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PHYSICOCHEMICAL EVIDENCE OF SOIL QUALITY FROM SAUTHEASTERN PART OF THE OVCE POLE VINE DISTRICT

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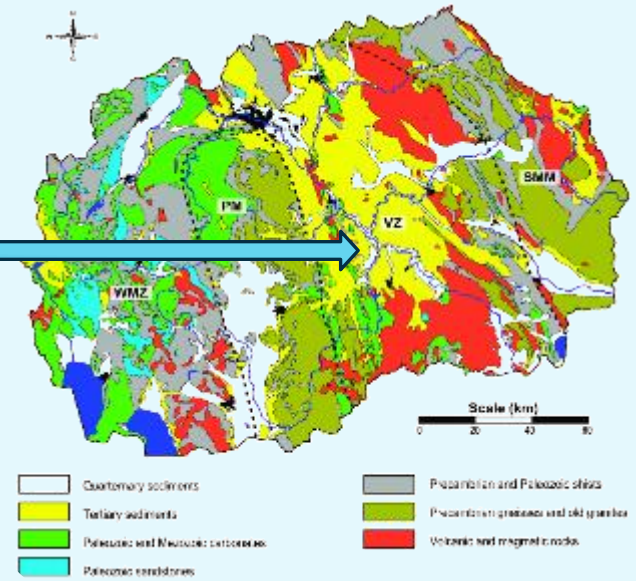
INTRODUCTION

- In viticulture, soil plays a central role
- Soil provides nutrient and water for vines.
- Soil structure affects root development and stability.
- Soil pH and mineral content influence grape quality.
- Soil properties are key for terroir expression, which is essential for vineyard identity and wine quality.

INTRODUCTION

Geological characterization
Ovče Pole Vine District

- **Ovce Pole Vine District belongs to Vardar Zone Geological unit**
- **Dominated by Quaternary sediments, marls, sandstones and conglomerates.**
- **Carbonate rocks are widespread across the region.**
- **Soil are generally alkaline due to the geological substrate.**
- **Traces of volcanic activity enrich the soil substrate.**
- **Geology influence soil texture, fertility and water retention capacity.**
- **Povardarie Wine Region**



Lithological map of Macedonia

Location of Ovce Pole Vine District

MATERIAL AND METHODS

- 18 Soil samples.
- Samples were taken from a depth of 0-30 cm using a soil auger .
- The quartering method was applied to reduce the volume of the composite sample.
- 15-20 individual soil cores were collected in a zig-zag pattern.
- Representative samples with a mass of weighing between 1-1,5 kg.

Sample	Sample Label	Location	Place	Coordinates
1	L1S1	Tri Cesmi	Ridot	41°46'29"N22°07'23"E
2	L1S2	Tri Cesmi	Ridot	41°46'33"N22°07'39"E
3	L1S3	Tri Cesmi	Ridot	41°46'18"N22°07'32"E
4	L1S4	Tri Cesmi	Ridot	41°46'23"N22°07'47"E
5	L1S5	Tri Cesmi	Ridot	41°46'10"N22°07'40"E
6	L1S6	Tri Cesmi	Ridot	41°46'13"N22°07'54"E
7	L1S7	Tri Cesmi	Ridot	41°46'03"N22°07'46"E
8	L1S8	Tri Cesmi	Ridot	41°46'04"N22°08'00"E
9	L1S9	Tri Cesmi	Ridot	41°45'54"N22°07'49"E
10	L1S10	Tri Cesmi	Ridot	41°45'56"N22°08'04"E
11	L2S1	Tri Cesmi	Vucevi Livadi	41°46'52"N22°07'51"E
12	L2S2	Tri Cesmi	Vucevi Livadi	41°46'52"N22°07'46"E
13	L2S3	Tri Cesmi	Vucevi Livadi	41°46'58"N22°07'51"E
14	L2S4	Tri Cesmi	Vucevi Livadi	41°46'57"N22°07'31"E
15	L3S1	Dolno Trogerci	Locva	41°49'47"N22°09'38"E
16	L3S2	Dolno Trogerci	Locva	41°49'35"N22°09'34"E
17	L3S3	Dolno Trogerci	Orman	41°49'15"N22°09'37"E
18	L3S4	Dolno Trogerci	Bulin Dol	41°49'19"N22°10'23"E

