



# Geochemical exploration methods

MFFAT720005

Earth Science Engineering MSc, geological engineering specialisation

2022/23 2nd semester

TANTÁRGYI KOMMUNIKÁCIÓS DOSSZIÉ

**Miskolci Egyetem**  
**Műszaki Föld- és Környezettudományi Kar**  
**Nyersanyagkutató Földtudományi Intézet**

## Tantárgy leírás

<b>Course name:</b> Geochemical exploration methods <b>Course leader:</b> Dr. Má dai Ferenc, egyetemi docens	<b>Course code:</b> MFFAT720005 <b>Department:</b> Department of Mineralogy and Petrology
<b>Recommended semester:</b> 2	<b>Pre-requisites:</b> MFFAT710001
<b>Weekly hours:</b> 1+2	<b>Assignment (a/gy/v):</b> Practical mark
<b>Credits:</b> 4	<b>division:</b> full time

**Main objectives of the course:**

Introduction into a basic area of mineral exploration methods, including the theoretical background of geochemical sampling, the detailed discussion of different sampling and analytical methods, as well as the methods of data processing and interpretation.

Completion of a geochemical exploration project, including field sampling, sample preparation, data processing and interpretation is an important part of the course.

**Relevant competences:**

- Applies the techniques and practices best available for geochemical sampling.
- To apply the right selection of analytical techniques and digestion solution for geochemical samples.
- To apply the hierarchical planning approach for geochemical sampling.
- Combines the applied and theoretical knowledge required for the complex interpretation of geochemical datasets and processes.

**knowledge:**

- Knows and applies scientific and technical theory and practice related to the profession of environmental engineering.
- Has a comprehensive knowledge of measurement technology and measurement theory related to the field of environmental engineering.
- Knows and applies environmental and remediation procedures (operations, equipment, devices), environmental remediation methods.
- Knows the operation of environmental protection facilities (especially water and wastewater treatment plants, hazardous and communal landfills, waste incinerators), their structures and the possibilities of their development.
- Knows and applies the rules of environmental impact assessment and preparation of environmental technical documentation.
- Knows and applies the methodology and tools of environmental informatics and modeling in a complex way.
- Knows the basics, boundaries, and requirements of the fields of work, as well as fire protection, safety technology, information technology, law, economics and management related to environmental engineering.
- Knows the promotion and opinion-forming methods related to environmental engineering.

**skills:**

- Can apply the acquired general and specific mathematical, natural and social science principles, rules connections and procedures in solving problems arising in the field of environmental protection.
- Able to conduct publications and negotiations in his/her field in his/her mother tongue and at least one foreign language.
- Able to perform environmental management tasks.
- During work, examines the possibility of setting research, development and innovation goals and strives to achieve them.
- Able to plan in a complex way, implement and maintain engineering interventions in the fields of soil subsurface, water, air, noise and vibration protection, wildlife protection, remediation and waste reduction, treatment, and processing.

**attitude:**

- Open and receptive to the knowledge and acceptance of professional, technological development and innovation in the field of environmental protection, and its authentic mediation.
- Assumes the professional and moral values related to the field of environmental protection.
- Seeks to plan and carry out tasks independently or in a working group at a professional level.
- Strives to carry out the required work in a complex approach based on a systems-based and process-oriented way of thinking.

**autonomy and responsibility:**

- Can solve environmental engineering tasks independently, takes decisions carefully, in consultation with the representatives of other (mainly legal, economic, energy) fields, independently, takes responsibility for the decisions.
- In making decisions, takes into account the basic requirements of occupational health and safety, technical, economic and legal regulations, and engineering ethics.
- Takes the initiative in solving environmental problems, identifies the shortcomings of the applied technologies, the risks of the processes and initiates the measures to reduce them.

**Short curriculum of the course:**

- Geochemical distribution of chemical elements in different rock types,
- Periodic table for geochemists
- Concept of the geochemical background.
- Geochemical delineation of a mineralization, a mineral deposit.
- Primary dispersion, methods of its exploration.
- Geochemical aspects of weathering.
- Geochemistry of the surface environment.
- Sorption processes
- Secondary dispersion and methods of its exploration.
- Sampling methods, sampling standards.
- Soil surveys, vegetation and water surveys.
- Stream sediment sampling methods, heavy minerals geochemistry.
- Major analytical methods.
- Data processing and statistical methods.

**Assignment:** completion of three exercises during the semester and participation in a 2-3 days field trip and completion of a sampling plan based on the field trip.

1. CIPW norm calculation exercise (20%)
2. Evaluation of a REE dataset (15%)
3. Geochemical evaluation of a drillcore (15%)
4. Field trip work and completion of the sampling plan (50%)

**Grading limits:**

> 80 %: excellent  
70 – 80 %: good  
60 – 70 %: medium  
50 – 60 %: passed  
< 50 %: failed

The 3-5 most important compulsory, or recommended literature (textbook, book) resources:

- Reedman J.H.: Techniques in mineral exploration (Appl. Sci. Publ. London, 1979)
- Kuzvart M. & Böhmer M.: Prospecting and exploration of mineral deposits (Elsevier, 1986)
- Wite W.M. (2007): Geochemistry. Online textbook, (John Hopkins University, 2007)
- Matveev A.A. (2003): Geokhimicheskie poiski MPI. (Izd. MGU, 2003)
- Grigoryan S.V.; Morozov V.I. (1985): Vtorichnie litogeokhimicheskie oreoli pri poiskah skritogo orudineniya (Nauka, Moskva, 1985)
- Hawkes H.E.: Principles of geochemical prospecting. (US DOE, Geological survey bulletin 1000-F)
- Geboj N.J.; Engle E.A. (2011): Quality Assurance and Quality Control of Geochemical Data: A Primer for the Research Scientist (USGS Open-File Report 2011-1187)
- Sarkar D., Datta R., Hannigan R.: Concepts and applications in environmental geochemistry. (Elsevier, 2007)

## Féléves órabeosztás

2022/23 2. félév

szerda 9-12 LFFTT

dátum	elmélet	gyakorlat
01.03.2023	Scope, requirements, rock forming minerals' geochemistry	CIPW norm calculation
08.03.2023	geochemical periodic table	
15.03.2023	szünet	
22.03.2023	Deposit types, primary dispersion, mineral stability	primary dispersion exercise
29.03.2023	Resource categories, geochemical landforms, concept of geochemical barriers	soil sampling, preparation
05.04.2023	Basic thermodynamic concepts, Redox processes, Eh-pH diagrams	Eh-pH modelling with the HSC Chemistry software (demo)
12.04.2023	sorption, element mobility	Red mud REE data normalization, interpretation
25.04.2023	analytical methods (ICP, XRF, classical analytics), selection criteria	Interpretation of the Pécs Karolina-valley sequence minor element geochemistry
03.05.2023	secondary dispersion, methodology of its mapping and sampling	Geochemical data processing of red mud datasets
10.05.2023	Sampling plan, sampling strategy	Geology background data of the Telkibánya ore field
17.05.2023	field work	
24.05.2023	Data processing, quality assurance, quality control	Delineation of catchment areas in the Telkibánya Kánya-hegy region
31.03.2023		team work: completion of a sampling plan for the Telkibánya ore field

## Assignments

### 1. exercise: CIPW norm calculation

The student should complete a norm calculation based on the given analytical data, following the algorithm given in the instructions. Received results should be evaluated according to the IUGS requirements (Streckeisen diagram, TAS diagram). The CIPW norm calculation instruction can be downloaded from the Moodle site of the course.

Deadline: 25 March.

### 2. exercise: Using the database provided the student should do a normalization of the REE dataset relative to the REE distribution in the upper continental crust, The samples shall be classified according their distribution trends as:

- L-type: light-REEs (La, Ce, Pr, Nd, Sm) normalized values are higher than that of the mid-REEs and heavy REEs.
- M-type: Elements of the mid-section (Eu, Gd, Tb, Dy) show higher values compared to the others,
- H-type: Heavy REEs show the highest relative concentration.

