ION POPESCU-VOITEȘTI. CONTRIBUTIONS TO THE TECTONO-STRUCTURAL KNOWLEDGE OF THE CARPATHIANS

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Abstract: Popescu-Voitești is one of the three great pioneers of the tectono-structural knowledge of the Carpathians, along with G. M.-Murgoci and L. Mrazec. All three of them were followers of the nappe theory, in fact they were the only ones in the Geological Institute of Romania during the first two decades of its existence. Tectonics was a constant of Popescu-Voitești's geological activity, starting with his doctoral thesis, published in 1911, and until the end of his life, when he published the fourth tectonic map of the Romanian Carpathians, in 1942. Three decades of studies regarding the Carpathians structure, starting from the Carpathians bend area and continuing throughout the Carpathian area on the territory of the country.

Keywords: Carpathian chain, nappe structure

INTRODUCTION

Popescu-Voitești is one of the three great pioneers of the tectono-structural knowledge of the Carpathians, along with Murgoci and Mrazec. All three of them were followers of the nappe conception, in fact they were the only ones in the Geological Institute of Romania during the first two decades of its existence. After 1927, when the 2nd Congress for the Advancement of Carpathian Geology took place in Romania, in which geologists familiar with nappe structure of the Alps also participated, the nappe theory was widely adopted by the Romanian geologists.

Tectonics was a constant of Popescu-Voitești's geological activity, starting with his doctoral thesis, published in 1911, and until the end of his life, when he published the fourth tectonic map of the Romanian Carpathians, in 1942. Three decades of studies regarding the Carpathian structure, starting from the Carpathian starting bend area and continuing throughout the Carpathian area on the territory of the country, with changes from one work to another, including comebacks.

It can be said that Voitești was obsessed, in the good sense of the word, with the creation of a perfect tectono-structural model, to harmonize all the geological data available at a given time. This is how it happens that in three decades he developed nine successive models, two for the Făgăraș Massif-Vrancea bend area

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(1911, 1918), five for the Romanian Carpathians (1914, 1915, 1929, 1936, 1942) and two for the entire Carpathian chain (1914, 1921).

THE EVOLUTION OF TECTONO-STRUCTURAL CONCEPTS

Popescu-Voiteşti, 1911. Based on the stratigraphic study of the Paleogene deposits in the Brezoi-Titeşti and Călimăneşti basins and the study of Reinhard (1911, p. 190-205; 221-223) on the crystalline from the southern Făgăraş Massif, Voiteşti separates on the map from his doctoral thesis the Bucegi Conglomerate Nappe, which includes the crystalline of the Făgăraş Mountains (their extreme southern part), Iezer and Leaota mountains (Fig. 1a). In the area of the Făgăraş Massif, the nappe lies over the crystalline of the Getic Nappe and over the Oligocene-Miocene formations of the Getic Subcarpathians. In the Carpathian bend area, the Bucegi Conglomerate Nappe overlies the Sinaia Beds and the Senonian Red Marls Nappe and it is covered by the Internal Nappe which includes the Fusaru Sandstone Nappe and the Siriu Sandstone Nappe (Fig. 1b).

Based on these tectonic data, Murgoci (1910, p. 109) deduced that the second paroxysmal phase of of the Getic Nappe emplacement is of Miocene age. It is an example of wrong structural interpretation tributary to a low degree of geological knowledge. The Bucegi Conglomerate Nappe will know six more incarnations (1914, 1915, 1918, 1921, 1929 and 1942), the last one on the initial contour from 1911. No Romanian geologist was so dissatisfied with his structural models and searched so persistently for the perfect model.

Mrazec, Popescu-Voiteşti, 1914. The first tectonic map of the Romanian Carpathians and the first structural correlations with the northern and western Carpathians (Fig. 2). The authors also attach the crystalline of the East Carpathians to the Getic Nappe, structurally equivalent to the Transylvanian Nappe in the Apuseni Mountains. The crystalline of the Făgăraş, Iezer, and Leaota mountains remains in the Bucegi Conglomerate Nappe. Under the Getic nappe, considered the upper nappe of the Carpathians, lie the nappes of the flysch: the Red Senonian Marls, the Bucegi Conglomerate Nappe, the Siriu Sandstone Nappe, the Fusaru Sandstone Nappe and the Marginal Nappe. Below the flysch nappes, considered of Miocene age, the Pericarpathian Nappe is separated, which also includes the Diapir Folds Zone. On the 1:6,000,000 scale tectonic sketch accompanying the map, the five flysch nappes are correlated with the Beskides and Sub-Beskides nappes of the northern and western Carpathians separated by Uhlig in 1907.

