RADIOCARBON 2018

Reconstruction of the karst Quaternary environment in Croatia based on radiocarbon results

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Hrvatska zaklada za znanost

REQUENCRIM

Reconstruction of the Quaternary environment in Croatia using isotope methods (2014-2018)

Dinaric karst occupies about half of the Croatian territory, encompassing continental and coastal areas and different climate zones, and is characterized by intensive carbonate precipitation in form of tufa, speleothem, lake sediment and algal rims.

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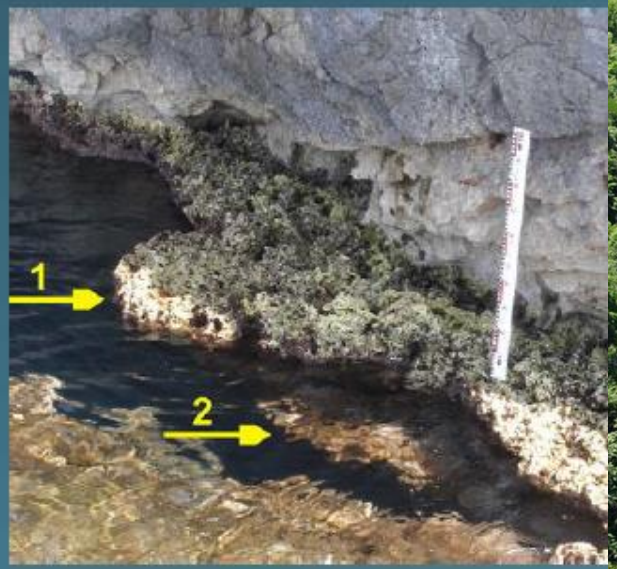
speleothems

tufa

algal rims



lake sediments

REQUENCRIM

Reconstruction of the Quaternary environment in Croatia using isotope methods (2014-2018)

- Financed by the Croatian Science Foundation
- Period 1.09.2014. – 30.08.2018.
- Aim: climate changes and environmental changes in the Croatian karst during the Quanternary
- Isotope methods: stable isotopes $^{13}C/^{12}C$, $^{18}O/^{16}O$, $^{2}H/^{1}H$; radioactive isotopes ^{14}C, $^{230}Th/^{234}U$

Expected results:

- Are there differences in paleoclimate and paleoenvironemntal conditions in various regions
- How various carbonate sediments record climate and environmental conditions prevailing during precipitation
- Relation between isotope composition of water and carbonates – equilibrium conditions?
- Sea level change in relation with climate conditions during last 2 ka

REQUENCRIM

Reconstruction of the Quaternary environment in Croatia using isotope methods (2014-2018)

Various carbonate sediments were studied (speleothems - 3 caves, lake sediments - the Plitvice Lakes, tufa deposits - the Zrmanja River area, marine algal rims

- To estimate the regional response of the karst environment to global changes during the Quaternary
- to determine specificities of each carbonate system

Radiocarbon dating revealed two groups with the ^{14}C ages <11,000 BP (all types of sediments) and >30,000 BP (speleothem and tufa).

The Holocene ages ranged from about 11,000 BP (speleothems) to the Anthropocene (top lake sediments).

