Characterization of soil organic carbon and its fraction labile carbon in ecosystems

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Long-term field experiments – a part of the project **"Biological and technological aspects of sustainability of controlled ecosystems and their adaptation to climate changes"**

- ***SOM quality***
- ***Physical properties***
- ***Chemical properties***
- ***Biological properties***

Organic carbon undergoes short and long term transformation in the soil. Under a dynamic equilibrium a portion of organic carbon is mineralized, and the same portion is newly formed

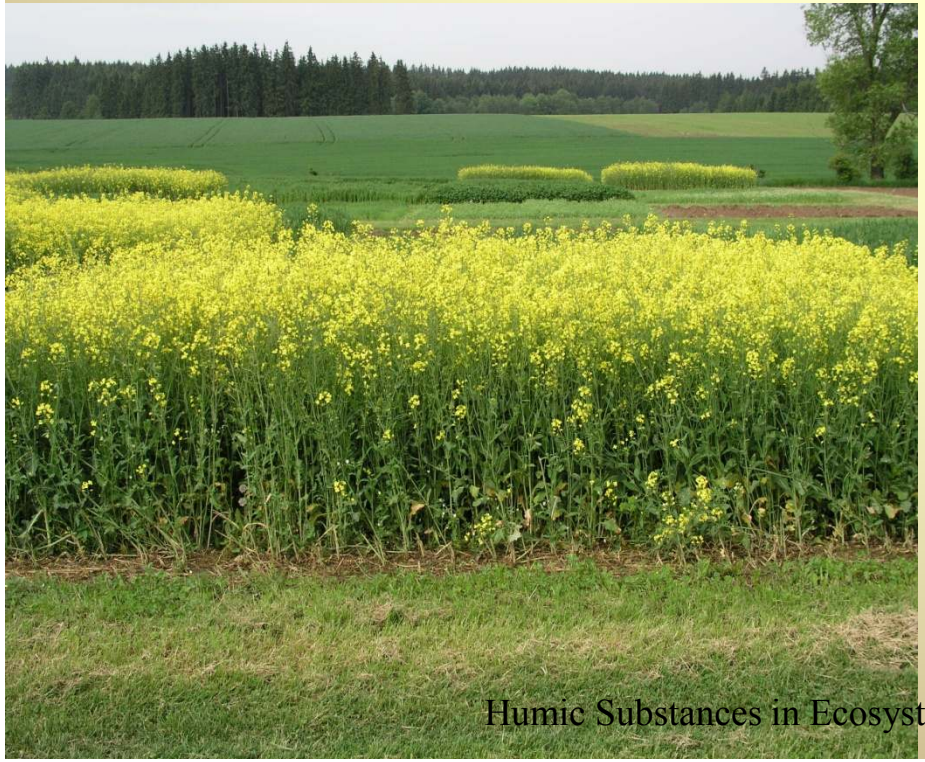
- **Stable carbon (TOC, HS, HA and FA sum)**
- **C labile (hot water extractable)**
- **C microbial (bacterial biomass)**

Aim of our study

- **Total carbon content**
- **HS quality**
- **HA quality - 13C NMR analysis**
- **Labile carbon content**
- **Bacterial biomass amount (Cmic)**
- **Basal respiration**

Land use:

Arable soils x Grassland
(locality Vatín)

