



# **San-in Disaster Prevention Forum**

## **Fall Symposium of 2016**

**19 November 2016**

**New Technologies Applied to  
Managing Disaster Risks**

**Sandro Moretti**

# Risk Management cycle

**INVESTIGATIONS**



1

**DIAGNOSIS**



2

**RISK REDUCTION**



4

**MONITORING**



3

# Investigations

- investigating the origin
- typology
- construction techniques
- restoration history
- evolution in time
- threats



Lungro

Cavallerizzo di Cerzeto

Cirò Marina

Stromboli

Image © 2006 TerraMetrics  
© 2006 Europa Technologies

© 2005

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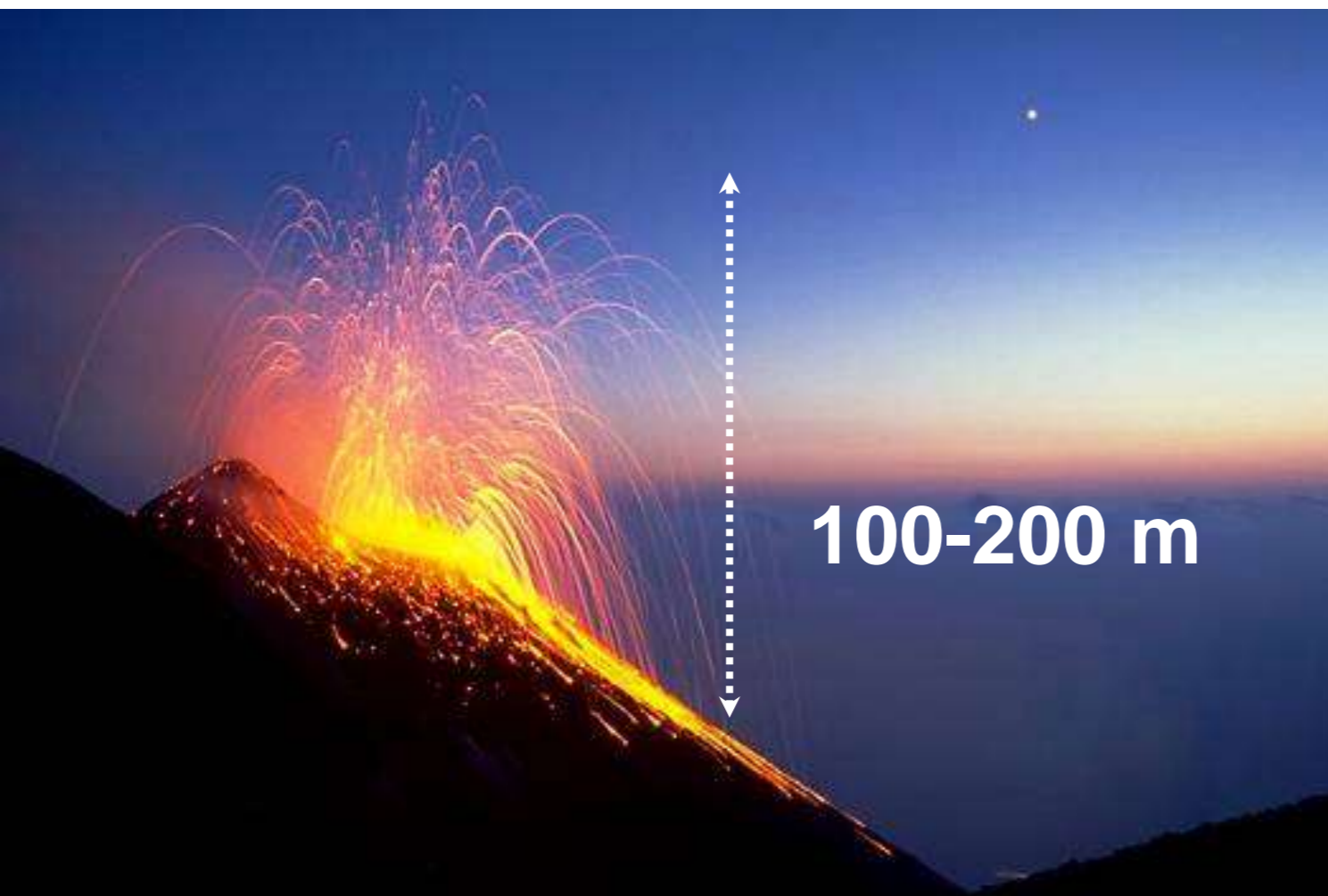
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# Monitored Risks Explosive Volcanic activity

