

Sveučilište u Zagrebu
RUDARSKO
GEOLOŠKO
NAFTNI FAKULTET



HRZZ TransFER

Proizvodnja željeza uz rijeku Dravu u
antici i srednjem vijeku: stvaranje i
transfer znanja, tehnologija i roba

01. 03. 2017. - 28. 02. 2018.

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Tomislav Brenko, mag. geol.

Sveučilište u Zagrebu

Rudarsko-geološko-naftni fakultet

Zavod za mineralogiju, petrologiju i mineralne sirovine

Sadržaj

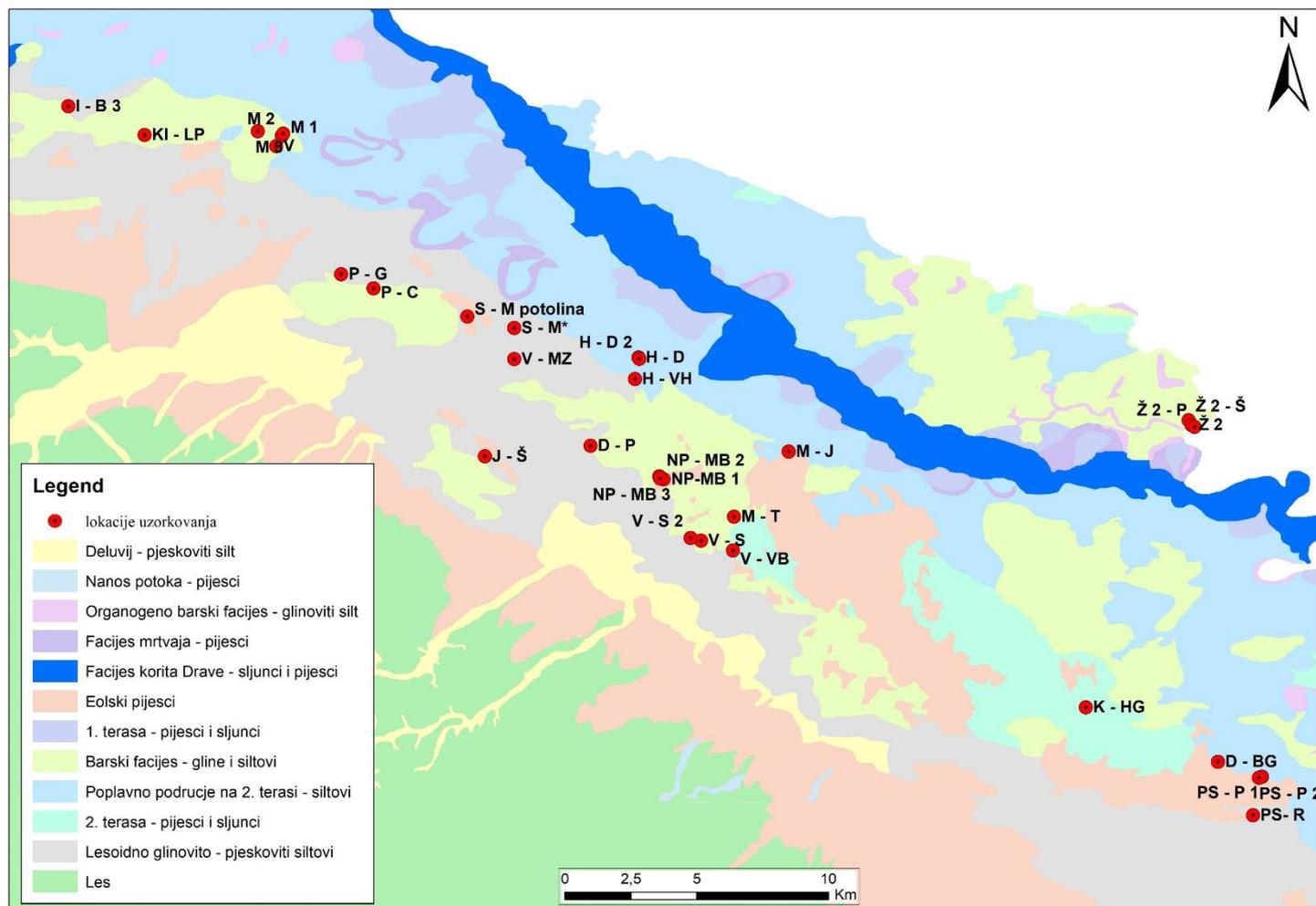
- Terenska istraživanja
- Laboratorijska istraživanja
- Rezultati
- Daljnja istraživanja
- Diskusija

Ciljevi projekta

- Opći cilj projekta TransFER je utvrditi:
- **tip mineralnih sirovina**, način primarne obrade i proizvodnje željeza u nizinskom području sliva rijeke Drave, i
- utjecaj proizvodnje na identitet zajednice i dinamiku razvoja socio-kulturoloških odnosa u društvu tijekom antike i srednjeg vijeka.
- U tu svrhu projekt TransFER će definirati:
- **1. podrijetlo željezne rude i potrebnih resursa** (glina, voda, drvo);
- 2. tehnologiju obrade željezne rude kroz razdoblja i intenzitet te proizvodnje;
- 3. utjecaj proizvodnje željeza u kontekstu socio-kulturološkog okružja i interakcija ljudi i roba.

Terenska istraživanja

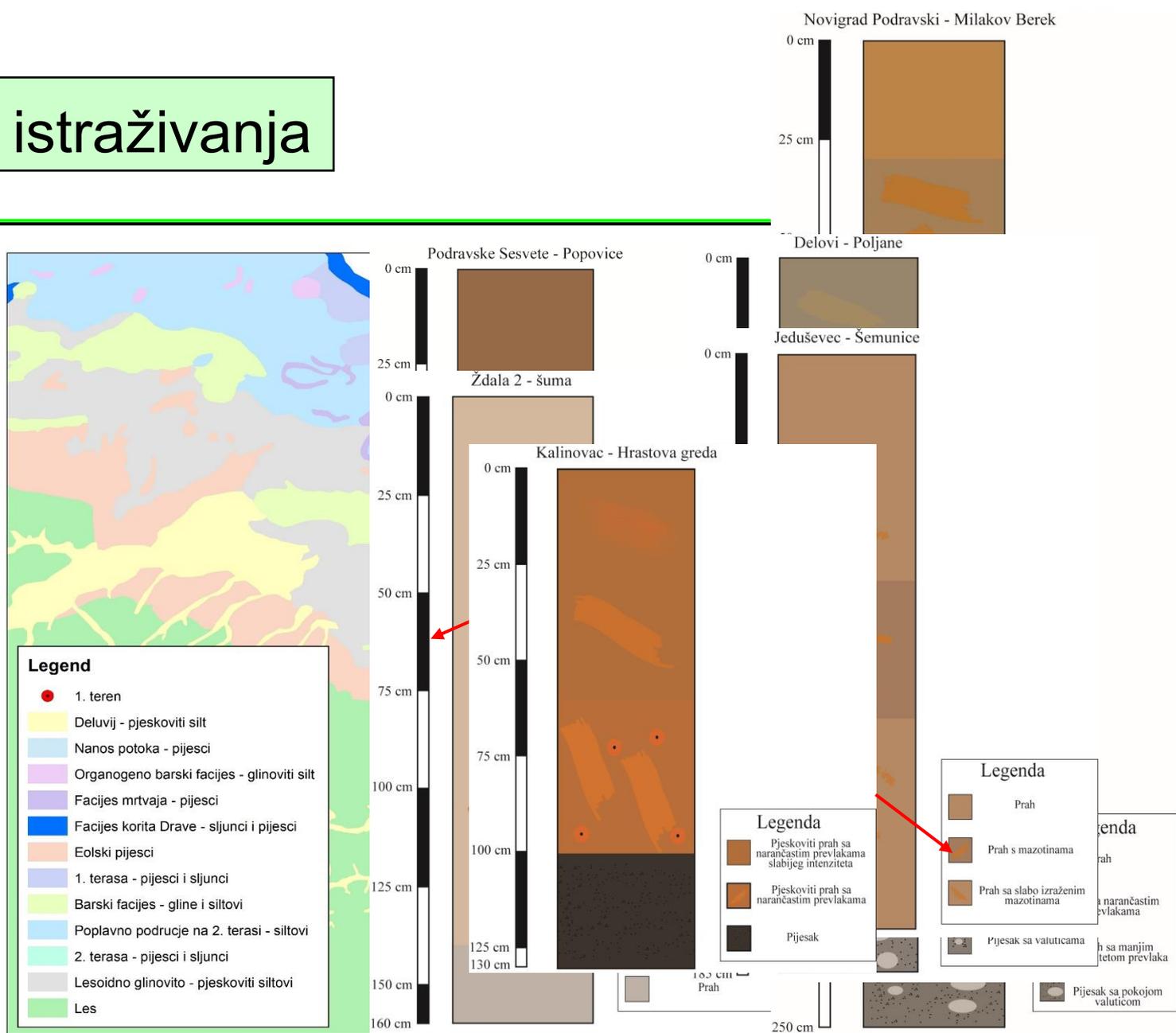
- 6 terena
- uzorkovano augerom
- 30 profila tla
- 2 potencijalne rudne tvorevine
- 20 profila pokazuju pojave željeza



