Romanian Journal of

STRATIGRAPHY

continuation of

DĂRI DE SEAMĂ ALE ŞEDINŢELOR INSTITUTULUI DE GEOLOGIE ŞI GEOFIZICĂ
COMPTES RENDUS DES SÉANCES DE L'INSTITUT DE GÉOLOGIE ET GÉOPHYSIQUE
(4. Stratigrafie)

Founded 1906 by the Geological Institute of Romania

ISSN 1220-5664

Vol. 76
Supplement Nr. 7
(3 volumes)

Xth. CONGRESS RCMNS
BUCURESTI • 1995

IUGS, REGIONAL COMMITTEE ON MEDITERRANEAN NEOGENE STRATIGRAPHY
4 – 9 September

ABSTRACTS

VOLUME 2

I.G.R.
45 N
24° E

Institutul Geologic al României
Bucureşti – 1995

GEOLOGICAL INSTITUTE OF ROMANIA

The **Geological Institute of Romania** is now publishing the following periodicals:

Romanian Journal of Mineralogy
Romanian Journal of Petrology
Romanian Journal of Mineral Deposits
Romanian Journal of Paleontology
Romanian Journal of Stratigraphy
Romanian Journal of Tectonics and Regional Geology
Romanian Journal of Geophysics

They supersede "Dări de Seamă ale Şedinţelor", "Memorii" and "Studii Tehnice şi Economice", whose apparition goes back to 1910. Beside regular volumes, each series may occasionally contain Supplements (for abstracts and excursion guides to congresses and symposia held in Romania) and Special Issues (for larger papers of special interest). "Anuarul Institutului Geologic al României" will appear also in a new form, containing both the annual activity report and review papers.

Editorial Office:
Geological Institute of Romania
Str. Caransebeş No. 1
RO – 79 678 Bucureşti – 32
Tel. (+40) 1 665 66 25, 665 75 30
Fax (+40) 1 312 84 44
e-mail GIRBHR@ROEARN.ICI.RO

The editor has changed the name as follows: Institutul Geologic al României (1910–1952), Comitetul Geologic (1953–1966), Comitetul de Stat al Geologiei (1967–1969), Institutul Geologic (1970–1974), Institutul de Geologie şi Geofizică (1975–1993), Institutul Geologic al României (since 1994).

ROMANIAN JOURNAL OF STRATIGRAPHY supersedes "Dări de Seamă ale Şedinţelor", Series 4/Stratigrafie – the last volume with this title being No. 74.

The manuscripts should be sent to the scientific editor and/or executive secretary. Correspondence concerning advertisments, announcements and subscriptions should be sent to the Managing Editor.

ISSN 1220–5664
Classification index for libraries 55(058)

Printed by the Geological Institute of Romania
Bucharest

Xth CONGRESS OF THE REGIONAL COMMITTEE ON MEDITERRANEAN NEOGENE STRATIGRAPHY

ABSTRACTS

VOLUME 2

SYMPOSIA:

1. "NEOGENE VOLCANISM; GEOTECTONIC SETTING, VOLCANIC EDIFICES, PROCESSES AND EVOLUTION"
2. " QUANTIFYING GLOBAL CLIMAT IN THE PLIOCENE"
3. " DEFINITION AND CHRONOLOGY OF THE MAJOR NEOGENE TECTONIC EVENTS

Institutul Geologic al României
Bucureşti–1995

Table of content :

Volume 2

Symposium 1

Symposium 2

Symposium 3

Volume 3

Symposium 4

Volume 2

X[th] R. C. M. N. S. Congress, Bucharest 1995

Symposium 1

Symposium Neogene Volcanism; Geotectonic Setting, Volcanic Edifices,Processes and Evolution

3

THE OLIGOCENE-MIOCENE VOLCANO-SEDIMENTARY SUCCESION OF FORDONGIANUS-SINI AREA (CENTRAL SARDINIA-ITALY)

A.ASSORGIA[1], K.BALOGH[2], S.BARCA[1], G.FLORE[3], S.LUXORO[4], R.LONIS[4], M.PINNA[3], A.PORCU[1], R.RIZZO[5] & C.SPANO[1]

1 Dipartimento di Scienze della Terra, Cagliari.
2 Institute of Nuclear Research of the Hungarian Academy of Sciences, Debrecen, HUNGARY.
3 External co-worker
4 Progemisa S.p.a., , Cagliari.
5 C.N.R., Centro Studi Geominerari e Mineralurgici, Cagliari.

The Fordongianus-Sini area is characterized by a volcano-sedimentary succession 300 m thick unconformably lying on the Paleozoic basement which is essentially constituted by Hercynian metamorphites, injected by late Hercynian granitoids. Locally, the crystalline basement is also unconformably covered by more or less extended sequences of Middle Triassic-Middle Jurassic carbonatic rocks, giving typical planar-like morphologies.

The former Cainozoic deposits are represented by continental polygenic conglomerates (CTC) derived from the Palaeozoic metamorphites; these deposits are rich in a argillaceous-arenaceous reddish coloured matrix, and they are genetically related to alluvial fan during a tropical climatic phase, as also testified by the abundance of vegetal Palaeogenic species. From stratigraphical point of view, in this area the early volcanic activity is partially interbedded to the CTC deposits and it is represented mainly by acidic to intermediate calc-alkaline products.

From a geodynamic point of view, the calc-alkaline volcanism of Sardinia is related to subduction of Mesogean oceanic lithosphere towards N or NW below the European continent, in response to the progressive convergence between African and European plates during Oligocene-Miocene time, and to the consequent translation towards East of Sardinian-Corsican Paleoplate. The examined area is located in the central part of the Sardinian Rift which appears to be related to dominant strike slip mouvements and/or transtensional processes and filled by the calc-alkaline volcanic products and the Miocene marine sediments, thick more then 1500 m.

The Fordongianus-Sini area is characterized by an important ash-pumiceous volcano-pyroclastic activity with range in composition rom rhyolites to rhyodacites, followed, at the top, by localized dacitic and sub-marine andesitic lava domes. The pre-Aquitanian volcanic succession is arranged in more pyroclastic Units, the most important of which, from the bottom to the top, are: Luzzana Unit (LU), Allai Unit (AL), Dacitic Lava Complex (DL), Ruinas Unit (RU), M.te Ironi Unit (MI), Asuni Unit (AS).

In the ignimbritic bodies of these units it is possible to recognize the classical internal zonation proposed by Sparks et al.(1973). Particulary, the clastic part (10-30%) is composed mainly by lithic fragments (cognate fragments with pophyritic texture owing to small tabular plagioclases and vitric groundmass) and xenolites of Palaeozoic basement which increases in modal percentage mostly in the lower-central parts of the layer 2 and/or in the degassing pipes (near Allai); while the juvenile fragments (pumice and scoriaceous fragments sometimes collapsed) are preferentially located at the top of the volcanic units.

Microscopically, the studied rocks show usually a porphyroclastic texture (particularly LU and AL). The generalized phenocrystalline association is characterized by the presence of clear large tabular twinned plagioclases crystals which usually show oscillatory zoning and more rarely patchy zoning. The clinopyroxenes, usually freshes, occur as small tabular single crystals or more often, as glomerules associated with plagioclases.

Stratigraphically, the first volcanic event (LU) is represented by chaotic dacitic pyroclastic flow, 10 m thick; microscopically, it shows vitroclastic to porphyroclastic textures. The clastic component is dominated, expecially in the inner-central part by Paleozoic xenolithes (15 cm). These characteristics suggest that the dominant eruption mechanism of the LU Unit may be related to eruption-column collapse. After period of relative quiescence of the volcanic activity,marked by the occurrence of a areneaceous-conglomeratic level, it occurs the gratest explosive volcanic event during Cainozoic, as testified by the deposition of a rhyolitic-rhyodacitic ash-pumice pyroclastic flow (AL). The ignimbrite body (40-80 m thick), outcropping in an area of about 300 Km, should be classified as large volume ignimbrite and it is generally massive and locally affected by reomorphic textures. Microscopically, it shows porphyroclastic texture; the clastic components is dominated by cognate fragments "andesitic" in composition, showing quenching textures. After the AL Unit emplacement, the examined area is undergone to an abrupt morphostructural change because the development of a horst-graben system and consequent increase of erosive and sedimentary processes in correspondance of the Palaeozoic reliefs. Local quiescence of volcanic activity is testified by the occurrence of conglomeratic deposits similar to those observed at the bottom of the basal volcano-sedimentary sequence (CTC); they are related to the lower part of a alluvial fan. Above the latest lies another volcano-sedimentary sequence (DL-RU-MI-AS Units), about 100 m thick, constituted both by dacitic lava bodies, occurring as domes and minor dikes, and foam magma overflows, separated by terrigenous+tuffaceous sedimentary levels which are deposited in fluvial-lacustrine environments. It must be emphasized that these sediments, which appear coeval to the volcanic activity, are probably related to basins originated by volcano-tectonic depressions produced as a consequence of AL eruption.

The most important explosive product of the latest sequence is RU Unit, made up of dacitic ash-pumiceous ignimbrite, about 20 m thick. The evidenced volcanological characters suggest that the RU eruption mechanism is likely related to overflow of foamy materials fluidized by the presence of magmatic gases which are responsable of thermal feedback phenomena that may be found at the top of the ignimbrite body, which is generally reddish in color owing to the thermal Fe-oxidation. The essentially explosive volcanic activity, ranging from dacites to rhyolites, is followed by andesitic lava dome eruption (giving locally autoclastic breccias) in lacustrine environment, which begins with products of water-magma interaction phenomena (peperites) observable in AS Unit, and also it continues with submarine pillow lavas after Aquitanian marine transgression.

Contemporaneously to the described volcanic activity, a generalized marine Aquitanian transgression begins with increasing rifting processes. The Marne di Ales (Upper Oligocene-Aquitanian) and the Marmilla Formation (Aquitanian-Lower Burdigalian), the latter containing intercalated basic to intermediate submarine volcanic products (pillow lavas and hyaloclastites), are typical of this first transgression; while the Marne di Gesturi Formation (Middle Burdigalian-Langhian), that represents a second marine transgression, contains only acid pyroclastic products which mark the last Cainozoic volcanic activity in Sardinia.

GEOTECTONIC FRAMEWORK OF THE NEOGENE VOLCANISM IN ROMANIA

I. BALINTONI, I. SEGHEDI & A. SZAKACS

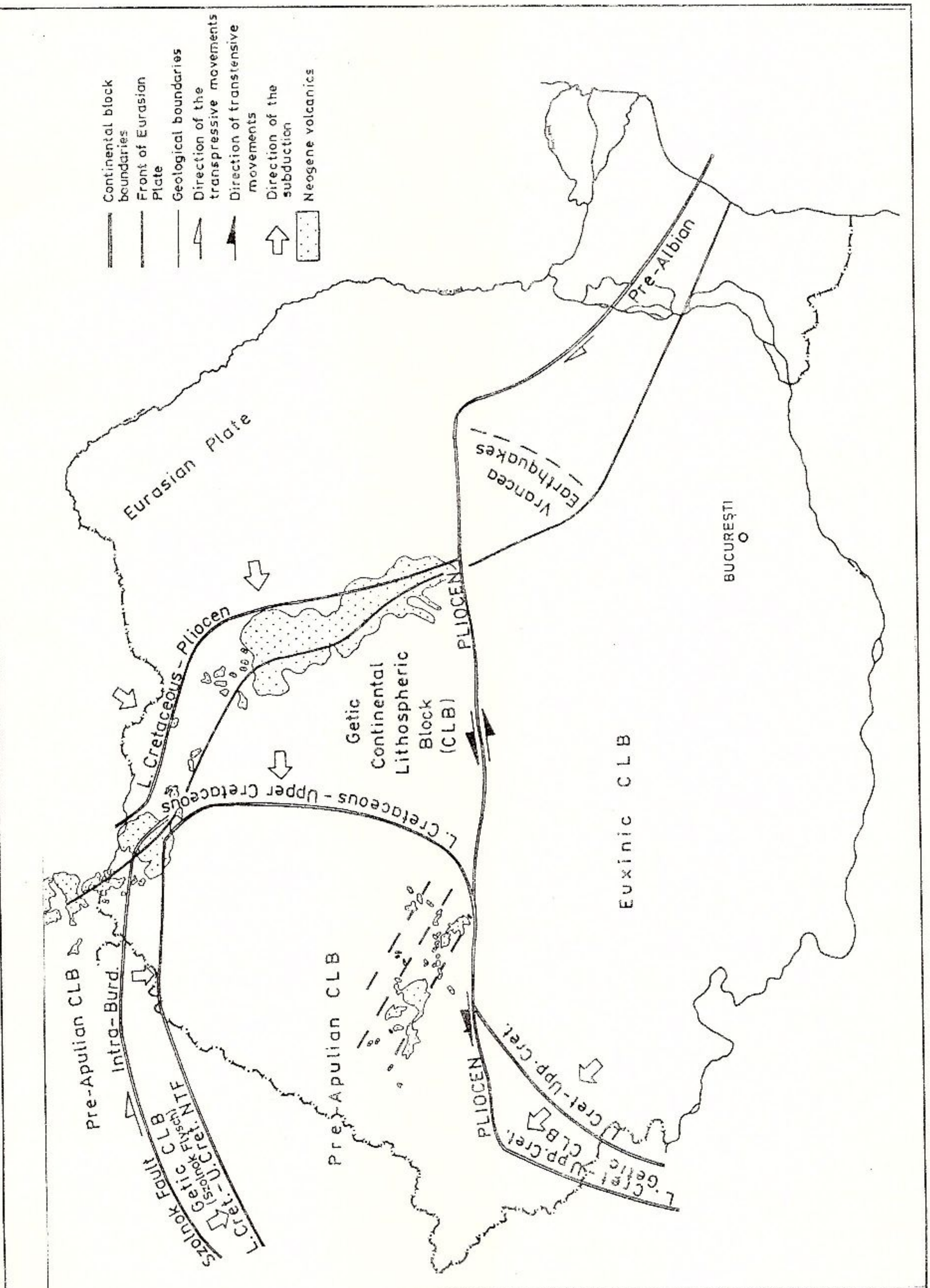
Geological Institute of Romania, Bucharest, ROMANIA

According to the distribution and the relations of the continental lithosferic blocks on the Romanian territory (Balintoni, 1994), Neogene magmatic rocks are distributed mainly along their contacts and at triple junctions (fig.). Time and space distribution of magmatism is directly related to the tectonic movements along the borders of the continental lithosferic blocks. The contact between the Getic block and the Eurasian plate is convergent being active from the upper Cretaceous (Sandulescu, 1984), but strongly reactivated during Early Miocene (18-16 Ma). The main crustal shortening lasted till the Pannonian, but some younger movements were recorded till Plio-Pleistocene times in the Brasov region (Royden, 1988).

Important shortening was recognized north of the North-Transylvanian fault, where the Getic block was overthrusted by the faster moving Zemplin block, detached from the pre-Apulian craton. In the same time lithospheric stretching and thinning within the intracarpathian realm initiated the Pannonian Basin. Extensive explosive silicic volcanism in both Pannonian and Transylvanian basins is related to these processes between 18-14 Ma. Then crustal shortening was accompanied by subduction of the Eurasian plate beneath the Getic continental lithosferic block allowing the generation of mantle-related calc-alkaline magmas. A complex suite of subduction-related volcanic and subvolcanic rocks, younger than 14 Ma, was generated along the limit between the Getic block and the Eurasian plate, above the assumed front of the latter - the Oas-Gutii, Tibles-Toroiaga-Rodna-Birgau and Calimani-Gurghiu-Harghita segments - pointing out the geometry of the actual collision zone (fig.). The obvious southward age progression along the Calimani-Gurghiu-Harghita volcanic chain (10 $\pm$ 0.2 Ma) corresponds to crustal shortening migration in the same direction. The high-K calc-alkali volcanics at the southern end of the chain are likely the result of downbending of the subducted slab to steeper angle at the junction of a convergent contact and a strike-slip one (Royden, 1982, Szakacs et al.1993).

The contact between the Getic and pre-Apulian continental lithosferic blocks is also convergent, but crustal shortening stopped at the Upper Cretaceous/Paleogene boundary when the banatitic magmatism was generated. The Neogene calc-alkaline magmatism (14-7.5 Ma) in the Apuseni Mts. is located along a NW-SE graben structure (Bleahu et al. 1981), on the pre-Apulian block toward the limit with the Euxinic and Getic blocks. The opening of the graben and the generation of the acid-intermediary calc-alkaline volcanism are related to the dextral transpressive movements along the central Hungarian fault, that bounds the Szolnok flysch to NW (Csontos et al.,1992). The same fault allowed the migration of the Zemplin block toward NE and generation of the Magura-Petrova and other Pienninic nappes described by Sandulescu(1984). In this context the tectonic setting of the calc-alkaline volcanism in the Apuseni Mts. with respect to the main tectonic boundaries is as yet not fully understood.

The northern contact of the Euxinic block was mainly of transtensive strike-slip type. This contact was last active in Pliocene-Pleistocene times (3-1 Ma) allowing the generation of contemporaneous extension-related shoshonitic magmatism at the SW ends of both Apuseni Mts. and East Carpathian volcanic ranges and alkali basaltic volcanism (Banat and Persani Mts. areas).


Continental block boundaries
Front of Eurasian Plate
Geological boundaries
Direction of the transpressive movements
Direction of transtensive movements
Direction of the subduction
Neogene volcanics
Eurasian Plate
Pre-Albian
Vrancea Earthquakes
BUCUREŞTI
L. Cretaceous - Pliocen
Getic Continental Lithospheric Block (CLB)
PLIOCEN
Euxinic CLB
L. Cretaceous - Upper Cretaceous
Pre-Apulian CLB
Intra-Burd.
Szolnok Fault
Getic CLB
(Szolnok Flysch)
L.Cret.-U.Cret. NTF
L.Cret.-Upp.Cret.
L.Cret.-Upp.Cret.
Getic CLB

NEOGENE ALKALINE VOLCANISM IN EUROPE - A REVIEW

Hilary DOWNES[1] & Marjorie WILSON[2]

[1]- Dept of Geology, Birkbeck College, University of London, London, UK
[2] - Dept of Earth Sciences, Leeds University, Leeds, UK.

Neogene alkaline volcanic activity in Europe ranges from mildly undersaturated alkali basalts through basanites and nephelinites to melilitites and even carbonatites. The nature of their mantle source can be investigated by examining the trace element and isotopic composition of the most primitive magmas, appropriately screened to remove any effects of crustal contamination.

Alkaline magmatism in Europe began in early Tertiary times and continued into the Quaternary, although Neogene magmatism is the most significant period in terms of volume of erupted products.

Neogene alkaline magmatism included the majority of volcanic events in the Massif Central, Ohre Rift and Pannonian Basin. Hoernle et al.(1995) recently showed that the ultimate source of the magmas is an asthenospheric upwelling which underlies most of central and western Europe. The isotopic signature of this upwelling mantle can be detected in all Neogene alkaline magmatic activity in Europe. The location of magmatism is affected by local tectonics, e.g.rifting (Limagne Graben, Ohre Graben and Rhine Graben), and back arc extension (Pannonian Basin). Modification of the asthenospheric signature occurs due to local subduction and interaction with the sub-continental lithosphere (lower crust, upper mantle). Xenoliths of lower crust and upper mantle origin are frequently entrained in the rising alkaline magmas, so their chemical and isotopic signatures can be well-constrained. In this paper, we present a comprehensive review of age determinations, Sr-Nd-Pb isotope data and trace element analyses, and show that the mafic alkaline volcanism is largely the product of mixed asthenospheric and lithospheric sources.

13

ACID EXPLOSIVE VOLCANISM IN THE SOUTH-WESTERN PART OF GUTAI MTS. (EAST CARPATHIANS, ROMANIA)

Alexandrina FULOP, Sorin HALGA

Cuart S.A., 4800 Baia Mare, Romania

Gutai Mts. are part of the Neogene volcanic chain of Eastern Carpathians. Their complex structure consists of lavas and volcaniclastic deposits, intrusions and extrusions developed during Badenian, Sarmatian and Pannonian.

The most extensive volcanism was active during the Pannonian when dacites, andesites and basalts were settled as lava flows, intrusions and extrusions. Volcaniclastic deposits also occur, related to both dacites and andesites.

The volcaniclastic deposit related to Sindileu dacite occurs in the Cicarlau area (Alunet valley and Curatura lui Ceardas valley). Previously, it was considered to be a volcano-sedimentary sequence (Alunet valley) or a pyroclastic deposit related to the Piscuiatu quartz-bearing andesite (Curatura lui Ceardas valley),without being described.

The aim of this paper is to analyse thiese deposits in volcanological term, that may complete the image on the volcanic evolution of Gutai Mts. The volcaniclastic deposits from Cicarlau area are composed of ignimbrites and co-ignimbrite fall deposits. The ignimbrites are unsorted, ungraded coarse deposits with grainsizes corresponding to lapilli tuffs and breccias. They are heterogeneous, the main components being pumice clasts, dacite clasts and matrix; sedimentary clasts seldom appear. Plagioclase feldspar and pyroxene crystals are rare. The pumice clasts have internal tube vesicle texture due to stretching during the flow. They contain very few plagioclase crystals. The dacite clasts are often vesiculated or have a fluidal texture and the massive aspects show perlitic cracks. They consist of very few plagioclase feldspar and pyroxene crystals and a glassy groundmass. The matrix is composed of glass shards with cuspate and platy shapes retaining the original bubble-wall shapes or slightly deformed and compacted during the flow. The co-ignimbrite fall deposits are well stratified and well sorted. They are composed almost entirely of bubble-wall pumice fragments and small amounts of strongly fragmented crystals. Small clasts of dacites are also present but very rare. Explosive processes responsible for these deposits followed the dome growth and lava outflow of the Sindileu dacite considered to be a flow-dome. These explosive eruptions partly destroyed the dome and the lava flow. Abundant fragments of the parent lava (dacite) can be recognised within the deposits.

15

UPPER OLIGOCENE-LOWER MIOCENE VOLCANOGENIC SEDIMENTS IN THE CENTRAL-WESTERN MEDITERRANEAN REGION: WHAT VOLCANIC SOURCE AREAS AND GEODYNAMIC IMPLICATIONS ?

F.GUERRERA[1], M.MATTIOLI[2], A.RENZULLI[2], P.SANTI[2], F.VENERI[3], A.ASSORGIA[4] and K.BALOGH[5]

1-Instituto di Geologia, Universita di Urbino, ITALY;
2-Instituto di Vulcanologia e Geochimica, Universita di Urbino, ITALY;
3-Instituto di Geologia Applicata Universita di Urbino, ITALY;
4-Dipartimento di Scienze della Terra, Universita di Cagliari, ITALY;
5-Institute of Nuclear Research of Hungarian Academy of SciencesDebrecen, HUNGARY.

Volcaniclastic deposits are very widespread in the Mediterranean Region, interbedded within several Upper Oligocene-Lower Miocene marine formations along the Apennines, Maghrebides and Betic Cordillera. These volcanogenic sediments are representatives of periods of intense volcanic activity and their compositions have been roughly referred, by several authors, to calc-alkaline magmas erupted in volcanic arc systems. If source areas of these volcanogenic sediments were established,palaeogeographic and geodynamic reconstructions during that time span could be inferred with much more detail.

The most important and intensive calc-alkaline volcanic activity during Upper Oligocene-Lower Miocene is recognizable by primary products outcropping in the following Mediterranean areas: Aegean Arc, Sardinia, Alboran Sea, Valencia Through,Gibraltar Arc, Kabylides and the adjoining Carpatho-Pannonian Arc and Anatolids. Since about 20 Ma an alkaline volcanism also occurred, mainly concentrated in the Massif Central (France). No comprehensive hypotheses have been put forward on the palaeogeographic locations of the volcanic arc systems related to the volcanogenic sediments of peri-mediterranean chains, although the central-western Mediterranean represents the most probable source area.

This volcanic activity is linked to geodynamic constraints (arc/back-arc systems on oceanic and/or more or less thinned continental crust) which could account for the palaeogeographic and palaeotectonic evolution of the whole central-western Mediterranean area.

In the Apennines the calc-alkaline volcanogenic products are distributed in the internal (e.g. Calabro-Lucano Fm., Tusa Fm., Cilento Group, Aveto-Petrignacola Sandstones Fm., Tripoli di Contignaco Fm.) and external (e.g. Macigno, Cervarola Fm., Vicchio Marls Fm., Roccadaspide Fm., Bisciaro-like Fms, Macchialupo and Serra Funaro Basin) geostructural domains. Also in Sicily (e.g. Troina-Tusa Fm., Mixed Successions, Numidian Sequence), North Africa (e.g. Oligo-Miocene Kabbyle Fm., Talaa Lakra Fm., Beni Ider Fm.) and along the Betic Cordillera (e.g. Vinuela Group, Algeciras Fm., Almidar Fm.) the volcaniclastics occur both in internal and external domains. In the Venetian Foreland Basin (e.g. San Gregorio and M.Baldo Sandstones, Montefumo Marls) and within the Ligurian-Piemonte Tertiary Basin (e.g. Antognola Fm., Pietra da Cantoni Fm., Pteropodi Marls, Rigoroso Marls, Tonengo Calcarenites) volcaniclastic deposits are characterized by both calc-alkaline and alkaline affinities. A direct relationship between primary volcanics and Apennine-Maghrebide-Betic volcanogenic sediments is not easy to detect. By contrast, in some central-western Mediterranean sectors primary volcanics and their volcanogenic sediments are well exposed in Upper Oligocene-Lower Miocene volcano-sedimentary successions (e.g. Sardinia) or pointed out by deep-sea drillings (e.g. Valencia Through).

Depositional mechanisms inferred for most of the studied volcanogenic sediments seem to be related to erosion and/or reworking of pyroclastics and lavas shortly after their eruptions and slumping into the basins. In fact, thicknesses, grain-size variations, textural features, wide but non-homogeneous areal distributions and crystal-glass shard-lithic relationships in many of these deposits are consistent with mass-flow processes rather than primary pyroclastic fallout. Resedimentation by turbidity currents may have represented the most commom mode of transportation of these volcanogenic sediments into Upper Oligocene-Lower Miocene sedimentary basins. This, as well as the large abundance of volcaniclastic material, imples a short distance between the source and the sedimentary basin.

Tuffaceous sandstones and crystal-rich volcaniclastic sandstones are very widespread, although, fine-grained ash layers, generally altered to clay minerals, are also recognized. Very often, regarding the Apennine volcaniclastics, Sardinia had been indicated as the source area but its location during Upper Oligocene-Lower Miocene can not fit with the inferred epiclastic mass-flow processes because it was located too far from the sedimentation basins. In fact, the Corsica-Sardinia block started to drift from the Provencal Margin just during the Burdigalian. In addition, possible epiclastic processes from Sardinia would be prevented by the complex palaeogeography. Due to distances of about 1000 km between Sardinia and the Upper Oligocene-Lower Miocene sedimentary basins, where volcaniclastics are now recognizable, a relationship with Sardinia volcanic activity can be plausibly invoked just for some thin and very fine-grained pelitic volcaniclastics but not for thick volcaniclastic deposits.

Most of the Upper Oligocene-Lower Miocene volcanogenic material dispersed throughout the Apennines, Maghrebides and Betides was erupted by volcanic source vents closer than Sardinia: available data seem to support the existence of volcanic arc systems adjacent to the sedimentary basins, and located in internal position with respect to the basins themselves. Upper Oligocene-Lower Miocene primary volcanics might have underwent quick erosional processes and/or subsidence. Additionally, remnants of volcanic edifices could have been buried and concealed at depth by underthrusting processes during the post-early Miocene tectonic evolution of the Apennines. Large amount of buried Tertiary primary volcanics underneath the Po Plain cannot be however excluded as an area of provenance for the studied volcaniclastics.

In order to establish magma-source (crustal or mantle-derived) and to better define magmatic affinity of these volcanogenic material, trace elements determinations on juvenile glass fractions are in progress. This geochemical approach, together with radiometric ages and a detailed reconstruction of depositional mechanisms of the volcaniclastic deposits, should be the most useful tools to highlight the location of volcanic source areas in the framework of the Mediterranean Oligo-Miocene geodynamic and palaeogeographic setting. These analytical efforts should provide fundamental data to define the early stages of the Mediterranean geodynamic evolution.

19

VOLCANOLOGY AND CHRONOLOGY OF THE TIHANY VOLCANO, BALATON HIGHLAND (PANNONIAN BASIN, HUNGARY)

Sz HARANGI[1]., K. NEMETH[1] & K. BALOGH[2]

1- Department of Petrology & Geochemistry, Eotvos University, Budapest, Hungary
2- Institute of Nuclear Research, Debrecen, Hungary

The Tihany Volcano is situated on a peninsula of the northwestern part of the Lake Balaton. It belongs to the Balaton Highland Volcanic Field (BHVF) and is considered to be one of the oldest volcanic edifice of the Late Miocene to Quaternary extension-related alkaline basaltic areas of the Pannonian Basin. It comprises entirely pyroclastic deposits that are unique among the basaltic volcanoes of the BHVF. During the last years we have carried out a detailed volcanological study and K/Ar radiometric dating to reveal the formation and the chronology of this volcano.

Although, the major element composition of the basaltic rocks of Tihany slightly deviates from the other alkaline basalts of the BHVF, they have similar trace element characteristics. They show a slight LILE-enrichment compared to average OIB and are close to the Gough-type OIB end-member.

Detailed stratigraphic, SEM and granulometric studies have revealed that formation of the volcanic complex of Tihany is mainly characterized by cyclic surtseyan-type phreatomagmatic explosive activity resulting in various pyroclastic surge (mainly wet surge) and fall deposits. Five stages have been distinguished during the evolution of the Tihany Volcano. The early stage hydrovolcanic activity was confined to the centre of the peninsula and were initiated by the interaction between basaltic melt and subsurface water, 200-300 m below the paleo-sea level. During this phase wet base surge deposits dominated. The second stage was characterised also mainly by surtseyan-type wet base surge series, however, they can be found predominantly at the Bay of Fured (northeastern part of the peninsula). Then, the phreatomagmatic volcanic activity shifted to the western coast of Tihany. A decrease in the water/magma ratio changed the style of the eruption resulting in mainly dry pyroclastic surge deposits. Depth of the volcanic explosion was probably shallower compared to that of the early explosions. The fourth stage was also characterized by surtseyan-type phreatomagmatic explosive volcanism again at the centre of the peninsula. Formation of the Lake Kulso is considered to belong to this phase of the volcanic activity. The tectonic and depositional characters indicate a maar-type origin. During the final phase Strombolian-type eruptions occurred at the northern part of the peninsula (Dios-Godros area). This type of the explosive activity suggests a significant decrease in the water/magma ratio resulting pure magmatic explosive volcanism.

