UNECE ICP VEGETATION
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ATMOSPHERIC DEPOSITION OF MAJOR AND TRACE ELEMENTS IN THE MOUNTAIN CRIMEA STUDIED BY THE MOSS BIOMONITORING TECHNIQUE

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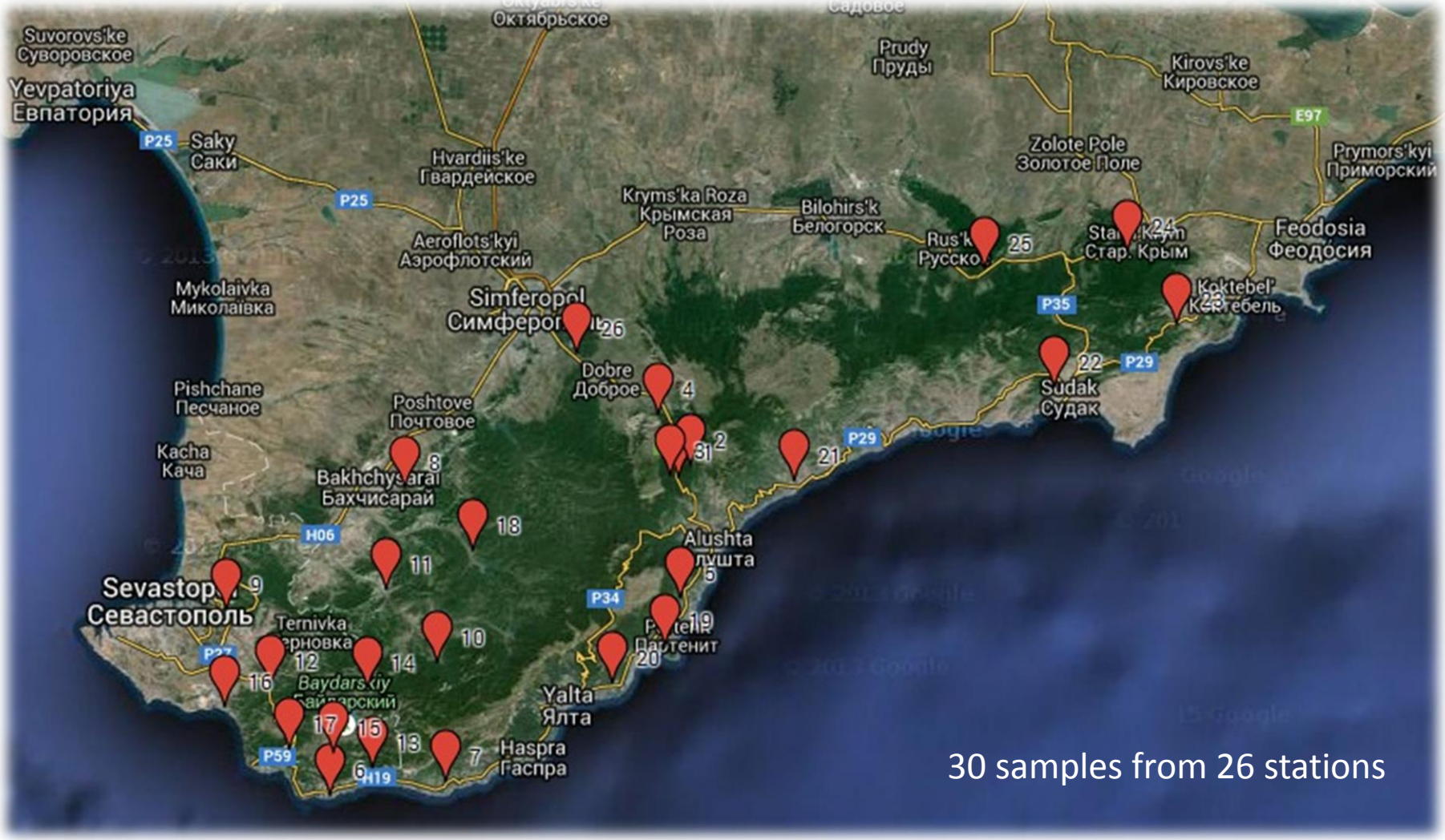
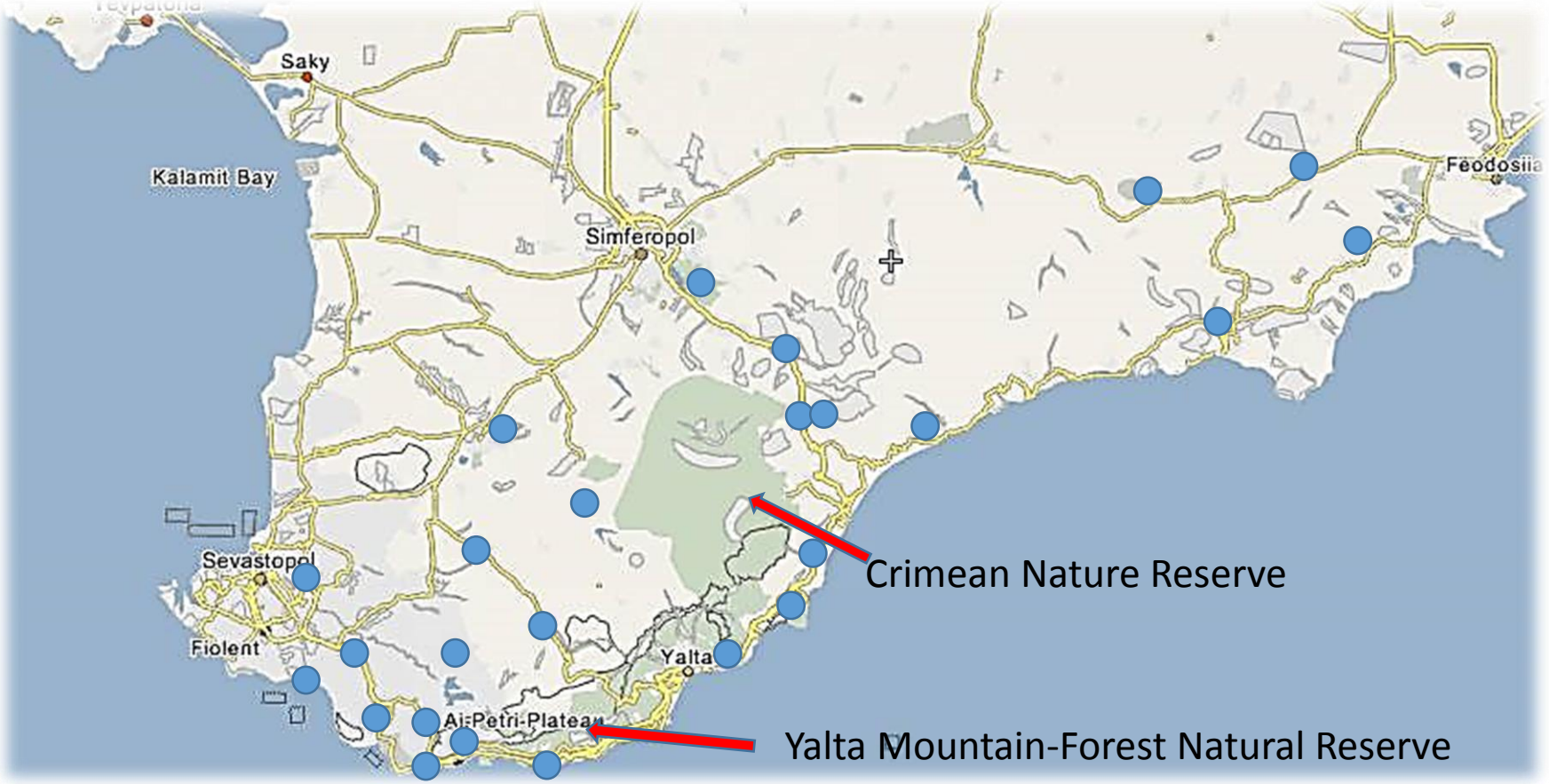
Sampling



