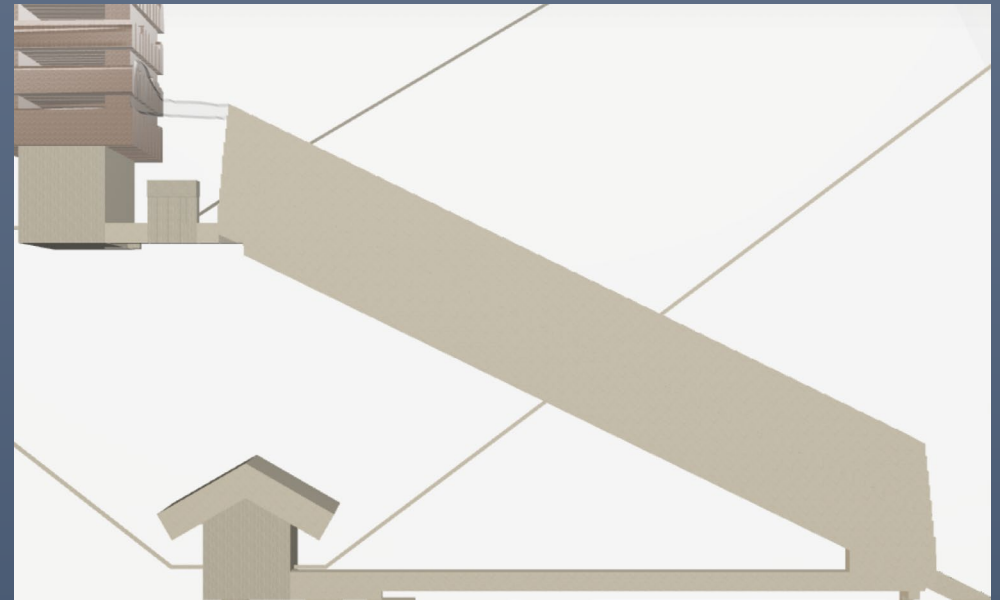
# Ascending and Descending Passages

- Formal entrance located on north side
- Descending passage leads to Subterranean Chamber
- Ascending passage entrance located partway down the descending passage



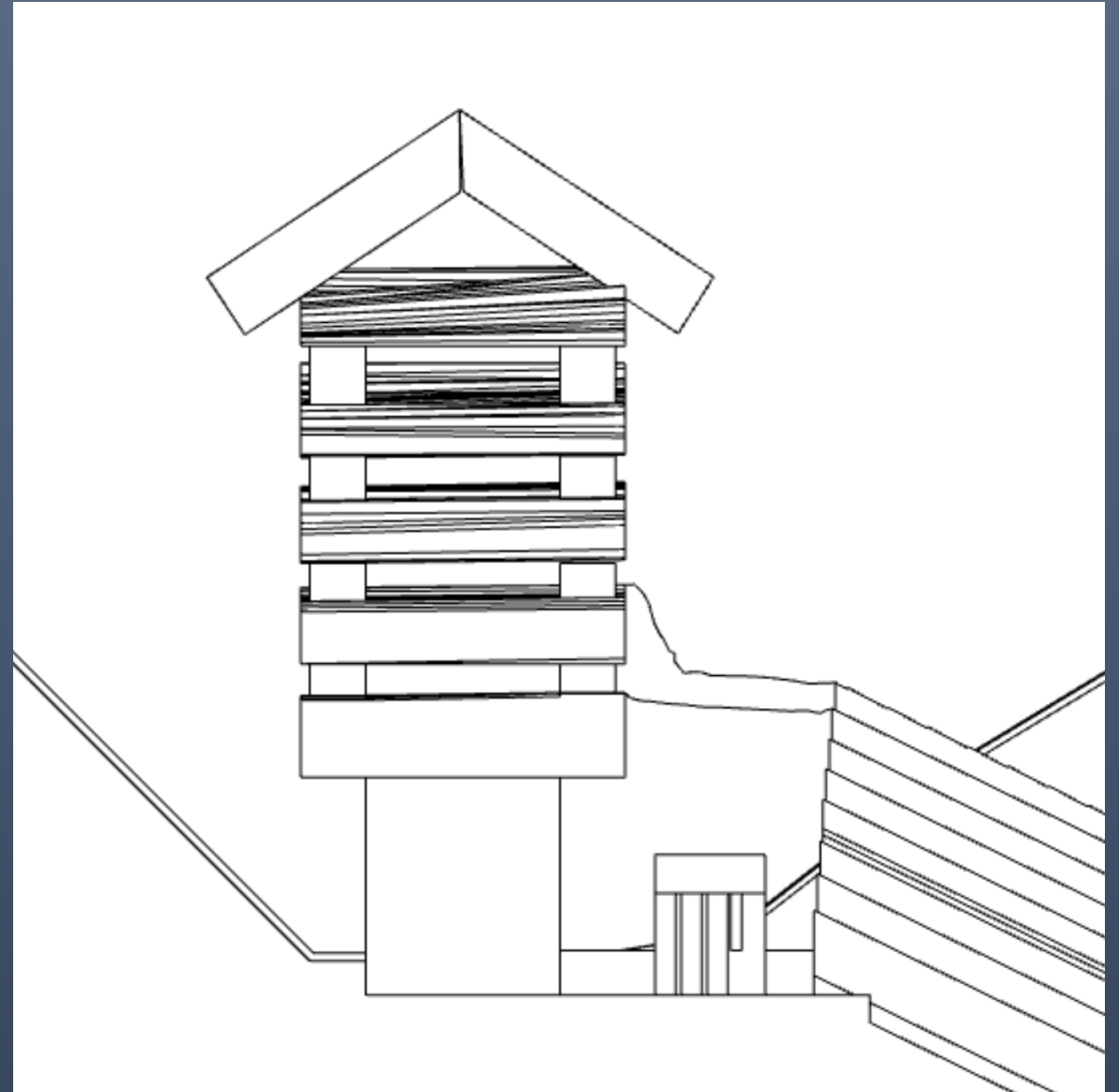
# Grand Gallery

- Long, tall passage to King's Chamber
- Lined with granite
  - Thickness unknown