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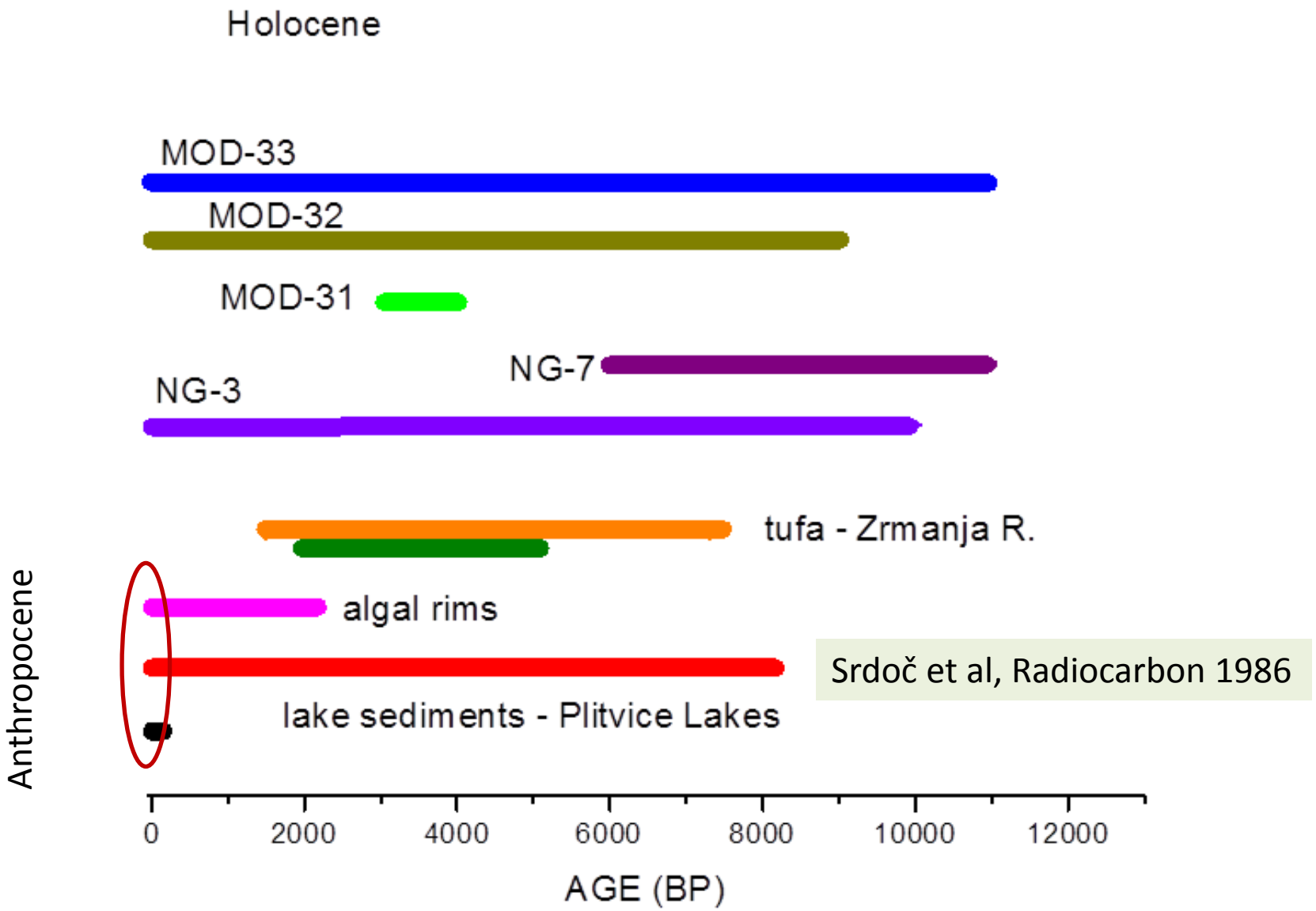
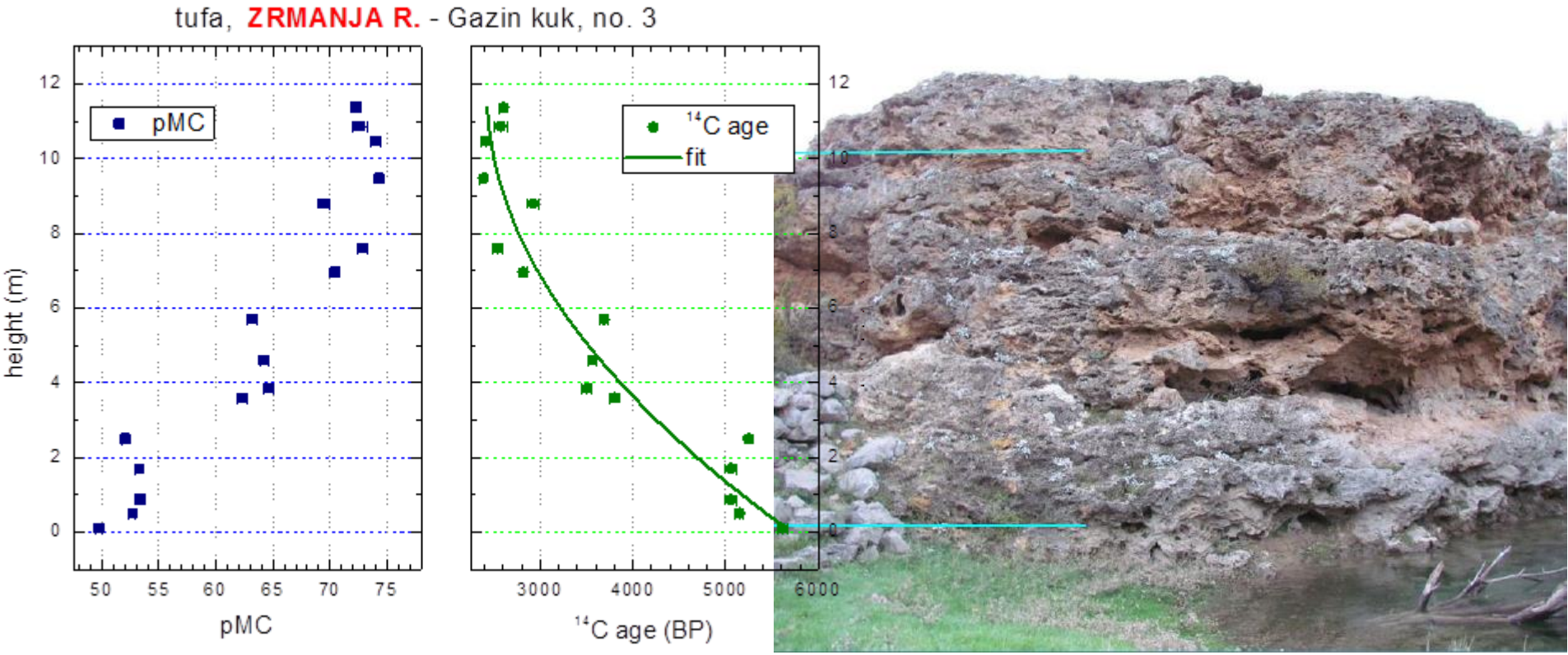
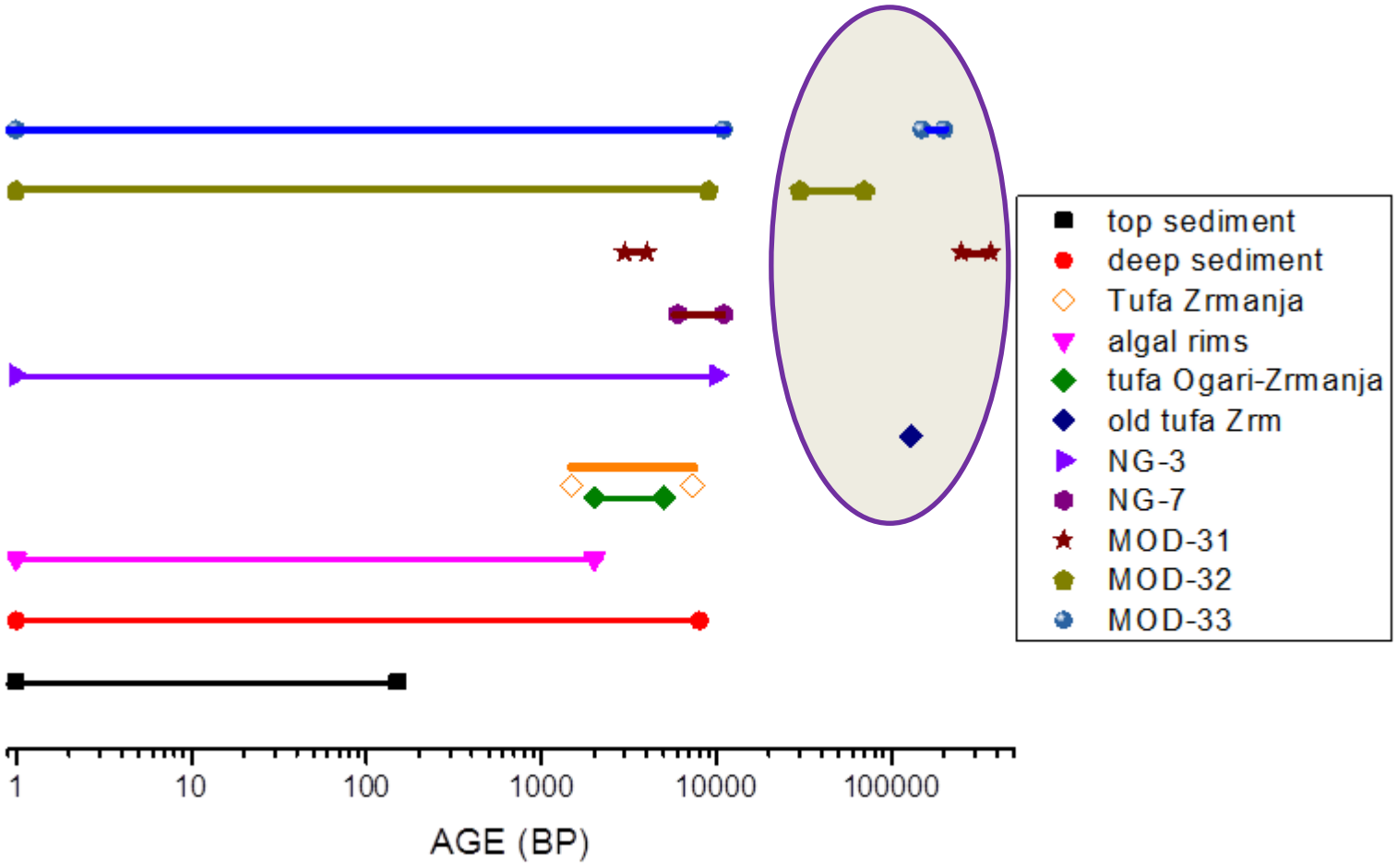


