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# The 2022 SASEG convention in Acqui Terme: a geological journey through the complex evolution of the southern Piedmont region (NW Italy)

Andrea Moscariello<sup>1</sup>

## Introduction

The SASEG 2022 convention field trip was held in Acqui Terme located in the SE Piedmont (NW Italy), at the center of the geological area known as the «Tertiary Piedmont Basin (TPB)», a name introduced in the late 70's to the region located in the southern part of the greater Po Plain basin in Piedmont. This area includes regions internationally renowned for their gentle hilly landscapes and eno-gastronomic excellences such as the Langhe and Alto Monferrato, casted between the Apennines to the South and the Po Plain and Monferrato hill to the North.

The TPB has been the center of the extensive geological research where fundamental

advances in the field of stratigraphy, sedimentology and palaeontology were made since the 70's. To name a few, key progress in describing and understanding turbiditic processes and resulting sedimentary successions (e. g. work by E. Mutti, G. Ghibaudo, F. Ricci Lucchi, etc.), refinement of the biostratigraphic subdivision of Cenozoic strata and the identification of key strata-types for the Neogene and Paleogene (Langhian, Serravallian, Tortonian) represent some of the geological highlights of this region.

The importance of this area is related to its proximity to the deep Po Plain basin located

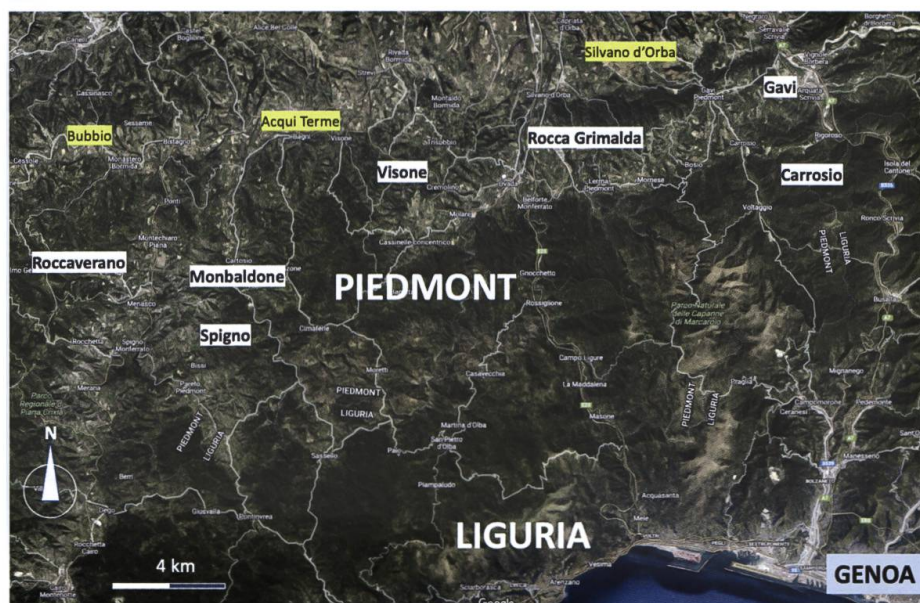


Fig. 1: Map of the area visited during the SASEG Convention in Acqui Terme. The location name on the white rectangle indicate the outcrops while the yellow indicate the lunch stops.

