Stop 3 : Minjera bauxites – upper Santonian/ upper Cenomanian – lower Eocene 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 3: MINJERA BAUXITES – upper Santonian/ upper Cenomanian – lower Eocene unconformity

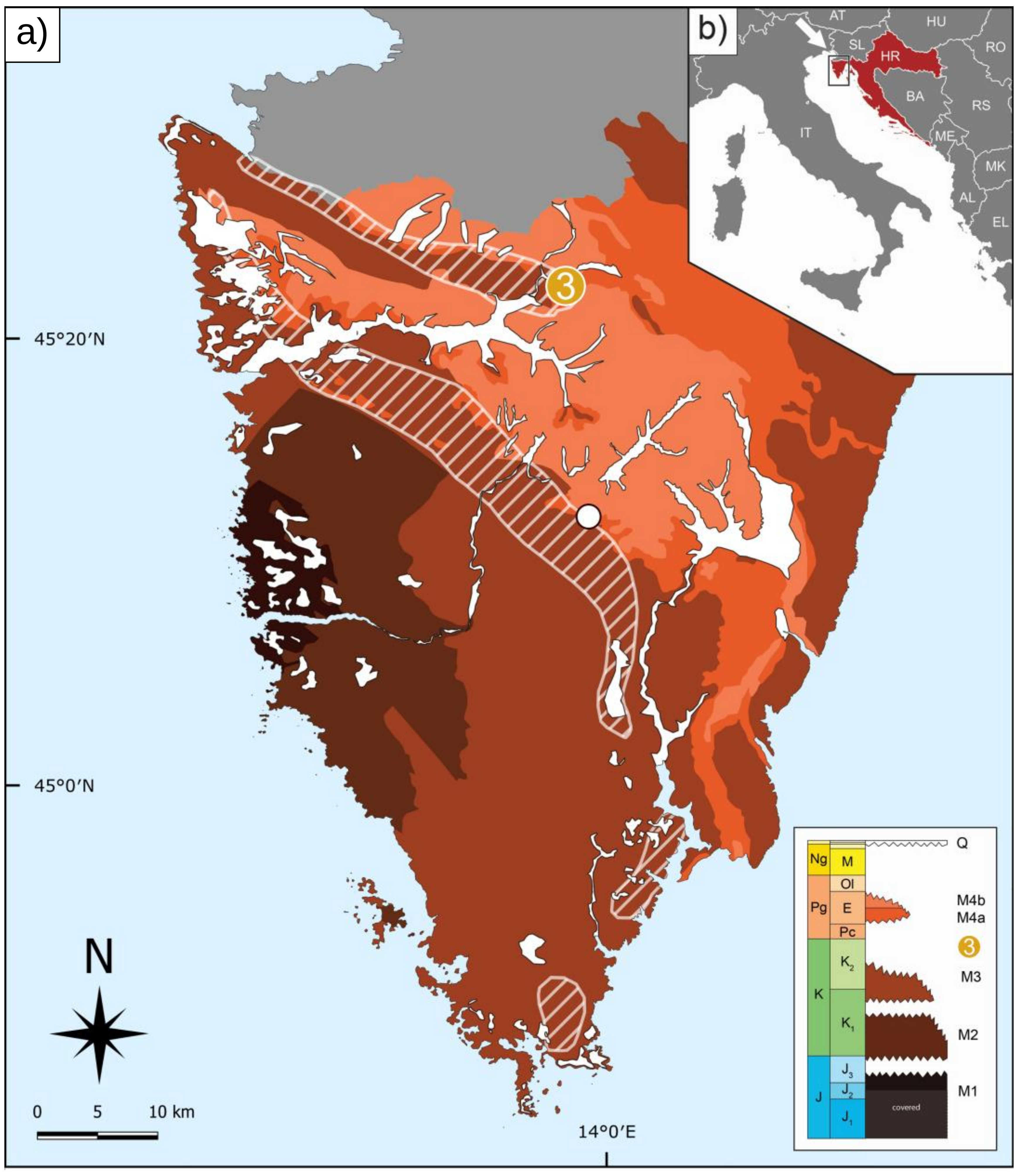

Figure 1. a) Geological map of the Istrian peninsula showing large-scale megasequences separated by regional unconformities, modified after VELIĆ et al. (1995). Legend: M1 – 1st Megasequence (lower Bathonian/lower Kimmeridgian); M2 – 2nd Megasequence (upper Tithonian/lower/upper Aptian); M3 – 3rd Megasequence (lower/upper Albian/upper Santonian); M4a – Carbonate deposits of the 4th Megasequence (lower– middle Eocene); M4b – Clastic deposits of the 4th Megasequence (middle– upper Eocene); Q – Quaternary deposits. (b) Location map of Istria. The location of the Minjera bauxite deposits is indicated by the **yellow circle**, while the general zones where the unconformity crops out are outlined **with white hatched lines**.

- The 3rd stop comprises a group of pyritised Palaeogene bauxites, known as the Minjera bauxites
- These bauxites represent the first mined and analyzed bauxites in the world, as they were mined as early as the 15th century, while they were analysed by Giovanni Arduino in 1780.
- The Minjera bauxites mark the 3rd unconformity, which is situated between the upper Albian to upper Cenomanian/ upper Santonian megasequence and the 4th Eocene megasequence
- The 3rd unconformity lasted between 25 to 40 My, during which time bauxites primarily formed, although other materials such as palaeosols and calcretes formed as well
- They are a part of a larger belt of Palaeogene bauxites in the peri-Mediterranean region, which formed as the flexular forebulge developed in the advancing carbonate terrains as a result of the Late Cretaceous closure of the Vardar Ocean (SCHMID et al., 2008, 2020)