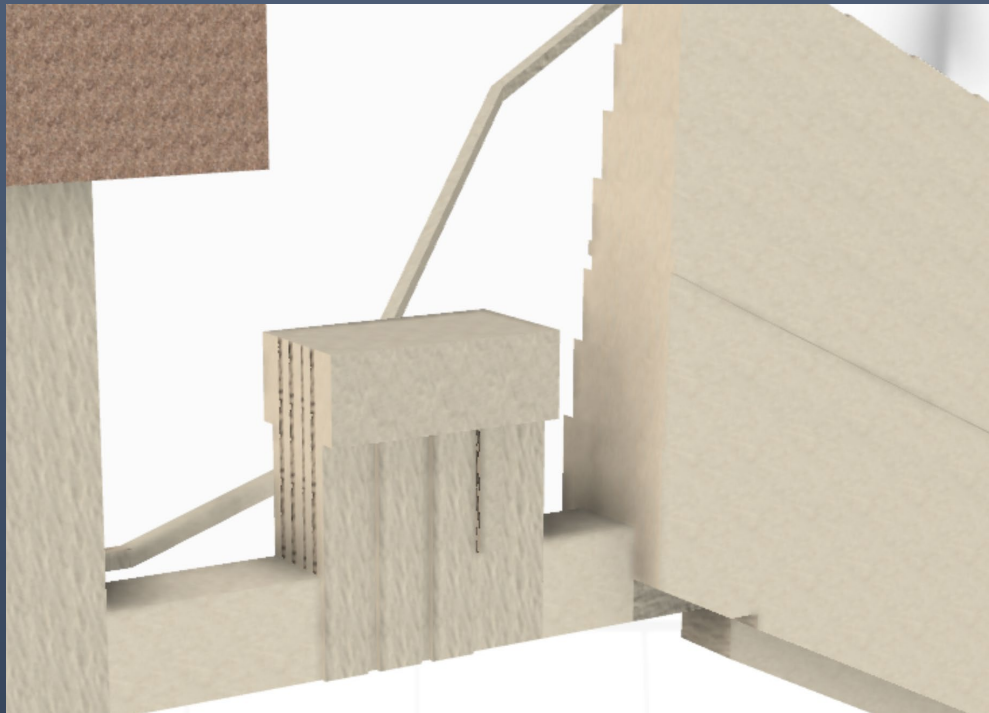
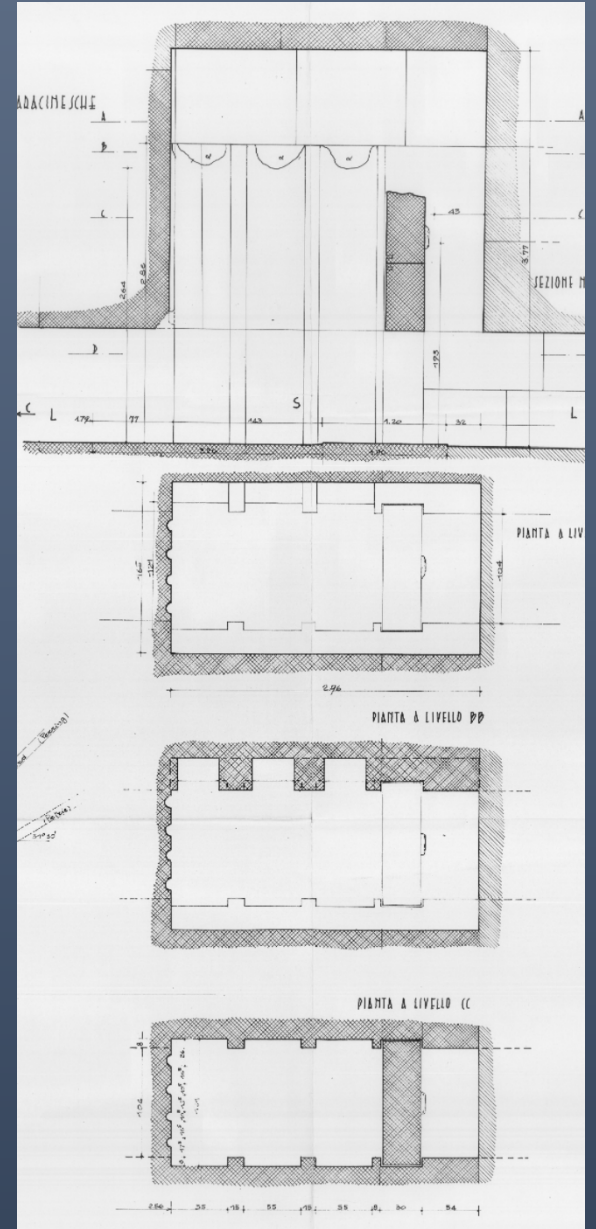
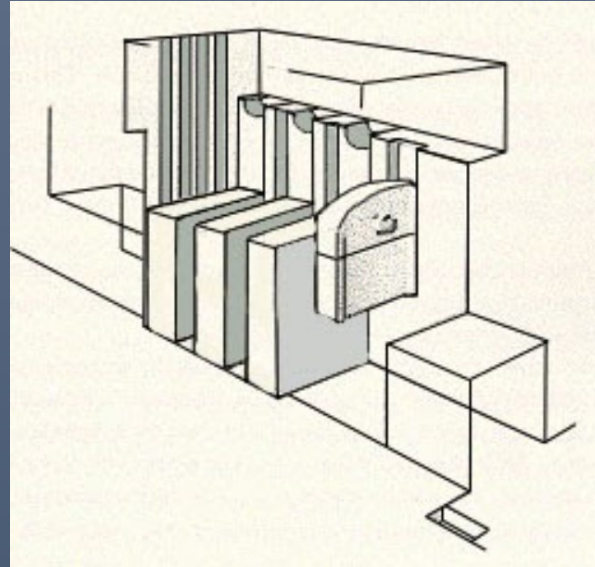
# King's Chamber

