Stop 2: Kanfanar quarry - Upper Aptian–upper Albian unconformity

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DIGITALNI AKADEMSKI ARHIVI I REPOZITORIJI

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

STOP 2: KANFANAR QUARRY - Upper Aptian–upper Albian unconformity

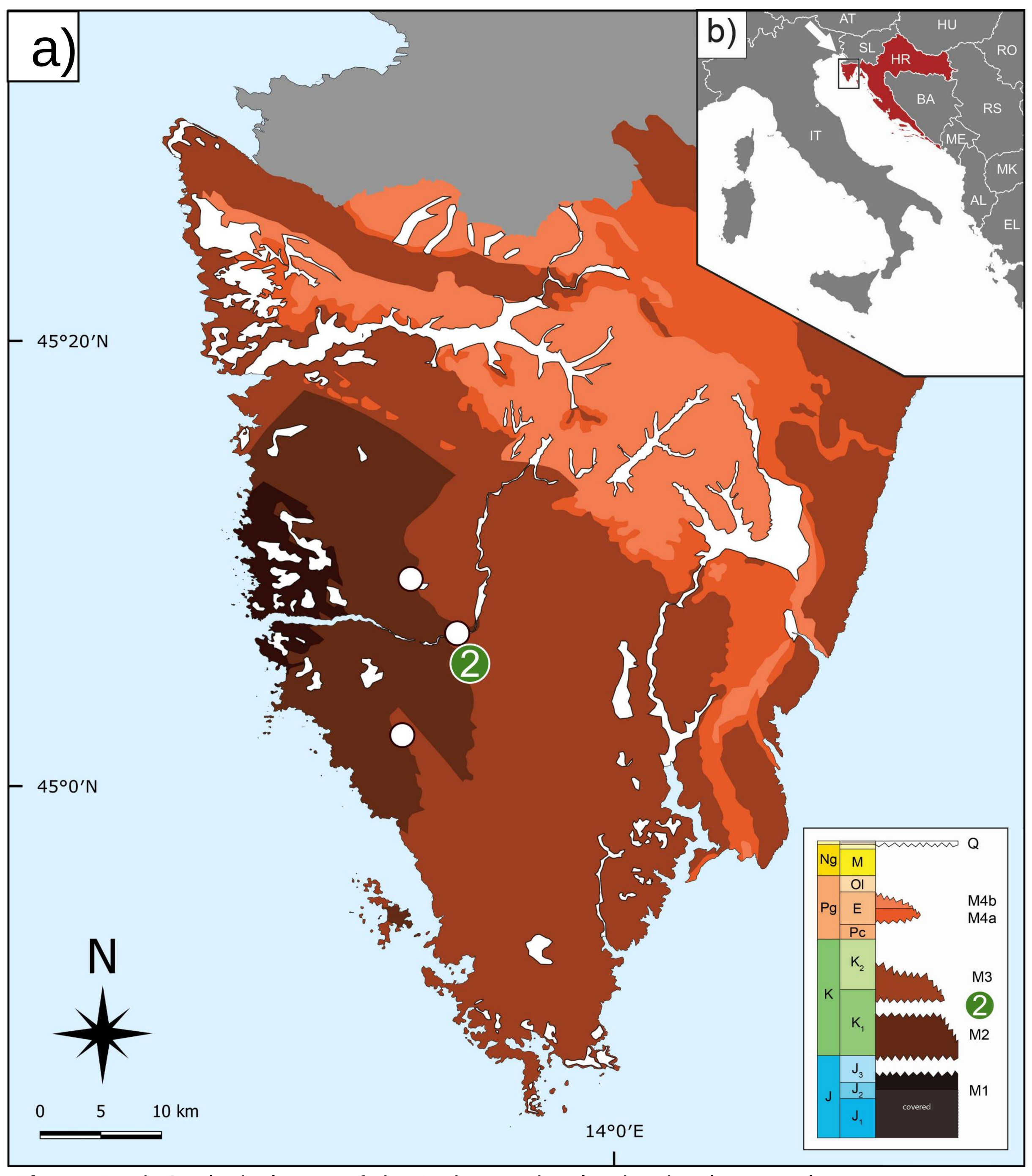
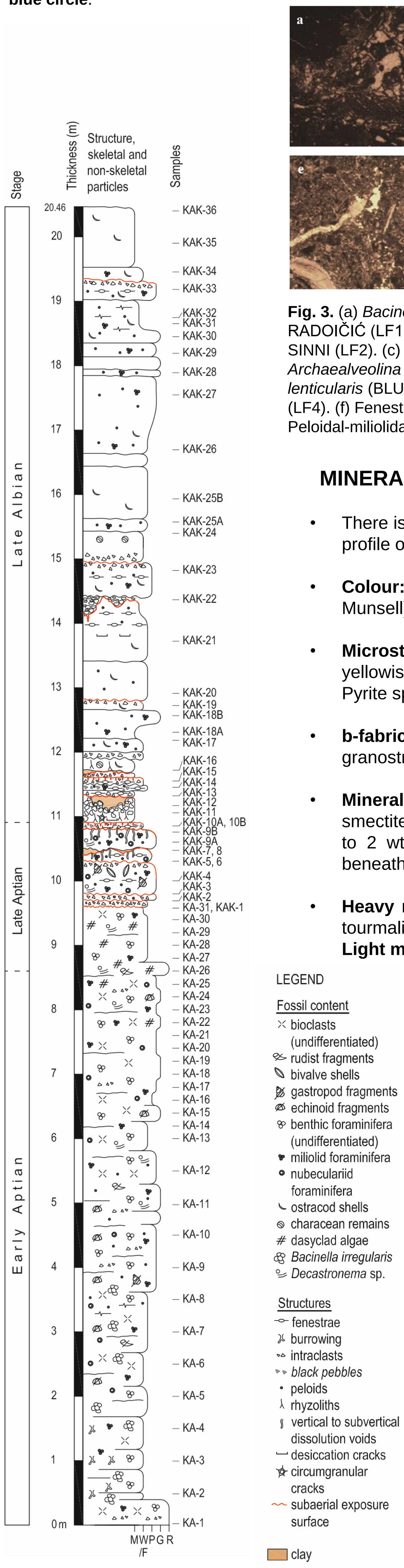


