MEETING ON THE GAS FIELDS OF WESTERN EUROPE

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G. MERLA

GUIDE-BOOK OF THE EXCURSION TO THE NORTHERN APENNINES

4th 5th Oct. 1957

with geological sections and a Geological Sketch Map 1:100.000

AGIP MINERARIA

1 - Geological setting of the excursion

§ 1. - From the structural and genetical standpoint, the buried folds of the Po valley belong to the Apennines. During the Upper Miocene, these folds stood much higher than now, that is the range extended considerably farther to the North-East, though partly submerged. Many crest and tops emerged and were subject to erosion. Successively, during the Pliocene and the Quaternary, a subsidence took place, and a sedimentary trough was re-established encroaching upon the folded fringe of the Apennines proper.

§ 2. - The Po valley borders to the SW on the Northen Apennines. In the Apennines one might expect the outcropping of the formations involved in the folds buried under the Pliocene and Quaternary deposits of the Po valley. Actually, the terranes outcropping in the Northern Apennines, namely, in their north-eastern slope, differ markedly from the pre-Pliocene formations of the Po valley. The difference is brought about: *i*) by a not very strong but definite difference of facies between the Oligocene and Miocene deposits of the Po valley and those of the Apennines, *ii*) by the presence, in the Apennines, of a peculiar and widespread rock complex, the so-called « argille scagliose » (lit. « scaly clays ») sensu lato. The « argille scagliose » are also referred to in the geological literature as « allochthonous cover » or « allochthon », « ophiolitic formation », « ophiolitic flysch », « Liguride nappe », « Ligurikum ». These terms are more or less synonimous. As far as we know, the « argille scagliose » are lacking in the Po valley area, except in a narrow strip bordering the Apennines.

§ 3. - For the lithology, stratigraphy and structure of the complex of the « argille scagliose » in the Parmesan section of the Northern Apennines, see the legend of the Geological Sketch Map. These local data hold true for the Northern Apennines in general but for minor differences.

As to the significance and origin of the « argille scagliose » two opinions are maintained.

According to one opinion, the puzzling features of the « argille scagliose » are the outcome of their allochthonous lay. The displacement of the several components took place more or less chaotically. *a*) Gravity is an outstanding agent of the movement, causing incompetent sediments

(like clays, shales and still unconsolidated rocks), or slabs of competent rocks resting on such sediments, to slide down the orogenic slopes. *b*) In addition to gravity, an important mechanical agent is the squeezing out of the allochthonous material from the troughs developing in front of the ridges in the autochton. In sould be borne in mind, as a matter of fact, that the crustal shortening ensuing from primary tectonical deformation in the autochthon is in no way negligible. This shortening may be evaluated at 15 %-25 % of the initial breadth in the case of a faulted anticline. The shortening is much more considerable in the case of overthrust structures. *c*) Plastic flowage or salt dome-like behaviour are probably attendant phenomena.

The direction of the movement is from W to E or from SW to NE. In Eastern Liguria, between the Scrivia and the Trebbia valleys, many formations that are known elsewhere as ingredients in the « argille scagliose » probably occur in an autochthonous condition.

If all this be true, the deformations of the autochthon only belong to the primary tectonics and indicate the amount of crustal shortening, while the deformations in the competent slabs of the allochthonous cover are more or less superficial effects of the displacements and accordingly cannot be taken into account in working out the tectonical pattern of the deep framework of the range. Actually, structural trends in the autochthon are continuous over large distances, the NW-SE trend definitely prevailing, let us say, from Lake Trasimeno to the Cisa Pass. On the contrary, no orderly trends can be detected in the allochthon.

Some of the ingredients of the « argille scagliose » are foreign to the autochthonous sedimentary area of the Northern Apennines, and must, therefore have originated in the tyrrhenian area or in Liguria west of the river Trebbia. Such are the « alberesi » etc. (« Monte Cassio flysch », « calcari a elmintoidi »), the pietraforte, the ophiolites. Other ingredients are identical with autochthonous rocks, and may, therefore, have entered the « argille scagliose » during their eastward and north-eastward movement. Such are, for instance, the slabs of « macigno » and of « marnoso-arenacea ».

This broadly outlined opinion of the allochthony has evolved from the contributions by Anelli, Migliorini, Signorini, Trevisan and the present writer (*).

A review in English has been published by John C. Maxwell (**).

(*) M. Anelli: *Sul comportamento tettonico delle argille scagliose nell'Appennino Emiliano*, Rend. Acc. Naz. Lincei, 32, 1923. — *Note stratigrafiche e tettoniche sull'Appennino di Piacenza*, Mem. R. Acc. Sc. Lettere ed Arti di Modena, serie V, vol. 3, 1938.

Carlo I. Migliorini: *Considerazioni su di un particolare effetto dell'orogenesi*, Boll. Soc. Geol. It., 52, 1933. — *I cunei composti nell'orogenesi*, Ibid., 67, 1948. — *Composite wedges and orogenic landslips in the Apennines*, Rep. 18th Sess. Int. Geol. Congr., Great Britain, part XIII, 1952.

R. Signorini: *Sulla tettonica dell'Appennino Romagnolo*, Rend. R. Acc. Naz. Lincei,

§ 4. - According to an alternative opinion, the « argille scagliose » are more or less at home where they outcrop. Minor displacements brought about by sliding or plastic flowage are admitted, or, if actual allochthony is maintained, the area of origin is sought for to the N and NE of the Apennines. Where, as in Tuscany, and on the Adriatic slope of the Apennines, the « argille scagliose » actually overlie the sandstones of Oligocene (« macigno ») or even of Miocene age « formazione marnoso-arenacea »), the suggestion is put forth that this is but a secondary lay, due to upward flowage through fault fissures and, or a certain amount of lateral outpouring.

This alternative opinion is basically grounded on the reluctance to admit the mechanical possibility of such lateral displacements as are advocated by the supporters of the allochthony from te West. Te same reluctance is also felt by some authors in regard of the north-eastward growth of the Apennines by successive birth of new tectonical ridges during the Miocene, which is another tenet of that theory.