At the western part of the Tihany peninsula the pyroclastic series contains large sedimentary blocks and bombs belonging to the Pa_2^2 (*Congeria balatonica*) level (Muller, pers.comm.), thus dating of this volcanic event confines better the position of *Congeria balatonica* level at the geological time-scale. Due to its stratigraphic importance a set of additional samples have been collected and dated.

The oldest pyroclastic series is considered to be found at the Monk's caves at the eastern part of the peninsula. Four additional samples have been analyzed from this locality. Together with the previous data they form a poorly defined isochron age of 7.55±0.83 Ma. Five samples have been dated from Diosteto, the fit to the straight line is only a little better than in the case of the previous one and defines an age of 7.15 ±0.69 Ma. Due to the greater scatter of K concentration in these samples (from 0.80% to 1.86%), this age is more reliablethan that obtained from the Monk's cave samples. Three samples from the Godros area result in ages ranging from 6.07 Ma to 5.24 Ma. Although these rocks belong to the youngest stage of the Tihany volcanic suite, the younger age could be interpreted in terms of alteration of the samples.

The new analyses support that the volcanic activity of the Tihany Volcano is a little bit older than 7 Ma. However, the frequent presence of excess Ar, the alteration of some of the basaltic fragments and the similarity of K concentration in most of the dated samples still causes some uncertainty. Successful preparation and dating of rock fractions with highly different K concentrations may help to establish an unquestionable timing of the volcanic process.

This work was partly supported by the Hungarian Research Fund (OTKA FO14122).

Fig. 1. Distribution of volcanic formations in the Tihany peninsula

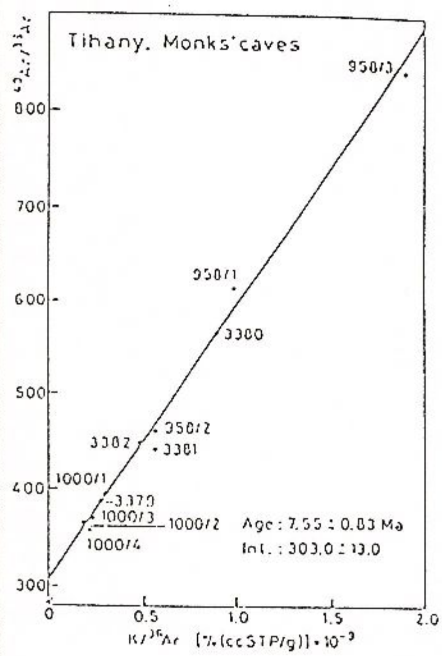


Fig. 2. Isochron diagram

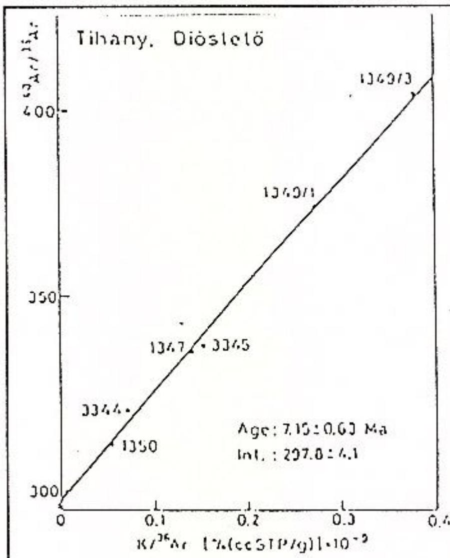


Fig. 3. Isochron diagram

23

LA QUESTION DU VOLCANISM CARPATIQUE EXTERNE PENDANT LE KERSONIEN - MEOTIEN INFERIEUR DE L'AVANFOSE DES CARPATHES ORIENTALES ET DE LA PLATFORME MOLDAVE

I. V. HUICA

Universite Petrol-Gaze Ploiesti, ROMANIA

Dans cette communication scientifique, on reunit les donnees en ce qui concerne les cinerites andesitiques et les gres tufitiques intercales dans les depots kersonien - meotien de l'avanfose des Carpathes Orientales et de la Platforme Moldave qui se trouvent dans la litterature geologique en ensemble, avec les resultats obtenus de l'auteur apres cinq annees de l'activite de terrain en districts Buzau, Vrancea, Bacau et Vaslui.

On insiste sur la repartition des cinerites andesitiques, des sables et des gres avec materiel andesitique sur des grandes surfaces comme: la Platforme Moldave, la courbure des Carpathes Orientales, le Bassin Comanesti et la Depression Getique.Suit la description des afleurements de cinerites andesitiques telle comme on ete observes en l'ete des annees 1972-1976, en commencant de la partie nord de la region, dans les secteurs suivants: la zone de l'est de Siret, la zone Cleja-Racaciuni, la zone de la vallee Trotus-la vallee Halos et la zone de la vallee Cremenet- Campuri.

L'epaisseur des couches de gres et de sables avec materiel andesitique de la zone de platforme et de la molasse externe varie entre 1 m. et 100 m.,mais dans le bassin Comanesti, le complex superieur areneux, cineritique touche 200 m.

Apres nos recherches, nous attirons l'attention sur des nouveaux afleurements avec des galets roules qui se trouvent dans la masse des cinerites andesitiques ou forment des bancs de conglomerats ou de microconglomerats avec l'epaisseur de 0.50-5.00 m.

Dans la plus grande partie des situations, les couches ne sont pas envahites de materiel terrigene que seulement accidentel.

Les eruptions volcaniques ont commencees en Kersonien, en se trouvant des fossiles index au cet sousetage: *Mactra caspia* , *M.bulgarica, M. intermedia, M. Crassicolis, M. orbiculata* dans la masse des cinerites andesitiques et des sables avec materiel cineritique.

L'activite maximum des volcanes a ete deroulee pendant du Meotien inferieur, quand on a ete depose l'orizont cineritique de Nutasca-Ruseni (Jeanrenaud, 1961-1971) mais en meme temps avec le debut du Pontien, les volcans ont cesse leur activite.

L'activite volcanique du chaine Harghita- Caliman a ete deroulee pendant le Pliocene superieur - Pleistocene inferieur, c'est a dire en arriere de l'activite volcanique de l'exterieur des Carpathes.

En ce qui concerne la formation des couches de cinerites andesitiques, nous avons arrive a la conclusion suivante: sur des fractures profondes ont ete insinuees des magmes andesitiques qui, par des explosions volcaniques ont genere des cinerites andesitiques; ces explosions ont eu lieu sous une couverture d'eau avec une epaisseur de 100- 300 m, ainci q'on ete possible que le materiel volcanique d'etre completement brise en petits morceaux sous l'eau; peut etre que dans les zones peu profondes,une partie de materiel volcanique a ete arrive a la surface en donnant naissance aux lapilli qui ont ete transportes a quelque distance de lieu d'explosion.

Tenant compte des donnes de la litterature de specialite, meme aussi des notre observations de terrain, nous avons arrive a la conclusion d'autochtonism volcanique carpatique externe du Miocene superieur- Pliocene inferieur de la Platforme Moldave et de l' avanfose des Carpathes Orientales.

25

EVOLUTION OF THE NEOGENE-QUATERNARY ALKALI BASALT VOLCANISM IN CENTRAL AND SOUTHERN SLOVAKLA (WEST CARPATHIANS)

V.KONECNY[1], K.BALOGH[2], O.ORLICKY[1], J.LEXA[1], D.VASS[1]

1- Dionyz Stur Institute of Geology, , Bratislava, SLOVAKIA
2- Inst. of Nuclear Research of the Hungarian Acad. of Sciences, Debrecen, HUNGARY

Alkali basaltic volcanism in central and southern Slovakia was active since the Upper Miocene to Quaternary time. It is situated mostly on stable blocks bordering young extension basins during the thermal stage of their subsidence. A local updoming contemporaneous with alkali basalts in the Cerova Vrchovina area may indicate the presence of a spatially limited mantle plume responsible for generation of alkali basalt magmas (P/T estimates for mantle xenoliths indicate recent adiabatic uprise).

Only scarce eruptive centres are known in the area of the Central Slovakia Neogene Volcanic Field dominated by andesites and rhyolites. Alkali basalts and basanites occur here as scattered necks, dikes, lava flows, and one cinder cone. Most of the alkali basalt to basanite volcanic activity took place in the area of southern Slovakia (Lucenec basin, Cerova Vrchovina hills), extending over the state boundary into northern Hungary. Numerous cinder cones, lava flows, necks, diatremes and maars have been observed.

Results of paleomagnetic measurements, K/Ar dating and variable relationship of volcanic products and morphology indicate, that volcanic activity of alkali basalts and basanites took place in several pulses (volcanic phases).

The oldest alkali basalt/basanite volcanic products are those in the area of central Slovakia, which are of Pannonian age, dated to 8.0-6.6 Ma. Slightly younger there are volcanic products of the Prodrecany basalt formation extending in the western part of the Lucenec basin, dated 7.2-6.4 Ma. This age is confirmed by rocks of the Poltar formation, which are of the Pontian age and lay over alkali basalt volcanic products belonging to the Prodrecany basalt formation.

Alkali basalts and basanites of the Cerova basalt formation extending over the Cerova Vrchovina hills are younger, of Pliocene to Quaternary age, dated 5.43-1.16 Ma. Owing to the mentioned synvolcanic updoming their relative elevation in the present landscape is related to their age: older volcanic products occupy relatively higher position on ridges, while younger volcanic products occupy relatively lower elevation in valleys. The youngest maars are at the level of recent alluvial flats. Their relationship to fluvial terraces indicates activity in the time of the Günz/Mindel glacials or after the Mindel glacial.

Cinder cone Putikov Vrsok and related lava flows in the western part of the Central Slovakia Neogene Volcanic Field is the youngest alkali basaltic volcanic activity manifestation in Slovakia. It is dated 0.53± 0.16 Ma. As the lava flow lays over the Riss terrace of the river Hron, its age is probably younger (0.13 - 0.22 Ma).

27

INTERMEDIATE CALC-ALKALINE VOLCANISM IN GUTAI MTS. (EASTERN CARPATHIANS): GEOCHEMICAL APPROACH

M. KOVACS[1], M. LUPULESCU[2]

1 CUART Company, 4800 Baia Mare, Romania
2 Dept. of Mineralogy, Univ. Bucharest, Romania

The Gutai Mts. belong to the Neogene/ Quaternary volcanic chain of the Eastern Carpathians. They represent the segment with the most complex volcanism in the northwestern part of the chain on the Romanian territory.

The intermediate volcanism consisting of explosive and effusive events with associated intrusions, developed during Sarmatian and Pannonian times (13.4 - 9.0 Ma) and, after 1 Ma of quaiescence, ceased with a basic phase (small intrusions of basalts) (8.0 - 6.9Ma).

The volcanic rocks are typical for the calc-alkaline suite, consisting of basaltic andesites, andesites, dacites and sparse rhyolites and basalts. Some important geochemical features - the calc-alkaline character, the lack of the typical tholeiitic and shoshonitic rocks and a general medium-K character - were emphasized by recent investigations carried out only on the andesitic (Kovacs et al., 1987, 1992). The present investigation includes the main rock types representing the products of the main volcanic phases (26 samples of basaltic andesites and andesites analysed by ICM-MS for more than 30 trace elements, 5 samples of dacites, one sample of rhyolite and one sample of basalt).

The La-Th and La-Ba diagrams (Gill, 1981) confirm the affiliation of the rocks to the subduction-related magmas. The REE contents are typical for calc-alkaline rocks. The chondrite-normalised REE diagram presents LREE enrichment, negative Eu anomaly and a insignificant fractionatiom of the HREE. It is worth to notice the similarity of the REE pattern for different types of rocks and of different ages. The same similarity can be pointed out in the chondrite-normalised spiderdiagrams (Thompson, 1984). The strong spiked pattern of Rb, Th, K suggesting enrichment, and characteristic trough at Nb, Ta and Ti suggesting depletion, are typical for the subduction-related volcanic arcs.

According to the recent interpretatios of Hawkesworth et al. (1991, 1994) regarding the destructive-plate margin rocks, the Gutai Mts. volcanics belong to the high Ce/Yb arcs with an average Ce/Yb ratio of 17.

The high values of the Rb, Rb/Sr and $^{87}Sr/^{86}Sr$ ratios (0.7065-0.7100) assert a significant crustal contamination of the magmas.This process took place during the crossing of the relative thick sialic crust or during the evolution of the magmas in shallow-crust magma chambers.

GEODYNAMIC ASPECTS OF THE NEOGENE VOLCANISM IN THE CARPATHO-PANNONIAN REGION

Jaroslav LEXA

Dionyz Stur Institute of Geology, Bratislava, SLOVAKIA

Mutual confrontation of ideas concerning evolution of the Carpathian arc, back-arc extension and volcanic activity during the Neogene - Quaternary time contributes to the general understanding of each one of the mentioned phenomena.

Lexa et al. (1993) have distinguished in the Carpatho-Pannonian region four essential types of volcanic activity: (1) areal type silicic volcanism related to back-arc extension processes, (2) areal type andesite volcanism related to advanced stages of back-arc extension processes, (3) arc-type andesite volcanism related to subduction processes in front of the Carpathian arc, (4) alkali basalt volcanism related to late stage back-arc extension processes. All four types of volcanic activity migrate generally eastward in time (with a great deal of overlapping), their timing in individual parts of the region allowing for an indirect estimate of governing geotectonic processes.

The areal type silicic volcanism indicates especially initial stages of back-arc extension in of a thick crustal environment, corresponding to initial stages of related subduction process in the outer flysch belt of the Carpathians (Eggenburgian in the western part, Early Badenian in the eastern part).

The areal type andesite volcanism indicates more advanced stages of back-arc extension accompanied by basin and range tectonics and progressive thinning of the crust, corresponding to ongoing process pulling the arc (Early Badenian to Sarmatian in the western part, Late Badenian to Pannonian in the eastern part). The onset of the arc type andesite volcanism indicates the moment when the subducted slab has reached the depth to generate andesite magmas (approximately 150 Km), its termination indicates the termination of the subduction process. A shift of volcanic alignment in time towards the subduction zone indicates a progressive verticalization of the subducted slab, owing to termination of the subduction zone retreat when reaching the continental margin and related compression of the accretion prism during arc/continent collision. In the given time the position of volcanic axis which respect the front of the accretionaria prisms gives us the geometry of the subduction zone. The timing of the arc type andesite volcanism is following. Late Badenian in the westernmost segment (Vah river valley Pieniny), Early Sarmatian in Slanske Vrchy mountain range and south-eastward into northern Romania, Middle Sarmatian in the segment from Pieniny to Beregovo area, Late Sarmatian to Early Pannonian in the segment Vihorlat- Gutai Mts., Pannonian in the segment Gutai Mts.-Tibles-Rodna in northern Romania, Pontian to Quaternary in the segment Calimani- Harghita in central Romania. The short duration of volcanic activity in individual segments implies, that subduction process was terminated shortly after the slab has reached appropriate depth. It follows, that the outer flysch basin, whose crust was subducted, needed to be at least 200 Km wide, however, no more than 250 to 300 Km, otherwise the volcanic activity would continue for a longer time. Subduction processes are progressively younger eastward along the arc, perhaps implying slab detachment mechanism. The alkali basalt volcanism indicates transition to the geotectonic regime following active subduction processes in the given segment of the arc (Late Pannonian-Pontian in the western part, Late Pliocene-Pleistocene in the easternmost part).

31

NEOGENE MAGMATISM IN SOUTHEASTERN SPAIN

Herve LEYRIT[1], Christian MONTENAT[1], Francisco SERRANO[2], Jean HERNANDEZ[3] & Pierre BORDET[1]

1- Inst Geologique Albert-de-Lapparent (IGAL) - Inst. Polytechnique Saint-Louis Cergy-Pontoise , FRANCE.

2- Departamento de Geologia - Facultad de Ciencias - Universidad de Malaga , SPAIN.

3- Universite de Lausanne - Inst de Mineralogie- Petrographie, Lausanne-SUISSE.

The Miocene sedimentary series are located within the internal zone of the Betic Cordilleras, between Almeria and Alicante. Late Miocene deposits are predominantly deep marine planktonic-rich sediments. A diversified Neogene magmatic activity is closely related to the Trans-Alboran shear zone. It includes volcanic, plutonic and metallogenic events which interfered with the tectonic and sedimentary processes.

Neogene volcanism is restricted to the easternmost part of the Betic Cordileras. It may be split into four major belts : (1) the Cabo de Gata group (CGG), (2) the Mazarron group, (3) the lamproite group and (4) the alkali basalts group.

(1) Located in the Cabo de Gata (NE of Almeria), the CGG represents one of the most important Miocene volcanic complexes of the Mediterranean (about 500 km outcropping; more than 1000 m in thickness of drilled volcanics below sea level). The CGG include several calk-alkaline sequences referenced as sequences A to D. The sequences A is composed of two different petrochemical suites: low-K andesites (Aa suite) overlain by a thick pile of dacites, rhyolites and ignimbrites enriched in K2O (Ab suite). Several flow of Aa suite are interbedded with pelagic marls and turbidites which are late Burdigalian - early Langhian. The age of Ab suite is not precise, probably Serravalian. The sequence B is composed of low-alkali rocks (domes and brecias) ranging from andesites (the most frequent) to dacites and rhyolites. Ages (K-Ar) range from 12.4 to 9.3 Ma. Sediments interbedded within sequence B are calcarenites abounding with *Heterostegina* indicating an upper Tortonian age. The sequence C is an acid suite (ignimbritic rhyolites) locally strongly enriched in K_2O and hydrothermalized, located in the central

part of the CGG (gold ore deposits of Rodalquilar). K-Ar datation of rhyolites indicate 8.9 - 8.7 Ma. The sequence C is capped by Messinian reefs. The sequence D corresponds to low-alkali andesites (similar to sequence B) grouped in several volcanoes located closes to the coast (San Jose, Roldan,etc.). No stratigraphic relationships between sequence C and D are observed, but ages are comprise between 8.7 and 7.5 Ma. Various plutonic equivalents (gabbros to granodiorites) of these volcanics are evidenced by the way of erupted pebble-dykes.

(2) The Mazarron group is another calc-alkaline sequence with high Al content, derived from shallow crustal anatexis from the Betic metamorphic sequence basement. It includes a variety of dacitic to rhyolitic volcanoes located in outer position with regard to the CGG (figure). The volcanics cut early Tortonian pelagic deposits (Cartagena) or are interbedded with late Tortonian marls (Hinojar-Mazarron). Radioisotopic datings (K-Ar) give ages comprise between 8.3 and 6.6 Ma.

(3) The lamproites group are represented by ultrapotassic-basic volcanics of deep mantelic origin. They are present as small bodies (pipes, dikes, sills, cones and flows) scattered on a large area to the west and northwest of the preceding groups. These lavas are interbedded within Messinian deposits or intruded in basal Messinian. Isotopic K-Ar ages range from 7.0 to 5.7 Ma.

(4) The alkali basalts group occur in the Cartagena area. Some of these lavas contain large ultramafic and high metamorphic inclusions. These volcanics are Pliocene (from 2.8 to 2.6 Ma).

References

Bellon H., Bordet P. & Montenat C. (1983) - Le magmatisme neogene des Cordilleres Betiques (Espagne).Bull.Soc.Geol.France(7),25, p. 205-218.

Bordet P. (1985) - Le volcanisme miocene des Sierras de Gata et de Carboneras. Doc.& Trav. IGAL n.8, 70 p.

Bordet P., Esquevin J. & Larouziere F.D. de (1982) - Sur l'age tortonien de certains des granitoides inclus dans les conglomerats miocenes de l'Espagne du Sud-Est. C.R. Acad. Sci. Paris, 295, p. 483-486.

Bordet P. & Larouziere F.D. de (1982) - Granitoides et plagiogranitoides dans le Tortonien de l'Espagne du Sud-Est, C.R.Acad.Sci.Paris, 295, p. 591-594.

DiBatistini G., Toscani L., Iaccarino S. & Villa I. (1987) - K-Ar ages and geological setting of calc-alkaline volcanic rocks from Sierra de Gata, SE Spain.Neues Jhrb. Miner. Mh.H8, p. 369-383.

Hernandez J., Larouziere F.D. de, Bolzee J. & Bordet P. (1987) - Le magmatisme neogene betico- rifain et le çouloir de decrochement "trans-Alboran". Bull. Soc. Geol. France (8) ,3, p. 257-267.

Larouziere F.D. de, Bolze J., Bordet P., Hernandez J., Montenat C. & Ott d'Estevou P. (1988) - The Betic segment of the Lithospheric Trans-Alboran shear zone during the Late Miocene. Tectonophysics, 152, p. 41-52.

Montenat C. Editor (1990) - Les bassins neogenes du domaine betique oriental (Espagne) Doc. & Trav. IGAL no. 12-13, 392 p.

Montenat C., Bolze J., Bordet P. & Ott d'Estevou P. (1984) - Extrusion de type "pebble dyke" a elements plutoniques miocenes dans le Tortonien des Cordilleres betiques orientales, Espagne.C.R.Acad.Sci.Paris, 299, p. 343-346.

Montenat C. & Serrano F. (1994) - Potential integrated Miocene stratigraphy in Southeastern Spain.Bull.Liais. & Inform. IUGS Sub.Geochron., vol.l2, p. 67-73.

Serrano F. (1992) Biostratigraphic control of Neogene volcanism in Sierra de Gata (southeast Spain). Geol. Mijn., 71, p. 3-14.

THE CATALAN VOLCANIC ZONE (NE SPAIN): AN OUTLINE

J. MARTI[1] ,J. MITJAVILA[1] & E.R. NEUMANN[2]

1 - Institute of Earth Sciences Jaume Almera (CSIC), Barcelona, SPAIN.

2 - Mineralogisk-Geologisk Museum, University of Oslo, Oslo, NORWAY.

The Catalan Volcanic Zone (CVZ) exhibits the greatest concentration of Middle Miocene to recent volcanism in the Valencia Trough. The CVZ is mainly represented by poorly differentiated alkaline basalts (leucite basanites, basanites and olivine basalts). The presence of ultrabasic xenoliths is characteristic of some volcanoes. The xenoliths may be divided into pyroxenites, melagabbros, amphibolites and spinel lherzolites, the pyroxenites being the most abundant.

The CVZ is characterized by cinder cone eruptions along fissure zones. The existence of hydromagmatic events is also common. Small-sized cinder cones were produced during short-lived monogenetic eruptions associated with widely dispersed fractures of short lateral extent. This suggests that each eruption was caused by an individual batch of magma which was transported rapidlyfrom the source region, each batch representing the products of an individual partial melting event. The total volume of extruded magma was relatively small, suggesting a low magma supply rate.Nevertheless, the volume of extruded magma seems to increase progressively from the early episodes.

The CVZ is associated with extensional tectonics and can be explained within the framework of a low volcanicity rift model. This intraplate volcanism results from partial melting due to extension-driven decompression. A progressive increase in the extension rate from the early to the last volcanic episode has occurred, favouring the interaction of two mantle sources.

SUB-SEA BOTTOM INTRUSIVE SILL FED BY A SUBAERIAL LAVA FLOW-ACTIVITY OF 1779-80, SAKURAJIMA VOLCANO, SOUTHWEST JAPAN

Ono KOJI

Oyo Corporation, Ichigaiya Bldg., Tokyo , JAPAN

An-ei islets of the northeast coast of Sakurajima emerged from the sea, 140m in depth, during the activity of Sakurajima volcano of 1779-80. This paper argues about the genesis of the islets by topography, geology and historic documents.

AN-EI ERUPTION OF 1779-80: Sakurajima volcano is is presently the most active volcano in Japan. Its cone-forming, large-scale eruptions occur at the interval of a few hundred years and erupt 1-2 km^3 of andesite-dacite pyroclastics and lava flows. The last but one of such large eruption was the activity of 1779-80 in An-ei era. The main phase of the eruption was a plinian pumice ejection and lava extrusion from the vent of the NE and SW flanks. These vents probably are located on and fed by a NNE-SSW- trnding dike. Both lavas flowed down the flanks and entered into the sea in a few days from the start of eruption.

EMERGENCE OF ISLETS: The first appearance of an islets, 400m northeast off the front of the NE lava flow, was one week after the entrance of the lava into the sea. The second islets neighboring to the northeast of the first appeared on the next day. Four first-stage islets were successively emerged in four months. In the second stage another two islets were grown slowly during more than half a year following the first stage. Submrine explosions accompanied by tsunami occurred several times during and sometimes after the growth of the islets.

TOPOGRAPHY AND GEOLOGY: Detailed mapping of submarine topography revealed that the islets are located on branching submarine ridges rooted to a point of the sea-entered lava flow. Large craters up to 400m in diameter are found along the submarine ridges. The first-stage islets are made of andesites lavas with water-chilled surface. While, the second stage islets are mainly of submarine pumice flow deposits topped by a clay beds with abundant marine shell fossils

(5,300 14_C y BP). Clearly they are uplifted sea-bottom sediments. Huge andesites bombs with bread-crust skin are scattered on an islet.

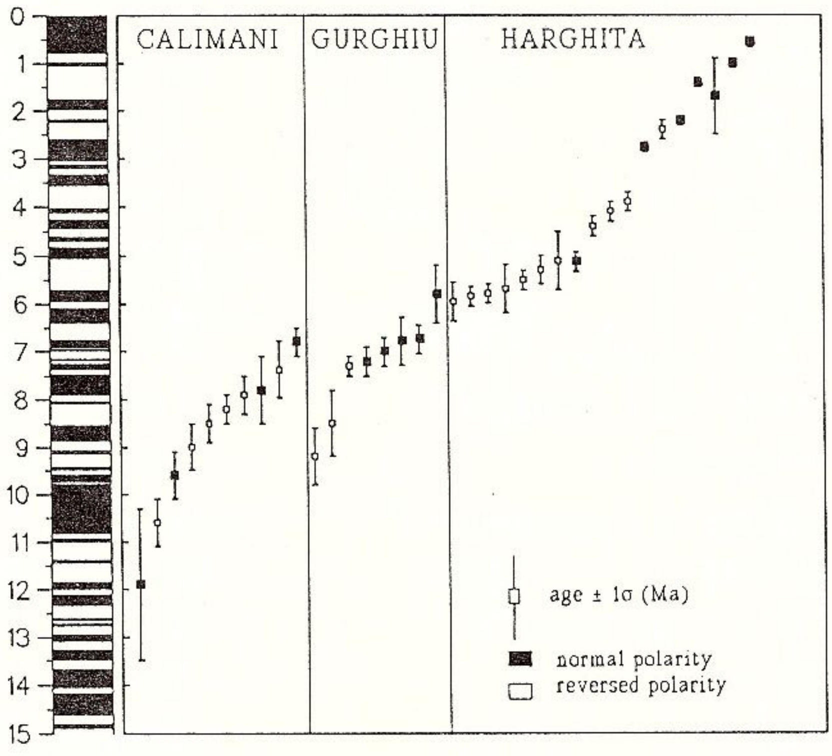
GENESIS OF ISLETS: The first-stage islets are the top parts of a subaqueous lava flow extended from the land lava entered into the sea. The second-stage islets are made of uplifted sea-bottom sediments. Large submarine craters along the ridges and the huge bombs on the islet have to be resulted from the explosions in historic records. The uplift was due to an intrusion of a sill or lacolith-form (the existence of andesites was confirmed by a recent drill). The lava entered in the sea apparently rode on the sea bottom just after the entrance, but heavy andesite lavas broked the structure of soft-bottom sediments, dropped down to a level and extended as a sill or a lacolith on the level by gravity potential to drain the inside non-solidified part of the land-lava.

CORRELATION BETWEEN K-AR DATA AND THE MAGNETIC POLARITY ALONG THE CALIMANI-GURGHIU-HARGHITA CHAIN (EAST CARPATHIANS)

C.PANAIOTU[1], C.E.PANAIOTU[1], St. PATRASCU[1], S.VOINEA[1], A.SZAKACS[2], I.SEGHEDI[2], Z. PECSKAY[3]

1- University of Bucharest, ROMANIA
2- Geological Institute of Romania, Bucuresti , ROMANIA
3- Institute of Nuclear Research of the Hungarian Academy of Sciences, HUNGARY

The available K-Ar datings and magnetic polarity data from the Calimani-Gurghiu-Harghita volcanic chain are correlated in this study. All the paleomagnetic sites with the latitude of the virtual geomagnetic pole greater than 45^0 were rejected from this analysis. The paleodirections of the Earth magnetic field recorded at these sites represent probably intermediate direction during the transition between two magnetic polarities or excursion of the geomagnetic field. In the figure K-Ar dataobtained from the sites which were sampled for paleomagnetism are represented. The polarity time scale used for the correlation of the magnetic polarity and the K-Ar data is that provided by Cande and Kent (1992). In most cases there is a good agreement between the observed magnetic polarities and the expected magnetic polarities according to the K-Ar data and the polarity time scale. Considering the confidence limits of the K-Ar data and those of the polarity time scale, in a few cases (e.g. Bacta-Gurghiu, northeastern part of South Harghita, southernmost Harghita) we suggest some minor correction to the K-Ar data. If we consider all the available magnetic polarity data, the general pattern agrees with the succession of the volcanic rocks suggested by the K-Ar data.



0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
CALIMANI
GURGHIU
HARGHITA
age ± 1σ (Ma)
normal polarity
reversed polarity

SPACE AND TIME DISTRIBUTION OF NEOGENE-QUATERNARY VOLCANISM IN THE CARPATHO-PANNONIAN REGION

Z. PECSKAY[1] , J. LEXA[2] , A. SZAKACS[3], K. BALOGH[1] , I. SEGHEDI[3] , V. KONECNY[2] , M. KOVACS[4], E. MARTON[5] , M. KALICIAK[6] , V. SZEKY-FUX[7] , T. POKA[8] , P. GYARMATI[7] , O. EDELSTEIN[4] , E. ROSU[3] , B. ZEC[6]

1 Institute of Nuclear Research of the Hungarian Academy of Sciences, Debrecen, HUNGARY.

2 Dionyz Stur Institute of Geology, Bratislava, SLOVAKIA.

3 Geological Institute of Romania, Bucuresti, ROMANIA.

4 Cuart S.A., Baia Mare, ROMANIA.

5 Eotvos Lorand Geophysical Institute, Budapest, HUNGARY.

6 Dionyz Stur Institute of Geology, Branch Kosice, Werferova ,Kosice, SLOVAKIA.

7 Department of Mineralogy and Geology, Kossuth University, Debrecen, HUNGARY.

8 Laboratory for Geochemical Research of the Hungarian Academy of Sciences, Budapest, HUNGARY.

An important amount of geochronological (K-Ar, F.T.), biostratigraphical and paleomagnetic data has been accumulated during the last decade enabling for the first time to obtain a resonably accurate picture of the space and time distibution of the Neogene-Quaternary volcanics in the Carpatho-Pannonian realm.

