On the heavy elements content of sediments and rocks from two semiclosed ecosystems: proglacial lake Bâlea (Făgăraş Mountains) and crater lake St. Ana (Harghita Mountains)

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Aims

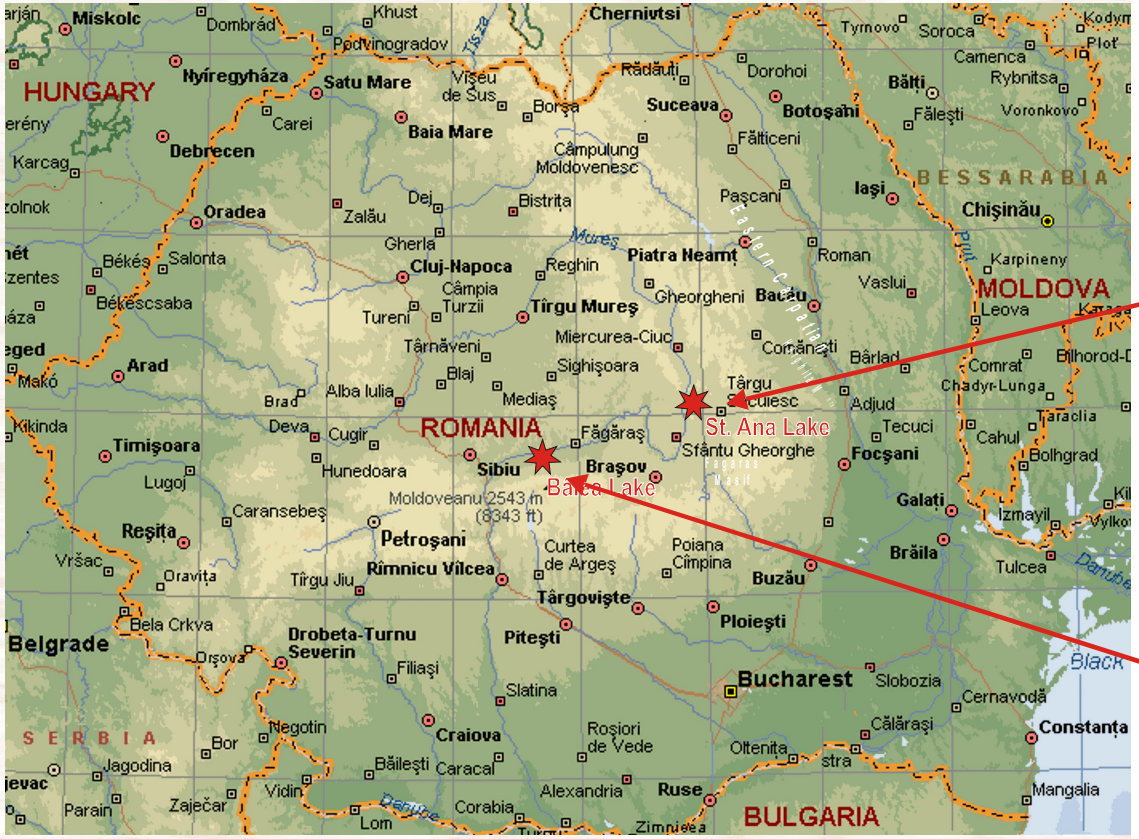
- To investigate the environmental status of two semiclosed ecosystems, far away from any sources of industrial pollution, in order to establish a "reference level" for pristine, uncontaminated source of water.
- To establish similitudes and differences between these ecosystems in order to predict their future evolution.
- To initiate and maintain a long term international cooperation regarding environmental analysis.

