1 INTRODUCTION

The Mecsek – Villány region (henceforward "the region" for short) is situated in Southeastern Transdanubia, in the corner made by the confluence of the Danube and the Drava rivers. It covers approximately 5100 square kilometers. Of its building elements, the most important are those two mountains (Pretertiary outcrops) which denote the region; however, the main part of it is a young Tertiary basin.

The Mecsek Mountains form a topographical feature 50 km long in SW-NE direction. Its mainly Paleozoic-Mesozoic bulk, cropping out from under the mildly featured Pannonian and Pleistocene hilly surroundings (not higher, in average, than 120 – 180 m), rises as high above sea level as 300 – 600 m.

About 30 km southward, emerge the the lower (440 m high) Villány Mts., structurally, stratigraphically and faciologically somewhat different. These two mountains emerge from the surrounding Pannonian and Pleistocene hilly region, like two islands. In fact, every transgression since the Middle Miocene, left these two positive morphological features as dry land, as islands.

The region, of which this paper is published, as mentioned, is of considerably larger area than the two mountains themselves. It cuts as large a square out of the map as enables us to interprete the structural conditions of the two mountains placed into the broader environment (Fig. 1 and supplements).

The region is composed of two outcrops and of the basins surrounding them. The basic structural feature of the basins (i. e. of the proper field of geophysical exploration) is as follows: under a series of loose, young Tertiary basin-sediments ranging in thickness between a few meters and 1500 m, the floor of the basin is built up of hard, old basement-components. In the following, we are going to denote this stratigraphically and petrographically equally well defined, geophysically important unconformity (base of the Neogene) as *basin-floor*, when this complex is – as a whole – related to the sequence of basin-sediments. When, however, it is detailed in itself, the classical concept and word *basement* will be used.

The basin-floor is petrographically, stratigraphically and structurally rather varying. Its general, large-scale rule is that, crossing the general strike of the structural pattern (i. e. in NNW-SSE direction), we find crystalline basement-strips alternating with Permian-Mesozoic strips. At present, the latters are in a higher position, consequently these crop out from under the Neogene cover in a larger measure than anything else, forming islandlike ranges. There are indications of the Permian-Mesozoic strips having been tilted to the East. The strips, on the West in every case, on the East generally, terminate near the limits of our region.

In the following, we are going to give – in stratigraphical order – a brief description of the formations of the region possibly to be confronted in the geophysical investigations.

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The oldest rock of the region is *Proterozoic* and *Old-Paleozoic crystalline schist*. It is composed of mica-schist, gneiss, amphibolite, phyllite; covering the entire (epi- mezo and kata-) range of the contact metamorphic process.

To the southwest of the Mecsek Mts., deep drillings hit metamorphic rocks, namely quartz-phyllite (at Szigetvár), serpentine, lime-phyllite and biotite-mica-schist (at Helesfa). On the western part of the Permian anticline, Helvetian gravels indicate a variety of metamorphic rocks (mica-schist, gneiss, amphibolite, clay-slate, epimetamorphic sandstone). The gravels seem to have originated from the south. Indeed, deep drillings to the south of the Mecsek found their source, the native metamorphic rocks.

There is no report of metamorphic rocks to the north of the Mecsek mountain, within the limits of the region, except for the metamorphie pebbles of the Permian. To the north of the region, however, in the deep drilling Kaposfő, crystalline schist was found. The rocks found in the deep drillings at Szalatnak and Györe (within the region), previosly regarded as phyllite, recently proved to be Silurian shales.

Southeast of the Mecsek mountain, the deep drilling at Alsónána found amphibolite. The crystalline, oldpaleozoic rocks, south of the Mecsek apparently form an anticline, with granite in its nucleus. This same anticline supplied the material for the Helvetian gravel-bed mentioned. Numerous deep-drillings (Keszü, Gyód, Téseny, Kisdér, Görcsöny, Baksa, Pellérd) disclosed the presence of this crystalline ridge under the Neogene cover. The constituents are: biotite-mica schist, chloritic mica schist, amphibole-schist, amphibolite, amphibole-gneiss, mica-gneiss and granular orthogneiss. At Görcsöny and Helesfa amphibolite changed to serpentine.