The alternative opinion has not yet been stated in a coherent and general way, and is mostly met with in the form of local explanations or of criticisms to the theory of allochthony by orogenic landslips. Reference can be made to Lipparini, De Sitter, Gortani (*).

§ 5. - Widely discrepant interpretations of the Oligocene and Miocene deposits along the Adriatic border of the Apennines ensue from the two opinions quoted in §§ 3-4.

According to the opinion of the alloctony from the West, the Oligocene and Miocene deposits overlying, or entangled in, the « argille scagliose » of the Po valley border must have slidden together with their substratum. In fact, since the « argille scagliose » overlie Oligocene and Miocene sandstones in the watershed area, the displacement advocated by the

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serie VII, vol. I, 1940. — *Colate supramioceniche di materiale oligocenico nel Parmense*, Boll. Soc. Geol. It., 62, 1943.

L. TREVISAN: *L'Elba Orientale e la sua tettonica di scivolamento per gravità*, Mem. Ist. Geol. Univ. Padova, 16, 1950.

G. MERLA: *I graniti della formazione ofiolitica appennina*, Boll. R. Uff. Geol. d'Italia, 58, 1933. — *Ricerche tettoniche nell'Appennino Settentrionale*, Rep 18th Sess., Great Britain, part XIII, 1952. — *Geologia dell'Appennino Settentrionale*, *Boll. Soc. Geol. It.*, 70, 1952.

(*) JOHN C. MAXWELL, *Geology of the Northern Apennines., by Giovanni Merla; Composite wedges in orogenesis, by Carlo I. Migliorini*, Bull. A.A.P.G., 37, 1953.

See also: A. ALMELA y JOSÈ M. RIOS: *Reseña de una excursión geológica al Apenino Septentrional*, Notas y Comunicaciones del Instituto Geológico y Minero de España, n. 31, 1953.

(**) T. LIPPARINI: *Studi stratigrafici e tettonici nell'Appennino Settentrionale*, Boll. R. Uff. Geol. d'Italia, 69, 1944.

L. U. DE SITTER: *Structural Geology*, Mac Graw Hill Publ. Co., 1956, p. 286-288.

M. GORTANI: *Recenti progressi nella conoscenza strutturale dell'Italia*, Geotektonisches Symposium zu Ehren von Hans Stille, Festschrift überreicht von der Deutsch. Geol. Ges., der Geol. Verein., und der Pal. Ges., Struttgart, 1956.

theory must have occurred after the Oligocene at least. By a mechanism of this sort, slabs of neritic formations originally laid down several tens of kilometers to the west of their present position, or even in the Ligurian or Tyrrhenian area, have been brought in close proximity of the contemporary deposits of the Po valley. If this be true, no direct continuity exists between the Oligocene and Miocene deposits of the Po valley subsurface and those outcropping along the border of the Apennines.

According to the opinion of the autochthony of the « argille scagliose », the Oligocene and Miocene deposits of the Adriatic border of the Apennines were laid down more or less in situ, and are but lateral partsf of the Po valley deposits brought to the surface by the final upheaval of the Apennines. More or less the same view is taken by the supporters of the allochthony of the « argille scagliose » from the North in pre-Oligocene times.

§ 6. - Accepting the allochtony from the West of the « argille scagliose », along the Adriatic border of the Apennines Tertiary autochthon disappears from the surface in the Sillaro valley, dipping under the allochthonous cover. The next autochthonous outcrop is met with no nearer than 75 miles to the NW, in the Salsomaggiore area. Possibly, Tertiary autochthon also plugs out from beneath the allochthonous cover in the Baganza valley. This is the so-called « Baganza conglomerate » or « Salti del Diavolo (= the Devil'scliff) conglomerate », according to a working hypothesis by L. Lucchetti (Agip Mineraria). This hypothesis must be proven but seems plausible.

§ 7. - In order to connect the Po valley subsurface geology with the surface geology of the Apennines a few drilling areas and seismic lines must be taken into consideration.

i) The *Paderno drilling* (*Bologna*) has met about 4.000' of « argille scagliose ». These are overlain in surface by gypsiferous Upper Miocene and Pliocene. Since the drilling was stopped in the « argille scagliose », it is not significant as to whether the « argille scagliose » are autochthonous or not. Their considerable thickness compared by surface structure may be taken as an indication of plastic inflow in the core of an anticline.

ii) The *Castelvetro structure* (*SW of Modena*). Seismic survey has shown the presence of an anticline. Drillings have found « argille scagliose » below Tortonian clays, while in another anticline a few miles to the NE no « argille scagliose » have been found, at least down to the Helvetian levels where the drilling was stopped.

iii) The *Vallezza oil field* (*SE of Fornovo di Taro*). The structure of this area is of prime importance for the relationships between the « argille scagliose » and the Tertiary deposits of the Po valley. As the Geological Section shows, a double anticline exists under a more or less chaotic cover belonging to the « argille scagliose » lato sensu. These

« argille scagliose » are made up by folded and kneaded chunks and slabs of Eocene flysch and Oligocene clastics. The buried anticlines belong to coarse clastics of Helvetian age (information by Agip Mineraria). The shift of opinion from autochthony towards an almost complete allochthony as a result of deeper drilling in the area is also evident when successive papers by Greig and Wiedenmayer are compared (*).

In the Vallezza area, therefore, the intercalation of considerably thick chaotic material between Helvetian and Upper Miocene is a proven fact. To the supporters of the allochthony from the West this means the arrival of the « argille scagliose » in the sedimentation area corresponding to the present border of the Apennines by the end of the Miocene. To the supporters of the alternative opinions, (such as autochthony of the « argille scagliose », or of part of them like the « Monte Sporno » flysch, arrival of the a.s. in pre-Oligocene times from the N and NE, or even from the SW), the aforesaid intercalation is but a minor thrust or slide effect, while the true body of the Cretaceous and Eocene flysch now kneaded in the « argille scagliose » must be sought for several thousand meters deeper, beneath the Oligocene-Miocene series of the Po valley.

iv) A few miles north-westwards, near *Ozzano in the Taro valley,* a drilling has reached Helvetian clastics under « argille scagliose ».

v) Finally, in the *Salsomaggiore area,* the structure buried at Vallezza comes widely to the surface. Surface geology and drilling in the Centopozzi area show that a series made of Oligocene/Aquitanian sands, Lower Miocene (« Langhian ») shales, Middle Miocene (« Helvetian ») calcarenites, sands and conglomerates is overlain by the « argille scagliose » complex containing slabs of allochthonous Oligocene (grey marls with beds of molasse and conglomerates, tripolaceous shales).