### 3. exercise: The database given on the Mecsek coal basin from the Karolina valley open pit shall be evaluated based on distribution of Ge concentration values. Students shall interpret the data, considering the possible ways of Ge fixation change of lithology.

### 4. exercise: Geochemical sampling exercise: Students shall prepare a sampling plan for geochemical prospecting works in the Telkibánya region for a 2 sq. km area. The sampling plan shall describe the steps of the expedition for a soil geochemistry sampling completed along an orthogonal net.

#### Tasks:

- step 1: Reconnaissance and stream sediment sampling
- step 2: Soil sampling campaign
- step 3: completion of a budget for sampling and chemical analyses

Soil sampling geometry could be either by orthogonal grid or ridge and spur method

#### Chapters of the sampling plan

##### step 1.

- definition of involved parties, tasks to be completed towards different stakeholders, expected relating costs
- evaluation of existing geological, geochemical data
- selection of chemical elements that should be sampled, explanation why these elements are selected
- designation of sampling points for stream sediment sampling (max. 12 points)
- technical instructions for stream sediment sampling (sample size, sampling depth, how to find traps)

- documentation requirements (system of labelling, list of parameters that should be characterized at the sampling point)
- sample processing instructions for stream sediment samples
- safety regulations
- Schedule for stream sediment campaign (max. 7 days)

step 2.

- delineation of the sampling area for soil sampling, based on the results of the stream sediment sampling campaign
- selection of chemical elements that should be sampled, explanation why these elements are selected
- designation of expected geochemical barriers on the sampling area for different selected elements
- characterization of the soil type expected on the area
- density and geometry of the sampling grid
- technical instructions for soil sampling (sample size, sampling depth, orientation)
- documentation requirements (system of labelling, list of parameters that should be characterized at the sampling point)
- sample processing instructions for soil samples (sieving, splitting, packing)
- sample storage instructions
- safety instructions
- Schedule for soil sampling (max 14 days)

Step 3:

- selection of analytical methods, chemical elements to be analysed, detection limits.
- Risk assessment: expected errors, pitfalls
- Composition of the sampling team (No. of geologists, technicians etc.)
- personnel costs
- wages
- catering (accommodation, food etc.)
- rental costs
- transportation costs in field
- housing / workshop / laboratory / office
- sample transportation costs to chemical laboratory
- analytical costs

Submission deadline: 14 May.

## CIPW. norm calculation exercise

dataset: 6/65600

### 6 / 65600 input data:

	Wt %	molecular weight:	mole ratio
SiO2	73,79	60,0848	1,2281
TiO2	0,98	79,8988	0,0123
Al2O3	13,83	101,9612	0,1356
Fe2O3	0	159,6922	0,0000
FeO	2,8	71,8464	0,0390
MnO	0	70,9374	0,0000
MgO	0,19	40,3114	0,0047
CaO	1,05	56,0794	0,0187
Na2O	4,41	61,979	0,0712
K2O	2,83	94,2034	0,0300
P2O5	0	141,9446	0,0000
CO2	0	44,01	0,0000
Cr2O3		151,9902	0,0000
NiO		74,7094	0,0000
BaO		153,34	0,0000
SrO			
ZrO2		123,2188	0,0000
F		18,9984	0,0000
Cl		35,453	0,0000
S			
H2O	0	18,01534	0,0000
SO3		80,0582	0,0000
Σ	99,88		

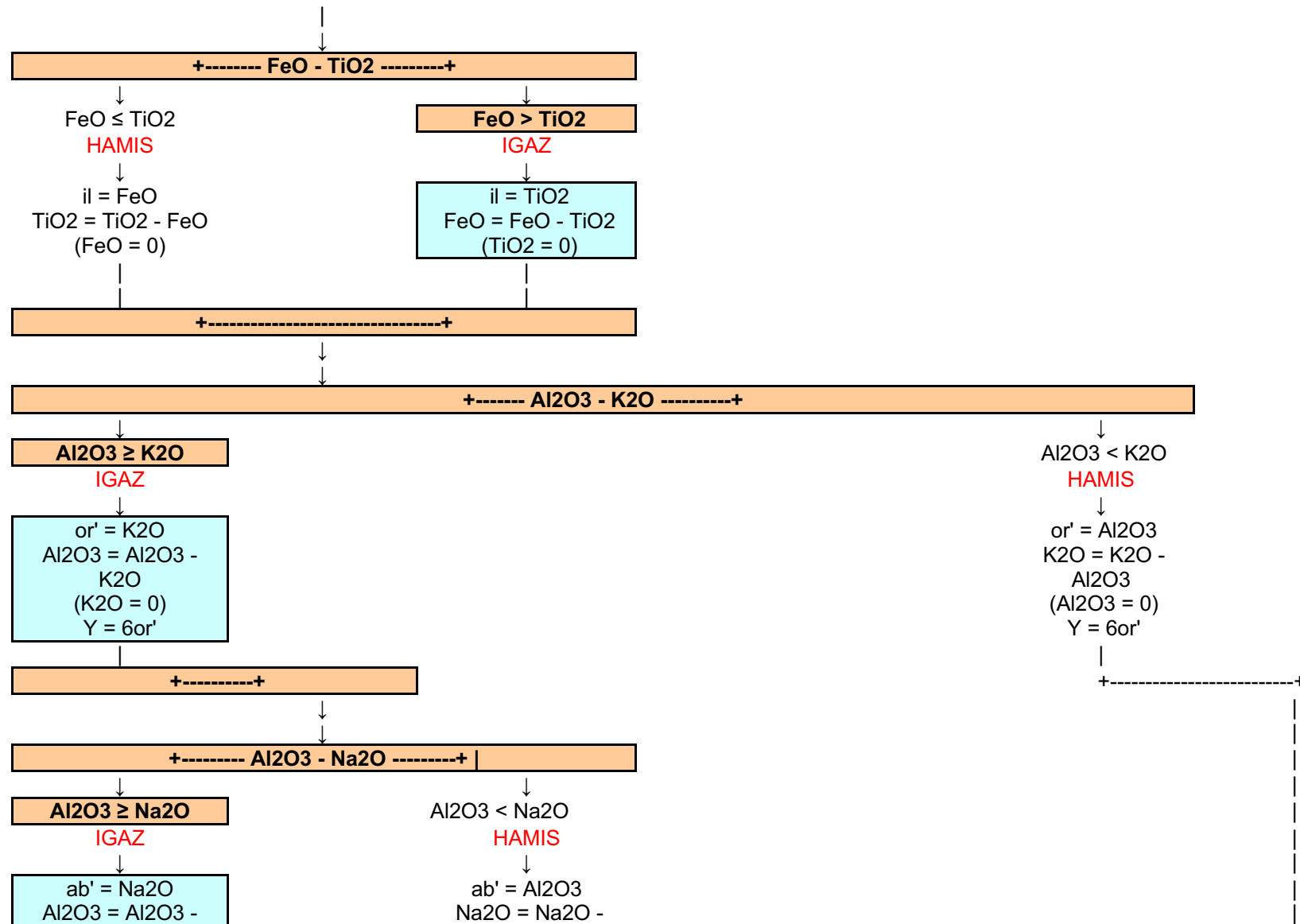
### accompanying components:

