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ON SOME PROBLEMS OF PALINSPASTIC RECONSTRUCTIONS AND CENO-MESOZOIC PALEOGEOGRAPHICAL DEVELOPMENT OF THE WESTERN CARPATHIANS

(Figs. 4)

Abstract: The paper deals with several problems of the West Carpathian paleogeographical reconstructions, appearing in the course of application of modern knowledge and in correlations with the neighbouring areas of the Alpine-Carpathian orogen. A successful reconstruction of the original sedimentary area in each stage of evolution depends on a successful elimination of the effects of younger space deformations (both distensive and compressive). The recognition and a more exact quantitative definition of some time stages of pre-Alpine and Alpine deformation phases still presents a number of problems. Thus, the effort concentration of specialists from different branches of science appears to be necessary for solving a whole series of problems and for forming a realistic paleogeographic picture of our region in the individual stages of evolution.

Резюме: Работа обсуждает некоторые затруднения палеогеографической реконструкции территорий Западных Карпат, появляющихся при применении современных знаний и при корреляции с соседними областями альпийско-карпатского орогена. Успех реконструкции исходного осадочного бассейна на каждой стадии его развития зависит от успешной элиминации влияний младших деформаций пространства (растяжительных и компрессивных). Но отличение и более точное квантитативное выражение некоторых временных этапов альпийских и доальпийских деформаций в Западных Карпатах пока еще довольно проблематичное. Для разрешения целого ряда подобных вопросов и для создания реальной картины палеогеографической ситуации нашей территории в отдельных периодах следует сосредоточить исследовательское стремление специалистов из нескольких дисциплин.

Development of methodology

The methods of paleogeographic reconstruction and their probability to approach the actual situation of a given area in a given period always depended on the stratigraphic knowledge of rock sequences, their tectonic arrangement, character, style and degree of deformation and on the geological scrutiny of the entire area. Development of the West Carpathian palinspastic reconstructions provides a good example of such a process. The concept of the original arrangement and the extent of the sedimentary area has always formed an integral part of the tectonic hypothesis. D. Andrusov, 1959, estimated the width of the West Carpathian area in Mesozoic to be 360 km but later (1968), 300—600 km. Similarly, M. Mahel' (1978, 1979, 1980) supposed this space to have been 450—500 km wide. Alpine authors (A. Tollmann, 1978 et al.) Belt, argued that this zone in the Upper Jurassic was more than 350 km wide. at least. M. Mišík, 1978, analyzing the development of the Carpathian Klippen Belt, argued that this zone in the Upper Jurassic was more than 350 km wide.

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M. Krs and Z. Roth, 1979, deduced from paleomagnetic data that the whole West Carpathian area had been 1200—1300 km wide prior to Mid-Albian deformation. This hypothesis conforms to the supposition of a gradual, eastward widening of the Tethyan Ocean, formulated on the basis of numerous studies on several of its segments.

Application of the palinspastic method

The arrangement of paleogeographic reconstruction is the aim of synthesis of lithological, stratigraphic and tectonic studies of each formation and an important transitional grade within the paleotectonic development investigation of each orogen. During this development, older stages were gradually recovered by younger ones while a lot of information were successively decreasing in fossil record. Therefore methods of palinspastic reconstruction mutually differ in several aspects for the Paleo-Alpine and Neo-Alpine etaps. These problems concerning reconstruction of paleo-space of the original sedimentary basins and in the Alpine folded area were a cause of many controversies and mistakes. Several authors still apply the observed facts onto palinspastically incompensated maps. Trying to avoid this wrong way, many investigators (H. Stille, 1953; D. Andrusov, 1959, 1968; E. Scheibner; 1963; A. Tollmann, 1966; R. Trümpy, 1969; M. Maheľ, 1969 a-b etc.) still in past tried to estimate the space reduction by analyses of tectonic deformation of orogenic structures. Despite of this fact, these authors always realized the incomplexity of their reconstructions, caused by in-encountering of subduction of large areas, the arguments on their extent (and position) were often missing. Postulating plate tectonic principles (A. G. Smith, 1971; J. F. Dewey et al., 1973; R. Trümpy, 1975; H. Laubscher — D. Bernoulli, 1977; J. E. T. Channell et al., 1978 etc.) indicated that enrolling sedimentary units, preserved even after last stage of space reduction, is unsufficient for a reliable reconstruction: it is also necessary to reconstruct the ancient magmatic and folded arcs, trenches and basins, to compensate rotation of blocks and microcontinents and to determine the original width of subducted folded zones along with parts of obducted, overthrust and subsequently eroded units. The true paleogeographic reconstruction can be obtained only by a synthesis of paleomagnetic, lithofacial, biofacial, biogeographical, structural and other criteria.

The mutual position of Eurasian and African cratons and its changes since the end of Paleozoic was determined on the basis of paleomagnetic data relatively soon and sufficiently. However, the problems with determination of number, dimensions, position and pertinence of microcontinents in the Mediterranean area are more difficult. J. F. Dewey et al., 1973; A. Bosellini — K. J. Hsü, 1973; H. P. Laubscher, 1975; V. J. Dietrich, 1976; D. Roeder, 1976, 1977, 1980; K. J. Hsü et al., 1977; A. Tollmann, 1978; K. C. Condie, 1979 and the other, discerned several microcontinents (Iberian, Adriatic or Apulian, Carnic or Kreios, Rhodopean, Moesian, Pannonian, Pontic, Tauric . . .) and microplates (Paleotethyan, Alboran, Mesogean etc.). On the other hand, L. E. Ricou — J. Marcoux, 1980 tried to reconstruct the Mesozoic Tethys like a simple ocean without intervening microcontinents. However, their model was not in agreement with all the observed facts, being variance of a classical hypothesis on North African origin of Austro-Alpine, Carpathian and

Apușeni nappes, Southern Alpine and Dinaric units (cf. J. E. T. Channell — F. Horváth, 1976; F. Horváth et al., 1979 etc.).

The paleogeographical and paleotectonic developments with accompanying palinspastic changes were relatively well investigated in the West Mediterranean sector of Tethys (M. Boccaletti, 1975 etc.). Less, but still rather well-known, is the situation in the East Mediterranean (V. Jacobshagen et al., 1971; X. LePichon — R. Blanchet, 1978; C. A. M. Şengör et al., 1980; P. Bernier — J. J. Fleury, 1980; D. Nance, 1981 etc.). Majority of mistakes concerns especially the Carpathian-Balcanian segment of the Europian Alpides and its relation to the Crimean-Caucasian orogenic branch: numerous authors (M. Sandulescu, 1972; J. F. Dewey et al., 1973; M. Boccaletti et al., 1974 a-b; E. Szádecky-Kardoss, 1976; D. Roeder, 1976; K. Birkenmajer, 1976; K. J. Hsü et al., 1977; A. Tollmann, 1978). I. Varga, 1978; R. Unrug, 1979; F. Horváth et al., 1979; S. Vrána, 1980; B. Leško — I. Varga, 1980; J. Jaroš, 1980 etc. came often to controversial opinions and conclusions.

