



NATIONAL TECHNICAL UNIVERSITY of ATHENS

Spatial Information System:

A need for integrated Monument's Documentation

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Geographic Information System is a tool for:

legal, administrative and economic decision making
planning and development

emphasis on geographical reference

Spatial Information System

for applications on Monuments, as:

- **Attribute element** equally important as **Geographical element**
- **Spatial datum** is the local environment of the site

Components of a Spatial Information System

- Data entry subsystem
 - geometric documentation
 - attributes on relational Database
- Data storage and retrieval subsystem
 - large volume of geometric 2D/3D data
- Data manipulation and analysis subsystem
 - interactive process between SIS – User
 - automated processes
 - complexity of object
- Data visualisation subsystem
 - 2D and 3D representations in vector and raster format
 - 3D textural scenes - Modelling
 - Augmented Reality

Archaeological Spatial Information System:

Why ?

- Multi-level and Multi-purpose Documentation
- Interrelation of different kinds of information
- Ease retrieval of information through queries
- Avoiding multiple storage of data
- Entry of new types of data and updating of information
- Other special reasons depending on the application

Where ?

- ✓ Restoration of a monument
- ✓ Conservation of a monument
- ✓ Development of an archaeological site

How ?

3 examples on 3 different monuments

Procedure stages

1st stage: Geometric recording

Photogrammetric procedures

Field surveys

Terrestrial Laser scanning

2nd stage: Development of the SIS

Structure of the system

Data Management

3rd stage: Implementation of the SIS

Provision of products

A. Restoration of a monument: Application on the Wall of Ancient Messene

General Information

- Established in 369 B.C.
- Political & Cultural centre until the 3rd A.C. century
- 9 km Wall Hellenistic fortification-skill
Irregularly rectangular
construction system
2.45 – 2.80 m wide
- 2 main Gates: Arcadian and Laconic Gate



Object of the study: part of the Wall of 70m length
355 scattered blocks-stones in situ

Geometric Recording

Photogrammetric procedures

Aerial photos

more than 200 photos

- Helicopter

camera UMK13x18

7 photos in 2 strips

photo-scale 1:300



- Balloon

camera Rolleiflex6006

multi-coverage 23 strips

photo-scales 1:90 – 1:200



Photogrammetric procedures

Terrestrial photos **more than 80 photos**

North and South façade of the Wall

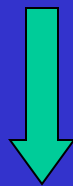
camera Rolleflex6006

photo-scale 1:100 – 1:150

Dense network of premarked control points

field surveys

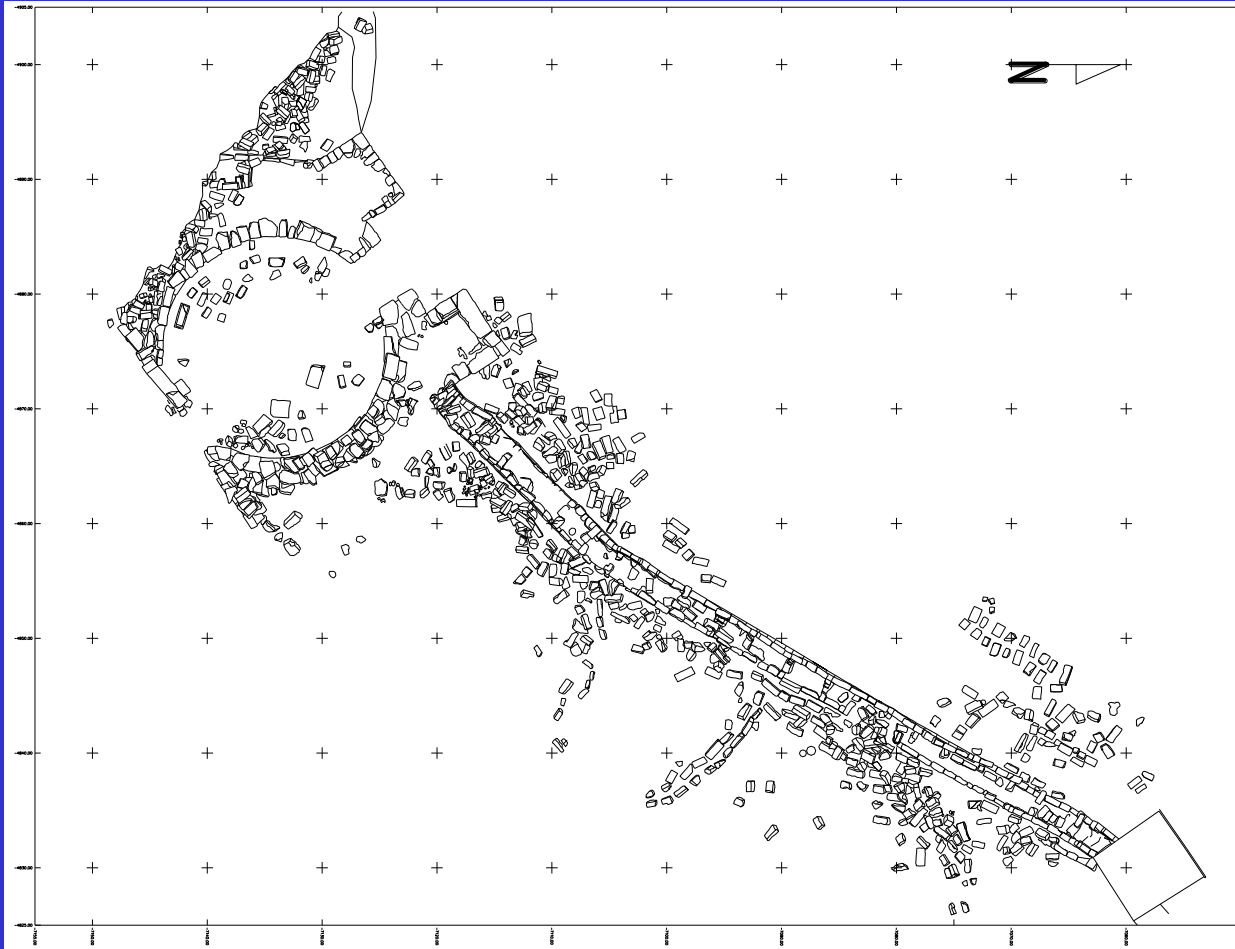
aerial-triangulation



High accuracy results : rms < 1.5cm

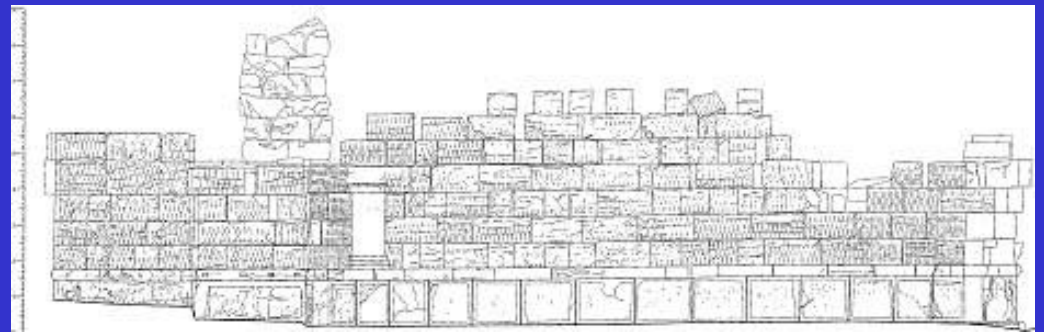
3D compilation of the wall and the scattered blocks

2D vector products



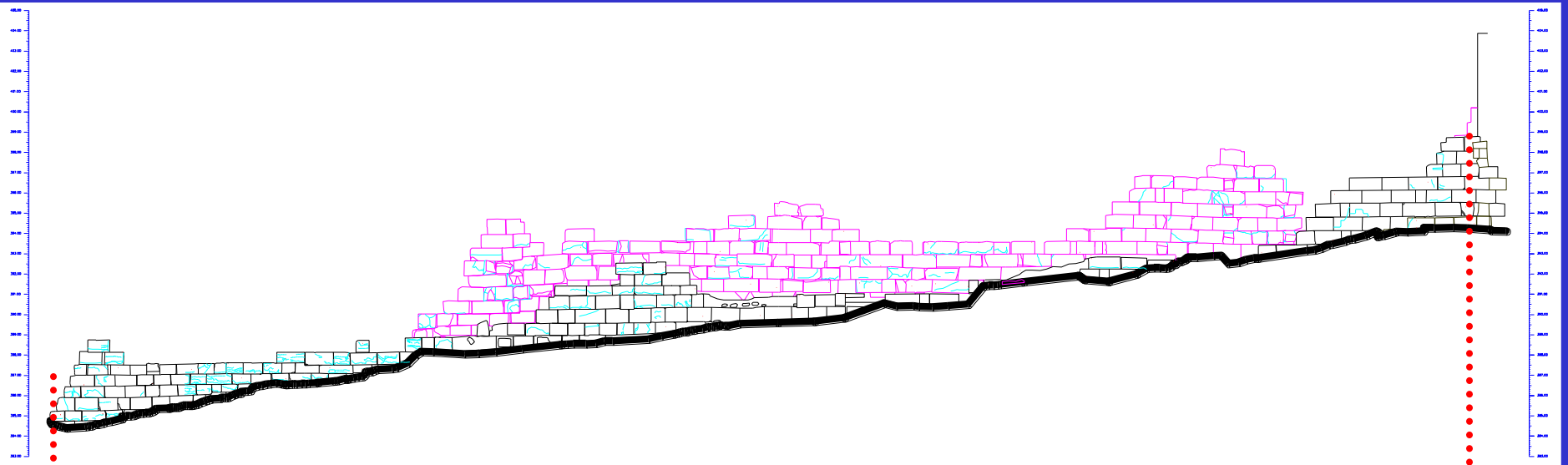
Planimetric view

Part of the Façade of
the Wall



2D vector and raster products

The southern Façade: a. Vector plan



b. Orthophoto-mosaic



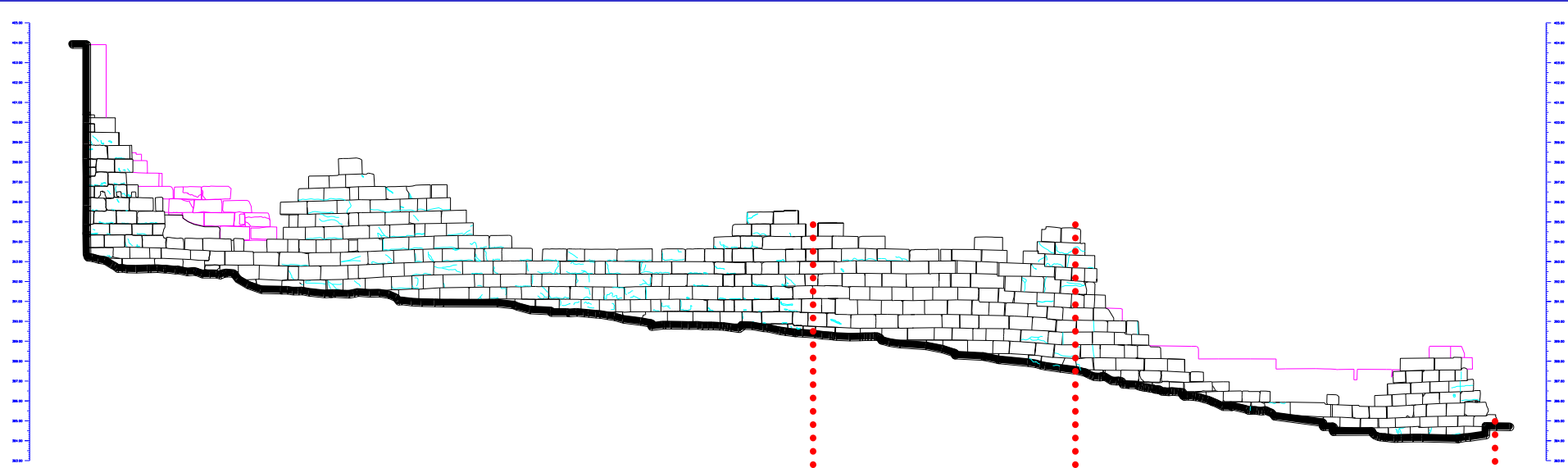
Restoration proposal using the SIS

- 3D recording
 - photogrammetric procedures
 - field surveys
 - direct measuring of all surfaces of each scattered block
- Database for scattered blocks
 - number of the stone
 - morphological characteristics
 - structural characteristics
 - geometrical characteristics
 - direction of falling
 - location of landing surfaces
- Use of visualisation tools
 - interactive procedure

Level of automation ?