The Neogene volcanic activity started with high-volume acid calc-alkaline explosive eruptions accompanied by ignimbrite and ash-fall tuff emplacement. The oldest K-Ar ages (20 Ma) for these rocks were found partly in the Pannonian Basin and partly in the West Carpathians.

During the middle Miocene to Quaternary (17-0.2 Ma) calc-alkaline, mainly intermediate stratovolcanic complexes were formed in the West Carpathians and East Carpathians, respectively.

Within the alkaline (shoshonitic, alkali-basaltic, K-trachytic and ultrapotassic) volcanism two age groups can be distinguished: an older group (17-7 Ma) and a younger one (6-0.5 Ma).

Quaternary volcanic activity is confined to the West Carpathians, East Carpathians, Persani Mts. and Apuseni Mts.,including both calc-alkaline, shoshonitic and alkali-basaltic rock suites.

The available radiometric data show a very complex picture of the magmatic evolution, locally displaying across-arc (e.g. Slanskye Vrchy Mts. in the West Carpathians) or along-arc (e.g. Calimani-Gurghiu-Harghita in the East Carpathians) migration of the magmatic activity.

RECENT K-AR DATINGS OF NEOGENE-QUATERNARY CALC-ALKALINE VOLCANIC ROCKS IN ROMANIA

PECSKAY[1] Z., EDELSTEIN[2] O., SEGHEDI[3] I., SZAKACS[3] A., KOVACS[2] M., CRIHAN[2] M., BERNAD[2] A.

1 Institute of Nuclear Research of the Hungarian Academy of Sciences, Debrecen, HUNGARY
2 "Cuart" Company, Baia Mare, ROMANIA
3 Geological Institute of Romania, Bucuresti, ROMANIA.

Neogene-Quaternary plate convergence related calc-alkaline magmatic rocks from Romania were dated on the basis of K-Ar determinations.

The magmatites occur in Apuşeni Mts. and East Carpathians. In the East Carpathians the discontinuous magmatic arc is segmented in two main volcanic areas, Oas-Gutai (OG) and Calimani-Gurghiu-Harghita (CGH) at the extremities and an intrusive (subvolcanic) segment (Tibles-Toroiaga-Rodna-Bargau: TTRB) in the middle.

According to biostratigraphical data the volcanic activity started in Badenian, but the oldest dated rocks are at 14.6 Ma.

The volcanic activity ceased at about 0.2 Ma.

The preliminary data from Apuseni Mts. suggest Sarmatian as the main interval for developing magmatic activity (10.7-13.4 Ma).

The range of apparent ages during Pannonian (9-11 Ma) in TTRB is partly coeval with that of OG reflecting the paroxysm of the magmatic activity. The longest interval of activity was detected in Gutai Mts. (13.5-6.9 Ma).

An obvious age progression along the arc was pointed out for CGH volcanic chain, enhanced along the terminal 40 km of SouthHarghita Mts. (4.3-0.2 Ma).

45

GEOCHRONOLOGY OF THE NEOGENE VOLCANISM IN THE VIHORLAT MOUNTAIN RANGE (EASTERN SLOVAKIA)

Z. PECSKAY[1], M. KALICIAK[2], V. KONECNY[3], J. LEXA[3]

1 Institute of Nuclear Research of the Hungarian Academy of Sciences, Debrecen, HUNGARY
2 Dionyz Stur Institute of Geology, Kosice, SLOVAKIA
3 Dionyz Stur Institute of Geology, Bratislava, SLOVAKIA

Eroded andesite stratovolcanoes of the Vihorlat mountain range represent the oldest western part of the East Carpathian volcanic arc. In the mountain range structure there are distinguished four essential lithostratigraphic units:

1.Mostly reworked, fine grained rhyodacitic tuffs (Hrabovec tuffs) interbedded with the fauna bearing late Early Badenian marine sediments underneath the volcanic complex. Thickness of the tuff horizon is 20-50 m.

2. Rhyodacite extrusive dome underlying rocks of the Popriecny andesite stratovolcano Radiometric dating at 12.0 $\pm$0.5 m.y. indicates Middle Sarmatian age, which should be considered as the minimum age of emplacement.

3. Extrusive domes, lava flows and related coarse breccias of hornblende-pyroxene and leucocratic pyroxene andesites (Vinne complex) underlying rocks of the Kyjov andesite stratovolcano in the western part of the mountain range. Epiclastic volcanic breccias assigned to this complex on the basis of petrographic composition are interbedded with the Middle Sarmatian marine sediments. Radiometric dating at 2.0+0.5 and 12.6+0.6 Ma indicates Middle Sarmatian age in agreement with structural position and biostratigraphic evidence.

4. The mountain range itself is build of several basaltic andesite/pyroxene andesite stratovolcanoes, still pronounced in morphology. Stratovolcanoes are grouped into two alignments: (A) the eastern branch aligned in the NW-SE direction and continuing

south-eastward into Ukraine and Northern Romania, represented by isolated volcanoes Morske Oko, Diel and Popriecny; (B) the western branch aligned in the NE-SW direction, represented by smaller overlapping volcanoes Vihorlat, Sokolsky porok and Kyjov, which may be considered as parasitic ones with respect the Morske Oko stratovolcano, evolved along the system of transversal faults.

Central zones of stratovolcanoes are represented by remnants of effusive/pyroclastic volcanic cones, by intrusions of andesite/diorite porphyry, and by hydrothermaly altered rocks. In proximal zones they are formed of lava flows and subordinate coarse reworked pyroclastic and epiclastic rocks. Periclinal dips up to 20 degrees have been observed. Reworked pyroclastic rocks and epiclastic breccias, conglomerates and sandstones dominate in distal zones of stratovolcanoes.

Monogenetic volcanoes Kyjov, Sokolsky potok and Vihorlat are built of medium grained basaltic andesites to two-pyroxene andesites. Larger stratovolcanoes Morske Oko, Del, Popriecny evolved in two stages: the first stage is represented by medium grained basaltic andesites to two-pyroxene andesites as in the case of other volcanoes; the second stage involves more evolved rocks, porphyritic andesites, leucocratic pyroxene andesites and fine grained basaltic andesites.

Activity of all mentioned andesitic stratovolcanoes was contemporaneous. No reliable biostratigraphic data are available. Superposition over the above mentioned Middle Sarmatian rocks and radiometric data in the range 11.8 to 10.2 m.y. place the volcanic activity into the interval Middle Sarmatian - Early Pannonian. The youngest radiometric data 9.7 and 9.4 m.y. correspond to the late stage lava neck of the Vihorlat stratovolcano, respectively to the late stage dyke of the Diel stratovolcano.

47

NEW DATA CONCERNING THE EVOLUTION OF NEOGENE VOLCANISM IN THE APUSENI MOUNTAINS

E. ROSU[1] , A. STEFAN[1] , Z. PECSKAY[2] , Gh. POPESCU[1]

1. Geological Institute of Romania, Bucuresti, ROMANIA
2. Institute of Nuclear Research of Hungarian Academy of Sciences, Debrecen, HUNGARY

In the Apuseni Mountains the Neogene volcanic activity developed in three main episodes. The first one begin in Langhian and is represented by rhyodacitic tuffs, sometimes interbedded with globigerine bearing marls (Hartagani), anologus to "Dej tuff".

The second episode, prevailingly is constituted by large volume calc-alkaline andesitic rocks and is attributed to Kossovian-Pontian interval. The first products are represented by andesitic volcaniclastics (quartz andesites with amphibol and biotite) interbedded with Spirialis Marls strata (Zlatna, Hartagani, Brad,Sacaramb) (a volcano-sedimentary formation). The explosive intrusive breccias related to Rosia Montana and Bucium Rodu rhyodacites and dacites (13.5+1.1 Ma) were probably also generated in this episode. During Kossovian in Zarand area the volcanic activity generated a volcano-sedimentary formation constituted mainly by amphibol-pyroxene andesites.

The volcanism continued with quartz andesites with amphibol, biotite + pyroxene which pierce and cover the Kossovian volcano-sedimentary formation at Sacaramb (13.6$\pm$ 0.96 Ma, isochrone age, Lemne et al.1983), Brad (12.9+0.5 Ma) and Zlatna. The previous mentioned andesites occur also at Deva, Bucium, Baia de Aries,without yet being dated. The similar andesites (Cetras type) from Hartagani-Sacaramb area suggest a larger time interval of generation (10.9 $\pm$ 0.5 Ma, Lemne et al. 1983). The amphibol andesites and especially the amphibol and pyroxene andesites (Barza type) are largely developed as lavas, pyroclastics and enrooted bodies in Brad (12.4+1.2 Ma), Bolcana-Hondol, Zlatna, Bucium areas and less in Zarand Mountains (13.4$\pm$1.2 Ma).

In Zarand area the pyroxene andesites prevail and outcrop as pyroclastics, lavas and enrooted bodies (12.4$\pm$0.7 - 13.0$\pm$0.7 Ma). The distal facies sedimentary strata intercalated in these pyroxene andesites volcaniclastics were dated paleontologically to the Lower Volhinian (Minisul de Sus); these deposits are covered by Upper Basarabian limestones at Almas-Crocna (Sagatovici, 1968).

The next volcanic products are represented by brown amphibol and pyroxene andesites, often with megaporphiric texture. Their age is Upper Sarmatian-Pannonian (?) (12.52±0.62 Ma) in the Western and Central part of the Apuseni Mountains and Pannonian at Rosia Montana (9.3 ± 0.47 Ma) and Baia de Aries.

The last magmatic products in Hartagani-Sacaramb area are represented by small andesitic bodies with alkaline features (Zambrita Hill, Toader Brook) (10.5+0.42 Ma). In Rosia Montana - Bucium area the last products are the Detunata basaltic andesites (7.39± 0.35 Ma).

The third episode is the youngest one, and is represented by latites from Uroiu Hill (Simeria). Their age is 1.6±0.11 Ma.

GEOCHRONOLOGY OF NEOGENE-QUATERNARY VOLCANIC ROCKS IN ROMANIA

I. SEGHEDI[1], A. SZAKACS[1], M. KOVACS[2], E. ROSU[1], Z. PECSKAY[3]

1 Geological Institute of Romania, Bucharest, ROMANIA
2 Cuart S.A., Baia Mare, ROMANIA
3 Institute of Nuclear Research of the Hungarian Academy of Sciences, Debrecen, HUNGARY

Neogene-Quaternary magmatic rocks in Romania correspond to calc-alkaline (acid and intermediate), shoshonitic and alkali-basaltic series groups. The magmatites occur mainly in the East Carpathians and Apuseni Mountains, as well as in the Transylvanian Basin and Banat area.

The acid (mainly rhyolitic) calc-alkaline volcanics,represented by tuffs, are the older ones, widely recognized in the whole Transylvanian Basin, as well as in the Extracarpathian zone and eastern part of the Pannonian Basin (e.g. Banat area). They are interbedded with Lower Badenian sedimentary strata. Acid tuffs were recognized also in Kossovian in the northern Romanian territory (Baia Mare-Maramures area).

The intermediate calc-alkaline volcanism is largely distributed in East Carpathians and Apuseni Mountains. The rocks covèr a large range from basalts to rhyolites, being mostly represented by andesites. The volcanic activity generated stratovolcanic edifices and domes (Oas-Gutai segment and Calimani-Gurghiu-Harghita segment in East Carpathians and Zarand segment in Apuseni Mountains), or shallow intrusions clustered in Tibles, Toroiaga, Rodna, Bargau segment (East Carpathians) and northeastern part of the Metaliferi area (Apuseni Mountains). The volcanic activity started in East Carpathians at 13.4 Ma in Gutai Mountains and ended at ca. 0.2 Ma in South Harghita Mountains, showing along-the-arc age progression. In the Apuseni Mountains the magmatic activity developed between 14.6-7.4 Ma.

Shoshonitic magmatism is present as minor occurrences in the southern part of South Harghita Mountains (1.2-2.2 Ma) as well as at the southeasternmost extremity of Neogene volcanic area of Metaliferi Mountains (1.6 Ma).

Alkali-basaltic volcanism are encountered in the Persani Mountains and the Banat area. It is represented by simple or complex small-sized volcanic edifices of both explosive and effusive activity. According to K-Ar data the range of volcanic activity is 2.2-0.35 Ma in the Persani Mountains and 2.5-2.9 Ma in Banat.

The close space-time relations of the calc-alkaline, shoshonitic and alkali-basaltic volcanism at the Neogene-Quaternary boundary correspond to important distensive tectonic movements at this period

CIRCUMMEDITERRANEAN POST COLLISIONAL NEOGENE VOLCANIC ARCS: BETICS (SOUTH-EAST SPAIN) AND EAST CARPATHIANS (ROMANIA) - A COMPARATIVE APPROACH

I. SEGHEDI[1], J.L. BRANDLE[2], A. SZAKACS[1], E. ANCOCHEA[2]

1 Geological Institute of Romania, Bucharest, ROMANIA
2 Universidad Complutense, Facultad de Ciencias Geologicas, Madrid, SPAIN

The Neogene volcanic activity in both examined areas - the Betics and the East Carpathians - postdated the continent-continent collision and it took place in the inner parts (opposite with respect the tectonic transport direction) of the collision-generated orogenic belts. The comparative examination of these two Tethysian volcanic areas suggests a number of significant similarities and some important differences as well.

The Neogene volcanism begun with large volume silicic explosive activity in both areas ranging between 18-14 Ma in East Carpathians, and 24-18 Ma in the Valencia trough and western Mediterranian.

The main calc-alkaline activity developed in both areas between 13-7 Ma, being much more extended in the East Carpathians. In both areas high-K calc-alkaline and shoshonitic compositions characterizes, at least partially, the late-stage volcanic products.

Coeval alkali-basaltic volcanism occurred in both areas during the Pleistocene-Pliocene interval.

The differences consist essentially of the presence of ultrapotassic volcanism in the Betics, coeval with the latest calc-alkaline and shoshonitic activity. Such kind of volcanism did not occur in the East Carpathians.

All the data suggest a very complex magmatic evolution as a result of an agitated geotectonic history during the convergent motion of Eurasia and Africa. The magma-enerated

processes includes, in both areas, partial melting of different sources located in upper mantle as well as in the crust, followed by a complex interplay of combined fractional crystallization, magma mixing and assimilation processes occurring in crustal magma chambers.

GENETIC TYPES AND AGE OF VOLCANICLASTICS IN THE CALIMANI-GURGHIU-HARGHITA VOLCANIC CHAIN (EAST CARPATHIANS): TOWARDS A NEW VOLCANOLOGICAL MODEL

A. SZAKACS[1], I. SEGHEDI[1], Z. PECSKAY[2]

1 Geological Institute of Romania, Bucuresti, ROMANIA
2 Institute of Nuclear Research of the Hungarian Academy of Sciences, Debrecen, HUNGARY

Volcaniclastics are widespread especially along the western and eastern peripheries of the Neogene to Quaternary volcanic range Calimani-Gurghiu-Harghita (CGH). Being formerly assigned to a "volcano-sedimentary formation" consisting of three lithological units (Radulescu et al., 1964, 1973), so far they have not been the subject of modern volcanological investigation.

A large number of outcrops were examined along the western and eastern sides of the range as well as in the crosscutting Mures valley, and the volcaniclastics were genetically diagnosed in most of them. A wide spectrum of genetic types of both pyroclastic and epiclastic origin has been recognised.

Unlike previous estimations and extensive usage of the term "aglomerate", pyroclastic fall deposits show a modest contribution (up to 10-12%) of the bulk volume of the volcaniclastics in the CGH range. Several eruptive mechanisms such as plinian, vulcanian and strombolian have been revealed by their lithological study. Pyroclastic flow deposits are widespread in the western and southern Calimani Mts., western and northern Gurghiu Mts., and at the southern end of the Harghita Mts. Part of them are unwelded pumice-rich ignimbrites of amphibole andesitic and dacitic composition. Block-and-ash flow deposits, mostly of basalt-andesitic composition, are well represented and related to summital lava dome and/or lava flow extrusions and collaps onto the slopes of the steep-sided composite volcanoes. Both Merapi and Peleean types of block-and-ash flow mechanisms have been inferred. Pyroclastic surge deposits are also present (e.g. dacitic phreatomagmatic base surge deposits in the Ciomadul Massif, South Harghita). Basalt-andesitic and andesitic pyroclastic flow-related ground surge and ash cloud surge deposits are recorded in the southern Calimani and North Harghita Mts. Although volumetrically unsignificant, they are important indicators of eruptive mechanisms in some areas of the CGH range.

Most of the volcaniclastics belong to the category of volcanic epiclastics (or volcanogenic sediments), especially of debris avalanche and debris flow origin accounting for more than 60% of the bulk of volcaniclastics in the study area. Hyperconcentrated flood flow deposits and normal stream flow deposits have been identified as well.

The recognition of the genetic types of volcaniclastics modifies significantly the picture of eruptive mechanisms within the the CGH volcanic chain. According to our data extrusive-effusive activity prevailed whereas explosive mechanisms had less significant contribution to the deposition of the great bulk of the volcaniclastics than thought before. Sin- and intereruptive mass-wastage processes constituted the main redistribution mechanism of volcanic material as coalesced peripheral volcaniclastic aprons around composite volcanoes. The contribution of explosive products such as pyroclastic flow deposits was highly important in building up the volcanic aprons.

The geochronological study (K-Ar method) of the volcanicastics as compared with the stratovolcanic edifices has clearly pointed out the coevality of the two. Age progression along the axial composite volcanoes is mirrored in the ages of the adjacent volcaniclastic deposits. These age relationships are incompatible with the so far generally accepted structural model of the CGH chain consisting of a lower volcanic compartment represented by the "volcano-sedimentary formation", and an upper stratovolcanic compartment, separated by a significant erosional unconformity.They rather suggest an alternative model that envisages volcanic facies zones distributed from the center to the periphery as follows: a central or near-vent facies, a proximal or cone facies, and a distal or peripheral facies. In such a model, the juxtaposed, and in places overlapping, volcaniclastic aprons represent the external, distal facies of the axial composite volcanic edifices. Unlike the older one, this model permits to assign certain volcaniclastic deposits to their source volcanoes as it was tentatively attempted in two cases in Gurghiu Mts. (Fancel-Lapusna edifice) and Northern Harghita (Varghis edifice), respectively. The new structural view would find useful application in the current geological mapping as well as in the geophysical modelling of the East Carpathian Neogene/Quaternary volcanic areas.

TIME-SPACE EVOLUTION AND MAGMA PRODUCTION RATES IN THE CALIMANI-GURGHIU-HARGHITA VOLCANIC CHAIN (EAST CARPATHIANS, ROMANIA)

A. SZAKACS[1], I. SEGHEDI[1]., D. IOANE[1], Z. PECSKAY[2], M. ROGOBETE[1]

1 Geological Institute of Romania, Bucharest, ROMANIA
2 Institute of Nuclear Research of the Hungarian Academy of Sciences, Debrecen, HUNGARY

The Calimani-Gurghiu-Harghita volcanic chain (CGH) in the East Carpathians is the southernmost and longest continuous segment of the Neogene/Quaternary Carpathian volcanic arc.

12-9.5 Ma old intrusions, in the southward extension of the East Carpathian subvolcanic zone, underlie the volcanic pile in the Calimani Mts. The prevolcanic intrusive magmatism in Calimani was roughly coeval with volcanism in the Apuseni and Oas-Gutai Mts. as well as with the emplacement of shallow intrusions in the Tibles-Toroiaga-Rodna-Bargau subvolcanic zone.

The oldest volcanic activity apparently occurred in the eastern part of the Calimani Mts. where the Dragoiasa dacites were emplaced ca. 9.3-9 Ma ago. Similar K-Ar ages were sporadically recorded among the lithic clasts in andesitic volcaniclastics in both Calimani and northern Gurghiu Mts. The earliest stage of volcanism is roughly contemporaneous in these two regions. The duration of the active volcanism is ca. 2.5 Ma in the Calimani Mts., whereas in the Gurghiu Mts. it lasted until ca. 5.8 Ma. The volcanoes were simultaneously active along half of the length of CGH between ca 7.0-6.8 Ma. The younger volcanism in Gurghiu, mostly its southern part, overlaps in time with the earliest eruptions in North Harghita Mts. The Northern Harghita volcanoes are remarkably contemporaneous (6.3-5.3 Ma) excepting the southernmost Varghis volcano that is overall younger (5.5-4 Ma). The northernmost South Harghita volcano (Luci-Lazu, 5.1-3.6 Ma) is younger as a whole but partially overlap with the active stage of Varghis volcano. Tha chain-terminus South Harghita segment, from Cucu volcano southwards, displays an obvious short-distance age progression of volcanism after a gap of at least 0.5 Ma between the Luci-Lazu and

Cucu volcanoes. The Ciomadul volcano is the youngest (1.0 to 0.2 Ma) of the whole Carpathian volcanic arc.

As a whole, along-arc age progression is obvious in CGH (at a rate of ca. 17 km/Ma) whereas no across-arc migration of volcanism has been recorded. Age progression is much more enhanced along the terminal North and South Harghita segments of the chain (ca. 7 km/Ma).

Age-volume correlation along the arc shows that high eruptive and magma-production rates characterized the northern half, and the earlier stages of evolution, of the chain whereas progressively lower eruption rates reflect the waning stage of volcanism along the arc. This difference along with some striking pecularities of the chain-terminus South Harghita segment (Szakacs et al., 1993) suggests variable tectono-magmatic regimes (and settings?) along the Carpathian magmatic arc.

K-AR AGE AND GEODYNAMIC POSITION OF THE NEOGENE BASIC VOLCANICS OF THE MOESIAN PLATFORM (BULGARIA)

Y.YANEV[1], Z.PECSKAY[2], P.LILOV[1]

1 Geological Inst., Bulg.Acad. of Sci., Sofia, BULGARIA
2 ATOMKI, Hung.Acad., Debrecen, HUNGARY

Immediately after the end of the Paleogene collisional volcanism in the Rhodopes (37-25 MA), within plate basic volcanism of limited volume was manifested 120 km Northwards - in the Moesian platform (Fig.1A).14 small volcanoes (the biggest one with 1 km diameter and 130 m height) form a 40 km long meridional strip (Fig.1B).The latter overlies the Suhindol-Svishtov cryptofault, that occurs only in the basement of the platform (after Karaguleva & Shanov, 1990). The volcanoes lie above "en- echelon" faults trending 20-35 N thus marking the right offset movement along the cryptofault.

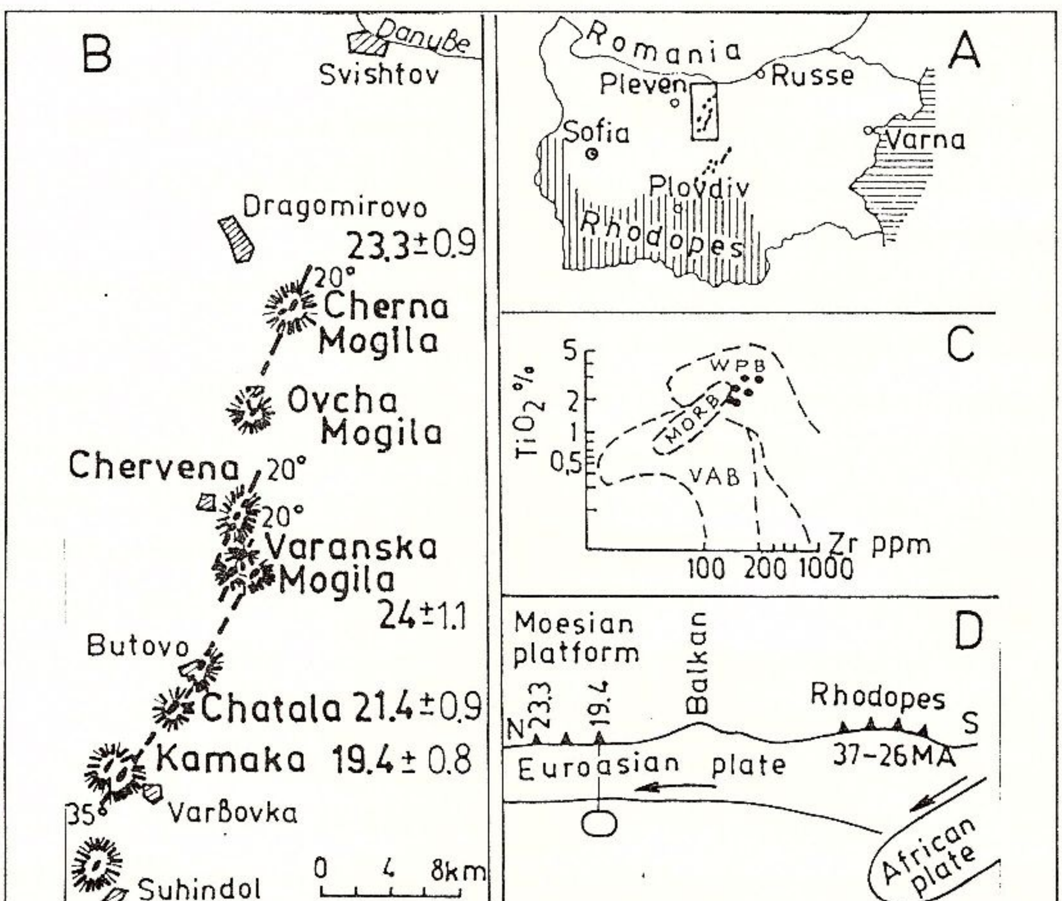
The volcanoes are composed of short lava flows, pyro- and epiclastics cut by small sills, dykes, stocks and domes of basanite composition (SiO_2 = 40.5-47.5; Na_2O = 2.75-4; K_2O = 0.7-1.4% wt). According to Marchev et al.(1992) these are constituted of olivine phenocrystals (Fo 86-89 with a rim of Fo 68-80), diopside (Wo 49 En 43 with a rim of Wo 52 En 32), a small amount of enstatite (Wo 2-3 En 77-83), Ti-magnetite and ilmenite. The groundmass consists of nepheline (Or 13 Ab 31) and analcim with microlites of the porphyric minerals as well as plagioclase (An 50-60), anorthoclase (Or 31 Ab 56), biotite (Al IV = 2.2; Fe/Mg =0.44; Ti = 1). T of olivine crystallisation is 1250-1270 C and T of Fe-Ti oxides is 880^0-910^0 , fO2 corresponds to QFM buffer and P=15.6-18.6 kb (according clinopyroxene composition) and 11-21.8 kb (according orthopyroxene composition). The basanites contain mantle xenoliths consisting of forsterite Fo90 (66-75%), Cr-diopside (5-15%), enstatite En90 (15-20%) and spinel (2%). The Zr/Ti diagram of Pierce indicates that they are typical within plate basalts (WPB) - Fig.1C. K/Ar studies were carried out on the magnetic fraction (0.1-0.16mm) of bulk samples consisting of the groundmass. The impossibility to separate the pyroxene and the olivine microlites lead to the presence of small amount waste Argon and respectively to earlier age than true one. The age determined is Lower Miocene (from 23.5+0.9 to 19.4+0.8 MA), as a rejuvenating of the volcanic activity in South direction is observed (Fig. 1B). This migration of the age could be explained with the eventual movement at the time of volcanism northwards to the Moesian platform over the mantle source (similar to the "hot spots"). It is probably a result of the Paleogene collision between the Eurasian and African lithosphere plates (Fig. 1D) which face front is located about 250 km South of the Rhodopes.

At the time of the within plate basic volcanism of the Moesian plate considered herein, acid and intermediate Ca-alkaline volcanics are formed in the Carpathian and Pannonian basin whereas alcaline basalts similar to the above described are intruded quite later - during the Paleocene and the Quaternary.

References :

Karaguleva J. and Shanov S., 1990. In: AETZ "Belene".

Izsledvania I stanovishta na BAN., 412 p.; Marchev P.,Saltikovski A., Yanev Y., Daieva L., Genshaft J.,1992.N.Jb.Miner.Abh., 164, 2/3, 113-137.



A. Distribution of Neogene basic volcanics (black points) in Bulgaria. The rectangle shows the volcanic area of the Moesian platform (Fig. B), the hatched part - the Paleogene collisional volcanism in the Rhodopes.

B. Area of basic volcanics in the Moesian platform with the presumable "en-echelon" magma-conducting faults (K-Ar age is in MA).

C. Zr/TiO2 discriminate diagram of Pierce 1980 (WPB - within plate basalts).

D. Idealised section showing the continental collision of the African and Eurasian lithosphere plates and the movement of the latter Northwards over the presumable magmatic source of the basic volcanoes in the Moesian Platform; in the Rhodopes-collision volcanism

Xth R. C. M. N. S. Congress, Bucharest 1995

Symposium 2

Quantifying Global Climate in the Pliocene

PLIOCENE CLIMATE IN THE EASTERN MEDITERRANEAN ACCORDING TO THE POLLEN RECORD

Andronicki DRIVALIARI

Institut des Sciences de l'evolution, Universite Montpellier II, Montpellier , FRANCE
School of Geotehnical Sciences, Aristotle University of Thessaloniki, Thessaloniki, GREECE

The paleovegetation and climate reconstruction of Pliocene (about 5.2 to 2.6 Ma.) has been reviewed according to palynological investigations in the Eastern Mediterranean.

Continental and marine sections have been palynlogicaly examined and relevant interpretations about pollen sedimentation have been extracted for the region.

The specific paleogeographic trends of the studied area (Tethys- Paratethys connections, altitudinal variations, fluvial activity, etc.) are obviously reflected by the microfloristic composition of each Pliocene section, as well as by the differences between sections.

The spread of subtropical and and tropical floristic elements testify about the warmer climatic conditions in the Mediterranean, as in a global scale, previous to the modern climatic cycles.

The studied localities are exposed following a latitudinal transect from Balkans to Northern Africa (Roumania, Bulgaria, Greece, Israel and Egypt). The differences between the palynological average spectra are related to the paleovegetation elements, which almost correspond to the modern phytogeographic variations in the region.

According to the continental paleovegetation record, further paleoclimatic interpretations have been advanced concerning the existence of a climatic gradient of both latitudinal and altitudinal order since Lower Pliocene.

The comparasion between the Pliocene and modern climatic gradients reveals the smoothness of the thermic range in contrast to the sharpness of the hydrometric range in the same latitudinal scale.