Figure 1. a) Geological map of the Istrian peninsula showing large-scale megasequences separated by regional unconformities, modified after Velić et al. (1995). Legend: M1 – 1st Megasequence (lower Bathonian/lower Kimmeridgian); M2 – 2nd Megasequence (upper Tithonian/lower/upper Aptian); M3 – 3rd Megasequence (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 Rovinj-1 deposit is indicated by the **blue circle**.

- The 2nd unconformity is situated between the upper Tithonian to lower/upper Aptian 2nd megasequence and the upper Albian to upper Santonian 3rd megasequence (Fig. 1).
- The unconformity is a result of a relative sea-level fall caused by the interaction of eustatic changes and synsedimentary tectonics in the Istrian part of the Adriatic Carbonate Platform.
- The duration of the emersion phase varied between 11 and 19 million years.
- The evidence of exposure is characterized by greenish-grey clay, found mainly in paleokarst pits, varying in thickness from a few centimetres to a meter.
- Terrestrial deposits associated with this regional unconformity can be found at various places (Fig. 2).
- The 1st stop (in Kanfanar quarry) represents one of the best exposures of the 2nd unconformity. The quarry was opened for the needs of the Austro-Hungarian railways and it is renowned for containing the high-quality natural stone, a light brown Lower Aptian oncolithic limestone (pietra d'Istria), extracted by both surface and underground methods

Fig. 2. Outcrops of terrestrial deposits associated with second regional unconformity. (a) Selina quarry. (b) Kanfanar quarry. (c) Lakovići quarry. (d) Goda quarry. (e)Tri jezerca quarry. (f)Road cut of Istrian Y near Kanfanar.



