

THE STRUCTURE OF THE NORTHERN UMBRIAN APENNINES, ITALY¹

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ABSTRACT

De Feyter, A. J. 1982 The structure of the Northern Umbrian Apennines, Italy – *Geol. Mijnbouw* 61: 183-189.

The structure of the Northern Umbrian Apennines is broadly comparable to the structure of the Alta Romagna to the north. Three major tectono-stratigraphic units can be distinguished. The lower two are the Umbrian parautochthon and the Nero unit. The Nero unit, comprising the Alpe della Luna sequence, can be seen as an internal, southwestern part of the parautochthon, that was thrust upon the external parautochthon to the northeast. The Nero unit was overridden from the southwest by the third tectono-stratigraphic unit, the Tuscan nappe. The structure of the area is complicated by the presence of a structural high, which seems to be related to large, north-south running dextral strike slip faults. It overprints a paleo-high, which is the consequence of the southwest-northeast directed Apenninic orogenic compression.

INTRODUCTION

The structure of the Tuscan-Romagnan Apennines has recently been described by TEN HAAF & VAN WAMEL (1979). During the summer of 1979 I investigated the possible continuation of this structure to the south, in the Northern Umbrian Apennines of the Città di Castello-region (Fig. 1). Especially the Nero unit was considered of interest, since it forms such a distinctive tectono-stratigraphic unit between the Tuscan nappe and the Umbrian parautochthon. The results of the investigations are presented in the map and sections of Figs. 2 and 3.

TECTONO-STRATIGRAPHIC UNITS OF THE NORTHERN UMBRIAN APENNINES

Since the tectono-stratigraphic units of the Northern Umbrian Apennines continue in the Tuscan-Romagnan Apennines, the nomenclature of TEN HAAF & VAN WAMEL (1979) is used in this

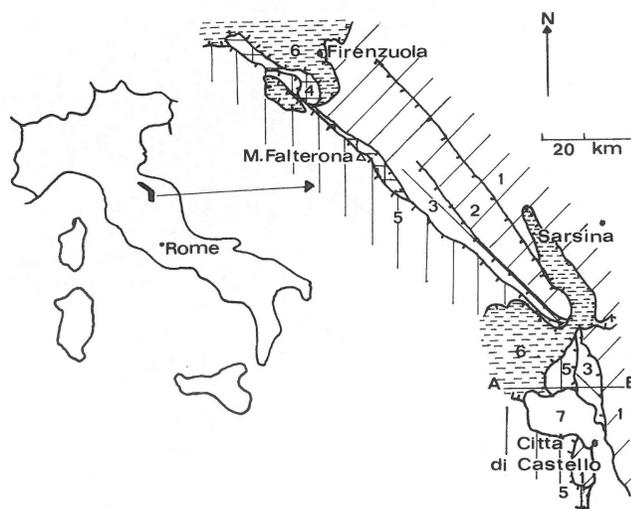


Fig. 1
Tectono-stratigraphic elements of Romagna and Northern Umbria. North of line A-B: After De Jager (1979) and Ten Haaf & van Wamel (1979). South of line A-B: Area investigated by the author. The structure is, however, derived from the Carta Geologica d'Italia (1969). Note the differences with Fig. 2.
1: Romagnan and Umbrian parautochthon; 2: Castellaccio unit; 3: Nero unit; 4: Castel Guerrino-Castiglione unit; 5: Tuscan nappe s.l.; 6: Ligurid allochthon; 7: Quaternary deposits of Valtiberina.

¹Manuscript received: 1981-11-06.

Revised manuscript accepted: 1982-03-26.