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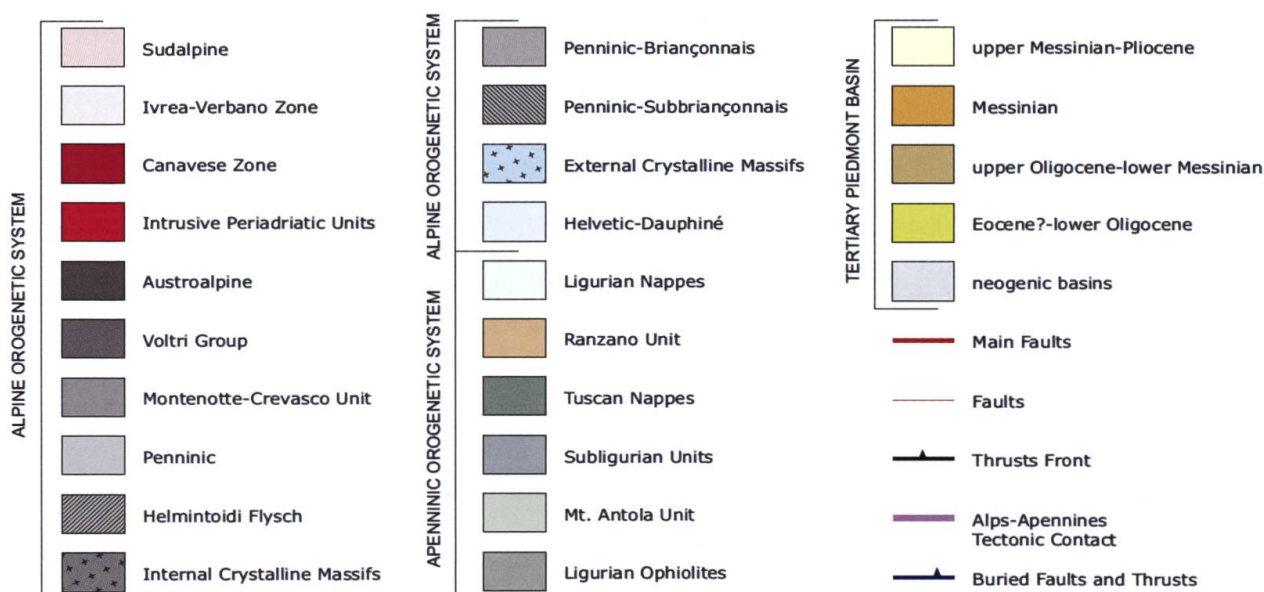
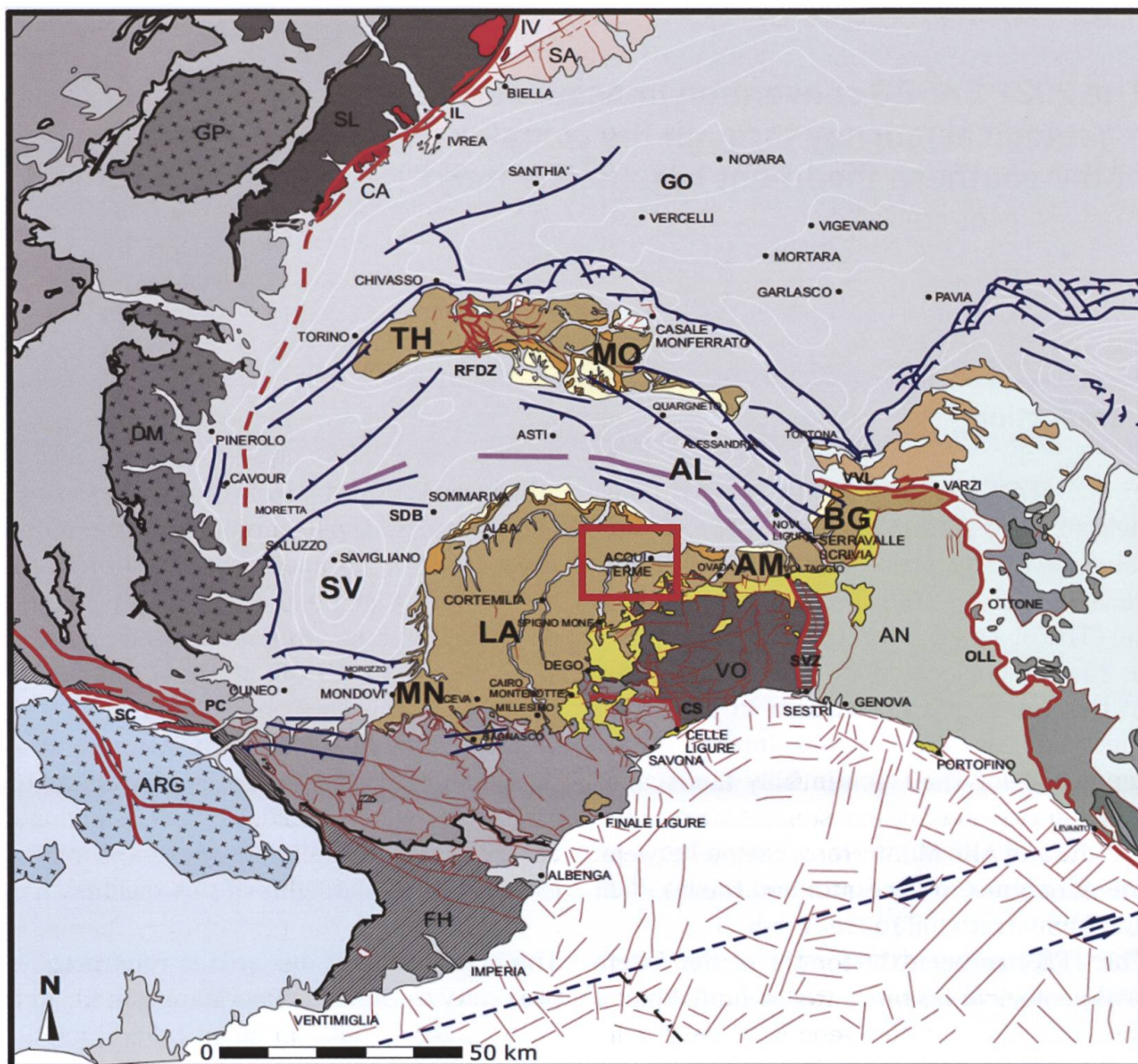


