Stop 4 : terra rossa soil profile in the Koroniki vineyard : Upper Eocene – Recent Unconformity

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Field trip A2 - Red Istria

Western Istrian Anticline as an ideal natural laboratory for the study of the regional unconformities in carbonate rocks

STOP 4: TERRA ROSSA SOIL PROFILE IN THE KORONIKI VINEYARD: Upper Eocene – Recent Unconformity

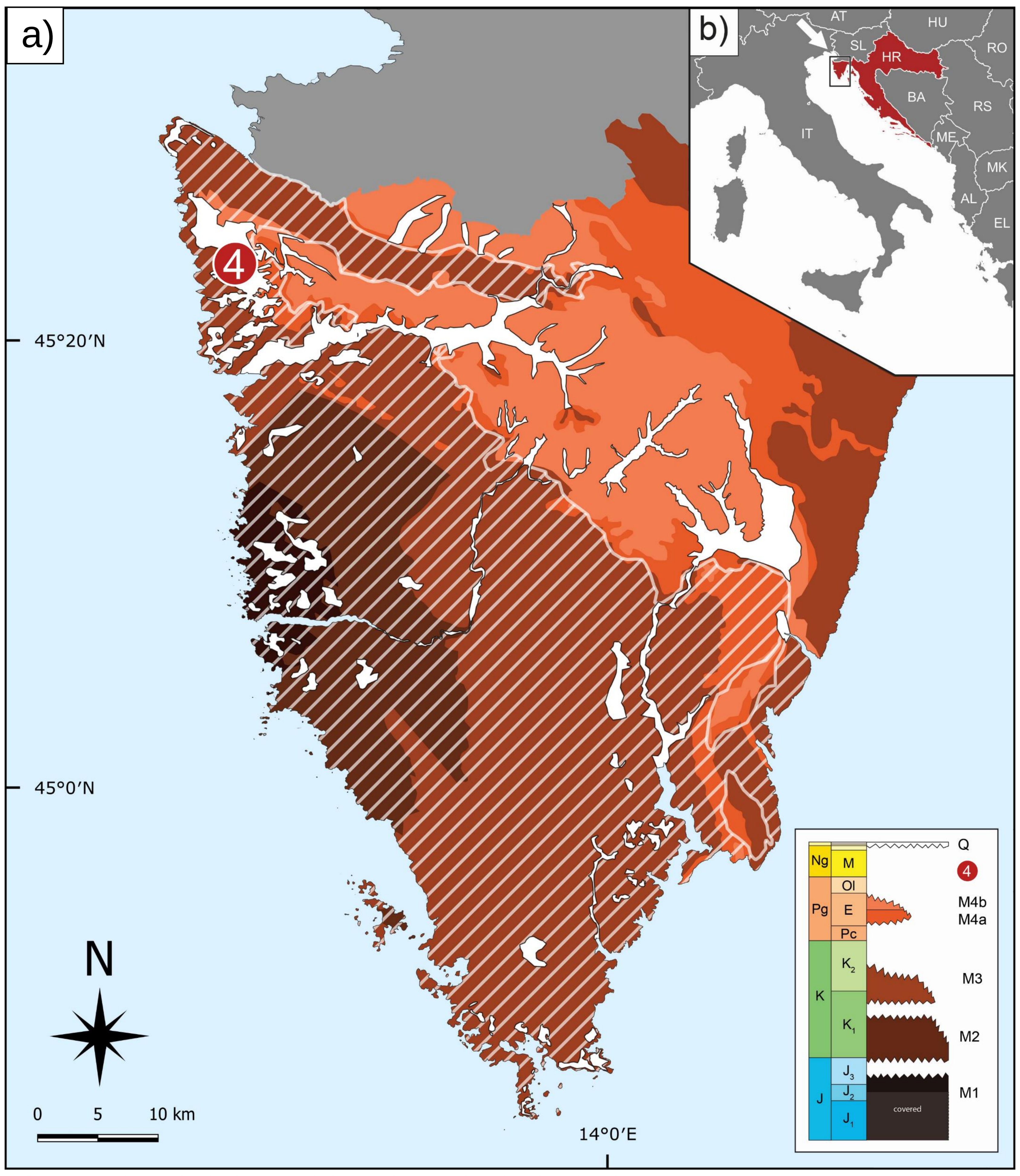

Figure 1. a) Geological map of the Istrian peninsula showing large-scale megasequences separated by regional unconformities, modified after Velić et al. (1995). (b) Location map of Istria. The location of the Koroniki vineyard is indicated by the **red circle**. Area where soils are predominantly mapped as terra rossa is shaded. For detailed description see Field trip A2 guide.