Labels, locations and coordinates of the unified soil samples

Soil sampling

MATERIALS AND METHODS

- ***ISO 10390*** ***(pH-H_2O, pH-KCl)***
- ***ISO 11265*** ***EC (Electrical conductivity)***
- ***ISO 14235:199*** ***OM (Hummus)***
- ***ISO 10693*** ***$CaCO_3$***
- ***ISO 11261*** ***Nitrogen***
- ***ISO 11263*** ***P_2O_5***
- ***ISO 9964:1993*** ***K_2O***
- ***ISO 11465*** ***HM (Moisture)***
- ***ISO 11277*** ***(Texture)***
- ***ISO 11508:2017*** ***(Bulk density)***
- ***ISO 17294-2*** ***(Fe, Mn, B, Cr, Pb, Cd, Zn, As, Mo, Ca, Mg, Hg, K)***

RESULTS AND DISCUSSION

Soil Texture Analisys

FAO/WRB classification system and USDA soil texture triangle

Sample	Coarse Sand %	Glay and Silt %	Glay %	Fine Sand %	Silt %	Total Sand %	Bulk Density %	Soil Type
S1	36	51	4	12	47	48	1.5	Sandy Soil
S2	34	16	1	50	15	84	1.6	Sandy Soil
S3	24	14	1	62	13	86	1.6	Sandy Soil
S4	21	9	1	70	8	91	1.7	Sandy Soil
S5	27	35	6	41	29	68	1.7	Sandy Soil
S6	30	14	1	56	13	86	1.5	Sandy Soil
S7	43	14	1	43	13	86	1.6	Sandy Soil
S8	35	12	1	53	13	88	1.5	Sandy Soil
S9	22	16	2	62	14	84	1.6	Sandy Soil
S10	32	18	2	50	16	82	1.6	Sandy Soil
S11	17	23	2	60	21	77	1.5	Sandy Loam
S12	17	24	2	41	22	58	1.4	Sandy Loam
S13	19	30	3	51	27	70	1.3	Sandy Loam
S14	16	25	2	59	22	75	1.2	Sandy Loam
S15	30	69	20	1	49	31	1.3	Powdery Clay Loam
S16	28	64	20	8	44	29	1.2	Powdery Clay Loam
S17	15	79	17	6	62	21	1.4	Powdery Clay Loam
S18	12	82	10	6	72	18	1.1	Powdery Clay Loam

- Sandy soils (highly permeable, dry quickly, low nutrient retention).
- Better holding water and support good root development.
- Quaternary sediments (alluvial sends and marls).

- Powdery Clay Loam soils (high water retention, slow permeability, good water storage, aeration management).
- Alluvial deposit

RESULTS AND DISCUSSION

Sample	pH-H_2O	pH-KCl	EC µS/cm	N g/kg	P_2O_5 mg/100g	K_2O mg/100g	OM %	OC %	$CaCO_3$ %	HM %	KH %
L1S1	7.86	7.46	394	0.99	19.2	24.8	2.13	1.16	1.22	0.50	1.005
L1S2	8.02	7.53	377	1.17	13.3	40.1	2.24	1.25	0.41	0.91	1.009
L1S3	7.48	6.79	323	0.98	24.8	65.5	1.74	1.05	7.13	0.85	1.008
L1S4	7.79	7.11	335	1.10	8.44	30.4	1.96	1.15	0.51	1.12	1.011
L1S5	8.09	7.41	326	1.15	42.9	50.1	2.22	1.25	0.31	1.16	1.011
L1S6	7.97	7.46	310	1.12	28.3	39.7	1.95	1.12	0.73	1.17	1.011
L1S7	8.02	7.51	298	1.01	19.9	41.3	1.83	1.11	0.75	1.21	1.012
L1S8	8.23	7.42	250	1.11	10.8	40.6	2.05	1.20	1.75	0.54	1.005
L1S9	7.82	7.46	442	1.01	9.06	42.7	1.71	0.95	2.11	0.54	1.005
L1S10	8.66	7.05	462	1.02	9.82	34.6	1.42	0.85	2.83	0.91	1.009
L2S1	7.74	7.42	314	1.17	26.6	30.1	1.24	0.72	7.79	1.21	1.012
L2S2	7.21	7.11	334	1.06	13.4	28.9	1.42	0.80	11.7	0.75	1.007
L2S3	8.16	7.41	341	1.07	28.5	43.6	1.96	1.16	10.5	2.82	1.029
L2S4	7.11	6.91	325	1.10	29.2	36.4	1.78	1.10	11.1	1.16	1.011
L3S1	7.78	7.41	377	1.22	24.6	46.5	2.46	1.45	8.69	0.95	1.008
L3S2	7.36	7.31	441	1.17	18.7	41.1	2.09	1.20	12.9	0.64	1.006
L3S3	7.62	7.42	481	1.12	9.99	45.2	2.04	1.20	25.4	0.56	1.005
L3S4	7.68	7.43	460	1.14	23.5	49.6	1.93	1.12	18.2	0.42	1.004

