Tentative Correlation of Palaeozoic Rocks, Italian Peninsula and Islands

G. B. Vai

Summary

A correlation chart of the principal Italian Paleozoic outcrop areas outside the Alps (Fig. 1) on the basis of recent papers and of unpublished personal researches is suggested. The different sequences are grouped according to the main structural units of the Alpine orogeny, i. e.: Apennines and Sicily, Calabro-Peloritan "Massif" and Sardinia. Pre-Flysch, Hercynian Flysch and late to post-Hercynian stages, when recognized, are subdivided within the correlation chart (Fig. 4). Strong tectonic evidence of Hercynian orogeny is present everywhere.

In the Northern Apennines (Fig. 2) we can map now a quite large Tuscan Hercynian "Massif" strongly or completely fragmented and thrusted by the Alpine orogeny. Nevertheless its Hercynian palaeogeographic setting may be tentatively suggested (Fig. 3).

Strong to chaotic Alpine tectonization and lack of knowledge allow only a vague chronologic correlation of the Palaeozoic rocks of the Southern Apennines, the Sicilian Alpine Chain and the Calabro-Peloritan "Massif".

Introduction

Classic Palaeozoic sequences in the Italian area are known for a long time from Sardinia and the Carnic Alps. The Carnic Palaeozoic being continuously investigated from Italian, Austrian and foreign scientists is well correlated with the Standard Stratigraphic Scale and the principal Palaeozoic sequences of the world (see f. i. Flügel and Schönlaub, 1972; Vai, 1975; 1976); it represents the standard for the stratigraphy of the entire Italian Palaeozoic (the Cambrian only excluded). However every attempt to correlate Italian Palaeozoic rocks outcroping outside the Alps with the Carnic Palaeozoic sequence is difficult by the following reasons: (i) the outcrops are scattered and very small (except Sardinia), mostly tectonized and metamorphosed by Hercynian, Alpine or both diastrophism; (ii) little work has been done in important areas (e. g. Sardinia); (iii) there is possibly a strong Lower Palaeozoic biogeographic zonation (disfavouring correlation) owing to pre-Carboniferous mobile setting of the present cluster of Mediterranean microplates (Vai, 1975, 1976).

Within these limits we tentatively suggest a correlation chart of the principal Italian Palaeozoic outcrops outside the Alps on the basis of recent papers and of unpublished personal researches; older data and/or interpretations have been critically integrated as far as possible (Fig. 4). We follow the inferred order of main structural units of the Alpine mountain building (the latest responsible for the present physiographic setting in Italy) i. e.: Apennines and Sicily, Calabro-Peloritan "Massif" and Sardinia (Fig. 1). The standard for the correlation chart is based on the

* Work supported by CNR

Author's address: G. B. Vai, Istituto di Geologia e Paleontologia, Via Zamboni 67, I-40127 Bologna (Italy).

Carnic Alps sequence, which has been summarized by VAI, 1975, 1976; the terminology for stage subdivision within geologic basin evolution adopted in those papers is followed here, too.

1. APENNINES

Palaeozoic rocks crop out to a certain extent only in Southern Liguria, Tuscany and Northern Latium (Fig. 2). Moreover scattered outcrops are recorded from (see Fig. 1):

i) Northern (Ligurian) Apennines, "eugeosynclinal" Polcevera sequence, Sestri-Voltaggio zone, near Genova: quartz porphyr tectonically associated with sericitic schists; inferred Permian age (IBBEKEN, 1963) or possibly older;

ii) Northern (Ligurian-Emilian) Apennines "eugeosynclinal" sequence: alkaline granite boulders (BONATTI, 1933; MERLA, 1933) respresenting tectonic fragments included within Cretaceous-Eocene ophiolitic olistostromes; according to radiometric data of about 300 Ma (EBERHARDT *et al.*, 1962) they are interpreted as Hercynian granites;

iii) Northern (Umbrian) Apennines, "miogeosynclinal" sequence, near Perugia: cloritic schists and phyllites of Verrucano facies in a borehole of about 1700 m depth (GHELARDONI, 1962), undetermined Permo-Triassic age;

iv) Southern (Lucanian) Apennines, Lagonegro Unit II (SCANDONE, 1972), near Potenza: loose boulders of calcarenitic microfacies leading Middle to Upper Permian fusulinids derived from the Mt. Facito formation of Anisian to Ladinian age (the oldest stratigraphic unit cropping out in the Southern Apennines) (DONZELLI and CRESCENTI, 1970); the fusulinids seem to be reworked in a graded sediment whose relation with the enclosing formation is not clear.

SOUTHERN LIGURIA, TUSCANY, NORTHERN LATIUM

We are able to present a first spotty map of a quite large Tuscan Hercynian "Massif". It has been strongly tectonized and variously metamorphosed in Hercynian time before being covered unconformably by the so called "Verrucano s. s." (or Verrucano Group) of Permian ? to Triassic age. Subsequently the Tuscan Hercynian Massif underwent Alpine thrusting with local metamorphism and later block faulting; therefore it is presently only found in discrete nuclei, not larger than some tens of km, in the Apuane Alps, Punta Bianca (near La Spezia), Monte Pisano, Iano (near Volterra), Farma creek (Monticiano-Roccastrada area), Boccheggiano and surrounding area, eastern part of Elba Island, Monte Argentario, and Monti Romani area (Fig. 2).

Apuane Alps

The Apuane Alps represent the highest uplifted and eroded tectonic window of the Northern Apennines. The presently mappable lithostratigraphic sequence is from the bottom (ELTER et al., 1966):

1) "*lower phyllites*" with albitic gneiss lenses
2) *porphyroids* and *porphyritic schists*
3) *quartzites and* "*upper phyllites*" with *schistose* "*Orthoceras*" *dolomite* lenses
4) *conglomerates* and "Grezzoni" Formation

