The Southern Apennines

Gran Sasso

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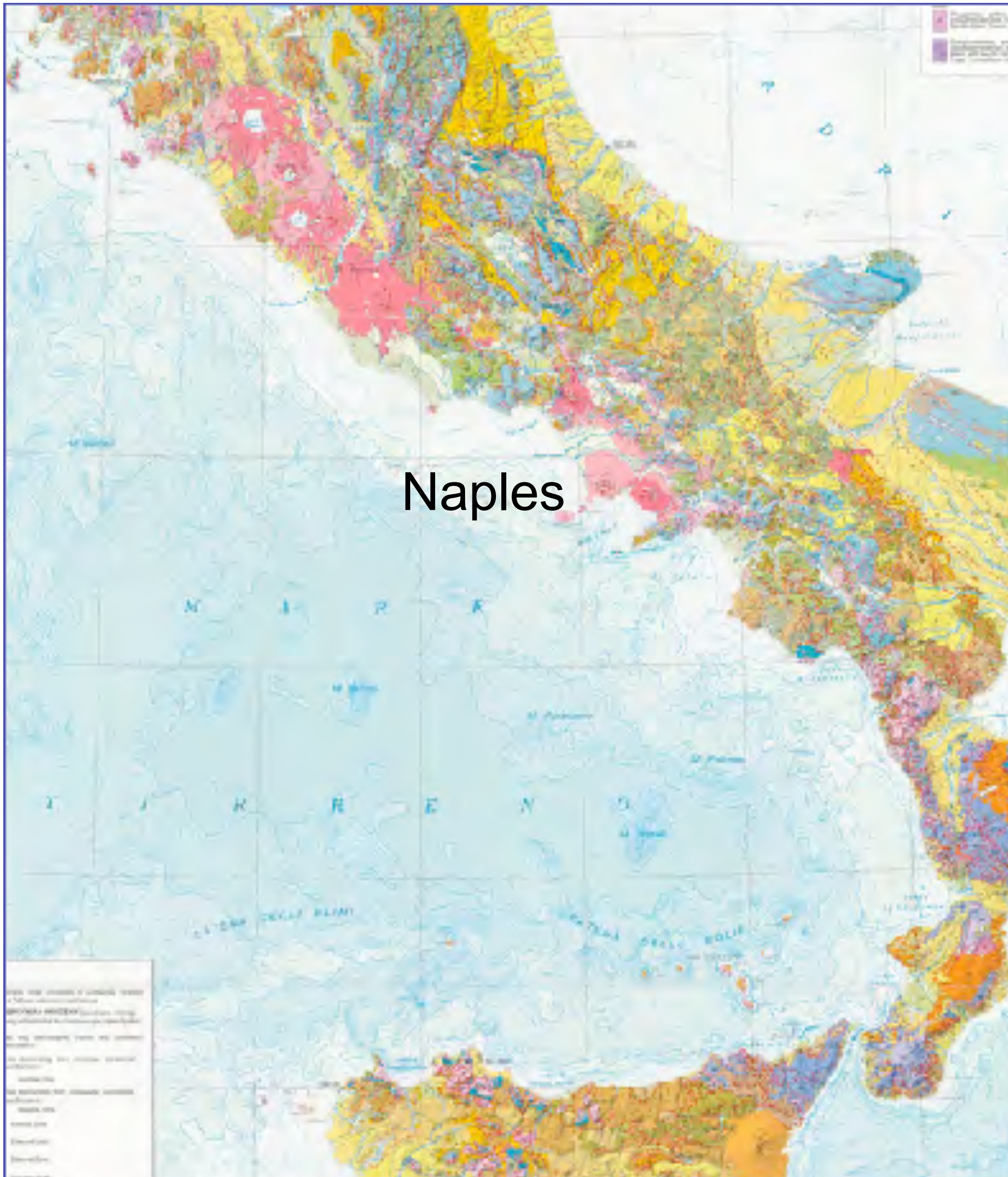
APAT
Agenzia per la Protezione dell'Ambiente e per i Servizi Tecnici
Dipartimento Difesa del Suolo
GEOLOGICAL MAP OF ITALY
MAIN TECTONO-STRATIGRAPHIC UNITS


Naples

The Apennines

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Bay of Naples and Apennines

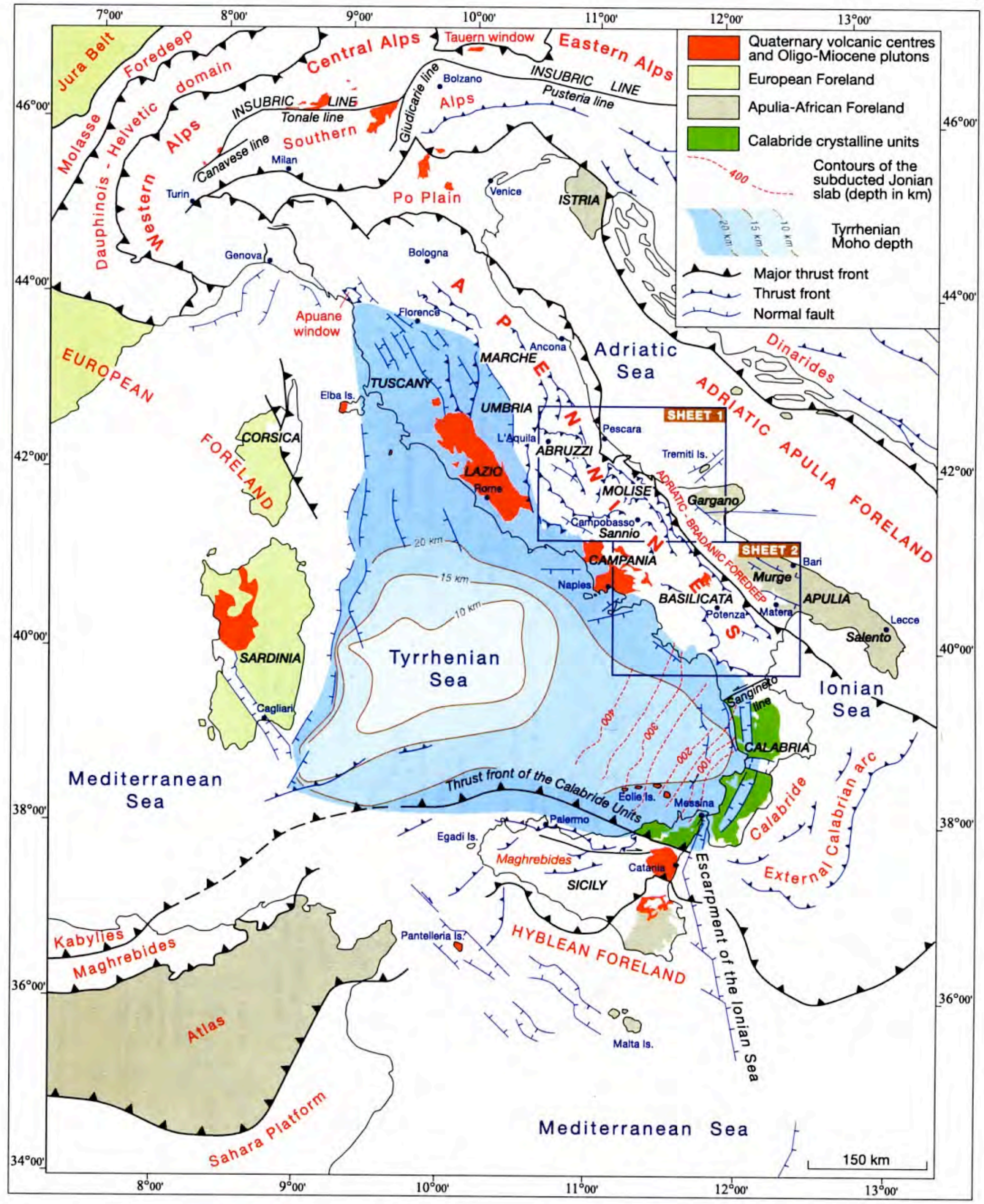

Figure 1. Structural scheme of Italy and surrounding regions. The two rectangles frame the regions mapped in the Sheets 1 and 2 of the *Geological-Structural Map of the Central-Southern Apennines*.

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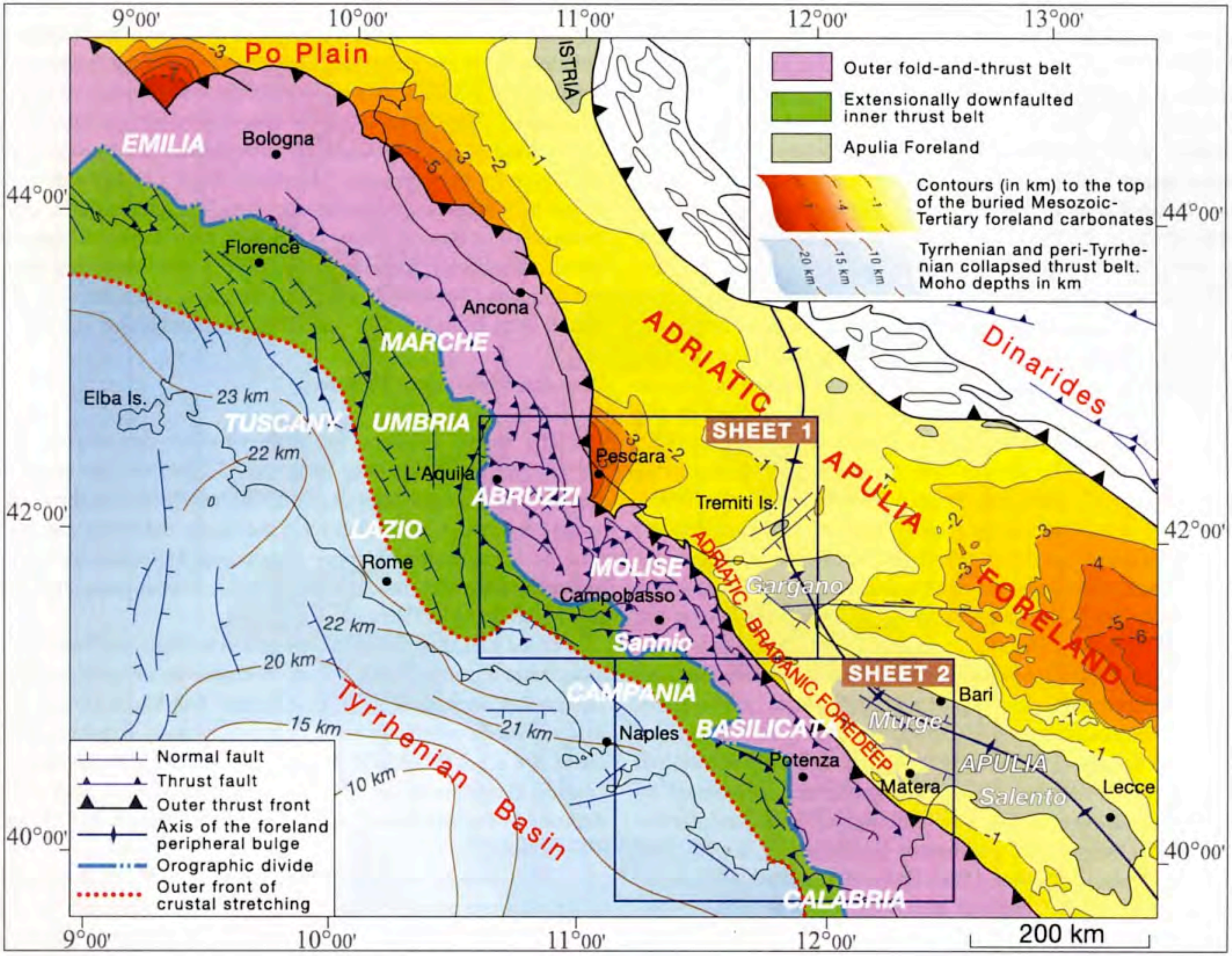

Figure 3. Major crustal and structural domains of the Apennines. The inner domains (west of the orographic divide) are characterized by intense extensional dissection of the thrust belt, with foundering of the Tyrrhenian basin and peri-Tyrrhenian margin, to the WSW of the outer front of crustal stretching. The outermost domains (east of the orographic divide) preserve the contractional features of the thrust belt and display strong components of uplift. Note the axis of the foreland peripheral bulge and the relevant flexure of the Adriatic-Apulia Foreland underneath the outer thrust front of the Apenninic chain, shown by the contours to the top of buried Mesozoic-Tertiary carbonates. The rectangles frame the areas mapped in Sheets 1 and 2 of the *Geological-Structural Map of the Central-Southern Apennines*.

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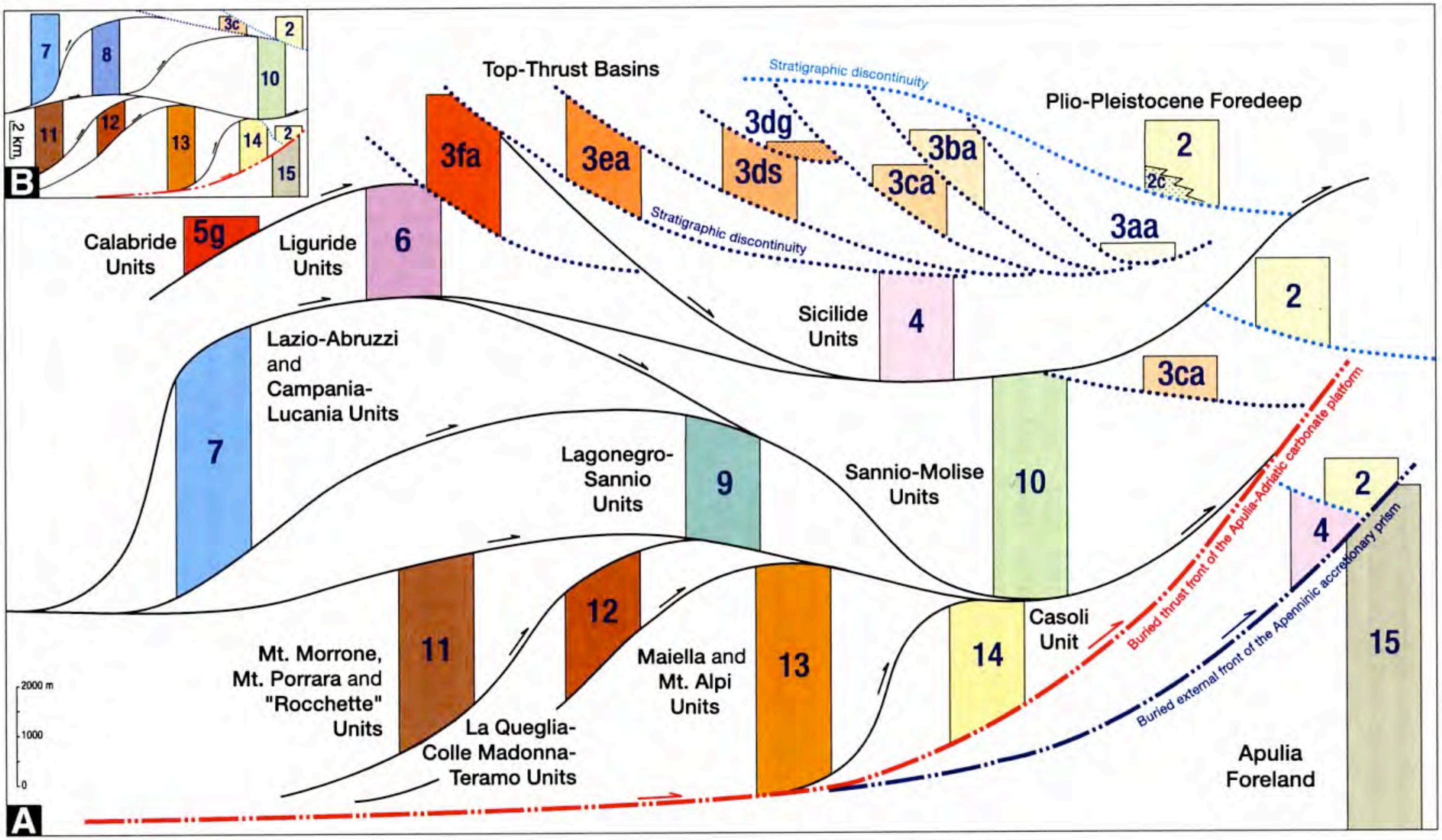

Figure 4. (A) Stratigraphic and structural relationships between the tectonic units of the central-southern Apennines. (B) Inset illustrating the different geometry of the imbricates in the Abruzzi and Molise regions (central Apennines). Numbers are the same as in the legend of the *Geological Map* (Sheet 1).

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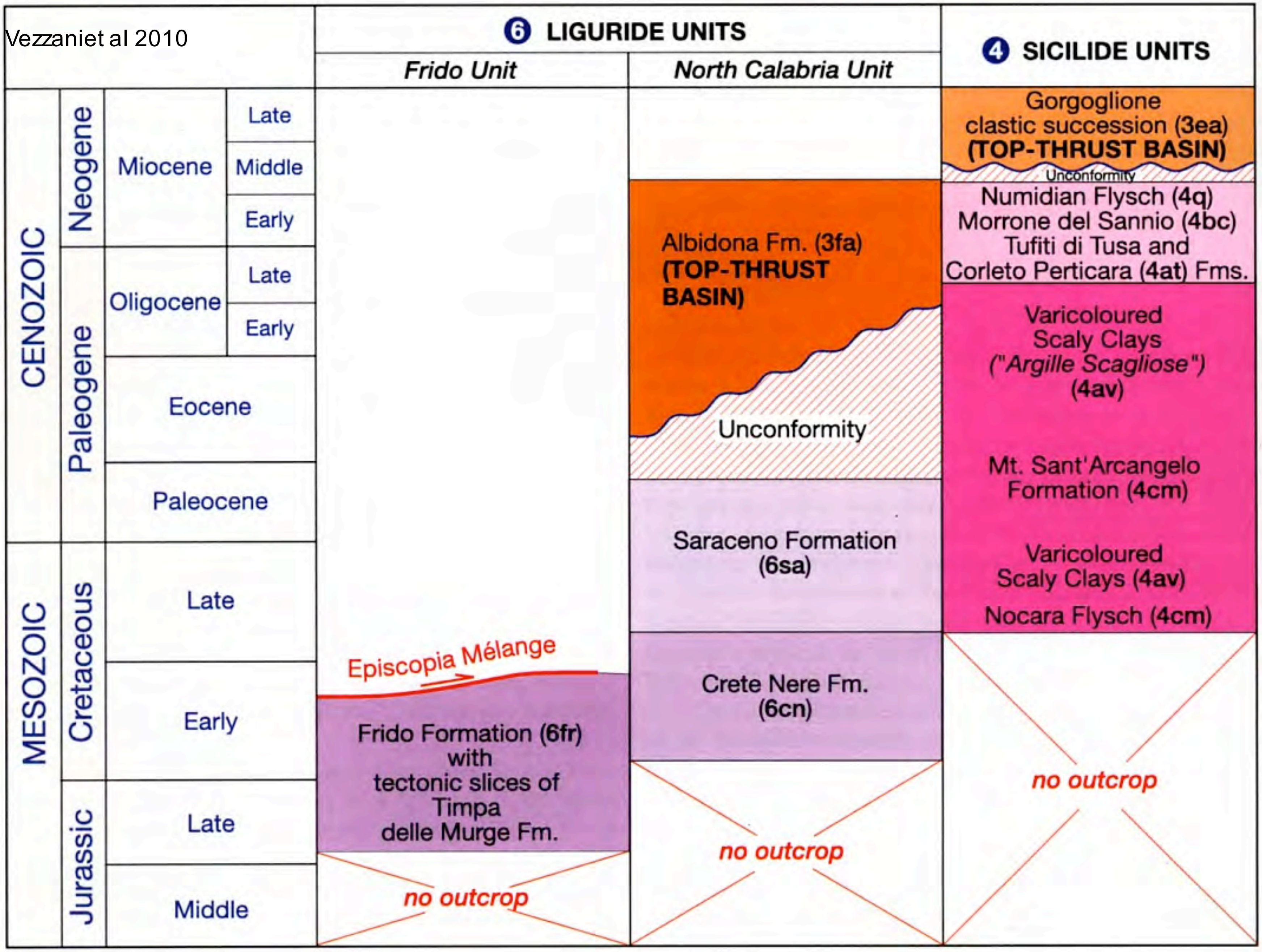

Figure 6. Inner domains: major tectono-sedimentary characteristics of the Liguride (6) and Sicilide (4) Units and of the Albidona (3fa) and Gorgoglione (3ea) top-thrust basins, cropping out at the boundary between Basilicata and Calabria.