Srdoč et al, Radiocarbon 1986

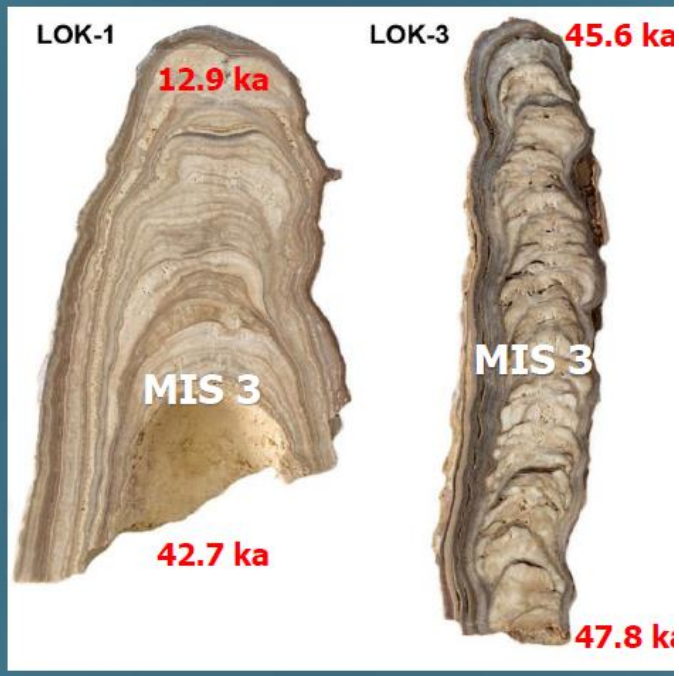


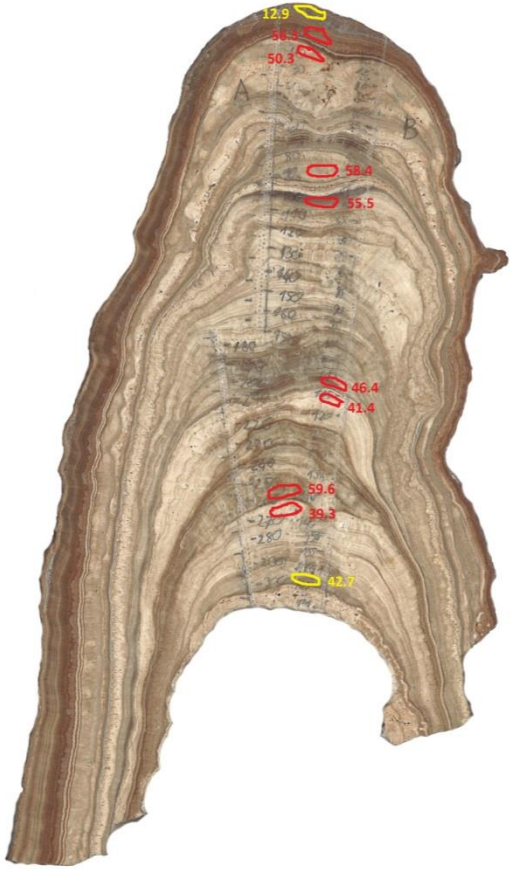
12 m height, not active – about 3000 years of precipitation → 4 mm/yr !?

The speleothem and tufa samples from the group ^{14}C age > 30,000 BP were dated by the U-Th series method up to MIS 10 and MIS 5 stages, respectively.



Preliminary U-Th and ^{14}C dating



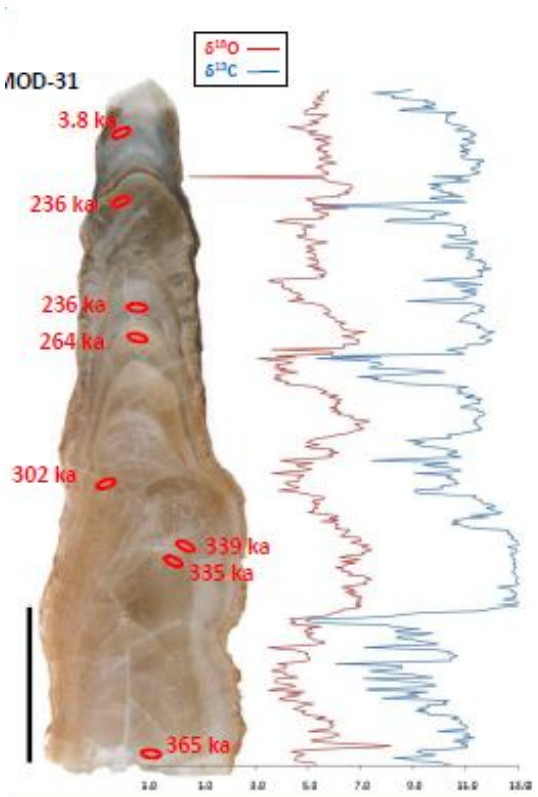


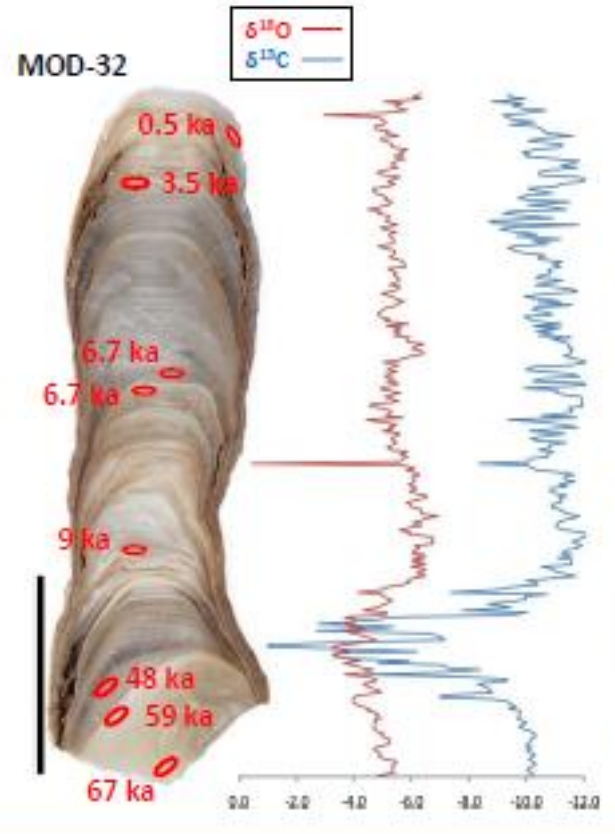
IN PROGRESS

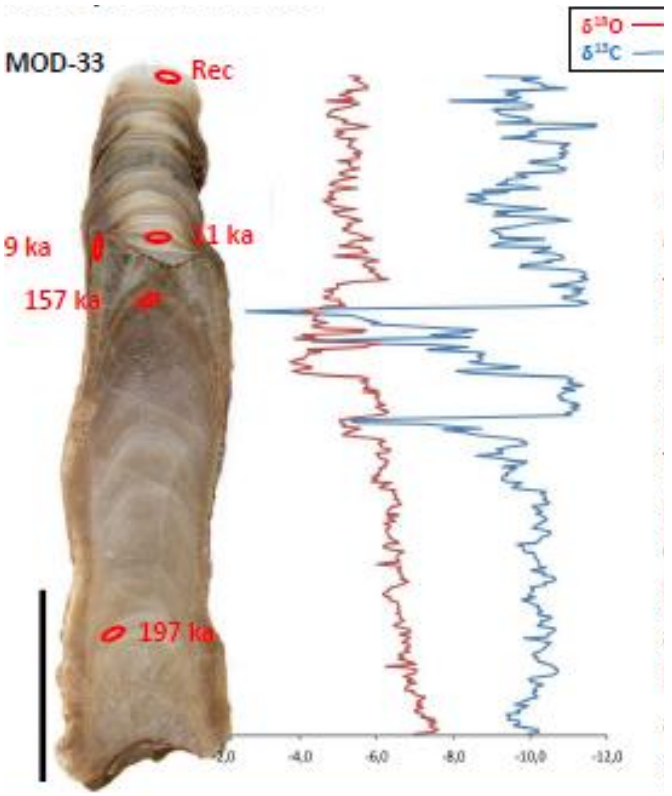
REQUENCRIM

Reconstruction of the Quaternary environment in Croatia using isotope methods (2014-20

