

# TERRESTRIAL DATA ACQUISITION & 3D MODELING FOR THE MAYAARCH3D PROJECT

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FABIO REMONDINO

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3D Optical Metrology unit

Trento, ITALY

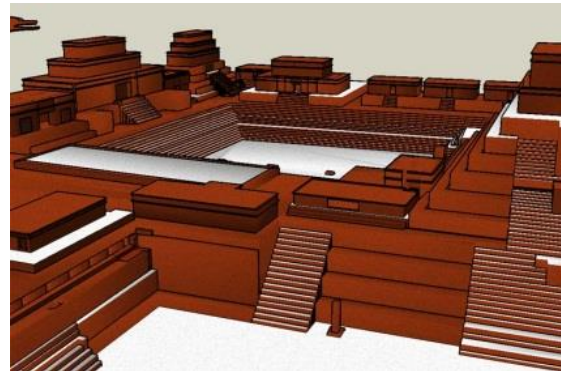
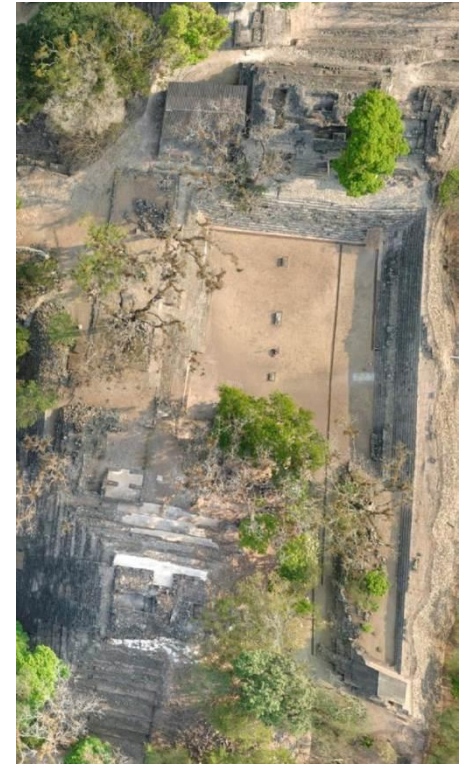
<http://3dom.fbk.eu>



Bundesministerium  
für Bildung  
und Forschung

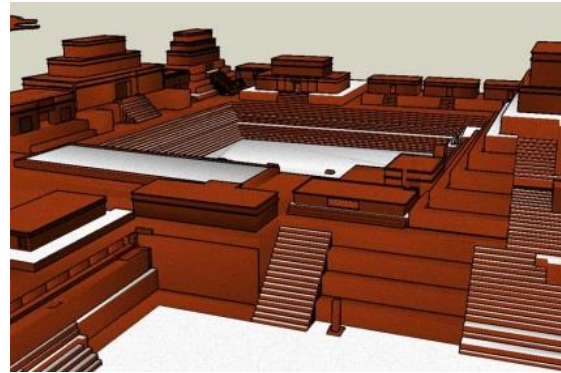
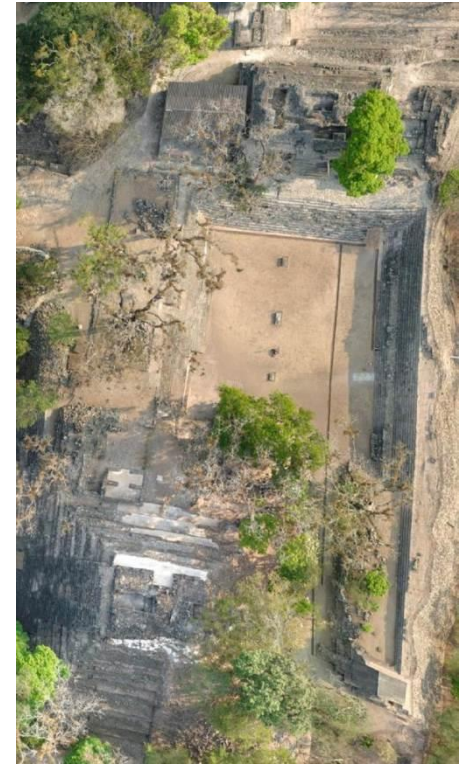


- FBK goals
- 3D Surveying and modeling in Copan
  - Specifications & requirements
  - Field campaigns in 2009 & 2013
  - Data acquisition, processing & 3D modeling
  - Data segmentation & optimization
  - Further products (beside 3D models...)
- Conclusions

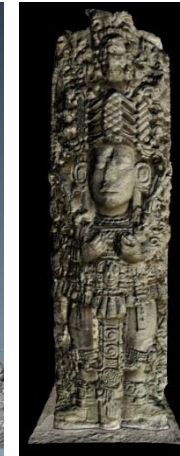
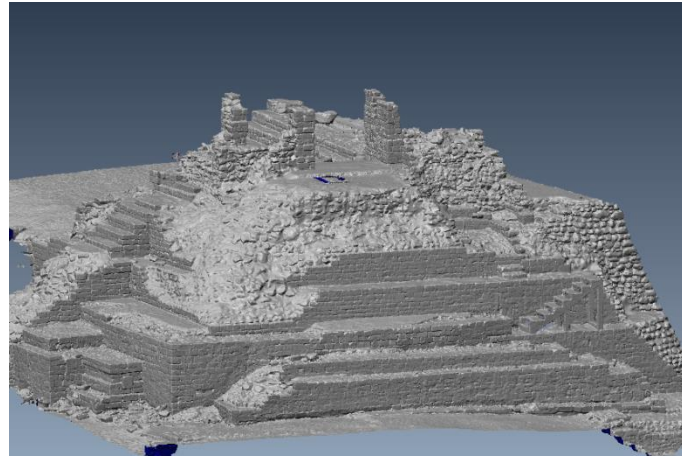
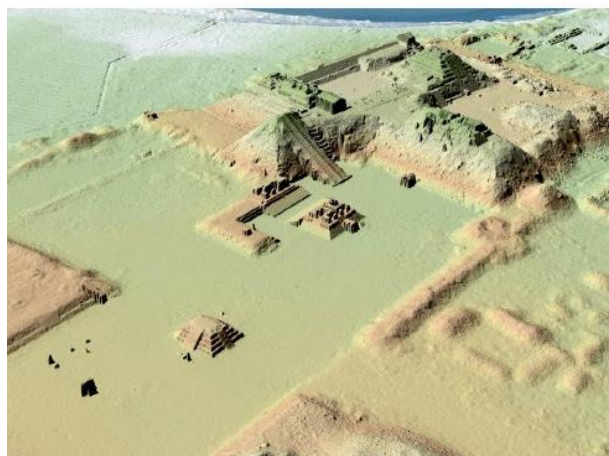
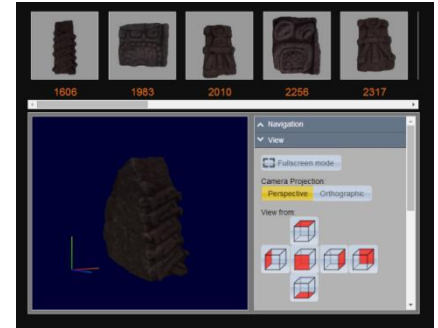




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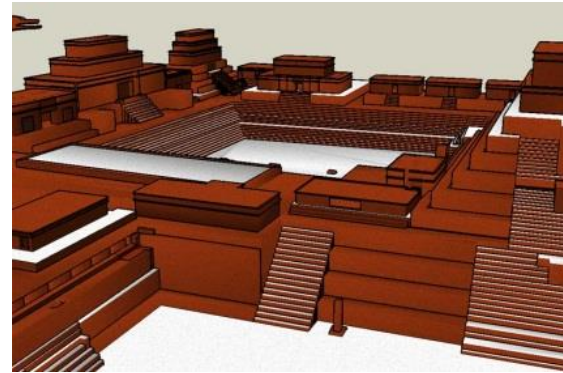
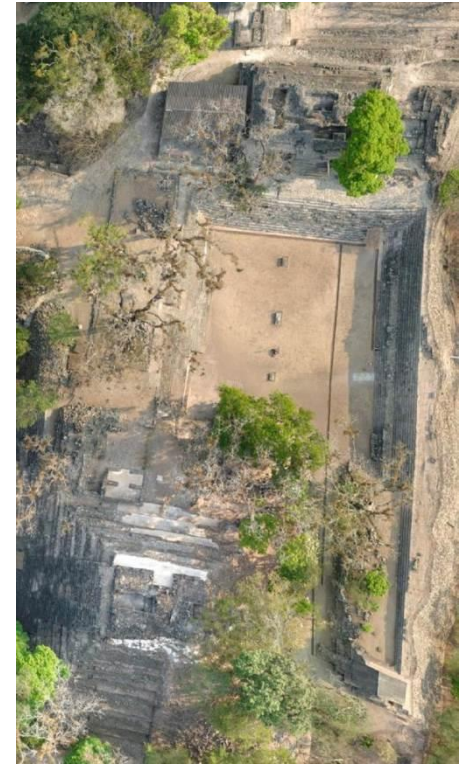


- ❑ 3D data collection, modeling and visualization **from landscape scale** (territory, heritage site, archaeological area) **to object scale** (temple, relief, artifact)
- ❑ 3D surveying and modeling of Maya heritage for:
  - documentation and digital conservation
  - archaeological analyses & studies
  - virtual anastilosis
  - web access / sharing digital resources

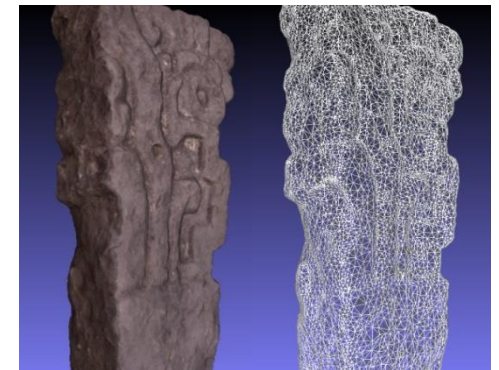




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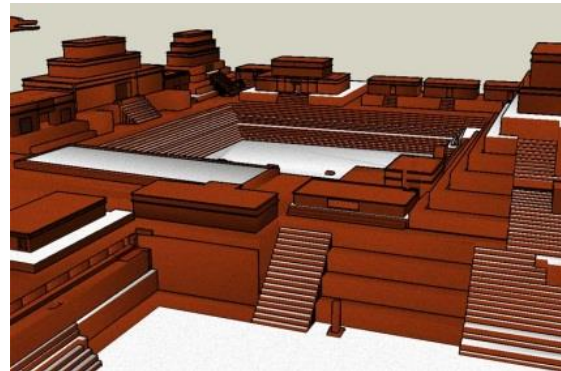
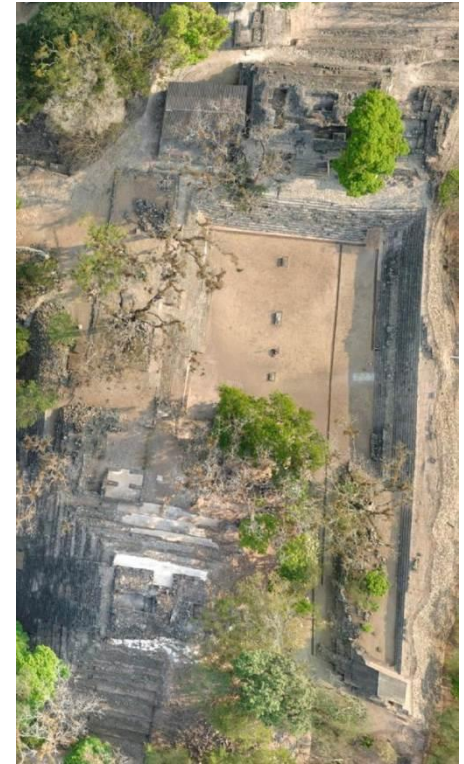


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- ```
graph TD; A[Specifications / Requirements] --> B[Project design / Planning]; B --> C[Data acquisition]; C --> D[3D model generation]; D --> E[3D model segmentation & optimization]; E --> F[Data representation]; F --> G[Users / World]; H[Specifications / Requirements] --> E
```
- The flowchart illustrates the process of 3D model generation and segmentation. It begins with 'Specifications / Requirements' on the right, which points to 'Project design / Planning' on the left. The process then flows vertically through 'Data acquisition', '3D model generation', and '3D model segmentation & optimization'. A second 'Specifications / Requirements' box on the right points to the '3D model segmentation & optimization' step. Finally, the process concludes with 'Data representation' on the left, which points to 'Users / World' on the right.