Level of Hazard: medium

~400 moderated explosions each day



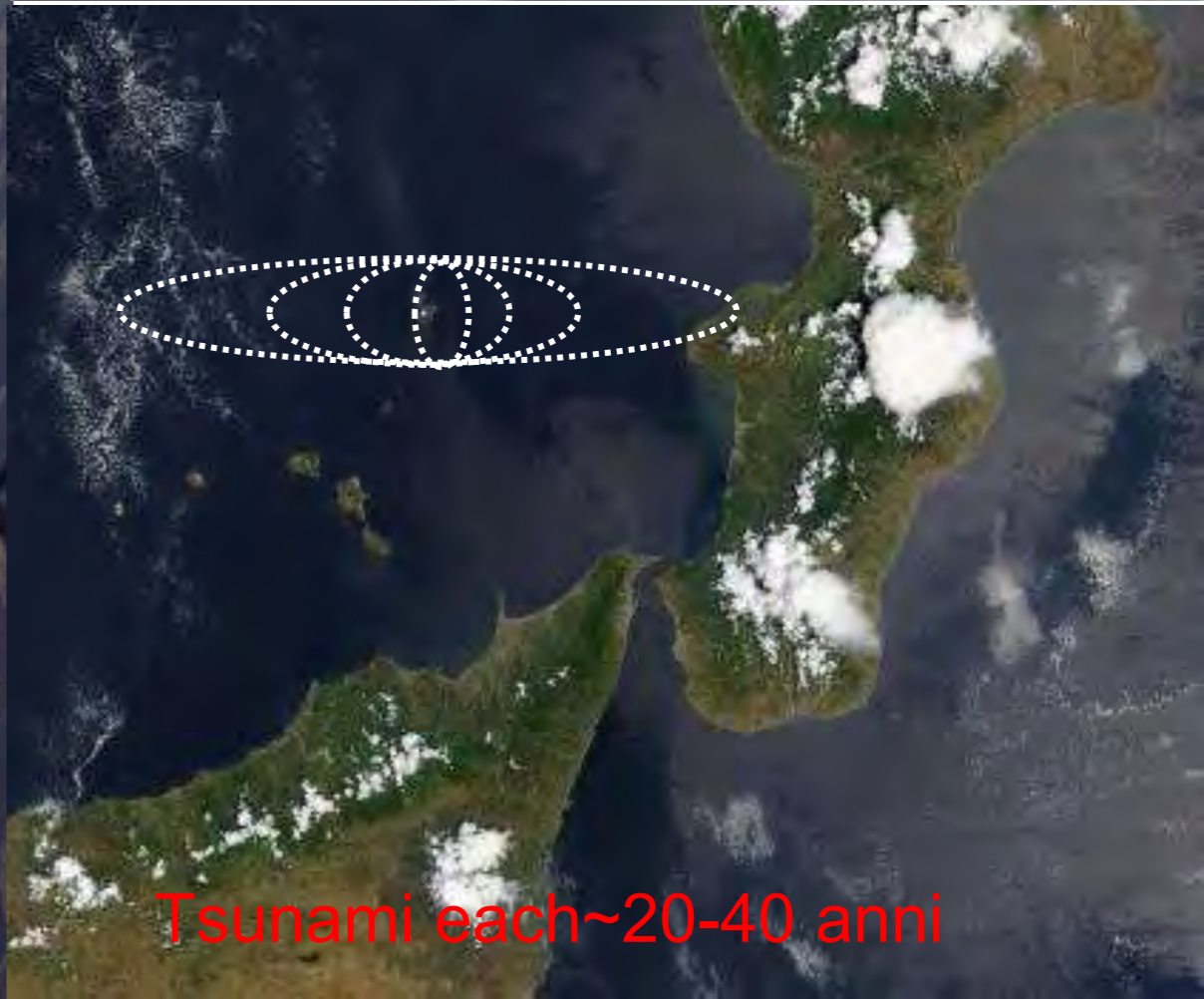
# Monitored Risks slope instability and tsunami