$\delta^{18}O$ and $\delta^{13}C$ depth series supported by preliminary U-Th results





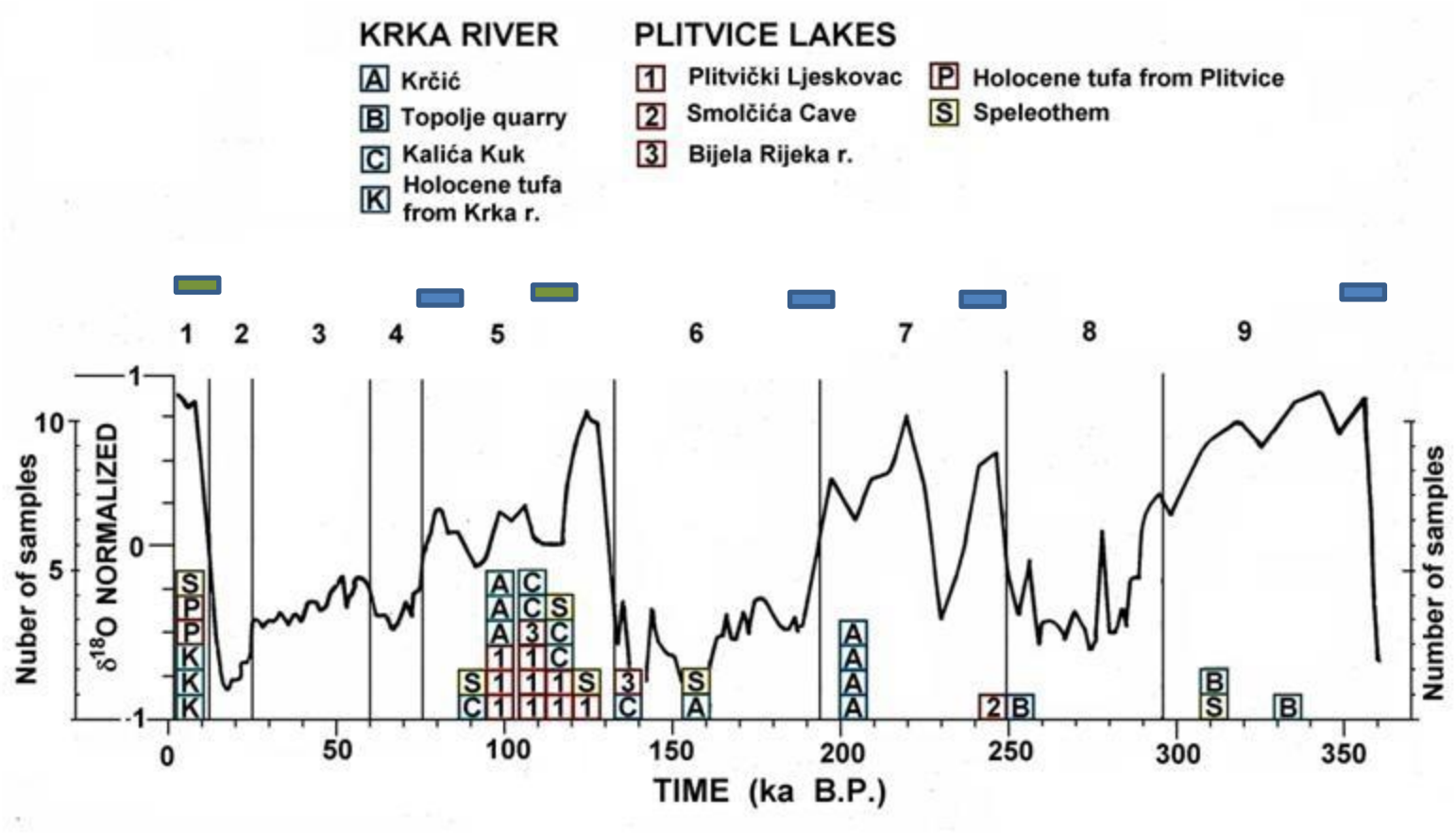


MOD-31 – MIS10 – MIS7, probably with several Hiatuses visible in st.isot. data; deposition recommenced in the late Holocene

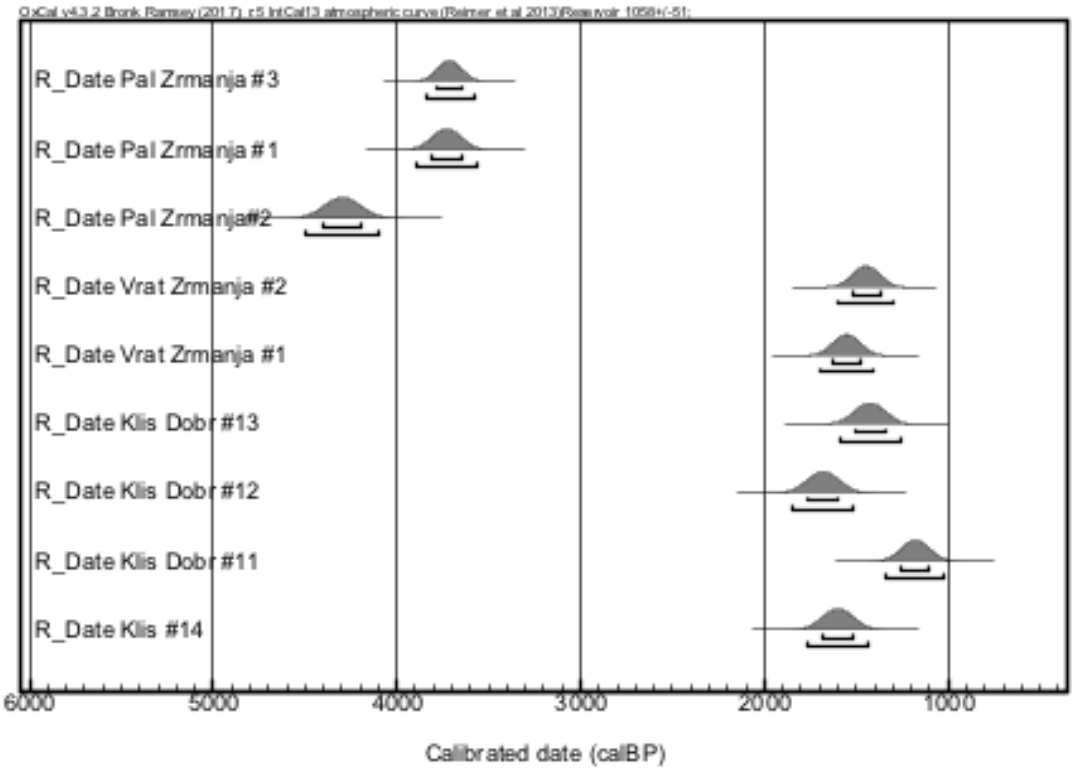
MOD-32 – MIS4 and MIS3, and the Holocene Pronounced variation in $\delta^{13}C$