The problems with reconstruction of this segment of Alpine orogen are joined with its complicated geological history, the dissection by transversal fault systems (roughly parallel systems with the border of adjacent East European plate), unusually great crustal heterogeneity, and its complicated deformation (M. Mahel', 1969, 1973, 1978, 1980; E. Bončev, 1975; K. J. Hsü et al., 1977; G. Wein, 1978; J. Karagjuleva et al., 1980 etc.). Moreover, many new data on the differentiation of original sedimentary areas, tectonic pertinence and structure of rock complexes (M. Mahel', 1978, 1979 a-b-c; M. Mišík et al., 1980 etc.), on the allochthonity of crystalline massifs, considered before as "autochthonous" (A. Klinec, 1966; M. Mahel', 1978, 1980 etc.) and on the extensive space-shortening by deformations and convergence to collisional subduction of lithospheric blocks and also on the considerable rotation of individual segments of this orogen (M. Krs, 1979; M. Krs et al., 1979; M. Krs — Z. Roth, 1979; M. L. Baženov et al., 1980 etc.), obtained recently, lead to the production of new palinspastic schemes, in many aspects different from the pre-existing ones (M. Mahel', 1979, 1980). Although several authors recently presuming three even four Mesozoic oceans (Magura, Pieniny, Ľubeník, Meliata) in the original West Carpathian space, an opinion is stated that the Central West Carpathian Mts. were a shelf area of the Variscan consolidated crustal block during the Permian and the Triassic, northward limited by the rifted basin of Klippen Belt (M. Mišík et al., 1977, 1980) and southward by the oceanic realm of the Paleozoic-Triassic Paleotethys. The southern West Carpathian units, only insignificantly affected by Variscan folding and metamorphism (Gemeric, Bükkic, cf. M. Mahel', 1978, 1979, 1980) probably belonged to an intraoceanic shelf fragment of Paleotethys, not to the southern Penninic border (as supposed I. Varga, 1978; B. Leško — I. Varga, 1980). A broad back-arc basin with slight volcanism and accelerated subsidence evolved during the Permian and the Triassic in the Hronic and Silicic (M. Mahel', 1974, 1978, 1979). This development ceased after the Paleotethyan closure during the Early Kimmerian phase, when opening of a new oceanic basin began in southern Penninic and its equivalents (Pennine-Vahic-Siret Ocean). Both, the parallel Zliechov- and Magura (= North Pennine?) troughs originated by tension and by subcrustal erosion in the Jurassic rifting phase at first, later on they were incorporated into arising back-arc basins of the Penninic Ocean (M. Mahel', 1979). Like the Paleozoic-Triassic Paleotethyan margins, the Penninic Ocean margins could also originally have a pair of opposite subduction zones, swallowing the oceanic crust from both sides (north-vergent zone northward, south-vergent one below the Austro-Alpine and Central Carpathian units on the south cf. E. Rod, 1977; D. Roeder, 1977), prior to the Upper Cretaceous-Eocene collision of Eurasia and Kreios plates.

During the Neoalpine development of the West Carpathian area the Paleogene sedimentation was concentrated in flysch troughs on mobile substrate along the North European margin, with partially oceanized bottom (cf. A. Tollmann, 1978). The alpine-type deformation of the underground and foreland of the Austrian and Laramian nappes caused new space-reduction of the orogen, elastically deforming the platform margin (D. Roeder, 1980). Rejuvening fault activity along with the effect of an active mantle diapirism (L. Stegena et al., 1975; J. G. Sclater et al., 1980) rendered space for new frontal, intramontaneous and back orogen sedimentary basins. Contemporary basins with the Neogene filling represent mere relics of the origin extensive sedimentary areas. The reconstruction of their original extent and also relations requires to take into consideration not only stratigraphic, sedimentological and biofacial criteria, but also geodynamics of their origin and development. These basins evolved contemporary with the breakage of the West Carpathian orogen into blocks which have been unevenly overthrust northward; this process caused the vaulting of the West Carpathian arc (Z. Roth, 1980; M. L. Baženov et al., 1980). According to M. Kováč (1980), the West Carpathian NW segment has been pushed to 40 km; the NE one even 80—100 km onto the foreland during Neogene. The reconstruction of the foredeep must also encounter considerable areas, hidden under the flysch nappes or even incorporated into nappe units (R. Ney et al., 1974). The exactness of palinspastic reconstruction of this area is underlined by the indications of sedimentary compressive (nappe) movements. The reconstructions of the Paleogene-Lower Miocene flysch basins (Ždánice, Skole units) or of the Lower Miocene marine connections through this (later significantly elevated and eroded) zones are joined with other problems. The interpretations of the Eggenburgian connection of Eastern Slovakia basin with the Carpathian fore-deep, e. g., differ significantly (T. Buday et al., 1967; D. Ďurica, 1976; J. Gašparík, 1978; R. Rudinec, 1978 etc.), owing to the lack of primary data. The correlation of intra-Carpathian basins is complicated by different mobility of the individual Insubric System blocks (M. Krs — Z. Roth, 1979); although the movement of the East Alpine segments ceased in the Lower Miocene, the orogeny of the Eastern and Southern Carpathians continued up to the end of the Miocene. That is why the present arrangement of Miocene sediments differs from the original paleogeographic situation.

Inequabilities in time and effects of individual "phases" of the Alpine orogeny prove that they represented only local accelerations or vectoral changes of compression, evoked by global factors (A. Tollmann, 1966, 1978; M. Mahel', 1971, 1980). Many of them (especially during the Middle and Upper Cretaceous and Miocene — Pliocene) had a local significance and they are probably local evidences of more important long-timed movements with a global importance.

Paleobiogeography and "paleobioprovincional" division

The investigation of organism distributions and their dependences is a useful aid for understanding of connections and barriers in marine basins at a given time interval. The use of this method is necessary especially at paleogeographic reconstructions of complicated deformed alpine-type orogenic areas.

As usually, the Mesozoic world use to be divided on the warm Tethyan bioprovince separating the Boreal and Paleoaustral (in the Triassic called Maorian) ones. The fauna of the German subprovince, which has diversified on Eurasian epicontinental shallows, inundated by the Middle Triassic transgression, from the Tethyan faunas spread along the Iberian and North African coasts up to the Middle East (N. M. Farsan, 1979). The distribution of the Triassic brachiopods (A. S. Dagys, 1974) confirms the division of the Tethyan province onto the Alpine-Carpathian and Indian-Himamalayan subprovinces (F. Neumayer, 1872; cf. K. Pożaryska — W. Brochwicz-Lewiński, 1975). The question of provincionality of the Triassic faunas has been recently elaborated by the conodontologists, again. H. Kozur (1980) distinguished seven provinces of the Triassic conodontophorids. However, the frequent discrepancies in the definition of individual provinces, in classification of individual faunas and in delimitation of time and space boundaries and facial and bathymetric relations (J. Trammer, 1975; K. Budurov, 1975; S. Kovács, 1980; O. Jendrejáková et al., 1982 etc.) indicate that the paleobiogeographic and paleoecological study of the Triassic conodontophorids is still in its beginning.

The diversification of the European Jurassic brachiopod faunas into the "Mediterranean" and "North European" types (D. V. Ager, 1963; A. Vörös, 1977, 1980) indicates an effect of the Jurassic spreading which probably separated the fragments of the European (Kreios) and the African (Apulia) shelves already in the Liassic, in such a degree that a specific fauna, different from the faunas of nearshore shallows could diversify on them. The bioprovincional study also enclear the connections between the Danish-Polish aulacogene, the Dobrogea, Crimea and Caucasus and the Alpine-Carpathian areas. The Anisian sea-way between the Tethys and Silesian nearshore part of the North European Triassic basin, localized by this method, represents a typical example of this approach. The brachiopods, conodontophorids, molluscs and diploporid algae penetrated evidently through the mouth of the Danish-Polish aulacogene but in no case through the north — western part of the Miocene Carpathian Foredeep ("the Moravian Gate", cf. H. Senkowiczowa in L. Malinowska, 1979; or P. A. Ziegler, 1980) where there are no traces of the Triassic subsidence. The mouth of the Danish-Polish aulacogene has been closed since the Ladinian to the Lower Cretaceous (I. Gajewska — T. Marcinkiewicz, 1978; P. A. Ziegler, 1980). Despite of this fact, in the Jurassic this area still connected the Submediterranean basins of Western Europe with the Dobrogea, Crimea and Caucasus (I. Simionescu, 1910; J. Kopik, 1979). Since the Valanginian to the Hauterivian the Boreal ammonites migrated through the mouth of the Polish trough into the periferal West Carpathian zones (Z. Vašíček, 1979). On the other hand, several Tethyan species contemporaneously penetrated through Poland into the North Germanic basin (W. Pożaryski — W. Brochwicz-Lewiński, 1979; E. Michael, 1974). Although the Tethyan-Boreal connection was many times interrupted (A. Raczyńska, 1979) and reestablished again (Albian-Cenomanian, W. Pożaryski — W. Brochwicz-Lewiński, 1979; E. Michael, 1974 or in the Coniacian-Senonian, J. Salaj — V. Gašparíková, 1979), the connection between the Submediterranean and Dobrogea-Crimea-Caucasian-Kopet Dagh Belt endurated (F. A. Middlemiss, 1979; T. Neagu — A. Bărbulescu, 1979 etc.). These facts indicate that the Danian-Polish aulacogene was connected with the Dobrogean and Crimea more durable than with the Carpathian area. Thus, the supposed temporary barrier had to occur between it and the Tethys more southward than A. Raczyńska (1979) or P. A. Ziegler (1980) presupposed (cf. W. Pożaryski — K. Żytko, 1979, 1980). The original course of these structures was probably covered during the deformation of the Carpathian arc and its overthrusts onto the cratonic foreland (D. Roeder, 1976, 1977 etc.).