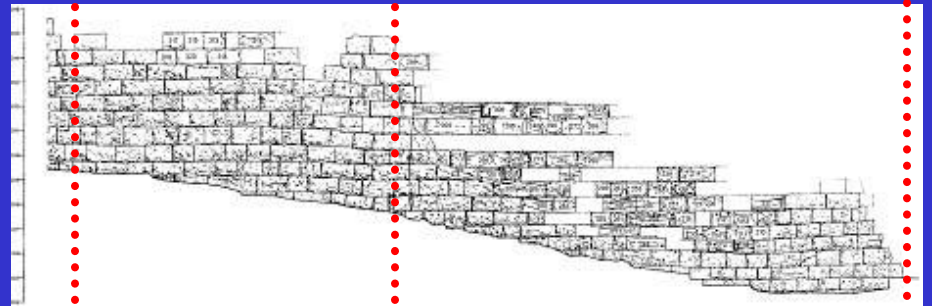
Results

The northern Façade



The existing situation

The restoration plan



B. Conservation of a monument: Application on the Dafni Monastery

Katholikon of the
Byzantine Monastery of Dafni
11th century

At the southwestern suburbs
of Athens



- Masterpiece of Byzantine architecture
- Fine mosaics in the interior

An earthquake at 7 Sept. 1999 caused severe damages

Aim of the study

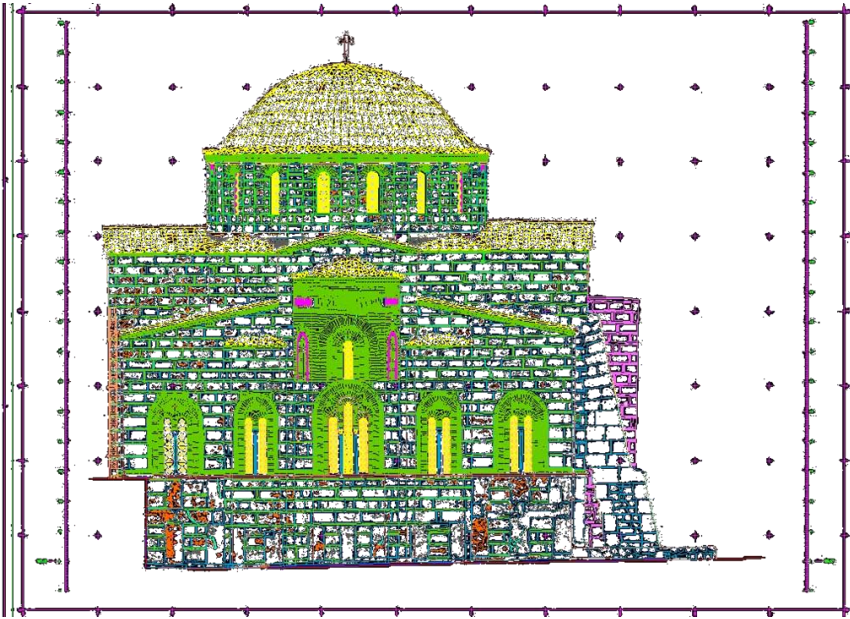
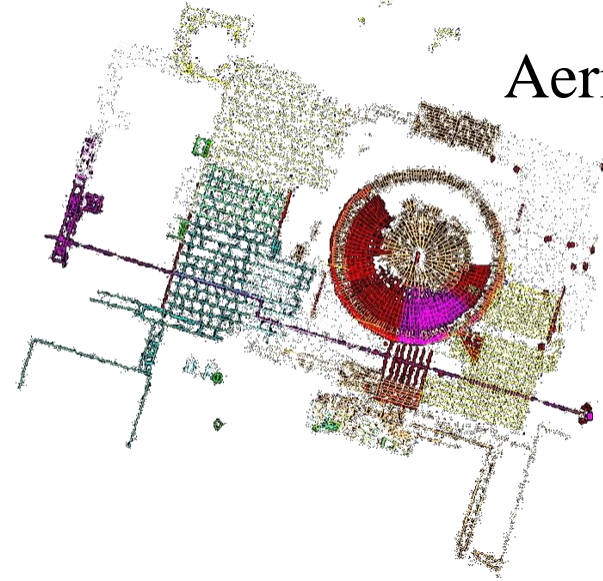
Creation of SIS with detailed DataBase suitable to record and manage the geometric and qualitative information of every constructural element on the monument's surface

Geometric data

- Vector drawings at a scale of 1:25
- Orthophotos of the facades at a scale of 1:25
- 5 horizontal sections
- 20 vertical sections
- Orthoimages of all the mosaics at a scale of 1:5

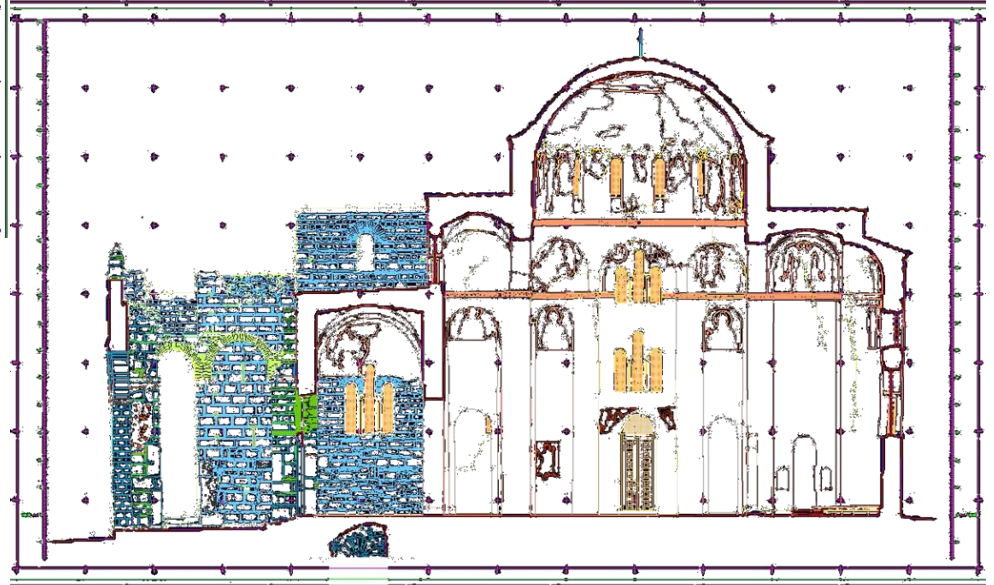
2D vector products

Aerial view



Eastern facade

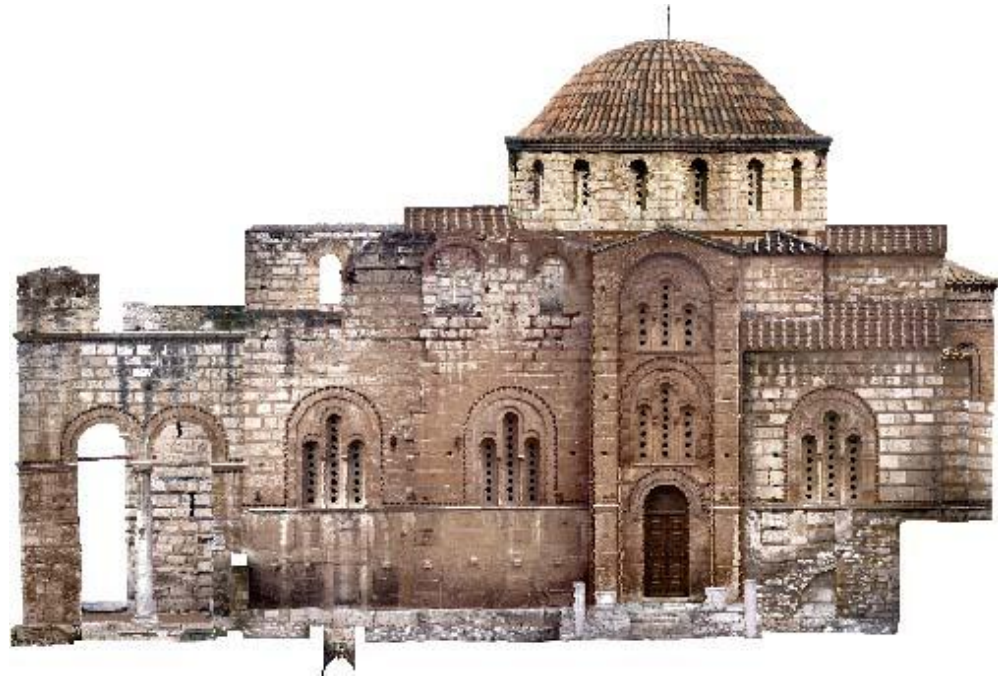
Vertical section



2D raster products



Orthophoto-mosaics



External facade

Attribute information

- Geological properties
- Deterioration-degradation type
- Surrounding connecting material
- Type and date of intervention
- Dimensions
- Name of the mosaic

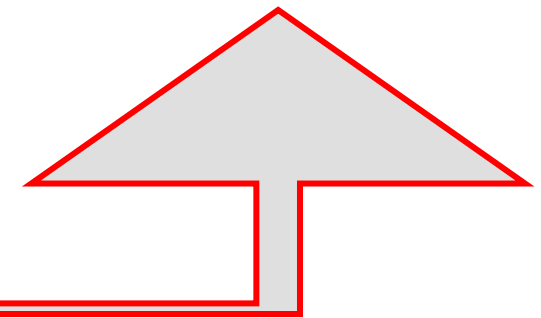
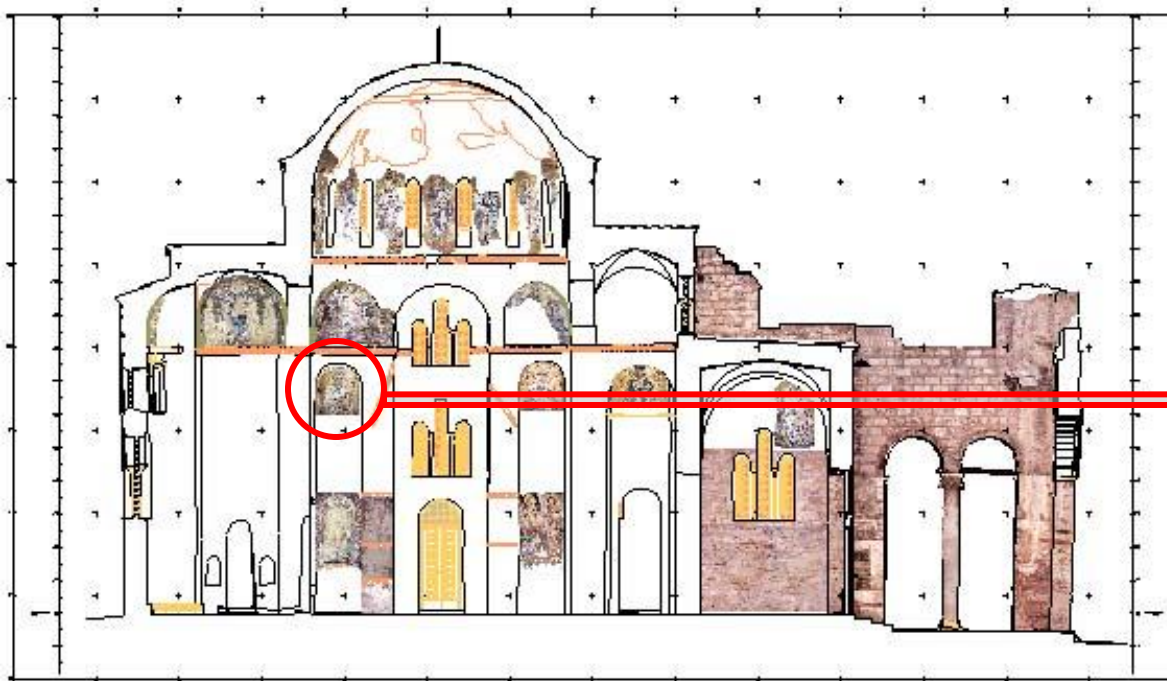
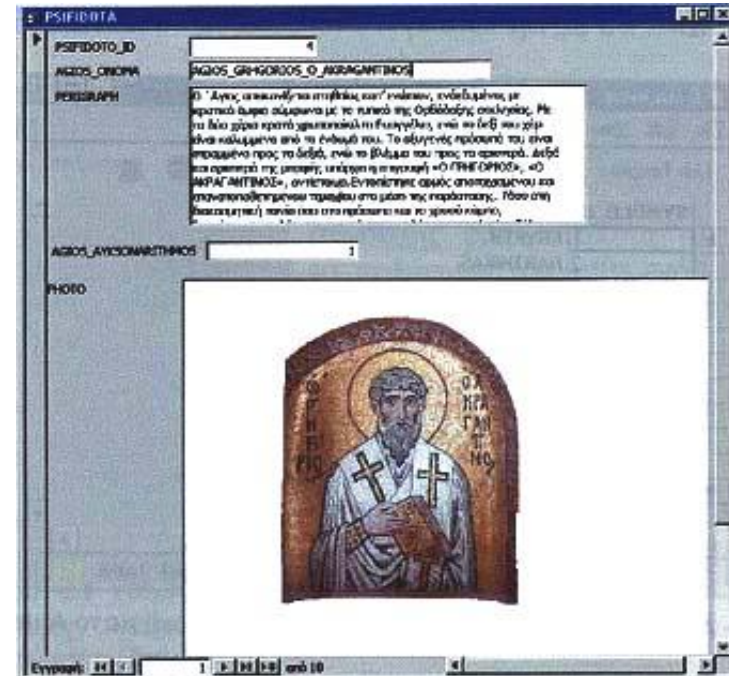
Data Base design