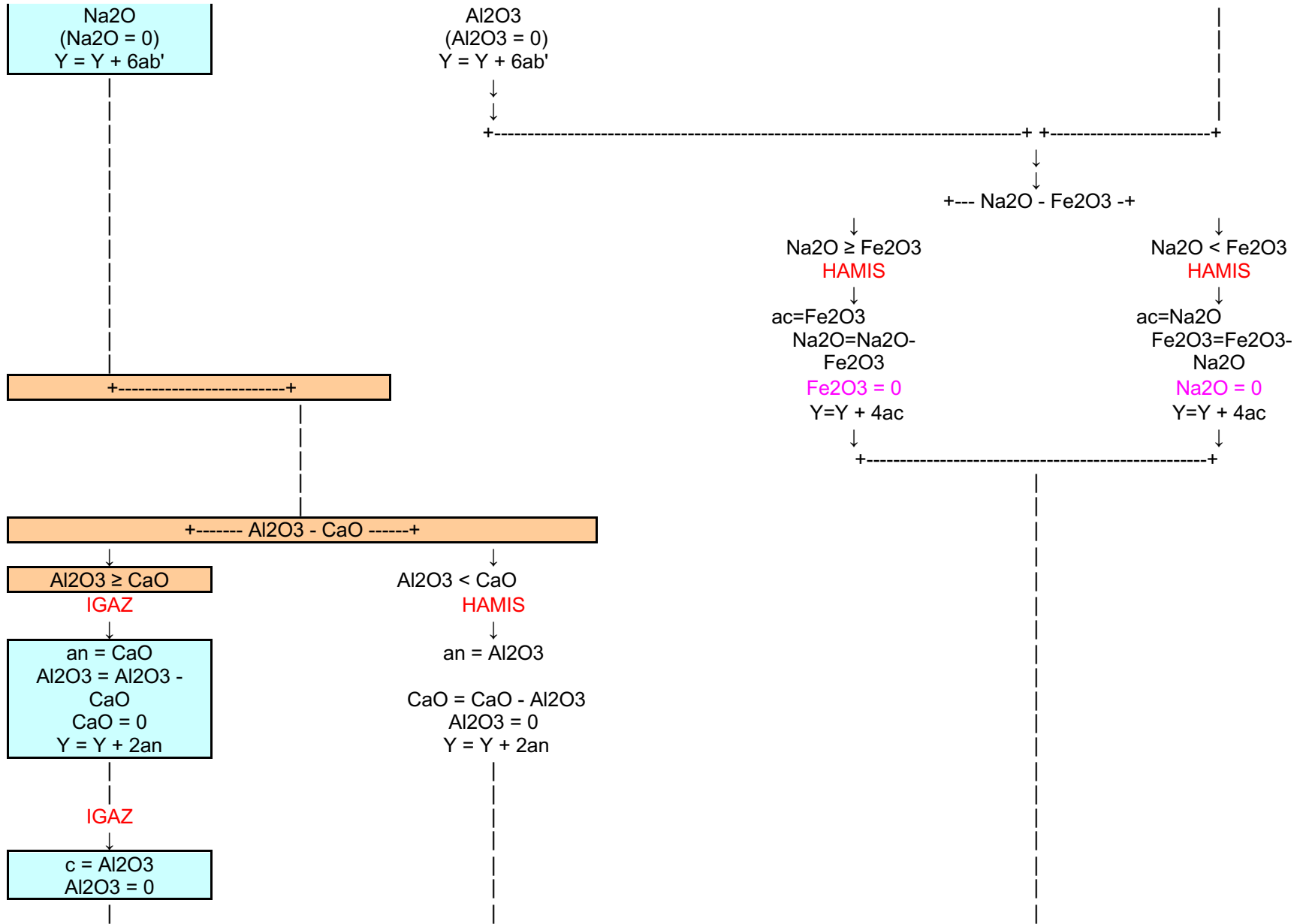
FeO = FeO + MnO + NiO	0,0390
CaO = CaO + BaO + SrO	0,0187
zr = ZrO2	0,0000
ap = P2O5	0,0000
fr = F/2	0,0000
hl = Cl	0,0000
pr = S/2 (SO3/2)	
cc = CO2	0,0000
cm = Cr2O3	0,0000
CaO = CaO - 3,33 · P2O5	0,0187
F = F - 2/3 · ap	0,0000
CaO = CaO - F/2	0,0187
Na2O = Na2O - Cl/2	0,0712
FeO = FeO - S	0,0390
CaO = CaO - CO2	0,0187
FeO = FeO - Cr2O3	0,0390
Y = zr	0,0000

