

Historical Disasters Data Extraction and a Modern Marine Geohazards Early Warning System in the Area of the North Bulgarian Black Sea Coast

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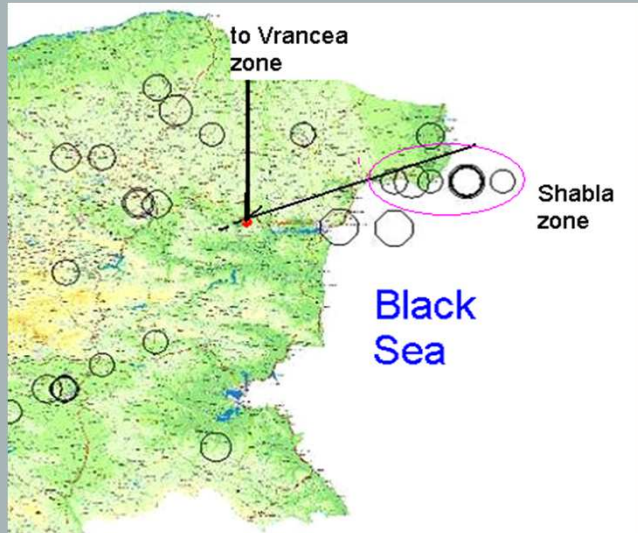
MGU, Sofia, Bulgaria

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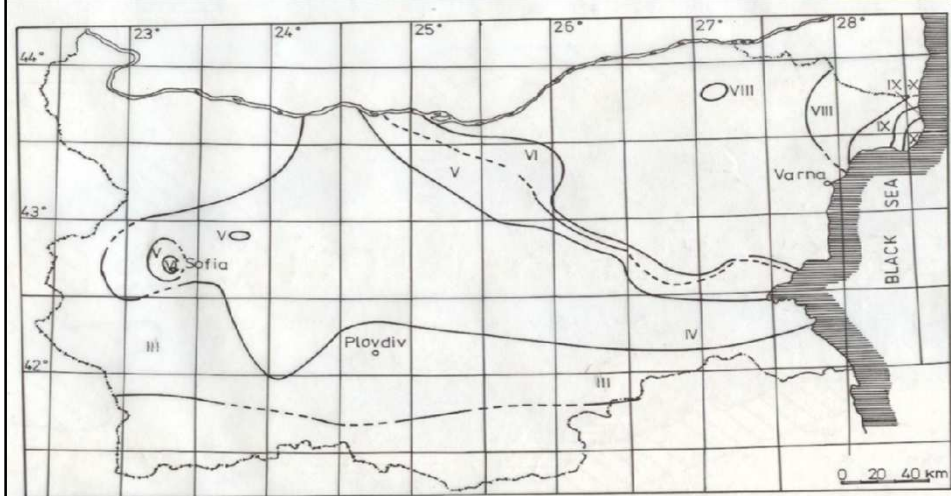
Historical Disasters – Data, Case studies

- ▲ *Archaeological findings:*
- ▲ *Cybele temple*
- ▲ *Solnicata-Provadia*
- ▲ ***Geodesy measurements for useful data extraction:***
- ▲ *Leveling*
- ▲ *GPS, triangulation*
- ▲ ***Why we consider Shabla source as dangerous?***

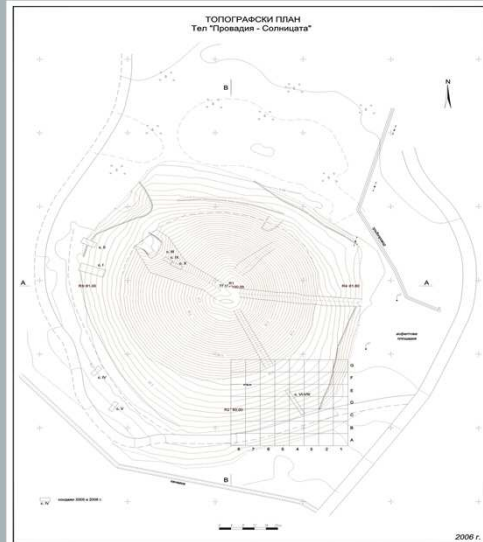
Provadia site location (red dot) and local seismicity – the directions to the both candidate seismic zones (Vrancea and Shabla) are presented



Shabla zone generated the macroseismic field of the event M7.2 (31st March 1901). The observed intensity on the site of Provadia is VII MSK.