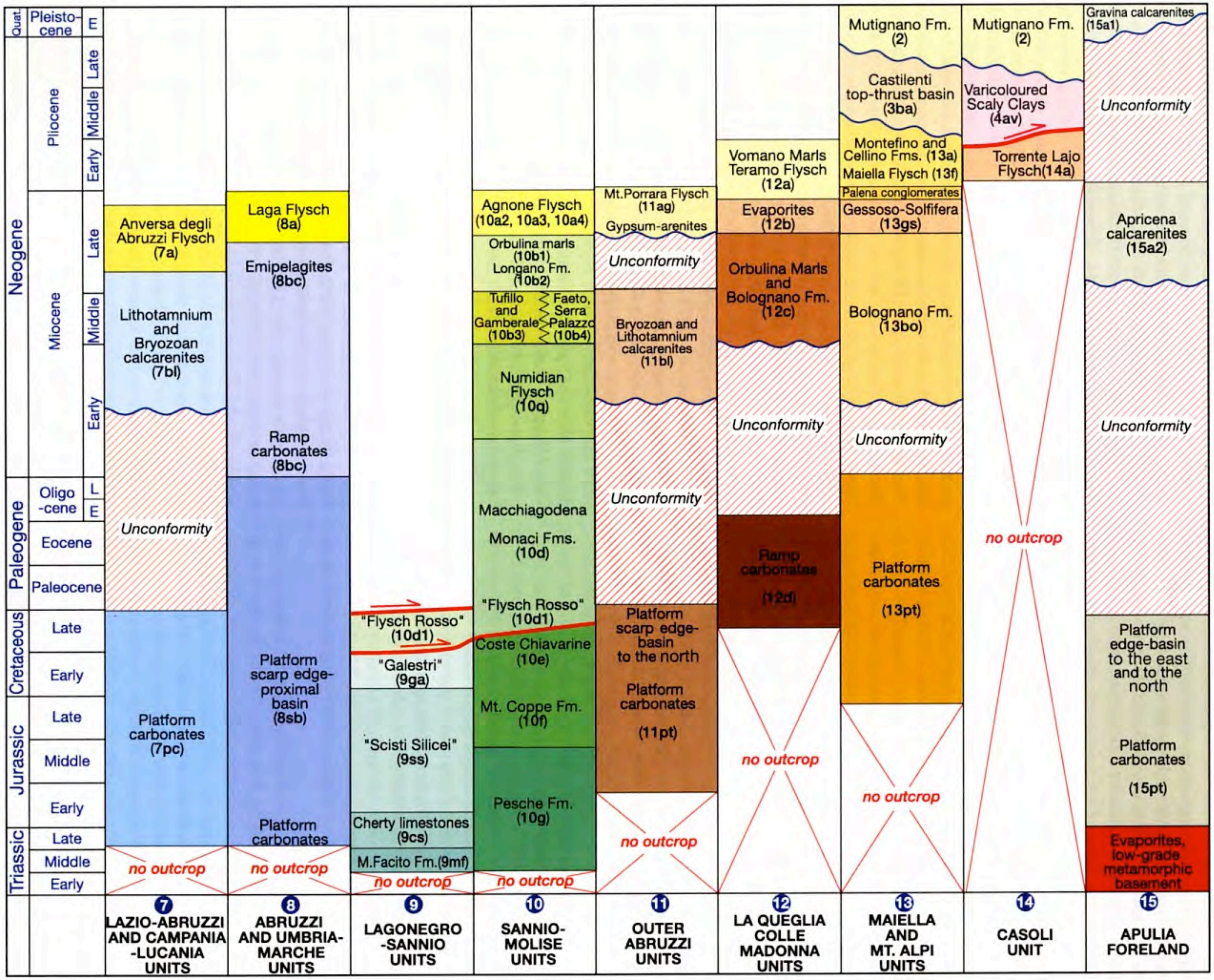

Figure 8. Outer domains: main stratigraphic successions and ages of the external units of the Apenninic chain. Time-space migration of shortening from the Tyrrhenian to the Adriatic zone is well reflected by the age (late Miocene to middle-late Pliocene) of the foredeep flysch deposits that are progressively younger from Unit 7 to Unit 14.

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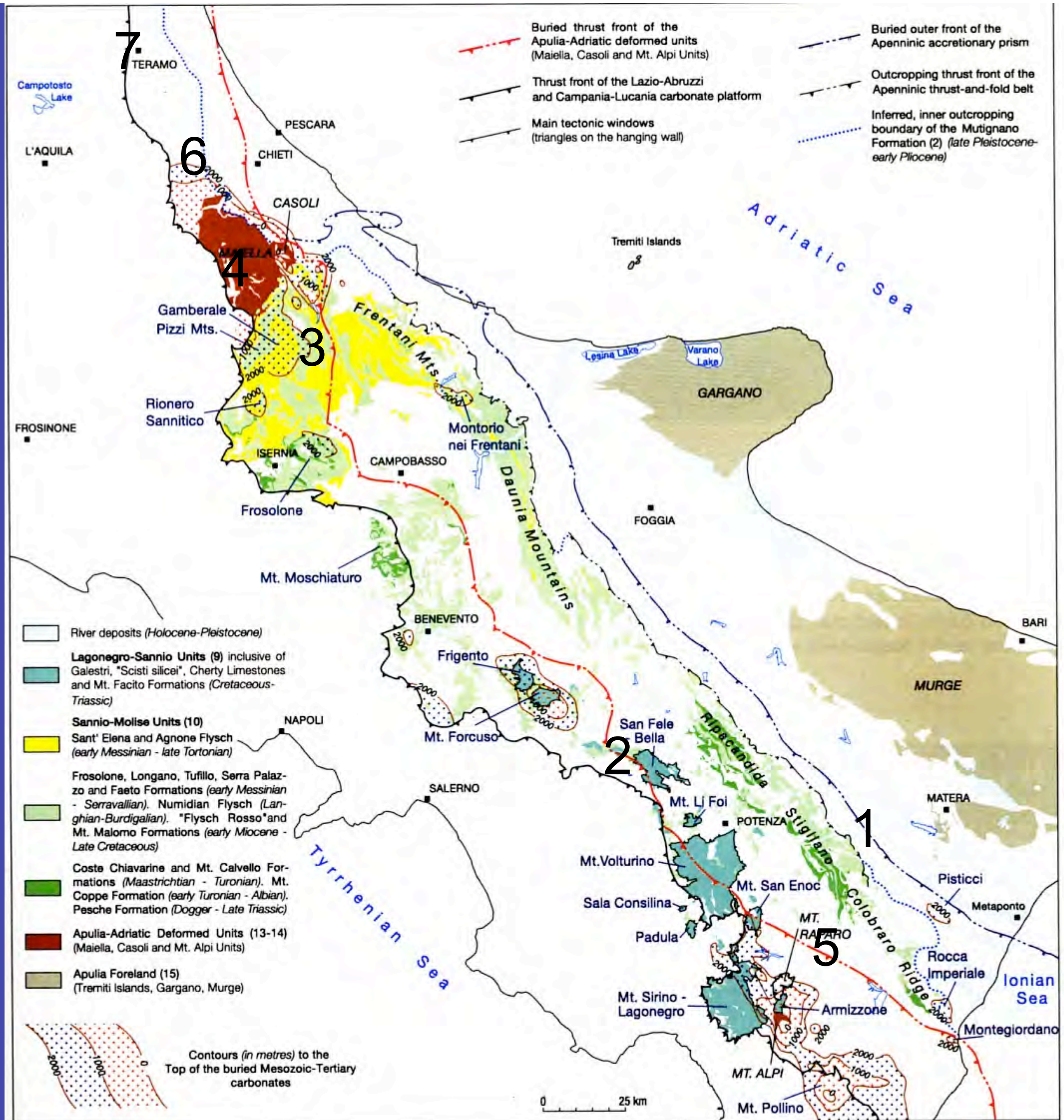

Figure 9. Tectonic windows of the Lagonegro Units and relationships with the structural highs of the Apulia-Adriatic deformed Units (Maiella, Casoli and Mount Alpi). See text for a discussion and interpretation.

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Figure 7. Varicolored Scaly Clays (4av, "Argille variegate" or "Argille varicolori" of the Italian authors) of the Sicilide Units. Thinly bedded red, green and bluish clays alternating with calcilutites, cherty limestones and organic blackish horizons (Bonarelli level equivalent) in the overturned Calanche section, near Campomaggiore (see Sabato et al., 2007).

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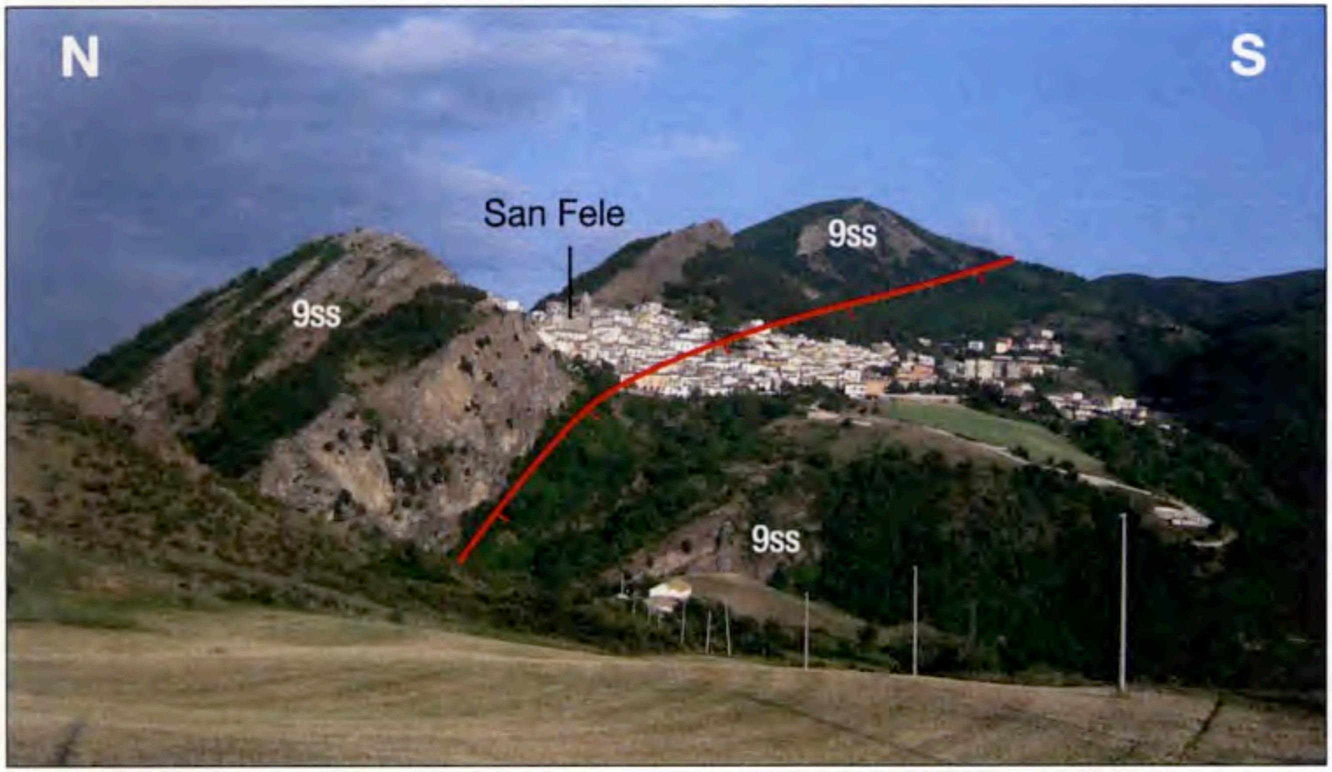

Figure 10. Tectonic window of San Fele (Basilicata), with the "Scisti silicei" (Formation 9ss of the Lagonegro-Sannio Units) emerging on the NE flank of a NW-SE faulted anticline. In red is the trace of the NW-SE normal fault shown in cross sections 5 and 6 in Sheet 2. The outcropping succession (Cretaceous-Jurassic) consists of thick beds of graded calcareous breccias and calcarenites with nodular cherts, alternating with red and green radiolarites and cherty argillites, in cm-thick beds. This Lagonegro-Sannio succession in proximal facies shows strong stratigraphic analogies with the Sannio-Molise Units (see Bertinelli et al., 2005a; 2005b; Passeri et al., 2005).

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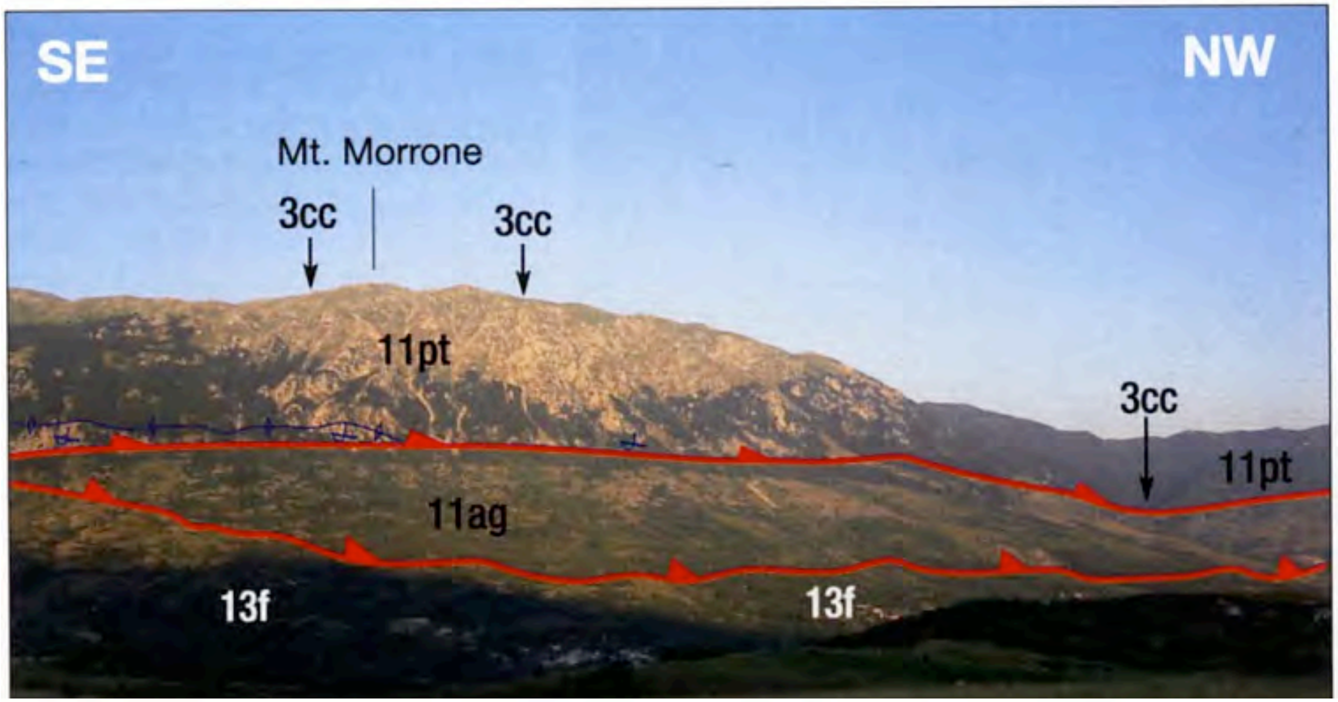

Figure 12. Frontal view of the WNW-striking slope of Mount Morrone (Abruzzo), with subvertical to overturned beds of platform carbonates (11pt, Late Cretaceous–Malm), thrust above the Messinian Mount Porrara Flysch (11ag) along a low-angle SW-dipping thrust fault (marked in red). The Mount Porrara Flysch is on its turn thrust over the lower Pliocene Maiella Flysch (13f). The arrows mark the outcrops of the middle-lower Pliocene conglomerates of the Mount Coppe top-thrust basin (3cc) that unconformably cover the Mount Morrone carbonates (11pt). View from Caramanico.

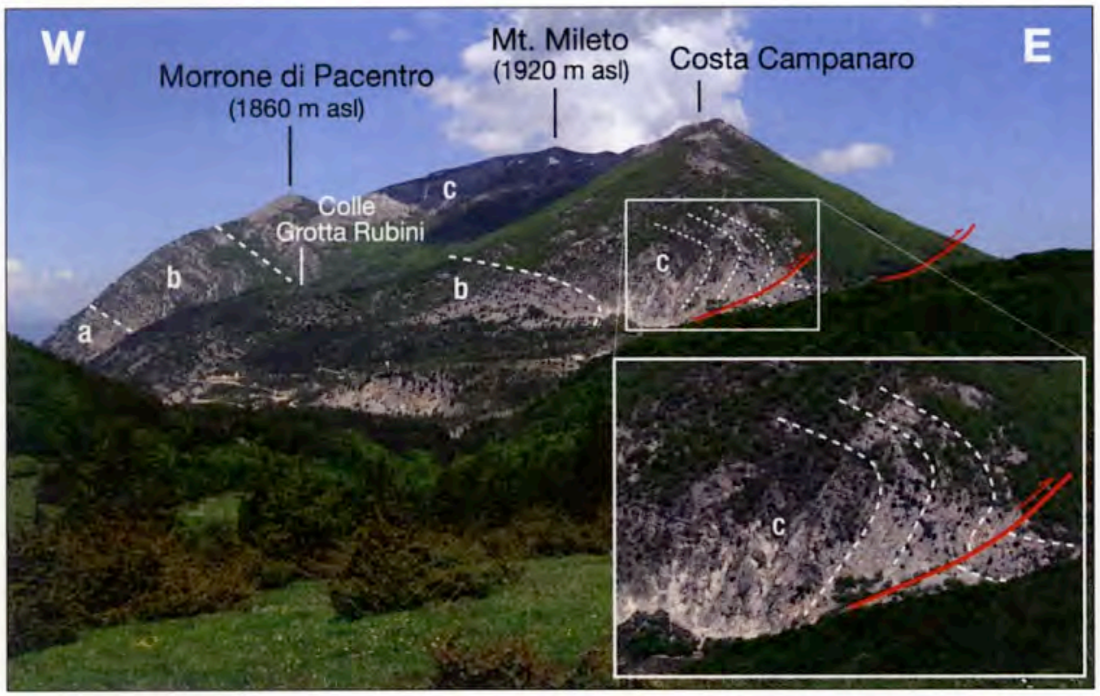

Figure 13. Cross-section view on the structure of Mount Morrone along the right bank of the Vella River (view from San Germano, along the road Campo di Giove–Guado San Leonardo). The oucropping succession of the Mount Morrone Unit consists of: (A) basal member of thick-bedded gray dolomitic limestones (Dogger-Lias); (B) alternating calcilutites and oolitic limestones (Malm-Dogger); (C) bioclastic grainstones with corals, greenish marls with *Orbitolina* spp., mudstones and wackestones with bauxitic horizons (Late Cretaceous–Malm). The inset shows in detail the structure of the Mount Morrone thrust front, with the overturned fold (bedding marked in white) of the Upper Cretaceous platform carbonates thrust over the Mount Porrara Flysch (11ag, not visible in the photograph).

