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NEW SEDIMENTOLOGIC, PETROGRAPHIC, BIOSTRATIGRAPHIC AND STRUCTURAL DATA ON THE REITANO FLYSCH (MAGHREBIAN CHAIN, SICILY)

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Key-words: Sedimentology, Petrography, Biostratigraphy, Structural Geology, Reitano Flysch (Sicily).

Riassunto. È stato effettuato uno studio sedimentologico, petrografico, biostratigrafico e strutturale degli affioramenti esterni del Flysch di Reitano (Catena Magrebide occidentale, Sicilia) allo scopo di chiarirne l'età, le relazioni con il substrato ed il significato paleogeografico, finora molto controversi. I risultati delle analisi hanno rivelato alcune caratteristiche peculiari del Flysch di Reitano esterno, e cioè: 1) gli affioramenti sono caratterizzati da variazioni orizzontali e verticali di facies; 2) le facies e le direzioni delle paleocorrenti variano bruscamente su piccole distanze; 3) le arenarie sono caratterizzate da detrito vulcanoclastico estremamente fresco, che è assente negli affioramenti interni del Flysch di Reitano; 4) le strutture deformative, benchè influenzate dalle diverse litologie, vengono considerate come dovute a transpressione in regime di taglio; 5) il limite tra il Flysch di Reitano esterno e la sottostante Formazione di Polizzi è stratigrafico, ed ambedue le formazioni hanno una età oligocenica inferiore. Sulla base dei suddetti dati, viene tentativamente proposto un nuovo schema evolutivo, il cui Flysch di Reitano interno rappresenta un bacino "satellite" ed il Flysch di Reitano esterno viene considerato un piccolo bacino di tipo *pull-apart*.

Abstract. A sedimentologic, petrographic, biostratigraphic and structural study was carried out on the external outcrops of the Reitano Flysch (Western Maghrebian Chain, Sicily) in order to clarify its age, relationships with its substratum and paleogeographic significance, all of which are still very controversial. The results of our analyses yielded some peculiar features of the external Reitano Flysch, namely; 1) the outcrops are characterized by vertical and horizontal variation in facies; 2) the facies and paleocurrent directions vary abruptly over short distances; 3) the sandstones are characterized by remarkably fresh volcanoclastic detritus, which is absent in the internal outcrops of the Reitano Flysch; 4) the deformation structures, though influenced by the differences in the lithology, are considered to be the result of transpression under a shear regime; 5) the boundary between the external Reitano Flysch and the underlying Polizzi Formation is stratigraphic; both formations have an Early Oligocene age. On the base of the above data, a new evolutionary scheme is tentatively proposed, where the internal Reitano Flysch represents a "satellite" basin and the external Reitano Flysch is considered a small basin of pull-apart type.

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Introduction.

The Maghrebian orogenic chain extends for about 2000 km in the Western Mediterranean and is characterized by a nappe structure verging towards the south (Durand Delga, 1980). The Flysch Domain (Fig. 1A) comprises a complex stack of allochthonous units consisting of Cretaceous-Tertiary sequences. In Sicily, these sequences are the so-called Sicilide Units, which comprise the mainly Cretaceous Monte Soro Unit and the Sicilide s.s. Unit, the age of which ranges up to the Oligocene (Fig. 1B). The Sicilide Units are geometrically overlain by the Reitano Flysch, which is characterized by a sedimentary supply from the crystalline rocks of the Calabro-Peloritani Arc. The relationships of the Reitano Flysch with its substratum and the nature of the substratum itself vary from internal to external areas.

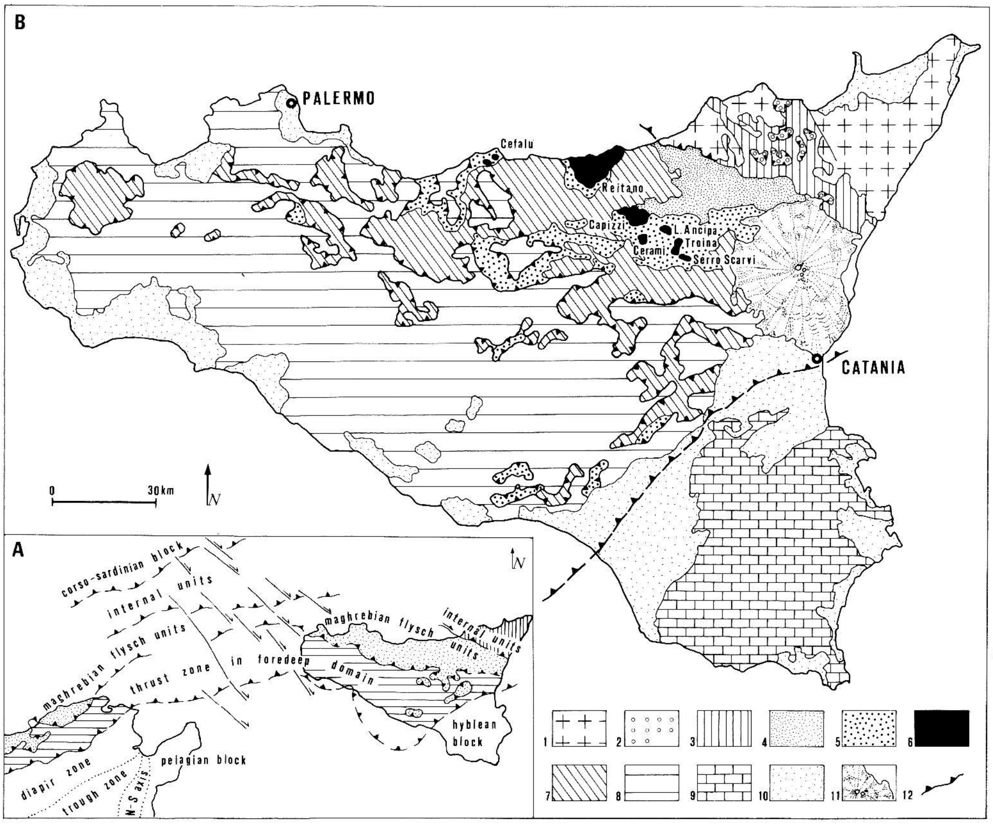
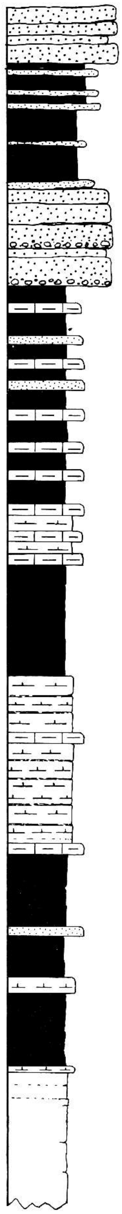


Fig. 1 - A) Structural sketch of the Western Maghrebian Chain.
B) Geological sketch map with the distribution of the Reitano Flysch outcrops in Sicily Maghrebian Chain. 1) Internal Units; 2) Antisicilide Units; 3) Capo d'Orlando Flysch; 4) Monte Soro Unit; 5) Sicilide s.s. Units; 6) Reitano Flysch; 7) Numidian Flysch; 8) External Units; 9) Hyblean foreland; 10) Quaternary deposits; 11) Etna magmatites; 12) Main overthrust fronts.



OGNIBEN 1960	Lower A.S. / E.-M. EOCENE	POLIZZI FORMATION (Cerami and Troina facies) / MIDDLE-LATE EOCENE	REITANO FLYSCH / OLIGOCENE-EARLY MIOCENE
SCHILIRO' 1968	Lower A.S.	POLIZZI FORMATION (Troina facies) / EOCENE: Early, Middle, Late	REITANO FLYSCH / OLIGOCENE: Early
GEREVINI 1969	Lower A.S. / CRETACEOUS-PALEOCENE	POLIZZI FORMATION (Cerami facies) / EOCENE: E., Middle, Late	REITANO FLYSCH / OLIGOCENE: Early
WEZEL 1973	A.V. →	TROINA - TUSA FLYSCH / LATE OLIGOCENE - EARLY MIOCENE	
GUERRERA & WEZEL 1974	AV$_T$?— / LATE CHATTIAN	TUSA FLYSCH / AQUITANIAN	
VEZZANI 1974	Lower A.V.	POLIZZI FORMATION (Cerami and Troina facies) / EARLY EOCENE → LATE EOCENE	REITANO FLYSCH / L. OLIGOCENE-E. MIOCENE
LENTINI et al.1987	A.V.	TROINA - TUSA FLYSCH / LATE OLIGOCENE AQUITANIAN	REITANO FLYSCH / BURDIGALIAN?
COURME & MASCLE 1988			OLIGO-MIOCÈNE MOLASSIQUE / LATE EOCENE, EARLY OLIGOCENE →, ← M.OLIG.
CARBONE et al.1990	A.V. / OLIG.-E.MIOC.	TROINA - TUSA FLYSCH / EARLY MIOCENE	REITANO FLYSCH / BURDIGALIAN-SERRAVALLIAN
PRESENT PAPER			POLIZZI Fmt. REITANO FLYSCH / EARLY OLIGOCENE

Fig. 2 - Schematic lithologic column (about 1000 m thick) of the Sicilide Unit in the external area with a synopsis of the different lithostratigraphic and chronostratigraphic assignments.