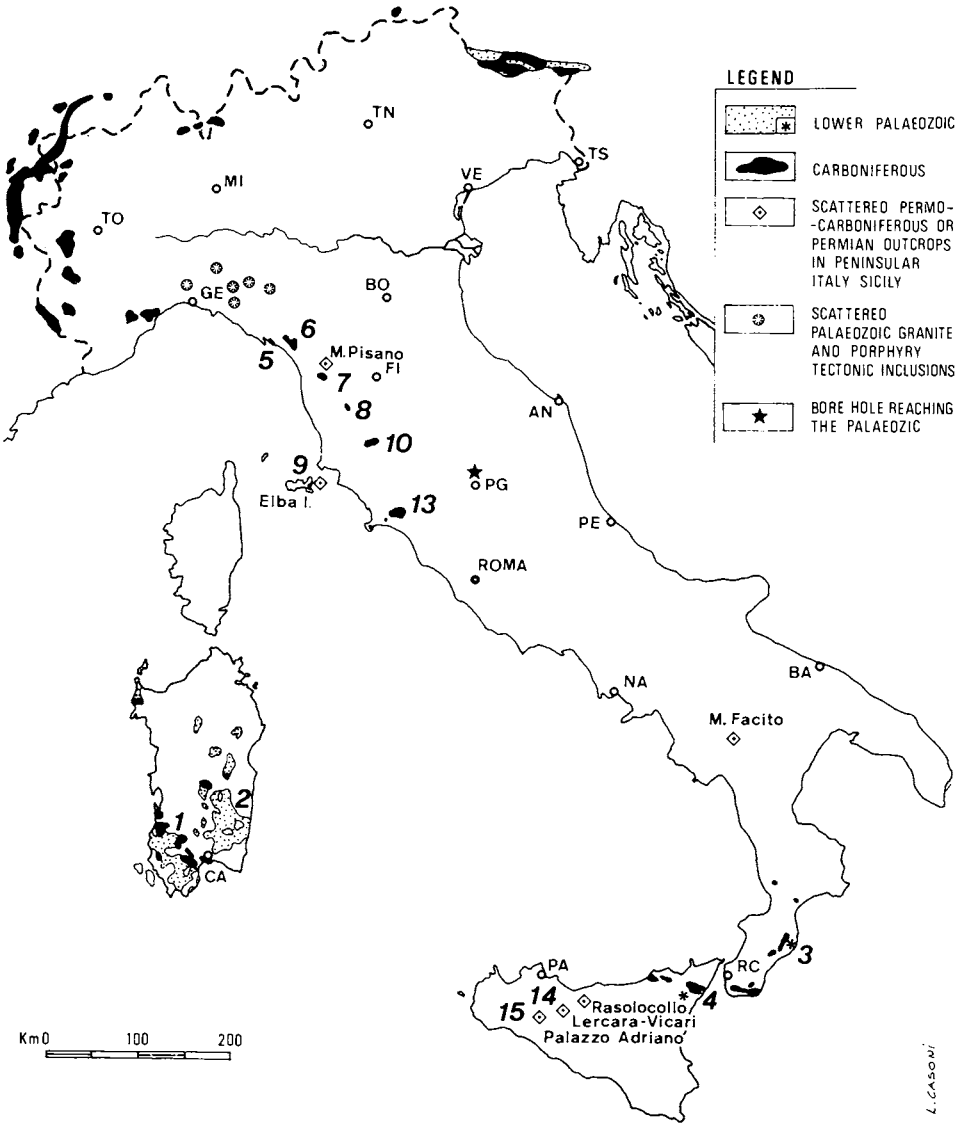

Fig. 1 — Location map of the Palaeozoic rocks in Italian Peninsula and Islands. The ?Permo-Triassic Verrucano Group is excluded. Numbers refer to the stratigraphic sequences of Fig. 4. Lower Palaeozoic and Carboniferous outcrops in the Alps are reported for comparison.

The chronology and structural interpretation of this sequence has been changed by VAI, 1972. He found direct evidence of a former Lower Palaeozoic carbonate platform in several outcrops of the Apuane core. Few of the previously known "*Orthoceras* limestone or calcschist lenses" contain orthoconic and coiled nautiloids, crinoid ossicles, ostracods and a conodont fauna (*Kockelella variabilis* W. etc.) belonging to the "obere *Kockelella* Stufe", indicating a Ludlovian age. Up to now this conodont fauna has only been found in the Frigido River outcrop near Massa; here the conodont bearing unit, about 2 m thick, is locally less metamorphic than the remaining part of the dolomitic sequence reaching a maximum of 12 m.

The dolomitic "*Orthoceras*" lenses, usually epimetamorphic, represent thrust sheets or synsedimentary olistoliths, included within the so called "quartzites and upper phyllites, porphyroids and porphyritic schists". This volcanoclastic formation shows characters of a Flysch unit which can be thought to represent the Hercynian geosynclinal stage, even if direct evidence of its Carboniferous age is not yet available; in any case its age should not be younger than Lower to Middle Carboniferous or than the main regional Hercynian phase. A strong Hercynian diastrophism, associated with metamorphism is shown by microtectonic analysis but is mostly masked by overprinted Alpine metamorphism associated with asymmetrical folding and thrusting.

The volcanoclastic formation enclosing the Silurian carbonate olistoliths is underlain by the "lower phyllites with albitic gneiss" and unconformably overlain by very thin lenses of Verrucano s. s. conglomerate (? Permian to Triassic regression deposits) gradually passing to the Upper Triassic "Grezzoni" Formation. Consequently the late-Hercynian Molasse unit is not represented in this area.

Punta Bianca

Not far from the Apuane core the Palaeozoic sequence of Punta Bianca near La Spezia is built up by arenaceous phyllites (outcropping thickness about 100 m) slightly unconformably overlain by a quite untypical Verrucano Group sequence (200 m). Both units are epimetamorphic.

The repeated carbonate intercalations within the clastic Verrucano Group are peculiar to this area and the M. Brugiana area (NW Apuane); they imply stronger marine influx here. Moreover the Ladinian age of these carbonates (ELTER and FEDERICI, 1964, FEDERICI, 1965) testifies for the Verrucano Group an age range wider than usually assumed during the last years and a certain diachronism of some facies at least. According to G. PISA (pers. comm.) the combined presence of *Diplopora annulata* and *D. annulatissima* should indicate an Upper Anisian (*avisianus*-Zone) to Lower Ladinian age.

This is one of the reasons why we tentatively extend the possible age of the pocket-like basal part of the typical quartz conglomerates (and not only that of the polygenic conglomerates sometimes present below it: e. g. M. Pisano, and possibly Punta Bianca and M. Romani) down to the Permian.

Monte Pisano

Although strongly tectonized and badly exposed the Palaeozoic sequence outcropping here is particularly important. It is subdivided into the following units (RAU and TONGIORGI, 1974):

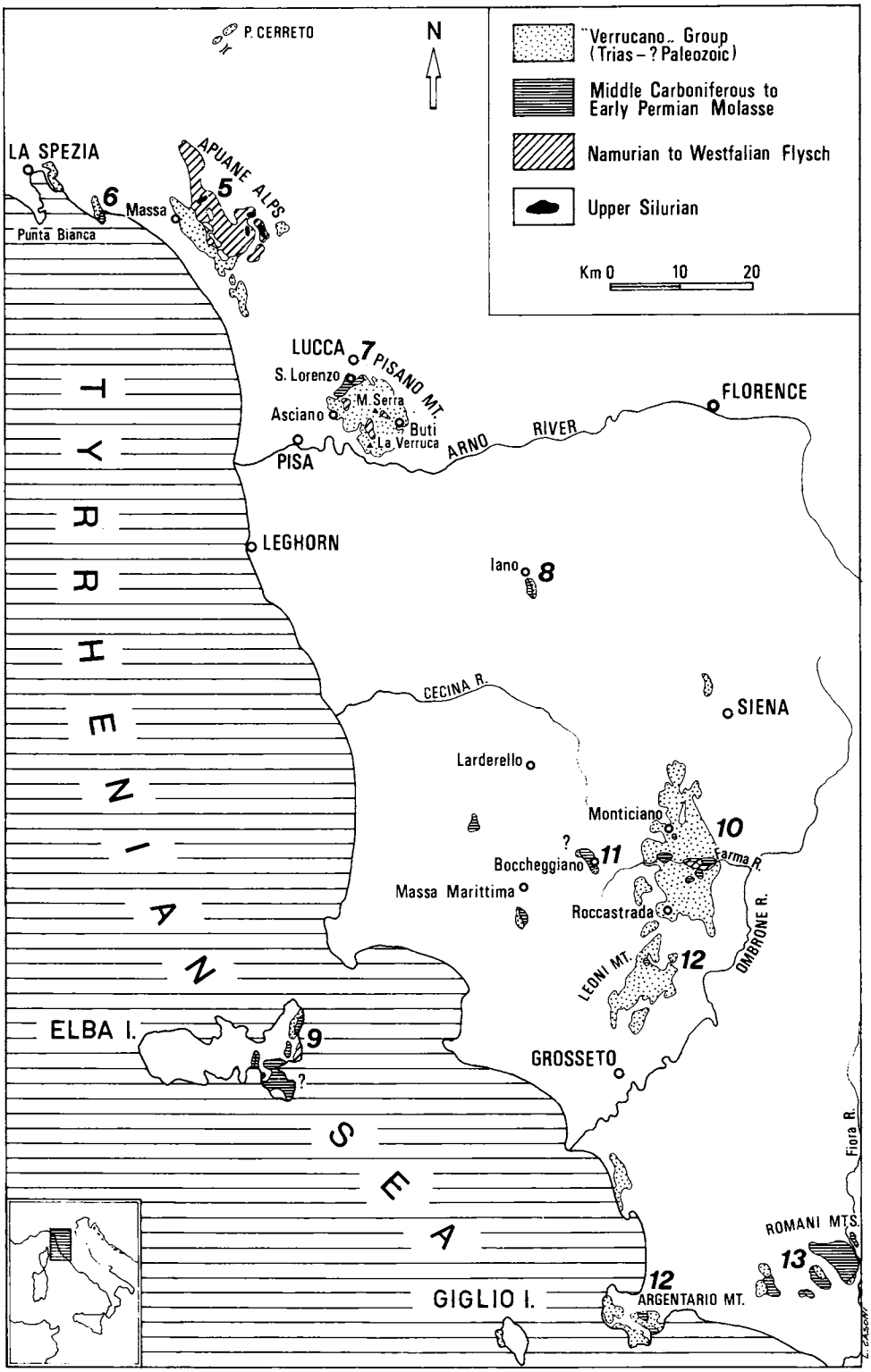

Fig. 2 — Schematic map of the Tuscan Hercynian "Massif".
Pre- and synorogenic, late orogenic, and post-orogenic deposits are subdivided. The Palaeozoic and Triassic units outcropping in southern Liguria, Tuscany and Northern Latium have been formerly referred to Verrucano *sensu lato*.