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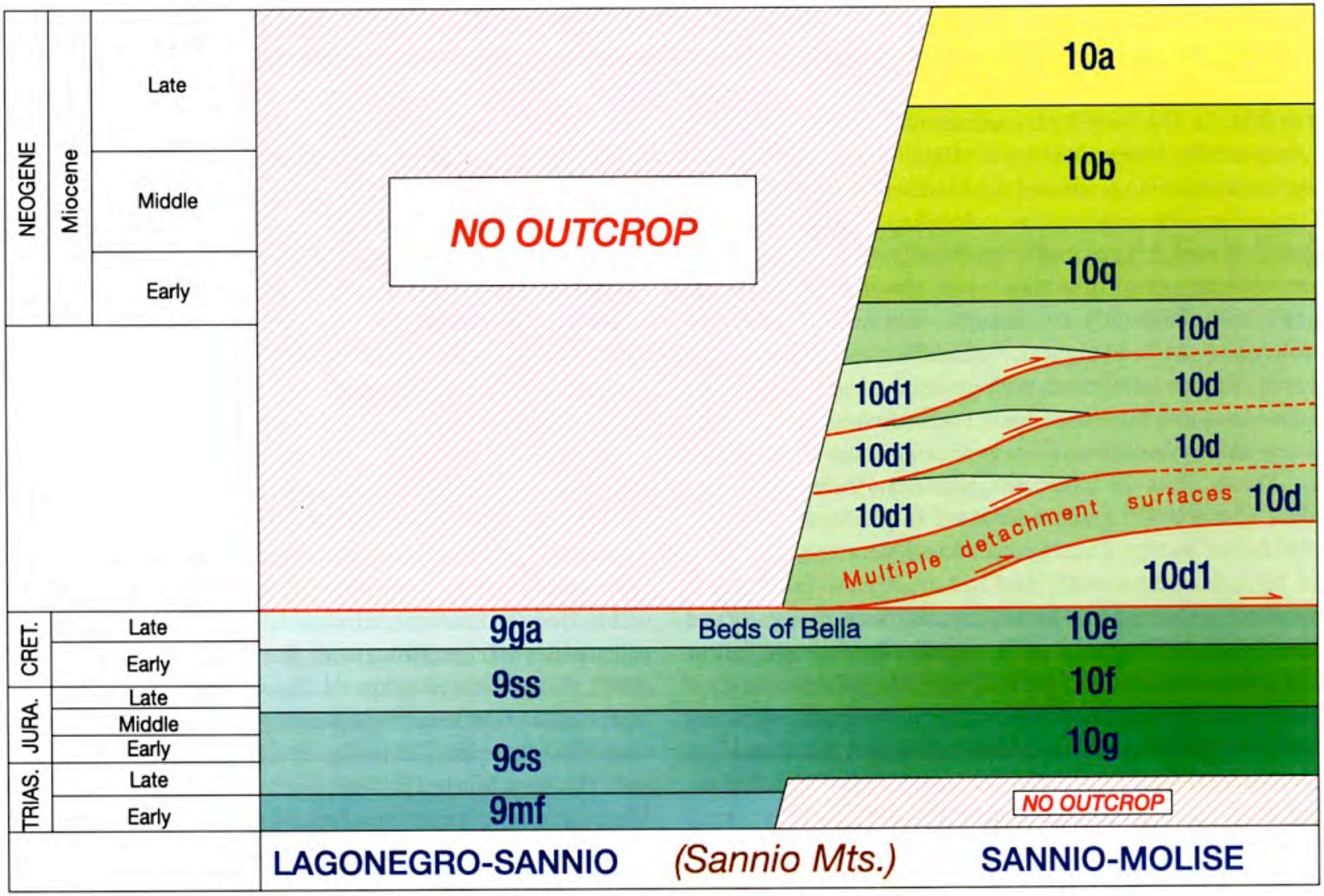

Figure 11. Stratigraphic relationships between the Lagonegro-Sannio and the Sannio-Molise Units. Numbers are the same as in the legend of the *Geological Map* (in Sheet 1). The Sannio-Molise Units are interpreted as transitional proximal facies, detached from the original Lagonegro-Sannio basinal succession, that lack all the terms younger than the Early Cretaceous (Fig. 8). See text for a discussion.

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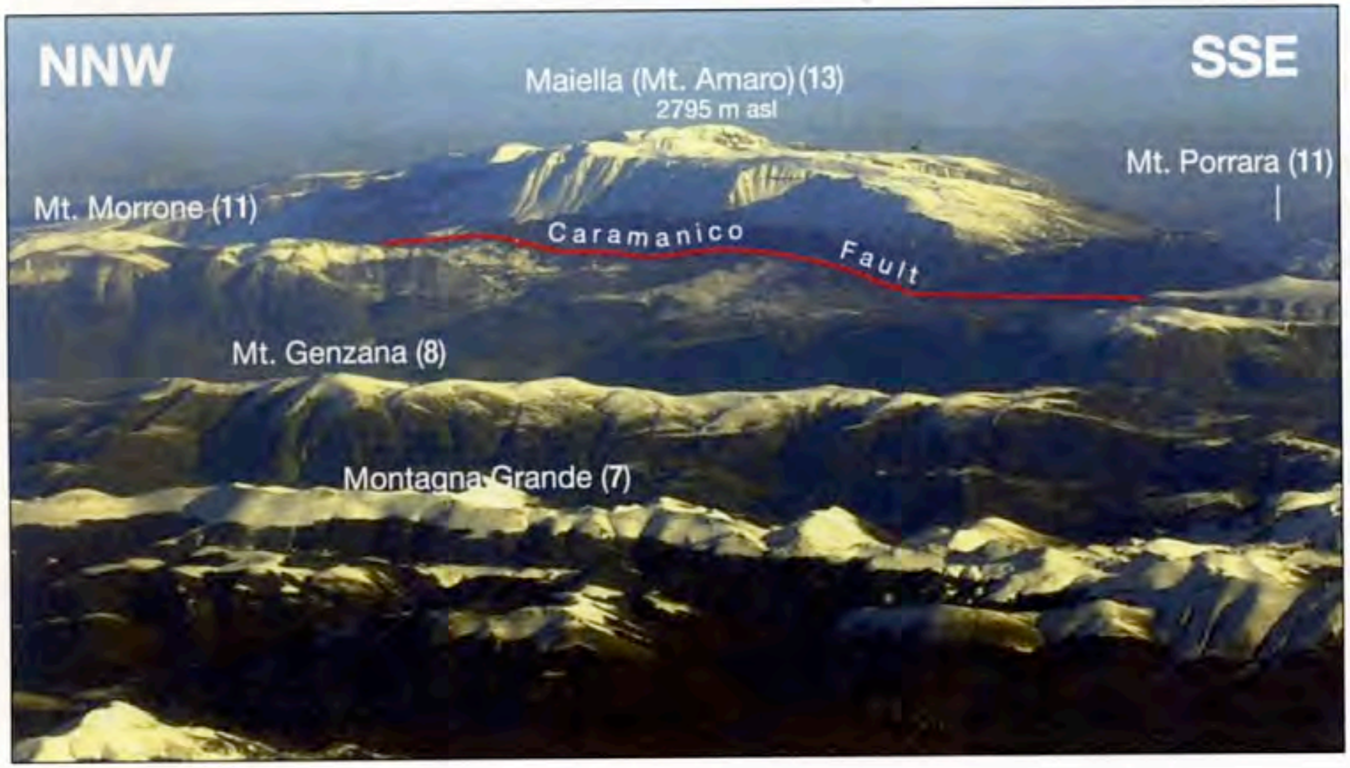

Figure 15. Aerial view eastward of the increasing uplift in the central Apennines carbonate platform. The platform carbonate successions of Montagna Grande (7—Lazio-Abruzzi Units) and Mount Genzana (8—Abruzzi and Umbria-Marche Units) are overthrust to the east onto the successions of Mount Morrone–Mount Porrara (11—Outer Abruzzi Units). In the background to the east is the deformed and strongly uplifted foreland of the Apenninic chain represented by Maiella (13—Apulia-Adriatic deformed Units), culminating at Mount Amaro (2795 m asl), the second highest peak of the Apennines. The Maiella emerges as a N-S–striking, doubly plunging anticline, truncated on its western flank by the Caramanico normal fault (see Fig. 14). The eastern flank of the anticline designs a large half dome (see Fig. 34) and is overthrust by the Sannio-Molise and by the Sicilide Units in the hazy Adriatic coastal region.

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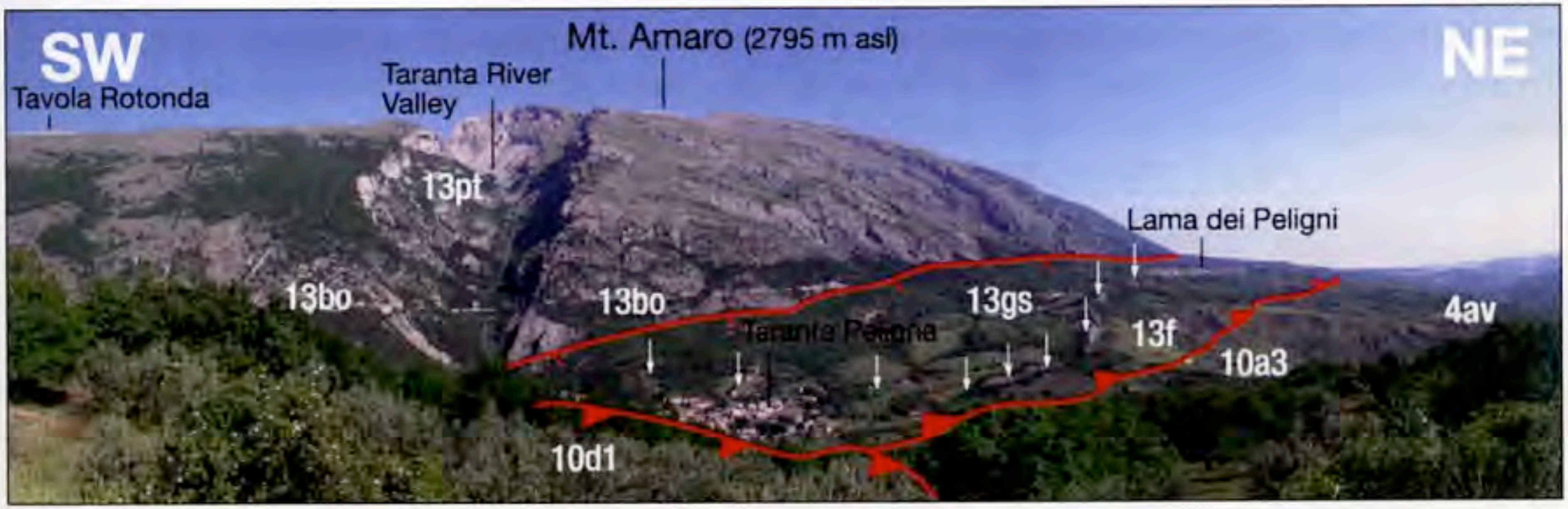

Figure 34. Eastern flank of the Maiella anticline (Unit 13), cut by the Taranta River Valley. The deep gorge exposes the gradual transition from gently E-dipping beds (at the valley head) to steeply dipping beds at the base of the calcareous scarp. The morphological scarp is controlled by the 60°–70° eastward dip of the calcareous succession, with the thick beds of the Tortonian–lower Miocene Bolognano Formation (13bo) discordant above the Santo Spirito Formation (Oligocene-Paleocene) and the Orfento Formation (Late Cretaceous), both included in the undifferentiated 13pt succession (Fig. 8). At the boundary between the Messinian (13gs) and the lower Pliocene Maiella Flysch (13f) are the Palena Conglomerates (marked by the white arrows), continuous from Lama dei Peligni (north end of the photograph) to Taranta Peligna (in the foreground), and, farther to the south (outside the photograph), to Lettopalena and Palena. The Palena Conglomerates (basal part of the early Pliocene, biozone with *Sphaeroidinellopsis* spp.) are only 10–30 m thick (Fig. 8). They overlie the gypsiferous marls of the Messinian "Gessoso-Solfifera" Formation (13gs) and grade upward to the lower Pliocene turbidites of the Maiella Flysch (13f), outcropping in the meadows to the east. The photograph shows that the Maiella Flysch is thrust above the Molise (10a3) and Sicilide Units (4av) north of Taranta Peligna. Photograph by Cristina Accotto.

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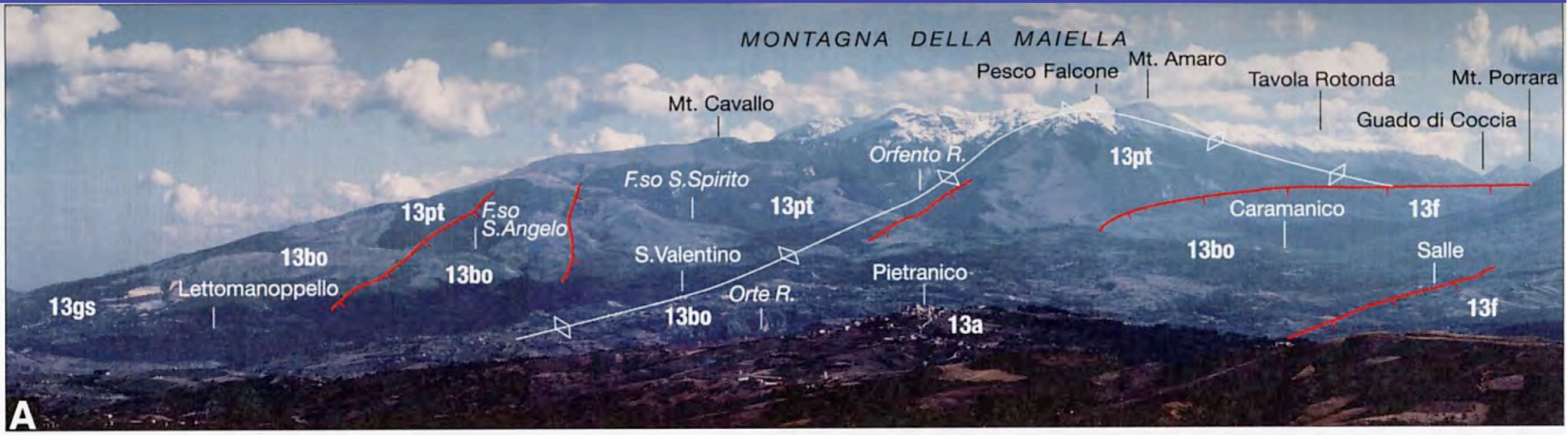

Figure 29. (A) View from north on the steep, western scarp of Maiella and Mount Porrara controlled by the N-S–striking, W-dipping Caramanico normal fault (see also Fig. 15). The Caramanico fault is one of the largest normal faults in the mapped area, exposed for a length of ~29 km. Offset increases from 2.5 to 4.2 km between Tavola Rotonda and Mount Amaro, and decreases along strike to the north, down to zero km over a distance of 25 km (see Fig. 14). In the hanging wall of the Caramanico fault is the downfaulted lower Pliocene Maiella Flysch (13f) (see cross section 2 in Sheet 2). In the fault footwall is the uplifted Meso-Cenozoic calcareous succession in carbonate platform facies of the Maiella Unit (13pt). In the foreground (Pietranico hill) are the lower Pliocene turbiditic sandstones and claystones with intercalations of polygenic breccias of the Montefino and Cellino Formations (13a). (B) West of the area of photograph A are visible the geometric relationships between the Morrone (11), La Queglia (12) and Maiella Units (13). The succession of Mount Morrone (11pt and 11ag) tectonically overlies the lower Pliocene Maiella Flysch (13f); see cross section 2 in Sheet 2. The middle-lower Pliocene conglomerates of the Mount Coppe top-thrust basin (3cc) unconformably cover the Mount Morrone carbonates (11pt), and are tectonically sliced onto the Messinian Mount Porrara Flysch (11ag). The La Queglia Unit, bounded by thrust faults to the west and to the east is tectonically interposed between the Morrone Unit in the hanging wall and the Maiella Unit in the footwall. Thrusting controls the complex relationships between different terms, as the lower Pliocene–Messinian Teramo Flysch (12a), the La Queglia Flysch, the Gessoso-Solfifera Formation (12b), and the calcareous succession in Maiolica and Scaglia facies (12d). Photograph by Paolo Barrasso. (C) Geological map of the area illustrated in photographs A and B. Colors and labels are the same as in the *Geological Map* (Sheet 1).

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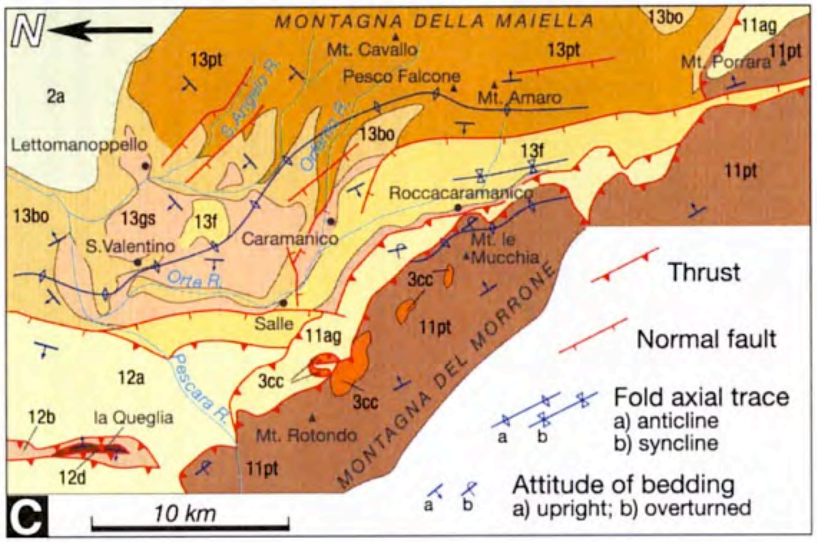

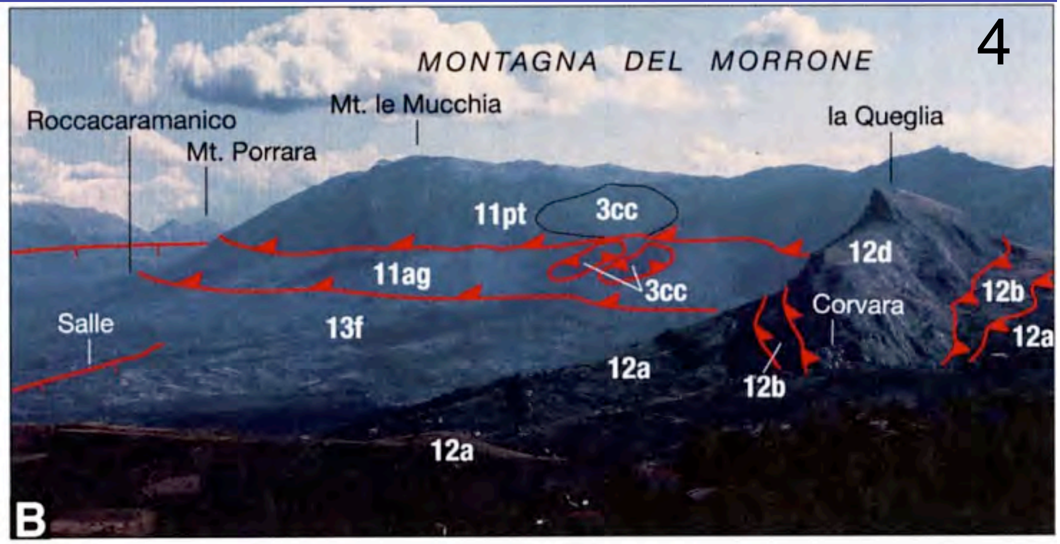

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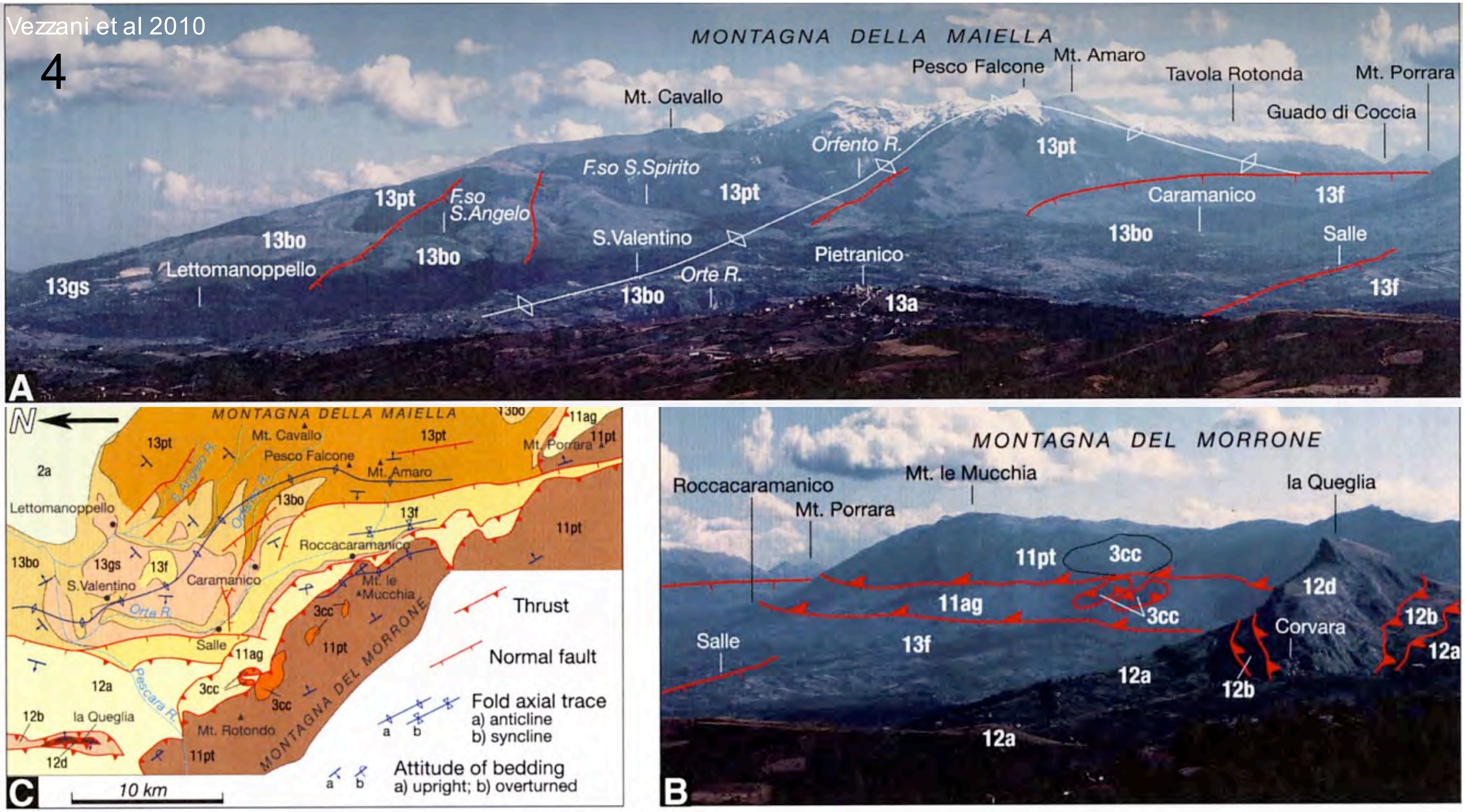

