Eastern Macedonia and Trace
Institute of Technology
Kavala - Greece

Water Quality Assessment

Kavala

Quality of Water intended for human consumption

80/778/EU / 15.7.80

98/83/EC / 3.11.98

Drinking Water 1980/778/EU

A. ORGANOLEPTIC PARAMETERS

PARAMETER	UNIT OF MEASUREMENT	GUIDE LEVEL (GL)	MAXIMUM ADMISSIBLE CONCENTRATION (MAC)
Colour	mg/l measured on Pt-Co scale	1	20
Turbidity	mg/l SiO_2 Jackson units or NTU	1 0.4	10 4
Odour	Dilution Number	0	2 @ 12°C 3 @ 25°C
Taste	Dilution Number	0	2 @ 12°C 3 @ 25°C

80/778/EU

B. PHYSICAL – CHEMICAL PARAMETERS

PARAMETER	UNIT OF MEASUREMENT	GUIDE LEVEL (GL)	MAXIMUM ADMISSIBLE CONCENTRATION (MAC)	COMMENTS
Temperature	°C	12	25	—
H^+ conc.	pH unit	6.5-8.5	9.5	Non-reactive Water
Conductivity	µS/cm at 20°C	400	—	Relation to metallic ions in water
Chlorides	mg/l (Cl)	25	—	Conc. > 200 –>danger
Sulfates	mg/l (SO_4)	25	250	—
Silica	mg/l SiO_2	—	—	each country has their own limits
Calcium	mg/l Ca	100	—	—
Magnesium	mg/l Mg	30	50	—
Sodium	mg/l Na	20	175 in 1984 150 in 1987	WHO 120
Potassium	mg/l K	10	12	—
Aluminum	mg/l Al	0.05	0.2	—
Total hardness	mg/l Ca	min 60	—	Dependent on Ca and Mg
Dry residue	mg/l (after drying at 180°C)	—	1500	—
Dissolved oxygen	% O_2 saturation	—	—	Saturation value > 75% except sub terranean water)
Free CO_2	mg/l CO_2	—	—	Non-reactive water

80/778/EU

C. UNDESIRABLE SUBSTANCES

PARAMETER	UNIT OF MEASUREMENT	GUIDE LEVEL (GL)	MAXIMUM ADMISSIBLE CONCENTRATION	COMMENTS
Nitrates	mg/l NO_3	25	50	—
Nitrites	mg/l NO_2	—	0.1	—
Ammonium	mg/l NH_4	0.05	0.5	—
Nitrogen (Kjeldahl)	mg/l N	—	1	—
Oxidizability of $KMnO_4$	mg/l O_2	2	5	Calc. In acidic medium with T°
TOC Total organic carbon	mg/l C	—	—	If the conc.↑, Must examine
H_2S	µg/l S	—	Undetectable organoleptically	Toxic gas
Subst.extract. w/chloroform	mg/l dry residue	0.1	—	—
Soluble Hydrocarbons	µg/l	—	10	—
Phenols	µg/l C_6H_5OH	—	0.5	Except natural Phenols
Boron	µg/l B	1000	—	—
Iron	µg/l Fe	50	200	—
Manganese	µg/l Mn	20	50	—
Copper	µg/l Cu	100 at extraction	—	>3000µg/l may provoke corrosion
Zinc	µg/l Zn	100 at extraction	—	> 5000 µg/l astringent taste
Phosphorus	µg/l P_2O_5	400	5000	—
Flouride	µg/l F 8 -12°C	—	1500	Depends on temperature
Cobalt	µg/l Co	—	—	—
Suspended substances		None	—	—
Resid. chlorine	µg/l Cl		0.2	
Barium	µg/l Ba	100	—	—
Silver	µg/l Ag	—	10	—

80/778/EU

D. TOXIC SUBSTANCES

PARAMETER	UNIT OF MEASUREMENT	GUIDE LEVEL (GL)	MAXIMUM ADMISSIBLE CONCENTRATION (MAC)	COMMENTS
Arsenic	µg/l As	—	50	—
Beryllium	µg/l Be	—	—	—
Cadmium	µg/l Cd	—	5	—
Cyanides	µg/l CN	—	50	—
Chromium	µg/l Cr	—	50	—
Mercury	µg/l Hg	—	1	—
Nickel	µg/l Ni	—	50	—
Lead	µg/l Pb	—	50 (in running water)	Found in lead pipes not>100 µg/l
Antimony	µg/l Sb	—	10	—
Selenium	µg/l Se	—	10	—
Vanadium	µg/l V	—	—	—
Pesticides and related products	µg/l	—	0.1/each 0.5/total	Pesticides/ organo-chlorines, carbonates, PCB and PCT
Polycyclic aromatic H.C.	µg/l	—	0.2	—

80/778/EU

E. MICROBIOLOGICAL PARAMETERS

MICRO-ORGANISMS	SAMPLE VOLUME (ml)	GUIDE LEVEL (GL)	MAX ACCEPT. CONCENTR.	
			Membrane Method	Tube method (NPP)
Total coliforms	100	—	0	NPP<1
E. coli	100	—	0	NPP<1
Fecal streptococci	100	—	0	NPP<1
Chlostrides	20	—	—	NPP<1
Tot.bact.couts TBC for human Consumption	1ml 37°C 1ml 22°C	— —	10 100	
TBC in closed containers	1ml 37°C 1ml 22°C	— —	5 20	

1998/83/EC

1. CHECK MONITORING (10)

2. AUDIT MONITORING:

- Microbiological parameters - PART A (2)
- Chemical parameters - PART B (26)
- Indicator Parameters - PART C (19)
- Radioactivity (2)

98/83/EC

1. CHECK MONITORING (10)

Ammonium, Conductivity, pH, E.coli, Coliform bacteria, Colour, Iron, Odour, Taste, Turbidity

98/83/EC

2. AUDIT MONITORING

PART A

Microbiological parameters

Parameter	Parametric value (number/100 mL)
Escherichia coli (E. coli)	0
Enterococci	0

PART B

98/83/EC

Chemical parameters

Parameter	Parametric value 80/778 - 98/83	Unit
Acrylamide	0,1	µg/L
Antimony	(10) 5	µg/L
Arsenic	(50) 10	µg/L
Benzene	1	µg/L
Benzo(a)pyrene	0,01	µg/L
Boron	1	mg/L
Bromate	10	µg/L
Cadmium	5	µg/L
Chromium	50	µg/L
Copper	2	mg/L
Cyanide	50	µg/L
1,2-dichloroethane	3	µg/L
Epichloridrine	0,1	µg/L

★new

98/83/EC

Parameter	Parametric value 80/778 - 98/83	Unit
Fluoride	1,5	mg/L
Lead	(50) 10	µg/L
Mercury	1	µg/L
Nickel	(50) 20	µg/L
Nitrate	50	mg/L
Nitrite	(0,1) 0,5	mg/L
Pesticides	0,1	µg/L
Pesticides total	0,5	µg/L
Polycyclic aromatic H/C	(0,2) 0,1	µg/L
Selenium	10	µg/L
Tetra & trichloroethene	10	µg/L
Trialomethanes - total	100	µg/L
Vinyl chloride	0,5	µg/L

PART C
Indicator Parameters

98/83/EC

Parameter	Parametric value 80/778 - 98/83	Unit
Aluminum	200	µg/L
Ammonium	0,5	mg/L
Chloride	(200) 250	mg/L
Color, Odour, Taste, Turbidity	Acceptable to consumers	-----
Conductivity	2500	µS/cm
Hydrogen ion conc.	6,5-9,5	pH
Iron	200	µg/L
Manganese	50	µg/L
Oxidisability	5	mg/L O_2
Sulfate	250	mg/L
Sodium	(250) 200	mg/L
Coliform bacteria	0	No./100ml

98/83/EC

Radioactivity

Parameter	Parametric value	Unit
Tritium	100	Becquerel/L
Total indicative dose	0,1	mSv/year

98/83/EC

Optional Monitoring

Parameter	Parametric value	Unit
PCBs- PCTs total each	0,5 0,1	µg/L µg/L
Silver	10	µg/L
Phosphorus P_2O_5	5	mg/L
Dry residue	1500	mg/L
Potassium K	12	mg/L
H_2S	Undetectable organoleptically	-----

