Coastal Survey of archaeological sites using drones

In Poseidon's Realm XXI

Underwater archaeology - interdisciplinary approaches and technical innovations

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Presentation layout

- Introduction in mapping with drones
- Water refraction and limitations in coastal areas
- Proposed algorithm
- Testing against bathymetric Lidar data in ancient Amathounta site
- Implementation in Ag. Napa coast

Mapping with drones: Photogrammetric Products

Three main products:

- Stereoplotting and vector plots
- Digital Surface Models
  - Or Image Based 3D Modelling (IBM)
- Ortho Photo Mosaics
  - Corrected from central projection
  - Corrected from elevation distortion
  - Color corrected mosaic
  - Uniform scale and high detail

Orthophoto vs sketch and vector plot

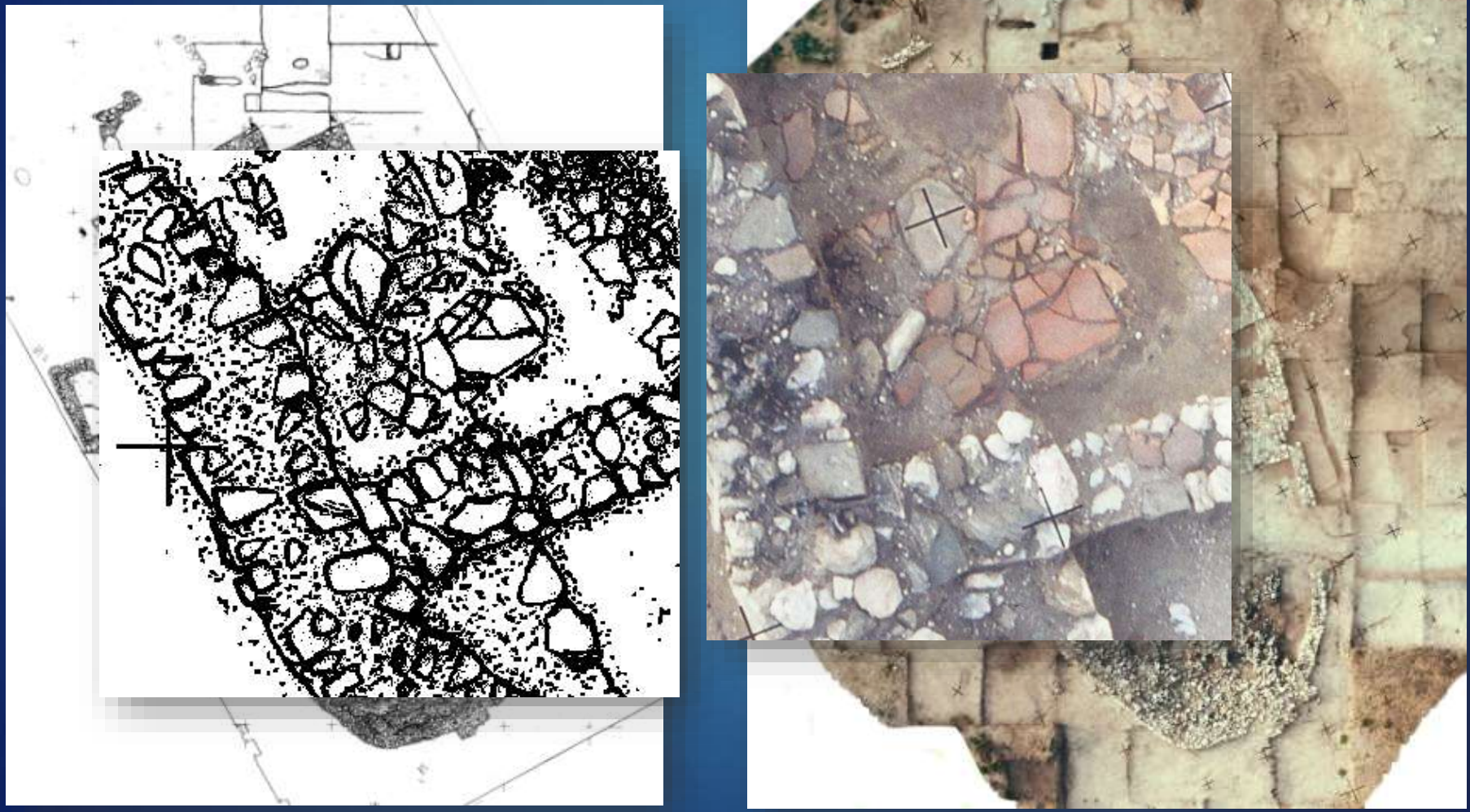


Photo platforms 1/2

Mapping with drones: Wide adoption

Two major advancements:

- Navigation automation with GPS, on multi-copters and fixed wing AUAV
  - Strong cost reduction after wide adoption
- Software automation
  - Simple
  - Easy
  - Fully automated 3D modelling
  - hence more users, wider adoption of technique

… make one revolution!

AUAVs: Current photo platform

- Several names
  - UAV, AUVs
  - UAS
  - Drones
- Specs
  - Range and flying time
  - Load capacity
  - Automations