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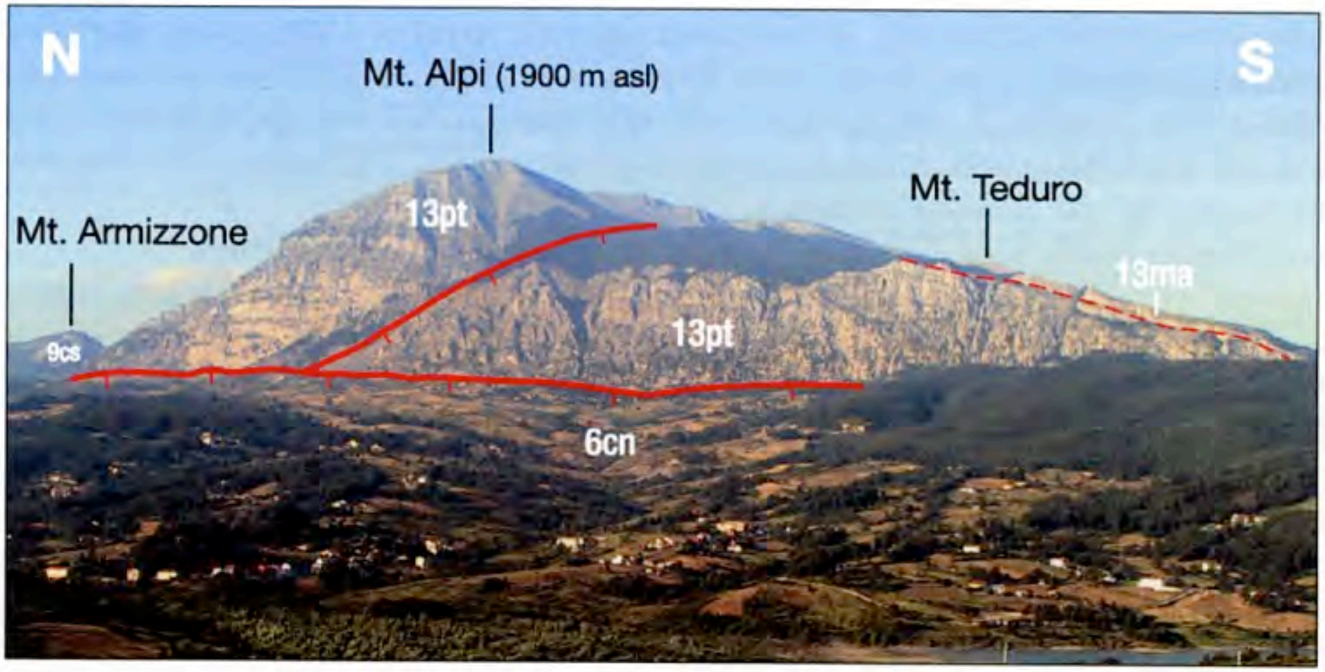

Figure 16. Strongly uplifted foreland of the Apenninic chain in Basilicata. Frontal view of the Mesozoic carbonate platform of the Apulia-Adriatic deformed Units (13pt) emerging in the structural high of Mount Alpi (see "Structural Scheme" in Sheet 2 and Fig. 9). The Lower Cretaceous–Upper Jurassic limestones of Mount Alpi (13pt), overlain at Mount Teduro by Messinian biocalcarenites, calcilutites and mudstones (13ma, see cross section 9 in Sheet 2), are strongly uplifted by a major N-S–striking normal fault (see "Buried Structure of the Central-Southern Apennines" in Sheet 1 and text for a discussion). In the pastures in the foreground outcrops the argillitic succession of the Lower Cretaceous Crete Nere Formation (6cn, Liguride Units) that tectonically overlies the Galestri Formation of the Lagonegro-Sannio Units (cross section 9 in Sheet 2). At the northern end of the photograph are the Jurassic–Upper Triassic Cherty Limestones (9cs) of Mount Armizzone (Lagonegro-Sannio Units). Photograph by Rocco di Perna.

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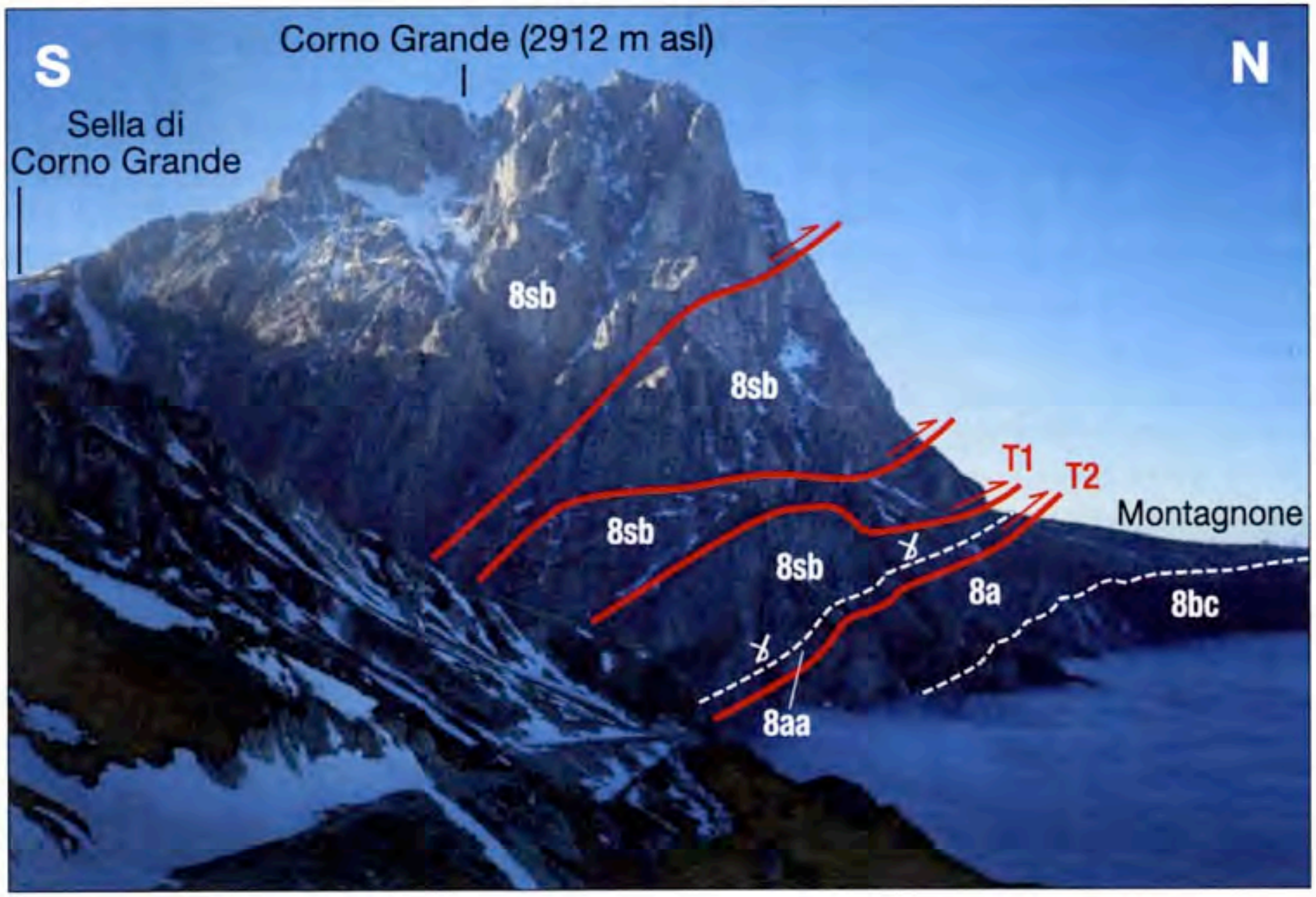

Figure 19. Sunrise at Corno Grande (Gran Sasso thrust belt, Abruzzi), the highest peak of the Apenninic chain (2912 m asl). Lower Jurassic massive platform limestones ("Calcare Massiccio," 8sb), tectonically sliced in several imbricates, are overthrust onto the overturned flank of a syncline that deforms a basinal succession of Mesozoic-Cenozoic age. In the immediate footwall of the major thrust fault (T1) is the S-dipping overturned succession from Lower Cretaceous–Jurassic Maiolica Formation to the Messinian Gran Sasso Flysch (8aa), that is on its turn overthrust (thrust fault T2) onto the upright section of the Montagnone, partly covered by the clouds in this photograph, but well exposed on the steep frontal scarp (see Fig. 20). In the footwall of thrust fault T2 crops the Messinian Laga Flysch (8a) and the underlying succession from the Messinian–upper Tortonian Orbulina Marls to the middle-lower Miocene Marne con Cerrogna-Bisciaro (8bc). Photograph by Anna Bigozzi.

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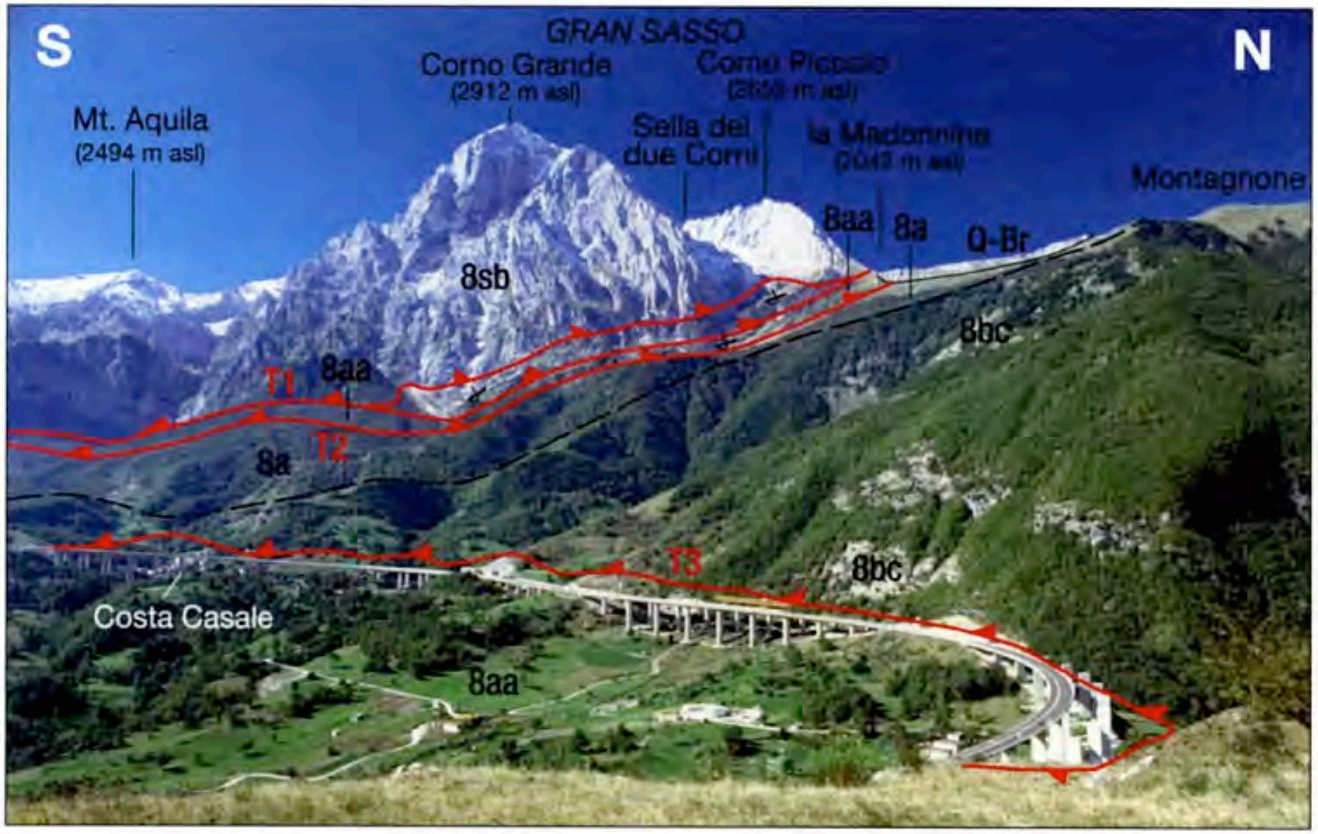

Figure 20. Panorama on the northern frontal scarp of the Gran Sasso thrust belt. The "Calcare Massiccio" of the Lower Jurassic carbonate platform is in outcrop at Corno Grande and dips to the NNW beneath the pelagic cherty limestones of the "Corniola" and the mudstones of the "Verde Ammonitico," deposited in a proximal pelagic basin adjacent to the platform (refer to Figure 2 for the paleogeography). These thinly bedded formations, in outcrop in the saddle west of Corno Grande (Sella dei due Corni), are stratigraphically overlain by the massive beds of the "Entrochi Calcarenites" of Corno Piccolo that are overthrust (thrust fault T1 dipping 20–40° S) onto the overturned flank of an E-W–striking asymmetric fold, deforming the basinal succession of Messinian–Late Jurassic age. This overturned succession (in outcrop north of Corno Piccolo) includes the formations of "Maiolica," Rudistid Calcirudites, "Scaglia," "Marne con Cerrogna," and Orbulina Marls (see Ghisetti and Vezzani, 1990, and Ghisetti et al., 1990, for details). The subparallel thrust fault T2 truncates the succession between the Gran Sasso Flysch (8aa) in the hanging wall and the Laga Flysch (8a) in the footwall. T2 thrusts the whole E-W–striking Gran Sasso edifice onto the N-S–striking Montagnone anticline (right-hand side of the photograph). Note that the basal thrust fault T3 that duplicates the Montagnone succession is N-S striking. In the footwall of the Gran Sasso overthrust (to the east of La Madonnina), the Messinian Laga Flysch (8a) is covered by remnants of Quaternary breccias and conglomerates (Q-br).

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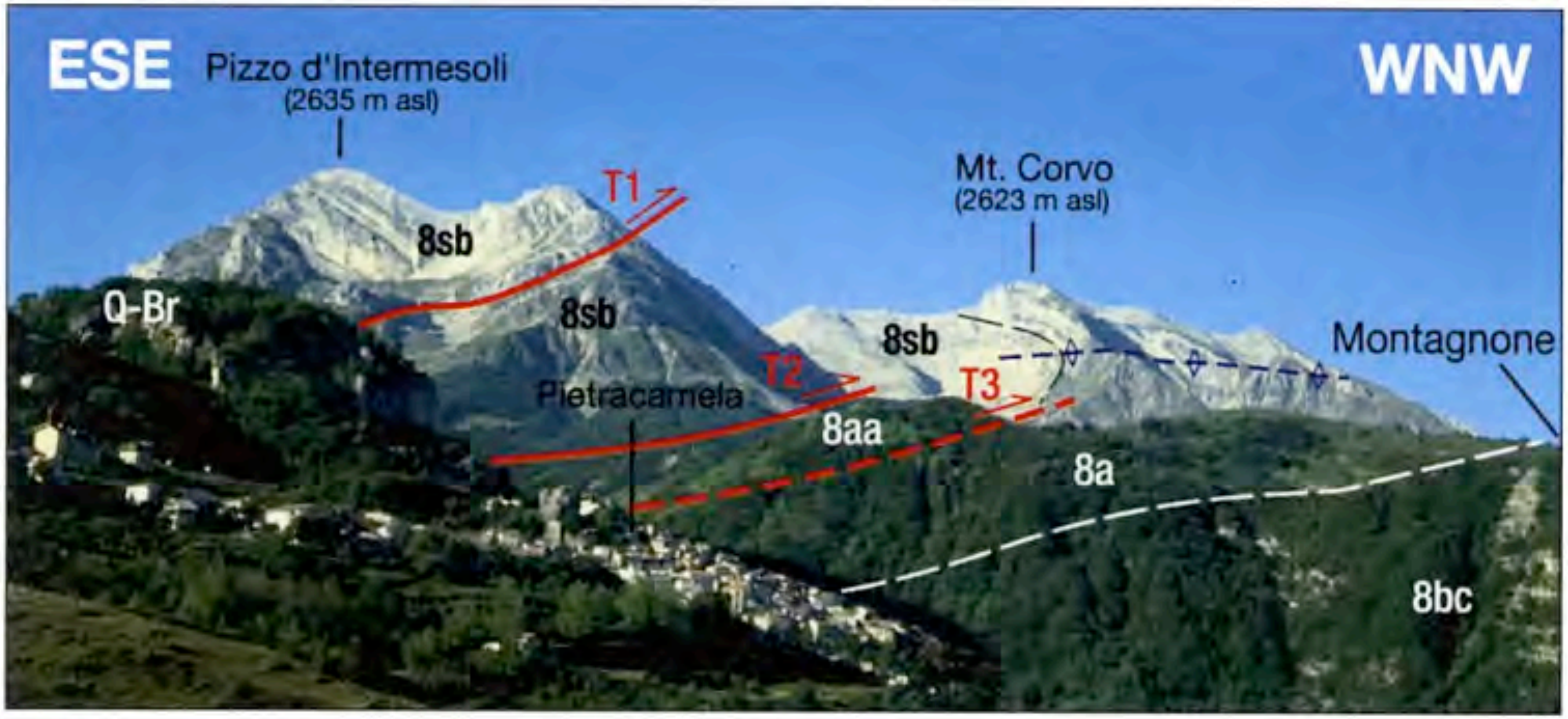

Figure 21. Panorama of Pizzo d'Intermesoli and Mount Corvo, in the western segment of the Gran Sasso thrust belt. View from Prati di Tivo. The succession of the Abruzzi and Umbria-Marche Units (8sb) is folded along an E-W–striking anticline with a gently N-dipping upright limb, and a steep, S-dipping overturned limb. The fold is truncated by an E-W–striking, S-dipping subhorizontal frontal thrust fault (T1) propagating across the anticlinal hinge. One more thrust fault (T2) superposes the overturned fold limb over the Gran Sasso Flysch (8aa). The whole E-W–trending edifice of the Gran Sasso chain is translated by the lowermost, subparallel thrust fault T3 and thrust over the Messinian Laga Flysch (8a), which stratigraphically overlies the "Marne con Cerrogna" (8bc) of the Montagnone succession (see Figs. 19 and 20). The outcrop above the village of Pietracamela is made of cemented Quaternary breccias (Q-Br).