The present study represents an attempt to clarify the age and paleogeographic significance of the Reitano Flysch, which are still controversial. In fact, wide discrepancies exist in the literature on both ages and mutual relationships of the different formations. The different interpretations are summarized in Fig. 2. In particular, the ages assigned to Reitano Flysch vary from Oligocene (e. g. Ogniben, 1960) to Burdigalian (Lentini et al., 1987) and Serravallian (Carbone et al., 1990), and the boundary with the underlying Polizzi Formation has been considered continuous as well as transgressive. In turn, the Polizzi Formation was given an Eocene age by Ogniben (1960), Schilirò (1968), Gerevini (1969) and Vezzani (1974) but a Late Oligocene-Early Miocene age is given by other authors.

The outcrops of Cerami, Troina, and Serro Scarvi (Fig. 1B, Fig. 8) (external Reitano Flysch) (henceforth e.R.F.) (1) have been studied in detail through an interdisciplinary approach which involved sedimentologic, petrographic, biostratigraphic and structural analyses.

Sedimentology.

The facies analysis carried out on the Cerami and Troina outcrops revealed comparable stratigraphic settings. In fact, in both the Troina and Cerami areas, the Reitano Flysch overlies the upper pelitic facies of the Polizzi Formation with a sharp, locally erosional contact. The vertical assemblage of the sedimentary facies is also very similar in the two areas and can be subdivided as follows (Fig. 3):

1) the lower member is over 100 m thick. In the Serro Scarvi and Troina sections (Fig. 3 Sect. I-II) it is constituted by very coarse-grained facies (conglomerates and pebbly sandstones) in massive or thick beds grading upward to fine medium-grained sandstones in broad-channeled bodies, few decimeter thick (Loiacono & Puglisi, 1983, fig. 7).

In the Cerami area (Fig. 3 Sect. III-IV) the lower member is constituted by medium to coarse-grained sandstones arranged in some coarsening and thickening upwards cycles. In these cycles the thin and medium bedded facies, internally laminated, are related to tractive currents, whereas the thickest ones, massive or normally graded with coarse sands, pebbles and clay chips at the base, usually show erosive lower contact. These beds are the product of high-density gravity flows. The two sections of Cerami outcrop show, in the same lower member, a grain size decreasing from the southern section (Fig. 3 Sect. III) to the northern one (Fig. 3 Sect. IV), according to west and northwest paleocurrent directions.

2) The middle member, mainly pelitic, overlies the lower one with a sharp contact (Cerami area) or with a rapid thinning of the sandstone beds (Troina section).

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(1) e.R.F. and i.R.F. informally define two distinct lithostratigraphic units

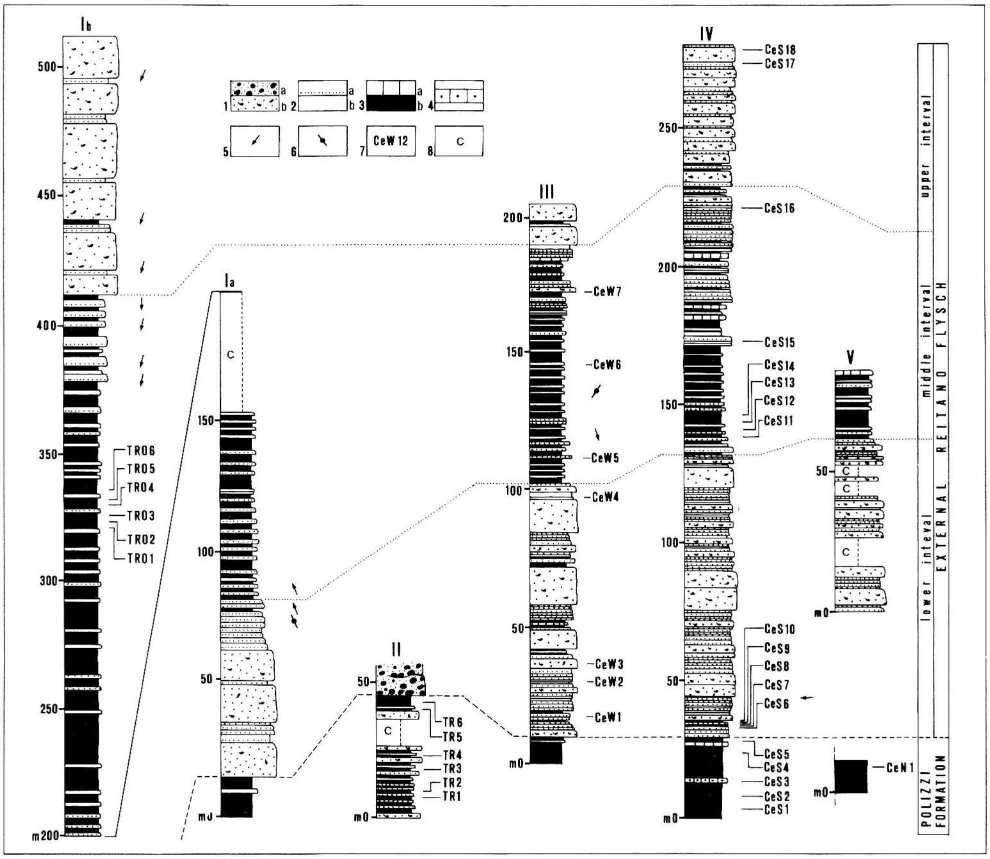

Fig. 3 - Stratigraphic logs and correlations in the external Reitano Flysch of Troina and Cerami areas. I) Troina section; II) Serro Scarvi section; III) Cerami W section; IV) Cerami S section; V) Cerami N section.
1) Coarse-grained facies (a=conglomerates; b=massive or crude laminated coarse-medium sandstones with rip-up clasts and clay chips). 2) Medium to fine sandstone facies (a=very common Ta-e sequences; b=prevalent Tb-e, Tc-e sequences). 3) Pelitic facies (a=limestone; b=mudstone). 4) Calcareous turbidite. 5) Paleocurrent orientation. 6) Paleocurrent direction. 7) Sample location. 8) Not exposed interval.

This member is constituted by thin-bedded fine-grained sandstones and thicker pelitic beds; some hemipelagites and thin beds of coarse-grained sandstones (thicker in Troina sections) with small lateral continuity, occur.

The thickness of this member is notably different in the two areas: 100 m in the Cerami section, 250 m in the Troina section. Both the sections show a thickening and coarsening upward vertical trend; the transition to the upper member is gradual and located where the sandstone/pelite ratio becomes >1.

3) The upper interval, about 100 m thick in either areas, is mostly composed by sheet-like sandstones characterized by thickening and coarsening upward trend (Fig. 3 Sect. Ib, III, IV).

Two sandstone facies are distinguished in each cycle: the lower facies made by coupled beds (sand-pelite) with graded laminated sand overlied by laminated mud; Tb-e and Ta-c Bouma sequences are the most common. The upper facies shows massive sandstones, coarse or very coarse-grained, crude laminated; clay chips or mud clasts are frequently observed (rip up clasts).

The quite similar sedimentary evolution of the analyzed sections (Troina and Cerami) allows to attempt a comparative interpretation of the external Reitano Flysch. The whole succession may be a sedimentary complex built up by the stacking of individual short-lived turbidite system in a small, tectonically controlled basin, characterized by modified sediment supply during the filling. In fact the paleocurrent directions and the petrographic features (see next paragraph) suggest different turbidite systems rather than different stages ot the same system (sensu Mutti & Normark, 1987).

The lower member is interpreted as a lowstand system tract (Van Wagoner et al., 1987). The lower boundary, an erosional submarine surface without a main unconformity, is the base of a sequence initiated during a relative sea level lowstand. The upper boundary with a pelitic member represents a relative highstand.

The comparative study of the lower member of the Troina, Serro Scarvi and Cerami sections, allows to reconstruct a slope-fan system: Troina, Serro Scarvi besides Ancipa sections (Loiacono & Puglisi, 1983) show very coarse deposits of a channelled system; in the Cerami sections the sandstone bodies belong to a prograding wedge.

A transgressive system tract is recognized in the pelitic member. The different thickness of the pelitic facies in Cerami and Troina areas is probably due to locally different subsidence rates, higher in Troina section.

The sheet-like sandstone bodies of the upper member in both Troina and Cerami sections (Fig. 3 Sect. Ib, III, IV) are very similar to depositional lobes of outer fan (Mutti & Ghibaudo, 1972; Mutti & Ricci Lucchi, 1972), diagnostic of a sand-rich turbidite system upon the highstand mud facies. In the studied sections they appear as progradational features, even if the associated channelled deposits are lacking.

In this member the change of the dispersal pattern can suggest a major shift in the source area, with regard to syndepositional tectonic activity.

Petrography.