- Conceptual scheme
- Logical scheme
- Implementation in the physical level

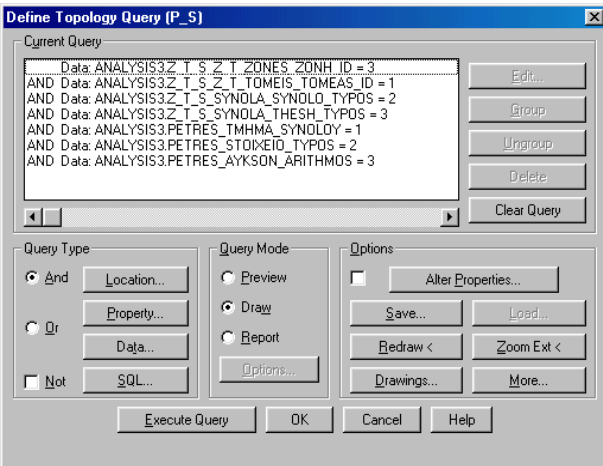
Insertion, Update, Modification of information

- Quality characteristics of constuctural elements
- Quality characteristics of Images - Mosaics
- Texts
- Video & sound

Information
Form

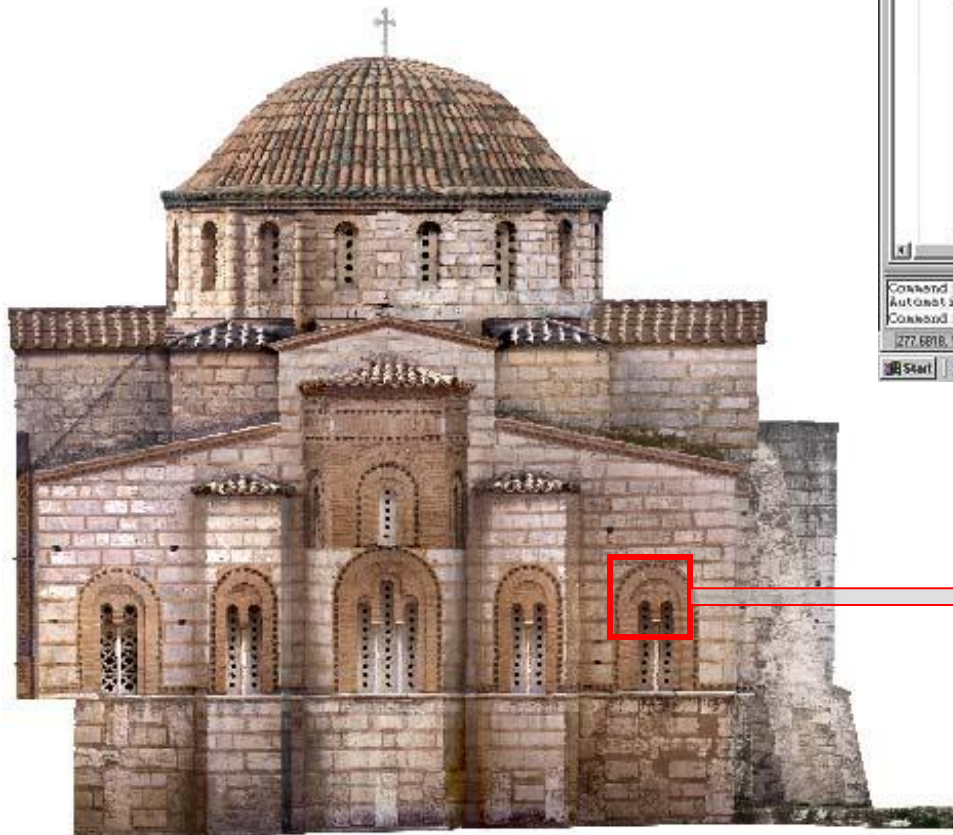
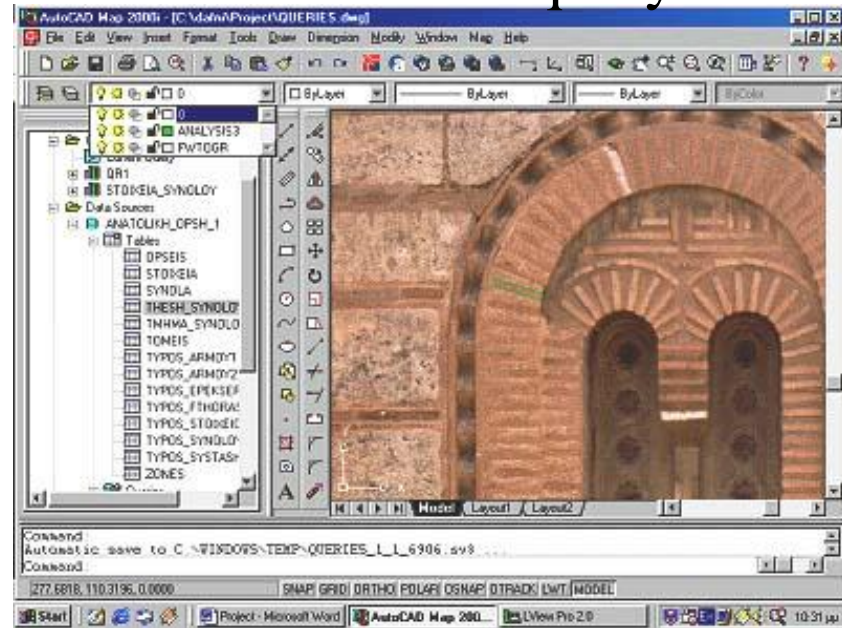


Database Querying



Window
with a SQL
query

Result of the query



Topology Query

Closing Remarks

- ✓ Fast recovering of information and attributes about each element of the monument
- ✓ Ability to relate quantitative and qualitative attributes to each other and to space
- ✓ Re-specification of the database components according to the users' needs

C. Development of a site:

Application on Archaeological site of Mycenae



MYCENAE : Historical Information

- Location: 150km southwest of Athens
- The biggest center of Prehistoric Hellenism 2nd Millennium BC
- Human settlements since 19th century BC, best period:1300-1100BC
- Two disasters: 10th century & 468 BC, final abandonment at Roman Times
- Elements of the Archaeological site:
 - Acropolis 3.2 hectares: ruins of palaces, temples, houses, etc
 - Cyclopean Walls and the famous Lion Gate
 - 60 hectares at the western and south-western side of the Acropolis:
 - Tholos tombs of great art
 - Ruins of buildings, store-houses
- Golden and clay excavation finds

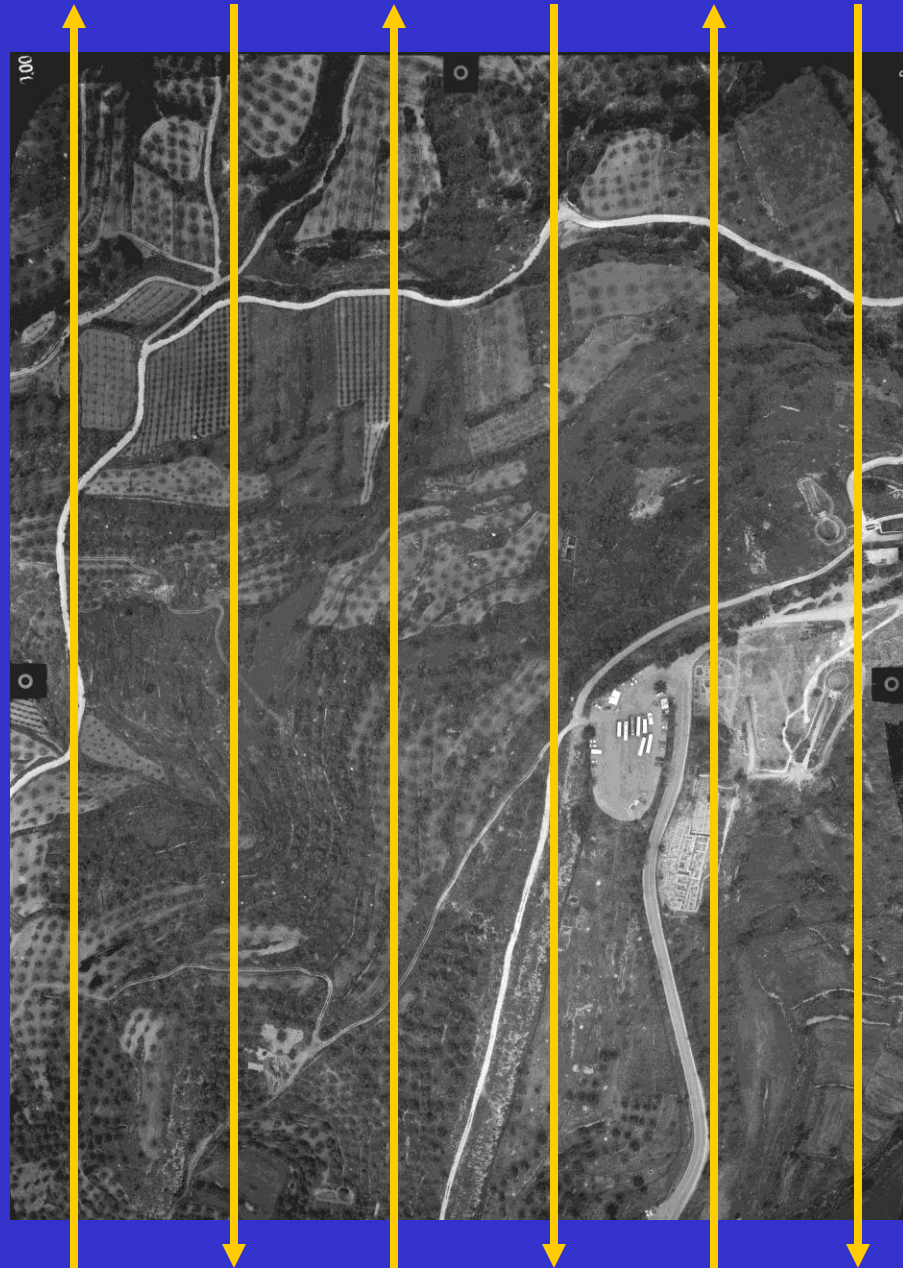
Geometric Recording of the site

Photogrammetric procedures

- Airphotos taken by helicopter (UMK 13x18, c=100mm)
 - 45 photos-6 strips, scale 1:2000
 - 6 photos, scales between 1:500 - 1:1000
 - 7 photos-1 strip, scale 1:600
 - 18 photos- 3 x 6 tombs (semi-destroyed), scales 1:200 – 1:300
- 25 Control Points GPS
- Aerial-triangulation BINGO
- Digital Photogrammetric Stations: SoftPlotter Autometric
 Archis Plus SISCAM
 - Automated DEM, Breaklines
 - Orthophotos & Orthophoto-mosaic
 - Stereo-restitutions