Fig. 2: Geological map of the "Tertiary Piedmont Basin" located in the southern Piedmont, at the north of the Alps and the Apennines. The Acqui Terme location is indicated by the red rectangle.

to the North where the company ENI carried out extensive exploration activities for hydrocarbons in the 60's, 70's and early 80's. Equally, this area has been at the center of extensive research associated with its geothermal potential related to the occurrence of hot springs well known since the XII century.

As such, this area has been visited and studied by generations of geoscientists looking at different aspects of the prevailing clastic succession whose composition, architecture and tectonic style unravel the complex history of the disappearance of Ligurian ocean and the rising of the Alps and Apennines chains.

## Symposium presentations

During the Saturday seminar the SASEG members enjoyed three scientific presentations offered by Mario Rossi (former Snr geoscientists for special studies in ENI), Prof Giuseppe Mandrone from the University of Turin and his collaborator Dr. Jessica Maria Chicco. The topics presented included first a thorough review of the geological insight developed over the years highlighting the value of integrating detail stratigraphic and sedimentological study in outcrops with seismic and borehole data. This was followed by two presentations on the Acqui Terme geothermal province addressing both the deep geological structures controlling the recharge and accumulation of water and their geochemical signatures, and the great potential which this renewable energy source, already recognised since roman time, could have if properly explored and exploited. Based on water geochemical data, the subsurface of Acqui Terme could hold deep geothermal water resources up to 120°C associated with high flow rates. Moreover, at shallower depth, two additional potential geothermal reservoirs were also identified, the deeper at ca. 1000 m of ~ 70°C and the shallower at 200-

300 m depth at ~ 40° C. Based on this, power production could yield between 1 and 3 MW and could provide between 8 a 16 GWh of renewable energy to Acqui Terme. This would represent almost 20-40% of the total demand. Unfortunately, political, administrative and economic obstacles have so far prevented further implementation of the project with additional exploration investigations including borehole drilling.

After the seminar, the SASEG convention participants visited the Bollente (Fig. 3c), one of the many hot springs in the region of Acqui Terme located in center of the town. Compared to the other, this is the hottest one reaching ca. 70°C although the marble plaque in the square of the same name indicates a temperature of 74.5°C.

The primary chemistry of the Bollente and the other springs is the result of chemical reactions that took place inside the reservoir located at depth >1000 m. The chemical composition of the thermal waters has been traced and the temperature, pressure and CO<sub>2</sub> values to the type of rock present in the reservoir has been determined. The latter is very similar in chemical and mineralogical characteristics to the metabasites of the Voltri Group. The fact that this geological element is present at great depths in the deep Acqui Terme subsurface is confirmed by recent geological-structural models. The Voltri Group therefore rises to the surface in the structural highs located between the provinces of Alessandria, Genoa and Savona while it is covered by hundreds of meters of more recent sedimentary rocks in correspondence to Acqui Terme.

## Excursions

During the two days excursion some of the key locations which best describe the fast evolution of the sedimentation at the northern margin of the young Alpine chain were



visited. This region experienced a complex tectonic evolution where several quickly subsiding mini-basins formed which were rapidly infilled by large thickness of clastic sediments.

## First day

The first day of the field trip focused on the basin infill onset. Spectacular example of onlap geometry of the continental conglomerates overlain by marine sandstones of the Rupelian Molare Formation over the crystalline basement here made of exhumed metabasites from the Ligurian ocean crust, were observed. The basal contact of the marine sandstones corresponds to a regionally extensive transgressive surface, highlighted by a characteristic lag of coarse to very-coarse conglomerate, locally discontinuous, varying in thickness from a few decimetres to some metres.

