



Orvieto Cliff: landslides protection and enhancement

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Orvieto , Italy, 22 August 2023



The town of Orvieto, located 105 km north of Rome, was included in 1937 in the list of inhabited areas threatened or affected by landslides.

REGIO DECRETO 4 marzo 1937-XV, n. 1069

Aggiunta dell'abitato di Orvieto, in provincia di Terni, a quelli da consolidare a totale carico dello Stato.

VITTORIO EMANUELE III
PER GRAZIA DI DIO E PER VOLONTÀ DELLA NAZIONE
RE D'ITALIA
IMPERATORE D'ETIOPIA

Visto il decreto Luogotenenziale 30 giugno 1918, n. 1019;

Sentito il Consiglio superiore dei lavori pubblici;
sulla proposta del Nostro Ministro Segretario di Stato per i lavori pubblici;

Abbiamo decretato e decretiamo:

A norma dell'Art. 1, sub 7, del decreto Luogotenenziale 30 giugno 1918, n. 1019, aggiunto a tutti gli effetti della legge 9 luglio 1908, n. 445, titolo IV agli abitati indicati nella tabella D allegata alla legge stessa (consolidamento di frane minaccianti abitati), quello di Orvieto, in provincia di Terni.

Ordiniamo che il presente decreto munito del sigillo dello Stato, sia inserito nella raccolta ufficiale delle leggi e dei decreti del Regno d'Italia, mandando a chiunque spetti di osservarlo e di farlo osservare.

Dato a Roma, add 4 marzo 1937 - Anno XV

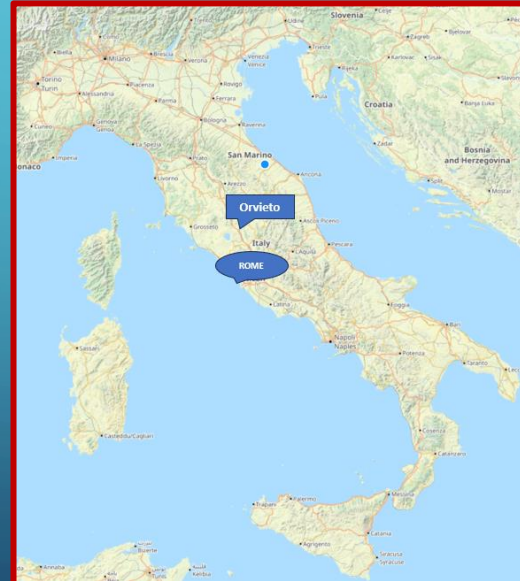
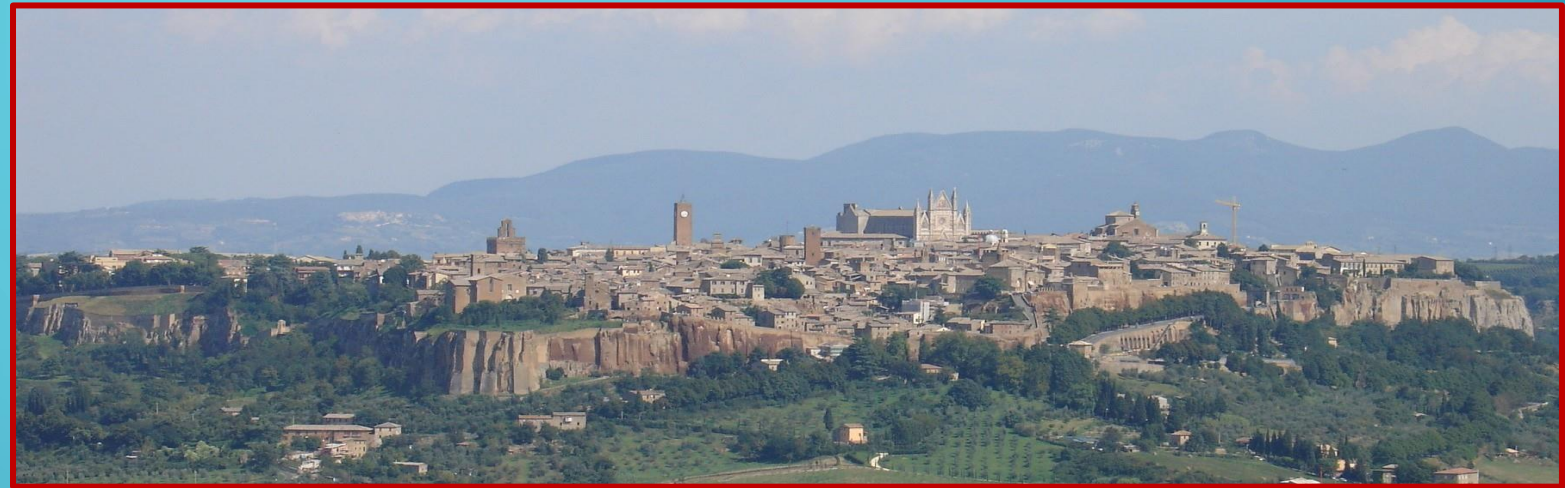
VITTORIO EMANUELE.