- Antechamber
  - Housed a gate system
- Tomb
- Room lined with granite
- Voids and granite blocks with a gabled "roof" above
  - Traced profiles from Italian plans for each side
  - Used Loft tool to create blocks





# Antechamber



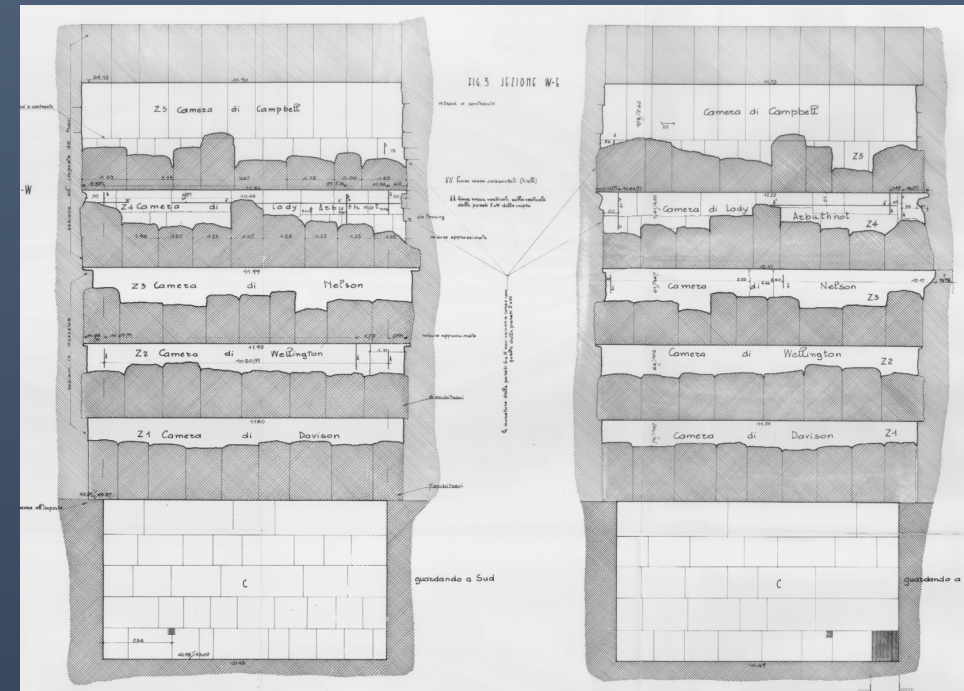
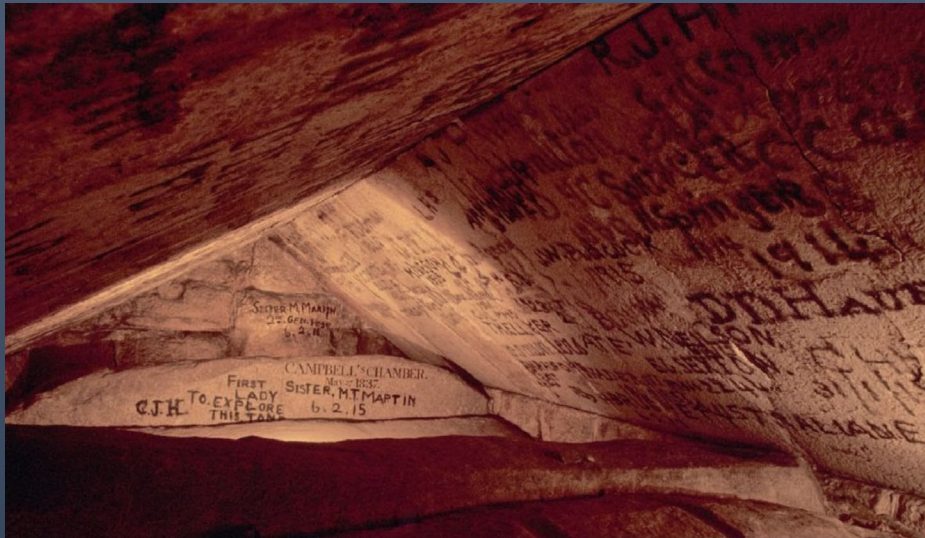
# King's Chamber

- Sarcophagus located inside
  - Without lid
  - Roughly cut
- Walls of granite
  - Thickness unknown