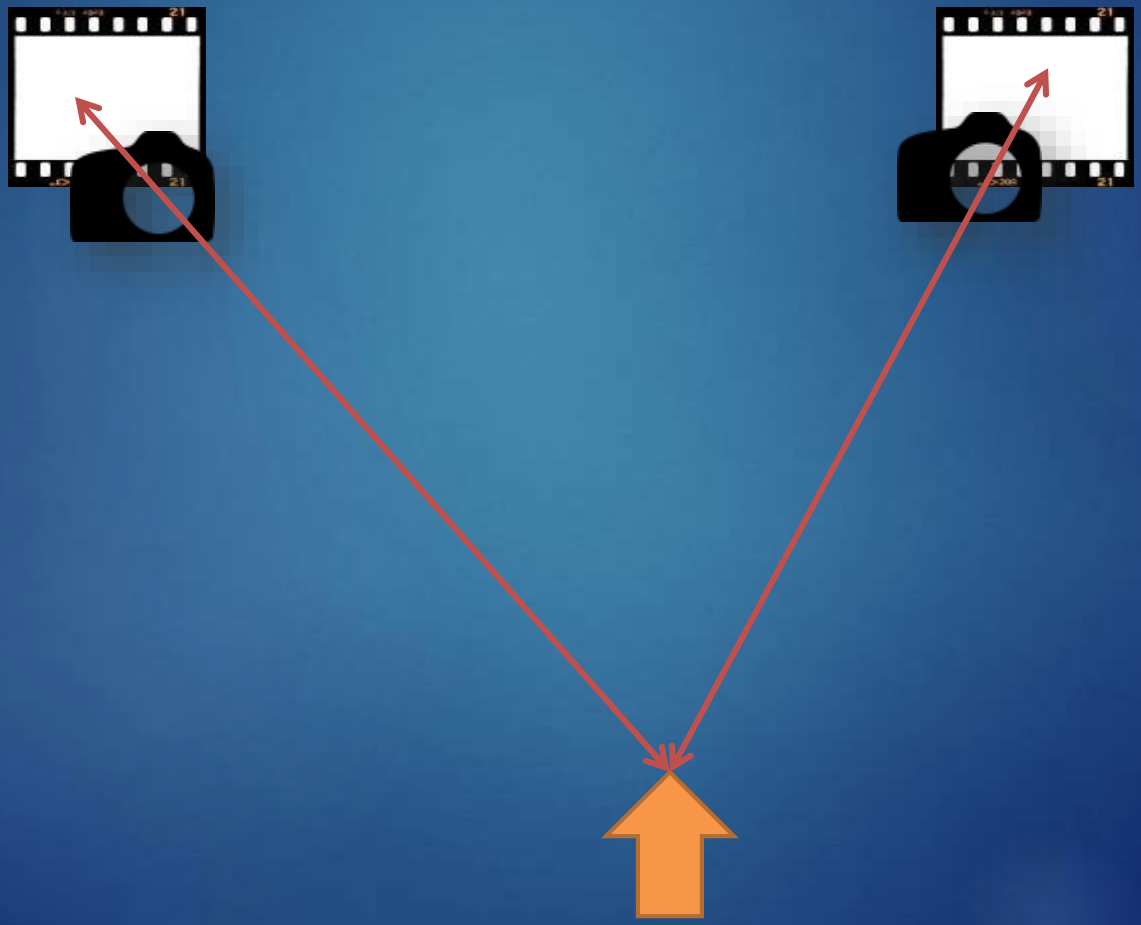
Mapping with drones Perfect tool?

Seems so, …, so far:

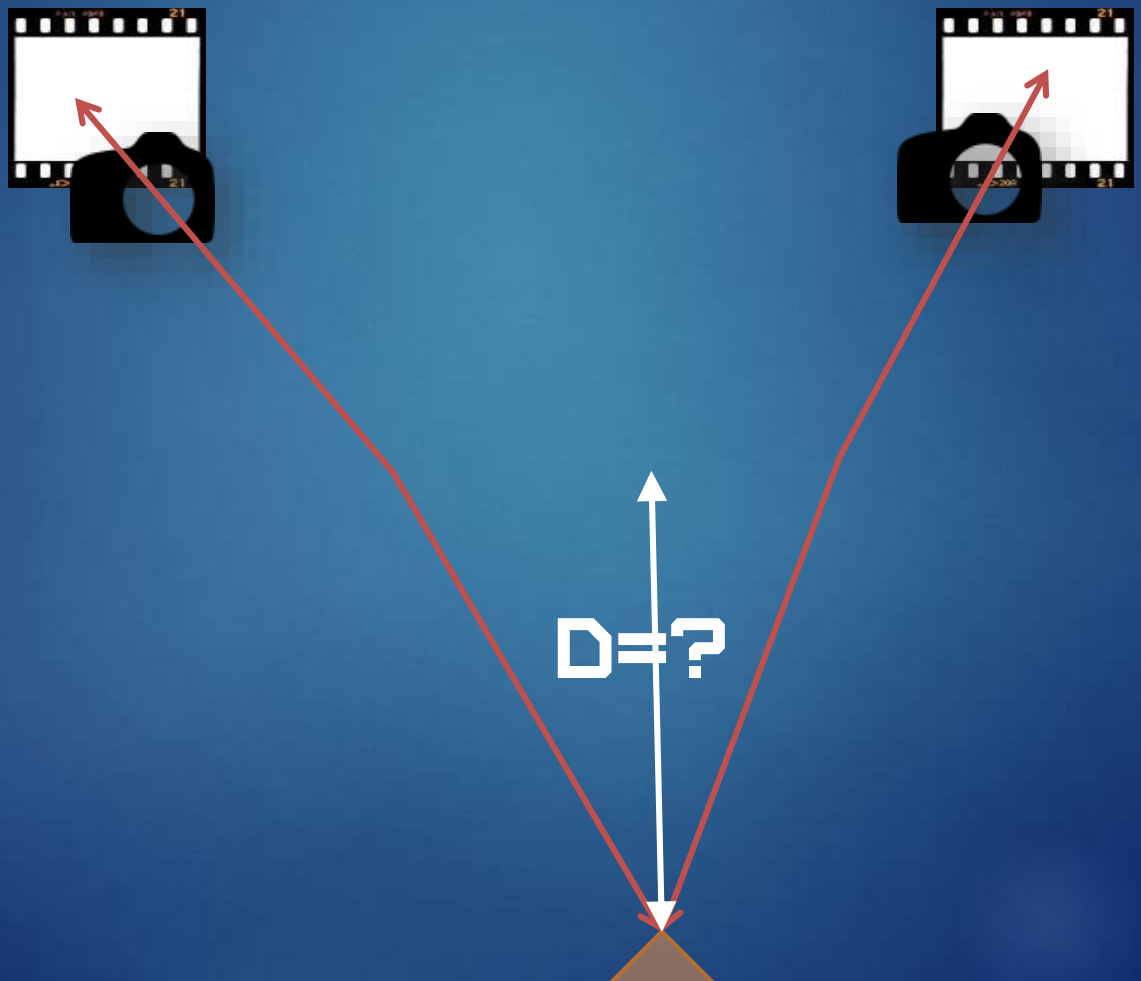
- Cost effective (automation)
- Fast acquisition and processing (auto)
- Accurate 3D model
- Versatile level of detail
- Adopted by non experts
- Provide much more visual information (orthophotomaps and textured 3D models)
- Support interpretation and understanding of the relationship among neighboring sites, finds, areas, in a context rich map