1) *Buti phyllites and quarzites:* they underwent Hercynian epimetamorphism, radiometrically dated (mineral age) to 275 ± 12 Ma (BORSI *et al.*, 1967), connected with strong tectonization; later on slight Alpine metamorphism overprinted the unit. The Buti formation, like the Apuane quartzites and phyllites, shows turbidite characters and can be regarded as Hercynian synorogenic Flysch (VAI, 1972; VAI in COCOZZA *et al.*, 1974) of undetermined pre-Stephanian Carboniferous age.

2) *San Lorenzo shales*, with minor amount of cross-bedded sandstones, carbonaceous siltstones and thin graphitic beds, often arranged as cyclothems. They contain a rich flora (ranging in age from Cantabrian to Lower Autunian) with rare limnic bivalves, insects and *Estheria*. The unit represents the late orogenic filling of a subsiding limnic or paralic basin. Although the contact with the underlying and overlying units is poorly exposed there is no doubt that the San Lorenzo formation represents a different tectonic stage in comparison with the Buti formation. According to the stratigraphic dating of the San Lorenzo shales the main Hercynian tectonic phase, responsible for the first metamorphic event of the Buti formation, can be approximately correlated with the Leonian event (i.e. an intermediate phase of the Asturian group).

3) *Asciano breccias and conglomerates:* immature often fanglomeratic deposits with clasts mostly derived from the two preceding units. Thickness: 0 to 50—80 m. The unit seems to overly slightly unconformably the San Lorenzo formation; the unconformity is related to Saalian movements and the age of the unit tentatively referred to as Permian by RAU and TONGIORGI, 1974.

The contact with the overlying Verrucano Formation is badly exposed; so we do not know whether the erosional phase between Asciano formation and Verruca Formation is a major one or one of them we can expect in such continental deposits.

4) *Verruca Formation:* continental deposits which consist from bottom to top of the following units: a) basal, pocket-like, residual polygenic conglomerate 0 to 7 m thick of possible Permian to Triassic age; b) coarse quartz conglomerate („anageniti grossolane" of possible Permian to Triassic age; c) violet schists and d) quartzites („anageniti minute"); all these units pass laterally one into the other, particularly a) and b) which can be strongly diachronous.

5) *Monte Serra Quartzites:* in the lower part of the Formation molluscs of Carnian age (RAU and TONGIORGI, 1974) are present.

For the general problem of the Verrucano s. s. (= Verrucano Group) age see above.

Iano

This small outcrop near the top of a late Neogene horst block shows repeated alternations of marine faunas (crinoids, bivalves and possibly brachiopods) with plant remains of Stephanian age (BARSANTI, 1903; MAZZANTI, 1961). The outcropping sequence is built up of weakly metamorphosed shales, mudstone breccias and cross-laminated sandstones of shallow marine deltaic environment; plant debris and some leaves allowing an assignment to the Stephanian A have been found here (VAI and FRANCAVILLA, 1947). The thickness of the unit is some hundred metres, 20 of them outcropping.

This Upper Carboniferous unit is slightly unconformably overlain by the Verrucano Group. A very thin layer of porphyroids or porphyritic schists has been reported from this sequence (BARBERI, 1966).

The Iano outcrop was probably very close to the coast line of the southern Tuscan marine Molasse basin (see below and Fig. 3).

Elba Island

The Upper Palaeozoic sequence here is more complete but severely tectonized in Alpine time with overprinted thermic metamorphism. The following restored sequence of stratigraphic units (belonging to different Alpine tectonic units of the Elba building) can be tentatively proposed:

1) *Ortano formation:* phyllites, sandstones, porphyroids and porphyritic schists. The unit, excluding the thermic overprint, shows stronger metamorphism than the Rio Marina unit (see below). It can be lithostratigraphically correlated with the quartzites, upper phyllites, porphyroids and porphyritic schists of the Apuane Alps.

2) *Rio Marina formation:* slates, sandstones, quartz conglomerates and graphitic layers. The unit, mostly marine, is poorly fossiliferous containing crinoids, molluscs, plant debris and, very rarely, brachiopods and fusulinids (DE STEFANI, 1894; BODECHTEL, 1964; VAI in COCOZZA *et al.*, 1974); its age is mainly Upper Carboniferous (DE STEFANI, 1894), ranging from Westfalian/Stephanian boundary (VAI in COCOZZA *et al.*, 1974: plants) to Lower Permian (KAHLER, 1969: *Parafusulina* of earlier type). Thickness: some hundred m.

Like the equivalent Iano shales this unit should have been deposited very near the coast line.

The M. Calamita schists may represent a more metamorphic equivalent of Rio Marina formation.

3) *Verrucano Group*, slightly unconformably overlying the Permo-Carboniferous Rio Marina unit.

Monticiano-Roccastrada massif (Farma River area)

The Palaeozoic of this sequence has been found quite recently (COCOZZA, 1965; COCOZZA *et al.*, 1974; PASINI, 1974). It is particularly important as it represents the second sequence in the Northern Apennines where platform carbonates of Hercynian pre-Flysch stage are recorded and the first one where Hercynian Flysch deposits are tectonized without appreciable metamorphism.

We have distinguished the following sequence:

1) *Farma formation:* represented by pelitic-arenaceous turbidites of outer fan to basin plain environment with common North to South transport direction. At least one carbonate olistostrome with clasts of oolitic, pelletoidal and micritic limestones is intercalated within the turbidites; some of the clasts contain calcisphaerids, *Tuberitina*, *Profusulinella*, *Pseudostaffella* and *Endothyridae* of Bashkirian age; this fauna predates the Farma turbidites. Other clasts contain spiriferids of possible Dinantian to Upper Devonian age. The olistostrome should derive from a relict structural high area or from a marginal carbonate platform.

The outcropping thickness of the turbidites is at least 200 m.

Both sedimentologically and structurally the unit represents the Hercynian Tuscan Flysch.

2) *Carpineta formation:* shales, slates, sandstones with scattered lenticular carbonate intercalations, often silicified or mineralized. The clastics contain crinoids, rare brachiopods (spiriferids) and molluscs. The carbonates yielded solenoporids, encrusting algae and forams, *Girvanella*, *Epimastopora*, *Archaeolytophyllum missouriensum* J., *Bradyina nautiliformis* (M.), *Endothyra bradyi* M., *Ozawainella* ex gr. *angulata* (C.), *Tetrataxis conica* R., *Tuberitina* sp. p., trilobite and echinoderm fragments, rare gastropods and brachiopods. The age inferred from these fossils is partly Moscovian to ?Permian.

Recently (FERRARI, A. and VAI, G. B.; VAI, G. B. and PERRI, C.; in prep.) corals ("*Neokoninkophyllum*") and conodonts (*Idiognathodus delicatus* GUN.) were found for the first time in a carbonate block probably deriving from this unit. This conodont fauna, associated with the usual fossils of the Carpineta carbonates, may indicate an age from Derryan to Missourian (Middle-Upper Pennsylvanian). The unit seems to be completely marine. It represents a lithostratigraphic and partly time equivalent of the well known Permo-Carboniferous Molasse of the Southern Alps and external Dinarides area (VAI, 1976).

3) *Verrucano Group*, unconformably overlying the Carpineta formation.

Boccheggiano area

The Boccheggiano phyllites (SIGNORINI, 1966; COCOZZA and LAZZAROTTO in COCOZZA *et al.*, 1974a) may represent a more metamorphosed (epizone) equivalent of the Carpineta formation (Farma area, see above). Repeated dolomite and evaporite intercalations are reported in the subsurface (VIGHI, 1966); their age (or ages) and type of contact are uncertain.

The Boccheggiano unit is unconformably overlain by thin, discontinuous lenses of the Verrucano Group or directly by the Tocchi Formation.