Terenska istraživanja

1. teren

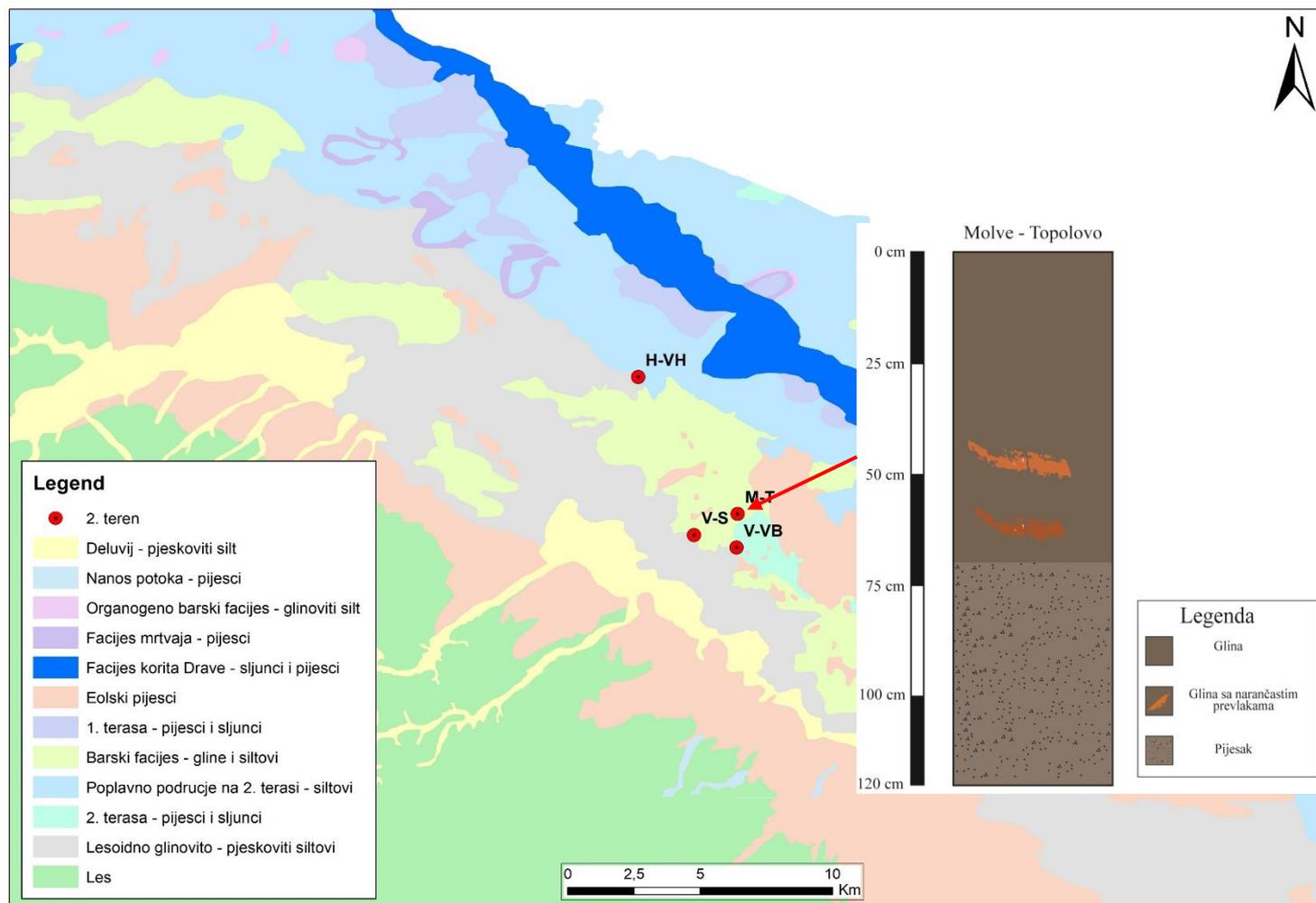
- 10 profila tla
- 8 profila tla pokazuju pojave željeza



Terenska istraživanja

2. teren

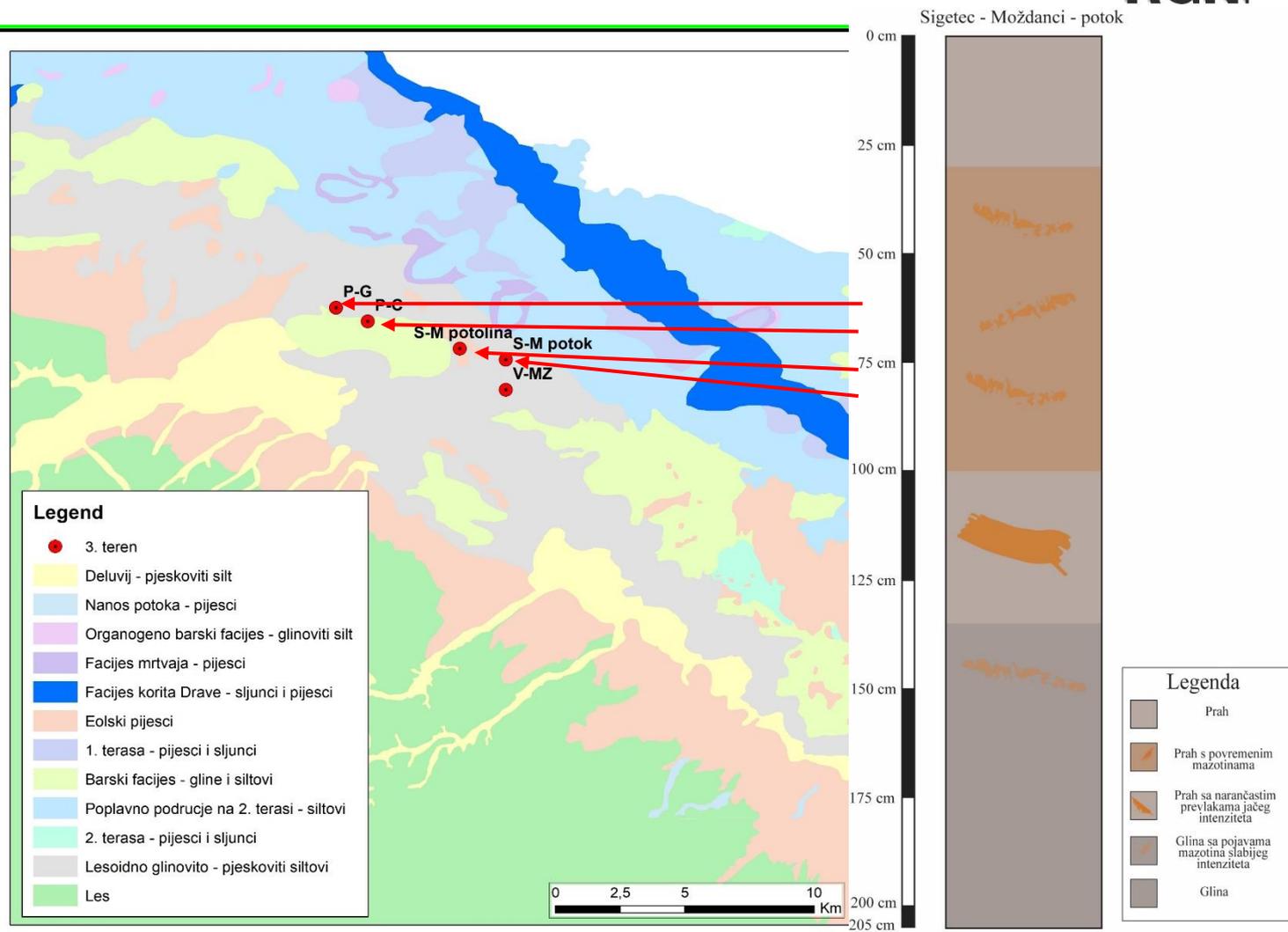
- 6 profila
- 1 pokazuje tragove željeza



Terenska istraživanja

3. teren

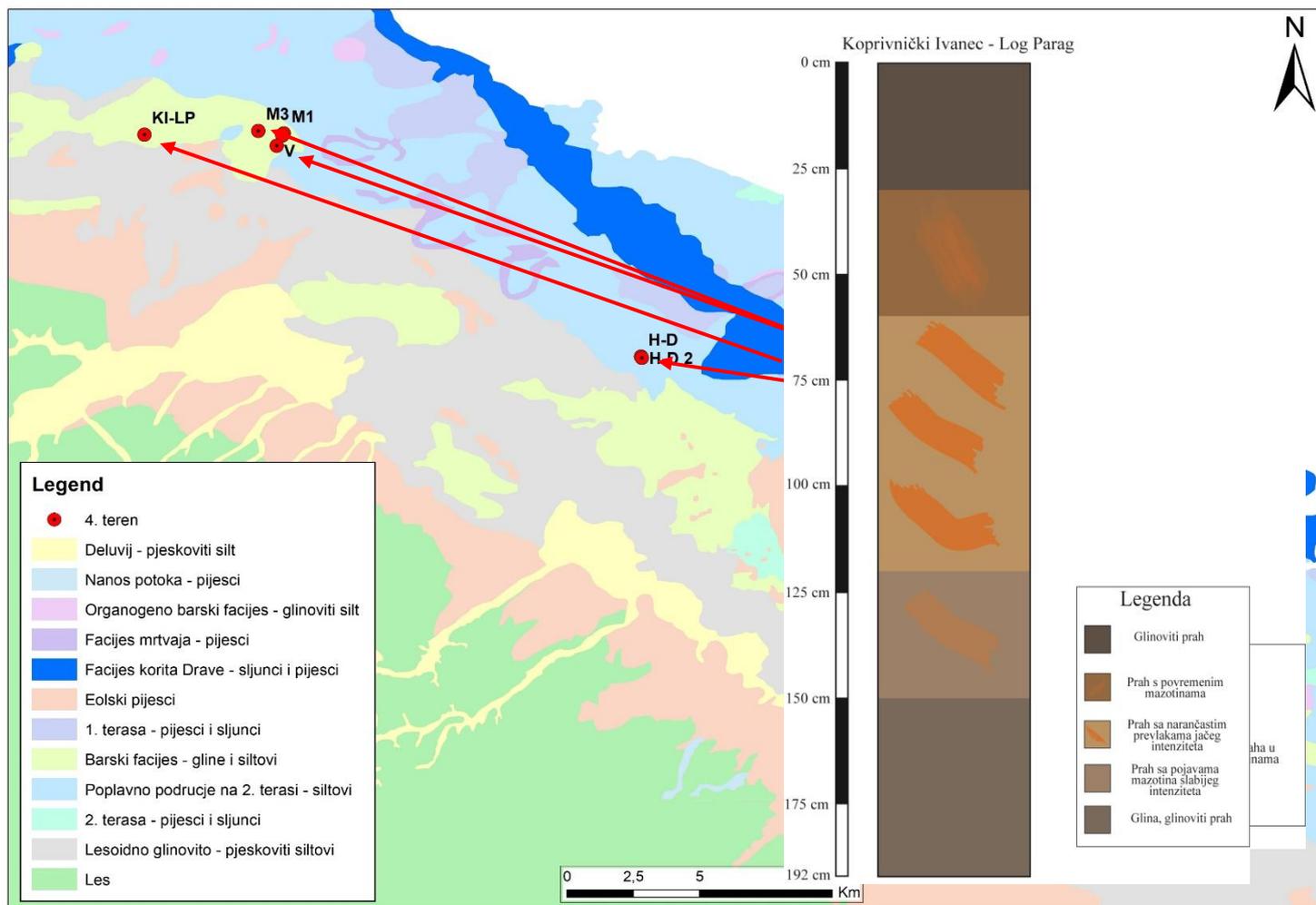
- 6 profila
- 4 pokazuju tragove željeza