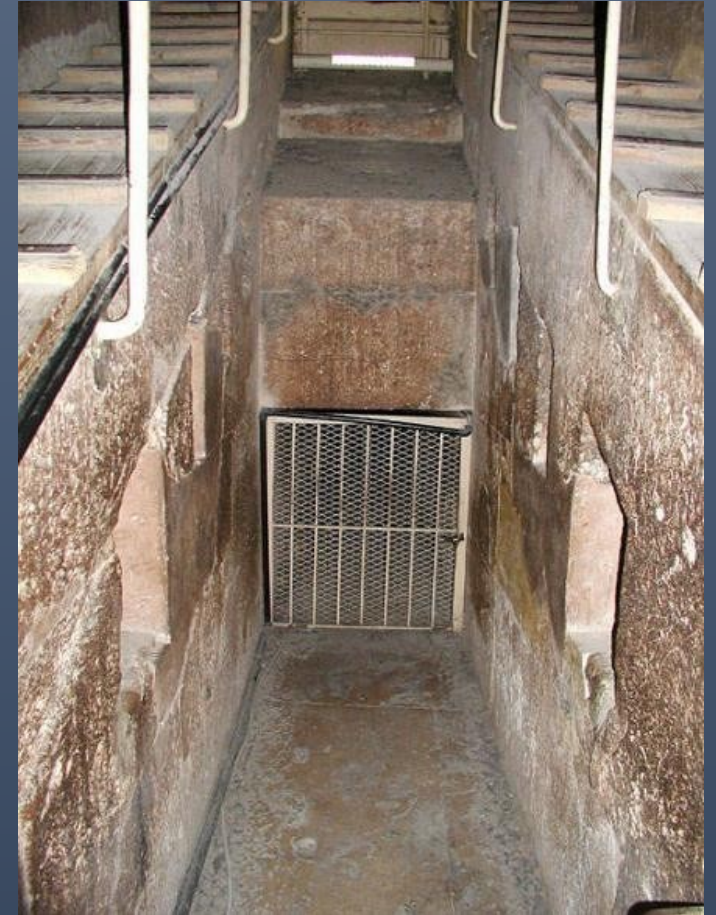
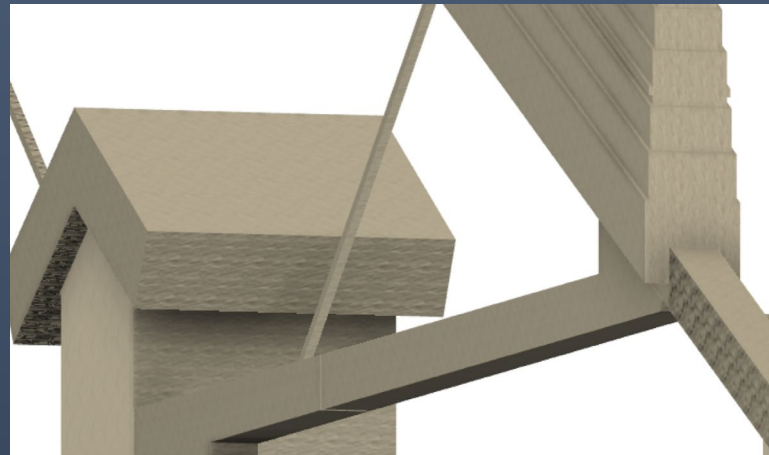
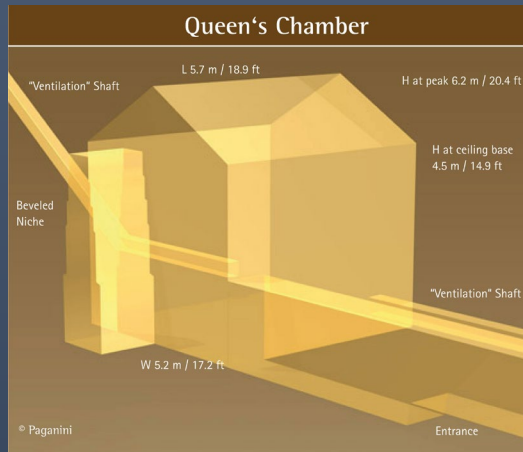
# Relieving Chambers

- Pithed roof distributes weight off the chamber
- Scaled and traced the profiles
- Lofted them into a 3D shape



# Queen's Chamber

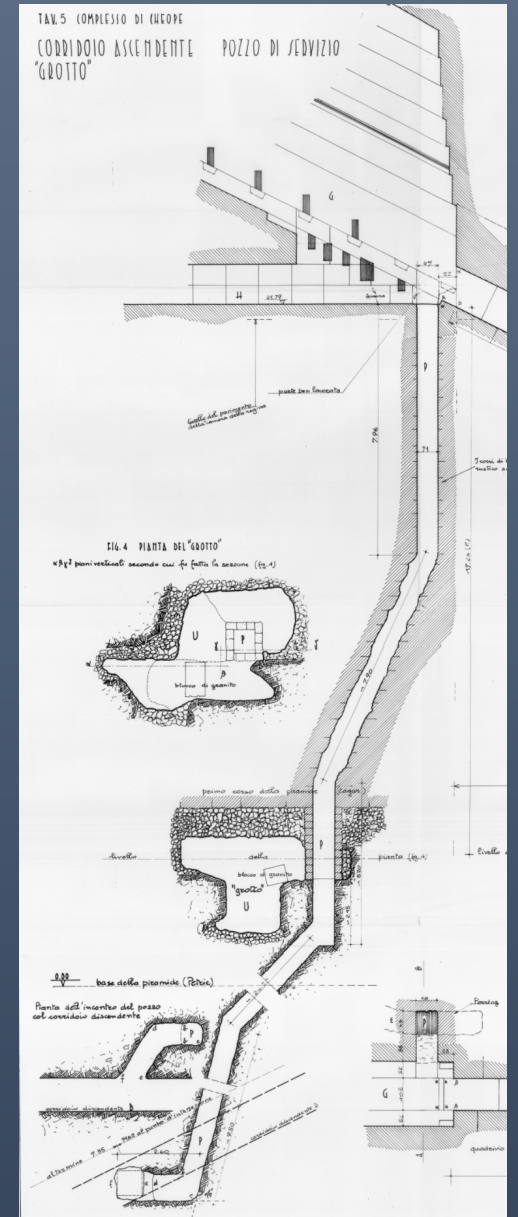
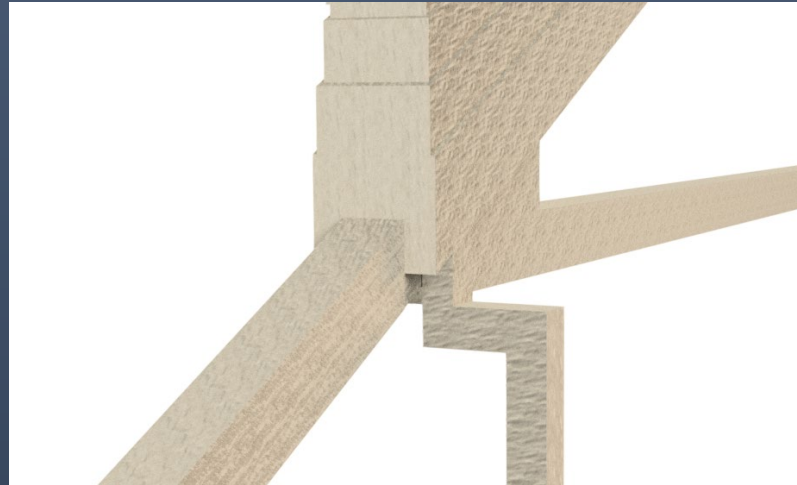
- Entrance from Grand Gallery
- Assumed to be Queen's Chamber by shape of the ceiling in the room