Initial considerations

Major problem: water refraction



Major problem: water refraction

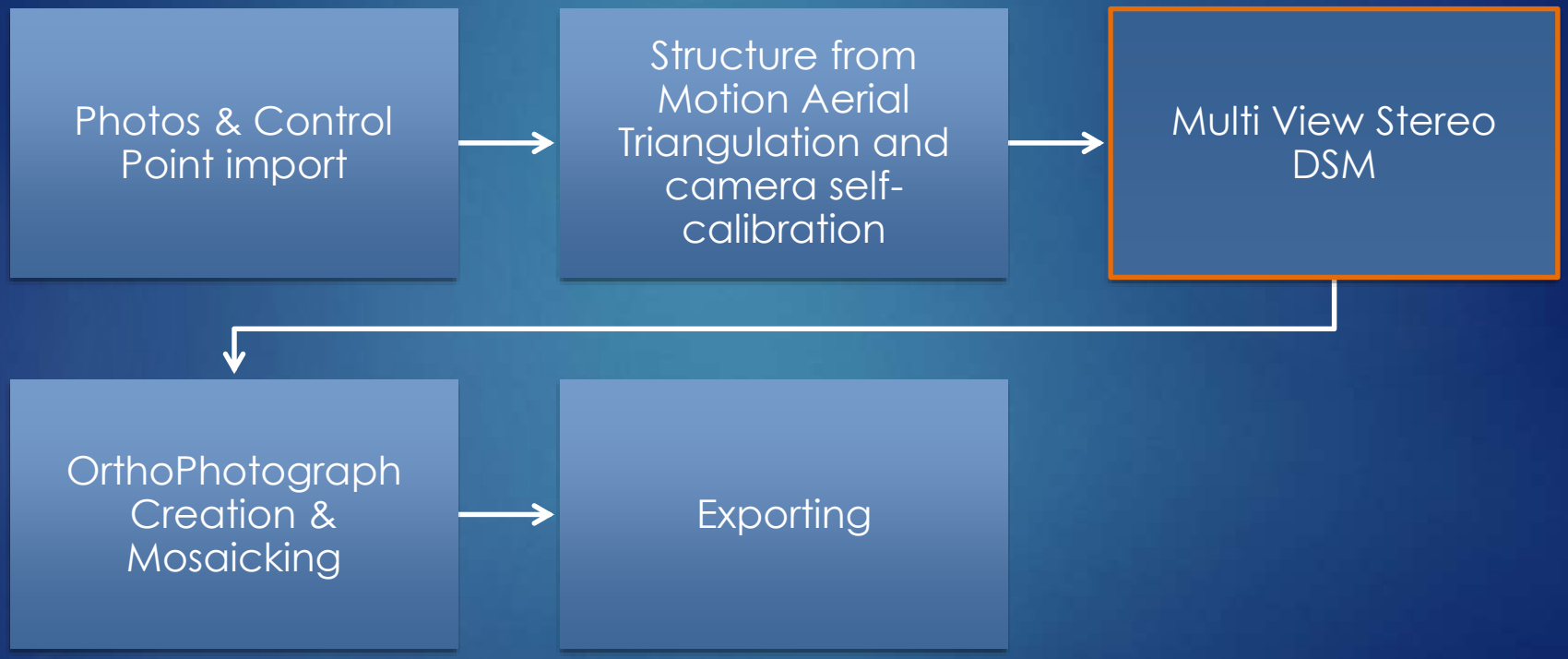


Anything below sea surface is wrong!