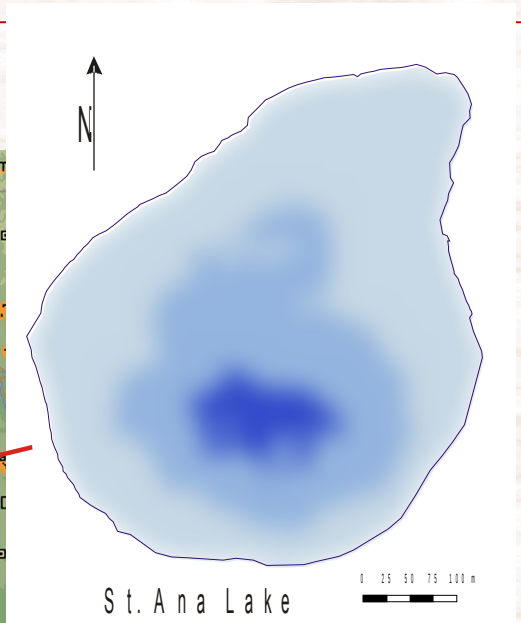
Lakes

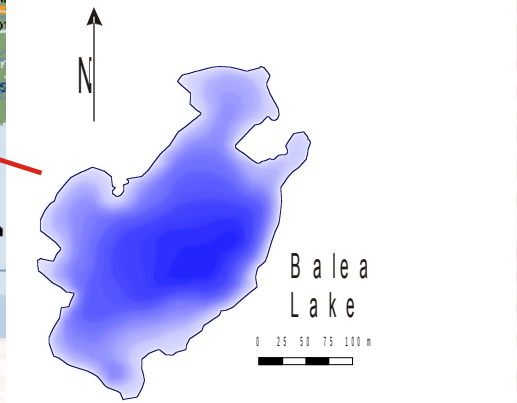
- For this purpose we have chosen two lakes with different origin: proglacial lake Bâlea and crater lake St. Ana, unique in Romania and among the few existing in Europe.

- Both lakes are high altitude lakes, far away from any source of industrial pollution. Due to geographical location, both of them are accessible only in summer time and to a restrained number of tourists.

Lakes


HUNGARY
ROMANIA
SERBIA
BULGARIA
BESSARABIA
MOLDOVA
Miskolc
Debrecen
Nyíregyháza
Satu Mare
Baia Mare
Oradea
Cluj-Napoca
Târgu Mureş
Arad
Timişoara
Sibiu
Braşov
Bârsa Lake
St. Ana Lake
Piatra Neamţ
Bacău
Iaşi
Chişinău
Suceava
Botoşani
Galaţi
Brăila
Buzău
Ploieşti
Bucharest
Craiova
Drobeta-Turnu Severin
Rîmnicu Vîlcea
Petroşani
Reşiţa
Târgovişte
Piteşti
Constanţa
Belgrade
Moldoveanu 2543 m (8343 ft)
Mureş
Danube
Black


N
St. Ana Lake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Balea Lake

Bâlea lake:

- 4.6 ha and 11.4 m maximum depth
- the greatest of its kind in Făgăraş Mountains,
- located in the homonym glacial depression (cyrcus), at an altitude of 2050 m
- minerotrophic lake with an active water circulation, typical for high altitude glacial lakes
- slow accumulation of sediments: 20 cm to 80 cm thick
- no older than 10 ky

Bâlea lake:

Bâlea lake:

- Bâlea glacial circus is located in the Suru Formation which belongs to the Făgăraş Series
- The main lithological association is constituted of chlorite-sercitous schists, amphibolic schists and limestones representing an area affected by the retromorphism rebalanced under low grade conditions
- Lake sediments consist of two fractions: a coarser one deriving from the gnessic and amphibolic fraction and a finer, sandy one, originating from the mylonitic and limestone fraction

St. Ana lake:

St. Ana lake:

- the unique crater lake in Romania, occupies the Southern crater of Ciomadu extinct volcano
- Located in a volcanic caldera, at an altitude of 2050 m
- ombotrophic lake with no water circulation
- relatively rapid accumulation of sediments consisting of fine silt and organic detritus: 4 m thick
- last eruption of Ciomadu volcano was dated about 28 ky ago

Materials and Methods

Samples:

- totally five cores with about 2 m of sediments from both lakes and about 55 samples of rocks
- Bâlea lake: paragneisses (paragneisses, paragneisses associated with chloritic schists, quartzo-feldsparic paragneisses with garnets and paragneisses associated with amphibolitic schists) and amphibolites, characteristic for the Suru Formation.
- St. Ana lake: only fragments of andesite, collected from different location within volcanic caldera

Materials and Methods

Digital radiography:

- All digital radiographic images of cores were obtained in the same experimental conditions, *i.e.* anodic potential of 110 kV, anodic current of 30 mA, scanning speed of 1 cm/s, at a vertical resolution of 0.5 mm and a horizontal resolution of 0.3 mm, by using a home made CT.

- After been X-rayed, all cores were cut into two cm sections for further investigations.

Materials and Methods

Activation Analysis:

- was carried out at the research reactor of WWR IRT type, at the Moscow Engineering Physics Institute (Moscow). Samples weighing 100–200 mg, together with reference materials: IAEA-433, IAEA 140/TM, IAEA SL-1 and IAEA Soil-7, were irradiated with thermal neutron in the vertical experimental channels at a fluency density of of $9\text{-}10^{12}$ n $cm^{-2}s^{-1}$ for 15–20 h.