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## ■ Archaeological studies & analyses

- Reality-based 3D models
- High resolution geometric models + high resolution textures



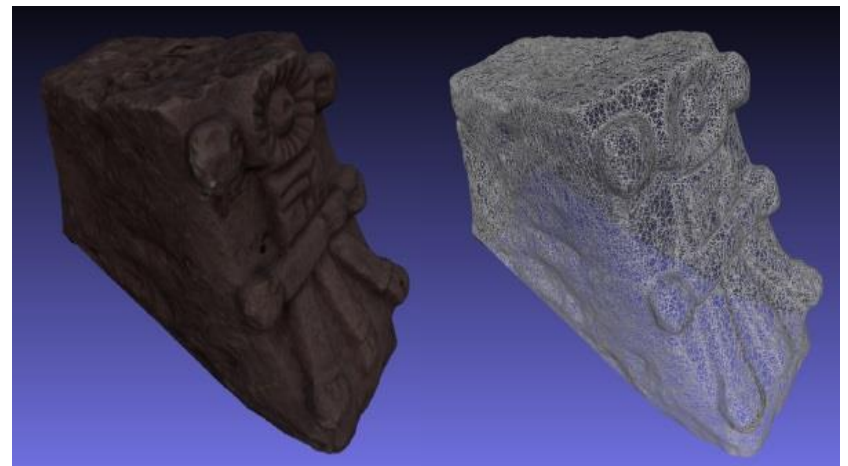
## ■ Web access / sharing

- Reduced / Optimized 3D models (low number of polygons, medium resolution texture)

### CRIA - 2317

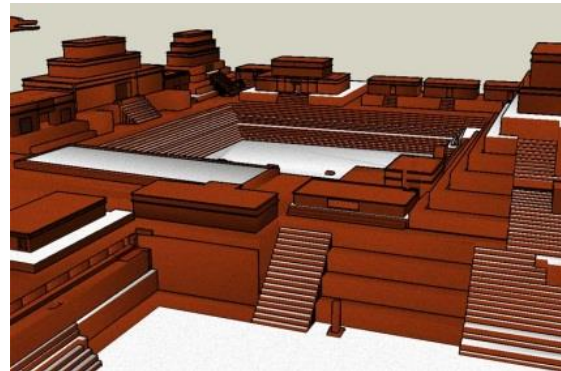
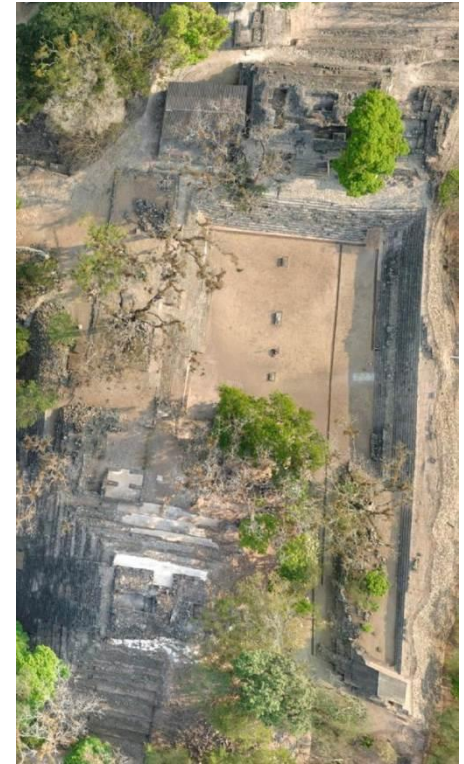
High Resolution - 5 M. Polygons

Low Resolution - 100.000 polygons





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## 3D Surveying & Modeling

### REALITY-BASED

- PHOTOGRAMMETRY
- REMOTE SENSING
- COMPUTER VISION
- LASER SCANNING
- CLASSICAL SURVEYING

### NOT REAL

- COMPUTER GRAPHIC
- PROCEDURAL MODELING

➤ Field campaign in 2009:

- ❑ Great Court, East Court, Stela A, Stela B