2. - Points of interest on the excursion route

§ 8. - Leaving the Emilian Way after Fidenza, the route turns to the SW to cross the Salsomaggiore anticline by the Val Parola road. On the NE side of the anticline the Helvetian is beveled off and covered by Pliocene sands and conglomerates. The outcropping core of the anticline is made by grey Langhian shales (visible in the distance on the left). After the village Banzola, Helvetian deposits are met with forming the SW side of the anticline. These clearly dip under soft terranes (« argille scagliose »; no autcrops along the route).

After crossing the Salsomaggiore anticline, the road climbs winding

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(*) D. A. Greig: *Descrizione geologica e cenni sullo sviluppo della miniera di Vallezza,* Atti e Mem. R. Acc. Sc. Lett. e Arti di Modena, serie 5, vol. 2, 1937.

Carlo Wiedenmayer: *Sull'Eocene di Monte Sporno nella finestra di Parma,* Società Petrolifera Italiana, 1955.

to the right to reach S. Vittore. Sight on the SW side of the anticline: soft grounds of « argille scagliose », wooded slopes of allochthonous Oligocene marls resting on the former and dipping south-westwards under typical « argille scagliose » in the background, with patches of « Monte Cassio flysch » and dark crags of ophiolites.

On the way down to Salsomaggiore more exposures of Helvetian, and sights on the « argille scagliose » to the SW.

After the town of Salsomaggiore, the route climbs towards Bargone skirting the NW end of the anticline. Exposures of white marls of allochthonous Oligocene resting on the autochthonous Helvetian/Langhian of the anticline. Pliocene conglomerates and sight on the border of the Apennines and on the Po plain.

§ 9. - On the way from Salsomaggiore to the S. Antonio pass and then down to Pellegrino Parmense and to river Taro, over a distance of about 40 kms, the route goes through a rugged country of « argille scagliose ». Good exposures show chaotic structure. Slabs of « Monte Cassio flysch », peaks and crags of ophiolites (Pietranera, Rocca Lanzona). Between Pellegrino Parmense and the river Taro, a large patch of Oligocene (grey marls, subordinately sands and conglomerates) rests on the « argille scagliose ».

§ 10. - From Fornovo on, the route follows the highway to the Cisa Pass. On the right, sight on the Taro valley. At Monte Prinzera, wide exposures of brecciated and massive serpentine. On the slope down to the Taro, isolated ophiolitic crags scattered among easily erodible « argille scagliose ».

§ 11. - At 17 kms from Fornovo, the route quits the Cisa road and turns to the left towards Terenzo and Calestano. A patch of « Monte Cassio flysch » is crossed before reaching Terenzo, and then, after a strip of soft « argille scagliose » recognizable by the landforms, another flysch is met with forming the Monte Croce and belonging to the « Monte Sporno flysch ».

The valley of the river Baganza is reached at Calestano, after going down through a rolling slope (mainly Oligocene clastics, « red beds », of the Vallezza area).

§ 12. - A few kms upstreams of Calestano, very good exposures are visible on both sides of the valley. Here Eocene « Monte Sporno flysch », outcrops from beneath the « argille scagliose ». The structure is no simple upfolding, as the formation is repeatedly cut through by overthrusts thrown up to the North. A thick flap is overturned at the upstream (= southern) contact with the « argille scagliose », as it can be ascertained by graded beds of sandstones. « Monte Cassio flysch » resting upon the « argille scagliose » is visible on the other side of the river.

According to several authors (Anelli 1908 and successively, Behrmann 1936, Wiedenmayer 1955) the « Monte Sporno flysch », which is proven of Eocene age by macro- and microforams., represents the more or less autochthonous substratum outcropping from beneath the « argille scagliose ». According to the opinion of the general allochthony from the West, embodied in the Geological Sections, it is but an ingredient of the argille scagliose », and gives no clues as to the nature of the local substratum. If the former opinion be true dense rocks of the substratum, e.g. mesozoic limestones or basement rocks should lie in the Monte Sporno area at least 4500 meters higher than in the Vallezza area. Owing to the close proximity of the two areas (about 4 kms), this would reasonably entail a major fault across the river Baganza downstreams of Calestano. As a matter of fact, the gravimetric map of the so-called « Parma window » (see Wiedenmayer, 1955, Pl.4) does not show any such disturbance, as the gravimetric slope goes down unchanged in the area. Furthermore, scraps of « Monte Sporno flysch » are scattered in the « argille scagliose » of the watershed.

§ 13. - The stop at Le Chiastre, about 10 kms further, allows to observe the « Baganza conglomerate ». This conglomerate occurs in a very peculiar lay, that is, as a gigantic wall crossing the whole Baganza valley from side to side over a lenght of more than 4 kms. The pebbles are mainly of crystalline rocks. Nothing is known about the age of the conglomerate. On grounds of broad analogy, an Oligocene or Miocene age can be surmised. Neither is grounds of broad analogy, an Oligocene or Miocene age can be surmised. Neither is anything definite known concerning the situation of the conglomerate with respect to the « argille scagliose ». If the conglomerate was originally laid down above the « argille scagliose », the only ensuing structure more or less in keeping with the actual lay would be a pinched syncline slightly overturned upstream. In this case, no substantial north-eastwards sliding after the folding could reasonably be admitted, since it seems unlikely that such a thin wall of hard rock could have moved together with the « argille scagliose » without being scattered into fragments. In the Geological Section preference has been given to a tentative suggestion by L. Lucchetti, of which mention has been made in § 6. This interpretation would prove more convincing if the conglomerate passed upstream (= to the SW) to finer clastics. That this is the case is quite possible, the area bordering the conglomerate to the SW is covered, so that it is by no means evident that the « argille scagliose » come in actual contact to the SW with the conglomerate.

