

GIGS – GRUPPO ITALIANO DI GEOLOGIA STRUTTURALE

FIELD TRIP 2003 – Southern Apennines

Geological outlines

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The GIGS Field Trip 2003 is planned at illustrating the first-order structural features of the Southern Apennines from the Tyrrhenian margin of the mountain chain in the Paestum area to the front of the allochthonous sheets in the Vulture volcano area. The trip route will roughly follow the trace of the line CROP-04 (see fig. 1). The latter is a reflection seismic profile that cuts across the entire thrust belt-foredeep-foreland system from Agropoli to Barletta showing in the thrust belt good seismic signals down to 8-10 sec TWT, that is to depths exceeding 20 kilometres (MAZZOTTI *et al.* 2000).

The overall structural architecture of the Southern Apennines may be approximately described as a huge duplex system of Mesozoic-Tertiary shallow-water carbonates overlain by a complex pile of platform-and-basin-derived rootless nappes (CASERO *et al.* 1988; CASERO *et al.* 1991; CELLO and MAZZOLI, 1999; CELLO *et al.* 1987; LENTINI *et al.* 1996, 2002; MONACO *et al.* 1998; MATTAVELLI *et al.* 1993; MENARDI NOGUERA and REA 2000; MOSTARDINI and MERLINI 1986; PATACCA and SCANDONE 1989; PATACCA *et al.* 1992a; ROURE and SASSI 1995; ROURE *et al.* 1991).

The buried duplex system is made up of carbonate imbricates detached from the Apulia platform during Pliocene and Pleistocene times. In the mountain chain, the top of the duplex lies at depths ranging from 1500 to 6000 metres b.s.l., except in the Monte Alpi tectonic window where the deformed Apulia carbonates reach about 1900 metres above sea level. The autochthonous portion of the Apulia platform crops out in the Gargano, Murge and Salento regions, which form the present foreland of the Southern Apennines. Between the Gargano-Murge region and the leading edge of the buried duplex system, the autochthonous Apulia carbonates form a sort of homocline gently dipping towards the thrust belt. The structural depression derived from the carbonate-platform deflection, called in the geological literature Bradano Trough, represents the youngest foredeep basin of the Southern Apennines, active in late Pliocene and Pleistocene times.

The allochthonous sheets forming the roof of the carbonate duplex system are constituted of Mesozoic-Tertiary sedimentary sequences referable to platform and basin depositional domains (Sicilide and North-Calabrian basinal realms, Alburno-Cervati platform, Lagonegro basin, Matese-Simbruini platform and Molise basin, see fig. 2). Nappe stacking took place through Miocene times.

In the early Pliocene, the entire pile of nappes overthrust the Apulia platform before the latter began to be involved in the compressional deformation. The severe telescopic shortening of the Apulia carbonates during late Pliocene and Pleistocene times caused a further forward (north-eastward) transport of the allochthonous sheets of about 30 kilometers; in addition, duplex-breaching processes irregularly alternating with the forward nappes transport caused important re-imbriication of the allochthonous sheets and generation of important antiformal stacks in the roof units of the Apennine system (PATACCA and SCANDONE 2001).

In the foreland area, the Apulia platform was entirely penetrated by the Puglia 1 well (total depth: 7070 m) that encountered at 6112 m Permian-lower Triassic siliciclastic deposits stratigraphically underlying upper Triassic dolomites and evaporites. The contact between the shallow-water carbonates (plus anhydrites) and the siliciclastic deposits corresponds to a sudden decrease in the P-wave velocity. In several commercial lines, this contact is marked by a package of well-organized reflectors conformably underlying the reflection-free carbonate platform. We do not know whether the Apulia platform carbonates and the underlying siliciclastic deposits unconformably overlie a Hercynian crystalline basement or they are a portion of the sedimentary cover of an older (Caledonian?) continental crust.

In the Southern Apennines, the Mesozoic-Tertiary Apulia carbonates forming the buried duplex system represent the main target of petroleum research. As a consequence of the extensive oil exploration in the region, considerable information on the subsurface structures is available. At the time in which the line CROP 04 was planned, the knowledge of the subsurface features, together with the stratigraphic and structural information derived from the regional geology, made possible the construction of realistic geological profiles across the thrust belt-foredeep-foreland system down to a depth of 8-10 kilometres. At greater depths, the interpretation of the tectonic structures was mostly based on the analysis of the gravimetric and magnetic anomalies, as well as on a number of constraints derived from the results of scattered experiments of deep seismic sounding. Presently, the line CROP 04 allows the interpretation of the subsurface structural features down to a depth of 20-25 kilometres (see fig. 3).

