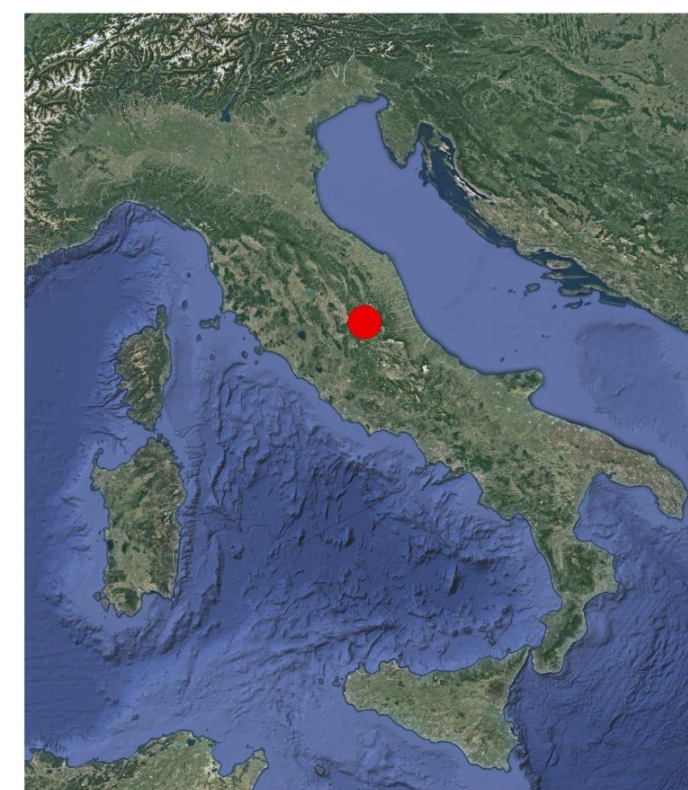


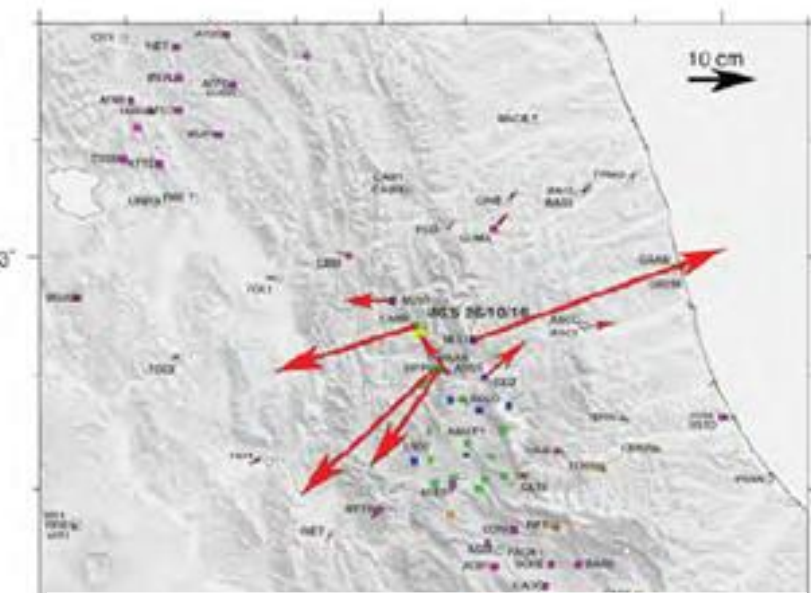
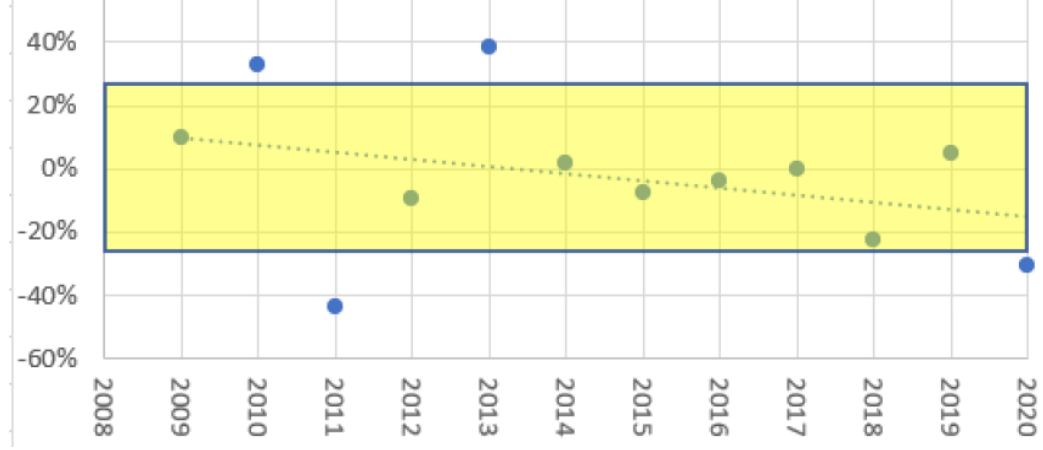
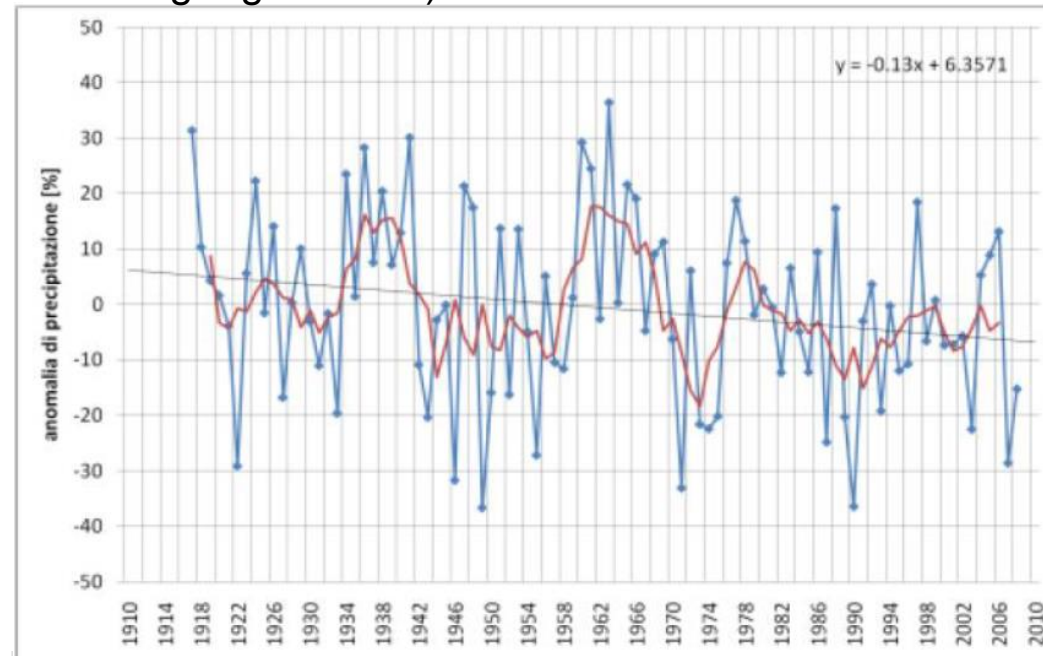
Introduction

The study covered the territories of Cascia and Norcia, in the province of Perugia (Umbria).

The focus of the project was to provide an update the availability of groundwater resources that changed over the last decade, both for climatic reasons and in relation to the seismic events that have affected the region.



Long term trends in rainfall (PTA Umbria, SECLI project & Norcia gauge station)