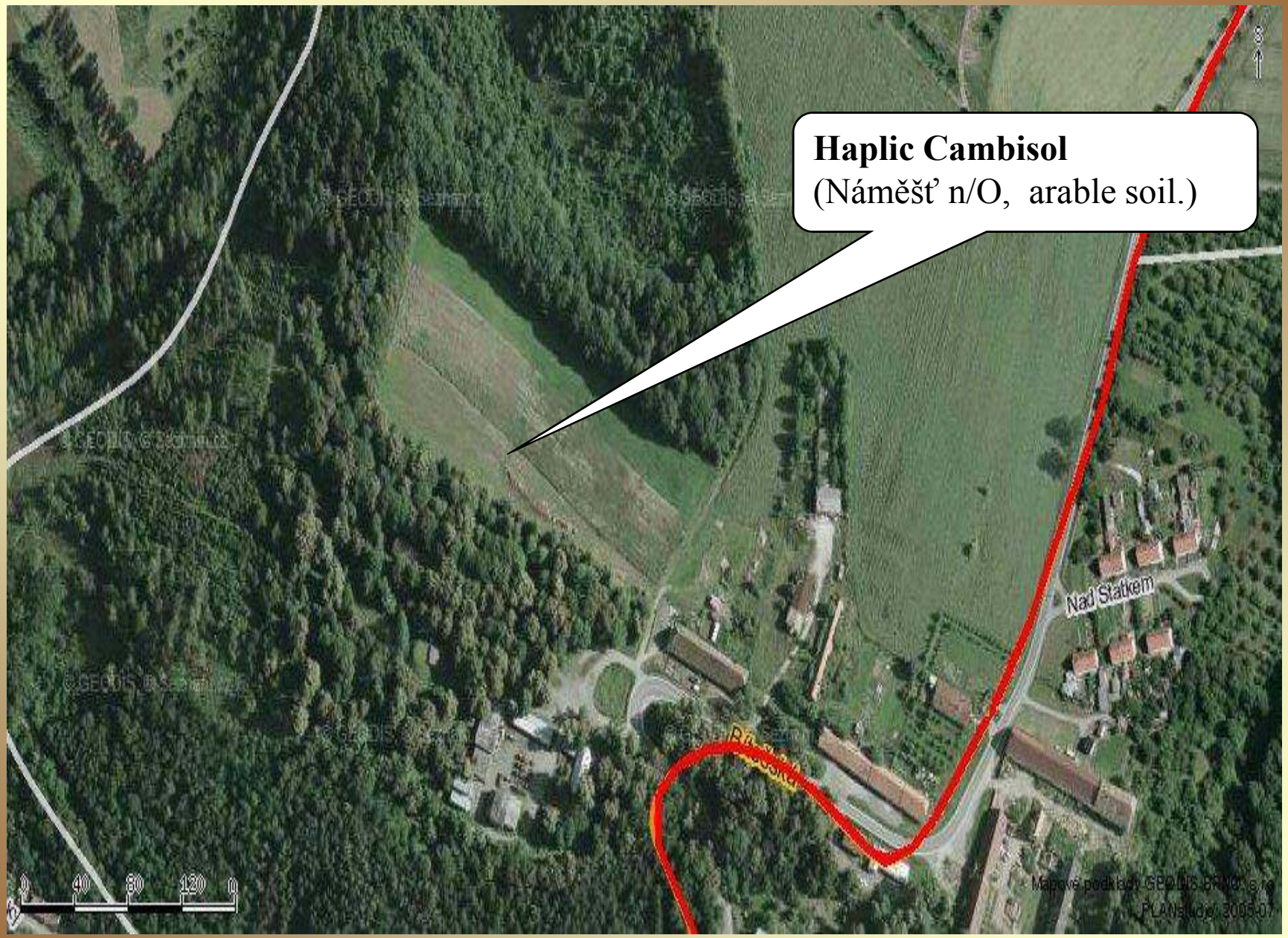


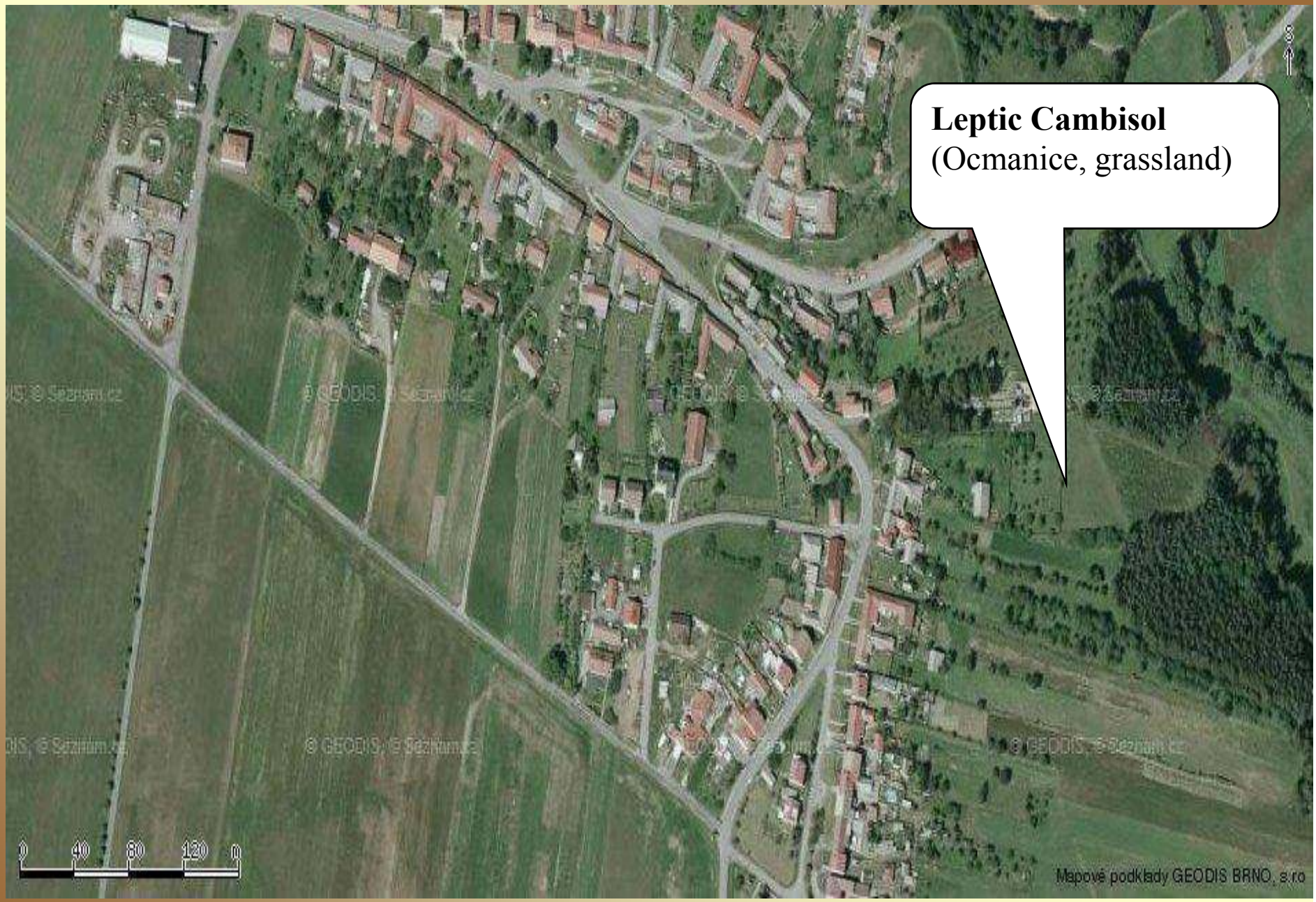
Localities

Locality	Cambisols Subtypes	Land use	GPS N	GPS EO	Atitude (m) m.a.s.l.
Vatín	Eutric C.	arable	49° 31,091′	15° 58,196′	530
Náměšť	Haplic C.	arable	49° 12,808′	16° 9,757′	430
Vatín	Eutric C.	grassland	49° 31,091′	15° 58,196′	531
Ocmanice	Leptic C.	grassland	49° 13,909′	16° 7,782′	450