General view of the site

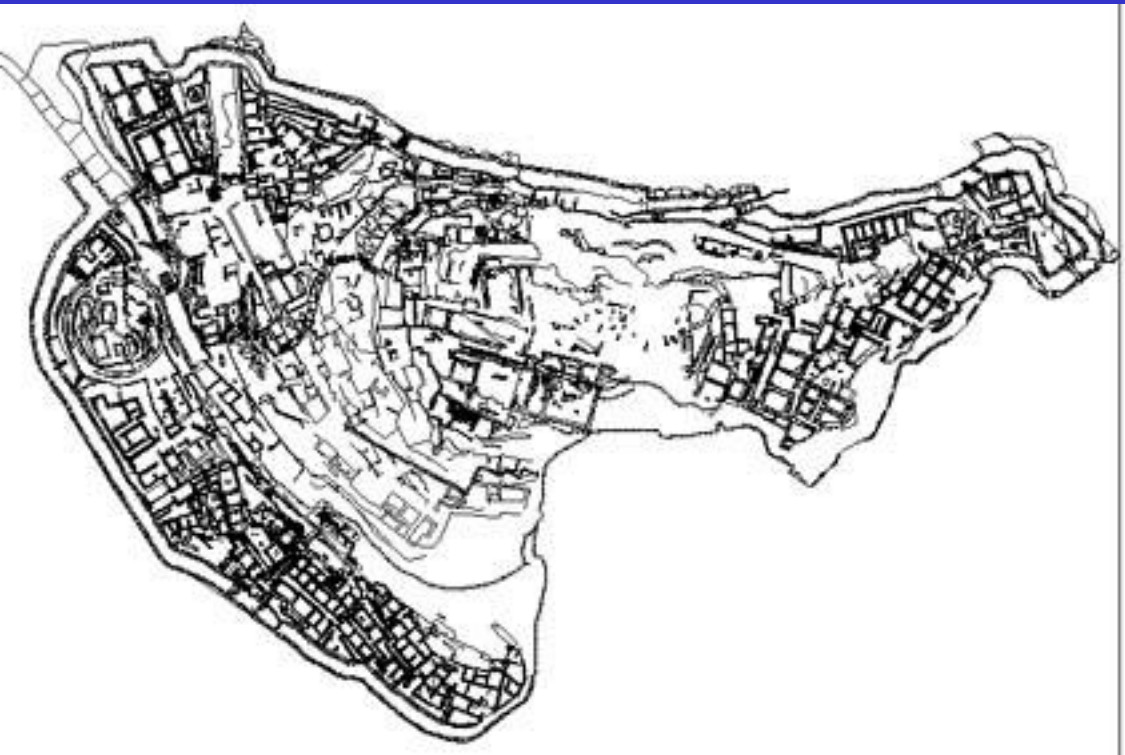
Aerial photo with the flight lines



Photogrammetric procedures

- Terrestrial photos
 - internal parts of the Walls,
 - palace facades,
 - staircases,
 - parts of Grave Circle A
 - internal facades of each one of the Tholos Tombs
- Control Points Field surveys
- Rectifications ARCHIS
- Orthophotos DPS ARCHIS PLUS
- Stereo-compilations DPS Stereometric

