USRED LJETA NA SNIJEGU I LEDU U HRVATSKOJ – ŠTO NAS ČEKA U BUDUĆNOSTI?

DALIBOR PAAR

FIZIČKI ODSJEK, PMF, SVEUČILIŠTE U ZAGREBU

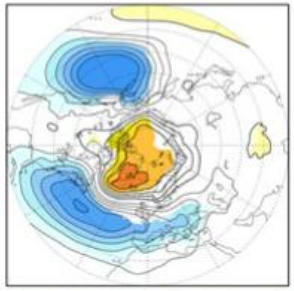
CENTAR ZA KLIMATOLOŠKA ISTRAŽIVANJA PMF-A

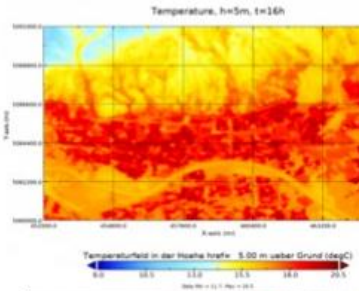
ŽSV Sambor, 7.4.2022.

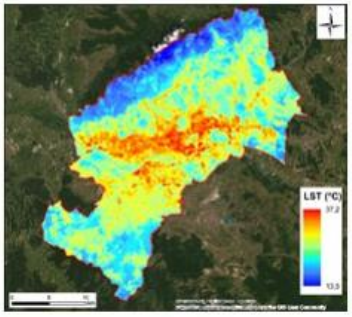
CENTAR ZA KLIMATOLOŠKA ISTRAŽIVANJA

Istraživačke aktivnosti i projekti

Klimatska varijabilnost, klimatske promjene velike skale, klimatsko modeliranje, urbana klimatologija, utjecaj klimatskih promjena na biološku raznolikost i funkcije kopnenih, morskih i slatkovodnih ekosustava, utjecaj klimatskih promjena na fiziologiju vrsta, utjecaj klimatskih promjena na rasprostranjenost vrsta i biogeografske procese, utjecaj klimatskih promjena na usluge ekosustava, utjecaj klimatskih promjena na agronomiju, klima jadranskog područja, utjecaj klimatskih promjena na krške sustave, regionalna klimatologija – klima Hrvatske, utjecaj klimatskih promjena na protočne režime, utjecaj klimatskih promjena na opasnost od riječnih poplava, relativna promjena morske razine i klimatske promjene tijekom kasnog holocena, mikroklima speleoloških objekata, napredne statističke metode i matematičko modeliranje








Područje istraživanja

Korištenje prijenosnih iskustava istraživanja špilja na Zemlji na Marsu

Ante Premužić

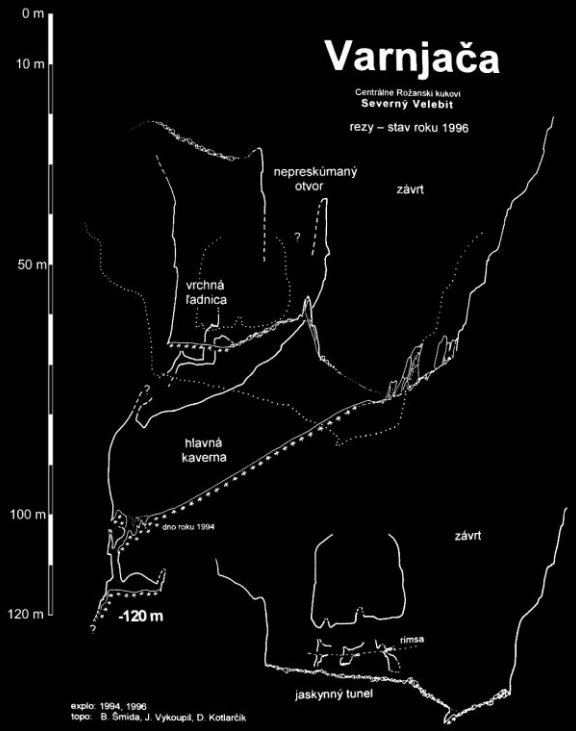
Slika 2.15 | Hela Krajač (1899. – 1999.) i Ivan Krajač (1877. – 1945.)