Like Murgoci, Mrazec and Voiteşti considered that the nappes were formed by overfolding, as result of the underthrust exerted by the vorland on the Carpathian geosyncline. Although they do not say it explicitly, the authors thought that the subduction movement was facilitated by the major faults in the vorland (Dâmboviţa, Peceneaga-Camena, Focşani-Galaţi-Tulcea and Trotuş lines), otherwise these faults would not have been figured on all the tectono-structural synthesis maps of the Carpathians.

Mrazec, Popescu-Voitești, 1915. The authors details the lithological content of the nappes in the Eastern Carpathians, bringing new arguments regarding their correlation with the nappes in the Northern Carpathians. With the same contour, the Getic Nappe becomes the Transylvanian Nappe, under which the outcrop areas of the Sinaia Beds are also figured. The age of the flysch nappes remains Miocene. The contour of the nappes in the Făgăraş-Vrancea Bend region is adjusted and the Diapir Folds Zone is removed from the Pericarpathian Nappe.

Popescu-Voitești, 1918. The author approaches the complicated structure of the Olt Valley, including the crystalline islands from the Călinești-Racovița sector in the Bucegi Conglomerate Nappe. In the Olt Valley, the edge of the nappe separates on the NW-SE direction the Brezoi Basin, located under the nappe, from the greater part of the Titești Basin, which is part of the nappe body. The southwestern corner of the Titești Basin remains under the nappe, thus being included in the Brezoi Basin. The age of the thrust is considered to be Upper Oligocene-Miocene.

Popescu-Voitești, 1921. Structural tectonic units of the Carpathians (scale 1:8,000,000). This sketch map was published in the Annals of Mines from Romania and in his geology textbook, printed in two editions (1921 and 1924), the first being awarded by the Romanian Academy. The sketch shows the crystalline (with Mid-Cretaceous folds alignments) and eruptive formations as well as two tectonic units from the East Carpathians, the Flysch Carpathians (with Tertiary folds alignments) and the Subcarpathians (with post-Pliocene folds alignments). The post-Pliocene folds also affect the Getic Subcarpathians and the Transylvanian Basin (concentric, domal folds). The whole area of the Carpathian crystalline is included in the Dinaric domain that lies above the Flysch Carpathians.

The Vorland faults are also shown on the sketch, radially arranged on the Carpathian arch. Before the nappe front, the faults that delimit the North-Dobrogean orogen (Peceneaga and Galați-Tulcea faults) are connected in a single fault that crosses the Carpathians and continues to the northwest along the Neogene volcanic chain, in the idea of linking the eruptive rocks from the north of Dobrogea with the Neogene volcanics. The same thing happens with the Dâmbovița Fault, figured in an almost north-south direction to intercept the basalt occurrences in the Pre-Balkans, south of Svistov.

Without the correlation part with the Northern Carpathians and the Eastern Alps, the sketch was reproduced in the Geotectonics of Romania (Săndulescu, 1984, p. 16), in the chapter on the history of the structural knowledge of the Romanian territory, wrongly cited as being after Mrazec and Popescu-Voitești, 1914.

Popescu-Voitești, 1929. The 1:250,000 scale tectonic sketch of the Carpathian regions from 1929 is the most modern tectonic synthesis at the time. The author makes correlations with the Alps structure, which he sees in perfect concordance with the Carpathians structure. Very interesting are the geotectonic considerations regarding the evolution of the Alpine-Carpathian geosyncline, with reference to the recent, for its time, theory of continental drift evolved by Wegener.

In this context, Voitești evokes the northward movement of the African continent resulting in the crushing of the Alpine-Carpathian geosyncline and the formation of the overfolding nappes in the Alps and Carpathians.