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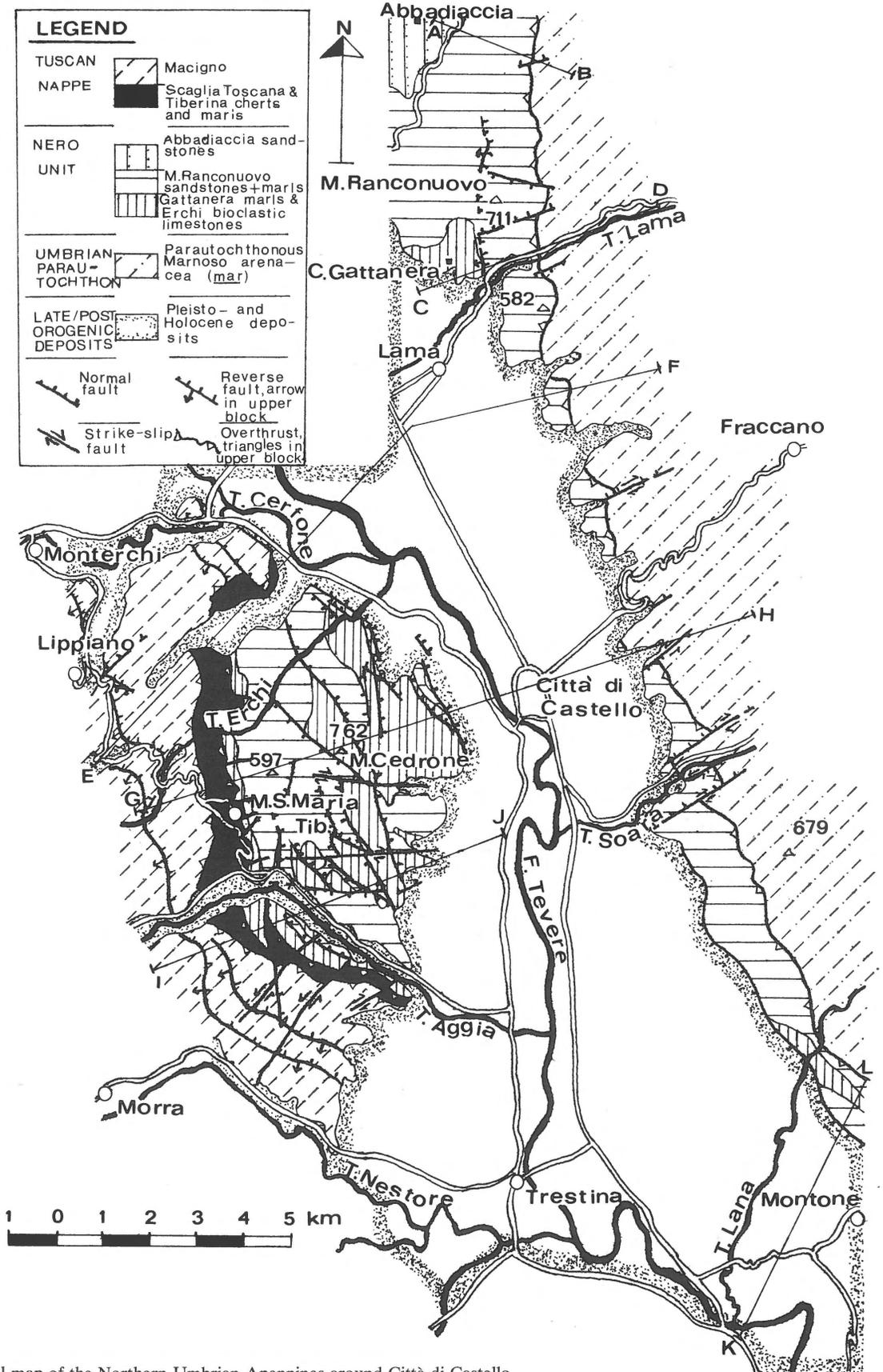


Fig. 2
 Geological map of the Northern Umbrian Apennines around Città di Castello.