98/83/EC

Temperature, Potassium K, Silica SiO_2,

Calcium Ca, Total Hardness, Dry residue,

Dissolve O_2, Free CO_2, Oxidizability of $KMnO_4$,

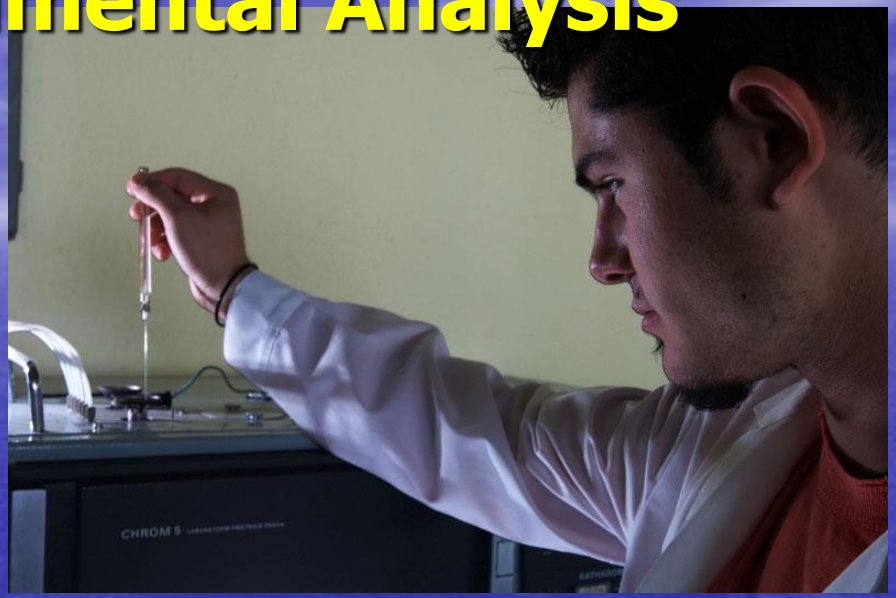
H_2S, Phenols, Phosphorus P_{205}, Cobalt Co,

Barium Ba, Berilium Be, Cyanide CN….

Minimum frequency of sampling and analyses for water intended for human consumption

Volume of water distributed or produced each day within a supply zone (Notes 1 and 2) m^3	Check monitoring number of samples per year (Notes 3, 4 and 5)	Audit monitoring number of samples per year (Notes 3 and 5)
≤ 100	(Note 6)	(Note 6)
> 100 ≤ 1 000	4	1
> 1 000 ≤ 10 000	4 + 3 for each 1 000 m^3/d and part thereof of the total volume	1 + 1 for each 3 300 m^3/d and part thereof of the total volume
> 10 000 ≤ 100 000		3 + 1 for each 10 000 m^3/d and part thereof of the total volume
> 100 000		10 + 1 for each 25 000 m^3/d and part thereof of the total volume

TEI EMT
Laboratory of Instrumental Analysis



QMSCERT®
ΠΙΣΤΟΠΟΙΗΤΙΚΟ

Η QMSCERT, ένας διαπιστευμένος οργανισμός πιστοποίησης τρίτου μέρους
και συντονιστής συστημάτων διαχείρισης ISO 9001 λειτουργώντας σύμφωνα με τις απαιτήσεις
του ISO 17021 γνωστοποιεί ότι ο οργανισμός:

ΕΡΓΑΣΤΗΡΙΟ ΕΝΟΡΓΑΝΗΣ ΑΝΑΛΥΣΗΣ
Τ.Ε.Ι. ΚΑΒΑΛΑΣ
ΑΓΙΟΣ ΛΟΥΚΑΣ
Τ.Κ. 654 03 ΚΑΒΑΛΑ

Με πεδίο εφαρμογής:

Φυσικοχημικές και Μικροβιολογικές Αναλύσεις
Πόσιμων Υδάτων και Αποβλήτων

Έχει καθιερώσει και εφαρμόζει διαχείρισης ποιότητας το οποίο είναι σε συμμόρφωση με
το Διεθνές Πρότυπο

ΕΛΟΤ ΕΝ ISO 9001:2008

17 Φεβρουαρίου 2013
Ημερομηνία Λήξης Πιστοποίησης

18 Φεβρουαρίου 2010
Ημερομηνία Πιστοποίησης

Κωδικός ΙΑΕΑ: 35

Για το Συμβούλιο της QMSCERT

CERT
Inspection - Certification

IAF

ΕΣΥΔ

QMSCERT®
CERTIFICATE

QMSCERT, an accredited provider of third party system certification organization for
ISO 9001 quality management systems and acting in accordance with the Requirements of
ISO 17021 for registrars attests that:

LABORATORY OF INSTRUMENTAL ANALYSIS
T.E.I. of KAVALA
AGIOS LOUKAS, GR-65403,
KAVALA, GREECE

with a scope of:

Physicochemical & Microbiological Analysis of
Drinking & Waste Water

has established a quality management system that is in conformance with the
International Standard

EN ISO 9001:2008

February 17th, 2013
Certification Period Ending

February 18th, 2010
Certification Date

IAF/EA Code: 35

For the QMSCERT Board

CERT
Inspection - Certification

IAF

ΕΣΥΔ

Εξαγωγή

ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ
ΤΕΧΝΟΛΟΓΙΚΟ ΕΚΠΑΙΔΕΥΤΙΚΟ ΙΔΡΥΜΑ
(Τ.Ε.Ι.) ΚΑΒΑΛΑΣ

ΔΟΚΙΜΑΣΤΙΚΗ ΠΑΡΑΚΟΛΟΥΘΗΣΗ ΠΟΣΙΜΩΝ ΥΔΑΤΩΝ 2014

(οδηγία 98/83/ΕΚ , Υ2/2600/2001)

ΕΡΓΑΣΤΗΡΙΟ ΕΝΟΡΓΑΝΗΣ ΑΝΑΛΥΣΗΣ
ΥΠΕΥΘΥΝΟΣ - ΕΠΙΚΟΥΡΟΣ ΚΑΘΗΓΗΤΗΣ ΘΩΜΑΣ Δ. ΣΠΑΝΟΣ
Τηλ&FAX: 2510-462169. e-mail: tspanos@teikav.edu.gr

ΟΝΟΜΑ(ΔΗΜΟΣ - Δ.Δ.)
Δείγμα πόσιμο από **δίκτυο , δεξαμενή , γεώτρηση**

ΣΥΝΟΛΟ ΑΝΑΛΥΣΕΩΝ: 6

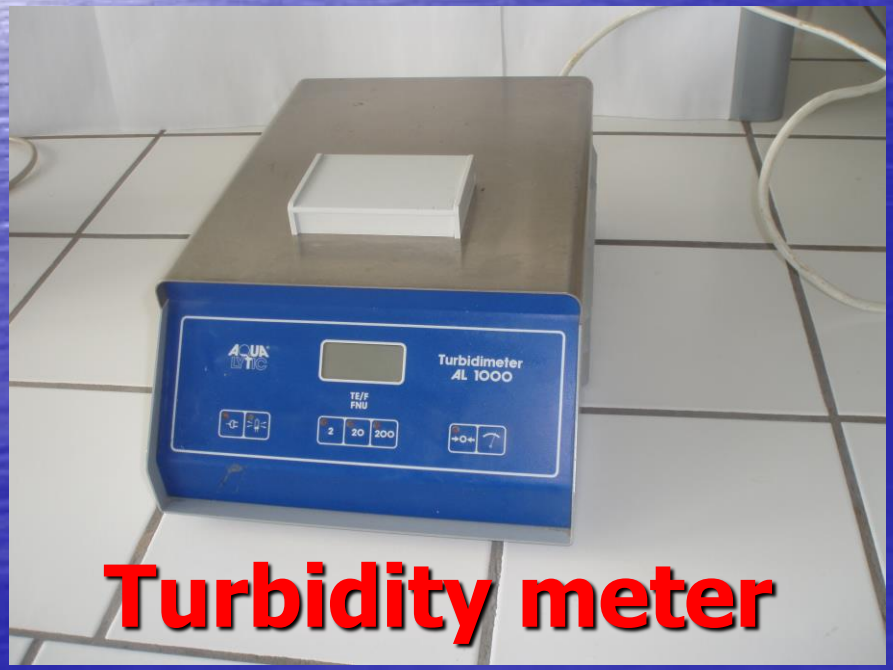
	ΙΑΝ	ΦΕΒ	ΜΑΡ	ΑΠΡ	ΜΑΙ	ΙΟΥΝ	ΙΟΥΛ	ΑΥΓ	ΣΕΠ	ΟΚΤ	ΝΟΕ	ΔΕΚ	ΥΠΕΡΒΑΣΕΙΣ ΣΥΝΟΛΟ	ΜΑΧ	Μ.ΟΡΟΣ	ΠΑΡ.ΤΙΜΗ
ΟΡΓΑΝΟΛΗΠΤΙΚΕΣ ΠΑΡΑΜΕΤΡΟΙ																
Οσμή	Απ/τή	Απ/τή	Απ/τή	Απ/τή	Απ/τή	Απ/τή										Αποδεκτή
Χρώμα	Απ/τό	Απ/τό	Απ/τό	Απ/τό	Απ/τό	Απ/τό										Αποδεκτό
Γεύση	Απ/τή	Απ/τή	Απ/τή	Απ/τή	Απ/τή	Απ/τή										Αποδεκτή
Θολότητα	Απ/τή	Απ/τή	Απ/τή	Απ/τή	Απ/τή	Απ/τή										Αποδεκτή
ΦΥΣΙΚΟΧΗΜΙΚΕΣ ΠΑΡΑΜΕΤΡΟΙ																
Αγωγιμότητα 20°C	1055	1040	1022	1020	1006	1006							0			2500 μS/cm
Συγκέντρωση ιόντων υδρογόνου 25°C	8,15	8,12	8,25	8,02	8,3	8,3							0			6,5-9,5
Αμμώνο NH4	0	0		0	0	0							0			0,5 mg/l
Υπολειμματικό χλώριο	0,11	0,1	0,07	0,03	0	0,1							0			0,1-0,3 mg/l
Νιτρικά NO3	36				20	16							0			50 mg/l
Σίδηρος Fe	0	0,05	0		0,01	0							0			0,2 mg/l
ΜΙΚΡΟΒΙΟΛΟΓΙΚΕΣ ΠΑΡΑΜΕΤΡΟΙ																
Ολικά κολοβακτηριοειδή 37°C-24h	0	0	0	0	0	0							0			0
Escherichia coli (E.Coli) 37°C-24h	0	0	0	0	0	0							0			0