Basic soil characteristics

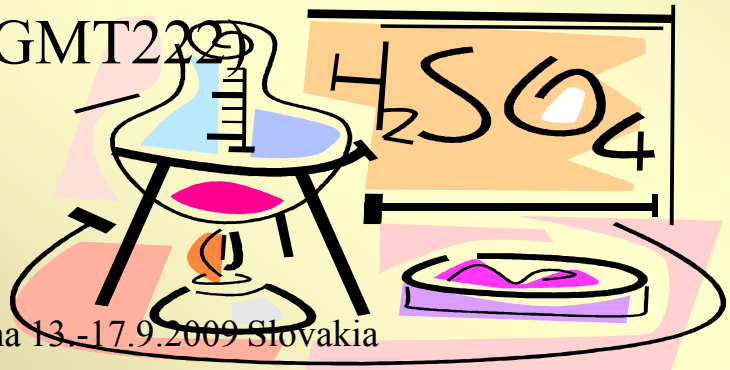
Soil types	pH/H2O	pH/KCl	Texture classes (%)		
			2,00-0,05	0,05-0,002	< 0,002mm
Leptic C.	4.1	5	50	40	9.5
Haplic C.	5.1	4	0	81.6	18.4
Eutric C. 1	5.1	4.8	55	35.0	9.5
Eutric C. 2	4.9	4.4	72.2	17.7	10.1


Haplic Cambisol
(Náměšť n/O, arable soil.)
Nad Statkem
0 40 80 120 m

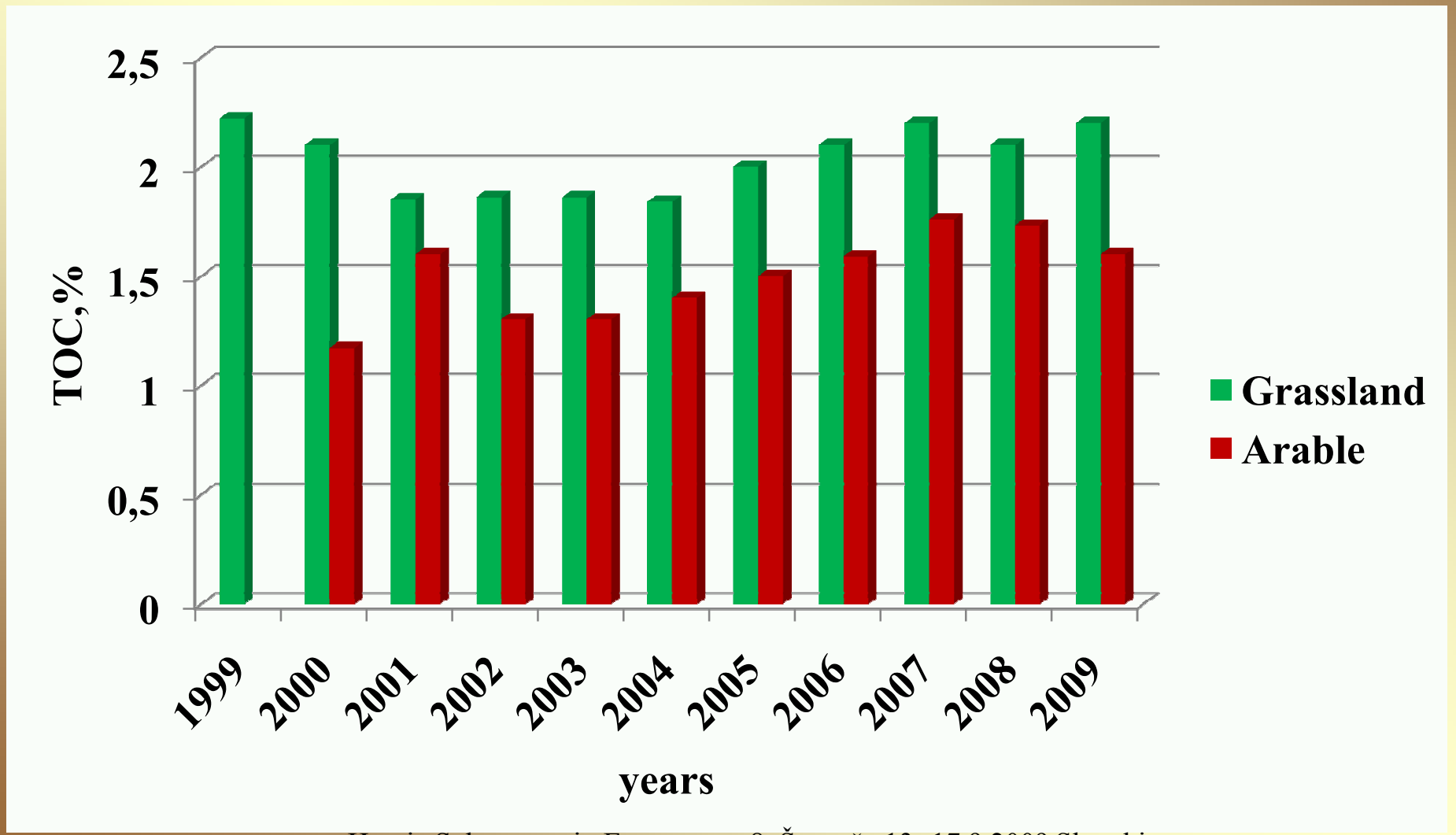

Leptic Cambisol
(Ocmanice, grassland)
0 40 80 120 0
Mapové podklady GEODIS BRNO, s.r.o