MOD-33 – most intensive deposition during MIS6; again through the whole Holocene

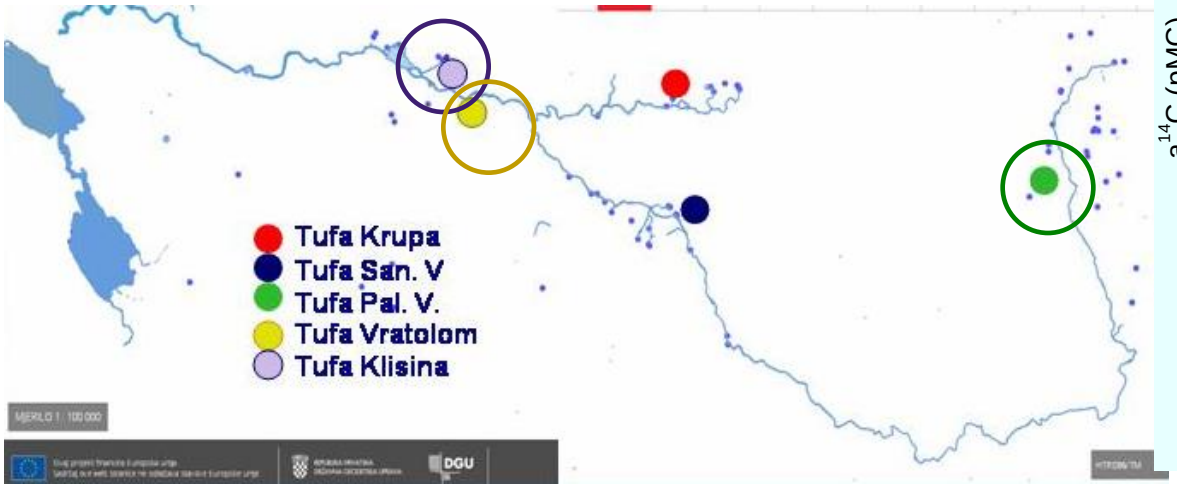
In the Dinaric karst, tufa is formed during interglacials

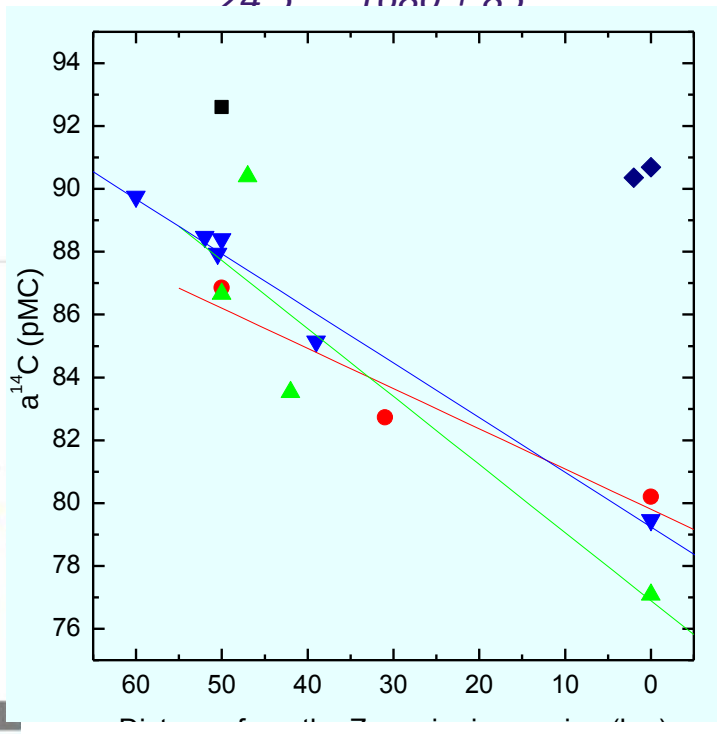


Tufa from Palanka, Vratolom, Island “Klisina”, Zrmanja river



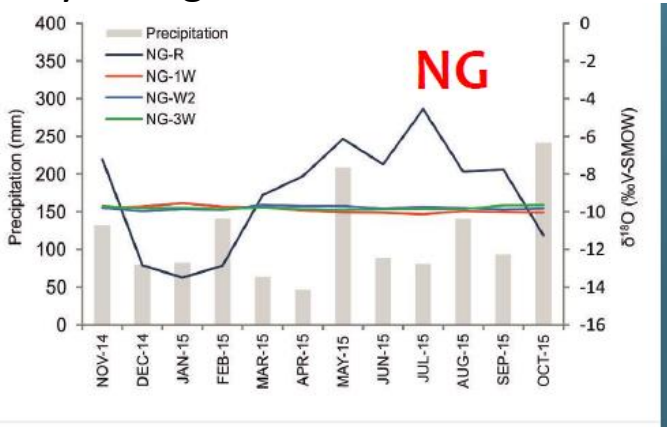
m asl	*^{14}C age, BP*
264	*3715 ± 65*
280	*3730 ± 80*
280	*4295 ± 100*
29	*1445 ± 75*
30	*1550 ± 75*
24	*1425 ± 85*
24.5	*1680 ± 85*

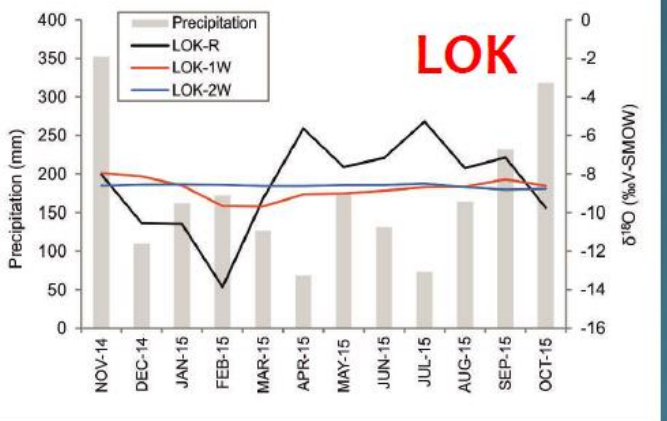


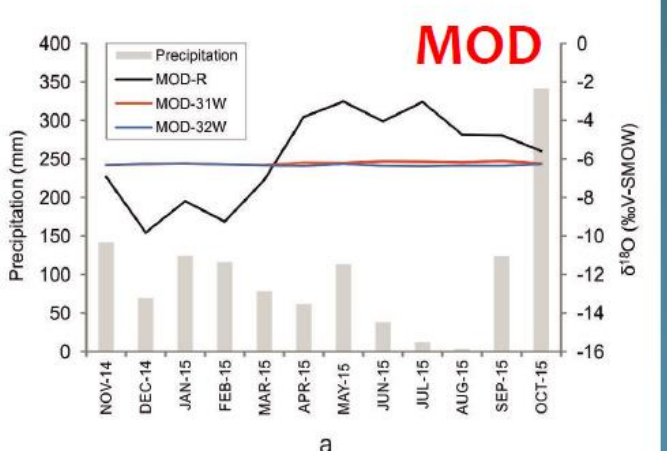


Monitoring of modern environmental settings in three caves revealed variable atmospheric influences and specific hydrological behaviour of each drip site.