The location of the site PROVADIA-SOLNICATA. Artificial hill from Thracian times (V BC-VI AD century) and the site of excavations of the ancient village



The recent view of the artificial hill – Provadia-Solnicata and excavations



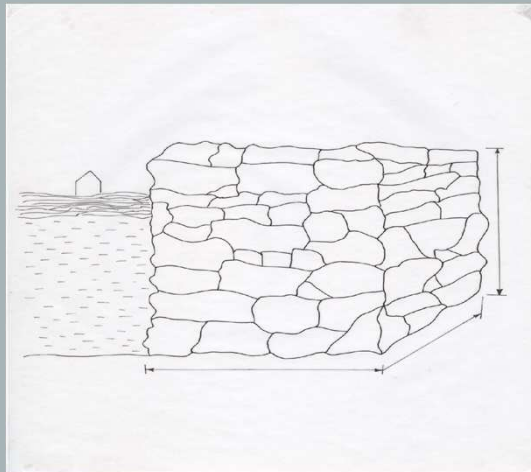
On this place 5400 years BC people started to produce salt (the most expensive and valuable product of these times)



Investigating the possible reasons about what put down the fallen huge stones.



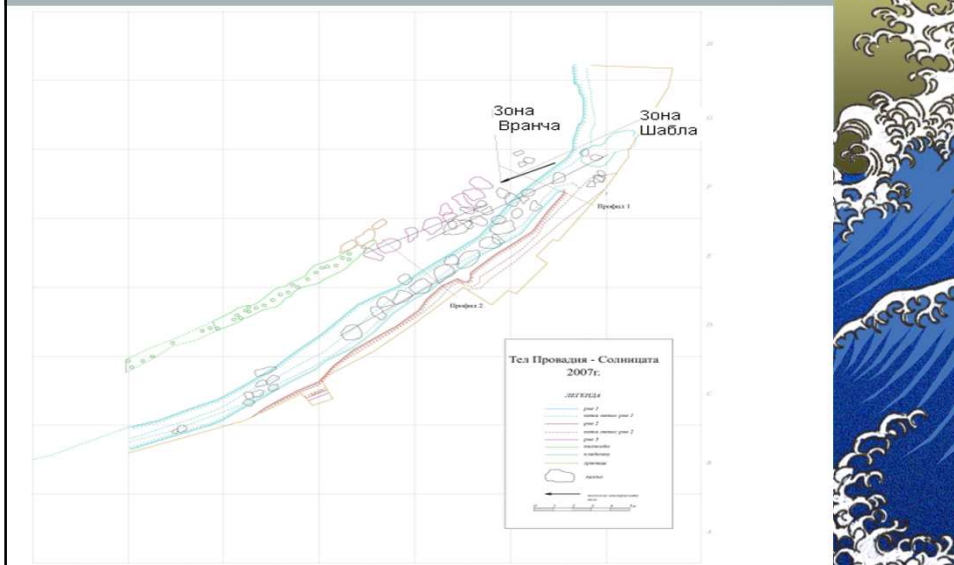
The big (first) bastions –
approx. dimensions 5 x 3 x 3 m.



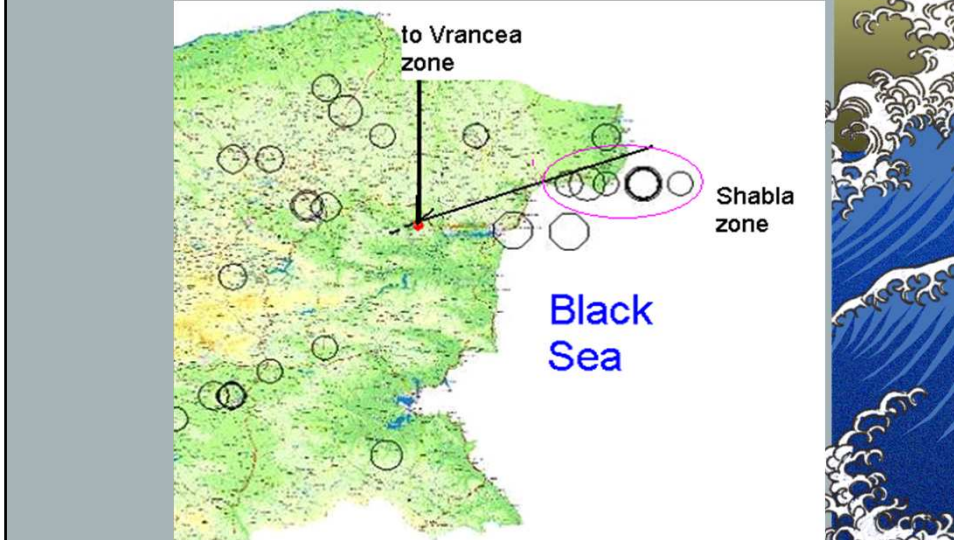
The big stones (in situ) are parts of the bastions
defending the village during the ancient times