Methods of study

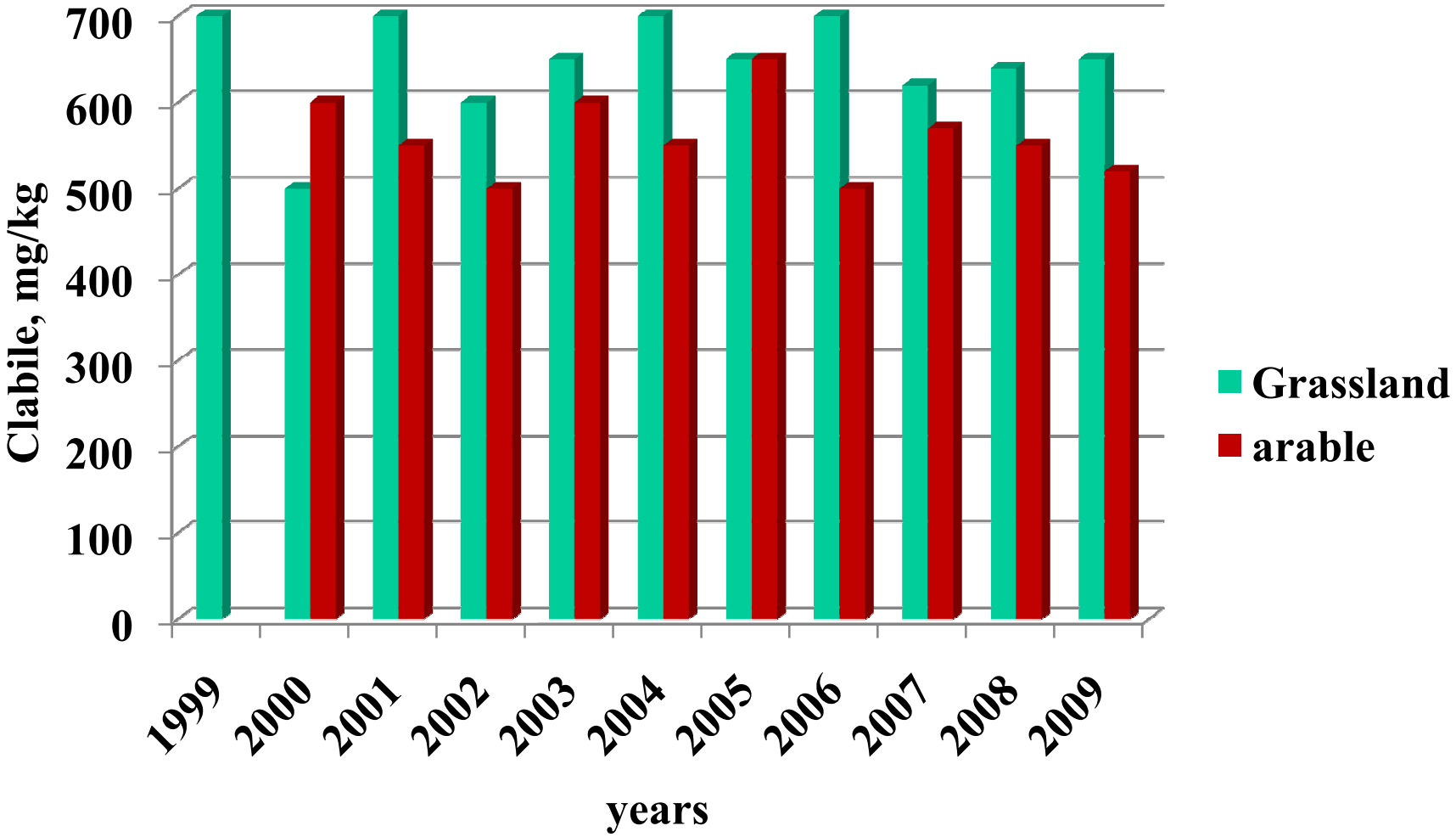
- **TOC and Nitrogen content** (LECO-CNS analyzer)
- **C labile** (hot water extraction method)
- **HS fractionation** (short fractionation method), **HA isolation** (IHSS method)
- **13C NMR** (Varian INOVA 600 spectrometer)
- **Cmic =Bacterial biomass** (Fumigation extraction method)
- **Basal respiration** (Apparatus Vaisala GMT222)
- **ANOVA**