30 samples from 26 stations

Region of studies



Mosses

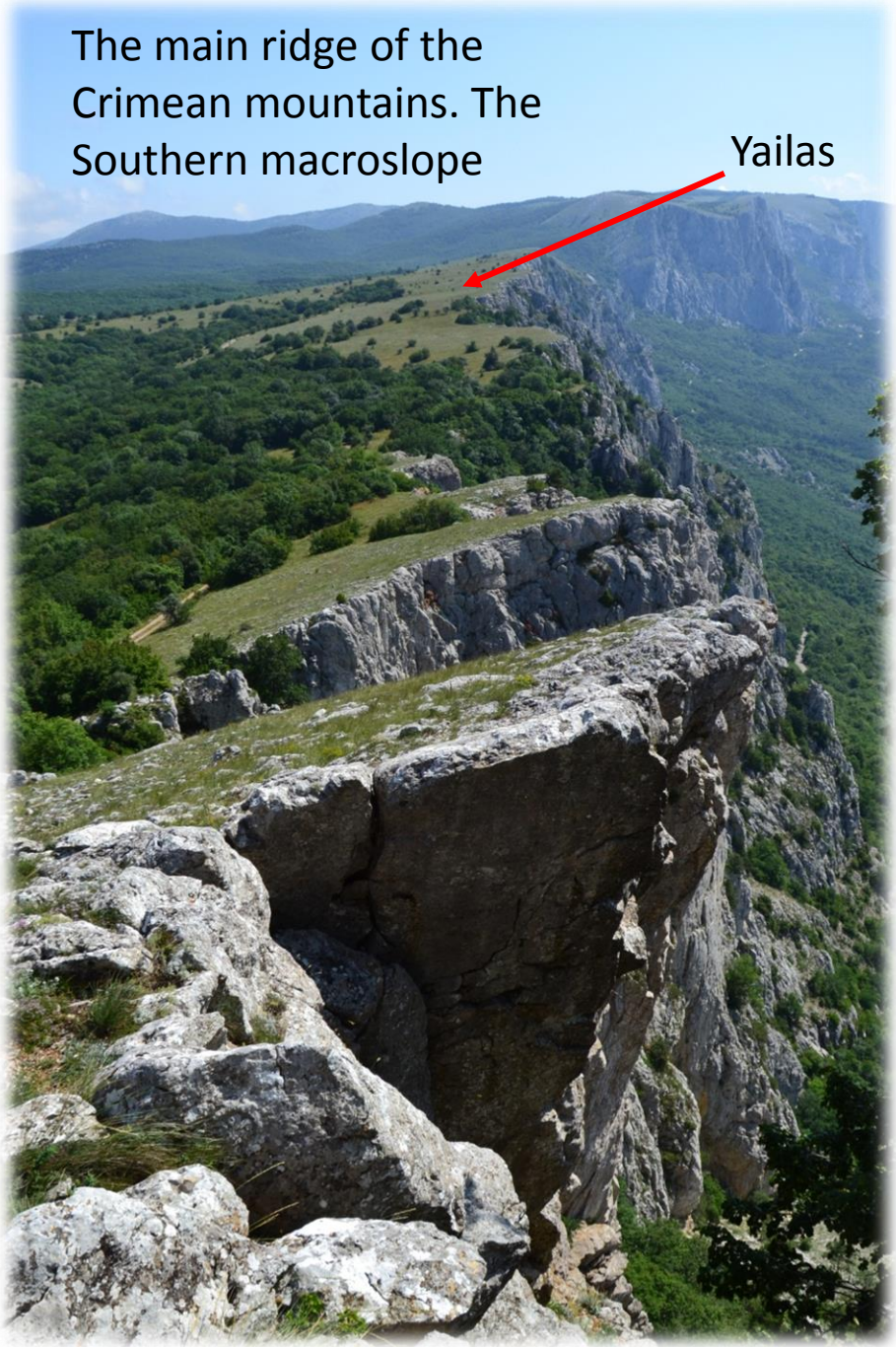
- Pleurozium shreberi
- Hylocomium splendens