COBOLLI-GIGLI.

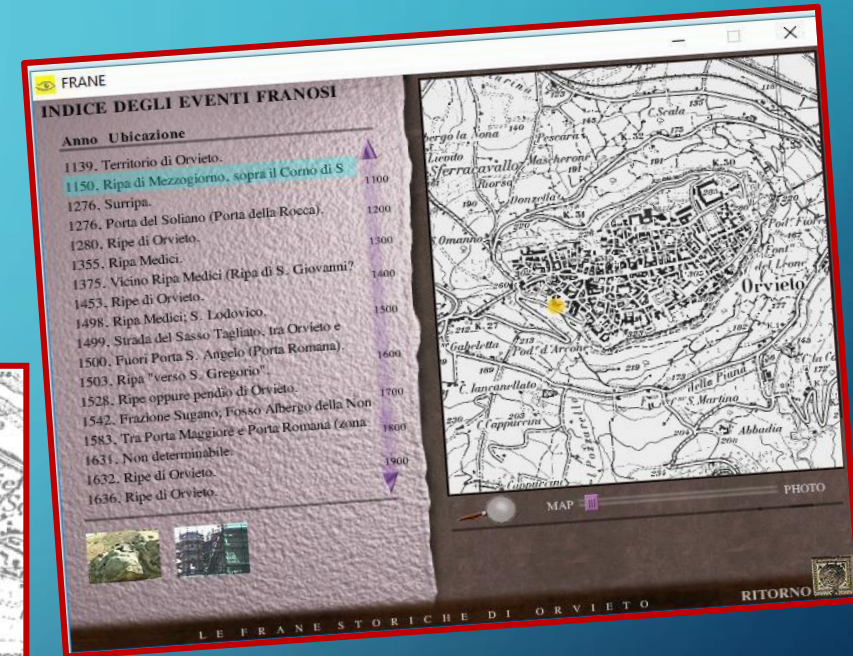
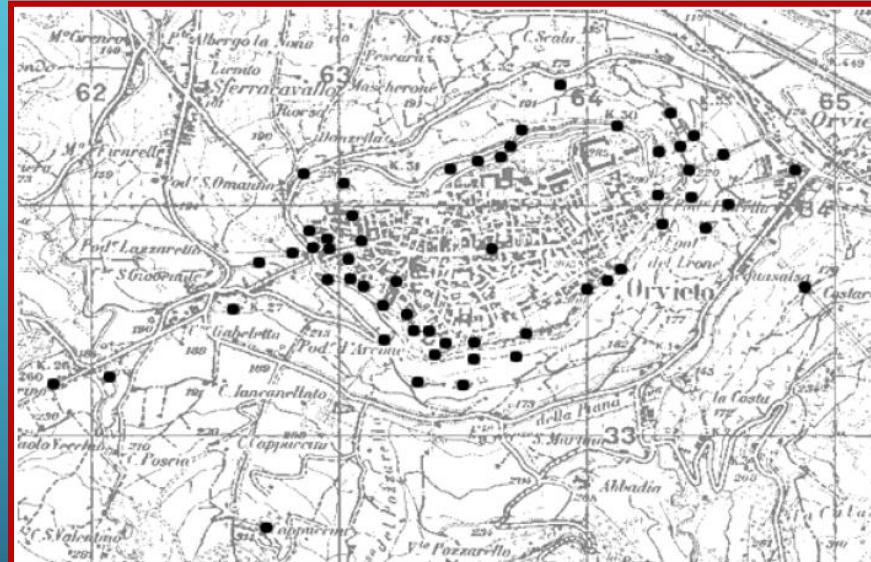
Visto, il Guardasigilli: SOLMI.