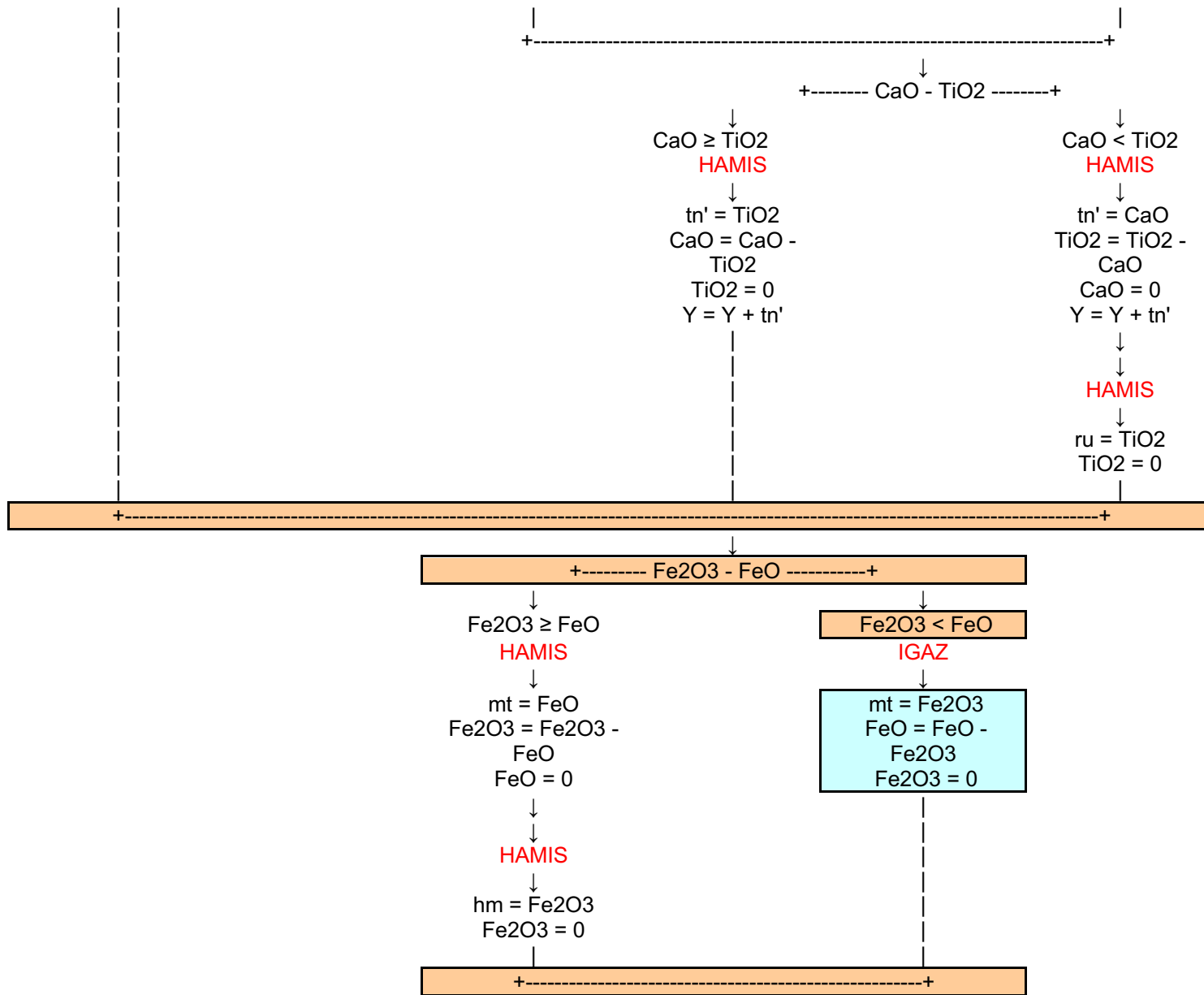




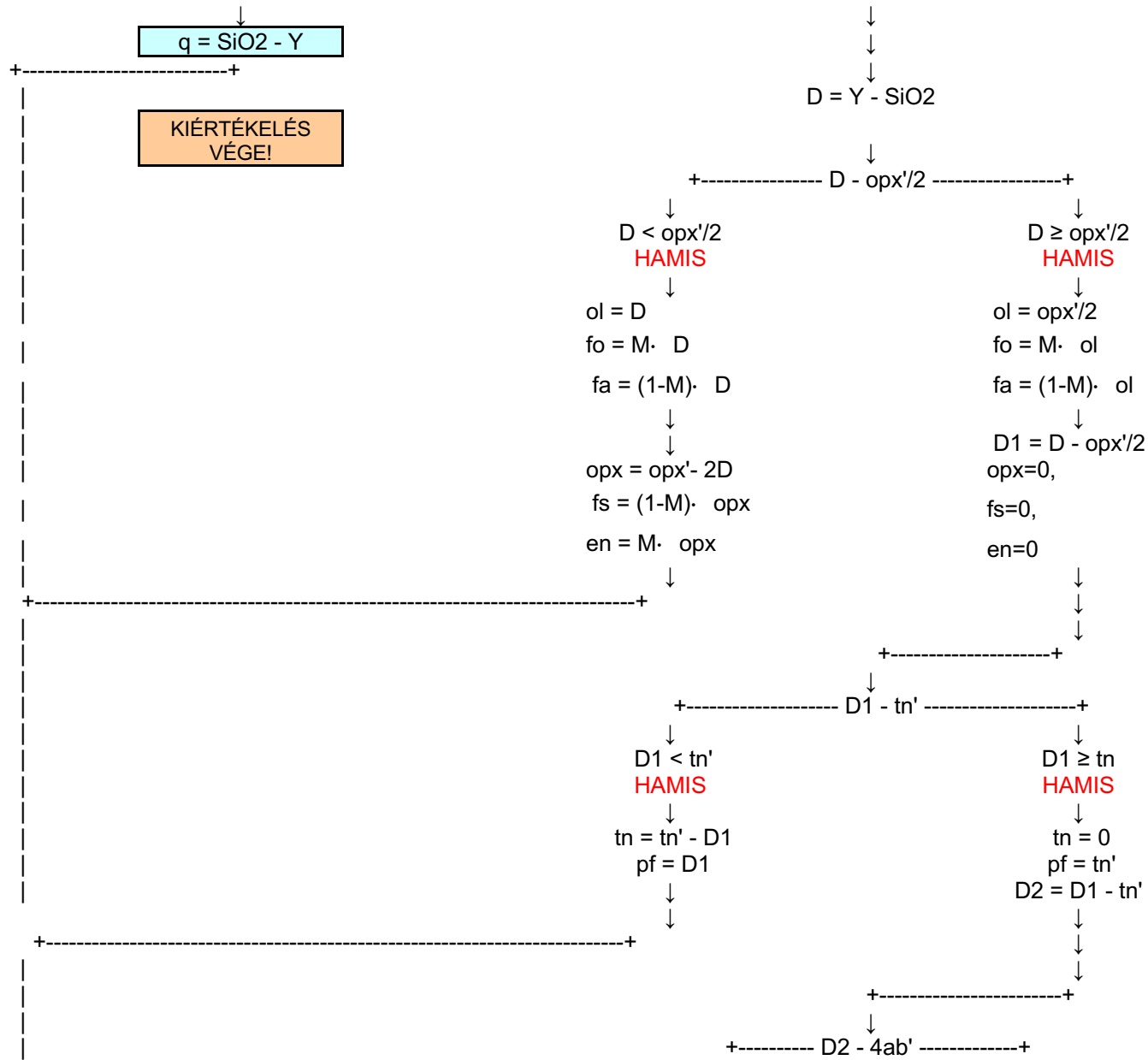
**Calculation:**

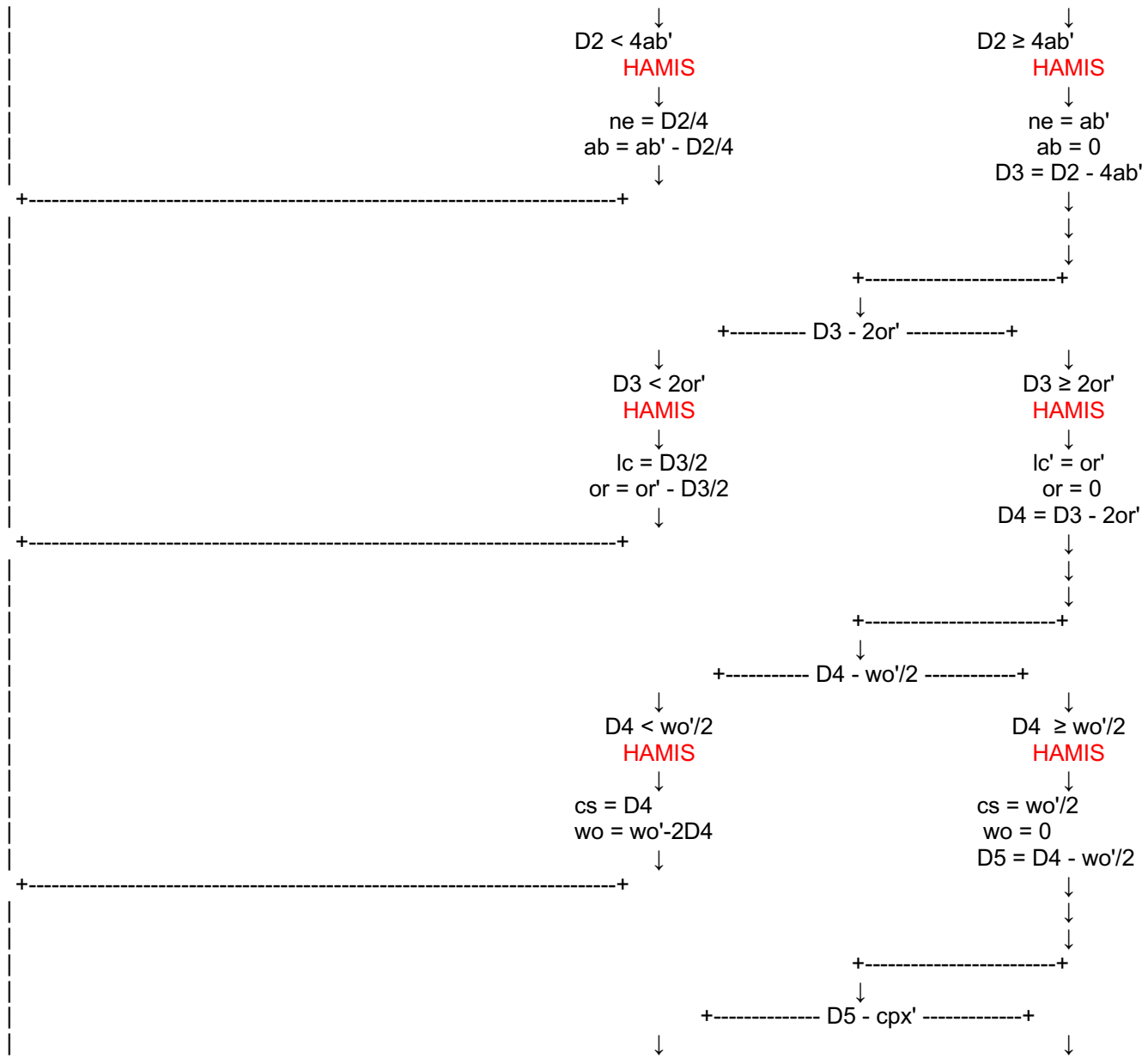


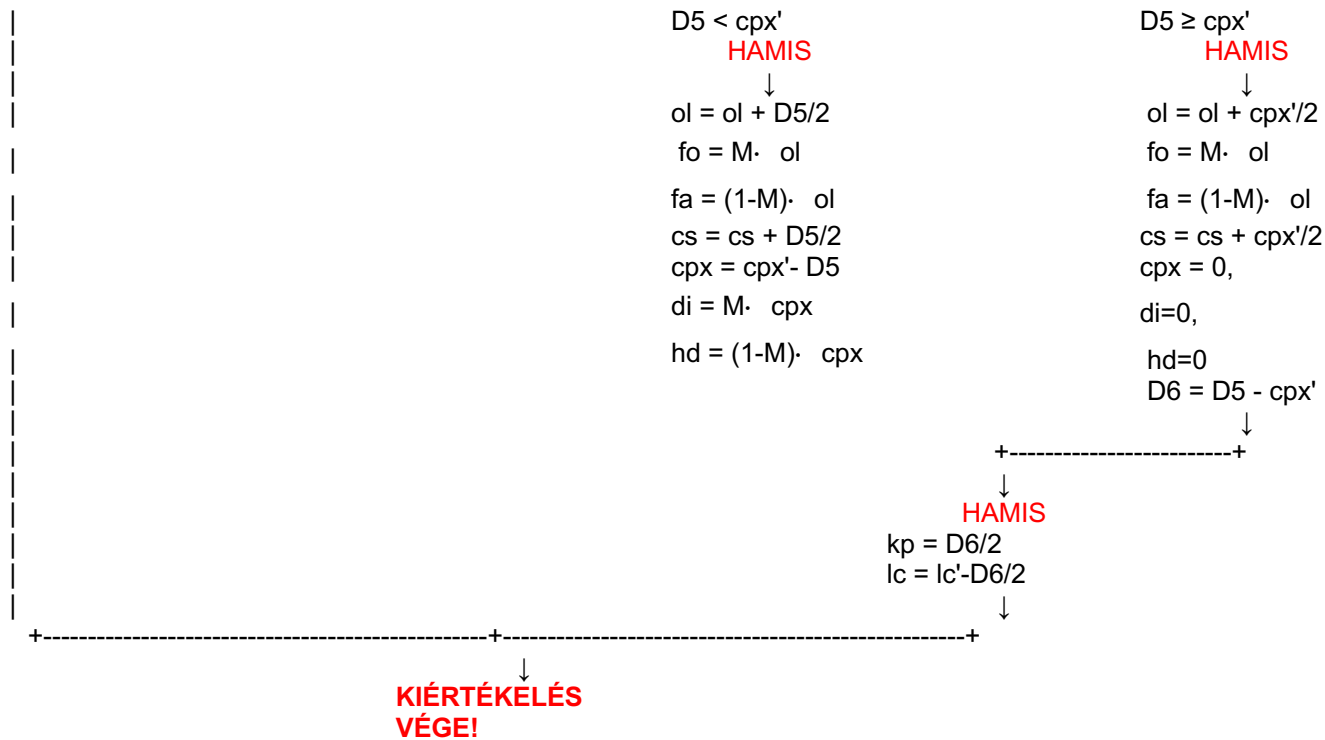












**Calculation of norm components:**

FeO > TiO <sub>2</sub>	ll = 0,0123	FeO = 0,0390 - 0,0123 = 0,0267	
Al <sub>2</sub> O <sub>3</sub> ≥ K <sub>2</sub> O	or' = 0,0300	Al <sub>2</sub> O <sub>3</sub> = 0,1356 - 0,0300 = 0,1056	Y = 6 * 0,0300 = 0,1802
Al <sub>2</sub> O <sub>3</sub> ≥ Na <sub>2</sub> O	ab' = 0,0712	Al <sub>2</sub> O <sub>3</sub> = 0,1056 - 0,0712 = 0,0344	Y = 0,1802 + 6 * 0,0712 = 0,6072