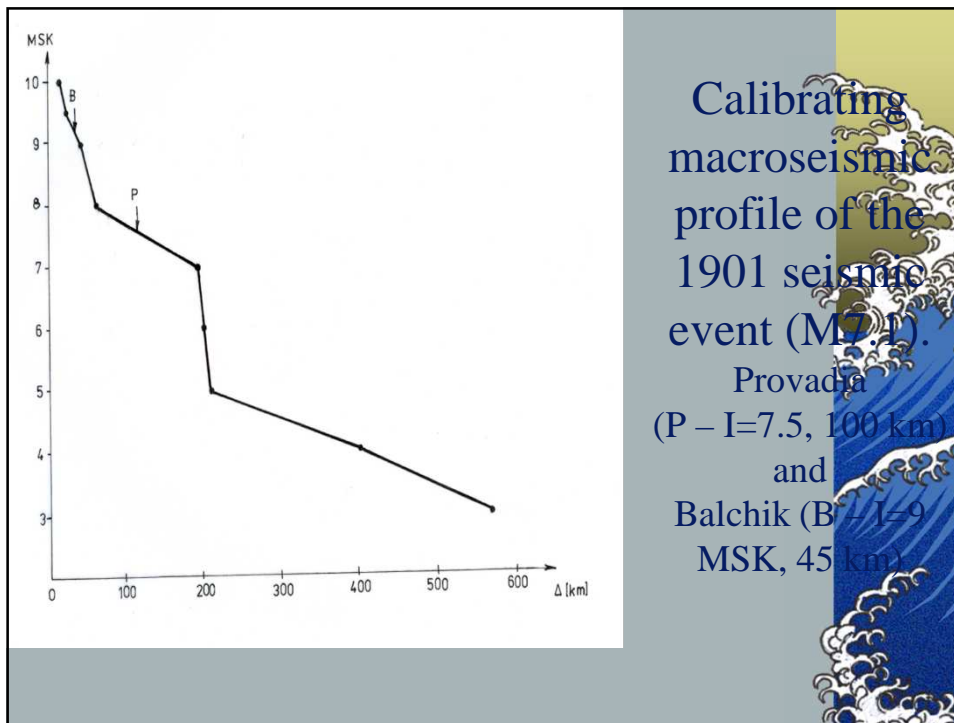


Schema of the fallen stones. The arrow shows the direction of the seismic force. Triangulation for force direction establishment



Site location (red dot) and local seismicity – the directions to the both candidate seismic zones (Vrancea and Shabla) are presented





Possible explanation and earthquake parameters extracted.

- ▲ *The only way to explain the fallen big stones from the ancient bastions is the assumption of strong seismic event ($M > 7.0$), which occurred about 4500 years BC in Shabla-Kaliakra seismic zone. If so, this could be the most ancient earthquake in Europe recorded there.*

Some physical considerations:

- ▶ *Seismic waves - very high velocities –7-8 km/s.*
- ▶ *Tsunami waves with much lower velocity – between 40-800 km/h.*
- ▶ *The time difference between the tsunami and the seismic waves is in the range of 10^2 to 10^4 of seconds.*
- ▶ *High effective tsunami warning systems*