The petrographic features of the Reitano Flysch sandstones (gross composition and heavy mineral assemblages) confirm a previously hypothesized difference between the e.R.F. (Troina, Lago d'Ancipa, Cerami and Serro Scarvi) and the i.R.F. (Capizzi and Reitano) outcrops of Reitano Flysch (Puglisi, 1979). New petrographic data have been obtained from a stratigraphic section measured in the Cerami outcrop and from some samples collected in the Capizzi area. The petrographic analysis was performed according to the criteria given by Gazzi (1966) and Gazzi et al. (1973) (Tab. 1). The Qm, F and Lt parameters are also included, as suggested by Graham et al. (1976) and

	CERAMI W						CERAMI S			CAPIZZI				
	Ce2	Ce3	Ce4	Ce5	Ce6	Ce7	Ce15	Ce16	Ce18	130	131	132	133	134
Qm' (monocrystalline quartz grains)	22.9	22.2	21.2	25.6	29.8	22.6	22.1	28.7	20.5	19.3	20.2	29.3	30.3	25.5
Qp (polycrystalline quartz grains)	6.9	5.5	4.6	9.3	5.7	8.3	5.8	6.6	6;6	15.2	26.0	12.8	11.7	19.4
Ql (quartz in coarse-grained rock fragments,> 0.06mm)	0.9	1.4	1.1	1.6	1.4	0.4	3.5	0.9	5.3	15.1	3.3	0.6	2.9	1.8
Ch (chert)	1.6	1.0	1.1	2.7	0.6	1.3	3.2	1.4	0.8	-	-	-	-	-
Ks (k-feldspar single grains)	2.5	2.0	2.9	5.6	7.2	17.3	6.7	4.9	8.2	2.9	1.6	2.2	6.0	3.8
Kl (k-feldspar in coarse-grained rock fragments)	0.6	-	-	0.3	0.3	1.9	3.2	1.1	4.5	-	-	-	0.3	1.4
Ps (plagioclase single grains)	15.8	15.3	14.4	12.2	18.6	14.0	19.8	19.8	15.4	12.0	9.2	10.2	9.8	9.7
Pl (plagioclase in coarse-grained rock fragments)	0.9	1.7	1.1	1.6	1.4	1.3	7.3	2.8	5.0	-	0.8	2.8	3.3	2.5
Lv (volcanic rock fragments)	18.5	13.8	9.9	10.0	2.6	1.4	3.0	0.7	2.1	-	-	-	-	-
Lm (fine-grained metamorphic rock fragments,<0.06mm)	-	1.0	3.8	5.4	-	1.0	0.6	0.7	0.3	3.4	6.2	7.8	10.8	8.4
Ms (mica and chlorite single grains	9.1	7.6	9.2	3.8	6.3	7.2	12.0	5.4	6.6	5.1	14.2	15.8	9.1	7.5
Ml (mica and chlorite in coarse-grained rock fragments)	0.3	-	-	0.3	-	0.4	0.3	-	-	1.8	2.3	2.4	4.8	2.2
Ot (other minerals)	2.2	2.0	1.1	1.6	0.6	0.7	-	0.4	0.3	-	-	-	-	-
Mt (silicoclastic matrix)	-	-	-	-	-	0.7	12.5	-	-	1.3	1.4	5.4	2.6	2.2
Cm (carbonate cement)	17.8	26.5	29.6	20.0	25.5	21.5	-	26.6	24.4	23.9	14.8	10.7	8.4	15.6
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Q (= 100 x Q/Q+F+L)	45.8	47.1	46.6	52.9	55.5	46.9	46.0	55.6	48.3	73.0	73.6	64.7	59.8	64.3
F (= 100 x Q/Q+F+L)	28.0	29.7	30.6	26.4	40.7	49.6	49.2	42.3	48.2	21.9	17.2	23.3	25.8	24.1
L (= 100 x Q/Q+F+L)	26.2	23.2	22.8	20.7	3.8	3.5	4.8	2.1	3.5	5.1	9.2	12;0	14.4	11.6
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Qm (= Qm' +Ql)	33.9	37.0	37.1	36.6	46.2	33.1	34.0	43.8	37.5	50.7	68.7	63.9	44.2	61.8
F	28.2	29.7	30.6	26.4	40.7	49.6	49.3	42.3	48.2	21.9	17.2	23.3	25.8	24.1
Lt (total lithic fragments = L + Qp + Ch)	37.9	33.3	32.3	37.0	13.1	17.3	16.7	13.9	14.3	27.4	14.1	12.8	30.0	14.1
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Tab. 1 - Gross composition of e.R.F. and i.R.F. sandstones.

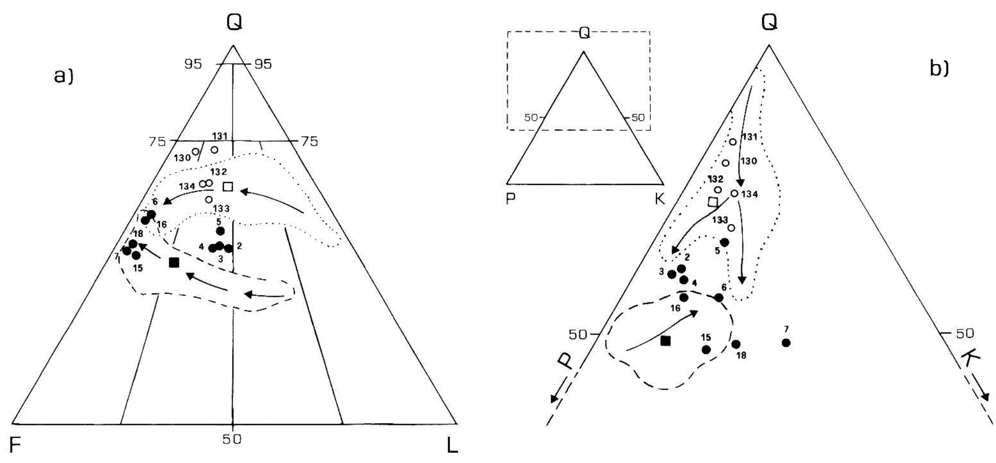

Fig. 4 - a) Quartz-Feldspars-Lithic fragments and b) Quartz-Plagioclase-K- feldspar ternary plots showing gross composition of Reitano Flysch sandstones. ●) New data from the external outcrops (Cerami section); o) new data from the internal outcrops (Capizzi area); dashed line) external outcrops (Troina, Cerami, Lago d'Ancipa areas; data from Puglisi (1979) and from Loiacono & Puglisi (1983); ■) mean; dotted line) inner outcrops (Reitano area; data from Puglisi (1979); □) mean.

by Dickinson & Suczek (1979) as a means of recognizing the provenance of the clastic supply. The Cerami section sandstones (Fig. 4a) show a vertical compositional evolution from lithic arkoses to arkoses; the samples from the lower-middle interval are rich in volcanic detritus (Pl. 19). The Capizzi area sandstones are devoid of volcanic

	CERAMI W							CERAMI S		CAPIZZI					
	CeW1	**CeW2**	**CeW3**	**CeW4**	**CeW5**	**CeW6**	**CeW7**	**CeS15**	**CeS16**	**130**	**131**	**132**	**133**	**134**	**135**
transparent	27.2	34.7	61.9	50.9	33.6	42.0	35.4	44.6	36.9	55.7	36.0	35.7	13.4	27.9	12.2
opaque	17.1	11.9	21.8	27.9	27.4	46.1	39.8	18.6	30.9	0.9	1.0	2.4	4.1	15.8	12.9
turbid	55.7	53.4	16.3	21.2	35.5	21.9	24.8	36.8	32.2	43.4	63.0	61.9	82.5	56.3	74.4
barite	-	-	-	-	3.5	-	-	-	-	-	-	-	-	-	-
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
zircon	15.7	7.5	5.5	7.5	13.2	9.5	7.8	8.0	15.1	0.5	17.4	15.3	10.5	3.2	29.3
tourmaline	4.5	2.7	3.1	2.1	-	1.5	2.2	4.7	2.3	3.7	5.6	9.4	9.3	6.5	4.3
rutile	1.1	4.5	3.7	0.7	2.3	0.9	2.2	2.0	1.2	3.3	7.5	5.4	3.1	1.6	7.8
garnet	29.3	43.8	11.2	17.8	51.7	47.2	57.0	57.0	36.6	80.2	54.8	52.5	53.1	69.2	36.2
monazite	1.1	0.9	0.9	-	2.3	0.9	-	1.3	0.6	0.7	2.4	4.0	-	1.6	7.8
xenotime	-	0.6	-	-	0.6	-	-	-	-	0.6	0.3	0.2	0.6	-	2.6
picotite	3.1	1.5	1.2	0.7	1.1	8.9	5.0	3.4	6.4	-	-	-	-	-	-
sphene	3.7	3.3	1.8	3.2	2.9	5.6	5.6	4.8	7.6	-	-	-	-	-	-
epidote	27.0	9.0	6.5	3.6	20.1	21.7	8.9	4.0	24.4	-	-	-	-	-	1.7
chloritoid	-	-	1.5	-	-	-	0.6	0.7	-	0.2	0.3	0.7	1.2	-	1.7
staurolite	11.2	12.9	4.6	2.8	3.4	3.6	6.7	11.4	5.2	2.6	5.6	0.5	6.8	10.3	2.6
amphibole	-	0.9	2.5	4.3	-	-	-	-	-	-	-	-	-	-	-
clinopyroxene	2.2	10.6	55.4	55.5	1.8	-	1.2	-	-	-	-	-	-	2.2	-
anatase & brookite	1.1	1.8	2.1	1.8	0.6	0.3	2.8	2.7	0.6	3.5	6.1	12.0	15.4	5.4	6.0
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Tab. 2 - Heavy mineral assemblages of e.R.F. and i.R.F. sandstones.