Figure 4 is an interpreted line drawing of the entire profile, from Agropoli (Tyrrhenian coast) to Barletta (Adriatic coast of the Italian peninsula). Several boreholes located along the profile, together with several commercial lines have provided important constraints for the identification and characterization of the major tectonic features in the buried Apulia carbonates and in the Apenninic nappes. Starting from the foreland towards the Tyrrhenian Sea, the most remarkable tectonic structures crossed by the CROP 04 line in correspondence to the Adriatic margin of the mountain chain are represented by the frontal ramp of the allochthonous sheets and by the San Fele antiformal stack. The geological features associated to the Apennine frontal ramp have been described in PATACCA and SCANDONE (2001) and will matter of discussion in the day 4. The San Fele stack consists of at least seven imbricates of rock units referable to the Lagonegro nappes. The San Fele 1 well stopped in the stack at 5315 metres without reaching the Apulia carbonates. The latter are supposed to form a ramp anticline beneath the San Fele antiformal stack at a depth of about 3 seconds TWT.

West of San Fele, the buried Apulia carbonates form as a whole an antiformal structure that reaches its culmination in correspondence to Monte Marzano. The top of the carbonates rises from a depth probably exceeding 5000 metres below sea level in correspondence to San Fele 1 to a depth slightly exceeding 3000 metres in correspondence to Monte Marzano. We have related this antiformal structure to an important thrust in the Apulia carbonates. The well-structured package of high-frequency and low-amplitude reflectors deepening from about 4.5 seconds TWT beneath the Tanagro Valley to about 7 seconds beneath the southern flank of the Alburni mountains corresponds, in our opinion, to Permian-lower Triassic siliciclastic deposits transported in the hangingwall of the aforementioned thrust. Whatever the interpretation of these reflectors may be, they mark a geological object that has been involved in the compressional deformation and has been incorporated in the thrust belt. Consequently, they constrain the Apennine base thrust at a depth of about 8 seconds TWT, that corresponds in a depth-converted section to a depth exceeding 20 kilometres below sea level.

Another important feature shown by the CROP 04 line is represented by a thick package of continuous, strong reflectors below the Alburno-Cervati carbonates. This package, roughly parallel to the top of the buried Apulia carbonates, is quite evident between the western termination of the seismic line and the northern margin of the Alburni Mountains at depths ranging from 3-4 seconds to 1-2 seconds TWT. We have attributed these reflectors to the Lagonegro units on the basis of regional considerations. This interpretation is strongly supported by stratigraphic data coming from the Acerno 1 well located at the northern margin of the Campagna tectonic window. This well crossed more than 3500 metres of basinal deposits referable to the Lagonegro units before reaching Messinian evaporites on top of the Apulia carbonates at a depth of 3818 metres below sea level.

Other schemes in the recent geological literature (e.g. MAZZOLI *et al.* 2001) postulate quite modest horizontal displacements in the buried Apulia carbonates forming the backbone of the Southern Apennine duplex system. In our structural reconstruction, on the contrary, a telescopic shortening of several tens of kilometres is required in late Pliocene and early Pleistocene times in order to justify the forward transport of the Apenninic nappes on the upper Pliocene-lower Pleistocene deposits of the foredeep basin, the creation of huge antiformal stacks in the allochthonous sheets and the imbrication of the entire pile of nappes along the outer margin of the mountain chain.