The old axis of the Carpathian geosyncline coincides with the Almăj and Semenic Mountains, from where it connects with the eastern extremity of the Alpine geosyncline through the east of the Apuseni Mountains and the Transylvanian Basin. The Carpathian geosyncline closes completely at the end of the Aptian under the pressure of the Dinarides advancing eastwards like a spur, pressing on the western edge of the Apuseni Mountains and leading to the formation of Mid-Cretaceous nappes, whose stack (5 nappes) constitutes a veritable mountain range that Voitești calls Dacian. The Tertiary nappes system contains three nappes, the Siriu Sandstone Nappe, the Fusaru Sandstone Nappe and the Marginal Nappe.

The five nappes within the Dacides nappe stack are as follows:

- The Transylvanian Nappe, developed over a large area in the western Apuseni Mountains and as a covering outliers in the Perșani Mountains and the Eastern Carpathians;
- The Bukovinian-Bucegi Conglomerate Nappe, which includes all the crystalline of the East Carpathians below the Transylvanian Nappe, being extended in the southeast of the Apuseni Mountains, on the northwestern border of the South Carpathians and in the area of the Cozia, Iezer, Leaota and Perșani mountains;
- the Getic Nappe (reappears) and the Băile Herculane-Retezat Scale;
- the Sușița Granite Nappe, a syncline with an unclear position, and
- the Iron Gates Nappe, also a syncline of uncertain position.

Most of the Bukovinian-Bucegi Conglomerate Nappe in the South Carpathians will be included by Streckeisen (1932, p. 28-30) in the Upper (Supragetic) Nappe. This nappe will later be contested by Codarcea (1940, p. 63-64) and Ghika-Budești (1940, p. 188-191), but confirmed in the northwest of the Banat region by Cantuniari (1930, p. 146-149).

Popescu-Voitești, 1936. The author makes a series of changes to the contour of the Dacides, especially those at the top of the nappe stack. The Transylvanian Nappe is extended over the whole area of the Perșani Mountains, on the northern slope of the Făgăraș Mountains and on the area of the Cozia, Iezer, Leaota and Bucegi mountains previously included in the Bucegi Conglomerate-Bukovinian Nappe. In addition to the crystalline of the East Carpathians, the nappe includes the crest area of the Făgăraș Mountains and the northwestern border of the central and western South Carpathians. The rest of the crystalline remains at the Getic Nappe and at the Retezat-Cerna Scale. The area of the Danubian granite massifs is included in the Sușița-Parâng Granite Nappe, and the Iron Gates crystalline in the homonymous nappe, both with virtually unchanged contours.

Popescu-Voitești, 1942. On the occasion of his retirement, professor Popescu-Voitești held a final dissertation on the geology of the Romanian Carpathians at the Faculty of Sciences of the University of Bucharest. The tectonic sketch of the Carpathians on the scale of 1:25,000,000 that illustrates the text of the

dissertation (Fig. 3) is practically the tectonic model from 1936, to which Voiteşti makes important corrections only in the area of the eastern South Carpathians.

On the northern slope of the Făgăraș Mountains, the Bukovinian Nappe it is much extended to the detriment of the Transylvanian Nappe. The Bucegi Conglomerate Nappe, with its long history, is brought back into the structure of the Flysch Carpathians on the contour of 1911 (Făgăraş, Iezer and Leaota mountains) but at the base of the Mid-Cretaceous nappe stack, together with the Iron Gates Nappe.

At present, the largest part of the crystalline basement of the Bucegi Conglomerate Nappe in the area in which the nappe was initially defined by Voiteşti is part of the Median Dacides, i.e. the Infra-Bukovinian Nappe and the Getic Nappe (Săndulescu, 1984, p.188-189; 204-205).

In the same work, Voiteşti made remarkably up-to-date changes and additions to the vorland tectonics. First of all, the Peceneaga-Camena and Focșani-Tulcea faults no longer cross the orogen in the idea of connecting the Neogene volcanics of the East Carpathians with the eruptive rocks of the northern Dobrogea. Secondly, the Dâmbovița Fault is correctly placed on the NW-SE direction, corresponding to the current Intramoesian Fault, with an important role in the alpine evolution of the Carpathian arch. Thirdly, between the Dâmbovița Fault and the Peceneaga-Camena Fault, the Buzău Tectonic Line is depicted for the first time, on the direction of the current Capidava-Ovidiu Fault which separates the Precambrian basement of the Moesian Platform from its central Dobrogean sector regenerated during the Cadomian orogeny (Săndulescu 1984, p. 84-91).