PALYNOLOGICAL SPECTRA AND PALAEOENVIRONMENTS OF UPPER NEOGENE IN EASTERN MEDITERRANEAN REGION. CLIMATIC AND PALAEOGEOGRAPHIC ASPECTS OF A LATITUDINAL TRANSECT (FROM ROUMANIA TO THE NILE DELTA).

Androniki DRIVALIARI

Universite Montpellier II,FRANCE

Palynological studies have been carried out in different basins of Upper Cenozoic in Eastern Mediterranean following a latitudinal transect from Roumania to the Nile Delta. The material is provided from boreholes and outcrops in continental basins of the Paratethyan realm and in marine basins of the Tethyan realm. The age is extended from Lower Miocene to Upper Pliocene.- The paleontological studies consider mammals, molluscs, planktonic foraminifera and nannoplankton. The palynological data are provided from continental basins of Upper Miocene and Pliocene in Roumania and Bulgaria and from neritic to fluviodeltaic sediments in northern Aegean (Lower to Middle Miocene and Lower Pliocene). The marine sections of South-Eastern Mediterranean are of Lower Pliocene age in Crete and of Upper Miocene to Lower Pliocene age in Israel; the neritic to fluviodeltaic sequence of the offshore borehole in the Nile delta is of Upper Miocene to Upper Pliocene age.

The differences in the palynological spectra reflect the different types of sedimentation.

The differences between the palynological average spectra of the various localities are related to the differential distribution of the paleovegetation elements. They almost correspond to the modern phytogeographic variations of the Eastern Mediterranean. According to the remarkable variety of circum-mediterranean landscapes in space and time, the use of palynology as a stratigraphic tool is not recommended on a larger geographic scale.

The palynological floras of Eastern Mediterranean reveal the amplitude of a common paleofloristic stock through the Mediterranean. The establishment of its phytogeographic context is ancient, which explains its modern floristic particularities, as well as some variations in the organisation of the modern vegetation in the Mediterranean.

The existence of a climatic latitudinal gradient (thermic and xeric), of a different amplitude than the modern one, dates back to Lower Pliocene.

THE EVOLUTION OF THE CLIMATE DURING PLIOCENE - LOWER PLEISTOCENE IN THE SOUTH OF THE DACIC BASIN

P. ENCIU, S. RADAN, L. STOIAN, A. HADNAGY, M. RADAN, M. ENCIU

Geological Institute of Roumania, Bucharest, ROUMANIA

In the south- western region of the Dacic Basin the upper part of a littoral-lacustrine clayey- sandy formation (symbol A in figure 1) with Parscovian cardiaceans and gasteropoda, dated 4.5 - 4.25 Ma BP, has been investigated (geologically and paleomagnetically) by hydrogeological boreholes with continous mechanical drilling.

The first part of the next formation (symbol B), prevaillingly clayey- coaly, accumulated within the interval of 4.25 - 3.9 Ma in a swamping deltaic plain in the conditions of a mixed, subtropical- warm temperate climate. Owing to the extension of the swamps, the cardiaceans disappear at the level of the sands of the coal beds V and VI; in heavy fraction the sands of the B formation contain 40- 50 % authigene minerals specific for the anoxic environments.

In the interval of accumulation of B_2 member the sedimentation takes place on an alluvial plain. At ca 3.9 Ma the climate becomes slightly colder and drier; *Meliaceae, Sequoia, Ginkgo, Nyssa* disappear; the first occurrences of *Artemisia* and *Ephedra* are reported and subsequently the growth of the *Gramineae* is recorded, while the *Pinus / Abies + Picea* ratio becomes supraunitary.

As a consequence of the swampy conditions existing during the accumulation of the B formation and, at present, due to the constituent sands, the infiltrating waters get a slightly acid pH (in borehole H6 Brabova, pH=6) and have significant contents in F^-, Fe^{2+}, SO_4^{2-}, NH_4^+ (the last mentioned component has ca 55 mg/l in borehole H6 Brabova).

The next interval of slight cooling has been identified in the upper part of the B formation at ca 3.1 Ma.

The calibration of the clayey- sandy beds from the base of the succesion investigated in the central- southern zone of the Dacic Basin (symbol B_3 in figure 1) with normal polarities (= Upper Gauss) has been achieved with the aid of the ornamented unionids assemblages and *Melanopsis (Canthidomus)* dv.sp.

The next formation (C) consists of the three members: Fratesti 1, 2, 3 (Feru et al., 1983), each of them starting with thick sand beds with gravels (gneiss, andesite, sandstone pebbles), poor in palynomorphs (these belong mainly to the lower, aquatic plants).

In the lower part of the C formation, the molluscs are similar to those from the Upper Romanian deposits existing in the Slatina zone (Andreescu et al., 1981); at the median and upper levels Pleistocene forms have been identified.

The paleomagnetic samples show prevailingly reverse polarities.

The above- presented data allowed the assignation of the C Formation to the Matuyama epoch. These data as well as the previously published ones concerning the age of the three members (ca 2.1 Ma ; 1.7 Ma and 0.9 Ma), resulted from the study of the mammals (Feru et al., 1983), led to the hypothesis of a correlation between the genesis of these members and the three glacial cycles : Biber, Donau and Gunz, that took place at 2.4 Ma, 1.7 Ma and 0.9 Ma.

Above C Formation, clayey- sandy deposits, rich in calcareous concretions and ferric oxides, are extremely poor in palynomorphs and contain rare ostracods reported especially from the Middle Pleistocene formations in the south of the Ukraine (Cepalinga et al., 1984).

The paleomagnetic samples, which are quite numerous in this argillaceous interval (noted D in fig. 1) show normal polarity. Paleontological content (*Cyclocypris* dv.sp., *Cyprinotus* dv.sp. etc.), its biostratigraphic significance and the polarity of this interval justify the correlation with the base of the Bruhnes epoch.

References

Andreescu I., Radulescu C., Samson P.M., Chepalyga A.L., Troubikhine V.M., 1981 : Chronologie (Mollusques, Mammiféres, Paléomagnétisme)des formations plio-pléistocènes de la zone de Slatina (Bassin dacique); Roumanie. Trav. Inst. Spéol."Emil Racovita",20, p. 127-137, Bucarest.Chepalyga A.L., Nagadev N., Mihailescu C., 1984 : Reghionalianaia stratigraficeskaia shema cetverticiniih otlajenie Moldavskoi SSR, Mejvedamstvennii stratigraficeskii kamitet SSSR, Leningrad.

Enciu P., Andreescu I., 1990 : Stratigraphy of the Pliocene- Pleistocene deposits in the south- western part of the Dacic Basin; Inst. Geol. Rom., D.S., 74/4 (1987), p. 141-156, Bucuresti.

Peru M., Radulesco C. & Samson P.M., 1983 : Succesion des Mammifères plio-pléistocènes dans le Bassin dacique (Roumanie); An. Inst. Geol.Rom., 59, p. 161-168, Bucuresti.

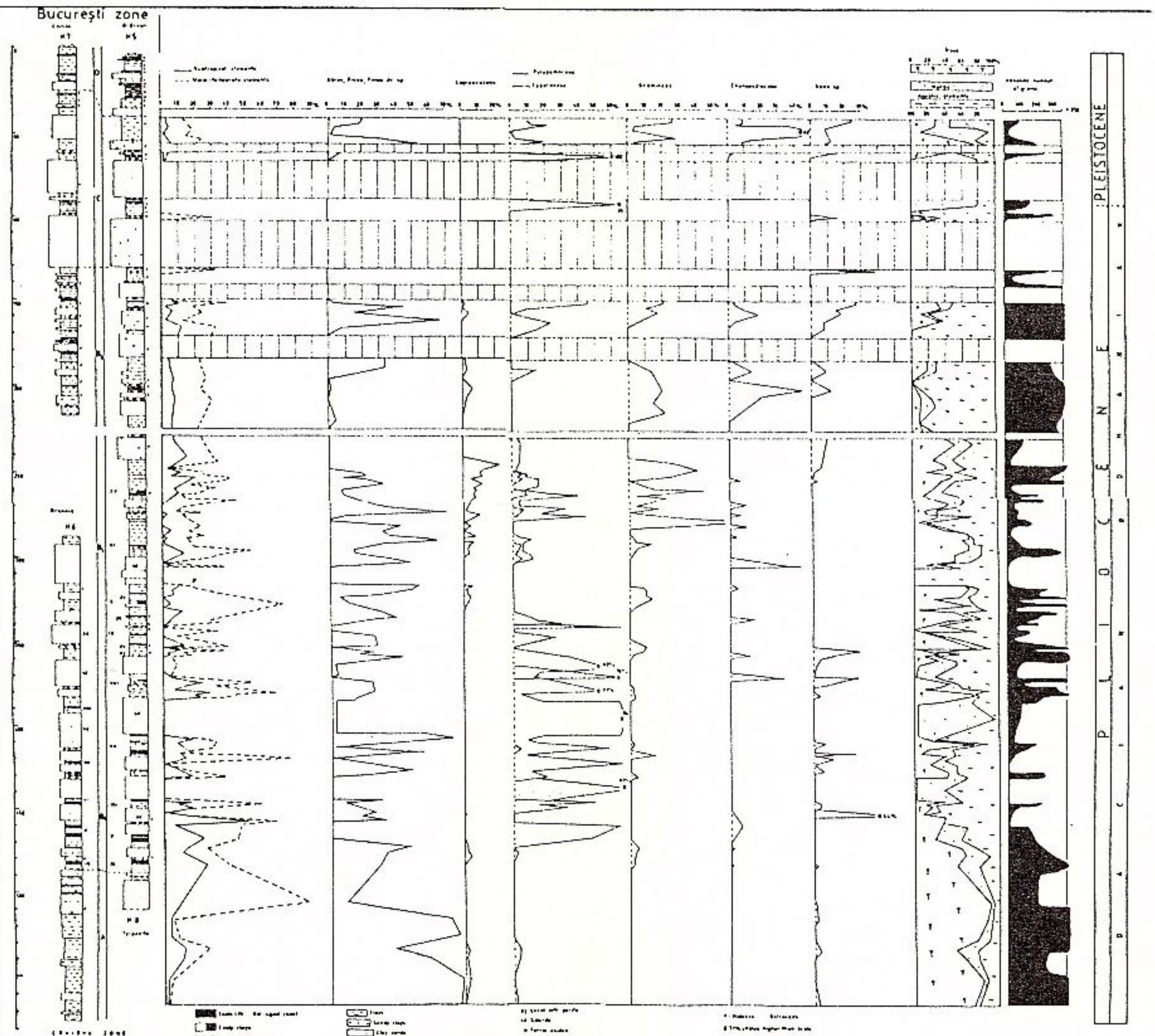


Fig. 1.

QUANTIFICATION DES FACTEURS CLIMATIQUES DU PLIOCENE DE LA MEDITERRANEE OCCIDENTALE : ASPECTS METHODOLOGIQUES ET PREMIERS RESULTATS.

Severine FAUQUETTE

Lab. de Botanique Historique et Palynologie, Univ. de Droit d'Economie et des Sciences d'Aix-Marseille, Marseille, FRANCE

Le réchauffement survenu il a 3.1 Ma au Pliocène est souvent considéré comme le meilleur analogue passé pour modéliser l'évolution du climat de la Terre dans l'optique de l'intensification de l'effet de serre.

Notre objectif consiste à quantifier les facteurs climatiques du Pliocène du pourtour de la Méditerranée occidentale à partir de nombreux spectres polliniques déjà obtenus dans cette région. Pour cela, nous avons mis au point une méthode particulière de reconstitution des variables climatiques basée sur une très grande quantité de spectres polliniques actuels recueillis sur une grande partie de l'hémisphère nord et caractérisant ainsi tous types de milieux végétaux et de climats.

Pour le Pliocène, la difficulté réside dans le fait qu'il n'existe actuellement nulle part dans le monde de spectres analogues du fait de la présence de taxons subtropicaux en mélange avec des taxons méditerranéens voire médio-européens. Ce problème nous oblige à aborder les reconstitutions d'une part d'un point de vue quantitatif, faisant intervenir les statistiques pour traiter un grand nombre de spectres polliniques et de taxons et, d'autre part, d'un point de vue semi-quantitatif afin d'intégrer les taxons faiblement représentés mais bons indicateurs climatiques comme c'est le cas pour quelques taxons subtropicaux.

Cette méthode a dans un premier temps été testée sur les spectres polliniques actuels avant d'être appliquée dans un deuxième temps aux spectres du Pliocène. Nous prendons ici l'exemple des diagrammes polliniques de Tarragone et de San Onofre réalisés à partir de deux sondages effectuésen mer, prés de la côte est de l'Espagne.

L'EVOLUTION DU CLIMAT DANS LE NEOGENE DU SECTEUR ORIENTAL DE LA PARATETHYS CENTRALE

Răsvan GIVULESCU[1], Nicolae TICLEANU[2], Iustinian PETRESCU[1]

[1] Université de Cluj- Napoca, Cluj- Napoca, ROUMANIE
[2] Institut Géologique de la Roumanie, Bucharest, ROUMANIE

On présente une reconstitution à base de macroflore et du pollen des climats qui se sont succédés au cours du Neogène sur le territoire actuel de la Roumanie.

Tout d'abord on présente les aspects concernant la stratigraphie des gisements au restes des plantes fossiles utilisés pour les reconstitutions climatiques, l'évolution des principaux éléments floristiques et phytocoenotiques neogènes, l'analyse écologique des principaux paramètres climatiques (temperature moyennne annuelle, l'umidité et régime des précipitations).

Les reconstitutions phytocoenotiques de même que l'analyse paléoclimatique ont été facilités par de nombreuses flores fossiles éxistentes dans les dépôts du Neogènes, à savoir celles de l'Aquitanian (Corus), du Volhynien (Daia, Sacadat, Deva- Tampa), du Pannonien s.restr. (Malvensien) (Valea Crisului, Cornitel, Delureni), du Pontien (Chiuzbaia, Baita, Borsec), du Dacien et du Roumanien (gisements fossilifères du Bassin Dacique). Les informations offertes par ces paléoflores ont été completées par des donnes palynologiques. Il y a eu aussi des situations quand l'information floristique s'est avérée insufisante, comme pour les depots du Burdigalien et du Badenien, présents dans des facies marins. C'est alors que nous vous appelé éxclusivement aux informations palynologiques.

Pour les reconstitutions paléoclimatiques, on a coroboré les informations des analyses physiognomiques des paléoflores (rapport entre les feuilles dentées et celles au bord entièr) avec les résultats palynologiques des différentes comunautés végétales fossiles. Dans la plus part des cas, les données physiognomique ont été confirmées par celles palynologiques, ou en tout cas elles sont très proches.

Finalment on constate une tendance générale d'abaissement des temperatures moyennes annuelles de 19,5^0 C dans l'Aquitanien à 13^0 C à la fin du Romanien. En detaille il ne s'agit pas d'une ligne droite mais d'une sinussoide, qui réflet les oscilations de cette température. Les résultats obtenus sont corréllables aux variations régionales ou même planetaires.

PALAEOECOLOGICAL REMARKS ON THE VILLAFRANCHIAN FAUNAS OF MACEDONIA, GREECE

Dimitris S. KOSTOPOULOS, George D. KOUFOS

Aristotle University of Thessaloniki, Dept.of Geology-Physical Geography, Lab. of Geology and Paleont., Thessaloniki, GREECE

During the last fifteen years, several Villafranchian mammalian localities have been found in Macedonia, Greece and abundant material has been unearthed. The material comes from seven different localities, which belong to three chronological levels, corresponding to Middle, Late and Latest Villafranchian.

The study includes the computing of faunal similarity indices, based on taxonomic comparisons upon the faunal lists. The faunal composition of each level has been computed and it is given by pie-diagrams and various indices. An analysis of the body weight is also given by cenograms and by using multivariate analysis. The fauna of each level is compared with some recent and fossil faunas, in order to find the palaeoenvironmental conditions.

The preliminary results of the study suggests:

- an open environment with relatively arid conditions during middle Villafranchian,
- similar environment are also found during late Villafranchian but the conditions seems to be more humid,
- during latest Villafranchian the climate is being more wet, while a grassland environment is possible.

PALEOCLIMATIC AND PALEOGEOGRAPHIC EVOLUTION IN THE SW AEGEAN ARC (GREECE) DURING THE NEOGENE TO EARLY QUATERNARY PERIOD:

KOUTSOUVELI A., IOAKIM C., TSAILA S., THEODOSSIOU I.

[1] IGME, Athens, GREECE
[2] Dept of Geology, Univ. of Patras, Rio Patras, GREECE

Marine and lacustrine sediments of Early Quaternary age from locations along the SW external part of the Aegean Arc (Eastern Mediterranean) have been studied in order to model the paleoclimatic and paleoenvironmental evolution of the area.

Our work is based mainly on the interpretation of biostratigraphically dated sediments from sections in the Messinia peninsula (SW Peloponnesus), Sitia region (east Crete), Heraklion basins (central Crete) and Rhodes island. These sediments were deposited in neogene margins bounded and dissected by normal faults. The latter are related to the Nio-Pliocene and Quaternary extensional phases, showing that these basins were marked by syntectonic sedimentation.

In the Messinia peninsula, three surface sections have been studied. The sediments of two of them are attributed to Pliocene, while those in the other one to Lower Pleistocene.

The studied sections of the Sitia area contain sediments which were deposited during Upper Miocene to Lower Pliocene, while those in the Heraklion basin include assemblages of Pliocene age.

Finally, biostratigraphical studies in sections of Rhodes island confirm an Upper Pliocene Lower Pleistocene age for these sediments.

The studied formations unconformably overlay Mesozoic strata and consist of clastic sediments (marls, sandstones, sands, clays, laminites and conglomerates). Micropaleontological and lithostratigraphic analysis give us a way to model the paleoenvironmental and paleoclimatic conditions in these areas during Miocene to Early Quaternary period.

MALACOLOGICAL EVIDENCE FOR CLIMATIC VARIATIONS IN THE WESTWRN MEDITERRANEAN DURING THE PLIOCENE.

Jordi MARTINELL, Rosa DOMENECH, Carles GILI, Marta SOLSONA

Dep. Geologia Dinamica, Geofisica i Paleontologia. Fac. Geologia, Univ. de Barcelona, Barcelona ; SPAIN

There is evidence for latitudinal climatic variations during the Lower Pliocene derived from the study of the malacofauna of the Western Mediterranean.

The molluscs of the Roussillon (S France), Alt Emporda and Baix Llobregat (NE Spain) basins, situated in the NW Mediterranean, and those of the Estepona basin (Malaga, SW Spain), in the SW Mediterranean, have been taken into consideration.

Firstly, the composition of the total number of species and families of these malacofauna has been evaluated, manifesting the high diversity typical of tropical and subtropical environments.

Secondly, the number of species and families which at present have a tropical/ subtropical distribution have been counted, and in the case of extinct forms, those which belong to a genus or subgenus with the same kind of distribution have also been counted. This has been effected separately for bivalvia, gastropoda, and for the whole, and the values obtained in the NW basins have been compared with those of the SW basin.

In all cases, the results show a major presence of tropical forms and a significant increase of these in the southern latitudes.

MALACOLOGICAL EVIDENCE FOR CLIMATIC VARIATIONS IN THE WESTERN MEDITERRANEAN DURING THE PLIOCENE

Jordi MARTINELL, Rosa DOMENECH, Carles GILI, Marta SOLSONA

Dep. Geologia Dinamica, Geofisica i Paleontologia, Fac. Geologia, Univ. de Barcelona, Barcelona, SPAIN

There is evidence for latitudinal climatic variations during the Lower Pliocene derived from the study of the malacofauna of the Western Mediterranean.

The molluscs of the Roussillion (S France), Alt Emporda and Baix Llobregat (NE Spain) basins, situated in the NW Mediterranean, and those of the Estepona basin (Malaga, SW Spain), in the SW Mediterranean, have been taken into consideration.

Firstly, the composition of the total number of species and families of these malacofauna has been evaluated, manifesting the high diversity typical of tropical and subtropical environment.

Secondly, the number of species and families which at present have a tropical/subtropical distribution have been counted, and in the case of extinct forms, those which belong to a genus or subgenus with the same kind of distribution have also been counted. This has been effected separately for bivalvia, gastropoda, and for the whole, and the values obtained in the NW basins have been compared with those of the SW basin.

In all cases, the results show a major presence of tropical forms and a significant increase of these in the southern latitudes.

THE IMPORTANCE OF THE INVESTIGATIONS INTO CLIMATIC CHANGES DURING THE NEOGENE TO INTERPRET THE PARATETHYS- TETHYS CONNECTION

PANTIC N., DULIC I.

Rudarsko- Geoloski Fakultet, Beograd, YUGOSLAVIA
NIS- NAFTAGAS, Novi Sad, YUGOSLAVIA.

The paleobotany provides valuable data on drastic climatic changes that have happened during the Neogene on the northern hemisphere. The major characteristic of these changes is a narrowing of the warm climatic belts (tropical and subtropical), especially over the last 20 million years.

this paper traces the migration course of climatic changes during the Neogene from the North to the South across the European area. Such a coarse of climatic changes results in a longer survival of the thermophilic floral elements on the Paratethyan southern margin, on the Balkan inland and particularly in the Tethyan areas.

This is also supported by the migration of the main phase of lignite beds formation (from Czechoslovakia the Pannonian up to Greece in the Middle Pliocene).

These climatic events should be taken into account in the correlation of associations of vertebrate faunas and the associations of marine and fresh water faunas, especially in the north-south direction (the Paratethys- Tethys connection).

INFLUENCE OF CLIMATIC CONDITIONS TO THE CHANGE OF ASSEMBLAGE DURING THE OLIGOCENE - PLIOCENE IN THE WESTERN CARPATHIANS AND ADJACENT AREAS

Viliam SITAR

Comenius University, Faculty of Sciences, Dep. of Geology and Paleontology, Bratislava, SLOVAKIA

Several localities with preserved fossil flora there are situated in the form of prints in the Western Carpathians. On the basis of this flora study as well as palynology research it's possible to state that the climate and other ecological factors had influenced the change and the migration of flora.

While the Oligocene and Lower Miocene flora had a strong thermophile to subtropic character, during the Badenian and Sarmatian flora's character has been changed in favour of the temperate zone's elements. Namely in the Oligocene sediments, there are represented mainly species of evergreen plants with leathery and large leaves. There is present also *Sequoia*, which has't been found in the Miocene. In the Lower Miocene *Lauraceae, Persea, Magnolia, Engelhardia, Platanus neptuni* etc., occur chiefly; there are absent the representatives of coniferous species. In Badenian , many elements are absent. There are mainly representatives with large leaves / *Magnolia, Persea*/ here appear *Taxodium* and *Glyptostrobus,* and also the representatives of actotertiary elements / *Ulmus, Fagus* -- type *F. orientalis, Quercus, Carpinus* ... In Sarmatian *Lauraceae* and dominate representatives of *Fagaceae, Betulaceae, Aceraceae, Salix, Populus* are absent or very rare; but *Byttneriophyllum* and *Taxodiaceae*. In Pliocene, *Lauraceae* are absolutely absent and there are present all elements of the temperate zone with a predominance of conifers, what refers to the considerable cooling with preserved continental characters.

PALEOCEANOGRAPHIC CONDITIONS IN THE EASTERN MEDITERRANEAN IN THE EARLIEST PLIOCENE

SPROVIERI R., McKENZIE J., Di STEFANO E., SACRANTINO S.

Departement of Geology and Geodesy, Palermo, ITALY.

A 14 m composite sequence of "Trubi" covering the lowermost part of the Pliocene (M Pl 1 - base M Pl 2) was sampled in detail from 2 sections outcropping on the Jonian side of Calabria (Southern Italy). We conducted micropaleontological and stable isotopic analyses of 4 samples each from the marls and limestones beds of the first 13 lithological couplets, in order to study the paleoceanographic conditions in the eastern Mediterranean just after the flooding following the Messinian salinity crisis. In the studied composite section, the base of the Pliocene is recognized 5 lithological cycles below the base of Thvera subchron. The mean time interval between the studied samples is about 2.5 kyr.

The main results indicate that:

1) For each lithological couplet, a positive relative abundance fluctuation of *Globigerinoides obliquus* + *Globigerinoides quadrilobatus* (indicative of warm water conditions) can be recognized in coincidence with the marly interval. In the more carbonate rich intervals, *Globigerina bulloides*, indicative of a cold and high productivity environment, prevails.

2) Within the abnormally thick limestone level of lithological cycle 6, from which 4 marl samples and 14 limestone samples have been analyzed, a positive relative abundance fluctuation of *Globigerinoides* spp. is present. Therefore, 2 positive abundance fluctuations of *Globigerinoides* spp., 1 in the marly interval and 1 in the limestone interval, can be recognized in this single lithological cycle. Since the abundance fluctuations of *Globigerinoides* spp. are forced by the precessional cycles, the recognition of 2 abundance fluctuations prove that 2 precessional cycles are present within cycle 6, as proposed by Hilgen (1991).

3) The amplitude of the abundance fluctuations of *Globigerinoides* spp., with a grater difference between the marly and limestone intervals, increases from the marly level of the

lithological cycle 9. Below cycle 9, the amplitude of the abundance fluctuations of *Globigerinoides* spp. is smaller and a smaller difference occurs between the limestones and the marls.

4) *Uvigerina peregrina* is more abundant in the marly intervals and is frequent in the segment between cycle 4 and 12, but is rare below and above. *Globocassidulina subglobosa* is more abundant in the limestones and sharply decreases in abundance above cycle 10. More generally, although the benthic foraminifera assemblage diversity is practically unchanged along the section, an abrupt switch from the group of species indicative of more or less under- oxygenated bottom conditions, which are more frequent below, to the group of species indicative of more oxygenated bottom condition, which are more frequent above, occurs at the base of cycle 11, above which the latter group always dominates the faunistic assemblage.

5) The Oxygen isotope composition of planktonic foraminifera (*Globigerinoides obliquus)* display extreme fluctuations between more negative values within the marls and less negative values in the limestones of up to about 2 $^0/_{00}$. This trend in Oxygen isotopic analyses is very consistent with the indications provided by the relative abundance fluctuations of *Globigerinoides* spp., i.e. the marls represent warmer surface waters whereas the limestones reflect cooler temperature by as much as 10*C. In addition, the amplitude in Oxygen isotopic fluctuations, with a greater difference between marls and limestone levels, increases with and above cycle 8.

6) No time lag exists between the change in abundance fluctuations .of *Globigerinoides* spp. and isotopic values and the lithological change between marls and limestones and viceversa. The 2 events, tied to the precessional cycles, are virtually synchronous at the studied time interval between the samples.

According to these results, warmer conditions of the surface waters and a more extreme temperature differences between cold and warm periods began about 150 kyr above the base of the Pliocene. A more restricted, more or less under- oxygenated bottom conditions prevailed, during the marly intervals, up to cycle 10, about 210 kyr above the base of the Pliocene. Above this cycle, coincident with the first common occurrence of *Globorotalia margaritae,* a benthic foraminifera assemblage indicative of a more oxygenated bottom environment and more open communications between the Mediterranean and the Atlantic ocean populated the Mediterranean basin. These results are in excellent agreement with the paleoceanographic events interpreted from an high-resolution stratigraphic study of earliest Pliocene sediments from the Tyrrenian Sea (Leg 107, ODP site 652) ((McKenzie, Sprovieri and Channell, 1990).

LOWER PLIOCENE POLLEN RECORDS IN THE CIRCUM WEST MEDITERRANEAN REGION AND CLIMATE QUANTIFYNG

Jean-Pierre SUC[1], Adele BERTINI[2]

[1] Institut des Sciences de l'Evolution, Universite Montpellier, FRANCE
[2] Dipartimento di Scienze della Terra, Firenze, ITALY

The West Mediterranean region is very rich in pollen records of Lower Pliocene. They reflect the relative influence of longitude, latitude, and altitude. As today, several provinçes are distinguished: South Mediterranean, North Mediterranean, Atlantic (Suc et al. , 1995). This enables quantified climatic reconstructions considering the narrow comparison which existed with the modern vegetation organization.

Paleotemperatures have been estimated taking into account the northern limit in the present geographic distribution of some thermophilous taxa which are not nowadays living in the Mediterranean area. It seems that repetitive lowerings in minima temperatures have been more active than a regular decrease in mean annual temperatures for eliminating these taxa (Suc et al., in press).

References:

Suc J.P., Bertini A., Combourieu- Nebout N., Diniz F., Leroy S., Russo-Ermolli E., Zheng Z., Ferrier J., 1995 : Structure of West Mediterranean vegetation and climate since 5.3 Ma. Acta zool. cracov., 38, 1 : in press.

Suc J.P., Diniz F., Leroy S., Poumot C., Bertini A., Dupont L., Clet M., Bessais E., Zheng Z., Ferrier J., in press : Zanclean (Brunssumian) to lower Piacenzian (lower-middle Reuverian) climate from 4° to 54° North latitude (West Africa, West Europe and West Mediterranean areas). Meded. Rijks Geol. Dienst.

PLIOCENE VEGETATION, CLIMATE AND ENVIRONMENT IN THE BLACK SEA COSTAL REGION.

Tatiana V. SVETLITSKAYA

Institute of Geography, Russian Academy of Sciences, Moscow, RUSSIA

An integrated study of paleobotanical, paleozoological and paleomagnetic investigations in the southwestern part of the Former USSR has made it possible to define the main trends in the Pliocene paleogeography of this region. According to generally stratigraphic scheme of the Neogene in Eastern Paratethys region accepted in Russia, Pliocene includes Pontian, Kimmerian And Kujalnician regional stages.

At the beginning of the Pontian stage (5.4 - 4.7 MA, according to the paleomagnetic scale) as the result of the Mediterranean waters intrusion, the Zanklian transgression took place and joined all basins till the Caspian sea. An essential part of the territory in question was occupied by a warm marine basin (mean annual water temperature was about +12*C -=!% C). Near shore area was covered by forest- steppe vegetation, where some species of *Hipparion* fauna .occured. The climate was humide and temperate with temperature of June about - +25*C and -+5*C.

In the middle Pliocene (Kimmerian time)(4.7 - 3.4 MA) the major part of the territory was land. Sea basins existed only within the limits of the Black sea and Caspian sea depressions. Warm- temperate mixed forests with heat- loving and moderately heat-loving species (*Acer, Quercus, Juglans* and less common *Morus, Castanes, Carya)* were prevalent. During the first part of the Kimmerian, the percentage of subtropical genera in the flora increasedover the late Pontian level, reflecting the rise of the temperature. The maximum temperature increase occured 4.2- 4.0 MA. Mean January temperature rose by almost 2*C (to 6*C).and mean July temperature rose from +22*C to +23*C. By the end of this period, the proportion of steppe elements increased and steppe and forest- steppe landscapes appeared. The faunistic assemblage developed during this time reflect the progressive aridification. The

climate was apparently humid and moderatively warm (January temperature was about +4 ^{0}C and July temperature about +22 ^{0}C).