Terenska istraživanja

4. teren

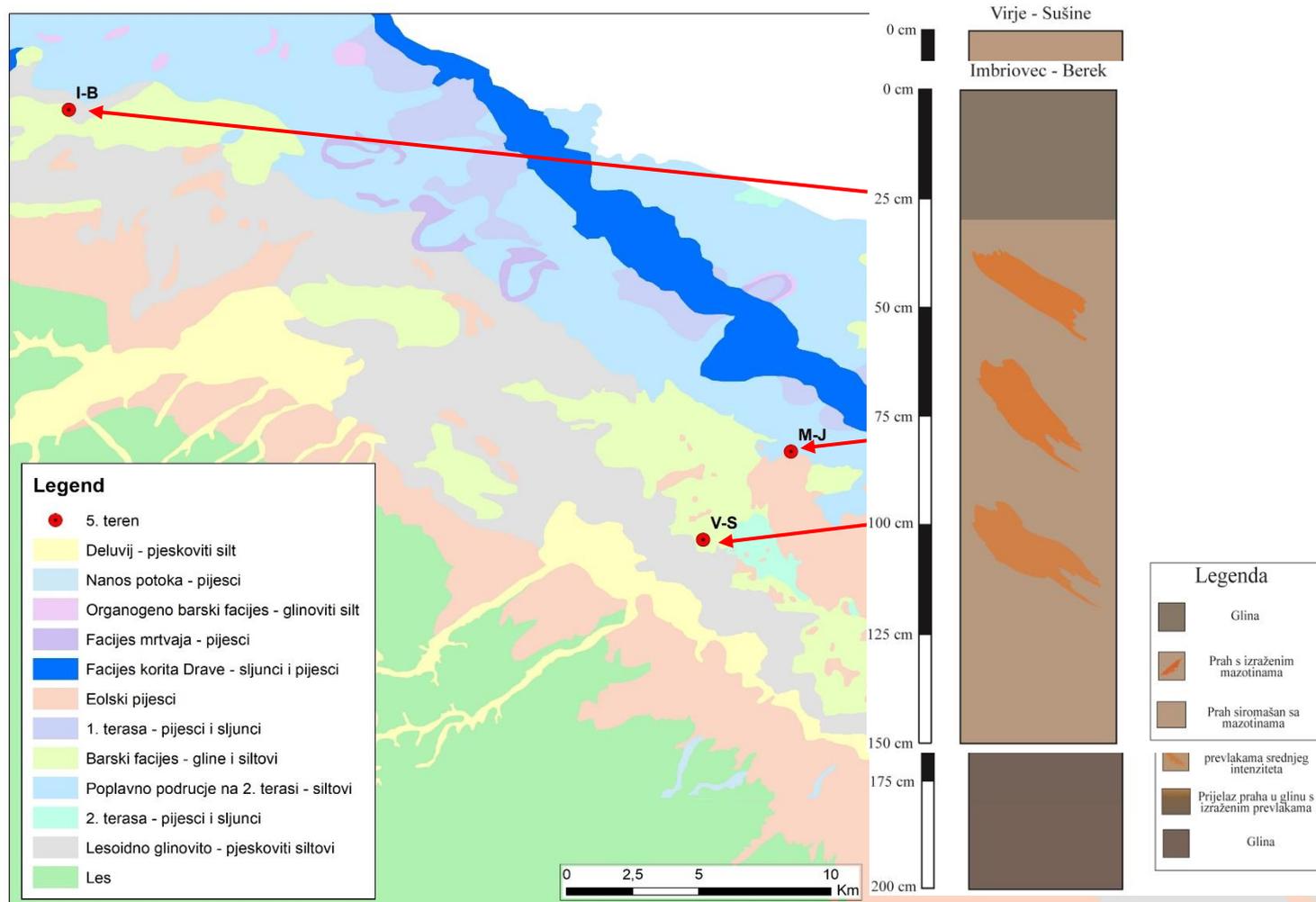
- 7 profila tla
- 4 pokazuju tragove željeza



Terenska istraživanja

5. teren

- 5 profila sa 3 lokacije
- 3 pokazuju pojave željeza



Laboratorijska istraživanja

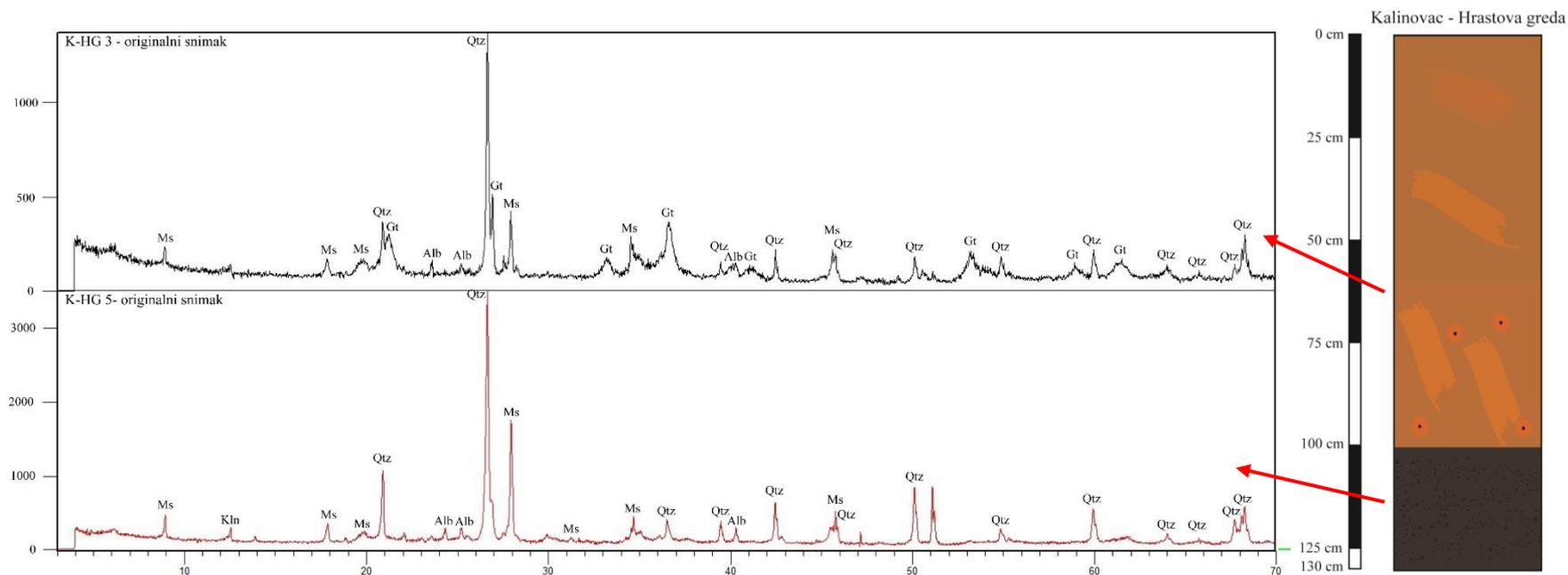
- svrha analiza:
 1. Mineralni sastav – XRD, mikropetrografske analize
 2. Kemijski sastav – DCB, OKS, SEA, zlatotopka
 3. Dodatne analize – magnetski susceptibilitet