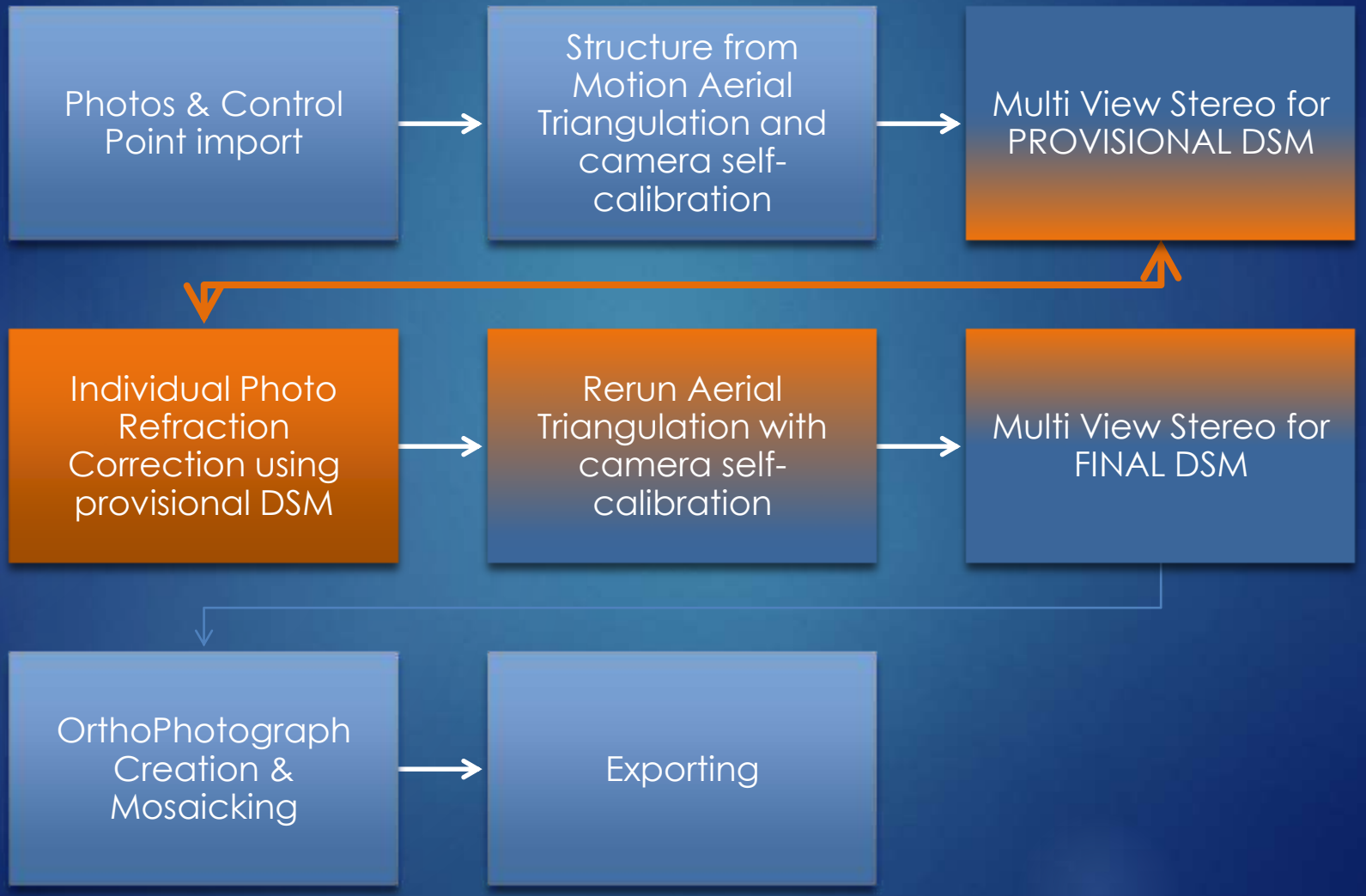
Solution

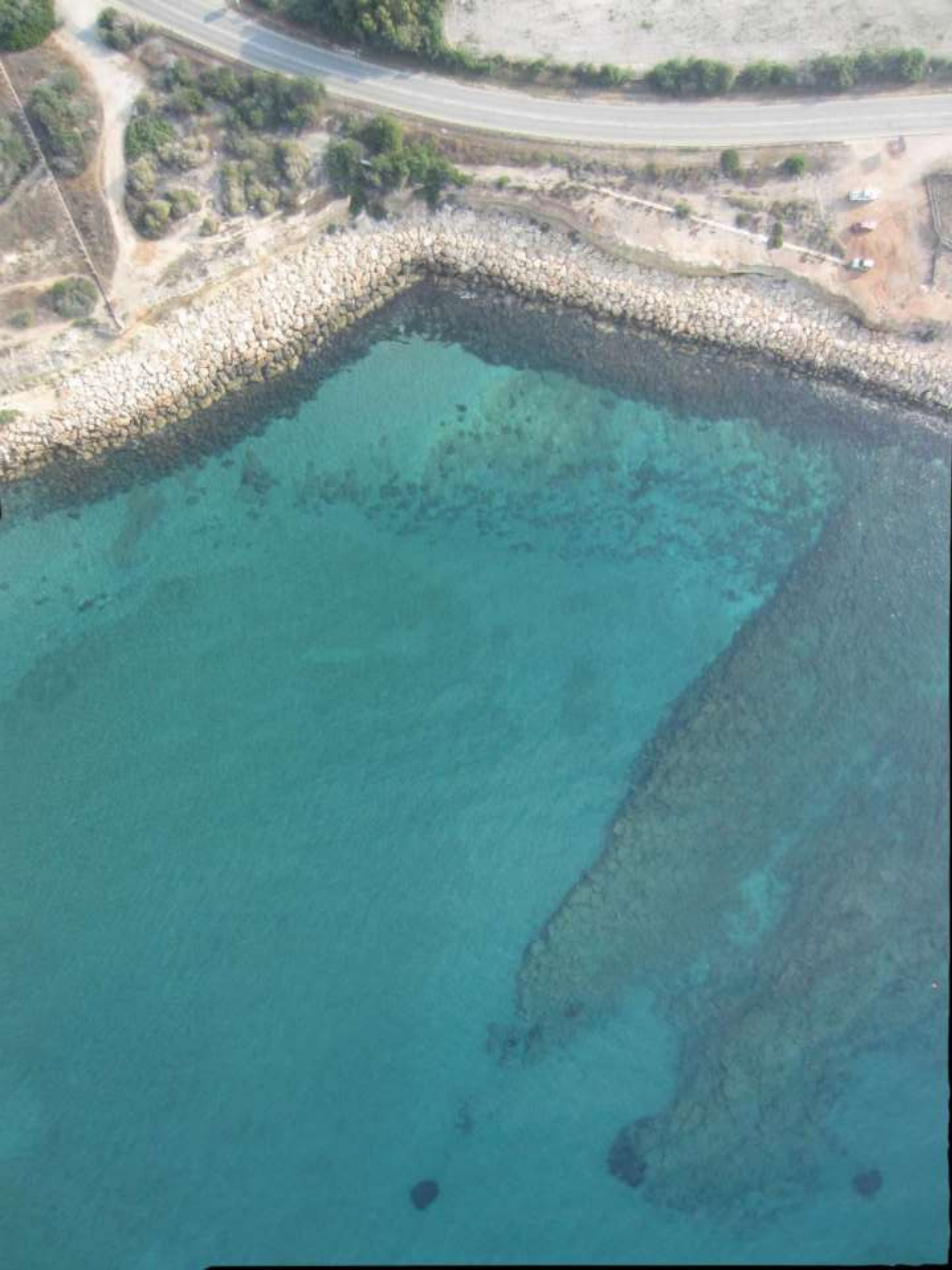
- Each image area covered with water, should be treated for refraction
  - Either analytically or image based correction
- Since depth is needed for refraction correction, and we do not know it, we have to adopt an iterative process
- The final process should be a slight modification of standard practice (and software)