Ο ΥΠΕΥΘΥΝΟΣ

ΣΠΑΝΟΣ Δ. ΘΩΜΑΣ

Conductivity meter

pH meter



Turbidity meter

electronic dosage

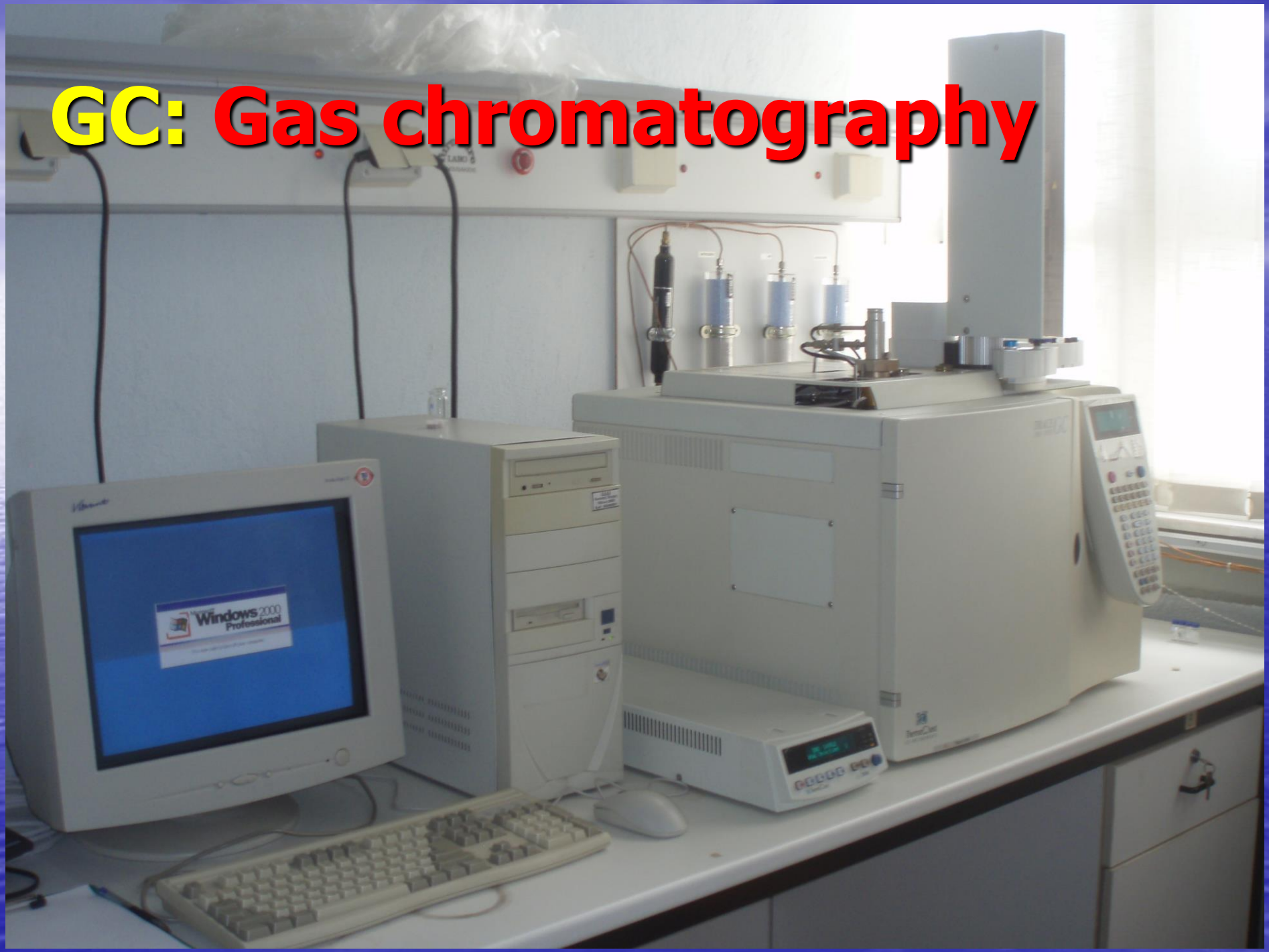
UV-VIS spectrophotometer

COD Instrument

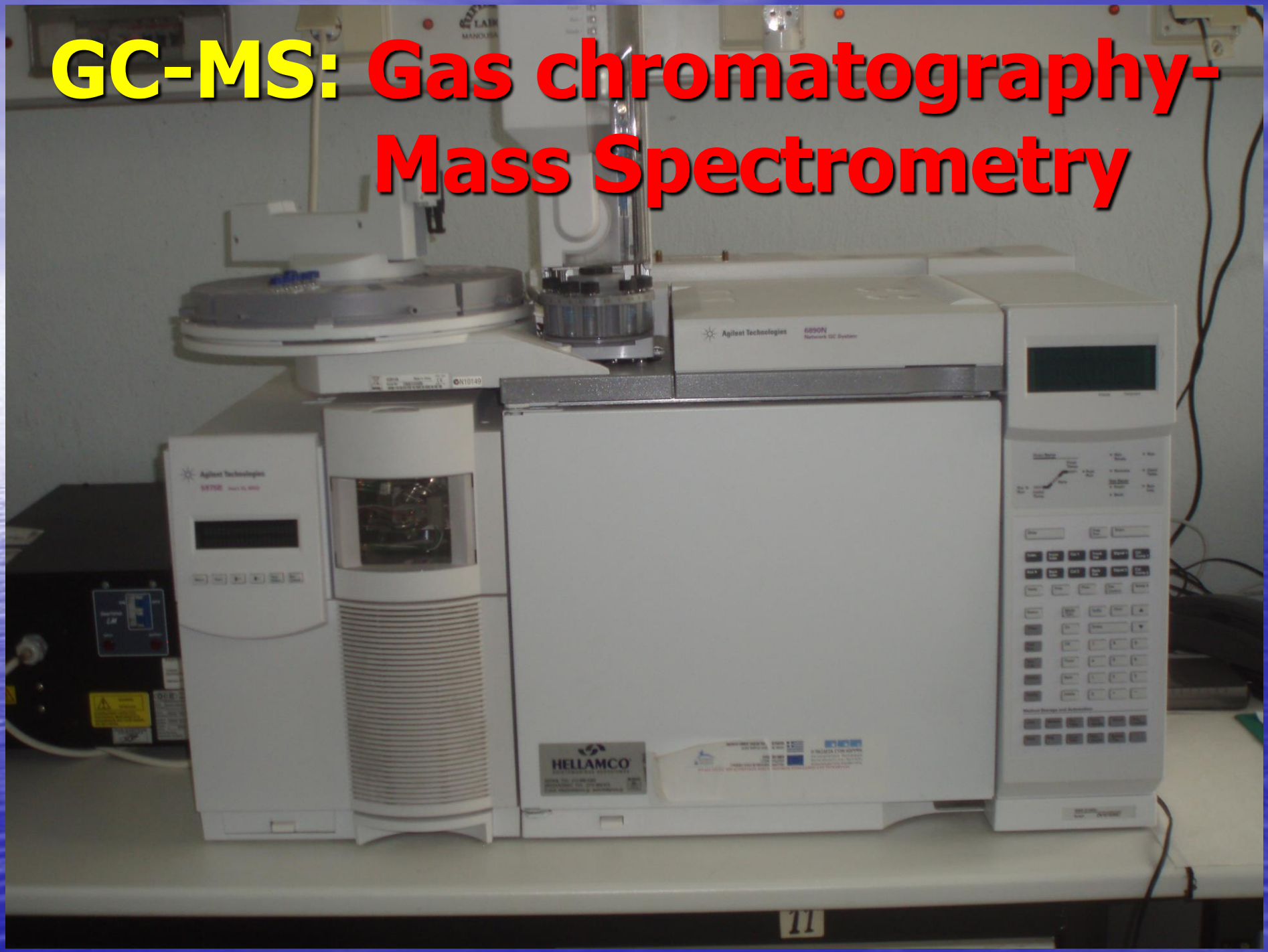
Flame meter

Auto titrator

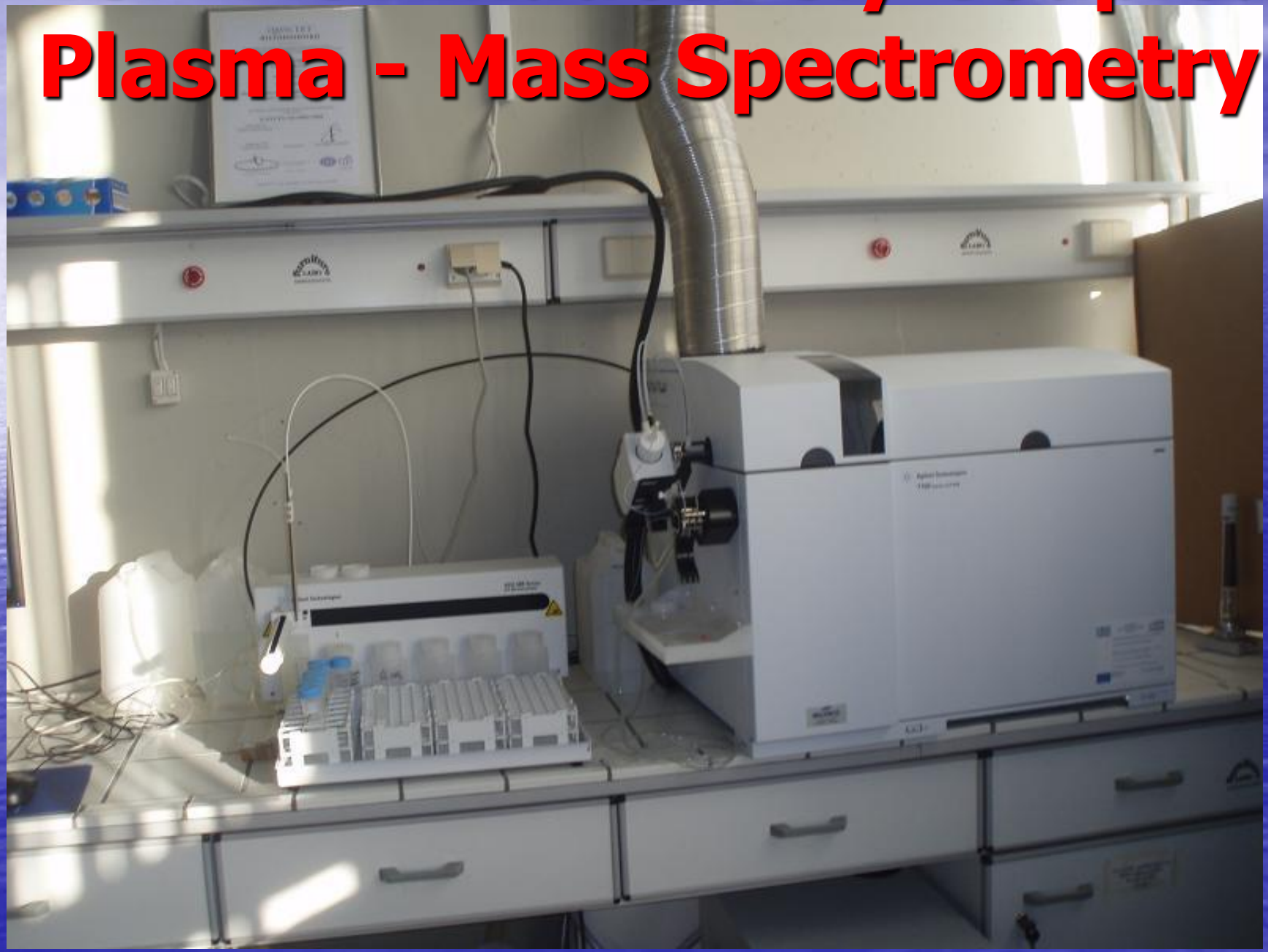
UV-VIS: spectrophotometer


GC: Gas chromatography
Windows 2000
Professional

GC-MS: Gas chromatography-Mass Spectrometry



ICP-MS: Inductively Coupled Plasma - Mass Spectrometry



Offline ICP-MS Data Analysis - 2015_07_15_13M.b - 2015_07_09 13M

DA Method Editor | Process Batch | Conc | Count | Default Columns

File Edit View Process DA Method Report Tools Global Help

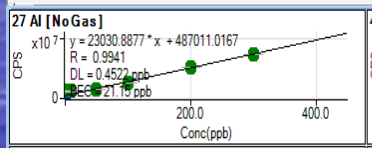
Batch Table : FullQuant

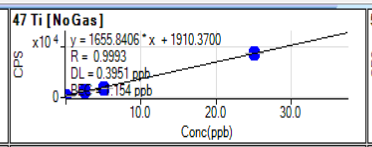
FQ Outlier:

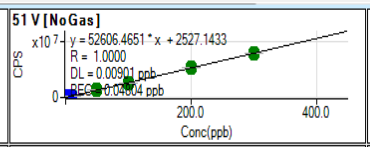
Sample: | Sample Type: <All> | Analyte: 27 Al [No Gas] | ISTD: | Tune Mode: <All>