➤ Field campaign in 2013:

- ❑ Temple 18, Stela 11, different artefacts, Virtual Tour



- ❑ Great Court, East Court, Stela A, Stela B
- ❑ Integration of different 3D recording techniques (UAV & terrestrial photogrammetry, terrestrial laser scanning, GPS)
- ❑ 3 days of acquisitions in collaboration with ETH Zurich





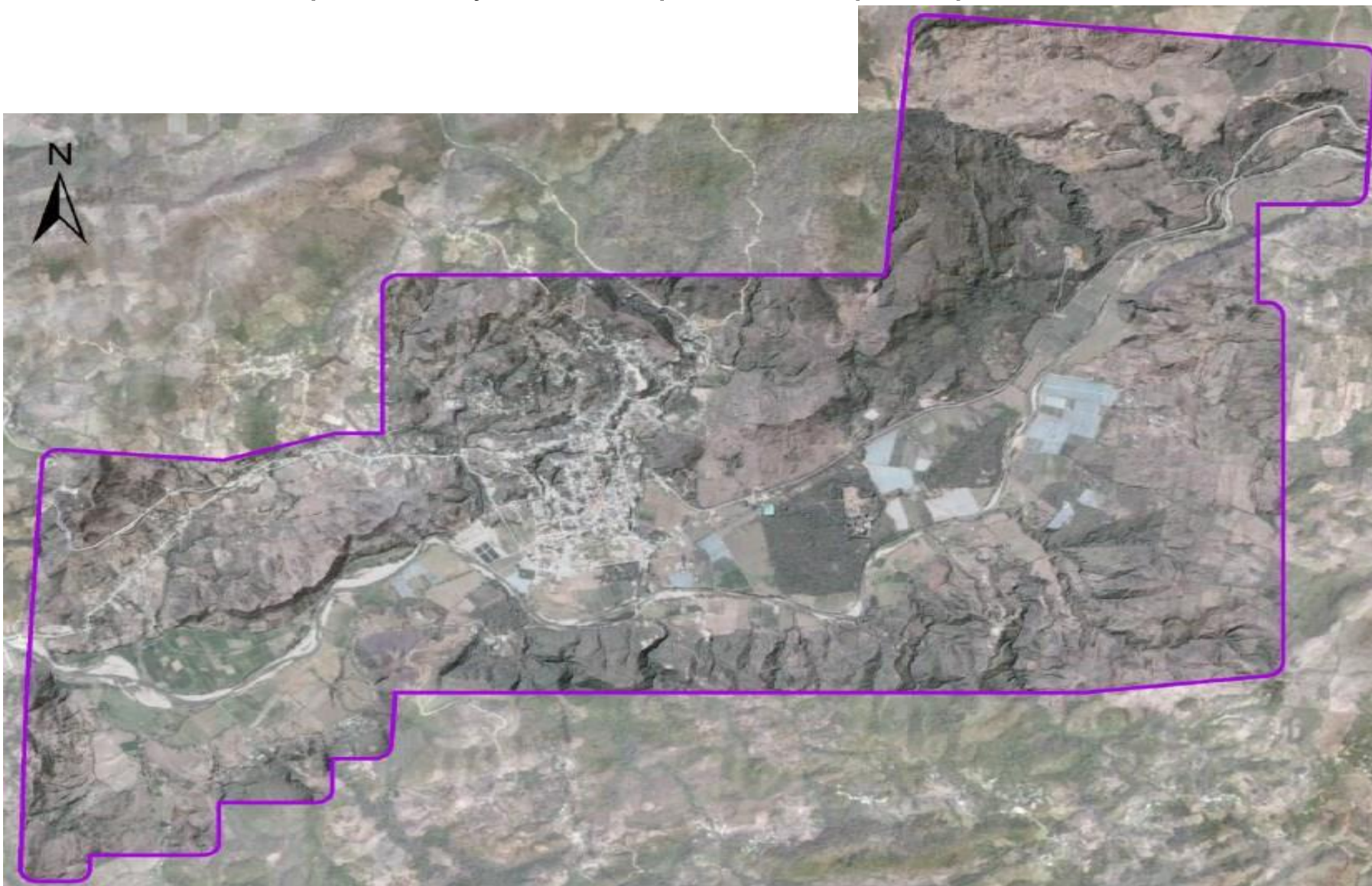




- ❑ Entire valley, Temple 18, artefacts in the museum, Virtual Tour
- ❑ Integration of different 3D recording techniques (LiDAR, terrestrial photogrammetry, terrestrial laser scanning, GPS)
- ❑ 1 week of acquisitions



LiDAR on the Copan valley, ca 25 sqkm, ca 15 pts/sqm





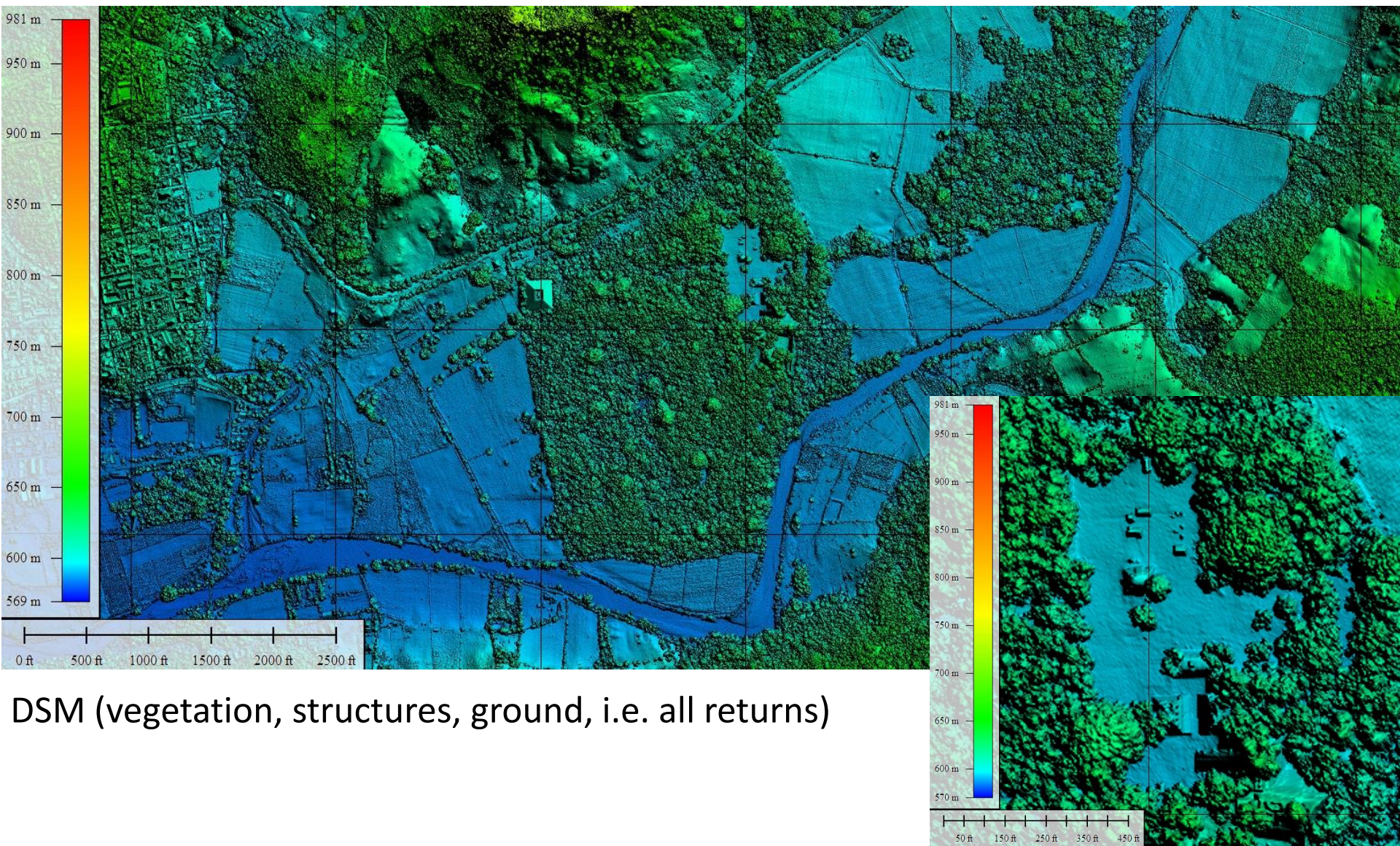
LiDAR on the Copan valley, ca 25 sqkm, ca 15 pts/smq



Intensity values

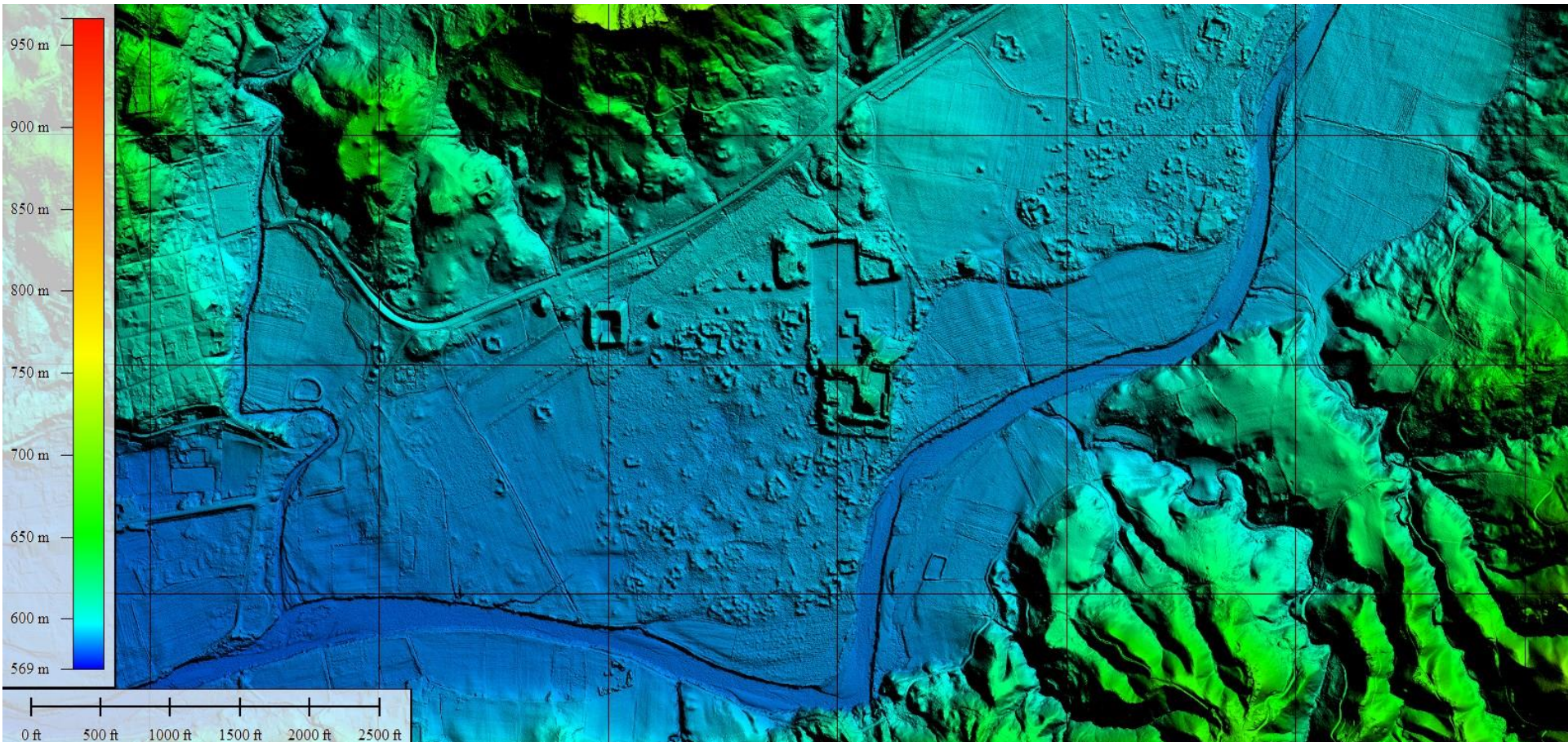