Registrato alla Corte dei conti, add 9 luglio 1937 - Anno XV.

Atti del Governo, registro 387, foglio 63. - MANCINI.



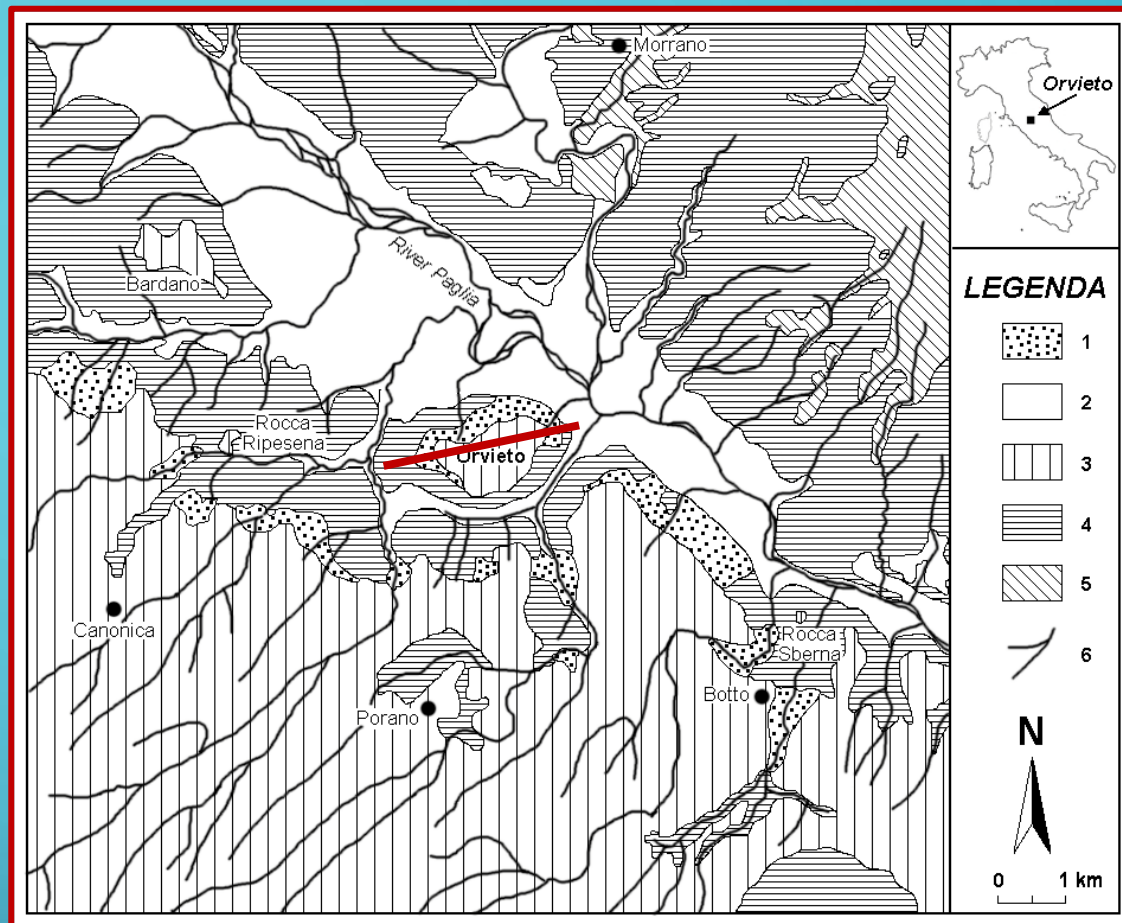
Historical research has uncovered that landslides in Orvieto date as far back as 1139: 208 landslides from 1139 to 1990



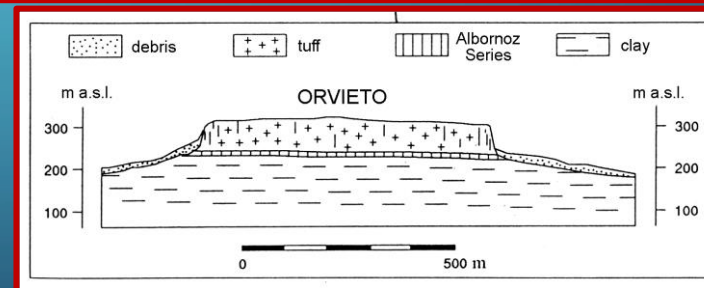
Geological sketch of the Orvieto area, at the boundary between Latium and Umbria (central Italy).