During the Neogene the West Carpathian sector of the Central Paratethys belonged to the Trans-European bioprovince. The composition of its endemic fauna was influenced during the individual stages by immigrants coming among the neighbouring bioprovinces (Boreal, Atlantic, West and East Mediterranean and Indopacific ones). The changes in bioprovincial composition of the faunas reflected principal changes in paleography (J. Seneš, 1966): the movements on the Zagros subduction and configuration changes of the barrier zones in Central Iran during the Upper Oligocene and the Lower Miocene caused the migration of the Indopacific faunal elements into Caucasian area (L. Neveskaya et al., 1979) to the Central Paratethys (J. Seneš, 1966; F. Steininger et al., 1979). The occurrence of the Boreal species in the Lower Miocene East Paratethyan faunal associations indicates a short-termed connection between Northern Europe along the Teissere-Tornquist line (D. P. Khrushchov et al., 1979). The Badenian interruption of the Indopacific elements immigration into the Paratethys was probably coused by westward movement of the Anatolian and Moesian blocks (N. Gökcen, 1979; M. Boccaletti et al., 1979). Similarly, by the paleobioprovincional analysis of fauna structures can be indicated the Upper Badenian up-lifting of the Dinarides (J. Seneš, 1966; F. Steininger et al., 1979; M. Kováč, 1980 etc.) or the Pliocene up-lifting of the Caucasus (M. Boccaletti et al., 1979).

Paleo-Alpine development of the West Tethyan closure

a) The Early Triassic situation

According to H. Brause (1979) and the other authors, Paleo-Europe consists of the suboceanic Rhenohercynic and sialic Saxothuringic, the latter being derived from the Paleozoic Gondwanian shelf (F. Patočka, 1980). After the Variscan orogenic collision of these two plates, the north-southern convergence of Laurasia and Gondwana turned into the east west. The troughs of the Atlantic-Tethyan graben systems progressively splitting the subtriangular Paleo-European craton (P. A. Ziegler, 1980) became a new tectonic category in its development: they connected the Alpine orogenic cycle with the development of Atlantic (M. Mahel', 1974; H. Brause — G. Beutler, 1977). The beginning of the Triassic sedimentation was affected by global regression (according to G. R. Stevens, 1980 caused by south pole glaciation) which was immediately followed by eustatic rise of sea level. This rise was accompanied by activization of troughs, both on the Paleo-European craton (in Viking-Horn- and Polish-troughs) and on the Tethyan shelves. The activization of troughs indicated a regional extension of the Earth crust (P. A. Ziegler, 1980). The significant Baikalian-Caledonian-Variscan consolidation belt, rimming the East European plate (Fennosarmatian block by H. Stille, 1953) had a character of more than 5000 km long and to 300 km wide depression belt (V. I. Slavin — V. E. Khain, 1980; V. I. Slavin — N. Safdari, 1980 etc.) from south and west. The origin of these troughs was connected with co-action of horizontal movements (W. Pożaryski — W. Brochwitz-Lewiński, 1980). The Danish-Polish trough, as one among the most important structures in this zone was established along the Teissere-Tornquist (= Greenland-Pontus etc., cf. J. Znosko, 1979) line, delimited by it on the eastern side (J. Kutek, 1980: W. Pożaryski — W. Brochwicz-Lewiński, 1979). In the underlie of the present Eastern Carpathians (W. Pożaryski — K. Żytko, 1979, 1980) the trough continued far southward.

b) The Middle Triassic changes in sedimentary regimes

The Anisian "Montenegrian phase" caused the first important break in sedimentary regime on rapidly stabilizing carbonate platforms of the Tethyan shelves. Its effects were observed in the Dinarides (B. Berće, 1963), in the Alps (conglomerates, breccias, sedimentary gaps introduced by A. Tollmann, 1966), and in the Western Carpathians (M. Mišík, 1968; J. Michalík, 1979). P. A. Ziegler, 1980, ascribed to this phase also the cause of transgression of the Muschelkalk Sea into NW Europe and of the next extent of carbonate platforms facies into the shelf regions with terrigene-clastic sedimentation. Wide Variscan consolidated shelf began to diversify during this period onto taphrogeosynclinal troughs, ridges and bars (T. Bechstädt et al., 1976; G. Kauffmann, 1976 etc.)

The Ladinian-Lower Carnian "Labinian" phase the most outstanding in East and SE Asia reached even greater extent and intensity. In Europe it affected particularly the Caucasus, Crimea, Dinarides and Southern Alps, accompanied by expressive subsidence, volcanism and differentiation of tectonic structures and bottom morphology (M. Epting et al., 1976). T. Bechstädt et al., 1978, interpreted this mobility as an effect of early "aborted rifting" of the Tethyan shelf. However, M. Marinelli et al., 1980, considered the South Alpine area to be a subcrustal eroded Triassic back-arc basin in a proximity of the north-western Paleotethyan active margin (of the Pacific type), similarly to the situation, supposed in the Caucasus area by S. A. Adamiya — I. D. Shavishvili (1979) and by S. A. Adamiya et al. (1977 a-b).

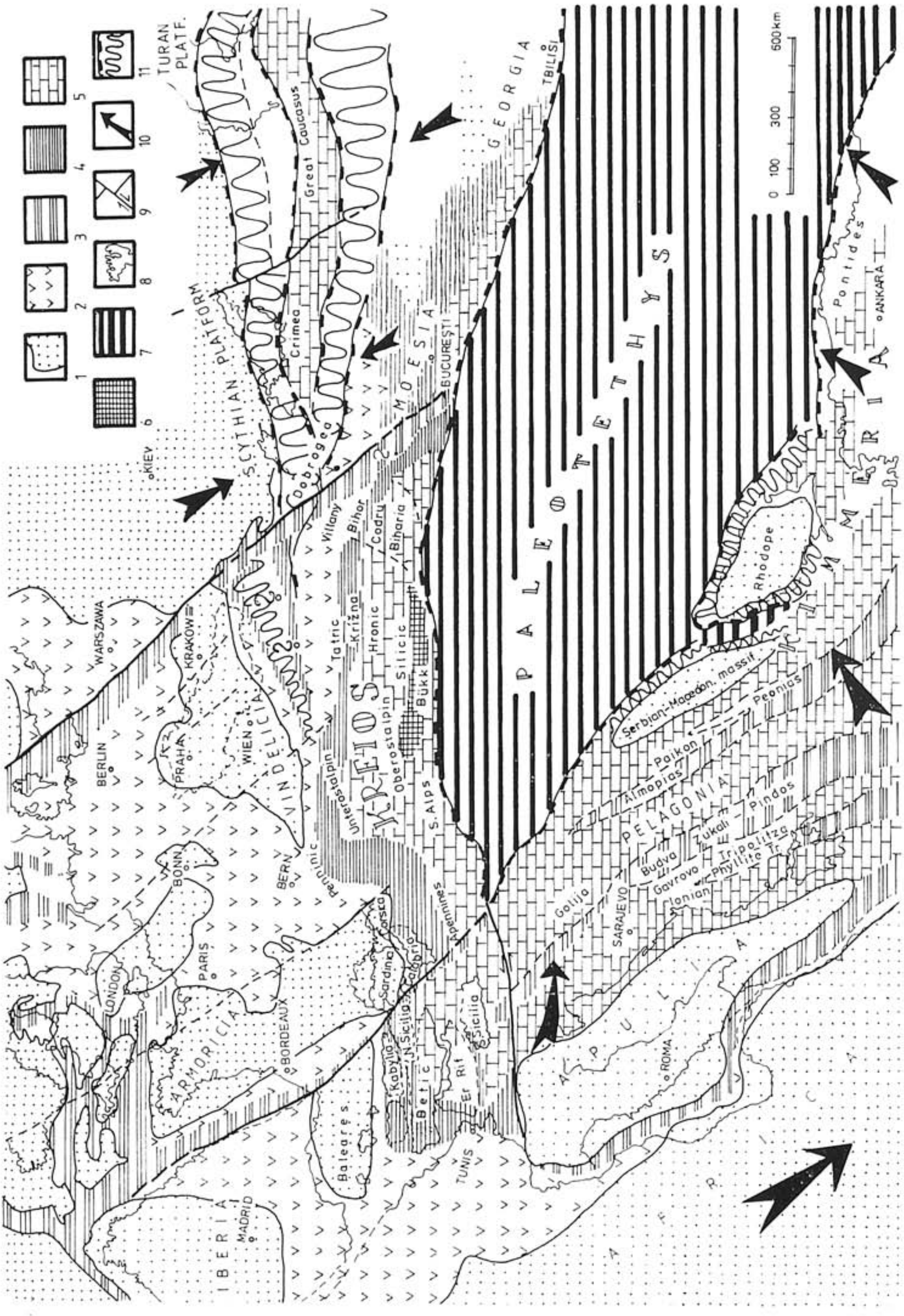
The West Carpathian Silicic is rather similar to the Austroalpine and South Alpine developments by the Triassic carbonate platform facies with (sole) volcanoclastics. Less subsidence of this complicately broken Alpine-Carpathian shelf reflects its different geotectonic regime (M. Mahel, 1969, 1979, 1980). Despite of this, the Triassic Silicic subsidence rate is the highest within the all Western Carpathians. The increased subsidence rate indicates (A. Tollmann, 1978) zones with crustal transformation. The extensive Ladinian-Carnian collaps of the Southern and Northern Alpine and Southern West Carpathian basins has been connected with the origin of back-arc basins during the north-vergent subduction of disappearing Paleotethyan oceanic crust. The flysch-like Wengen- and Lunz-basins were produced in this way (M. Maheľ, 1980). Huge masses of the Ladinian-Carnian Bükk ophiolites (Z. Balla et al., 1980) seem to confirm the supposition of the presence of the Upper Paleozoic-Triassic Ocean in the southernmost West Carpathian zones.