CONCLUSIONS

Popescu-Voiteşti was a perfectionist and we can give two examples in this regard. The first refers to the tectonic synthesis of 1929, when Voiteşti notes the **perfect** structural concordance between the Carpathians and the Alps, as well as their **perfect** orographic continuity. The second is recorded in 1930 on the occasion of some observations regarding the stratigraphy and tectonics of the South Subcarpathians. The last observation refers to the relations between the geological structure and the orography of the Subcarpathians. We quote: "all the crests of the hills in the South Subcarpathians correspond to the crest of the anticlines; the transverse valleys follow areas of the transverse dip of the anticlines axes, while the lateral valleys are synclines; the tectonics of the Southern Subcarpathians **perfectly** matches their orography; the current relief of the Subcarpathians is therefore in **perfect** harmony with the structure...", I ended the quote. It seems obvious to us the determination with which Voiteşti repeats the word perfect, twice in two different geological contexts.

We end this exhibition with a splendid evocation of the tireless scientist, made by Marcian Bleahu (1980, p.33): "Voiteşti was not the man of immutable truths, but of working hypotheses, of attempts to include disparate data in a whole. He did not create for eternity but for contemporaries, but his work gives you even

today (...) the feeling of a round system, **perfectly** articulated, if not true, in any case truthful, as well as the voluptuousness of an integral vision (...), as has never been realized before, about the structure and evolution of the Romanian land".

BIBLIOGRAPHY

Bleahu 1980, Bleahu M., *Opera ştiinţifică a lui Ion Popesu-Voiteşti, privire de ansamblu. An. Inst. Geol. Geofiz.*, vol. LV, p. 24-33.

Cantuniari 1930, Cantuniari Ş, *Contribuţiuni la cunoaşterea geologiei Banatului. II-Studii geo-tectonice în regiunea Mâniom-Reşiţa-Vodnic. DSS Inst. Geol. Rom*., vol. XVII (1928-1929), p. 140-150.

Codarcea 1940, Codarcea A., *Vues nouvelles sur la tectonique du Banat méridional et du Plateau de Mehedinţi. An. Inst. Geol. Rom*. vol. XX, p. 1-74.

Ghika-Budeşti 1940, Ghika-Budeşti Ş., *Les Carpates Méridionales centrales. Recherches pétrographiques et géologiques entre le Parâng et le Negoi*. Teză de doctorat, Monitorul Oficial, 68 p.

Mrazec, Popescu-Voiteşti, 1914, Mrazec L., Popescu-Voiteşti I., *Contribuţiuni la cunoaşterea pânzelor Flişului carpatic în România. An. Inst. Geol. Rom.*, vol. V, fasc. II/1911. Extract, 32 p.

Mrazec, Popescu-Voiteşti 1915, Mrazec L., Popescu-Voiteşti I., *Date noi pentru clasificarea Flişului carpatic (cu o schiţă tectonică 1:2 230 000). DSS Inst. Geol. Rom*.,vol. III, p.33-52.

Murgoci 1912, Murgoci G. M., *The geological synthesis of the South Carpathians. CR du XI-ème Congrès International de Géologie*. Stockholm, 1910, p. 871-881.

Popescu-Voiteşti 1911, Popescu-Voiteşti I., *Contribution a l'étude stratigraphique du Nummulitique de la Depression Gétique (Roumanie Occidentale).* Teză de doctorat. *An. Inst. Geol. Rom.*, vol. III/1909, p. 275-372.

Popescu-Voiteşti 1918, Popescu-Voiteşti I., *La nappe du conglomérat des Bucegi dans la vallée de l'Oltu avec de nouvelles données sur la structure de cette vallée dans la région des Carpates méridionales (avec 14 coupes, deux esquisses hydrographiques, 11 planches photographiques et une esquisse géologique). An. Inst. Geol. Rom.*, vol. VIII/1914, p. 56-117.

Popescu-Voiteşti 1924, Popescu-Voiteşti I. ***Elemente de geologie cu privire generală asupra geologiei României***, ed. a II-a, Institutul de Arte Grafice Ardealul, Cluj. (Ediţia I, 1921), 467 p.

Popescu-Voiteşti 1929, Popescu-Voiteşti I. *Aperçu synthetique sur la structure de régions carpatiques roumaines. Rev. Muz. Geol.-Min. Univ. Cluj*, vol. III, nr. 1, p. 1-40.