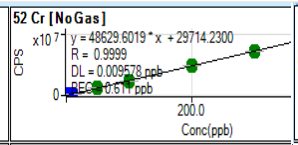
FullQuant

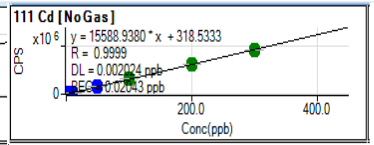
		Rjct	Data File	Acq. Date-Time	Type	Level	Sample Name	27 Al [No Gas] Conc. [ppb]	27 Al [No Gas] Conc. RSD	27 Al [No Gas] CPS	47 Ti [No Gas] Conc. [ppb]	47 Ti [No Gas] Conc. RSD	47 Ti [No Gas] CPS	51 V [No Gas] Conc. [ppb]	51 V [No Gas] Conc. RSD	51 V [No Gas] CPS	52 Cr [No Gas] Conc. [ppb]	52 Cr [No Gas] Conc. RSD	52 Cr [No Gas] CPS	55 Mn [No Gas] Conc. [ppb]	55 Mn [No Gas] Conc. RSD	55 Mn [No Gas] CPS	56 Fe [No Gas] Conc. [ppb]	56 Fe [No Gas] Conc. RSD
1			001CALB.d	7/15/2015 5:30:47 PM	CalBlk	1	Calibration Blank 5%	0.000	N/A	487011.02	0.000	N/A	1910.37	0.000	N/A	2527.14	0.000	N/A	29714.23	0.000	N/A	30016.47	0.000	N/A
2			002CALS.d	7/15/2015 5:36:36 PM	CalStd	2	Std 5 ppb mixt Agilent	31.773	1.5	1218777.87	0.990	35.3	3550.27	6.094	0.9	323116.18	6.315	0.6	336798.94	7.053	0.1	538323.33	42.858	0.4
3			003CALS.d	7/15/2015 5:40:38 PM	CalStd	3	Std 10 ppb mixt Agilent	30.565	3.5	1190956.98	<0.000	N/A	1315.85	10.713	2.1	566098.00	10.990	1.8	564173.91	14.099	2.2	1046100.27	27.238	7.2
4			004CALS.d	7/15/2015 5:44:43 PM	CalStd	4	Std 50 ppb mixt Agilent	47.050	1.4	1570613.39	<0.000	N/A	1293.61	49.916	0.5	2628445.84	50.213	1.5	2471567.50	60.536	1.0	4392721.08	65.470	1.6
5			005CALS.d	7/15/2015 5:48:39 PM	CalStd	5	Std 100 ppb mixt Agilent	91.313	1.1	2590026.98	<0.000	N/A	801.98	98.367	1.7	5177244.39	98.371	1.5	4813442.30	96.973	1.5	7018711.38	92.259	1.7
6			006CALS.d	7/15/2015 5:52:30 PM	CalStd	6	Std 200 ppb mixt Agilent	206.962	1.4	5253537.96	0.270	61.9	2356.73	201.393	0.6	10597111.46	202.383	0.6	9871508.79	200.586	0.4	14485922.66	195.389	1.1
7			007CALS.d	7/15/2015 5:56:20 PM	CalStd	7	Std 300 ppb mixt Agilent	297.614	0.9	7341327.56	0.307	20.9	2418.87	299.588	0.6	15762773.50	298.864	0.8	14563356.12	298.692	1.3	21556276.18	301.870	0.5
8			008CALS.d	7/15/2015 6:00:12 PM	CalStd	8	Std 5 Mo ppb TEI	<0.000	N/A	477104.86	2.654	8.5	6305.33	0.027	72.0	3945.09	<0.000	N/A	26468.76	2.552	0.7	213944.03	1.916	29.8
9			009CALS.d	7/15/2015 6:05:56 PM	CalStd	9	Std 10 Mo ppb TEI	7.575	1.6	661460.09	4.208	0.9	8877.75	0.014	28.6	3253.23	<0.000	N/A	25520.80	3.433	0.7	277394.00	5.841	6.6
10			010CALS.d	7/15/2015 6:11:42 PM	CalStd	10	Std 50 Mo ppb TEI	19.495	4.6	936009.32	25.143	1.1	43543.21	0.081	8.8	6763.69	0.236	6.7	41209.45	5.928	2.0	457271.54	7.000	12.6
11			011CALS.d	7/15/2015 6:17:27 PM	CalStd	11	1 ppm Ag	68.029	3.8	2053770.33	<0.000	N/A	1519.16	0.013	16.5	3192.10	0.014	107.8	30409.73	12.980	1.5	965494.05	14.231	3.9
12			012CALS.d	7/15/2015 6:21:22 PM	CalStd	12	5 ppm Ag	14.352	1.1	817553.91	<0.000	N/A	577.81	<0.000	N/A	1424.19	1.481	1.2	101731.55	4.916	1.0	384333.25	13.315	4.8
13			013CALS.d	7/15/2015 6:27:06 PM	CalStd	13	7 ppm Ag	7.350	2.0	656292.72	<0.000	N/A	914.06	<0.000	N/A	1550.13	2.033	2.3	128594.84	3.033	1.8	248577.38	16.184	0.3
14			014SMPL.d	7/15/2015 6:32:51 PM	Sample		B0	<0.000	N/A	173816.74	0.336	13.6	2466.95	0.005	56.6	2782.73	3.202	0.9	185438.14	<0.000	N/A	29133.42	11.337	5.3
15			015SMPL.d	7/15/2015 6:38:35 PM	Sample		1	20.951	32.6	969520.13	0.293	18.9	2395.64	<0.000	N/A	2190.96	3.157	8.9	183255.36	0.068	93.4	34928.40	11.802	26.9
16			016SMPL.d	7/15/2015 6:43:21 PM	Sample		2	<0.000	N/A	416881.07	0.252	19.2	2327.11	<0.000	N/A	2158.55	2.691	1.5	160586.03	0.066	12.3	34783.66	5.852	10.2
17			017SMPL.d	7/15/2015 6:49:06 PM	Sample		3	7.267	45.4	654376.98	0.460	72.1	2671.62	0.222	7.2	14213.17	3.015	0.9	176310.60	0.433	7.6	61195.26	5.911	10.0
18			018SMPL.d	7/15/2015 6:54:50 PM	Sample		4	252.580	11.5	6304159.41	0.246	42.1	2316.93	0.044	3.9	4835.15	2.711	4.6	161531.00	2.704	9.2	224914.00	13.003	42.6
19			019SMPL.d	7/15/2015 6:58:44 PM	Sample		5	17.340	4.0	886355.80	0.214	19.3	2264.13	0.112	5.5	8420.10	2.687	1.0	160364.84	2.464	1.2	207581.64	2.985	19.9
20			020SMPL.d	7/15/2015 7:04:28 PM	Sample		6	<0.000	N/A	254976.84	0.201	28.9	2242.84	0.094	6.1	7478.81	7.177	0.0	378731.83	8.363	1.2	632719.24	1.487	53.0
21			021SMPL.d	7/15/2015 7:10:11 PM	Sample		7	<0.000	N/A	127282.80	0.046	156.9	1986.31	<0.000	N/A	934.32	2.623	1.5	157287.42	0.200	2.5	44451.76	1.214	61.8
22			022SMPL.d	7/15/2015 7:15:54 PM	Sample		8	15.987	1.2	855213.94	0.465	28.4	2680.88	7.855	0.8	415746.65	2.259	2.0	139569.20	0.279	4.2	50103.55	0.957	71.3