Rezultati

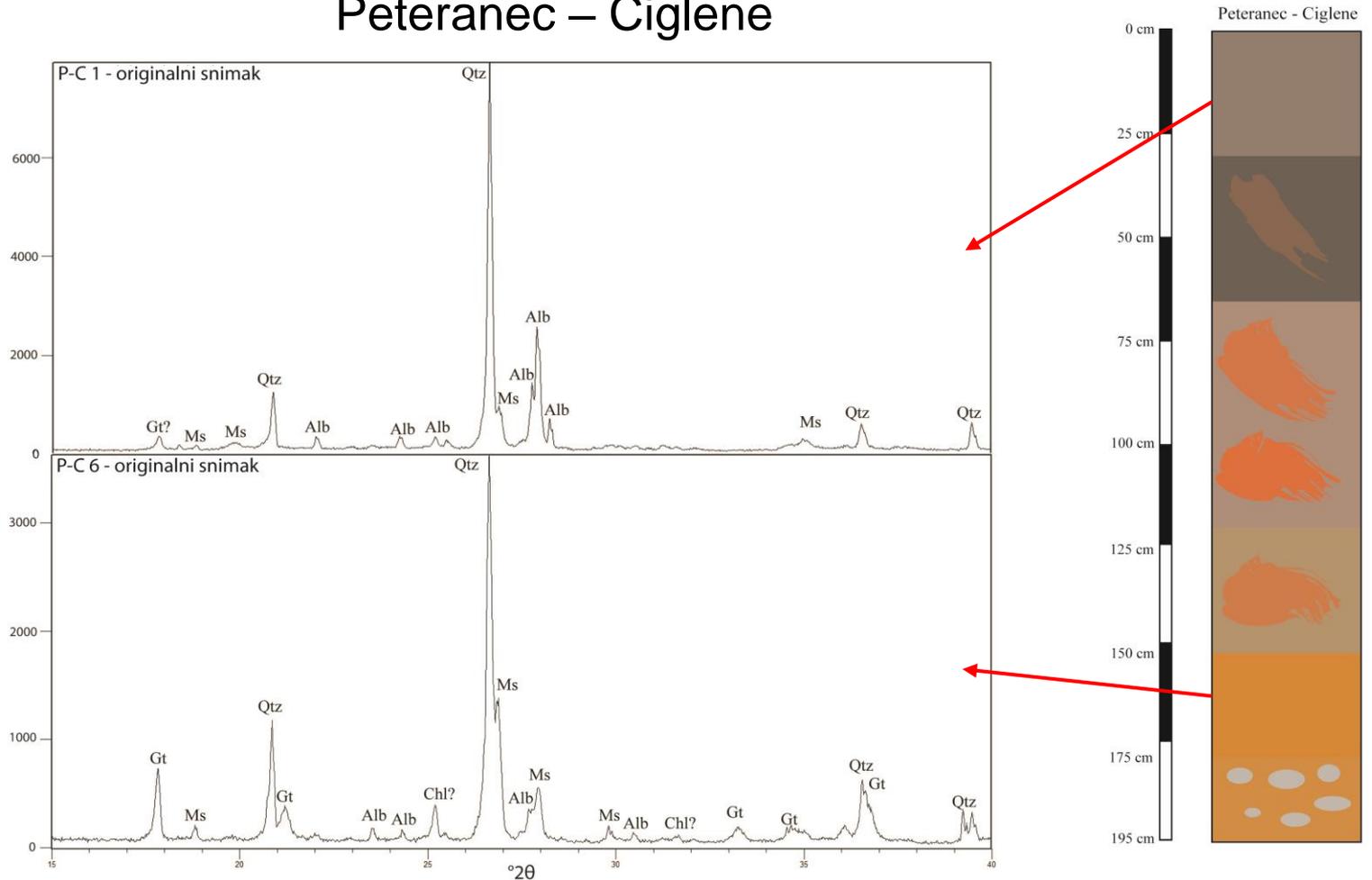
1.1. XRD

- 71 uzorak tla + 8 uzoraka tla i rude
- 3 profila tla ukazuju na željezovite minerale (goethit)