c) The Early Kimmerian orogeny

Gondwana continents, associated in the proximity of south pole began to move northward at the end of the Triassic (G. R. Stevens, 1980). These events conform to the "Lower" and "Meso-Kimmerian phase" of H. Stille (1924) in the Tethyan realm. This period of deformations was evident apparently in Eastern Asia, degree of deformation decreasing westward (A. Tollmann, 1966). The intensity of volcanism, significant especially along the Turan and Tarim blocks and in the Fore-Caucasus (V. I. Slavin — V. E. Khain, 1980; V. I. Slavin — N. Safdari, 1980) decreased in the same direction. The convergence of Kimmeria (Rhodopes, Pontides, NW and Central Iran, Afghanian Mid-Mountain, Central Tibet and China) with the southern Eurasian foreland caused the closing of the Paleotethys and deformation of adjacent zones (C. A. M. Şengör et al., 1980). F. Hirsch (1976), C. Montenat — D. Vachard (1980) and M. Küsten (1980) confirmed the Triassic/Jurassic reorganization of paleogeographical conditions in the Kimmerian continent, separated from the Gondwana shelf. A wide flysch troughs belt accompanied the Lower Kimmerian orogen northward: from Fore-Caucasus and Crimea (S. L. Byzova, 1980), Kotel and Tulcea-zones of Balkan (P. Gočev, 1976) to the circum Rhodopean belt (M. Maheľ, 1969, 1973, 1978; V. Jacobshagen et al., 1978).

The West Tethyan area had a different development. The vaulting of the whole area indicated by shallowing, regression and spreading of terrigeneous and evaporite facies (A. Bosellini — K. J. Hsü, 1973; H. Laubsher — D. Bernoulli, 1977; J. Michalík, 1978, 1980; R. Borrouilh — D. S. Gorsline, 1979 etc.) was ten million years later followed by a collapsing ("Rhaetic transgression", P. A. Ziegler, 1980 etc.). In this area, the Lower Kimmerian orogeny is indicated either by sediment deformation and breccia intercalations (A. Tollmann, 1966) or by transgressive character of the Liassic sequences (M. Maheľ, 1963). The transgression of the Tethys westward into the Protoatlantic rifts along Northern Marocco has been acom-

Fig. 1. A paleogeographical sketch of the western Tethys during Triassic/Jurassic boundary (Early Kimmerian phase).
Explanations: 1 — dry-land facies and source areas, 2 — Keuper facies, 3 — rifts and troughs, 4 — non-volcanic extensional basins, 5 — carbonate platforms, 6 — back-arc basins with volcanic activity, 7 — oceanic bottom, 8 — Recent coast-line (for orientation), 9 — main fault-lines, 10 — plate movement direction, 11 — deformed zones.


1 2 3 4 5 6 7 8 9 10 11
TURAN PLATF.
GEORGIA
TBILISI
Great Caucasus
Crimea
SCYTHIAN PLATFORM
KIEV
MOESIA
BUCUREȘTI
Dobrogea
PALEOTETHYS
Pontides
ANKARA
CIMMERIA
Rhodope
Serbian-Macedon. massif
Peonias
Paikon
Almopias
PELAGONIA
Pindos
Zukali
Tripolitza
Budva
Gavrovo
Ionian
Phyllite Tr.
Golija
SARAJEVO
APULIA
ROMA
AFRICA
WARSZAWA
KRAKÓW
BERLIN
PRAHA
WIEN
VINDELICIA
BONN
BERN
PARIS
LONDON
ARMORICIA
BORDEAUX
IBERIA
MADRID
Baleares
Kabylia
N.Sicilia
Betic
Rif
Er
Sicilia
TUNIS
Apennines
Corsica
Sardinia
Calabria
S. Alps
Penninic
Unterostalpin
Oberostalpin
KREIOS
Tatric
Križna
Hronic
Silicic
Bükk
Villany
Bihor
Codru
Biharia
0 100 300 500 km

panied by a collapse of continental borders and by extrusions of olivinic and quartz tholeiites (W. Manspeisen et al., 1978).

In several West Carpathian zones (Tatric, Hronic, Silicic) the Triassic/Jurassic border is accompanied by significant discontinuity. Moreover, the separation of occurrences of the Triassic sediments from the Jurassic/Cretaceous sequences (stressed by M. Mišík et al., 1977, 1980; H. Kozur, 1980; M. Mahel', 1981) could indicate the closing of the Triassic sedimentary basins in the Klippen Belt by the Lower Kimmerian space reduction in the same way like in the Great Caucasus (G. A. Chikhradze, 1979).

d) The Jurassic development of the Western Tethys

Sea-spreading of the Tethyan oceanic bottom (J. Dercourt, 1970; J. F. Dewey et al., 1973 etc.) occurred differently in its various segments. The development of the eastern one, delimited by the Vardar zone on the west, has been connected with the Himalayan-Indian-Iranian block system movements and with the opening of the Indian Ocean (H. Laubscher — D. Bernoulli, 1977). The main subduction belts dipped under the coastal continents of the disappearing Paleotethys (K. C. Condie, 1979). An extensive carbonate platform disappeared during the north-vergent Lower Kimmerian subduction in the area of the Great Caucasus. The renewed crustal extension produced a new Jurassic strongly subsiding back-arc basin with partially oceanized bottom (S. A. Adamiya, 1977; G. A. Chikhradze, 1979). Thick terrigeneous and flyschoidal sequence (to 10 000 m thick) subsided in this basin, followed by 3500 m thick complex of ultrabasics, basics and acid erruptives which represented a new progressive shortening of the basin. The subduction culminated by the Bathian Meso-Kimmerian orogeny, accompanied by granitoid intrusions.

A flysch trough in an extensive carbonate platform system originated also on the periphery of the Serbian-Macedonian Massif and Rhodope block (M. Mahel', 1973). The compression, accompanied by metamorphism and by the origin of granite batholiths occurred during the Middle Jurassic (V. Jacobshagen et al., 1978). The subduction zone on the northern border of the Kimmeria (Fig. 2) had southern vergence, the movement of the Kimmerian blocks to the N-NE proved in Iran (M. Alavi, 1980) and in Afghanistan (K. Krumsiek, 1978). The progressively expanding Mesogea Ocean evolved from the rift system on the south of this microcontinental belt (H. Lapierre — G. Rocci, 1976; F. Baroz et al., 1976; J. F. Parrot, 1977).

The north-western branch of the Mesogea splitted obliquely several older structures (A. Agyriadis, 1975; P. Scandone, 1975; K. J. Hsü et al., 1977): it penetrated through the Vardar zone, Munti Metaliferi and Eastern Carpathians (the Siret Ocean of N. Norman — H. Savu, 1974) and southern Penninic of the Western Carpathians and Alps (M. Mahel', 1974, 1978, 1981; H. P. Laubscher, 1975; V. J. Dietrich, 1976; D. Roeder, 1976; S. Prey, 1978; A. Tollmann, 1978 etc). According to several authors (M. Mahel', 1974; D. Roeder, 1976; W. Frisch, 1981) this south Penninic Ocean developed by transformation of the Mid-Atlantic one: it attained nearly 1000 km width until the Middle Cretaceous. The expanding Penninic Ocean (= Vahicum by M. Mahel', 1981) separated an extensive block of the Lower Mesozoic carbonate shelf ("Carnic plate" by J. F. Dewey et al., 1973, alias "Austroalpine-South-Alpine-Adriatic microcontinent" by V. J. Dietrich, 1976, or, more precisely defined "Kreios microcontinent" by A. Tollmann, 1978).