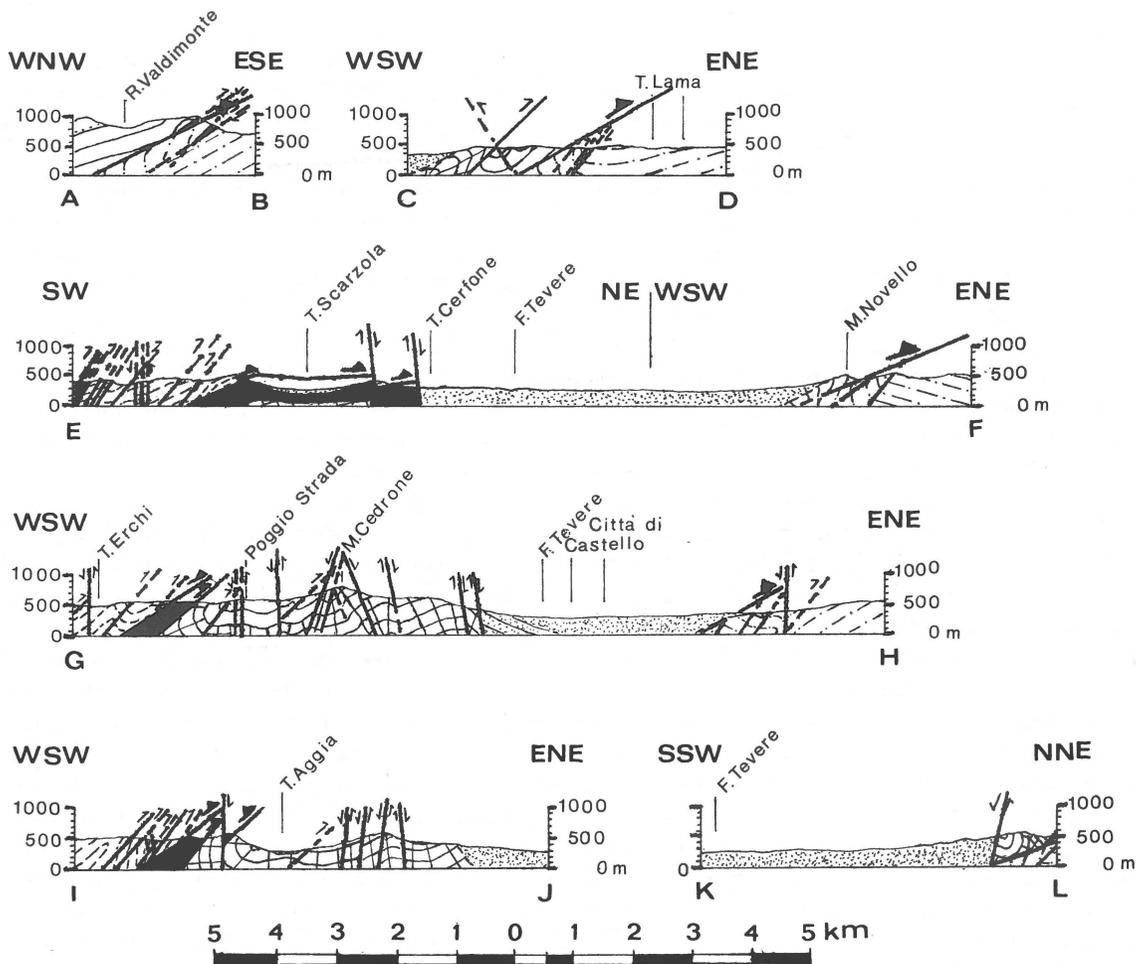


Fig. 3

Sections through the area shown in Fig. 2, but showing more detail. Major tectonic contacts indicated by heavier lines. Legend as in Fig. 2, although the hatching pattern follows the bedding. For Gattanera marls and Erchi bioclastic limestones a second hatching perpendicular to the bedding is added.

paper. The stratigraphic features of the different tectonic units can be summarized as follows:

(1) The Tuscan sequence of the Tuscan nappe has been described from neighbouring areas by MARROCU & PIRINI (1961), NOCCHI (1961) and NOCCHI & CATINELLI (1964). Its basal part consists of the Oligocene heavily tectonized varicoloured shales of the Scaglia Toscana, in which large slabs of the Lower Miocene, more competent Tiberina cherts and marls are tectonically embedded. The upper part consists of the Lower to Middle Miocene Macigno, composed of turbiditic graywackes and marls, with subsidiary calcarenites and limestones. The thickness of the total sequence is at least 1500 metres.

(2) The Nero unit comprises only the Alpe della Luna sequence, within which several formations can be distinguished. The lowermost, Lower Miocene Erchi bioclastic limestones, with subsidiary marls and turbiditic sandstones, attain a thickness of at least 450 metres. The Erchi beds are followed by the Gattanera marls, on the Carta Geologica d'Italia (1969) indi-

cated as Schlier marls, likewise of Early Miocene age. The marls are highly variable in thickness.

On top of these lower units appear approximately 750 metres of Middle Miocene Monte Ranconuovo beds (CEN-TAMORE & JACOBACCI, 1968; MICARELLI, 1969; JACOBACCI ET AL., 1970). They consist of turbiditic arenites and marls, with subsidiary marly limestones, bioclastic limestones and thin, sandy to shaly beds with plant material. They are covered by the Middle Miocene Abbadiaccia sandstones. These were only deposited east of the Tiber (i.e. Tevere) valley, where their thickness is at least 300 metres. Younger units of the Alpe della Luna sequence, not exposed in the Città di Castello region, have been described by TEN HAAF & VAN WAMEL (1979).