Downstream, a large patch of « Monte Cassio flysch neighbours the conglomerate. The « Monte Cassio flysch » is made up by regular bands of grey marly limestone weathering yellow alternating with clays and shales. In the M. Cassio and Monte Montagnana area some *Inoceramus*

have been found. Upper Cretaceous is, therefore, present in the « Monte Cassio flysch ». In the present writer's opinion, this flysch extends upwards to the Eocene, and corresponds to the « calcare alberese » of Tuscany. Both formations pass gradually downwards to fine calcareous re-sedimented sandstones, the so-called « pietraforte », which in many places have yelded *Inoceramus* and Ammonites. « Pietraforte » is present at the base of the « Monte Cassio flysch » of Monte Dosso in the Ceno valley (see Geological Section). The « Monte Sporno flysch » too should belong to the same group of formations, which, on the whole, are the equivalent of the pelagic « scisti policromi » of the Tuscan facies. It seems likely that a substantial part of the « argille scagliose » sensu stricto (see legend of the Geological Sketch Map) originated through comminute crumbling of flysch formations as the « Monte Cassio flysch » etc.

§ 14. - About 3 kms further, chaotic « argille scagliose » with ophiolites are met with. But the best exposures of these rocks occur on the road from Berceto to the Valley of the Taro, in the neighbourhood of Roccaprebalza.

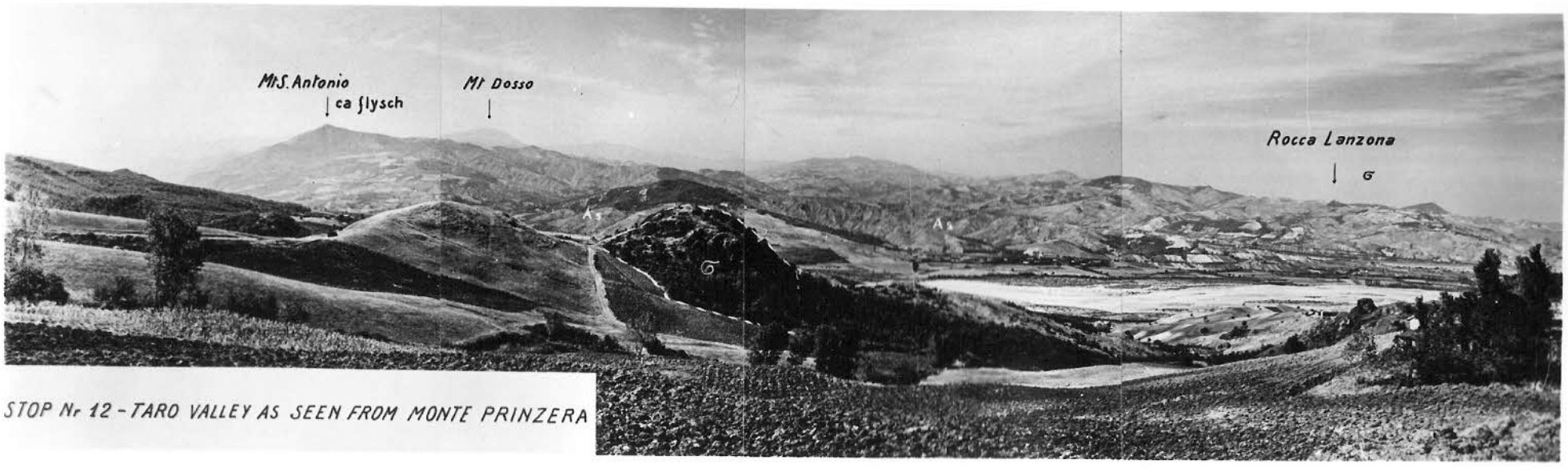
§ 15. - The main route of the excursion ends at the Passo della Cisa. The Pass is notched in a « pietraforte » series. The « pietraforte » is overturned (note the grading in the beds of sandstone), and passes upwards (= geometrically downwards) to marly shales and limestones of « Monte Cassio flysch ». This passage is easily seen on the left of the Pass, in the crest of Monte Valori. This overturned slab of « Monte Cassio flysch » rests (Monte Borgognone, Passo del Righetto) on the « macigno sandstone » of the watershed. Sight to the South on towering Monte Orsaro (« macigno »). The Monte Orsaro marks the North-West end of a long tectonical ridge in the autochthon, extending over a lenght of about 250 kms to the neighbourhood of Chiusi. With the possible exception of the Baganza conglomerate, the « macigno » of Monte Orsaro and Monte Borgognone represents the first reappearing, from beneath the allochthonous cover, of the autochthon outcropping in the Salsomaggiore anticline.

The nature and tectonical significance of the sandstones of Monte Molinatico are still debated, the existing geological maps being quite inadequate. Surveys by geologists of the Agip Mineraria are being carried out. The Monte Molinatico sandstone is possibly an allochthonous slab of « macigno ». Its allochthony seems confirmed (Ten Haaf) by flow-marks and drag-marks on the lower surface of the beds. These marks in the Monte Molinatico sandstones run almost at right angle with respect to the constant NW-SE direction they follow over the whole extent of the autochthonous « macigno » and « marnoso arenacea ».