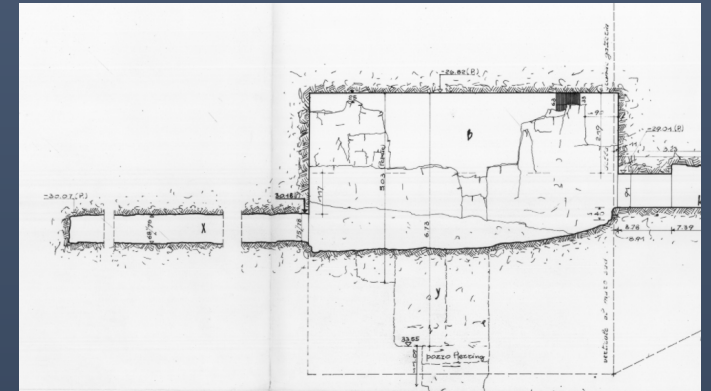
# Well Shaft

- Extends from the Grand Gallery to the end of the descending passage
- Small chamber (grotto) mid-way down at ground level
- Less accurate passage
  - No given angles from plans
  - Grotto is at ground level



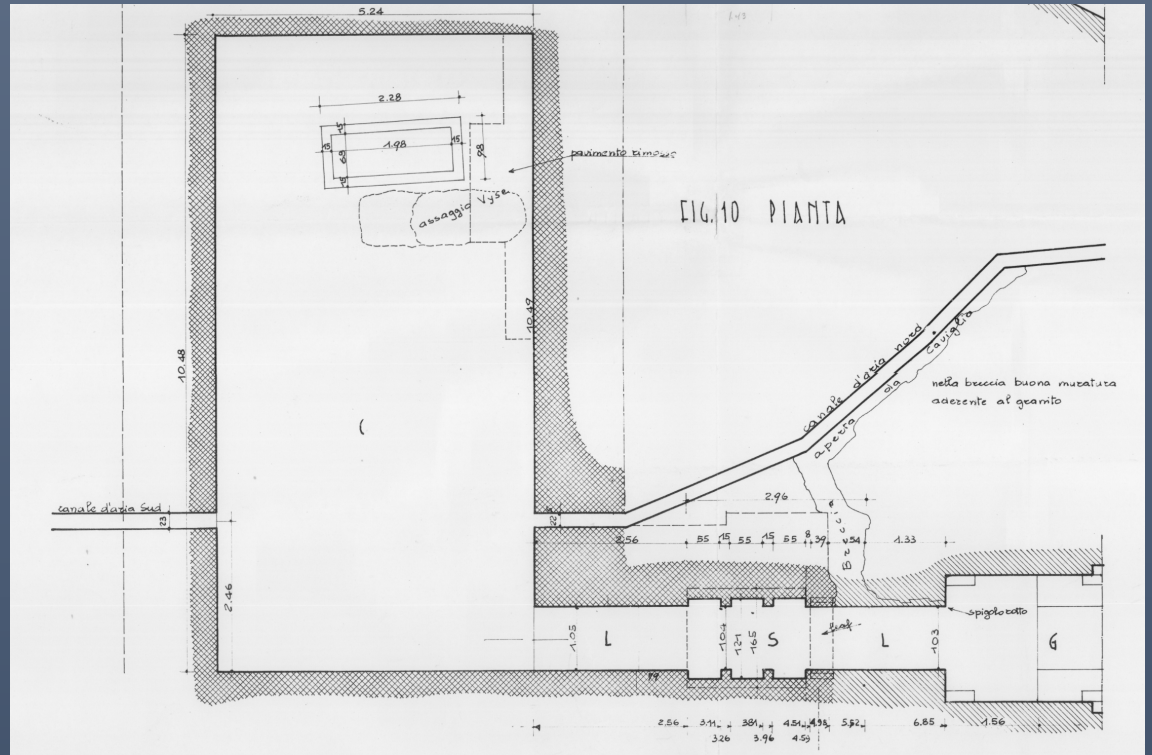
# Subterranean Chamber

- Lines up closely with Queen's and King's Chambers
- Accuracy less important
  - Elevation is under ground level