As to the age of genesis, the next formation is the *granite*. Two main types of it are known: 1. the Mórágy type, found beside the Mórágy outcrop in the deep-drilling Alsónána, Szilágy, Martonfa, Bátaszék under crystalline rocks or Permian sandstone; and 2. the Nagyváty – Nyugatszenterzsébet type, found at Nyugatszenterzsébet in outcrop and under Pannonian; in the deep-drillings Dinnyeberki, Gyűrűfű, Korpád under Lower-Permian sandstone, further in the deep-drilling Helesfa (No 2) under metamorphic rocks.

These two types of granite are in relationship. In their bulk they are pink-coloured, microcline-orthoclas granites, with aplite-veins and pegmatite interbeddings. Their texture ordinarily shows signs of cataclase.

Recently, granitoid rock was found in the Szalatnak deep-drilling, under Silurian. Grey coloured, its contact is unknown so far. It is similar to the Mórágy (1.) type.

In the Helvetian gravel mentioned, there are white specimens of mica-abounding granitic origin, transported from the south like the entire gravel bed. The exact place of their origin (their native formation), however, is unknown as yet.

The age of the granite in the metamorphic complex was determined by K-Ar method as 285 million years. In fact, the granite can be only older than this, since age-determination records the last alteration only; and the last significant alteration of the granite can be attached to the early Variscian orogenesis.

The granite, where it is in original (not tectonical) contact with the metamorphites, produced a slight effect at most. This indicates that the essential metamorphism took place before the granite intrusion. For *this* reason, we regard the older members of metamorphites as Proterozoic ones.

Consequently those rocks, which apparently settle *upon* the granite (Szalatnak) and the degree of their metamorphism can hardly be termed even as much as epi-metamorphism, have been classified as Silurian or Old-paleozoic in general. Recently a finding of fossil (*Graptolith* sp.) affirmed this statement.

Silurian is known, on the northern margin, from deep-drillings at Györe and Szalatnak. Its original metarial was terrestrial clay, conglomerate, fine-grained marine sandstone and clay-shale. The formation as a whole underwent a slight metamorphism, and was strongly folded. It has a tectonic contact with granite, but contains also granite in its gravel-components.

The next stratigraphical unit is *Upper Carboniferous*. The Helvetian gravel mentioned already several times, announced this formation (dark clay-shale pebbles with plant-impressions) for the first time. Native Upper Carboniferous is only known from the deep-drilling Téseny. This Téseny Carboniferous is dark-grey clay-shale and grey felsparic sandstone. Slightly dislocated, it settles upon metamorphites, in all probability unconformably.

A complete sequence of the formations of the *Permian* period is known in the western Mecsek, on the surface. The lower Permian consists of alternating beds of coarse conglomerate, red sandstone, aleurolite and a quartzporphyry lava-flow. Volcanism partly even preceded the Permian, since the latter contains, from its base upward, porphyry and quartzporphyry pebbles. The lower part of the lower Permian is of fluviatile origin, while its upper, purely aleurolite part is of marine or lacustrine origin. Quartzporphyry is in the lower fluviatile section.

The Upper Permian consists of alternating beds of conglomerate, red, brown, grey, green sandstone, red and grey aleurolite. Its upper part, the so-called Jakabhegy sandstone shows a gradual transition toward Triassic. This Upper-Permian is of fluviatile origin. Its clastic sediments refer to a supply-background of granite, crystalline schist and quartzporphyry.

The supply (transportation) of Permian sediments – according to the investigations – took place from northwestern direction. Hence, a Variscian range and a quartzporphyry volcanism is supposed to have existed then and there.

The buried Permian of the region is known in two varieties, both on different areas. One is the Mecsek type, in the localities Gyűrűfű – Dinnyeberki and Korpád (Neogene-covered lower Permian); Gorica and Kán (triassic-covered complete Permian); Szalatnak and Györe (the so-called Jakabhegy facies upon Silurian); Szekszárd, Szilágy and Martonfa (Jakabhegy facies upon granite).

The Permian is thickest in the western anticline and surroundings (3000 m); westward and northward it is thinning. It is supposed to thin out eastward too, since the basin of sedimentation of the eastern Mecsek subsided significantly in the Mesozoic era, not in the Permian. Should we suppose a subsidence of the eastern basin similar to that of the western one, then we ought to estimate the sediment-thickness of the eastern perisyncline for as high as 10 000 m; which means almost geosyncline dimensions. At any rate, we should be obliged to assume a "root", a considerable depression of the Con-

rad and Mohorovičič discontinuities, supported neither by seismic, nor by gravity results.