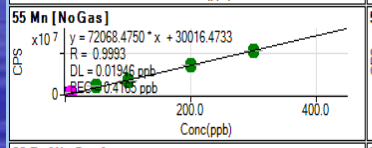


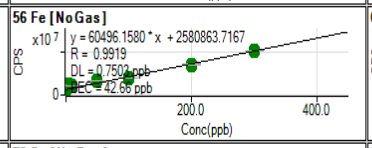


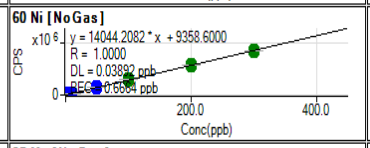


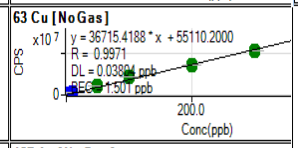


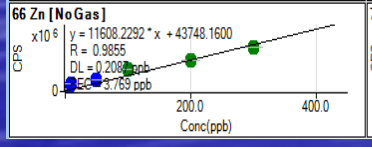


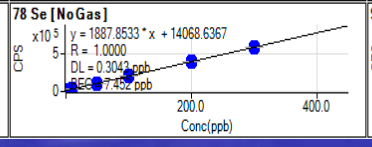


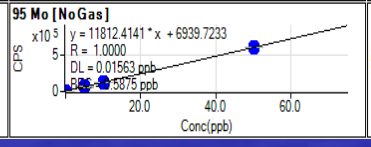


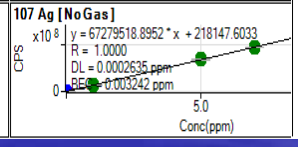


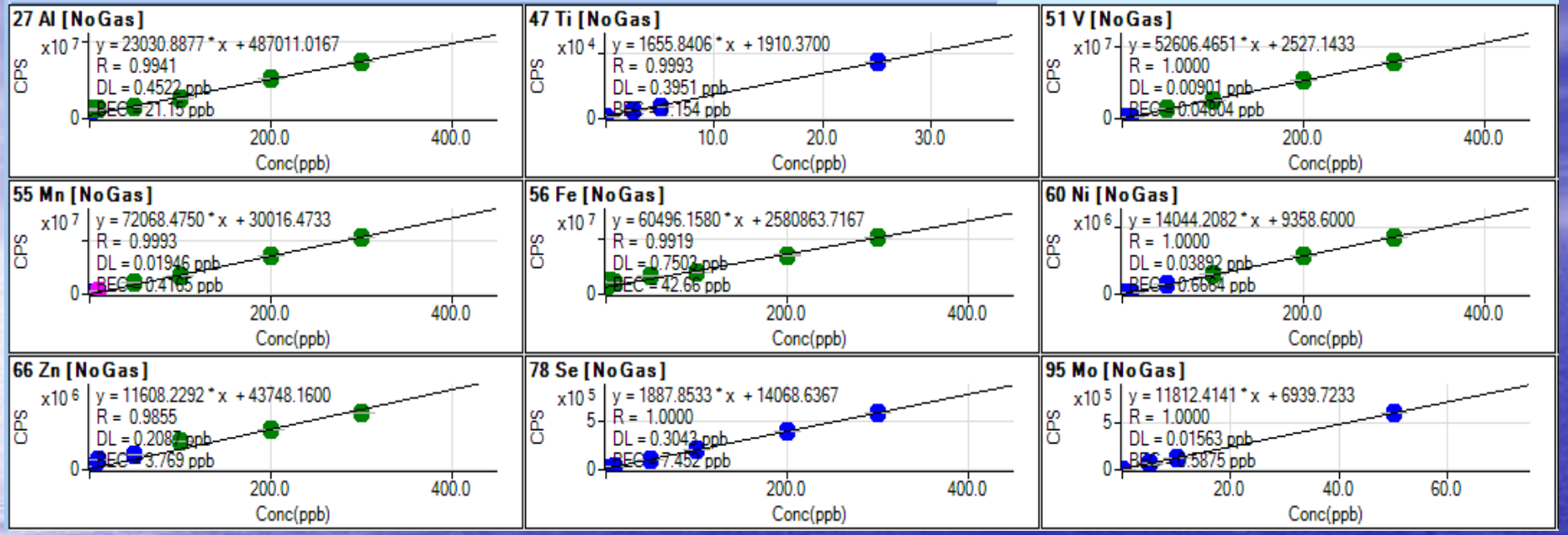


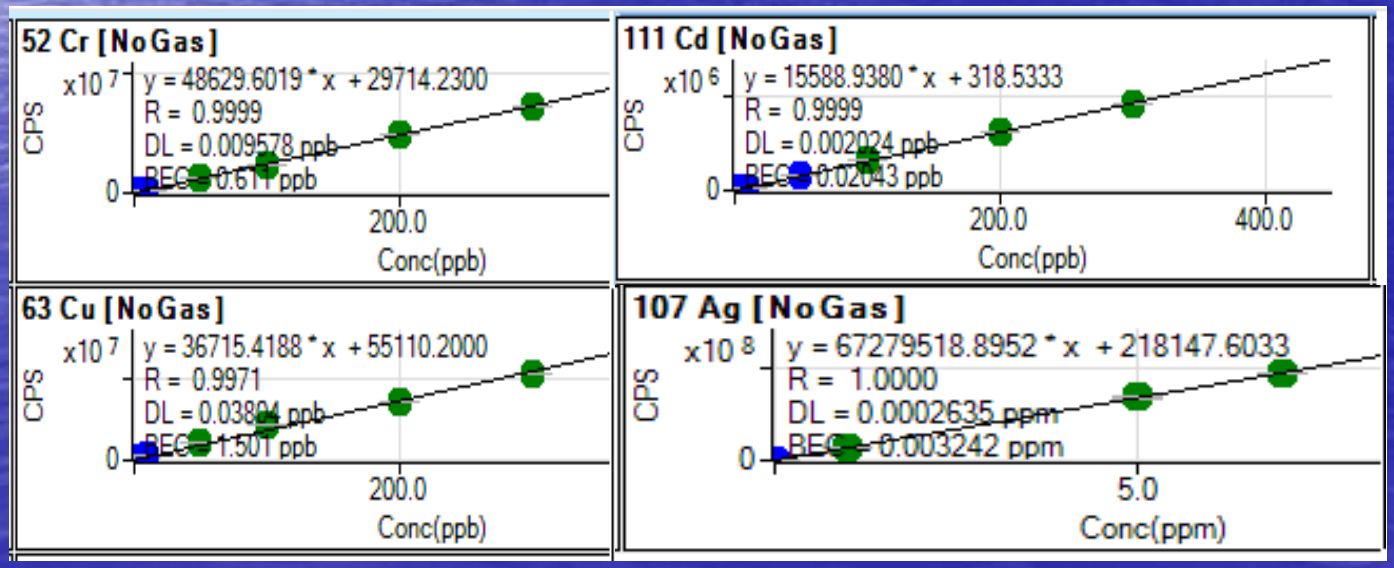




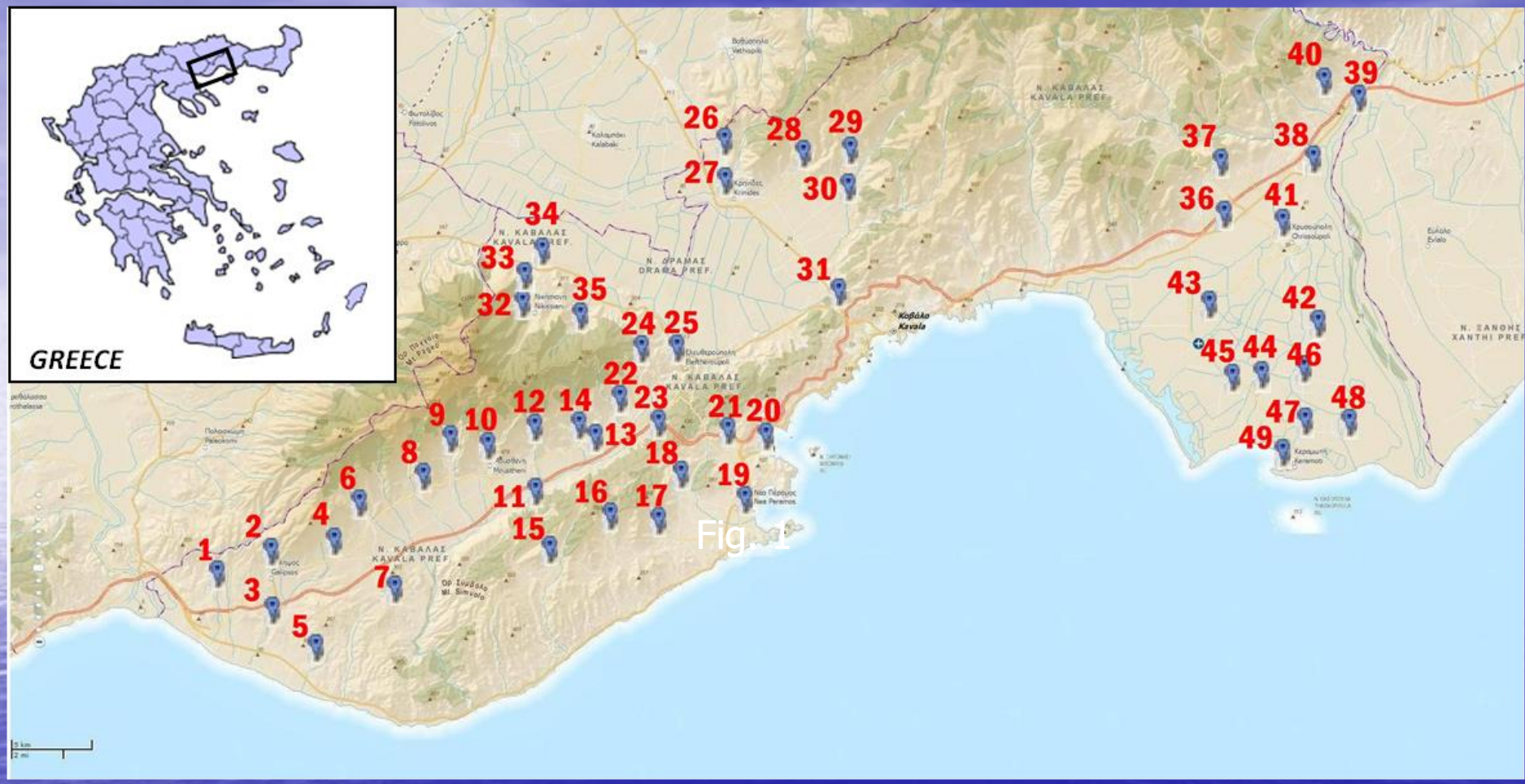





27 Al [NoGas]
x10 7
y = 23030.8877 * x + 487011.0167
R = 0.9941
DL = 0.4522 ppb
REC = 21.15 ppb
CPS
Conc(ppb)
47 Ti [NoGas]
x10 4
y = 1655.8406 * x + 1910.3700
R = 0.9993
DL = 0.3951 ppb
CPS
Conc(ppb)
51 V [NoGas]
x10 7
y = 52606.4651 * x + 2527.1433
R = 1.0000
DL = 0.00901 ppb
REC = 0.04804 ppb
CPS
Conc(ppb)
55 Mn [NoGas]
x10 7
y = 72068.4750 * x + 30016.4733
R = 0.9993
DL = 0.01946 ppb
REC = 0.4165 ppb
CPS
Conc(ppb)
56 Fe [NoGas]
x10 7
y = 60496.1580 * x + 2580863.7167
R = 0.9919
DL = 0.7503 ppb
REC = 42.66 ppb
CPS
Conc(ppb)
60 Ni [NoGas]
x10 6
y = 14044.2082 * x + 9358.6000
R = 1.0000
DL = 0.03892 ppb
REC = 0.6664 ppb
CPS
Conc(ppb)
66 Zn [NoGas]
x10 6
y = 11608.2292 * x + 43748.1600
R = 0.9855
DL = 0.2087 ppb
REC = 3.769 ppb
CPS
Conc(ppb)
78 Se [NoGas]
x10 5
y = 1887.8533 * x + 14068.6367
R = 1.0000
DL = 0.3043 ppb
REC = 7.452 ppb
CPS
Conc(ppb)
95 Mo [NoGas]
x10 5
y = 11812.4141 * x + 6939.7233
R = 1.0000
DL = 0.01563 ppb
REC = 0.5875 ppb
CPS
Conc(ppb)