LEGENDA:

- 1) talus (Olocene);
- 2) Recent and present alluvial sediments, also terraced (Olocene - Upper Pleistocene);
- 3) Volcanic rocks of the Alfinia Plateau (Middle Pleistocene);
- 4) Gravels, sands and clays (marine clastic sediments, Lower Pleistocene - Pliocene);
- 5) Marls and sandstones (pre-Pliocenic bedrock);
- 6) River Paglia and its main tributaries.



Section Southeast Northwest





Schematic Geomorphological Map

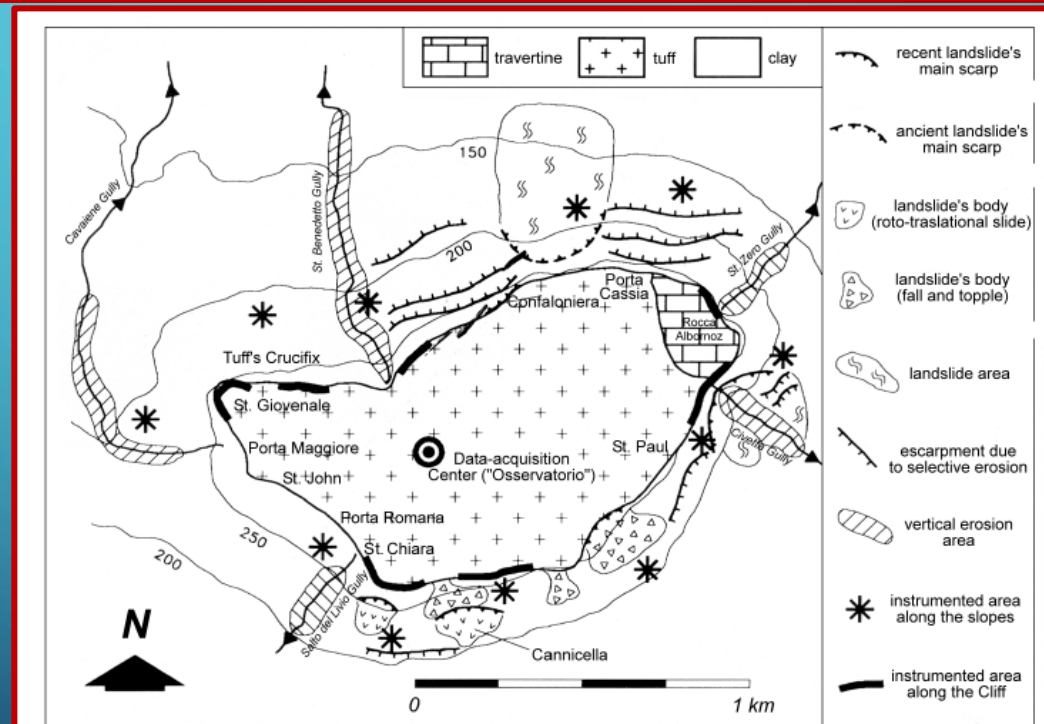
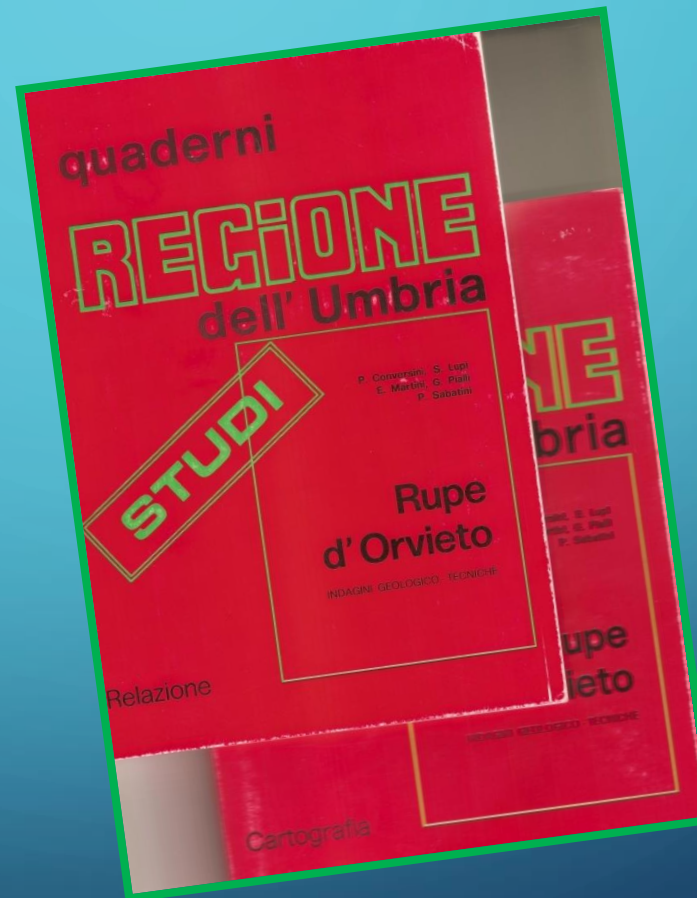