(3) The parautochthonous Marnoso-arenacea (*mar*) constitutes the lowest tectono-stratigraphic unit exposed in the Città di Castello region. The *mar*, that was deposited during the Middle Miocene (MICARELLI, 1969), consists of an alternation of turbiditic arenites and marls, with subordinate limestones. Its thickness is at least 1500 metres.

STRUCTURE OF THE CITTÀ DI CASTELLO REGION

Figs. 2 and 3 demonstrate that the Nero unit does not terminate north of Città di Castello (as suggested by the Carta Geologica d'Italia, 1969), but that it can be traced for tens of kilometres to the southeast. The contact between the Nero unit and the Umbrian parautochthon, which is a thrust-plane in the north, can be traced for more than 25 km along the eastern side of the Tiber valley to the south, gradually changing into a reverse fault. The thrust-plane originates from a dislocation on the northeastern limb of an overturned anticline with a southwest dipping axial plane. That brought the Nero unit in northeastern direction on top of the southwestern limb of an overturned syncline with the same orientation of the axial plane, that is still observable in the parautochthon. The amount of overthrusting in the north is probably in the order of a few kilometres, and seems to decrease southward. That might explain the rather small differences in lithology between the Alpe della Luna sequence and the *mar* in the south, compared to the north. Further to the south, in the Perugia region, the parautochthonous *mar* seems to be in direct contact with the overthrusting Tuscan nappe (FAZZINI, 1959; NOCCHI, 1961; DESSAU, 1962). This leads to the conclusion that the Alpe della Luna sequence should be seen as an internal, southwestern part of the Miocene deposits of the Umbrian basin, thrust upon the more external parautochthonous *mar* (Fig. 4). The dislocation between Nero unit and *mar* diminishes in importance towards the south. The same has been observed at the northern termination of this dislocation (Fig. 1; see also DE JAGER, 1979).

The western limit of the outcrops of the Alpe della Luna sequence is formed by the contact with the overthrusting Tuscan nappe, as already observed by PRINCIPI (1928, 1932) and SIGNORINI (1941). However, in more recent Italian publications a stratigraphic contact between the Alpe della Luna sequence and the Tuscan sequence is suggested (MICARELLI, 1969).

The movement of the Tuscan nappe towards the northeast has been facilitated by the shale-rich horizons of the Tuscan sequence, which became heavily tectonized; the shales serving as a lubricant zone for the overthrusting (Scaglia Toscana).

The semi-circular outcrop-line of the thrust-plane, west of the Tiber valley, can be explained as follows:

(1) North of M.S. Maria Tiberina the bending of the – here originally northwest-southeast striking – thrust-plane towards a more southwest-northeastern strike is the consequence of a local tilting of approximately 25° towards the north, probably caused by the downwarping of the Tiber valley depression.

(2) South of M.S. Maria Tiberina a similar bending seems to be present. At first glance one could assume a similar tilting as mentioned above, albeit towards the south. However, the bending of structures related to the overthrusting, such as reverse faults within the Tuscan nappe (Fig. 2), indicates an

original curvature of the thrust-plane here. Instead of the general northeast directed movement of the Tuscan nappe a movement towards the north seems more likely here. In such a situation the minor strike-slip faults along the thrust-plane could have been caused by the glacierlike movement of the Tuscan nappe, during gravitational spreading. This would imply that the front of the Tuscan nappe was not far away. The minimum amount of this overthrusting, which mainly took place during the Late Miocene, is about 5 km. This concept is illustrated in Fig. 5.

As demonstrated in Fig. 2 most structures with a northwest-southeastern strike, that are genetically related to the thrusting, were affected by late tectonic movements, which can be summarized as follows:

(1) Dextral and sinistral strike-slip faulting, especially along the Tuscan thrust-plane, as a result of differential movements of the Tuscan nappe.