  + common Crimean mosses:
    - Homalothecium Philippeanum Kindb.
    - Rhytidiadelphus triquetrum

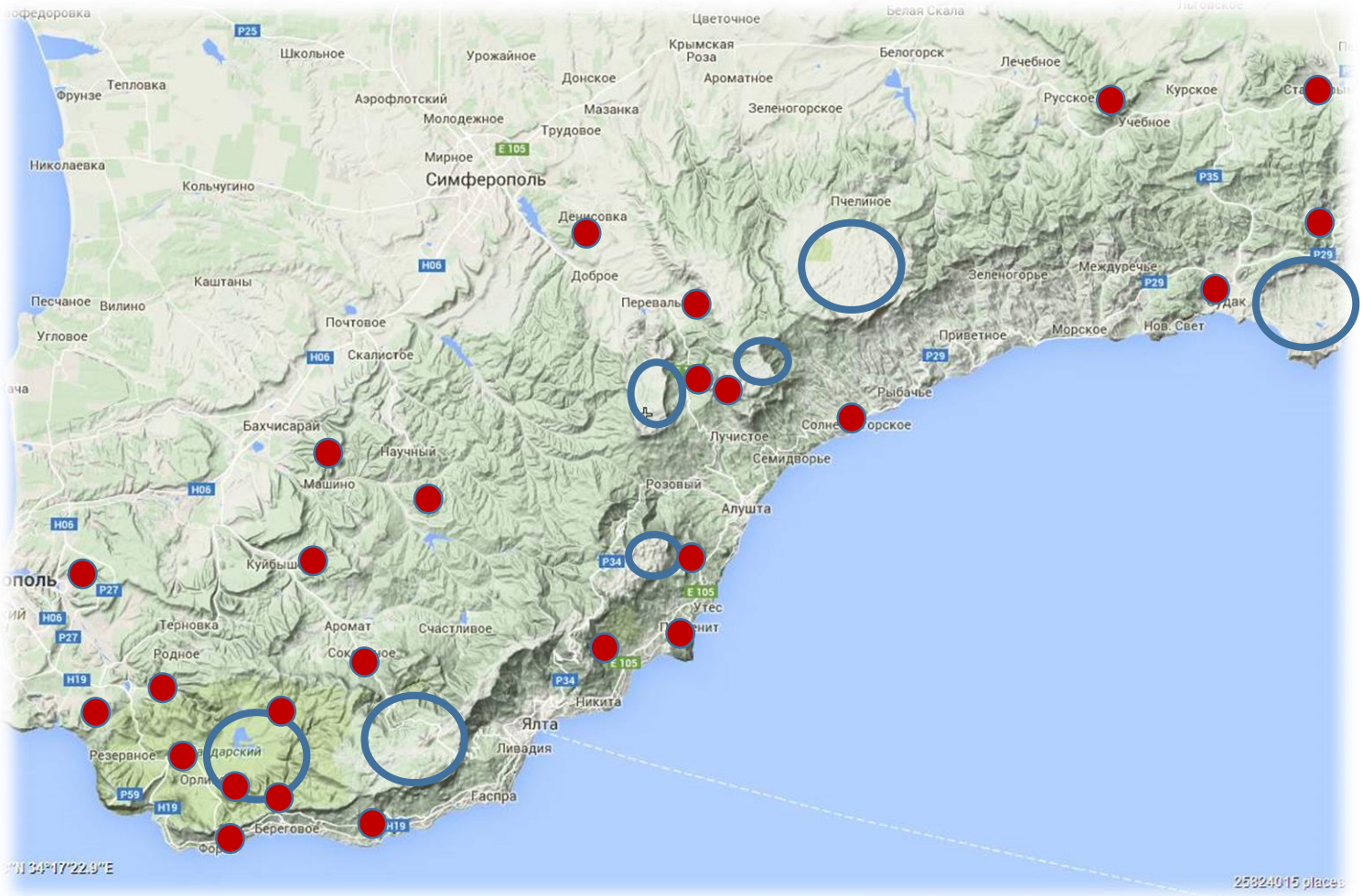
Typical cuestal relief in central part of the Crimea