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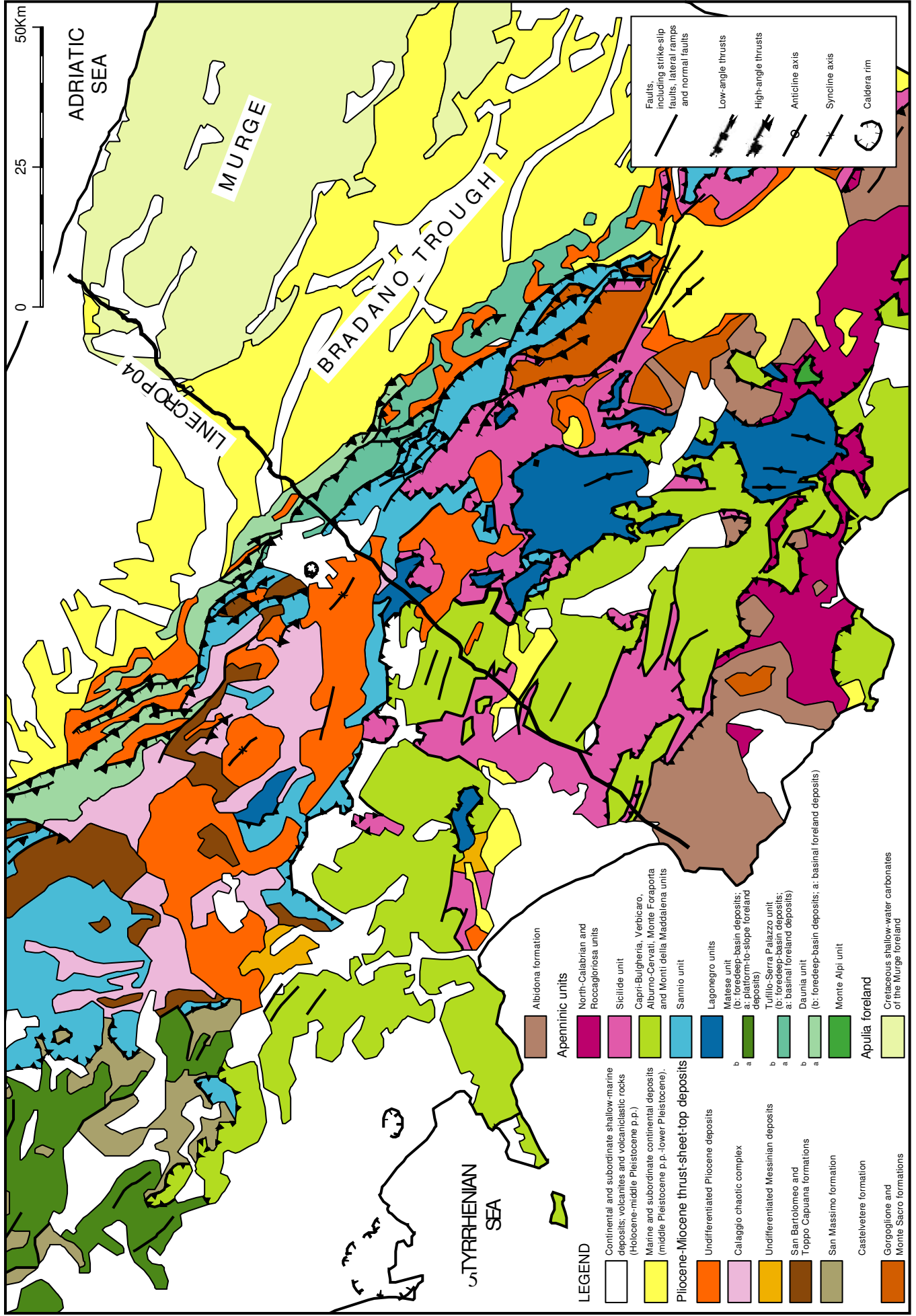


Fig. 1. Simplified geological map of the area crossed by the line CROP 04.

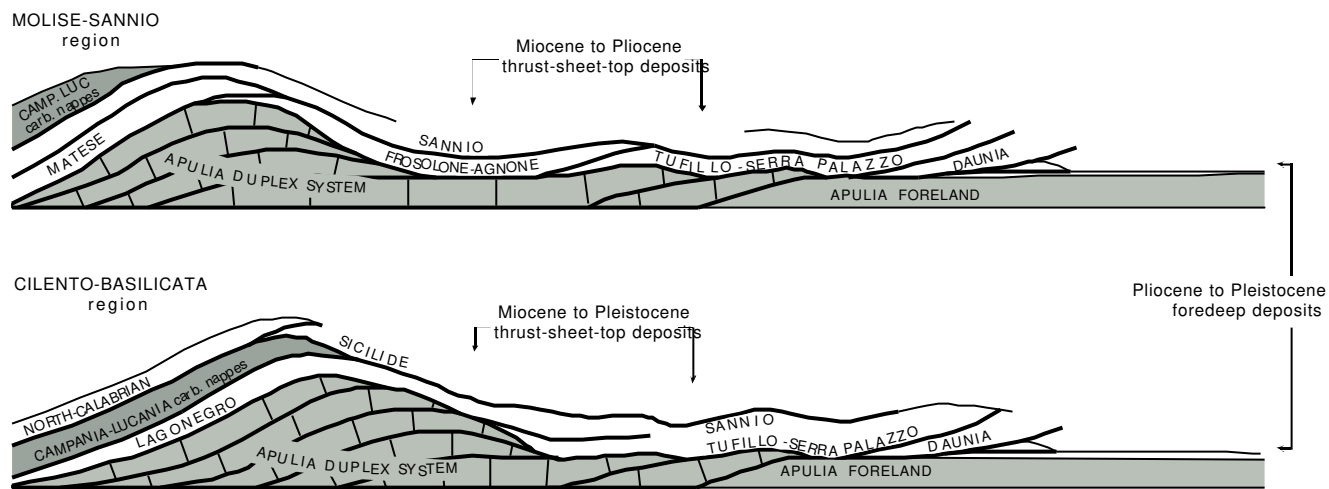


Fig. 2. Sketch of the geometrical relations between the different Apenninic nappes.