Fig. 7 – Schematic geomorphological map of the Rock of Orvieto. From CONVERSINI et alii (1995), modified.

After the 1977 Cannicella landslide that threatened the slopes of Orvieto's cathedral, the Region of Umbria commissioned a Geological and Technical Study that was taken as the basis for a special law that the Italian Parliament passed in 1978



Cannicella landslides 1977



**Law 25 May 1978 No. 230 was adopted calling for
“Urgent actions for the consolidation of the cliff of Orvieto
and hill of Todi to safeguard the landscape and historical,
archaeological and artistic heritage of the two towns”**

The law authorized the Regional Government of Umbria to carry out studies and interventions on both Orvieto and Todi, historic towns presenting similar problems.

In the “Orvieto Project”

the following interventions were foreseen and completed:
strengthening of the cliff, stabilization of slopes and ditches,
consolidation of the caves, re-organization of drainage and
improvement of the water and ecological systems of the slopes,
substitution and completion of the sew- age system, paving of
streets and waterproofing of the city areas;

re-organization of the archaeological park areas,
implementation of alternative mobility plans, installation of
geotechnical and topographic monitoring instruments

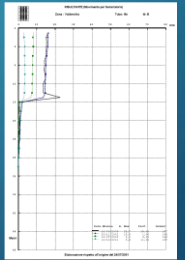


Within the framework of the important interventions for the consolidation of the Orvieto rock and slopes, began in 1978, the Regional Government of Umbria, in coordination with the Municipality of Orvieto, set up an

“OBSERVATORY FOR PERMANENT CONTROL AND MAINTENANCE”

with the aim of managing the upkeep of the works carried out for the consolidation and structural stabilization of the cliff, as well as managing the protection of the historical and environmentally sensitive sites and the system designed to monitor the structural behavior of the interventions and the potential phenomena of geological instability in the region (Pane & Martini 1997).

In addition, the Observatory functions as an operational unit for the prevention of risks, as well as a centre for the control and study of the different problems faced during implementation, and as an experimental centre for the identification of innovative maintenance and monitoring methods