2D Vector products



**Planimetry of the
Acropolis**

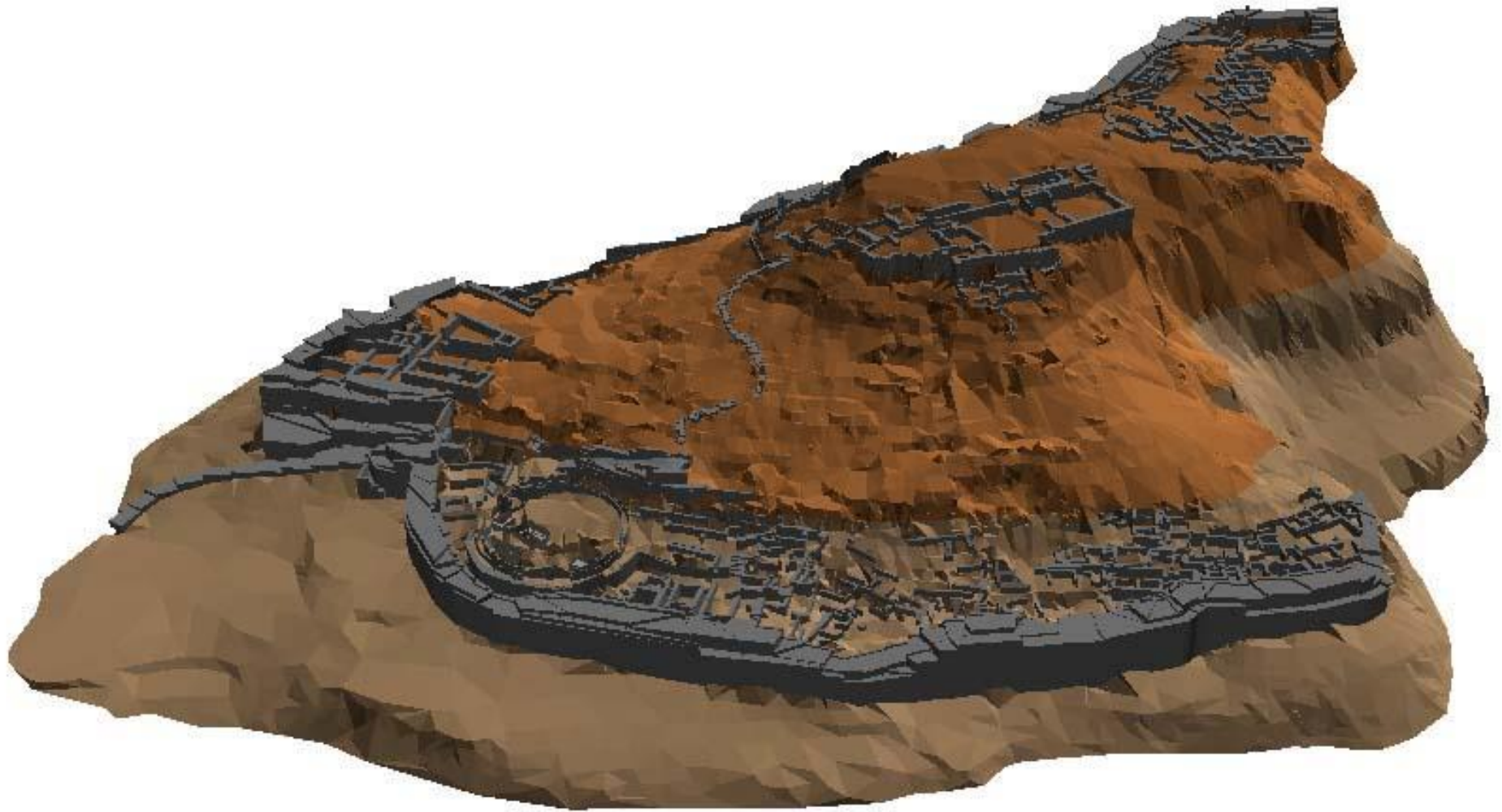
Section of a tomb



3D vector product

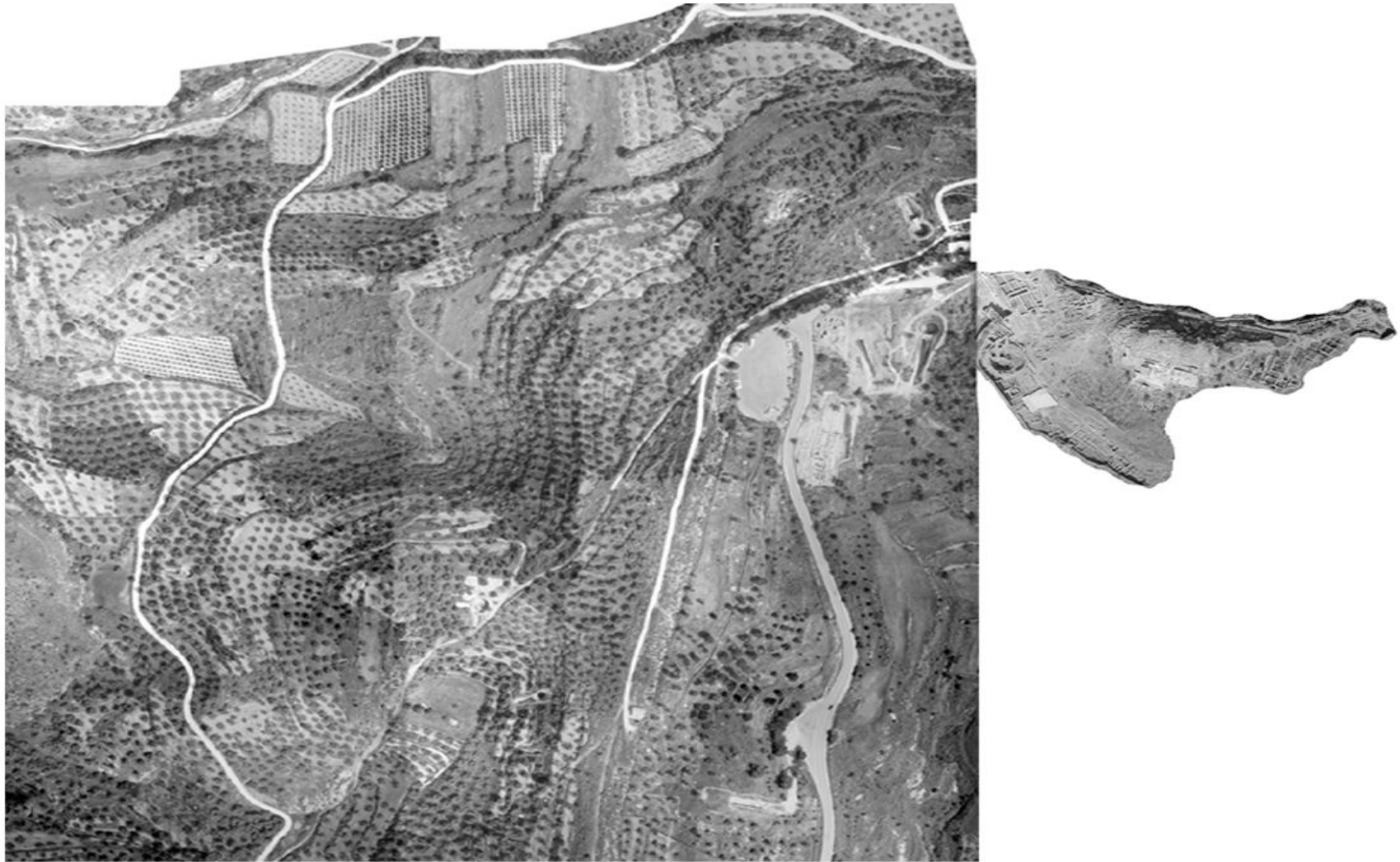


3D view of the vector data of the Acropolis



Produced by AutoCAD & ArcView-3D Analyst

2D raster products



Orthophoto-mosaic of the Archaeological Site

Spatial Information System

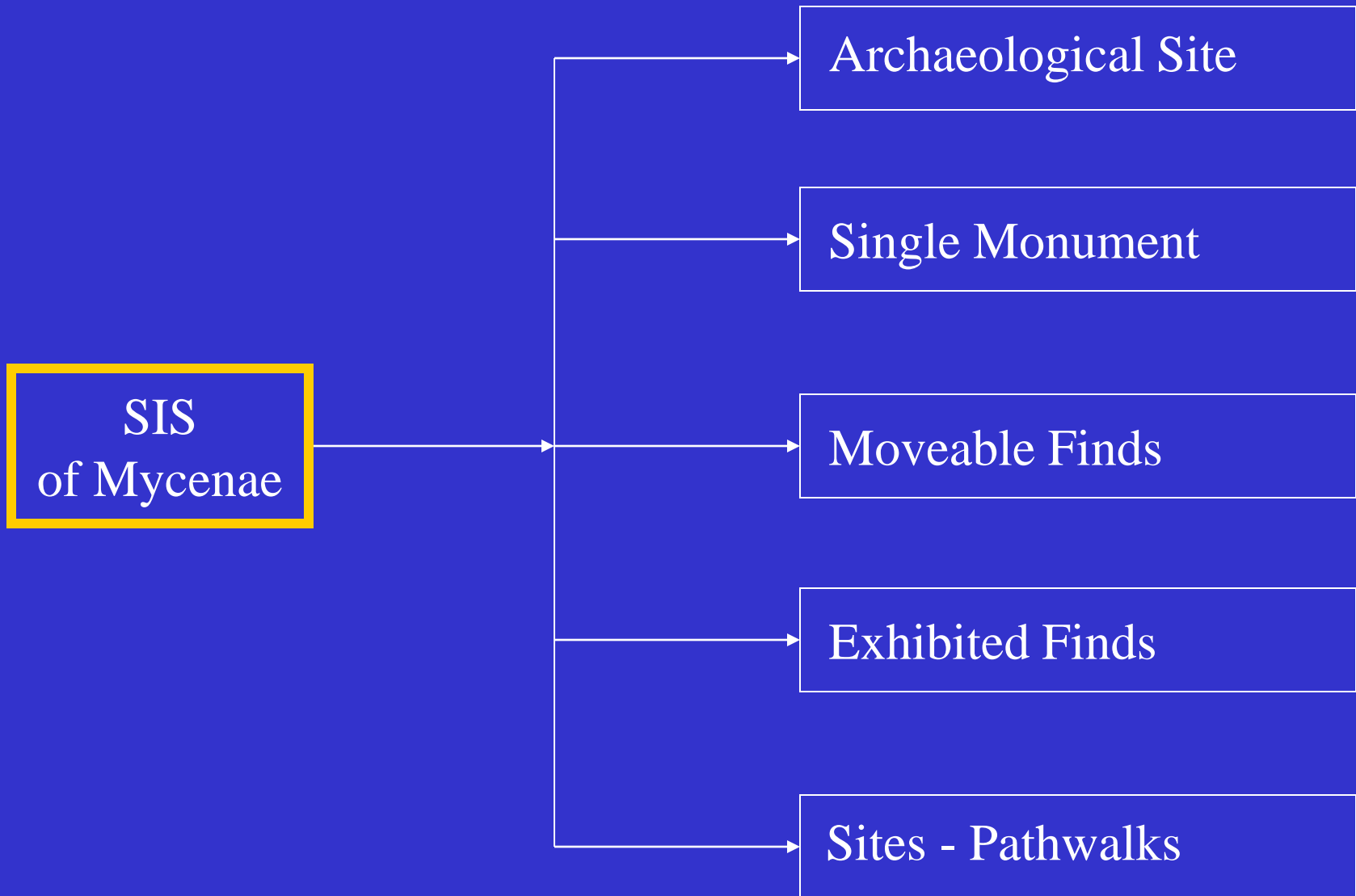
General Principles

- To avoid the unreasonable insert of existing data of large volume
- To make best use of the SIS as a decision making tool both for demonstration purposes and for research support, usable by tourists/visitors and by professionals
- ARCVIEW v3.1 of ESRI with 3D Analyst
3D Studio MAX for model visualization
Adobe Premiere for video producing and editing

Data of the SIS

- All products of the detailed geometric documentation
 - 2D plans
 - 3D viewsat various detail levels, time periods and historic phases
- Texts from historic sources and literature
- Digital images
 - recent or old photos
 - excavation photos
 - old graphs
 - recreations of the site
 - video
- Videos of tour paths with a pre-defined walk-through and flyovers

STRUCTURE OF THE SIS (1)





Spatial Information System

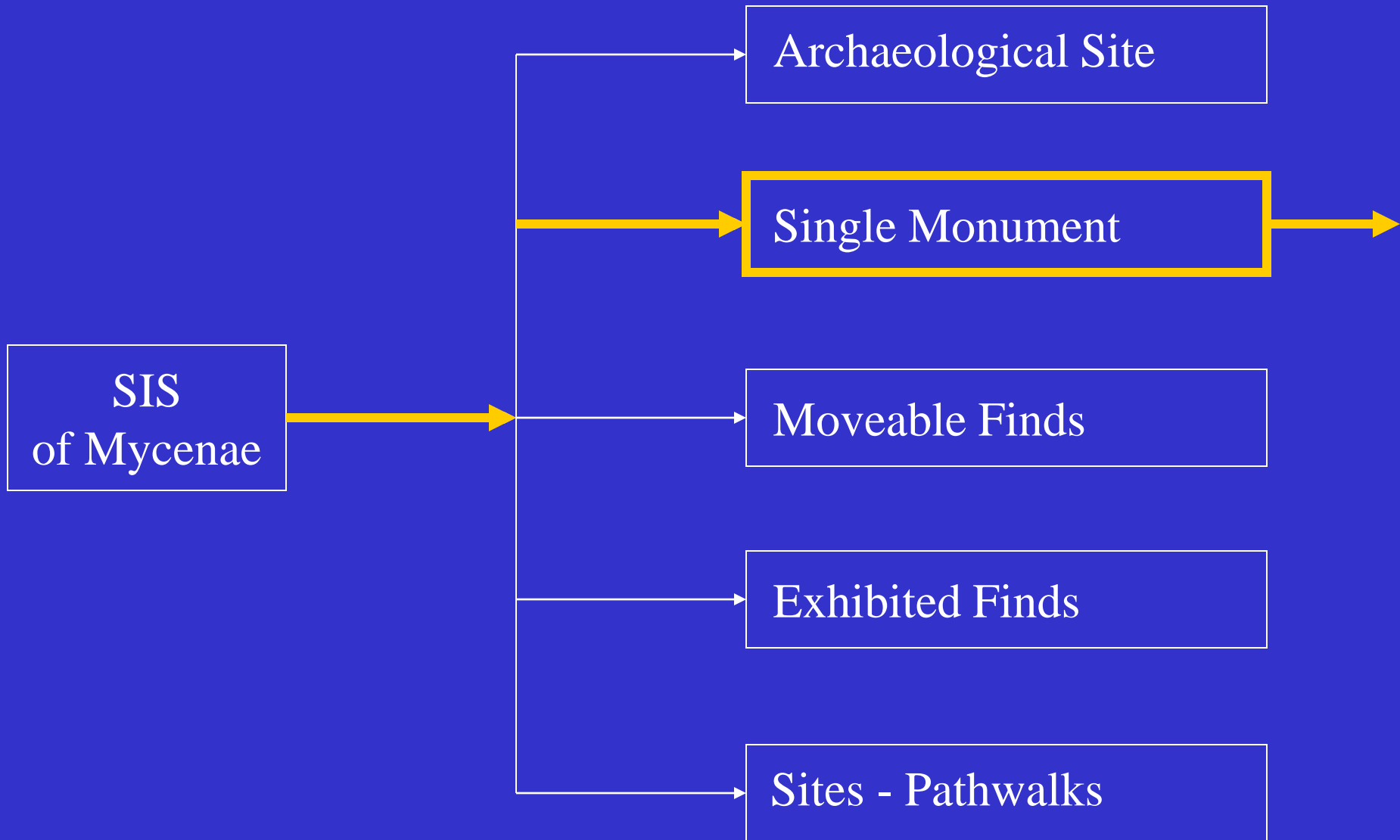
for the

Archaeological Site of

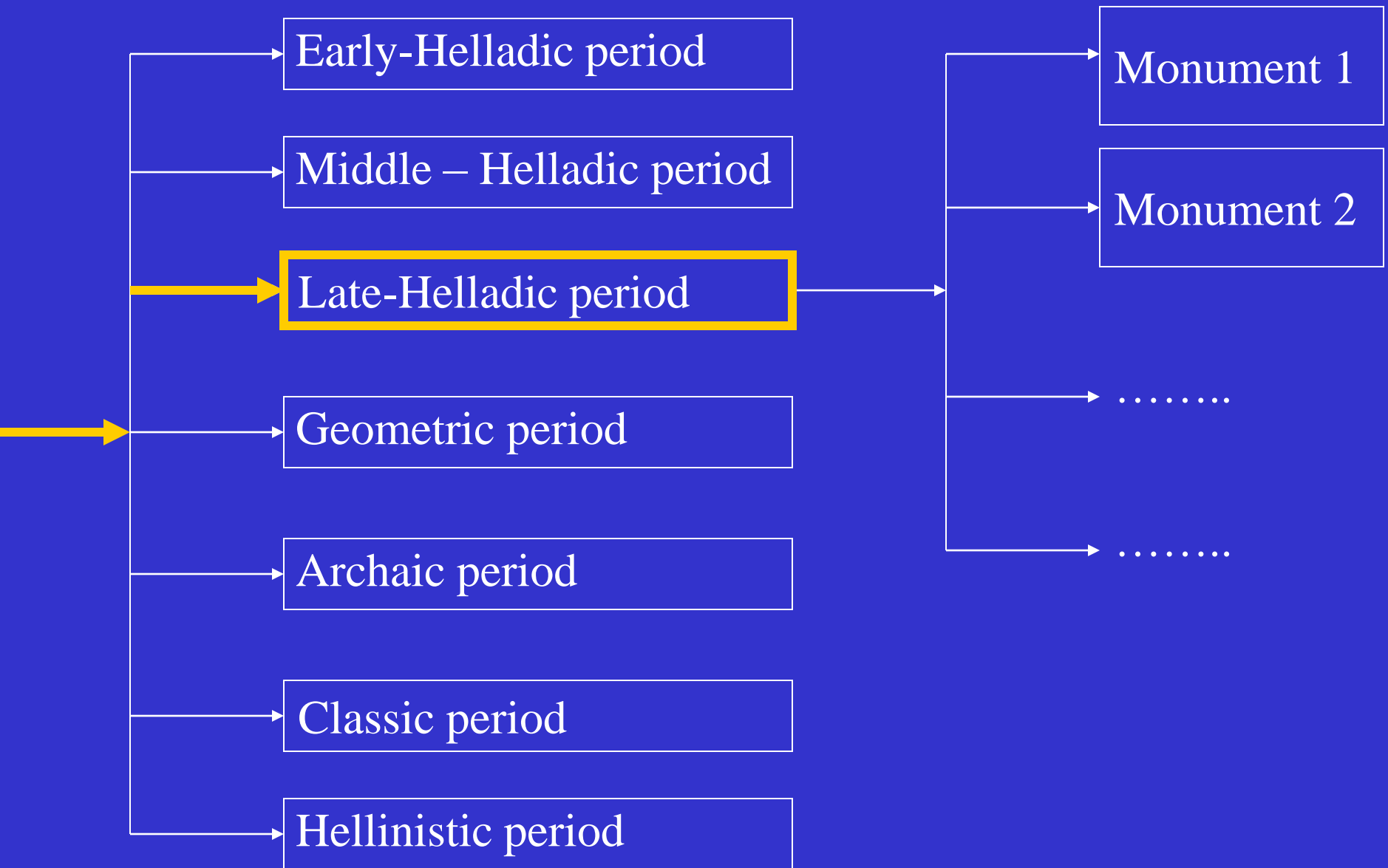
MYCENAE



STRUCTURE OF THE SIS (1)



STRUCTURE OF THE SIS (2)