Al <sub>2</sub> O <sub>3</sub> ≥ CaO	an = 0,0187	Al <sub>2</sub> O <sub>3</sub> = 0,0344 - 0,0187 = 0,0157	Y = 0,6072 + 2 * 0,0187 = 0,6446



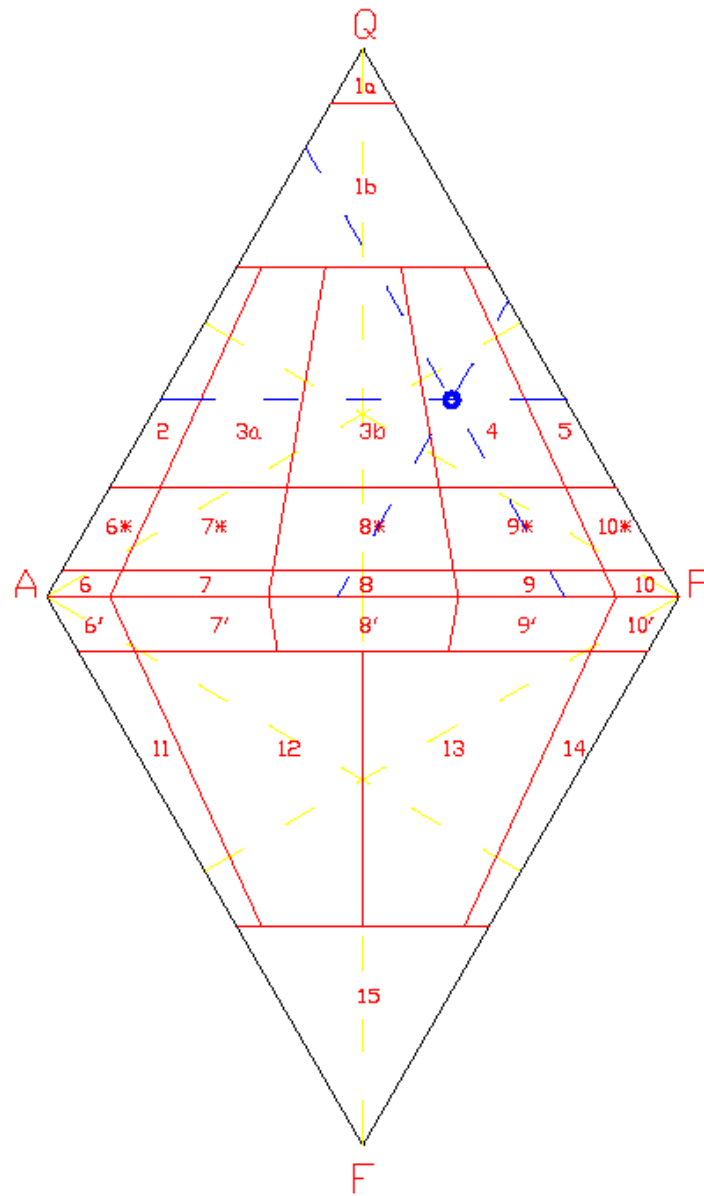
	$c = 0,0157$	$Al_2O_3 = 0$	
$Fe_2O_3 < FeO$	$mt = 0$	$FeO = 0,0267 - 0 = 0,0267$	
$MF = 0,0047 + 0,0267 = 0,0314$ $M = 0,0047 / (0,0047 + 0,0267) = 0,1500$			
$CaO < MF$	$cpx' = 0$ $di' = 0$ $hd' = 0$ $opx' = 0,0047 + 0,0267 = 0,0314$ $fs' = 0,0267$ $en' = 0,0047$		$Y = 0,6446 + 0,0314 = 0,6760$
$SiO_2 \geq Y$	$q = 0,5521$		