Lava estrusion each ~10 anni



Slope instability  
Every ~20-40 anni



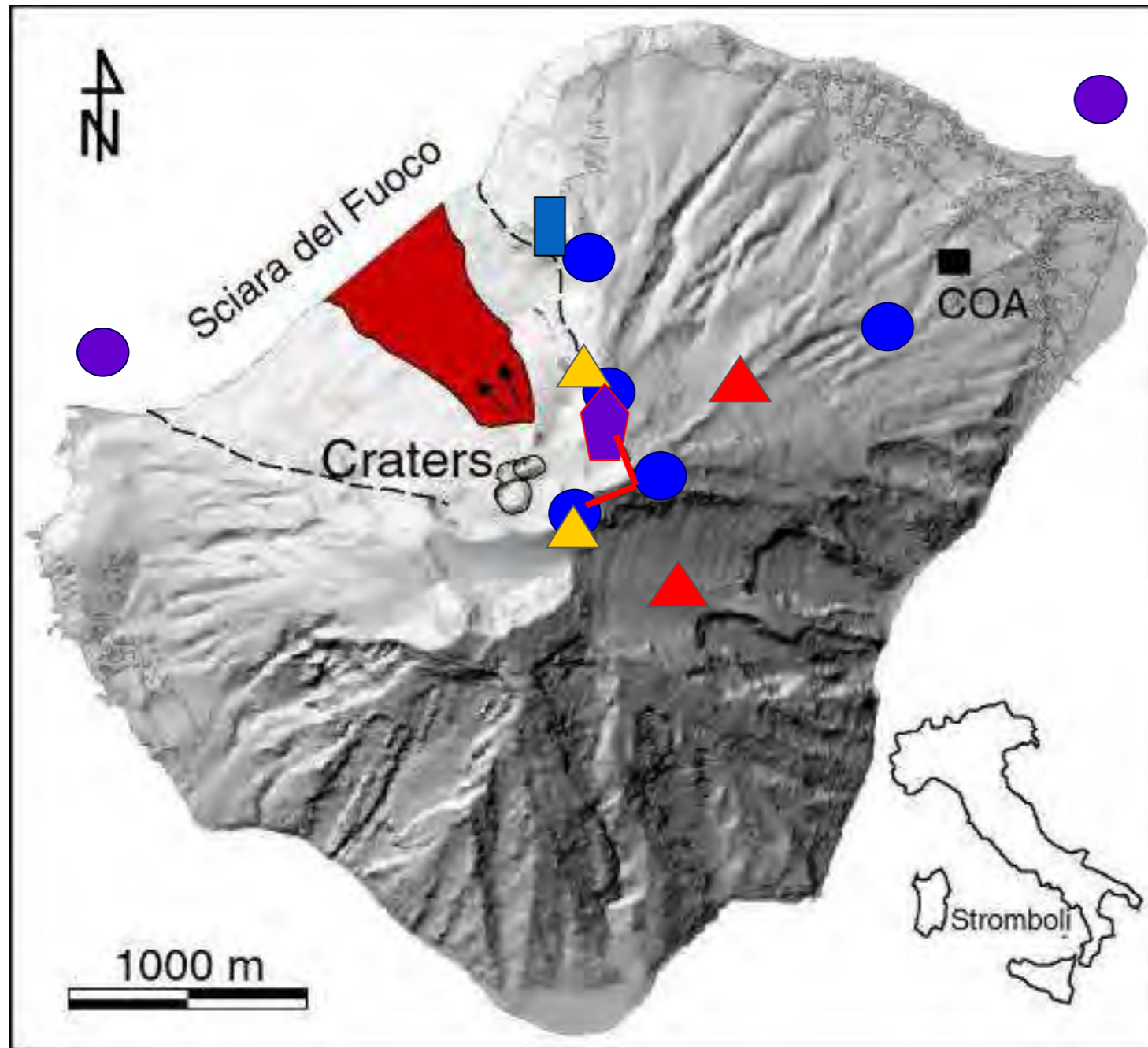
Tsunami each ~20-40 anni



Sector Collapse and  
megatsunami  
each ~2000 anni

photo INGV

# Integrated sensor network



- 5 Sismic Monitoring stations + 5 infrasonic microfons
- ▲ 2 Thermal infrared Sensors (9-14 $\mu$ )
- ▲ 2 Tiltmeters
- 2 Wavemeters
- 1 Interferometer InSAR-LISA
- ⬠ 1 Thermal camera FLIR A10
- └ 1 Infrasonic Array (5 elements)