LiDAR on the Copan valley, ca 25 sqkm, ca 15 pts/smq





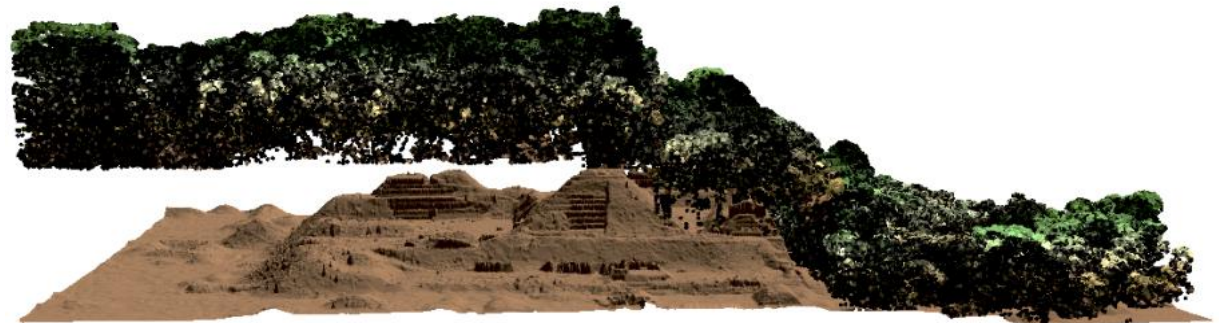
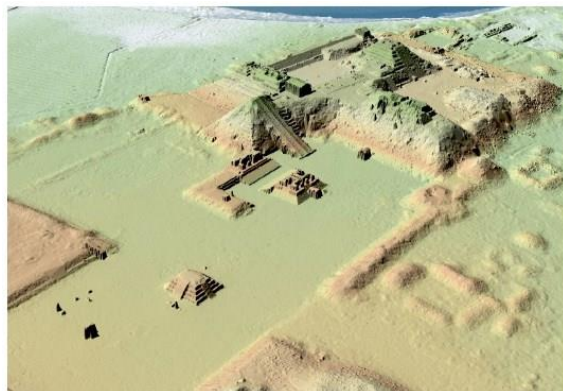
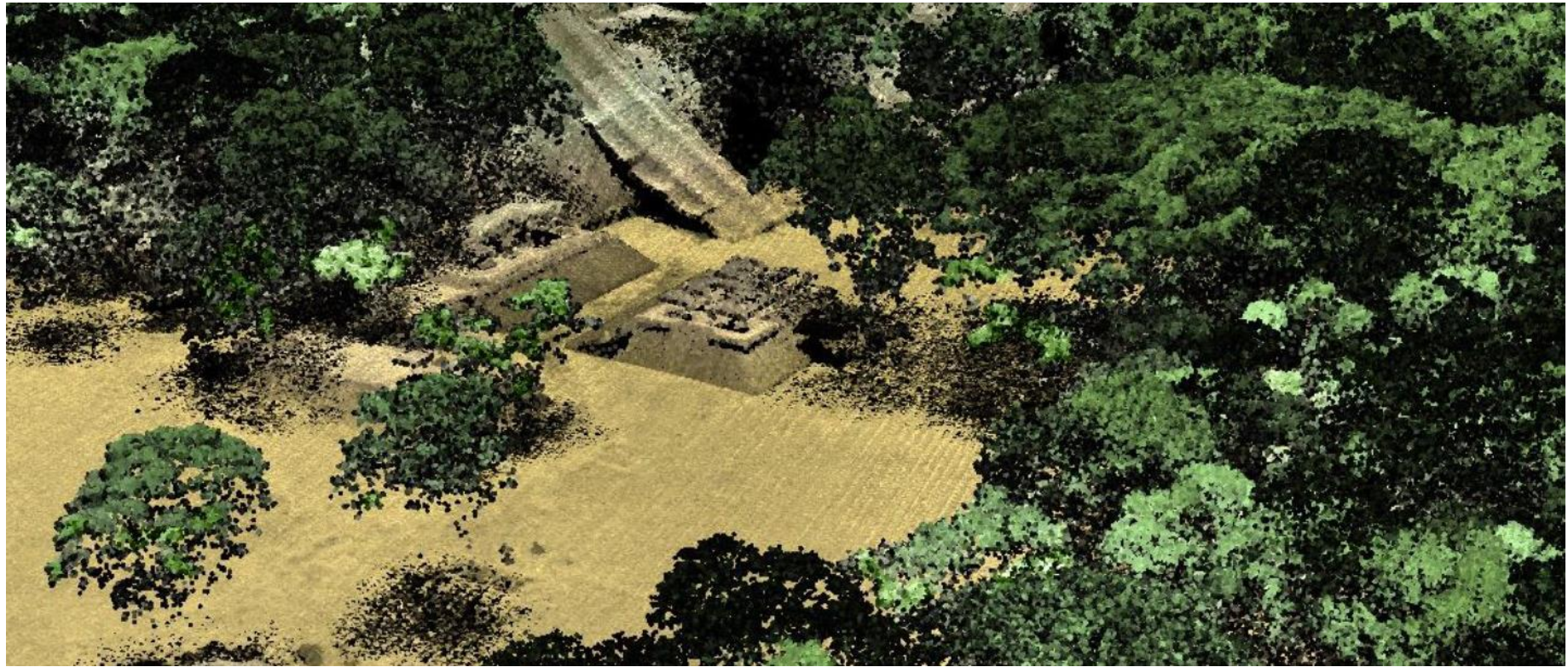
LiDAR on the Copan valley, ca 25 sqkm, ca 15 pts/smq



DTM (ground + structures, i.e. last returns)

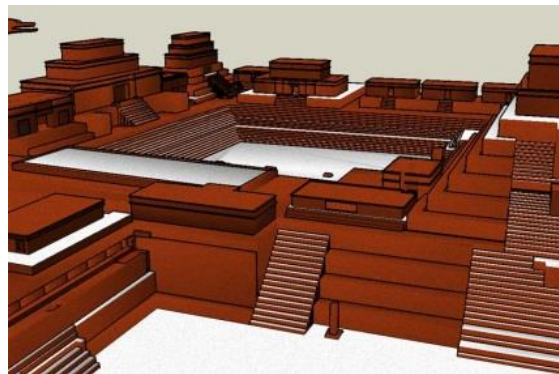


LiDAR on the Copan valley, ca 25 sqkm, ca 15 pts/smq

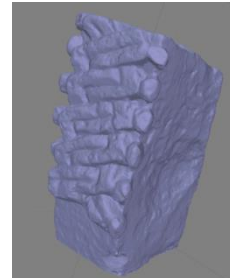
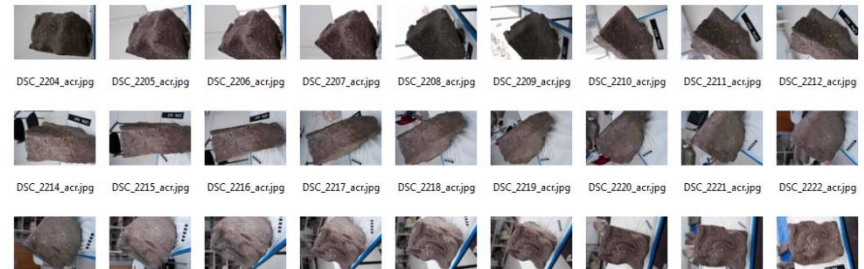
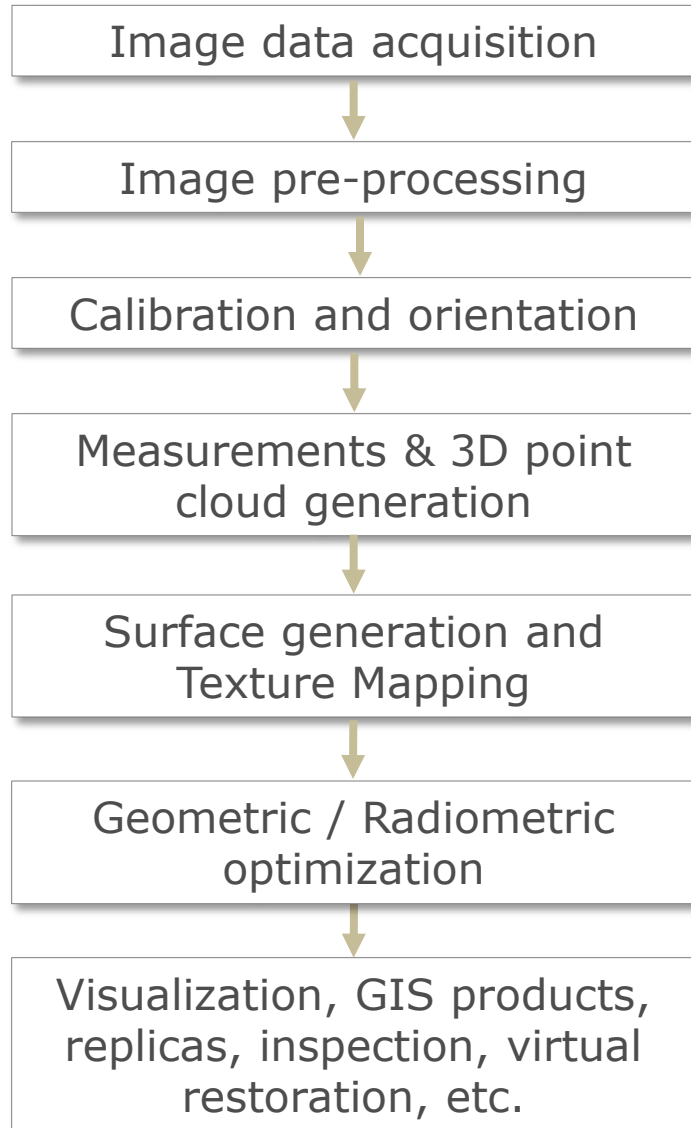




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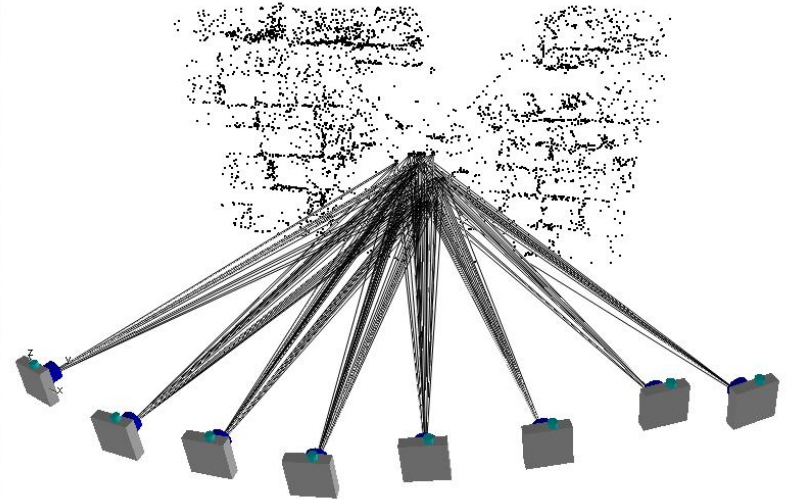


## ■ Image-based method (outdoor & indoor)



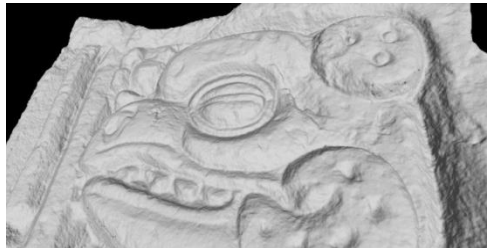


- Image-based method (2009)



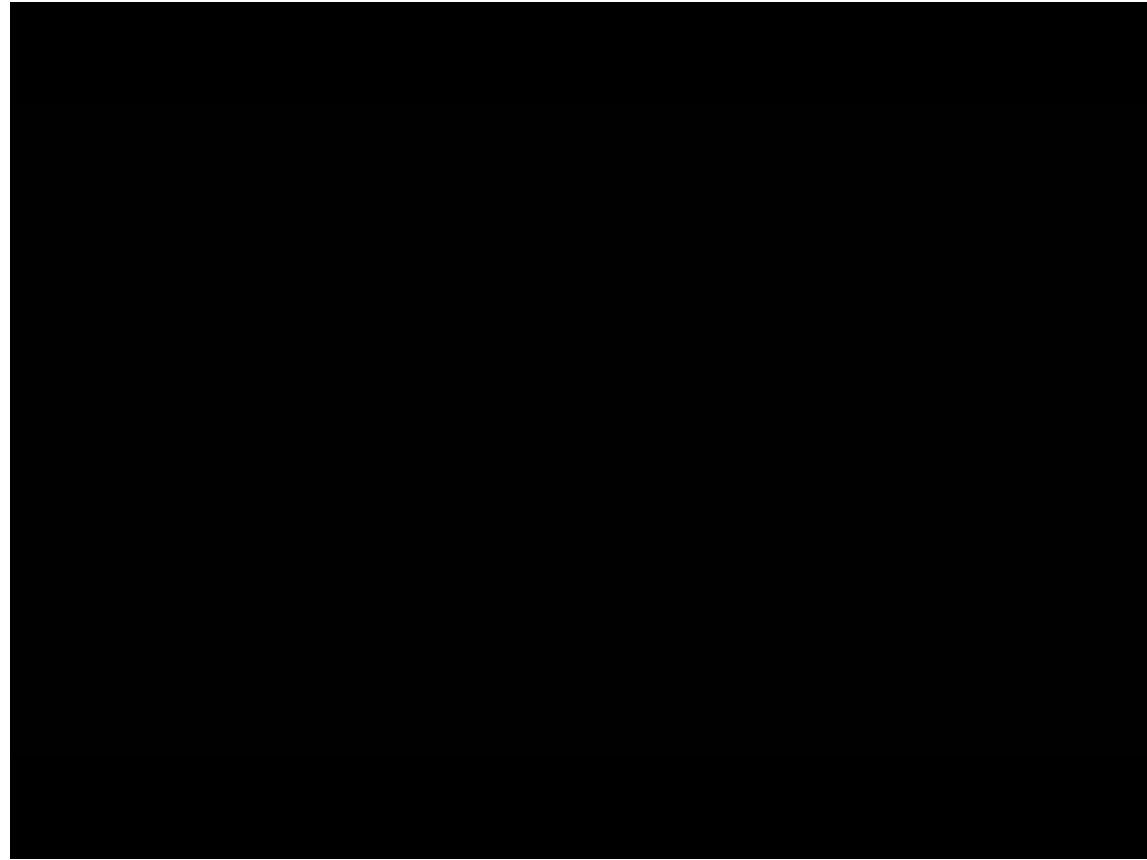
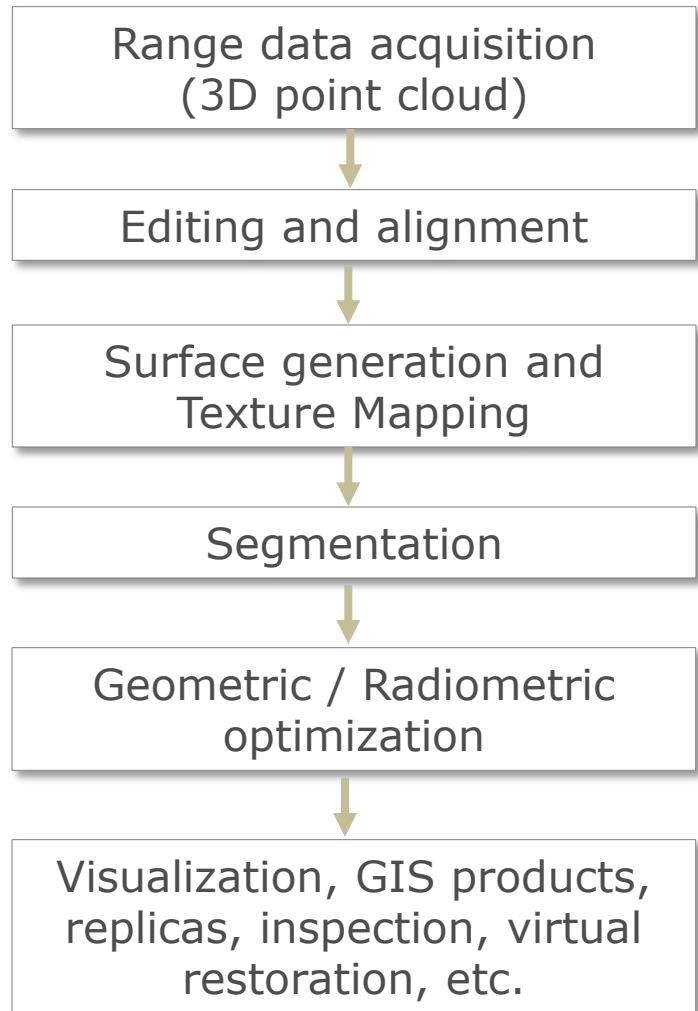


- Image-based method (2013)

