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LEGEND FOR GEOLOGICAL MAPS AND THE BRIEF DESCRIPTION OF FORMATIONS

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Produced in the framework of the collaboration between the Stratigraphic Commission of Hungary and the Uniform Hungarian Geological Map System (EOFT)

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PREFACE

This issue can partly be regarded as a gap filling work. This shows the present stage of our knowledge on geological formations. This contains the uniform legendary key system which can be applied for the Hungarian Geological maps of all regions (*Part I: The legend of Geological maps*). This work is important because in the last decades even those maps contained legendary keys with very different styles, resolution and content which were complied by the Hungarian Geological Institute which was the basis of geological mapping.

The aim of compilation of this volume was to process uniform geological legend system. During the last 10-15 years the Quaternary formations were classified based on genetic relationships whereas in case of older beds the mapping based on the Formation system both in the Hungarian Geological Institute and in other literature. The processed legend system reflects this approach. Thus demand has risen for the uniform presentation of them and their geological content. The presentation of Quaternary formations is based on the unpublished mapping guideline complied by *Miklós Kaiser*. The Stratigraphic Commission of Hungary (MRB) has collected the data for years for the description of the Hungarian Formations, but uniform, extensive study has only been published about the Triassic period. In case of certain chronostratigraphic units this compilation work is in an advanced stage, in other ages it is only in clarification stage. This work presents the description of all the accepted older than Quaternary formations. Furthermore, even those well-known formations are presented which are not accepted yet but we propose them. The brief introductions for the formations were collected by *Géza Császár*, the director of MRB (*Part II: The Brief description of Formations*).

At the end of the second part the older than Quaternary formations are presented in alphabetical order with their code. After this the present system is described in details by overview tables which are divided by age. These tables are the simplified versions of those were complied by the sub-commissions of Stratigraphic Commission of Hungary, with the exception of the Quaternary formations (*Appendix*). We have to emphasize that the system is not closed and rigid, it can be changed and should be changed by the new ideas, by the acceptance and infiltration of existing but non-accepted knowledge.

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I. The legend of Geological maps

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INTRODUCTION

A new project started in 1992, in the Hungarian Geological Institute for the standardization of the Hungarian Geological maps (Uniform Hungarian Geological Map System - EOFT). The aim of the project is to produce uniform maps with uniform legendary key system in two scales:

– in mountain areas 1: 25 000
– in hilly and flat areas 1:100 000

The maps with scale of 1:25 000 are produced in covered (reconnaissance and covered) and if it is possible in uncovered versions.

These maps are gradually digitalized so they can later be corrected, moreover they can always be turned in up-to-date version.

Both larger and smaller scale maps can be complied with this legend system, later ones from the previously mentioned base maps (partly as the base material of those maps). One of the basic conditions is to produce a uniform legendary key system for them. Hopefully this new system can be used for maps of any scales.

The legend system for Quaternary formations have ***genetic basis*** (for this, the system worked out by the Little Hungarian Plain division of the Geological Institute was taken into consideration mainly; this system was complied by *Síkhegyi, F.* and *Scharek, P.*). In case of the map symbols (codes, indexes) shorter, simplified indexes are proposed, as they sometimes are too long for illustrations in the maps. (The most frequent short indexes are given in tables.)

In case of the older than Quaternary formations the legend system worked out by the Stratigraphic Commission of Hungary (MRB) was used as a basis and this was partly modified. This legend system bases on the ***Formation system*** (*Császár, G.* 1991: The Hungarian lithostratigraphic units ad their symbol system — Stratigraphic Commission of Hungary, Hungarian Geological Society). Certainly it is possible that there is no group for certain formations even in this system so they cannot be ranked into any of the accepted formatios. In these cases either genetics or petrography-based indexes can be used. During time both the age and the name of the formation can be changed. In case of the formation names mainly those proposed by the MRB are accepted which can be influenced by the results of the mapping (and if it is necessary they can be changed). In case of age determination we should decide based on the available dataset and if it is necessary the age of the formation can be modified.

The basic symbols should be completed with the abbreviations of rock types (mainly in case of the larger scale maps). In this legendary key system we have not made an effort to have it complete, we give the possibility for the local geologists to create the appropriate legend for the less frequent formations. In these cases it is necessary to report and collate the new symbols with the responsible person of the EOFT to avoid the possible coincidence.

METHODS FOR DELINEATION OF GEOLOGICAL FORMATIONS

The formations can be delineated (indicated) in three ways in a geological map. The most important is the geological index or symbol (code) of the formation which defines the area the most accurately, in function of the scale and resolution of the map. The coloring of the map is very important, it raises its graphic quality. Finally, if it is necessary we can complete the previously mentioned legend with superficial symbols.

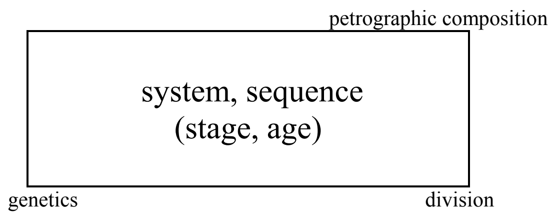
In this legendary key system we mainly focus on the possible forms of geological indexes, in case of coloring and superficial symbols we try to provide guidelines.

THE GEOLOGICAL INDEX (EOFT SYMBOL)

The form of geological index (EOFT symbol)

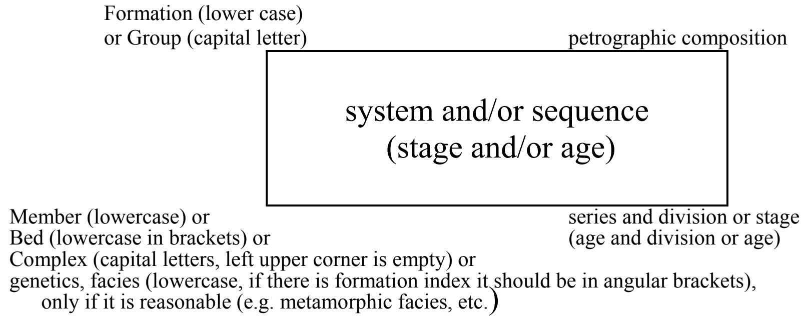
The middle part of the index is the so-called main index which represents the geological age (chronostratigraphic unit). The data which refines this age are in the lower right part of the index, whereas further information indicated in the other three corners of the index, based on the followings:

In case of Quaternary formations (without ranking into formations)



e.g.: ${}_{fl}Qh_2^m$, ${}_{f}Qh_1^h$, ${}_{fe}Qp_3^h$, ${}_{e}Qp_3^l$, ${}_{f}Qp_3^k$, etc.