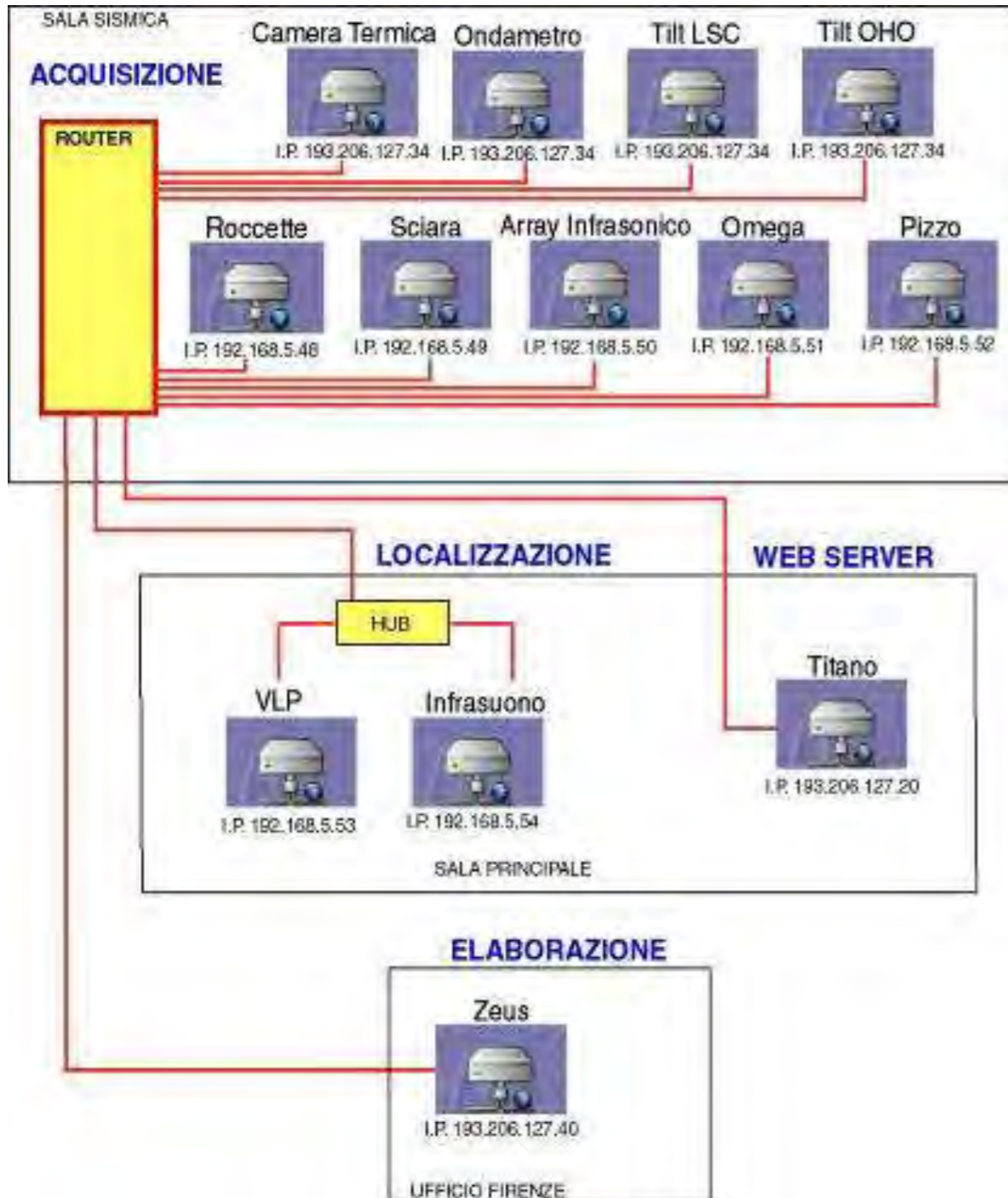


# COA Centre (integrated monitoring system Head Quarter)



# Managing network system COA

## IntraNet Data Managementi COA



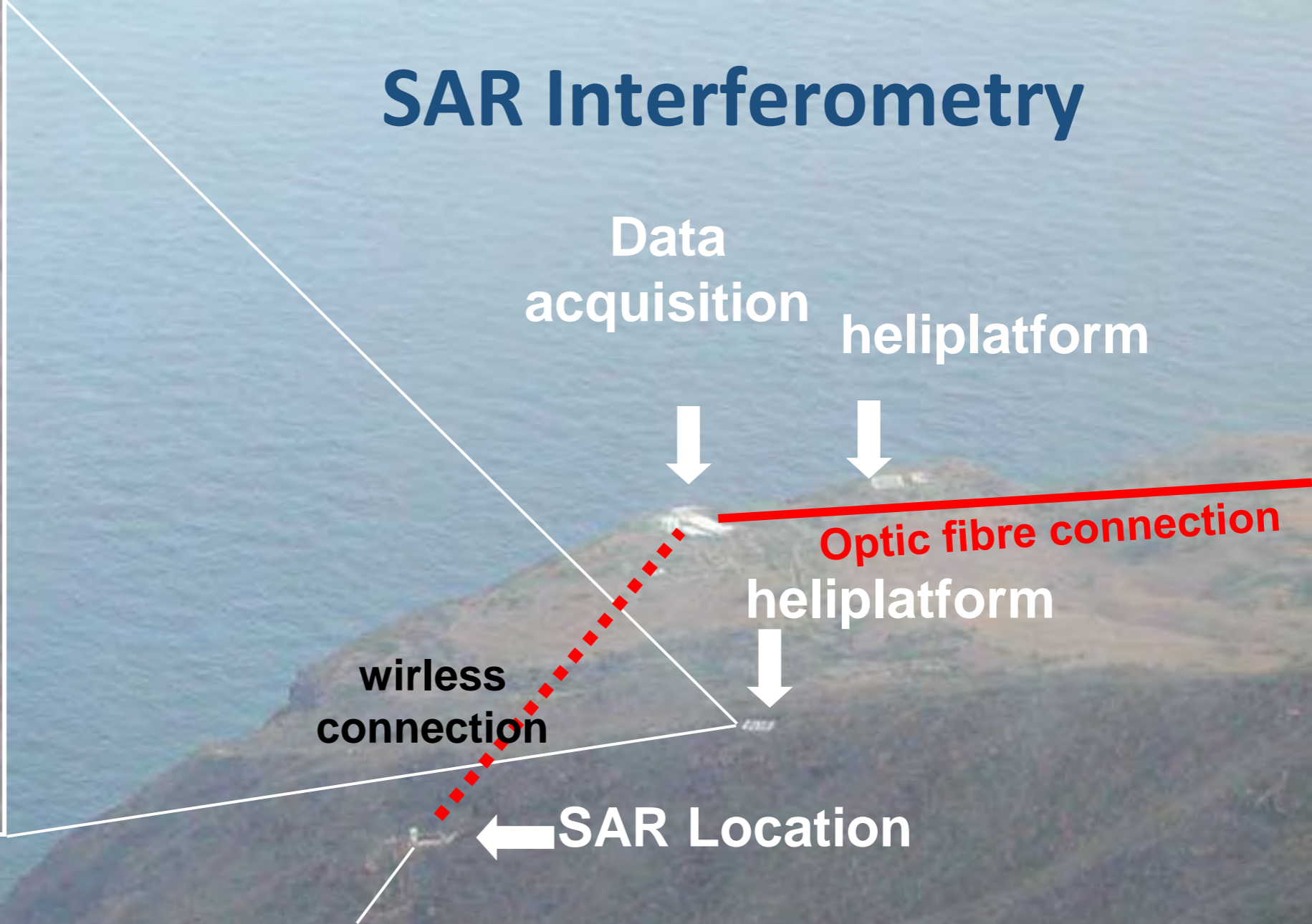
- 13 PC in parallel
- sismic and infrasonic system
- on-line data analysis
- web data Visualization