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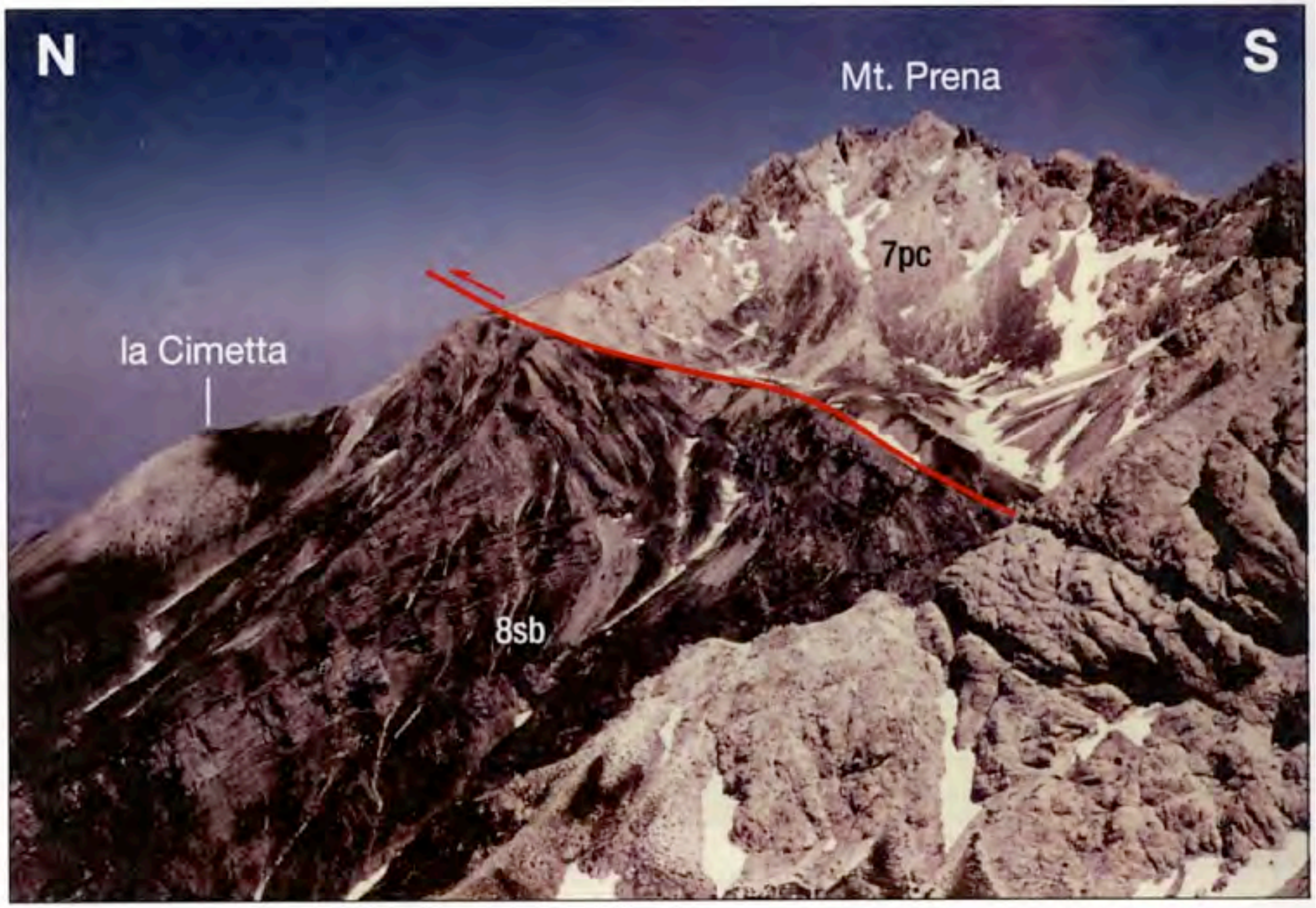
Figure 22. Panorama of the northern slope of Mount Prena in the Gran Sasso thrust belt (Lazio-Abruzzi Units). The Mount Prena Triassic dolomites (7pc) are thrust over a Mesozoic-Cenozoic platform scarp edge-proximal basin succession (8sb) folded into a tight syncline, with a flattened, S-dipping overturned limb. The E-W–striking and S-dipping thrust fault (in red) truncates the synclinal hinge (in Corniola Formation, Jurassic) and propagates upward across the overturned limb, decapitating the well-bedded, low competence succession of the "Maiolica" (Early Cretaceous–Malm) and "Scaglia" (Eocene–Late Cretaceous) Formations (see Ghisetti and Vezzani, 1986a, 1986b, for details).



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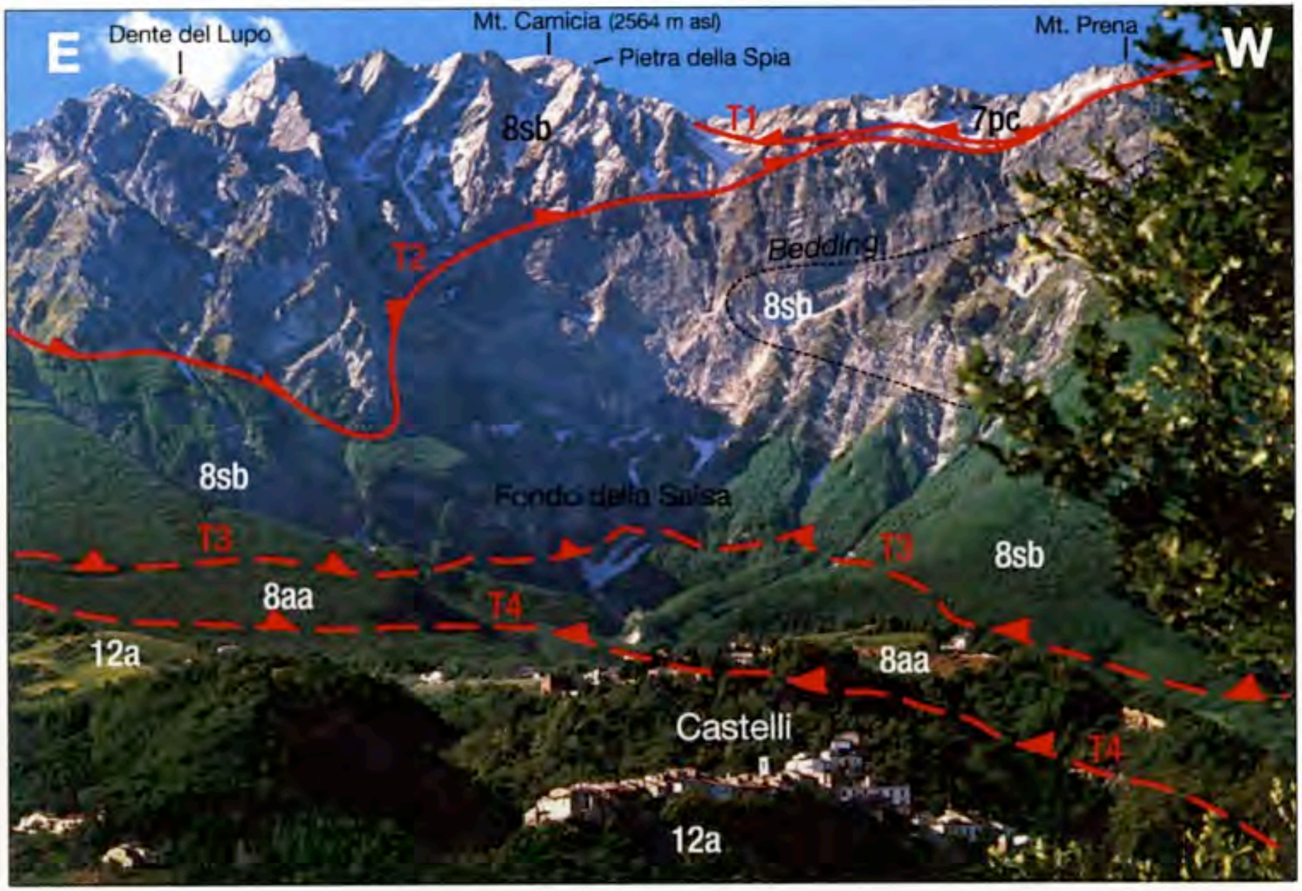

Figure 23. Panorama of the steep north slope of Mount Camicia, in the Gran Sasso thrust belt (Abruzzi). The village of Castelli is in the foreground. The erosional surface exposes: (*a*) the thrust front of Mount Prena (T1) between Mount Prena and Pietra della Spia, that superposes the Lazio-Abruzzi Units (7pc) to the Abruzzi and Umbria-Marche Units (8sb), and, (*b*) the frontal overthrust of Mount Camicia (T2), with steeply NNE-dipping beds of the "Corniola" Formation (Jurassic) in the hanging wall (along the crest from Mount Camicia to Dente del Lupo), and the folded Mesozoic-Cenozoic succession of carbonate proximal basin (continuous from the "Corniola" to the "Marne con Cerrogna" Formations) in the footwall. This is one of the best examples of out-of-sequence thrusting in the Gran Sasso thrust belt (see Ghisetti and Vezzani, 1986a, 1986b, 1991), with decapitation of an overturned flattened syncline in the footwall (trace of bedding indicated on the photograph), with an E-W–striking subhorizontal axial surface (gently dipping to the south), that is tectonically superposed (T3) above a narrow E-W strip of alternating sandstones and clays of the Messinian Gran Sasso Flysch (8aa). In the footwall of the NNW-SSE thrust fault T4 are the claystones of Castelli belonging to the lower Pliocene–postevaporitic Messinian Teramo Flysch (12a). Photograph by Pino dell'Aquila.

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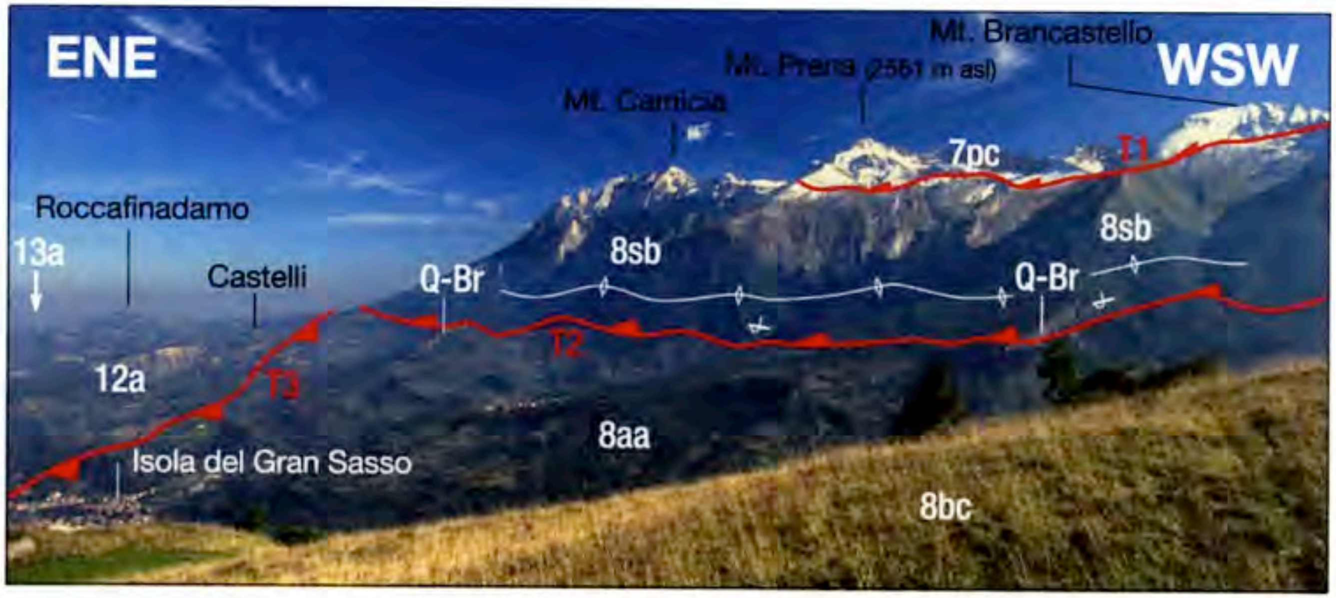

Figure 24. Panorama (view from Cima Alta, Montagnone) of the eastern segment of the E-W–striking Gran Sasso frontal overthrust (Abruzzi and Umbria-Marche Units, 8). The frontal scarp reaches up to 2000 m of relief. The thrust front of Mount Prena (T1) is the highest in the tectonic pile and superposes the platform carbonates of the Lazio-Abruzzi Units (7pc) to the scarp edge-proximal basin succession of the Abruzzi and Umbria-Marche Units (8sb). The latter are folded into a tight syncline, with a flattened, S-dipping overturned limb. East of Mount Camicia (at the left of the image) the frontal thrust gradually rotates from E-W to N-S strike, describing the large-scale Gran Sasso–Mount San Vito–Mount Picca arcuate thrust front (Ghisetti and Vezzani, 1997). The N-S–striking arm of this thrust front is partially depicted in Figures 25, 26, and 27; see also "Structural Scheme" in Sheet 2. The village of Castelli is in the background. Quaternary breccias are indicated by Q-Br. In the foothills are the footwall units deformed by N-S folds and thrust faults, decapitated by the overlying E-W frontal thrust fault T2. From west to east, the Gran Sasso overthrust overlies formations of progressively younger age belonging to different units: the Messinian Gran Sasso Flysch (8aa) tectonically overlying (thrust T3) the lower Pliocene–postevaporitic Messinian Teramo Flysch (12a). In the background, label 13a indicates the lower Pliocene Montefino and Cellino Formations. This setting is indicative of the post lower Pliocene out-of-sequence transport of the imbricated Gran Sasso Units, eventually associated with anticlockwise rotations along sets of shallow-dipping detachments (see Dela Pierre et al., 1992).

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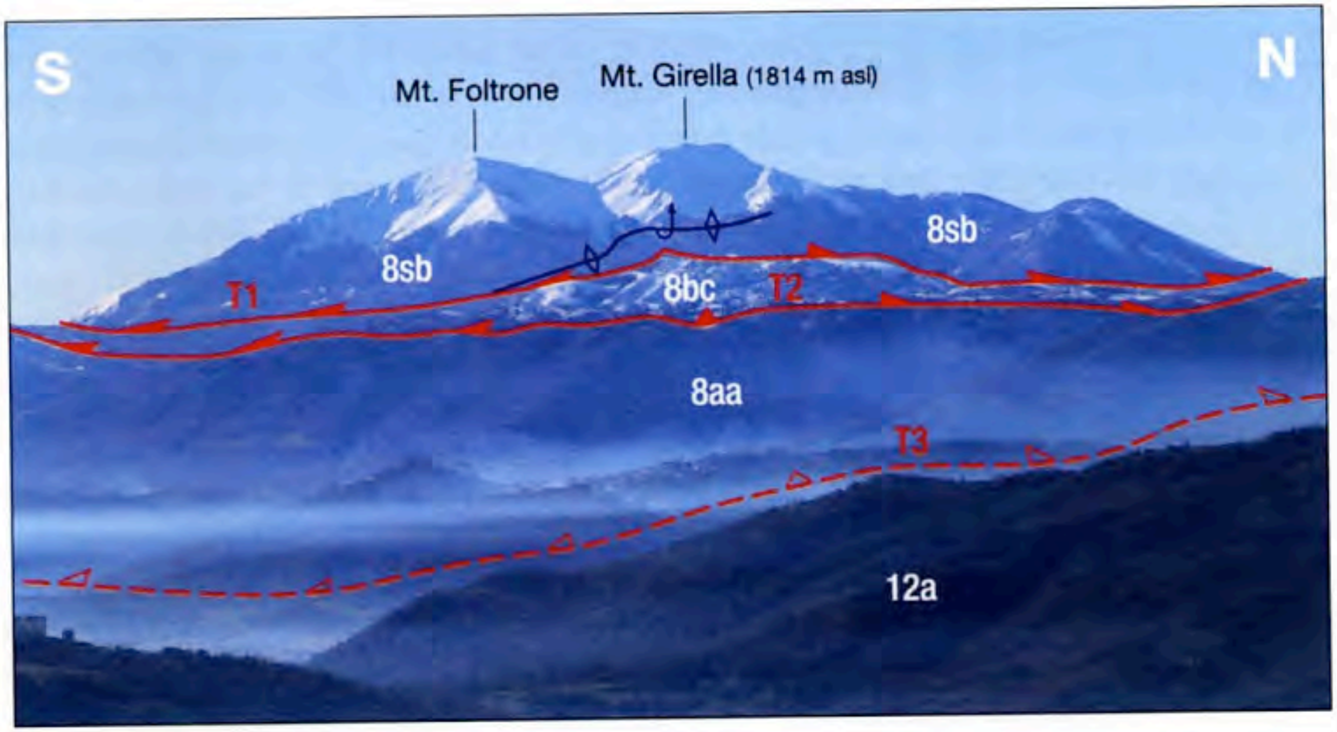

Figure 33. Panorama on the Montagna dei Fiori thrust front. In the background is the Meso-Cenozoic proximal basin succession of the Abruzzi-Umbria-Marche Units (8sb), deformed by a NNW-SSE–striking anticline whose eastern, overturned limb is truncated upsection by the thrust fault T1. In the footwall are the middle-lower Miocene Orbulina Marls, the "Marne con Cerrogna" and "Bisciaro" Formations (8bc), tectonically transported (along the thrust fault T2) above the Messinian Gran Sasso Flysch (8aa). In the foreground (partially masked by the light fogs in the valley) is the NNW-SSE–striking thrust fault (T3) that superposes the Messinian Gran Sasso Flysch (8aa) onto the lower Pliocene–postevaporitic–Messinian Teramo Flysch (12a) of the La Queglia–Colle Madonna–Teramo Unit.