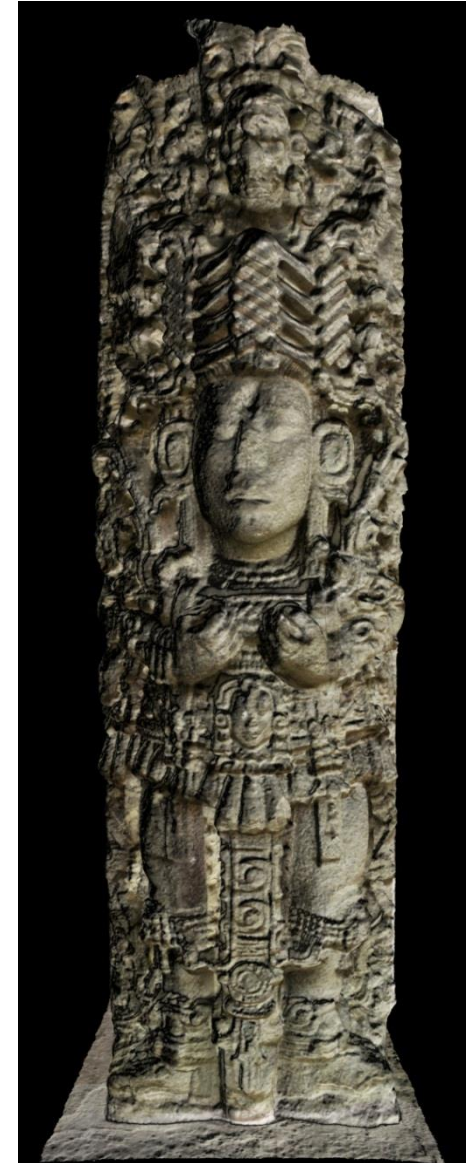
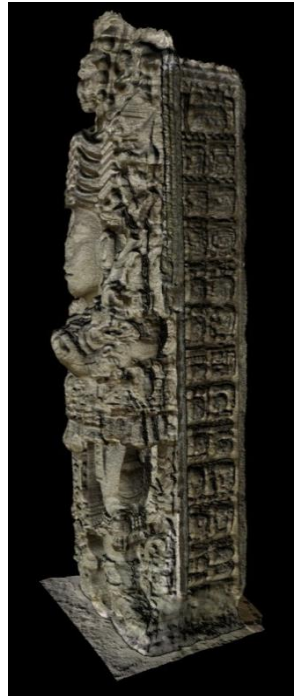
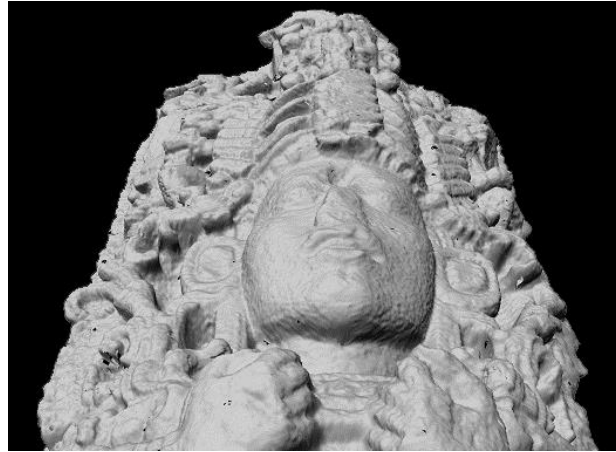




- **Range-based method**



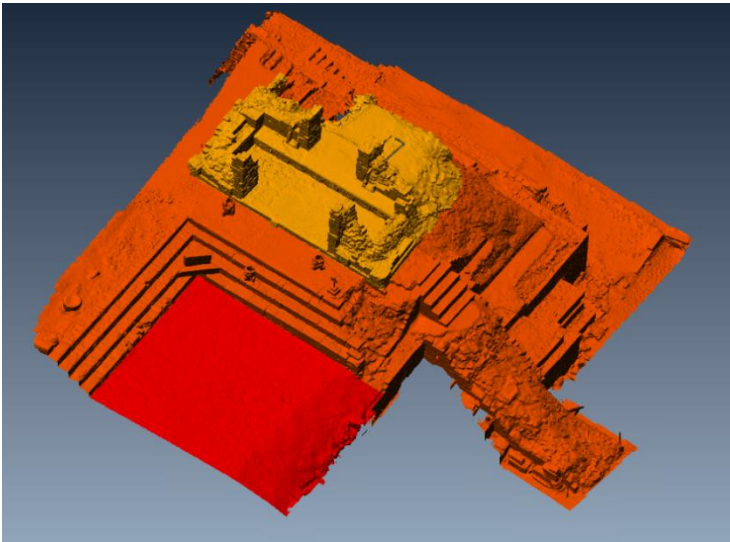
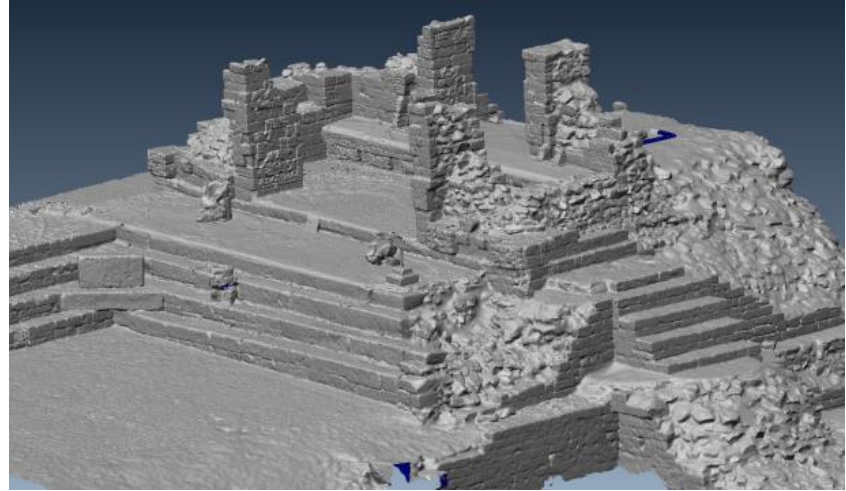
- Range-based method (2009)



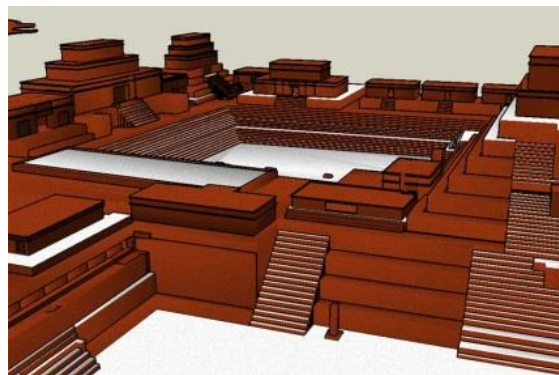
**Stela B (3.45 x 0.95 x 0.80 m)**



- Range-based method (2013)



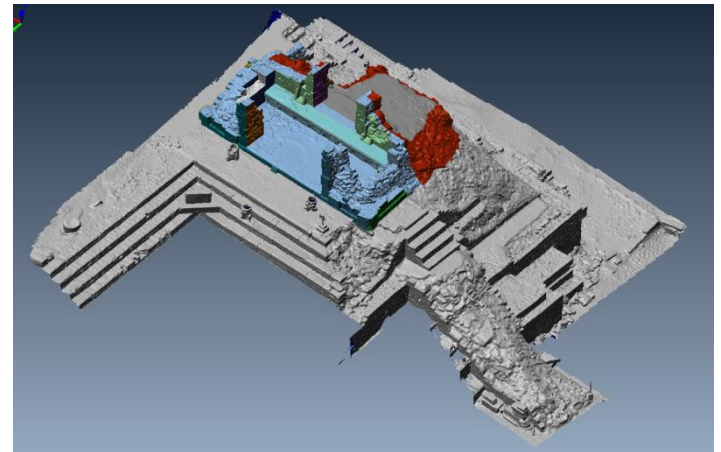
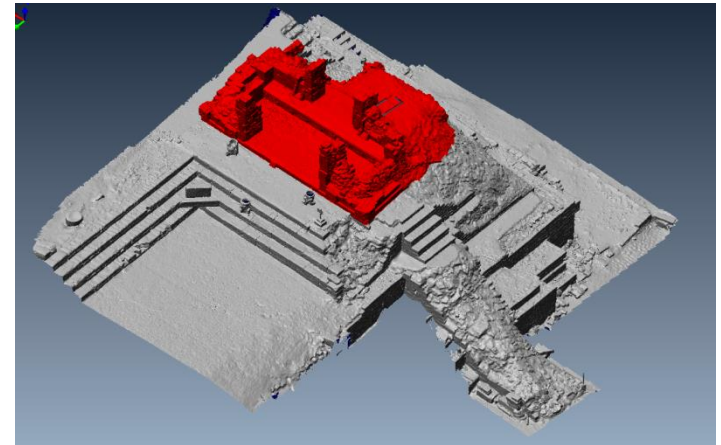
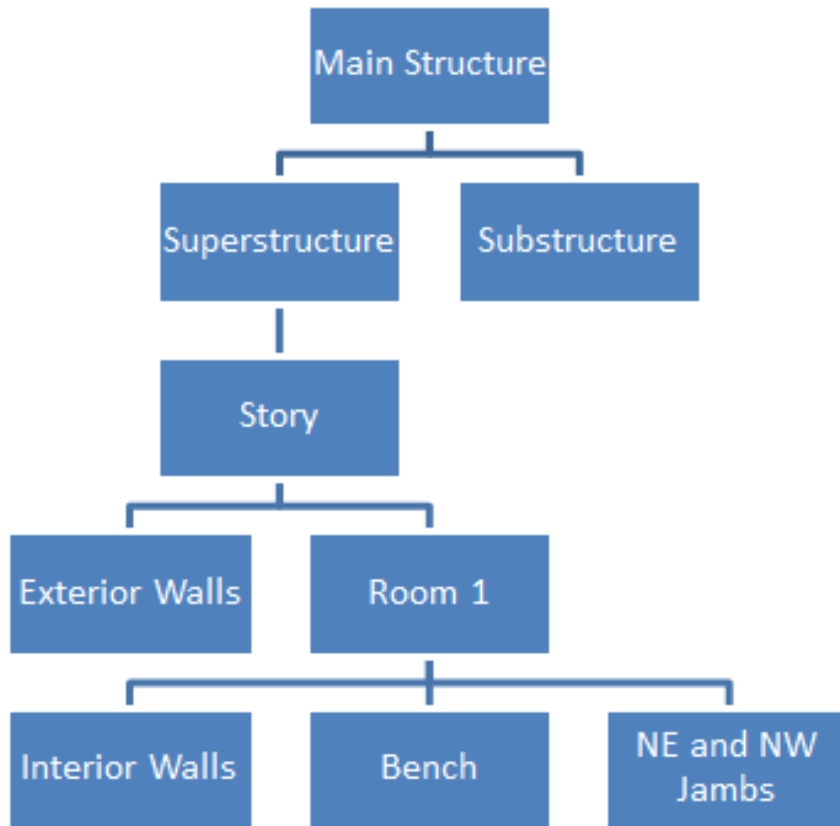
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## Segmentation

Semantic segmentation from an archaeological / historical point of view  
Geometric segmentation of the 3D models



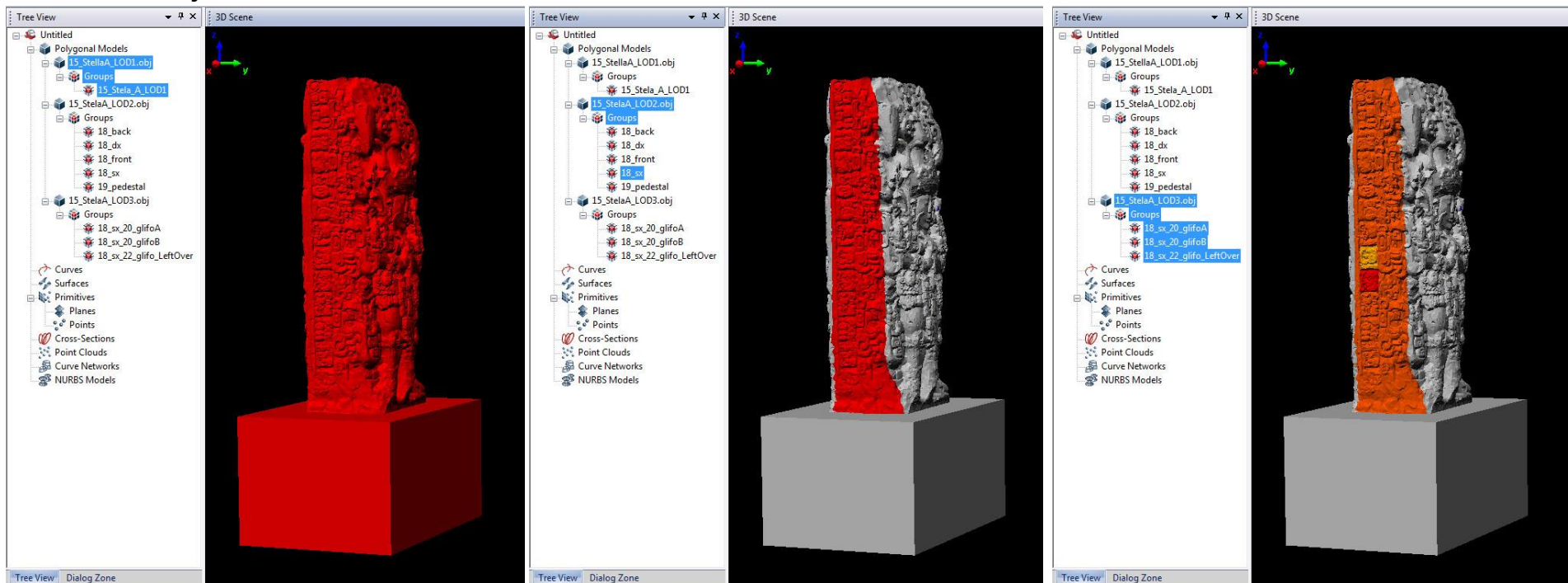
## ■ Segmentation

- So far, fully manual approach – automated methods do not work on complex reality-based 3D models