## Norm components (Wt%)

symbol	mineral	fomula	mol Wt	ratio	Wt%
q	kvarc	SiO <sub>2</sub>	60,09	0,5521	33,17352
c	korund	Al <sub>2</sub> O <sub>3</sub>	101,96	0,0157	1,603002
or	ortoklász	K <sub>2</sub> O-Al <sub>2</sub> O <sub>3</sub> -6SiO <sub>2</sub>	556,70	0,0300	16,72404
ab	albit	Na <sub>2</sub> O-Al <sub>2</sub> O <sub>3</sub> -6SiO <sub>2</sub>	524,48	0,0712	37,31839
an	anortit	CaO-Al <sub>2</sub> O <sub>3</sub> -2SiO <sub>2</sub>	278,22	0,0187	5,209239
lc	leucit	K <sub>2</sub> O-Al <sub>2</sub> O <sub>3</sub> -4SiO <sub>2</sub>	436,52	0,0000	0
ne	nefelin	Na <sub>2</sub> O-Al <sub>2</sub> O <sub>3</sub> -2SiO <sub>2</sub>	284,12	0,0000	0
kp	kaliofilít	K <sub>2</sub> O-Al <sub>2</sub> O <sub>3</sub> -2SiO <sub>2</sub>	316,34	0,0000	0
ac	akmit	Na <sub>2</sub> O-Fe <sub>2</sub> O <sub>3</sub> -4SiO <sub>2</sub>	462,03	0,0000	0
ns	Na-metaszilikát	Na <sub>2</sub> O-SiO <sub>2</sub>	122,07	0,0000	0
ks	K-metaszilikát	K <sub>2</sub> O-SiO <sub>2</sub>	154,29	0,0000	0
wo	wollasztónit	CaO-SiO <sub>2</sub>	116,17	0,0000	0
cpx	klinopiroxén				
di	diopszid	CaO-MgO-2SiO <sub>2</sub>	216,56	0,0000	0
hd	hedenbergit	CaO-FeO-2SiO <sub>2</sub>	248,11	0,0000	0
opx	ortopiroxén				
en	ensztatit	MgO-SiO <sub>2</sub>	100,39	0,0047	0,473169
fs	ferroszilit	FeO-SiO <sub>2</sub>	131,94	0,0267	3,523657
ol	olivín	(Mg,Fe) <sub>2</sub> SiO <sub>4</sub>			
fo	forszterit	2MgO-SiO <sub>2</sub>	140,69	0,0000	0
fa	fayalit	2FeO-SiO <sub>2</sub>	203,79	0,0000	0
cs	Ca-ortoszilikát	2CaO-SiO <sub>2</sub>	172,25	0,0000	0
mt	magnetit	FeO-Fe <sub>2</sub> O <sub>3</sub>	231,54	0,0000	0
il	ilmenit	FeO-TiO <sub>2</sub>	151,75	0,0123	1,861292
hm	hematit	Fe <sub>2</sub> O <sub>3</sub>	159,69	0,0000	0
nc	Na-karbonát	Na <sub>2</sub> O-CO <sub>2</sub>	105,99	0,0000	0
tn	titanit	CaO-TiO <sub>2</sub> -SiO <sub>2</sub>	196,07	0,0000	0
pf	perovszkit	CaO-TiO <sub>2</sub>	135,98	0,0000	0
ru	rutil	TiO <sub>2</sub>	79,90	0,0000	0
ap	apatit	3CaO-P <sub>2</sub> O <sub>5</sub> -1/3CaF <sub>2</sub>	336,22	0,0000	0
cc	kalcit	CaO-CO <sub>2</sub>	100,09	0,0000	0
zr	cirkon	ZrO <sub>2</sub> -SiO <sub>2</sub>	183,31	0,0000	0
fr	fluorit	CaF <sub>2</sub>	78,07	0,0000	0
hl	halit	NaCl	58,44	0,0000	0
cm	kromit	FeO-Cr <sub>2</sub> O <sub>3</sub>	223,84	0,0000	0
pr	pirit	FeS <sub>2</sub>	119,97	0,0000	0
<b>Összesen:</b>					<b>99,8863</b>

<b>Mafic total=</b>	<b>1,8613</b>	<b>M&lt;90%</b>
<b>Q (quartz)=</b>	<b>33,1735</b>	<b>35,89%</b>
<b>A (alkali feldspars)=</b>	<b>16,7240</b>	<b>18,09%</b>
<b>P (plagioclase)=</b>	<b>42,5276</b>	<b>46,01%</b>
<b>F (feldspathoids)=</b>	<b>0</b>	<b>0%</b>
<b>Σ=</b>	<b>92,43</b>	

## QAPF diagram:



QAPF diagramm

### **Interpretation**

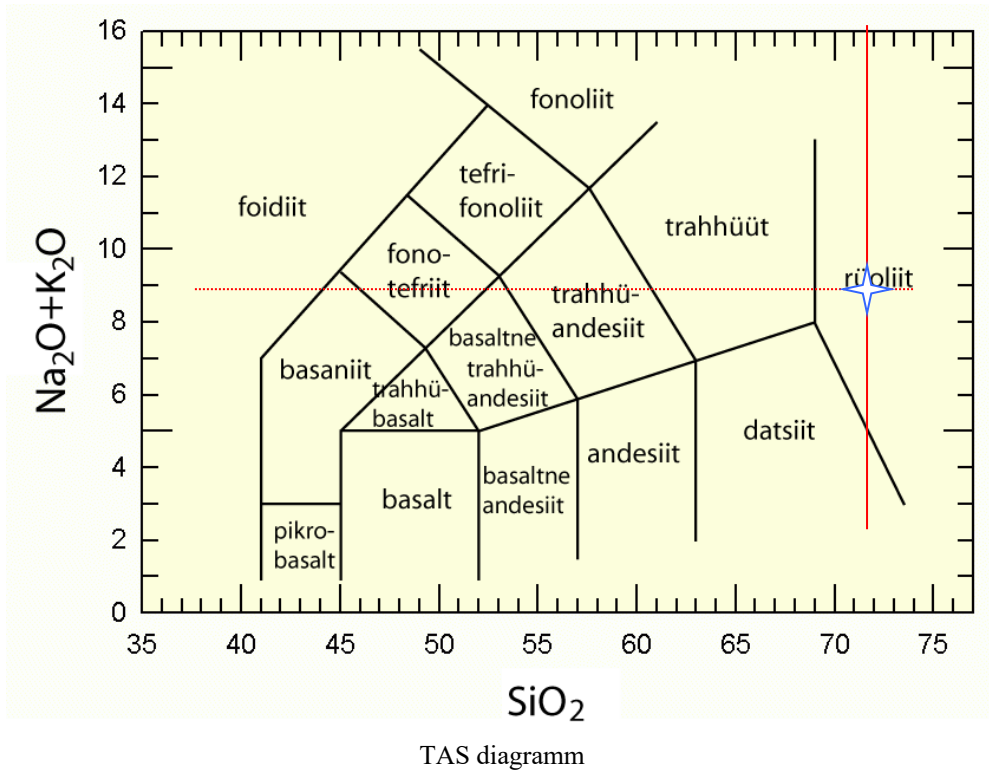
coarse grained rock:

**Granodiorite**

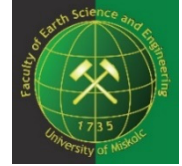
fine grained rock:

**Dacite**

## Interpretation by the TAS diagram:



According to the TAS diagram: **Riolite**



# GEOCHEMICAL SAMPLING PLAN FOR TELKIBANYA AREA

By: Gunbileg Ganbat  
Neptun code: GZG2WB

- **Step 1.1 Definition of involved parties, tasks to be completed towards different stakeholders, expected relating costs.**

There are usually 3 parties involved in exploration work License owner (client), government (local government and environmental agency) and servicing company. Local residents sometimes involved in permission to work, due to location of exploration area. Permission to conduct exploration work would be given only after plan of exploration work previewed and validated by local authority, at least a week prior to exploration work. Therefore, cost of a geologist or project manager's travelling cost to the area.

- **Step 1.2 Evaluation of existing geological, geochemical data.**

Geology of the area of basically consists of Miocene volcanic rocks and related clastic rocks (due to Carpathian volcanism). There are 2 intensification occurred during Miocene first in Badenian age then Sarmatian.