GOVERNMENT OF ROMANIA



Project MARINEGEOHAZARDS



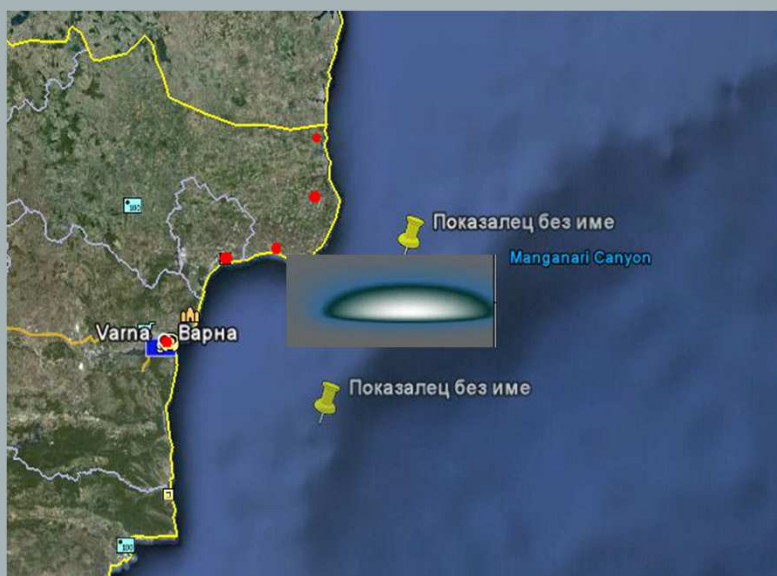
Common borders. Common solutions.

Project MARINEGEOHAZARDS

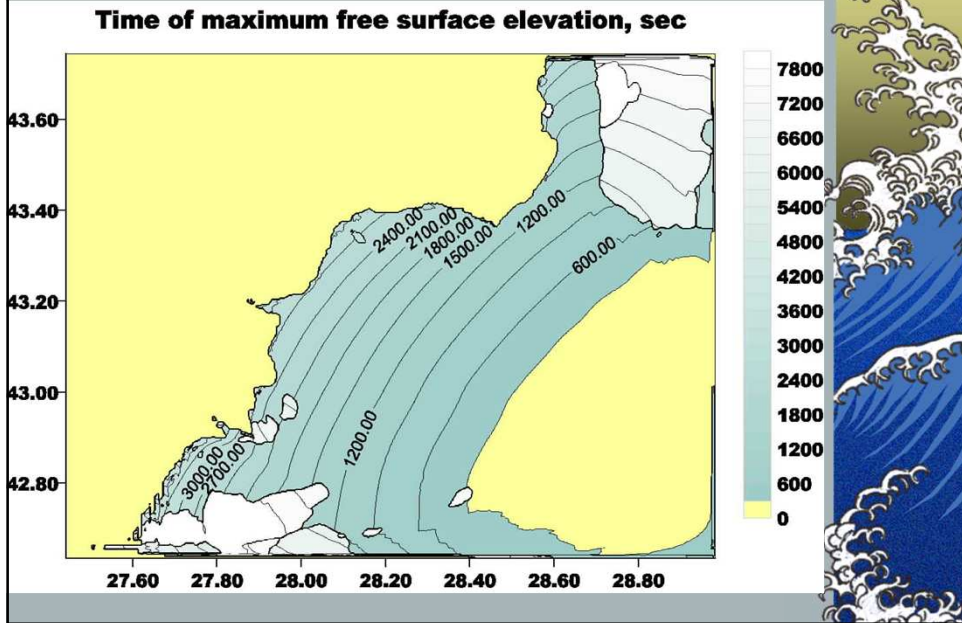
- ▲ *Coordinator: GeoEcoMar*
- ▲ *4 partners:*
- ▲ *GeoEcoMar, National Institute of Earth Physics (ROM);*
- ▲ *Geological Institute, Institute of Oceanology (BAS-BG)*