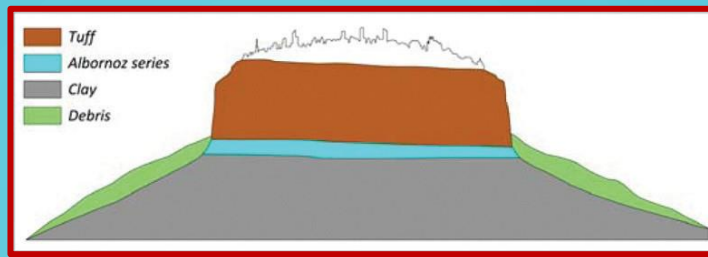


**Tuffaceous wall
maintenance**

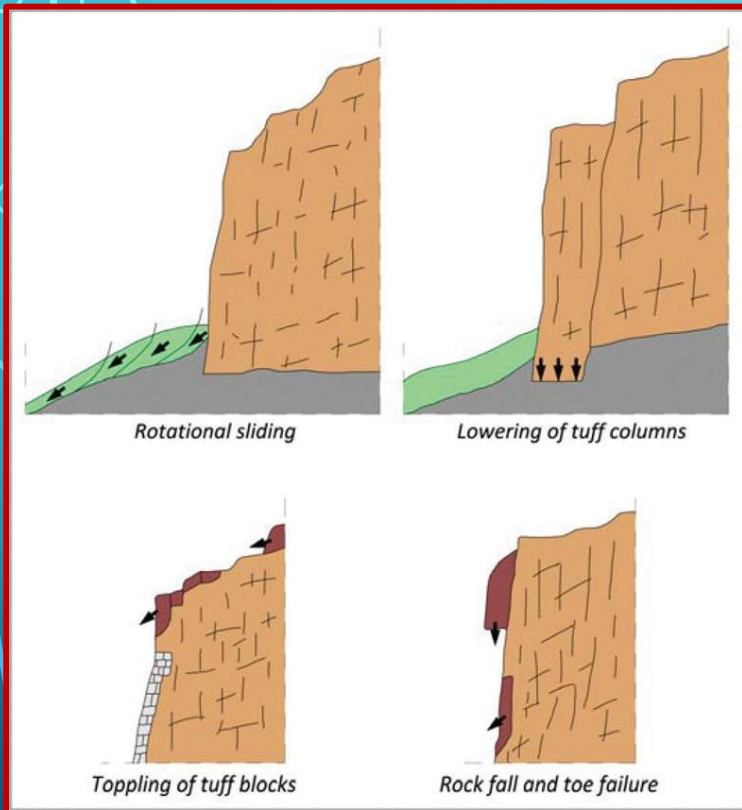


**Drainage well
maintenance**





Failures and instability phenomena



FAILURES CAN BE SO CLASSIFIED:

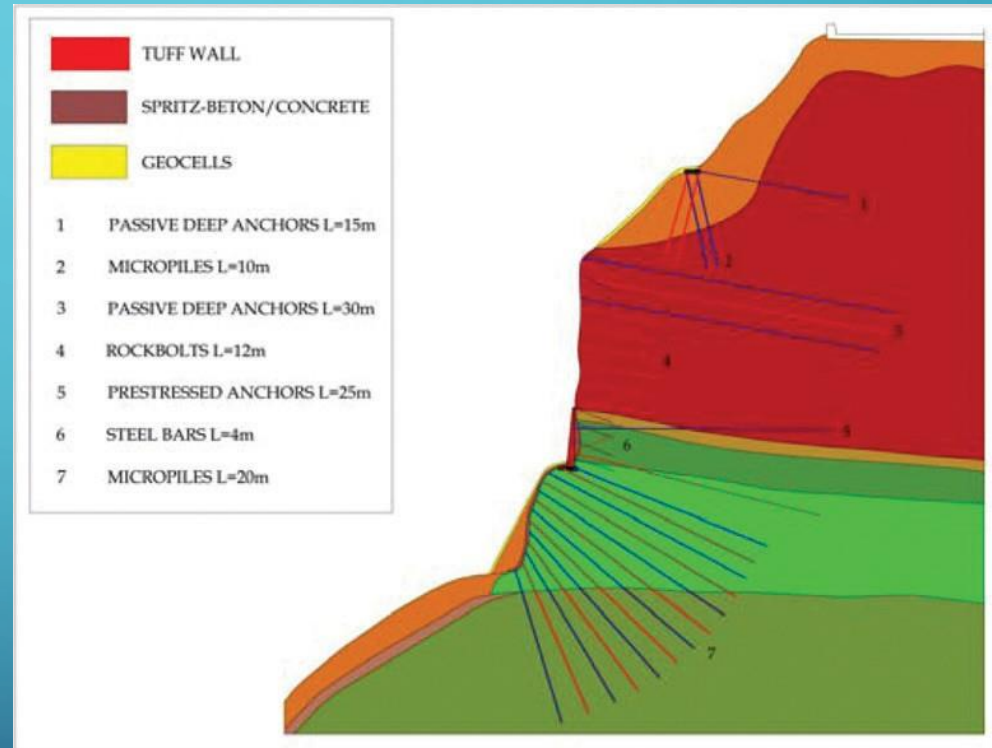
- landslides along the slopes (in the pliocenic clays and in the rocky debris)
 - earth flows, mud flows and soil creep
- failures in the tuff cliff (along the external boundary): rockfalls, desquamations
 - local subsidences due to undermining