- Sc, Cr, Co, As, Se, Br and Sb

Materials and Methods

Activation Analysis:

- Sc almost no industrial significance, excellent reference element for uncontaminated environment
- Cr, Co, As, Se, Br and Sb are all of them heavy elements (metals) intensively used in industrial activities and whose presence could be associated with anthropogenic pollution
- All of them could be very well investigated by INAA

Materials and Methods

Activation Analysis:

- All gamma spectra were recorded by using a HPGe detector of ORTEC GEM 25185 type with an energy resolution of 1.85 keV for the 1332 keV of ^{60}Co line.

- by using IAEA SL-1, IAEA Soil-7 samples, the difference between our values and certified values, for both of them were less than 1% for Rb and Tl in Soil-7 and 14.7 % in the case of Nd in Soil-7.

Materials and Methods

Activation Analysis:

- After activation, measurements were performed three times, in three different phases:
- 5 to 10 days after exposure, the contents of Na, As, Br, Sb, La, Sm, Yb, Lu, Au were determined;
- the second set of measurements were carried out 15 to 25 days after irradiation with the determination of Fe, Cr, Rb, Ce, Nd, Tb;
- in the third and final phase, 40 to 45 days after exposure, we have determined the content of the most long lived radionuclides Sc, Co, Cs, Eu and Ta.

Materials and Methods

Statistical assessments:

- To interpret of our data, we have used both Correlation Analysis (CA) and Principal Component Analysis (PCA) in connection with similar data corresponding to the Upper Continental Core (UCC), Pacific and Indian Oceans MORB or established by actual Romanian Regulations concerning the environmental pollution.
- All statistical analysis were performed by means of StatSoft® Statistica 6.0.

Results and Discussion

Sediments:

- Sediments collected from the Bâlea Lake consisted, at their upper part, mainly of blackish, seldom green-grayish silt, with fragments of vegetation and few aquatic invertebrates, while the deeper ones contained also sand and fine to coarse gravel.

- The granulometric analysis showed the predominance of silt up to 80%, while vegetal fragments, sand as well as gravel or lithic fragments accounted for the rest of 20%.

Results and Discussion

Sediments:

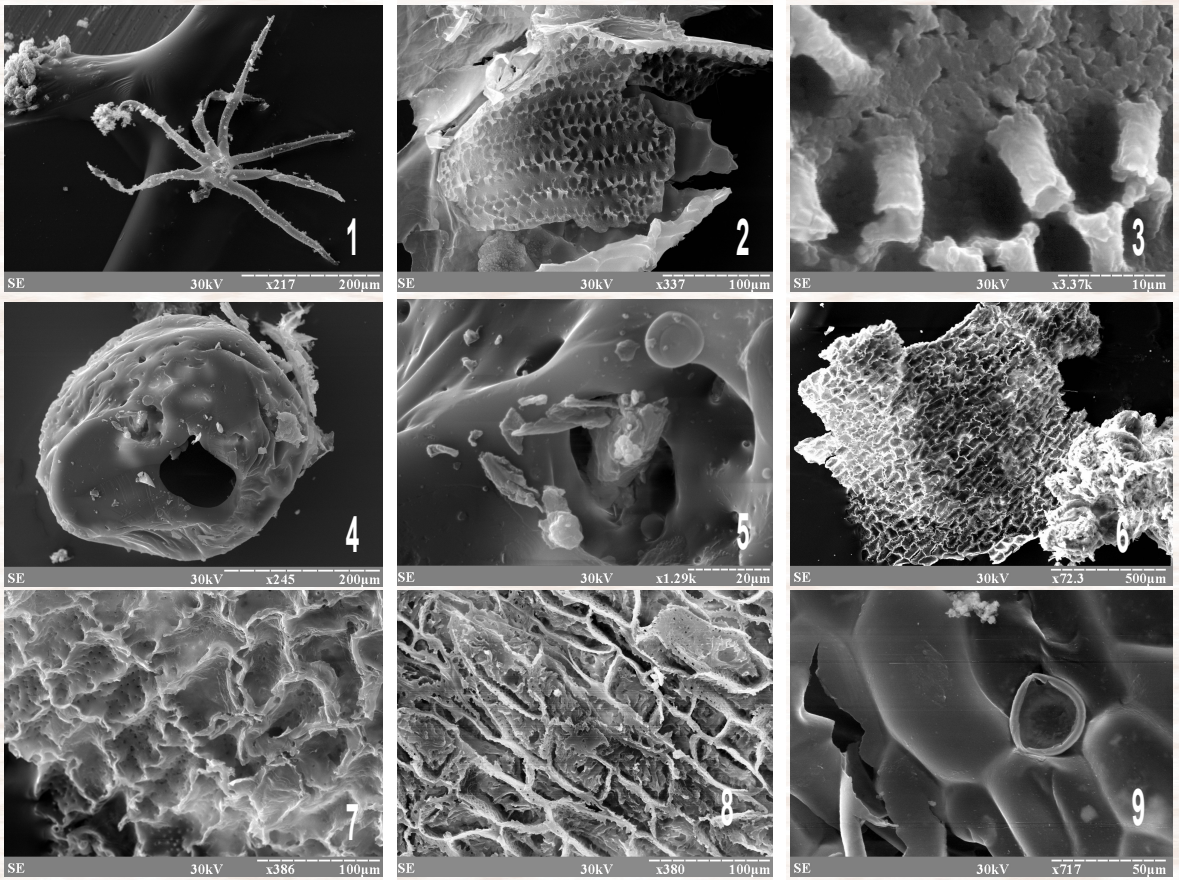
- The sediments of St. Ana Lake were more homogenous, consisting of brownish silt, rich in fragments of vegetation and in some places, exhaling a weak odor of H_2S.