# Soil deformation: LISA Linear Synthetic Aperture Radar



# SAR Interferometry



# System Installation (February 2003)





GREECE

TURKEY

CYPRUS

MEDITERRANEAN  
SEA

SYRIA

LEBANON

IRAQ

ISRAEL

Amman

JORDAN

Petra

EGYPT

SAUDI  
ARABIA

RED SEA



World Heritage Site

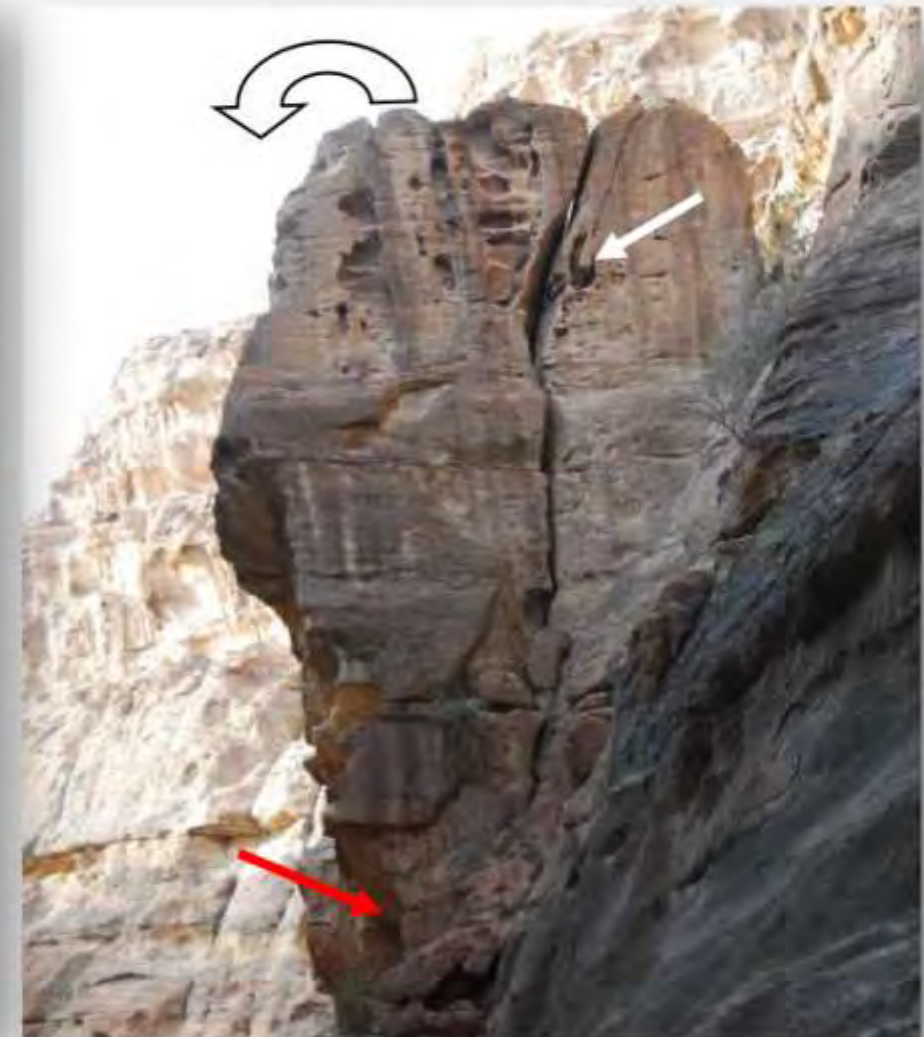
# Rock fall and slides



Small blocks volumes  
(volumes  $< 5\text{m}^3$ )