Standard algorithm



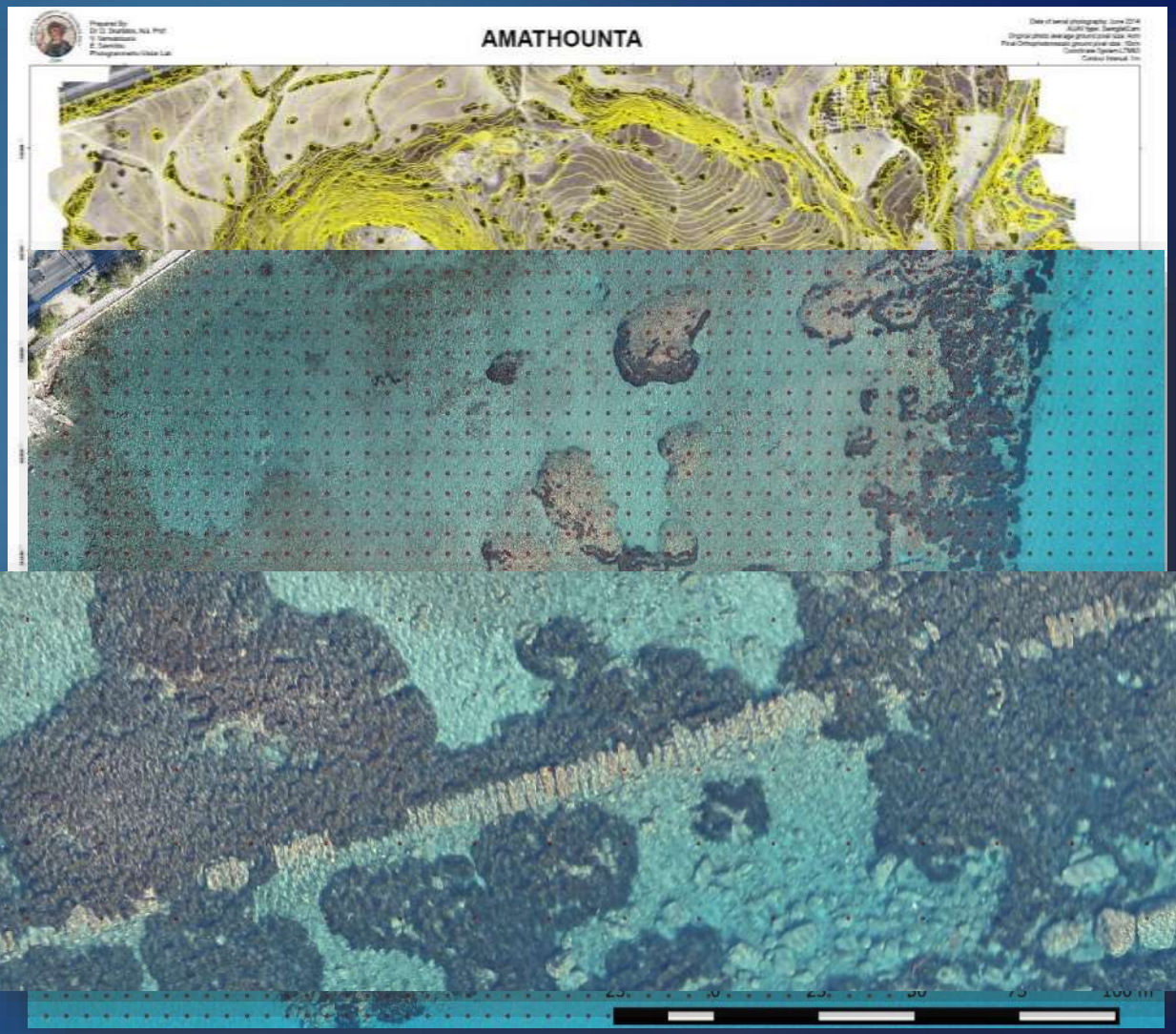
Proposed algorithm





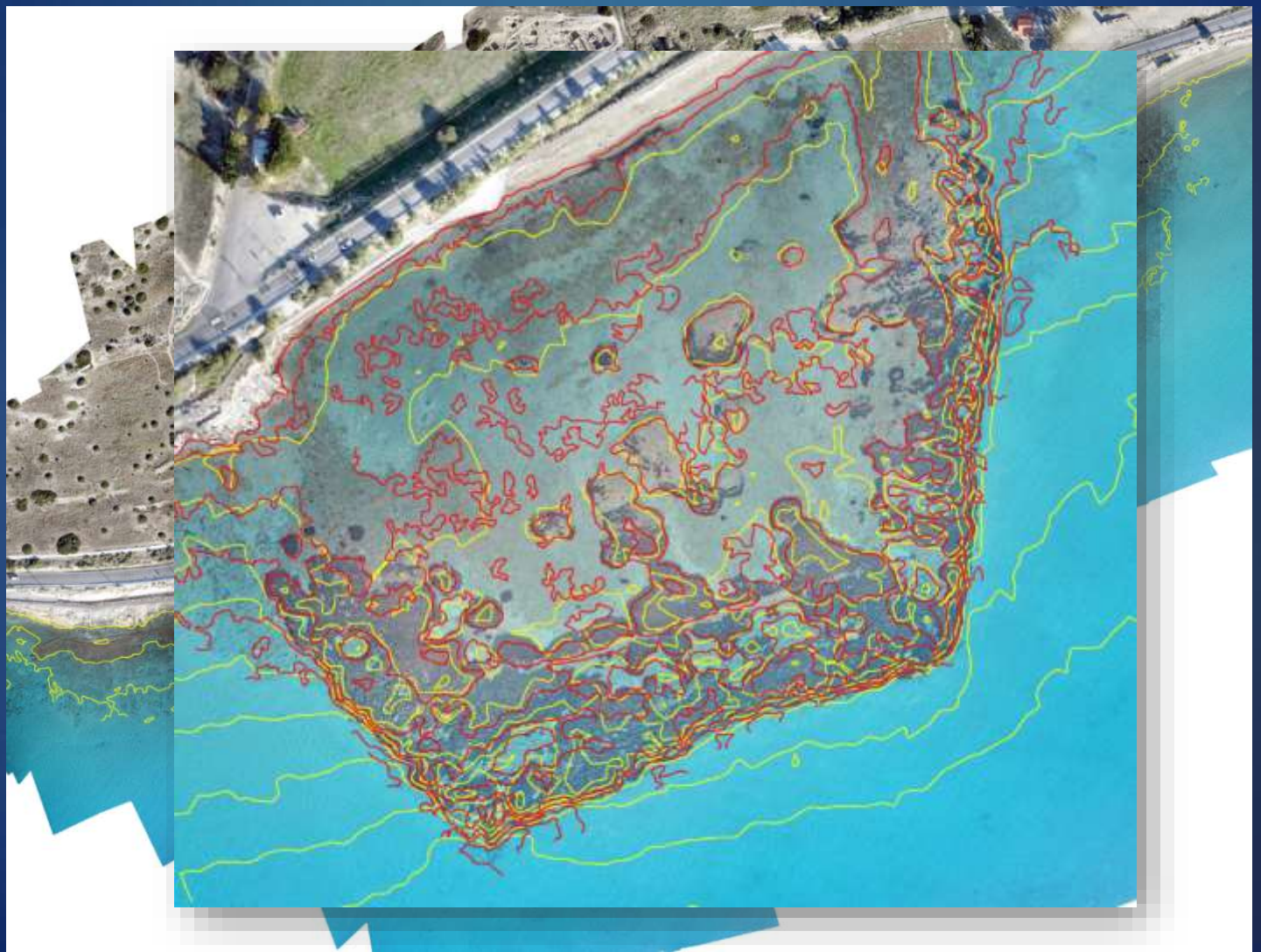
Test site: Amathus

- Large archaeological area, with different sites
  - Useful to Dept. Antiquities
- Lidar depth data
  - 5m grid
  - ~0.10m depth accuracy