- Digital radiographies of also illustrated the difference between the vertical profiles of Bâlea and Sf. Ana cores, the first one presenting, at their inferior part more lithic fragments than in the case of Sf. Ana, which appear almost homogenous.

Results and Discussion

Sediments (SEM images)

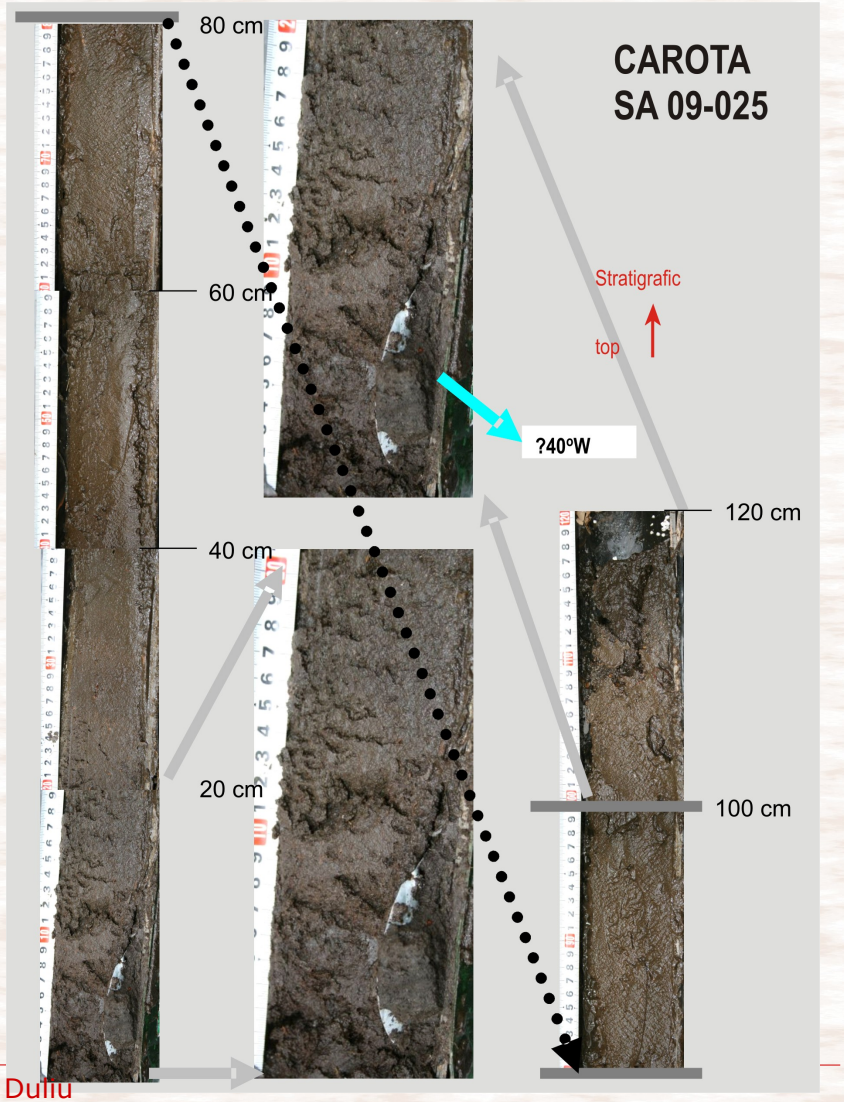
1 Fungi (fragment)
2-5 Diatoms (fragments)
6-9 Vegetal tissue (fragments)