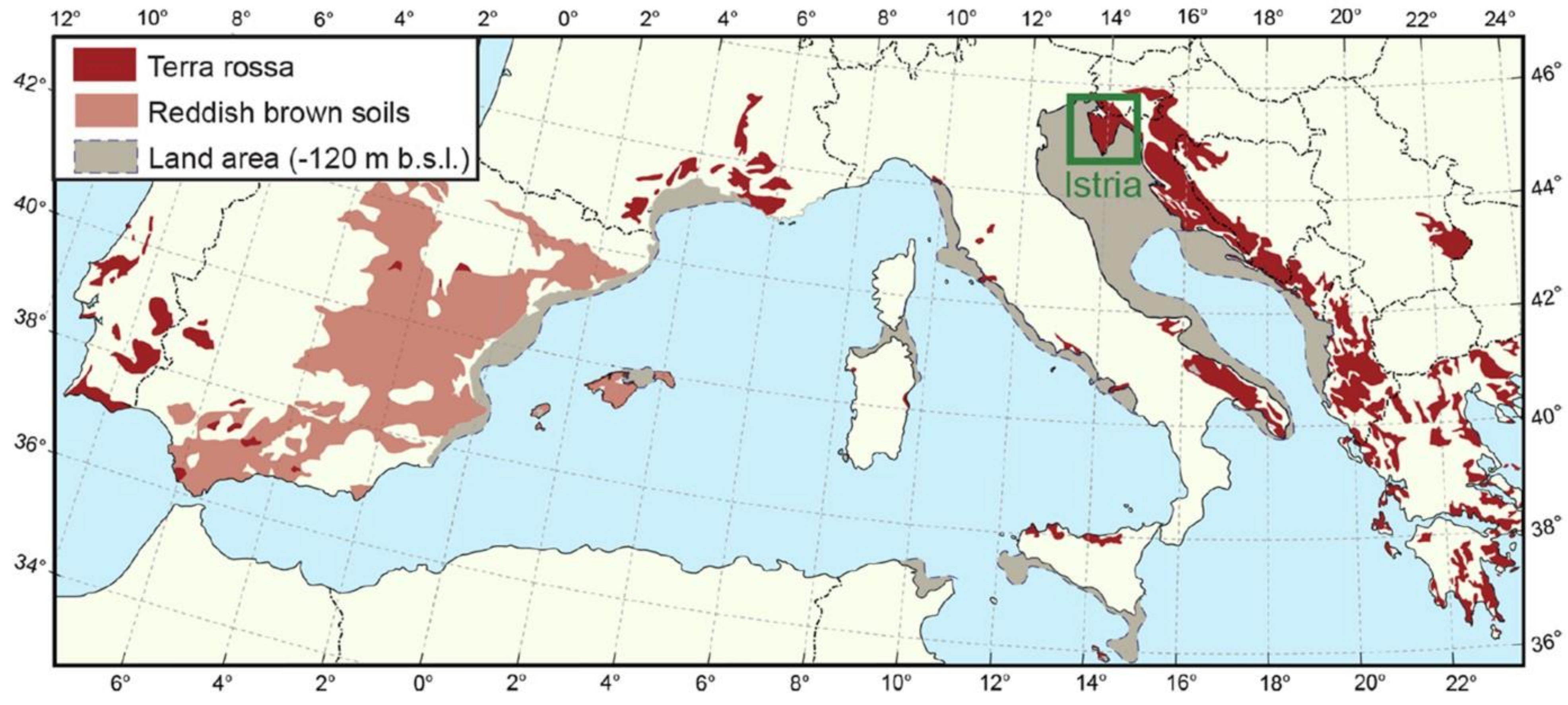

Figure 2. Distribution map of terra rossa soils and surface shelf during the low sea levels. Large occurrences of terra rossa in the eastern Adriatic are associated with the large shelf area that, when emerged, provided siliciclastic material for terra rossa formation. Although this map shows most recent palaeogeographic situation, large shallow shelf of the eastern Adriatic coast is probably formed in Oligocene (POPOV et al.,2004), thus from that age, recurrent aeolian transport of emerged shelf material onto the carbonate platform is probable (from Razum et al., 2023).