Lion Gate

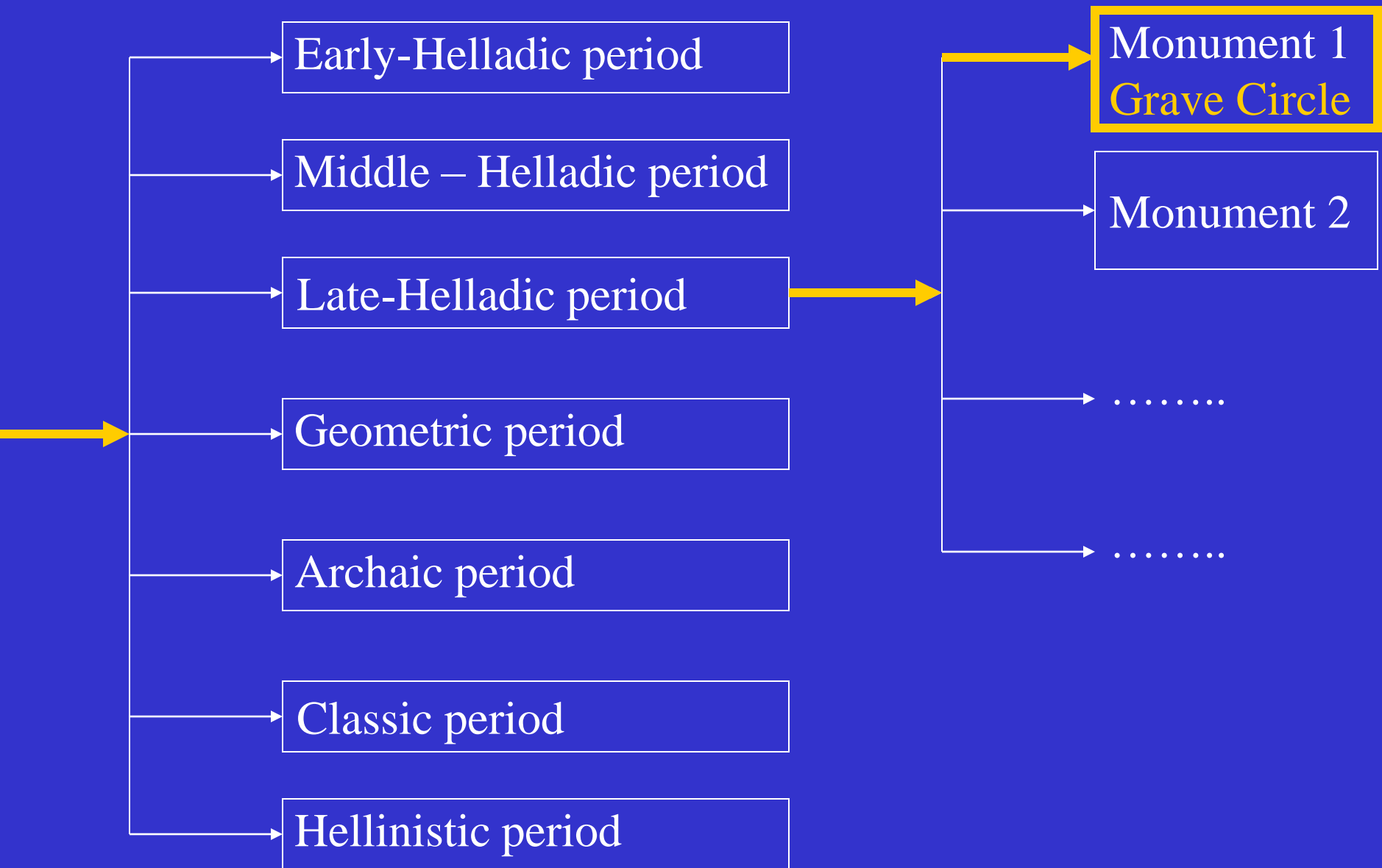
SE Extension

**Grave
Circle A'**

Palace

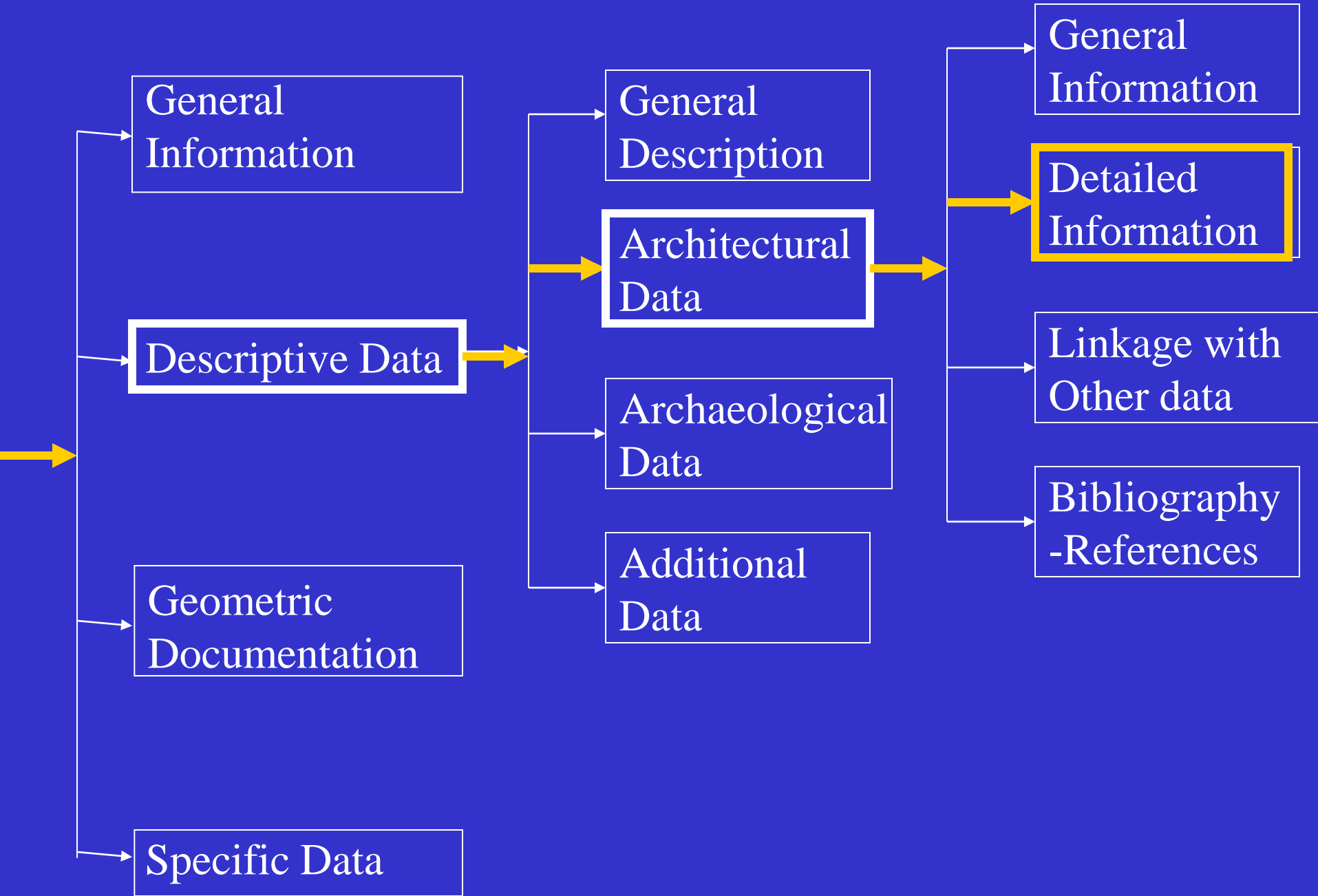
House of Columns

STRUCTURE OF THE SIS (2)

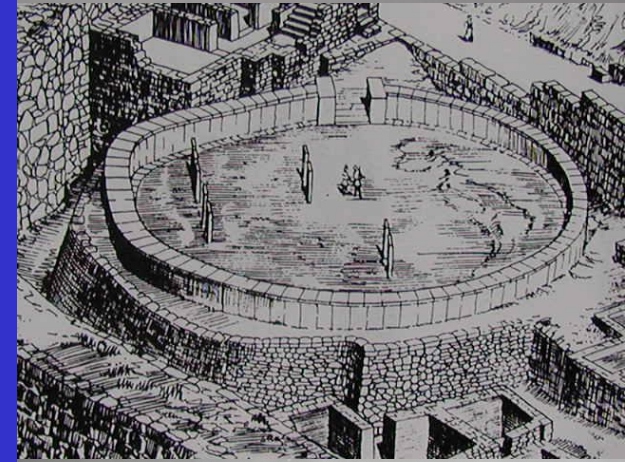
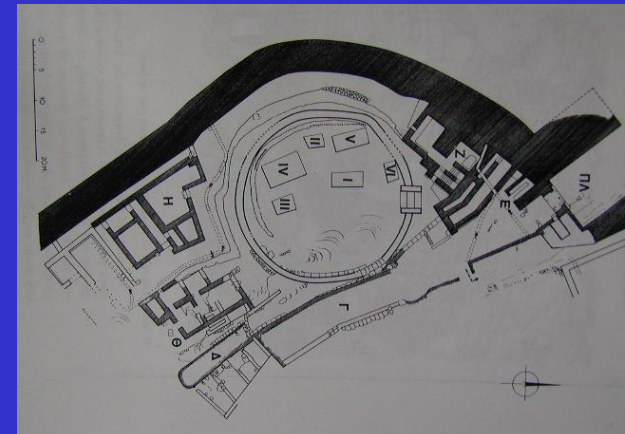
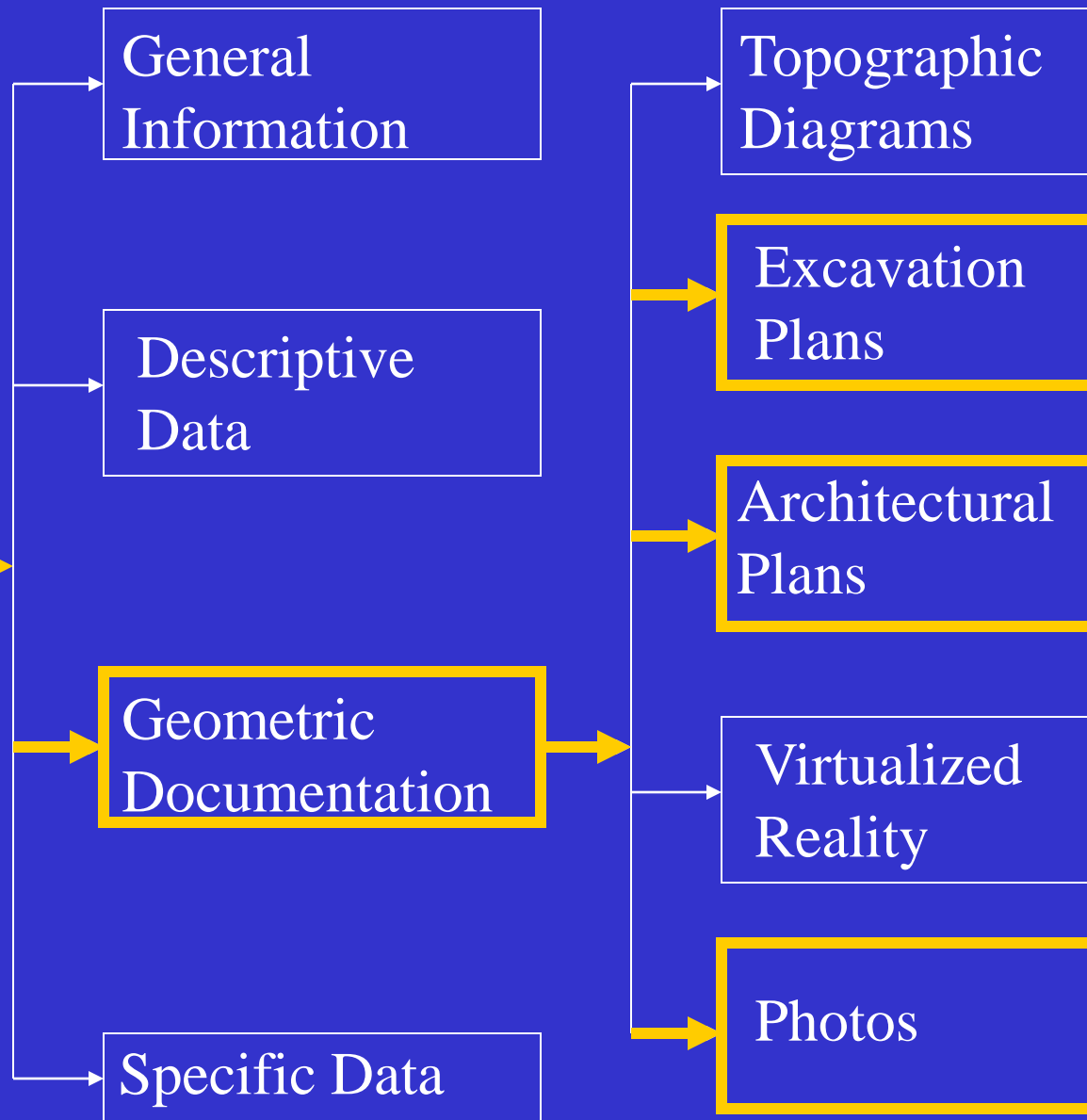