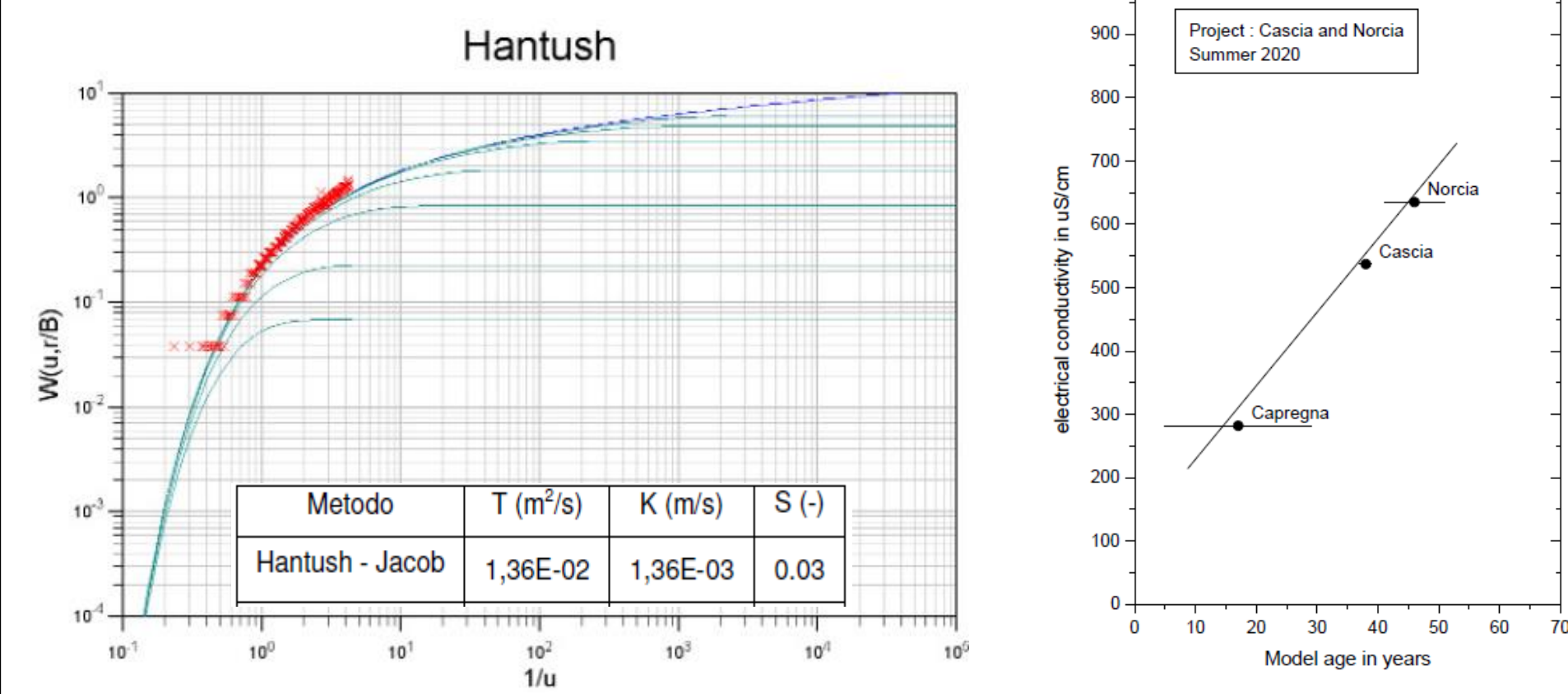


Soil displacement after seismic shock 30.10.2016 (INGV, 2017)