The pH across all samples ranged between 7.09 and 8.66, with most samples falling within the slightly to moderately alkaline range.

Alluvial and colluvial, developed under semi-arid to arid conditions calcareous nature of the parent material.

Low to moderate salinity across the sites.

The low organic carbon (OC ranging from 0.7% to 1.2 %) indicates limited organic input and microbial activity.

RESULTS AND DISCUSSION

Exploratory factor analysis (EFA)

Factor loading Matrix-Factor analysis (FA)

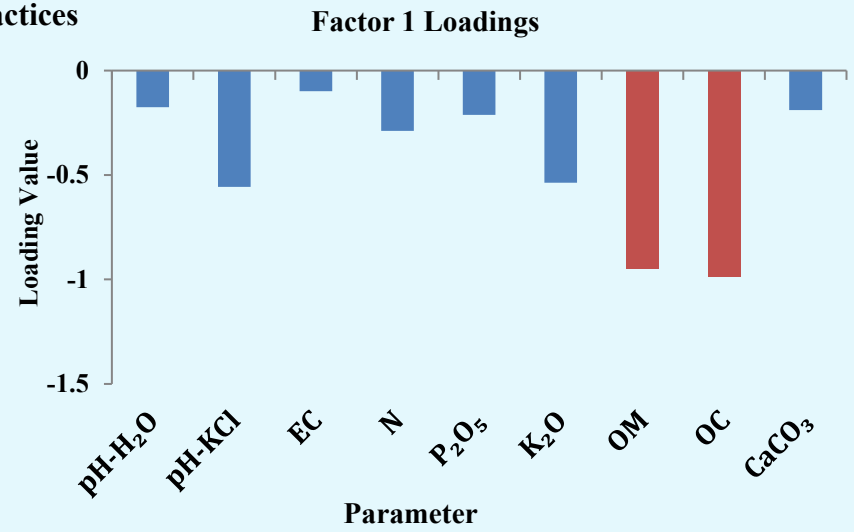
Parameter	F1	F2	F3	F4	Comm.
pH-H_2O	-0.17	-0.26	**0.70**	0.15	0.62
pH-KCl	-0.56	0.01	**0.41**	-0.32	0.58
EC (µS/cm)	-010	**0.78**	0.32	0.14	0.74
N (mg/kg)	-0.29	0.12	-0.06	**-0.41**	0.27
P_2O_5 (mg/100g)	-0.21	-0.29	-0.46	-0.04	0.35
K_2O (mg/100g)	-0.54	0.03	-0.22	**0.48**	0.57
OM (%)	**-0.95**	0.04	0.06	-0.04	0.91
OC (%)	**-0.98**	-0.01	-0.02	0.01	0.98
$CaCO_3$ (%)	-0.19	**0.81**	-0.21	0.09	0.75
E-Value	**0.98**	**0.84**	**0.70**	**0.55**	**0.64**
Variability %	**31.63**	**27.12**	**27.85**	**17.58**	

Exploratory factor analysis (EFA) was performed on soil data collected from the Tri Cesmi and Dolno Trogerci sites within the Ovče Pole Vine District.

Analysis extracted four latent factors, collectively explaining 99.5 % of the total variance.