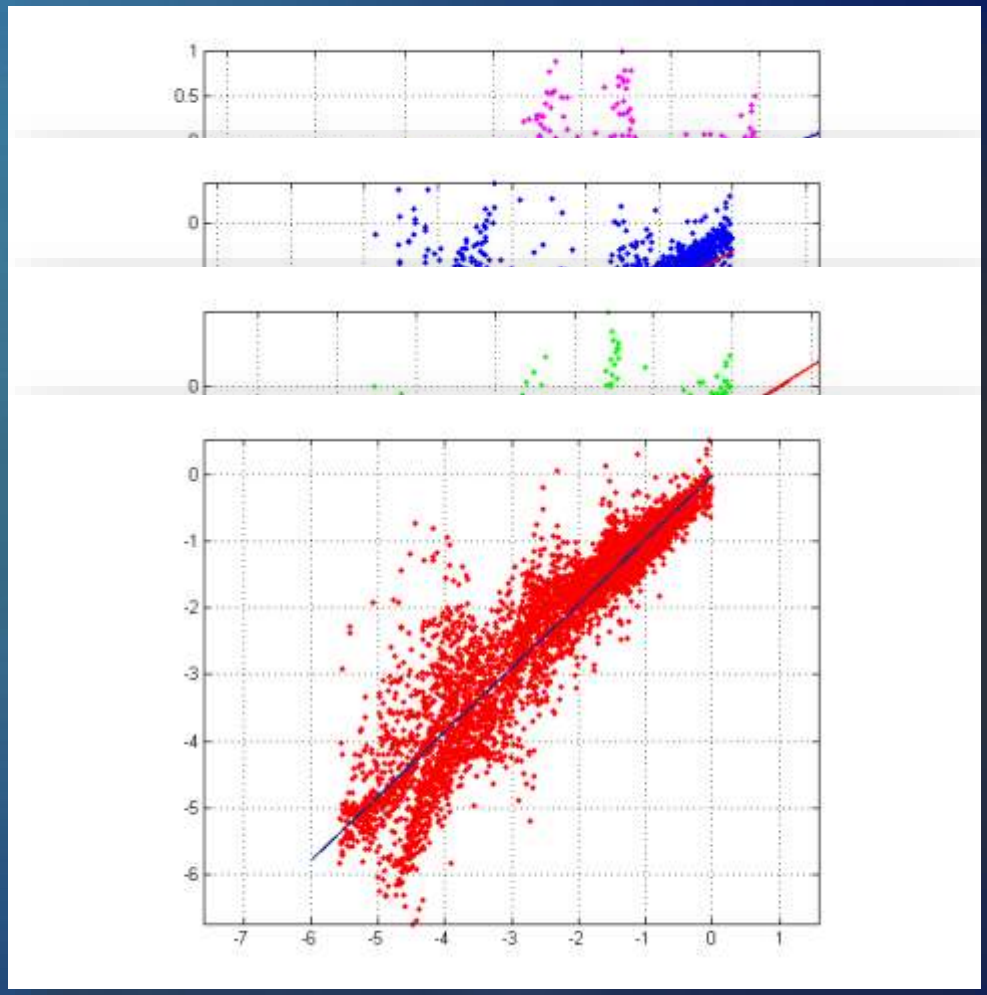
Underwater harbour

Initial and final contours vs Lidar contours

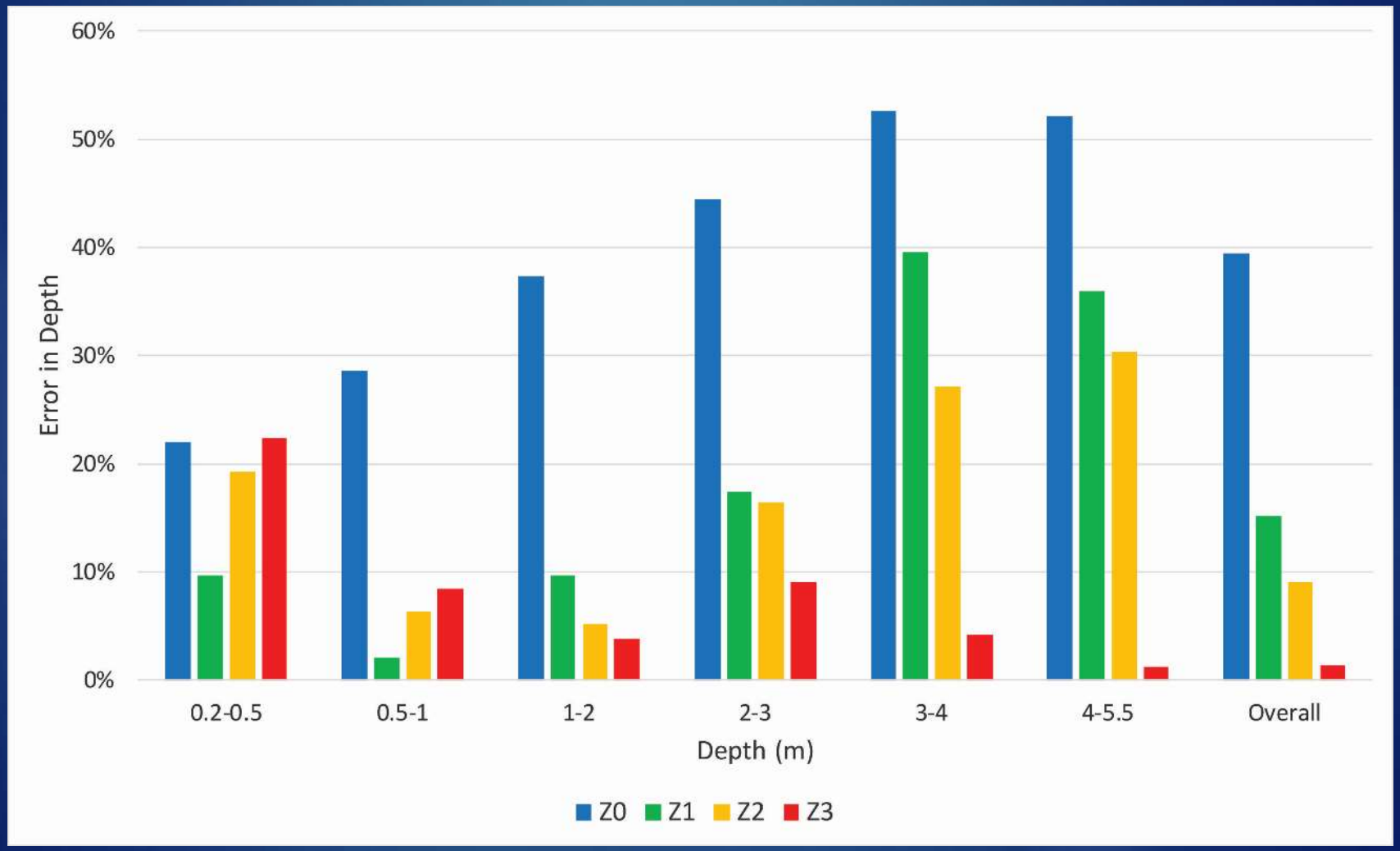


Checking against ~5500 Lidar points

Iteration	Mean [m]	Standard deviation [m]	Percentage %	RMS [m]
0	1.07	0.92	39.5	1.41
1	0.60	0.93	15.6	1.10
2	0.46	0.74	9.1	0.87
3	0.08	0.53	-1.4	0.53