In the late Pliocene (Kuajnician time)(3.4- 2.3 MA) this region was an elevated plain on which the modern river network was formed, the sea basin remained only at the south of the area. Mixed conifer- broad- leaved forests grew along the northern Black sea coast at the beginning of this time. Compared with that of the Kimmerian, the terrestrial vegetation of Kuajnician time had lower representations of broad- leaved trees and greater lewels of steppe taxa. A substantial reduction of the forest area is observed at the end of the Kuajnician time, among the remaining arboreal trees pine and dark- coniferous types prevail. In faunal assemblage, the warmth- loving animals (Giraffes, Tapirus etc.) dissapear and the warm- moderate types (apart from *Archidiscodon, Equus, Cervus* etc.) occured more widely.

The climate was apparently dry with warm- moderate temperature (January temperature was about +4^0 C and July temperature was +22 ^{0} C).

X[th] R. C. M. N. S. Congress, Bucharest 1995

Symposyum 3

Definition and Chronology of the Major Neogene Tectonic Events

EVOLUTION D'UN BASSIN NEOGENE DE TYPE "FORELAND" EXEMPLE : BASSIN DU HODNA (M'SILA - ALGERIE)

A.AREZKI [1], H.NAILI [2], A.BELAID [2], A.SAIDANI [2], Z.BELHADJ [2]

[1] Division Exp- Sonatrach, ALGERIE.
[2] CRD- Sonatrach, ALGERIE.

Le bassin du Hodna se localise dans le nord de l'Algerie. Il est limité au nord par les monts du Hodna , au sud par les premiers reliefs de l'Atlas saharien et par la région des Selemates à l'est. Geomorphologiquement, c'est un bassin Neogene appartenant au domaine complexe du nord de l'Algerie.

L'interprétation des sections seismiques orientées nord- sud a permis d'individualiser une série sédimentaire discordante sur le Paléogène et le Crétacé supérieur, sa puissance atteint 2000 m au centre du bassin.

L'analyse stratigraphique des échantillons, de sondages pétroliers et de coupes de terrain, prelevés dans cette série sédimentaire a dégagé des associations microfaunistiques de foraminiferes planctoniques et benthiques caractérisant le Miocène moyen.

Un inventaire non exhaustif de la microfaune rencontrée est dresse ci- dessous : *Praeorbulina glomerosa* Blow, *Orbulina suturalis* Bronnimann, *Globorotalia peripheroronda* Blow& Banner, *Orbulina universa* d'Orbigny, *Globigerinoides triloba* Reuss, *Globigerinoides sacculifer* Brady, *Globigerinoides quadrilobatus* d'Orbigny, *Globigerinoides sicanus* Destefani, *Globigerina praebulloides* Blow, *Globigerina woodi* Jenkins, *Globoquadrina venezuelana* Hedberg, *Globoquadrina dehiscens* Chapman, Darr & Collins, *Globoquadrina baroemoenensis* Leroy.

L'association de foraminiferes benthiques se compose des genres : *Bolivina, Uvigerina, Bulimina, Lenticulina, Cibicidae* et *Nodosariidae* etc..., caracterisant un domaine marine assez profond.

En outre l'exploitation de ces profils seismiques permet de subdiviser la série Miocène en quatres séquences progradantes du nord vers le sud dénommées :

Miocène 1, Miocène 2, Miocène 3 et Miocène 4.

Ces différentes observations mettent en évidence un déplacement du bassin du nord vers le sud, cette géodynamique est à lier a la mise en place des le Crétacé supérieur de la chaîne plissée et nappée de l'Atlas tellien et qui s'est poursuivie surtout pendant l'Éocène moyen (phase atlasique d'orientation nord ouest- sud est).

La phase tectonique sus- citée se traduit, entres autres, au nord du bassin, par des chevauchements créant une surcharge tectonique qui engendre le bassin Miocène du Hodna, flexural de type "FORELAND" dans lequel se déposent les séries du Miocène.

Ces séries sédimentaires, intéressantes de par leurs épaisseurs jouent un rôle positif pour l'enfouissement de la matière organique du Crétacé supérieur (Cenomano- Turonien).

99

CHRONOLOGY OF THE MAIN CENOZOIC SEDIMENTARY AND VOLCANOLOGICAL EVENTS IN SARDINIA (ITALY)

A. ASSORGIA [1], K BALOGH.[2], S. BARCA [1], C. SPANO [1]

[1] Department of Earth Science, University of Cagliar , ITALY
[2] Institute of Nuclear Research- of Debrecen, HUNGARY

In the Upper Paleocene- Lower Eocene time when the Sardinian Island was attached with southwest European plate, the first phase of tectonic activity started probably extensional type which was responsible for a partial marine ingression. This marine phase was active during Lower- Middle Eocene and cover only south central part of the Island. The marine sediments deposited on the eastern part (Quirra, Gerrei) results neritic- epibathial facies at places Nummulitic limestone, while in the western (Sulois) miliolitic limestone were deposited with successive interlayering of lignifarcus layers. A unique volcanic activity in this extensional tectonic phase is represented by alkaline basaltic sill (camptonitic) interbedded with miliolitic limestone. Published K/Ar radiometric data on whole rock samples provide an age of 62+- 2 Ma years old. (Maccioni et al., 1990).

Successively, continental sedimentary phase occur during Middle Eocene- Lower Oligocene with clayey- arenaceous- conglomeratic deposits (Cixerri Formation). The deposits were derived by the erosion from existing highs following a compressive tectonics probabley of Pyrenaic phase. Starting from Middle Oligocene (33 Ma, Beccaluva et al., 1985 and the reference therein),calcalkaline volcanic activity essentially made of andesitic lava (SA1) attributed to an oceanic lithosphere subduction towards N or NNW direction below the European continent (Coulon, 1977). In the Upper Oligocene, extensional movements favour the structural depression (Sardinian trough) above 200 km long and 50 km wide (Vardabasso, 1962, Cherchi and Montadert, 1984).

The first Cenozoic Syn- Rift sediments are constituted by terrigeneous deposits largely of continental origin characterized by the presence of clastic material derived from the ancient Paleozoic relief by erosion and partially from Oligocene andesitic volcanic products and gave rise to Ussana Formation. The Ussana Formation partially passes into sandy neritic deposits of marine origin (Arenarie di Gesturi Formation), while in the deep zone there is more marly deposit of Marne di Ales Formation.

All these sedimentary formations are, in general, preceeds or coeval to explosive volcanic products of lower ignimbrite series (SI1).

In the Lower- Middle Burdigalian, a thick (= 500 m) Volcano- sedimentary complex were filled (Marmilla Formation) within the rift. This Formation is made upof marl, sandstone and silt; volcanics varieties of pillow lavas, hyaloclastics and explosion breccias (Maccioni, 1974) of basic to intermediate in composition and belong to the Upper andesitic series (SA2) with the age of Lower Miocene.

Long after the compressive Lower- Middle Burdigalian phase (Cherchi and Montadert, 1984), andesitic volcanic cycle has terminated. Indeed, successively, clayey- marl of Marne di Gesturi Formation, which overlie the Marmilla Formation, contain only explosive acidic products which belong to the Upper Ignimbritic series (SI2) and close the Cenozoic calcalkaline volcanic cycle at 15+- 0.8 Ma (Pecorini, 1974; Morra et al.,1994) . This end of calcalkaline volcanic activity in Sardinia after a while is associated with the anticlockwise rotation of the Corsican- Sardinian microplate (Cherchi and Montadert, 1984). This phenomena is confirmed by the paleomagnetic data (Montigny et al., 1981). The Cenozoic marine sedimentation within the Sardinian trogh was active until the Messinian only in the south central Sardinia (Cherchi, 1985 and the riferences therein).

The above stated events are an evidence to the subdivision of Cenozoic volcanic cycles in Sardinia started by basic- intermediate lava products in part brecciated (SA1) and followed by an acidic- intermediate ignimbrites outcropped in the north central part (Logudoro- Bosano) (SA1). Another volcanic product with basic to intermediate (SA2) in composition manifests the submarine environment in the south central Sardinia (Marmilla, Arcuentu) with pillow lavas and hyaloclastics inclusion.

The Cenozoic calcalkaline volcanism closure consists of acidic to intermediate volcanic products (SI1) localized in the south western Sardinia, where the comenditic products with an age of 15 Ma (Morra et al., 1994) are exposed.

From a volcanological point of view, in these calcalkaline volcanic cycle two main activities can be observed. The first one shows the lava emission with low mechanical energy to which small pyroclastic flows and surges of phreatomagmatic in origin are associated. These products are chemically categorized both under basic- intermediate and acidic- intermediate range- . The second volcanic activity is explosive discharges large volume of pyroclastic pamice and ash flows, and chemically gropped under acidic to Simplified Geological-Structural sketolt map of Sardinia (after Cherahi and Montadert, 1984 and Morra et al., 1994) . 1) Pliocene-Quaternary sediments. 2) Pliocene Quaternary volcanics. 3c) Marine sediments and volcanics of Oligo-Miocene cycle; a) "andesites" (SA.2-SA.1; b) "ignimbrites" (SI2-SI1); 4) Cixerri Formation (Eocene-Oligocene); 5) Undifferentiated Paleozoic basement and Mesozoic carbonates; 6) main regional faults intermediate range. These bimodality in the volcanological character seem to be attached more to the geotectonic situation which was active in Cenozoic than different magmatic evolution mechanisms.

Bibliography

Beccaluva L., Cevetta L., Macciotta G., Ricci C.A., 1985 : Geochronology in Sardinia results and problems. Rend. Soc. It. Idin.Petr.

Cherchi A., 1985 : 19th European Micropaleontologies Colloquium. Oct.1-15, 1985 ,p 338.

Cherchi A., Montadert L., 1984 : Il sisteme di rifting Oligo- Miocenico del Mediteraneo occidental e sue conseguenze paleogeografiche sul Terziario sardo. Mem. Soc. Geol.It.

Coulon C., 1977 : Le volcanisme paleo-alkaline cénozoique de Sardeigne (Italie); Petrographie, geochimie et genése des laves andésitiques et des ignimbrites. Signification geodinamique. Thése Univ. Marseille.

Maccioni L.,1974 : Nuovi ritrovamenti di lave a euxinic nel Miocene della Marmilla (Sardegna Centro- occidentale). Rend.Sem.Fac.Sc.Univ.Cagliari

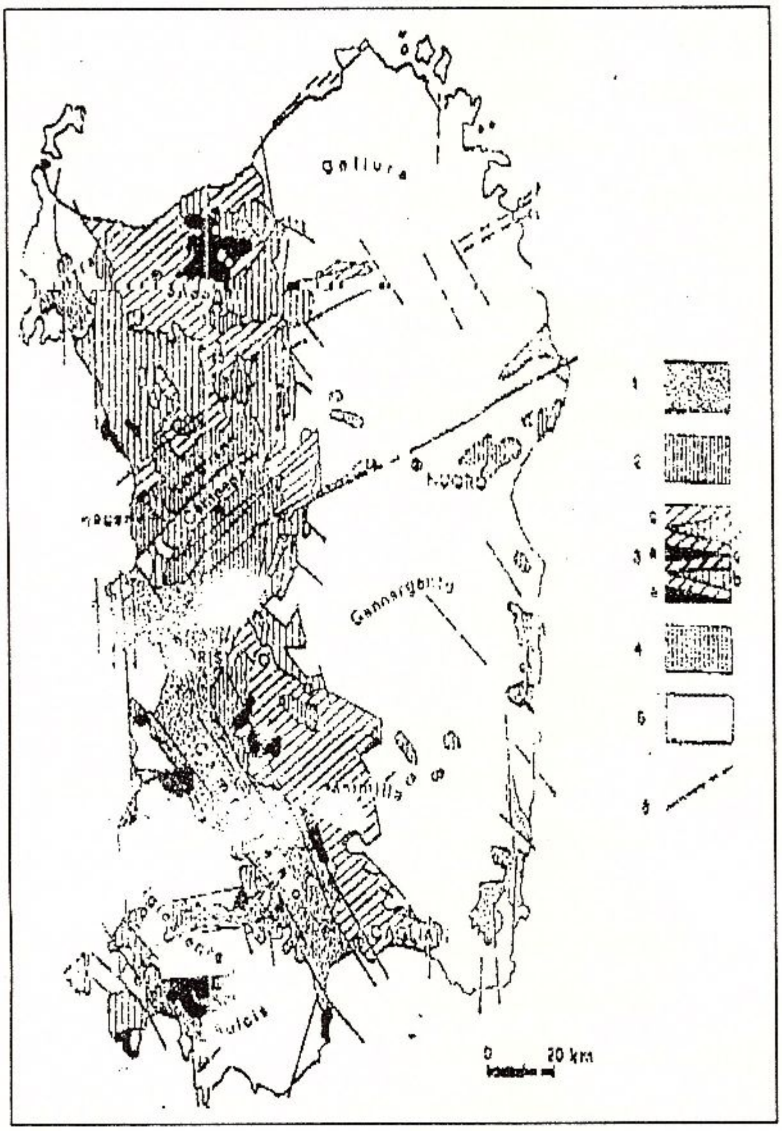
Maccioni L.,Marchi M., Salvadori A., 1987 : Eocene alkaline lamprophyre in south- western Sardinia (Italy).(New occurrence).Rend.Sem.Fac.Sc.Univ.Cagliari

Montigny R., Edel J.B., Thuzat R., 1981 : Oligo-Miocene rotation of Sardinia: K/Ar ages and Paleomagnetic data of Tertiary volcanism. Earth and planetary Solense letters

Morra V., Secchi F.A., Assorgia A., 1994 : Petrogenetic significance of peralkaline rocks from Cenozoic calcalkaline volcanism from SW Sardinia, Italy. Chem.Geol.

Pecorini G., 1974 : Sui tufi pomicei langhiani della Sardegna meridionale. Boll. Soc. Geol. It.

Vardabaso S., 1962 : Questioni paleogeografiche relative al Terziario Entico in Sardegna. Mem.Soc.Geol.It. Atti "Il Paleogene in Italia".



Simplified Geological-Structural sketolt map of Sardinia (after Cherohi and Montadert, 1984 and Morra et al., 1994).
1) Pliocene-Quaternary sediments.
2) Pliocene-Quaternary volcanics
3) Marine sediments and volcanics of Oligo- Miocene cycle:
a)"andesites"(SA2-SA1;
b) "ignimbrites"(SI2-SI1)
4) Cixerri Formation(Eocene-Oligocene)
5) Undifferentiated Paleozoic and Mesozoic carbonates
6) main regional faults

NEOGENE PALEOGEOGRAPHIC CHANGES IN THE ALPINE- CARPATHIAN - PANNONIAN JUNCTION ZONE, AS MARKED BY SEDIMENTARY FACIES DISTRIBUTION.

I.BARÁTH

Geological Institute of the Slovak Academy of Sciences, Bratislava, SLOVAKIA.

In the studied area, the Lower Miocene sedimentation started by the Eggenburgian mostly shallow- marine transgressive sequence. Its spatial distribution marks the sea way from the East Alpine foredeep eastward through both the West Carpathian Flysch Zone and the Pieniny Klippen Belt (PKB) into the northeastern part of the Vienna Basin. The further prolongation of the sedimentary area is indicated by sediment remnants along the Váh river valley at the Central Western Carpathian (CWC) western margin as well as in the intramontane Bánovoce, Horná Nitra, and Turiec basins. The ancient emerged island chains, directed along the principal structural boundaries both of the Northern Calcareous Alps (NCA) and the CWC nappes (SW - NE) are well bordered by the coarse marginal clastics. Along the inner margin of the PKB, there is observable postsedimentary shortening of the sedimentary area, which caused the present intimate tectonic contact of the marginal coarse sediments and the offshore pelagic marls. According to these data, the sea connection with the Lower Miocene basin in the southern part of the Magura Basin in Poland is very probable.

During the Ottnangian sea- level drop, the sedimentary area in the northern parts of both the Vienna and the Danube basins diminished and a large north- prograding Bockfliess deltaic system developed in the central part of the present Vienna Basin.

The Western Carpathian escape, followed by strike- slip faulting, caused the subsidence of the central part of the Vienna Basin during the Karpatian. The southern margin of the Karpatian marine sedimentary area in the Vienna Basin did not overstep the southern margin of the NCA. In most of the area, marine clayey- silty sediments deposited. Howevre, at its southern and northeastern margins, the north- prograding Aderklaa and Jablonica deltaic systems continued its development by final coarse clastic sedimentation.

Since the Early Badenian, the basin- forming tectonics prosecuted by the subsidence of the southern part of the Vienna Basin and by the opening of a new sea connection through both the Styrian Basin and the Little Hungarian Plain with the Mediterranean area. The Badenian sea- shore deposits are represented by the marginal gravels, sands, and organogene limestones, which are distributed around the intrabasinal elevations of the Styrian Basin, on the present eastern margin of the NCA, along the western and southern margins of the Leitha Mts.- Malé Karpaty horst structure, and around the northern margins both of the Vienna and the Danube basins. During the same time, a huge east to southeast-prograding delta of the Paleodanube started to develop in the western part of the Vienna Basin, continuing its progradation during the whole Middle to Late Miocene. A relief inversion due to the Middle Miocene tectonic movements led to cessation of north-prograding deltas in the area studied. Since the Late Badenian, south-prograding deltas took place in the northern embayments both of the Vienna and the Danube basins.

PALINSPASTIC RECONSTRUCTION OF THE SWISS MOLASSE

Jean-Pierre BERGER

Geological Institute University Fribourg, SWITZERLAND

The Swiss Molasse foreland basin is composed of :

- Early Oligocene marine sediments deposited along the alpine front (Untere Meeresmolasse= UMM)
- Late Oligocene and early Miocene freshwater deposits deriving from alpine alluvial fans and drained towards the East (Untere Susswasser molasse= USM)
- Early Miocene marine sediments deposited along the alpine front (Obere Meeresmolasse= OMM)
- Middle Miocene freshwater sediments deriving from alpine alluvial fans but drained towards the West (Obere Susswassermolasse= OSM)

First results concerning paleogeographic maps were presented during the RCMNS-Congress in Budapest 1985 and published by HAMOR & al., 1988. Several subsequent local studies dealing with biostratigraphy, paleomagnetism and geochronology in the Swiss Molasse basin yielded some new results concerning paleogeographic relationships between Mediterranean and Paratethys basins. Discussion on stratigraphic correlation was presented at the RCMNS- congress in Barcelona (1990) and published by BERGER 1992.

This presentation discusses paleogeographic and palinspastic maps of the Swiss Molasse basin from Early Oligocene to Pliocene. These maps were prepared for the IGCP Project 329 "Paleogeographic and Paleoecologic evolutions of Paratethyan basins during Neogene and their correlation to the Global scale".

Different problems will be highlighted :

- reconstruction of the Oligocene Freshwater Molasse (USM) deposits according to alpine tectonics

- relationships between Rhodanian basin, Bresse graben, Rhine graben, Molasse basin and Paratethys during the deposition of the Oligocene Lower Marine Molasse (UMM) and the Miocene Upper Marine Molasse (OMM)

- the particular geographic distribution of the Upper Freshwater Molasse (OSM, Middle Miocene)

- the relationships between bentonite levels observed in the OSM and volcanic/ impact activity.

- the very rare deposits of Late Miocene and Pliocene sediments, and their significance in terms of alpine orogenesis.

References

Berger , 1992 : Correlative chart of the European Oligocene and Miocene : application to the Swiss Molasse Basin. - Eclogae geologicae Helvetiae 85/3, p. 573- 609

Hamor G., Halmai J. & al. , 1988 : Neogene paleogeographic atlas of central and eastern Europe. - Ung.Geol.Inst.; Budapest.

DELINEATION OF LATE MIOCENE BURIED PALAEO - CHANNEL SYSTEM IN THE SIRTE BASIN, LIBYA.

A.A. BINSARITI

Great Man Made River Project, Benghazi, LIBYA

The discovery of the Late Miocene Sahabi Palaeo - hydrographic system in the Sirte Basin was taken as a supporting evidence for the hypotesis of the Mediterranean desiccation dureing the Messinian stage (Barr and Walker, 1973). Due to its importance as a significant groundwater resource, this paper attempts to recognise and trace the subsurface extensions of the Sahabi Channel System in other areas of the basin itilising available geological and hydrogeological criteria. Sparsely distributed seismic control- points are known to be in accord with the results of the present hydrogeological interpretations.

The distribution of the channel system is controlled by the pre- Messinian palaeotopographic configuration of the Sirte Basin. This configuration was inherited from the early stages of basinal tectonic development since the Late Jurassic time. Palaeo- channels are found to be closely associated with and subsequent to, major structural troughs. They are also found to be closely associated with the distribution of fresh ground - water lobes in the desert aquifers. The location of the Sahabi Channel is apparently controlled by the NNW - SSE trending axis of the basin. Groundwater quality data suggest that other buried channel systems also exist in association with the Maradah Trough to the west of the Sahabi Channel System.

Recognition of buried channels by geochemical means is dependent on the salt concentration contrast existing between the pore water of the channel - fill sediments and the pre-Messinian host deposits which often contain relatively higher salt concentrations. In this paper, channel extensions were recognised by the application of hydrogeological concepts such as the spatial variability of the groundwater electrical conductivity which was used initially as a reconnaissance method. The details of the southern extension of the Sahabi Channel are mostly

established by synthesising data of aquifer transmissivities superimposed on groundwater electrical conductivity distribution.

The use integrated multi- data sets, as outlined here, is proved to be a more effective approach of systematic recognition of bureid channels which determines trends of groundwater exploration and development in the desert areas of the Sirte Basin.

MAJOR COMPRESSIVE EVENTS IN THE NORTHERN APENNINES SINCE LATE TORTONIAN

Mario BOCCALETTI[1], Marco BONINI[1], Giovanna MORATTI[2], Federico SANI[1]

[1] Dipartimento di Scienze della Terra - Università degli Studi di Firenze - ITALY

[2] C.N.R., Centro di Studio di Geologia dell'Appennino e delle catene perimediterranee - Firenze, ITALY

The Neogene- Quaternary evolution of Northern Apennines has been interpreted with classic model of a migrating eastward compressive external front, followed an extensional regime in the back areas connected with the Tyrrhenian basin formation.

However, in the last fewyears, new structural data have been collected both in the interval areas, in the Neogene- Quaternary marine and continental sediments of the basins, and in the external exposed thrust- belt. In both areas a complex structural evolution has been reconstructed, allowing to distinguish some main tectonic events, similar in age, affecting both areas. In particular, it seems that the Messinian and Late Pliocene, but also the Early Pliocene and Early- Middle Pleistocene events could be very important in the structural evulution of the Northern Apennines.

These structural data lead to hypothesize that the compressive regime in the internal areas was active until the end of the Messinian since early Pliocene the area was affected by an extensional tectonics sometimes interrupted by compressive events. In this context some of the Northern Apennines basins have been related to the thrust activity, both during Tortonian- Messinian and during Plio- Pleistocene times.

On the other hand, the knowledge on the deep structure of the Northern Apennines has increased with new geophysical and subsurface data acquired in the last few years. It is believed, therefore, that the basement has an important role even in the tectonic evolution of the internal sector of the area and, as a consequence, its involvement could explain the compressive tectonics.

In this paper, therefore, a new model which matches together field data and geophysical evidence is proposed.

PALEOENVIRONNEMENTS ET PETROFACIES DE LA FORMATION KLIWA SUPERIEURE

Aura CEHLAROV, Gheorghe MOMEA, Lucia MOMEA

S.C. "Prospectiuni" S.A., Bucuresti, ROMANIA

Par l'interprétation dinamique et hidrodinamique des données granulométriques d'échantillons des arénites de la Formation Kliwa supérieure (Miocène inférieur de la Nappe de Tarcau) on a essayé de reconstituer l'origine et les conditions de transport et sédimentation pour ces dépôts. '

Les grains d'origine éolième auraient été transportés principalment par sauts et en suspension par un paléocurant qui aurait eu une vitesse hypothétique de 13,6 cm/ s, calculée par la méthode Middleton.

Les indices granulométriques inscrivent la plupart des échantillons dans l'aire des turbidites du diagramme Passega.

THE MESSINIAN SALINITY CRISIS : DATA FROM GEOLOGY, BIOSTRATIGRAPHY AND GEOCHEMISTRY FOR A PALINSPASTIC RESTORATION OF THE CENTRAL APENNINS (ITALY)

P. Cipollari [1], M. Barbieri [2], F. Castorina [2], D. Cosentino [1]

[1] Dip. Scienze della Terra, III Università di Roma, ITALY

[2] Dip. Scienze della Terra, Università "La Sapienza", Roma, ITALY

The Messinian salinity crisis represents one of the most important events in the Miocene of the Mediterranean area. The authors who worked on this topic pointed out the palaeoenvironmental implications and the stratigraphic significance of this crisis (Hsu et al., 1977; Cita and Wright, 1979).

In Italy evaporites referable to the Messinian salinity crisis are widespread and cr out both along the Tyrrhenian side of the Apennines (evaporites of the Neogene Tus cycle and similar facies in southern Italy) and along the Adriatic one (Gessoso Solfif Fm.).Furthermore, gypsum deposits similar to that described above are also present Calabria and Sicily. Moreover, in the central Apennines the stratigraphic record of th Messinian salinity crisis is also indirectly marked by resedimented or diagenetic gypsum i non-evaporitic sedimentary environments (e.g. gypsarenites in the Laga foredeep basin Gypsum- bearing terrigenous deposits are also present as bounded outcrops on the centr portion of the Apenninic chain. However, in the literature for some of these deposits ther are unrealistic chronostratigraphic indications.

Geology. In this paper all the gypsum- bearing terrigenous deposits that crop out in th central Apennines along a SW- NE strip, between Formia (Tyrrhenian side of the Apennine and Anversa degli Abruzzi (Adriatic side of the Apennines), have been analyzed. particular, 7 stratigraphic sections have been studied, which from SW towards NE are : Trivio, Penitro sud and Penitro nord (Piana di Formia), Collepardo (Ernici Mts.), Petrella Liri and Picinisco (Roveto valley), Anversa degli Abruzzi (Montagna Grande-Mt. Genzana).

All these sections are referable to four different geodynamic domains. The structural-stratigraphic features recognized in the Trivio, Penitro sud and Penitro nord sections allow to refer them to a syn- rift stage (Cipollari and Cosentino, 1992). On the contrary, the Collepardo section has to be refered to a thrust- top basin located close to the active thrust front of the Apenninic chain (Cipollari, 1995). Furthermore, the Roveto valley sections (Petrella Liri and Picinisco) consist of turbiditic siliciclastic deposits sedimented in a foredeep basin. Finally, the stratigraphic features observed in the Anversa degli Abruzzi section, similar to that of the Gessoso Solfifera Fm., permit to locate this sector in a foreland palaeodomain.

Biostratigraphy. The biostratigraphic analysis carried out on these sections using calcareous nannofossil assemblages has pointed out the presence of *Amaurolithus* spp. whose first occurrence defines the base of CN 9b subzone (Okada and Bukry, 1980) (uppermost Tortonian- Messinian). From a stratigraphical point of view, among the recognized species the most important are : *A. delicatus,* whose FO is close to the Tortonian/ Messinian boundary, and *A. amplificus,* which is characterized by a very short range within the middle-upper Messinian.

Geochemistry. From all the described sections 13 selected gypsum samples and 1 oyster shell (Collepardo section) have been collected. In this study, we use $^{87}Sr/^{86}Sr$ ratio on the collected samples to provide age estimates which are important to evaluate the kinematic evolution of the study area. It can be noticed that our Sr isotopic data (0.70890+- 2) result statistically indistinguishable from those measured by Muller and Muller (1991)(0.708896+_17) on 16 gypsum samples from the Mediterranean area and by Ahron et al. (1993) (0.708914+_14) on 3 gypsum samples from the South Pacific area. All the analyzed samples have Sr isotopic ratios which fall in the range of the "lower gypsum" of the Gessoso Solfifera Fm.

Conclusive remarks. The results of the isotopic analysis allow to consider all the analyzed samples as isochronous and thus permit to reconstruct the geographic distribution of the geodynamic domains of the central Apennines during the Messinian salinity crisis. Moreover, taking into account 50% of shortening (Hill and Hayward, 1988; Patacca et al. 1992a; Calamita et al., 1994; Cavinato et al., in press) the palinspastic restoration of the central Apennines orogenic system has been attempted. Considering a discontinous foreland propagation of the chain- foredeep system (Vai,1989; Patacca et al., 1992b; Cipollari, 1995), the late Messinian active thrust front of the central Apennines should be located just on shore the present Tyrrhenian coast, in correspondence of the Volsci range.

References

Aharon P., Goldstein S.L., Wheeler C.W., Jacobson G., 1993 : Sea- level events in the South Pacific linked with the Messinian salinity crisis. Geology, 21 : 771-775

Calarnita F., Cello G., Deiana G., Paltrinieri W., 1994 : Structural styles, chronology rates of deformation, and time- space relationships in the Umbria- Marche thrust system (central Apennines, Italy). Tectonics, 13 : 873-881

Cavinato G.P., Cosentino D., Funiciello R., Parotto M., Salvini F., Tozzi M., in press : Constraints and new problems for a geodynamical model of the Central Italy (CROP 11 Civitavecchia- Vasto deep seismic line). Boll.Geof.Teor.Appl.

Cipollari P., 1995 : Modalità e tempi di propagazione del sistema catena- avanfossa nella zona di incontro tra Appennino settentrionale e Appennino centrale. Tesi di Dottorato di Ricerca in Scienze della Terra, VII ciclo, Università degli Studi di Roma "La Sapienza" : 229 p.

Cipollari P., Cosentino D., 1992 : Considerazioni sulla strutturazione della catena dei Monti Aurunci : vincoli stratigrafici. Studi Geologici Camerti, vol.spec. 1991/2 : 151-156.

Cita M.B., Wright R., 1979 : Geodynamic and biodynamic effects of the Messinian salinity crisis in the Mediterranean. Paleogeography, Paleoclimatology, Paleoecology, 29(1/2) : 1-222.

Hill K.C., Hayward A.B., 1988 : Structural constraints on the Tertiary plate tectonic evolution of Italy. Marine and Petroleum Geology, 5 (1) : 2-16.

Hsu K.J., Montadert L., Bernoulli D., Cita M.B., Erikson A., Garrison R.E., Kidd R.B., Meliéres F., Muller C., Wright R.H., 1977 : History of the Mediterranean salinity crisis. Nature, 267 (5610) : 399-402.