THE REMEDIATION AND REHABILITATION WORKS

Hydraulic works in the city areas

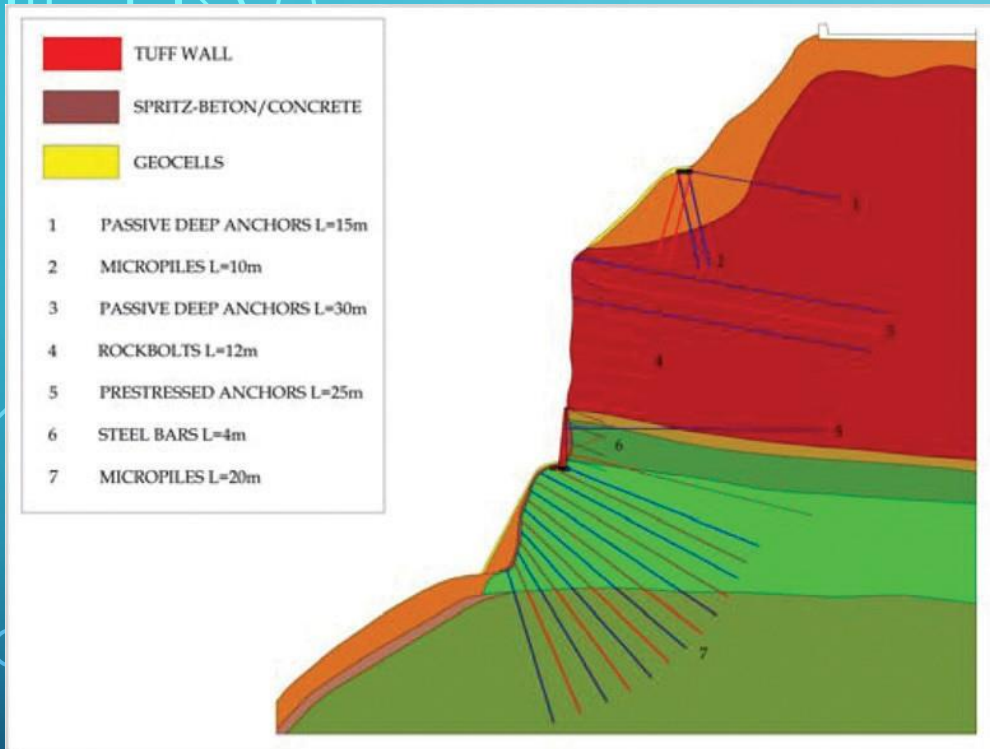


Strengthening of the cliff



THE REMEDIATION AND REHABILITATION WORKS

Strengthening of the cliff



Arrangement upper cliff edge



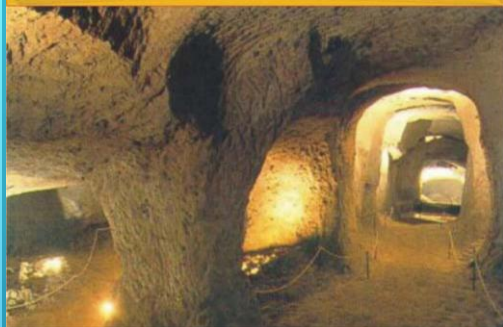
**Stabilization of the slopes.
drainage wells and horizontal drains**



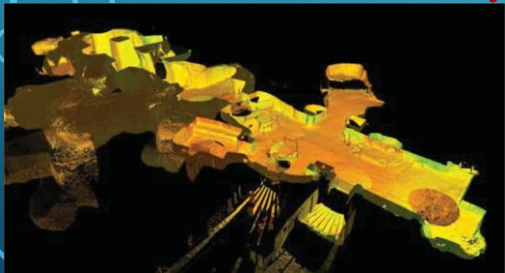
*Restoration of
the
historical walls*

SURVEY AND CONSOLIDATION OF THE CAVES

“Grotta delle Macine”
geophysical survey.



“Grotta delle Macine”
Laser Scanner 3d survey.