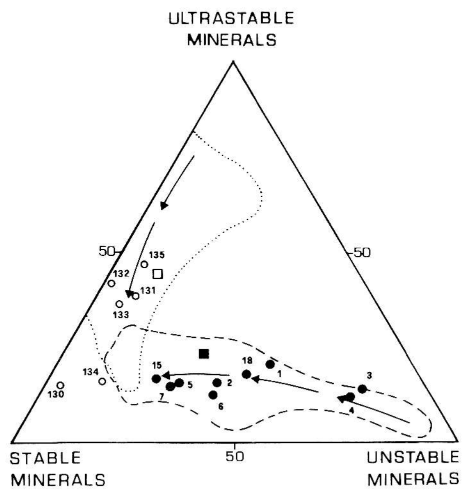

Fig. 5 - Heavy mineral assemblages plotted according to their decreasing stability. Ultrastable minerals: zircon, tourmaline, rutile, anatase and brookite. Stable minerals: garnet, monazite and xenotime. Unstable minerals: sphene, epidote, staurolite, chloritoid, clinopyroxene and amphibole. Symbols as in Fig. 4.

rock fragments and have a greater maturity; in fact they show a trend from phyllarenites to arkoses (Puglisi, 1979).

The greater abundance of K-feldspars and plagioclases, mainly with volcanic textural characters (Fig. 4b) suggests that the sediment source area of the Cerami sandstones (e.R.F.) could be related to plutonic rocks during volcanic events, and/or to metamorphic rocks of higher grade than that inferred for the i.R.F.

Volcanic supply in the basal and middle interval of the Cerami section is characterized by the occurrence, and sometimes abundance, of remarkably fresh augitic clinopyroxenes and hornblendes (Tab. 2; Fig. 5). These unstable minerals indicate lack of weathering and post-depositional dissolution. Their excellent state of preservation could support the hypothesis of a volcanism penecontemporaneous with the sedimentation and very rapid burial.

Apart from the volcanic supply, both the e.R.F. and i.R.F. sandstones show the same provenance from sedimentary and/or crystalline areas already deformed or undergoing deformation.

Dissected arc and recycled orogen could represent the provenance of the external and internal outcrops of the Reitano Flysch respectively, as shown by the diagrams of Dickinson et al. (1983) (Fig. 6). The volcanic detritus in the e.R.F. sandstones could be related to a syntectonic event which took place along strike-slip faults in convergent zones.

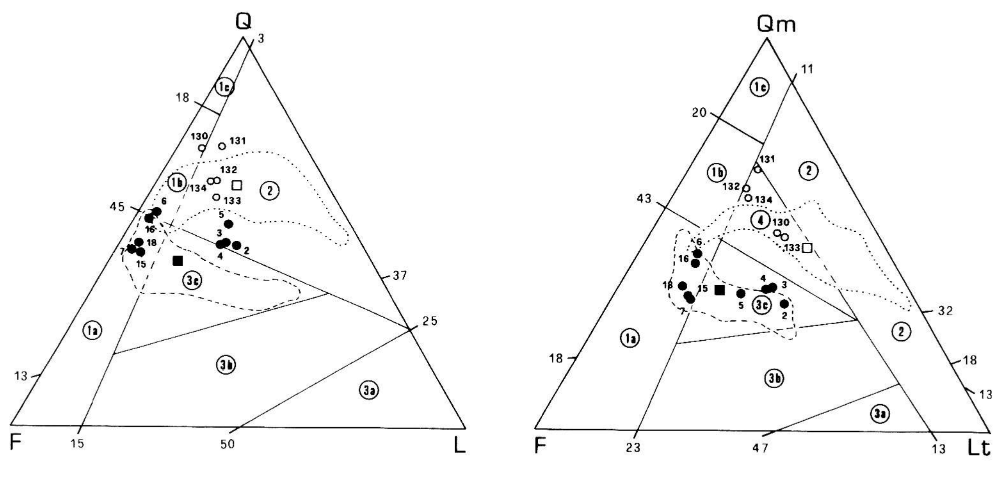

Fig. 6 - Q-F-L and Qm-F-Lt ternary plots showing composition fields corresponding to different types of provenance (according to Dickinson et al., 1983). 1) Continental block provenance (a=basement uplift; b=transitional continental; c=craton interior); 2) recycled orogen provenance; 3) magmatic arc provenance (a=undissected arc; b=transitional arc; c=dissected arc); 4) mixed provenance. Symbols as in Fig. 4.

Biostratigraphy.

A biostratigraphic study was carried out on both the Polizzi Formation and the Reitano Flysch. The calcareous nannofossil and planktonic foraminifera contents were studied in three sections:

1) the Serro Scarvi section, where only the Polizzi Formation is represented;

2) the Troina section, where only the external Reitano Flysch is represented;

3) the Cerami sud section, where the boundary between the two formations is represented.

Few of the collected samples yielded a rich and well preserved calcareous plankton assemblage, which could be used to study the vertical distribution of selected and stratigraphically significant nannofossil and foraminiferal taxa (Fig. 7; Pl. 20, 21). This semiquantitative analysis was integrated with a quantitative analysis of the calcareous nannofossil assemblage in the three mentioned above sections as well as in the Cerami nord section (Tab. 3). A minimum of 300 specimens was counted in each sample, in order to compare the percentages of each species. The biostratigraphic results of these analyses are very similar for all the studied sections; they are briefly summarized below.

Planktonic foraminifera.

In the three examined sections (Cerami sud, Troina and Serro Scarvi) the assemblages have a generally reduced size. The hantkeninids are absent; their extinction level corresponds to the P17/P18 zonal boundary of Blow (1969), which is here considered as coincident with the Eocene/Oligocene boundary (Pomerol & Premoli Silva, 1986; Nocchi et al., 1988). In the smaller grain size, *Chiloguembelina* and *Pseudohastigerina* are the dominant taxa, with *C. cubensis*, *P. naguewichiensis*, *P. barbadoensis* and *P. micra*. The LO of pseudohastigerinids marks the P19/P20 boundary. *Globigerina ampliapertura* is frequent, and "*Globigerina*" *tapuriensis*, the first occurrence of which slightly predates the LO of hantkeninids, is rather common. The marker of the base of Zone P19, *Globoquadrina sellii*, is absent; however this taxon is frequently scarce or lacking in coeval Italian sequences (Premoli Silva et al., 1988). These data suggest a zonal assignment to the Zone P 18 of Blow (1969) but the presence of at least part of the Zone P 19 can not be ruled out for the above mentioned reason.

Calcareous nannofossils.

The absence of the rosette-shaped discoasters, except for a few reworked specimens, in the four studied sections (Cerami Nord, Cerami Sud, Troina and Serro Scarvi) suggests an age younger than the NP 20/NP 21 boundary of Martini (1971).

In most of the samples *Coccolithus formosus* and *Reticulofenestra umbilicus* cooccur. The LO of these species mark the base and the top of the NP 22 respectively. Due to the difficulties of recognizing this zone in the Mediterranean, some authors (e. g. Premoli Silva et al., 1988) use the LO of *Isthmolithus recurvus* to approximate the

SECTIONS						SELECTED CALCAREOUS PLANKTON DATA																	
						Calcareous nannofossils										Planktonic foraminifera							
CHRONOSTRATIGRAPHY	NANNOFOSSIL BIOSTRATIGRAPHY	FORAMINIFERAL BIOSTRATIGRAPHY	LITHOSTRATIGRAPHY	meters	samples	*Reticulofenestra umbilicus*	*Coccolithus formosus*	*Clausicoccus fenestratus*	*Lanternithus minutus*	*Isthmolithus recurvus*	*Sphenolithus distentus*	*Sphenolithus predistentus*	*Helicosphaera recta*	*Zygrhablithus bijugatus*	*Cyclicargolithus abisectus*	*Catapsydrax unicavus*	*Chiloguembelina spp.*	*Globigerina galavisi*	*Globigerina tapuriensis*	*Globorotalia gemma*	*Pseudohastigerina barbadoensis*	*Pseudohastigerina micra*	*Pseudohastigerina naguewichiensis*
TROINA																							
RUPELIAN	NP 21/23	P 18	REITANO FM.	338	**Tro 6**	R				R		R	R	R	R	F	C	R		R	C	C	A
				329	**Tro 5**		R		R	R		F	R	F		R	A	R	R	R	C	C	A
				328	**Tro 4**												R					R	R
				327	**Tro 3**	R		R	R			F	F	F		R	R		R			R	R
CERAMI SUD																							
RUPELIAN	NP 21 / NP 23	P 18 / P 19	REITANO FM.	274	**CeS 17**			R	R		R	F	R	C	F	R	R	R	R	R	R	R	R
				144	**CeS 14**		R	R	R			F	R	R		R	A	F	F	C	A	A	A
				140	**CeS 12**	R	R	R	F			F	R	R	F	F	A	C	R	C	A	C	A
				138	**CeS 11**	R	R	R	F		R	F	F	F	R	R	R	R	R	R	R	R	R
			POLIZZI FM.	29	**CeS 5**	R	F	F		R		F	R			R	R	R	R	R	R	R	R
				27	**CeS 4**	R	R	R	R	F		F	R	R		R	F	R	R	F	C	R	F
				15	**CeS 3**	R	R	F		R		F	R	F		R	F	R	R	F	C	R	F
				6	**CeS 2**			A	F	R		F		F		R	A	R	R	A	A	A	A
				4	**CeS 1**	R	R	F	F	R		R		F		R	A	R	R	C	A	R	A
SERRO SCARVI																							
RUPELIAN	NP 21 / NP 22	P 18	POLIZZI FORMATION	44	**Tr 6**	R	F	F	R	R		R		F		C	A	C	R	C	A	C	A
				40	**Tr 5**			F	F			C		F		F	R	R	R	R	R	R	R
				25	**Tr 4**		F	F	F			R		F		R	R	R	R	R	R	R	R
				18	**Tr 3**	R	F	C	F	R		F		R		F	A	C	R	C	A	C	A
				11	**Tr 2**	F	R	F		F		F				R	F	R	R	C	R	R	R
				7	**Tr 1**	F		F		F		R		R		R	F	R	R	F	R	R	F

Fig. 7 - Distribution of selected calcareous plankton taxa in the Serro Scarvi, Troina and Cerami sections. A) abundant; C) common; F) few; R) rare.