Results and Discussion

Sediments

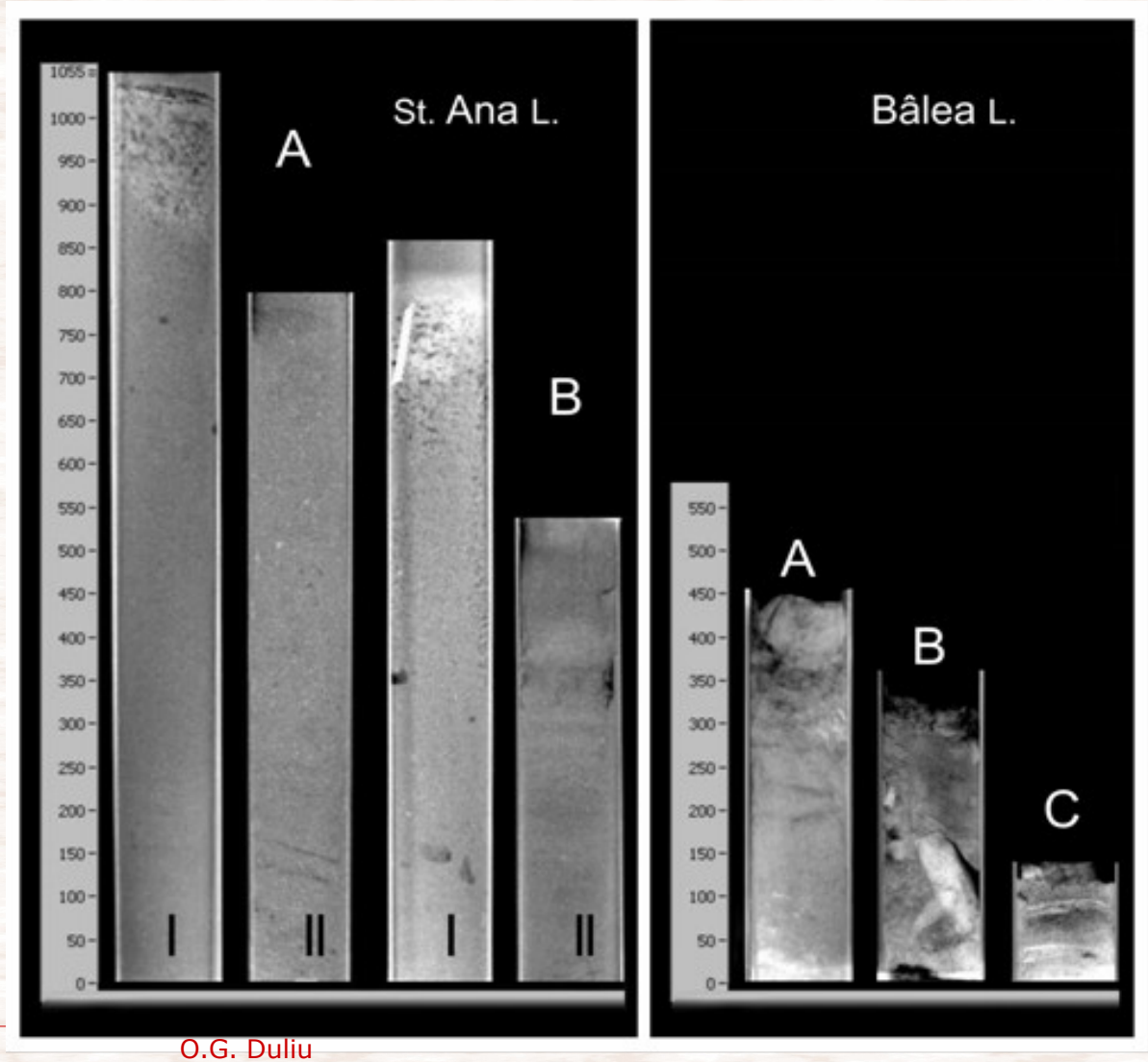
A general view of sediments collected from St. Ana Lake, rich in vegetal detritus.



Results and Discussion

Sediments

Significant differences concerning texture and mineral content due to local petrology