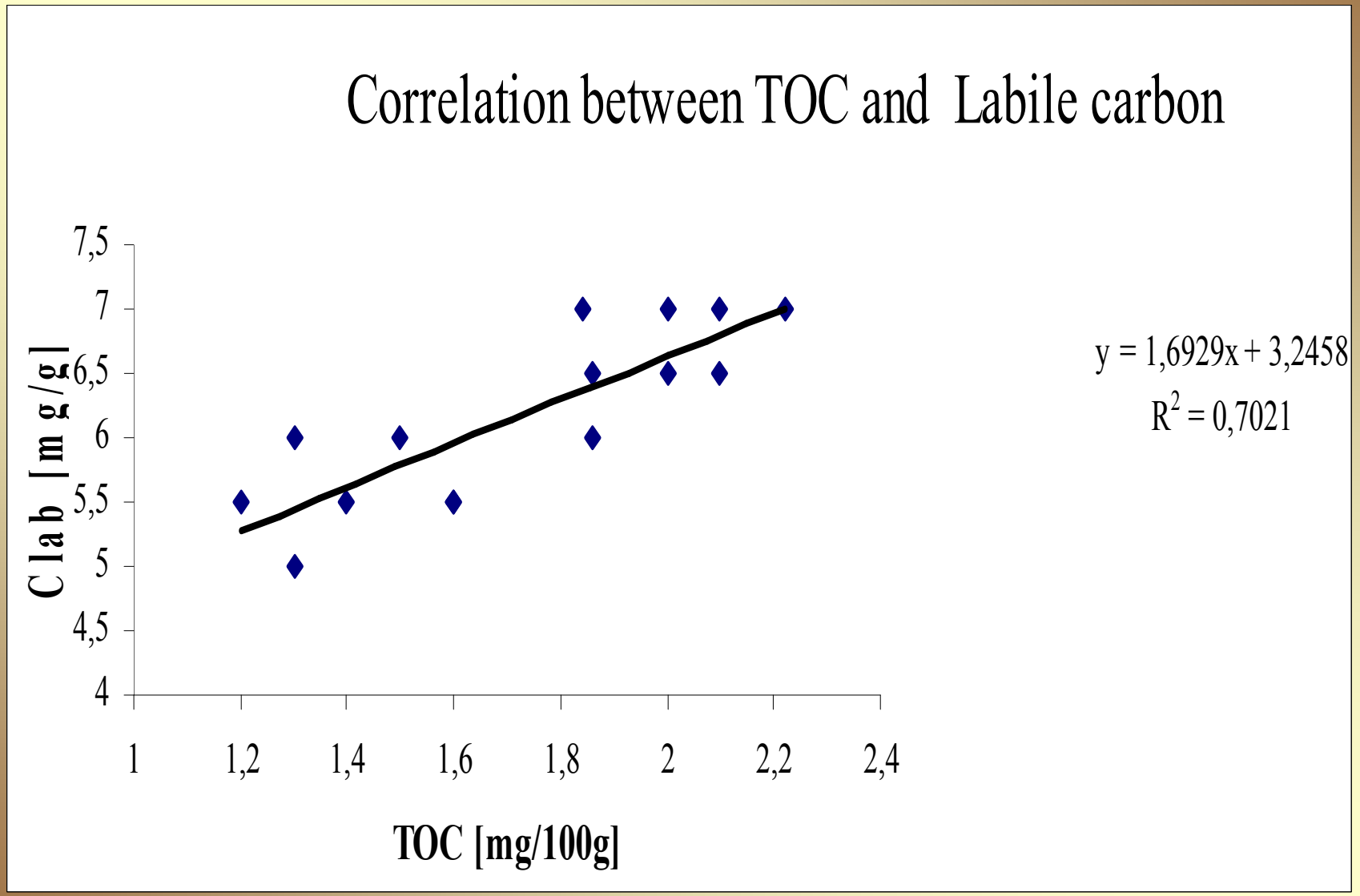
TOC content in Eutric Cambisol (Vatín)



Labile carbon content in Eutric Cambisol (Vatín)



Correlation between TOC and Labile carbon



Results

- **After 10 years of experiment TOC and C labile content were higher in grassland**
- **Correlation between TOC and Labile carbon content was found (R= 0.84)**
- **Statistically significant differences between arable soils and grassland in TOC and labile carbon were found**

Humic substances quality

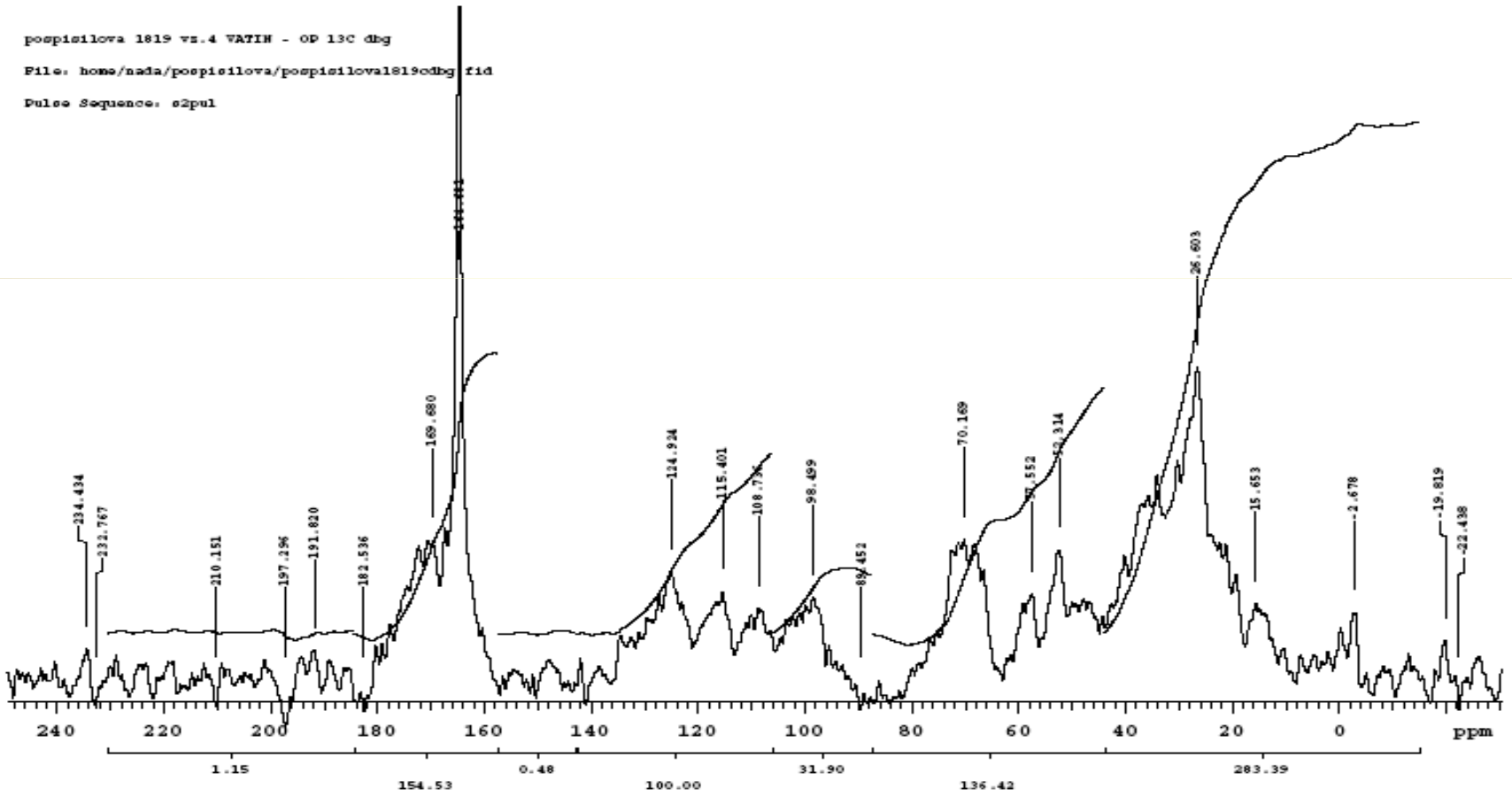
Cambisols subtypes	TOC (%)	Clabile mg/kg	HS sum mg/kg	HA sum mg/kg	FA sum mg/kg	HA/FA	HD (%)	Q4/6
Leptic C.	3.84	607	4.14	1.44	2.7	0.4	4	5.7
Haplic C.	2.23	562	4.65	1.6	3	0.5	9	5.7
Eutric C. 1	1.97	500	6.8	1.8	5	0.5	10	8.3
Eutric C. 2	2.26	560	7.6	2.9	4.7	0.6	13.3	9.1

