

EVOLUTION AND PALAEOGEOGRAPHY OF THE VARISCAN OF NEO-EUROPE

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The tectonic framework of the middle part of Neo-Europe is dominated by two lineaments: The Periadriatic Lineament northward of the Southern Alps and the Balcan—Dinaric Lineament between the Vardar-Zone and the Serbo-Macedonian Massif (Fig. 1.). They are firstly clearly apparent in the Late Palaeozoic when they separate a terrestrially developed outer region from a marine inner region.

This facies division can be followed further into *Asia Minor* and *Transcaucasia* [BRINKMANN, R., 1968]. Here, playing a dividing role similar to the Serbo-Macedonian Massif, the *North-Anatolian Swell* separates a southern zone of the marine Late Palaeozoic from the northern terrestrial zone.

The inner region of Neo-Europe includes the Southern Alps and the Dinarides as well as the Igal—Bükk Palaeozoic Trough [WEIN, Gy., 1968]. The latter separates

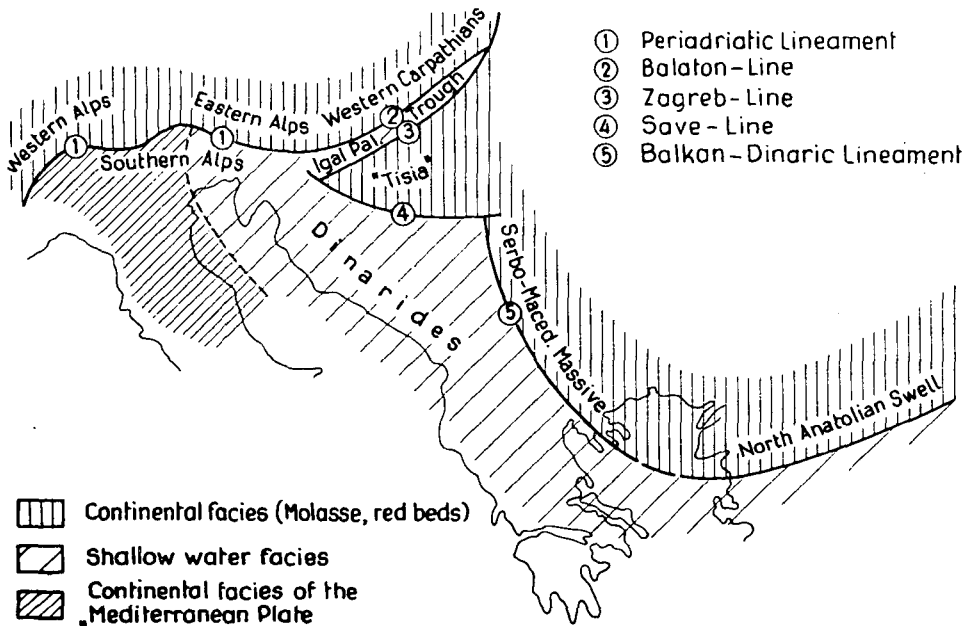


Fig. 1. Palaeogeographic sketch of Neo-Europe during the Later Palaeozoic (Upper Carboniferous/Permian).

the Pannonian Massif [Tisia: SZALAI, T., 1970] from the Palaeozoic of the Western Carpathians and its subterraneous connection with the Palaeozoic of the Styrian Basin.

In the *Southern Alps*, the development begins with a thick pelitic—psammitic sequence of probable Cambro—Ordovician age. Radiometric data (430 m. y.) indicate metamorphism and (?) orogenesis during the Caradocian [GRAESER, S., J. HUNZIKER, 1968; McDOWELL, F., 1968; PIDGEON, R., V. KÖPPEL, M. GRÜNENFELDER, 1968]. In the fossiliferous series, these disturbances are evidenced only through secondary events (volcanism, stratigraphic break [SELLI, R., 1963]). The subsequent carbonate-platform and deep-water development of the section during the Silurian, Devonian and Lower Carboniferous ended before the Asturian folding with a Middle Carboniferous flysch-sedimentation [FRANCAVILLA, F., 1966]. At the same time, connected with an uprise, building of some molasse troughs was taking place in the Lugano area. The time between the Asturian orogeny and the development of the Mesozoic Tethys was characterized by repeated, but non-contemporaneous transgressions, thick accumulations of ignimbrites connected with postorogenic granites [BORSI, S. *et al.*, 1966, 1972; JÄGER, E., H. FAUL, 1959: “late-Hercynian magmatic province of Trento and Lugano”] dated as 270 m. y. old, and followed by a largescale erosion [RAU, A., E. TONGIORI, 1972].