- 1930. – 1933. šumarski inženjer Ante Premužić koordinira izgradnju „Premužićeve staze”
- 1929 - Ante Premužić, Ivan Krajač i Marko Vukelić istražuju jamu Varnjaču do dubine 100 m
- 1930. U Varnjaču se spustila i Hela Krajač

1929 1990 2000 2010 2020

Ante Premužić

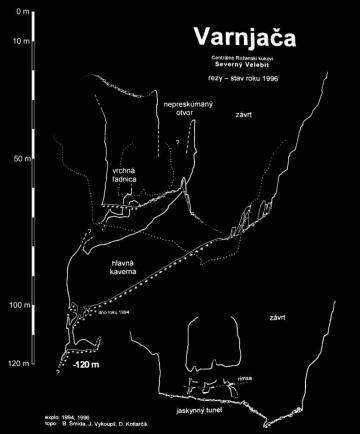
Slika 2.15 | Hela Krajač (1899. – 1999.) i Ivan Krajač (1877. – 1945.)



- 1930. – 1933. šumarski inženjer Ante Premužić koordinira izgradnju „Premužićeve staze”
- 1929 - Ante Premužić, Ivan Krajač i Marko Vukelić istražuju jamu Varnjaču do dubine 100 m
- 1930. U Varnjaču se spustila i Hela Krajač

1929 1990 2000 2010 2020

Ante Premužić

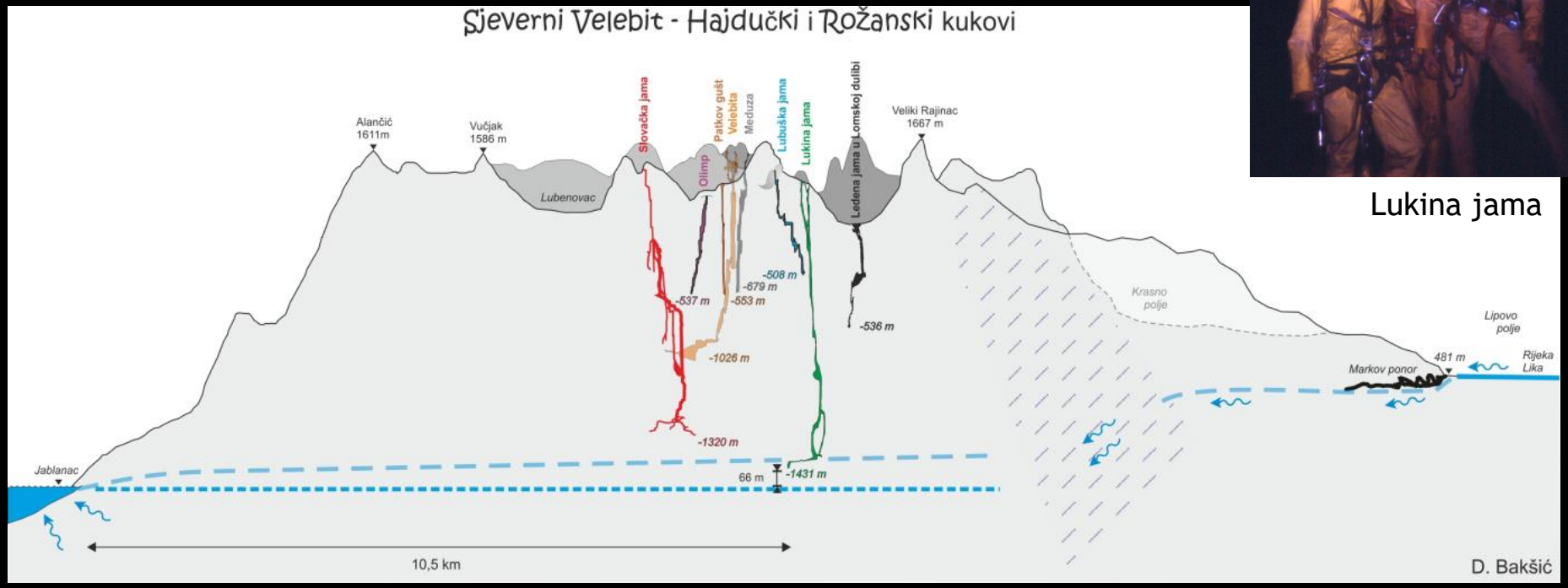


Slika 2.15 | Hela Krajač (1899. – 1999.) i Ivan Krajač (1877. – 1945.)