Homogenized stable isotope composition of drip water and stable cave environmental settings give confidence for calcite deposition under isotope equilibrium conditions enabling retrieval of paleoclimate and paleoenvironmental information.







$\delta^{18}O$ amplitude:

Rainwater 8.9‰
Drip water 0.3-0.6 ‰

Rainwater 8.6‰
Drip water 0.3-1.3 ‰

Rainwater 6.8‰
Drip water 0.2 ‰

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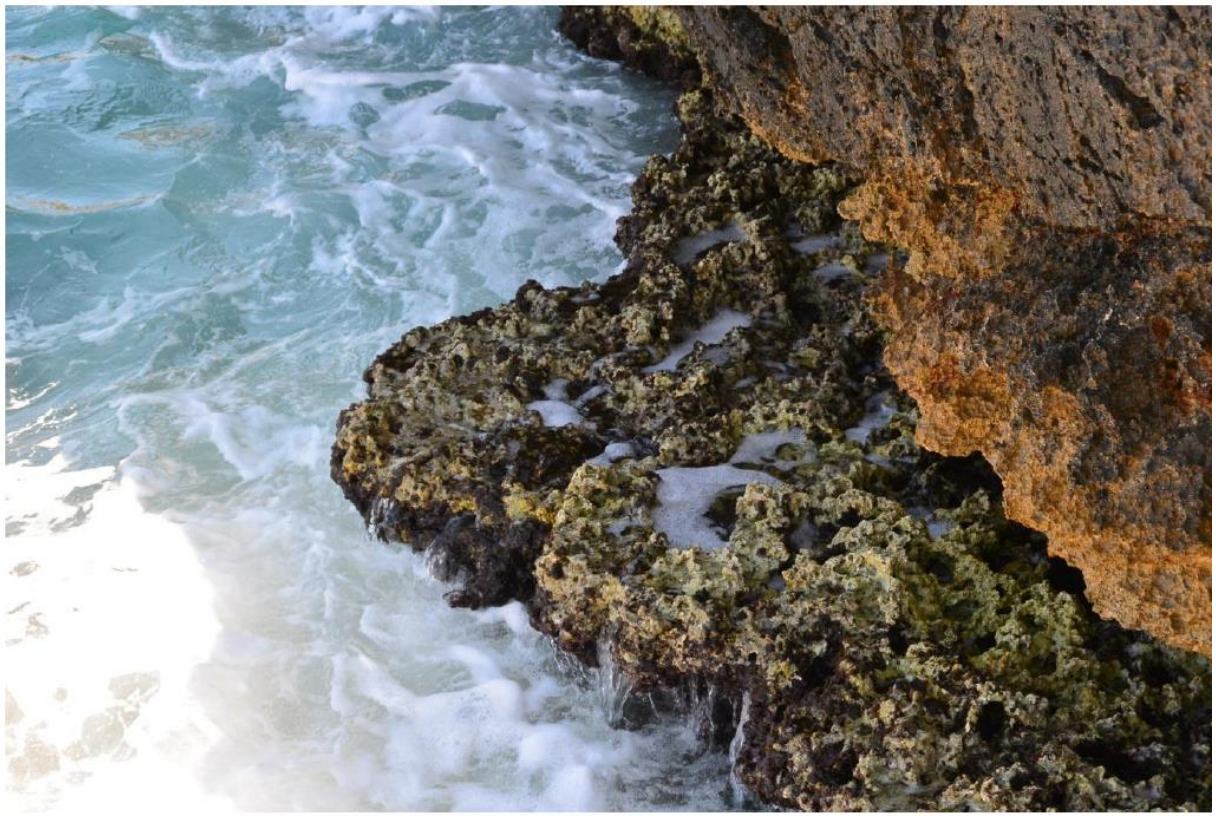
Algal rims (*Lithophyllum byssoides*) are good and precise sea-level indicators and their morphology, age and stable isotope composition could be linked to climate changes.

The goals of algal rims study

- to determine the marine reservoir effect essential for accurate calculation of the algal rim ^{14}C ages
- to reconstruct relative sea-level changes along the eastern Adriatic coast beginning at 5th century.



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Pre-bomb marine organisms – algae and mollusks

Marine reservoir ages of shells and algae differ, even though both inhabit the same ares – intertidal zone to the shallow sea

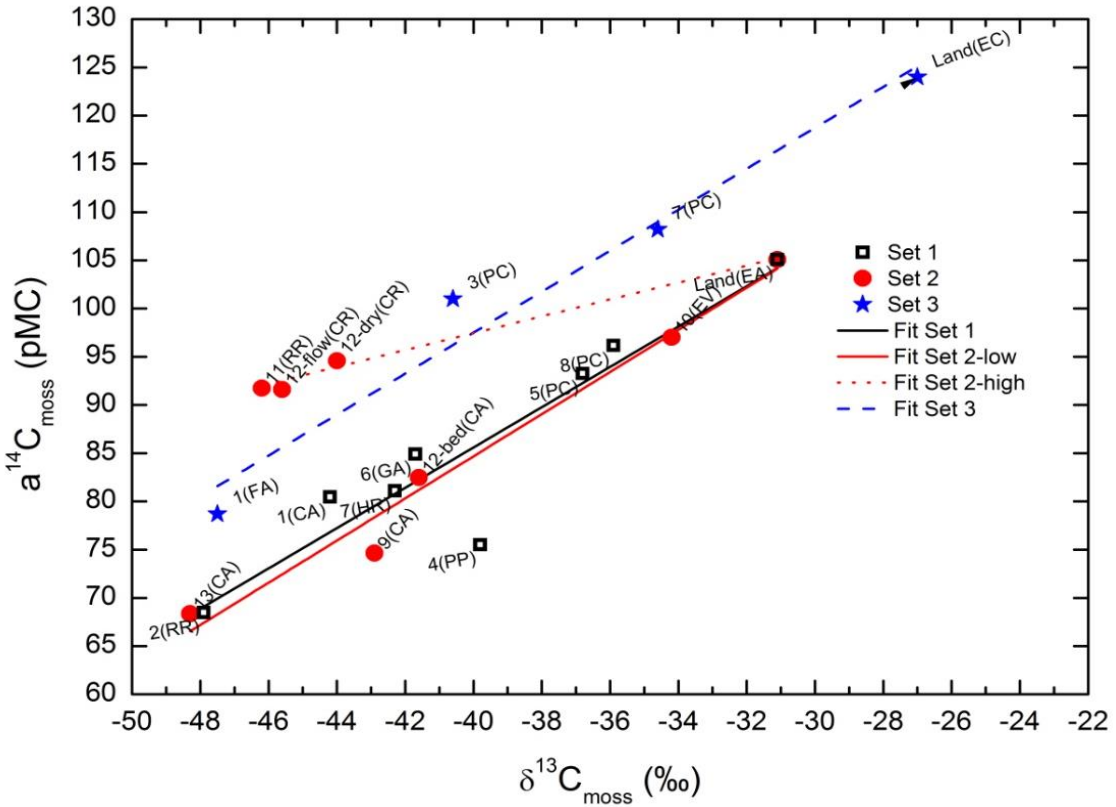
	Algae	shells
Reservoir age	355 ± 34 ^{14}C yr	513 ± 53 ^{14}C yr
ΔR	-9 ± 34	154 ± 52