Muller D.W., Muller P.A., 1991 : Origin and age of the Mediterranean Messinian evaporites: implications from Sr isotopes. Earth and Planetary Science Letters, 107: 1-12.

Okada H., Bukry D., 1980 : Supplementary modification and introduction of code numbers to the low- latitude coccolith biostratigraphic zonation (Bukry, 1973; 1975). Mar. Micropal., 5 (3): 5-321.

Patacca E., Scandone P., Bellatalla M.,Perilli N.,Santini U., 1992a : La zona di ginzione tra l'arco appenninico settentrionale e l'arco appenninico meridionale nell'Abruzzo e nel Molise. Studi Geologici Camerti, vol.spec. 1991/2: 417-441.

Patacca E., Sartori R., Scandone P., 1992b : Tyrrhenian Basin and Apenninic Arcs: kinematic relations since late Tortonian times. Mem.Soc.Geol.It., 45 (1990): 425- 451.

Vai G.B., 1989 : Migrazione complessa del sistema fronte deformativo- avanfossa- cercine periferico: il caso dell'Appennino settentrionale. Mem.Soc.Geol.It., 38 (1987): 95-105.

117

AN ALTERNATE INTERPRETATION OF THE MESSINIAN SALINITY CRISIS: CONTROVERSY RESOLVED ?

Georges CLAUZON[1], François GAUTIER[2], Jean- Pierre SUC[2]

[1] Institut de Géographie, Université de Provence, FRANCE
[2] Institut des Sciences de l'Evolution, Université Montpellier II, FRANCE

Following the discovery in 1970 of late Miocene (Messinian) evaporite deposits beneath the Mediterranean sea floor, a sharp debate ensued which pitted opponents of two contrasting models which sought to the origin of the terminal Miocene desiccation phase: the "deep basin- shallow water" model, on the one hand and the "shallow basin- shallow water" model, on the other. Seemingly contradictory arguments have been used to support these two hypotheses :

1) the cutting of deep fluvial canyons in support of the "deep basin" model;

2) the persistence of open marine conditions (reflected in marine faunal/ floral associations) throughout the "salinity crisis", supporting the "shallow basin" model.

We have recently established a magnetostratigraphy for the Messinian of the West and Central Mediterranean which is very consistent with the apparently continuous sequence of the Atlantic Moroccan region. Comparison of these records indicates that evaporite deposition began simultaneously in the southern Spanish and Sicilian basins (early Chron C3r = Gilbert reversed). Together with the demonstrated presence of stratigraphically coeval reefs in the northern Caltanissetta basin, these observations suggest that the Sicilian series is not representative of the deep basin depositional series. The marginal evaporites have been eroded during the later phase of evaporite deposition.We propose a model which incorporates a recently developed astronomical chronology consistent with global climatic evolution and which envisions a two stage process for the formation of the terminal Miocene "Salinity Crisis" :

1) deposition of marginal evaporites (including those of Sicily) beginning at ~5.80 Ma and corresponding to a phase of global sea- level fall (Antarctic glaciations);
2) major and rapid (tectonically induced) sea- level fall in the Mediterranean which provoked the desiccation of the basin, formation of deep evaporite deposits and strong erosion on its margins (from 5.60 to 5.32 Ma) before the Zanclean deluge.

DISTRIBUTION OF MESSINIAN CARBONATE PLATFORMS IN THE ORAN AREA (ALGERIA)

Jean-Jacques CORNEE[1], Mostefa BESSEDIK[2], Lahcene BELKEBIR[2], Bouhameur MANSOUR[2], Jacques MULLER[1], Jean-Paul SAINT MARTIN[1]

[1] Université de Provence, centre de Sédimentologie-Paléontologie,Marseille, FRANCE
[2] Université d'Oran, Institut des Sciences de la Terre, Oran, ALGERIE.

New field works led to identify new Messinian carbonate platforms outcrops between Oran and Oued El Malah (Western Algeria). The new data provide important informations for a better understanding of both the Messinian plaeogeography and the Messinian "salinity crisis" in the margins of the Paleomediterranean.

The Messinian carbonate platforms are composed of five main sedimentary units, from bottom to top :

- Unit 1 rests upon Tortonian- Messinian marls or unconformably upon a previously deformed substratum. It is made of sandstones, conglomerates, or bioclastic limestones with *Heterostegina* and *Clypeaster.*

- Unit 2 is made of prograding red- algae bioclastic and, locally, oolitic limestones. In the Bou Zadjar area, Unit 2 includes coral beds with diverse scleractinian genus. Basinward prograding beds change into marls and diatomites interbeddings.

- Unit 3 is made of a prograding coral reef complex with dominant *Porites,* microbialites and *Halimeda.*

- Unit 4 is made of white micritic limestones displaying ostracods and sponge spicules and develops upon the outermost part of Unit 3. The micritic limestones often suffered *in situ* brecciation, can be interbedded with gypsum lenses, and often display salt remnants.

- Unit 5 is made of oolitic and stromatolitic limestones from shallow water environment, overlaying Units 3 and 4 even in the innermost part of the platform.

Three major distinctive carbonate platforms are identified. In each of the platforms the progradational directions of the carbonated units 2 and 3 are strongly changing, depending on their position against the substratum. The platforms are widely developed wether on the top of dissymetric horsts of the substratum or against older volcanoes. Such preexisting structure created a complicated paleogeographic pattern during Messinian times, with carbonate shoals, marine straights between small basins and islands. After removing post- Messinian deformations, the three main platforms are organized in a progradational geometry only, without general downstepping.

The sedimentary organization of the carbonate platforms and their distribution indicate basins during Messinian, with two active processes :

- Aggradation led to the infilling of the accomodation, facies ranging everywhere from pelagic marls during lower Messinian to coral reefs then gypsum and stromatolitic beds during upper Messinian;

- Progradation of the carbonate units from the substratum blocks toward the basins reduced the width of the straights. Evaporite deposition during Unit 4 could be the first consequence of narrowing communication zones between the coastal basins.

121

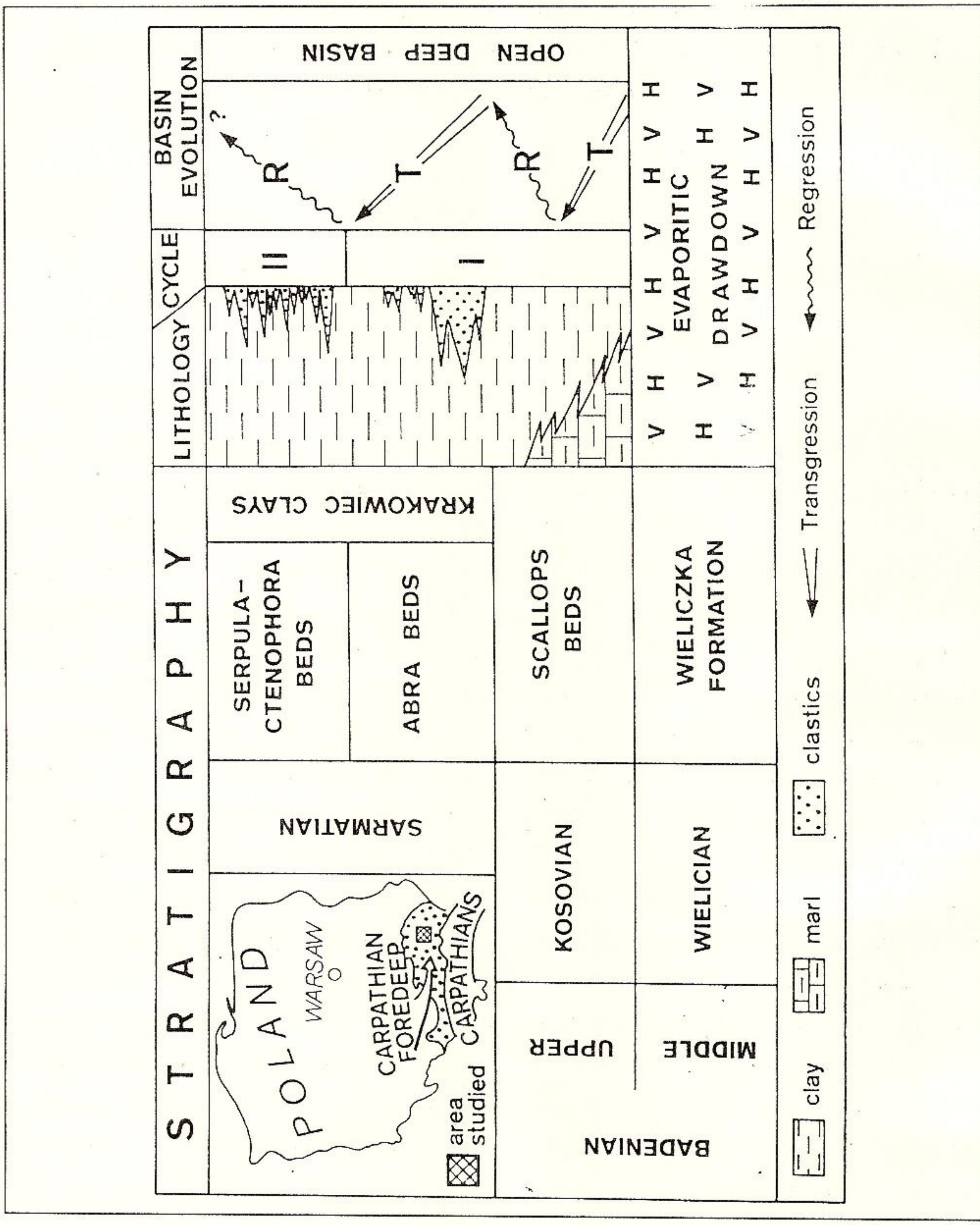
DEPOSITIONAL HISTORY OF POST- EVAPORITIC MIDDLE MIOCENE COMPLEX FROM THE NORTH- CENTRAL PART OF THE CARPATHIAN FOREDEEP (S POLAND)

Grzegorz CZAPOWSKI

Panstwowy Institut Geologiczny, Warsaw, POLAND

The post- evaporitic Middle Miocene (Upper Badenian and Lower Sarmatian age), unfolded complex, drilled in the north- central part of Carpathian Foredeep (sulphur mining area), is over 500 m thick and consist of almost homogenous series of clay/ siltstones with rare sandstone/ gravelly sand interbeds and tuffite layers. This complex is subdivided - due to included fauna - into three units : the Scallops Beds (dated as Upper Badenian= Kosovian substage), the Abra Beds and Serpula- Ctenophora Beds (both called the Krakowiec Clays and considered as Lower/ Middle? Sarmatian in age - Figure). Lithology and sedimentary structures indicate that the whole described series was deposited within an open deep marine basin, developed in the Foredeep area after the Middle Badenian (Wielician substage) evaporitic shallowing/ draw- down. Pelitic deposition from suspension prevailed in the basin but also some effects of traction/ turbidity currents (massive/ fractioned and cross-bedded coarse- fine clastics) and volcanic eruptions (tuffite intercalations) were registered. Beside the almost constant environmental conditions (basin depth, depositional style) two transgressive- regressive cycles were defined in the whole sequence : the lower cycle, including the Scallops and Syndosmya Beds and the upper one, represented by the Serpula-Ctenophora Beds. Boundary of both cycles is reflected in variations in water salinity (borium content) and decline of most faunal elements. This boundary probably records in the basinal part of the Foredeep the "mature" stage of Lower Sarmatian transgression (extending from the Eastern

Parathethys), which initial evidences (development of foram assemblage with Anomalinoides dividens) are commonly found far below (within Abra Beds).



NOUVELLES DONNEES SUR LE MESSINIEN DE SICILE (ITALIE)

F. GAUTIER[1], J.J. CORNEE[2], J. MULLER[2], J.P. SAINT MARTIN[2]

[1] Université de Montpellier II, Montpellier, FRANCE

[2] Université d'Aix en Provence, Marseille, FRANCE

Des études récentes de calibration magnétostratigraphique ont permis de proposer un cadre chronostratigraphique à la sédimentation messinienne de Méditerranée occidentale et plus particulièrement de Sicile. Nous avons montré que les coupes représentant la Formation de Tripoli (diatomitique) comportent toutes des lacunes dues à la tectonique chevauchante. Cette Formation s'étale sur une durée plus longue que celle admise par les travaux antérieurs. Par ailleurs nous avons mis en évidence le synchronisme du début de la " Crise de Salinité" sur les marges de la Méditerranée occidentale.

Nos travaux dans le bassin de Caltanissetta en Sicile centrale apportent des donnée nouvelles qui portent sur plusieurs points :

- La paléomorphologie et l'évaluation de la paléobathymètrie du bassin après soustraction des déformations post- messiniennes;
- La position stratigraphique des dépôts évaporitiques, notamment le sel;
- Les phénomènes de gypsification tardive sécants sur la stratigraphie;
- La signification des faciès du Calcaire de Base.

Les observations, recueillies lors de levers cartographiques le long de deux transects interceptant plate- forme et bassin, conduisent à esquisser un schéma synthétique du Messinien de Sicile en accord avec ce qui est observé dans les autres bassins messiniens de Méditerranée occidentale. Ainsi, le bassin de Caltanissetta, qui referme d'importantes masses salifères, a comme ailleurs tout les caractères d'un bassin

peu profond. Les conséquences en sont importantes pour l'interprétation générale de la Méditerranée messinienne.

THE SEQUENTIAL- STRATIGRAPHY INTERPRETATION ON NEOGENIC DEPOSITS IN DURRES BASIN (PRE ADRIATIC FOREDEEP)

Sazan GURI, Stavri DHIMA

Oil & Gas Geological Institute, Fier, ALBANIA

Stratigrafical- sequential analysis. The terrigenous deposits are involved within the upper Oligocene- oneward. They are respectively represented by:

1) a clay sandstone classical rythm facies (flysch dep.), where debris limestone levels, marls intercalations etc. are encountered.

2) a sandstone- clay facies (flyschoidale deposits), where sandstone are massive and extensional.

3) a marl- clay prone facies (Burdigalian) rarely interbeded with sandstone.

4) a clay- sandstone facies (molassic dep. - Serrevalian onwards) where the sandstone components is encreased toward the basin borders and vertically.

Tectonic. By using an enourmus geological and seismic data it is attained to throw light on: 1) compression tectonic regime

2) tectonic phases

3) structural range and tectonic style

4) tectonic faults and their forming mechanism.

In this context a clear framework of evolutive geotectonic stages is provided.

Stratigraphical- sequential interpretation. All indicators data of multidisciplines (seismic, sedimentology, petrography, paleontology etc.) are integrated. There are also used the Vail et al. all's conception respectivelly applied in passive margins.

It is attained to individualise 10 siliciclastic depositional sequences, three of which are respectively related with flysch, flyschoidal and premolassic deposits and 7others belong to molassic one. By the combination of seismic data with geological one it is attained to determine:

1) sequence boundary and basal surface type (Sb1 or Sb2)

2) system tracts and seismic facies within it

3) depositional environments and their relative facies Hence, it is concluded :

1) the depositional sequence generally belong to type 1, with Sb1 basal boundary and rarely of Sb2 type.

2) in the older sequences (A,B,C,D,) fig.1 , the lowstand system tracts are preserved.

It is noticed that the lowstand system tracts are predominated by turbidite facies of basin and slope fans, whereas in that of highstands (Tortonian onward) there is encontered a lateral change of environment, begining from continental (aluvial), transitional (coastal anddeltaic) to marine (shelf, slope and basin).

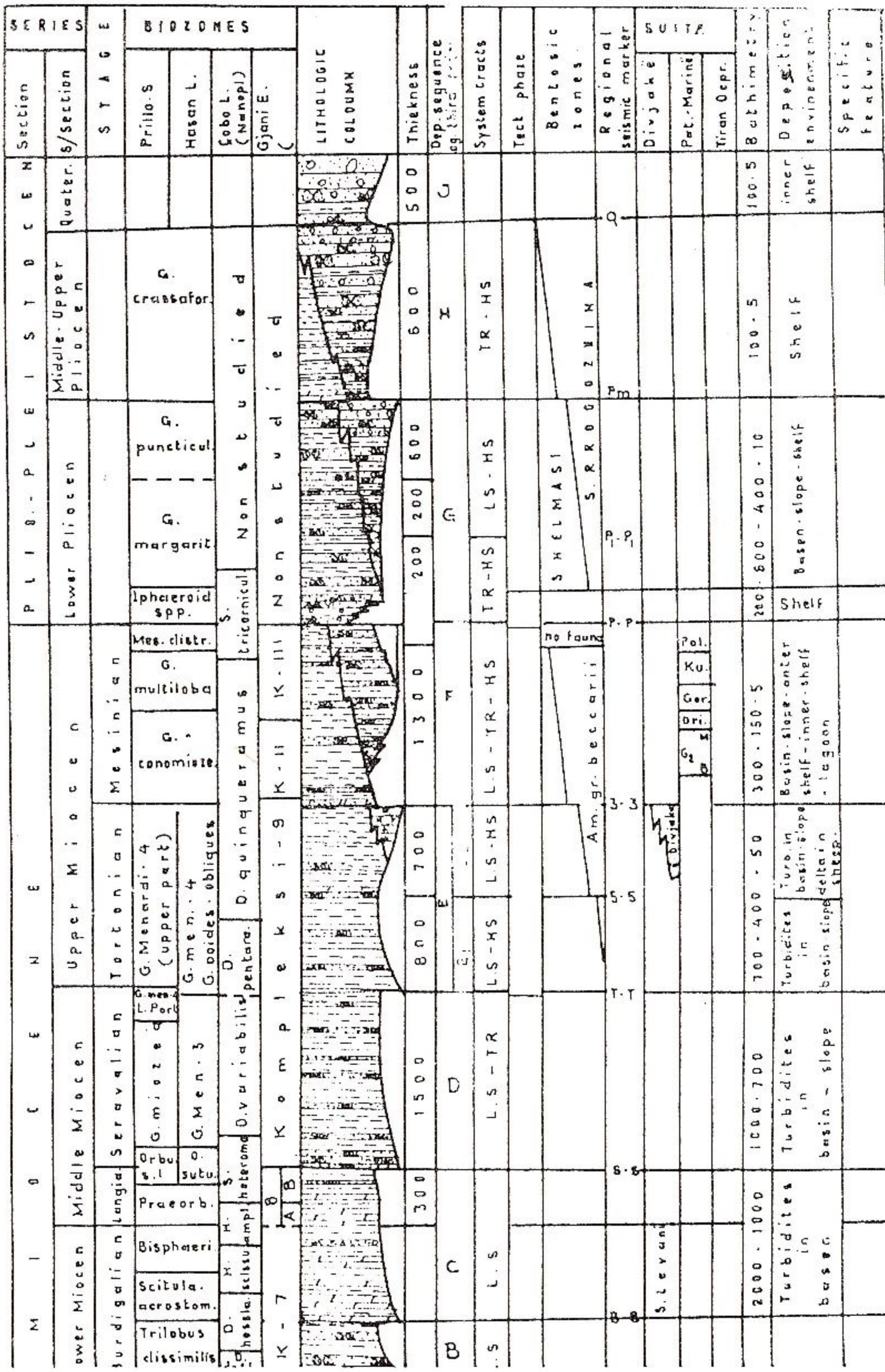
It is also realised that the qualitative parameters of Vail et al. (depositional shoreline break, shelf break etc.) are encountered in short distance in comparision with passive margin proposed by them. Finally we point out that the sequence forming mechanism is deticated to the combination between the sea level fluctuations and compression tectonic factors, but in this region the former predominant.

In each of the sequence, the system tracts and their respective environments are determined. .

There are also evaluated the facies geometry and often, is given the possible predictable resewoirs.

Combining the geochemical, structural and facies data is localised the best structural place.

A SUMMARISE STRATIGRAPHIC COL UMN OF PERI ADRIATIC FOREDEEP



MIOCENE CONTINENTAL BASINS IN GREECE : NEOTECTONIC PALAEOENVIRONMENTAL, PALAEOCLIMATIC EVOLUTION

Chryssanthi IOAKIM, Antonios METTOS, Theodora RONDOYANNI

I.G.M.E., Athens, GREECE

In the present study, detailed tectonic and biostratigraphic data from the continental basins of the Greek territory, are used toghether in order to show the relations between various parameters and their role in the genesis of depositional sequences during the Miocene.

A long period fieldwork, a number of local geological problems related to complex stratigraphic relationships and tectonic deformations of the hole area had to be overcome.

The Miocene continental basins evolution in Greece can be divided in the following areas :

a. Basin et Aliveri and Kymi, Northern- Central Euboea (Early Miocene).

b. Basin et Plakia in Crete, (Middle Miocene).

c. Serres basin in Northern Greece, Kerassia area in Euboea and Samos island, (Late Miocene).

d. Katerini basin, Moschopotamos area in Central Greece, (Late Miocene - Lower Pliocene).

Data are presented in the form of detailed litho- biostratigraphic columns and composite structural profiles. Palaeogeographical and palaeoclimatological interpretations are discussed, which display encountered reflections of syndepositional tectonics.

UPPER NEOGENE EVOLUTION OF SEDIMENTARY ENVIRONMENTS IN THE LITTORAL ZONE OF DACIC BASIN

Dan C. JIPA

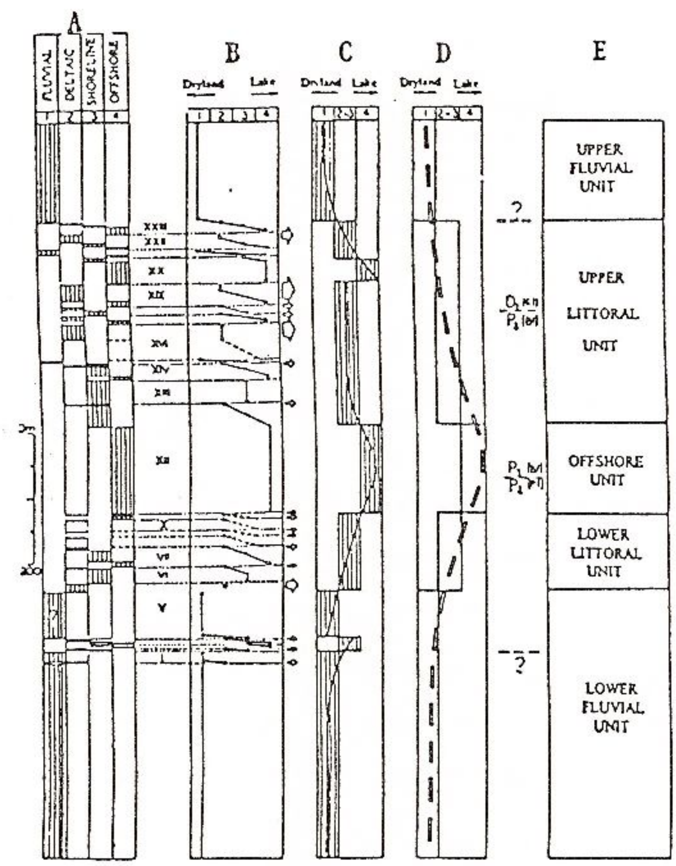
Romanian Center for Marine Geology and Geoecology, Bucharest, ROMANIA

Pontian to Dacian deposits outcropping in Tigveni area (Arges County, Romania) have been investigated by means of facies, sequence and paleoenvironmental analysis. This study lead to the recognition of fluvial (alluvial plain) and lacustrine (shore, delta and offshore) sedimentary environments.

Examining the evolution of these sedimentary environmentsit results that the alluvial sediments occur at both the lower and upper parts of the investigated sequence. Littoral (shore and deltaic) sedimentary accumulations succede the lower fluvial sediments and precede the upper fluvial deposits. Clayey offshore deposits are interbedded within the littoral sequence. An important Pontian offshore unit occur in the middle part of the investigated sequence. Other, thinner offshore sedimentary units have been observed at different levels.

The sedimentary paleoenvironments in the northern, littoral zone of the Dacic Basin manifest a symmetrical evolutionary trend. The lower half of the sequence shows a transgressive evolution, from lower alluvial deposits to offshore clayey sediments. The upper half of the investigated sequence becomes regressive, evolving from offshore to alluvial environmental conditions.

At least three minor evolutionary cycles are superimposed on the main transgressive - regressive genetic trend.



Genetic evolution chart of the Upper Neogene deposits of Tigveni zone (Romania)

A. Paleoenvironments. B.Genetic units. C.Minor evolution cycles. D Main genetic trend. E.Genetic- stratigraphic Upper Neogene units. Biostratigraphic boundaries after F.Marinescu and I.Papaianopol.

133

GEOLOGICAL AND PALAEOGEOGRAPHIC EVOLUTION OF WESTERN GREECE, DURING THE NEOGENE - QUATERNARY PERIOD IN THE GEODYNAMIC SETTING OF THE HELLENIC ARC

Evangelos KAMBERIS[1], Chryssanthi IOAKIM[2], Stella TSAILA- MONOPOLIS[3], Fedon MARNELIS[1], Spilios SOTIROPOULOS[1]

[1] DEP - EKY, Maroussi, GREECE
[2] IGME, Athens, GREECE
[3] University of Patras, Dep.of Geology, Rio/Patras, GREECE.

After recent investigations in Western Greece new data concerning the tectonic and palaeogeographic evolution of this region as well as the litho- biostratigraphic and facies succession during the Neogene - Quaternary period has been established.

It is well known that West. Greece is very active tectonically. Subduction of Mediterranean oceanic crust under the Eurasian continental one is taking place in the SW Ionian region, while a continent - continent collision occurs in the region of the NW Greece.

After these geological investigations three distinct sedimentary sequences of post-Acquitanian age have been recognized and are seen to have been affected by three compressional phases. The first sedimentary sequence was deposited during the Lower Miocene (Burdigalian), the second one during the Lower Miocene to Lower Pliocene period and the third one has started in the latest Lower Pliocene and continues to present day.

A series of palaeogeographic maps covering the Neogene to Quaternary period in the studied region are presented here. They are based on the correlation of surface geological sections, drilling data, litho- biostratigraphic analysis (Foraminifers and Palynology) and interpretation of seismic profiles.

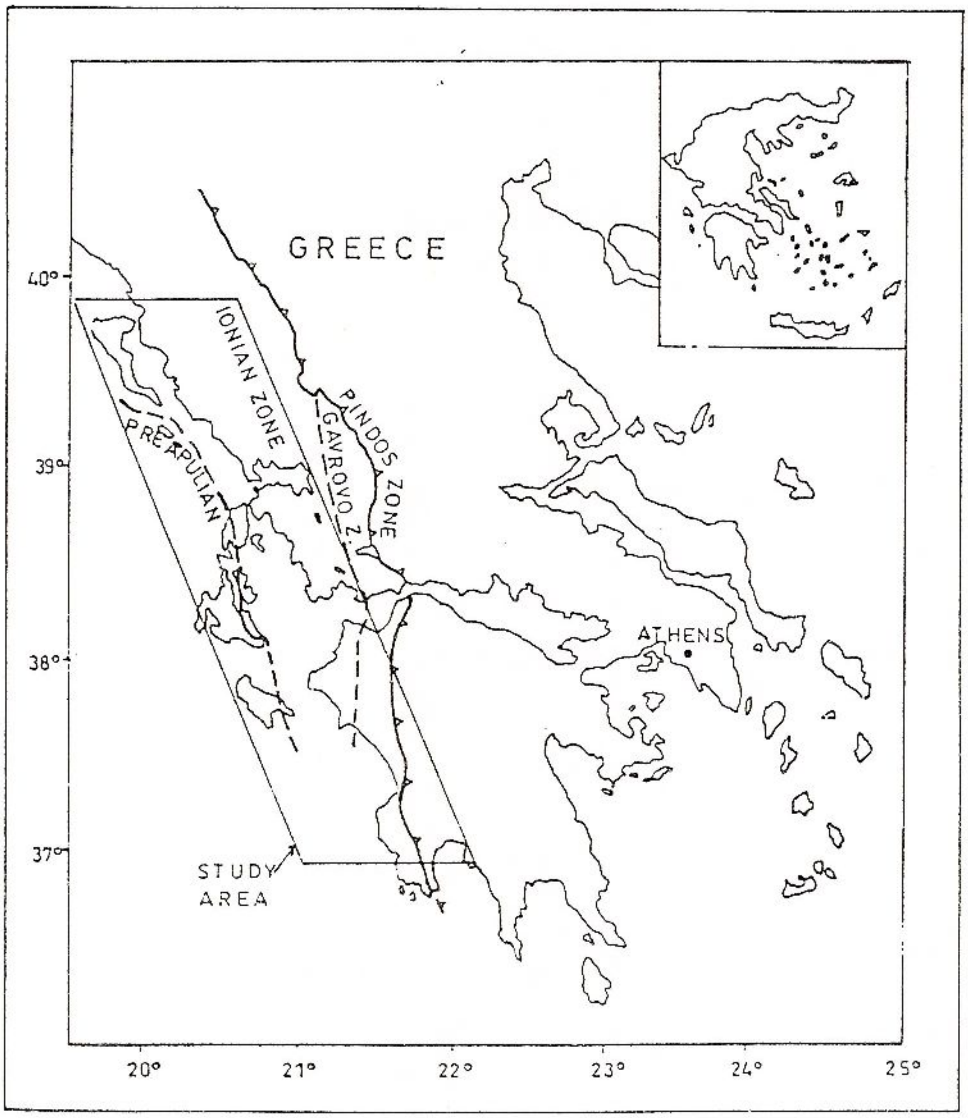


FIG. 1 MAP OF THE STUDIED AREA

TECTONIC VERSUS EUSTATIC EVENTS DURING THE LATE CENOZOIC EVOLUTION OF THE WESTERN CARPATHIAN BASINS

Michal KOVAC

Comenius University, Faculty of Sciences, Dep. of Geology and Paleontology, Bratislava, SLOVAKIA.

Origin of the Neogene intramountain basins of the Western Carpathians differs in tectonic regime resulting from the geodynamic process, which were taking place during the Lower Miocene collision of the orogen and platform, as well as during the Middle and Upper Miocene back- arc rifting and following thermal subsidence. Their further characteristic feature is the original paleogeographic position, which influenced the sea connection with the Mediterranean and sedimentary environment in the Central Paratethys.

In the Lower Miocene, as a consequence of the collision between the Eastern Alps and North European plate, the extrusion of the Western Carpathian and North- Pannonian crustal fragments accelerated to the east. This process was accompanied by compressive regime in the forming accretionary wedge of Carpathian externides and in the frontal part of the internides.

The Eggenburgian sedimentary environment of the Central Paratethys had mainly a marine character due to the sea ways connecting basins of the Western Carpathians with Mediterranean through the Alpine foredeep, as well as trough “transdinarid corridor”.