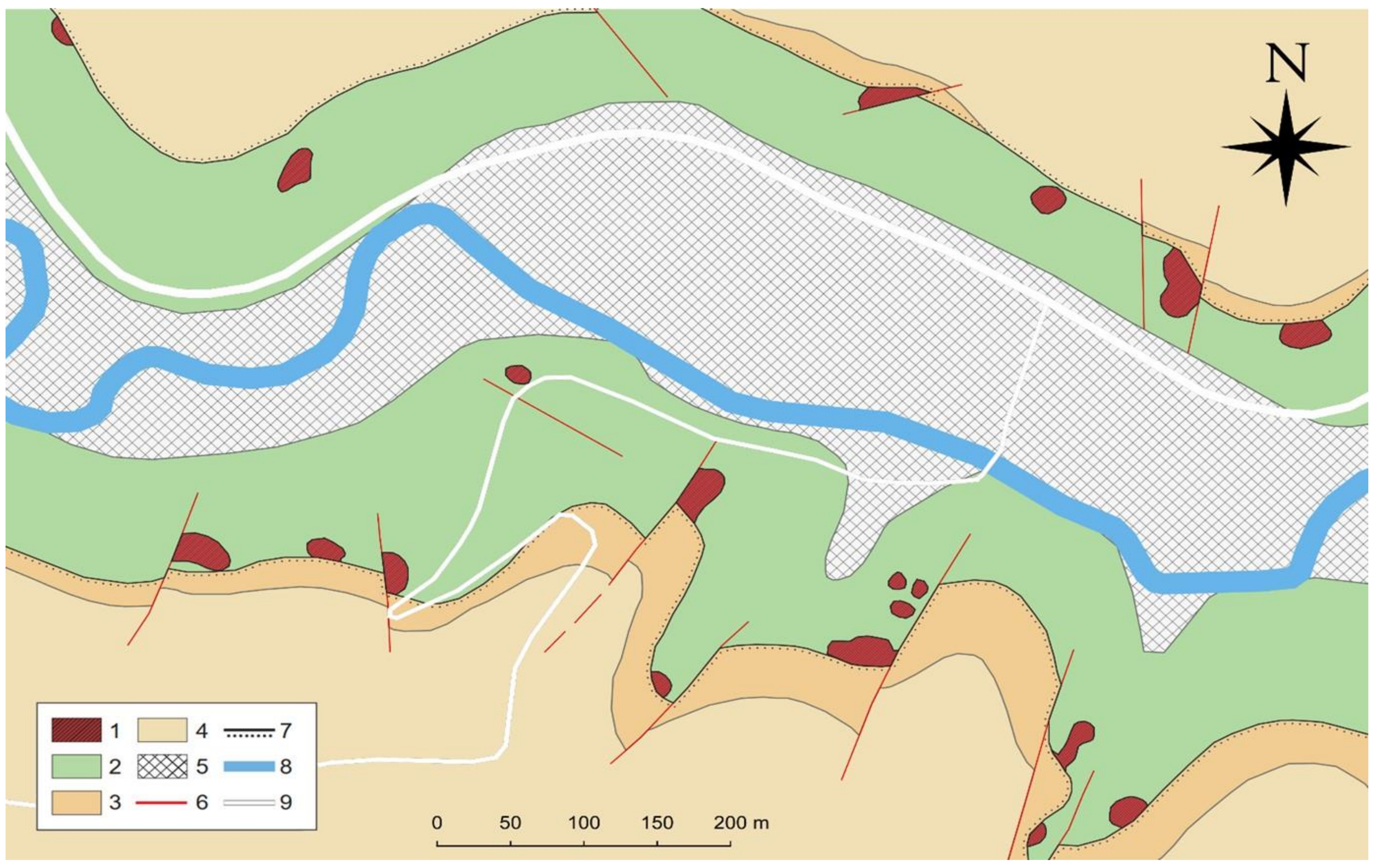

Figure 2. Geological map of the of the Minjera bauxites, modified after ŠINKOVEC et al, 1994; 1 – bauxite, 2 – Rudist limestones, 3 – Kozina beds, 4 – Foraminiferal limestones, Quarternary aluvial deposits, 6 – Faults, 7 – Transgressive boundary, 8 – Mirna river, 9 - Roads