Towards the SE, this zone grades into the *Dinarides* with facies changes, but without a clear boundary. After the Variscan folding, the dominantly shaly—calcareous Early Palaeozoic was transgressed from the south by units of the Upper Carboniferous and Permian [RAMOVŠ, A., 1964; KOCHANSKY DEVIDÉ, V., 1964]. With this transgression came during the Lower Permian the development of the shelf-edging Trogkofel-reef [KAHLER, F., 1974; KOCHANSKY-DEVIDÉ, V., 1969], which separates the thick shallow-water deposits of the clastic Košna-sequence [KOCHANSKY-DEVIDÉ, V., 1973; RAMOVŠ, A., V. KOCHANSKY-DEVIDÉ, 1965] from the “oceanic” (?) area to the east [DIMITRIJEVIĆ, D., 1972; ILČI, M., 1969]. This model requires that a mainland was present in the Apennine area: a supposition supported by the terrestrial Permian of the Autochthon of Toscania [MAZZANTI, R., 1961]. Still unsolved is in this model the origin and age of the thick Gröden-beds of the Savefalten [GRAD, K. *et al.*, 1962].

A picture very similar to that is found in the Eastern Dinarides where the Late Palaeozoic beds of *West Serbia* build up a transgressive sequence above the older, folded Palaeozoic strata [FILIPOVIĆ, I., 1973]. These transgressive units, together with the marine sequence of the Late Palaeozoic of the *Igal—Bükk Trough*, which is known by the boreholes Karád and Bugyi, further in the Bükk Mountains [BALOGH, K., 1964], form a Late Palaeozoic shelf sequence along the mainland of the *Pannonian* and the *Serbo-Macedonian Massives*, both of them being characterized by a thick terrigenous Upper Carboniferous molasse and Permian Red beds with volcanic rocks [PANTIĆ, N., 1964; TENCHOV, Y., 1973].

The significant facies contrast existing between the Late Palaeozoic of the *Igal—Bükk Trough* resp. the terrestrial development north of the Lake Balaton (in the Bakony Mts. and in the West-Carpathians) indicates that the *Periadriatic Lineament* has its continuation probably in the *Balaton-Line* (Fig. 1).

The counterpart of the marine inner region of Neo-Europe with its mainland areas in the west and east is found northward of the *Periadriatic Lineament* in the form of the Late Palaeozoic terrestrial sequences in the Eastern Alps and the Western Carpathians.

The Early Palaeozoic and the Lower Carboniferous of the *Eastern Alps* are

more or less comparable to the development in the Southern Alps [FLÜGEL, H. W., H. P. SCHÖNLAUB, 1972]. This similarity also holds true in respect of the Upper Ordovician metamorphism under intermediate pressure and medium-to-high temperature and the acid magmatism which can be found in several crystalline areas in the western part of the Eastern Alps [BORSI, S. *et al.*, 1973], and the Variscan folding, metamorphism and orogeny [JÄGER, R., 1971].

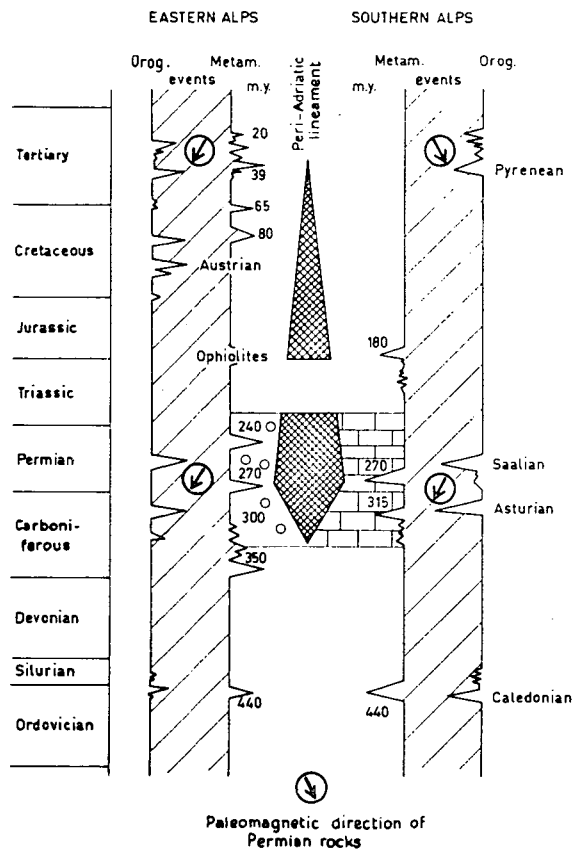


Fig. 2. Diagram of the development of the Eastern and Southern Alps.