CERAMI SUD

samples	meters	*Cyclicargolithus floridanus*	*Coccolithus pelagicus*	*Reticulofenestra bisecta*	*Clausicoccus fenestratus*	*Sphenolithus* spp.	*Sphenolithus predistentus*	*Sphenolithus distentus*	*Reticulofenestra* spp.	*Reticulofenestra umbilicus*	*Isthmolithus recurvus*	*Cyclicargolithus abisectus*	*Helicosphaera* spp.	*Helicosphaera compacta*	*Helicosphaera recta*	*Discoaster* spp.	*Discoaster tani*	*Cribrocentrum reticulatum*	*Coccolithus formosus*	*Lanternithus minutus*	*Zygrhablithus bijugatus*	*Braarudosphaera* spp.	Reworked
CeS 17	274	71,90	5,88	6,86	0,65	3,92	1,31	0,65	0,33	0,00	0,00	1,31	0,98	0,00	0,33	0,00	0,00	0,00	0,00	0,33	5,23	0,00	0,33
CeS 14	144	68,95	11,40	5,13	0,28	3,42	1,99	0,00	3,70	0,00	0,00	0,00	0,85	0,28	0,28	0,28	0,00	0,57	0,28	0,28	0,85	0,57	0,57
CeS 12	140	66,02	14,56	2,91	0,65	4,21	1,62	0,00	1,62	0,32	0,00	1,29	0,97	0,00	0,65	0,32	0,00	0,32	0,97	1,62	0,32	0,00	1,62
CeS 11	138	64,41	11,39	4,27	0,36	2,13	2,13	0,30	2,85	0,36	0,00	0,36	0,36	0,00	1,78	0,00	0,36	0,36	2,49	1,42	2,49	0,36	2,14
CeS 5	29	63,67	10,38	8,65	1,04	2,42	1,04	0,00	4,15	0,69	0,69	0,00	0,00	0,69	0,69	1,38	0,00	0,00	1,04	0,00	0,00	0,00	3,46
CeS 4	27	68,65	6,52	2,19	0,31	5,64	3,13	0,00	1,88	0,31	1,57	0,00	0,94	0,94	0,31	0,63	0,31	0,31	0,63	0,63	0,31	0,31	4,39
CeS 3	15	48,15	18,52	3,37	2,69	3,70	2,02	0,00	7,07	0,67	0,34	0,00	2,02	0,67	1,01	2,69	0,00	0,34	0,67	0,00	0,34	0,00	5,39
CeS 2	6	54,33	14,67	6,00	9,99	5,67	1,00	0,00	0,00	0,00	0,33	0,00	0,67	0,67	0,00	0,00	0,00	0,00	0,00	4,00	2,67	0,00	0,00
CeS 1	4	58,47	11,50	7,99	3,51	6,71	0,64	0,00	0,96	0,32	0,32	0,00	1,28	0,00	0,00	0,00	0,00	0,32	0,96	3,51	1,60	0,96	0,96

CERAMI NORD

samples	meters	*Cyclicargolithus floridanus*	*Coccolithus pelagicus*	*Reticulofenestra bisecta*	*Clausicoccus fenestratus*	*Sphenolithus* spp.	*Sphenolithus predistentus*	*Reticulofenestra* spp.	*Reticulofenestra daviesi*	*Reticulofenestra umbilicus*	*Isthmolithus recurvus*	*Cyclicargolithus abisectus*	*Helicosphaera* spp.	*Helicosphaera compacta*	*Helicosphaera recta*	*Discoaster* spp.	*Discoaster tani*	*Cribrocentrum reticulatum*	*Coccolithus formosus*	*Lanternithus minutus*	*Zygrhablithus bijugatus*	Reworked
Ce 7	91	72,12	9,62	1,92	0,64	3,21	1,92	0,32	1,28	0,00	0,00	0,64	2,88	0,00	0,00	0,64	0,32	0,32	1,60	0,00	0,64	1,92
Ce 5	83	68,31	10,77	5,54	0,00	1,54	1,85	2,77	0,62	0,00	0,00	0,00	0,92	0,31	0,62	0,31	0,00	0,00	1,23	0,31	0,31	4,31
Ce 3	72	68,45	9,23	7,14	1,49	6,55	0,60	0,60	0,30	0,00	0,30	0,00	0,89	0,00	0,00	0,30	0,00	0,00	0,89	1,79	1,19	0,30
Ce 1	5	66,34	15,36	2,94	2,29	1,31	1,63	0,98	0,65	1,63	0,65	0,00	0,00	0,98	0,00	0,65	0,33	0,00	0,00	0,00	0,00	3,92

TROINA

samples	meters	*Cyclicargolithus floridanus*	*Coccolithus pelagicus*	*Reticulofenestra bisecta*	*Clausicoccus fenestratus*	*Sphenolithus* spp.	*Sphenolithus predistentus*	*Reticulofenestra* spp.	*Reticulofenestra daviesi*	*Reticulofenestra umbilicus*	*Isthmolithus recurvus*	*Cyclicargolithus abisectus*	*Helicosphaera* spp.	*Helicosphaera compacta*	*Helicosphaera recta*	*Coccolithus formosus*	*Lanternithus minutus*	*Zygrhablithus bijugatus*	Reworked
Tro 6	338	79,21	9,57	3,63	0,00	2,31	0,66	0,00	1,32	0,66	0,33	0,33	0,33	0,66	0,33	0,00	0,00	0,33	0,66
Tro 5	329	80,81	8,38	3,24	0,00	1,35	1,89	0,27	0,00	0,00	0,27	0,00	0,27	0,27	0,27	0,81	0,27	1,89	0,00
Tro 3	327	69,67	11,67	4,33	0,33	2,00	2,33	0,00	0,33	0,33	0,00	0,00	1,00	0,33	1,00	0,00	0,67	1,00	5,00

SERRO SCARVI

samples	meters	*Cyclicargolithus floridanus*	*Coccolithus pelagicus*	*Reticulofenestra bisecta*	*Clausicoccus fenestratus*	*Sphenolithus* spp.	*Sphenolithus predistentus*	*Reticulofenestra* spp.	*Reticulofenestra daviesi*	*Reticulofenestra umbilicus*	*Isthmolithus recurvus*	*Helicosphaera* spp.	*Helicosphaera compacta*	*Discoaster* spp.	*Discoaster tani*	*Discoaster barbadiensis*	*Cribrocentrum reticulatum*	*Coccolithus formosus*	*Lanternithus minutus*	*Zygrhablithus bijugatus*	Others	Reworked
Tr 6	44	62,95	9,84	6,56	3,61	6,56	0,98	0,66	0,33	0,98	0,33	0,66	0,66	1,31	0,00	0,33	0,00	2,30	0,33	1,31	0,33	0,00
Tr 5	40	66,99	6,86	4,90	2,29	1,31	4,58	0,00	1,96	0,00	0,00	1,31	0,65	1,63	0,33	0,00	0,00	0,00	2,29	3,59	1,31	0,00
Tr 4	25	51,79	18,89	8,14	3,58	2,93	0,33	1,30	1,30	0,00	0,00	0,33	0,98	0,33	0,00	0,00	0,00	1,63	4,23	1,63	0,00	2,61
Tr 3	18	61,72	12,21	4,62	5,94	1,65	1,32	0,99	2,64	0,33	0,66	1,98	0,00	0,00	0,00	0,66	0,33	1,32	1,65	0,33	0,33	1,32
Tr 2	11	61,23	9,42	4,35	4,35	1,81	2,17	3,62	1,81	1,09	1,81	2,17	0,72	0,36	1,45	0,00	0,00	0,36	0,00	0,00	2,54	0,72
Tr 1	7	66,45	9,77	5,54	2,93	2;28	0,33	0,98	0,98	1,63	1,30	1,30	1,30	1,30	0,33	0,00	0,00	0,00	0,00	0,33	0,00	3,26

top of the Zone NP 22. In our sections *I. recurvus* is present in the lower part. It is to be noted that in the middle and upper interval of the Cerami sud section, rare *Sphenolithus distentus* were detected, however the FO of this species is believed to be an unreliable marker for the base of Zone CP 10 of Okada & Bukry (1980) (Olafsson & Villa, in press). On the other hand, the presence of *Cyclicargolithus abisectus* (> 10 μ) and *Helicosphaera recta* is recorded in the Troina and Cerami sections. These two taxa are already recorded within the Zone NP 23 (Perch-Nielsen, 1985; Premoli Silva et al., 1988; Olafsson, in press; Villa, unpublished data) and therefore their occurrence suggests that the zone NP 23 is at least partly represented in the middle and upper interval of the Cerami and Troina sections.