- 1930. – 1933. šumarski inženjer Ante Premužić koordinira izgradnju „Premužićeve staze”
- 1929 - Ante Premužić, Ivan Krajač i Marko Vukelić istražuju jamu Varnjaču do dubine 100 m
- 1930. U Varnjaču se spustila i Hela Krajač

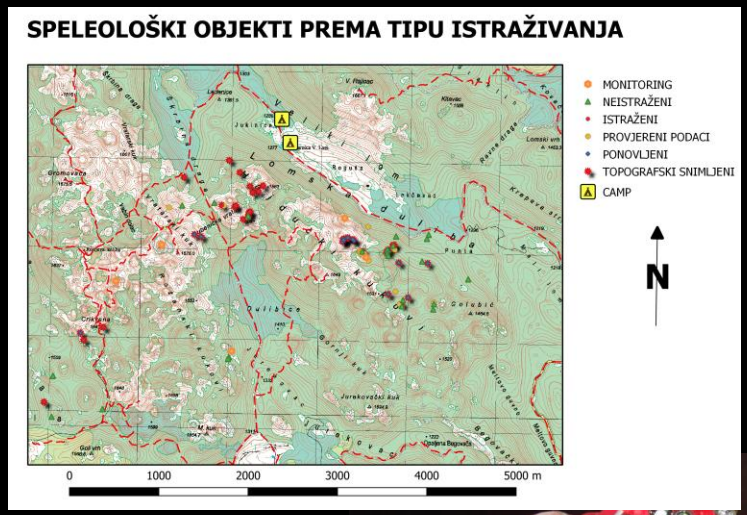
1929 1990 2000 2010 2020

Lukina jama



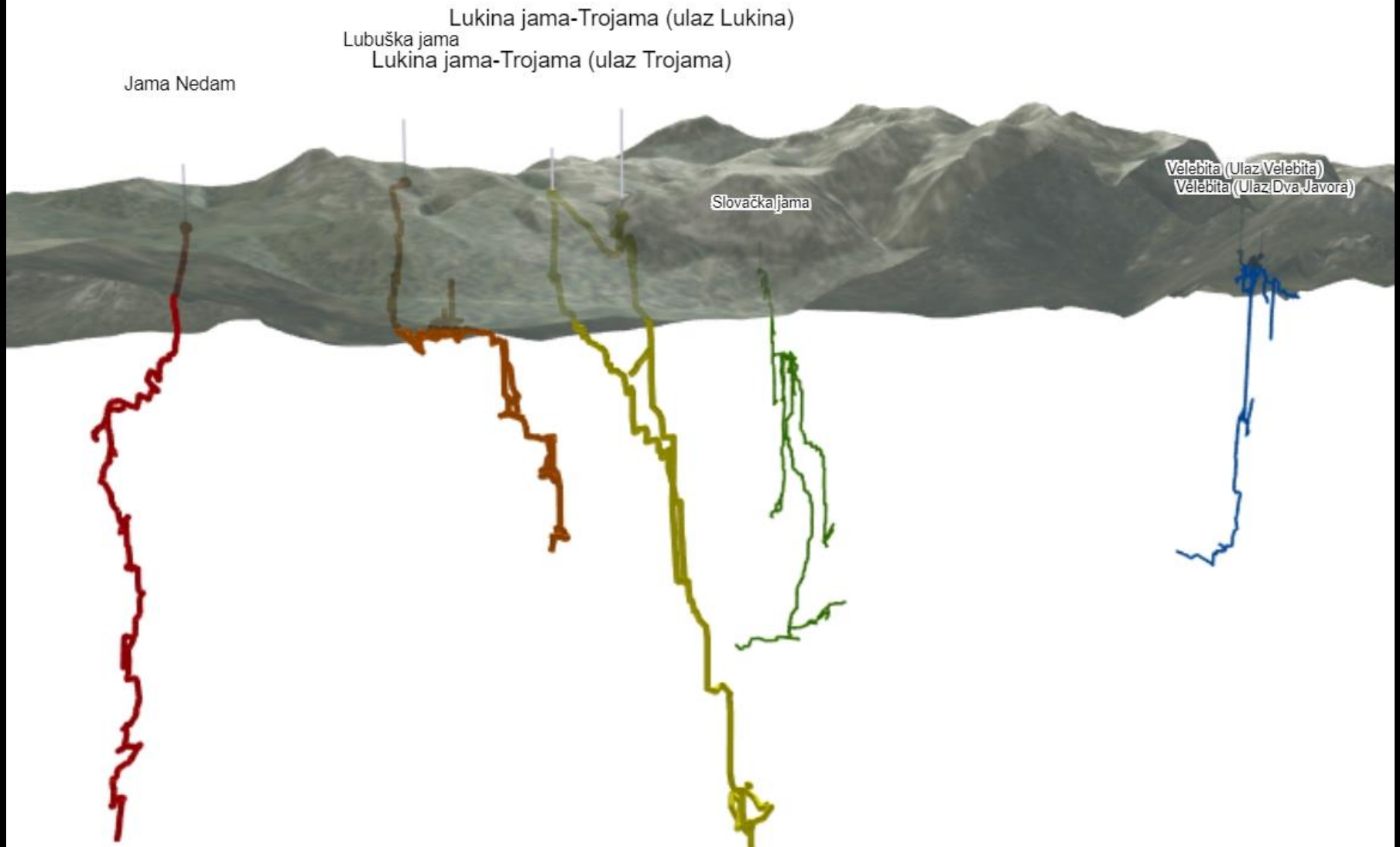
1992. Otkriće i početak istraživanja Lukine jame