In the contrast, there are clear differences between the Carboniferous and Permian where the development is comparable to that of the Autochthon of the Apennines, or to that of the Pannonian resp. Serbo-Macedonian Massif. In this respect it is noteworthy that — both in the Southern and in the Eastern Alps — a pre-Upper Carboniferous erosion surface cuts the earlier beds, and the latter come even older from east to west whereby the values of the cooling age measured on Variscan biotites and muscovites suggest a postorogenic pre-Permian uplift and an erosion of 5 km/10 m. y. [BORSI, S. *et al.*, 1973].

A special case within this terrestrial development is shown by the marine sequence of Namurian—Westphalian age of the Northern Gemerides (West-Carpathians) which probably had no connection to the Igal—Bükk Trough, but — as its fauna shows — was connected to the north and northeast [ABONYI, A., 1971].

The facies division of the Late Palaeozoic of Neo-Europe presented here shows that three geotectonically differing, major areas were developed, probably associated with the Variscan orogeny:

1. the marine—terrestrial facies of the “Mediterranean Plate” with the Southern Alps, Dinarides, Apennines and Igal—Bükk Trough;
2. the eastern continental facies of the Pannonian, resp. Serbo-Macedonian Massif and the North-Anatolian Swell;
3. the development north of the Periadriatic Lineament and the Balaton-Line, which is similar in many respects to the facies No. 2.

In the discussion of the palaeogeography of the Late Palaeozoic of Neo-Europe, one cannot forget the palaeomagnetic data which indicates a probable counter-clockwise rotation of the Mediterranean Plate of 50° during the Paleogene [SOFFEL, H., 1973]. It should be remembered, however, that borders of this plate are still unknown. It is obvious to bring the facies differences during the Permian into connection with this plate rotation. On the other hand it is to be mentioned, that the regression of the Triassic sea put an end to the clear separation during the Permian, and the Periadriatic Lineament is no longer during the Triassic time clearly apparent [BOSELLINI, A., K. HSÜ, 1973]. Only from Jurassic onwards, differences in the facies can be seen again on both sides of the mentioned lineament, coinciding with the clear differences of the orogenic and metamorphic events on both sides of the Periadriatic Lineament (*Fig. 2*).

REFERENCES

- ABONYI, A. [1971]: The Stratigraphical-Tectonical Evolution of the Gemeride Carboniferous. — *Geol. Práce* 57 pp. 339—348, Bratislava
- BALOGH, K. [1964]: Die geologischen Bildungen des Bükkgebirges. — *Ann. Inst. Geol. Publ. Hungarici* 48, 2, 719 p., Budapest
- BALOGH, K., A. BARABÁS [1972]: The Carboniferous and Permian of Hungary. — *Acta Miner. Petr.*, 20, 2, pp. 191—207, Szeged
- BORSI, S., DEL MORO, A., G. FERRARA [1972]: Eta radiometric triche delle rocce intrusive del Massiccio di Bressanone—Ivigna—Monte Croce (Alto Adige). — *Boll. Soc. Geol. Ital.*, 91, pp. 387—406, Roma
- BORSI, S., A. DEL MORO, F. SASSI, G. ZIRPOLI [1973]: Metamorphic evolution of the Autstridic rocks to the south of the Tauern Window (Eastern Alps): radiometric and geo-petrologic data. — *Mem. Soc. Geol. Ital.*, 12, pp. 549—571, Pisa
- BORSI, S., FERRARA, G., E. TONGIORGI [1966]: Rb/Sr and K/Ar ages of intrusive rocks of Adamello and M. Sabion (Trentino, Italy). — *Earth Planet. Sci. Lett.*, 1, pp. 55—57, Amsterdam
- BOSELLINI, A., K. HSÜ [1973]: Mediterranean Plate Tectonics and Triassic Palaeogeography. — *Nature* 244, pp. 144—146, London.
- BRINKMANN, R. [1968]: *Geol. Palaeont.*, 2, pp. 111—119.
- FILIPOVIĆ, I. [1973]: Theses (unpubl.) — Beograd
- DIMITRIJEVIĆ, D. M. [1972]: Hercynian Metamorphism in the Central Part of the Balkan Peninsula. — *Z. Deutsch. Geol. Ges.*, 123, pp. 329—335, Hannover
- FLÜGEL, H. W. [1975]: Einige Probleme des Variszikums von Neo-Europa. *Geol. Rundschau* 64, 1, pp. 1—62, Stuttgart
- FLÜGEL, H. W., H. P. SCHÖNLAUB [1972]: Geleitworte zur stratigraphischen Tabelle des Palaeozoikums von Österreich. — *Verh. Geol. B.—A.*, 1972, pp. 187—198, Wien
- FRANCAVILLA, F. [1966]: *Giorn. Geol.*, (2) 33, pp. 493—526.
- GRAD, K., A. HINTERLECHNER—RAVNIK, A. RAMOVČ [1962]: Regionalna Ispitivanja Razvoja Gredenskih Sloveja u Sloveniji. — *Rep. 5. Meeting Geol. F. P. R.* pp. 78—81, Beograd.
- GRAESER, S., J. HUNZIKER [1968]: Rb-Sr- und Pd-Isotopen-Bestimmungen an Gesteinen und Mineralien der Ivrea-Zone. — *Schweiz. Min. Petr. Mitteil.*, 48, pp. 189—204, Zürich.