Monte Argentario—Monte Leoni

The *M. Argentario sandstones*, carbonaceous shales, slates and phyllites (GELMINI, 1969; GASPERI and GELMINI, 1973), usually less metamorphic than the Boccheggiano phyllites, contain scattered crinoid remains at M. Argentario (VAI in COCOZZA *et al.*, 1974); the depositional environment is shallow marine. The outcropping thickness of the unit exceeds 100 m.

The M. Argentario formation is unconformably overlain by the Verrucano Group, mostly continental to deltaic (thickness 337 m at M. Argentario, about 1000 m in the M. Leoni area).

Monti Romani

The M. Argentario sandstones, carbonaceous shales and slates (and possibly mineralized carbonate lenses) crop out largely here, too, less metamorphic than at M. Argentario, with an outcropping thickness of 300—400 m (GASPERI and GELMINI in COCOZZA *et al.* 1974a).

This Molasse unit is unconformably overlain by a reduced thickness of the Verrucano Group (some to some tens of metres) or directly by the Tocchi Formation; in the Campigliola area the M. Argentario formation is unconformably overlain by the Upper Triassic "Calcare Cavernoso" with intercalated thin residual breccia mostly made of M. Argentario schists and sandstones.

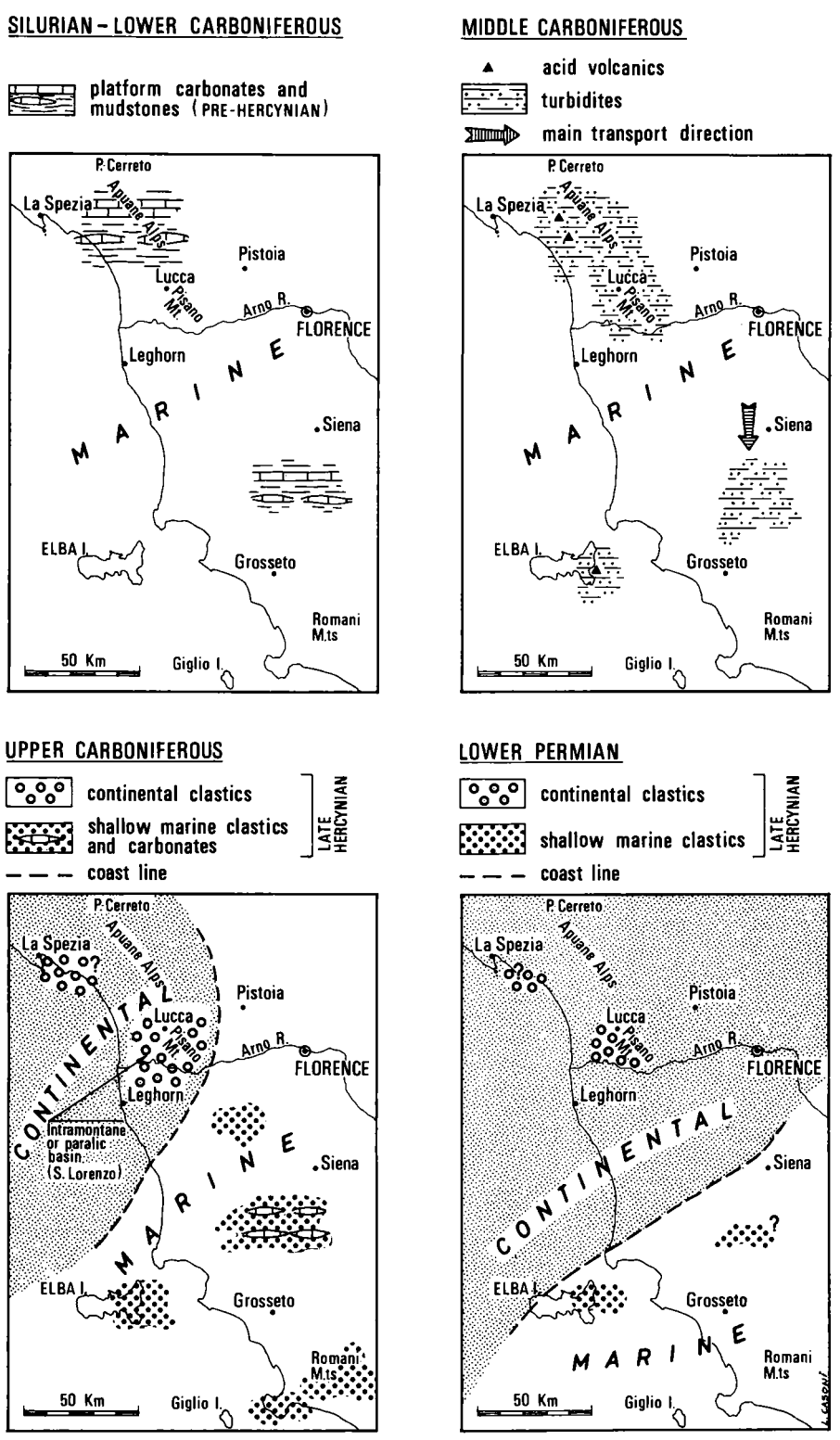

Fig. 3 — Palaeographic elements of the Tuscan Hercynian basin during Silurian to Lower Carboniferous, Middle Carboniferous, Upper Carboniferous and Lower Permian (plotted on present geographic base). Undifferentiated continental areas: finely dotted.

The data listed above for the different Northern Apennines sequences (see also Figs. 4 and 2) allow a first attempt to plot the paleogeographic elements for the Silurian-Lower Carboniferous, Middle Carboniferous, Upper Carboniferous and Lower Permian of the Tuscan area (Fig. 3) on the basis of the present geographical setting. The basic stratigraphic-structural settings involved in this reconstruction are pre-Flysch, Hercynian Flysch and late Hercynian Molasse units.

2. Sicily

The present section refers to the Sicilian Alpine belt as distinct from the Calabro-Peloritan "Massif".

The famous richly fossiliferous Sosio Permian and related outcrops represent a swarm of ?Upper Carboniferous to Middle Permian carbonate and clastic olistoliths and/or thrust sheets chaotically embedded in or sometimes separated only by thin Miocene mudstone layers. The principal outcropping areas are: 1) Palazzo Adriano (Sicani Mts., near Sosio River); 2) Lercara-Vicari; 3) Rasolocollo (between Madonie and Termini Imerese Mts.)

In the Palazzo Adriano area the classic Sosio fauna (fusulinids, ammonoids, etc.) is thought to represent the Middle Permian (Guadalupian) (Kahler, 1974; Pasini, 1964; Skinner and Wilde, 1966; etc.).

The Lercara-Roccapalumba surface and subsurface sequence (Caflisch and Schmidt di Friedberg, 1967) includes:

1) oolithic and pseudoolithic limestones with ostracods of probable Carboniferous age (according to Mascle and Termier, 1970 and to Ruggieri and Di Vita, 1972 the most probable age of the unit is Lower Permian)

2) mudstones and calcarenites with fusulinids and other fossils of undetermined Permian age; according to Furnish and Glenister (fide Skinner and Wilde) Lower Permian is also represented here;

3) carbonaceous sandstones;

4) Upper Triassic Mufara Formation with *Halobia* limestone.

Recently Corradini and Olivieri 1975 found one *Neogondolella* of probable Permian age in dark limestone Museum blocks from the Lercara area.

The whole Palaeozoic of the Sicilian Alpine belt needs detailed biostratigraphic study.

The structural relation between this Palaeozoic and the enclosing rocks is mainly explained by the following ways: i) Permian or Triassic "Wildflysch" reworked by Miocene olistostrome; ii) intrabasinal thrust sheets upon Middle Miocene clay, partly interposed between the sheets (Caflisch and Schmidt di Friedberg, 1967); iii) Miocene "Sicilide" olistostrome (Ruggieri and di Vita, 1972).

3. Calabro-Peloritan "Massif"

Calabride units include Palaeozoic para- and orthometamorphites underlying Mesozoic carbonates. They crop out in Calabria (Coastal Range, Sila, Serre and Aspromonte) and Sicily (Peloritani Mountains).