Radiocarbon, Vol 57, Nr 4, 2015, p 527–538 DOI: 10.2458/azu_rc.57.18452

NEW DATA ON MARINE RADIOCARBON RESERVOIR EFFECT IN THE EASTERN ADRIATIC BASED ON PRE-BOMB MARINE ORGANISMS FROM THE INTERTIDAL ZONE AND SHALLOW SEA

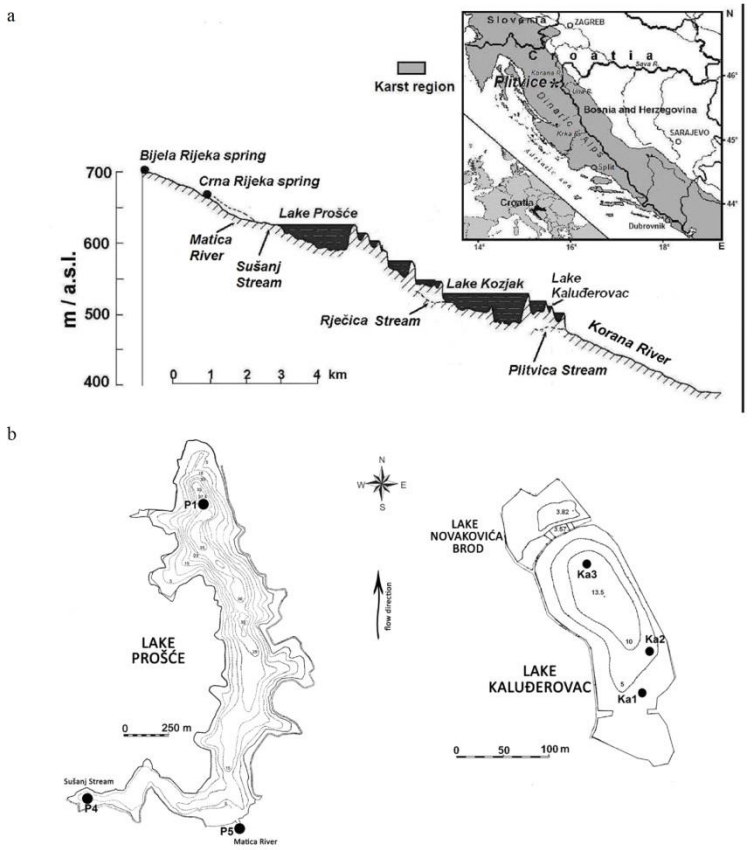
Sanja Faivre[1,2] • Tatjana Bakran-Petricioli[3] • Jadranka Barešić[4] • Nada Horvatinčić[4]

Mosses are important fragments in the karst environment and they play an active role in tufa formation. Submerged mosses use carbon from two sources: atmospheric CO_2 and dissolved inorganic carbon (DIC). It was found that certain species of mosses incorporate carbon only from dissolved inorganic carbon (DIC), while certain aquatic moss species show higher ^{13}C fractionation if the share of atmospheric CO_2 is higher or if the flow velocity is higher. Understanding the source partition can help understanding formation of secondary carbonates that constitute tufa barriers.



Hrvatska zaklada za znanost

Lake sediments, Lake Prošće and Lake Kaluđerovac, Plitvice Lakes, Croatia



a) cross-section of the Plitvice Lakes,
b) Sampling locations: Lake Prošće, sediment cores P1, P2, P3, Lake Kaluđerovac, sediment cores K1, K2, K3

two karst lakes having different characteristics (size, depth, environment):

- How do lake sediment respond to the environmental conditions?
- What is the difference between two lakes of different sizes?
- Which fraction, organic or carbonate, of the lake sediments, better describes paleo-environmental conditions?
- What can we conclude about the changes in the environment of the Plitvice Lakes during the last ~150 years by studying ~40-cm-long sediment cores? Any anthropogenic contamination?

- Significant fractions of land-derived both carbonate and organic components were recognized in the shallow, coastal area of Lake Prošće brought to the lake by tributaries
- The composition of deep-water sediment in the same lake indicated *in situ* calcite precipitation and aquatic OM produced in the lake.
- In Lake Kaluđerovac homogenous precipitation of autochthonous calcite was observed inside the lake, without an allochthonous fraction.
- Increased bioproductivity in the recent decades was found in Lake Prošće, which can be correlated with a slight increase of the lake water temperature in last three decades