In the Ottnangian as a result of the Lower Miocene compressive event the disintegration of the sea way in the front of the Alps took place, connected with the uplift of internal zone of the orogene. In the Western Carpathian basins prevailed the sedimentary environment with lower salinity, resp. in the hinterland of the orogen it was the lacustrine environment with coal sedimentation.

At the end of the Lower and the beginning of the Middle Miocene culminated the collision of the Western Carpathians and North European plate, there was formed the mountain chain arc. In the western part of moving orogen was formed the Vienna Basin as a consequence of the NW-SW sinistral strike-slip faults and in the eastern part the NW-SE dextral shear opened the East Slovakian Basin in transtensional regime. In the Western Carpathian basins prevailed again marine sedimentary environment. Characteristic feature was the steep relief of the internal part of the orogen and formation of the deltaic systems prograding in direction to externides, resp. to the axial parts of basins with intensive subsidence.

If we compare oscillation of sea level and eustacy in the Mediterranean / Haq et al. ,1987, Steininger et al., 1988 / and in the Western Carpathians during the Burdigalian / it means in the Eggenburgian, Ottnangian and Karpatian in the Central Paratethys area / we can state an apparent difference between them. In the Carpathians area the Eggemburgian transgression was followed by the Ottnangian sea level fall caused just by the local Lower Miocene compressive tectonic event. Following Karpatian transgression again corresponds with the Mediterranean sea level rise during the late Burdigalian.

The Middle Miocene compressive event led to the uplift of Carpathian externides and to the Middle Badenian evaporite crisis in the foredeep that interfered also the area of the Transcarpathian Basin. This compressive event caused also further uplift of the Western Carpathian internides, accompanied by the desappearance of the sedimentation in the part of hinterland after the Lower Badenian / Langhian/. Strengthening of the compressive event influence can be time correlated with the sea level falls in the Mediterranean in the Langhian and Serravallian.

During the Middle and Upper Miocene an extension prevailed in the whole area, as a consequence of the initial rifting and following thermal collapse of mantle diapir in the Pannonian Basin.

Unlike the Mediterranean, where during the Langhian and Serravallian a gradual sea level fall begins, in the itramountain basins of the Western Carpathians takesw place a relative coastal onlap from the Badenian to Sarmatian. This phenomenom can be explained by extensive subsidence in the Vienna, Danube and Transcarpathian basins, as a results of the whole-crustal extension, which controlled formation of depocentres. The filling of mentioned basins was realized mainly due to new deltaic systems, generally oriented to the Pannonian domain.

From the Upper Miocene the Western Carpathian intramountain basins become a part of the Pannonian Basin System, in which the sedimentary environment changed from the Badenian from marine to brackish during the Sarmatian and gradually from the Pannonian to freshwater, due to absolute isolation from the Mediterranean. Sedimentation, in the Western Carpathian area, was concentrated mainly to the southern and central part of the Vienna, Danube and Transcarpathian Basins. The subsidence in the Vienna and Danube Basins continued also in the Pliocene.

As for the correlation of sea level changes during the Pannonian and Pontian in the Carpathian- Pannonian area with the Mediterranean development during the Tortonian and Messinian it's very difficult because of mutual isolation. In spite of this it can be correlated the sea level fall in the Mediterranean during the Messinian with the ceasing of sedimentation at the end of the Pontian in periphery the Pannonian Basin System.

PALAEOGEOGRAPHIC AND PALAEOTECTONIC SIGNIFICANCE AND REGIONAL CORRELATION OF THE PLIOCENE- EARLY PLEISTOCENE SEQUENCES IN SOUTHERN APENNINS AND SICILY

LENTINI F., CATALANO S., CARBONE S., DI STEFANO A.

Instituto di Geologia e Geofisica, Università di Catania, Catania, ITALY

In Sicily and in Southern Apennines, Pliocene- Early Pleistocene sequences conceal different structural setting according to their location within the Apenninic- Maghrebian Orogen. In the external area they fill the "foredeep basins" depression located on the downthrown margin of the Foreland facing the front of the chain; other Plio- Pleistocene sequences have been recognized within "satellite basins", perched on the allochthonous units of the orogenic domains; further Plio- Pleistocene horizons have been found within "hinterland basins", located in the peri- Tyrrhenian margin affecting the internal sectors of the orogenic belt. This suggests that at the moment of deposition of Plio- Pleistocene sediments, the modern structural domains of the Central Mediterranean area (Lentini et al., 1993) were already well outlined. They consist of the Foreland Domain, grouping different crustal sectors belonging to the Afro- Adriatic margin and to the Ionian Basin (Finetti et al., 1994); the Orogenic Domains, which are composed by three distinct chains, the Apulian-Sicanian Chain, the Apenninic- Maghrebian Chain and the Kabilo- Calabride Chain. The three edifices represent respectively the product of the Neogene deformation of the african margin, of the Tethys oceanic palaeodomains and of the european margin and drawn a regional scale duplex structure; the Tyrrhenian Basin deriving by the extension affecting the internal areas of the orogen since the Serravallian.

The Plio- Pleistocene foredeep deposits rest on the Foreland sequences partly underthrusting the units of the chain. The Lower Pliocene sediments are concealed beneath the allochthonous edifice; the Middle Pliocene- Lower Pleistocene horizons form an imbricated fan at the front of the orogen (Bianchi et al., 1987).

The Plio- Pleistocene horizons which deposited within the perched basins rest unconformably upon the allochthonous nappes and fill structural depression tectonically controled by ramps which breach the orogenic edifice, displacing the pre-existing tectonic contacts between the different units.

In Sicily these deposits are arranged in two cycles forming two distinct foreward prograding clastic fans : the former developed during the upper part of the Early Pliocene and the Middle Pliocene in the piedmont areas, and rest unconformably upon a strongly folded substratum, including the Messinian evaporites and the Lower Pliocene marls of the "Trubi Fm"; the latter developed during the Late Pliocene- Early Pleistocene on the southern slope of the previous clastic fan, covering the Early- Middle Pliocene bottom set deposits. The upper horizons of this second cycle are slightly deformed, and extend toward the front of the chain joining the coeval foredeep deposits. The deposition of these two cycles post-dates a significant tectonic phase producing an imbrication of the allochthonous units and occurred in a general regressive context during a major emplacement of the nappes on the foredeep sequences.

A different evolution has been recorded by the Plio- Pleistocene "satellite basins" deposits in the external sectors of the Southern Apennines (Carbone et al., 1991). They are arranged in three distinct inward aggrading terrigenous cycles, including Lower Pliocene deposits, indicating a persistence of a wide regional subsidence of the area during their depositin. They post- dates a general emersion of the area occurred during the Late miocene.

The Plio- Pleistocene deposits of the peri- Tyrrhenian basins, fill triangular- shaped structural depressions controlled by faults belonging to the "South- Tyrrhenian Fault System" (Finetti et al., 1994), a transform belt accomodating to the south the opening of the Tyrrhenian Basin. They form two distinct cycles: the former, dating from the upper part of the Early Pliocene to the Middle Pliocene rests with a low- angle uncomformity upon the Lower Pliocene pelagic marls of the "Trubi Fm" and represents a regressive sequence evolving from marly horizons to upper sandy levels; the latter is composed of clays and calcarenites which unconformably lies not only upon the previous Pliocene deposits, but also on the pre- Pliocene substratum (Di Stefano & Lentini, 1995). The unconformity between the two cycles suggest a severe tectonic phase responsible for the activation of normal faults driving the overall collapse of the perityrrhenian areas along those structural trends which still today control the tyrrhenian coast in northern Sicily (Catalano & Cinque, 1995).

The analysis of the Plio- Pleistocene cycles put in evidence unconformities correlatable at a regional scale despite their location within the orogen ("foredeep", "satellite" or "hinterland" basins). Such evidences suggest that the Recent tectonic evolution of the different structural domains are strictly linked each other. In particular unconformities connected to compressional events in the orogenic domains correspond to discontinuities in the hinterland basins, related to the extensional tectonics along the tyrrhenian margin. The variable geometry and facies distribution of the Plio- Pleistocene deposits within the orogenic belt (e.g. Sicily and Southern Apennines) are due to differences in the Recent tectonic evolution of each orogenic segment during the late collisional events.

References

Bianchi F., Carbone S., Grasso M., Invernizzi G., Lentini F., Longaretti G., Merlini S., Mostardini F., 1987 : Sicilia orientale: Profilo geologico Nebrodi- Madonie. Mem.Soc.Geol.It., 38, 429-458.

Carbone S., Catalano S., Grasso M., Lentini F., Monaco C., Traumutoli M., 1991 : Carta geologica della Val d'Agri. Scala 1:50.000 (2 fogli0, S.EL.CA., Firenze.

Catalano S., Cinque A., 1995 : dati preliminari sull'evoluzione neotettonica dei Peloritani settentrionali (Sicilia nord-orientale) sulla base dei dati morfologici. Abstracts Scient. Meeting "Geodinamica e tettonica attiva del sistema Tirreno-Appenninio", Camerino, 9- 10 febbr. 1995.

Di Stefano A., Lentini R., 1995 : Ricostruzione stratigrafica e strutturale dei depositi plio- pleistocenici del margine tirrenico tra Villafranca Tirrena e Faro (Sicilia NE). Abstracts Scient. Meeting "Geodinamica e tettonica attiva del sistema Tirreno-Appenninio", Camerino, 9-10 febbr. 1995.

Finetti R., Lentini F., Carbone S., Catalano S., Del Ben A., 1994 : il ruolo cinematico e deformativo del Sistema Sud-Tirrenico. Abstracts 77* Nat. Congr. SGI- Bari.

Lentini F., Carbone S., Catalano S., 1994 : Main structural domains of the central mediterranean region and their neogene tectonic evolution. Boll.Geofis.Teor. e Appl., (in press).

TIMING OF MAJOR EVENTS IN THE NEOGENE GEOLOGIC EVOLUTION OF THE BETIC CORDILLERA (SE SPAIN)

A.C. LÓPEZ- GARRIDO, J. RODRIGUEZ-FERNÁNDEZ , C. SANZ DE GALDEANO

Instituto Andaluz de Ciencias de la Tierra; CSIC-Univ. de Granada, Granada, SPAIN

The main discontinuities recognized in the Betic Neogene sedimentary record allow to divide it in seven intervals of time. Each discontinuity correspond to tectonic deformation.

Oligocene to Early Aquitanian. The main nappe structuring of the Betic Internal Zone, forming three superimposed tectonic complexes (which from bottom to top are: Nevado-Filabride, Alpujarride and Malaguide) occurred during this period. Towards the end of this time there are an important sedimentary hiatus in the Malaguide complex.

In the External Zone, the Prebetic received a detritic sedimentation, with marine and continental intercalations, ended towards the Late Oligocene-Aquitanian. In the Subbetic, the sedimentary record shows clear signals of tectonic instability, as are some olistostromic deposits in the Southern Subbetic trough.

Late Aquitanian to Early Burdigalian. In the Internal Zone and along its contact with the External Zone several unconformable sedimentary formations developed, these being fed by rocks from both the Malaguide and Alpujarride complexes.

During the Early Burdigalian, or to the end of it, was formed this contact between the Internal and External zones. Thus, the Internal Zone, moving westwards from an original distance larger than 400 km, locally thrusted the southern margin of the Subbetic. It was strongly deformed, to the extent that the units of its eastern extreme are almost completely missed, its central units have undergone considerable northwestward displacements and especially the units of its northwesteren front contribute to the olistostromal masses deposited in the foredeep (the North Betic Strait formed in this time). A band of transcurrent dextral strike-slip faults of N70E trend developed in the Subbetic, moving even during the Middle Miocene. Further West, tectonic units of the former Flyschs basin were also westward desplaced. In the Prebetic a transgression took place.

Late Burdigalian to Langhian. During the Late Burdigalian, in the External Zone began a transgression mainly characterized by the deposition of white marly facies. These facies became part of the olistostromal formations in the North Betic Strait, because the Subbetic structuring had not yet reached its conclusion, even thrusting on the Prebetic. To the West, the Flyschs units continued moving westwards, although some of these units, organized as olistostromical masses, subsequently rode over the Internal Zone and even over the Alboran basin. Moreover, in this western area, many units adopted a curved arrangement, like those of the Penibetic (the western internal part of the Subbetic) which show important clockwise rotations during the Early- Middle Miocene.

Serravallian. A significant transgression, which caused the development of bioclastic platform and marly deposits upon almost all of the External Zone and important clastic wedges in the Internal Zones, took place.

The processes of thrusting (toward the NNW) continued in the Subbetic Zone. The North Betic Strait continued trapping large quantities of olistostromal masses. Their front migrated towards the foreland, with development of some piggyback basins. In the SE of the Betics a considerable amount of volcanic mass began outflow.

At the end of the Serravallian the thrusting of the Subbetic on the Prebetic stoped. In the Internal Zone, E-W faults, particularly those of the Alpujarra Corridor, became active, with right- lateral movements. Coetaneously, an important sea level fall is recorded in all the Betic Cordillera.

The mechanism producing during the Early and Middle Miocene the displacement of the Betic- Rifian Internal Zone is linked with the formation process of new oceanic crust in the western Mediterranean, especially in the Algero- Provecal basin, accompanied by the thinning of the continental crust in the Alboran sea. This process of expansion produced, among other effects, the westwards expulsion of the Betic- Rifian Internal Zone, which in its turn induced the deformations of the Betic and Rifian External Zones. During this westwards movement, the Internal Zone also suffered important internal displacements among its complexes, and even withim themselves, in such a way that the upper ones moved westwards in relation to the lower ones. These displacements are generally considered of extensive character.

The end of the westwards displacements of the Internal Zone made that the geodynamic situation changed dramatically from the Late Miocene.

Tortonian. An important palaeogeographic change occurred at the beginnings of the Tortonian, appearing numerous intramontane basins in the Internal Zone and in the area of contact with External Zone. These basins were flooded by the Tortonian sea, the best documented transgression in the Neogene record of the Betic Cordillera. In this time appear the first detritus inherited from the Nevado- Filabride complex, evidence of the beginning of its exhumation.

During the Late Tortonian the Gibraltar Arc attained finally its present structure. Coevally occurred the final structuring of the Prebeti with the formation of folds and tectonic slices, moving north and northwestward. The Prebetic emerged and close the North Betic strait, transformed in the Guadalquivir basin, which still progressed towards the foreland and where the olistostomal complex continued its advance. To the end of the Tortonian is detected a clear N-S to NNW- SSE compressive stage (and an E-W extension), contributing to the uplift of some of the most important sierras of the Internal Zone (Sierra Nevada, Filabres, etc.). During this time the eustatic fall, combined with a progressive uplift of the Betic and Rif cordilleras, produced the isolation of the Mediterranean sea. So, the communication between the Atlantic and the Mediterranean through the Betic Cordillera was reduced to few narrow straits, like in the Málaga basin.

Messinian. The complete isolation of the Mediterranean provoked its desiccation. Then developed "bull 's-eye" type facies distribution in the Messinian peripheral basins of the Alboran sea. In the Guadalquivir basin the olistostromal complex ended its advance.

Tectonicaly was important the displacement of the Palomares and Carboneras NE-SW sinistral strike-slip faults, related with a N-S to NNW- SSE compression and an approximately perpendicular extension. The volcanic outflow continued.

Many of the intramontane basins formed at the beginnings of the Tortonian became continental (in several of them this occurred by the end of the Tortonian). This process was helped by a radial extension affecting especially the central part of the Betic Cordillera, combined with an important uplift.

Pliocene and Quaternary. An important eustatic rise, and possibly the movement of E-W faults, produced the invasion of water from the Atlantic through the present Gibraltar Strait, causing a widespread transgression in the Mediterranean. So, the Pliocene began in the Betic Cordillera with a quick and sudden marine inundation of the peripheral basins of the Alboran sea, while the continental basins of the interior developed lacustrine areas changing to fluvial systems.

The radial extension (coexisting somehow with a N-S to NNW-SSE compression) continues till present, producing important vertical displacements of mostly of the ancient fault sets, with subsidence in the basins and important uprising in the surrounding reliefs. At the Late Pliocene a regression took place and the physiography of the Betic Cordillera was by now very similar to that of present day.

NEOGENE TECTONICS OF THE VAD'OVCE DEPRESSION (Western Carpathians)

Frantisek MARKO, Michal KOVAC

Dept of Geology & Paleontology, Fac. of Natural Sciences, Comenius University, Bratislava, SLOVAKIA

Neogene structural developement of the Central Western Carpatians was significantly affected by faulting, wich was responsible for basins opening as well as their desintegration. The Vad'ovce depression filled by the Lower Miocene sediments is situated inside tectonically very active ENE-WSW striking zone running between differentialy moving external (flysch zone) and internal (Central Western Carpatians) blocks. This zone has been recognized by microtectonic analysis and structural synthesis as wrench corridor responsable for tectonic architecture of the studied area.

Except of the Eggenburgian-Pannonian fillings of the sedimentary basins , there are in the wider surroundings Jurrasic-Cretaceous units of the Pieninny klippen belt zone extremely shortened and sheared in the neoalpine period, the Upper Cretaceous-Paleogene sediments of the "gossau facies" and the Triassic-Jurassic units of higher austroalpine nappes interpreted here as continuation of nappe units from the Northern Calcareous Alps.

The Great variety of rock ages in which structural investigation have been realised allowed to reconstruct superposition of tectonic events affecting the area during the Neogene period. As a tool for the structural reconstruction have been used paleostress analysis (right dihedra method) based on the processing of the mesoscale fault data.

From field structural observations by different directions of fault related to principal stress axes. There are observations supporting dextral shearing allong ENE-WSW trending wrench zone in transpressive regime during the Upper Paleogene-Lower Miocene time span. This kinematics is reflected in the nature of mesoscale faults affecting the Pieniny Kilppen belt and the Eggenburgian and Late Cretaceous sediments in periklippen zone, from which ESE-WNW (E-W respectively) orientation of horizontal compression have been reconstructed.

Taking into account magnitudes and sense of the rigid body block rotations taking place inside ENE-WSW trending strike-slip zone, it was possible to reconstruct original position of structures and stress axes of next stages recorded in recently having been already twisted blocks. Measurements of paleomagnetic meridians show apparent tendency of the anticlockwise block rotation in the wrench zone during the Middle Miocene, what was confirmed also by structural investigations. This is why kinematics of the main wrench zone has been interpreted as sinistral one working in transtensile regime during the Middle-Late Miocene , and was active at least also during the Early Pliocene period.

In the Vad'ovce depression and surroundings was recognaized (from fault slip data) apparent clockwise rotation of the maximum compressive stress s1 from ESE-WNW direction to NE-SW direction during the Miocene. Due to Middle-Upper Miocene anticlockwise rigid body block rotation inside main wrench zone the older than Middle Miocene records of compressions are not recently in original directions, but twisted counterclockwise.

During the above defined stages of the Miocene tectogenesis in the studied area took part origin, developement and extinction of the Eggenburgian sedimentary basin. It was born as relatively independent but communicating (linked) system of compressional basins folowing ENE-WSW trending wrench zone. The Eggenburgian pattern of sedimentation has been desintegrated after the Karpatian. Starting with the Baddenian there was changed structural plan including changes of sedimentation depocentres. The Eggenburgian/Ottnangian sedimentary basin suffered degradation, uplift and erosion. This is why Vad'ovce depression currently representes rotated remnant of the Eggenburgian sedimentary basin, rimmed by faults of various ages.

In recent distribution, geometry of geological bodies and geological architecture of an area dominate the Middle/Late Baddenian-Pliocene structural plan. All structures are arranged as transtesional duplexes in sinistral shear zone. Alternations of subsided (for ex. Vad'ovce depr.) and uplifted (for ex. Cachtiche Karpaty Mts.) blocks are typical for mature wrench zone. Young Karpatian and Baddenian sediments were deposited upon destructed and rotated remnants of the old Eggenburgian basin in the northern part of the Danube basin.

149

DEFORMATION MECHANISMS AND GEODYNAMIC EVOLUTION OF VELIKA MORAVIA THROUGH IN THE NEOGENE AND THE QUATERNARY

Milun MARCOVIC, Ilija DOKOVIC, Slobodan KNEZEVIC, Meri SUMAR

Faculty of Mining and Geology, Univ. of Beograd . Institute for Regional Geology and Paleontology, Belgrade,YUGOSLAVIE

Abstract - Velica Morava through is a complex morphostructural feature formed in the Neogene on the SSE periphery of the Panonian Basin. It is composed of many well individualized depressions and fewer horsts wich generaly form a negative structural feature of thecomplex thru type. Paleogeographically, Velica Morava through was a Pannonian Sea "sinus" that penetrated deep into the continent between the Dinarides and the Carpatho-Balkanides. Its mere position suggests a possible generation of complex tectonic relations during the Neogene and the Quaternary.

The mechanisms that controlled the origin and transformation of structural relations in the Velika Morava through during the Neogene and the Quaternary were the following: (a) Lithospheric extension and "post-tectonic" thermal subsidences in the Pannonian Basin as a consequence of the converging Carpathian fragments and European plate; (b) Lateral compression applied to the Dinarides, Serbian-Macedonian Massif and Carpatho-Balkanides, resulting from the convergent relationship of the African(Adriatic) and the Europian (Mesian) plates; (c) Isostatic processes initiated by Meso-Cenozoic contraction of the structural-facial (formational) contents and the crustal build-up in the domains of the Dinarides, partly Serbian-Macedonian Massif and the Carpatho-Balkanides.

The above mechanisms operated parallelly through the Neogene, and on their interactions and spatial manifestations depended: position, morphology, kinematics, genesis,and transformation of the Velika Morava through structural features.

GEODYNAMICS OF LITHOSPHERIC TRANSCURRENT SHEAR ZONE : THE EASTERN BETIC TECTONIC CORRIDOR DURING LATE MIOCENE TIMES (SPAIN)

Christian MONTENAT , Herve LEYRIT, Philippe OTT d'ESTEVOU

Institut Geologique Albert-de-Lapparent (IGAL), Institut Polytechnique Saint-Louis Albert-de-Lapparent (IPSL), Cergy-Pontoise, FRANCE

The Betic segment of the Trans-Alboran shear zone which cross the Betic-Rifean realm along a general NE-SW trend has evolved since Miocene times onwards in a compressive submeridian stress field (oscillating between NW-SE and N-S), resulting from the Europe-Africa collision.

The eastern part of the Inner Betic zone (from Alicante to Almeria) displays numerous and varied aspects of the evolution of this tectonic corridor during late Miocene times (Montenat, 1990):

- synsedimentary structuration of sedimentary basins;
- magmatic activity which displays a variety of expressions, plutonism, volcanism, metallogeny;
- large horizontal (and vertical) movements related to strike slip faulting which have important influence on paleogeography. The tectonic activity is responsible for numerous evidence of (paleo) seismicity recorded by the sediments.

These different categories of phenomena associated with geophysic data (seismic refraction, gravimetry and areomagnetics), heat flow measurements and experimental petrology authorize to propose a geodynamic model of the shear zone (Montenat et al.,1987; Larouziere et al. , 1988).

The model enriched by further studies is presented to the symposium as an example of geoevent interrelationships and for comparison which other shear zones which may acted in the Mediterranean and peri-Mediterranean domain during Neogene times.

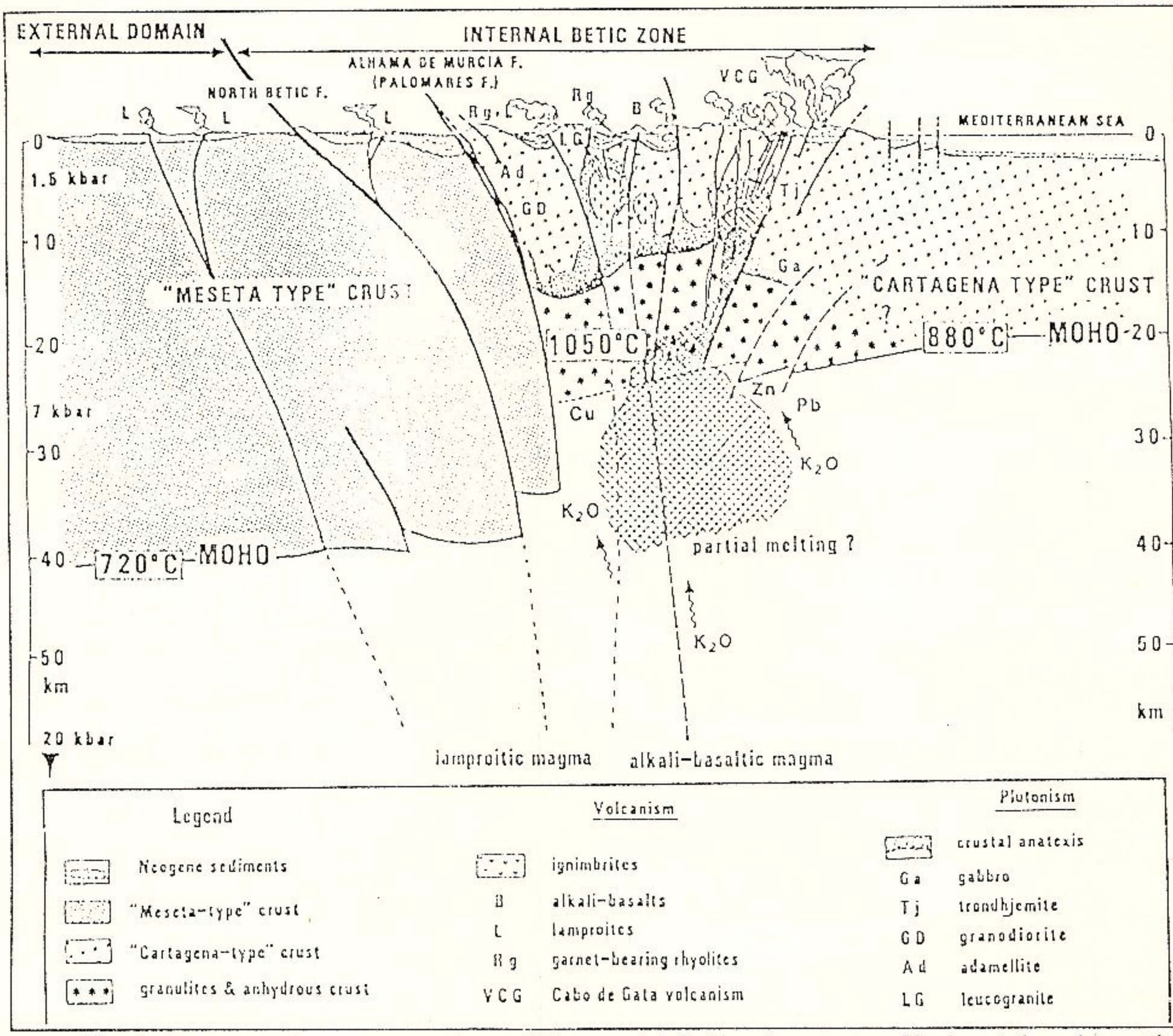


Fig.4. Interpretative cross-section of the crustal Betic shear zone. Horizontal and veertical scales are the same.

References:

Larouziere F.D., Bolze J., Bordet P., Hernandez J., Montenat C., Ott d'Estevou P., 1988 : The Betic segment of the lithospheric trans-alboran shear zone during the late Miocene. Tectonophysics, 152, 41-52.

Montenat C., 1990 : Les Bassins neogenes du domaine betique oriental (Espagne). Tectonique et sedimentation dans un couloir de decrochement. Premiere partie : etude regionale. Doc. et Trav. IGAL, Paris, 12-13 : 1-392, 3 maps color 1:1000000.

Montenat C., Ott d'Estevou P., Larouziere D., Bedu P., 1987 : Originalite geodinamique des bassins neogenes du domaine Betique oriental (Espagne).- Notes et Memoires, TOTAL, 21 : 11-50.

NEOGENE DEFORMATION IN THE SOUTH CARPATHIAN BEDING AND RELATED STRUCTURES

F. MOSTER

Geological Institute, University of Tubingen, GERMANY

The western South Carpathians form an almost 100 km wide fault zone along the western margin of the Moesian platform. The geological data indicate a nappe system of a lowermost Danubian unit (Moesian platform), an ophiolite complex (Severin ocean) and an uppermost Getic nappe (East Carpathian-Rhodopian) fragmented during collision by wrenching and dextral translation. Field studies in the western part of the South Carpathians demonstrate almost brittle deformation with 3 main phases of movement:

(1) Cretaceous collision with closure of the Severin ocean and thrusting of the East Carpathian-Rhodopian fragment onto the western continental margin of the Moesian platform, forming the nappe structure; (2) Paleocene brittle transpression: Fault-striae analysis in the Danubian unit and Getic nappe indicate a pre-Badenian E-W compression in a SW-NE trending dextral strike-slip zone; (3a) Miocene compression due to the dextral wrench zone developed on the northern border of the Moesian platform: E-W trending strike slip-faults in the Muntele Mic region show a dextral displacement of the Getic nappe of at least 10 km; (3b) Miocene extension due to the development of the Pannonian basin: fault-striae analysis in middle Miocene sediments indicate a NNW-SSE orientated fault system in the Caransebes-Mehadia-basin which seems to be kinematically connected with the halfgraben of the Bosovici-basin. This basin is interpreted as a roll over structure created by a crustal detachement fault transferring the Getic nappe northwestward; (3c) Miocene strike-slip movement with basin formation south of the Cerna-Jiu line on the margin of the Moesian platform: fault-striae data along the Miocene Baia de Arama- and Orsova-graben indicate a post-Badenian dextral strike-slip movement opening the Orsova basin as a pull-apart structure and cutting Cerna-Jiu fault system, which has been active during the early Tertiary.