Older than Quaternary formations (ranking into formation system)



e.g.: ${}^{f}T_3$, ${}^{m}Ol_2^{k}$, ${}^{r}Mb_2$, ${}^{b}E_3$-Ol_1, ${}^{G}K_{1\text{-}2}$, ${}^{h}{}_{z}T_1$, ${}^{p}{}_{(n)}K_2$, ${}_{M}Pz$, ${}^{f\text{-}d}T_3^{m}$, ${}^{ta}Pa_2^{\beta t}$, ${}_{eld}Ol^{x}$, etc.

The content of the geological index (EOFT symbol)

Left upper index

Formation (Fm) — lowercase

This symbol contains one or two lowercase letters from the name of the formation (if it is possible the initials). This symbol can be used the most consistently in the Mesozoic and Paleogene (e.g.: ${}^{d}T_3$). In case of the Paleozoic formations the exact age and/or metamorphic grade determinations cause the major problems (e.g.: ${}^{l}O$-D). In the Cenozoic from the Miocene times the deviations from the standard chronostratigraphic scale makes the system very complicated (For the Quaternary formations the existing formations cannot be used well for mapping, so that we do not suggest to use them. This is replaced by indexes based on genetic classification).

The transitional beds of two formations can be indicated by combining of the symbols (e.g.: ${}^{m\text{-}t}Ol_2$, if one of the formations is older the symbol of that will be indicated first: e.g.: ${}^{f\text{-}d}T_3$).

Group — Capital letters

This stratigraphic category is the general name of those formations which stratigraphically, genetically and petrologically related to each other. At this present this category is only used in several ages (undivided Paleozoic, Triassic, Jurassic, Cretaceous, Pannonian – e.g.: ${}^{G}K_{1\text{-}2}$, Gerecse Group, ${}^{M}T_2$ Misina Group etc.). The establishment of further Groups would be reasonable (e.g.: in the Jurassic and for the demonstration of further stratigraphic analogies in the Triassic, etc.).

Left lower index

In case of Quaternary (sometimes older) formations — abbreviations indicating genesis (facies)

a	anthropogenic formation
b	marsh deposit
d	deluvium
e	eolic deposit
el	eluvium (local debris)
f	fluvial (lacustrine) sediment
g	colluvium in general (deluvial deposits, rarely debris, slump, solifluction sediments)
l	limnic sediment
o	cave debris
p	proluvium (sediments of periodic streamlets)
s	sediments produced by slumps and slides
sz	solifluction sediments
x	chemogenic sediments (alkaline soil)
c	terrestrial sediments, in general
m	marine sediments
v	volcanic formations

In case of those formations which are characterized by complex genetics, composite abbreviations were made e.g.:

lb	lacustrine – marsh sediments
fe	fluvial – eolic formations
fl	fluvial – lacustrine sediments

Older than Quaternary formations

Indexes for lithostratigraphic units smaller than Formations:

Member (lowercase, as left lower index)

e.g.: ${}^{b}{}_{n}T_2$ — Buchenstein Fm, Nemesvámos Mb

(form, written by word processor: ${}^{b}{}_{n}T_2$)

Bed (lowercase, as left lower index)

e.g.: ${}^{p}{}_{(n)}K_2$ Pénzeskút Fm, Nána Bed

(form, written by word processor: ${}^{p}{}_{(n)}K_2$)

Indexes for lithostratigraphic units larger than Formations:

Complex (capital letters, in this case the left upper index is empty) as a larger stratigraphic unit than Formation

e.g.: ${}_{BB}Pz$ Babócsa C.

For expression of genetics

In case of the older than Quaternary formations the genetic classification or facies is not indicated when the formations are ranked into official stratigraphic units. We can indicate it only in that case if we would like to particularly emphasize it. Besides this we can indicate the genetic term in those cases if the older formation cannot be ranked into any of the formations or into other officially accepted formations. Here we present our suggestion for the volcanic and metamorphic facieses.

Volcanic facieses:

vf	*Superficial facies* (volcanic s. str. edifice)	
vff		effusive subfacies: lava flow, lava field
vft		extrusive subfacies: domes, breccias
vfx		explosive subfacies: tuff, agglomerate
vk	*Conduit facies:* lava, breccia	
vs	*Subvolcanic facies:* laccolites, stocks, dykes etc.	

Major ***metamorphic facieses:***

kp	*blueschist (glaukophaneschist)*
zp	*greenschist*
am	*amphibolite*
gr	*granulite*
km	*contact facieses*

Other indexes related to metamorphism:

am	*anchimetamorphic* (zeolite, prehnite-pumpelleyite facies)
dm	*dinamometamorphic* (cataclasite, milonite)
mg	*migmatite*

For the **non-official division** of stratigraphic units Arabic numbers can also be used temporarily (e.g. in maps instead of member), until the "official" stratigraphic division is decided. E.g.: ${}^{m}{}_{1}Mb$, ${}^{m}{}_{2}Mb$ – Mátra Andesite Fm, lower or upper stratovolcanic complex.

Right upper index — for indication of modal composition (in any ages)

Comments:

– The symbols indicating rock compositions can be joint to any of the formation indexes or genetic symbols depending on the scale of the map. E.g.: ${}^{so}Pa_2^{h}$, ${}_{f}Qp_2^{k}$.

– In case of those indexes built up by more letters hyphen is used between them if the given abbreviation is already in use for another formation. E.g.: al: silt (aleurite), a-l: clayey loess.

– In case of the common presence of more rock types comma divides the abbreviations. E.g.: ${}^{m}Ol_2^{a,h,k}$ – Mány Formation (clay, sand, pebble).

– The enumeration of abbreviations is not complete, if it is necessary new symbols can be used in any of the symbol groups, but these should be discussed with the responsible person of the EOFT.

– If inside one stratigraphic unit, in case of the same lithology, further division is necessary but it does not mean change in the sequence, can be solved by a number after the abbreviation of the rock name. E.g.: ${}^{p}J_1^{m1}$, ${}^{p}J_1^{m2}$.

a/ Loose sedimentary rocks (+ chemogene and biogene rock types either)

If we do not want to separate the coherent rock types these abbreviations can also be used for them.

a	clay (in less detailed division clay marl or silt, also)
al	silt (aleurite)
l	loess
h	sand
k	gravel (in less detailed division sandy pebble, pebbly sand, also)
y	debris
b	block, boulder
t	peat, muck
be	bentonite
at	alginite
c	coal, carbonaceous clay, lignite
x	bauxite, bauxitic clay
di	diatomite
ka	kaoline
v	bog iron
n	humid soil
pt	paleo soil
f	land fill
mh	mine dump
sz	communal waste, waste deposit
etc.	