Quaternary International xxx (2017) xxx-xxx

Contents lists available at ScienceDirect

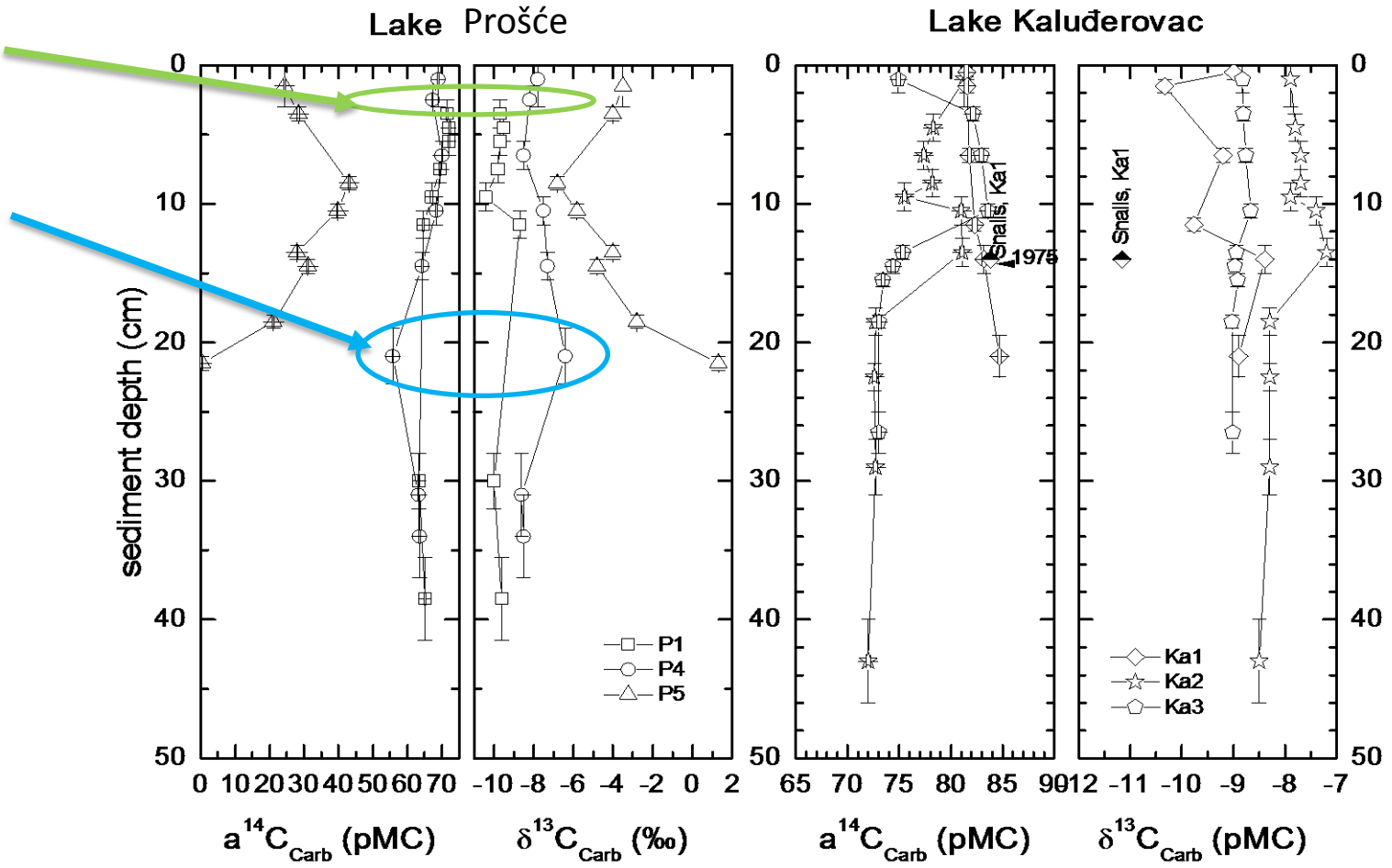
Quaternary International

journal homepage: www.elsevier.com

Mineralogical, organic and isotopic composition as palaeoenvironmental records in the lake sediments of two lakes, the Plitvice Lakes, Croatia

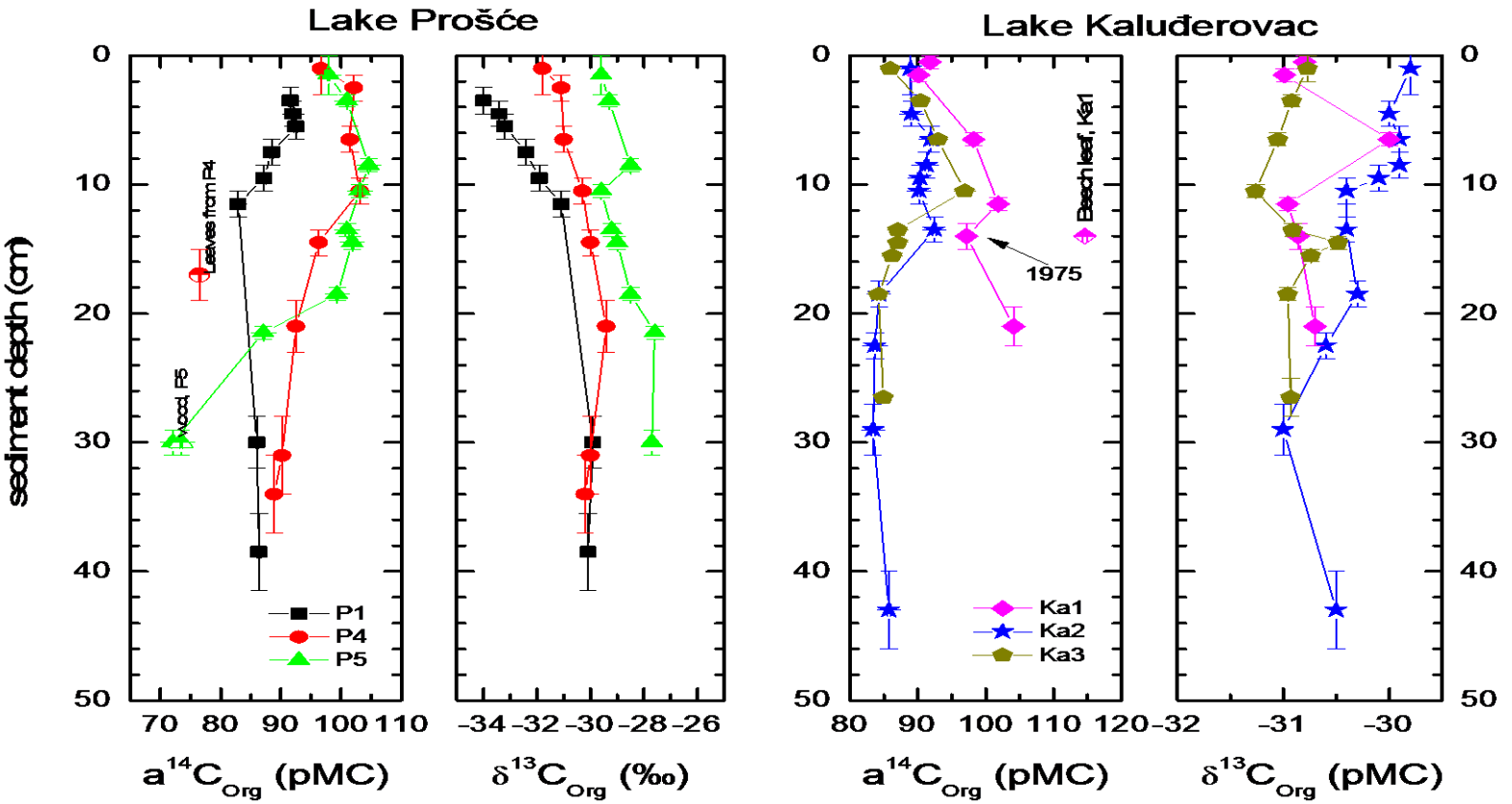
Nada Horvatinčić [a, *], Andreja Sironić [a], Jadranka Barešić [a], Ivan Sondi [b], Ines Krajcar Bronić [a], Damir Borković [a]

- Local anthropogenic influence was not evident, but the response to the global ^{14}C bomb peak was observed by the occurrence of the a^{14}C peak in both carbonate and organic fractions (damped and delayed).
- Disturbances in carbon isotope depth distribution in the sediments of shallow, coastal lake areas enabled identification of extreme hydrological events in 1981 and 2010 – justified by hydrological data (*flow rate, precipitation*)



Concluding remarks (work in progress)

- Different carbonate sediments from the Dinaric karst of Croatia record climate and environmental changes in their isotopic composition
- The Anthropocene changes recorded in top layers of lake sediments in both organic and carbonate fractions, and in algal rims
- The Holocene records in lake sediments, tufa and speleothem
- Older tufa outcrops are not easy to find
- Speleothems can be well preserved and cover the longest period
- We have to learn how to read these records and combine isotopic with other geochemical analyses


Lake Prošće
Lake Kaluđerovac
sediment depth (cm)
Leaves from P4
Wood, P5
P1
P4
P5
Beech leaf, Ka1
1975
Ka1
Ka2
Ka3
a14COrg (pMC)
δ13COrg (‰)
a14COrg (pMC)
δ13COrg (pMC)