157

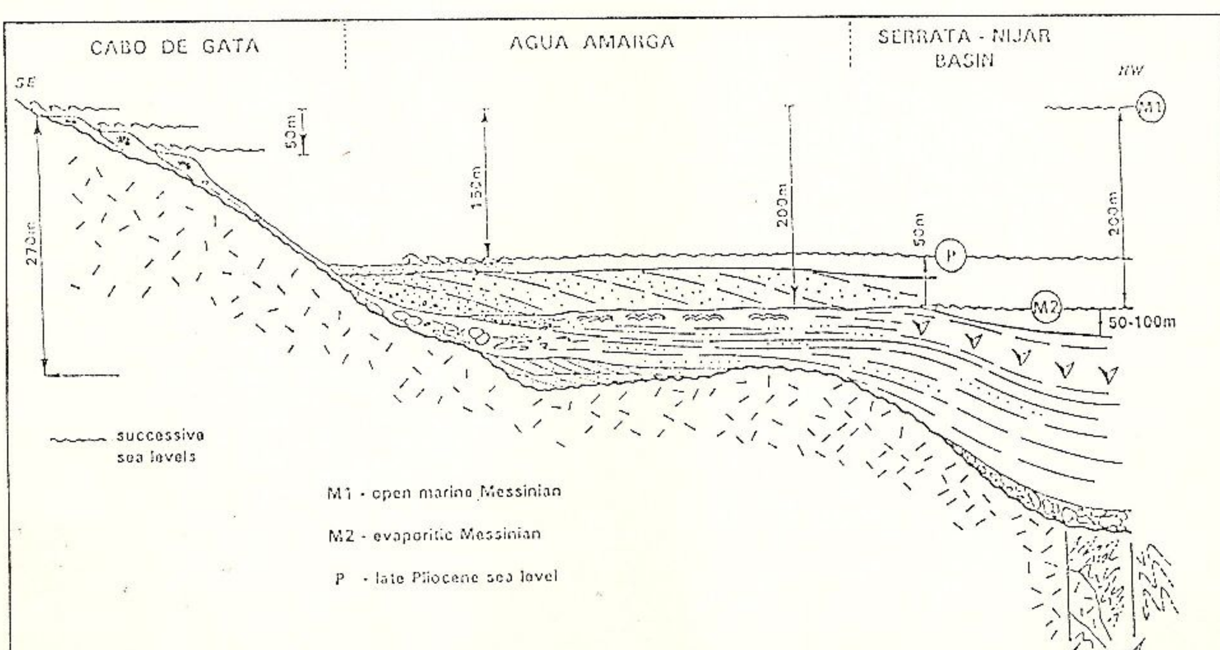
DATA FOR ESTIMATION OF MESSINIAN SEA LEVEL VARIATIONS IN THE MEDITERRANEAN BASIN. EXAMPLE OF THE EASTERN BETIC BASINS (SPAIN).

Philippe OTT D'ESTEVOU, Christian MONTENAT

Institut Geologique Albert-de-Lapparent (IGAL), Institut Polytechnique Saint-Louis Albert-de-Lepparent (IPSL), Cergy-Pontoise ,FRANCE

The amplitude of Messinian sea level fluctuations in the Mediterranean basin is a much debated question for a long time.

As part this symposium devoted to the correlations of Mediterranean Neogene events, it may be usefull to collate and compare data resulting from precise field surveys carried out all around the Mediterranean. For that purpose, data collected in Southeastern Spain, for example in the Cabo de Gata area (Almeria) are presented in order to be compared with other results. The data, based on mapping and regional studies (stratigraphy, sedimentology, tectonic) are schematized on the diagram below.



* During ope marine Messinian, a gradual lowering of sea level, about 50 m, is recorded by successive generations of terraced reefs.

* At the beginning of the evaporitic event, the sea level was about 200 m lower, as evidenced by stromatolitic tidal flat lying on the foot of emerged and karstified reefs.

* During the cyclical phases of gypsum deposit alternating with pelitic marine sediments, sea level oscillated with an amplitude of some tens meters. It resulted in a general lowering of about 50 meters (San Miguel de Salinas for ex.).

* The rise of sea level during Pliocene times cannot be detailed. However late Pliocene beach sands deposited around the relief of Cabo de Gata indicate a shoreline standing about 50 m higer than the Messinian stromatolitic flat.

Oil prospecting in the offshore of Murcia (Torrevieja) demonstrated that Messinian karstified reefs similar to those outcropping onshore (Santa Pola for ex.) are buried under a thick cover (about 900 m) of Pliocene pelagic sediments. That situation is obviously related to faulting which occurred with important vertical component (mainly submeridian faults) close to the Messinian/ Pliocene boundary.

The role of such large tectonic movements must be kept in mind to understand the relations between Pliocene pelagic deposits and the "deep" Messinian basin.

DIAPIRISM RELATED TO MIOCENE SHALE MOVEMENTS IN THE SHOUTHWESTERN ALBORAN SEA. (WESTERN MEDITERRANEAN).

M. OUAZZABA[1], A. DEMNATI[1], A. CHALOUAN[2]

[1] ONAREP, Direction Exploration, Rabat, MAROC
[2] Faculte des Sciences, Rabat, MAROC

Seismic interpretation combined with drill hole data have shed a new light on the origin of diapirism and the timing of its mobility.

Seismic velocity analysis and well data did not confirm the hypothesis of salt diapirism within the Miocene succession. However these data support shaliness nature of diapirs. Seismic reflection configuration suggest that the diapirism is synsedimentary. Its mobility started at least in Messinian time.

In terms of petroleum exploration, the shale mobility will favour the creation of structures related to growth faults which, in turn, will host sandy turbiditic reservoirs known as attractive exploration targets in many analogs all over the world.

PLIO- PLEISTOCENE EVOLUTION OF PIGGYBACK BASINS IN THE GULF OF TARANTO (IONIAN SEA-ITALY)

T. PESCATORE [1], M.R SENATORE.[2]

[1] Dipartimento di Fisica Teorica - Universita degli Studi di Salermo, Salermo, ITALY
[2] Dipartimento di Scienze della Terra- Universita degli Studi Federico II di Napoli, Napoli, ITALY

The Gulf of Taranto is considered part of the present-day foredeep area of the Southern Apennines Chain; it includes allochthonous thrust sheets to the west, the trough at the toe allochthonous thrust sheets (the Taranto Valley) in the central area and the Apulia Foreland to the east.

The study of sparker 30 kJ and 6 kJ profiles allowed to locate in the western sector two oversthusting fronts: the outer is the front of the allochthonous thrust sheets (Metaponto thrust Sheet, OGNIBEN, 1986), the inner one probably represents the seaward extension of a deep seated front recognized on land (MOSTARDINI & MERLINI, 1986). In this sector two piggyback basins, filled with Plio-Pleistocene sediments overlapping on deformed allochthonous unit of the chain occur. They are from west to east the Corigliano Basin and Amendolara Basin.

In these basins two seismic units are recognized.

* An upper seismic unit with subhorizontal, parallel and continous, reflectors represents the Plio-Quaternary sediments of the Amendolara and Corigliano basins. Two sub-units separated by a surface of slight discordance can be distinguished in the Amendolara Basin the reflectors of the lower sub-unit are tilsed slightly towards the west and are onlapped by the upper sub-unit. Tilting and onlap are evident only on the eastern margin of the basin and correspond to areas of morphologic relief.

* A lower seismic unit, with discontinous and chaotic reflectors, represens the deformed substratum of the two basins; it has been correlated with the most external, eastward,

allochthonous units of the Southern Apennine chain (FINETTI & MORELLI, 1972; FINETTI, 1976; ROSSI et al., 1983; TRAMUTOLI et al., 1984; PESCATORE & SENATORE, 1986).

In these basins two wells have been drilled (Lucia 1 and Letizia 1; AGIP, 1977). The stratigraphic section penetrated at the wells includes more than 1000 m of Pleistocene clay: in the deposits of Lucia 1 well, ca 700 m are undeformed and ca 400 m are deformed. Therefore, the following correlation seems appropriate: the upper seismic unit of sub-horizontaql, continous and regular, reflectors represents undeformed Pleistocene clay; the lower seismic unit is deformed Pleistocene sections and constitutes the substratum.

The slight unconformity between the reflecting horizons within the upper seismic unit of the Amendolara Basin might have been caused by the uplift of the frontal ramp of the thrust sheets. This episode of uplift probably occurred after the last compressive phase determining the Metaponto Thrust Sheet dated on land as Early Pleistocene.

MIDDLE MIOCENE PLANKTIC FORAMINIFERA: BIOSTRATIGRAPHIC REMARKS

Maria POTETTI

Dipartimento di Scienze della Terra, Universita di Camerino, Camerino, ITALY

Within the research project on the tectono-sedimentary evolution of Miocene minor turbiditic basins in the Umbro-Marchean Apennines (Central Italy), detailed biostratigraphic studies have been carried out on planktic foraminifera (Calamita et al., 1980; Cantalamessa et al., 1982), and in particular on taxa like *Globorotalia peripheroronda, Globorotalia mayeri/ siakensis,* and *Globigerinoides ruber/ subquadratus.* The extinction of these species is generally used for indicating the Middle Miocene zone boundaries, both in Mediterranean areas and in low latitudes ones.

These studies have shown that the stratigraphic distribution of the above-mentioned taxa is different from what was normally recognized. What then seemed a local phenomenon has since proved to be a generalized fact recently confirmed by numerous Authors finding the LO of these species a problematic datum, both inside and outside the Mediterranean basin.

In the Umbro- Marchean area, *Globorotalia peripheroronda* is rare and not distributed homogeneously. Moreover, it is somewhat difficult to recognize its extinction level. According to Iaccarino (1985), its disapperance from the Mediterranean seems to occur sooner than at low latitudes probably due to environmental controls which prevented the entry or the evolution of the younger taxa of the lineage.

Instead, *Globorotalia siakensis* is a widely distributed taxon ranging from low to medium latitudes, and is also common in the Mediterranean area. Many Authors consider it conspecific with *Globorotalia mayeri*, even if it shows different features, greater morphological variability and a different stratigraphic distribution (from early Oligocene to Middle Miocene). However, all

Authors agree in considering these two species to have disappeared contemporaneously in the upper part of middle miocene prior to the appearance of *Neogloboquadrina acostaensis*. Conversely, in the area under study *Globorotalia siakensis* is found until early Tortonian in association with the first specimens of *Neogloboquadrina acostaensis.* This points to its distribution being more extensive towards the top, or else to its persistence in certain areas being perhaps connected to particular environmental conditions.

With regard to *Globigerinoides subquadratus*, some Authors consider it conspecific with *Globigerinoides ruber*, whereas others maintain that these are two distinct species with a range from early to Middle Miocene, in the case of *Globigerinoides subquadratus*, and from late Miocene to Recent in that of *Globigerinoides ruber.* All Authors agreed, however, on the extinction of *G. subquadratus,* and on the pseudoextinction of *G. ruber* (the latter could have continued living in isolated areas and then subsequently have exploded, Bolli & Saunders, 1985), that occurred inside the *Globorotalia siakensis* zone (or at the lower boundary of the of *Globorotalia mayeri* zone9. In our areas, forms of *G. subquadratus/ ruber* are found not only in Tortonian, associated with *Neogloboquadrina acostaensis,* but also in Upper Middle Miocene in association with *Globorotalia siakensis* and *Globigerinoides obliquus* after the extinction or pseudoextinction of the two above-mentioned species too (see Liska, 1985).

On the basis of what has been said above, as well as on the evidence presented by many Authors, both inside and outside the Mediterranean area, and since the three events considered are neither synchronous nor homotaxic sometimes, the use hitherto made of the disappearance of a taxon in widely applied zonal schemes would need to be reconsidered.

References

Calamita F., Centamore E., Chiochini U., Deiana G., Micarelli A., Potetti M., Romano A., 1980 : Ricerche stratigrafiche sui sedimenti miocenici del bacino di Camerino (Marche centro- meridionali). Studi Geologici Camerti, 5 (1979), 89-110.

Cantalamessa G., Centamore E., Chiocchini u., Di Lorito L., Leonelli M., Micarelli A., Pesaresi A., Potetti M., Taddei L., Venanzini D., 1982 : Analisi dell' evoluzione tettonico-sedimentaria dei "bacini minori" torbiditici del Miocene medio-superiore nell' Appennino umbro-marchigiano e laziale- abruzzese: 8) Il bacino della Larga tra il F. Fiastrone- T. Fiastrella e il T. Fluvione. Studi Geologici Camerti, 6 (1980), 81- 133.

Liska R.D., 1985 : The range of Globigerinoides ruber (d'Orbigny) from the middle to late Miocene in Trinidad and Jamaica. Micropaleontology, 31 (4), 372- 379

Bolli H.M., Saunders J.B. , 1985 : Oligocene to Holocene low latitude planktic foraminifera. In Bolli H.M., Saunders J.B. and Perch Nielsen K. (eds), Plankton Stratigraphy,Cambridge Univ. Press, 155- 262.

Iaccarino S., 1985 : Mediterranean Miocene and Pliocene planktic foraminifera. In Bolli H.M., Saunders J.B. and Perch Nielsen K. (eds), Plankton Stratigraphy, Cambridge Univ. Press, 283-314.

THE MESSINIAN MAMMAL FAUNAS FROM ITALY AND THEIR PALEOBIOGEOGRAPHIC IMPLICATIONS

L. ROOK[1] , G. FICCARELLI[1] , T. KOTSAKIS[2], F. MASINI[3], D. TORRE[1]

[1] Dipartimento di Scienze della Terra. Universita di Firenze, Firenze, ITALY
[2] Dipartimento di Scienze della Terra, III Universita di Roma, Roma, ITALY
[3] Dipartimento di Geologia e Geodesia, Universita di Palermo, Palermo, ITALY

The late Miocene pre-Messinian mammal communities of Italy attest the existence, in central Mediterranean, of two distinct endemic bio-provinces during the Tortonian. Both were affected by noticeable changes during the Messinian.

The Abruzzo-Apulia paleobioprovince is documented by the fauna from the Abruzzi national park (Scontrone), a markedly endemic faunal assemblage consisting of taxa with strong European affinities. This paleobioprovince persisted, in its southern areas, untill the earlyest Pliocene. By the Messinian in fact the Abruzzi-Apulia paleobioprovince was disrupted, and most of the Abruzzo area sank, while the Apulian part persisted as attested by the Gargano *Microtia* fauna.

The Tusco-Sardinian paleobioprovence is documented by the faunas from southern Tuscany (Maremma) and northern Sardinia (Porto Torres). The Tusco-Sardinian fauna includes endemic elements with either African and European affinity, thus testifying that the area was repeatedly connected by temporary passageways either to Europe or Africa. The Tusco-Sardinian paleobioprovence comes to an end during the Messinian, as attested by the late Turolian (MN 13 unit) vertebrate faunal assemblages from southern Tuscany (Baccinello V3, Casino) which are completly different from the previous endemic ones and are composed of taxa common to late Turolian European localities.

Comparable late Turolian (MN 13) faunas are documented along all the Italian peninsula from norther regions (Ciabot Cagna in Piedmont and Brisighella in Romagna) to southern ones (Gravitelli in Sicily). They tesify the complete emersion of the Apennine chain, and the complete connection of the Italian peninsula with the european mainland.

SEDIMENTATION BREAKS IN THE UPPER MIOCENE OF SOME BOREHOLES IN THE KOLUBARA BASIN, NORTHWESTERN SERBIA

L. RUDNIC, S. MITROVIC

University of Belgrade, Faculty of Mining and geology, Institute of Regional Geology and Paleontology, Belgrade, YUGOSLAVIA.

The sedimentation discontinuity in the Upper Miocene of the southern Pannonian Basin periphery has been known before. Its evidence was mainly based on biosedimentological, and some neotectonic and geomorphologic, data. A micropaleontological and biostratigraphic analysis of Upper Miocene formations on cores from certain drilling intervals in Kolubara Basin, revealed several greater or smaller breaks in sedimentation. Major breaks are the discontinuous successions between Sarmatian and Pannonian, and Pannonian and Pontian, and a shorter break within the Pannonian.

The conclusion is based on detailed biostratigraphic and paleontological studies of ostracod and foraminiferal microfauna and molluscan macrofauna. Sedimentological and petrological analysis and neotectonic interpretations of the study area are consistent with the former investigation results.

Cores from some boreholes (Vcr-1/77, J-612/81, T-145/81), analysed for biostratigraphy and paleontology, include standard Lower Sarmatian foraminiferal zones (Papp et al., 1974). Several minor breaks were noted in Slavonien- Lower Pannonian, or an incomplete development of the Pannonian (Krstic, 1985). It generally lies apparently conformable over Sarmatian deposits, but the lack of basal Slavonien formations was noted in each of the surveyed intervales. Moreover, there are minor breaks within the Lower Pannonian. Upper Pannonian- Serbien, is not completely developed in any of boreholes. It is mostly lacking the basal ostracod *Amplocypris abscissa* (Krstic, 1985). Pontian sedimentation cycle is also polyphase with only the youngest levels present.

Upper Miocene in the Kolubara Basin, based on the mentioned paleontological and sedimentological characters, is a quite discontinuous time interval of a succession of relatively calm sedimentation phases with longer or shorter breaks. It was a consequence of significant Late Miocene orogenic movements in the transition from Sarmatian to the Pannonian, and during the Pannonian, and between the Pannonian and the Pontian. Minor emersions and level fluctuations in the Caspibrackish sea led to frequent changes in the microclimate and consequently the composition of biocenosis. The quite diverse living organisms were compelled to minor adaptations and biotope migrations within the relatively warm and humid climate realm. The abundant paleontological material, appeareance and composition of shells and their relation with the paleoenvironment, are reliable indications for paleoecological and paleogeographical reconstructions in this part of the Pannonian Basin, southern margin.

A NEW GEOCHEMICAL CIMMERIAN PROVINCE IN PLAIN CRIMEA (CIMMERIAN PALEO - SIVASH)

V.N. SEMENENKO[1], S.Ya. RAMSKY[2]

[1] Institute of Geological Sciences, Kiev, UKRAINE
[2] Crimean Geological Expedition, Simferopol, UKRAINE

As was mentioned earlier (V.Semenenko, 1987) we were first to establish the Miocene/ Pliocene boundary in the Euxinian-Caspian (which, as has become clear, should be drawn above the Pontian i.e. in the bottom of Cimmerian deposits, dated at about 5 Ma B.P. (Semenenko, 1979)) coincides with both with the Caucasus phase of orogenic displacements and with the initiation of the modern topographic features, in particular, formation of the Azov-Black Sea Basin in the outlines similar to those in the present time and the generation of the modern river network in the North Black Sea Region that followed the regression of the Early Pontian basin. Now it has become clear that the event resulted in generation of less distinct topographic features, i.e. the widely distributed now bars, bay barriers, and limans, including the Cimmerian paleo-Sivash.

Recent drilling along the south-western coast of the modern Sivash in the marginal, periclinal part of the Indol branch of the Indol-Kuban depression exposed a section represented by the dolomitic limestones, dolomites, dolomitic marls, calcareous sands and sepiolites, alternating with the Cimmerian ferriferous sandstones and ferriferous sandstones within the 160-200 m (BH 89), 190-230 m (BH 21) and 150-180 m (BH 23) depth intervals has made it possible to obtain new results.

Within the most deep part of the Indol branch of the depression the Cimmerian deposits reach up to 85-100 m in total thickness. The upper part of the section (up to 50 m) is quite similar to the rather deep Cimmerian facies exposed by drilling somewhat farther east, in the same Indol depression in its southern part, in particular at Arabatskaya Strelka where the whole cimmerian is represented by a section of carbonate-free clays and siltstones with the interbeds of ferriferous sandstone.

The lower, lacustrine-lagoonar, dolomitic, limestone-marly part of the section exposed somewhat farther west of Arabatskaya Strelka in its top is locally represented by an interbed of normal ferrous rocks (ferriferous sandstones, siltstones) of Cimmerian age up to 8-10 m thick overlain by a 30 to 50 m thick cyclic section represented by limestones and marls.

Farther west, just outsides the confines of the Indol depression, i.e. in Plain Crimea the section reduces its thickness, it does not now contain the characteristic interbeds of Cimmerian ferrous rocks; previously the section was identified in age together with its generally underlying Early Pontian limestones and marls.

The pra-Arbatskaya Strelka, i.e. the bar that separated the Azov part of the basin was situated within the water area of the modern Western Sivash. The ancient pra-Sivash was a round-shaped, but elongated lake, about 1500 km^2 in area, smaller than the modern Sivash (2500 km^2).

As was mentioned earlier, the lacustrine/ lagoonal sediments are represented by the rocks exhibiting different grades of dolomitization beginning from the pure dolomites and to dolomitic marls and sands as well to fatty on the touch rocks, named as light-weight "sea foam" or sepiolite (an aqueous magnesium silicate).

Not infrequent are the laminae of grey, very dense, heavy, mixed limestones enriched with strontium up to 0.5 %.

There are also the interbeds containing the shells of terrestrial and fresh water molluscs removed from the adjoining dry land.

Thus, in the Central Crimea existed a unique reservoir separated from the principal basin, a sort of a prototype of modern sivash, characterized by precipitation of carbonates. Based on the latter fact one may explain their almost complete absence (except for the lowermost layers of the Azov horizon) within the Cimmerian clays and siltstones of the Azov banch of the azov-Black Sea basin (Semenenko, 1975).

Hence, we have established a new geochemical province, in addition to dolomites, promising for boron, strontium, lithium, and some other elements.

THIS INVESTIGATIONS WERE SUPPORTED BY INTERNATIONAL SCIENTIFIC FOUNDATION (J. SOROS FOUNDATION) GRANT N U4 X 000.

BIOEVENTS ON THE BOUNDARY OF THE MIDDLE AND LATE SARMATIAN OF WESTERN GEORGIA AND THEIR CONNECTION WITH THE CHANGES OF PALEOGEOGRAPHICAL ENVIRONMENTS

I.I. SHATILOVA, L.P. RUKHADZE, L.S. MAISURADZE

L.Sh. Davitashvili Institute of Paleontology Georgian Academy of Sciences, Tibilisi, GEORGIA

During the Neogene some turning points in the history of marine and terrestrial biocoenosis of Western Georgia can be distinguished. The relation of some of them to one and the same stratigraphical boundaries permit to presum the existence of some significant changes in the environment, which influenced the proceeding of one or another bioevent. One of such boundaries is the transition between the Middle nad Late Sarmatian, when on the territory of Caucasus great paleogeographical transformations took place, accounting for the change of the configuration of the marine basin, which by size was already noticeably smaller than previous basins; the single Transcaucasus strait was exitinguished and a dry land took its place.

In the East, except for some regions, continental deposits started to form, while in the West, in the limits of the Rionian bay, the process of uninterrupted accumulation of the marine layers continued. By the end of the Middle Sarmatian in the composition of the marine biocoenosis significant changes were observed, owering to the further desalting of the basin. The rich and diverse fauna of bentonic foraminifera and molluscs gradually declined and by the end of the Middle Sarmatian almost entirely extincted. Out of the bentonic foraminiferas only Ammonia and a few Prodelphidium survived, as for molluscs, the genera Solen and Mactra were preserved, the latter of them occupying predominant position in the Late Sarmatian basin.

The end of Sarmatian was a turning point in the development of terrestrial flora as well. It was probably connected with orogenetic movements, due to which Georgia turned into a high mountainous country divided into two great regions- western and eastern ones. The territory adjoining the Black Sea was separated into an isolated region- Colchian refuge, where warm and humid climate was maintained and the fluctuations were not so notable as in other regions of the Paratethys. However after the Middle Sarmatian a great number of subtropical plants disappeared from the flora of the Western Georgia. Probably the conditions of that period were not favourable for the flourishing of evergreen plants and they failed in the struggle for the survival with the more competitive and plastic decidous plants, better adapted to the life in the environment of mountain relief with differential climatical zones. If the Early and Middle Sarmatian were the ages of the dominance of subtropical forests, from the Late Sarmatian their gradual extinction is observed. This process embraced the Meotian, Pontian and the bulk of Kimmerian, when on the territory of Western Georgia side by side with rich communities of warm-temperate and temperate climate still existed the subtropical forests. They were restricted to the habitats, where the conditions responding to their ecological demands still preserved. By the end of Kimmerian the subtropical formation on the whole Late Pliocene was characterized by the domination of polydominant decidous and coniferous forests, distinguished by rich systematical composition of trees and ferns. The whole process of the development of the Pliocene and Pleistocene floras of the Western Georgia also proceeded under the influence of activ tectonical movements, owing to which the new ecological niches appeared, vegetational zones were formed and climatical conditions were changed.

MAIN STAGES OF VEGETATION DEVELOPMENT ON THE NORTHERN MACROSLOPES OF THE CARPATHIANS IN NEOGENE

L. STUCHLIK [1]., S.V. SYABRYAJ[2]

[1]Institute of Botany, Polish Academy of Sciences, Krakowia, POLAND
[2] Institute of Geological Sciences, Ukrainian Academy of Sciences, Kiew, UKRAINE

On the basis of palynological investigations of Neogene sediments in the Carpathians the main stages of flora and vegetation development have been established. From the Egerian to the Late Levantinien 14 sporo-pollen complexes of the Eastern Carpathians and 7 complexes of the Western Carpathians have been determined. The results were compared with other macrofloristic investigations. Continuity of vertical zonation of vegetation in Western and Eastern Carpathians from the beginning of the Neogen is explained from paleobotanical point of view. Also the importance of explosive orogenic volcanism as a local climat forming factor, in the vegetation formation processes in this region during the Neogene, has been defined.

PALEOENVIRONMENTAL AND PALEOGEOGRAPHIC SIGNIFICANCE OF THE PALAEOGENE MOLASSIC BASINS OF THE NORTH AEGEAN AREA, GREECE.

Stella TSAILA- MONOPOLIS[1], Chryssanthi IOAKIM[2] , Nikolaos ROUSSOS[3]

[1] Depart. of Geology, University of Patras, Rio/ Patra, GREECE
[2] IGME, Athens, GREECE
[3] DEP- EKY, Maroussi, GREECE

The analytical study of some boreholes and stratigraphical sections exposed in the North part of Aegean area permit to recognize the Palaeogene basins.

Three distinct areas of molassic depositions have been recognized: Thessaloniki-Thermaikos basin, the area of Limons island and the western Thrace basins, being considered of terrigenous and marine origin. More than 90% of the total surface or these basins have been covered by younger sediments and occasionally by the sea.

The present investigations are based on biostratigraphic analysis, seismic interpretations and drilling data, derived mainly from the exploration activities of the Public Petroleum Corporation of Greece.

Especially, in the present paper a compilation of all the available biostratigraphic data is attempted from boreholes and land sections, located in the northern part of Aegean area. The results led to the correlations of microfauna (planktonic and benthic foraminifera), as well as of palynology (pollen and dinocysts). Moreover the geological and seismic data, have been compared with the above biostratigraphic data which permit to interprete the paleoenvironmental and paleogeographical evolution of the molassic basins, in the North Aegean area during the Paleogene.

INSTRUCTIONS TO AUTHORS

ROMANIAN JOURNAL OF STRATIGRAPHY publishes original scientific contributions dealing with any subject of this field.

Only papers presenting concisely and clearly new information will be accepted. The manuscript will be submitted for critical lecture to one or several advisers. Papers will be definitely rejected after a second unsatisfactory revision by the authors. The manuscripts will not be returned to the authors even if rejected.

Manuscripts are prefered in English or French. Manuscripts submitted in Romanian will be accompanied by an abstract in English or French (maximum 10 per cent of the manuscript volume).

Papers should be submitted in duplicate to the secretary of the Editorial Board, including the reproduction ready original figures. The manuscript should comprise: text (with a title page which is the first page of it), references, key words, abstract, illustrations, captions and a summary for technical purposes.

Author(s) should add a separate sheet with a short title (colontitle) of maximum 60 strokes and a summary indicating the hierarchy of headings from the text listed in decimal classification (1; 1.1; 1.1.1) but not exceeding four categories.

Text should be double-spaced typed (31 lines/page with 64 strokes each line) on one side of the paper only, holding an empty place of 3–4 cm on the left side of the page. The text cannot exceed 20 typewritten pages (including references and figures).

Front page (first page of the text) should comprise: a) title of the paper (concise but informative) with an empty space of 8 cm above it; b) full name(s) of the author(s); c) institution(s) and address(es) for each author or group of authors; d) text.

Footnotes should be numbered consequtively.

Citations in the text should include the name of the author and the publication year. Example: Ionescu (1970) or (Ionescu, 1970). For two authors: Ionescu, Popescu (1969) or (Ionescu, Popescu, 1969). For more than two authors: Ionescu et al. (1980) or (Ionescu et al., 1980). For papers which are in course of print the publication year will be replaced by "in press". Unpublished papers or reports will be cited in the text like the published ones.

Abstract, of maximum 20 lines (on separate sheet), must be in English, summarizing the main results and conclusions (not a simple listing of topics).

Key words (max. 10 items), in English or French, following the language used in the text (or the Resumé if the text is in Romanian), given in succession from general to specific, should be typed on the abstract page.

References should be typed in double-line spacing, listed in alphabetical order and chronological order for authors with more than one reference. Abbreviations of journals or publishing houses should be in accordance with the recommendations of the respective publications or with the international practice.

Examples:

a) journals:

Giuşcă, D. (1952) Contributions à l'étude cristallochimique des niobates. *An. Com. Geol.*, XXIII, p. 259–268, Bucureşti.

– , Pavelescu, L. (1954) Contribuţii la studiul mineralogic al zăcămîntului de la Muşca. *Comm. Acad. Rom.*, IV, 11–12, p. 658–991, Bucureşti.

b) special issues:

Strand, T. (1972) The Norwegian Caledonides. p. 1–20. In: Kulling, O., Strand, T. (eds.) Scandinavian Caledonides, 560 p., Interscience Publishers.

c) books:

Bălan, M. (1976) Zăcămintele manganifere de la Iacobeni. Ed. Acad. Rom., 132 p., Bucureşti.

d) maps:

Ionescu, I., Popescu, P., Georgescu, G. (1990) Geological Map of Romania, scale 1:50,000, sheet Cîmpulung. Inst. Geol. Geofiz., Bucureşti.

e) unpublished papers or reports:

Dumitrescu, D., Ionescu, I., Moldoveanu, M. (1987) Report. Arch. Inst. Geol. Geofiz., Bucureşti.

Papers or books published in Russian, Bulgarian or Serbian etc. should be mentioned in the references transliterating the name and titles. Example:

Krasheninnikov, V. A., Basov, I. A. (1968) Stratigrafiya kainozoia. Trudy GIN, 410, 208 p., Nauka, Moskow.

Illustrations (figures and plates) must be numbered and submitted as originals on separate sheets (tracing papers), ready for reproduction. The thickness of the lines, lettering and symbols on figures should be large enough to be easily read after size-reduction. The original size should not extend beyond the print area of the page: column width 8 cm, page width 16.5 cm, page length 23 cm for figures; the width of line drawings should not extend over a single (16.5/23) or double (23/33 cm) page area and must be selfexplanatory (including title, authors, legend etc.). The graphic scale is obligatory.

Photographic illustrations (black-and-white only) must be of high quality and should be grouped into plates 16/23 cm in size. Each plate should have the photos numbered, i.e. Pl. I, Fig. 1; Pl. II, Fig. 1.

Tables should be numbered and entitled. Original size of the tables should correspond to the above mentioned (8/16.5 or 16.5/23) dimensions of the printing area.

Author(s) will receive only one set of preprint proofs which must be returned, with corrections, 10 days after receiving them. Only printing errors should be corrected, no changes in the text can be accepted.

Thirty offprints of each paper are supplied to the author(s) free of charge.

Editorial Board