The previously mentioned symbols and further ones can be used jointly. E.g.:

hl	sandy loess
lh	loessy sand
a-l	clayey loess
h-k	sandy pebble

b/ Coherent sedimentary rocks

ag	claystone
au	aleurolite
hk	sandstone
kg	conglomerate
br	breccia
r	silicic sediments, radiolarite
gi	gypsum, anhydrite

c/ Carbonate deposits (and carbonate+pelitic transitional rocks)

m	limestone
mi	calcareous mud
mm	calcareous marl
mg	marl
am	clay marl

d	dolomite
dm	dolomite marl (dolomarl)

d/ Igneous rocks

Major rock types:

λ	riolite
ζ	dacite
α	andesite
τ	trachite
β	basalt
ϕ	phonolite
γ	granite
δ	diorite
ν	gabbro
σ	peridotite, pyroxenite
etc.	

Supplementary rock types:

pe	perlite
ho	pumice
etc.	

Dyke types:

π	porphyre, porphyry (e.g.: γπ)
a	aplite (e.g.: γa)
q	quartz, quartzite
etc.	

e/ Piroclastites

t	tuff (e.g.: βt)
rt	surge tuff
st	welded tuff
agg	agglomerate (e.g.: αagg)
br	breccia of intrusive and extrusive rocks (e.g.: αbr)
tu	tuffite

f/ Hydrothermal rock types

ge — geyserite (e.g.:
qge — with silicic material,
mge — with calcareous material,
dge — with dolomitic material)

lq	limnoquartzite
hq	hydroquartzite

g/ Metamorphic rocks

me	meta (as attribute, e.g.: metabasalt meß)
má	marble
ap	schist

ph	phyllite
cs	micaschist
amp	amphiboleschist (amphibolite)
gn	gneiss
lf	leukophyllite
q	quartzite
st	serpentinite
z	greenschist
pf	porphyroid
etc.	

If it is necessary the geological index can be completed by patterns for the representation of late alteration or magmatic or metamorphic facieses.

Supplementary symbolals (only in large scale maps)

In case of **sedimentary rocks** color, cement, fossil content, etc., e.g.:

v	red	–>	va	red clay
t	variegated	–>	ta	variegated clay
p	pyritic	–>	phk	pyritic sandstone
m	calcareous	–>	ma	calcareous clay
tz	cherty	–>	tzm	cherty limestone
bi	bituminous	–>	bim	bituminous limestone
kr	crinoideal	–>	krm	crinoideal limestone
rd	radiolaritic	–>	rdap	radiolaritic shale
i	infusion	–>	il	infusion loess
s	alkaline	–>	sa	alkaline clay
etc.				

In case of **igneous rocks** e.g.: characteristic mineral phases, texture etc.:

p	pyroxene- (e.g.: pα)
a	amphibole-
b	biotite- (pl. bα, as composite bapα)
etc.	

f	fluidal
sf	spherolitic
s	serpentinized
μ	micro- (e.g.: micro-diorite μδ)

In case of **metamorphic rocks** e.g.: mineralogical attributes

al	albite-
m	calc-
d	dolo-
q	quartz-

b	biotite-
kl	chlorite-
di	disten-
gr	garnet-
an	anthracite-
gf	graphite-
etc.	

Major index (basic code)

This indicates the chronostratigraphic (geochronologic) classification in the level of system (era) or series (age) (e.g.: Triassic or Miocene etc.).

Standard symbols are (those in brackets are not shown in the legend): Q, (Pl), M, Ol, E, Pc, K, J, T, P, C, D, S, O, (Cm), (Pε)

Exceptions:
– *Pa: Pannonian s.l.* (Mpa + Mpt + Pl = Upper Miocene – Pannonian s. str. + Upper Pannonian – Pontian stages + Pliocene)
– *Pz*: symbol for contracted *Paleozoic* formations. Inside this the following divisions are possible:

Late Paleozoic: Pz_2: P, C

Early Paleozoic: Pz_1: D, S, O, (Cm)

Right lower index

This symbol is for the further division within the chronostratigraphic units, in the major index. This indicates series if the major index contains the abbreviation of system (e.g.: J_1 = Lower Jurassic), if the major index indicates series the further division of this can be carried out by a number or by the initial of the stage, in this later case in the same level as the major index (e.g.: E_3 = Upper Eocene, Mb = Badenian stage of the Miocene).

a/ Three-phase units:
1, 2, 3 (Lower, Middle, Upper-, or Early, Middle, Late): E, K, J, T, D, and O
Note: The Cretaceous is usually two-phase unit in the international literature and in some cases the Ordovician either. (The Hungarian division of the three-phase Miocene differ form the international one so that the division by stage names is used instead)

b/ Two-phase units:
1, 2 (Lower, Upper or Early, Late): Ol, P, C
Note: The Permian and a Carboniferous can be both three and two phase in the literature. (The indexes correspond to the two-phase division. The Permian table reflects the three-phase division either.)

Exceptions considering the major and right lower indexes

Quaternary:

Besides the major division of the Quaternary (Qp — Pleistocene; Qh — Holocene) further divisions ensure the complete legend system (Lower, Middle, Upper Pleistocene — Qp_1; Qp_2; Qp_3; ó- and New Holocene — Qh_1; Qh_2).

Tertiary:

For the Miocene and Pliocene (Neogene) the Hungarian geochronological division is a bit different from the international one (but it is accepted) and even from the regional Paratethys division. The Pannonian s.l. between the Sarmathian and Pleistocene can be correlated with difficulties in the international timescale and it is difficult to define for foreigners. However, for the preservation of the Pannonian concept the EOFT suggests a compromise legendary key system:

– Pa: Pannonian s.l.

Pa_2: Upper Pannonian = Mpt (Upper Miocene, Pontian) + Pl (Pliocene)

Pa_1: Lower Pannonian = Mpa (Upper Miocene, Pannonian s. str.)

– M: Miocene older than Pannonian

Ms (Sarmatian stage - Middle Miocene, partly Upper Miocene)
Mb (Badenian stage - Middle Miocene)
Mk (Carpathian stage – Lower Miocene)
Mo (Ottnangian stage – Lower Miocene)
Me (Eggenburgian stage – Lower Miocene)
Mer (the Lower Miocene part of the Egerian stage)

Three columns can be seen in the legendary key system of Neogene stratigraphic units from which the middle column corresponds to the previous suggestions. (Divisions inside stages is also possible.) Left of it the original key system can be seen which was suggested by the MRB, right of it those indexes are seen which would fit with the international standard. (Mer, Me, Mo, Mk = M_1 — Lower Miocene; Mb, Ms = M_2 — Middle Miocene; Pa_1 and lower part of Pa_2 = M_3 — Upper Miocene; upper part of Pa_2 = Pl — Pliocene).