The correlation between planktonic foraminifera and calcareous nannofossil data (Fig. 7), taking into account the general scarcity and poor preservation of the assemblages, suggests that the Reitano Flysch and the upper part of the underlying Polizzi Formation span the interval corresponding to the foraminiferal Zone P18 (and possibly to part of the P 19 Zone), which is correlatable to the nannofossil Zones NP 21/NP 23 (lower part) according to Berggren et al. (1985) indicating an Early Oligocene (Rupelian) age.

Evolutionary scheme.

The above mentioned new petrographic data point out differences in composition, maturity and hence in provenance supply between the i.R.F. and the e.R.F. Furthermore the new biostratigraphic data confirm the stratigraphic relationship between the e.R.F. and the underlying Polizzi Formation (Sicilide Unit), whereas field analyses still in progress indicate that the i.R.F. unconformably overlies the already deformed Monte Soro Unit.

All the above mentioned reasons suggest the hypothesis that the e.R.F. and the i.R.F. deposited in two different basins.

Although the study on the i.R.F. is still at an early stage, we consider the i.R.F. as a possible episutural basin (piggy-back type) on the already deformed Monte Soro Unit, which was undergoing a partial overthrust by the Peloritani margin during the "mesoalpine" event. This event and the associated formation of episutural basins is well documented in the Ligurian nappes of the Northern Apennines, but is was not so far suggested for the Sicilian Chain.

The geodynamic interpretation of the e.R.F. basin is more complex. Some of its features suggest a tectonic control on the basin opening; they are briefly summarized below:

- the facies and paleocurrent directions vary abruptly over short distances;

Tab. 3 - Census data of calcareous nannofossil taxa expressed as percent of total number of individuals counted (Troina, Serro Scarvi and Cerami sections).

- the outcrops show a peculiar areal distribution and the different outcrops have vertical and/or horizontal asymmetry in facies development;

- the sandstones are characterized by a volcanoclastic composition which is absent in the i.R.F. sandstones;

- the volcanoclastic detritus is remarkably fresh due to a very rapid burial and/or to a volcanism penecontemporaneous to the sedimentation;

- the boundary between the e.R.F. and the underlying Polizzi Formation, though stratigraphic, shows an extremely sharp facies variation.

The age assignment of the synorogenic volcanism within the Sicilian Maghrebian chain is still an unsolved problem, because it is connected to the age assignment of the Sicilide sequences.

The available references on this subject provide a wide age range. The Tusa tuffites, in fact, are ascribed to the Middle-Late Eocene by Ogniben (1960), Amodio Morelli et al. (1976), Abate et al. (1988), Catalano et al. (1989), to the Late Oligocene by Vezzani (1974), Lentini & Vezzani (1978) and Montanari (1982) and to the Late Oligocene-Early Miocene by Guerrera & Wezel (1974).

If a Paleogene age will be confirmed, the volcanic supply within the Tusa tuffites and the e.R.F. sandstones could have the same provenance, since the volcanic detritus seems to be similar in composition.

If the Tusa tuffites and e.R.F. were different in age, the volcanic detritus within the e.R.F. sandstones could derive from a syntectonic igneous activity which took place locally along strike-slip faults linked to convergence (Sylvester, 1988).

The above mentioned characters indicate that the e.R.F. could represent the sedimentary filling of a small fault-controlled, rapidly subsiding basin. Its opening could be located at a releasing bend along a strike-slip fault zone affecting the thinned crust of the Sicilide basin close to the Peloritani margin (Fig. 9).

This inner chain directly supplied the e.R.F. basin with clastic materials. As a rule, most sediments of pull-apart basin are supplied from local sources, "unless a major delta, fed from an extensive area of erosion, enters one end of the basin" (Reading, 1980).

The dominant role of a simple shear in dissecting the carbonate platform since Middle Triassic-Early Liassic has been pointed out (Catalano & D'Argenio, 1982) as well simple shear has been invoked in the construction of the Sicilian fold and thrust belt (Ghisetti & Vezzani, 1984). Therefore it could be reasonable to hypothesize the activity of a shear regime also in the Early Oligocene during the opening of the e.R.F. basin. Probably the overthrusting of the more internal Peloritani margin could have precociously sealed the basin, which in turn was afterward overthrust on the African margin together with its substratum. If we accept, as a working hypothesis, this latter interpretation, we can see that, actually, the areal distribution of the facies in the e.R.F. fits well the basin shape theoretically proposed by Rodgers (1980) for basins caused by "en échelon" strike-slip faults. The direction of these paleofaults, tentatively reconstructed from the location of the depocenters according to the mathematical model of Rodgers (1980), could be W-E/WSW-ENE.

This direction must be rotated counterclockwise to restore the Neogene clockwise rotation of internal areas relative to the Hyblean foreland (Channell et al., 1990; Oldow et al., 1990). The 90° rotation which leads the faults at a N-S/NNW-SSE direction is a minimum value, considering that no published paleomagnetic data are available for the investigated area. It is interesting to note that the axis direction of the maximum horizontal shortening theoretically reconstructed from the direction of the main displacement zone (Sylvester, 1988) agrees with the motion of Africa relative to Europe reconstructed by Channell et al. (1979).

As stated before, these paleofaults do not outcrop at present and therefore this direction is only speculatively reconstructed.

Structural analysis.

The analysis of the deformation structures of the e.R.F. outcrops of Troina and Cerami was carried out to compare the post-Oligocene evolution of the area with the available reconstructions of the evolutive history of the Sicilide belt.

The deformation structures in the Cerami and Troina (e.R.F.) areas are influenced by their variable lithology. The Troina outcrop, mainly characterized by a thin-bedded pelitic sequence, was deformed mainly through folding, whereas in the Cerami area strike-slip faulting represents the main deformation mechanism, owing to the presence of a thick and massive basal sequence.

The left and right minor faults, striking respectively N-S/NNE-SSW and NW-SE, represent a conjugate system; the larger of them probably worked as normal fault in more recent times (Fig. 8).

The major syncline outcropping in the central part of the Troina area has an axial trend striking NE-SW, but it changes its direction close to the left lateral fault which cuts and rotates the axis to a N-S direction; at its southern end this fault merges into an upthrust directed NNE-SSW. The whole structural pattern can be framed into a local shear regime the master fault of which (not outcropping in the area) should strike W-E/WNW-ESE. It is impossible to date the deformation because of the absence of younger formations in the area.

All the above mentioned deformation structures, because of the small dimensions of the investigated area, can be attributed to either pure or simple shear regime.

Ghisetti (1979) and Ghisetti & Vezzani (1984), among many others, reconstruct a simple shear regime linked to the M. Kumeta-Alcantara shear zone; they interpret the clockwise rotation of the more internal tectonic units with respect to the Hyblean foreland as due to a component of movement related to the right lateral shear and hence this rotation should involve the crust.

Channell et al. (1990) and Oldow et al. (1990) attribute the deformation structures to pure shear which develops through at least two superposed compressional events; the different amount of rotation within the various imbricated slices is inter-

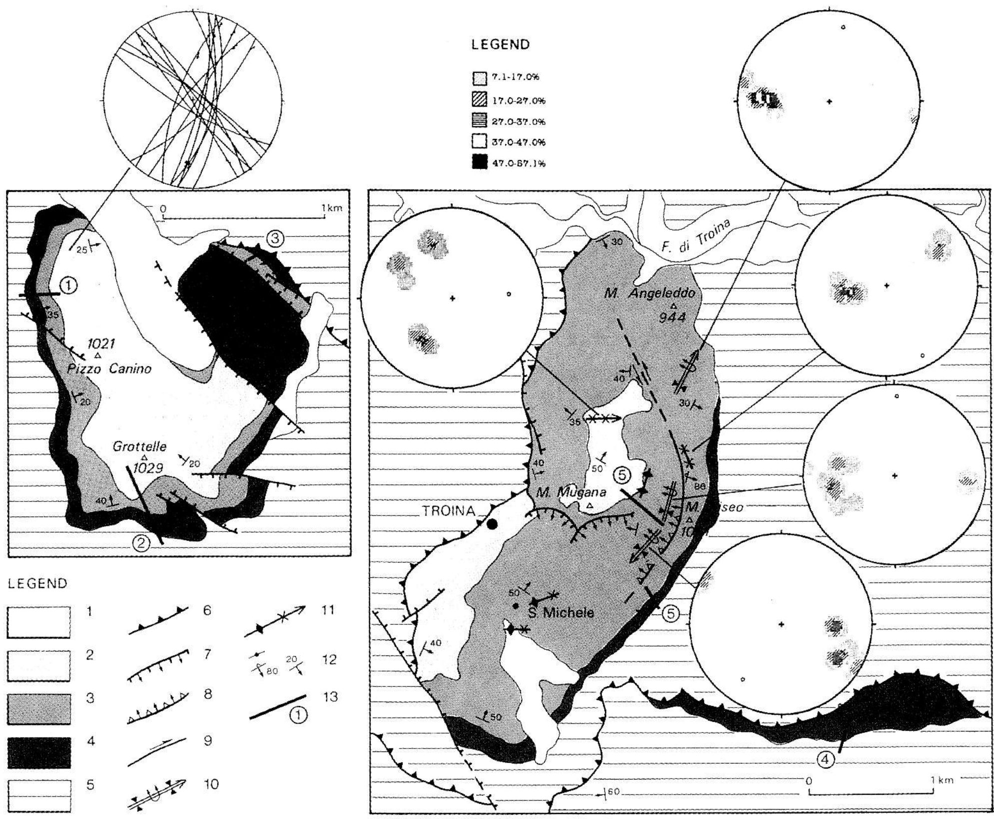

Fig. 8 - Geological-structural map of the Troina and Cerami areas (external Reitano Flysch). 1) Recent deposits; 2) e.R.F. upper arenaceous interval; 3) e.R.F. intermediate pelitic-arenaceous interval; 4) e.R.F. lower coarse arenaceous interval; 5) substratum of the e.R.F.; 6) overthrust (teeth on the overthrust block); 7) normal fault (barbs mark the downthrown block, arrows the fault surface dip); 8) thrust (open teeth mark the upthrown block, arrows the thrust surface dip); 9) strike-slip fault; 10) measured axial traces of the main recumbent syncline; 11) measured axial trace of minor folds; 12) attitudes of bedding surfaces; 13) log trace.
The stereograms relative to the Troina map (A) show the distribution of So poles: open circles mark the trace of mathematically reconstructed fold axes (Wulf net, lower hemisphere). The stereogram relative to the Cerami map (B) shows the right and left lateral strike-slip faults measured mainly in the lower massive arenaceous interval (Wulf net, lower hemisphere).