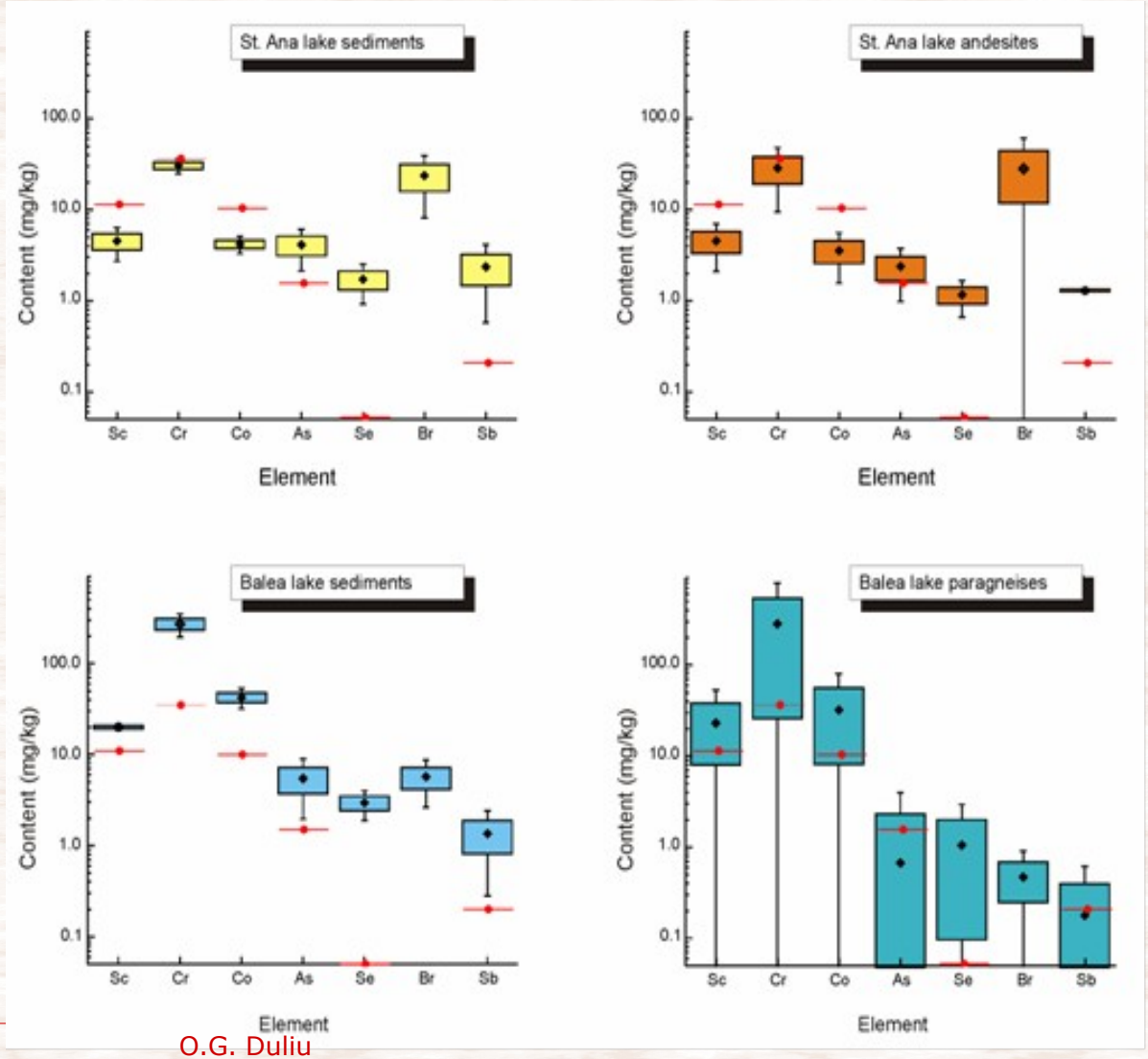
Results and Discussion

Activation Analysis:

	Sample		Sc	Cr	Co	As	Se	Br	Sb
St. Ana Lake	Sediments								
		Aver	4,5	31	4,2	4,1	1,7	23,7	2,4
		StDev	0,9	3	0,4	1,0	0,4	7,4	0,9
	Andesite								
		Aver	4,5	29	3,6	2,4	1,2	28,3	1,3
		StDev	1,2	10	1,0	0,7	0,3	16,4	0,0
Balea Lake	Sediments								
		Aver	20,0	272	42,3	5,5	3,0	5,7	1,4
		StDev	0,8	39	5,3	1,8	0,5	1,5	0,5
	paragneiss		14,5	404	30,0	<0.1	2,1	0,6	0,1
	paragneiss		12,8	81	14,0	<0.1	<0.5	0,4	0,1
	paragneiss		9,9	51	11,0	<0.1	0,9	0,3	0,1
	paragneiss + chloritic schists with garnets		31,5	693	69,0	4,3	2,5	0,2	0,1
	amphibolite +amphibolitic schist		29,0	37	52,0	<0.1	2,6	0,3	0,3
	paragneiss + amphibolitic schist		52,0	480	60,0	<0.1	<0.5	0,6	0,7
	paragneiss + chloritic schists		18,2	106	20,0	<0.1	0,9	0,3	0,1
	paragneiss + chloritic schists		19,1	114	16,0	<0.1	<0.5	0,8	0,1
		Aver	24,9	291	39,3	4,3	2,0	0,4	0,2
		StDev	16,0	274	24,5	-	0,8	0,2	0,2
	RR normal		-	30	15	5	1	50	5
	RR alert		-	100	30	15	3	100	12,5
	UCC		11	35	10	1,5	0,05	2.1	0,2
	MORB Pacific		31,8	714,3	nd	nd	nd	nd	nd
	MORB Indian		39,1	254,4	nd	nd	nd	nd	nd