Popescu-Voiteşti 1930, Popescu-Voiteşti I. *Câteva observaţiuni privitoare la stratigrafia şi tectonica Subcarpaţilor Meridionali. DSS Inst. Geol. Rom.*, vol. XV (1926-1927), p. 26-27.

Popescu-Voitești 1936, Popescu-Voitești I. *Evoluția geologo-paleogeografică a pământului românesc*, *Rev. Muz. Geol.-Min. Univ. Cluj*, vol. V, nr. 2/1935. Institutul de Arte Grafice Ardealul, Cluj, 211 p.

Popescu-Voitești 1942, Popescu-Voitești I. *Exposé synthétique sommaire sur la structure des régions carpatiques roumaines. Bul. Soc. Rom. Geol.*, vol V, p. 15-73.

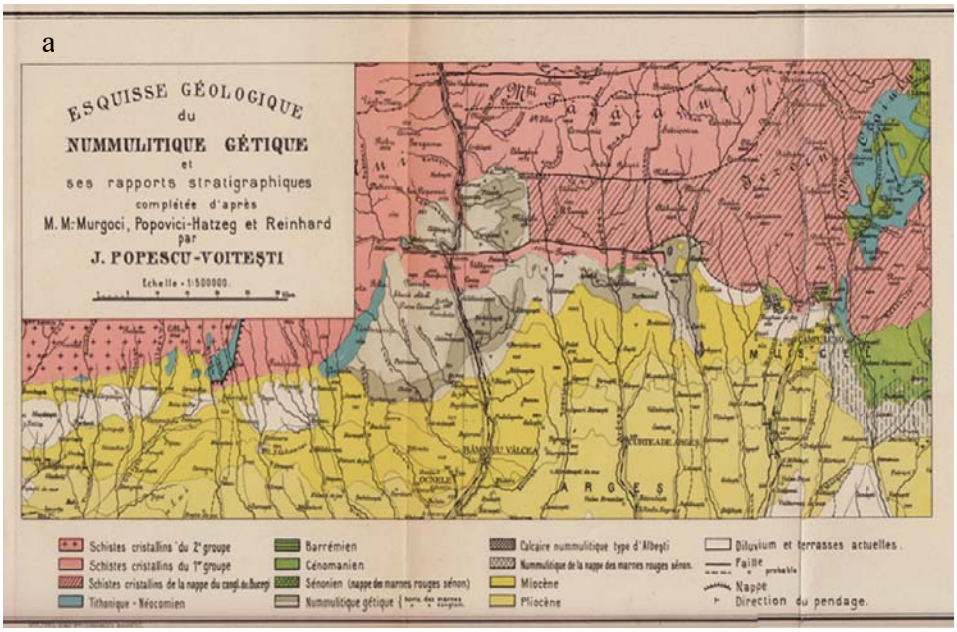
Reinhard 1911, Reinhard M. *Șisturile cristaline din Munții Făgărașului (clina română). An. Inst. Geol, Rom.*, vol. III/1909, p. 165-223.

Săndulescu 1984, Săndulescu M. ***Geotectonica României***. Editura Tehnică, București, 336 p.

Streckeisen, 1932, Streckeisen A. *Sur la tectonique des Carpates Méridionales*. Extras, 96 p. Imprimeria Națională, București.

Uhlig 1907, Uhlig V.K. *Über die Tektonik der Karpathen. Sitzungsberichten der k. Akad der Wiss, Mat. Natur Klasse*, Bd, CXVI, Wien.

Wegener 1915, Wegener A. *Die Entsehung der Kontinente und Ozeane*. Samml. Vieweg, nr. 23, Braunschweig, 94 p.