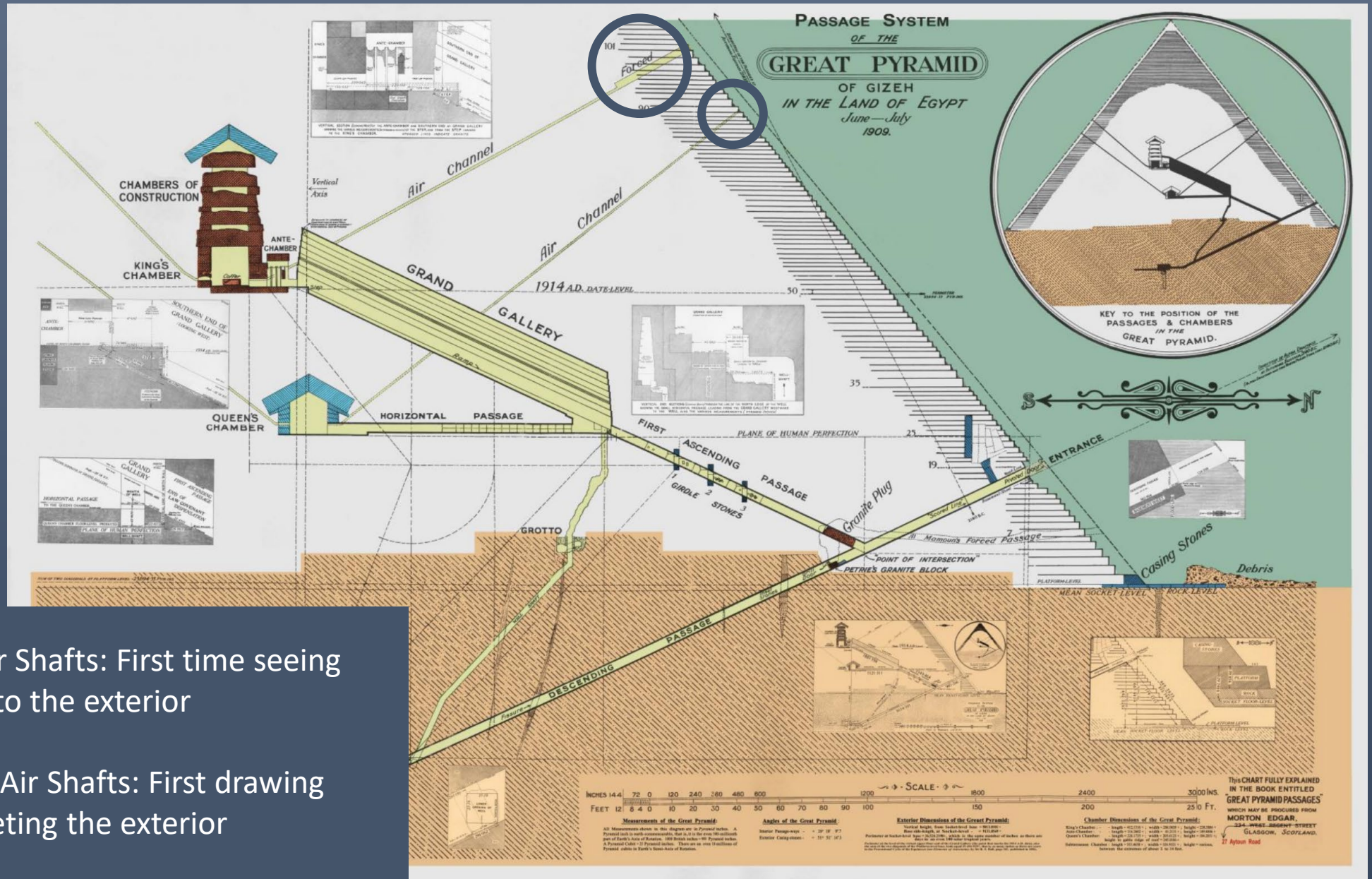


# Air Shafts

- King's Chamber air shafts
  - Extend to the exterior
  - North air shaft features several angles in two directions
- Queen's Chamber air shafts
  - Unknown how far they extend
- Not many defined dimensions
  - Traced from plans/sections