Possibilities for shortened indexes

The following order is suggested in case of those tables completed by computers where the characters can be written only normal position (e.g.: in case of field names):

$^{f}T_{3}$	–>	fT3	$^{p}{}_{(n)}K_{2}$	–>	p(n)K2
$^{f\text{-}d}T_{3}{}^{m}$	–>	f-dT3m	$^{G}K_{1\text{-}2}$	–>	GK1_2
$^{r}Mb_{2}$	–>	rMb2	${}_{M}Pz$	–>	M_Pz
$^{b}E_{2}\text{-}Ol_{1}$	–>	bE2-Ol1	${}_{f}Qh_{1}{}^{h}$	–>	fQh1h
$^{h}{}_{z}T_{1}$	–>	h_zT1			

The brief forms of the indexes can be used in maps, if the content of the map is very dense or the index of the formation is too long so the printout of complete form of the index causes difficulties. In case of Quaternary formations this is the symbol of genetic and/or rock classification. If it is necessary the symbol of the age “Q” can also be dropped.

E.g.: ${}_{fe}Qp_3{}^{h}$ –> fe; ${}_{e}Qp_3{}^{l}$ –> l; ${}_{fl}Qh_2{}^{m}$ –> fl^{m}; ${}_{f}Qp_3{}^{k}$ –> ${}_{f}p_3{}^{k}$

In case of the formation index, if it covers two ages and the rock type is indicated either the following brief form is suggested: Formation symbol in normal position, rock symbol in upper position (this can be used inside one map sheet as the formation names have the same symbol in different ages).
E.g.: ${}^{p}Ol_2\text{-}Me^{hk}$ –> p^{hk}; ${}^{b}E_2\text{-}Ol_1{}^{mg}$ –> b^{mg}

In case of composite age the index can be too long. If the rock type is not indicated the age and period without hyphen is suggested for the brief index.
E.g.: ${}^{c}Ol_2\text{-}Me$ –> ${}^{c}OlM$ (Csatka Fm); ${}^{p}Ol_2\text{-}Me$ –> ${}^{p}OlM$ (Pétervására Fm);
${}^{md}J_3\text{-}K_1$ –> ${}^{md}JK$ (Mogyorósdomb Fm)

In case of those formations which had formed during two periods, but in the given area it formed only in one of them only the index of that one period should be used.
E.g.: ${}^{c}Ol_2\text{-}Me$ –> ${}^{c}Ol_2$

If the formation formed during more periods and the delineation of these periods is possible in the map, the abbreviation of the stage should be written in subscript.
E.g.: ${}^{f}T_3$ –> ${}^{f}T_{3k} + {}^{f}T_{3n}$

Further information on the indexes

During the geological mapping carried out by the MÁFI, certain changes became necessary in the lithostratigraphic division used before. A part of our suggestions has been accepted by the Stratigraphic Commission of Hungary (MRB), other parts of them have not been discussed yet. The applied, but officially not accepted symbols in the EOFT legendary key system are:
Indicated by *,
whereas the redundant, old names (accepted by MRB) are
[...] in brackets.
(...) in brackets, if the names have already been mentioned (e.g. in other periods or Groups) elsewhere and are only repeated.
— — — This symbol separates those stratigraphic units which build up different Groups.

COLORATION OF GEOLOGICAL MAPS

Considering the coloration of geological maps the possibilities are very different if we use pencil, paint or we color or stripe it by computer or the map was printed. So it is not necessary to give exact tones. For basic principle the combination of three coloration disciplines is suggested.

In case of the older than Quaternary formations (sedimentary, volcanic and anchimetamorphic rocks) the basic color represents the geological age based on the international color scale.

Basic colors of periods:

Neogene	yellow
Paleogene	orange
Cretaceous	green
Jurassic	blue
Triassic	purple
Permian	yellowish-brown
Carboniferous	gray
Devonian	brown
Silurian	pale grayish-green
Ordovician	olive-green
Cambrian	dark bluish-green
Proterozoic	heliotrope
Archaic	pink

Certainly it is possible to deviate from these basic colors if there are no enough tones for the indication of the different rock types in one age.

In case of the intrusive, subvolcanic and strongly metamorphic formations the color indicates the composition. The further division of these formations can be solved by different tones. We consider the rock type to be strongly metamorphosed or metasomatized if the original rock type cannot be recognized. The uncertain igneous bodies, conduit filling material, volcanic or subvolcanic/intrusive rocks, should also be colored based on their composition. For these we do not intend to give exact colors, this should depend on the coloration of the map. (In case of igneous bodies red is used for the acidic rocks, green for the basic ones whereas purple for the ultramafics.)

In case of the Quaternary formations the colors indicate genetic types. We suggest the use of pale colors in order to distinguish them easily from older formations. The colors suggested for the genetic types:

f	fluvial	pale blue
l	limnic	blue
b	marsh	turquoise
e	eolic	yellow
el	eluvium	purple
d	deluvium	yellowish brown
p	proluvium	pale green
a	anthropogenic	pale gray

In case of those formations having complex genetics, the formation gets that color which indicates the dominant genetic relationship.

THE USE OF SUPERFICIAL SYMBOLS

The colored or black and white superficial symbols are only used if they help to understand the map. The composition and/or facies characteristics of the given formation is indicated, filling the patches of the formations, in the map. It is practical if the orientation of the superficial symbol follows the original structural directions of the formation if it can be established.

In case of *volcanic* formations the superficial symbol helps to separate the elements of the volcanic edifice. For example radial or concentric mockup is drown around the volcanic center. The compositional characteristics are reflected in the color, and/or shape of the scattered superficial elements.

In case of the *subvolcanic and intrusive* bodies the superficial symbols indicate the facial characteristics, i.e. grain size, composition, texture etc. Besides these, by the proper chose of graphic look of the symbol the original structure can also be indicated.

In case of *metamorphic* formations the superficial symbols should predominantly indicate the composition. (In anchimetamorphic rocks the symbols should indicate the original characteristics, predating metamorphism, whereas in case of the strongly metamorphosed rock types the secondary characteristics after metamorphism.) On the other hand if it is possible they should reflect the metamorphic structure (predominantly the schistosity by the direction of the superficial symbols) as well as the metamorphic facieses.

The *contact metamorphic* zones are indicated by colored dot lines. Depending on the strength of metamorphic grade the possibly red dots are situated close or rarely.

The *metasomatic* features (skarns, greisens, secondary quartzites) are indicated by colored superficial symbols.

The *slightly metasomatized* formations should be indicated in accordance with the base color of the strongly metasomatized ones. We suggest to distinguish them by strong colored superficial symbols (dots).

THE INDEXES OF FORMATIONS ACCORDING TO THEIR AGES

QUATERNARY FORMATIONS

In the followings, the most frequent basic indexes are presented, which can be completed with the symbol of the rock types in the function of our geological knowledge and the scale of the map.