(2) Vertical movements, such as the downwarping of the Tiber valley depression and the contemporaneous rising of the neighbouring M. Cedrone- and Alpe della Luna-highs took place during the Late Pliocene to Pleistocene (DESSAU, 1962). The major part of the vertical movements can be attributed to gentle folding. Observations that support this interpretation are the large scale tilting north of M.S. Maria Tiberina, and a north to south widening of the zones with overturned strata along the contact between the Nero unit and the Umbrian parautochthon north of Lama. This contact is assumed to have the form as illustrated in Fig. 6. From this it is obvious that outcrops at level A-B (comparable to the area east of Lama) will display a larger zone with overturned strata than outcrops at level C-D (comparable to the area further north). A tilting of approximately 10° is sufficient to explain this observation. Normal faulting accompanied the downwarping of the Tiber valley depression west of Città di Castello.

(3) Transversal strike-slip faulting is concentrated around M. Cedrone, and east of the Tiber valley around T. Soara. The faults have been active until the Pleistocene. Their relationship with the strike-slip faults along the Tuscan thrust-plane remains unclear.

(4) Normal faulting on the eastern edge of the Tiber valley, observable north of Montone, is attributed to the youngest major faulting phase, that occurred during the Pleistocene. These faults are assumed to be the result of a relative rising of the areas adjacent to the Tiber valley (JACOBACCI ET AL., 1970).