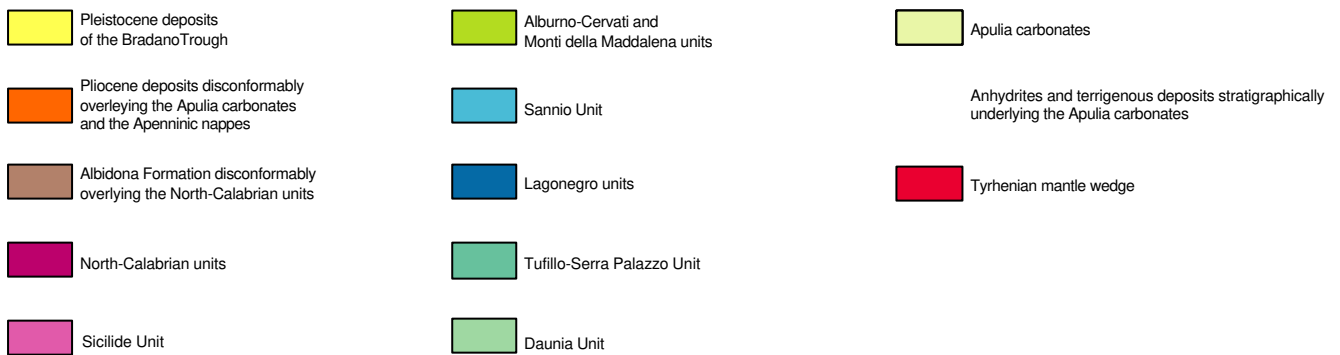
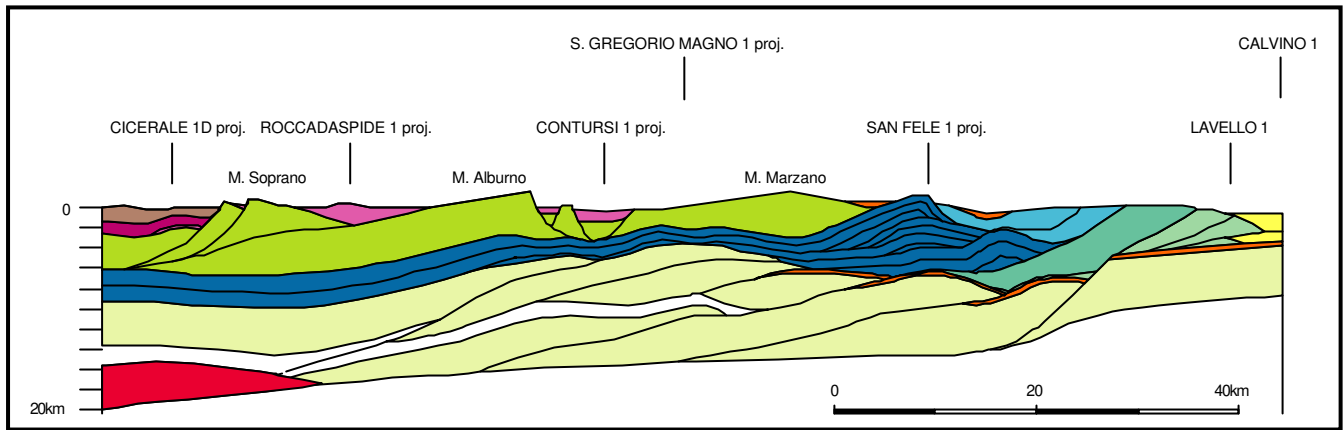


Fig. 3. Simplified geological section across the Southern Apennines along the trace of the line CROP 04.

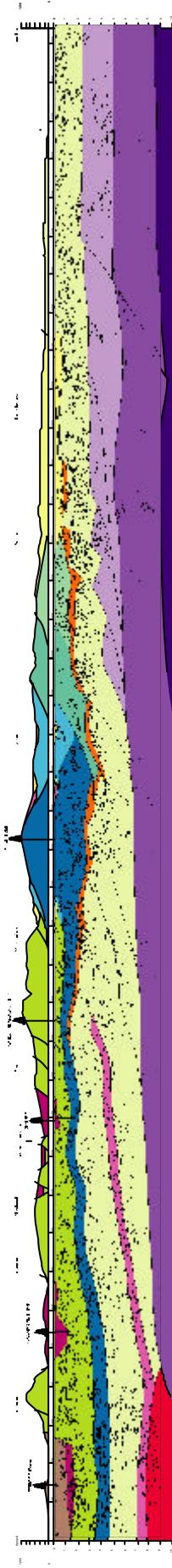


Fig. 4. Interpreted line drawing of the line CROP 04.