One of these Calabride units, the so called "Galati Nappe" (see Ogniben, 1975) presents at its stratigraphic base slightly metamorphic (anchizone to epizone) clastics and carbonates with rare Devonian fossils:

1) in *Calabria* (Stilo-Pazzano area) Afchain 1970 reports tentaculitids (determined as probable *Styliolina* by H. Lardeux) from the slightly metamorphosed

nodular limestone. These pelagic forms were abundant during Middle to early Upper Devonian.

A similar limestone in the same area yielded *Palmatolepis perlobata perlobata* U. and B. and other conodonts indicating an Upper Devonian (L. Famennian) age (DE CAPOA BONARDI, 1970).

From the same area GÖRLER and IBBEKEN 1970 report corals, bryozoans, crinoids, orthoconic and coiled cephalopods, trilobites and ostracods, in addition to tentaculitids, indicating most probably Middle Devonian and possibly Silurian to Upper Devonian age.

The sequence is severely tectonized and built up of slightly metamorphosed shales, nodular limestones (containing the badly preserved fauna) plus greywackes (of undetermined age); it covers the Calabria (Serre) crystalline massif being nonconformably overlain by Miocene clastics or by ?Triassic palaeosoil and Mesozoic carbonates.

2) in Sicily (south-central Peloritani Mts., Randazzo-Floresta road) TRUILLET, 1969—70, found and figured pelagic tentaculitids, identical with those of AFCHAIN, 1970, from limestones at the base of the "upper phyllites" with acidic to intermediate volcanics.

Some more or less metamorphic sequences of the Calabria "Massif" were referred too as Carboniferous or older being metamorphosed or cut by late Hercynian granitoid intrusions of radiometric age ranging about 283—264 Ma (BORSI and DUBOIS, 1968). Other "Palaeozoic", "Permo-Carboniferous" or "pre-Mesozoic" age assignments have been made on the base of structural-stratigraphic relationship but without any direct fossiliferous evidence (e. g. DUBOIS, 1970; COLONNA and ZANETTIN L., 1972; COLONNA *et al.*, 1973; PICCARRETTA *et al.*, 1973, BONARDI *et al.*, 1974; etc.).

4. SARDINIAN MASSIF

Many review papers dealing with the Palaeozoic stratigraphy or geology of Sardinia have been published recently (e. g. COCOZZA and JACOBACCI, 1975; SCHNEIDER, 1974). However, they mostly summarize older papers integrating them with the results of new researches which are usually scattered both stratigraphically and areally (CALVINO, 1961; ALBERTI, 1963; POLL, 1966; BOSELLINI and OGNIBEN, 1968; OLIVIERI, 1970; SERPAGLI, 1971; SCHNEIDER, 1972, 1974; MINZONI, 1972; HELMCKE, 1973; HELMCKE and KOCH, 1974; VAI and COCOZZA, 1974; etc.). Much routine work (exemplified by the monograph of RASETTI, 1972) is needed now for reaching an up to date framework of the whole, relatively large outcropping Sardinian Palaeozoic.

Therefore we give here only a short list of the principal fossiliferous horizons whose determination is sufficiently liable to chronologic correlation (numbers refer to the correlation chart of Fig. 4).

Cambrian (RASETTI, 1972) (about 700—1400 m):

— 1) Nebida Fm. („Arenarie") 100—800 m, Matoppa Mb.: early Lower Cambrian trilobites (*Hebedescina*, *Iglesiella*), molluscs (*Stenothecoides*), lingulids and archaeocyathids (DEBRENNE, 1972).

— 2) Nebida Fm., Punta Manna Mb.: early Lower Cambrian trilobites (*Anadoxides*, *Dolerolenus*, *Giordanella*, *Sardoredlichia*), archaeocyathids, algae, sponges, brachiopods and molluscs.

— 3) Nebida Fm., Punta Manna Mb.: early Lower Cambrian trilobites (*Enantiaspis, Dolerolenus, Nebidella*) and the same fauna as mentioned above.
— Gonnesa Fm. ("Metallifero") 200—800 m.
— 4) Cabitza Fm. (120—340 m), nodular limestone mb. ("calceschisti"): early Middle Cambrian trilobites (*Pardailhania, Corynexochus, Paradoxides, Peronopsis*, etc.), hyolithids.
— 5) Cabitza Fm., Cabitza shale Mb.: Middle Cambrian trilobites (*Paradoxides* cf. *mediterraneus, Conocoryphe, Ctenocephalus, Jincella*, etc.), brachiopods and echinoderms.
— Gentle Sardic folding phase

Ordovician (about 300—500 m):

— Nebida and Fluminimaggiore conglomerate (SW Sardinia). ?San Vito sandstones (SE Sardinia).
— 6) Sandy shales or slates (Iglesiente, Trexenta) (250—400 m): above rare phyllocarids, brachiopods and trilobites (asaphids and trinucleids) scattered in the middle part of the unit, a rich fauna ranging through most of the Caradocian is present in the upper part. It includes: trilobites (*Deanaspis, Dalmanitina*, etc.) (Vai unpubl.), brachiopods (*Heterorthis, Svobodaina, Strophomena, Leptaena, Rafinesquina, Porambonites, Nicolella, Leptestiina, Aegiromena*, etc.) (Vai unpubl.), bryozoans (*Chasmatoporella*) (Spjeldnaes, 1967) etc., cystoids (*Corylocrinus, Oocystis, Heliocrinites*))(Maccagno, 1965), crinoids, benthic tentaculitids, gastropods, conularids (*Exoconularia, Archeoconularia*) (Serpagli, 1970) and chitinozoans (Laufeld, 1974).

Shales and nodular limestone ("Cystoideenkalk" of Teichmüller, 1931) (SE Sardinia): Upper Ordovician (probably Lower Caradoc) conodonts (*Amorphognathus* cf. *twaerensis* B.), crinoids, cystoids and brachiopods (Helmcke and Koch, 1974).
— Direct evidence of Ashgill is still lacking.

Silurian (about 70—100 m):

— 7) Black shales and chert (SE Sardinia): Lower Llandovery graptolites (*Akidograptus acuminatus* (N.), *A. ascensus* D., etc.) of Zone 16 (Helmcke and Koch, 1974).
— 8) Black shales and chert (SE Sardinia): complete sequence of Upper Llandovery to Lower Ludlow graptolite Zones (Gortani, 1922a; Jaeger, 1973; Helmcke, 1973).
— Further Llandovery and Wenlock graptolites reported by older authors (Taricco, 1922; Gortani, 1922), even though needing revision, are most probably present throughout southern Sardinia.
— 9) "*Orthoceras*" limestone (SW Sardinia): uppermost Wenlock to Upper Ludlow conodonts of *sagitta* to *siluricus* Zone of Walliser (Serpagli, 1971).

Devonian (about 100—400 m):

— 10) Black graptolitic shales (SE Sardinia): Gedinnian (Lower Lochkovian) graptolites (*M. uniformis* P., etc.) of the *uniformis* Zone (Helmcke, 1973).
— 11) Black graptolitic shales (SE Sardinia): Gedinnian (Middle Lochkovian) graptolites (*M.* cf. *praehercynicus* J., *M. aequabilis* P.) of the *praehercynicus* Zone (Helmcke, 1973).
— 12) Shaly limestone (SW Sardinia): ?Gedinnian (Upper Lochkovian) pelagic tentaculitids (*Paranowakia intermedia* (B.), *N. acuaria* (R.) (Vai in Cocozza *et al.*, 1974b).

— 13) Nodular limestones and shales (SE Sardinia): Siegenian to Emsian (Pragian to Zlichovian) pelagic tentaculitids (*N. acuaria* (R.), *N. gemündina* R.), trilobites and conodonts (ALBERTI, 1963).
— 14) Styliolinid limestone (SE Sardinia): Upper Eifelian conodonts (*Icr. symmetricus* B. and M., *Pol. linguiformis* H., *Pol. webbi* S.) (ALBERTI, 1963).
— 15) "*Clymenia*" limestones (SE Sardinia): Upper Frasnian to Lower Tournaisian complete sequence of conodont zones from *Pa. triangularis* to *Ps. tri. inaequalis* Zone (OLIVIERI, 1970).
— Limestones with Upper Devonian conodonts (*Palmatolepis)* are reported also from SW Sardinia (LEONE, 1973).