Medium blocks volumes  
(volumes  $5\text{m}^3 \div 15\text{m}^3$ )



Large blocks volumes  
(volumes  $> 15\text{m}^3$ )

Petra (Jordan)

# Rock fall and slides



10 April 2002



May 2013

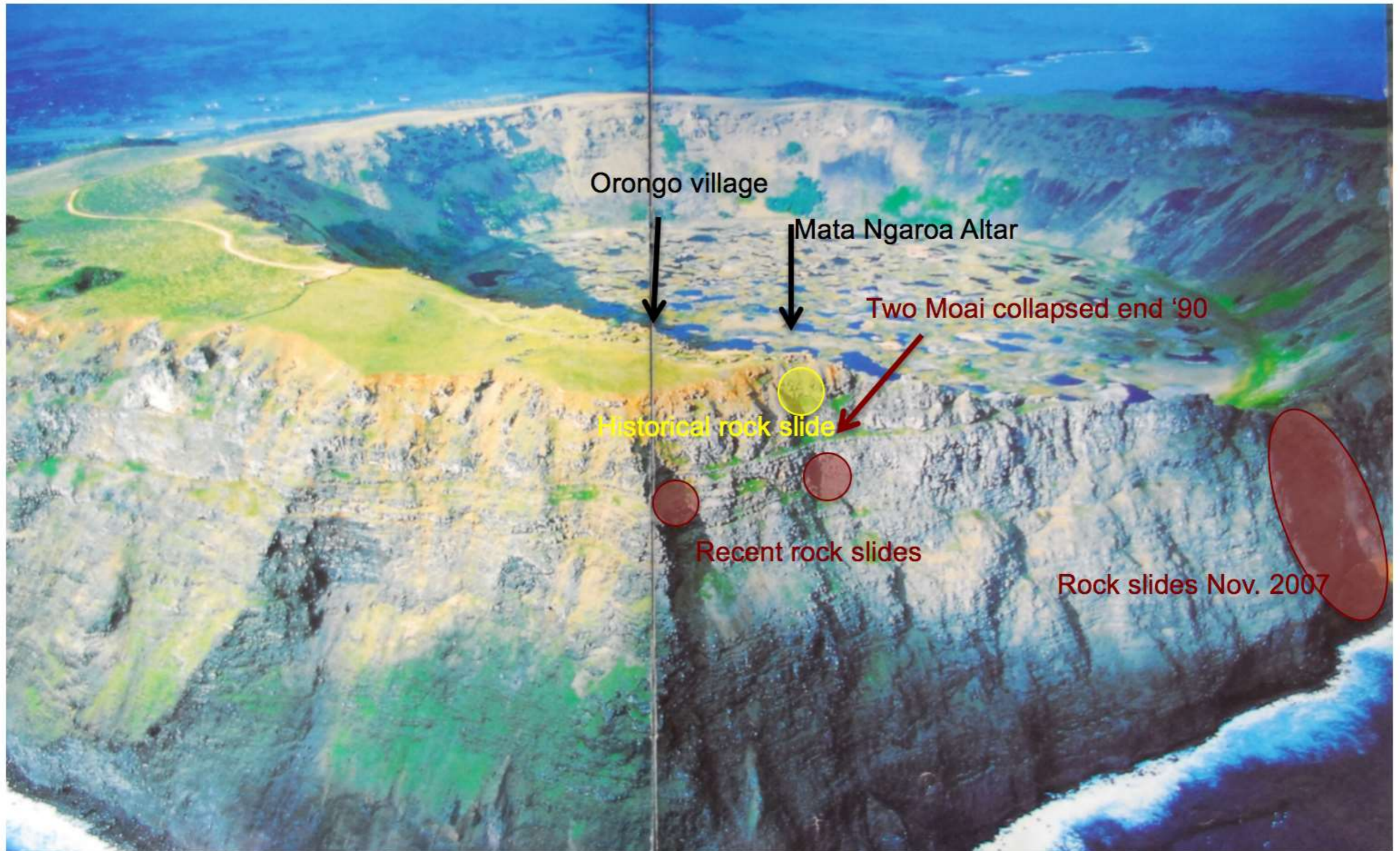
Petra (Jordan): Nabatean Tombs





Easter Island - Rapa Nui (Chile)

# Rock fall and slides



Easter Island - Rapa Nui (Chile): Orongo village - Rano Kau crater

# Rock fall and slides



Easter Island - Rapa Nui (Chile): Mata-Ngaroa Cerimonial Altar and Petroglyph



**Shar-E-Zohak (Afghanistan)**

# Soil erosion



Shar-E-Zohak (Afghanistan): fortress

# Soil erosion



Tiwanaku (Bolivia): Akapana pyramid earth mound

# Foundation settlement



Herat Minaret (Afghanistan)