Humic acids quality

Humic acid	C (at. %)	H (at. %)	N (at. %)	O (at. %)	Ash (%)
Leptic Cambisol	33.45	47.44	3.07	16.05	1.7
Haplic Cambisol	34.20	46.16	3.05	16.59	4.08
Eutric Cambisol 1	32.73	46.48	2.52	18.27	9.62
Eutric Cambisol 2	35.59	45.89	2.64	15.88	8.44

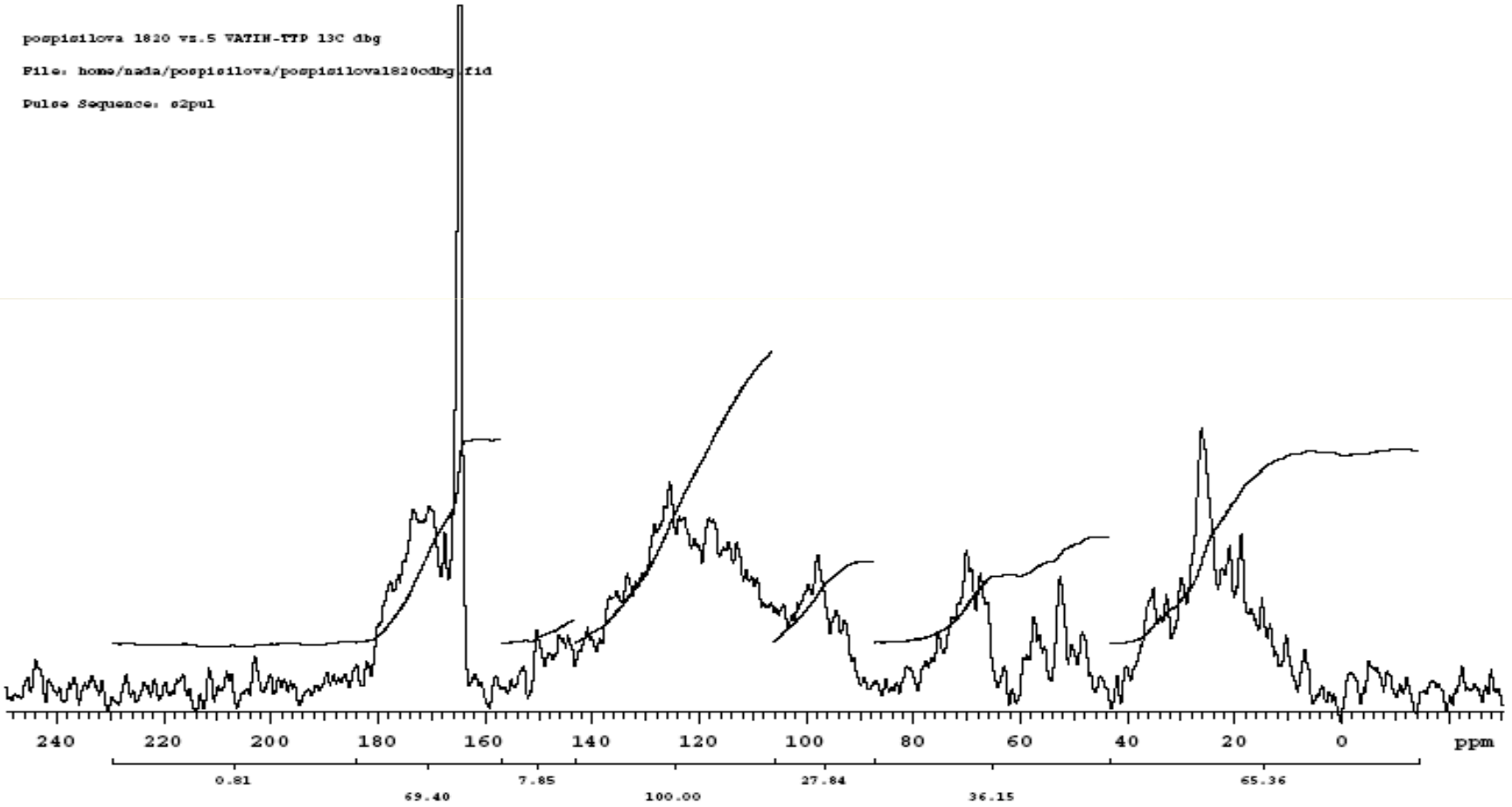
13C NMR spectra of HA

(Eutric C. 1, Vatín)