Several authors (J. Decourt, 1970; J. E. T. Channell — F. Horváth, 1976; F. Horváth et al., 1979; L. E. Ricou — J. Marcoux, 1980 etc.) consider this intraoceanic carbonate platform as a part of the North-African shelf. However, the palynospectrum of its sediments does not contain any African elements till the Albian-Cenomanian collision (A. Isler — N. Pantić, 1980). The Kreios microcontinent, according to A. Tollmann, 1978 8000 km long and 1500 km wide, was a characteristic paleogeographical element of the western Tethys. The Kimmerian continent in eastern part of the Tethys was seemingly equivalent of the Kreios: however, not only its origin but also its tectonic history were different (it was derived from the Gondwanian shelf, cf. C. A. M. Şengör et al., 1980).

The Jurassic relative lateral movement of the African craton to Laurasia (J. F. Dewey et al., 1973) produced a Californian type of the subduction in the western Mediterranean and gradual separation of the Alboran microcontinent and the Iberia (R. Borrouilh — D. S. Gorsline, 1979). Crustal distension in the Penninic, NW of Europe and adjacent part of opening Atlantic caused a relative shift of the Paleoeuropean lithospherical segment. The London-Brabant Massif and the Bohemian-Rhine block arose to the north-west along transversal fault systems, loosing the space for expanding south Penninic Ocean (J. Klomínský — J. H. Bernard, 1974; D. Roeder, 1976; P. A. Ziegler, 1980).

Deep pelagic conditions prevailed in the Tethys at the end of the Middle Jurassic. The subsidence during the "CCD-crisis (L. E. Ricou — J. Marcoux, 1980) was accompanied by frequent sedimentary gaps and breccias. Submarine slumpings occurred in this horizon of the Krížna Nappe in the Western Carpathians (M. Mišík, 1964; K. Borza et al., 1980 etc.), followed by variously thick silicite sequence. Moreover, M. Mišík, 1979, described a break of the Bajocian-Bathonian sequence in the Czorsztyn cordillera (Klippen Belt) and L. Kamenický et al., (1974) found the Jurassic acid magmatite pebbles derived from the Pienide cordillera.

e) The Late Kimmerian movements

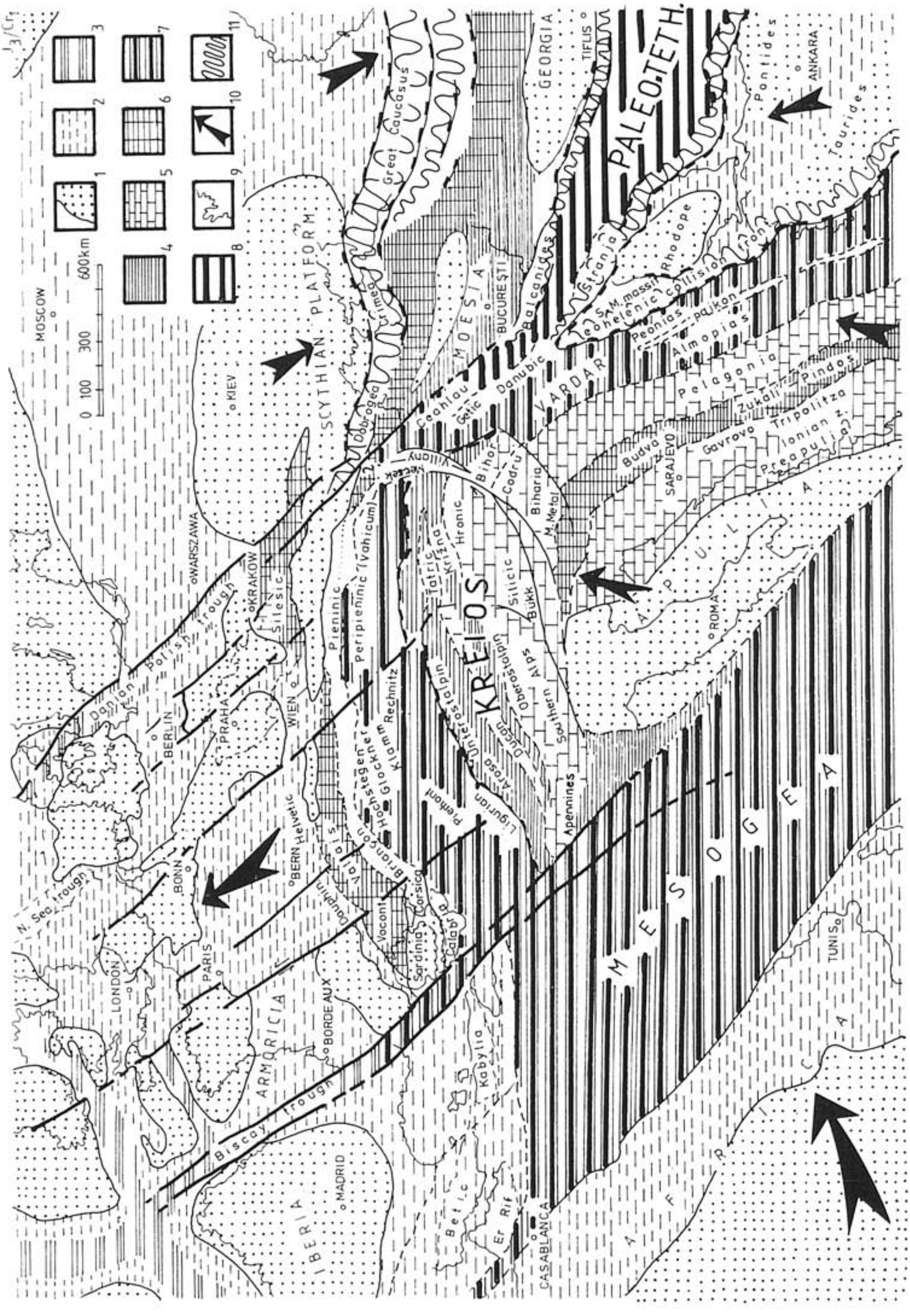
Continuing subduction of the Paleotethyan oceanic crust at the end of the Jurassic caused the direct collision of Kimmeria with periferal blocks of Laurasia (Skythian-Turanian-Afghanian-Tadjikiaones, cf. K. Krumsiek, 1976) accompanied by the foding in collisional zones: in Iran (M. Alavi, 1980), in Crimea (S. L. Byzova, 1980), in northern Dobrogea and Balkan (M. Mahel', 1973, 1978; P. M. Gočev, 1976, in internal Helenides and the Vardar zone (X. LePichon — R. Blanchet, 1978; V. Jacobshagen et al., 1978). The deformation of the Hellenides has been according to several authors (K. J. Hsü et al., 1977; D. Roeder, 1980) caused by collision of the eastern Apulian margin with prograding foreland of the principal Tethyan area. One among the fundamental paleogeographic megatransverses, delimiting the Alpine-Carpathian segment of the Tethys run through the Vardar zone (P. M. Gočev, 1976; L. E. Ricou — J. Marcoux, 1980). The majority of the flysch troughs in the Alpine-Carpathian area arisen during the Upper Jurassic-Lower Cretaceous termal subsidence (M. Mahel', 1973, 1974, 1978; P. Y. Chenet, 1979). Turbidite flows and olisthostromes transported the Austroalpine Hallstatt and Dachstein-Limestone fragments from the originating folded and overthrust structures far to the north (S. Prey, 1978). The regional discontinuities and breccias, associated with EW dislocations and north-verging folds are also known in other fore-Alpine and Alpine areas (A. Tollmann, 1966).