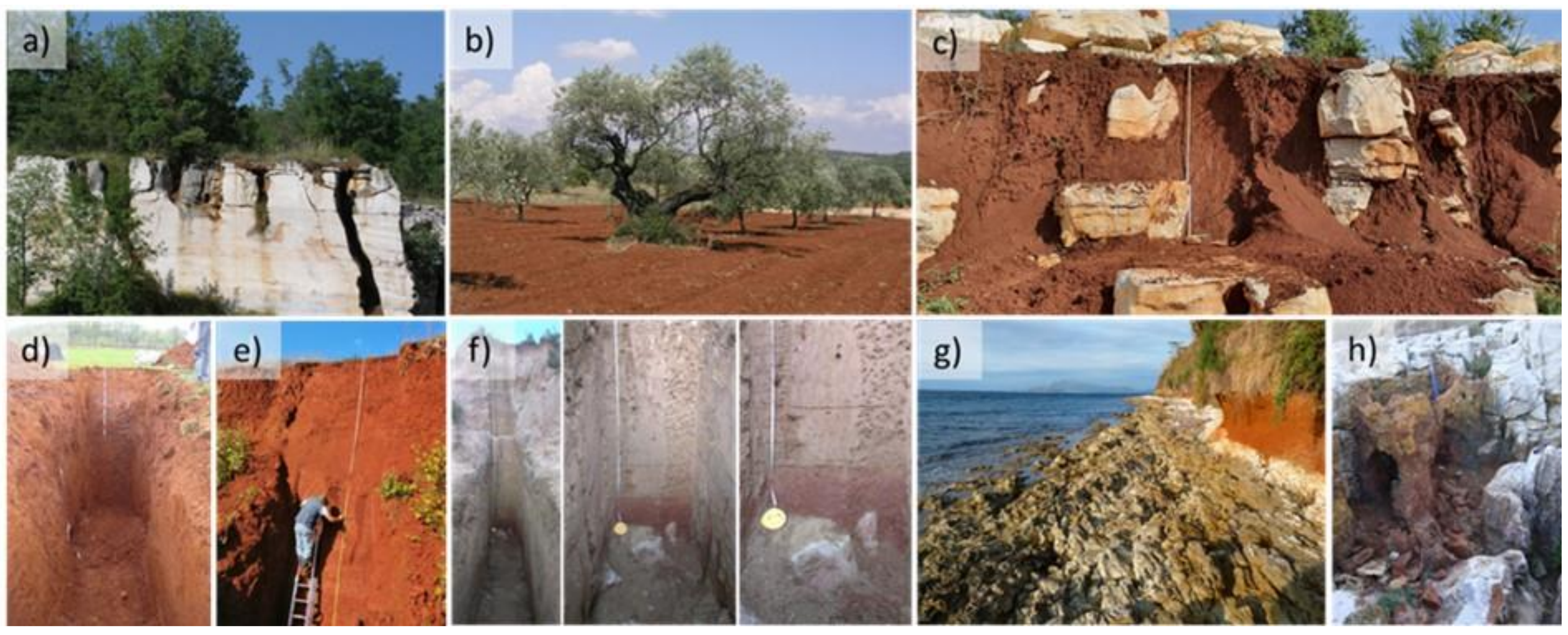

Figure 3. The appearance of terra rosa soil in Istria and in the northern Adriatic. (a) Terra rossa filling of karstified cracks, Seline. (b) Terra rossa as a substrate for olive cultivation, Novigrad. (c) Red polygenetic soil, Kanfanar. (d) Red pedosedimentary complex, Koreniki. (e) Red pedosedimentary complex, Rovinj. (f) Red palaeosol at the base of an eight-meter-thick loess-palaeosol sequence, Savudrija. (g) Red palaeosol, Susak island and (h) Red lithified palaeosol, Susak island.