Carboniferous (800—1000 m or more) and Permian
— For the carbonatic Dinantian following continuously the Upper Devonian limestones see above (15).
— Unfossiliferous turbidites and possibly other clastics and volcanics (= "Postgotlandiano") (VAI and COCOZZA, 1974).
— Strong Hercynian orogenic and metamorphic phase (or phases)
— 16) San Giorgio clastics and dolomites (SW Sardinia): Westfalian/Stephanian to Upper Stephanian flora (COCOZZA, 1967; FRANCAVILLA in COCOZZA *et al.*, 1974b) and palynomorphs (DEL RIO, 1973).
— Clastics and volcanics with Permian floras (late Hercynian movements and magmatism) (VARDABASSO, 1966; COCOZZA *et al.*, 1974b; FAZZINI *et al.*, 1974).

Recalling the scattered type of research carried out in Sardinia, the list of well documented fossiliferous horizons or intervals given above shows a practically continuous Palaeozoic sequence in both western and central eastern Sardinia (VAI and COCOZZA, 1974; HELMCKE and KOCH, 1974). The depositional continuity is proved to be broken only by two major gaps and related unconformities: i) the gentle Sardic folding phase and ii) the main Hercynian overthrusting phase (or phases) responsible for most of the present tectonic and metamorphic setting.

Other unconformities or disconformities reported by the authors within this interval are not supported by direct stratigraphic evidence and in some cases stem from lack of data "knowledge gaps". Such a lot of "at least local unconformities" claimed by the authors may be explained by the selective small scale overthrusting tectonics involving the thin Siluro-Devonian mudstone-limestone sequence (e. g. cross section of Fig. 1 in SERPAGLI, 1971; Fig. 3 in HELMCKE, 1973). As a consequence Siluro-Devonian sheets or lenticular tectonic bodies are dispersed within Carboniferous ("Postgotlandiano") or subordinately thicker Ordovician clastic sequences.

Of course the present interpretation requires that the Hercynian orogeny had played the main role in the structural building of Sardinia.

References

AFCHAIN, C. (1970): Présence de Tentaculitidae démontrant l'âge dévonien des niveaux calcaires intercalés dans les "phyllades" du substratum du chaînon calcaire de Stilo-Pazzano (Calabre méridionale, Italie). — C. R. Somm. Soc. Géol. Fr., **5**, 150—151, Paris.

ALBERTI, G. (1963): Sul Devonico inferiore e medio nella Sardegna meridionale. — Acc. Naz. Lincei, Rend. Sc. fis. mat. nat., **34**, 553—559, Roma.

Barberi, F. (1966): I porfiroidi della Toscana e la loro posizione stratigrafica. — Atti Symp. Verrucano, Soc. Tosc. Sc. Nat., 34—54, Firenze.
Barberi, F., Dallan, L., etc. (1969): Note illustrative della Carta Geologica d'Italia. Foglio 126 Isola d'Elba. — Serv. Geol. It., 41p., Roma.
Barsanti, L. (1903): Contribuzione allo studio della flora fossile di Iano. — Atti Soc. Tosc. Sc. Nat., Mem., 19, 1—36, Firenze.
Bodechtel, J. (1964): Stratigraphie und Tektonik der Schuppenzone Elbas. — Geol. Rundschau, 53, 25—41, Stuttgart.
Bonardi, G., Perrone, V. and Zuppetta, A. (1974): I rapporti tra "metabasiti", "filladi" e "scisti micacei" nell'area tra Paola e Rose (Calabria). — Boll. Soc. Geol. It., 93, 245—276, Roma.
Bonatti, S. (1933): Studio petrografico dei graniti della formazione ofiolitica appenninica. — Boll. Serv. Geol. It., 58 (7), 12—64, Roma.
Borsi, S. and Dubois, R. (1968): Données géochronologiques sur l'histoire hercynienne et alpine de la Calabre centrale. — C. R. Acad. Sc., 266 (sér. D), 72—74, Paris.
Bosellini, A. and Ogniben, G. (1968): Ricoprimenti ercinici in Sardegna. — Ann. Univ. Ferrara, 1 (1), 1—15, Ferrara.
Caflisch, L. and Schmidt di Friedberg, P. (1967): Un contributo delle ricerche petrolifere alla conoscenza del paleozoico in Sicilia. — Boll. Soc. Geol. It., 86, 537—551, Roma.
Calvino, F. (1961): Lineamenti strutturali del Sarrabus-Gerrei. — Boll: Serv. Geol. It., 81, 489—556, Roma.
Cocozza, T. (1965): Il Carbonifero nel gruppo Monticiano-Roccastrada (Toscana). — Ric. Sc., 35 (II-A), 488—523, Roma.
Cocozza, T. (1967): Il Permo-Carbonifero del bacino di San Giorgio (Iglesiente, Sardegna sud-occidentale). — Mem. Soc. Geol. It., 6, 607—642, Roma.
Cocozza, T., Lazzarotto, A. and Vai, G. B. (1974): Flysch e molassa ercinici del Torrente Farma (Toscana). — Boll. Soc. Geol. It., 93, 115—128, Roma.
Cocozza, T., Gasperi, G., Gelmini, R. and Lazzarotto, A. (1974a): Segnalazione di nuovi affioramenti paleozoici (Permo-Carbonifero?) a Boccheggiano e tra Capalbio e i Monti Romani (Toscana meridionale-Lazio settentrionale). — Boll. Soc. Geol. It. 93, 47—60, Roma.
Cocozza, T., Jacobacci, A., Nardi, R. and Salvadori, I. (1974b): Schema stratigrafico-strutturale del massiccio sardo-corso e minerogenesi della Sardegna. — Mem. Soc. Geol. It., 13, 85—186, Roma.
Cocozza, T. and Jacobacci, A. (1975): Geological outline of Sardinia. — In: Squyres C., Ed., Geology of Italy. — E. S. S. L. A. R., Tripoli 49—81, Tripoli.
Colonna, V., Lorenzoni, S. and Zanettin Lorenzoni, E. (1973): Sull'esistenza di due complessi metamorfici lungo il bordo sud-orientale del massiccio "granitico" delle Serre (Calabria). — Boll. Soc. Geol. It., 92, 801—830, Roma.
Colonna, V. and Zanettin Lorenzoni E. (1972): Gli scisti cristallini della Sila Piccola. 2°: I rapporti tra la formazione delle filladi e la formazione delle pietre verdi nella zona di Gimigliano. — Mem. Soc. Geol. It., 11, 261—292, Roma.
Corradini, D. and Olivieri, R. (1975): *Langeites siciliensis* n. sp., a polychaete jaw apparatus from the permo-carboniferous of northwestern Sicily. — Boll. Soc. Pal. It., 13, 156—163, Modena.
Debrenne, F. (1972): Nouvelle faune d'Archéocyathes de Sardaigne. — Ann. de Paléont., 58, 12—22, Paris.

De Capoa Bonardi, P. (1970): Segnalazione di una fauna a Conodonti del Devonico superiore nei calcari intercalati alle "filladi" di Stilo-Pazzano (Calabria meridionale). —Rend. Acc. Sc. Fis. Mat., Soc. Naz. Sc. Lett. Arti, Napoli, Ser. 4, 37, 127—128, Napoli.

Del Rio, M. (1973): Palinologia di un livello "permo-carbonifero" del bacino di S. Giorgio (Igliesiente, Sardegna sud-occidentale). — Boll. Soc. Geol. It., 92, 485—494, Roma.

De Stefani, C. (1894): Decouverture d'une faune paléozoique à l'Ile d'Elba. — Bull. Soc. Géol. Fr., sér. 3, 22, 30—33, Paris.

Donzelli, G. and Crescenti, U. (1970): Segnalazione di una microbiofacies permiana, probabilmente rimaneggiata, nella formazione di M. Facito (Lucania occidentale). — Boll. Soc. Nat., Napoli, 79, 59—75, Napoli.

Dubois, R. (1970): Phases de serrage, nappes de socle et métamorphisme alpin à la jonction Calabre-Apennin: la suture calabro-apenninique. — Rev. Géog. Phys. Géol. Dyn., sér. 2, 12, 221—253, Paris.