RELATIONSHIP BETWEEN STRUCTURAL AND STRATIGRAPHIC DATA

The generation of the Scaglia Toscana has been discussed

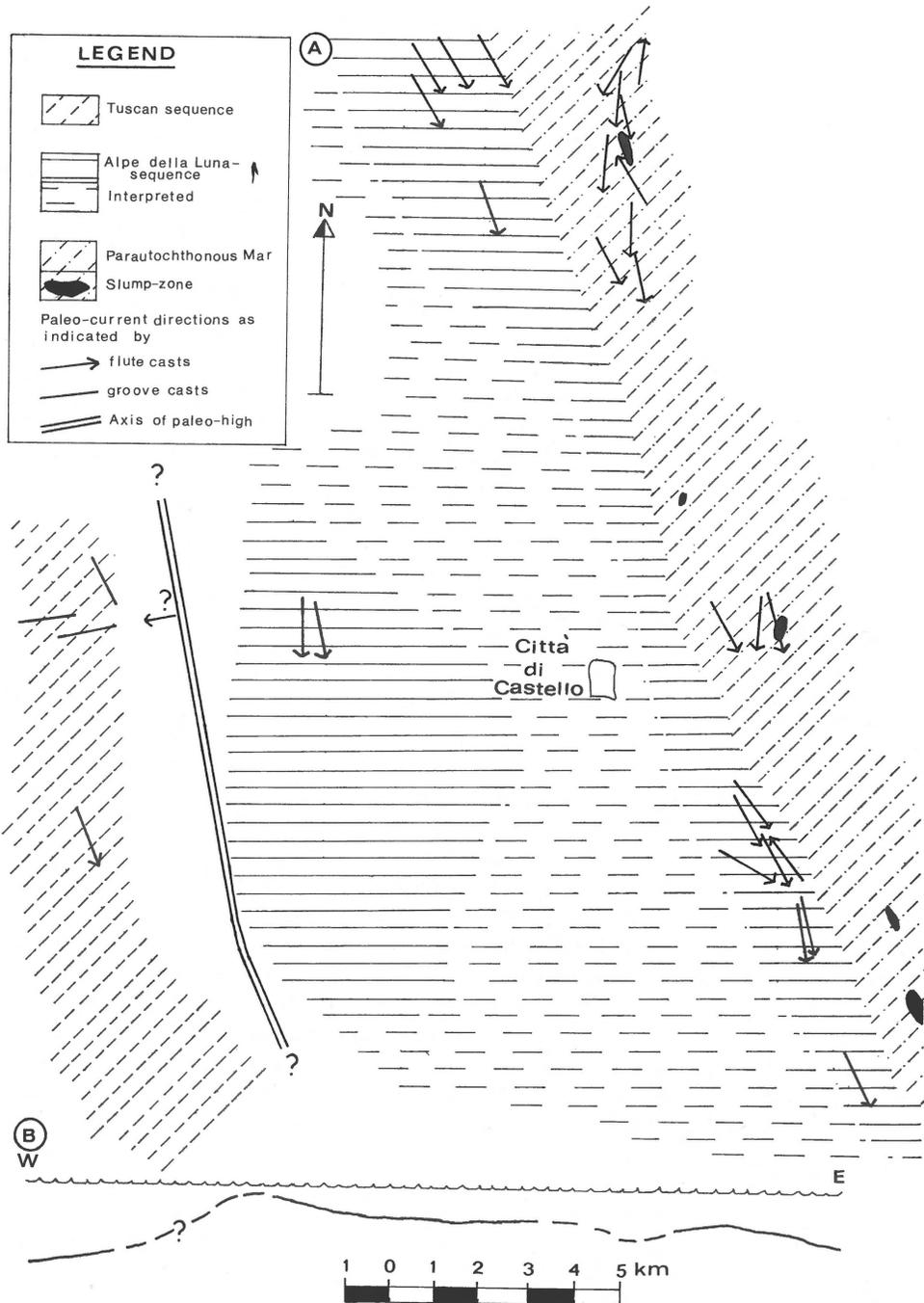


Fig. 4

A. Paleogeographic reconstruction of Northern Umbria, with paleo-current directions. The exact position of the Tuscan basin is uncertain. Furthermore it is not clear whether the Tuscan basin still existed during the deposition of the upper parts of the more eastern sequences (Late Middle Miocene). Città di Castello is shown as a fixed point with respect to the parautochthonous Mar.

B. Schematic cross-section through Fig. 4 A, just south of Città di Castello. From west to east one can see the Tuscan basin, the Tuscan-Umbrian high, and the Umbrian basin. The position of a relatively narrow depression east of the Tuscan-Umbrian high, which is supposed to be the continuation of the depositional environment of the Abbadiaccia sandstones further to the north, is indicated by a discontinuous line.