52 Cr [NoGas]
x10 7
y = 48629.6019 * x + 29714.2300
R = 0.9999
DL = 0.009578 ppb
REC = 0.611 ppb
CPS
Conc(ppb)
111 Cd [NoGas]
x10 6
y = 15588.9380 * x + 318.5333
R = 0.9999
DL = 0.002024 ppb
REC = 0.02043 ppb
CPS
Conc(ppb)
63 Cu [NoGas]
x10 7
y = 36715.4188 * x + 55110.2000
R = 0.9971
DL = 0.03804 ppb
REC = 1.501 ppb
CPS
Conc(ppb)
107 Ag [NoGas]
x10 8
y = 67279518.8952 * x + 218147.6033
R = 1.0000
DL = 0.0002635 ppm
REC = 0.003242 ppm
CPS
Conc(ppm)

LA-ICP-MS: Laser Ablation - Inductively Coupled Plasma - Mass Spectrometry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KAVALA PREF.
N. DRAMAS
DRAMA PREF.
Kavala
Fig. 1

Fig. 1

CA is used to group objects based on their features. Essentially, CA classifies objects characterized by a set of variables so that each object is very close to each other in the same cluster.

PCA is widely used as a dimension reduction, modeling and display method in its two-way or multi-way mode (new factors).

Multiple regression on principal components (source apportioning) is a very important environmetric approach which makes it possible to apportion the contribution of each latent factor (emission source) identified by PCA on the data set to the total mass (concentration) of a certain chemical variable. In this way it is possible to determine the impact of different factors, (both anthropogenic and natural), on the groundwater quality.