Eberhardt, R., Ferrara, G. and Tongiorgi, E. (1962): Détermination de l'âge absolu des granites allochtones de l'Apennin septentrionale. — Bull. Soc. Géol. France, 4, 666—667, Paris.

Elter, P. and Federici, P. R. (1964): Sulla presenza di terreni attribuibili al Trias medio nel promontorio orientale del Golfo della Spezia. — Boll. Soc. Geol. It., 83, 395—402, Pisa.

Elter, P., Giglia, G., Rau, A. and Tongiorgi, M. (1966): Il Verrucano della Verruca (Monti Pisani) nel quadro delle serie del Carbonifero, del Permiano e del Trias della Toscana settentrionale. — Atti Symp. Verrucano, Soc. Tosc. Sc. Nat., 3—33, Firenze.

Fazzini, P., Gasperi, G. and Gelmini R. (1944): Ricerche sul Verrucano. 2. Le successioni basali dei "Tacchi" tra Escalaplano e Jerzu (Sardegna sud-orientale). — Boll. Soc. Geol. It., 93, 221—243, Roma.

Federici, P. R. (1965): Nuove conoscenze sul Trias medio di Punta Bianca (Golfo della Spezia). — Boll. Soc. Geol. It., 84, 323—329, Pisa.

Flügel, H. and Schönlaub, H. P. (1972): Geleitworte zur stratigraphischen Tabelle des Paläozoikums von Österreich. —Verh. Geol. B.-A., 1972 (2), 187—198, Wien.

Gasperi, G. and Gelmini, R. (1973): Ricerche sul Verrucano. I. Il Verrucano del M. Argentario e dei Monti dell'Uccellina in Toscana. — Boll. Soc. Geol. It., 92, 115—140, Roma.

Gelmini, R. (1969): Ricerche geologiche nel gruppo di Monte Leoni (Grosseto, Toscana). — Mem. Soc. Geol. It., 8, 765—796, Roma.

Ghelardoni, R. (1962): Stratigrafia e tettonica del Trias di M. Malbe presso Perugia. — Boll. Soc. Geol. It., 81 (3), 247—256, Roma.

Görler, K. and Ibbeken, H. (1970): Erste Fossilfunde in den Metamorphiten des Kalabrischen Massivs (Süd-Italien). — N. Jb. Geol. Paläont., Mh., 1970 (7), 424—426, Stuttgart.

Gortani, M. (1922): Faune paleozoiche della Sardegna. Parte I. Le Graptoliti di Goni. — Palaeontographia Ital., 28, 41—67, Pisa.

Gortani, M. (1922a): Faune paleozoiche della Sardegna. Parte II. Graptoliti della Sardegna Orientale. — Palaeontographia Ital., 28, 85—112, Pisa.

HELMCKE, D. (1973): Schichtgebundene NE-Metall- und F-Ba-Lagerstätten im Sarrabus-Gerrei-Gebiet, SE-Sardinien. II. Bericht: Zur Stratigraphie des Silur und Unterdevon der Lagerstättenprovinz Sarrabus-Gerrei. — N. Jb. Geol. Paläont., Mh. **1973**, 529—544, Stuttgart.

HELMCKE, D. and KOCH, G. (1974): Schichtgebundene etc. III. Bericht: Zur Altersstellung der Porphyroide in der Lagerstättenprovinz Sarrabus-Gerrei. — Z. Dtsch. Geol. Ges., **125**, 91—98, Hannover.

IBBEKEN, H. (1963): Su un affioramento di porfido quarzifero permiano nella zona Sestri-Voltaggio (Alessandria). — Boll. Soc. Geol. It., **82** (2), 173—178, Roma.

JAEGER, H. (1973): The discovery of a late Silurian/early Devonian graptolitic sequence of Thuringian type in Sardinia, and its paleobiogeographic significance. — Second All-Union Coll. for Graptol. Studies in the USSR, Tallin, May 14—16.

KAHLER, F. and G. (1969): Einige südeuropäische Vorkommen von Fusuliniden. — Mitt. Geol. Ges. Wien, **61**, 49—60, Wien.

KAHLER, F. (1974): Fusuliniden aus T'ien-schan und Tibet. Mit Gedanken zur Geschichte der Fusuliniden-Meere im Perm. — Sino-Swed. Exped., V., **4**, 148p., Stockholm.

LAUFELD, S. (1974): Ordovicians chitinozoans from Portixeddu, Sardinia. — Boll. Soc. Pal. It., **12**, 3—7, Modena.

LAZZAROTTO, A., MAZZANTI, R. and MAZZONCINI, F. (1964): Geologia del promotorio Argentario (Grosseto) e del promontorio del Franco (Isola del Giglio-Grosseto). — Boll. Soc. Geol. It., **83** (2), 1—124, Pisa.

LEONE, F. (1973): La serie paleozoica del settore di Urbai-Monte Maiori (Valle del Cixerri, Sardegna sud-occidentale). — Boll. Soc. Geol. It., **92**, 621—633, Roma.

MACCAGNO, A. M. (1965): Contributo alla conoscenza della fauna ordoviciana della Sardegna. Gli echinodermi di Portixeddu. — Atti Acc. Sc. Fis. Mat. Napoli, **5** (5), 149—195, Napoli.

MAZZANTI, R. (1961): Geologia della zona di Montaione tra le valli dell'Era e dell'Elsa (Toscana). — Boll. Soc. Geol. It., **80** (2), 37—126, Pisa.

MASCLE, G. H. and TERMIER, G. (1970): Nouvelles données paléontologiques sur le Permo-Carbonifère de Lercara-Friddi (Sicile). — Riv. It. Paleont., **76**, 187—196, Milano.

MERLA, G. (1933): I graniti della formazione ofiolitica appenninica. — Boll. Serv. Geol. It., **58** (6), 5—115, Roma.

MINZONI, N. (1972): Lineamenti geologico-petrografici della formazioni paleozoiche affioranti nella zona di Meana Sardo (Sardegna centrale). — Ann. Univ. Ferrara, **1** (6), 67—87, Ferrara.

OGNIBEN, L. (1975): Lithostratigraphic complexes and evidence for tectonic phases in Sicily and Calabria. — In: Structural Model of Italy. — Quad. Ric. Scient., **90**, 365—408, Roma.

OLIVIERI, R. (1970): Conodonti e zonatura del Devoniano superiore e riconoscimento di Carbonifero inferiore nei calcari di Corona Mizziu (Gerrei-Sardegna). — Boll. Soc. Pal. It., **8**, 63—152, Modena.

PASINI, M. (1964): *Chusenella sosioensis* nuova specie di Fusulinide nel permiano della valle del F. Sosio. — Riv. It. Paleont., **70**, 169—182, Roma.

PASINI, M. (1974): *Archaeolythophyllum missouriensum* JOHNSON, una rhodophycea di interesse stratigrafico nel Carbonifero superiore della Toscana e delle Alpi orientali. — Riv. It. Paleont., **80**, 591—602, Milano.

PICCARRETA, G., AMODIO MORELLI, L. and PAGLIONICO, A. (1973): Evoluzione metamorfica delle rocce in facies granulitica nelle Serre nord-occidentali (Calabria). — Boll. Soc. Geol. It., **92**, 861—889, Roma.

POLL, J.J.K. (1966): The Geology of the Rosas-Terreseo Area (Sulcis, South Sardinia). — Leid. Geol. Med., **35**, 117—208, Leiden.

RASETTI, F. (1972): Cambrian Trilobite faunas of Sardinia. — Mem. Acc. Naz. Lincei, 11 (1), 100p.

RAU, A. and TONGIORGI, M. (1974): Geologia dei Monti Pisani a Sud-Est della Valle del Guappero. — Mem. Soc. Geol. It., **13**, 227—408, Pisa.

RUGGIERI, G. and DI VITA, G. (1972): L'età della Formazione Lercara. — Boll. Soc. Geol. It., **91**, 631—637, Roma.

SCANDONE, P. (1972): Studi di geologia lucana: Carta dei terreni della serie calcareo-silico-marnosa e note illustrative. — Boll. Soc. Nat. Napoli, 81, 225—300, Napoli.