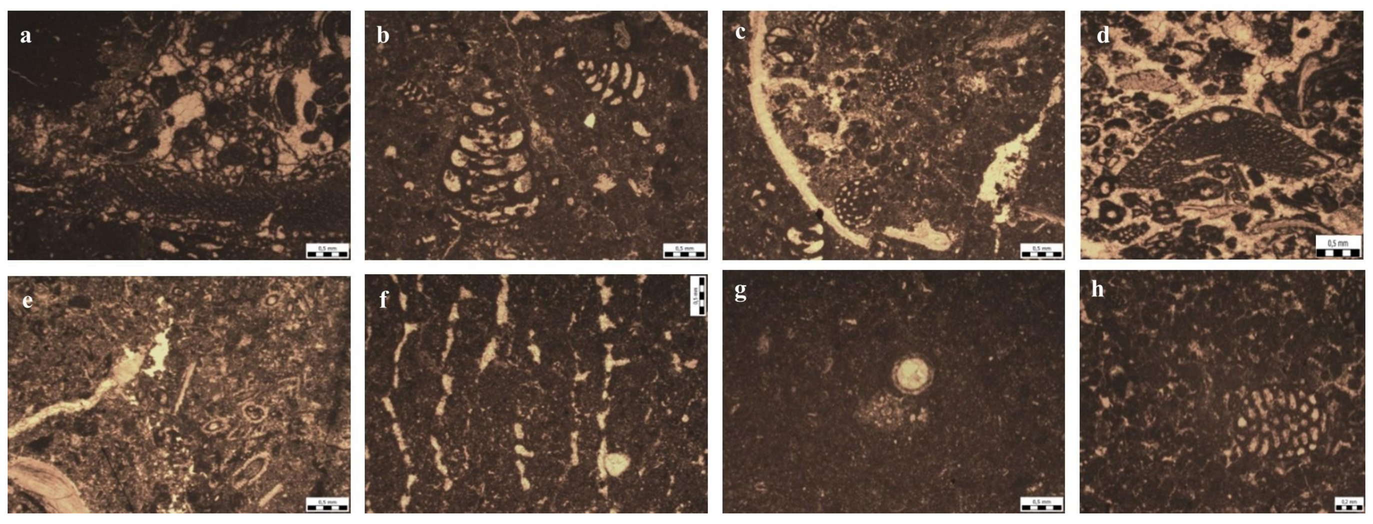


Fig. 3. (a) *Bacinella* wackestone to floutstone: *Palorbitolina lenticularis* (BLUMENBACH), *Bacinella irregularis* RADOIČIĆ (LF1). (b) Foraminiferal-peloidal wackestone-packstone: *Praechrysalidina infracretacea* LUPERTO SINNI (LF2). (c) Foraminiferal-peloidal packstone: *Voloshinoides murgensis* LUPERTO SINNI and MASSE, *Archaealveolina reicheli* (DE CASTRO), (LF2). (d) Peloidal-bioclastic packstone to grainstone: *Palorbitolina lenticularis* (BLUMENBACH) (LF3). (e) *Decastronema*-algal packstone: *Salpingoporella dinarica* RADOIČIĆ (LF4). (f) Fenestral-peloidal wackestone-packstone (LF5). (g) Characean-ostracod wackestone (LF6). (h) Peloidal-miliolidal packstone: „*Valdanchella*" *dercourti* DECROUEZ and MOULADE (LF7).

LITHOLOGY, SEDIMENTOLOGY AND MICROPALEONTOLOGY OF CARBONATES

Kanfanar lithofacies (LF)		Depositional environment
LF1	Micritic limestones with *Bacinella* oncoids and low diversity biota	Lagoons and low-energy shallows with a very low sedimentation rate, common bioturbated levels, and low biotic diversity
LF2	Finer-grained micritic limestones	Subtidal environment of elevated water energy to moderate energy
LF3	Grainy limestones with diverse biota	Deepening of the sedimentary environment and deposition in somewhat deeper subtidal environments characterized by higher biotic diversity
LF4	*Decastronema* - algal limestones (mostly wackestone–packstone)	Restricted to open shallow subtidal carbonate platform with moderate water energy
LF5	Fenestral micritic limestones occasionaly laminated with very low diversity biota	Restricted and protected shallow subtidal and intertidal inner carbonate platform with low water energy
LF6	Micrites with ostracods, and characean remains	Shallow subtidal carbonate platform with low water energy (with occasionally fresh water influence)
LF7	Fine-grained limestones with abundant miliolids	Shallow subtidal carbonate platform with moderate water energy

MINERALOGY AND MICROMORPHOLOGY OF GREENISH-GREY CLAY

- There is no significant variation in colour, microstructure, fabric and mineralogy along the profile of greenish-grey clay (Fig. 4).
- **Colour:** grey with areas of yellowish and greenish hues (5GY6/1 to 5GY7/1 after Munsell)
- **Microstructure:** predominantly granular, angular blocky, and planar (Fig. 5. a, b, c). The yellowish patches are partially opaque and likely composed of iron oxides (Fig. 5.e). Pyrite sporadically appears in aggregates of typical nodules (Fig. 5.g) and framboids.
- **b-fabric** - random streaking, stipple-speckled (Fig. 5. d, f), cross-streaking, and granostriated (Fig. 5 h, i) alternating throughout the sample.
- **Mineralogy:** phyllosilicates (60-90 wt%, represented b illitic material, illite-smecite and smectite), K-feldspar (5-10 wt%), gypsum (5-10 wt%), quartz (up to 5 wt%) anatase (up to 2 wt%), pyrite (2-4 wt%) and jarosite (2-8 wt%). (Insoluble residue of limestone beneath the clay: smectite, illite, kaolinite and goethite).
- **Heavy mineral fraction:** opaque minerals (most likely pyrite and jarosite), zircon and tourmaline (Fig. 6 a, b).
  Light mineral fraction: almost exclusively bright anhedral sanidine (Fig. 6 c).

Fig. 4. Profile of greenish-gray clay in Kanfanar quarry with Kubiena boxes.