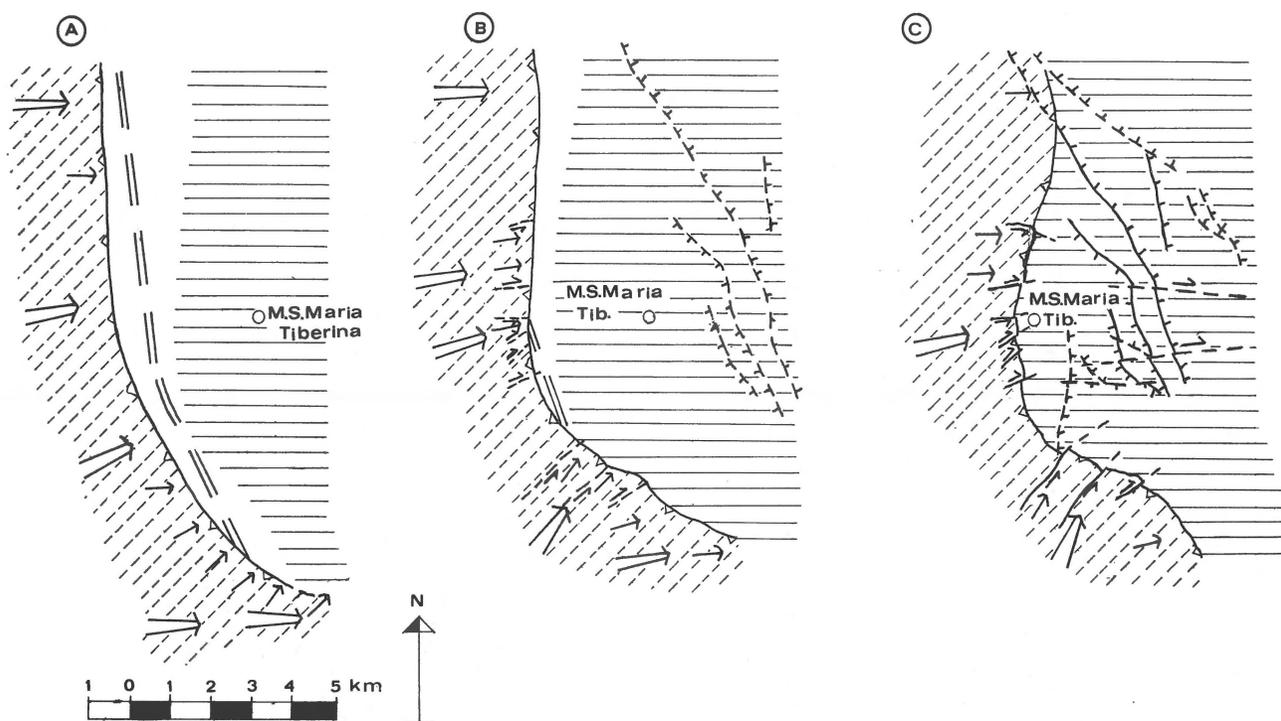


Fig. 5
Different stages in the overthrusting process of the Nero unit by the Tuscan nappe. Fig. 4 A shows the initial stage (Middle Miocene), while Figs 5 A and 5 B illustrate the Late Miocene situation. The axis of the Tuscan-Umbrian high, which decreased in importance during the Late Miocene, is indicated by the discontinuous lines 3 km west of M.S. Maria Tiberina. The movement of the Tuscan nappe is indicated by arrows. The development of major faults is shown as well. Fig. 5 C represents the final overthrusting stage (Late Miocene or Pliocene). M.S. Maria Tiberina is shown as a fixed point with respect to the Alpe della Luna sequence. Legend as in Fig. 4 A.

previously. The relatively competent Tiberina cherts and marls ended up as slabs within the shales. Probably these cherts and marls constituted the stratigraphic base of the Macigno. However, most Italian authors attributed them to the Alpe della Luna sequence and/or Umbrian parautochthon.

Within the Macigno the general direction of turbidity currents was either towards the southeast or towards the northwest, i.e. along the axis of the Tuscan basin. The east-westerly directions measured east of Lippiano (Fig. 4) have to be

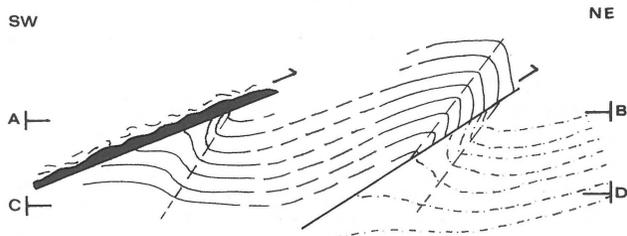


Fig. 6
Simplified cross-section through the major tectono-stratigraphic units. Legend as in Fig. 4 A, although the hatching pattern follows the bedding. Scaglia Toscana and Tiberina cherts and marls are given in black. Line A-B represents the area just north of Lama, while line C-D shows the situation further to the north. Tiber valley depression is not shown.

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explained by assuming deviating turbidity currents, due to the presence of the Tuscan-Umbrian high, that separates the Tuscan basin from the Umbrian (*mar*) basin, to the east.

CENTAMORE ET AL. (1972) considered the Alpe della Luna sequence as a deposit of the Tuscan-Umbrian high, which they located along the line of present structural highs, marked by the M. Acuto- and M. Tezio-windows in the Perugia region (Carta Geologica d'Italia, 1968), and the M. Cedrone- and Alpe della Luna-highs. However, since the Alpe della Luna sequence cannot be considered autochthonous, the paleo-high has to be located several kilometres to the west (Fig. 4). The various lithologies can be explained as due to the presence of such a high. The Erchi bioclastic limestones contain fragments of shallow water organisms and were deposited out of debris flows descending from the high. The relative marly M. Ranconuovo deposits west of the Tiber valley indicate a syn-sedimentary rising of the paleo-high during the Middle Miocene, due to Apenninic orogenic movements. The Abbadiaccia sandstones were deposited in a relatively narrow channel northeast of the paleo-high. Consequently, the Alpe della Luna sequence should not only be seen as a deposit on a paleo-high, but also on its northeastern slope (Fig. 4).

An additional indication of a paleo-slope towards the northeast is the occurrence of large slumps within the *mar* (Fig. 4), that was deposited by longitudinal turbidity currents.

CONCLUSIONS

The Nero unit has a structural position intermediate between the Umbrian parautochthon and the Tuscan nappe. It consists of the Alpe della Luna sequence, which was deposited on the Tuscan-Umbrian high and its northeastern slope.

The presence of structural highs is often attributed to diapirism (DESSAU, 1956), since thick evaporitic series of the Triassic Calcareo Cavernoso underlie the region. However, because the M. Cedrone-high as well as the tectonic windows of the Perugia region display a northwest-southeast elongated dome-form, and as these structural highs and the neighbouring depressions are aligned north-south they can be regarded as second-order drag folds, that are related to important north-south directed primary dextral strike-slip faults in the Tiber valley near Città di Castello. Further to the south such faults may occur in the Tiber valley between Perugia and Todi, as west of Todi northwest-southeast directed elongated tectonic windows have been observed (Carta Geologica d'Italia, 1968). Especially in the Perugia region second-order strike-slip faults occur. All these observations agree very well with the suggestion of important primary strike-slip faults.