Another type of Permian has been established in deep-drillings south of the Mórágy hills and in the neighbourhood of Villány. Thick Permian was found in the Turony deep-drilling, covered by Triassic and basin-sediments. Its facies reminds us of the Mecsek one; the essential difference is that the conglomerate is in reduced quantity, hardly containing any quartzporphyry pebbles. The intra-upper Permian unconformity recognized in the Mecsek area is unknown here; although no definite opinion can be given as yet, since no deep-drilling penetrated the formation so far. It can be recorded, however, that its supply area may have been in the south, and was, in petrographical respect, similar to that of the Mecsek Permian. In fact, it must have been lower lying, and sedimentation was steadier.

A formation similar in facies but representing only a part of the Upper Permian was drilled at Bátaszék, settled upon granite. Its facies is fluviatile and sometimes aeolic sandstone. Here, Permian extends beyond the border of the region towards the south Lowland. The Villány type Permian is thickest in the very vicinity of the mountain itself; the thickness is supposed to decrease in all directions.

The Mecsek type and Villány type Permian are separated by the South-Baranya crystalline ridge. This ridge is assumed to have functioned as a dam between the two basins, during sedimentation.

The Permian continously grows into Triassic here, too.

The *Triassic* of the region starts with the Seisian stage of lower Triassic. This stage continously develops from Permian, as said already. Its grainsize is strongly reduced. In the Upper Seisian, the clastic facies disappears and dolomite, dolomitemarl, anhydrite, gypsum and aleurolite constitute the formation, sometimes bearing the marks of hard, chaotic folding. Beside the exposures of the western Mecsek, Seisian was drilled at Gorica, Szalatnak, Mánfa, Turony and Bátaszék. Its thickness probably tops around the border of the western and eastern Mecsek, since subsidence in the Seisian stage must have been most intensive just here.

The Seisian is prevalently of marine origin.

The Campilian continues Seisian sedimentation. Its facies are: dolomite, dolomite-marl, limestone and calcareous marl. Except the locality Bátaszék, it can be found together with Seisian. The Campilian is of shallow, pelagic origin. Once its extension must have been far greater, a considerable part is supposed to have been eroded.

Middle Triassic formations occur in wide extension. They are known on the surface both in the western and in the eastern Mecsek, further in the Szászvár—Nagymányok Mesozoic overthrust belt ("northern overthrust belt"), at Báta and Várpuszta. Also the main bulk of Villány Mts. is composed of Anisian, similar to that of the Mecsek.

It was drilled at Szalatnak, Monyoród, Kisjakabfalva and Vékény.

The Anisian facies is carbonate; characterized by pelagic limestones and dolomites. Its fauna and its facies is essentially identical on all known sites of occurrence, once, it evidently must have covered the entire area. Its thickness is ranging between 500 and 900 m. Geophysically, — by its great density

and seismic velocity – the dark-grey Anisian limestone is the most marked key-horizon of the region.

The Ladinian formations are different according to whether they belong to the Mecsek or to the Villány area, announcing the sharp difference in the Upper Triassic and Jurassic. In the Mecsek Mts., dark-grey clay-shale, in the Villány Mts., dolomite represents the Ladinian stage.

Upper Triassic occurs only in the eastern Mecsek, on other parts of the region it is missing, in all probability, never formed either. Its facies is fluviatile, paludal middle size grained and coarse grained flinty sandstone, with a continous transition toward lower Jurassic. This formation represents the entire upper Triassic. Geophysically, it is so intimately connected to Lower Lias, that the Jurassic sedimentation cycle can be regarded geophysically as starting hence.

Jurassic is known on a considerable part of the region. On the surface: in the perisyncline and northern overthrust belt of the eastern Mecsek, in the Villány Mts. and in the Máriakéménd – Bár Mesozoic range; in deep-drillings: Jurassic or at least certain stages of it are known on several sites of the eastern Mecsek (southern upthrust belt, Ófalu – Zsibrik overthrust belt etc.).

Lias in the Mecsek Mts. continously develops from Rhaetic, bearing sandy, marly *(gresten)* facies. In the Lower Lias paralic formations (e. g. coal seams), further (upper) pelagic, finer grained formations (e. g. the so-called *Gryphea* beds or covering marl and the covering sandstone) settled. Still higher the facies becomes more and more carbonate, it shows more and more pelagic and oceanic (deep sea) marks. The subsidence and sedimentation passed from the western to the eastern Mecsek in the Upper Triassic-Lias. Upper Triassic-Lias may be assumed also to the north and west of the Mecsek, although thinned out. It was probably even eroded on several places. Then Dogger and Malm (predominantly) carbonates follow and the Jurassic ends in the eastern Mecsek with Tithon limestone. Its entire thickness exceeds 3000 m.