Material and Methods

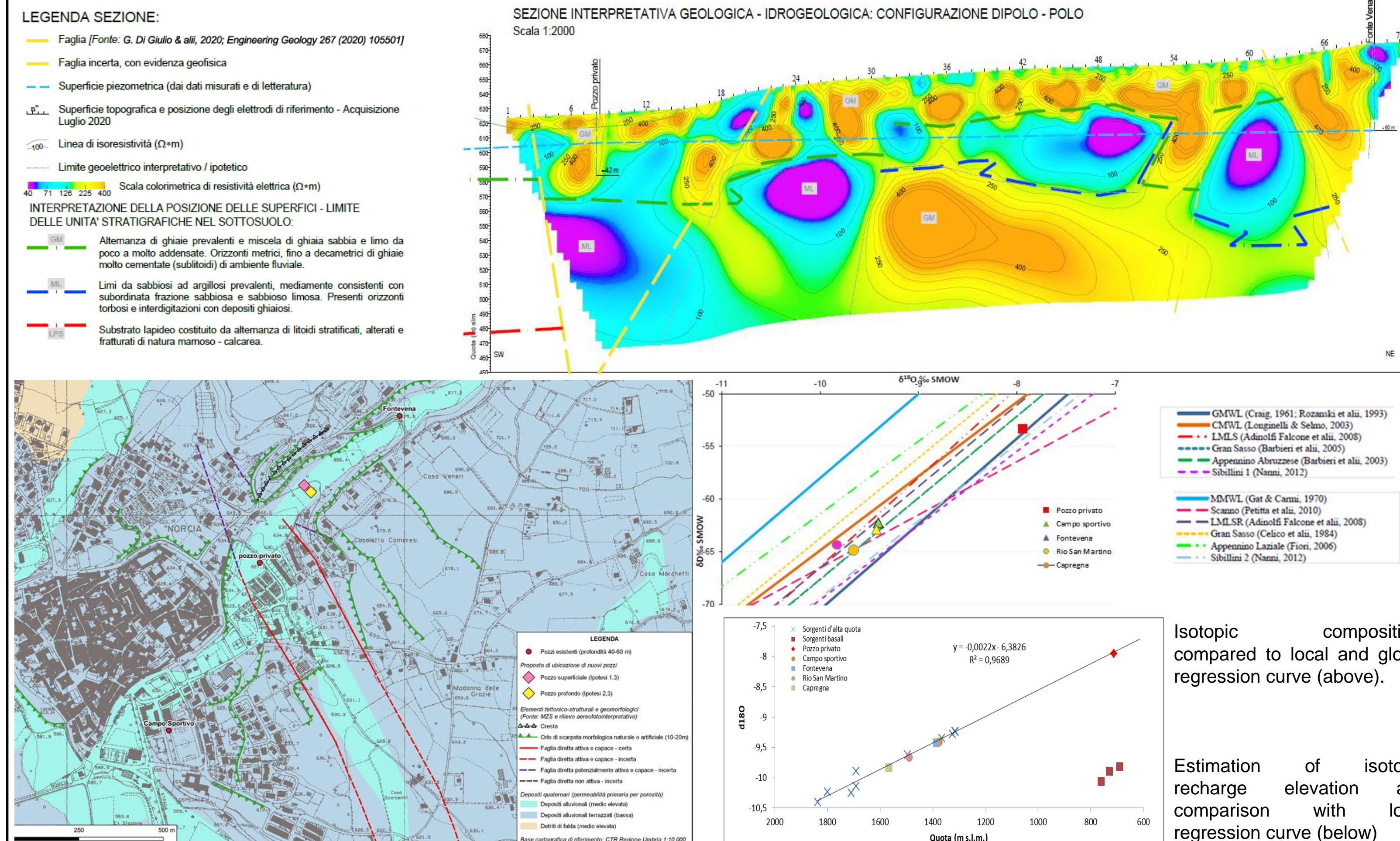
The study was supported by a specific on-site survey programme:

- ✓ classical hydrodynamic and geochemical monitoring techniques (pumping tests, piezometric surveys, discharge measurements in springs),
- ✓ deep geophysical prospections (electrical resistivity survey, pole-dipole and pole-pole) array,
- ✓ stable isotopes (²H, ¹⁸O) analysis
- ✓ dating "old" (¹⁴C) and "modern" (CFC-SF₆) age components (with radiogenic and anthropogenic tracers).