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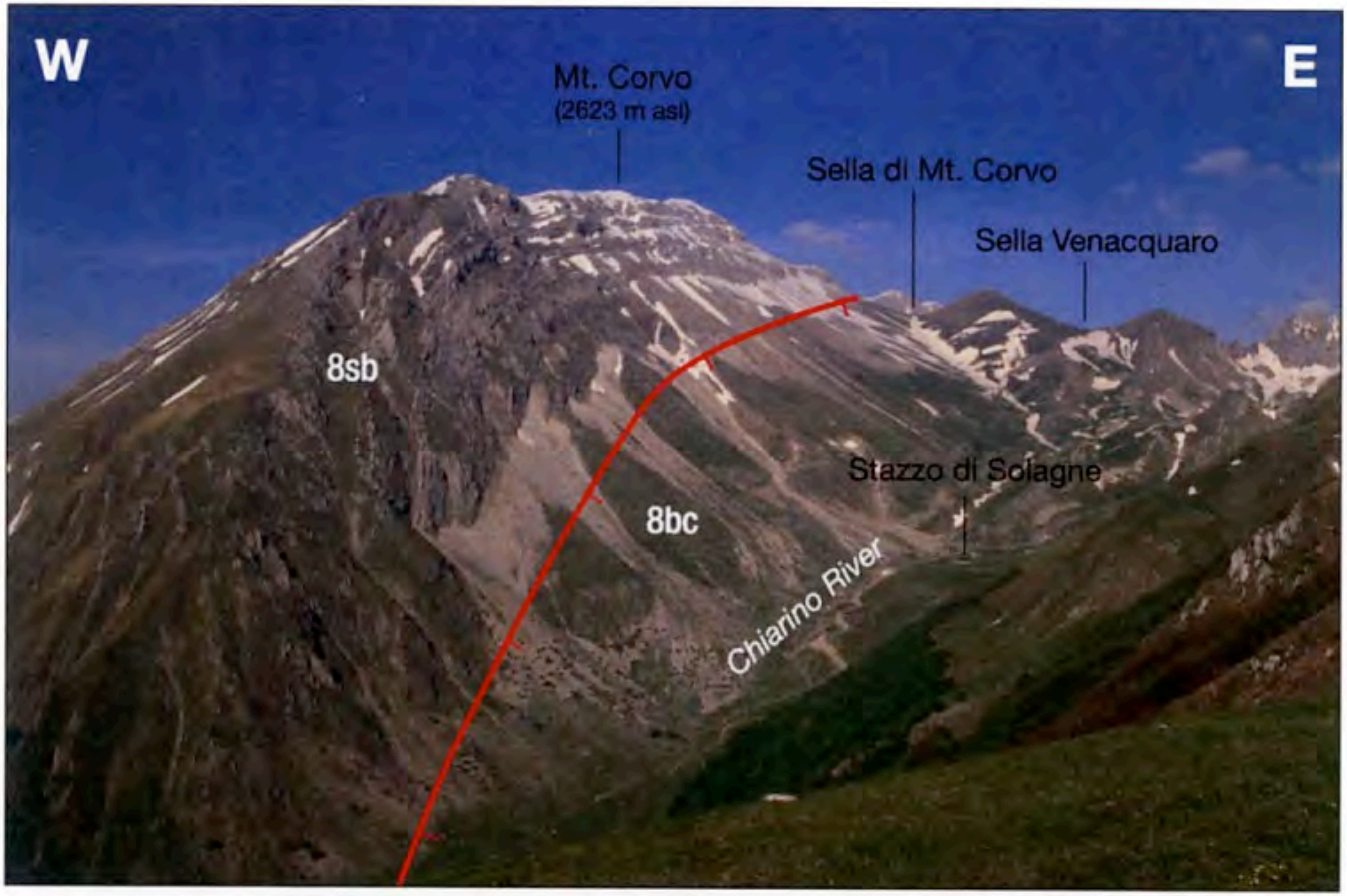

Figure 39. Western segment of the Tre Selle normal fault (in red) truncating the south flank of Mount Corvo, along the Chiarino River valley. This fault is part of a regional E-W system, developed at the back of the Gran Sasso–Mount Corvo thrust front. Here the fault plane dips 75°–85° S and uplifts the "Maiolica" and "Scaglia" Formations (Eocene-Cretaceous) in the footwall (8sb) relative to the Tortonian "Marne con Cerrogna" Formation (8bc) in the hanging wall. Total offset is ~1 km, and decreases westward.

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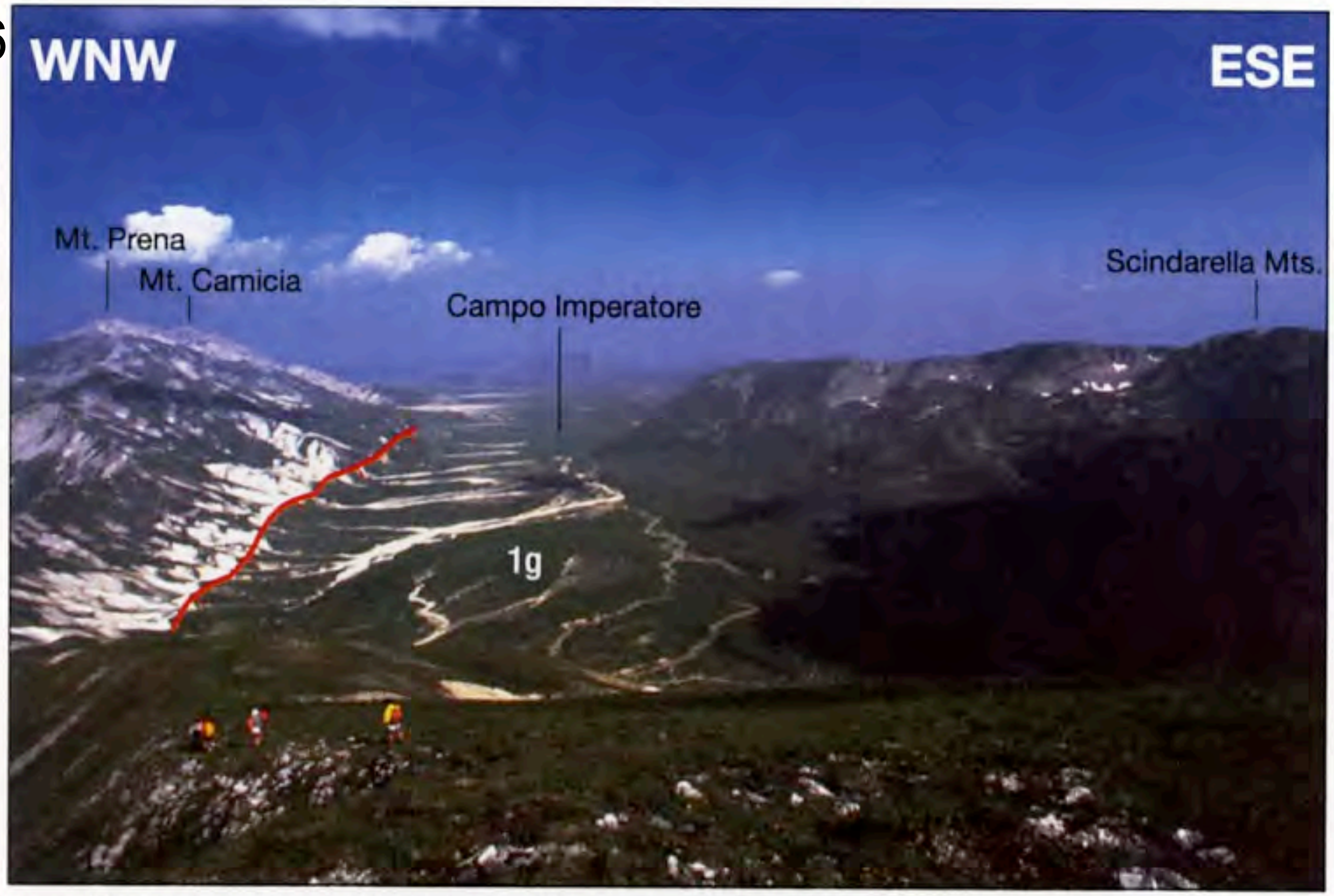

Figure 40. Western segment of the Vado di Corno normal fault (in red), at the rear of the Gran Sasso thrust front. View from Mount Aquila. On the left-hand side is the southern slope of the Mount Brancastello–Mount Prena–Mount Camicia ridge (the northern slope of the same ridge is illustrated in Figures 23 and 24), truncated by the Vado di Corno normal fault, with development of a thick belt of cataclasites and gouges that disrupt dolomitic and calciruditic units (bright white belt in the photograph). The fault dips 55°–70° S, and bounds the elevated intramontane basin of Campo Imperatore (see 1 in Fig. 38), filled with Quaternary moraines and fluvio-glacial deposits (1g) and with alluvial fans. Overall displacement is >1.5 km, with offset of the youngest alluvial fans and terraces (Carraro and Giardino, 1992). The southern margin of the Campo Imperatore basin is bounded by the ridge of the Scindarella Mountains, dissected by large glacial circuses.

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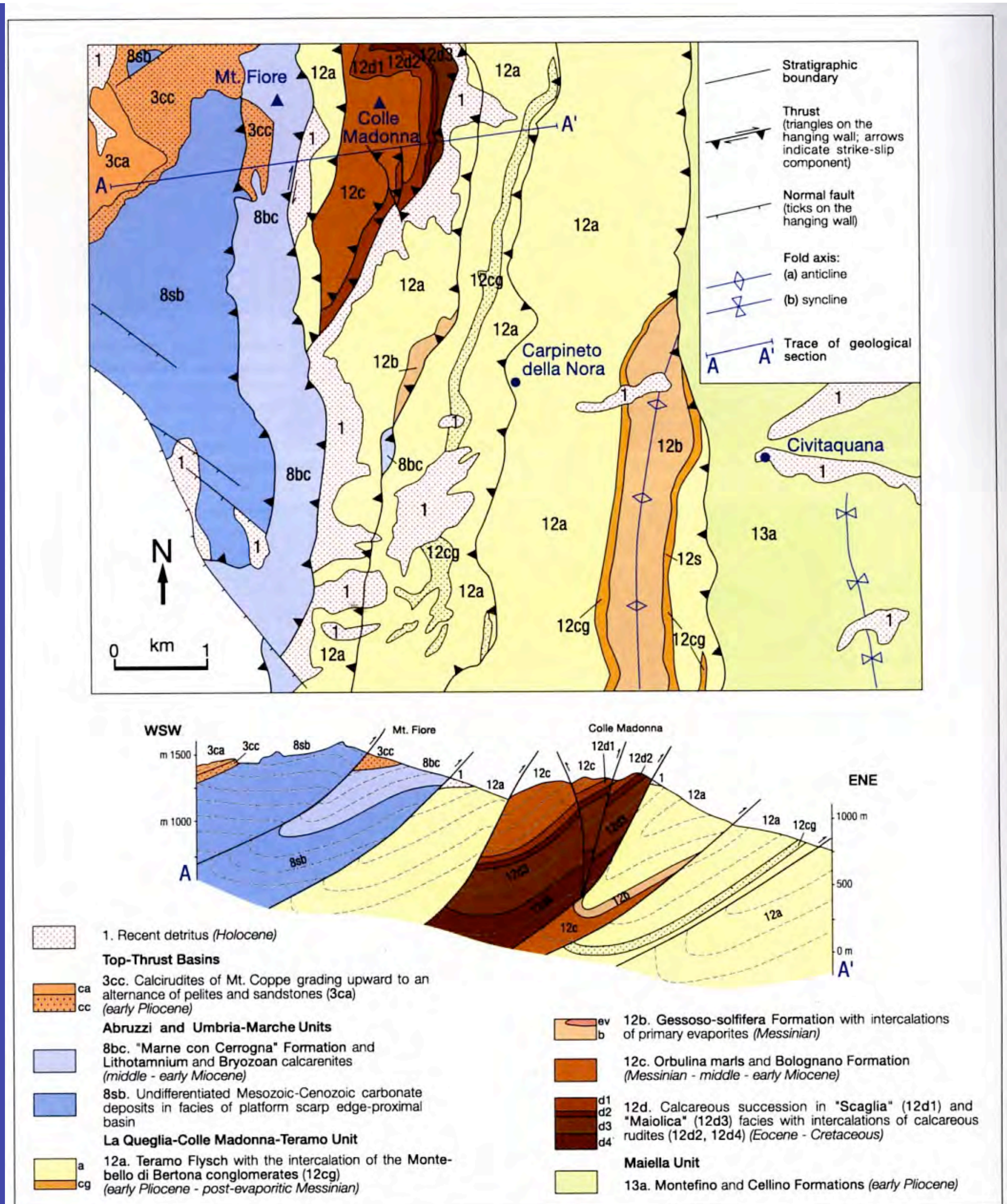

Figure 25. Geological map and cross section of the Colle Madonna tectonic slice (La Queglia–Colle Madonna–Teramo Unit, 12) underneath the Abruzzi and Umbria Marche Units (8), along the N-S–striking arm of the arcuate Gran Sasso overthrust (for details see Ghisetti et al., 1993b). Numbers are the same as in the legend of the *Geological Map* (Sheet 1). See also Figure 26.

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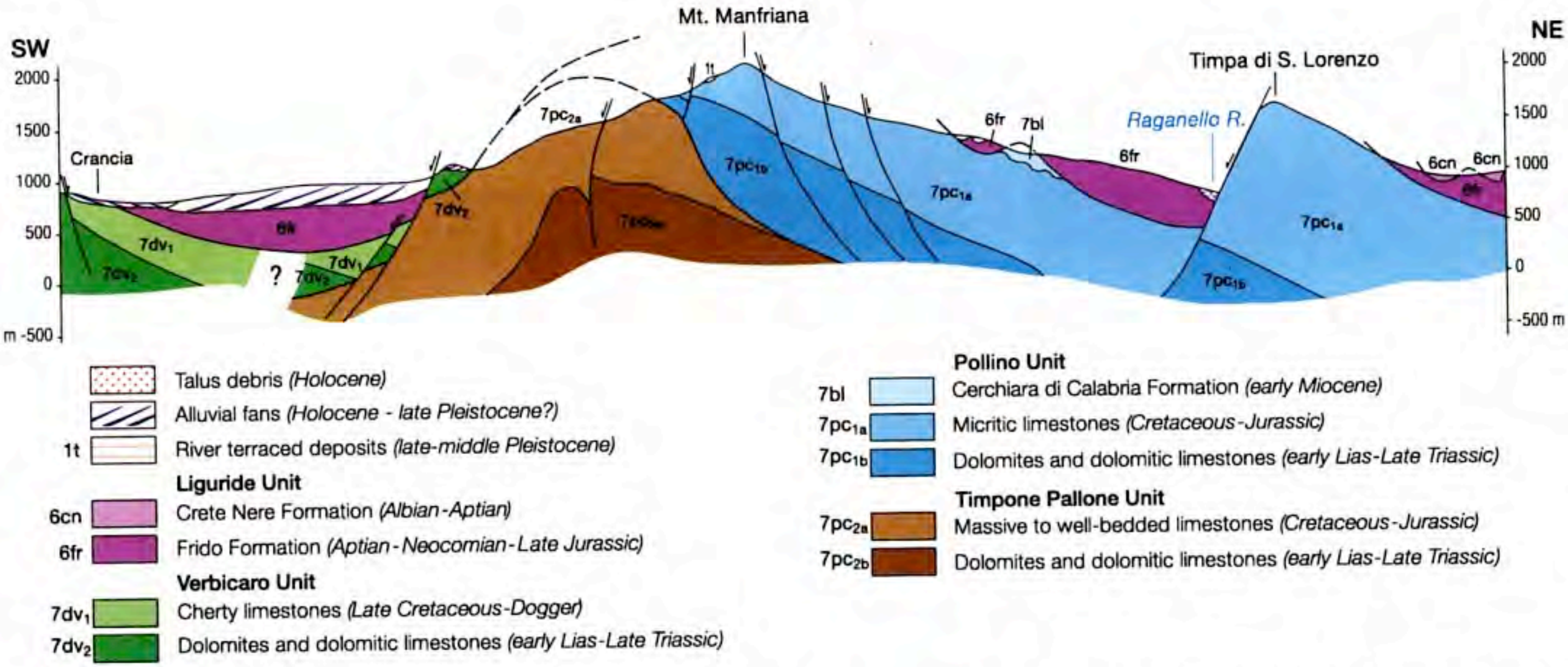

Figure 30. Cross section across the Mount Pollino area, at the Calabria-Basilicata border. The Timpone Pallone tectonic window is close to a buried structural high of the Apulia-Adriatic deformed Units (see Fig. 9 and "Buried Structure of the Central-Southern Apennines" in Sheet 1). The succession of Timpone Pallone Unit emerges from the Liguride (6), Pollino (7pc) and Verbicaro (7dv) Units, suggesting its pertinence to a structural high of the Apulia-Adriatic deformed Units. See text for a discussion. (Modified after Ghisetti and Vezzani, 1983).

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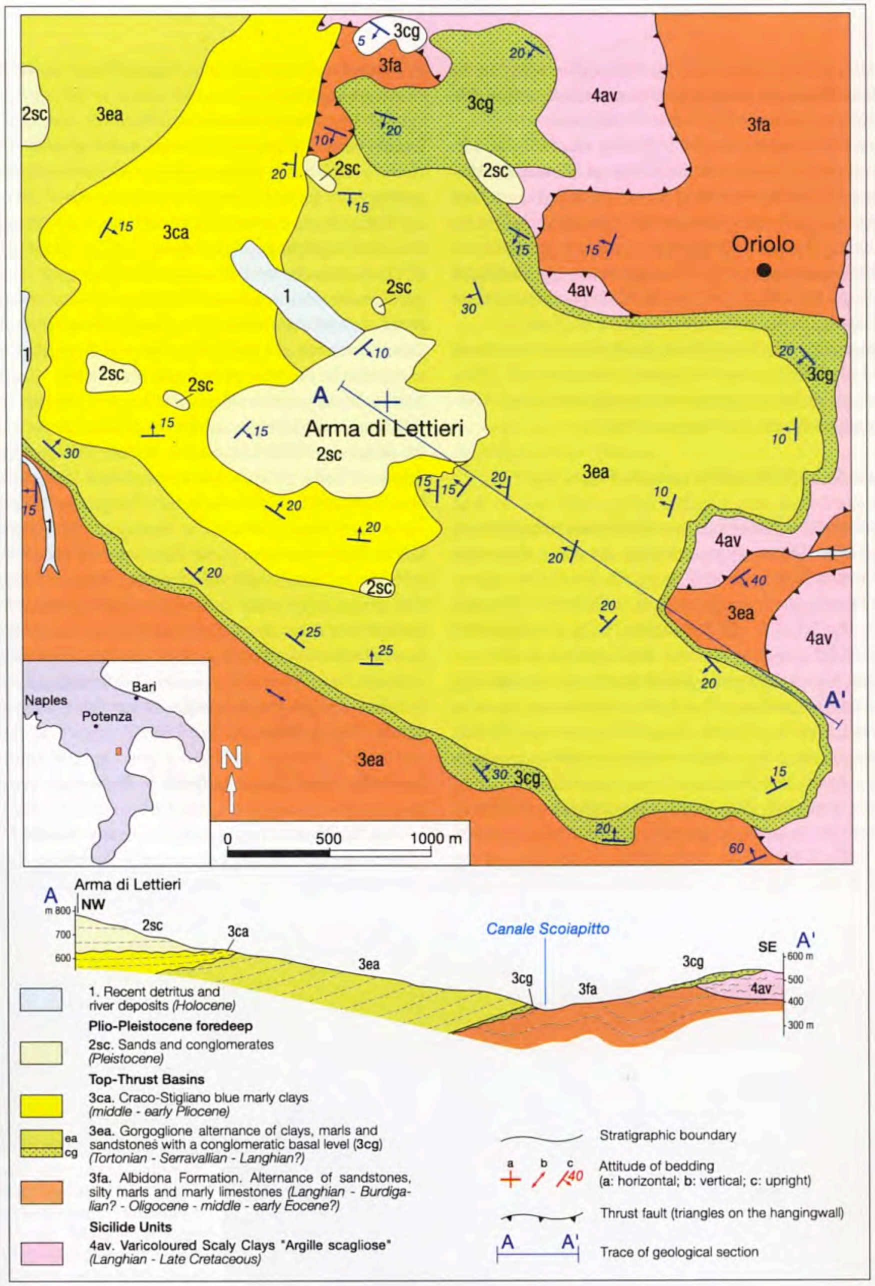

Figure 32. Geological map and cross section of the Oriolo area (Calabria-Basilicata border), showing the discordant superposition of the top-thrust basins of Albidona (3fa, Langhian–Burdigalian?–Oligocene–middle-early Eocene), Gorgoglione (3ea, Tortonian-Serravallian-Langhian?) and Craco-Stigliano (3ca, middle-early Pliocene). The map and the cross section also show the discordant superposition of the Pleistocene sands and conglomerates of Arma di Lettieri (2sc) that link the Adriatic-Bradanic Foredeep to the San Arcangelo Basin. See text for a discussion (Modified after Vezzani, 1967b).