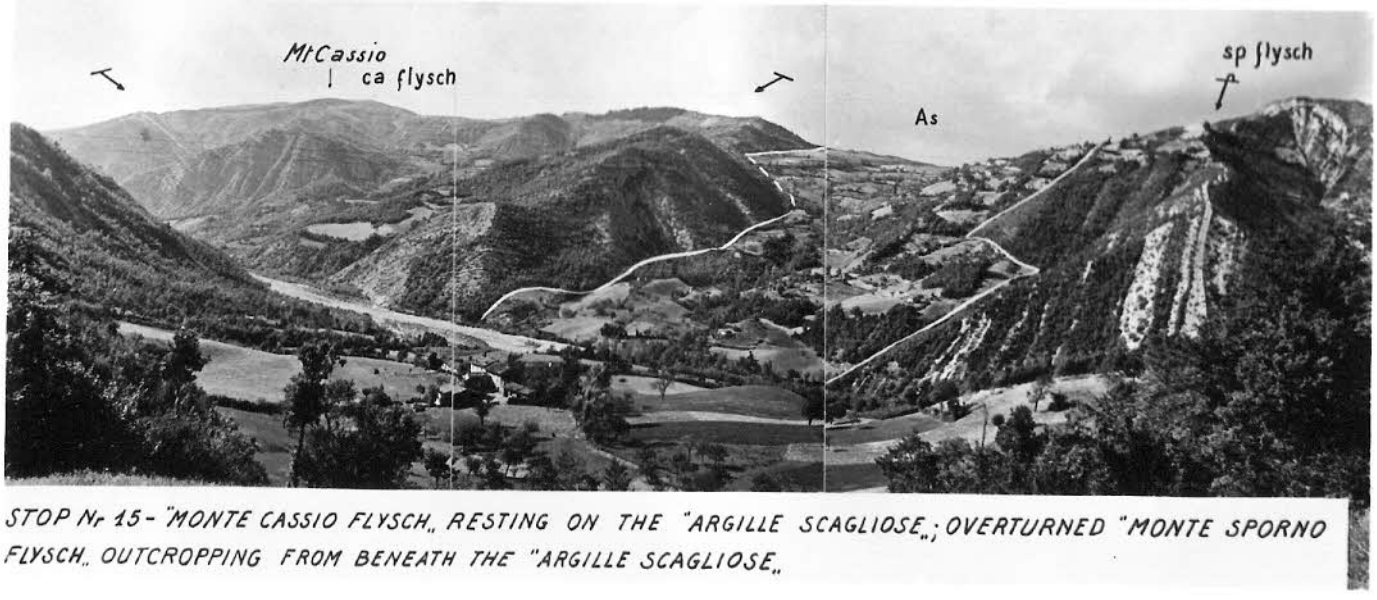
STOP Nr 3 - SOUTHERN SIDE OF THE SALSOMAGGIORE ANTICLINE.
"ARGILLE SCAGLIOSE„ RESTING ON THE HELVETIAN SANDSTONES