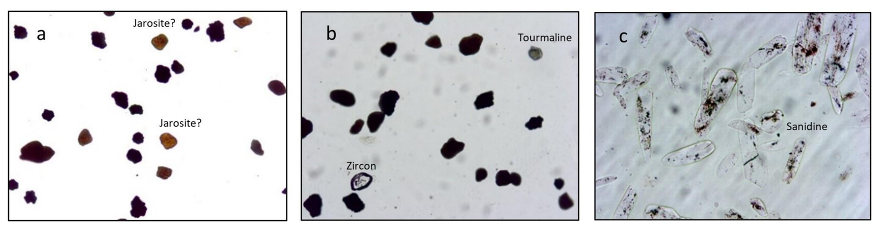


Fig. 6. Photomicrographs of heavy (a and b) and light (c) mineral fraction from upper part (0-20 cm) of the clay profile.

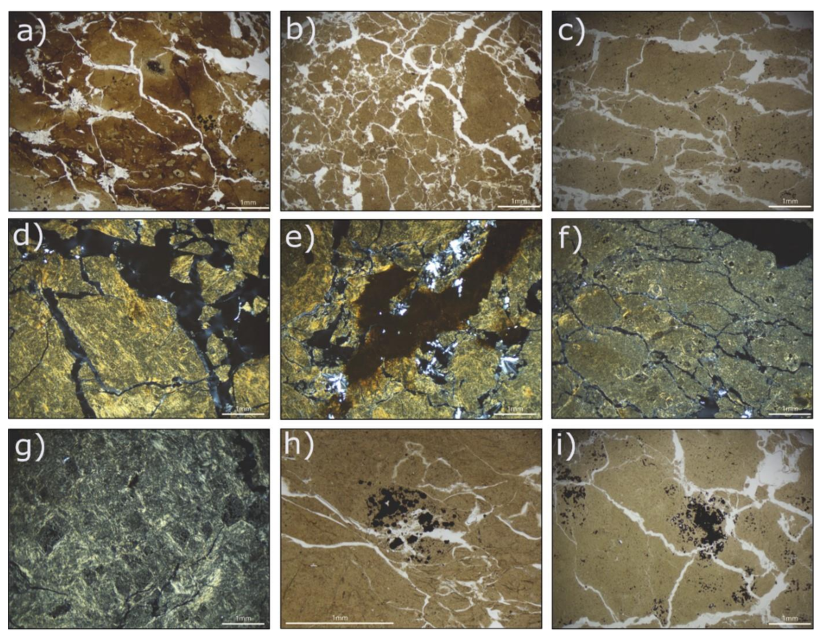


Fig. 5. Photomicrographs of greenish-grey clay. (a) Subangular blocky microstructure with visible gypsum rosettes and impregnation of peds with Fe-oxides. (b) Complex microstructure consisting of granular, channel, and subangular blocky microstructure. (c) Subangular blocky to planar microstructure. (d) Parallel striation and stipple-speckled b-fabric (CPL). (e) Fe oxides impregnation; gypsum rosettes (CPL). (f) Ganostriation and stipple-speckled b-fabric (CPL). (g) Granostriation around clasts rich in orthic nodules of pyrite and cross-striation of b-fabric (CPL). (h) Clast rich in orthic nodules of pyrite. (i) Aggregated orthic nodules of pyrite.

INTERPRETATION

Early Aptian / Late Aptian

- spacious lagoons and low-energy shallows - very low sedimentation rate - thin succession with common bioturbated levels
- deepening - subtidal environments - higher biotic diversity dominated by orbitolinid foraminifera - eutrophication caused by an oceanic anoxic event(OAE 1a)
- massive limestones ("Istrian Yellow") - cyclical alternations of mudstones/wackestones and *Bacinella* oncolite floatstones - very variable in thickness (max. 19 m)
- shallowing - laminated mudstones/wackestones with fenestrae overlain by breccia/conglomerate beds

Greenish-grey clay

- remnants of ancient soils that ranged from seasonally marshy to permanently waterlogged conditions (formed through the erosion and accumulation of surficial soils and sediments during a phase of alternating marine transgression that marked the end of the emergence period)
- Potential source materials contributed to the formation:
  (1) indissoluble limestone residue (minor – limited presence; signs of vadose zone (geopetal structures, crystal silt); shallow palaeokarstification)
  (2) aeolian dust (minor - significant atmospheric circulation; great amount of aeolian material due to arid climate on land; presence of metamorphic minerals)
  (3) volcanic material (dominant - abundance of bright anhedral sanidine; immobile chemical element ratios; negative europium anomaly; altered volcanic glass)

Late Albian

- oscillating transgression characterized by peritidal limestones, high-energy breccias/conglomerates, common laminated deposits with well-developed fenestrae and stylolites.

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