The transition from shallow marine to deep continental shelf and steep slope were appreciated by visiting the world renown outcrop of the Molino di Mombaldone erosional depression (Fig. 3e) within the Chattian Rocchetta Formation marly succession, showing a seismic-scale axial erosional thalweg related to a canyon/slope valley formation and its sedimentary infill.

Evidence of the fast deepening of the basin represented by few meter thick sequence of a thin siliceous beds interpreted as derived from radiolarians-rich mudstone were observed. These attest unequivocally to an important phase of relative sea-level rise, accompanied by a drastic reduction of coarse terrigenous input in slope and basinal settings during the Aquitanian time.

The last geological stop of the day ended by visiting the quarry of Visone where the carbonate sediments formed on top of a isolated structural high surrounded by deep clas-

tic basin survived for few millions of years during the Burdigalian time. The Visone Formation overlies unconformably the Chattian Rocchetta Formation and in turn, overlain by the Cortemilia Formation (mid and upper Burdigalian). In this location a detail observation of the outcrop allow the identification of at least two regressive-transgressive cycles which lead to the drowning of the platform itself.

In this location remarkable karst features associated with hot fluid dissolution and precipitation processes related to fluid circulation along a fracture network could be observed in detail. Based on original clumped isotopes analysis s(S. Bernasconi ETHZ, comm. pers.) the large euhedral calcite crystals occurring along these fractures record a temperature of precipitation of 70°C, which is consistent with the information known from the geochemical geothermometers and most importantly, the temperatures measured at the hot springs nearby.

## Second day

On the second day of the field trip the Cenozoic units outcropping in the eastern part of the TPB were visited.

The first stop was at the southernmost edge of the TPB close to the village of Carrosio where the Cenozoic strata dipping to the north are onlapping to the South on the Ligurian Units (basement) and the metamorphic complex of the Sestri -Voltaggio zone. The section includes the Molare Formation overlain by the Rocchetta Formation passing into the Cortemilia Formation. This section contains the Global Boundary Stratotype Section and Point (GSSP) for the Aquitanian (<https://stratigraphy.org/gssps/aquitania>).

The second stop focused on the well exposed sequence of the Serravallian unit consisting of a thick package of coarse to medium sand-



Fig. 3: Snap shots of the two days field trip providing a glance of the SASEG participants in the field engaged in stimulating discussions (a, d, e), the beautiful landscape of the Langhe region at the sunset (b), the «Bollente» square in Acqui Terme where the 70°C geothermal water springs out (c) and a convivial moment spent in testing the local products of the terroir (f).

stone deposited in a proximal shelf environment dominated by deltaic deposition. High sediment supply and fast sedimentation rate can be inferred by the primary sedimentary structures often characterised by slumps, large dewatering features and high-flow re-

gime parallel lamination and antidunes. The sedimentary succession records a clear transition from outer shelf (Cessole Formation, Langhian), prodelta and delta front over which a set of distributary channel deposits (Serravallian) prograded.



Deposits chrono-stratigraphically related to the same unit were observed ca 8 km more to the West in Rocca Grimalda where vertical convex-up sand waves deposited in the Serravallian outer shelf were involved in a large collapse process likely associated with shelf margin instability triggered by seismicity linked to the upper Miocene (Tortonian) tectonic activity. These deposits form a large chaotic complex which today form a topographic high from where the village of Rocca Grimalda stands out and dominates the valley of the river Orba.

## Acknowledgements

The two days field trip were punctuated by both cultural and superb eno-gastronomic experiences where the SASEG members could test excellent local food and a large variety of wines. Special thanks goes to Valeria Moscariello from Italian Steps (<https://italian-steps.com/en/>) who organised the spouse program and the conference dinner, the wine maker Gianfranco Torelli (<https://www.vinitorelli.it/en/>) for his excellent wines which were served at the Enoteca Regionale of Acqui Terme event and Chef Paola Arpione for preparing us a outstanding gastronomic lunch at the Tre Colline in Langa in Bubbio and organising a wine-testing competition where from the taste, aroma, structure, acidity and balance of *Barbera Superiore* from different local wine makers, the different terroirs laying on Serravallian, Tortonian and Messinian lithotypes had be identified (Fig. 3f).