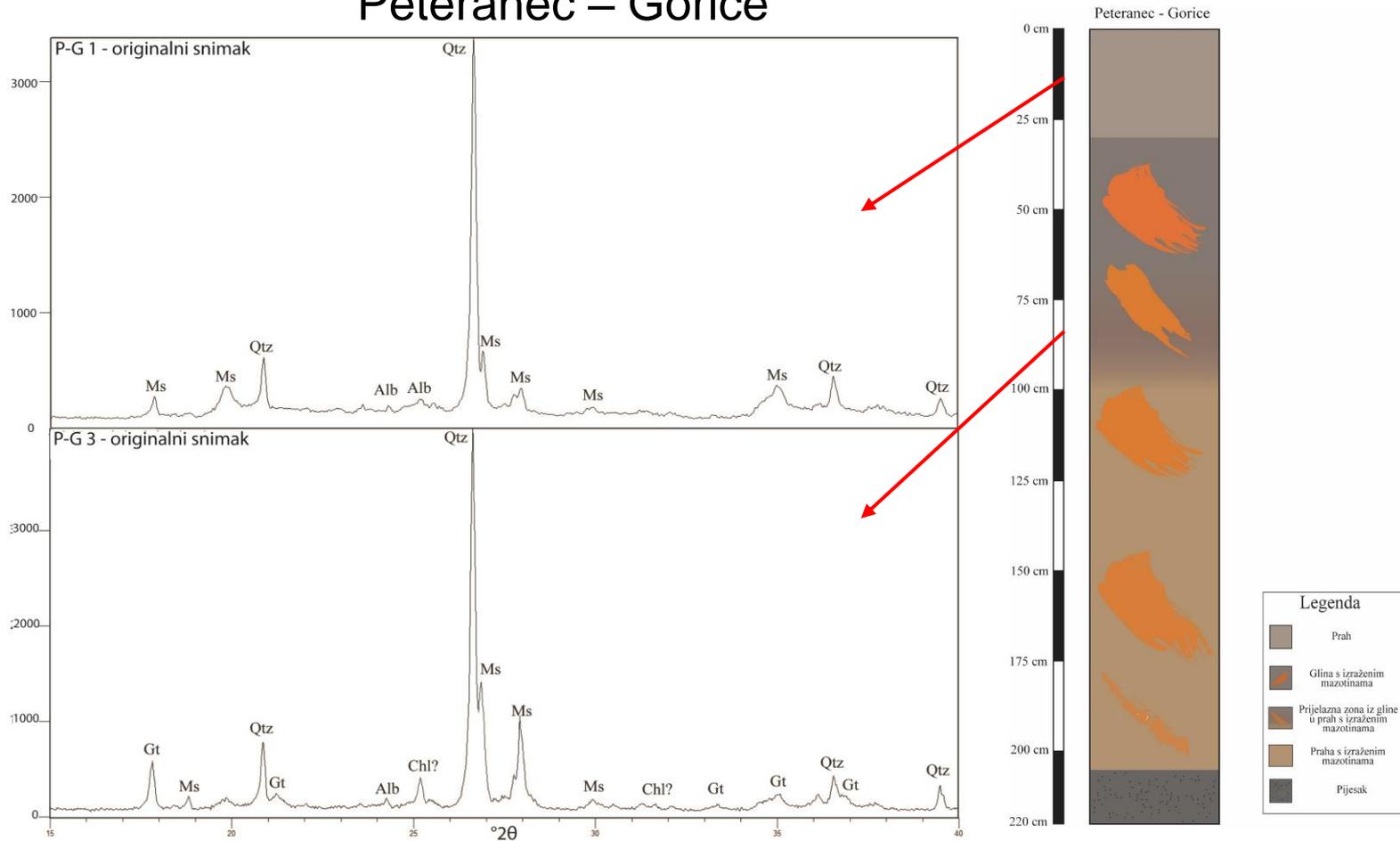
Kalinovac – Hrastova Greda



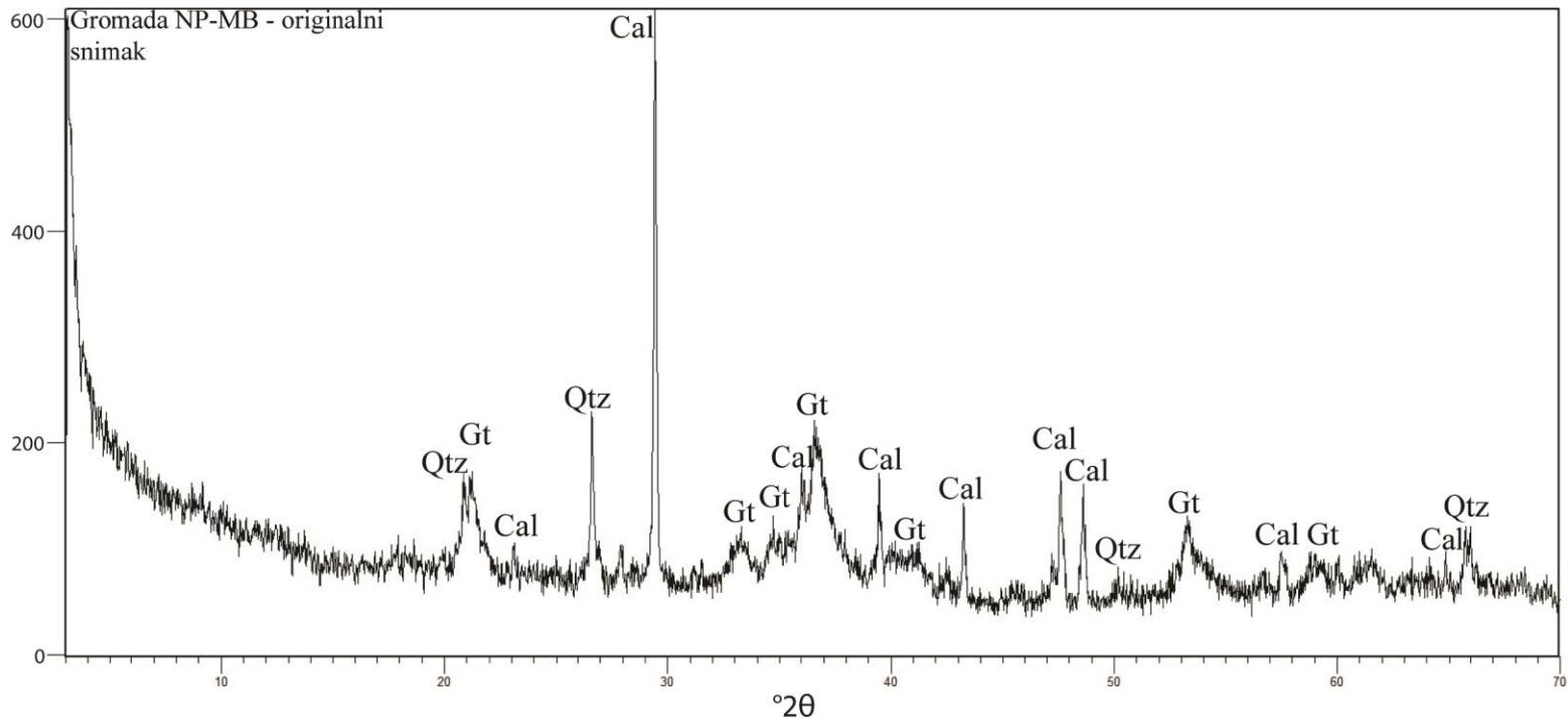
Peteranec – Ciglene



Peteranec – Gorice



Močvarna željezna ruda: Novigrad Podravski – Milakov Berek

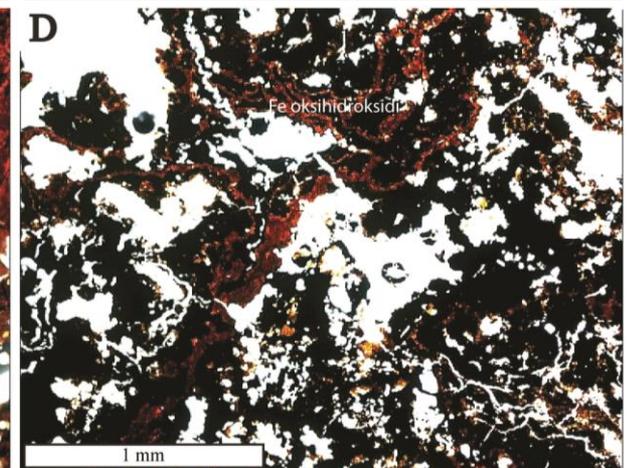
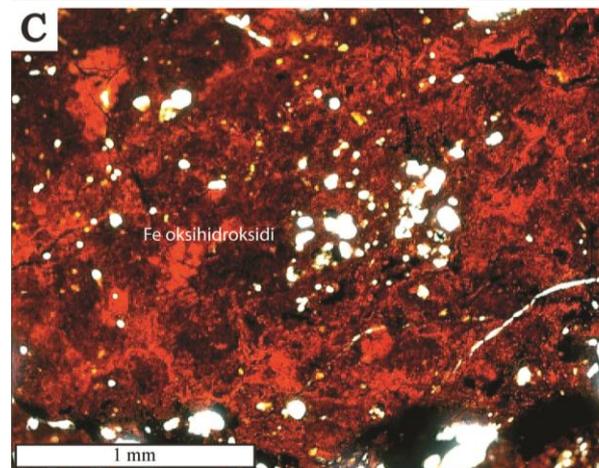
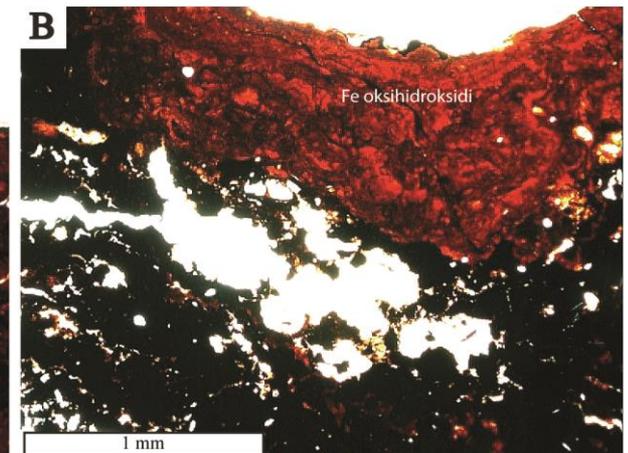
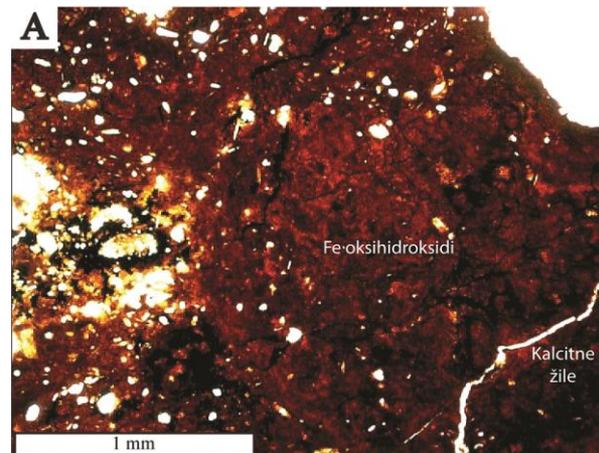


1.2. Mikropetrografske analize

Novigrad Podravski –
Milakov Berek

A i B – gromada
pronađena tokom
izrade cjevovoda

C i D – manja
gromada pronađena
11.2017.



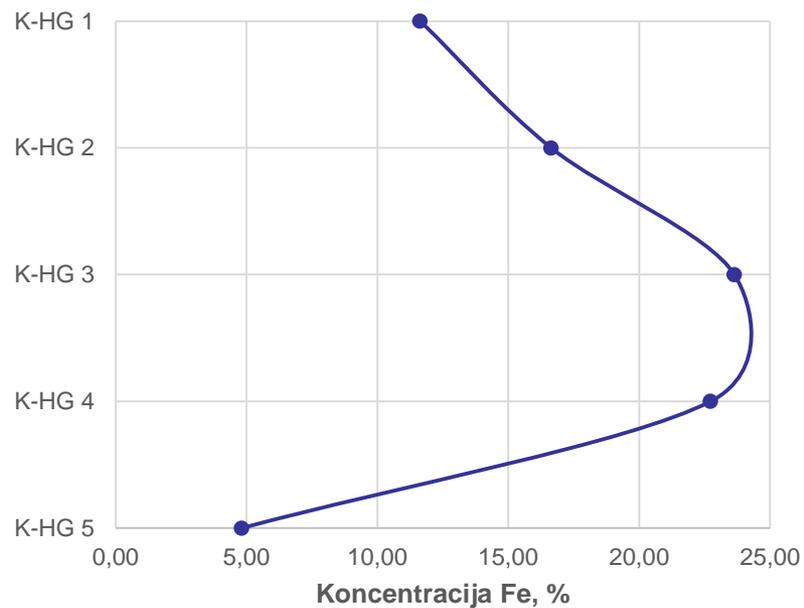
2.1. Zlatotopka

| Vrsta uzorka | Lab broj. | Lokalitet | Udio Fe, % |
|--------------|-----------|-----------|---------------|
| Tlo | 5771 | K-HG | 36,61 |
| | 5772 | K-HG | 32,84 |
| Konkrecije | 5773 | K-HG | 18,09 |
| Kuglice | 5775 | P-C | 29,97 |
| Ruda | 5774 | NP-MB | 40,09 |
| | 5774-S | NP-MB | 45,71 |
| | 5774-C | NP-MB | 32,02 |
| | 5774-Z | NP-MB | 28,55 |

2.1. Zlatotopka

Kalinovac – Hrastova Greda

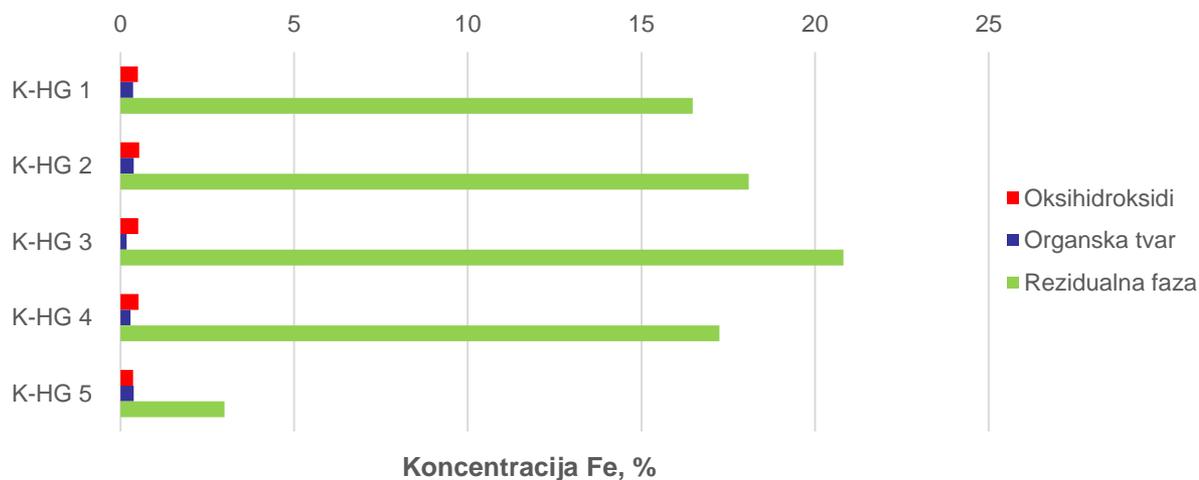
| Vrsta uzorka | Terenska oznaka | Dubina, cm | Udio Fe, % |
|--------------|-----------------|------------|------------|
| Tlo | K-HG 1 | 0-30 | 11,64 |
| Tlo | K-HG 2 | 30-60 | 16,64 |
| Tlo | K-HG 3 | 60-80 | 23,64 |
| Tlo | K-HG 4 | 80-100 | 22,73 |
| Tlo | K-HG 5 | 100-130 | 4,82 |