The Western Carpathian area has been only locally affected by the Upper Kimmerian movements, the Klippen Belt being the most distinctively influenced (M. Mišík, 1979, described here the Rogožnik breccia, condensed horizons and neptunic dykes). Similar but less distinctive effects are known in several next West Carpathian areas, too (M. Mahel', 1963, 1971).

f) The Austrian movements

At the end of the Lower Cretaceous the African craton changed its relative vergence of movement and began to converge with the Paleoeropean foreland (J. F. Dewey et al., 1973). The first effects of progressively increasing compressions in the Tethyan space appeared already during the Lower Cretaceous. The Valanginian-Heuterivian clastics of Rossfeldschichten in the Alpine Tyrolic (P. Faupl — A. Tollmann, 1978), conglomerates and olisthostromes in the Barremian-Aptian wildflysch of the East Carpathian Perşani and Buçegi Mts. (J. Jaroš, 1963), the Barremian-Aptian detric chrome-spinels in the West Carpathian Klippen Belt (M. Mišík et al., 1980) or in the Austro-Alpine (H. P. Laubscher, 1975 etc.) indicate a phase of relief diversification and overthrusting of the litospheric blocks northward. The tectonic activity of this period culminated in the Albian when hundreds kilometers of oceanic crust disappeared by lateral shift, convergence and rotation during the subduction (D. Roeder, 1976). Several events including separation of the Apuşeni block from the Central Carpathians (M. Mahel', 1978), beginning from the Penninic subduction under Austroalpine units (W. Frisch, 1976) splitting of the Iberia and Northern America (K. C. Condie, 1979) and onset of spreading in the Biscaya-rift which caused rotation of the Iberia (P. A. Ziegler, 1980) occurred before or just in the Lower Albian. In difference with extensive trends in NW Europe, the compression occurred in the Danish-Polish trough which finished the graben-stage of its development (W. Pożaryski — W. Brochwicz-Leviński, 1979). The eustatic rise of sea-level which had origin in the Aptian, culminated during the Cenomanian-Turonian by regional transgression (P. A. Ziegler, 1980). The Aptian-Albian paleogeographical changes and differentiation of the bottom morphology in the Alpine-Carpathian Tethyan segment resulted in reorganization of the ocean current regime which caused

Fig. 2. A paleogeographical sketch of the European Tethys during Jurassic Cretaceous boundary (Late Kimmerian phase).
Explanations: 1 — dry-land facies and source area, 2 — epicontinental seas, 3 — rifts and troughs, 4 — non-volcanic extensional basins, 5 — carbonate platforms, 6 — back-arc basins with volcanic activity, 7 — young oceanic bottom, 8 — ancient oceanic crust, 9 — Recent coast-line, 10 — plate movement direction, 11 — deformed zones.



MOSCOW
0 100 300 600km
KIEV
WARSZAWA
KRAKOW
BERLIN
PRAHA
WIEN
BONN
BERN
LONDON
PARIS
BORDEAUX
MADRID
CASABLANCA
TUNIS
ROMA
SARAJEVO
BUCUREŞTI
ANKARA
TIFLIS
SCYTHIAN PLATFORM
MOESIA
GEORGIA
PALEO.TETH.
Great Caucasus
Crimea
Dobrogea
Balcanides
Stranja
Rhodope
Pontides
Taurides
VARDAR
Danubic
Getic
Ceahlau
Almopias
Paikon
Peonias
Pelagonia
Pindos
Zukali
Tripolitza
Gavrovo
Budva
Ionian z.
Preapulia?
APULIA
MESOGEA
AFRICA
IBERIA
ARMORICIA
Biscay trough
N. Sea trough
Danian Polish trough
Silesic
Pieninic
Peripieninic (Vahicum)
KREIOS
Tatric
Križna
Hronic
Silicic
Bükk
Bihor
Codru
Biharia
M. Metal
Villány
Mecsek
Rechnitz
Klamm
Glockner
Hochstegen
Briançon
Valais
Helvetic
Dauphin
Vocont
Corsica
Sardinia
Calabria
Kabylia
Betic
Er Rif
Piemont
Ligurian
Arosa
Ducan
Unterostalpin
Oberostalpin
Alps
Southern
Apennines

a substitution of carbonates by siliceous-terrigene sedimentation. J. N. Senjkovskij (1978, 1979) explained this change as an effect of extensive upwelling, which changed the character of sediments and biotas on the shelf and adjacent epicontinental basins (Fig. 3). This hypothesis agrees well with the observations of T. Neagu — A. Bârbulescu (1979) in the Dobrogean Senonian sequences.

The Austrian movements caused in the Central West Carpathians an important shortening of the space and origin of the nappe structure (D. Andrusov, 1959; M. Mahel' et al., 1967; M. Mahel', 1971, 1974 etc.).

g) The Late Cretaceous development (Laramian movements)

The morphology and history of development of the Paleoeuropean Cenomanian-Turonian sedimentary besins indicate an important role of the NW-SE fault tectonics, connected with gradual opening of the Northern Atlantic. The rejuvenation of tectonic movements at the end of Cretaceous caused a revolution in the development of these basins: the inversions of the Mesozoic grabens distinctively appeared 1000 km apart from the Alpine deformation front (P. A. Ziegler, 1980).

These deformations caused a new extensive shortening of the Tethyan sedimentary realm. According to J. F. Parrot (1977), the western segment of the Mesogea (southern Meso-Tethyan branch) completely closed in the Middle Maastrichtian. The Laramian orogenic phase affected the Alpine (A. Tollmann, 1966) and West Carpathian area (particularly the Klippen Belt cf. D. Andrusov, 1966; M. Mahel', 1971). Wildflysch turbidites, olisthostromes and megabreccias occur frequently in these areas (M. Mahel' et al., 1967; F. Thiedig, 1975; M. Mišík et al., 1977 etc.). An evident deepening of the flysch zone and onset of typical facies of the "Magura-flysch" are also considered as effects of the Laramian orogeny (M. Mahel', 1973).

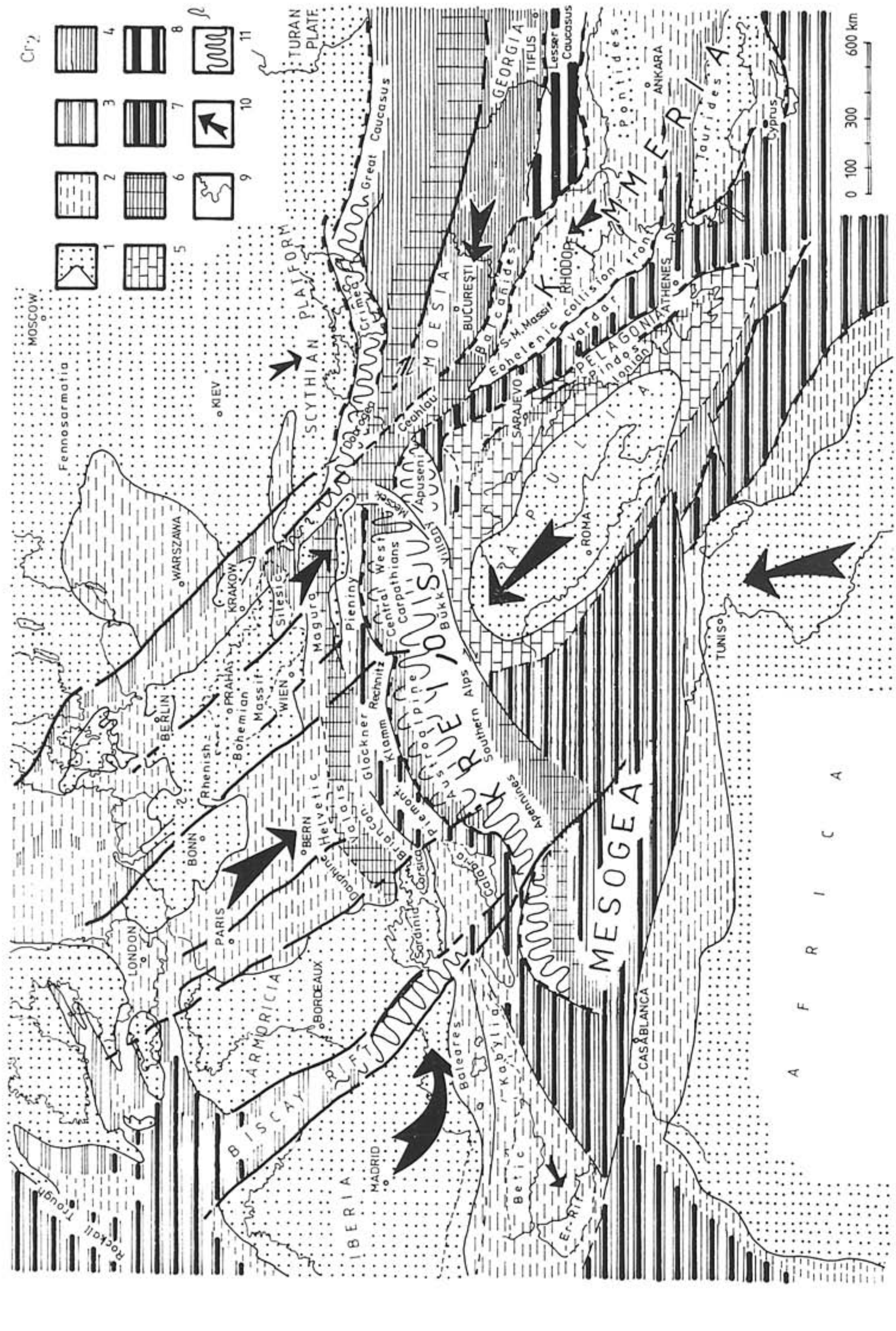
Meso- and Neo- Alpine development of the Mediterranean Tethys

a) The Early Cenozoic situation

The Cenozoic development of the Tethys was influenced by spreading of the Atlantic and Indian oceans (J. F. Dewey et al., 1973), separating of the Arabian Peninsula from Africa and separating of India from the Seychelian Isles, as well as by the collision of these Gondwanian fragments with Asia. Spreading of the Atlantic between Southern Africa and Patagonia, as well as between Greenland and Scandinavia caused a vectoral change in convergence of the African and Eurasian craton (W. Frisch, 1981). This process which originated after the Upper Cretaceous orogeny, controlled the Neoalpine development of