The late stage of Sarmatian volcanism develops succession of pyroxene andesites, rhyolite tuff and dacite. The Sarmatian sediments and pyroclastics lie concordantly on the Badenian ones. Intrusive breccias were found along its contacts with both Upper Badenian clays and Sarmatian clays and rhyolite tuff (Horváth and Zelenka, 1997).

While Badenian volcanic activity created dacitic domes, tuffs of dacitic-rhyolitic composition and tuff breccia deposited in a shallow marine environment.

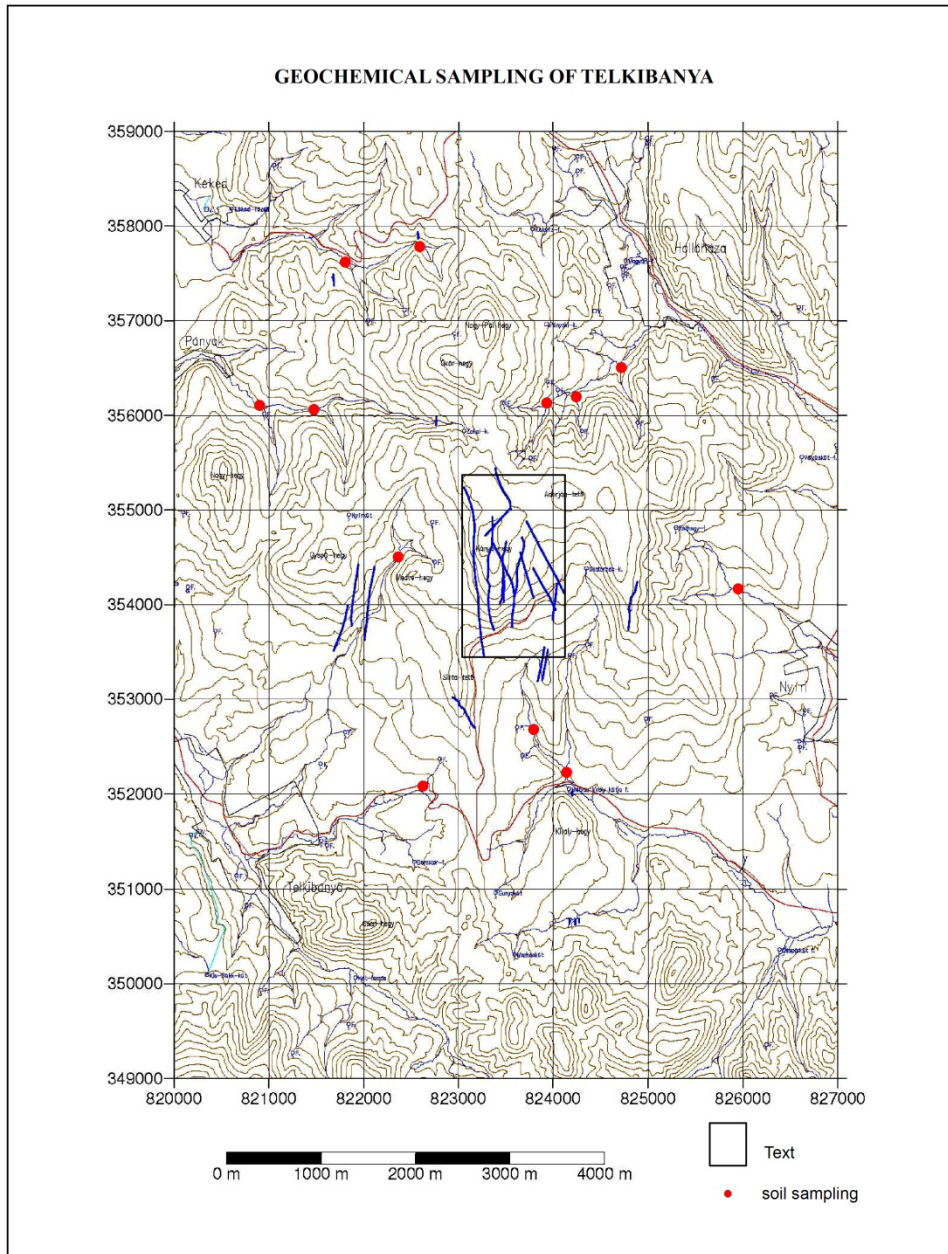
During and after the formation of the calderas and emplacement of the intrusion, faulting along NNW-SSE, NE-SW and E-W strikes occurred. Base-metal mineralization formed in association with both the Badenian and the Sarmatian volcanic stages. The rock material of the Badenian subvolcanic bodies became K-metasomatized, accompanied by an epithermal-hydrothermal veinstockwerk type ore mineralization. Mineralization in the area is found in veins along striking NNW that's parallel to the major faults of the area. Veins are at least 0.5-1 meters long and their width varies between 0.1-1 meters and their known depth is about 200 meters. In these ore zones polymetallic (Pb, Zn, Cu) ores were formed on deep levels and precious metal (Au-Ag) ores on high levels.

Correlation between drilling hole and geochemical analysis, K metasomatism is not related to gold mineralization, eventhough zonation of K enrichment coincide with Au enrichment.

- **Step 1.3. Selection of chemical elements that should be sampled**

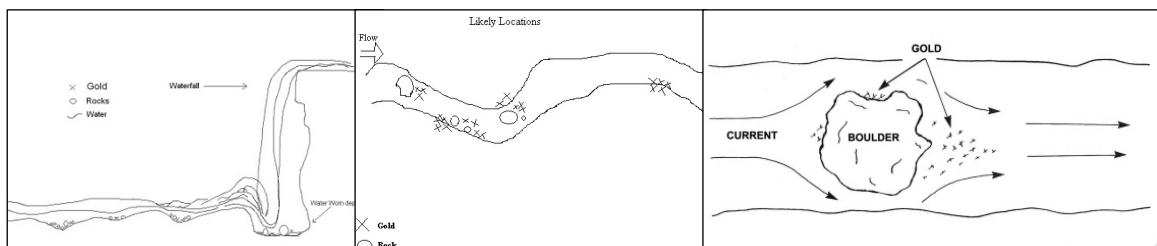
In low sulphidation epithermal Au, Ag deposits develop phyllic, argillic, propylitic alterations, especially in our case adularia, sericitic, hydrothermal alteration and K metasomatism. Ore minerals consist of native gold, electrum, native silver, pyrite, chalcopyrite, sphalerite, galena, arsenopyrite, cubanite, marcasite, covellite and tennantite, which are commonly associated with argillic alteration. Therefore, selection for chemical analysis should be concerning above mentioned mineralization and alteration.

▪ **Step.1.4. Designation of sampling points for stream sediment sampling**



**step.1.5. Technical instruction for stream sediment sampling (sampling size, sampling depth, how to find traps)**

In order to get all the possible anomalies following figure display basic traps where potential mineral





concentration.