SCHNEIDER, H.-J. (1972): Schichtgebundene etc. I. Bericht zur Lagerstättenkunde und Geologie. — N. Jb. Miner., Mh. **1972**, 529—541, Stuttgart.

SCHNEIDER, H.-J. (1974): Revision des Altpaläozoikums Sardiniens insbesondere des sardischen Konglomerates. — N. Jb. Geol. Paläont., Abh., **146**, 78—103, Stuttgart.

SERPAGLI, E. (1970): Ordovician conularids of Sardinia. — Boll. Soc. Palaont. It., 8, 3—15, Modena.

SERPAGLI, E. (1971): Uppermost Wenlockian-Upper Ludlowian (Silurian) Conodonts from Western Sardinia. — Boll. Soc. Palaeont. It., **9**, 76—96, Modena.

SIGNORINI, R. (1966): Il Verrucano della Toscana meridoniale. — Atti Symp. Verrucano, Soc. Tosc. Sc. Nat., 55—71, Firenze.

SKINNER, J. W. and WILDE, G. L. (1966): Permian fusulinids from Pacific Northwest and Alaska. — Univ. Kansas Paleont. Contr., **4**, 64p., Kansas.

SPJELDNAES, N. (1967): The palaeogeography of the Tethyan region during the Ordovician. — System. Ass. Publ., **7**, 45—57.

TARICCO, M. (1922): Sul Paleozoico del Fluminese (Sardegna). — Boll. R. Com. Geol. It., **48** (6), 1—22, Roma.

TEICHMÜLLER, R. (1931): Zur Geologie des Tyrrhenisgebietes. Teil 1: Alte und junge Krustenbewegungen im südlichen Sardinien. — Abh. Ges. Wiss. Göttingen, Mat. Phys. Kl., **3** (3), 1—94, Göttingen.

TRUILLET, R. (1969—1970): Etude géologique des Péloritains orientaux (Sicile). — Riv. Min. Sic., **115—117, 118—120** (1969) and **121—123** (1970), 157p.

VAI, G. B. (1972): Evidence of Silurian in the Apuane Alps (Tuscany, Italy). — Giorn. Geol., ser. 2, **38** (1), 349—372, Bologna.

VAI, G. B. (1975): Hercynian Basin Evolution of the Southern Alps. — In: SQUYRES C. Ed., Geology of Italy, E. S. S. L. A. R., Tripoli, 293—298, Tripoli.

VAI, G. B. (with contr. of ELTER, G.) (1976): Stratigrafia e paleogeografia ercinica delle Alpi. — Mem. Soc. Geol. It., **13/1** (1974), 7—37, Roma.

VAI, G. B. and COCOZZA, T. (1974): Il "Postgotlandiano" sardo, unità sinorogenica ercinica. — Boll. Soc. Geol. It., **93**, 61—72, Roma.

VAI, G. B. and FRANCAVILLA, F. (1974): Nuovo rinvenimento di piante dello Stefaniano a Iano (Toscana). — Boll. Soc. Geol. It. **93**, 73—79, Roma.

VIGHI, L. (1966): Descrizione di alcuni sondaggi che hanno attraversato lenti anidritico-dolomitiche intercalate alle filladi triassiche (Verrucano dei dintorni di Massa Marittima (Grosseto-Toscana). — Atti Symp. Verrucano, Soc. Tosc. Sc. Nat., 72—95, Firenze.

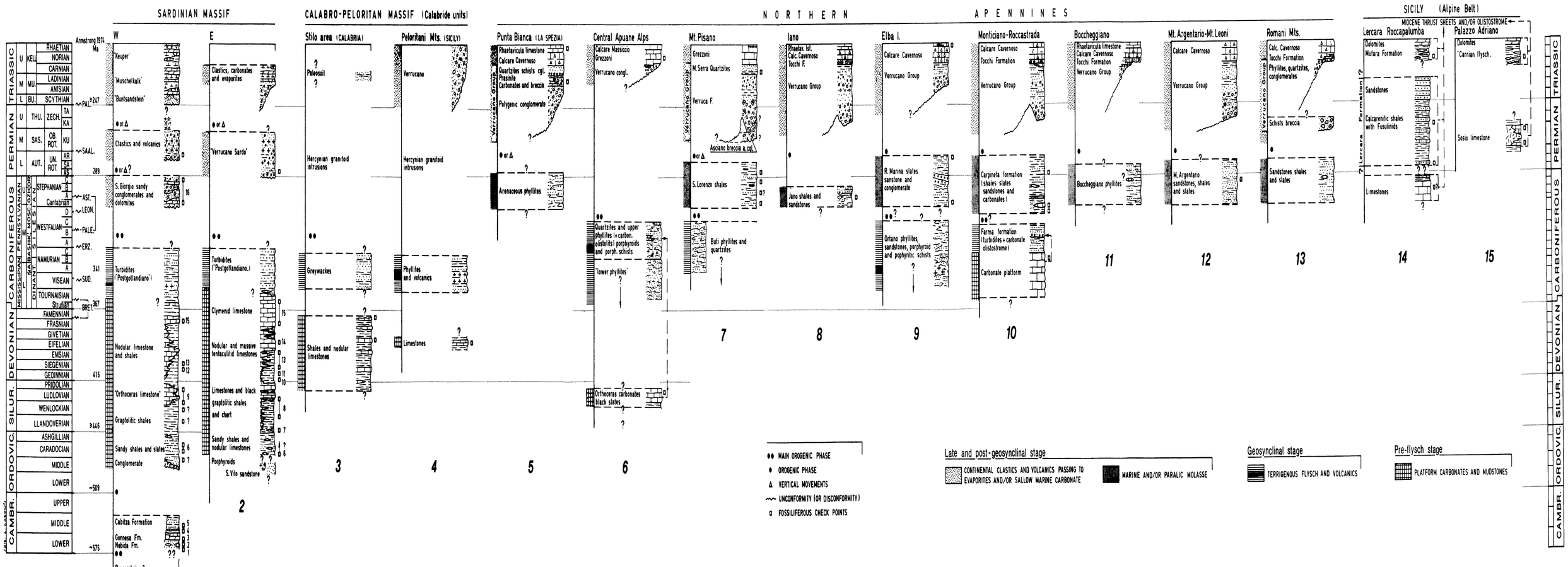

Fig. 4: Correlation chart of Palaeozoic sequences in Italian Peninsula and Islands. The sequences are grouped according to the main structural units of the Alpine orogeny: Sardinian Massif, Calabro-Peloritan Massif, Northern Apennines and Sicilian Alpine belt. Pre-Flysch, Hercynian Flysch and late to post-Hercynian stages, when recognized, are subdivided. Numbers refer to location and geologic map (Figs. 1 and 2).

The stratigraphic columns were compiled using unpublished personal data and the following sources: 1 (Serpagli, 1971; Rasetti, 1972; Leone, 1973; Vai and Cocozza, 1974; Cocozza and Jacobacci, 1975); 2 (Alberti, 1963; Vardabasso, 1966; Olivieri, 1970; Helmcke, 1973; Fazzini *et al.*, 1974; Cocozza and Jacobacci, 1975); 3 (modified after Görler and Ibbeken, 1970; Ahrhain, 1970; de Capoa Bonardi, 1970; Colonna *et al.*, 1973). 4 (modified after Trüllet, 1969–70), 5 (Elter and Federici, 1964; Federici, 1965); 6 (Barberi and Giglia, 1966; Giglia, 1967; Vai, 1972); 7 (Rau and Tongiorgi, 1974). 8 (Mazzanti, 1961; Vai and Francavilla, 1974). 9 (de Stefani, 1894; Bodertel, 1964; Barberi *et al.*, 1969; Kahler, 1969; Vai in Cocozza *et al.*, 1974). 10 (Cocozza, 1965; Cocozza, Lazzarotto and Vai, 1974). 11 (Cocozza and Lazzarotto in Cocozza *et al.*, 1974-a). 12 (Lazzarotto *et al.*, 1964; Gelmini, 1969; Gasperi and Gelmini, 1973; Vai in Cocozza *et al.*, 1974). 13 (Gasperi and Gelmini in Cocozza *et al.*,

VAI FIG. 4