- Different levels of segmentation

Entire object

One side

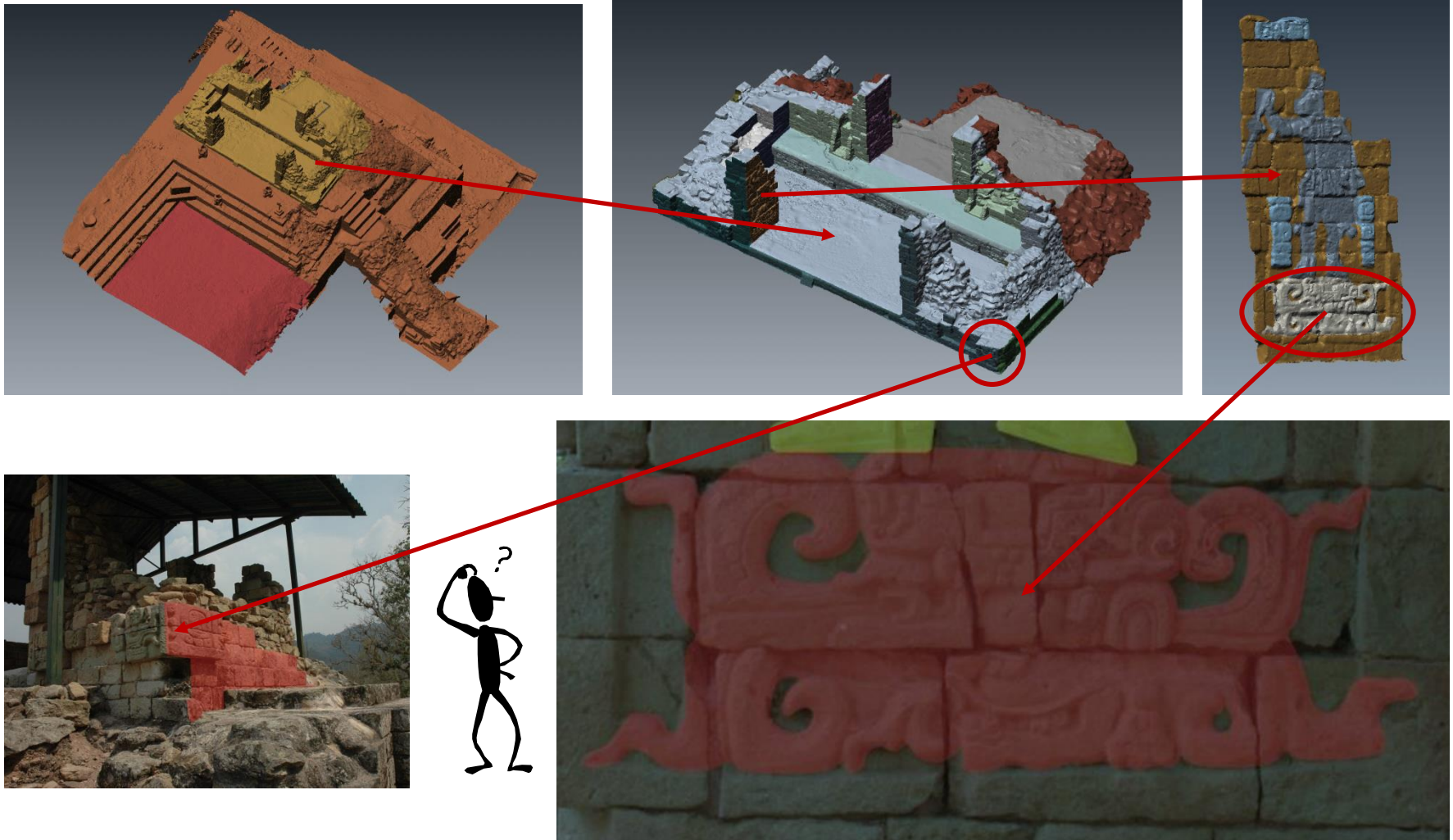
Details



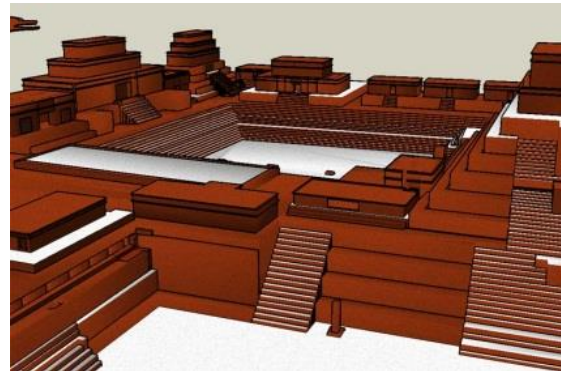
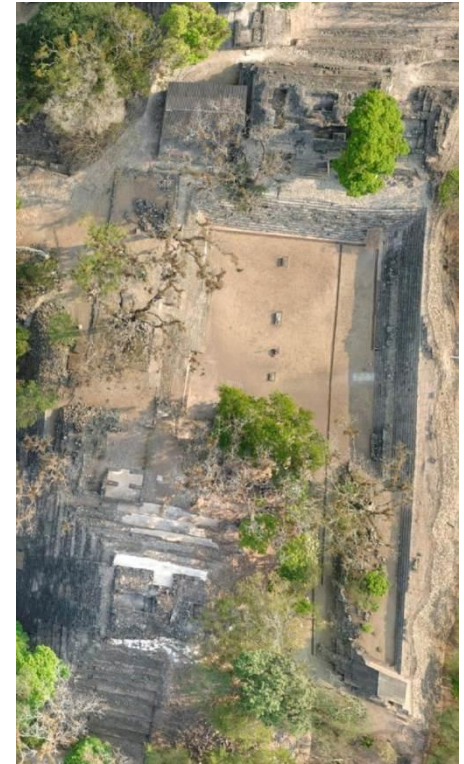


- Segmentation problems

How is the hieroglyph defined?



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## ■ Optimization

- To deliver web-compliant 3D models, to facilitate interaction, navigation and visualization
- To fulfil visualization tool capabilities

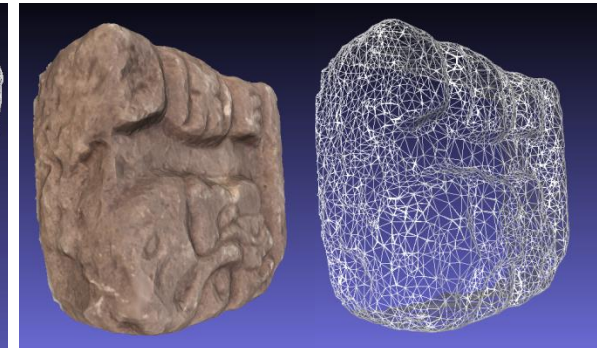
| Resolution | Vertex  | Polygons  | SIZE (MB) |
|------------|---------|-----------|-----------|
| High       | 987.151 | 1.972.140 | 203       |
| Medium     | 150.623 | 300.000   | 29,9      |
| Low        | 10.156  | 20.000    | 2,31      |



Full res.

Medium res.