2.2. Sekvencijska ekstrakcijska analiza – K-HG

| Terenska oznaka | Dubina | Tip uzorka | 1. korak, Fe (ppm) | 2. korak, Fe (%) | 3. korak, Fe (%) | 4. korak, Fe (%) |
|-----------------|-----------|------------|--------------------|------------------|------------------|------------------|
| K-HG 1 | 0 - 30 | Tlo | 19,64 | 0,50 | 0,37 | 16,48 |
| K-HG 2 | 30 - 60 | Tlo | 21,63 | 0,54 | 0,38 | 18,10 |
| K-HG 3 | 60 - 80 | Tlo | 21,50 | 0,51 | 0,18 | 20,81 |
| K-HG 4 | 80 - 100 | Tlo | 19,33 | 0,52 | 0,29 | 17,25 |
| K-HG 5 | 100 - 130 | Tlo | 44,18 | 0,36 | 0,38 | 2,99 |

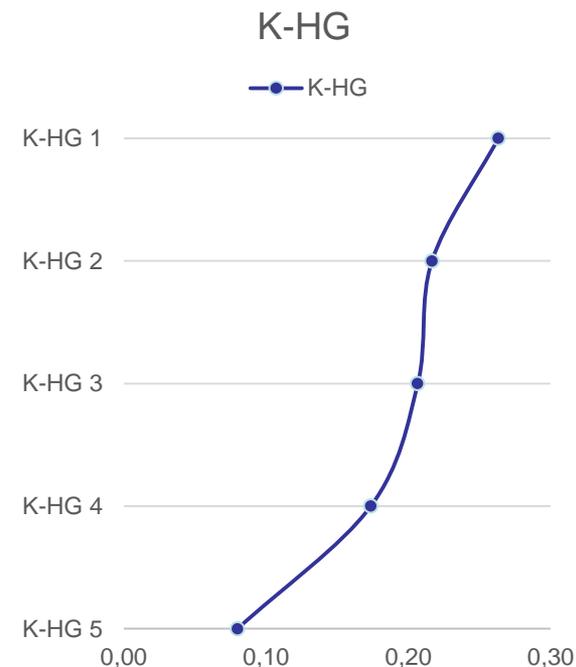
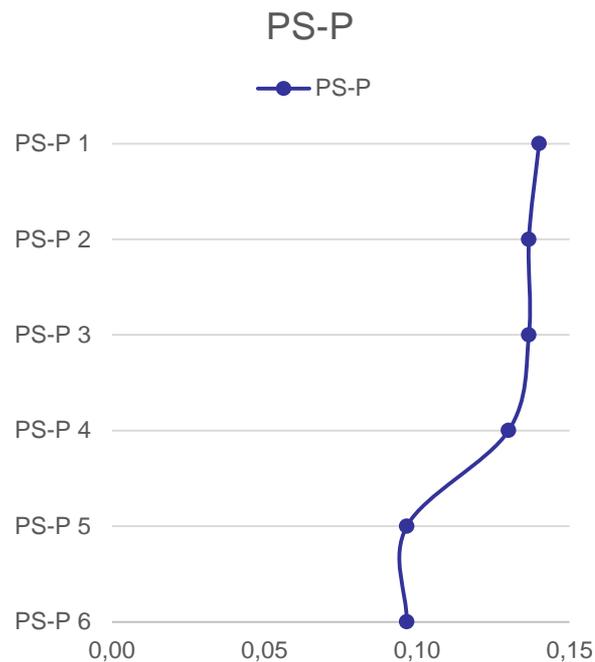
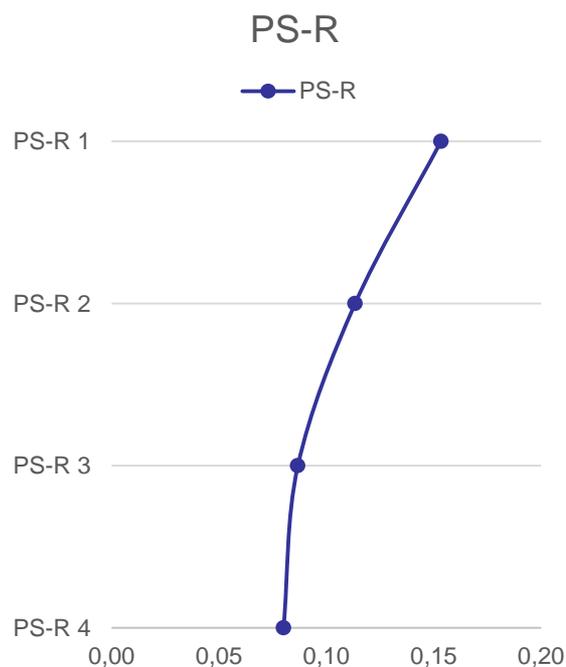
Sekvencijska ekstrakcijska analiza



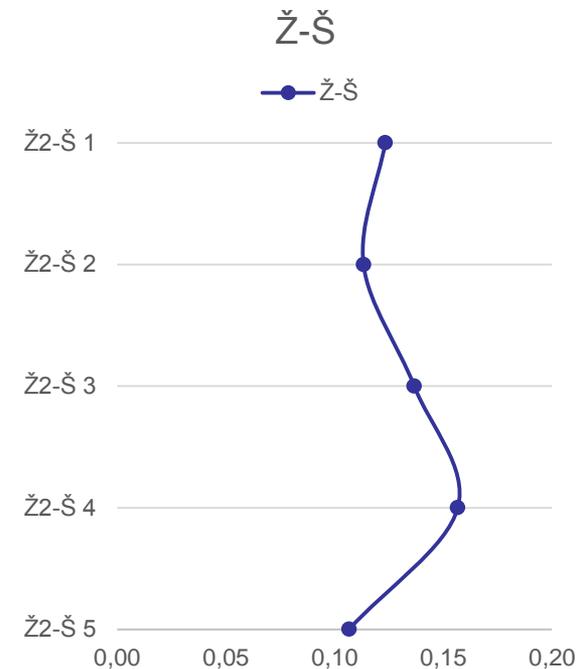
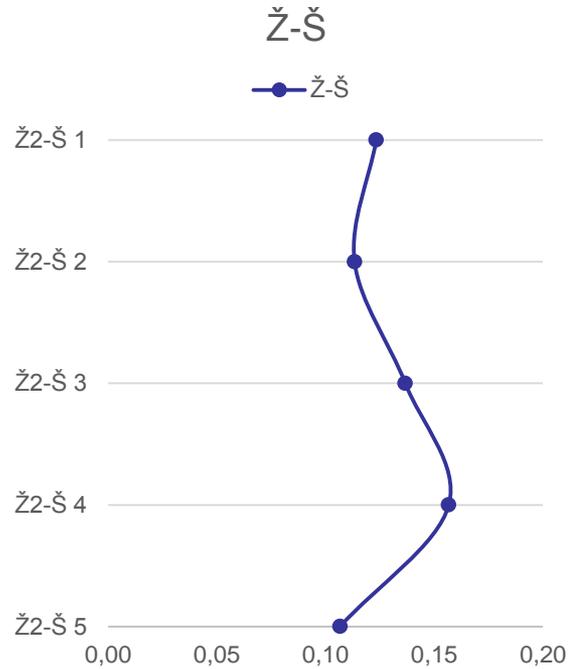
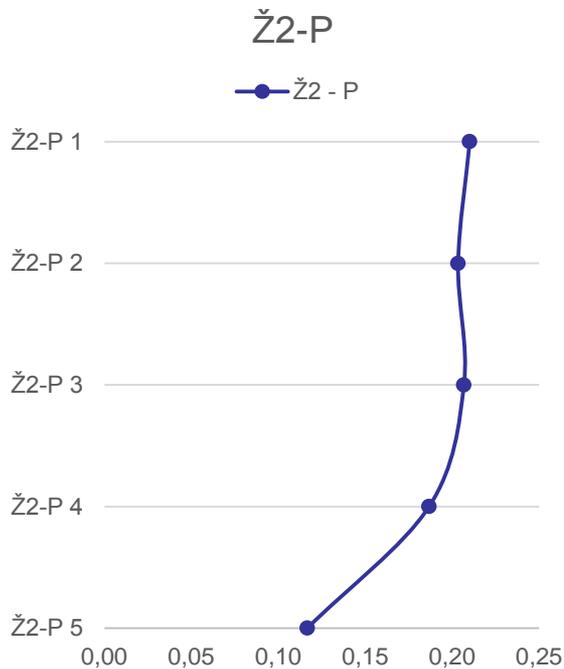
Rezultati