STOP Nr 10 - "ARGILLE SCAGLIOSE„

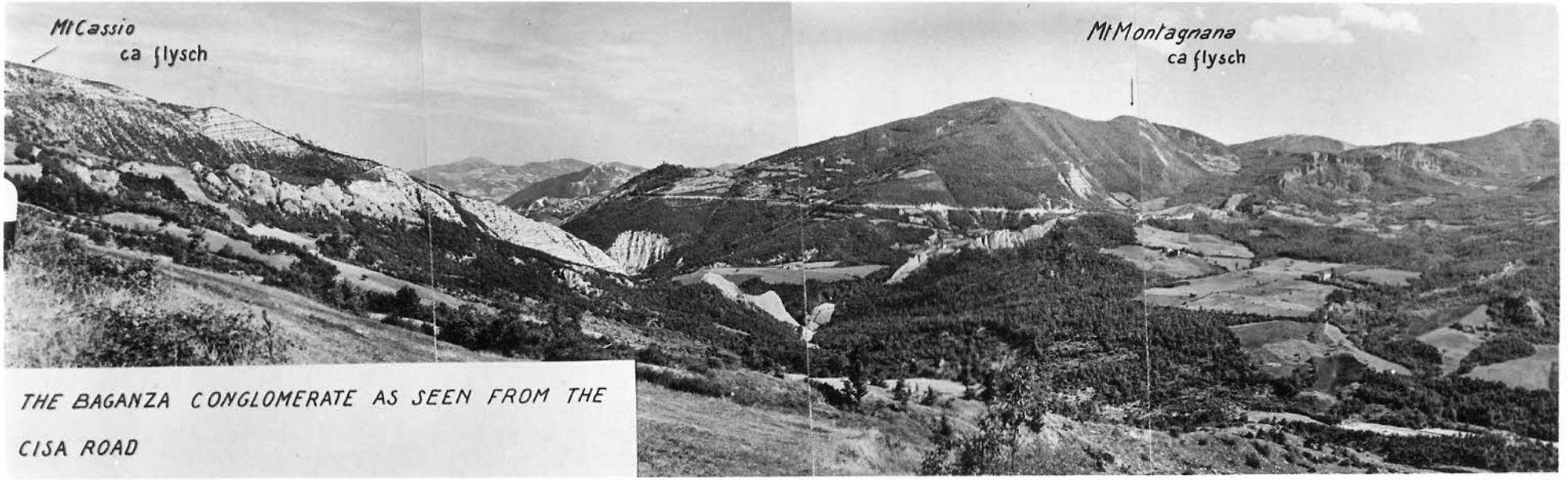
STOP Nr 11 - OLIGOCENE SANDSTONES CONGLOMERATES AND MARLS



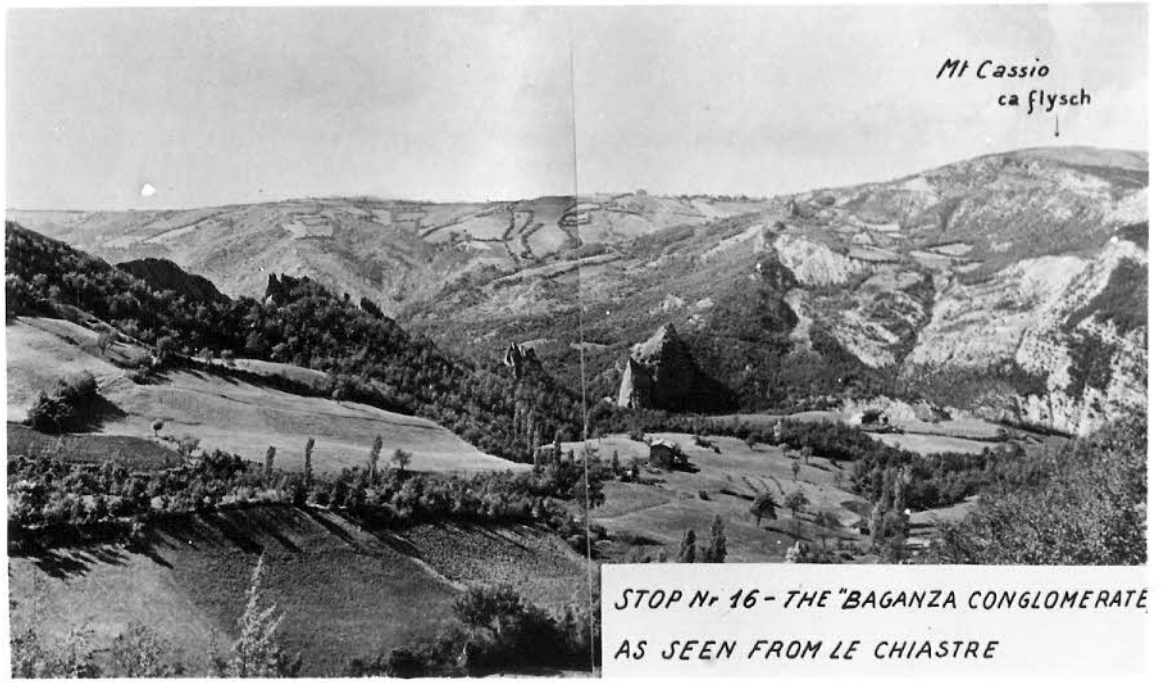
STOP Nr 12 - TARO VALLEY AS SEEN FROM MONTE PRINZERA



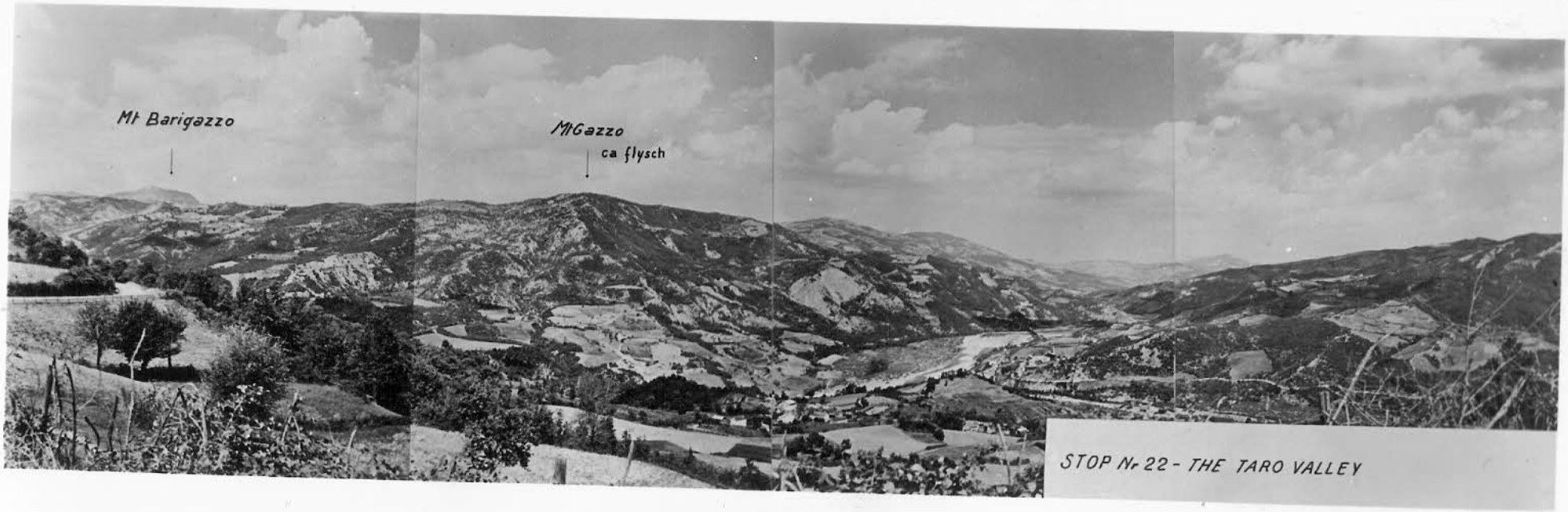
STOP Nr 15 - "MONTE CASSIO FLYSCH„ RESTING ON THE "ARGILLE SCAGLIOSE„; OVERTURNED "MONTE SPORNO FLYSCH„ OUTCROPPING FROM BENEATH THE "ARGILLE SCAGLIOSE„