The main ridge of the Crimean mountains. The Southern macroslope

Yailas

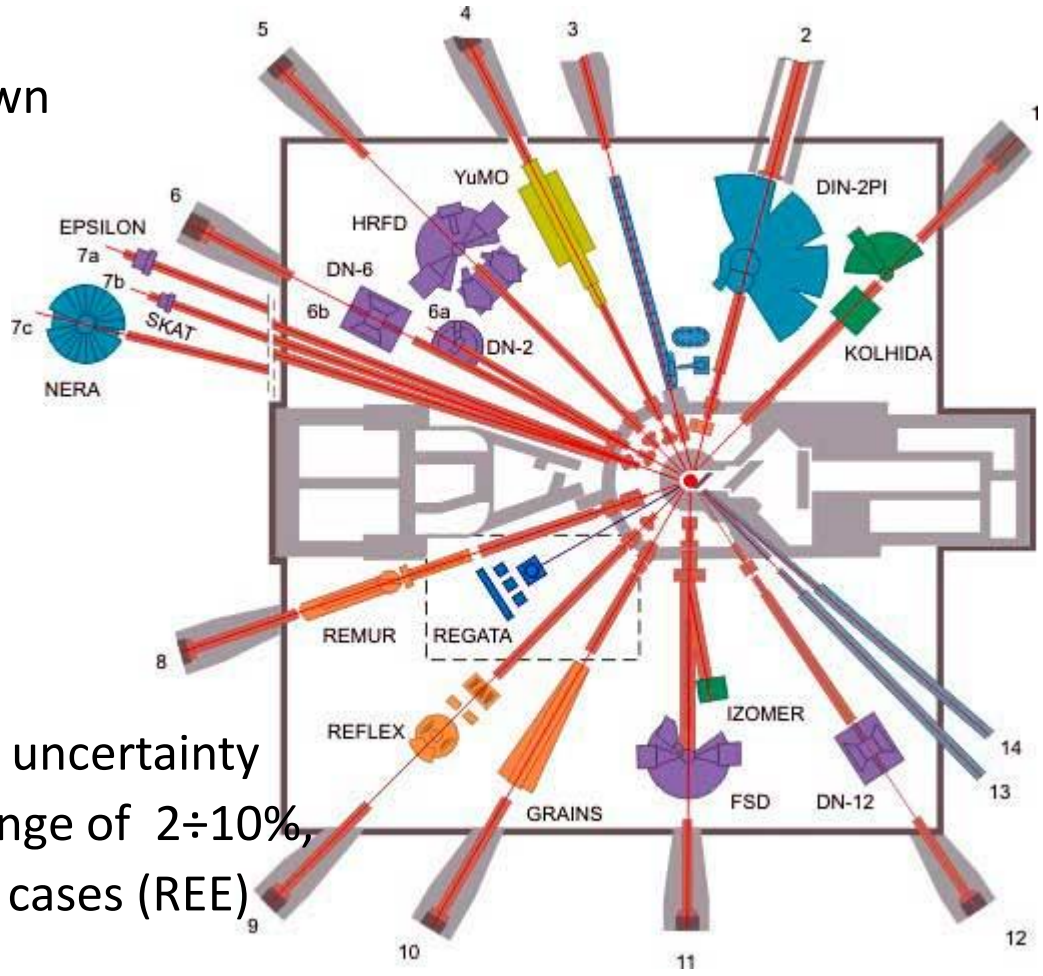


Relief of the region



Neutron activation analysis

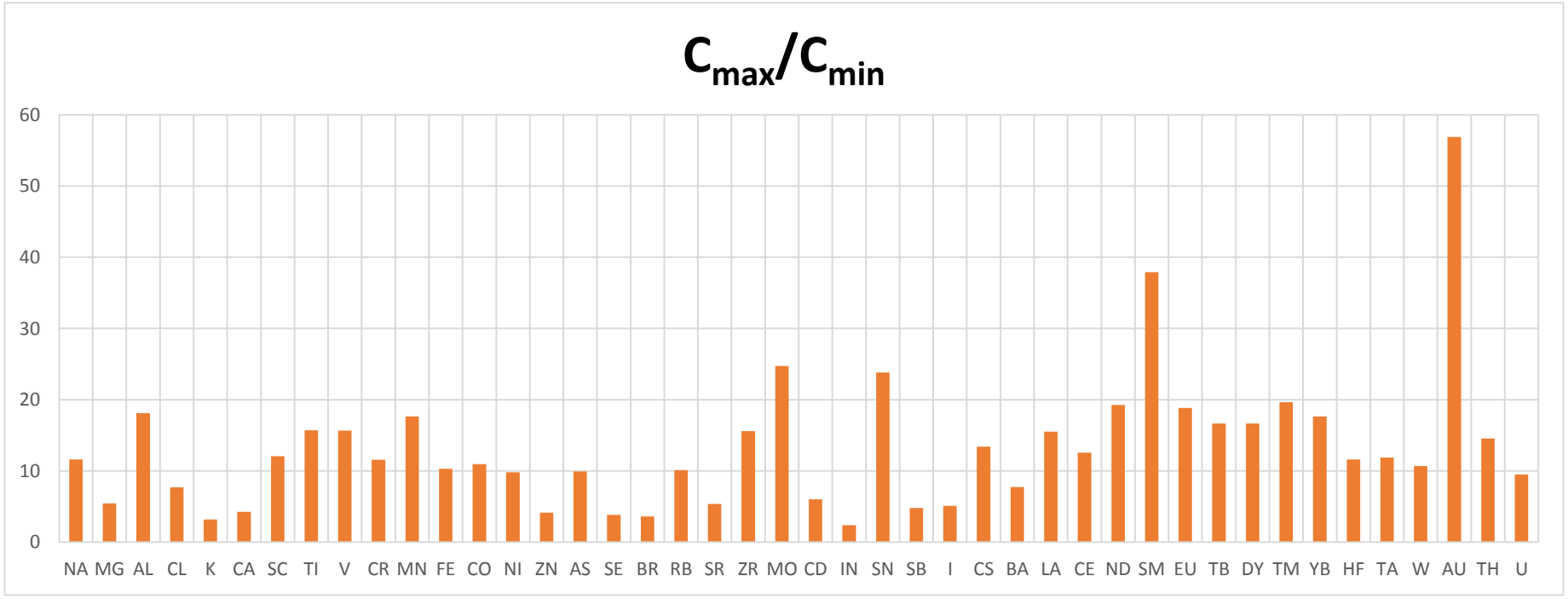
- NAA of mosses samples was carried out using REGATA facility in the IBR-2 (JINR)
- Manually homogenization
- Dried and packed for LLI and SLI
- NAA was carried out by well-known technique (Frontasyeva, 2013)