3. Magnetski susceptibilitet

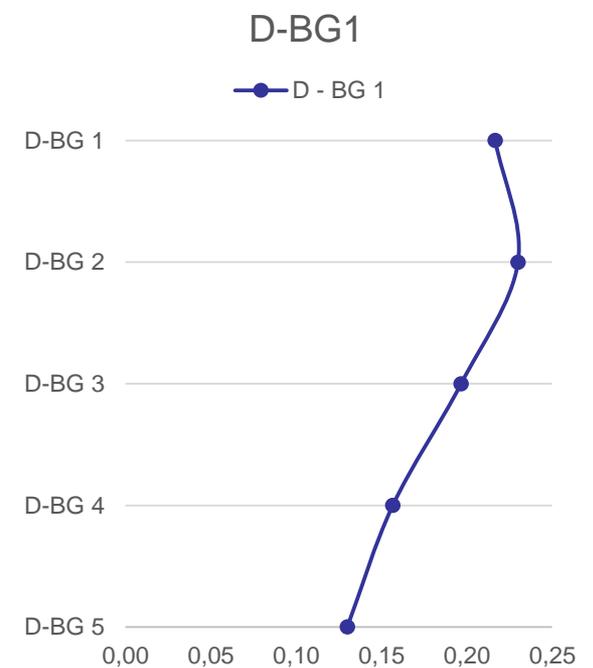
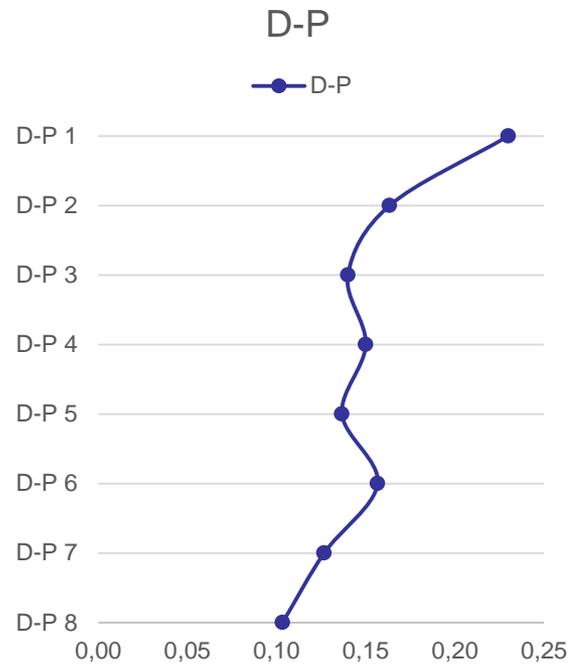
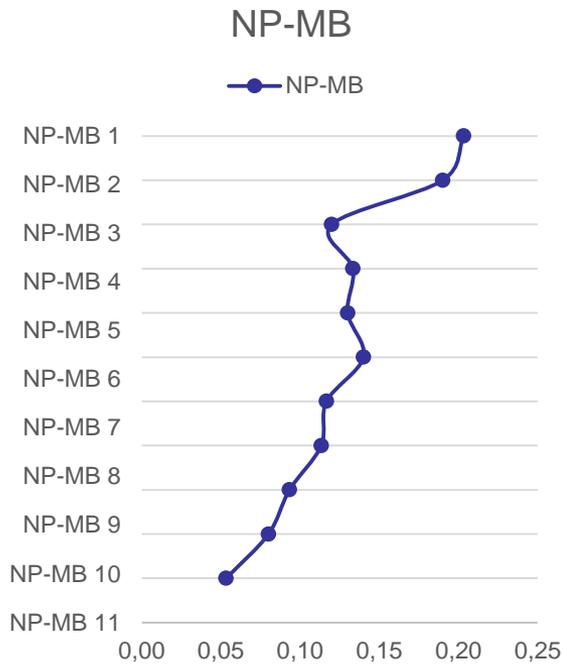
- 23 profila
- vidljiva korelacija → korištenje na terenu za određivanje zanimljivih profila?



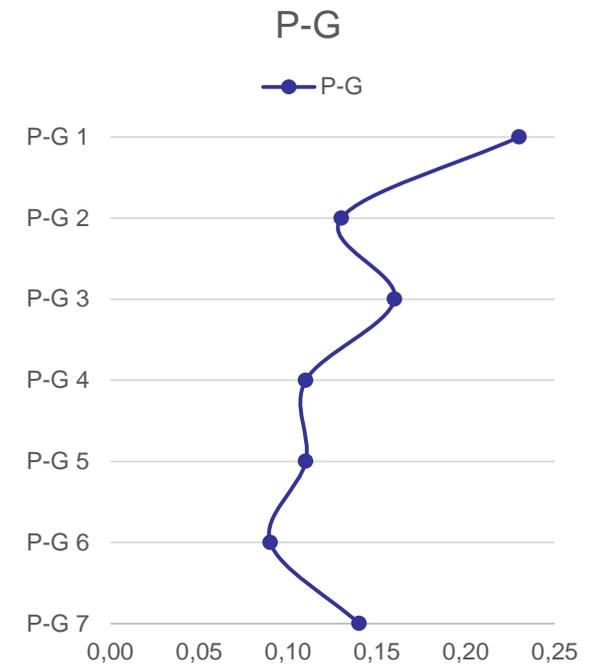
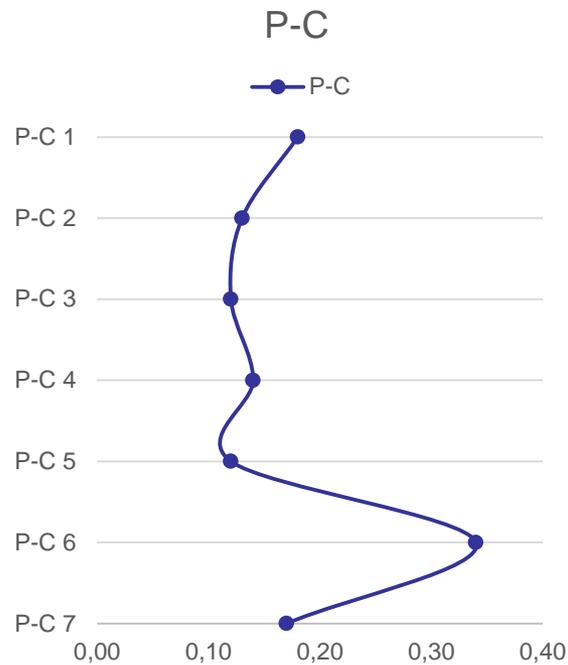
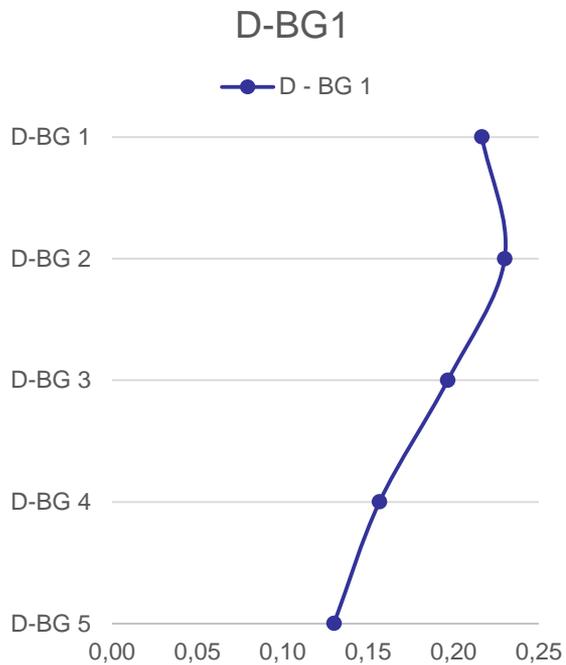
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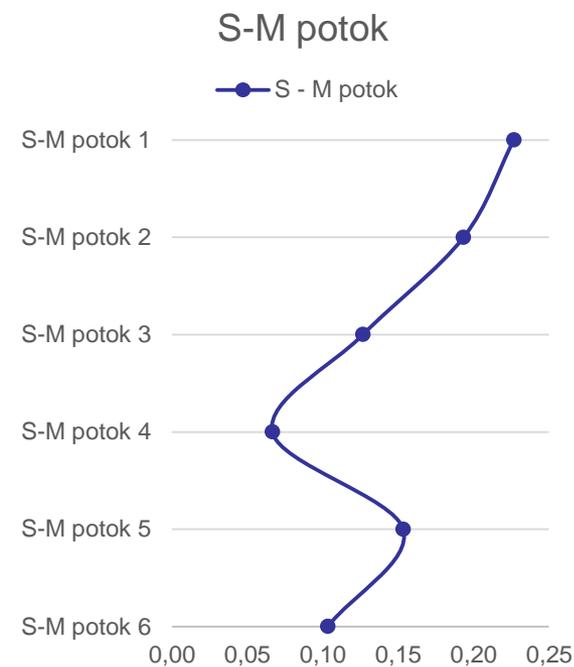
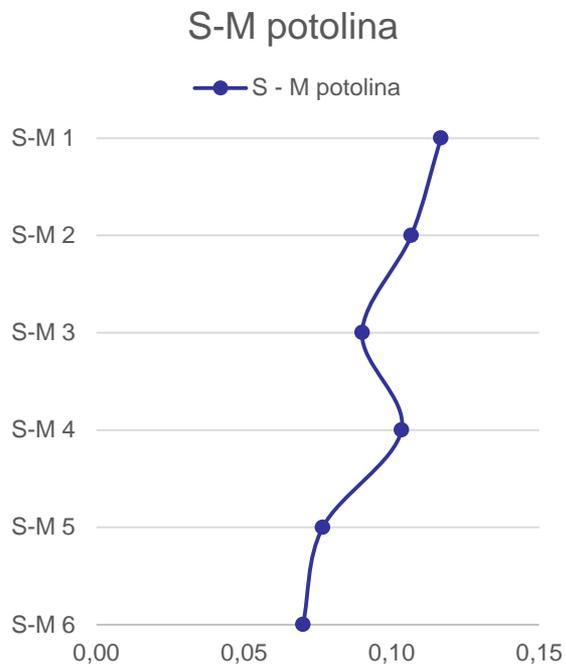
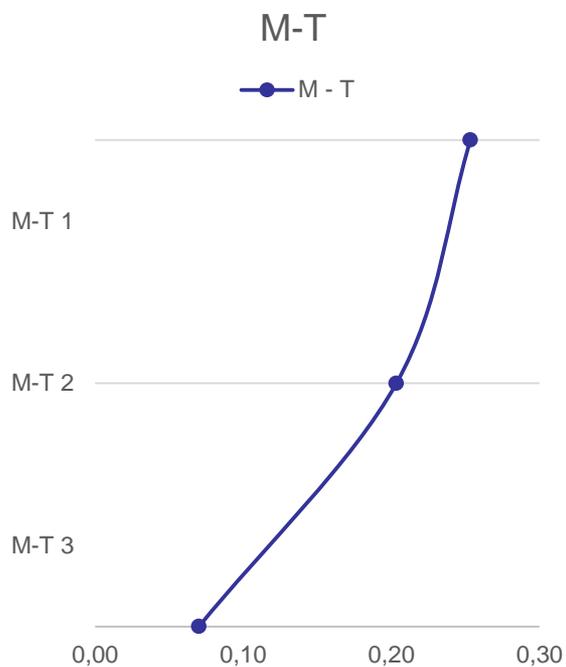
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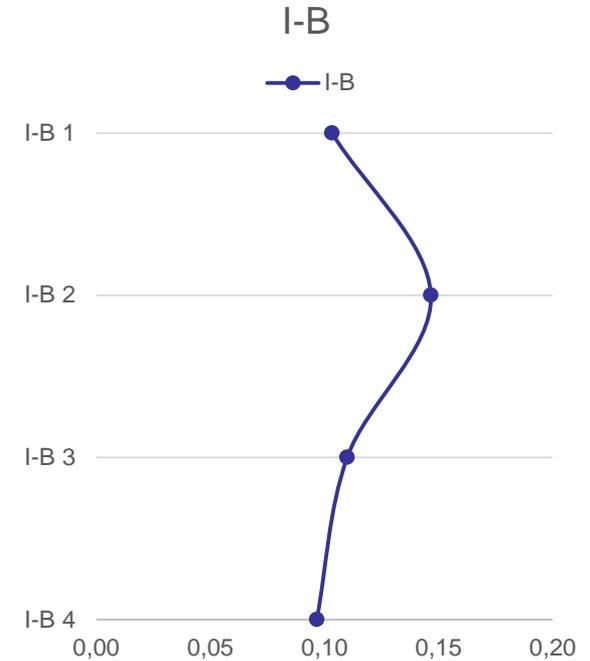
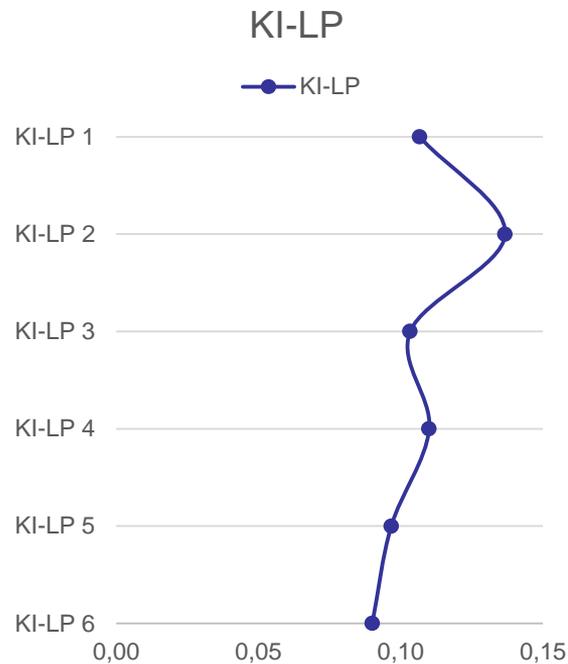
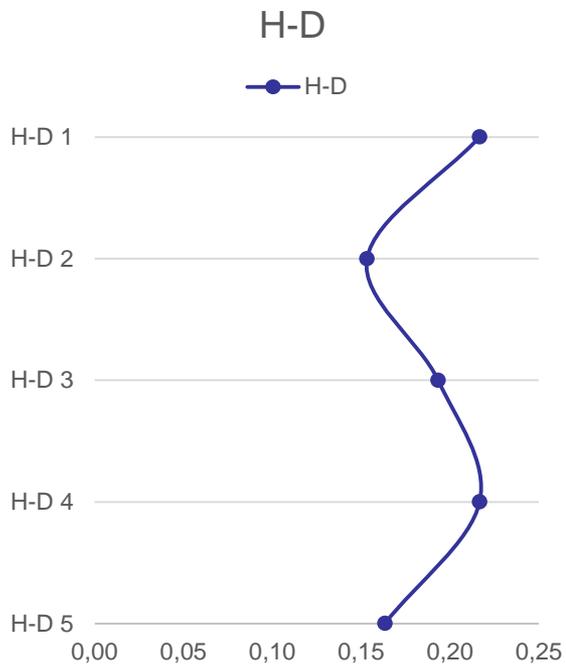