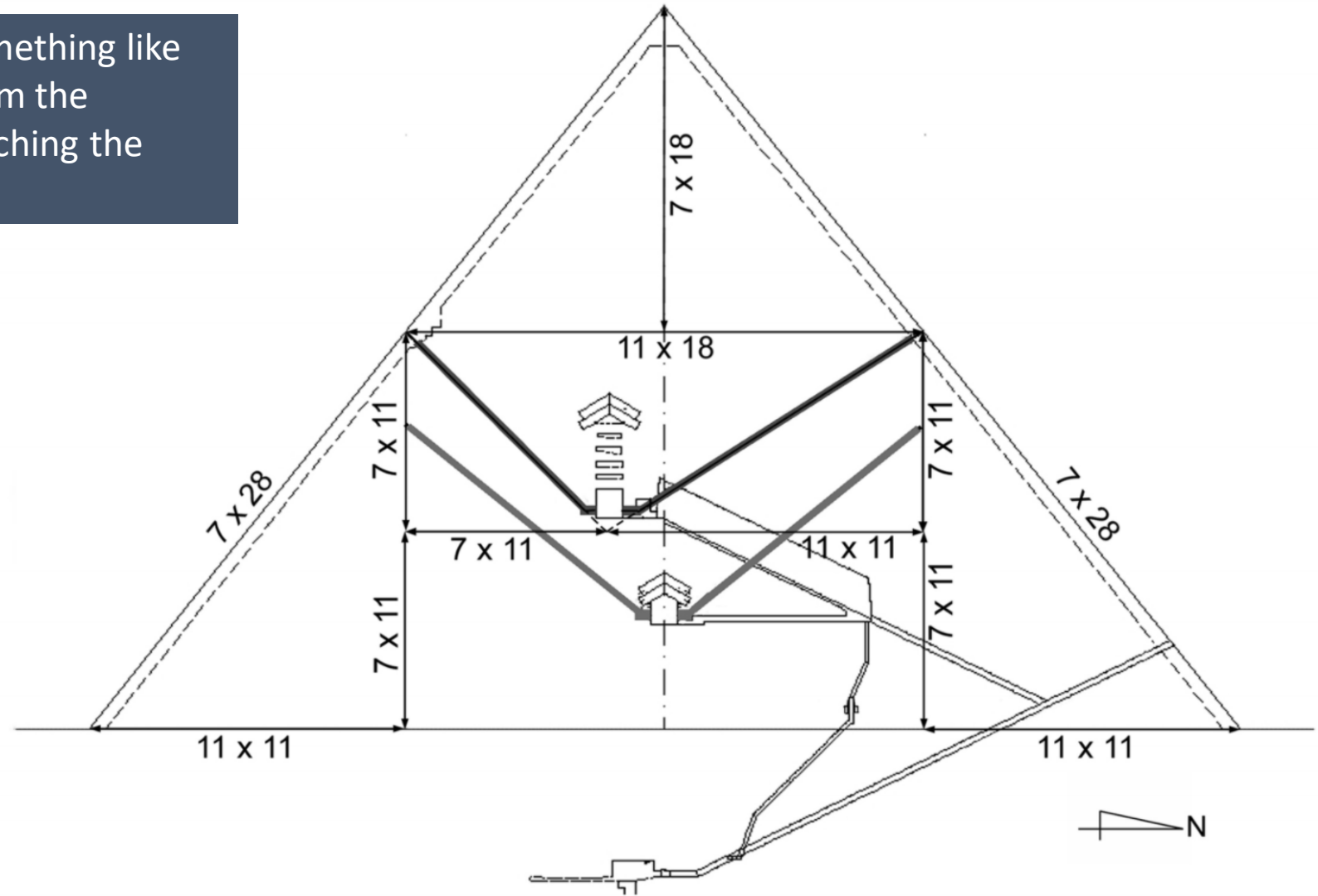




King's Chamber Air Shafts: First time seeing "Forced" passage to the exterior

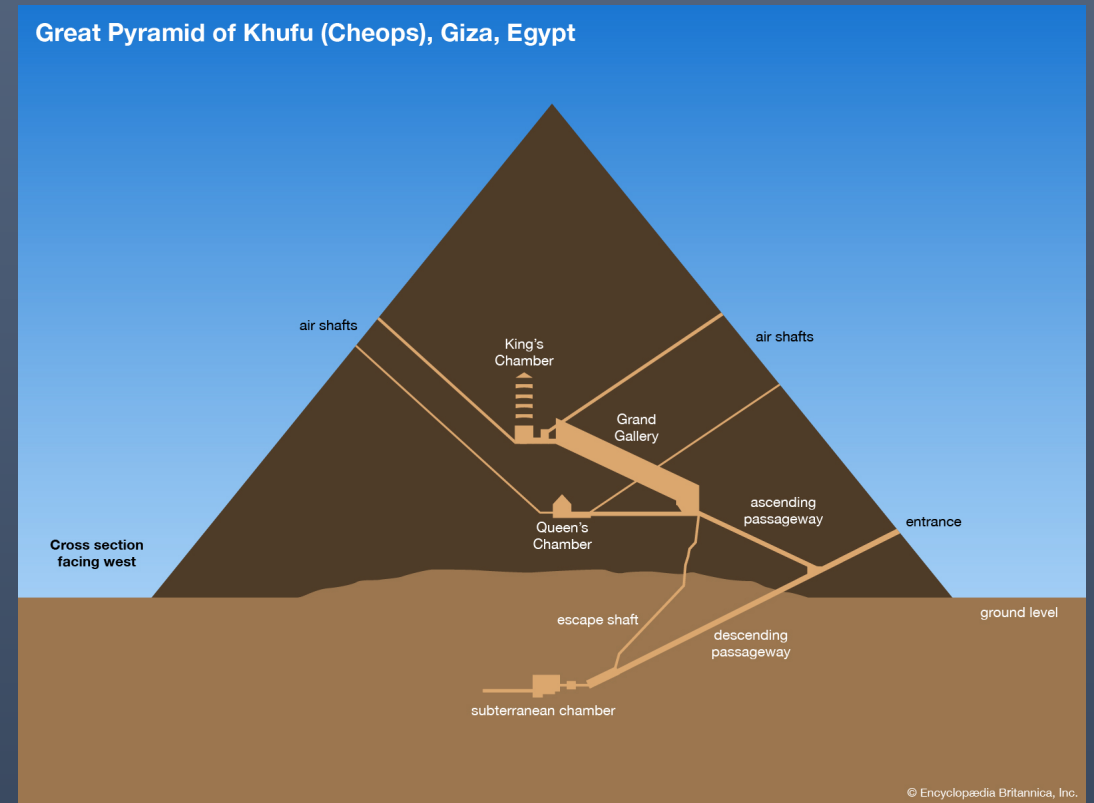
Queen's Chamber Air Shafts: First drawing to show them meeting the exterior

Most references show something like this with the air shafts from the Queen's Chamber not reaching the exterior