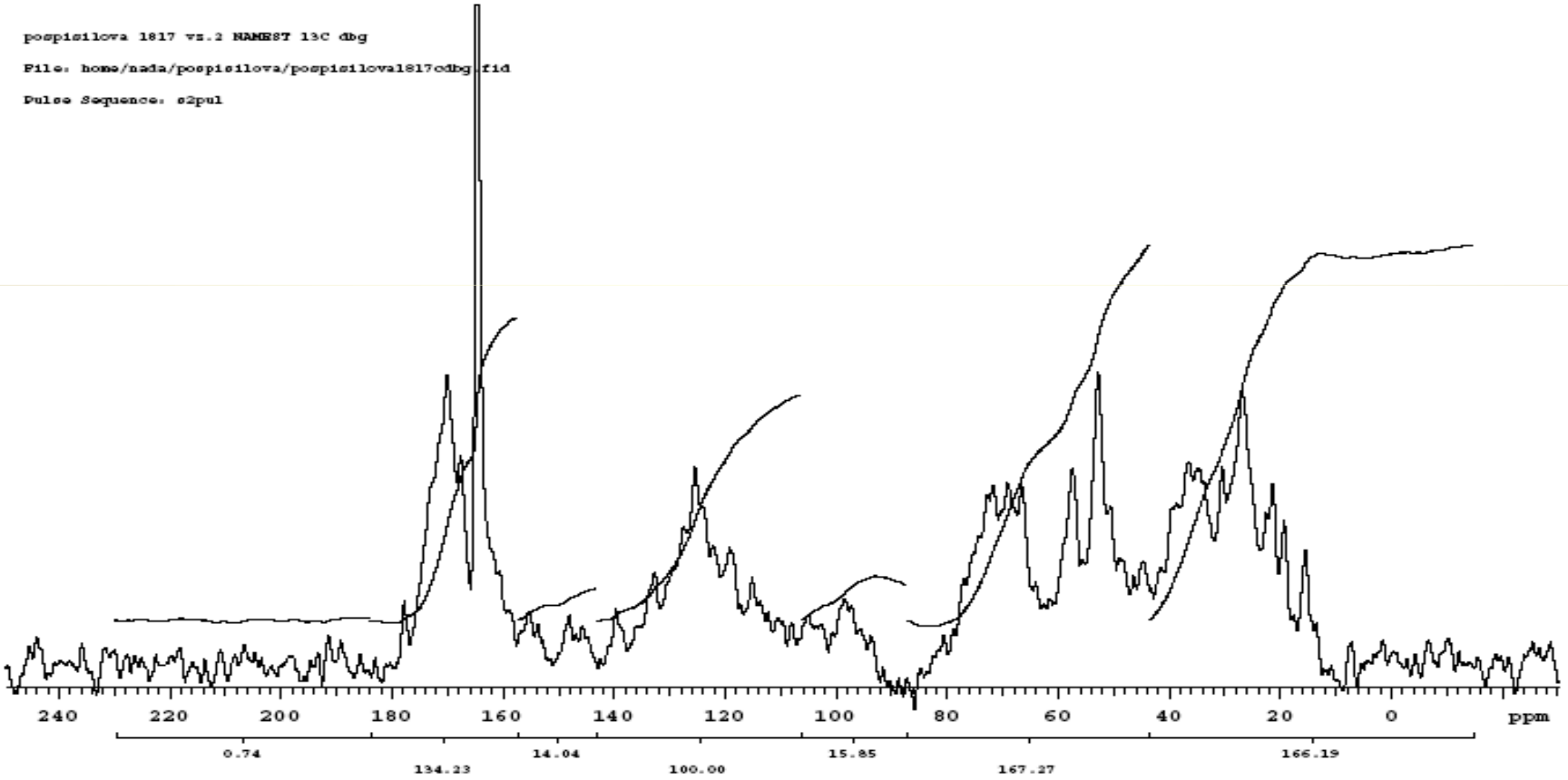
13C NMR spectra of HA

(Eutric C. 2 Vatín)