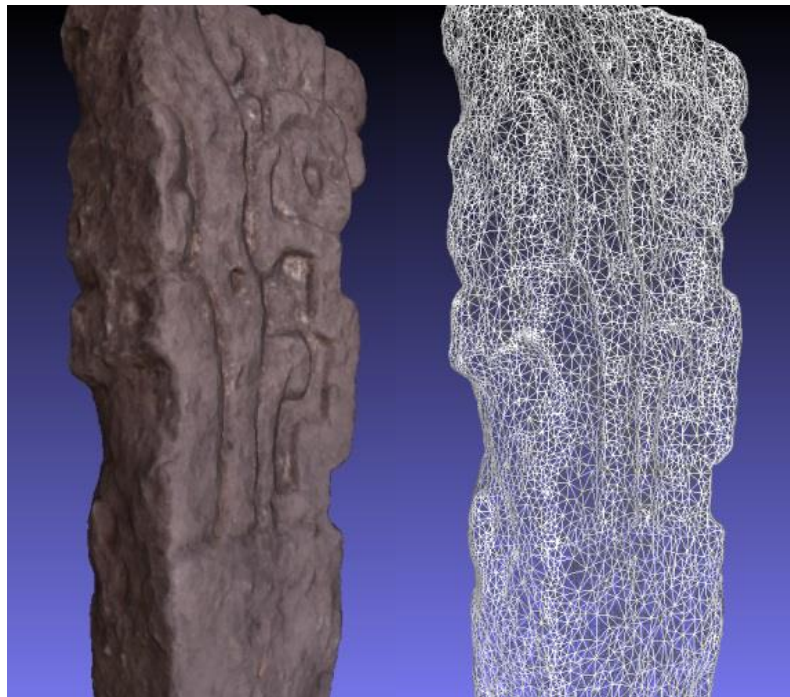
Low res.



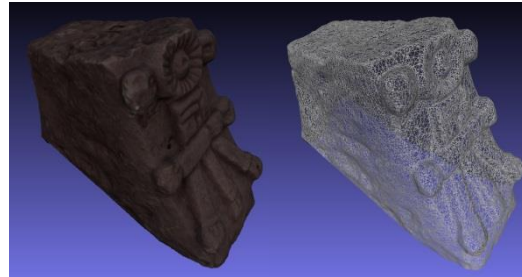
## ■ Optimization

- Try to keep a good compromise between size, texture & geometry

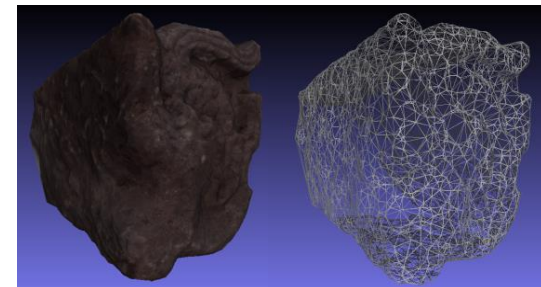
2563



2317



007



2630



C1

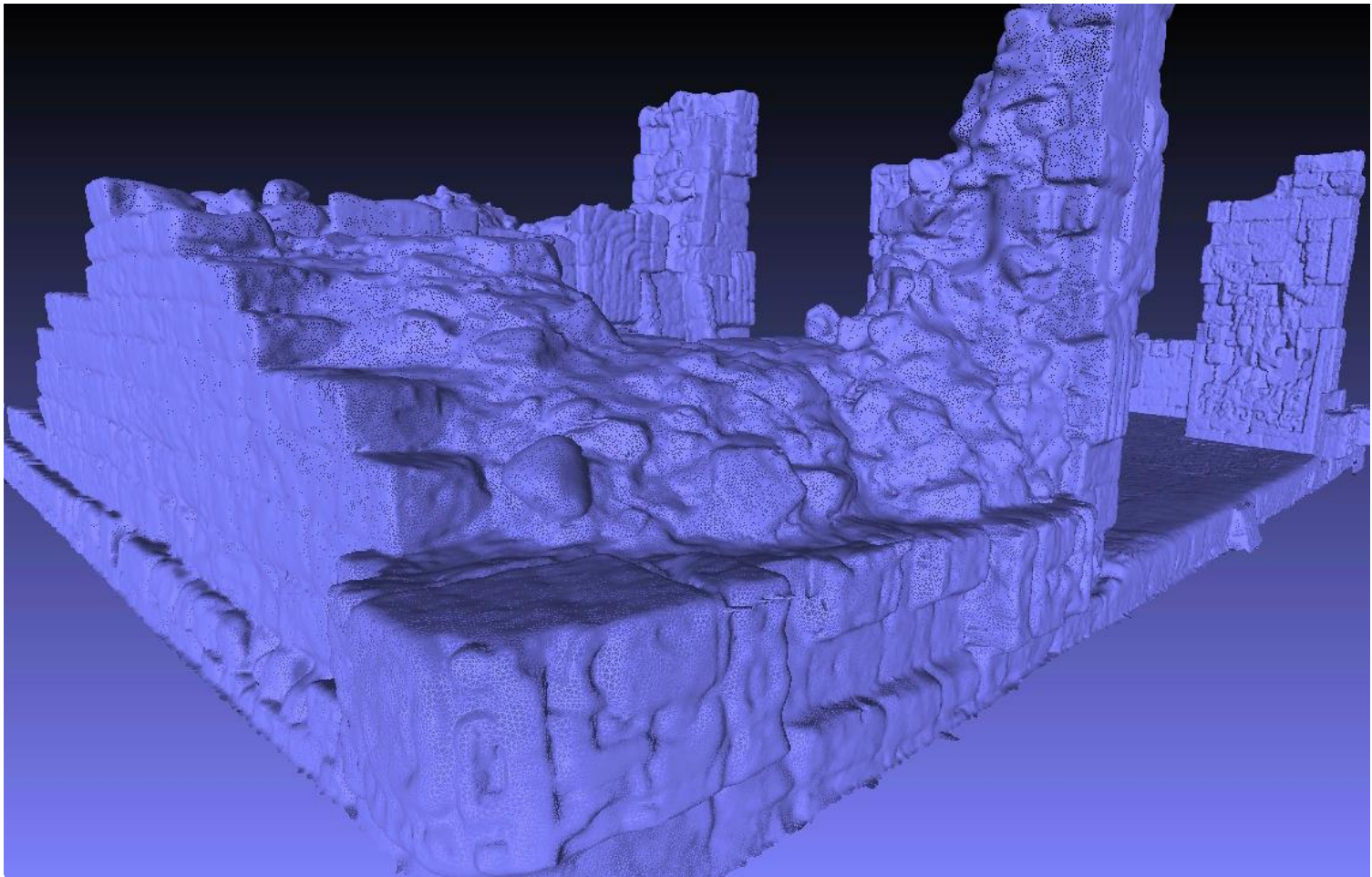




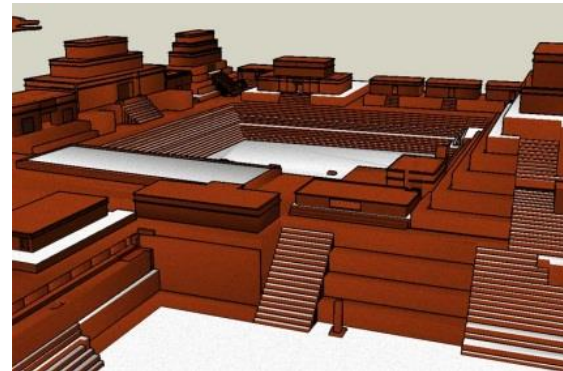
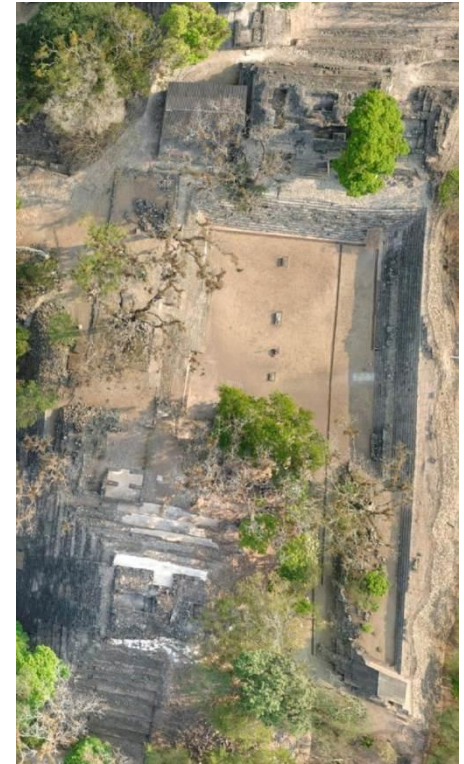
## ▪ Optimization

- Fully automated procedure BUT flatness & curvature must be considered and controlled

TEMPLE 18 – 900,000 polygons

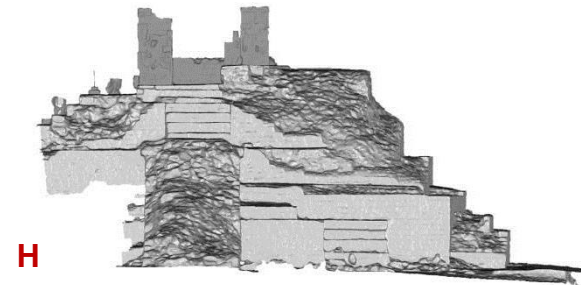
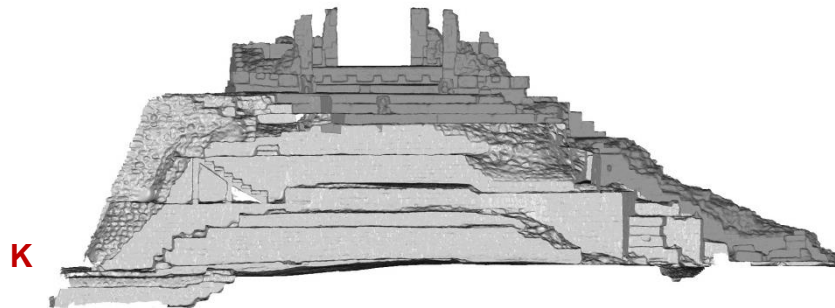
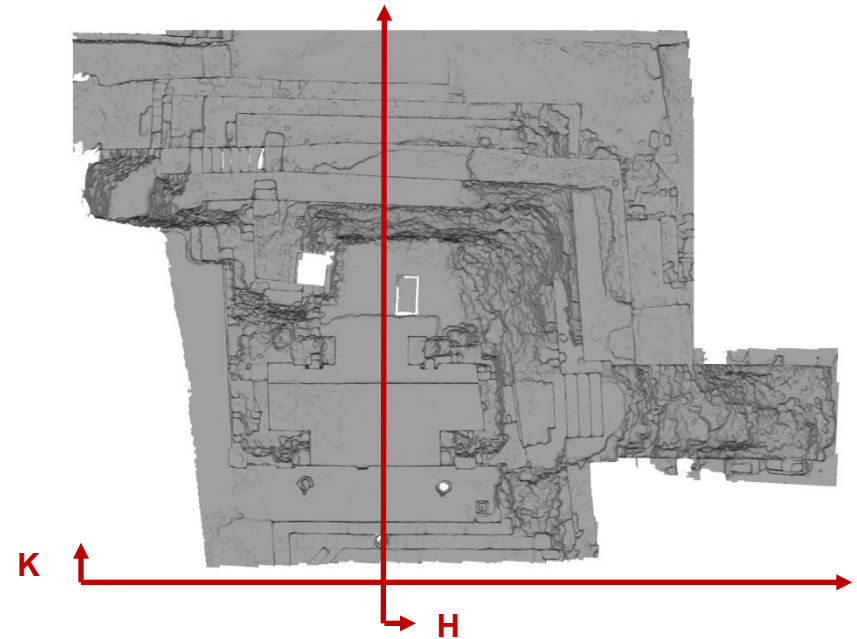
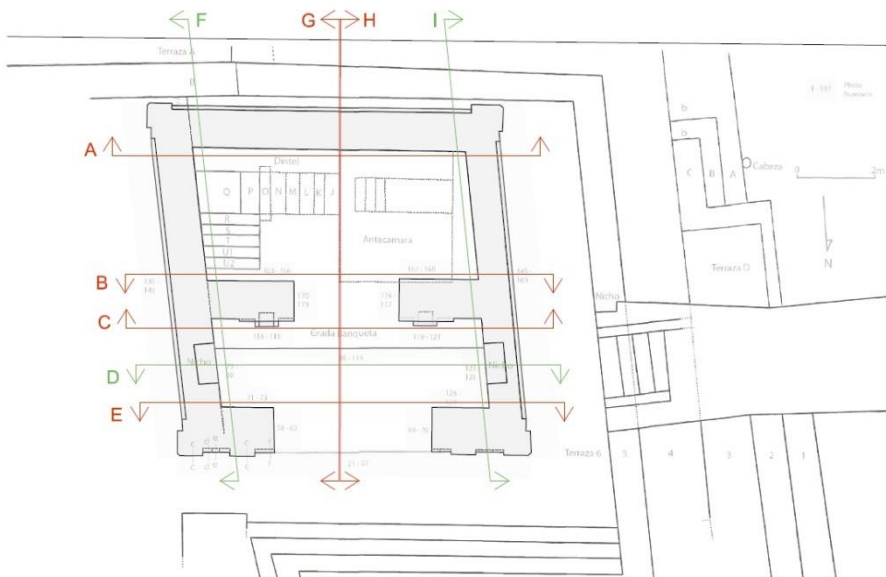


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- Archaeological & architectural analyses
- Validate old maps with the new 3D results
- Use new section for 3Dhypothetical reconstruction

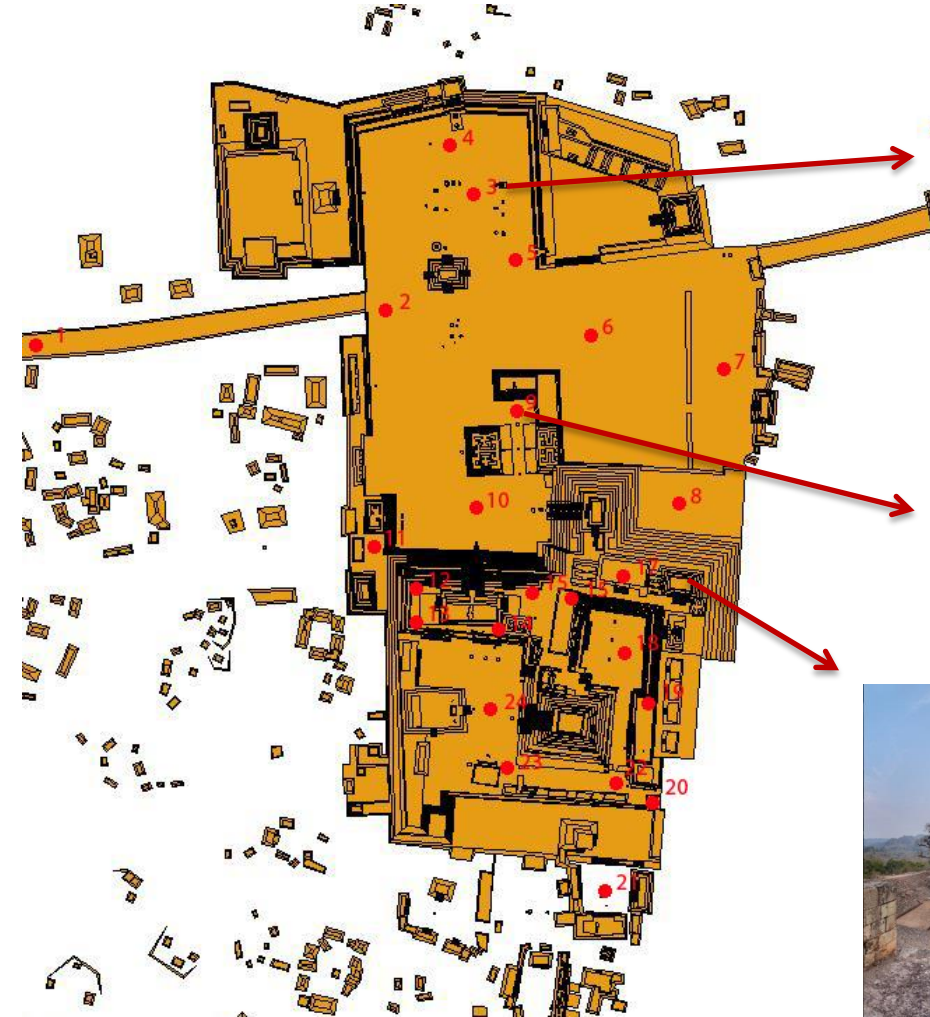


## ■ Virtual tour (on-going)

- Panoramic images for virtual access
- Immersive visualization