- The concentration determination uncertainty for most element falls within the range of 2÷10%, amounting to 20÷25% in only a few cases (REE)

Results and discussion

- The mass fraction of 40 elements Na, Mg, Al, Cl, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Zn, As, Se, Br, Rb, Sr, Zr, Mo, Sb, I, Cs, Ba, La, Ce, Nd, Sm, Eu, Tb, Tm, Yb, Hf, Ta, W, Au, Th and U were obtained by NAA in mosses from Crimean mountains.
- Mg, K, Ca, Zn, Se, Br, Sr, Sb and I were relatively uniform distributed in mosses ($C_{max}/C_{min} < 5$)
- The ranges of concentrations of Mo, Sn, Sm, Au had outliers



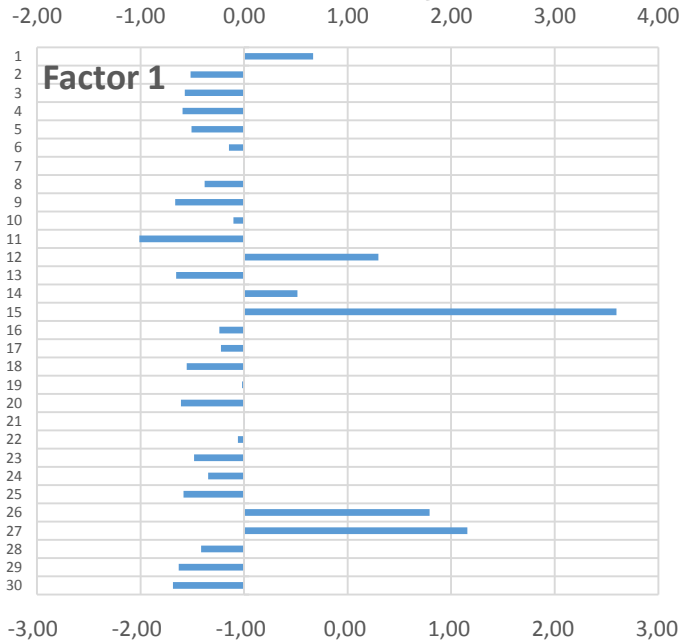
	Bulgaria, LZP		Macedonia		Norway		Crimean mountains (our data)	
Elements	median	range	median	range	median	range	median	range
Na	1320	179-9710	419	118-8673	-	-	298	185-2150
Mg	943	366-3740	2377	674-7421	1730	940-2370	2055	1090-5930
Al	16300	4120-76400	3736	825-17600	200	67-820	3250	870-15800
Cl	160	77.10-601	149	43-693	-	-	95	47-360
K	7250	3650-30900	8615	2861-18190	-	-	5960	3370-10700
Ca	11400	5520-21700	5593	1207-23640	2820	1680-5490	9080	4890-20900
Sc	2.25	0.12-13	0.81	0.12-6.79	0.052	0.009-0.220	0.62	0.4-4.3
Ti	672	170-3990	163	12-1365	23.5	12.4-66.4	169	54-850
V	17.9	6.30-124	6.9	1.79-43	0.92	0.39-5.1	4.3	1.4-22
Cr	13.3	2.71-260	7.47	2.33-122	0.55	0.10-4.2	4.8	2.4-27
Mn	450	56-3380	186	37-1475	256	22-750	98	32-561
Fe	5800	1250-32400	2458	424-17380	209	77-1370	1715	930-9610
Co	2.47	0.43-23.50	1.09	0.24-13.6	0.202	0.065-0.654	0.64	0.36-3.95
Ni	9.48	1.4-213	2.4	0.09-24	1.14	0.12-6.6	2.6	1.58-15.5
Zn	185	25-3750	39	14-203	26.5	7.9-173	29	14.5-60.1
As	2.83	0.48-22.40	0.8	0.12-8.0	0.093	0.020-0.505	0.7	0.39-3.87
Se	0.43	0.07-2.54	0.18	0.013-0.61	0.33	0.05-1.30	0.27	0.17-0.64
Br	6.42	1.66-19.50	2.16	0.06-7.7	4.5	1.4-20.3	4.9	2.67-9.63
Rb	24.8	6.93-229	10.9	5-47	7.7	1.3-51.5	5.6	3.41-34.5
Sr	71.2	19.50-527	31	11.8-136	15.8	3.6-43.3	27	13.8-74.2
Mo	0.49	0.12-1.78	0.19	0.03-1.12	0.135	0.065-0.70	0.09	0.009-0.2
Sb	2.07	0.14-46.50	0.2	0.039-1.4	0.033	0.004-0.240	0.15	0.08-0.38
I	2.18	0.90-7.71	1.18	0.36-2.8	2.5	0.6-41.7	1.4	0.6-3.1
Cs	1.32	0.19-8.81	0.39	0.097-1.7	0.072	0.016-0.88	0.27	0.16-2.2
Ba	164	35-1050	54	14-256	17.1	5.6-50.5	35	15.6-121
La	6.38	0.92-40.60	2.32	0.50-22	0.189	0.045-2.56	1.6	0.7-11
Ce	14.5	1.67-91.30	5.6	0.83-42	0.342	0.095-4.61	3	1.6-21
Sm	1.14	0.20-7.47	0.46	0.07-3.4	0.33	0.05-1.34	0.23	0.06-2.4
Tb	0.15	0.03-0.94	0.06	0.01-0.56	0.003	<0.002-0.030	0.04	0.02-0.29
Hf	0.93	0.21-7.62	0.26	0.05-3.8	-	-	0.2	0.132-1.53
Ta	0.18	0.04-1.38	0.09	0.013-0.79	0.01–	<0.01-0.07	0.05	0.0256-0.304
W	0.47	0.10-3.43	1.21	0.25-3.9	0.127	0.009-1.23	0.12	0.061-0.653
Au	0.002	0.001-0.024	0.0061	0.001-0.034	-	-	0.001	0.0003-0.017
Th	2.7	0.24-21.60	0.67	0.12-7.6	0.033	0.004-0.240	0.5	0.23-3.33
U	0.6	0.10-5.22	0.21	0.03-1.45	0.015	0.001-0.138	0.1	0.07-0.7