Another argument in favour of this idea is the distinct bending of the Bouguer iso-anomalies (especially the 0-isoanomaly) from a – for the Northern Apennines typical – northwest-southeast direction towards a north-south direction in the area under discussion (OGNIBEN ET AL., 1973).

Finally, it has to be emphasized that further work is still required to substantiate the structure proposed and, hopefully, investigations in the area south of Città could provide more evidence.

ACKNOWLEDGEMENTS

I am grateful to Prof. Dr. E. Ten Haaf and Dr. W. A. van Wamel, who encouraged me to publish the results of the Città di Castello fieldwork. Messrs. N. Molenaar and P. Duyndam helped by reviewing the manuscript, and Ms. C. Strolenberg prepared several drawings.

REFERENCES

- Carta Geologica d'Italia 1:100.000, 2nd Ed. (1968) Foglio 122: Perugia.
- (1969) Foglio 115: Città di Castello.
- Centamore, E. & A. Jacobacci 1968 Osservazioni stratigrafiche e tettoniche nei sedimenti miocenici ad oriente del F. Tevere nel F.º 115 'Città di Castello' – Boll. Serv. Geol. d'It. 89: 37-52.
- Centamore, E., A. Jacobacci & G. Martelli 1972 Modello strutturale Umbro-Marchigiano – Correlazioni possibili con le regioni adiacenti – Boll. Serv. Geol. d'It. 93: 155-188.
- De Jager, J. 1979 The relation between tectonics and sedimentation along the 'Sillaro line' (Northern Apennines, Italy) – Geol. Ultraiectina 19: 1-98.
- Dessau, G. 1956 Contributo alla geologia del gruppo di Monte Tezio (Perugia) – Boll. Soc. Geol. It. 56: 20-54.
- 1962 Geologia del Monte Malbe nel quadro dei massicci mesozoici del Perugino – Boll. Soc. Geol. It. 81: 315-364.
- Fazzini, P. 1959 Brevi cenni sui terreni sovrascorsi sulla serie umbra nell'Umbria Nord Occidentale – Boll. Soc. Geol. It. 78: 232-242.
- Jacobacci, A. et al. 1970 Note illustrative della Carta Geologica d'Italia alla scala 1:100.000 Fogli 115 'Città di Castello', 122 'Perugia' e 130 'Orvieto' – Serv. Geol. d'It.: 151 pp.
- Marrocu, R. & C. Pirini 1961 Nota micropaleontologica della serie di Monte Acuto (Perugia) – Boll. Soc. Geol. It. 80: 155-170.
- Micarelli, A. 1969 Studio micropaleontologico e stratigrafico di alcune serie mioceniche affioranti tra il F. Tevere e la catena del M. Nerone – Mem. Soc. Geol. It. 8: 273-287.
- Nocchi, M. 1961 Sui rapporti fra la serie toscana e la serie umbra a sud di M. Acuto e di M. Filoncio (Perugia) – Boll. Soc. Geol. It. 80: 181-246.
- Nocchi, M. & A. Catinelli 1964 Cenni sulla stratigrafia della serie Toscana e della serie Umbra nell'alta Val Tiberina – Boll. Soc. Geol. It. 83: 525-542.
- Ogniben, L. et al. 1973 Structural model of Italy, scale 1:1.000.000 – C.N.R. (Com. Sci. Fis., Com. Sci. Geol. Min.), Roma.
- Principi, P. 1928 Relazione sul rilevamento geologico dei quadranti al 50.000 'Città di Castello' e 'Monterchi' appartenenti al Foglio 115 della Carta Geologica d'Italia – Boll. R. Uff. Geol. d'It. 53: 1-9.
- 1932 Alcune osservazioni sulla costituzione geologica del quadrante al 50.000 'Monterchi' del Foglio 115 della Carta d'Italia – Boll. R. Uff. Geol. d'It. 57: 1-6.
- Signorini, R. 1941 Struttura dell'Appennino tra la Valtiberina e l'Umbinate – Giorn. di Geol. (2) 15: 17-30.
- Ten Haaf, E. & W. A. van Wamel 1979 Nappes of the Alta Romagna. In: W. J. M. van der Linden (ed.): Fixism, mobilism or relativism: Van Bemmelen's search for harmony – Geol. Mijnbouw 58: 145-152.