preted by these authors as the result of differential motion of tectonic units during stacking. The rotations are attributed to a thin-skinned process.

Conclusions.

In this study new data are presented on the age, the petrographic assemblages and the relationships between the e.R.F. and its substratum. Both the external Reitano Flysch and the underlying Polizzi Formation are attributed to the Early Oligocene.

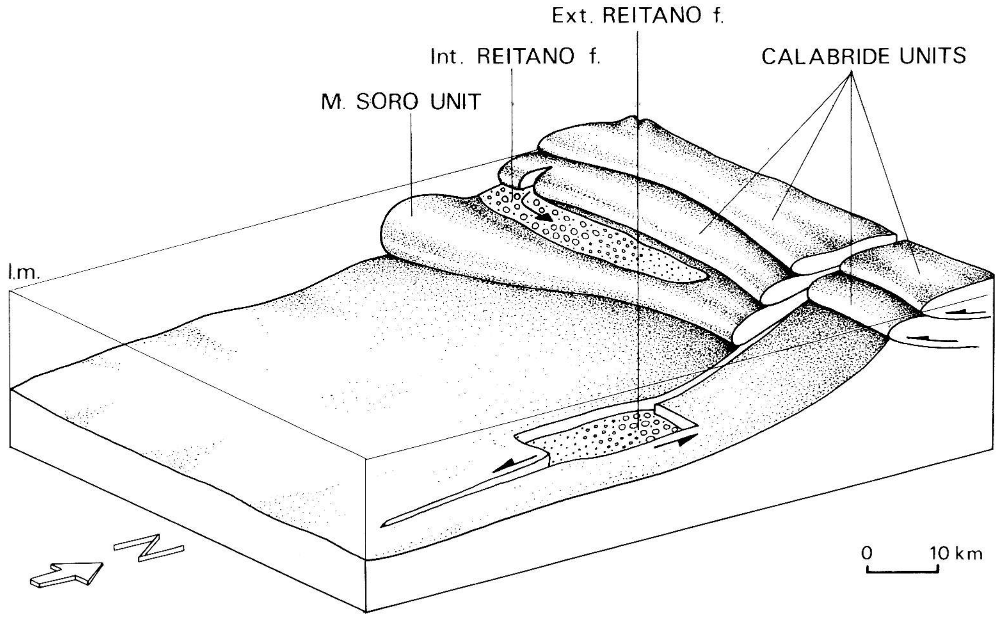

Fig. 9 - Block diagram sketching a possible evolutive scheme of the internal and external Reitano Flysch.

The few samples so far analyzed in the i.R.F. (Reitano and Mistretta areas) do not contradict this age assignment.

The samples so far studied from i.R.F. are devoid of volcanoclastic detritus; furthermore the i.R.F. unconformably overlies the already deformed M. Soro Unit. In the southern Capizzi area (near Pizzo Scimone and M. Malaspina) the i.R.F. is detached from its substratum and overthrusts the M. Soro/Sicilide contact. Therefore, the beginning of the sedimentation of the Reitano Flysch does not date this tectonic event, which could be younger than Early Oligocene.

The e.R.F., which contains volcanoclastic detritus, stratigraphically rests on the Polizzi Formation; both formations were subsequently deformed together. For all the above mentioned reasons, we tentatively propose a new evolutive scheme (Fig. 9) where the i.R.F. could represent a "satellite" basin on the M. Soro Unit, and the e.R.F. is interpreted as a small tectonic basin of pull-apart type.

This preliminary working hypothesis must be tested through further sedimentologic, petrographic, biostratigraphic and structural analyses on the i.R.F. outcrops.

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PLATE 19

Fig. 1 - Evidence of different supplies in the Cerami sandstones: volcanic rock fragments (top); perthitic orthose grains from plutonic rocks (bottom); 122 x.
Fig. 2 - Volcanic clasts showing porphyritic structure with plagioclase phenocrysts; 122 x.

PLATE 20

Fig. 1 - *Isthmolithus recurvus* Deflandre. Sample CeS 5; x 2600.
Fig. 2 - *Isthmolithus recurvus* Deflandre. Sample TR 1; x 2600.
Fig. 3 - *Lanternithus minutus* Stradner. Sample CeS 11; x 2600.
Fig. 4 - *Clausicoccus fenestratus* (Deflandre & Fert) Prins. Sample CeS 11; x 2600.
Fig. 5 - *Helicosphaera compacta* Bramlette & Wilcoxon. Sample TR 2, cross nicols; x 2600.
Fig. 6 - *Helicosphaera compacta* Bramlette & Wilcoxon. Sample TR 1, cross nicols; x 2600.
Fig. 7 - *Reticulofenestra bisecta* (Hay, Mohler & Wade) Roth. Sample CeS 14; x 2600.
Fig. 8 - *Reticulofenestra daviesii* (Haq) Backman. Sample TR 2; x 2600.
Fig. 9 - *Helicosphaera compacta* Bramlette & Wilcoxon. Sample TR 2, transmitted light; x 2600.
Fig. 10 - *Helicosphaera compacta* Bramlette & Wilcoxon. Sample TR 1, transmitted light; x 2600.
Fig. 11 - *Zygrhablithus bijugatus* (Deflandre) Deflandre. Sample CeS 11; x 2600.
Fig. 12 - *Discoaster tanii* Bramlette & Riedel. Sample CeS 4; x 2600.
Fig. 13 - *Sphenolithus predistentus* Bramlette & Wilcoxon. Sample CeS 4; x 2600.
Fig. 14 - *Sphenolithus distentus* (Martini) Bramlette & Wilcoxon. Sample CeS 11; x 2600.
Fig. 15 - *Helicosphaera recta* Haq. Sample CE sud 5; x 2600.
Fig. 16 - *Helicosphaera recta* Haq. Sample CeS 11; x 2600.
Fig. 17 - *Reticulofenestra umbilicus* (Levin) Martini & Ritzkowski. Sample CeS 5; x 2600.
Fig. 18 - *Reticulofenestra umbilicus* (Levin) Martini & Ritzkowski. Sample TR 2; x 2600.
Fig. 19 - *Helicosphaera recta* Haq. Sample CeS 4; x 2600.
Fig. 20 - *Reticulofenestra* sp. Sample CeS 4; x 2600.

PLATE 21

Fig. 1 - *Chiloguembelina* sp. Sample CeS; x 300.
Fig. 2 - *Chiloguembelina cubensis* (Palmer). Sample CeS 14; x 300.
Fig. 3 - *Chiloguembelina cubensis* (Palmer). Sample CeS 14; x 300.
Fig. 4 - *Globigerina ampliapertura* Bolli. Sample CeS 2; x 200.
Fig. 5 - *Subbotina angiporoides* (Hornibrook). Sample CeS 2; x 200.
Fig. 6 - *Catapsydrax unicavus* Bolli, Loeblich & Tappan. Sample CeS 14; x 200.
Fig. 7 - *Tenuitella* cf. *clemenciae* (Bermudez). Sample CeS 14; x 400.
Fig. 8 - *Pseudohastigerina micra* (Cole). Sample CeS 2; x 300.
Fig. 9 - *Pseudohastigerina barbadoensis* Blow. Sample CeS 14; x 300.
Fig. 10 - *Pseudohastigerina naguewichiensis* (Mjatliuk). Sample CeS 2; x 300.
Fig. 11 - *Pseudohastigerina naguewichiensis* (Mjatliuk). Sample CeS 2; x 300.
Fig. 12 - *Pseudohastigerina naguewichiensis* (Mjatliuk). Sample CeS 2; x 300.