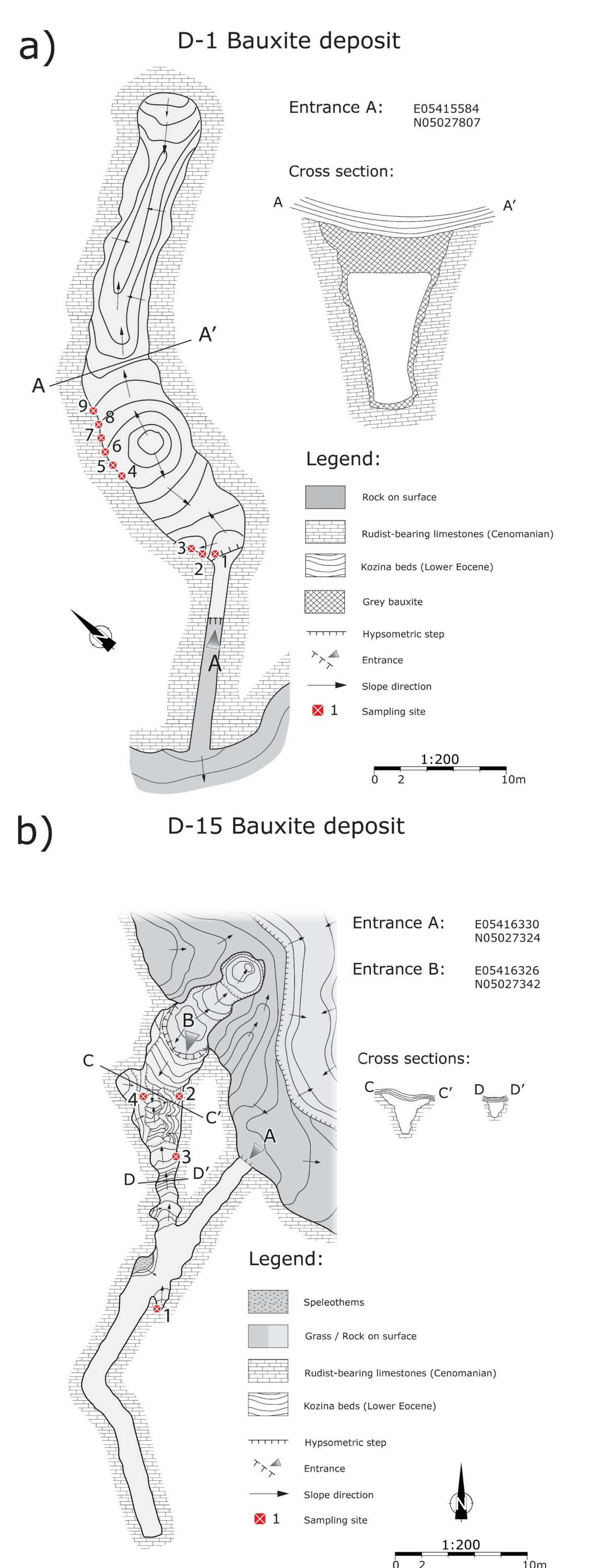

Figure 3. Plans of studied Minjera bauxite deposits and sampling sites within them. a – plan of the D-15 bauxite deposit, b – plan of the D-1 bauxite deposit

Figure 4. Field photographs of Minjera bauxites a) D-5 bauxite deposit, b) Entrance shaft into the D-7 bauxite pit, c) Lake in the D-3 bauxite deposit, d) Transition from the grey bauxite into the black bauxite and Kozina beds, e) Iron sulphide veins, f) Iron sulphide impregnation

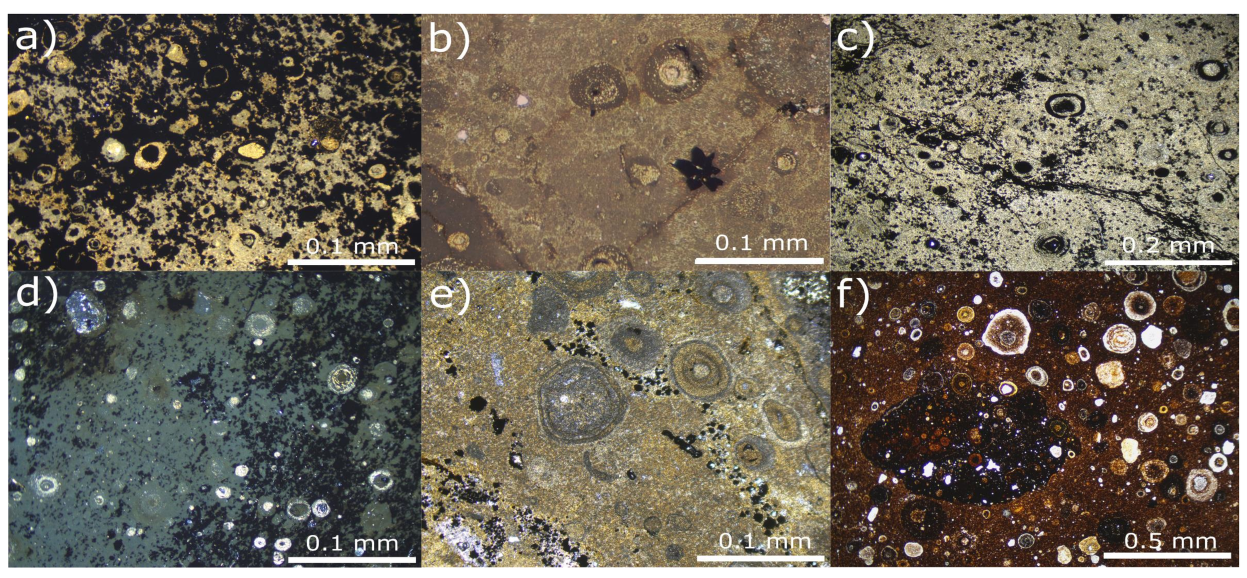

Figure 5. Photomicrographs of different samples from Minjera bauxites. a) – first generation of iron sulphides visible in the bauxite matrix together with iron sulphides replacing the iron oxide rich lamellae in the ooids, D-1 deposit, PPL; b – diasporic ooids and a marcasite rossette, D-15 deposit, PPL; c – iron sulphide framboids in the bauxite matrix and iron sulphide rich lamellae in ooids and veins, D-1 deposit, PPL; d – iron sulphides in the matrix of the bauxite, surrounding the diasporitic ooids, D-1; e – iron sulphide framboids and boehmite ooids in a deferrified bauxite matrix, D-15 deposit, PPL; f – ooids with alternating iron oxide and deferrified lamellae as well as pebbles ofred bauxite (MN-25), PPL.,