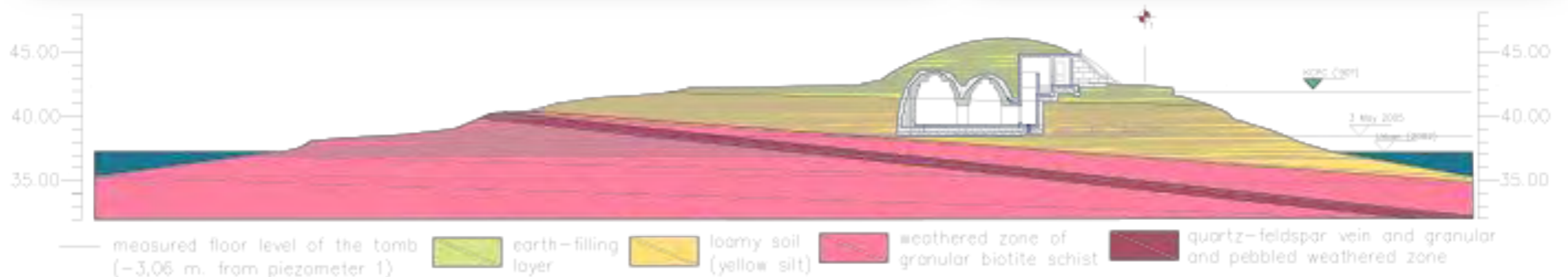
# Rock weathering and structural stability