1929 1990 2000 2010 2020



1992. – danas – sustavna speleološka istraživanja, speleološke ekspedicije

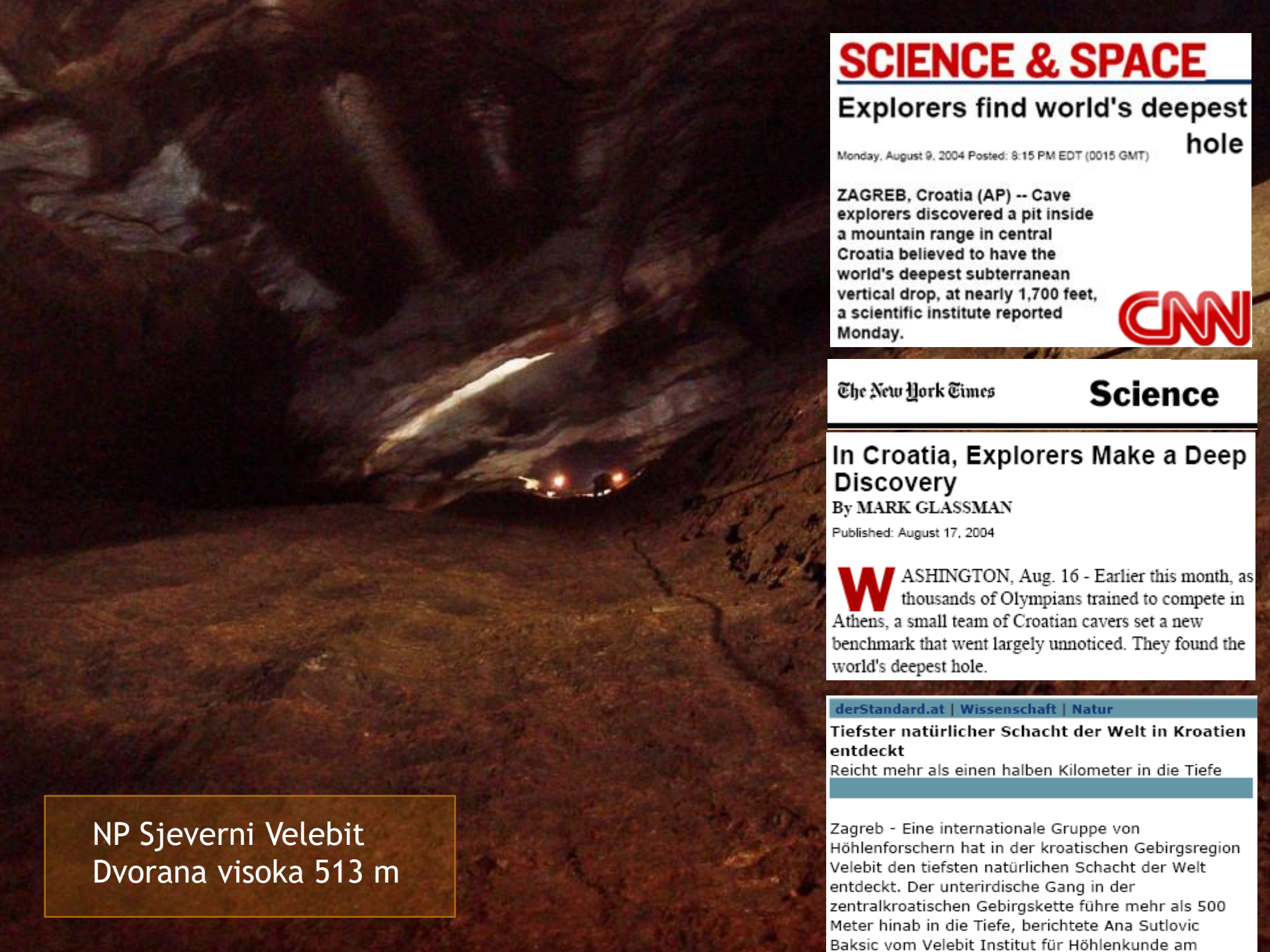
1929 1990 2000 2010



RB	Ime objekta	Položaj	Dubina
1	Jamski sustav Lukina jama - Trojama	Hajdučki kukovi, Sjeverni Velebit	–1.431 m
2	Slovačka jama	Mali kuk, Sjeverni Velebit	–1.324 m
3	Jamski sustav Velebita	Rožanski kukovi, Sjeverni Velebit	–1.026 m
4	Nedam	Hajdučki kukovi, Sjeverni Velebit	–1.021 m

Marina Grandić
SO Velebit, 2019.

Boravci na dubinama ispod 1000 m i preko tjedan dana …



NP Sjeverni Velebit
Dvorana visoka 513 m

SCIENCE & SPACE

Explorers find world's deepest hole

Monday, August 9, 2004 Posted: 8:15 PM EDT (0015 GMT)

ZAGREB, Croatia (AP) -- Cave explorers discovered a pit inside a mountain range in central Croatia believed to have the world's deepest subterranean vertical drop, at nearly 1,700 feet, a scientific institute reported Monday.

CNN

The New York Times **Science**

In Croatia, Explorers Make a Deep Discovery