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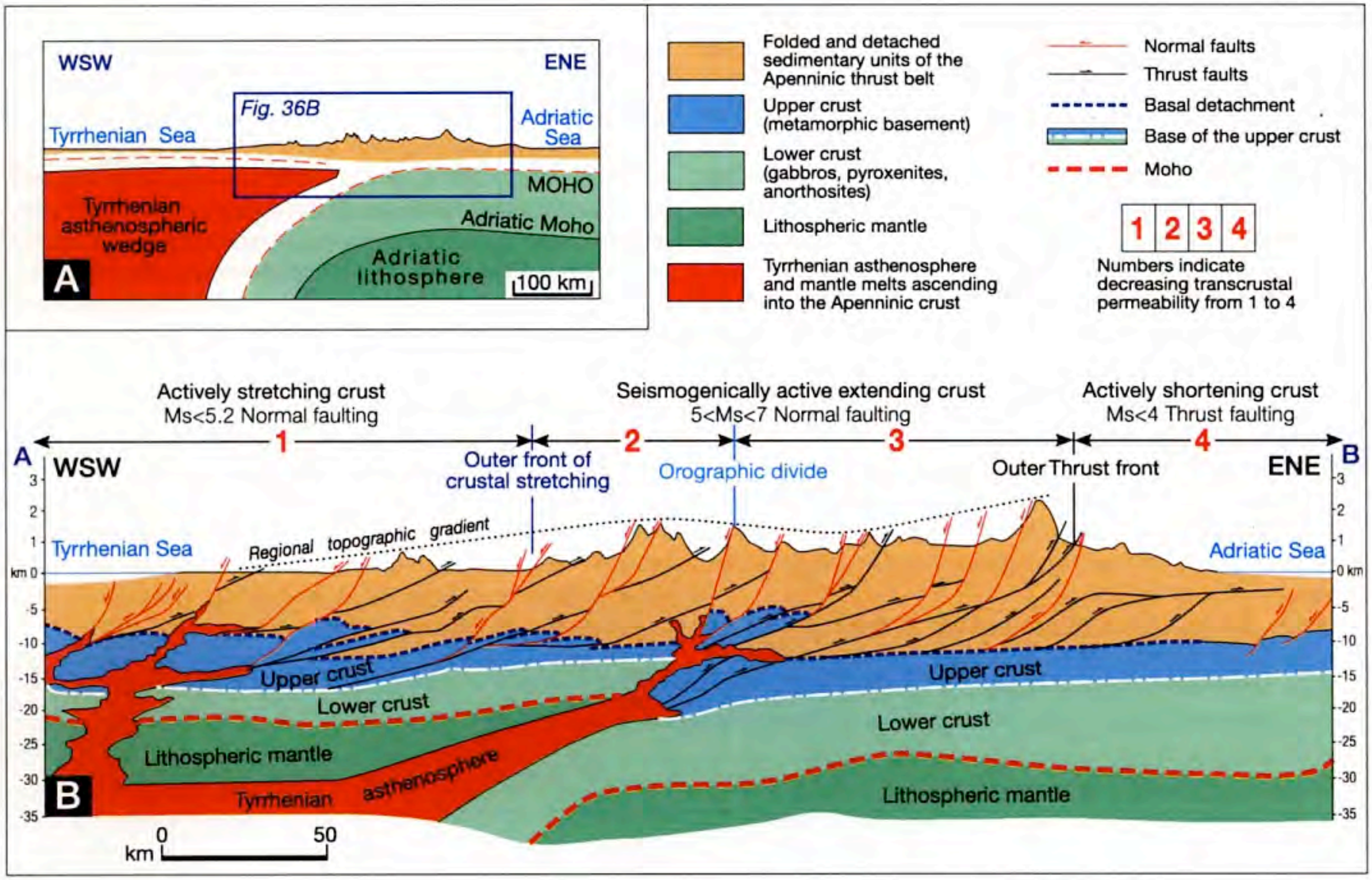

Figure 36. (A) Tectonic setting of the Apenninic chain related to asthenospheric wedging in front of the retreating Adriatic plate, and consequent extensional stretching of the Tyrrhenian hinterland and active shortening in the outer Adriatic zones (see Doglioni, 1991; Doglioni et al., 1996). (B) Cross section from the Tyrrhenian Sea to the Adriatic Sea (Latina-Ortona, see trace in Fig. 37) illustrating differences of geometry and depth of detachment of normal faults and changes of regional topographic gradient, as related to different deformation regimes from the hinterland to the foreland. The crustal section highlights the connections between deep and upper crustal deformations and the structural control on decreasing permeability and fluid mixing from the innermost domain 1 (stretched, highly permeable crust) to the outermost domain 4 (shortened, overpressured crust with restricted fluid circulation). Note the change in vertical scale above and below sea level. See also Figure 3. The belt of highest seismicity (see also Fig. 48) is located in between domains 2 and 3, where mature normal faults cut across the brittle crust (after Ghisetti and Vezzani, 2002b). Crustal depth of the Moho and of the intermediate crustal discontinuity is after Scarascia et al. (1998). Mature normal faults in the Tyrrhenian hinterland are depicted with listric geometry, penetrate the crust down to the intermediate crustal discontinuity, and cause collapse and thinning of the upper crust. In contrast, east of the orographic divide, the normal faults rotate into listric geometry at the depth of the basal detachment horizon (Late Triassic Burano anhydrites).

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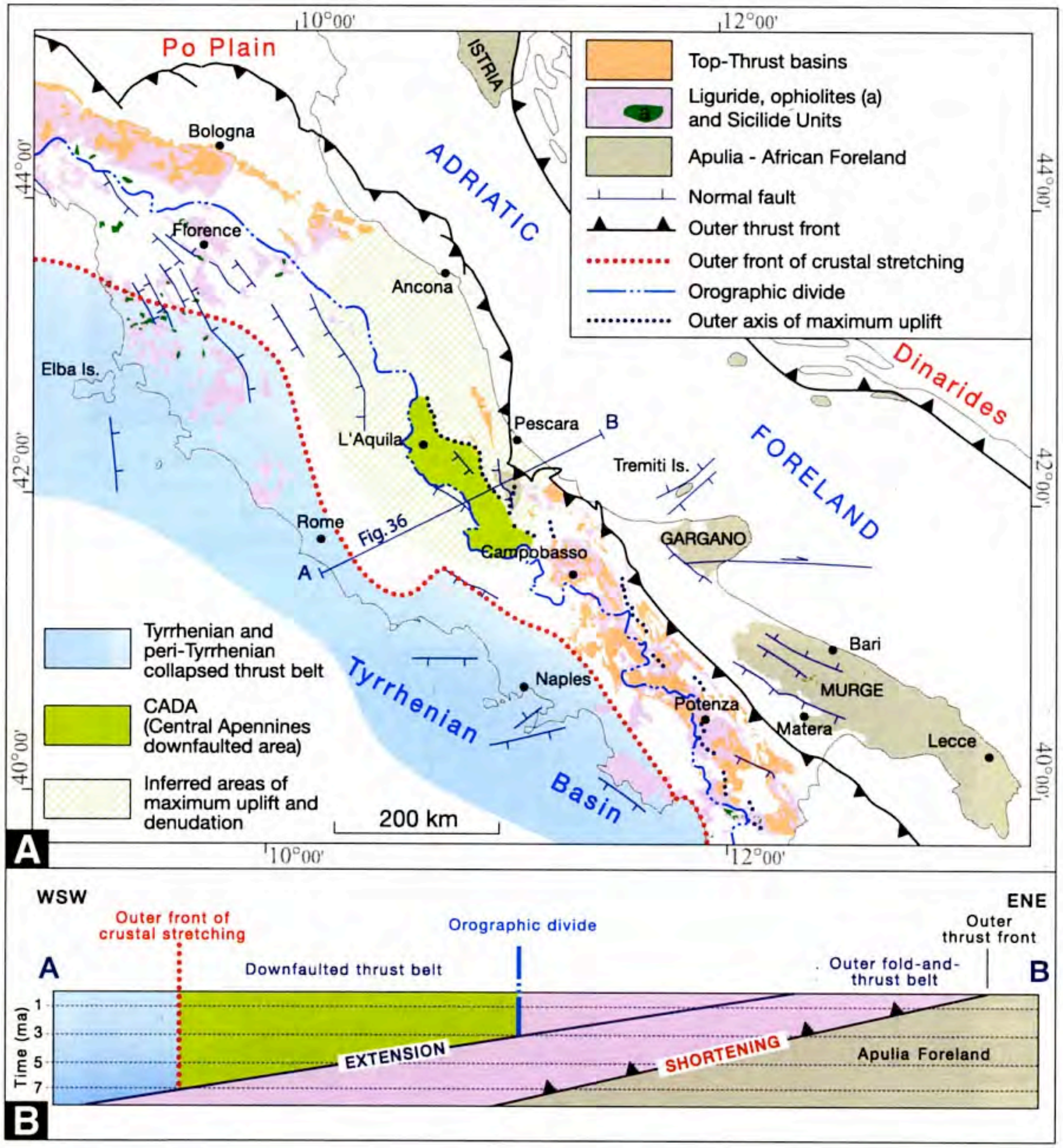

Figure 37. (A) Regional map illustrating the present position of the Sicilide and Liguride Units in relation to the distribution of the top-thrust basins, the position of the orographic divide, and the location and extent of the zone of maximum uplift and denudation since the middle Pliocene (modified after Ghisetti and Vezzani, 1999). A–B is the trace of the crustal cross section of Figure 36; (B) ideal transect illustrating the time migration of extension and compression since 7 Ma from the innermost (light blue) to the outermost (gray) tectonic domains. Note that extension and shortening have migrated at comparable rates (~4 cm/yr), and that extension of the thrust belt east of the orographic divide is relatively young (<3 Ma). Color code is the same as in Figure 3. (Modified after Ghisetti and Vezzani, 2002b).

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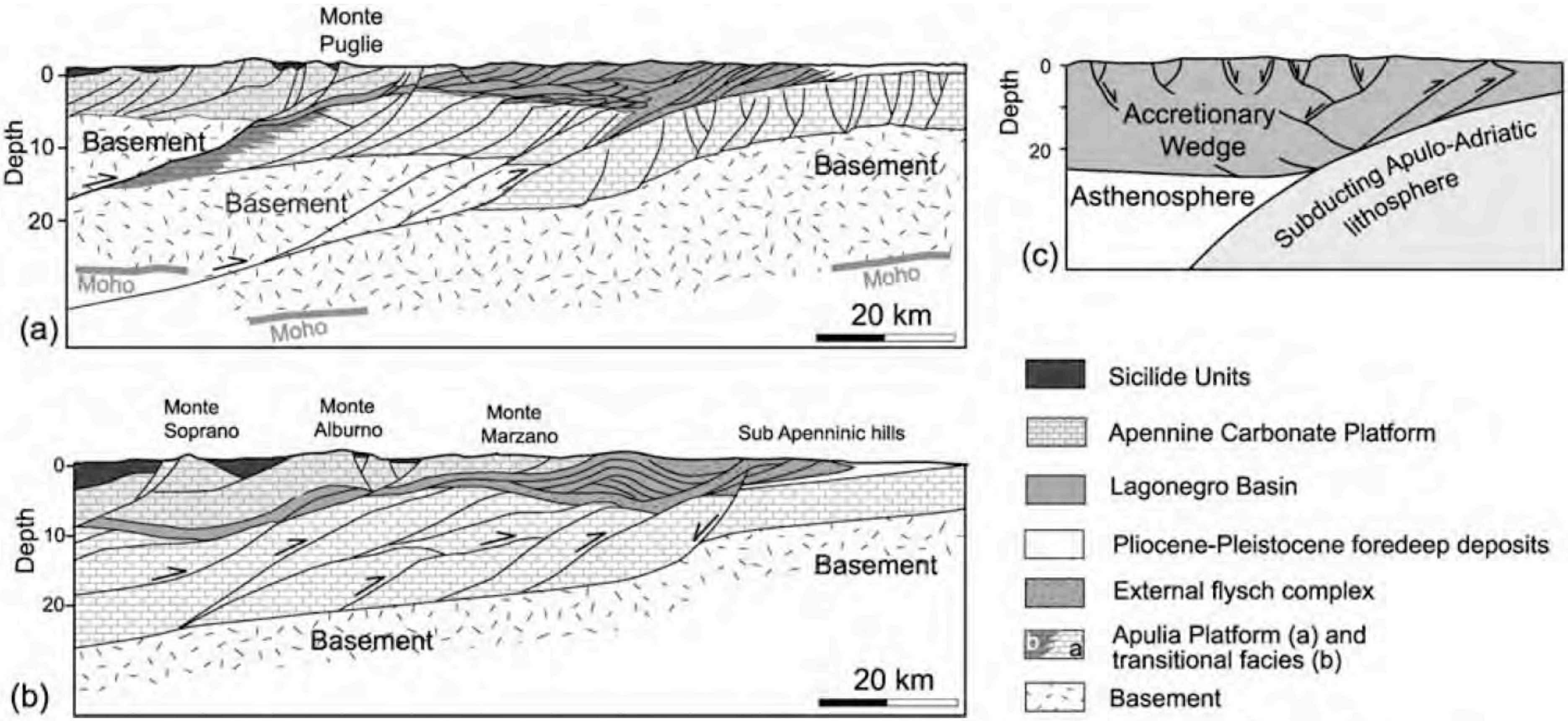

Figure 1. Conflicting interpretations about the deep structural setting of the southern Apennines. (a) Thick-skinned model. The Apulian crystalline basement is largely deformed and forms a large wedge within the SA accretionary prism. Shortening estimated at the top of the Apulian carbonates is small, in the order of 15–25 km (modified after *Menardi Noguera and Rea* [2000] with permission from Elsevier). (b) Thin-skinned model. The southern Apennines accretionary prism is made up of completely rootless sedimentary nappes. The basement remains essentially undeformed and dips westward below the accretionary prism. The total shortening of the buried Apulian thrust sheets is estimated to be not less than 90 km (modified after *Mazzotti et al.* [2000]). (c) The geodynamic scenario suggested by the available geophysical and geochemical data is characterized by the subduction of the Apulo-Adriatic lithosphere below the SA.

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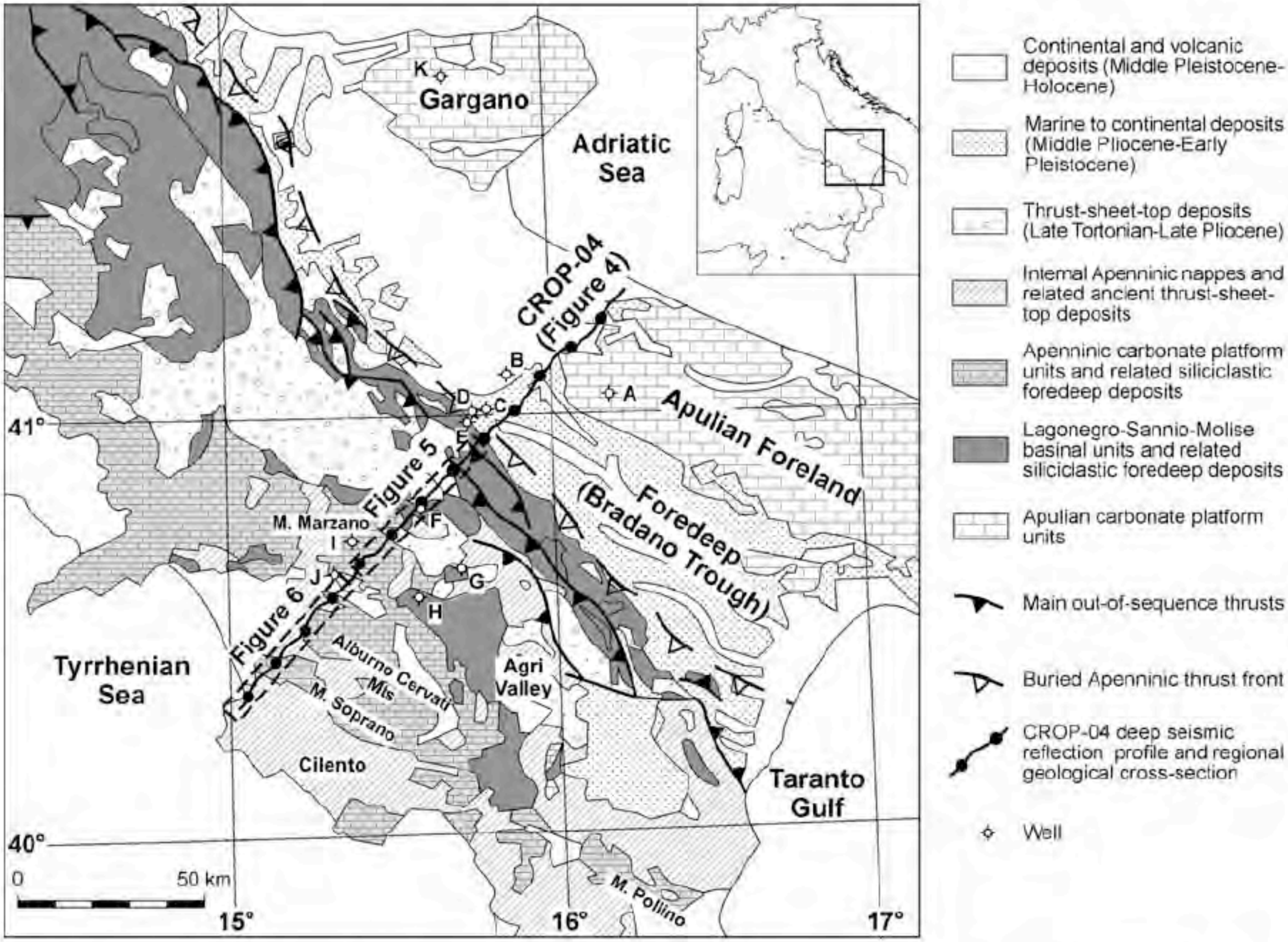

Figure 2. Simplified geological map of the southern Apennines (modified after *Patacca et al.* [1992a]). The location of the regional geological cross section shown in Figure 4 (basically coincident with the CROP-04 seismic reflection profile) is shown on the map. Boxes highlight the CROP-04 segments shown in Figures 5 and 6. Letters refer to wells (A, Puglia 1; B, Gaudiano 1; C, Bellaveduta 1; D, Lavello 5; E, Lavello 1; F, S. Fele 1; G, M. Foi 1; H, Vallauria 1; I, S. Gregorio Magno 1; J, Contursi 1; K, Gargano 1).

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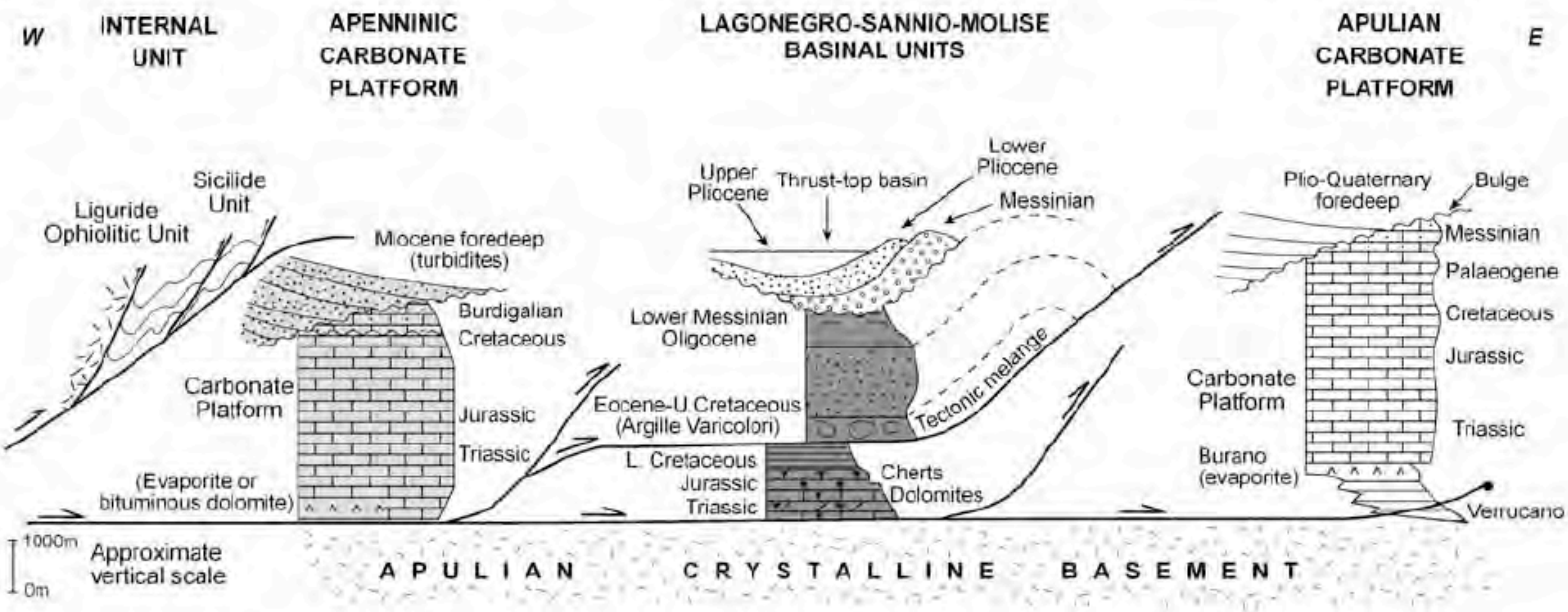

Figure 3. The main paleogeographic domain recognized in the southern Apennines developed during the Mesozoic rifting and the subsequent passive continental margin evolution of the Apulo-Adriatic plate. The Apennine and Apulian platforms and the intervening Lagonegro-Molise basin were originally located on the same Apulian crystalline basement (modified after *Casero et al.* [1988]).