New indexes can be created from the basic indexes based on genetic relationships and rock types, if it is necessary.

As a brief index usually the genetic (rarely petrologic) index is suggested in that period where the formation occurs most frequently.

Name of the formation	complete code	suggested brief code
Artificial (anthropogenic) formations	a	–
fill	a^f	–
mine dump	a^{mh}	–
communal waste (garbage)	a^{sz}	–

HOLOCENE (Qh)

NEW HOLOCENE (Qh_2)

Name of the formation	complete code	suggested brief code
Fluvial formations (alluvium usually, if it can be distinguished: shallow floodplain)	$_fQh_2$	$_fh_2$
Moving sand (it moves presently)	$_eQh_2^h$	$_eh_2$
Marsh deposits	$_bQh_2$	b
Lacustrine marsh deposits	$_{lb}Qh_2$	lb
Fluvial-deluvial sediments (mixed)	$_{fd}Qh_2$	fd
Fluvial marsh deposits formed in river valleys	$_{fb}Qh_2$	fb
Fluvial–proluvial formations of rivers and periodic streamlets	$_{fp}Qh_2$	$_{fp}h_2$
Calcareous mud, lacustrine lime	$_lQh_2^{mi}$	h_2^{mi}
Fluvial–lacustrine formations of valleys	$_{fl}Qh_2$	fl
Meadow limestone	$_{fl}Qh_2^m$	fl^m

Marsh peat, muck, mould	$_{b}Qh_2^{t}$	b^{t}
Alkaline formations	$_{x}Qh_2^{s}$	x^{s}
EARLY HOLOCENE (Qh_1)		
Fluvial deposits (high floodplain)	$_{f}Qh_1$	$_{f}h_1$
Fluvial-proluvial formations	$_{fp}Qh_1$	$_{fp}h_1$
Fluvial-deluvial formations (mixed)	$_{fd}Qh_1$	$_{fd}h_1$
HOLOCENE, in general (Qh)		
Fluvial deposits (shallow and high floodplains contracted)	$_{f}Qh$	$_{f}h$
Travertine deposited in streamlets	$_{f}Qh^{m}$	h^{m}
Fluvial-eolic sand	$_{fe}Qh^{h}$	fe^{h}
Rock fall sediments (debris)	$_{o}Qh$	$_{o}h$
Slide, slump sediments	$_{s}Qh$	$_{s}h$
PLEISTOCENE–HOLOCENE (Qp-h)		
Fluvial-proluvial sediments of rivers and periodic streamlets	$_{fp}Qp_3$-h_1	fp
Colluvium, in general	$_{g}Qp_3$-h	g
Pl.: slope debris		g^{y}
Deluvial formations	$_{d}Qp_3$-h	d
E.g.: slope loess with debris		d^{yl}
redeposited, bauxitic-clay		d^{x}
Local, slightly redeposited debris (eluvium-deluvium)	$_{eld}Qp_3$-h	eld
Proluvial-deluvial sediments of dry valleys	$_{pd}Qp_3$-h	pd
Fluvial-deluvial sediment (mixed)	$_{fd}Qp_3$-h	$_{fd}p_3$-h
Moving sand	$_{e}Qp_3$-h^{h}	e^{h}

PLEISTOCENE (Qp)

UPPER PLEISTOCENE (Qp_3)

Fluvial formations (terrace, alluvium)	$_fQp_3$	$_fp_3$
Formations of terrace II.	$_fQp_{3IIa}$	p_{3IIa}
Fluvioeolic sand	$_{fe}Qp_3^h$	fe
Eolic formations:		
loess, slope loess	$_eQp_3^l$	l
sandy loess (partly deluvial)	$_eQp_3^{hl}$	hl
loessy sand (partly deluvial)	$_eQp_3^{lh}$	lh
moving sand	$_eQp_3^h$	$_ep_3$
Slope sediments	$_gQp_3$	$_gp_3$
e.g.: — slope clay		$_gp_3^a$
Solifluction sediments	$_{sz}Qp_3$	
Loess, slope loess (if the deluvial character is dominant)	$_{ed}Qp_3^l$	l
Proluvial formations of rivers and periodic streamlets	$_pQp_3$	p
Travertine	$_lQp_3^m$ $_{fl}Qp_3^m$	p_3^m

MIDDLE AND UPPER PLEISTOCENE ($Qp_{2\text{-}3}$)

Fluvial formations (terrace, alluvium)	$_fQp_{2\text{-}3}$	$_fp_{2\text{-}3}$
Formations of terrace II.b	$_fQp_{2\text{-}3IIb}$	$p_{2\text{-}3IIb}$

MIDDLE PLEISTOCENE (Qp_2)

Fluvial formations	$_fQp_2$	$_fp_2$
Formations of terrace III	$_fQp_{2III}$	p_{2III}
Formations of terrace IV	$_fQp_{2IV}$	p_{2IV}
Travertine	$_lQp_2^m$ $_{fl}Qp_2^m$	p_2^m

LOWER AND MIDDLE PLEISTOCENE ($Qp_{1\text{-}2}$)

Terrestrial variegated clay, red clay	$_{eld}Qp_{1\text{-}2}^{ta,va}$

LOWER PLEISTOCENE (Qp_1)

Fluvial formations	${}_fQp_1$	${}_fp_1$
Formations of terrace V	${}_fQp_{1V}$	p_{1V}
Formations of terrace VI	${}_fQp_{1VI}$	p_{1VI}
Travertine	${}_lQp_1{}^m$ ${}_{fl}Qp_1{}^m$	$p_1{}^m$
Slope sediments	${}_gQp_1$	${}_gp_1$
e.g.: red clay		${}_gp_1{}^{va}$
Bentonite	${}_{eld}Qp_1{}^{be}$	be
Basalt	${}_vQp_1{}^{ß}$	$p_1{}^{ß}$
Basalt tuff	${}_vQp_1{}^{ßt}$	$p_1{}^{ßt}$

PANNONIAN s. l. – PLEISTOCENE (PLIOCENE–PLEISTOCENE)

Geyserite	${}_vPa_2$-Qp^{ge}	Pap^{ge}
Salgóvár Basalt F. (see at Pannonian form.)	${}^{sv}Pa_2$-Qp_1	${}^{sv}Pap_1$

FORMATIONS OLDER THAN QUATERNARY

In case of these formations the legendary key only contains the symbol of formations of higher level stratigraphic units. The symbols of members or beds are only indicated if our present knowledge allows it. These certainly should be completed by the symbols of petrologic characteristics if the scale and/or type of the map allows it.
For example: $^{bö}{}_{k}T_3{}^{d}$, $^{d}{}_{f}T_3{}^{m}$, $^{c\text{-}m}Ol_2{}^{a,h}$, $^{t}Ms^{mhk}$, $^{so}Pa_2{}^{h,a}$

In case of the members and beds we give those forms which can be complied by word processor. The form which should be used in maps are shown in *page 13*. ($^{bö}{}_{k}T_3$ –> $^{bö}T_3$).