Lalibela (Ethiopia) : monolithic rock-cut Churches



# Rising dumpness



Kogurio (North Korea): Susan-ri mounded stone chamber tomb

# Rock instability



Katski (Georgia): rock pillar Church

# Diagnosis



site conditions



materials & properties



hazard assessment



vulnerability & risk



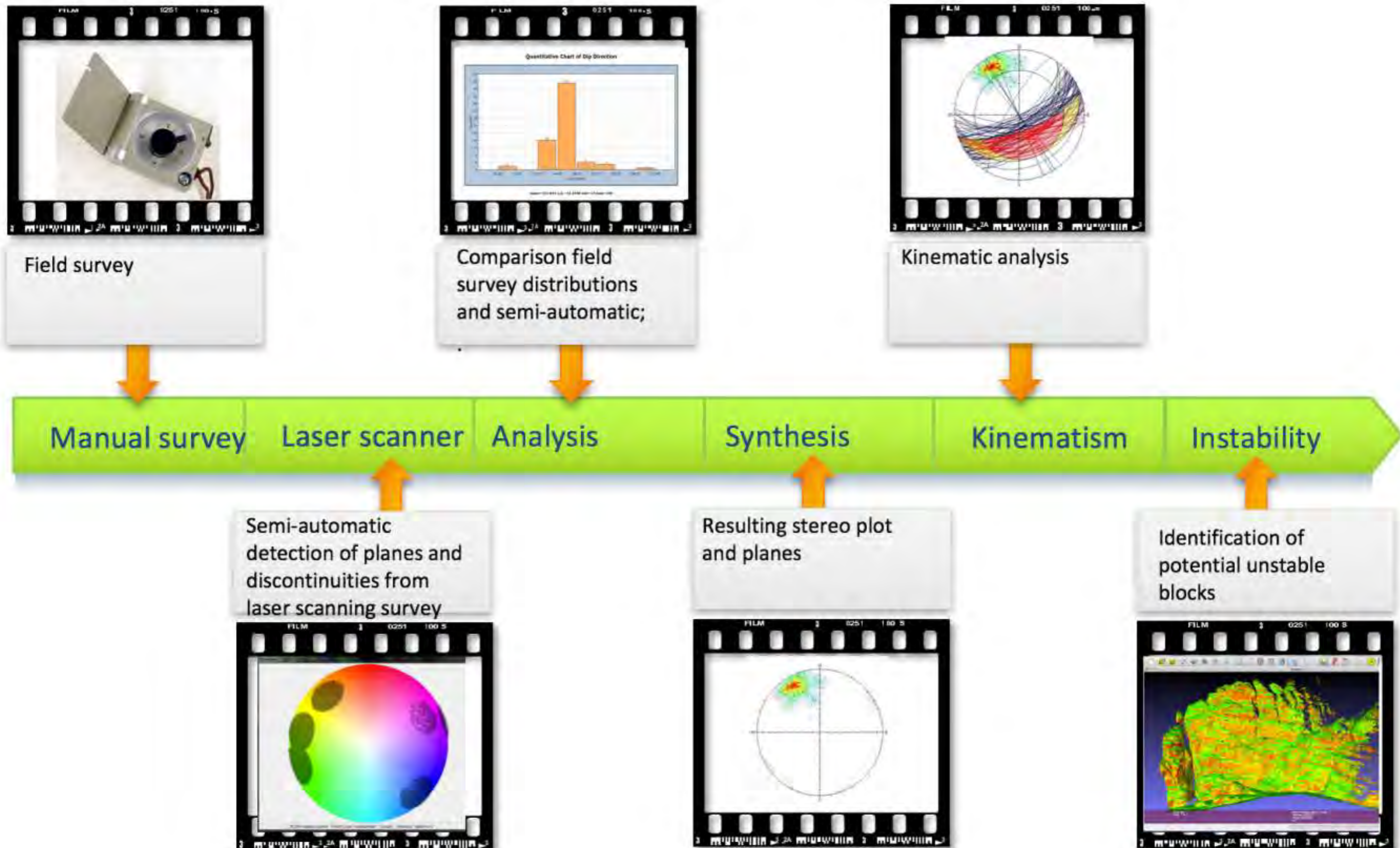
weathering & deterioration

# Laser scanner 3D

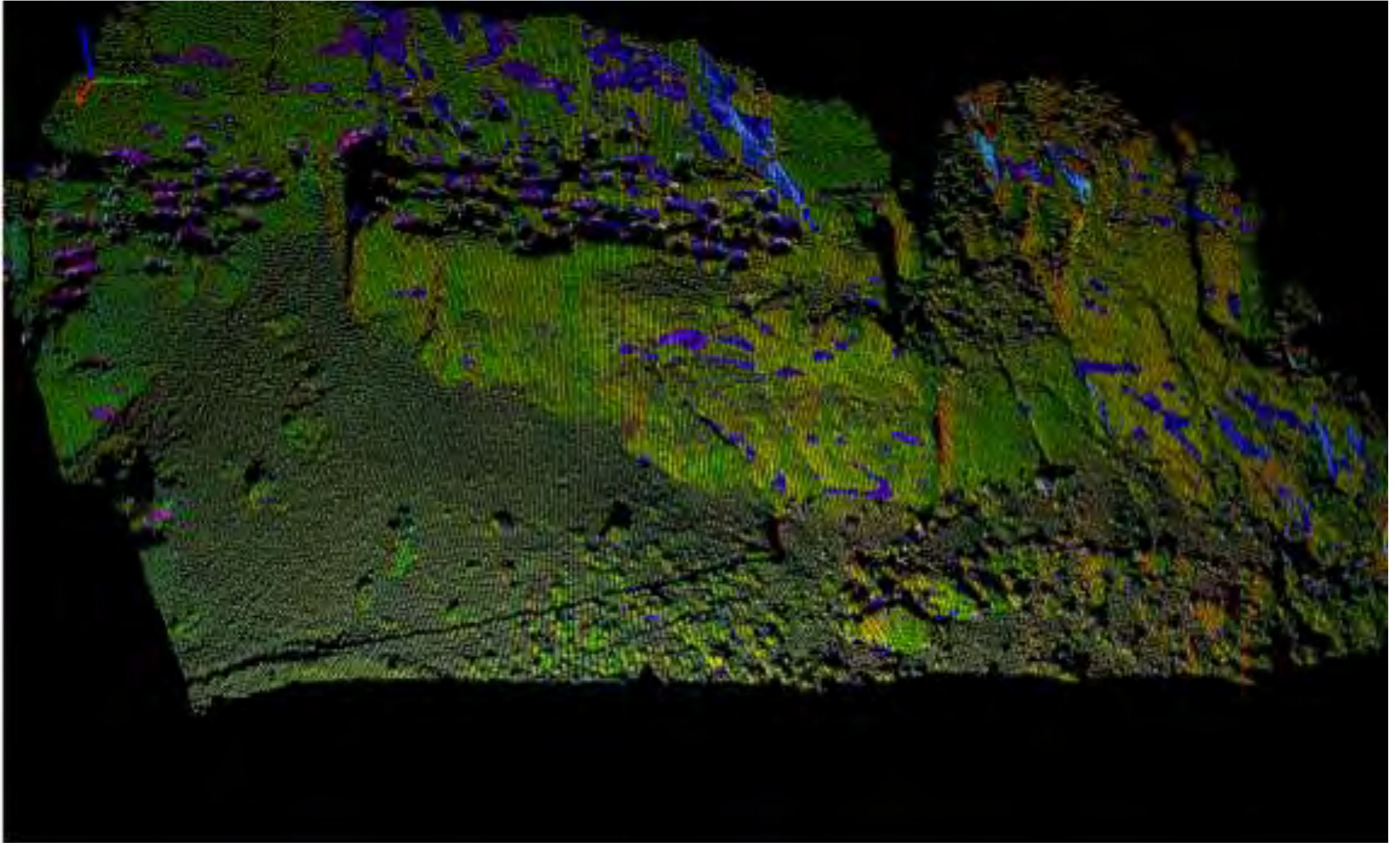


Petra (Jordan): the Siq

# Data extraction from Laser point cloud



# Discontinuity analysis



Petra (Jordan): the Siq