Figure 4. (a) Terra rossa soil profile located in a vineyard at Koreniki. (b) Cleaned terra rossa soil profile overlying a Lower Eocene foraminifera limestone with marked soil horizons.

Table 1. (a) Terra rossa soil profile located in a vineyard at Koreniki (northwest coast of the Istrian peninsula, Croatia). (b) Cleaned terra rossa soil profile overlying a Lower Eocene foraminifera limestone (marked by white arrow) with Ap, Ap/Bt1, Bt1, Bt2, 2Btb1, 2Btb2, 3Btb3 and 3Btb4 horizons (from DURN et al., 2023).

Soil horizon	Soil depth	Particles (sizes in mm) extracted after soil dispersion in sodium polyphosphate						Soil texture	Coarse/ fine sand	Coarse/ fine silt	Total clay/ silt	Fine/ total clay	WDC
		Coarse sand 2.0-0.2	Fine sand 0.2-0.063	Coarse silt 0.063-0.02	Fine silt 0.02-0.002	Coarse clay 0.002-0.0002	Fine clay <0.0002						
	cm	%											%
Ap	0-30	0.2	2.5	23.0	18.1	21.6	34.6	Silt clay	0.1	1.3	1.4	0.6	18.0
Ap/Bt1	30-70	0.2	1.2	14.1	24.0	23.3	37.2	Clay	0.2	0.6	1.6	0.6	5.0
Bt1	70-110	0.0	1.0	11.4	18.6	24.6	44.4	Clay	0.0	0.6	2.3	0.6	4.4
Bt2	110-170	0.2	1.0	10.0	15.2	14.7	58.9	Clay	0.2	0.7	2.9	0.8	2.8
2Btb1	170-200	0.0	0.7	9.0	30.8	29.7	29.8	Silt clay	0.0	0.3	1.5	0.5	1.3
2Btb2	200-230	0.1	0.4	4.2	11.4	14.4	69.5	Clay	0.3	0.4	5.4	0.8	3.2
3Btb3	230-260	0.0	0.4	3.1	27.0	24.2	45.3	Clay	0.0	0.1	2.3	0.7	3.8
3Btb4	260-300	0.1	0.1	1.1	9.4	17.7	71.6	Clay	1.0	0.1	8.5	0.8	2.0

WDC = water-dispersible clay (particles <0.002 mm extracted after soil dispersion in distilled water)

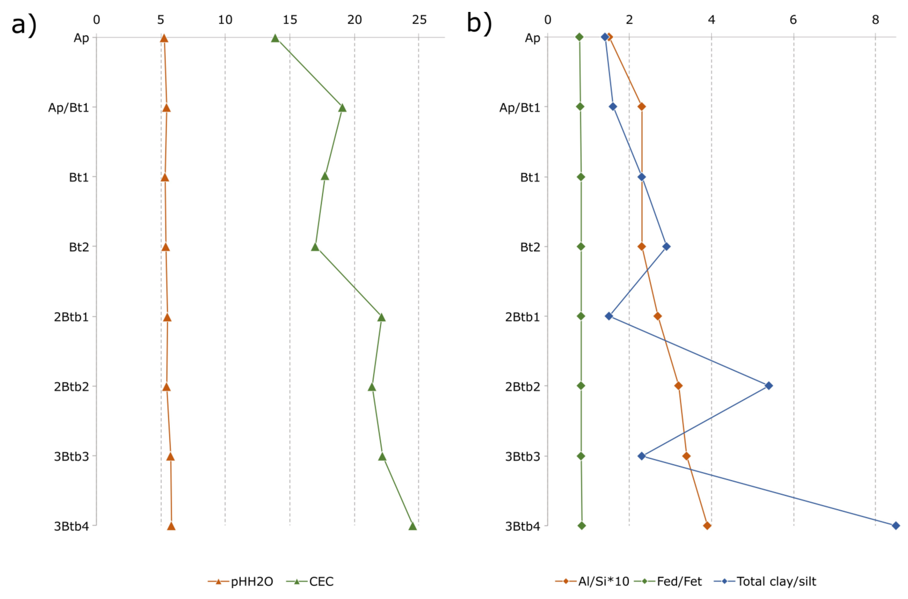

Figure 5. (a) and (b.) Distribution of selected parameters and indexes at Koreniki profile.