Fig. 3. A paleogeographical sketch of the European Tethys during Mid-Cretaceous events (Austrian phase).

Explanations: 1 — dry-land facies and source areas, 2 — epicontinental seas, 3 — rifts and troughs, 4 — non-volcanic extentional basins, 5 — carbonate platforms, 6 — back-arc basins with volcanism, 7 — oceanic bottom, 8 — ancient oceanic crust, 9 — Recent coast-line, 10 — plate movement direction, 11 — deformed zones.


Cr2
1
2
3
4
5
6
7
8
9
10
11
0 100 300 600 km
TURAN PLATE
Great Caucasus
GEORGIA
TIFLIS
Lesser Caucasus
ANKARA
Pontides
Taurides
Cyprus
MOSCOW
Fennosarmatia
KIEV
SCYTHIAN PLATFORM
Crimea
Dobrogea
MOESIA
BUCURESTI
Balcanides
S-M.Massif
RHODOPE
Eohelenic collision front
Vardar
PELAGONIA
ATHENES
Pindos
Ionian
SARAJEVO
Ceahlau
Apuseni
Mecsek
Villány
APULIA
ROMA
TUNIS
WARSZAWA
KRAKOW
Silesic
Magura
Pieniny
Central West Carpathians
Bükk
BERLIN
PRAHA
Rhenish
Bohemian Massif
WIEN
Rechnitz
Klamm
Glockner
Austroalpine
Southern Alps
Apennines
LONDON
BONN
PARIS
BERN
Helvetic
Valais
Briançon
Dauphine
Piemont
Corsica
Sardinia
Calabria
ARMORICIA
BORDEAUX
BISCAY RIFT
Baleares
Kabylia
Betic
Er-Rif
CASABLANCA
MADRID
IBERIA
Rockall Trough
MESOGEA
KIMMERIA
AFRICA

all the Mediterranean. Its first phase produced the externides, the later one gave origin to the extensive frontal and back sedimentary basins in the forming orogenic systems. The orogeny has been accompanied by partial microplate movements, displacement along the transform faults, breaking and incorporation of foreland blocks into the orogenic structures. North-vergent subduction zone east of the Vardar migrated to the African margin. It was rimmed by magmatic arc (Rhodopes, Pontids, Lower Caucasus, Iranides etc.), cf. S. A. Adamiya et al., 1977; M. Boccaletti, 1979; K. J. Hsü et al., 1977, and by an extensional back-arc basin (the Black Sea and the Caspian Sea being its relics). Another south-verging subduction, migrating towards the north-European continent, prevailed in the westernmore part of the Mediterranean (D. Roeder, 1980; M. Boccaletti — G. Guiazzon, 1974 etc.). The sediments of Srednogorje and the neighbouring Balcanides were deformed and partially covered by the Rhodope plate moving northward (K. J. Hsü et al., 1977). The deformations affected also the Pyrenees, Pennines, Dinarides, Alps and Carpathians.

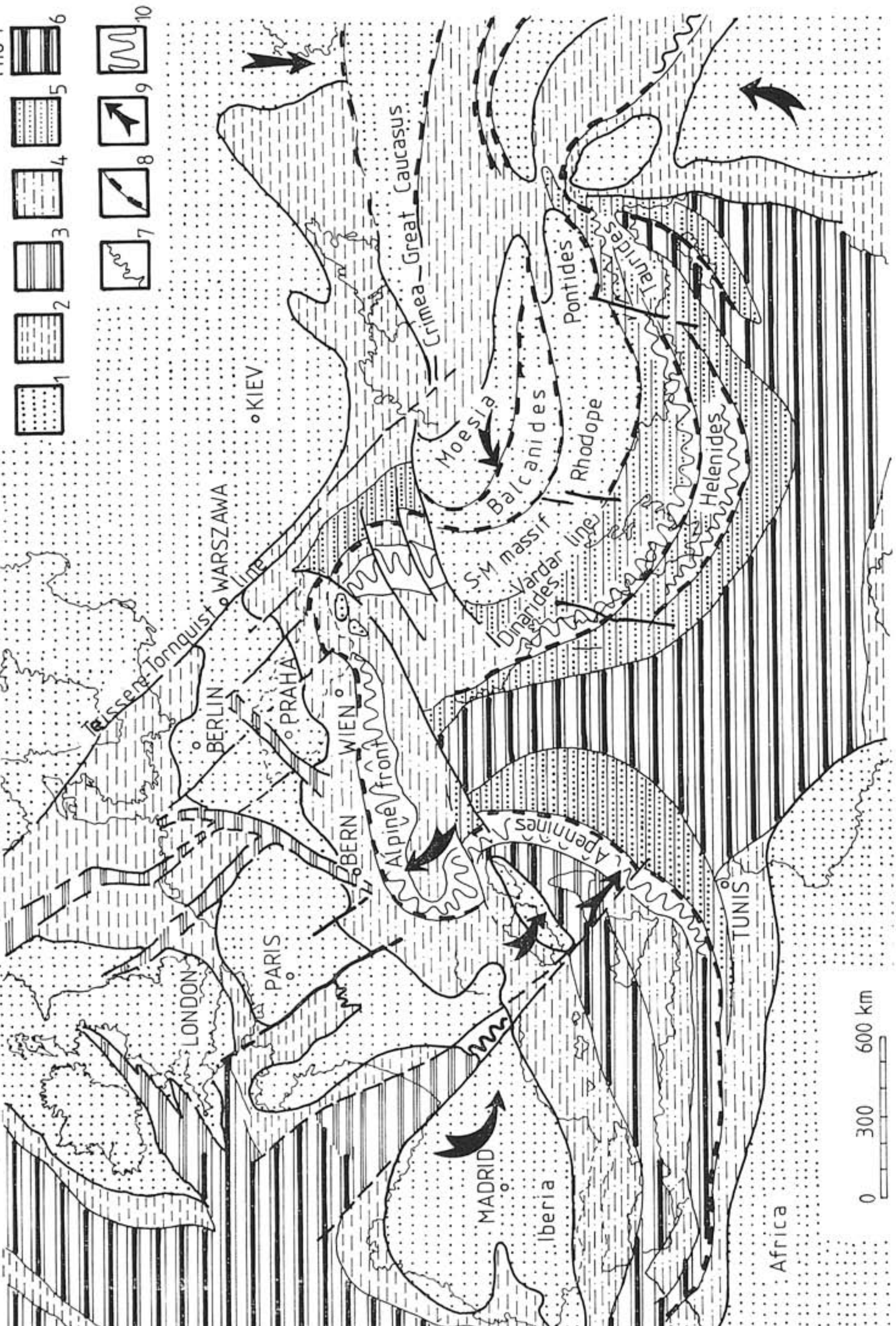
The disintegration of more or less uniform Alpine-Carpathian-Apuşeni block system began in the Upper Cretaceous. An important role in the Cenozoic individualization of the orogenic areas played width of the space between the front of the orogen and European cratonic margin. The overthrusting of the Austroalpine units onto the Rhenodanubian flysch (D. Roeder, 1980) and deformation of the White Carpathian-Krynica and Bystrica flysch in the Western Carpathians (Z. Roth, 1980) occurred in the Upper Eocene when the Alpine-Carpathian frontal system has been still continuous (reaching the Vienna-Miskolc line). While the West Alpine front has been strongly reduced by overthrusting the Rhenodanubic over the Helvetic in the Lower Oligocene (D. Roeder, 1980), the contemporaneous deposits of the frontal East Alpine molasse consist of the material from the Bohemian Massif. The rejuvenation of movements in the Eastern Alps is proved by an increasing share of the Alpine material in the Middle Oligocene conglomerate horizons. Thick Upper Eocene — Oligocene molasse sedimented also in the Balcanides and Rhodopes. The significant Oligocene sequence lies unconformably on the deformed Eocene underground in the Western Apennines (M. Boccaletti et al., 1970).

b) The Late Cenozoic situation

The Oligocene deformation of the extensive Tethyan areas caused a disintegration of the formerly continuous oceanic realm into isolated marine basins with development of different organic communities which evolved into the Atlantic, Mediterranean and Indopacific bioprovinces (A. Hallam, 1981). These bioprovinces were separated by barriers like the orogenic zone between Kabylie,

Fig. 4. A paleogeographical sketch of the European Tethys during Oligocene/Miocene boundary (Savian phase).