▪ **Step.1.6. Documentation requirements (system of labeling, list of parameters that should be characterized at the sampling point)**

1. Date of sample taken
2. GPS coordinates of sample
3. General description of the sample
4. Sample weight

▪ **Step.1.8. Safety regulations**

- ✓ It is important to follow instructions of the tools.
- ✓ Wear safety gloves, glass and helmet if it's necessary
- ✓ Not to leave one another in the field
- ✓ carry radio transmitter while working in a field has to (walky talky)
- ✓ Carry First aid kit in the vehicle

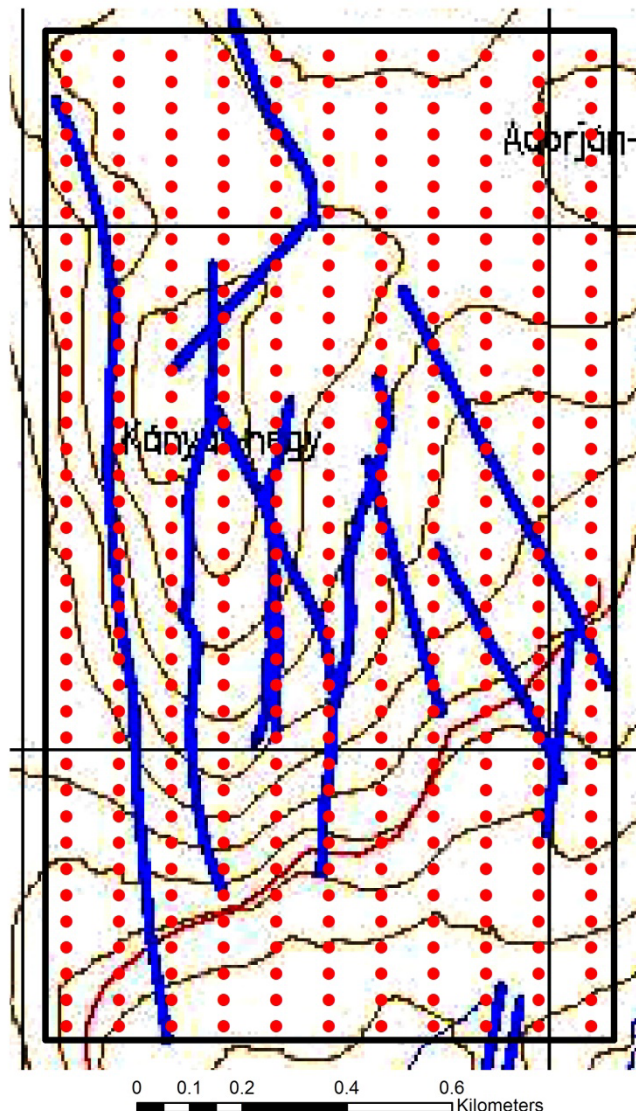
▪ **Step.1.9. Schedule for stream sediment campaign (max 7 days)**

These points located very difficult area to reach. Therefore, dividing these tasks into 2 teams for 2 two days. Each team will consist of 1 geologist and 1 technician. And driver for both team.

	Day 1	Day 2
Team 1	3 points	3 points
Team 2	3 points	3points

In total 5 personals: 2 geologist, 2 technician and a driver

▪ **Step.2.1. Delineation sampling for soil sampling, on result of stream sampling campaign.**



of the  
area  
based  
the

- **Step.2.2. Selection of chemical elements that should be sampled, explanation why these elements are selected**

In this case, gold and silver should be measured, together with pathfinder elements (Sb, As, Pb, Zn, Mo, Cu, Bi, Co, Ni, W, Be). Moreover, most of the gold is linked to pyrite, then iron should be also measured.

- **Step.2.7. Documentation requirements (system of labelling, lists of parameters that should be characterized at the sampling point).**

Labeling The standard European documentation EN 14899 :2005 should be used for the sampling documentation that should include.

1. Date of sample taken
2. GPS coordinates of sample
3. General description of the sample
4. Sample weight

- **Step.2.8. sample processing instructions for soil samples (sieving, splitting, packing)**



- **Step.2.9. sample storage instruction**

Sample bag should be plastic for free contamination and sealable. Sample has to be stored elevated from ground in cold and dry place.

- **Step.2.10. Safety instruction**

Soil sampling techniques involve shovels, hand augers and drill rigs. Some of the potential risks include sampling in areas containing buried utilities, pit cave-in, equipment failure. For personal health dehydration, muscle skeletal injury, and allergic reactions to plants and insect stings. Key safety issues associated with these actions. Each of these methods can have significant safety hazards, some of which can result in longterm injury or death. Therefore:

- ✓ It is important to follow instructions of tools.
- ✓ Wear safety gloves, glass and helmet if it's necessary
- ✓ Not to leave one another in the field
- ✓ Carry First aid kit in the vehicle

- **Step.2.11. Schedule for soil sampling (max 14 days)**

3 geologist and 3 technician divided into 3 teams consist of 1 geologist and 1 technician. To gather 418 soil sampling.

Team/days	1	2	3	4	5	6	7	8	9	10	11	12	13	14
First team	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Second team	10	10	10	10	10	10	10	10	10	10	10	10	10	9
Third team	10	10	10	10	10	10	10	10	10	10	10	10	10	9



- **Step 3.1. Selection of analytical methods, chemical elements to be analyzed, detection limit**

ANALYTE	RANGE (ppm)	DESCRIPTION	CODE	PRICE PER SAMPLE (€)
Au	0.0001-10	BLEG – ICP-MS finish BLEG – extraction AA finish	Au-CN12* Au-AA12	26.80
Au	0.001-10	BLEG – ICP-MS finish BLEG – extraction AA finish	Au-CN11* Au-AA11	17.85

Table 1. Bulk Leach Extractable Gold(BLEG), detection limit

ANALYTES & RANGES (ppm)								CODE	PRICE PER SAMPLE (€)
Ag	0.2-40	Cd	1-5,000	Mn	5-10,000	Sb	2-10,000	ME-ICP43 (25g)	8.95 complete package or 5.40 plus 0.40/element
As	1-10,000	Co	1-10,000	Mo	1-5,000	Zn	1-10,000		
Ba	10-10,000	Cu	1-10,000	Ni	1-10,000				
Bi	2-10,000	Fe	0.01%-20%	P	10-10,000			ME-ICP44 (50g)	
Ca	0.01%-15%	Mg	0.01%-15%	Pb	1-4,000				
Ag	0.01-25	Co	0.1-250	Se	0.2-250	U	0.05-100	ME-MS43 (25g)	
As	0.1-250	Hg	0.01-250	Sn	0.1-250	W	0.05-250		
Bi	0.01-250	Mo	0.05-250	Te	0.01-250			ME-MS44 (50g)	
Cd	0.01-250	Sb	0.05-250	Tl	0.02-250				

Table 2. Aqua regia digestion using the ICP-AES or ICP-MS, Detection limit

In order to achieve both adequate data and reduce price range, firstly, for gold anomalies Bulk Leach Extractable Gold (BLEG) method, for other trace elements Inductively Coupled Plasma Mass Spectrometry (ICP-MS) should be used.

In low sulphidation epithermal Au, Ag deposits develop phyllic, argillic, propylitic alterations, especially in our case adularia, sericitic, hydrothermal alteration and K metasomatism. Ore minerals consist of native gold, electrum, native silver, pyrite, chalcopyrite, sphalerite, galena, arsenopyrite, cubanite, marcasite, covellite and tennantite, which are commonly associated with argillic alteration. Therefore, selection for chemical analysis should be concerning above mentioned mineralization and alteration.

- **Step 3.2. risk assessment: expected errors, pitfalls**

There is possibility of 2 types of error could face with this project. Firstly, error with inadequate sampling, wrong numbering, sample loss on the transportation. Secondly, errors (such as accidents) which leads to with delay on progress, to its 7 people and in the mountainous area in 21 days. To deal with these issues at the same time, contingency 10% introduce in plan.

- **Step 3.3. composition of sampling team**

Team would consist of:

- ✓ 3 geologist – make sure technical geologists sampling procedure under instruction, and responsible for documentation of the point
- ✓ 3 technician – responsible for technical works such as taking samples under instruction of geologist
- ✓ Driver – responsible for delivering workers to the exploration area and back

- **Step 3.4. personal costs**

*Wages*

- ✓ Geologist 35euro per day
- ✓ Technician 25 euro per day
- ✓ Driver 25 euro per day

**Total: 1190euro**

*Catering*

	Food	Accommodation
Geologists, Technician, driver - 7 person for 14 days	2058 Euro	4410 euro
	<b>total</b>	<b>6468 euro</b>

*Rental costs*

	Unit price	piece	price
Car rental	29 euro	14 days	406 euro
Gas for the field work	0.923 euro	168km	155 euro
Gas price for Sample transportation cost (Telkibanya to Budapest)	0.923 euro	247km	228 euro
	<b>total</b>		<b>789 euro</b>