In the Villány Mts., the Jurassic starts with the Bath stage unconformably settling upon Ladinian dolomite. The formation starts with neritic facies and slowly changes to pelagic one. Its thickness is a few tens of meters. This Villány facies is petrographically similar to the corresponding Mecsek one, but differs in fauna.

The Aalènian cherty, *Crinoidea*-limestone in the Máriakéménd – Bár mesozoic range is petrographically and faunistically Mecsek type, although structurally it ought to be Villány type. This must have a paleogeographical explanation: namely, the Jurassic (Aalènian) transgression reached the area from the direction of the Mecsek, but never reached the Villány area. In the Bath stage the South-Baranya crystalline ridge already formed a dam between the two areas, the same way as in the Permian.

Cretaceous is known both in the eastern Mecsek and in the Villány Mts. In the eastern Mecsek, cretaceous limestone continues the white Tithon limestone which terminates the Jurassic. The limestone soon (in the Lower Valanginian) changes to calcareous marl.

The quiet sedimentation of the Valanginian stage was soon upset by the most important *volcanic activity* of the region: the basic diabase and phonolite

process, centering in the eastern Mecsek. Its products are: lavas, agglomerate, and tufite. The forms of its bedding: lava-covers and ramifying veins interweaving almost the entire perisyncline and northern overthrust belt (see: natural coke).

In the upper part of Valanginian and in the Hauterivian, clastic rocks and biogenic limestones settled. The thickness of the Cretaceous in the eastern Mecsek is about 200 m. No further members of the Lower Cretaceous sequence is reported from the Mecsek. In the Upper Cretaceous (Cenoman), however, *Globotruncana*-bearing calcareous marl developped.

The latter terminates the Mesozoic sedimentation in the Mecsek Mts.

On the Villány Mts. area (including the outcrops at Beremend and Kistapolca), in the lower part of the Valanginian, terrestrial conditions prevailed. In consequence, a few meters thick bauxite deposit was formed on the Karstic surface of the Tithon limestone. Upon this, biogenic limestone and marl formation (of secondary importance) settled, covering the entire range of the Lower Cretaceous. Its thickness is estimated at 300 m and no younger Mesozoic formations are reported from the Villány Mts. Traces of Lower Cretaceous diabase volcanic activity can be found also here, although only in veins (Turony, Diósviszló, Bár).

The Cretaceous fauna of the Mecsek is not identical with that of the Villány Mts., that means, that the dam between the two basins may have existed in the Cretaceous, too.

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Having passed through the enumerated formations, now all possible members of the basement-complex of the Neogene sedimentary rocks present themselves to our view. The stratigraphical and petrographical units specified may constitute the floor of the Neogene basin, i. e. the basement of the Neogene sedimentary cycle, — in consequence of the frequently repeated tectonical movements — practically in any lateral and vertical arrangement.

From this time on until as far as the Middle Miocene Helvatian stage, no lasting sedimentation took place in the region.

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Toward the end of the Lower Cretaceous in consequence of the *Austrian*, further on of the *Laramie* phases of *Alpine orogeny*, the two basins of sedimentations folded into mountains and were elevated. The process was not of geosyncline character, but a similar performance of an unstable zone within a so-called "internide mass" ("internide mass" of the Alpine-Carpathian orogenic belt). It was this time, that the anticline of the western Mecsek, the perisyncline of eastern Mecsek and the southward-dipping syncline-character overthrust belt range of the Villány Mts. took shape.

Of the numerous smaller or greater tectonical effects, which befell the region, this was the strongest and most important one in shaping the fundamental structural pattern.

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In the *Paleogene*, sedimentation is thought to have been interrupted; is started no sooner again than in the Neogene, on the margins of the newly built mountains.

Neogene sediments will be summed up shortly since they are nothing else but the cover of the basement, the latter forming the primary task for geophysical investigations. Nevertheless, they are not indifferent for us, for they affect both artificial and natural physical fields. Moreover, in the margins of the region (e. g. locality Sellye) Neogene sediments reach such a thickness as makes them suitable to accumulate oil, which is one of the most important minerals of our Neogene formation. This mineral and the possibility of its traps is, however, of secondary importance in our region, therefore nothing more but a rough sketch will be given of the Neogene.