RESULTS AND DISCUSSION

The high loadings suggest that this factor encapsulates the organic fertility status, likely influenced by both natural vegetation cover and anthropogenic inputs, such as vineyard practices



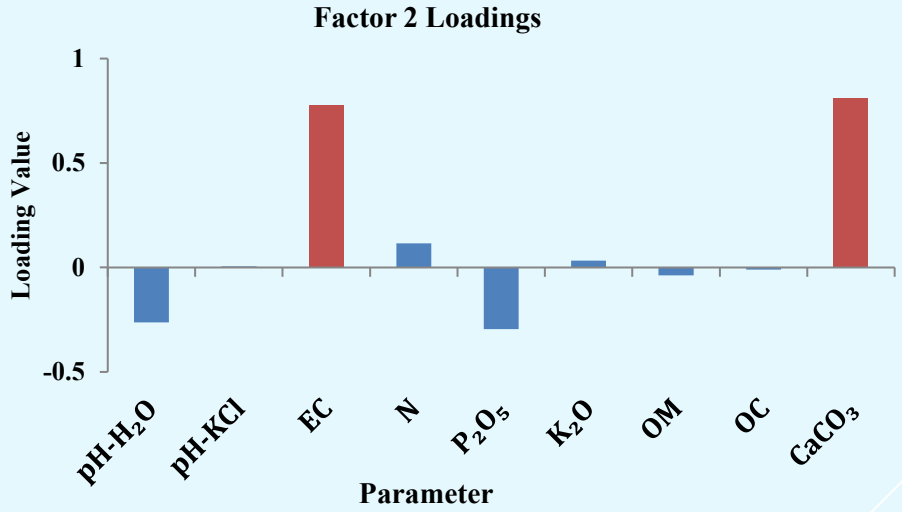
Factor 1 – OM and OC

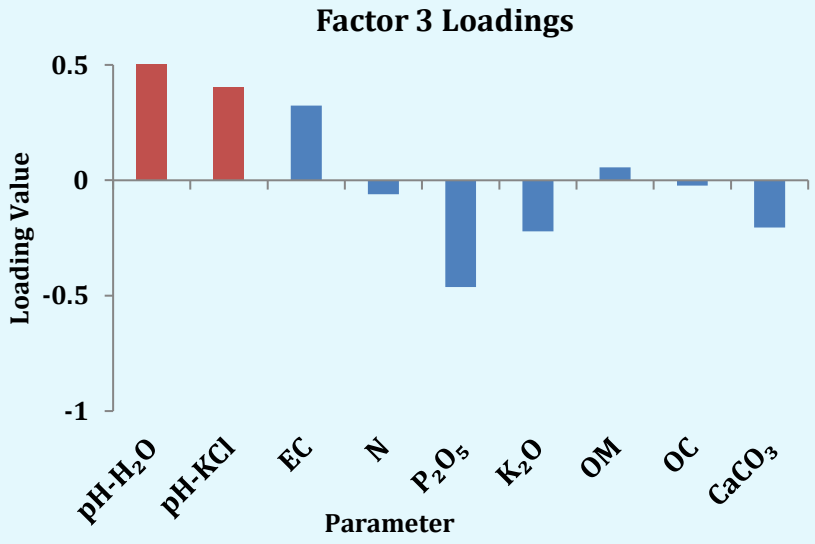
Factor 2 – EC and $CaCO_3$

Factor 3 – pH-H_2O and pH-KCl

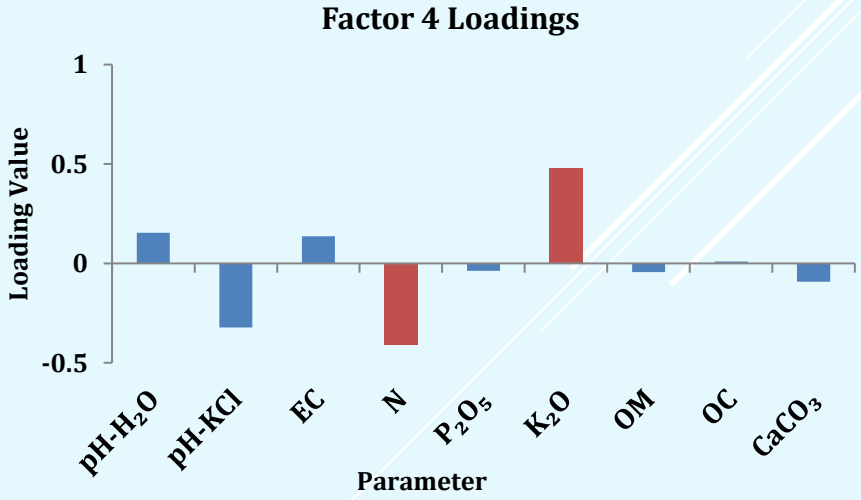
Factor 4 – K_2O and N

This factor reflects the salinity and calcareous nature of the soils, which are strongly tied to the underlying geology