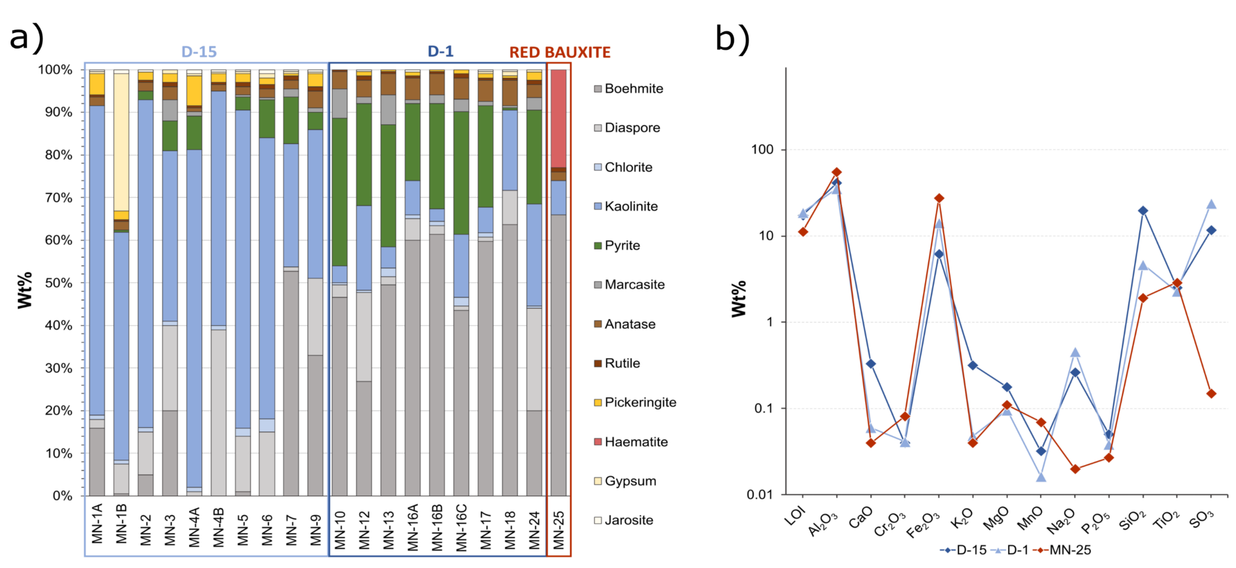

Figure 6. Plots displaying the mineralogical and major oxide composition of samples from Minjera bauxites. a – Plot displaying the mineralogical composition, b – plot displaying the average major oxide composition of the bauxite

CONCLUSIONS

1. The Minjera bauxite, during its bauxitisation phase, formed in a seasonal tropical climate, which is indicated by the altrenating deferrified and iron oxide rich lamelae in the ooids
2. The pyritisation of bauxite was epigenetic, and was triggered by the developement of a marshy envirnoment atop of the bauxite, which was later preserved as schizohaline limestones of the Kozina facies
3. The pyritisation proceeded in several stages: 1st stage - formation of poorly crystalline monosulphides in the matrix, 2nd stage – replacement of iron oxides in ooid lamelae and pebbles with pyrite and possibly marcasite, 3rd stage – developement of pyrite veins, cross-cutting the previously developed iron sulphides
4. The D-1 and D-15 show significant differences in mineralogy, as the D-15 body is composed mainly from highly kaolinitic and diasporic grey bauxite while the D-1 body comprises a highly boehmitic pyrite-rich bauxite
5. These two deposits also differ in morphology, as the D-1 deposit is a 20 m thick canyon-type bauxite deposit, while the D-15 deposit is a much smaller, 5 m thick sinkhole-type deposit
6. The mineralogical and morphological differences between the two deposits, arose from their different palaeotopographical positions, which led to different rates of chemical weathering and bedrock karstification between the two bauxite bodies

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