Rezultati

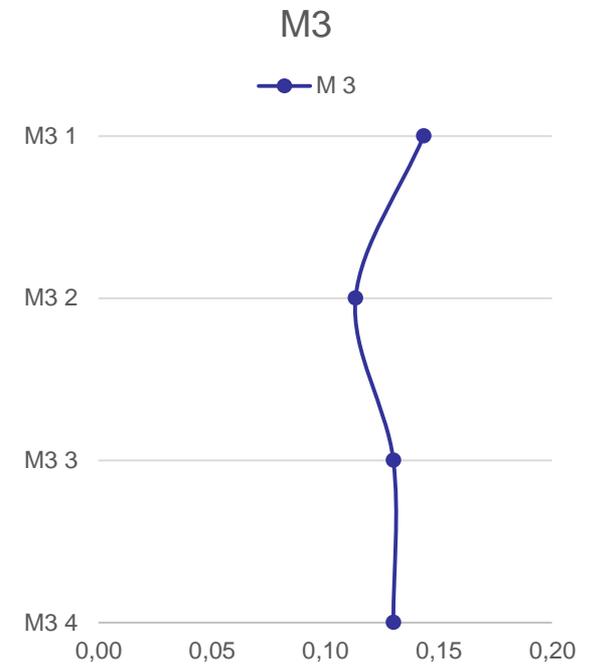
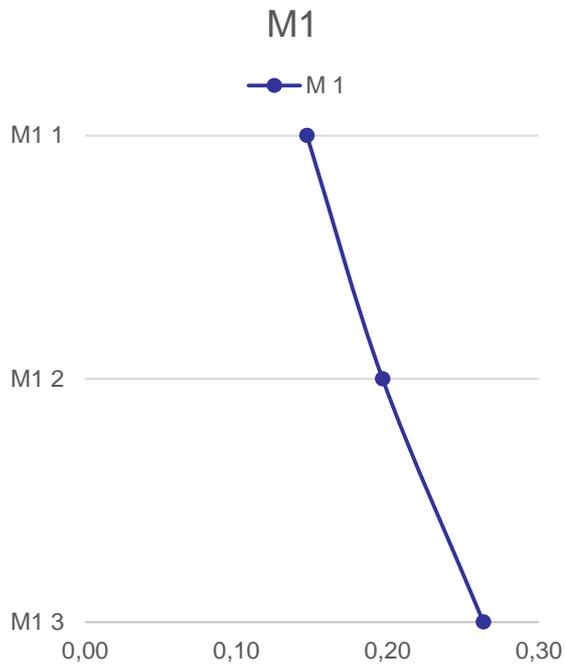
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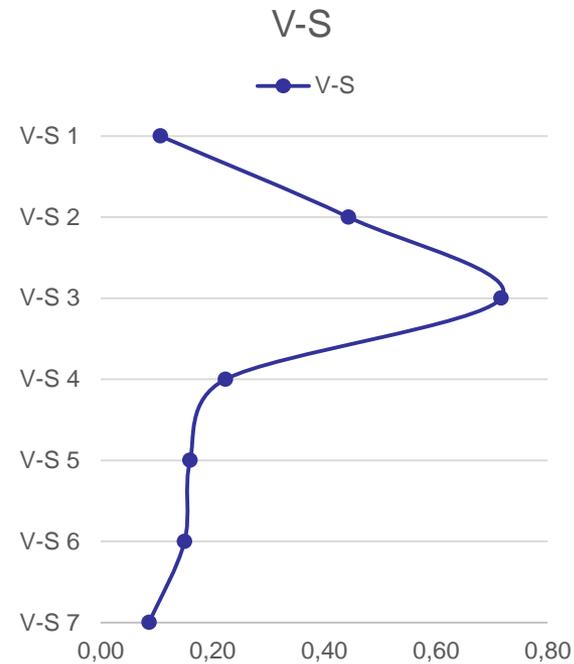
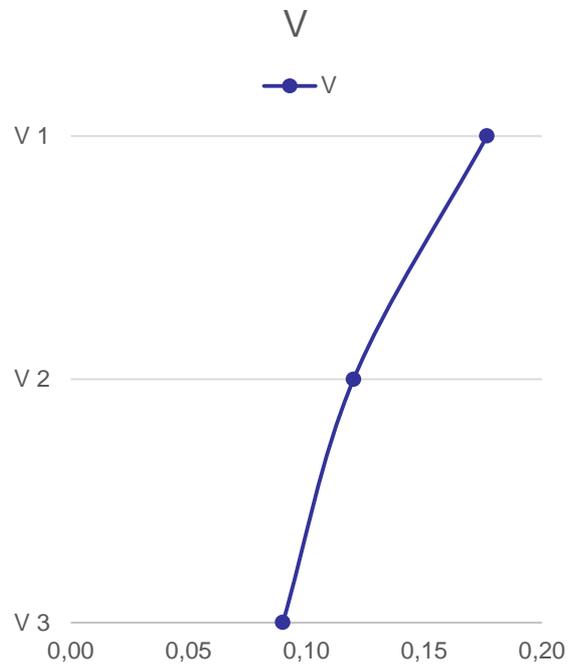
3. Magnetski susceptibilitet



3. Magnetski susceptibilitet



3. Magnetski susceptibilitet





Daljnja istraživanja

- Definiranje tipa tla – genetska korelacija tla i udjela željeza
- Određivanje fizikalno-kemijskih parametara tla (pH, Eh, el. provodljivost)
- Mikromorfološke analize – SEM-EDS, mikromorfologija tla
- Geokemijske analize



Diskusija

- Kalinovac pokazuje najviše vrijednosti željeza u tlu → pedološka jama na tom lokalitetu?
- Dezintegracija rude uslijed poljoprivrede? → istraživanja u zapuštenim dijelovima