Comparison of elemental contents

- Majority of elements had lower concentrations than in mosses sampled in areas bordering with industrial regions of Bulgaria and Macedonia (Marinova et al., 2012; Barandovski et al., 2008)
- At the same time these elements had higher concentrations compared with mosses from regions of relatively pristine areas of Norway (Steinnes et al., 2007)
- The values of Rb, Mo, Sm, W in the mosses from region of the Mountain Crimea were lower even than in mosses from relatively pristine region of Norway (median values)
- Mg, Ca, Ni, Se and I (iodine) reached the higher values than in mosses from Bulgaria or Macedonia

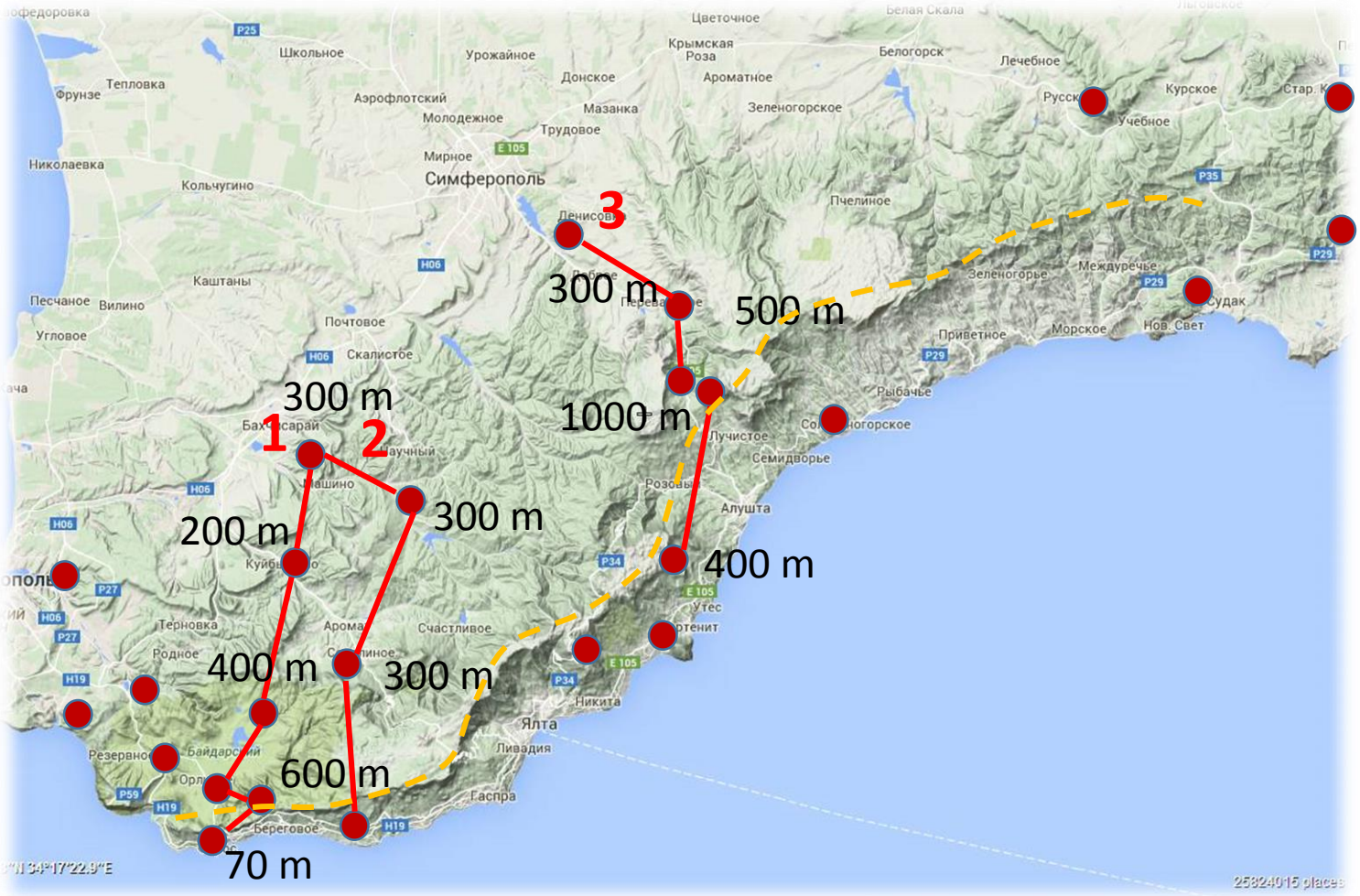
Principal component analysis

	Factor 1	Factor 2	Factor 3	Factor 4
NA	0.92	-0.08	-0.05	-0.13
MG	0.94	0.14	0.14	-0.03
AL	0.93	0.13	0.15	-0.02
CL	0.10	-0.04	0.03	0.93
K	0.80	-0.18	-0.15	0.39
CA	-0.01	0.14	0.86	0.11
SC	0.97	0.18	0.00	0.03
TI	0.93	0.22	0.14	0.02
V	0.89	0.27	0.20	0.05
CR	0.98	0.15	0.04	0.00
MN	0.37	0.64	-0.29	-0.07
FE	0.97	0.20	0.01	0.03
CO	0.97	0.20	-0.03	0.03
NI	0.93	0.31	-0.06	0.03
ZN	0.74	0.46	-0.11	0.23
AS	0.95	0.25	0.00	0.07
SE	0.81	0.35	-0.19	0.25
BR	0.16	0.86	0.19	-0.08
RB	0.97	0.19	0.00	0.06
SR	0.66	-0.35	0.29	-0.20
ZR	0.96	0.16	0.00	0.05
MO	0.69	-0.12	0.26	-0.39
SN	0.80	-0.04	0.22	0.10
SB	0.85	0.37	-0.04	-0.02
I	0.24	0.68	0.57	0.11
CS	0.98	0.14	0.02	0.03
BA	0.85	0.25	-0.15	0.06
W	0.94	0.27	-0.09	0.07
AU	0.00	0.04	-0.44	0.08
TH	0.97	0.19	0.01	0.03
U	0.97	0.11	0.02	-0.01
Expl.Var	20.48	3.00	1.79	1.44
Prp.Totl	0.66	0.10	0.06	0.05