Censimento delle proprietà delle grotte sul pianoro:
Rosso = cavità sotto strade e piazze pubbliche
Verde = cavità sotto edifici e pertinenze private;
Giallo = cavità sotto edifici e pertinenze pubblici

Cavity Map

Cavity Consolidation



Cavity Consolidation

THE ALTERNATIVE MOBILITY PLAN



Parking "Campo della Fiera"

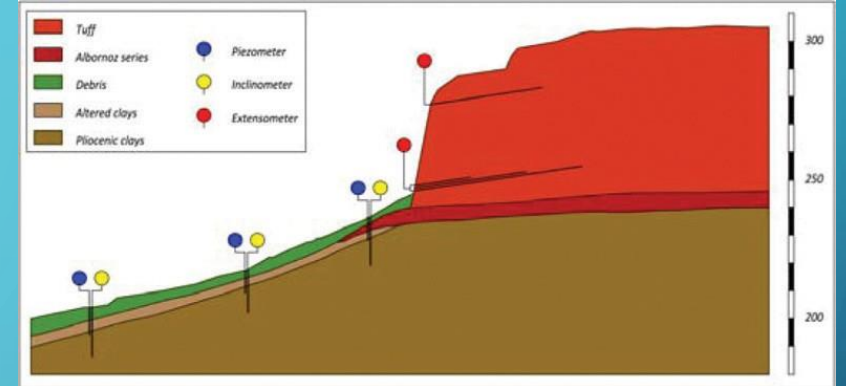
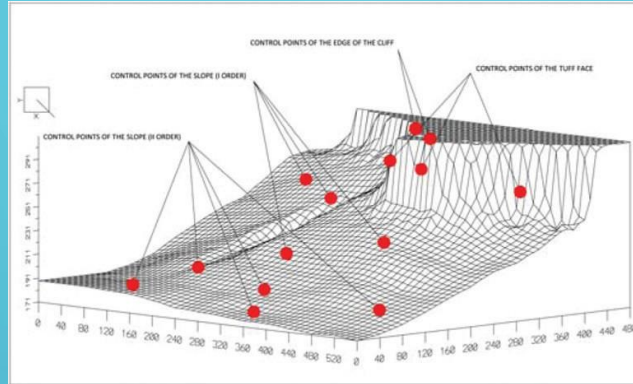


"Palazzo Crispo"
pedestrian access.



Funicular and
escalator access
to the Cliff.

THE MONITORING SYSTEM




COMUNE DI ORVIETO

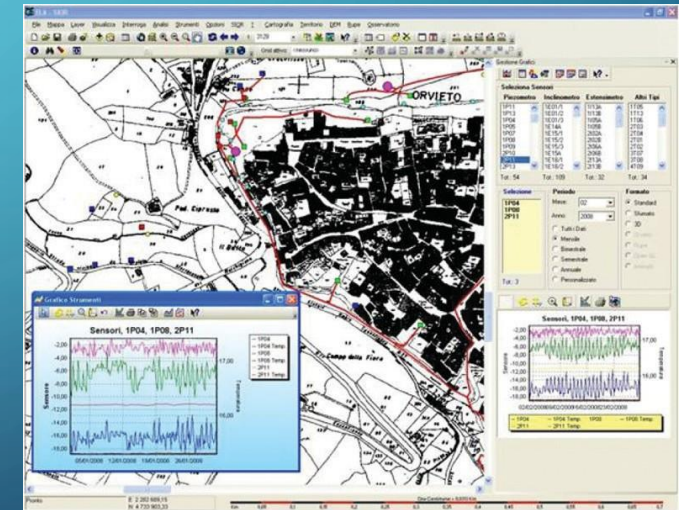
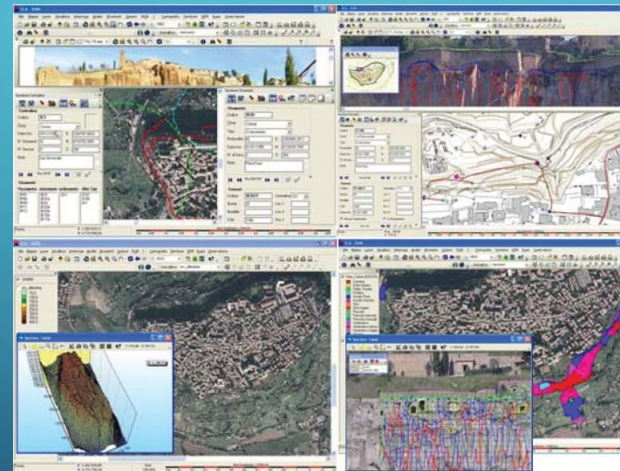

REGIONE DELL'UMBRIA

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BEFORE



AFTER



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