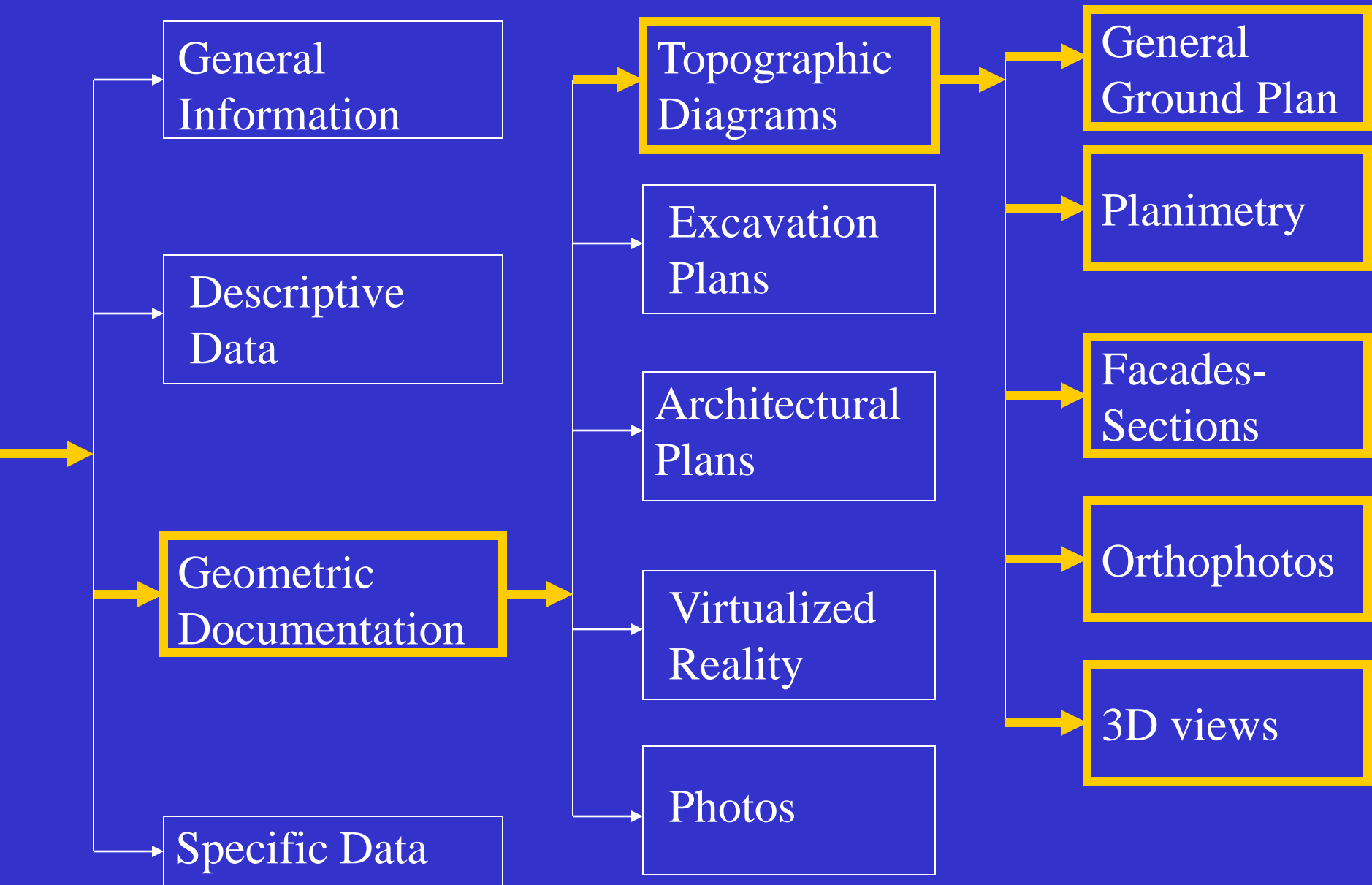
STRUCTURE OF THE SIS (3)

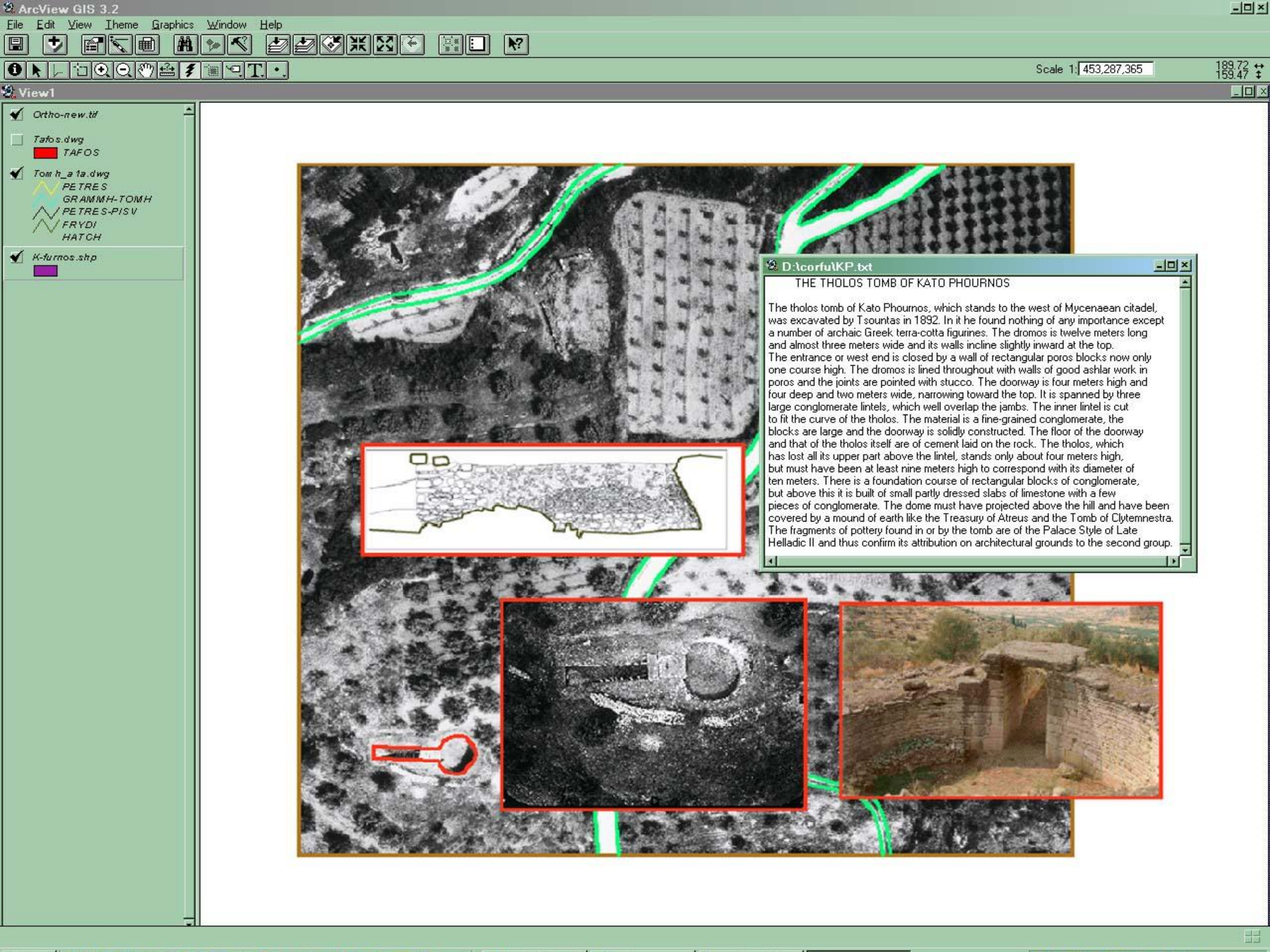


STRUCTURE OF THE SIS (4)

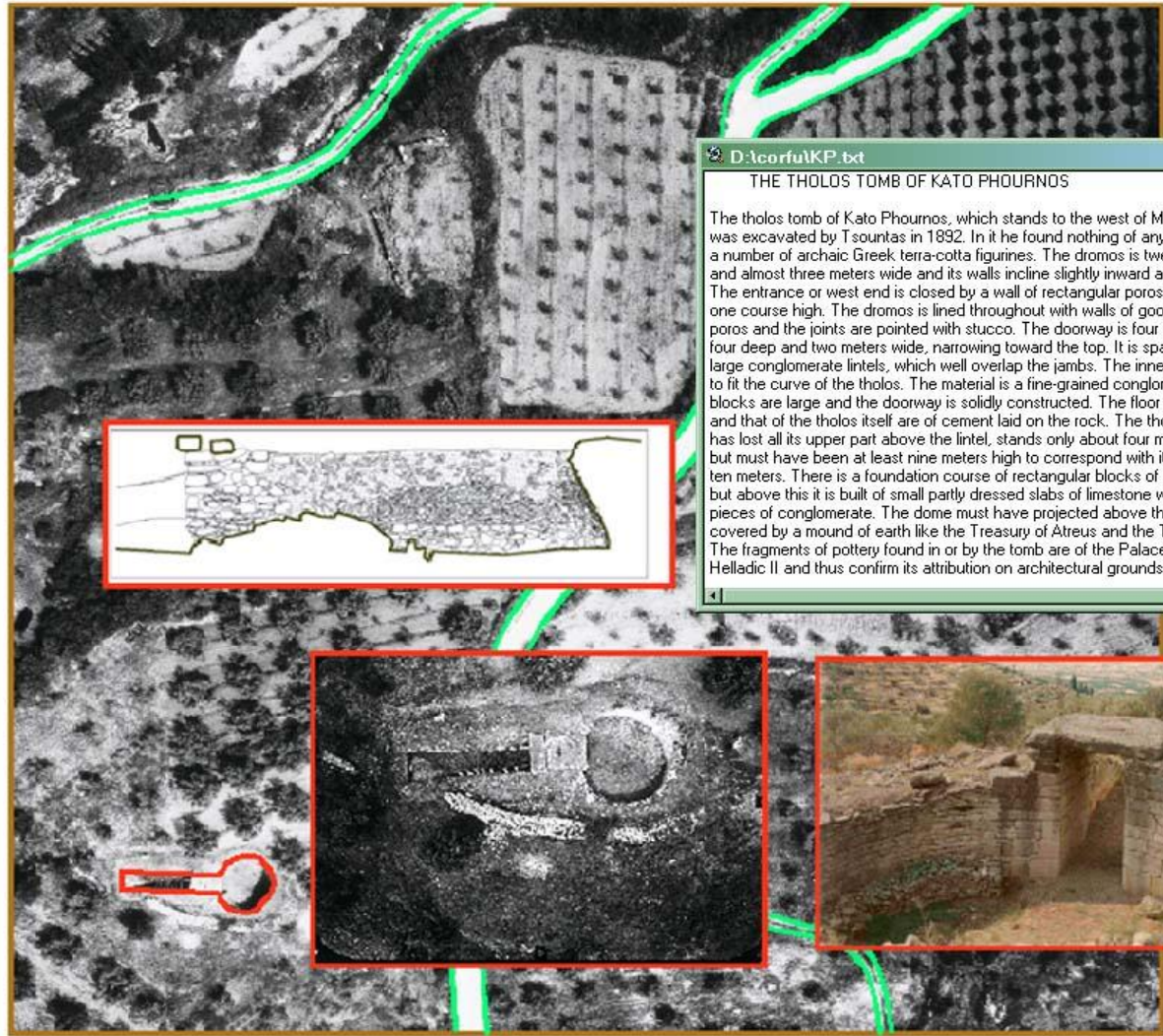


STRUCTURE OF THE SIS (4)