Explanations: 1 — dry-land facies and source areas, 2 — epicontinental seas, 3 — rifts and troughs, 4 — molassa, 5 — flysch basins, 6 — oceanic bottom, 7 — Recent coast-line, 8 — subduction zones, 9 — plate movement direction, 10 — deformed zones.


Mio 1
1
2
3
4
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9
10
KIEV
WARSZAWA
Teissere-Tornquist line
BERLIN
PRAHA
WIEN
BERN
Alpine front
PARIS
LONDON
MADRID
Iberia
Africa
TUNIS
Apennines
Dinarides
Vardar line
S-M massif
Moesia
Balcanides
Rhodope
Helenides
Pontides
Taurides
Crimea
Great Caucasus
0
300
600 km

Er-Rif, Maghrebides and Betic cordillera (M. Durand — Delga in M. Lemoine, 1978), or the Zagros orogen, originated by a collision of the Arabian and Iranian plates. The Paleogene limestone-clastic sequences of the Lower Himalaya were deformed in the first, the Oligocene phase of the India and Asia collision.

Several late orogenic collapse structures penetrated through the European craton in the Middle and Upper Oligocene (Rhine-Bresse and Eger graben, Vienna and Panonian basins, cf. A. Tollmann, 1978; P. A. Ziegler, 1980), connecting the Alpine foredeep and the North Sea basin. The isostatic uplift of extensive platform blocks during the tectonic inactivity lead to the relief inversion known after the Danish -Polish trough (Senonian to Paleogene, P. A. Ziegler, 1980) or after the margin parts of the Bohemian Massif in the Carpathian foreland (Oligocene to Ottnangian, Z. Roth, 1980).

The deformations of the Alpine-Carpathian orogenic front were long-timed and multi-phased. They were active synsedimentary in foreland of the overthrust units which partly became source areas, partially underground of the frontal basins of the orogen. The eastern part of the Magura unit also developed this way (L. Koszarski in M. Mahel', 1974): it overthrust over the Grzybow units, later were deformed along with it and both were overthrust northward over the deformed and eroded Dukla folds-unit and Silesic unit. The margin of the Magura unit also covers the Lower Badenian sediments, transgreding over the Silesic unit. The Godula-nappe of the Moravsko-slezské Beskydy Mts. sinistrally rotated on 40° during the Oligocene overthrusting (M. Krs et al., 1977). This fact enables to follow the original connection of the West Carpathian flysch basins and the Alpine flysch foreland (Z. Roth, 1980), neglected in R. Urung's (1980) reconstruction. The rotation of the Szolnok-Szeged-Baia Mare flysch trough (Z. Karagjuleva et al., 1980) and the start of the westward Moesian plate movements occurred in the same time.

The Mediterranean area considerably differentiated in the Miocene. While a neritic-reefal sedimentation continued in the southern part of the Dinarian externides, the Hellenides were divided by elevated ridges onto the pelagic Ionian, Beiotian and Pindos basins; moreover, the west — Hellenian flysch sedimentation in Peloponesus and Creta indurated to the Egerian. All the Dinaride-Hellenide system has been deformed during the Badenian when the Dalmatian nappes and SW-vergent folds originated. Uplift of this area caused the separation of the Central Paratethys and the Mediterranean subprovince (R. Blanchet in M. Lemoine, 1978; G. Kowalczyk et al., 1979; F. Steininger et al., 1979; J. Debelmas, 1980). A shallow Oligocene-Miocene Sea inudated the SW od Anatolia, Antalaya and Rhodos (N. Gokcen, 1979). Important paleogeographic changes occurred in the western Mediterranean. The Lower and Middle Miocene rotation of Corsosardinia to the SE opened the Algeria-Provençal basin (J. Debelmas, 1980). New folding of the Apennine orogen in the same time caused its rotational overthrust over the Apulian microcontinent into its present position (M. Boccaletti et al., 1970).

An activization of transformal and transversal faults is an expressive feature of the Miocene-Pliocene tectonogenesis (E. S. Bončev, 1971, 1980; M. Mahel', 1969; M. Mahel' et al., 1974; G. Wein, 1977; J. Karagjuleva et al., 1980). This faults had an important role in the arching of the Carpathian-Balkan sigmoide (particularly the Darnó-, Balaton-, Mecsek-, Dealu Mare-, Petroșani- and other lines). The Moesian microplate has been during the Savian phase pushed westward along the Timok-Pinot-Bunovo-line which separates the Southern Carpathians, Balcanides, Kraištide and Srednogorie. Tensional volcanic products of the mantle diapir extruded along the fault, separating the Carpathian, Pannonian and Transylvanian blocks (M. Krs — Z. Roth, 1979; L. Stegena et al., 1975; J. G. Sclater et al., 1980). This diapir, delimited by the Alps on the west, by the Carpathians on the north and east, and by the Dinarides on the south, influenced the Neogene development of the Pannonian basin. The forming of the Alpine-Carpathian front continued contemporary. While the reduction of the East Alpine frontal units reached the maximum in the Egerian (S. Prey, 1978), the finalization of the West Carpathian space reduction, connected with their displacement into the present situation occurred in the Karpatian (M. Kováč, 1980; Z. Roth, 1980). A space reduction of the Polish Flysch Carpathians took place between the Upper Oligocene and Sarmatian (M. Mahel' et al., 1974). The Eastern and Southern Carpathian overthrust on their foreland since the Upper Miocene till the present time (Vrançea zone, C. Roman, 1970).

Conclusions

The aim of the presented paper is in a classification of the opinions on the position of the West Carpathian area in the Mediterranean Mesozoic and Cenozoic palispastic schemes. At the same time, we should like to stress several important questions which are summarized in these items:

1. Problems concerning the original arrangement of the present tectonic units depending on tectonic, geophysical and deep drilling research. Their importance is prominent in strong deformed and reduced zones like the Klippen Belt, Vahic etc., predominantly.

2. Reconstructions of the original width of individual sedimentary basins are connected with the assessment of a deformation grade, subduction or other space deformations. The opinions concerning these problems are very unclear.

3. Reconstructions of the original orientation, mutual relations and connections of sedimentary basins depend on a successful paleomagnetic and structural analysis. Recently, their application brought a lot of interesting, often surprising results.

4. Location of the source areas, barriers, "cordilleras", sea connections, transport direction and sea currents belong to the sedimentological problems range. Their study brought new dimensions in apparently stabilized opinions about the Klippen Belt and flysch basins.

5. Investigation of the paleogeographical relations can cover apparently hidden and complicated coherence between remote areas. The success of such a study depends on the knowledge of paleontological material and spatial/temporal distribution of species, on the complex evaluation by all the presented groups and on the investigation of localities. This method can solve problems of the Mesozoic world division, of relations and pertinence of the individual Mediterranean, Submediterranean, Subboreal and Boreal basins. Similarly, it enclear

the problems of temporal sea-ways and barriers between the bioprovinces and local basins.

6. Interpretations of the "carried" basins, synchronous with the tectonogenesis and of the basins, established along the active synsedimentary faults, represent a special but not any rare problem. The extent of such basins changed during sedimentation with its relation to the adjacent areas. The interpretation of these basins (and all basins active during the accelerated tectogenesis or "folding phase") requires an extraordinary dynamic approach, taking into consideration all categories: time — space — movement. This is the only way to bring closer a real palinspastic paleogeographical conception of the situation in the individual stages of the Carpathian orogenic development.

Translated by Ľ. Lehotská

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