Our suggestions are indicated by bold letters if the symbols are different from those suggested by the MRB (the symbols of members and beds were not indicated in the MRB legendary keys).

PANNONIAN s. l. (UPPER MIOCENE — PLIOCENE)

Based on the recent base point of the MRB the former Groups of the Pannonian s. l. (Heves, Csongrád, Little Hungarian Plain, Somogy, Jászkunság, Maros, Kanizsa, Mura Groups) cancelled, so that the former Transdanubian and Peremarton Main Groups are described as Groups.

	MRB symbol (where it differs from the EOFT symbol)	**EOFT symbol**	Standard (international) symbol
Transdanubian Group	Pa_2	$\mathbf{^{D}Pa_2}$	$^{D}M_3\text{-}Pl$

OTHER SYMBOLS IN GEOLOGICAL MAPS

IN 1:25 000 SCALE (MOUNTAINUOUS) GEOLOGICAL MAPS

In covered versions

Bedrock

Debris

Formation borders covered by soil

Border of fluvial and marsh sediments in New Holocene

Fauna locality

Flore locality

Symbol and number of drill hole

Number of trench and pit

Working gate road

Abandoned gate road

Working mine

Abandoned mine

Cave

Karst object

In covered and uncovered versions

Facies border inside one formation

Measured stratal dip

Stratal dip (horizontal, vertical, overturned)

Stratal dip, strike determined from air photos

Direction of fluidal texture (in case of volcanites)

Cross-bedding

Cross schistosity, dip of schistosity

Faults, in general

Studied fault plains with dip directions

Determined assumed covered

fault

horizontal fault
(horizontal movement)

reverse fault, napple border

nappe, thrust plain

anticline axis

synclinal axis

direction and angle of anticline axis

rubbled zone

discordance

Elements of volcanic structure

General symbols

Settlement of the flow direction plane

flow direction

Special symbols in andesite volcanic fields

followed presumed

edge of caldera

edge of dome

contour of center

Special symbols in basaltic volcanic fields

Edge of crater

Eruption center

Covered version

Observed and established formation border

Assumed formation border

Line of geological cross section

Symbol and number of drill hole used for compilation

ADDITIONAL SYMBOLS FOR 1:100 000 SCALE (PLAIN AREA) GEOLOGICAL MAPS

Formation border

uncertain formation border

There are no other differences between the legendary key system of a 1:100 000 and 1:25 000 scale maps. Every other symbols can be used for the 1:100 000 scale maps on-demand.

II. The brief description of stratigraphic units

II.a Quaternary formations

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INTRODUCTION

The systematization of Quaternary formations bases predominantly on the genetic groups and petrologic composition of them, as it is wide spread in the international literature. In the following brief descriptions we mainly focus on the genetic basis and composite types. We specially emphasize the travertines and loess in which cases the composition is more characteristic than the different origin and formation environment. The stratigraphic units of Quaternary and the age of the major rock types is shown in appendix. The lower age limit of the Quaternary is 1.6 (or 1.8) million years in the international literature, but here we use the 2.4 million years suggested by the MRB.

THE DESCRIPTION OF QUATERNARY FORMATIONS BASED ON GENETIC TYPES

Anthropogenic formation (a)

This formation was accumulated by human activity. It is practical to distinguish the fills (a^{f}), mine dumps (a^{mh}) and communal waste deposits (both legal and illegal) (a^{sz}). In case of smaller scale they can be illustrated together (a).

Fluvial sediments (f)

The fluvial sediments were classified based on their ages and their compositions (grain size) in the legendary key.

The sediment group contains all the channel, floodplain, terrace and alluvium sediments with different structure.

Channel sediments are all the sediments which build up the bottom of the channel and the different banks. Their material is dominantly cross-bedded sand and pebbles (${}_{f}Qh_{2}^{k,h}$).

The *floodplain sediments* composed of an upwards-fining sequence. Their material is mainly composed of clay and silt, transported floated. Coarser fraction can only be found in the base of the sequence. In case of larger rivers, Early Holocene high (${}_{f}Qh_{1}$) and New Holocene shallow (${}_{f}Qh_{2}$) floodplain are distinguished. The first one is not or rarely affected by recent floods, only in case of extremely high water levels.

The material of the terraces is usually remnants of channel sediment. If it has floodplain origin it is mainly sand and pebble, as the finer fraction was eroded. The terraces are separated based on their ages (e.g.: ${}_{f}Qp_{3}$). If the structure of the terrace-system can be clarified, the certain terraces are indicated by roman numbers. In Hungary this system has been worked out for the Danube and its feeders (e.g.: ${}_{f}Qp_{3IIa}$, ${}_{f}Qp_{1VI}$). The terrace sediments are frequently covered by loess, moving sand and sometimes by travertine. Their characteristic thickness is 2 to 10 m.

In case of the alluvial fans we can distinguish several hundred meter thick deposits which filled up sinking basins (e.g.: Great and Little Hungarian Plains), and the local alluvium of smaller streamlets (e.g.: ${}_{f}Qp_{3}$). At the beginning of the sequence deposited by larger rivers bedded, cross-bedded pebbles and sand is characteristic which was settled as channel sediment. With the distance the material of the sequence becomes fine grained to sand- silt grain size, while the alluvial fan passes to bottomland basin fill sediments. The alluvial fan of smaller streamlets usually develops at the wing of larger valleys, frequently on the terraces of them. Their material is mainly unsorted sand, pebbles and debris. Their origin is mainly proluvial.

Inside the basin (e.g.: in the middle part of the Great Hungarian Plain) bottomland floodplain forms. These are characterized by silt, clay, rarely sand. Sometimes the enrichment of organic material is characteristic for the fine-grained fraction. In these cases a part of the sediments have fluvial-marsh origin.

Elevated, older alluvial fan can get into terrace position due to the etching of the river (e.g.: Kemeneshát, Győr-Tata alluvial fan - terrace).

Fluvial-lacustrine sediments (fl)

Those sediments can be ranked into this group which were deposited in the artificially closed passages of streamlet valleys with shallower gradient. The sequence is dominantly built up by silt, clay and sand occur in smaller quantities (${}_{fl}Qh_2$). The thickness of these sequences is usually several meters.

Fluvial-marsh sediments (fb)

This type of sediment occurs in slightly dipping, wide, alluvial valleys, in those sections where the runoff is weak. In shallow water level the marsh character, in higher water level the river character is stronger. The sediments dominantly composed of organic material - rich silt (pl.: ${}_{fb}Qh_2$). The thickness does not exceed several meters.