### Nikon D3X

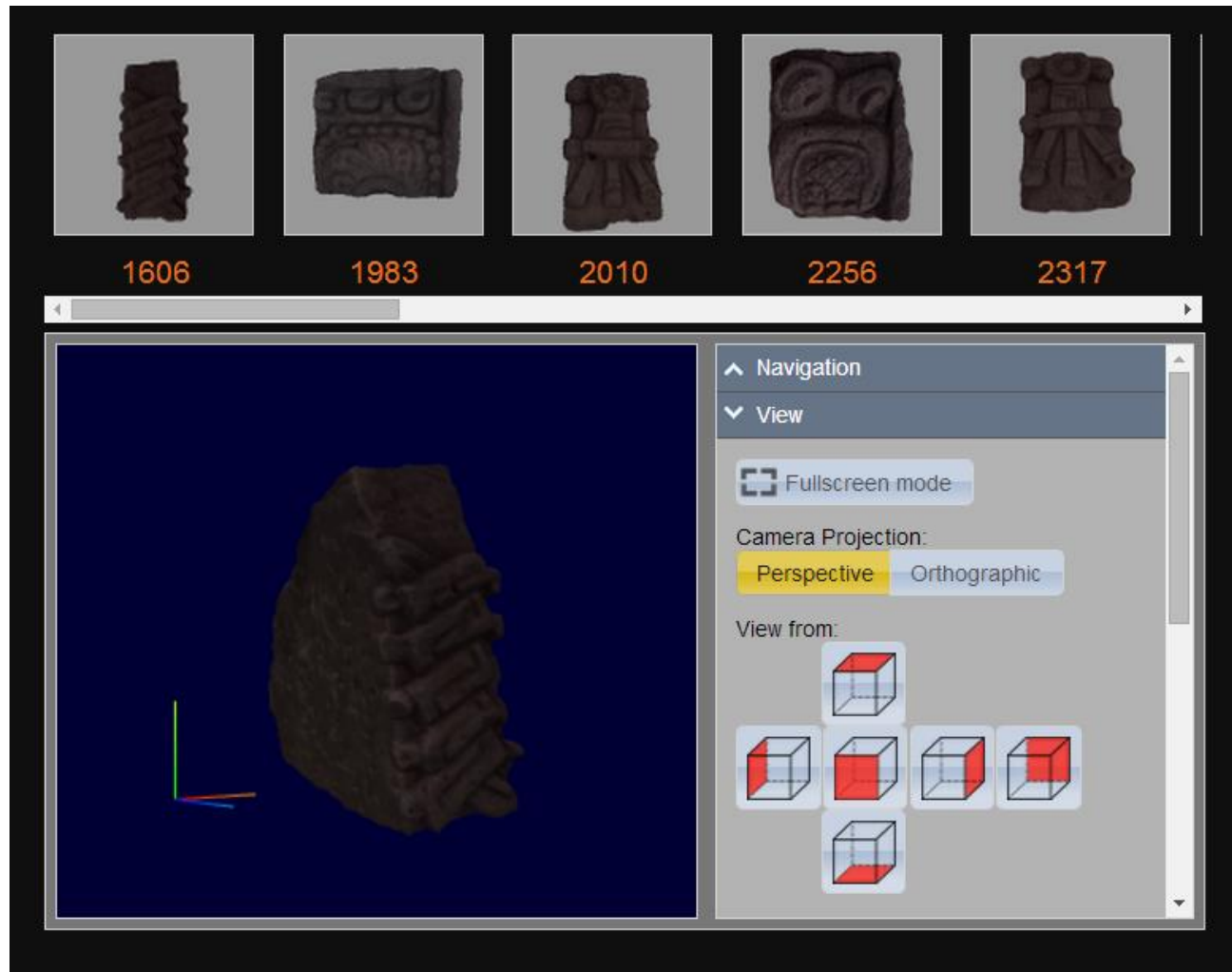
- 25 Camera position
- 1950 Images acquired



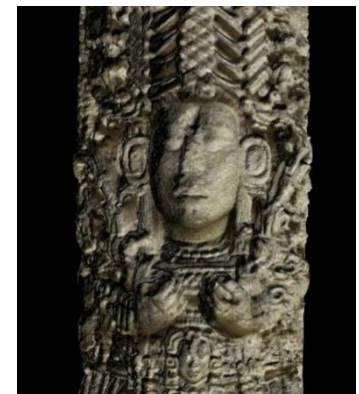
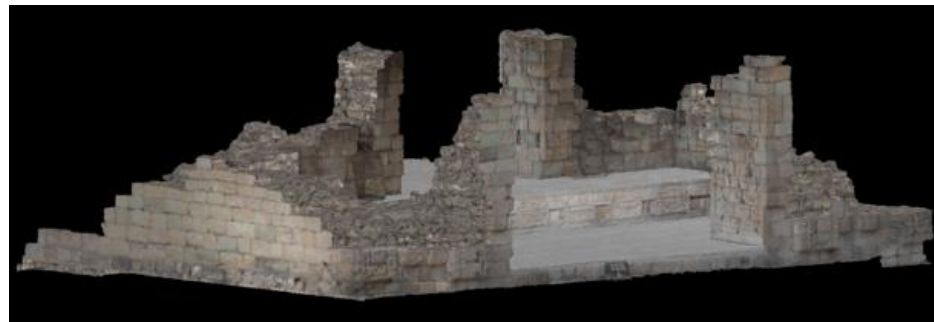
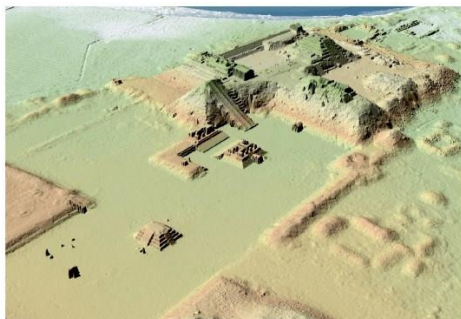


- **MAYAARCH3D viewer**

Developed by Heidelberg University



- ❑ Reality-based 3D surveying and modeling of the Copan site for archaeological analyses, remote studies, virtual reconstruction & web data sharing
- ❑ Photogrammetry & laser scanning as complementary techniques
- ❑ Data processing quite straightforward but problematic and demanding the segmentation and optimization steps
- ❑ Lack of practical solution for segmentation of large and complex 3D models
- ❑ Fulfil the visualization tool capabilities and web limitations
- ❑ Keep the high resolution models only for off-line analyses
- ❑ It's mandatory to keep good communication and discussions between interdisciplinary partners for the success of a project





...thank you...



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