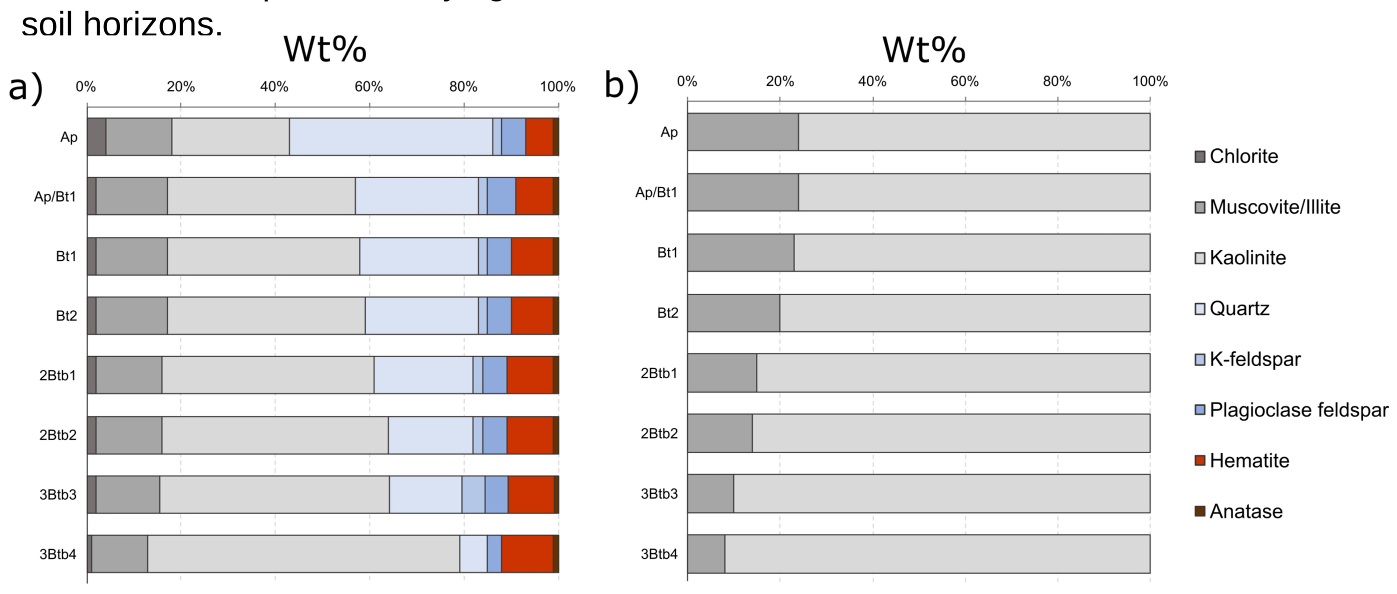

Figure 6. (a) Mineral composition of the < 2 mm fraction at Koreniki profile (in mass %). (b) Mineral composition of the < 2 µm fraction at Koreniki profile (in mass %).