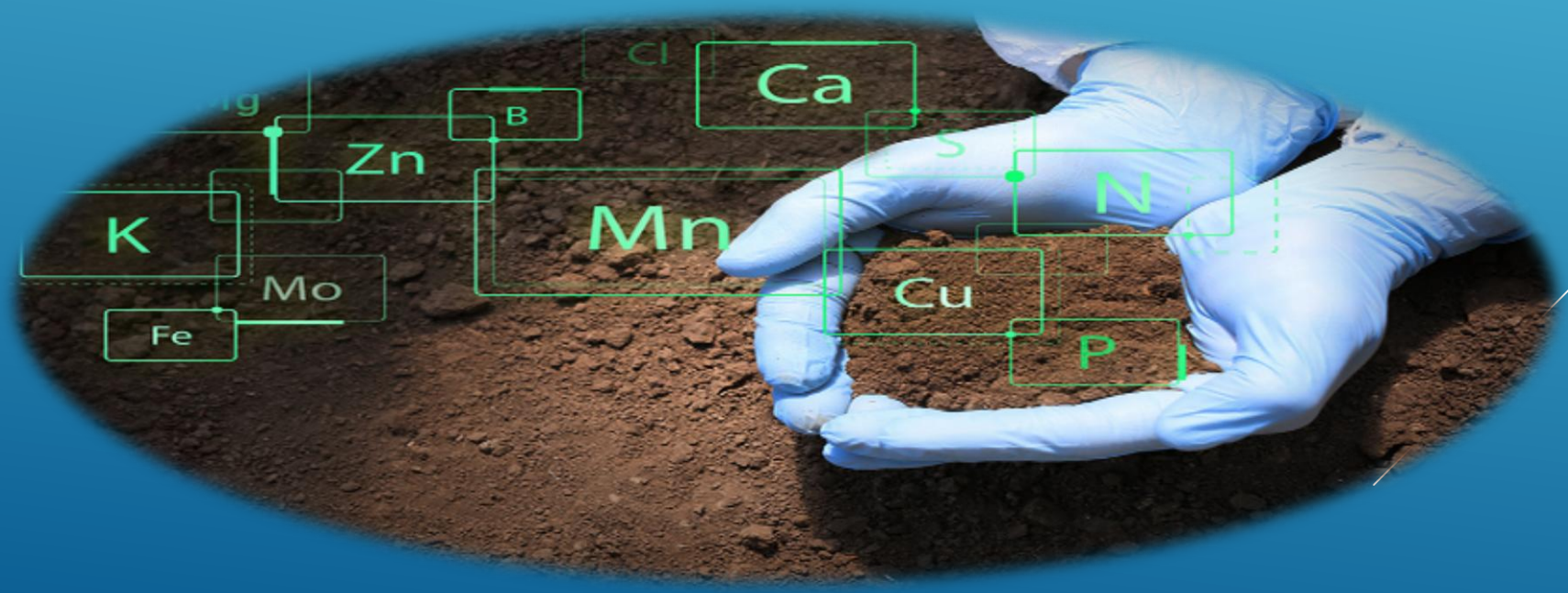
Identifying the acid-base status and buffering capacity on the soil



This suggests that may be governed by both soil mineralogy and anthropogenic inputs such as fertilization

RESULTS AND DISCUSSION

- ✓ **Micro and Macroelements are present in adequate concentrations.**
- ✓ **Heavy metals are within safe limits according to soil quality standards.**
- ✓ **No indications of contamination or excessive accumulation.**
- ✓ **Elemental composition supports healthy vine growth and sustainable soil management.**



CONCLUSION

- The soils from Tri Cesmi and Dolno Trogerci show significant physical and chemical variability.
- Soil texture, pH, OM, OC, EC, $CaCO_3$ content influence vine development and grape quality.
- Geological background strongly influence soil characteristic.
- Understanding soil properties is fundamental for characterization the terroir of the Ovce Pole Vine District.
- The research provides valuable guidelines for improving vineyard practices and sustainable grape production.


THANK YOU FOR YOUR
ATTENTION