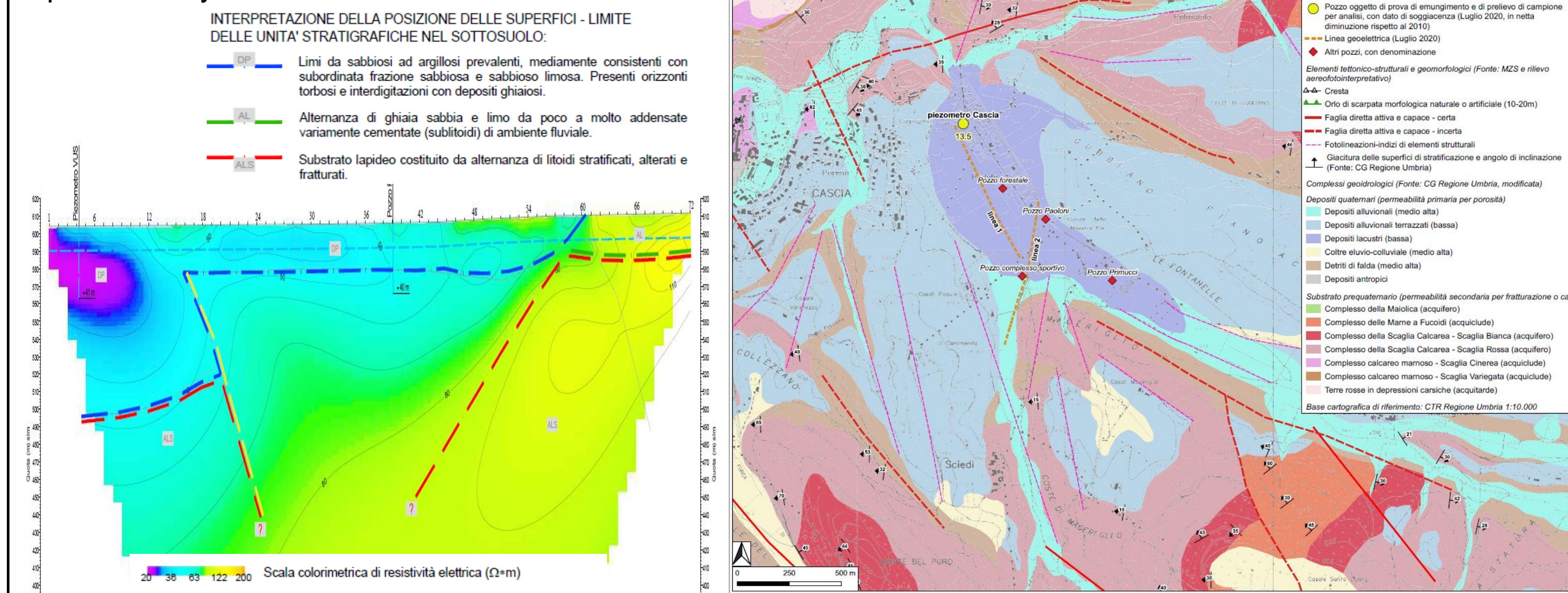


Results

In the Norcia Plain, the geophysical investigation has allowed to recognize the role of active deformative structures and the high thickness power of the quaternary deposits. The local recharging of the fan conoid system, open to anthropogenic tracers, imposes itself on genetically older waters, with slowed outflow in the sequences of low permeability fluvio-lacustrine deposits, interconnected with the coarser fan deposits of conoid.



In the study area of Cascia (Padule Plain) was found a condition of critical production at the water system. The semi-confined aquifer in the marshy fluvio deposits expresses a marked dynamic imbalance (piezometric decline 10m in 10 y), attributable to a reduction of the recharge and to a (possible) drainage component of seismic origin, with deep escape flows along the regional tectonic guidelines. The results of isotopic and dating analysis suggest a local recharge height, a recent component open to anthropogenic tracers and a radiocarbon age characteristics of a flow system with deep circulation components in medium-moderate permeability media.



Conclusions

In the light of these results it was possible to provide the Water Service Manager a support for the design of drinking water catchment works, in addition to the current equipment, able to meet a medium-time requirement long term, with an adequate safety factor against the local climatic and seismic variability.

Mean Residence Time estimation is related to aquifer properties/parameters

$$MRT = \phi * L / R$$

ϕ = porosity (-)
L = aquifer thickness (m)
R = recharge (m/y)

Cascia

$\phi = 0.15$ (-) L = 60 (m) R = 0.25 (m/y) => MRT = 36 y (according to CFC/SF₆)
 $\phi = 0.15$ (-) L = 210 (m) R = 0.01 (m/y) => MRT = 3150 anni (according to ¹⁴C)

Campione	¹⁴ C age	CFC age
Piezometro Cascia	3200	38

Norcia

$\phi = 0.25$ (-) L = 50 (m) R = 0.25 (m/y) => MRT = 50 y (according to CFC/SF₆)

$\phi = 0.15$ (-) L = 175 (m) R = 0.0025 (m/y) => MRT = 10500 anni (according to ¹⁴C)

Campione	¹⁴ C age	CFC
Sorgenti Capregna	2920	17
Pozzo privato Norcia	10600	46

References

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