Fluvioeolic sediments (fe)

Its material is mainly sand, with thin seams of fine-grained pebbles (e.g.: ${}_{fe}Qp_3^h$). The deposited sediment indicates both the fluvial and eolic characteristics. Most of these kind of sediments occur in the NW edge of the Transdanubian Range. Its characteristic thickness is 5 to 10 m. Its age is Upper Pleistocene, rarely Holocene.

Fluvial-deluvial sediments (fd)

It is mainly deposited at the base of the slopes, in the valley wings following the valleys. High amount of deluvial sediment (washed off the slopes) mixes to the fluvial sediments. Its material is mainly sand and silt. Its age is mainly Early Holocene (${}_{fd}Qh_1$) and Pleistocene-Holocene (${}_{fd}Qp_3$-h). Its thickness is several meters.

Fluvial-proluvial sediments (fp)

It is deposited by rivers and periodic streamlets. Usually the sediments of those streamlets are ranked here of which water level changes strongly. It is composed of coarse debris (sand, pebble, debris). Its age is mainly Holocene and Upper Pleistocene (pl.: ${}_{fp}Qh_1$). Its characteristic thickness is several meters, but sometimes it can reach the 10 to 20 m.

Proluvium (p)

The proluvium is composed of the sequence of integrated fans deposited by torrents rushed down at the edge of mountain ranges. It is characteristic dominantly for arid or semiarid areas. This type of sediment had formed during the glacial periods (as periglacial formations) at the foreland of mountain ranges, in Hungary. Its material is mainly composed of coarse-grained, unsorted, sharp grains of non-rounded debris, but it can contain finer grained fractions either. The sequence can be bedded, sometimes cross-bedded, the materials with different grain size can be mixed (e.g.: $_{p}Qp_3^{y}$).

In a wider sense, all the sediments can be classified as proluvium which were deposited by episodic, periodic streamlets (in this sense it can be delineated even in the bottom of dry valleys). This later sense was applied during the homeland mapping. The thickness of these sediments can reach the 20-30 m.

Proluvial-deluvial sediments (pd)

These are local sediments deposited at the bottom of dry valleys. Larger amount of deluvial material is washed off the valley wings by periodic streamlets during the wet periods and snow melting. The deposited sediment is characterized by variable grain size, the valley filling material is usually silt, sandy silt ($_{pd}Qp_3$-h). The thickness of the sequence is several m.

Lacustrine sediments (l)

In the middle part of the lakes horizontally bedded, fine grained sediment is deposited (clay, silt) whereas in the shore line sand and pebbles also occur. Later ones can form cross-bedded sequence. The swell forms the banks (e.g.: $_{l}Qh_2^{h}$).

The loose, non-cemented calcareous mud, lacustrine lime (lacustrine chalk) ($_{l}Qh_2^{mi}$) and dolomite mud are also deposited in lakes.

The thickness of lacustrine sediments is usually several m.

Lacustrine – marsh sediments (lb)

This type of sediment is deposited in periodically flooded, filled lakes. It is composed of fine-grained sediments (silt, clay) containing organic material. It is usually Holocene, in age (e.g.: $_{lb}Qh_2^{a}$).

Marsh sediments (b)

These sediments are characterized by different organic material content. Their material can be clay (meadow clay, marsh clay), silt, moreover peat originated from the decomposition of organic material, muck and mould. These later ones can be separated from each other based on the degree of degradation. In the peat the remnants of plants can be recognized whereas in the muck they are completely absent. The mould forms from the peat, with the strong humification of plant remnants. To this substance water and eolic material are also mixed in higher amount. The mould is rather soil so it is delineated together with the peat and muck. The marsh sediment on the surface usually have New

Holocene age (e.g.: ${}_{b}Qh_{2}^{t}$). The characteristic thickness of these sediments is between 2 and 8 m.

Eolic sediments (e)

These sediments are not described overall, only by rock types. Major rock types are:

– Moving sand (h)

Sorted sand, moved by wind. The grains are rounded, the sand forms characteristic morphology (dunes, mounds, closed drainage, etc.). During mapping currently moving (${}_{e}Qh_{2}^{h}$) and bound (${}_{e}Qp_{3}$-h^{h}, ${}_{e}Qp_{3}^{h}$) moving sand are distinguished. Its thickness can reach several tens of meters.

– Loess (l)

In case of its typical development the material is eolic silt, from which the loess forms by diagenesis. Eluvial, fluvial or gravity movement sediments can also mix to or intercalate with the eolic beds. The sequence is dominantly (45-60%) composed of silt, but contains sand and clay either.

Most of the Hungarian loess sequences are deluvially redeposited slope loess beds, but the loess fallen into water and the leached loess can also be separated. The typical (${}_{e}Qp_{3}^{l}$) and the slope loess (${}_{ed}Qp_{3}^{l}$) usually cannot be distinguished either horizontally or vertically, so they are usually outlined together during mapping (${}_{e}Qp_{3}^{l}$ –> with brief symbol „l"). The Holocene redeposited loess is classified as deluvial sediment.

The superficial loess deposits are usually Upper Pleistocene, in age. Older (Lower Pleistocene and Middle Pleistocene) loess occur only locally. In the thicker loess sequences paleo soil levels are also occur. The thickness of the loess deposits can reach the 50-60 m, in Hungary.

Major loess types:

Eolic (typical) loess (${}_{e}Qp_{3}^{l}$): Its color is grayish yellow, pale yellow. The sequence is usually unbedded, it has characteristic structure and forms. Its grains are covered by lime crust. Due to the gappy arrangement of the grains the structure of the rock is porous. The lime content of the rock is significant (10 to 30%), in case of stronger precipitation calcareous concretions can develop.

Infusion loess, loess mud (${}_{e}Qp_{3}^{il}$): The eolic dust deposited in water, or due to later water cover it was leached. It is more compact than the typical loess, its color is lighter, its lime content is less, its material could have mixed with fluvial clay, mud and sand. It occurs at the former floodplain of the rivers of the Great Hungarian Plain.

Clayey loess (loam loess, brown loess, brown soil, "glacial adobe") (${}_{e}Qp_{3}^{a-l}$): Due to the strong precipitation it is partly leached, it has relatively low lime content, it is more massive, brownish yellow, yellowish brown. A part of its material has been redeposited by slope processes. Instead of the earlier variable nomenclature we suggest the clayey loess name for them. This type of loess occur W of the Rába river and in Zala county.

Slope loess (${}_{ed}Qp_{3}^{l}$): A deluvially redeposited loess type found on slopes. It is bedded or unbedded, usually contains external material as lenses, nests, thin seams or sporadically.