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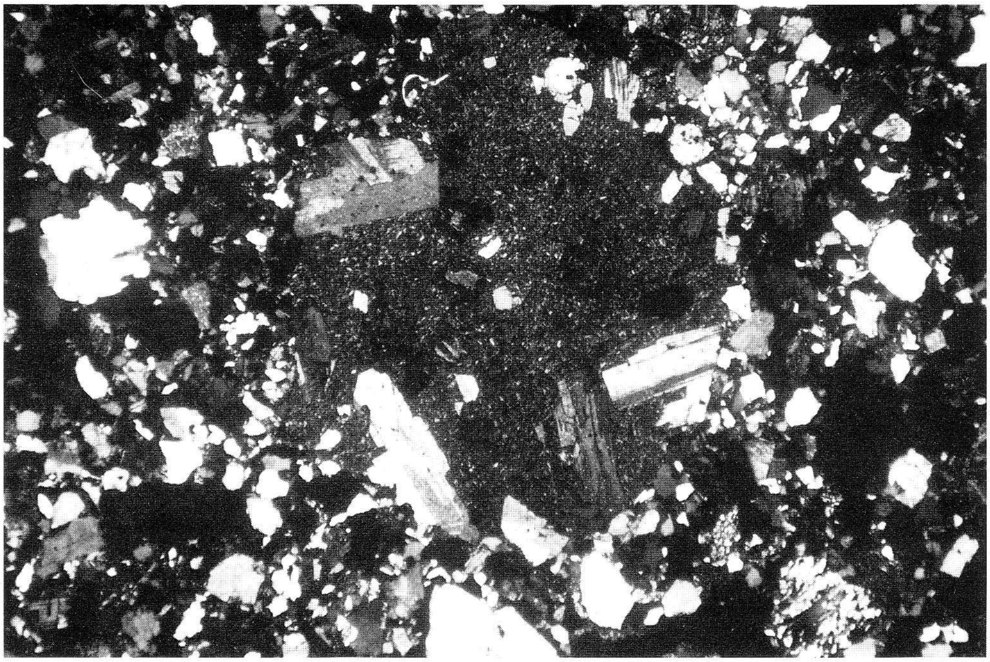

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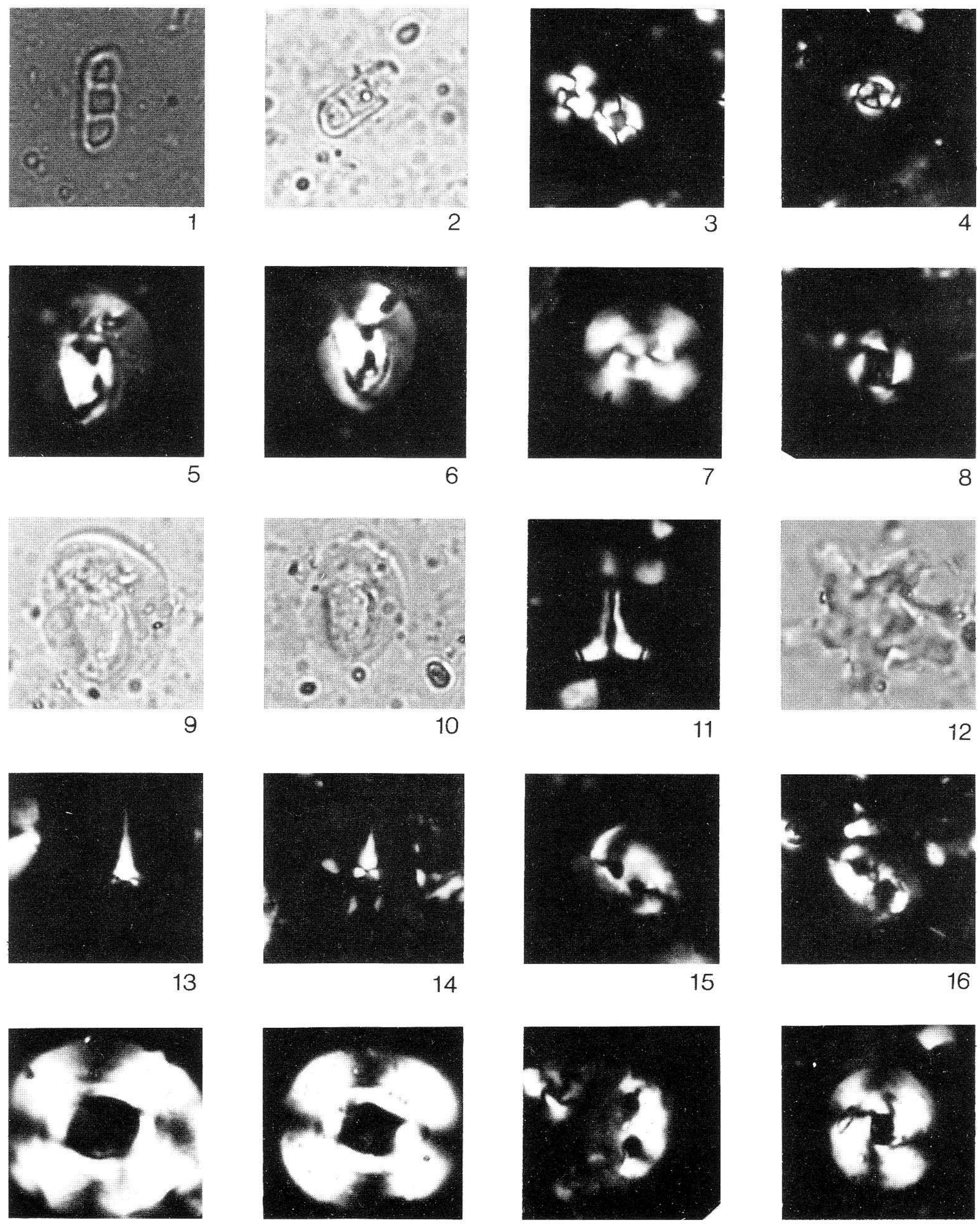
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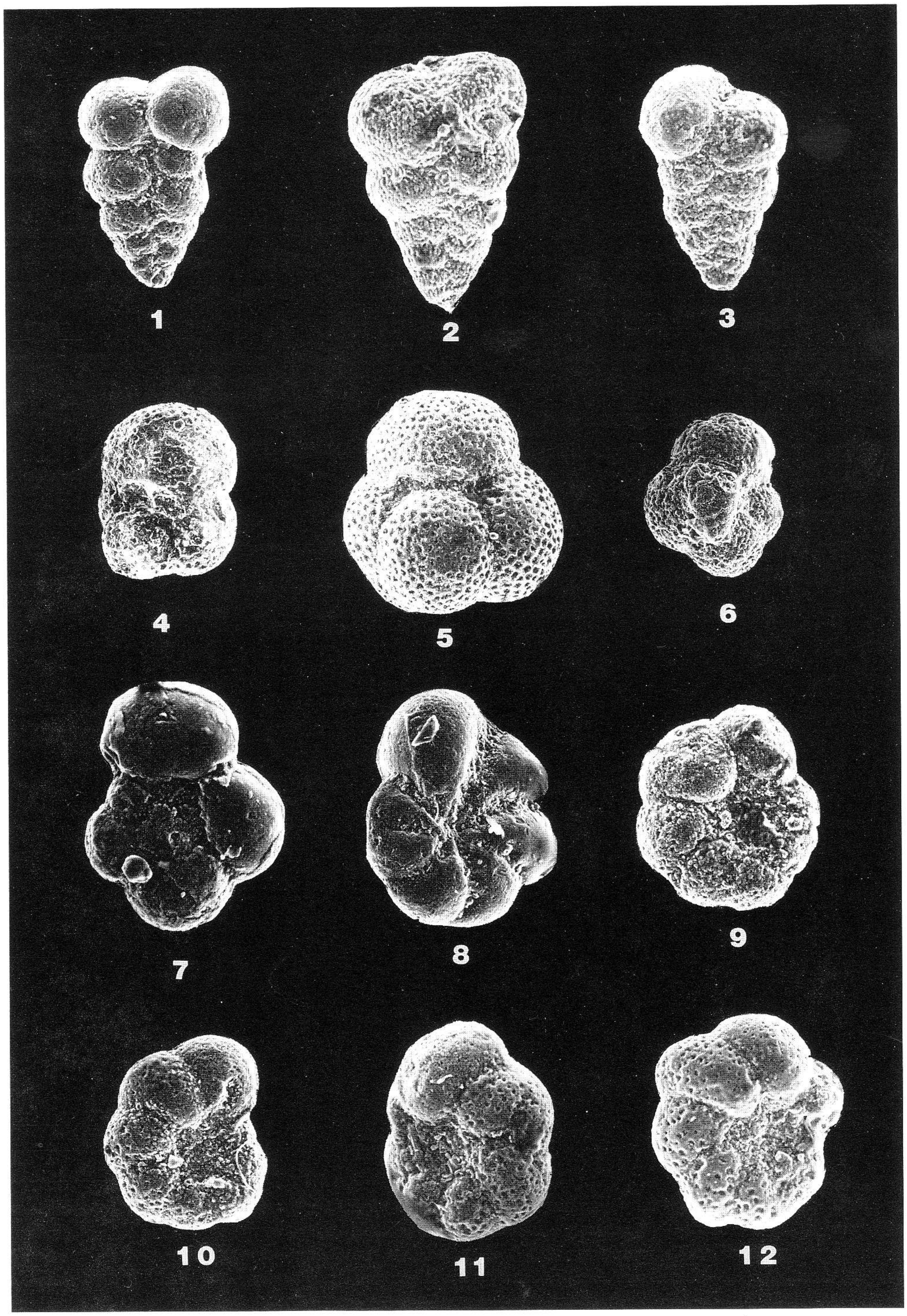
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