Cluster Analysis in parameters: 2 clusters
hardness, mineral components

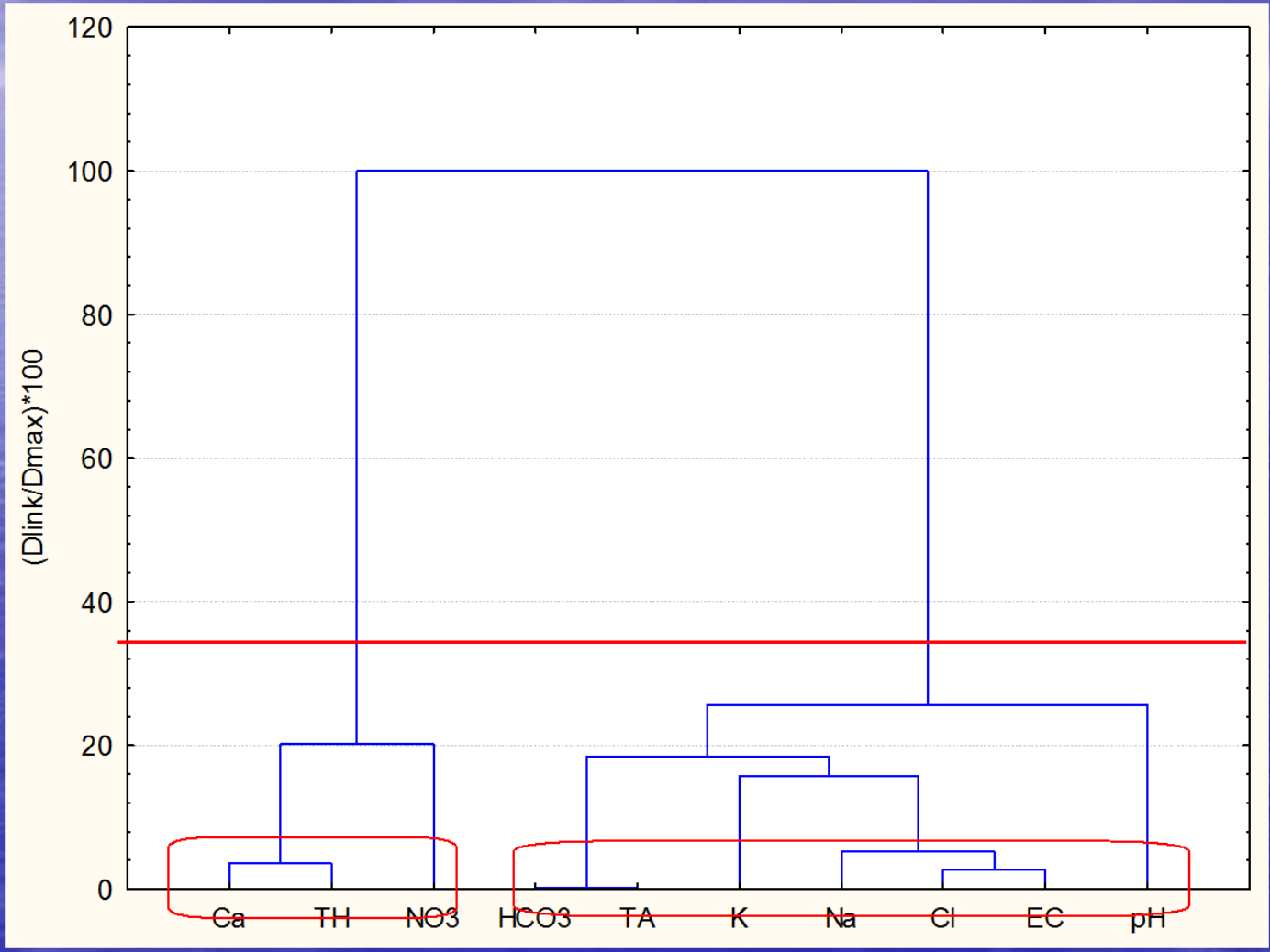


Fig. 2

CA in sampling locations: 3 clusters

K1 costal=7, K2 lowland=21, k3 semi mountainous=21

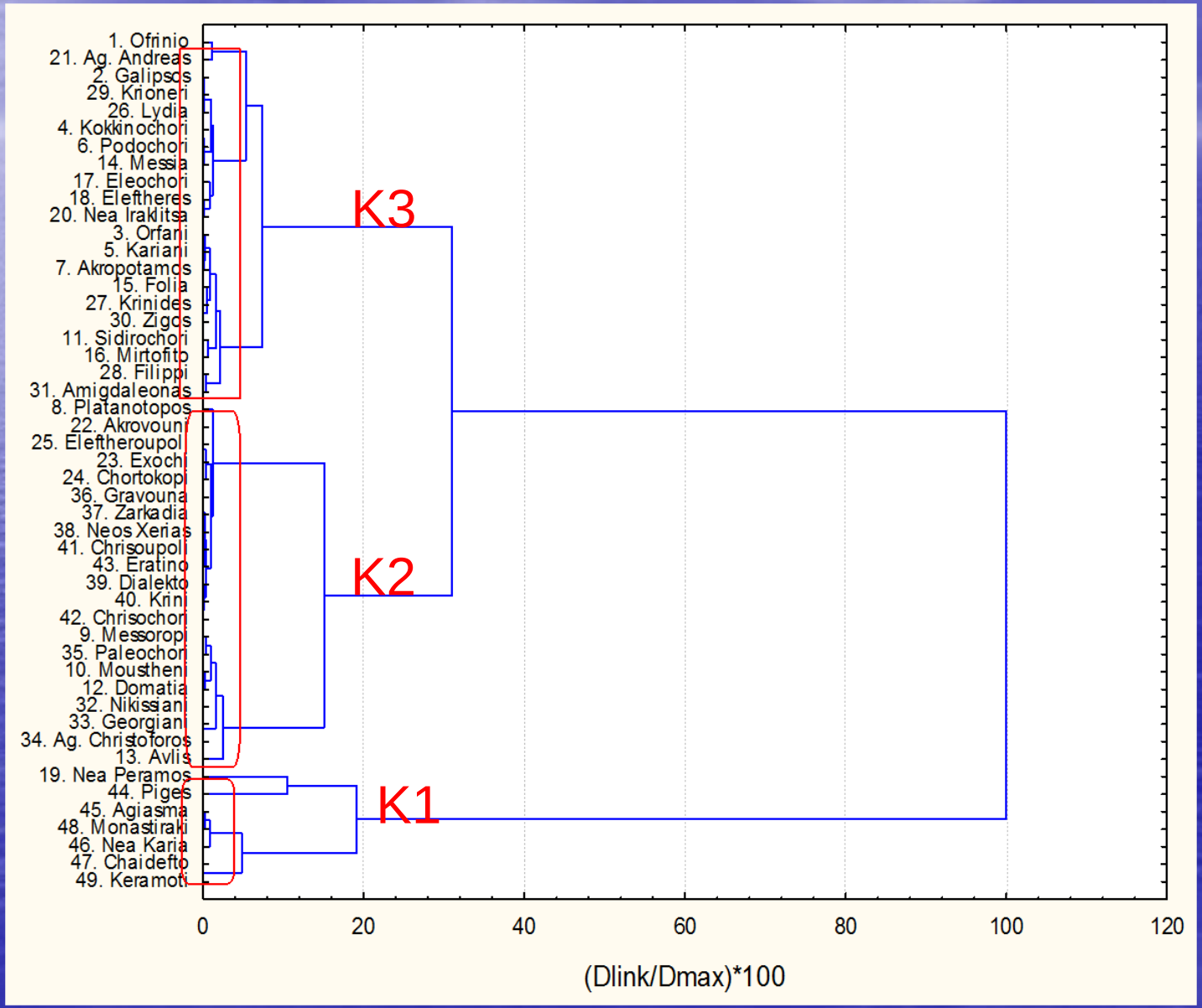


Fig. 3

Averages for chemical parameters in each cluster of sampling locations

Cluster	pH (units)	EC (µS/cm)	NO_3 (mg/L)	Cl (mg/L)	Na (mg/L)	K (mg/L)	TA (mg/L)	TH (mg/L)	HCO_3 (mg/L)	Ca (mg/L)
K1	**8.09**	**936.01**	**5.21**	**97.01**	**184.52**	**6.09**	**317.09**	**8.02**	**390.85**	**8.78**
K2	**7.76**	**365.52**	**7.34**	**4.14**	**5.66**	**1.08**	**170.10**	**18.20**	**203.99**	**45.73**
K3	**7.55**	**554.78**	**17.19**	**15.94**	**18.00**	**1.84**	**243.60**	**24.02**	**299.72**	**48.70**

Significant differences for the 3 clusters

Table 1

Principal Components Analysis using *Varimax* rotation mode

Variable	PC1	PC2
pH	0.16	-0.80
EC	**0.96**	-0.06
NO_3	0.05	**0.66**
Cl	**0.79**	-0.27
Na	**0.78**	-0.59
K	**0.61**	-0.21
TA	**0.90**	0.03
TH	-0.10	**0.94**
HCO_3	**0.91**	0.02
Ca	-0.23	**0.81**
Expl. variance %	43.1	31.2

are responsible for the data structure

PC1 – "mineral content" factor;
PC2 – "water hardness" factor;
statistically significant loadings are marked in bold.

Table 2. Factor loadings

over 70%

Principal Components Regretion
source apportionment in %

Variable	Intercept	PC1 (mineral)	PC2 (water hardness)	R^2
pH	12.6	22.8	64.6	0.64
EC	8.6	**91.4**	-	0.85
NO_3	12.5	8.2	**79.3**	0.72
Cl	13.5	**72.7**	13.8	0.81
Na	8.1	**77.7**	14.2	0.79
K	12.1	**71.5**	16.4	0.77
TA	11.1	**88.9**	-	0.85
TH	5.6	-	**94.4**	0.84
HCO_3	8.1	**81.2**	10.7	0.81
Ca	8.1	12.3	**79.6**	0.82

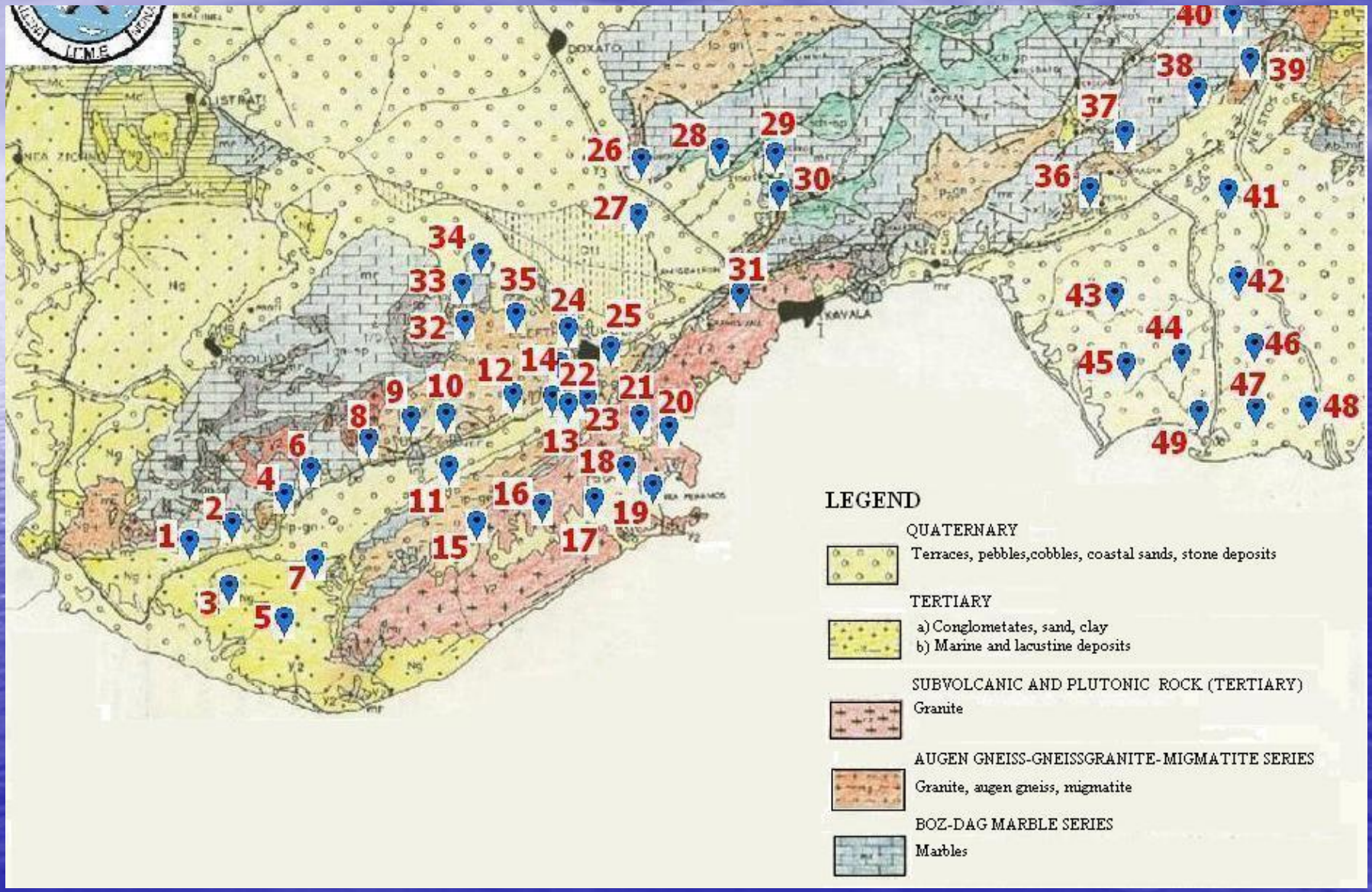
Table 3