Depth improvement vs depth



Ag. Napa, application site Archaeological survey

New marina development area

Ag. Napa, implementation site

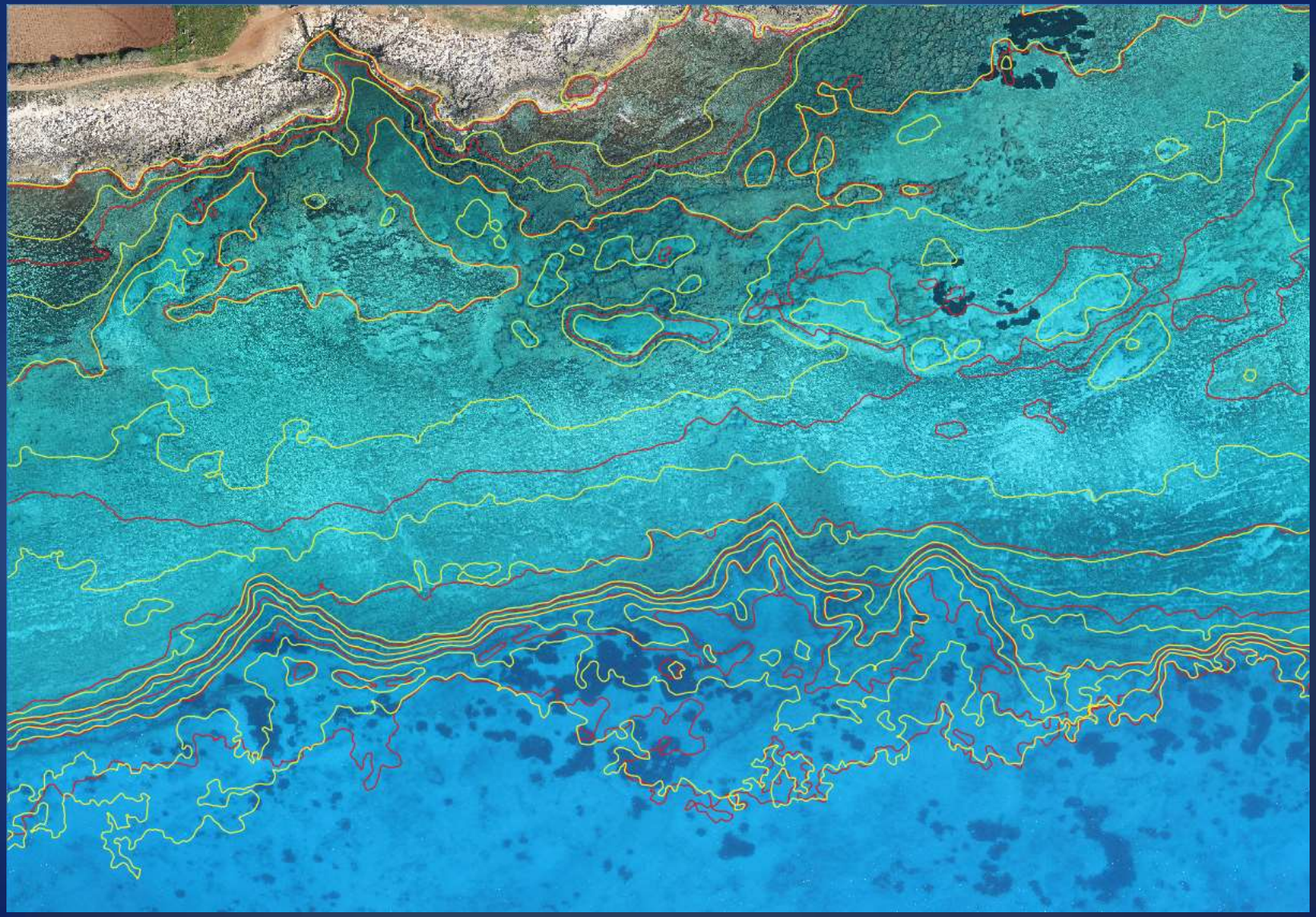
Flights

- 159 photos collected over 2 flights
- Average flying altitude ~ 207m
- Aerial imagery resolution ~ 7cm
- Area covered ~ 1.34km^2