- ILIĆ, M. [1969]: Über die stratigraphische Lage und die tektonischen Charakteristiken von Massiven der Ultrabasite der Dinariden. — Ann. Géol. Penins. Balk., **34**, pp. 519—541, Beograd
- JÄGER, E. [1971]: The History of Central and Western Europe. — Rend. Soc. Ital. Mineral. Petrol., **27**, pp. 241—247.
- JÄGER, E., H. FAUL [1959]: Age Measurements on some Granites and Gneisses from the Alps. — Bull. Geol. Soc. Amer., **70**, pp. 1553—1558, Boulder
- KAHLER, F. [1974]: Fusuliniden aus T'ien-schan und Tibet. Mit Gedanken zur Geschichte der Fusuliniden-Meere im Perm. — Rep. Sci. Exp. Sven Hedin **52**, (V. Invert. Palaeont. 4) p. 147, Stockholm
- KOCHANSKY-DEVIDÉ, V. [1964]: Comptes Rend. 4. Congr. Carbon., **2**, pp. 513—517.
- KOCHANSKY-DEVIDÉ, V. [1969]: Darvasitenkalk (Troglkofelstufe) in der Crna Gora (Montenegro). — Bull. Sci. (A) **14**, p. 217, Belgrad
- KOCHANSKY-DEVIDÉ, V. [1973]: Troglkofel-Ablagerungen in Kroatien. — Geol. Vjesnik **26**, pp. 41—51, Zagreb
- MAZZANTI, R. [1961]: Geologia della zona di Montaiione tra le valli dell'Era a dell'Elsa (Toscana). — Boll. Soc. Geol. Ital., **80**, pp. 37—126, Roma
- MCDOWELL, F. [1968]: Potassium-Argon Ages from the Ceneri Zone of Southern Switzerland. — Schweiz. Min. Petr. Mitt., **48**, pp. 211—212, Zürich
- PIDGEON, R., V. KÖPPEL, M. GRÜNENFELDER [1968]: Isotopic U-Pb Ages of Zircons from the Ceneri Zone, Southern Alps. — Schweiz. Min. Petr. Mitt., **48**, pp. 213—214, Zürich
- PANTIĆ, N. [1964]: Über die Verhältnisse zwischen Karbon und Perm in Ostserbien. — C. R. 5. Congr. Strat. Carb., **2**, pp. 605—609, Paris
- RAMOVŠ, A. [1964]: C. R. Congr. Carbon., **2**, pp. 731—739.
- RAMOVŠ, A., V. KOCHANSKY-DEVIDÉ [1965]: Die Entwicklung des Jungpaläozoikums in der Umgebung von Ortnek in Unterkrain. — Razpr. Doss. Slov. Akad., **8**, pp. 323—389, Ljubljana
- RAU, A., E. TONGIORI [1972]: The Permian of Middle and Northern Italy. — Internat. Sed. Petr., **15**, pp. 216—280, Leiden
- SELLI, R. [1963]: Schema Geologico delle Alpi Carniche e Giulie Occidentali. — Giorn. Geol., (2a) **30**, p. 121, Bologna
- SOFFEL, H. [1973]: Paleomagnetism of the Colli Euganei and the anticlockwise rotation of Italy during the Tertiary. SPP der DFG: „Geodynamik des Mediterranen Raumes“. 2 p. Trento.
- SZALAI, T. [1970]: Acta Geol. Acad. Hung., **14**, pp. 71—82, Budapest
- TENCHOV, Y. [1973]: Stratigraphy of the Stephanian-Permian Fossilbearing Sediments in NW Bulgaria. — Bull. Geol. Inst. Bulg., (Strat.) **22**, p. 55—71, Sofia
- WEIN, G. [1968]: Die Tektonik von Südosttransdanubien. — Jb. Geol. B.-A. **111**, pp. 91—113, Wien

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