Estimate the source emissions without direct measurement.

Large contribution % of PC1 and PC2 to the parameters concentration.

R2 close to 1 indicates good model validity.

The geological map of the investigated region in Northern Greece



Conclusion

By the use of multivariate statistical approaches like cluster analysis, principal component analysis, source apportionment by multiple linear regression on absolute principal component scores for interpretation of the complex water databases, it is possible to gain a better understanding of groundwater quality in the study region and the extraction of hidden information from the data set about the probable influences of the environment on the water quality.

This study leads to significant additional information about the water sources in Kavala area Greece and can assist in important scientific or political decisions for water quality management.

Publications

- Thomas Spanos1, Antoaneta Ene2*, Pavlina Simeonova3 "**Chemometric expertise of the quality of groundwater sources for domestic use**" Journal of Environmental Science and Health, Part A. Toxic/ Hazardous Substance & Environmental Engineering 50, 1099-1107, (**2015**).

- Thomas Spanos1, Antoaneta Ene2*, Christina Xatzichristou1, Agelos Papaioannou4 **"Assessment of Groundwater Quality and Hydrological Profile of Kavala Area, Northern Greece"** Romanian Journal of Physics 50 (11) 572-581, (**2015**).

- Thomas Spanos1, Antoaneta Ene2, Irina B. Karadjova3 **"Assessment of toxic elements Cu, Cr, Ni, Pb, Cd, Hg, Zn and Hexavalent Chromium in Sewage Sludge from Municipal Wastewater Treatment Plants by Combined Spectroscopic Techniques"**, Romanian Journal of Physics 60 (1-2), 237-245, (**2015**).