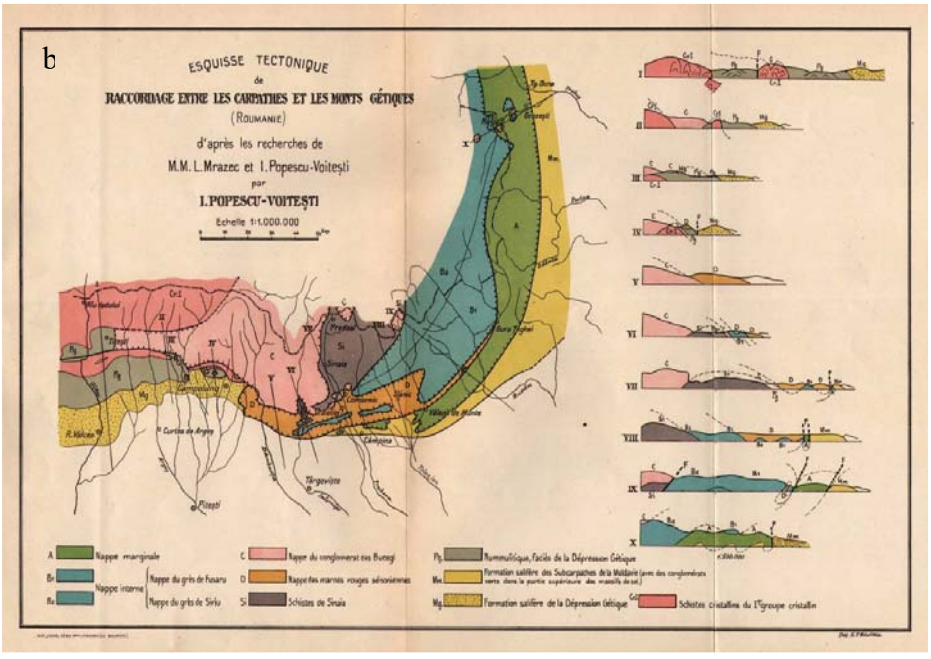


Fig. 1. Maps from Ion Popescu-Voitești's doctoral thesis (1911): a) geological sketch of the Getic Nummulitic, scale 1:500,000; b) tectonic sketch of the connection between the East and the South Carpathians, scale 1:1 000,000.

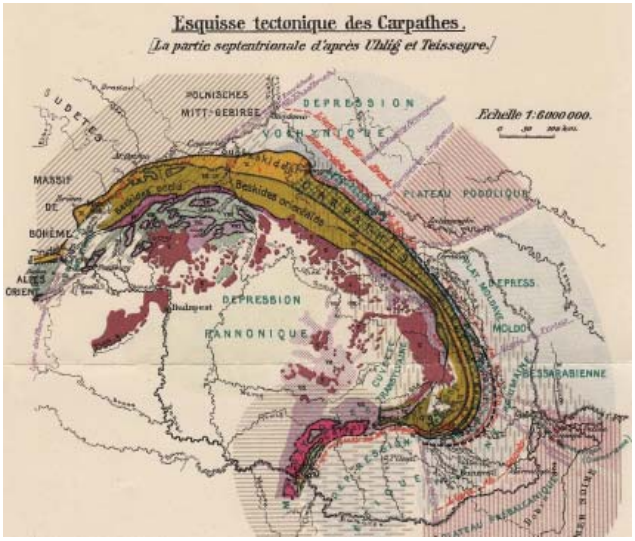


Fig. 2. Tectonic sketch of the Carpathians, scale 1:6,000,000 (Mrazec, Popescu-Voitești 1914).

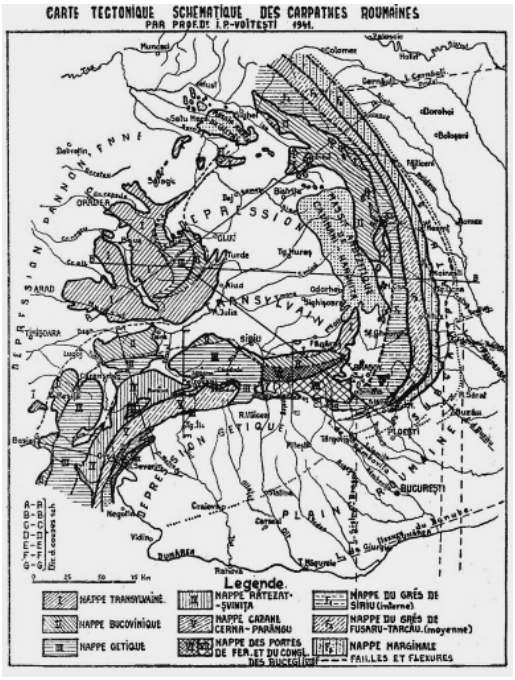


Fig. 3. Schematic tectonic map of the Romanian Carpathians, scale 1:25,000,000 (Popescu-Voitești 1942).