The Neogene is of general occurrence in the region, namely on the margins of the mountains and between the mountains. The Neogene sedimentation cycle starts in the Middle Miocene Helvetian stage, with variable grain size fluviatile clastic sediments, in the floor of the present basins north from the Mecsek Mts. The facies changes to marine as early as in the Helvetian itself, but without the change of the clastic character. In the Tortonian stage the flooded area widened; a considerable part of the South-Baranya ridge was inundated. Chiefly *Leitha*-limestones and sandy-clayey beds were deposited. In the Sarmatian stage, coarse limestone on the mountain-margins and clayey, marly facies in the open basins prevailed.

The Miocene of the region is characterized in general by the fact, that the grain-size decreases from floor to top, and the clastic sedimentation is – to a certain extent – replaced by biogenic one. A local facies is the Tortonian fresh-water lignite-formation of Hidas (see details later in chapter 25.1). The topography, rather rough in the beginning, became more and more mature.

From the Lower Helvetian on, until the Sarmatian, several banks of rhyolite-dacite tuffs and tufites are known. In the Upper Helvetian, an andesite-eruption occurred in the surroundings of Komló.

At the end of the Sarmatian stage, the intramontane basins started a comparatively sudden sinking (as well as the entire Hungarian basin did). In the Pannonian stage, we find the clastic sediments of the Pannonian landlocked sea in large extension. The filling up of the basin kept pace with subsidence and so, in the open sea-basins, a rather thick, fine-grained, *lenticular* Lower and Upper Pannonian formation was established.

Toward the end of the Pannonian stage, Permian-Mesozoic strips started to rise, and up to the Pleistocene still a considerable erosion took place. The complete thickness of Neogene can substantially exceed 1000 m.

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After the Lower-Pannonian substage violent *tectonical movements* worked and shaped such structural forms as are characterized even by overthrusts. If was then, that the Mecsek Mts., in the North and in the Southeast slid upon Pannonian strata.

After the Pannonian, the entire region rose high and dry and, although tectonical movements are known even in the Pleistocene, — the geographical, geological and structural pattern of today was essentially finished.

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Neither the Mecsek nor the Villány Mts. are of geosyncline origin; they are not orogenetic mountains. Both are parts of the Paleo-Mesozoic mass constituting the floor of the Hungarian basin. This basinfloor, having attained a certain isostatic equilibrium by its last subsidence within the orogenic arch of the Carpathian chain, now is situated with its rough topography, under the young Tertiary sediments, as a so-called "internide mass". The floor of the Hungarian basin consists of strips similarly to that of our region. What refers strips of the latter (namely, that some of them terminate within the region, i. e. within a rather short distance), may be considered as an expedient concept in judging the structure of the Hungarian basin as a whole. Some of the strips of the two mountains cross the east border of the region and have some part in the floor-structure of the southern Lowland (Kiskőrös, Madaras, etc.). The Mecsek has a stratigraphical relationship even as far as in Transylvania (Persány Mts.). This, howewer, does not mean an uninterrupted Mecsek-type strip ranging as far as that.

The Earth's crust in Hungary is thickest exactly in our region: 26 — 27 km (against the average 24 km), but even so it is far thinner than the world-average (30 — 35 km).

11 A BRIEF SUMMARY OF THE PROSPECTINGS IN THE REGION

The most important mineral deposits of the region are: the Lias coal of the Mecsek, the Permian sandstone containing radioactive minerals, and the Cretaceous bauxite of the Villány Mts. (Nagyharsány).

Beside these, recently there is knowledge about an Upper Seisian-Lower Campilian anhydrite and gypsum formation of large extent, though at present under no exploitation. At the contacts of the diabase-bodies and Jurassic limestones, some shoddy limonitic iron-ores are known. The coal deposits are paralic, intra-formation type ones, the Permian sandstone and the bauxite are terrestrial sedimentary rocks, the anhydrite-gypsum formation is of shallow-water, lagoon origin.

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Ancient records bear testimony that the firstly exploited mineral deposit of the region was iron ore. According to a contemporary charter, King Stephen I (The Saint), as early as at the beginning of the 11th century, donated 20 "iron diggers" (iron ore miners, to wit) to the Benedictine Abbey of Pécsvárad, in order to dig out the iron ore of the "Monte de Ferreo". We are awere of the fact, too, that also later, through Middle Ages, several forges were in operation at Pécs.