– Sandy loess (hl), loessy sand (lh)

Transitional formations between the eolic sand and loess. In the sandy loess the amount of silt is higher, whereas in the loessy sand the amount of the sand. Frequently it is mixed with deluvial material. Usually this formation is Upper Pleistocene, in age ($_eQp_3^{hl}$, $_eQp_3^{lh}$, $_{ed}Qp_3^{hl}$, $_{ed}Qp_3^{lh}$).

Eluvium (el)

Weathered, loose, non-transported sediment. Usually it is degraded in a certain degree, the increasing amount of resistant material is characteristic in these sediments. It can rarely be delineated in itself, the thickness of it is several m.

Eluvial-deluvial formations (eld)

The eluvial formations and those deluvial ones which were redeposited by slight slope movements are delineated together as eluvial-deluvial sediments (e.g.: $_{eld}Qp_3$-h). Usually these beds are deposited on flat surfaces. The variegated clay (e.g.: $_{eld}Qp_1^{ta}$), red clay (e.g.: $_{eld}Qp_1^{va}$), or the weathering product of volcanic rocks (humid soil) ($_{eld}Qp_{1\text{-}2}^{n}$). The thickness of variegated and red clay beds can reach the 50-60 m (e.g. Tengelic Clay Fm).

Slope sediments (g)

Those sediments are ranked here which were redeposited by slope movements, dominantly by gravitation. Earlier it was called as colluvium either, but several authors consider only the slope debris to be colluvial. Usually it is characteristic that the sediment is not rounded, un-sorted and mixed or bedded according to the former or present slope environment. The slope sediments with different origin can be outlined together, in this case the "slope" attribute should be used e.g.: slope clay (deluvial and solifluction — $_gQp_3^a$), slope debris ($_gQp_3^y$), slope loess etc). Those types which can be delineated in themselves are: debris (fall of rocks) (o), deluvium (d), solifluction sediments (sz) and sediments of slides and slumps (s). Their thickness is very variable, usually several meters, but sometimes they can exceed the 10 m thickness, either.

– Sediments of rock falls (debris) (o)

Sediments of rock falls are the debris formed due to gravitational effects, rock falls, flake off phenomena of rocks, sliding debris, rock flow, the gravitational fans of gullets and the debris covering the slopes or the base of slopes. This later one can have solely fall origin, but in most cases other slope processes also affect their accumulation. Those sediments containing blocks or large debris (e.g.: $_oQh^b$) are separated from fine slope debris based on their grain size.

Characteristic features of this sediment type are that they are usually unsorted, furthermore that the grains are not rounded but confined by flat breakage plains. If the sediment contains pebbles those ones are redeposited from older formations. The fall of loose sediments (fall of soil) usually forms chaotically mixed aggregation.

Most frequently these sediments can be found at the base of steep basaltic and dolomitic walls (e.g.: $_oQp_{3\text{-}h}^y$).

– *Deluvium* (d)

Deluvial sediments are accumulated by water which destroys the slope regionally or by the wash off effect of melted snow. The formed sediment is usually mixed, rarely homogeneous. In case of mixed material external material is found sporadically or parallel to the slope as thin seams or beds, e.g.: debris or pebbles in slope loess ($_{d}Qp_{3}$-$h^{yl,kl}$), etc. Almost uniform can be for example the bauxitic clay ($_{d}Qp_{3}$-h^{x}).

– *Solifluction sediments* (sz)

It occurs only locally as small patches, it is usually practical to outline together with deluvial sediments (as slope sediments).

The recent sludge flow and soil flow are separated from the gleisofluction. This later one occurs when the pelitic rocks become wet and thus plastic. This sediment has different types. In most cases the wet sediment slides down very quickly or rarely very slow creep of the soil beneath the vegetation occur which cannot be observed on the surface. The sludge flow of former periglacial areas also occur. The cause of this later one is the variable pressure due to melting and freezing and the gravitation.

The developed sediment is fine grained (clay or silt) or unsorted (coarser fractions also occur in the fine grained matrix). Their structure can be amorphous, wavy bedded or irregularly thrusted. The presence of sack and flan-like structures are also characteristic (e.g.: solifluction clay — $_{sz}Qp_{3}^{a}$).

– *Slide (slump) sediments* (s)

These sediments form by the movement of rocks on wet, clay-bearing surfaces. It shows characteristic morphology. The sediment usually has variable composition and can be chaotically mixed, but inside certain large block can keep the original sedimentary structure. It occurs that the slumped beds dip against the slope (pl. $_{s}Qh$).

Chemogenic sediments (x)

The alkaline formations of the Great Hungarian Plain, furthermore the dolomite and bog iron can be ranked into this group. The characteristics of alkaline formations are the grayish, colloidal surfaces (amorphous SiO_2) ($_{x}Qh_{2}^{s}$).

In certain point of view the travertines and geyserites formed at volcanic fields are also chemogenic sediments, but they are described separately.

Travertine (super script: ^{m})

Travertines develop in lakes or sometimes in rivers due to chemogenic processes. In the genetic index the formation environment is shown, so that the travertine types with different origin can be separated. Its habit can be tetarata type (this can be regarded as fluvial-lacustrine sediment), in these cases the limestone crystallized on slopes of rivers or smaller lakes, in many cases above the base of erosion. The formation of small basins is characteristic for its edifice of which edges travertine bars develop (e.g.: $_{fl}Qp_{3}^{m}$). The traveritnes of the lakes form at the base of erosion. They develop in smooth environment, their bedding is usually parallel (e.g.: $_{l}Qp_{3}^{m}$). The spring limestones form around springs of rivers or at the upper section of small streamlets (e.g.: ${}_{f}Qh_2^{m}$). They have clearly fluvial origin. The meadow limestone form thin beds in fluvial – lacustrine environment (e.g.: ${}_{fl}Qh_2^{m}$).

Several formation periods of travertines are known partly linked with the terrace formation (e.g.: Gerecse, Buda Mts.). If brief symbols are used (e.g.: p_1^{m}) the formation environment is not indicated. The thickness of these formations vary from several cm to several tens of meters.

Volcanic formations (v)

The result of volcanic activity is the accumulation of basalt in the vicinity of Bár (${}_{v}Qp_1^{\beta,\beta t}$) and Salgótarján (Salgóvár Basalt Formation — ${}^{sv}Pa_2$- upper part of Qp_1) and basalt tuff in Zala county, Little Hungarian Plain and Mezőföld.

We should mention the thin trachite tuff (tephra) (${}_{v}Qp_2^{\tau t}$) intercalations in the loess which most probably are Riss, in age.

Silicic, calcareous and dolomitic geyserites formed around the Lake Balaton due to the hydrothermal processes following the Pannonian basaltic volcanism. The formation of these bodies could take place even in the Pleistocene (e.g.: ${}_{v}Pa_2$-Qp^{ge}). Genetically they can partly be considered as chemogenous sediments.