THE BAGANZA CONGLOMERATE AS SEEN FROM THE CISA ROAD

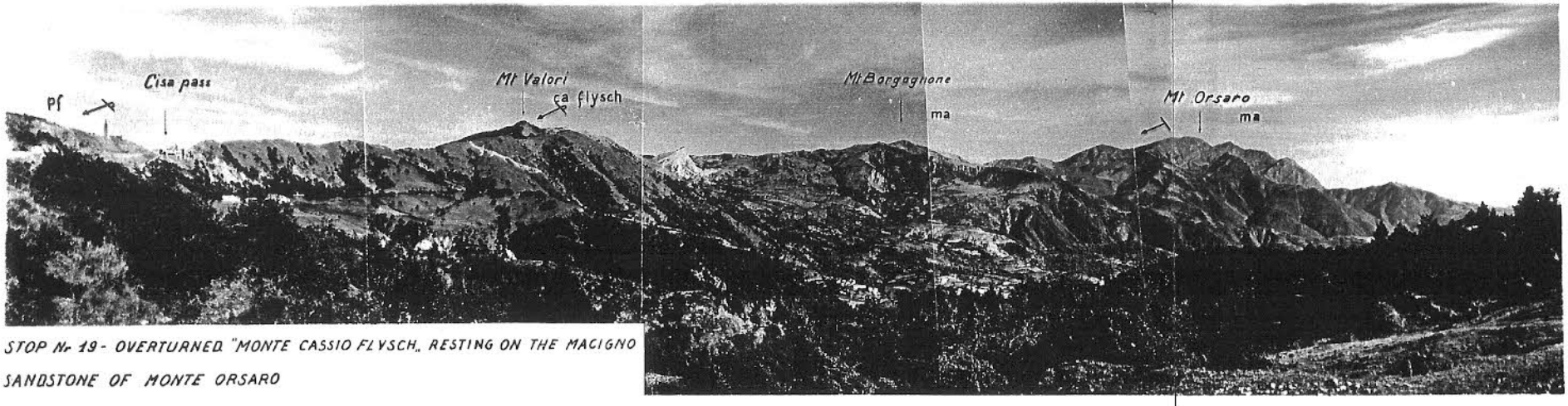


STOP Nr 16 - THE "BAGANZA CONGLOMERATE AS SEEN FROM LE CHIASTRE



STOP Nr 22 - THE TARO VALLEY

STOP Nr 20 - OPHIOLITES (LEFT) AND "ARGILLE SCAGLIOSE" OUTCROPS (RIGHT)



STOP Nr 19 - OVERTURNED "MONTE CASSIO FLYSCH" RESTING ON THE MACIGNO SANDSTONE OF MONTE ORSARO

ACC. NAZ. LINCEI - E.N.I. MEETING ON THE GAS FIELDS OF WESTERN EUROPE - MILANO 1957.

AGIP MINERARIA

G. MERLA - "TENTATIVE SECTIONS THROUGH THE NORTHERN APENNINES"

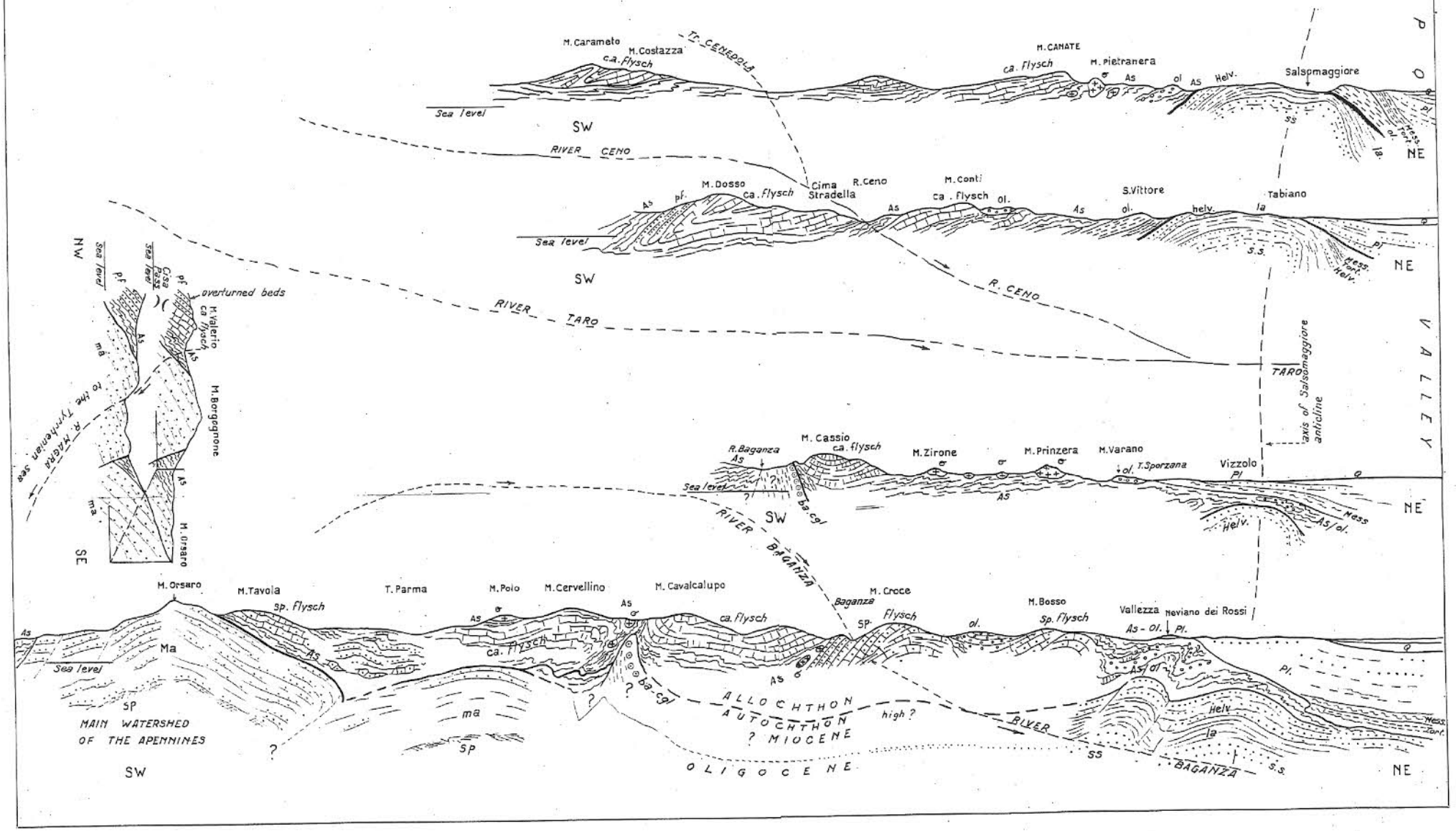
VERTICAL & HORIZONTAL SCALE 1: 100.000.