- ✓ Ortho-new.tif
- Tafos.dwg
 - TAFOS
- ✓ Tom_h_a_1a.dwg
 - ▲ PETRES
 - ▲ GRAMMH-TOMH
 - ▲ PETRES-PISV
 - ▲ FRYDI
 - ▲ HATCH
- ✓ K-furnos.shp
 -



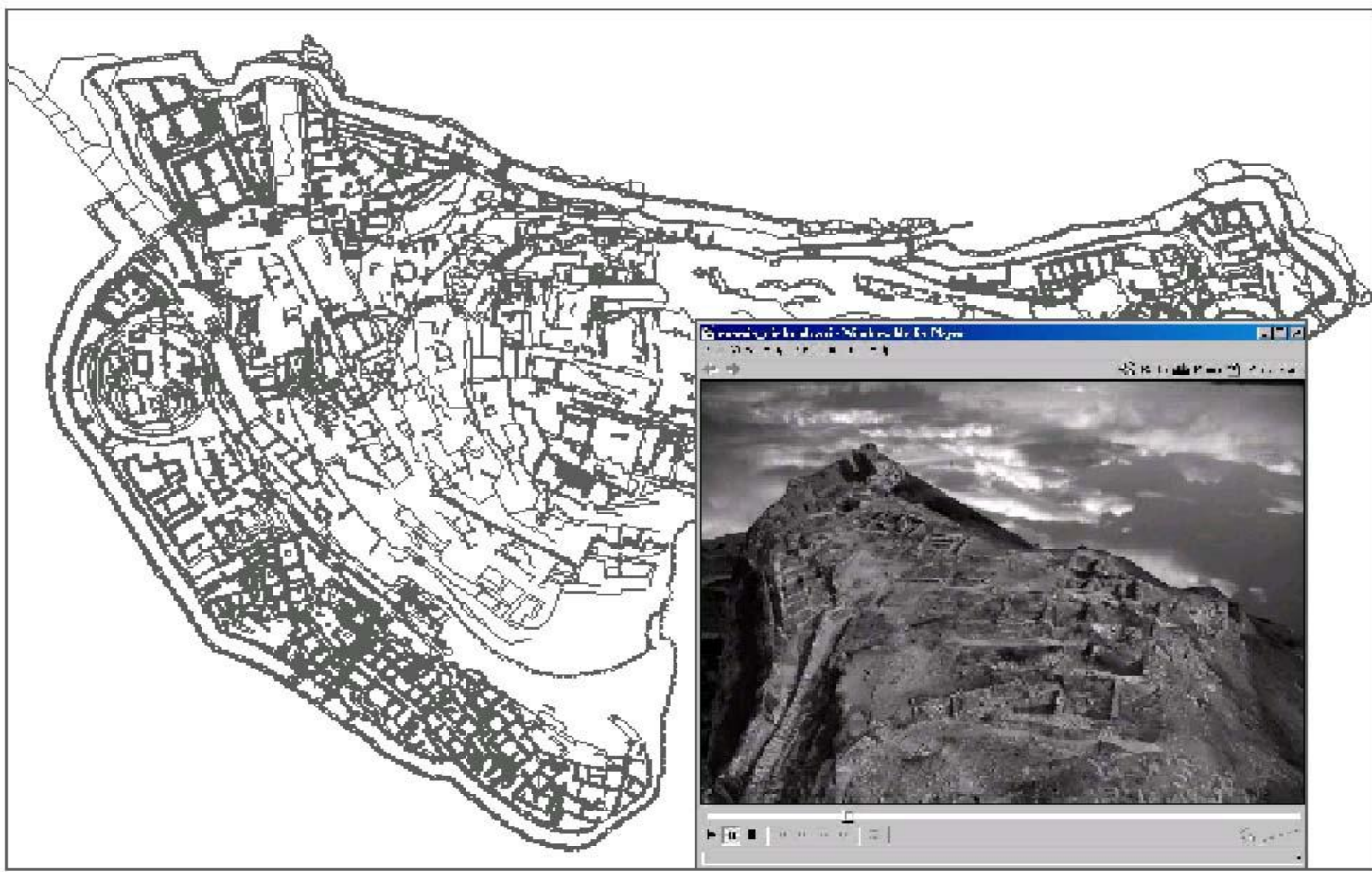
D:\corfu\KP.bt
THE THOLOS TOMB OF KATO PHOURNOS

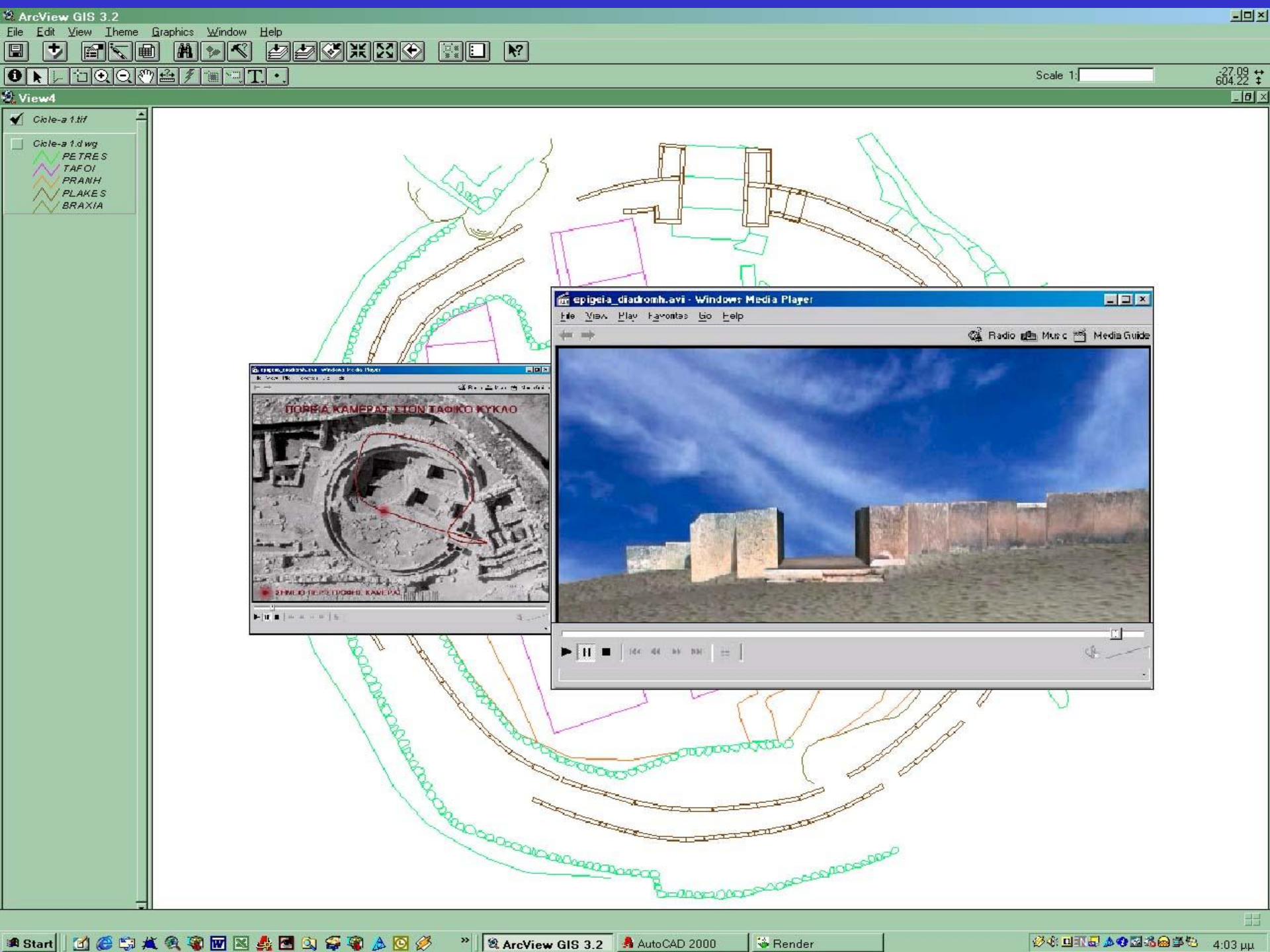
The tholos tomb of Kato Phournos, which stands to the west of Mycenaean citadel, was excavated by Tsountas in 1892. In it he found nothing of any importance except a number of archaic Greek terra-cotta figurines. The dromos is twelve meters long and almost three meters wide and its walls incline slightly inward at the top. The entrance or west end is closed by a wall of rectangular poros blocks now only one course high. The dromos is lined throughout with walls of good ashlar work in poros and the joints are pointed with stucco. The doorway is four meters high and four deep and two meters wide, narrowing toward the top. It is spanned by three large conglomerate lintels, which well overlap the jambs. The inner lintel is cut to fit the curve of the tholos. The material is a fine-grained conglomerate, the blocks are large and the doorway is solidly constructed. The floor of the doorway and that of the tholos itself are of cement laid on the rock. The tholos, which has lost all its upper part above the lintel, stands only about four meters high, but must have been at least nine meters high to correspond with its diameter of ten meters. There is a foundation course of rectangular blocks of conglomerate, but above this it is built of small partly dressed slabs of limestone with a few pieces of conglomerate. The dome must have projected above the hill and have been covered by a mound of earth like the Treasury of Atreus and the Tomb of Clytemnestra. The fragments of pottery found in or by the tomb are of the Palace Style of Late Helladic II and thus confirm its attribution on architectural grounds to the second group.



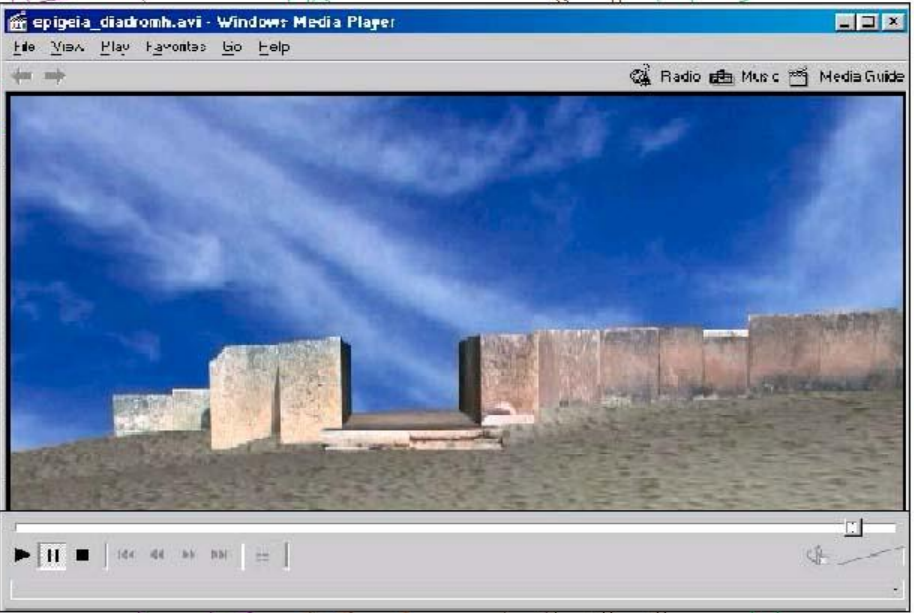
View2

- ✓ Katoch-14.dwg
 - 232-240
 - 240-250
 - 250-260
 - 260-270
- ✓ Flyover.tif
- ✓ T-test.dwg
 - PETRES
 - GRAMMH-TOMHS
 - PETRES-PISV
 - FRYDI
 - HATCH





- ✓ Cikle-a 1.tif
- Cikle-a 1.dwg
- PEΤRES
- TAFOI
- PRANH
- PLAKES
- BRAXIA



Conclusions

- **Traditional methods** for the documentation of the archaeological sites **are changing radically** due to the use of Spatial Information Systems
- There is a need for **3D recording, editing and visualisation** for applications on monuments despite the fact that the 3D processes are laborious and time-consuming
- **Integration** of all types of data should be possible and encouraged
- The implementation of an **Archaeological SIS** confronts the monument and the related pieces of information in a unique way; it contributes essentially to the study of the monument