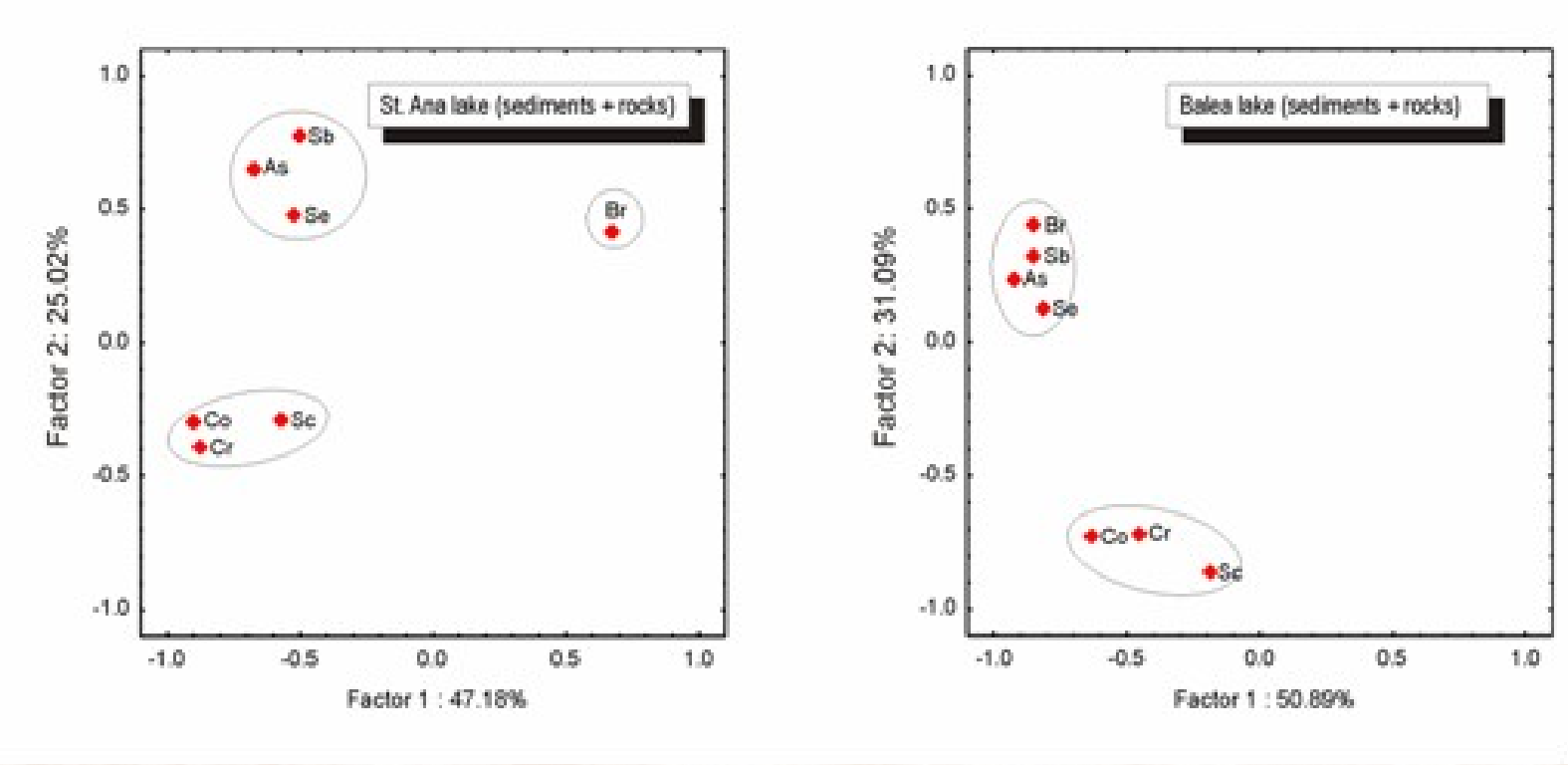
Results and Discussion

Activation Analysis:



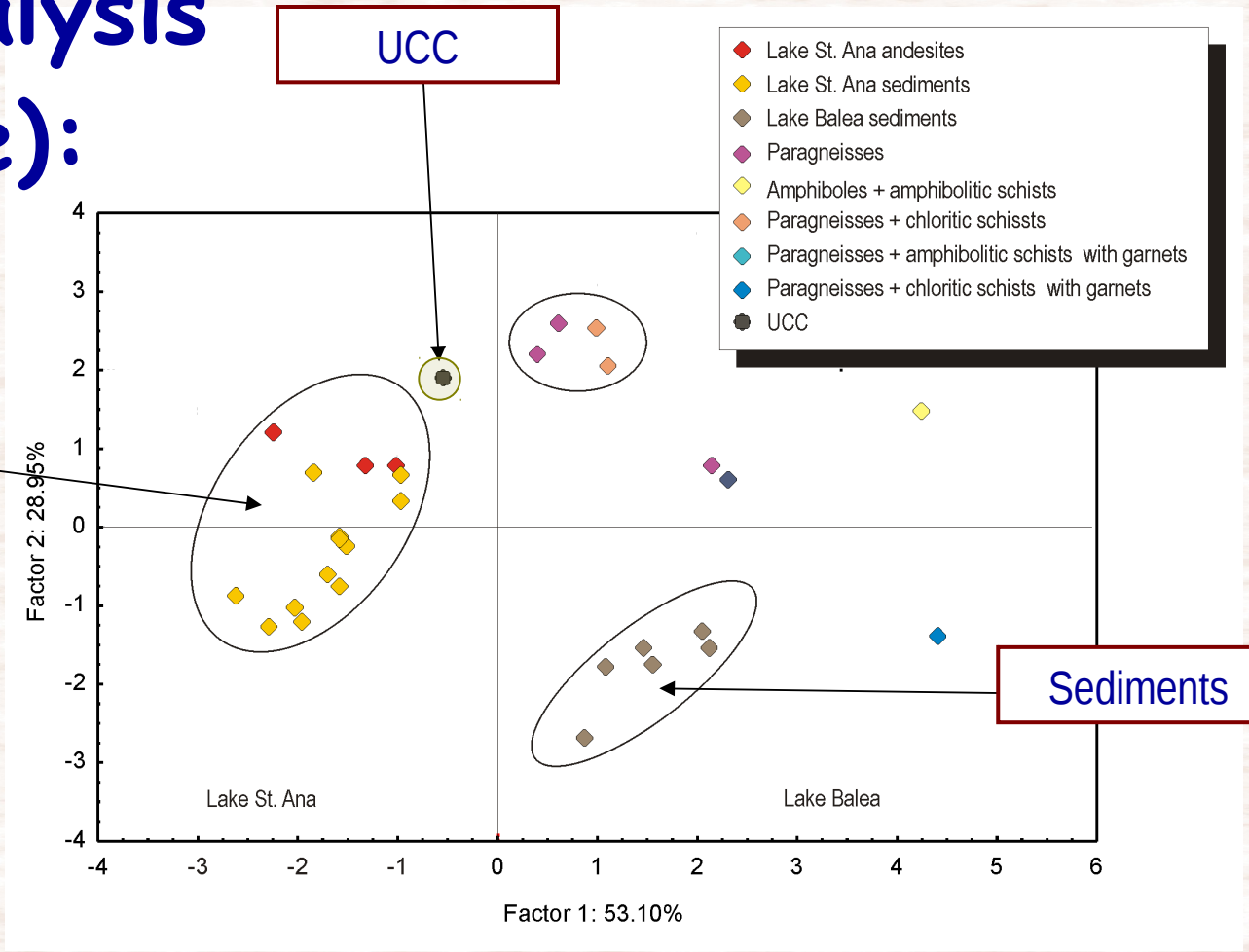
Results and Discussion

PCA Analysis (R mode):



Results and Discussion

PCA Analysis (Q mode):



Concluding Remarks

- By comparing the content seven heavy elements (Sc, Cr, Co, As, Sb, Br and Se) in sediments with those of surrounding rocks as well as with the numerical values stated by Romanian Regulations concerning the Environmental Pollution, it was established that, although their average content was different for the two lakes, all of them could be considered as natural, non polluting elements, but reflecting the significant differences between the petrology of their locations.

Concluding Remarks

- At the same time, Principal Component Analysis performed both in R and Q-mode allowed us to establish that in the case of R-mode analysis, all elements form two similar clusters, regardless the lake, while in the case Q-mode analysis, the samples form few clusters, reflecting their location.

Concluding Remarks

- These peculiarity should be taken into account when we intend to declare an environment pristine, free of any anthropogenic influence.

- In our cases the differences between two lakes regarding the content of Cr, As and Br could induce the apparent idea of a pollution process, fact unconfirmed by the geochemistry of surrounding formations.

Acknowledgment

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Thanks

Thank you for attention !