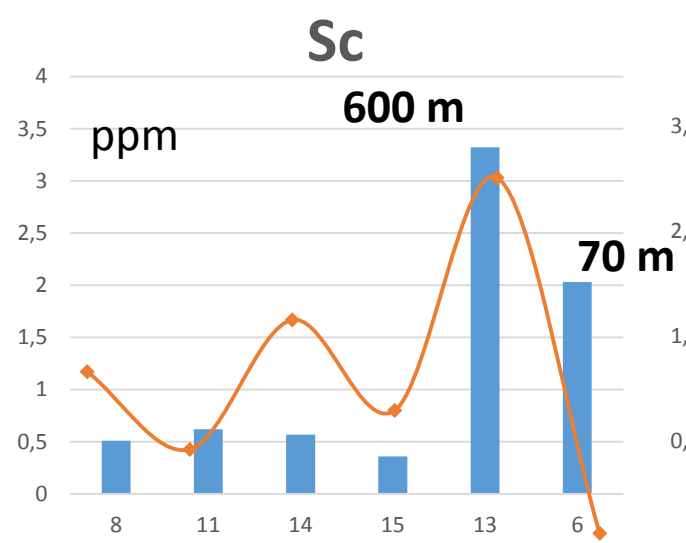
Altitude

Cross-sections through Crimean mountain range



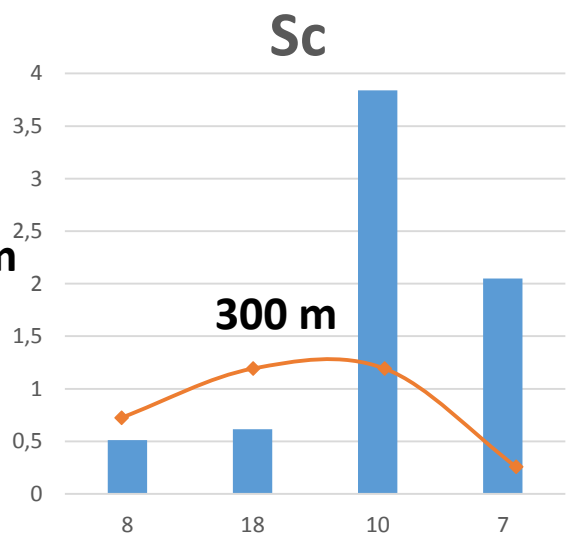
Cross-sections

1

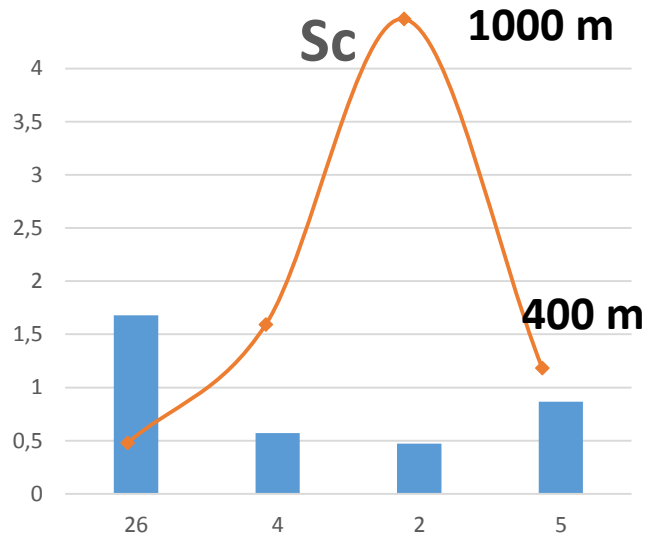


Stations from North to South

2

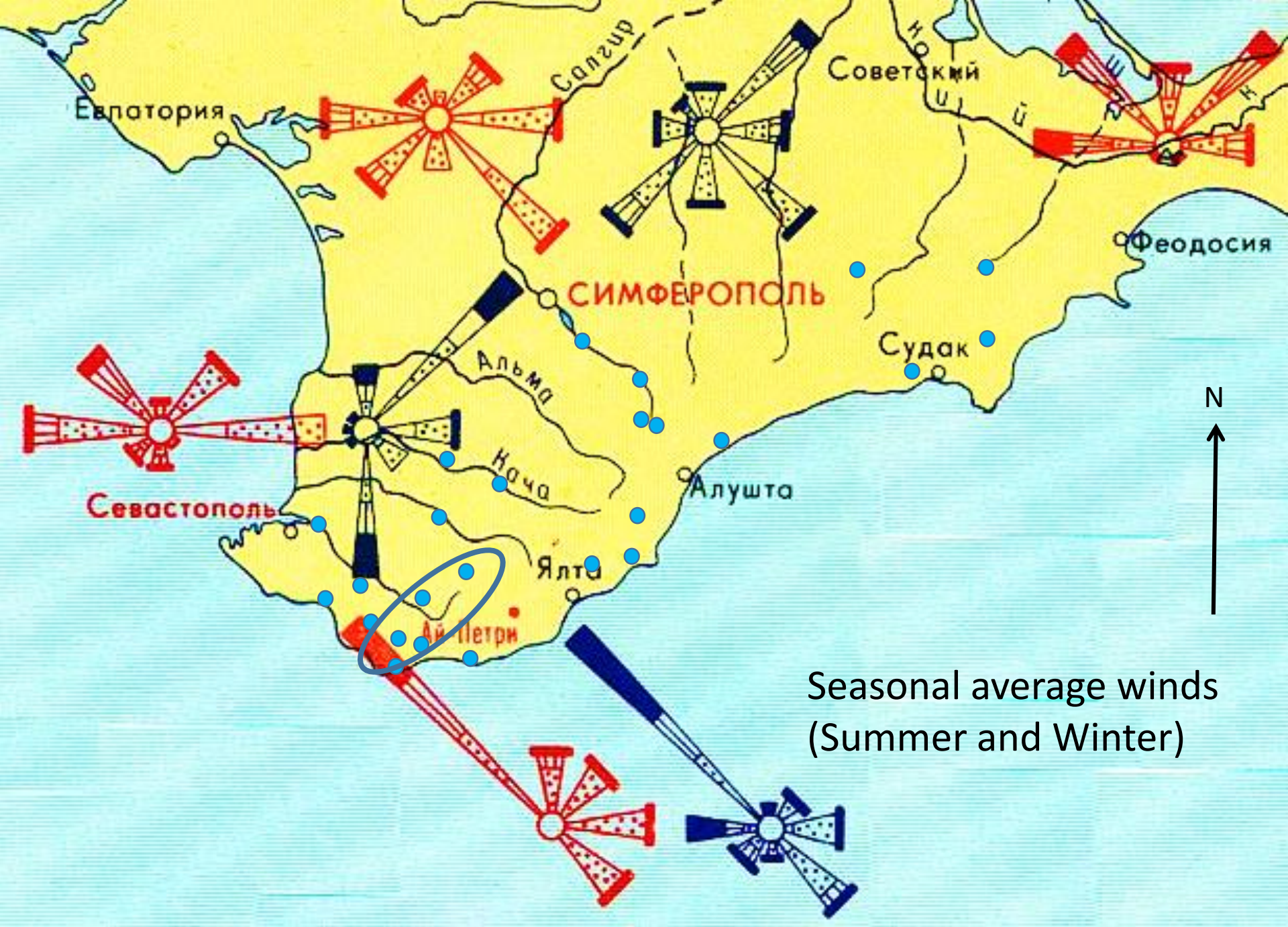


3



Deep and long valley

Sc – is a typical terrigenous element



Seasonal average winds
(Summer and Winter)

Conclusions

- The distribution of Cl in mosses differs from the other halogens (Br and I).
- The maximum concentrations of Au (0.02 μg/g) were observed in mosses collected on the coast near the Balaklava city. It is associated with the influences of the work of mining enterprises within the city of Balaklava.
- The values of Rb, Mo, Sm, W were lower than in the mosses from relatively pristine region of Norway because of specific elemental structure of rocks in studied region.
- Mg, Ca, Ni, Se and I reached the higher values than in mosses from Bulgaria or Macedonia. It pointed out the geochemical features of soils and aerosols in marine study region

Conclusions

- Such halogens as Br and I reached the maximal concentrations in mosses from coastal zones and highlands (yailas)
- Ca had maximal enrichment in mosses of main ridge with carsting rocks
- Maximal values of Cl were in highlands zones. Probably this element is associated with some mineral component of salts in soils

Thank you for attention!