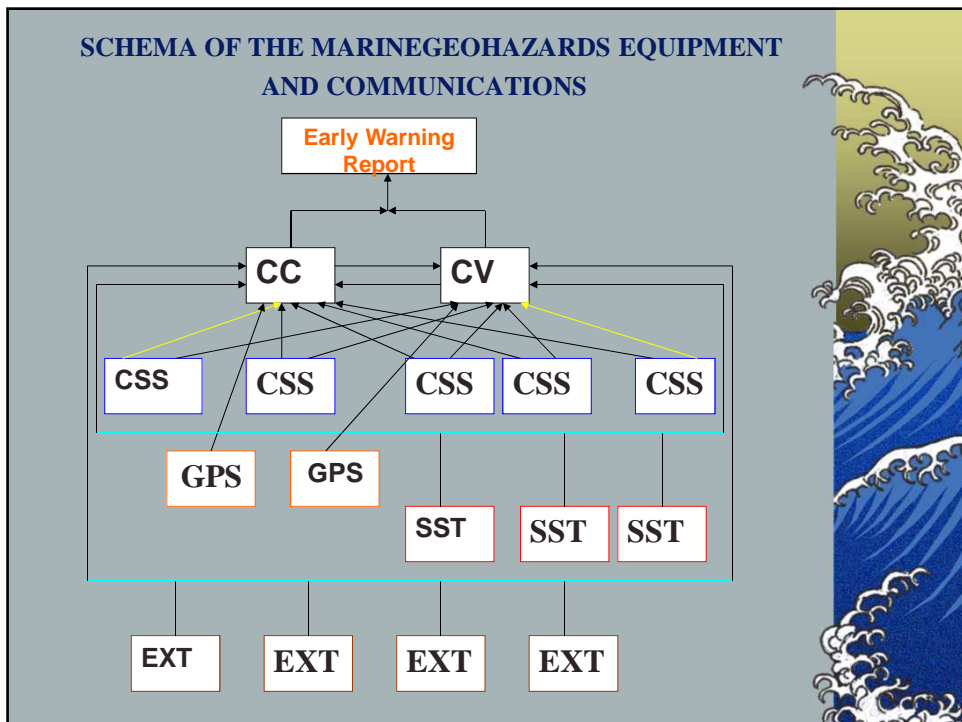
Bulgarian sea and land stations and the tsunamigenic seismic source – extracted from the ancient events



Travel time of the maximum water elevation



SCHEMA OF THE MARINE GEOHAZARDS EQUIPMENT AND COMMUNICATIONS



SCHEMA OF THE MARINE GEOHAZARDS EQUIPMENT AND COMMUNICATIONS – Legend

- ▲ *CC – Centre Constanta*
- ▲ *CV – Centre Varna*
- ▲ *Both Centers are equivalent*
- ▲ **LEGEND**
- ▲ *CSS – Complex Sea Station*
- ▲ *SST – Strong motion Station*
- ▲ *GPS – GPS Station*
- ▲ *EXT – Extensometer Station*
- ▲ *SAT – Satellite communication*
- ▲ *INT – Internet Communication*
- ▲ **COLORS**
- ▲ *Dark Blue – SEA MODULE*
- ▲ *All other colors – LAND MODULE*
- ▲ *Yellow – Satellite Communication*
- ▲ *Light blue – INTERNET*
- ▲ *Early Warning Report*

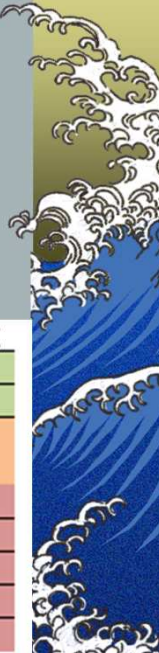
The network equipment

- ▲ *2 data centers: Varna and Constanta*
- ▲ *Seismic networks:*
 - *Romania, Bulgaria national seismic networks*
- ▲ *Strong motion devices (SMD) on coastal area*
- ▲ *Complex Bottom Stations*
 - (CBS=*OBS*+*DART*)
- ▲ *GPS (GNSS) networks:*
 - *Bulgaria (4), Romania (14) GNSS + the national networks*
 - *Local GPS networks*
- ▲ *EXT – Extensometers network*
 - *Bulgaria local network*

Decision Matrix for the tsunami warning – three levels of alert

Principles: Combinations = Convolution:
 Green + green = green
Domination of the higher degree (CBS is essential):
 Orange + orange = red
 Green + orange = orange
 Green + red = red
 Orange + red = red

SMD	CBS	GPS	EXT	Tsun warning
green	green	green	red	green
orange	green	green	red	green
red	green	green	red	orange
green	orange	green	red	orange
orange	orange	green	red	red
red	orange	green	red	red
green	red	green	red	red
orange	red	red	green	red
red	red	red	red	red



THANK YOU, FOR YOUR ATTENTION!