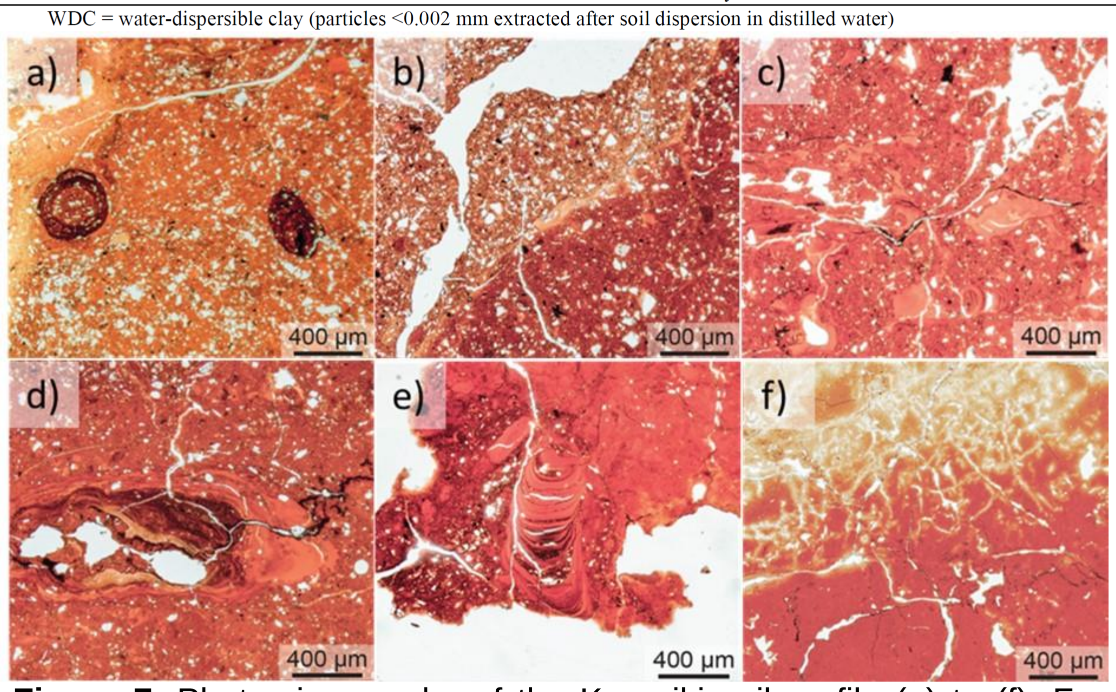

Figure 7. Photomicrographs of the Koreniki soil profile (a) to (f). For detailed description see Field trip A2 guide.

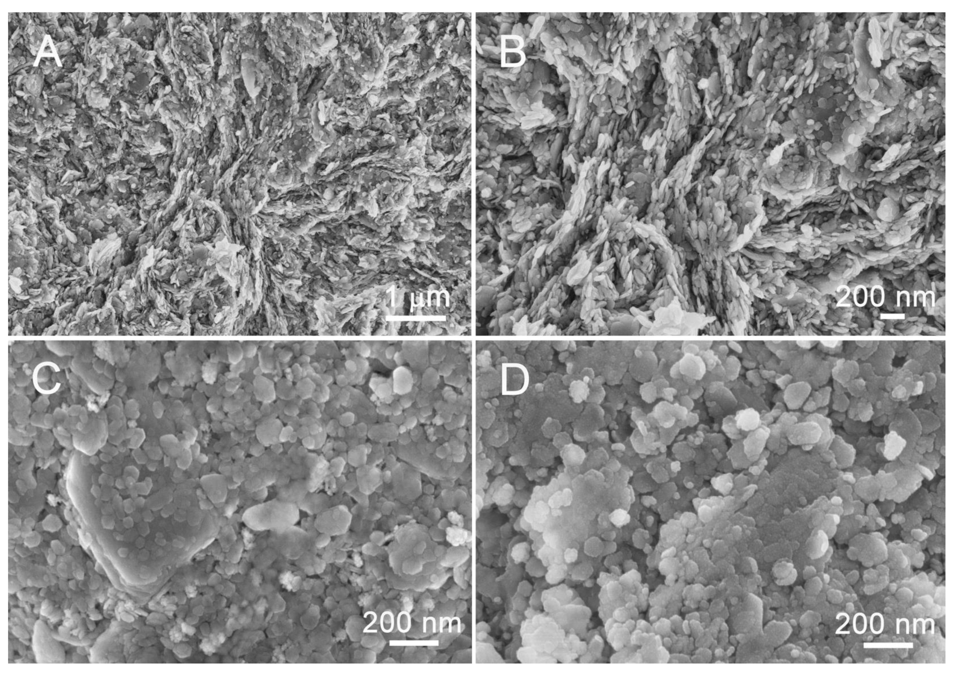

Figure 8. FE-SEM photomicrographs of soil microaggregates in the 3Btb3 horizon. Note the growth of pedogenic kaolinite nanoparticles in the soil Note the aggregated surface area of the larger kaolinite nanoparticles (from DURN et al., 2023).