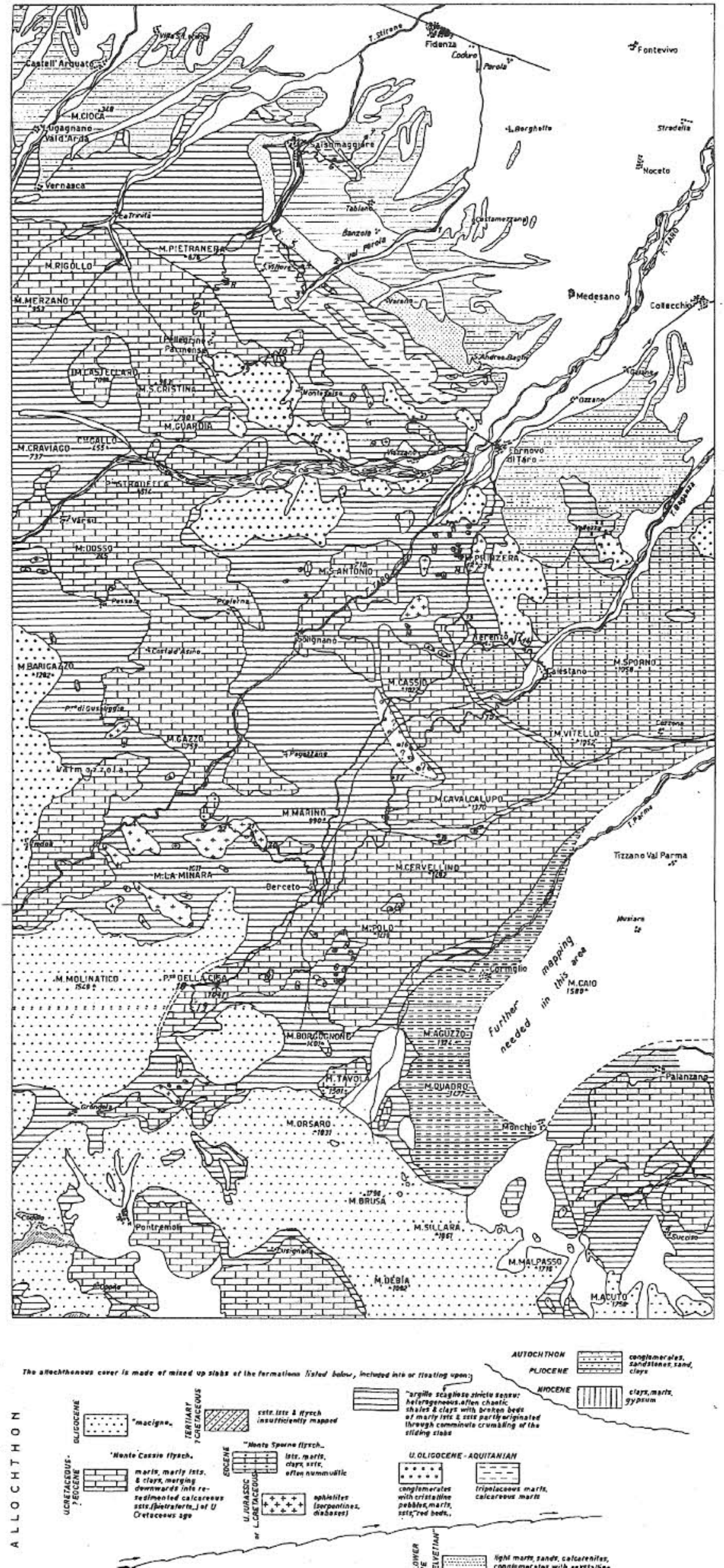
FOR SOURCES SEE GEOLOGICAL SKETCH MAP

ALLOCHTHON: As: "Argille scagliose" ss.: ca. flysch; "Monte Cassio flysch: sp. flysch: Monte Sporno flysch": pf: pietraforte at the base of ca. flysch; σ: ophiolites; ol: oligocene marls & conglomerates.

AUTOCHTHON: Sp: "scisti policromi"; ma: "macigno"; ss: "Serie di Salso; la: "Langhian" helv: "Helvetian"; Tort: "Tortonian"; mess: "Messinian"; Pl: "Pliocene"; Q: "Quaternary." ba.cgl: "Baganza conglomerate"

(for further explanation see geological sketch map)




Castell'Arquato
M.CIOCA
Lugagnano Val d'Arda
Vernasca
Salsomaggiore
Fidenza
Fontevivo
Borghetto
Noceto
M.PIETRANERA
M.RIGOLLO
M.MERZANO
Medesano
Collecchio
M.CASTELLARO
M.S.CRISTINA
M.GUARDIA
M.CRAVIAGO
M.GALLO
Fornovo di Taro
M.DOSSO
M.S.ANTONIO
M.PRINZERA
Solignano
M.BARIGAZZO
M.CASSIO
Calestano
M.SPORNO
M.GAZZO
M.VITELLO
M.CAVALCALUPO
M.MARINO
M.LA MINARA
Berceto
M.CERVELLINO
Tizzano Val Parma
M.POLO
M.MOLINATICO
P.so DELLA CISA
Corniglio
M.CAIO
further mapping needed in this area
M.BORGOGNONE
M.AGUZZO
M.TAVOLA
M.QUADRO
Palanzano
M.ORSARO
Monchio
Pontremoli
M.BRUSÁ
M.SILLARA
M.MALPASSO
M.DEBIA
M.ACUTO
Succiso
The allochthonous cover is made of mixed up slabs of the formations listed below, included into or floating upon:
ALLOCHTHON
OLIGOCENE
"macigno"
TERTIARY ?CRETACEOUS
ssts. lsts & flysch insufficiently mapped
"argille scagliose stricto sensu: heterogeneous, often chaotic shales & clays with broken beds of marly lsts & ssts partly originated through comminute crumbling of the sliding slabs
U.CRETACEOUS-?EOCENE
"Monte Cassio flysch"
marls, marly lsts. & clays, merging downwards into re-sedimented calcareous ssts. (pietraforte) of U Cretaceous age
EOCENE
"Monte Sporno flysch"
lsts, marls, clays, ssts, often nummulitic
U.JURASSIC or L.CRETACEOUS
ophiolites (serpentines, diabases)
U.OLIGOCENE - AQUITANIAN
conglomerates with cristalline pebbles, marls, ssts, "red beds"
tripolaceous marls, calcareous marls
AUTOCHTHON
PLIOCENE
conglomerates, sandstones, sand, clays
MIOCENE
clays, marls, gypsum
light marls, sands, calcarenites,