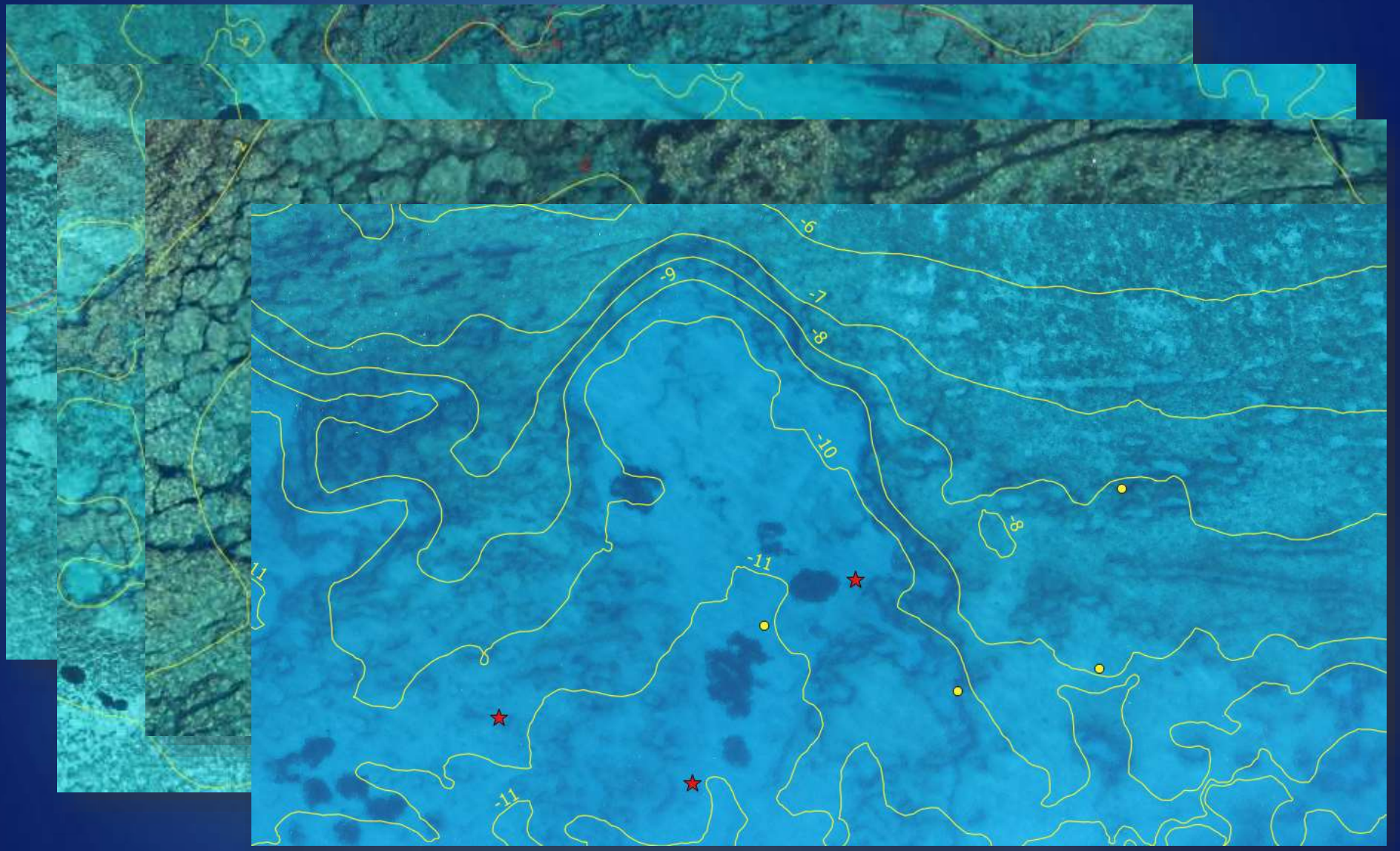
Ground Control Points

- 24 GCPs collected with GPS RTK
- XYZ error – 3.7cm, 3.7cm, 5.9cm
- Total error – 7.9cm/1.05 pix

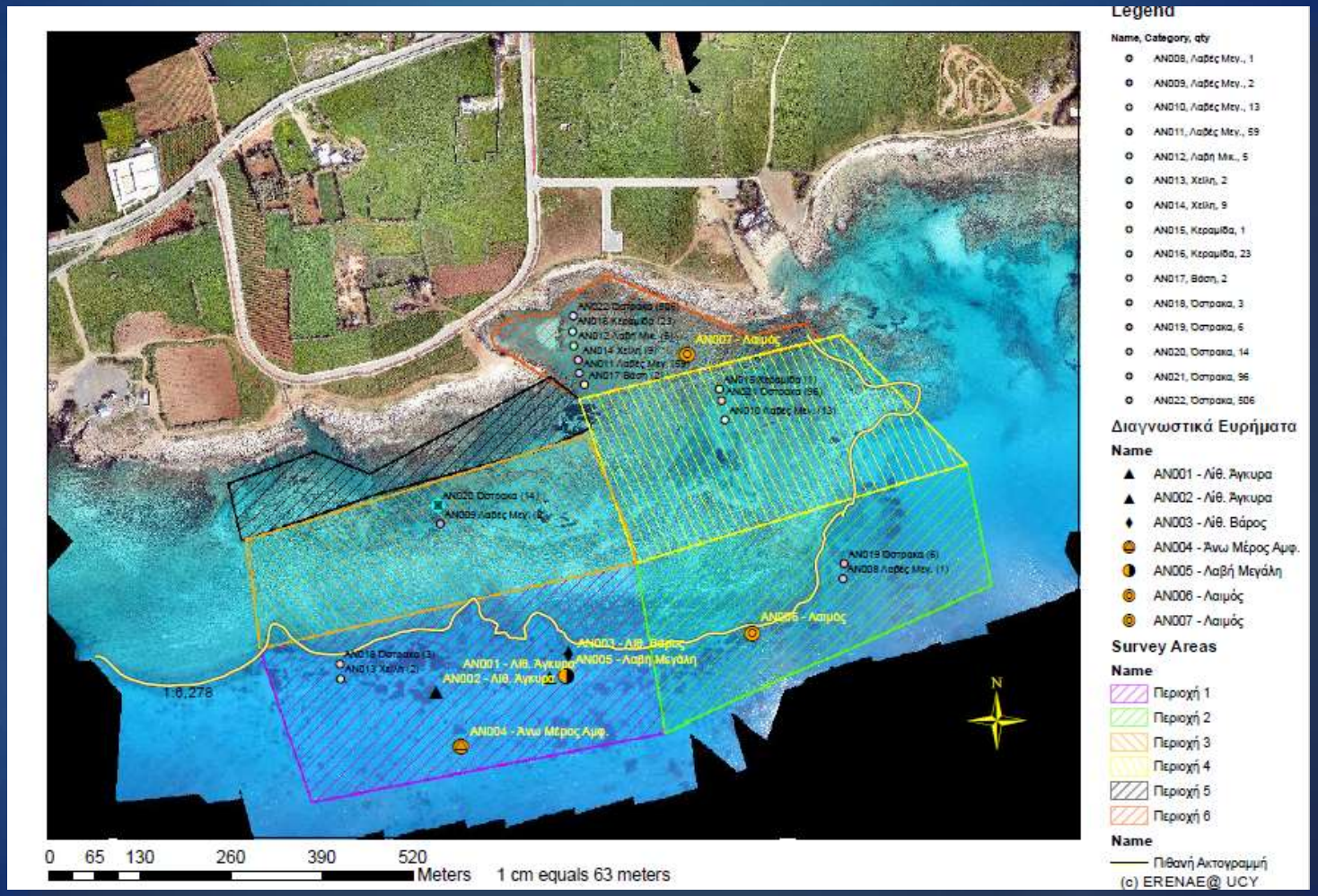
Bathymetric correction



Details



Final map to Dept. of Antiquities



Conclusions

- The proposed method and algorithm, performs depth correction and extraction for bathymetric contours, using aerial photos from drones
- Correct bathymetry improves accuracy of final orthophotomaps is shallow waters
- Hence, allowing seamless coastal orthophotomaps land and sea of up to 13m depth
- Therefore provide a unique mapping tool for surveying coastal archaeological sites
- BUT, still depended on sea waves and weather conditions during data capture

THANK YOU FOR YOUR ATTENTION!

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