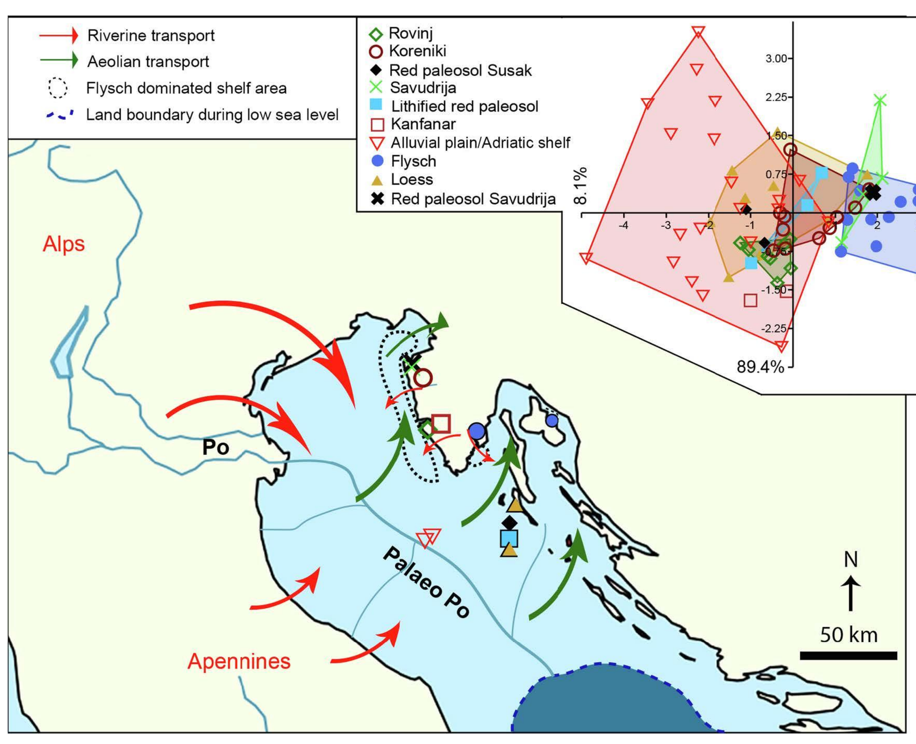

Figure 9. Reconstruction of sediment pathways based on linear discrimination analysis (LDA) of heavy mineral data (from RAZUM et al., 2023).

CONCLUSION

1. According to the WRB soil classification, the studied terra rossa profile is classified as Rhodic Lixisol (Clayic, Aric, Cutanic), where the relict soil properties are preserved in the present humid subtropical climate.

2. The very high Fe_d/Fe_t ratios observed place the studied profile among the most weathered terra rossa soils in Istria studied so far.

3. The micromorphological observations suggest that the presumably colluvial and aeolian contribution of allochthonous soil material played a crucial role in the development of this profile.

4. Kaolinisation and ferralitisation dominate in the profile characterized by lithic discontinuities, while intense clay translocation occurs despite the extremely stable soil microaggregates. Fine clay is dominated by pedogenic nano-sized and low crystalline subhedral to euhedral kaolinite. Larger aggregated kaolinite nanoparticles show growth of pedogenic kaolinite in situ.

5. The finding of a Lixisol in the study area indicates the old age of the surface of the karst depression and provides the first data on the burial history of the southwestern Istrian planation surface.

6. Present study suggests that some terra rossa soils previously classified as Cambisols or Luvisols may actually be Lixisols or other tropical soils (e.g., Nitisols) with preserved relict properties.

CONCLUSION

7. The provenance analysis showed that the terra rossa allochthonous material is mainly from the submerged alluvial plain/emegedAdriatic shelf, with two different signatures, Alpine/Apennine for all soil profiles except Savudrija red paleosol, where Eocene flysch was a dominant source, and Koreniki, where two samples with probably lower flysch contribution were found.

8. The terra rossa is most pronounced on the eastern Adriatic coast on a global scale because of the availability of the siliciclastic material that was eroded in the Adriatic basin and regularly blown off the emerged shelf surface during periods of low sea level.

9. It may be also proposed that favourable periods for the formation of the studied soil in the northernmost part of the Mediterranean were older Quaternary interglacials, the mid-Piacenzian Warm Period (Pliocene), and/or the Miocene Climatic Optimum.

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