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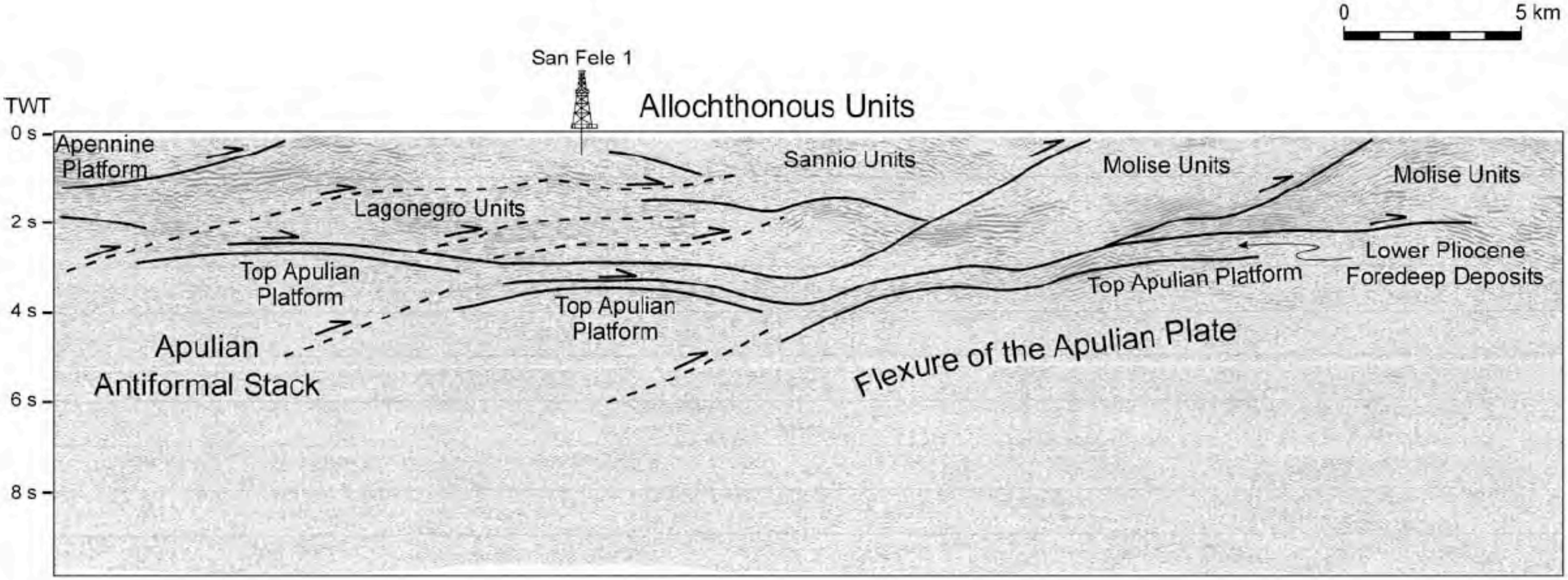

Figure 5. Detail of the central part of the CROP-04 seismic profile (location in Figure 2). The main structural features of the allochthonous units can be recognized. Top Apulia horizon has been traced integrating well data and the interpretation of industrial seismic lines.

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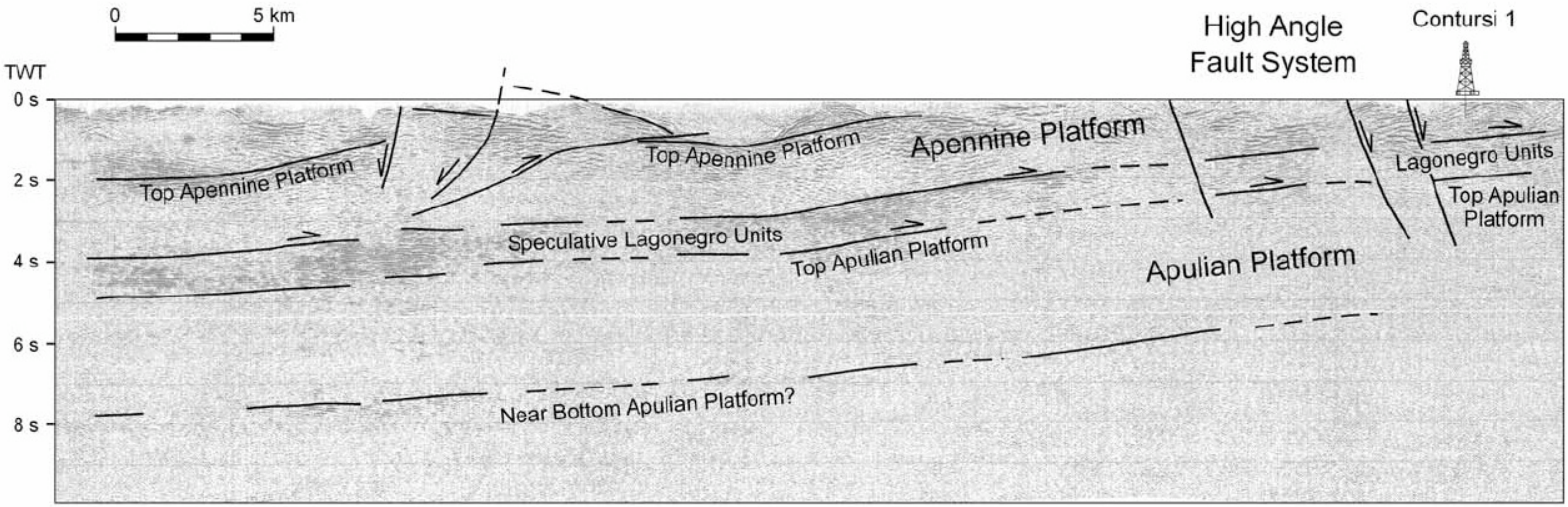

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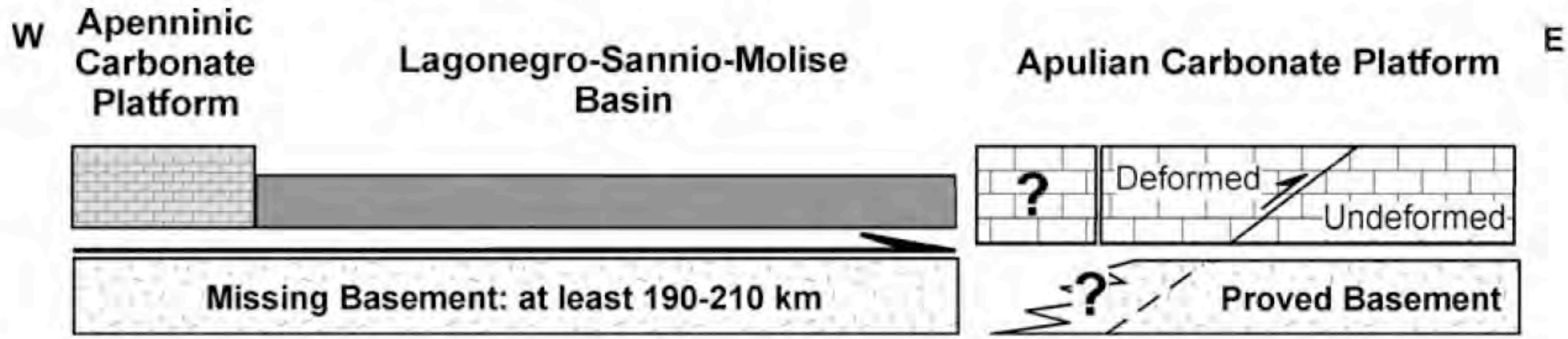

Figure 7. Palinspastic sketch along the regional cross section shown in Figure 4. The sedimentary covers belonging to the Apennine carbonate platform and to the Lagonegro-Molise basin are completely detached from their original basement. The amount of missing crystalline basement, originally located below these domains, has been approximately evaluated applying key-bed balancing techniques to derive the predeformational width of the sedimentary cover. On the basis of our estimates, the extent of the missing crystalline basement is estimated to be not less than 190–210 km.

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Thick Skin Model

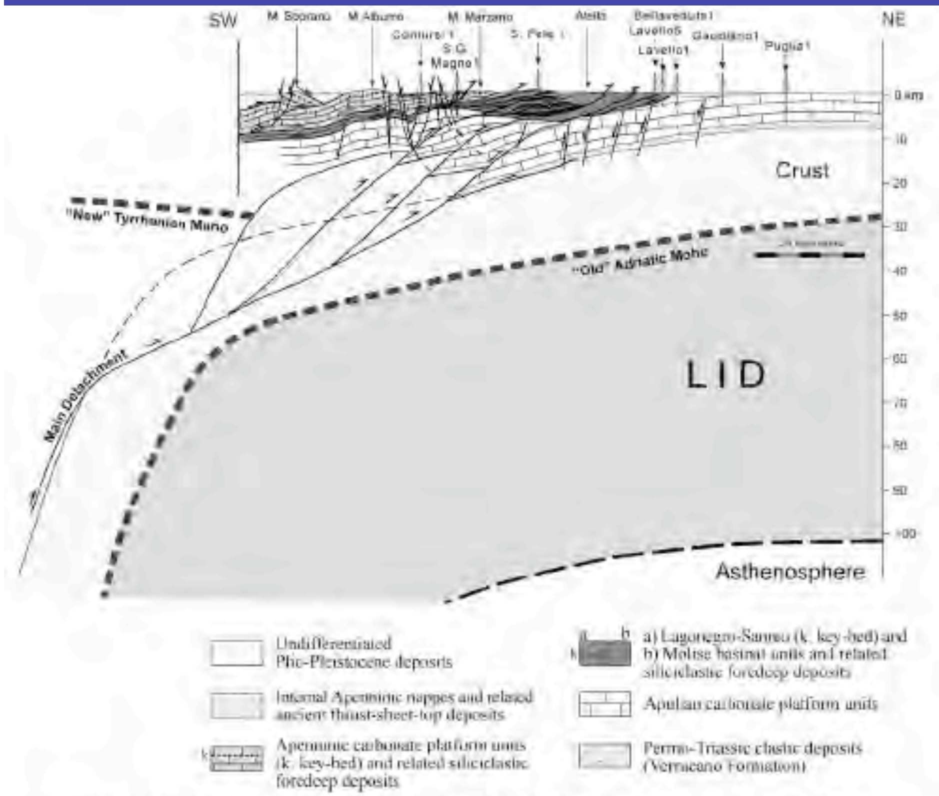

Figure 8. Thick-skinned tectonics interpretation of the SA deep structure (cross section location in Figure 2). The main thrusts offsetting the top Apulian carbonates are interpreted as deeply rooted. The resulting cross sections show three slices of the Apulian crystalline basement with shortening estimated at the top Apulian horizon of about 20 km. To place the basement slices and to permit their deformation, the present-day position of the subducting slab needs to be shifted more than 50 km westward. The modified structure no longer matches the crustal and lithospheric architecture constrained by the available geophysical data (compare Figures 4 and 8). The tectonic implications of this model show some inconsistencies with respect to well-documented geological features of the SA (see text).

Thin Skin Model

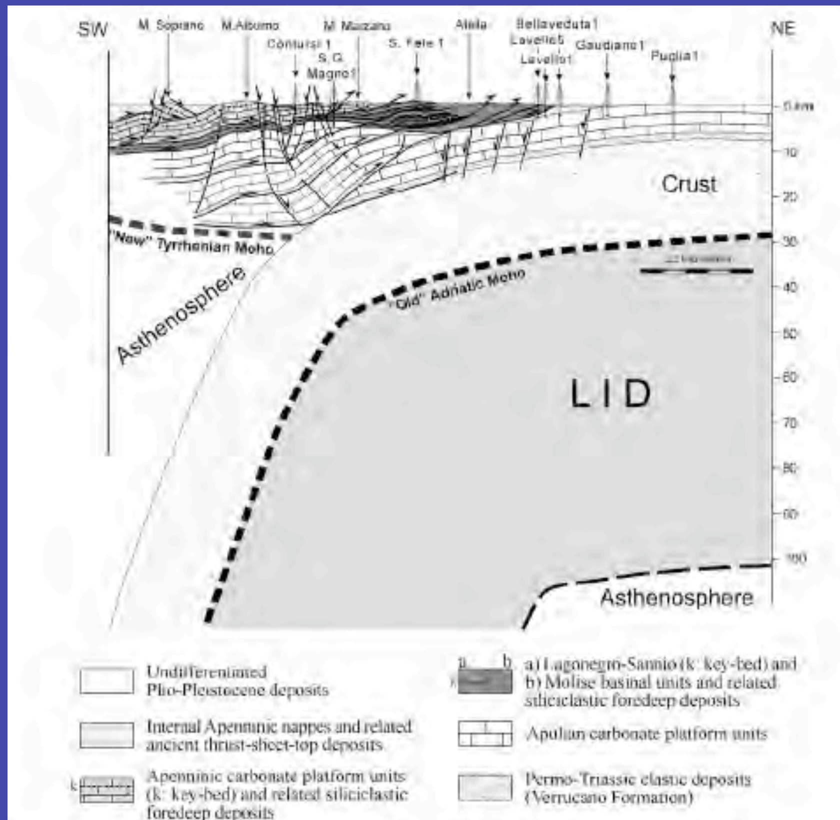

Figure 10. Thin-skinned tectonics interpretation of the SA deep structure (cross section location in Figure 2). The main thrusts recognized at TAP level have been extrapolated westward, flattening at depth. The resulting setting is characterized by the partial overlap of three main thrust sheets, made up by both the Apulian carbonates and the underlying Permo-Triassic clastics. The lowest thrust body becomes subhorizontal at depth, above the Tyrrhenian Moho. The total shortening of the Apulian thrust units should be at least than 90 km, while the total shortening of the allochthonous units (including the Apennine carbonate platform, the Lagonegro-Molise basin, and the Apulian carbonate platform) is estimated to be not less than 280–300 km.

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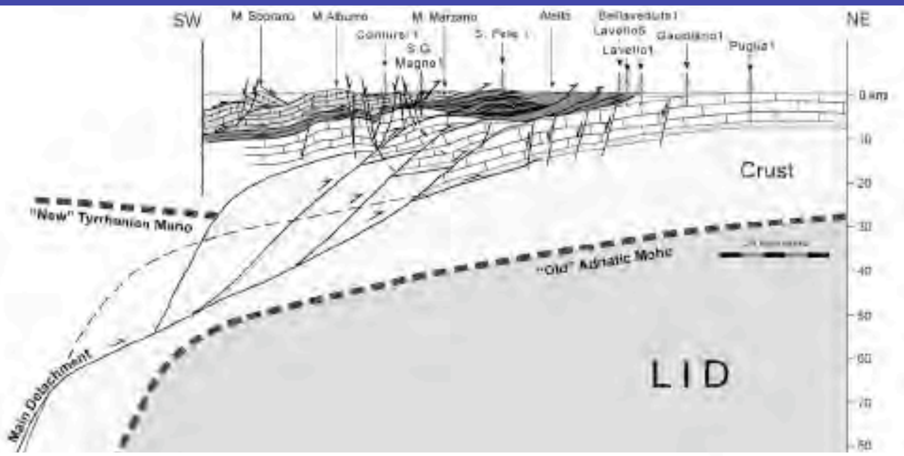
Thick Skin Model



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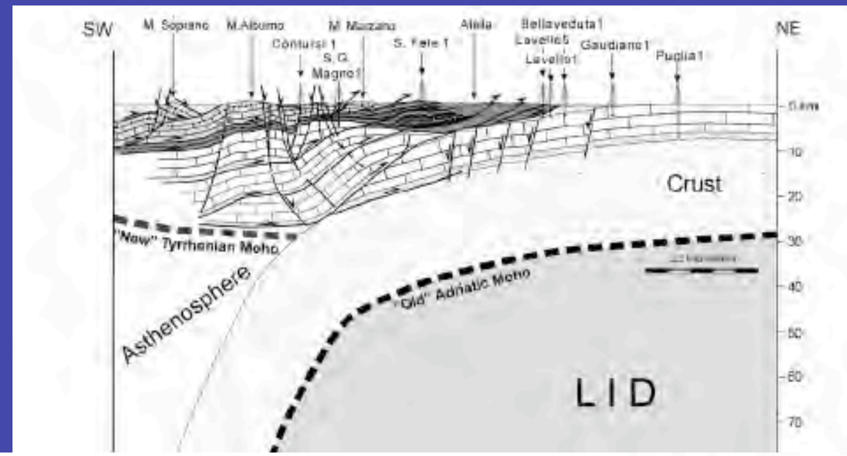

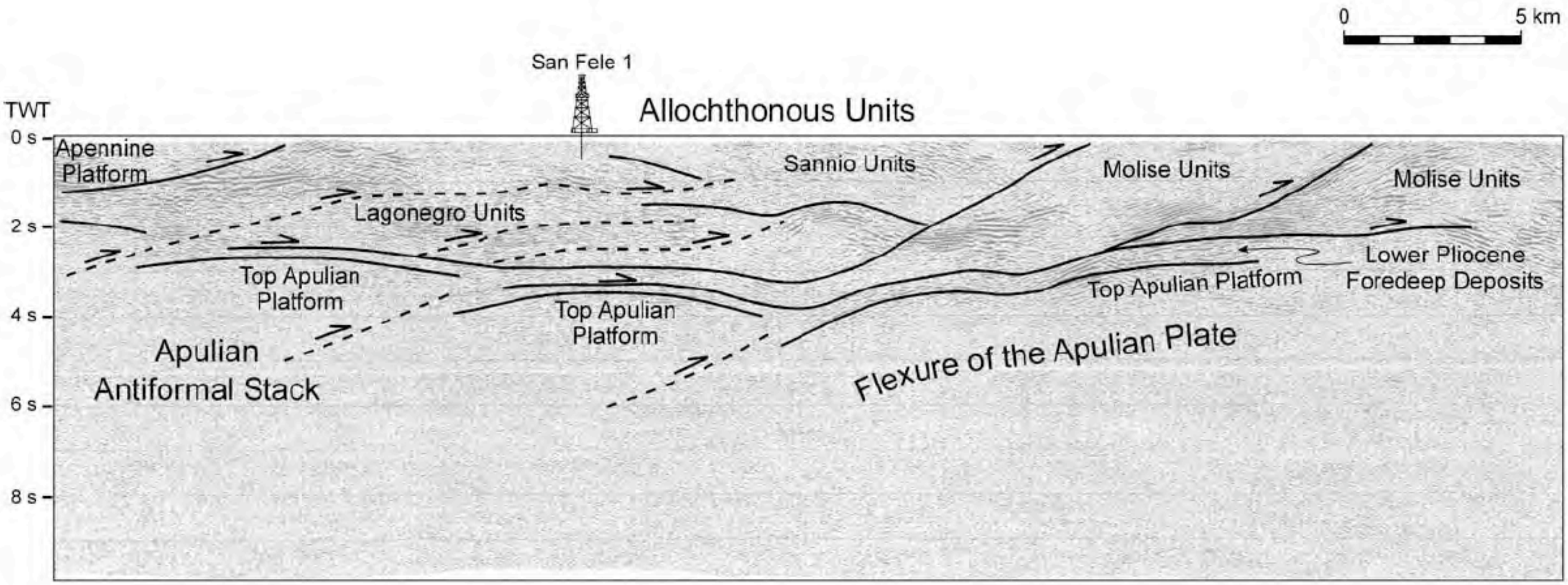

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Figure 5. Detail of the central part of the CROP-04 seismic profile (location in Figure 2). The main structural features of the allochthonous units can be recognized. Top Apulia horizon has been traced integrating well data and the interpretation of industrial seismic lines.