# Forced Passages

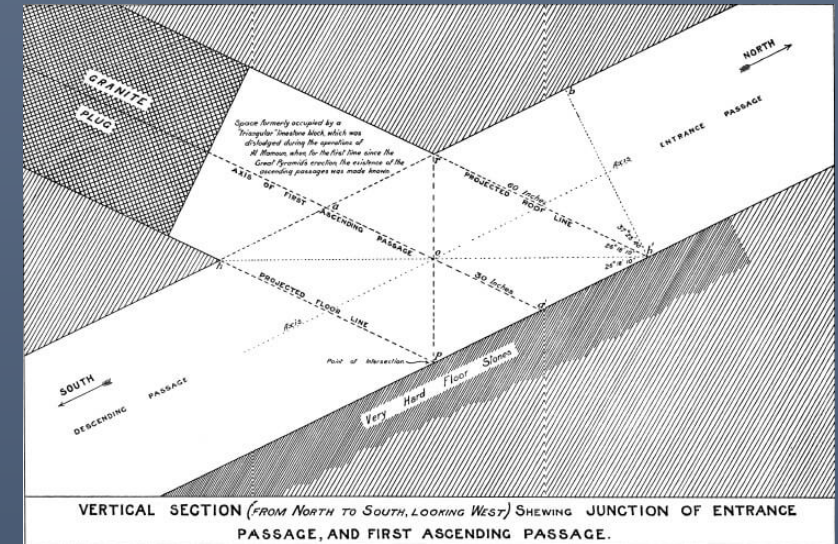
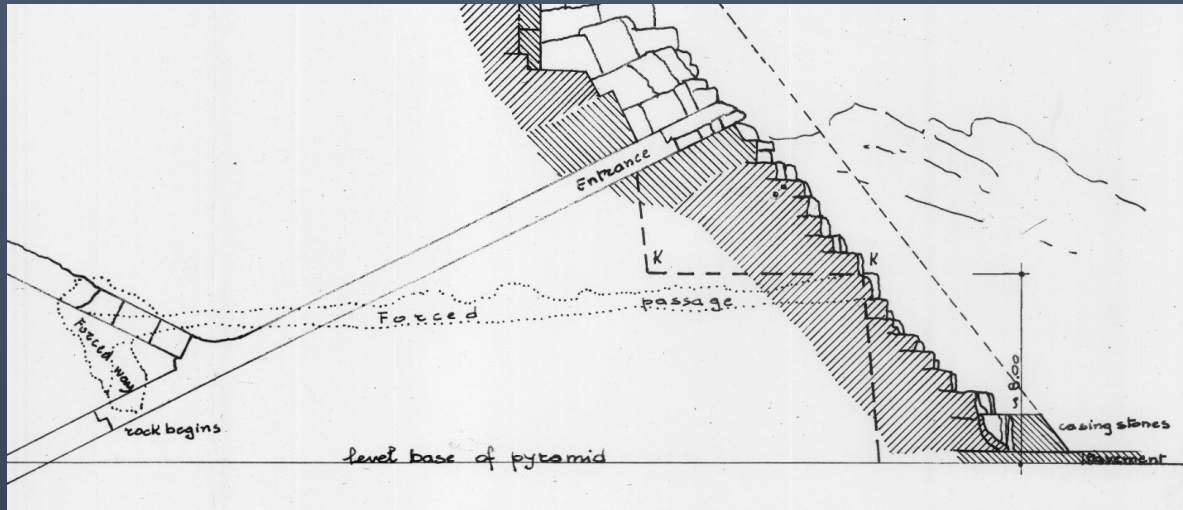
- Most sources exclude excavated or forced passages
- No accurate dimensions found
- Used scaling and tracing in my model





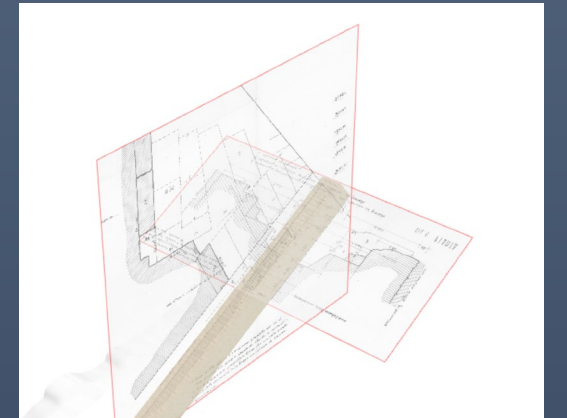
# Forced Entry

- Many section view approximate drawings
  - Hard to find sections along the east/west face
- Scaled and traced for model



# Remaining Work

- Granite thickness
  - Surrounding King's Chamber
  - Surrounding Grand Gallery
- Excavation areas
  - Queen's chamber
  - King's chamber
- Forced entry
  - Not many references with dimensions or plan views



- Granite plugs
  - Locations
- Main entrance
  - Irregular landscape
  - Need multiple sections and plans

# Image Citations

- Amos, Jonathan. “'Big Void' Identified in Khufu's Great Pyramid at Giza.” *BBC News*, BBC, 2 Nov. 2017, [www.bbc.com/news/science-environment-41845445](http://www.bbc.com/news/science-environment-41845445).
- Bayuk, Andrew. “A New Angle on the Great Pyramid.” *Dr. Hawass*, 8 July 2015, [www.drhawass.com/wp/a-new-angle-on-the-great-pyramidby-andrew-bayuk/](http://www.drhawass.com/wp/a-new-angle-on-the-great-pyramidby-andrew-bayuk/).
- DeSalvo, John. “A Picture Tour of the Great Pyramid of Giza.” *Great Pyramid of Giza Research Association*, [www.gizapyramid.com/newtour4.htm](http://www.gizapyramid.com/newtour4.htm).
- Whitaker, Alex. “Architectural Analysis of the Great Pyramid.” *Great Pyramid Architecture*, [www.ancient-wisdom.com/Ghizaarchitecture.htm](http://www.ancient-wisdom.com/Ghizaarchitecture.htm).