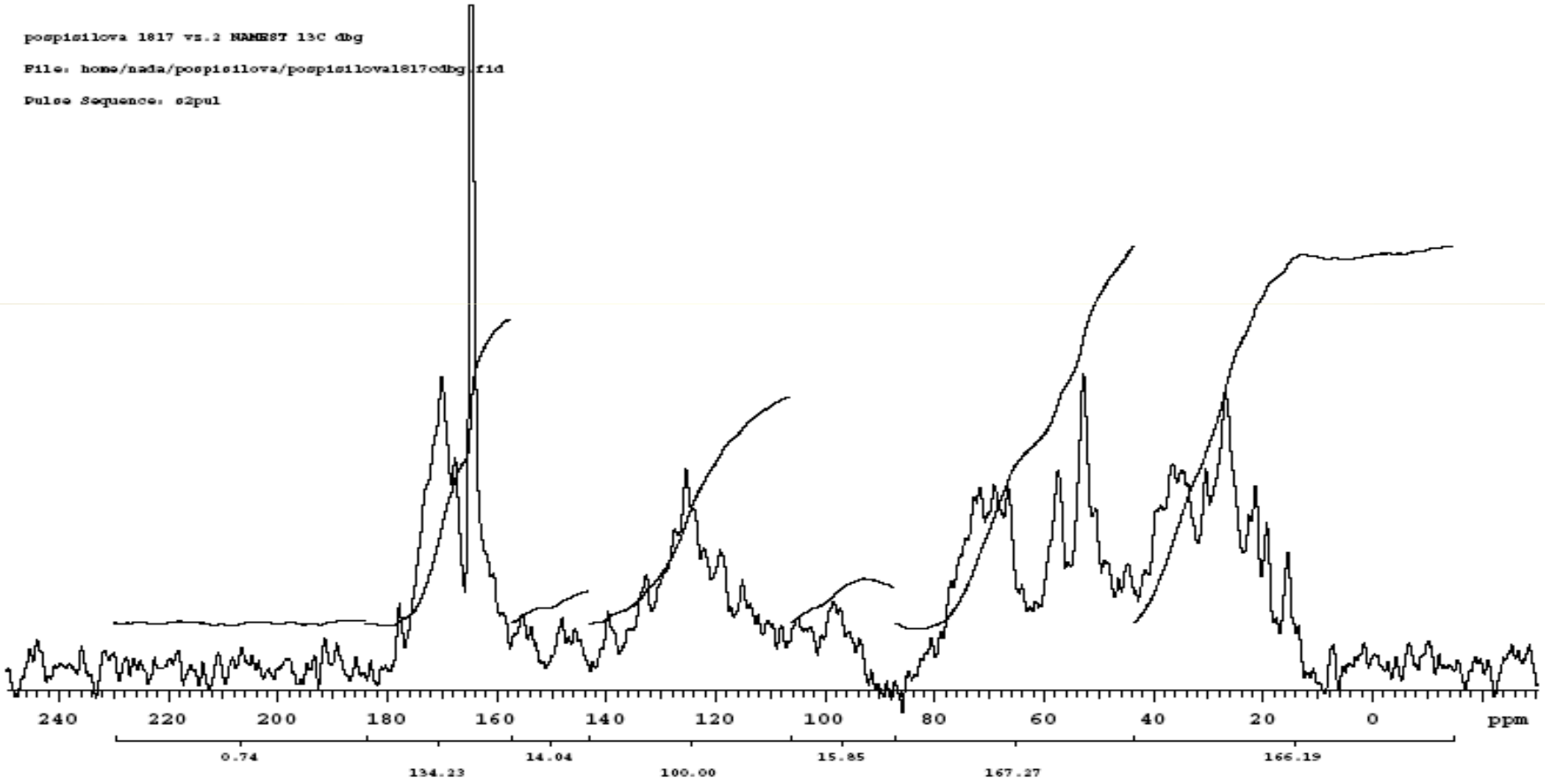
13C NMR spectra of HA

(Haplic C. Náměšť)



13C NMR spectra of HA

(Leptic C. Ocmanice)



Results and discusion

- **Elemental analysis showed that carbon content was decreasing in order:**

Eutric C. (2) > Haplic C. > Leptic C. > Eutric C. (1)

- **HA structure was affected by soil type and land use**

- **HA were young, 13C NMR spectroscopy showed higher aromatic carbon content in grassland and aliphatic carbon in arable soils**

Chemical and Biological properties

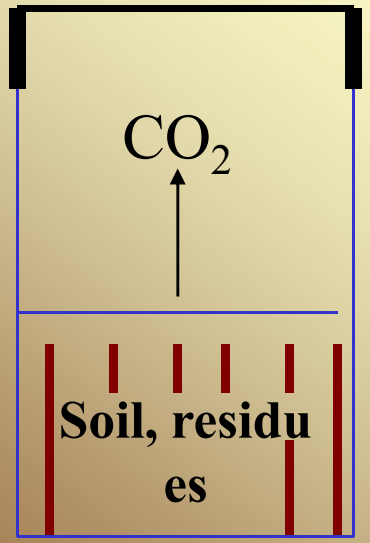
Soil types	pH/ H2O	pH/ KCl	% C	%N	C/N	mg CO_2/ 100g /h	Complex factor
Leptic C.	5	4.2	3.84	0.4	9.7	0.32	2.1
Haplic C.	5.1	4.2	2.23	0.3	8.35	0.21	1.6
Eutric C. 1	5.1	4.6	1.97	0.2	9.23	0.41	1.1
Eutric C. 2	4.9	4.4	2.26	0.25	9	0.60	1.22

Biological properties

Soil Types	Cmic µg/g dw	Cmic/ TOC	B/Cmic qCO2	B/G	G/Cmic qCO2
Leptic C.	249.9	0.42	8.7*10-4	0.2	0.004
Haplic C.	112.5	0.2	2.7*10-3	0.15	0.018
Eutric C. 1	86.9	0.17	4.7*10-3	0.1	0.045
Eutric C. 2	215	0.4	2.8*10-3	0.14	0.021

Results of microbial transformation:

- CO_2 output and bacterial biomass amount higher in grassland
- Ratio Cmic /TOC was lower in arable soil = influence of land use
- Decomposition rate (qCO2 = B/Cmic) higher in arable soils



Conclusions

1. ***More TOC, C labile, Cmic, and HS in grassland***
2. ***13C NMR analysis:***

- *more aromatic compounds in HA isolated from grassland*
- *higher HD in HA isolated from grassland*

3. ***Higher decomposition rate in arable soils***

4. ***Complex factor calculated from biological properties showed higher HS stability in grassland***

Acknowledgements

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Thank you for your attention!