By MARK GLASSMAN

Published: August 17, 2004

WASHINGTON, Aug. 16 - Earlier this month, as thousands of Olympians trained to compete in Athens, a small team of Croatian cavers set a new benchmark that went largely unnoticed. They found the world's deepest hole.

derStandard.at | Wissenschaft | Natur

Tiefster natürlicher Schacht der Welt in Kroatien entdeckt

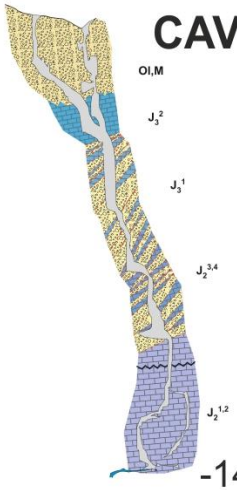
Reicht mehr als einen halben Kilometer in die Tiefe

Zagreb - Eine internationale Gruppe von Höhlenforschern hat in der kroatischen Gebirgsregion Velebit den tiefsten natürlichen Schacht der Welt entdeckt. Der unterirdische Gang in der zentralkroatischen Gebirgskette führe mehr als 500 Meter hinab in die Tiefe, berichtete Ana Sutlovic Baksic vom Velebit Institut für Höhlenkunde am

Otkrića dubokih jama i novih velikih speleoloških objekata i sustava potaknula su nova znanstvena istraživanja

Špiljske rekonstrukcije aktualnih procesa i paleoprocesa

CAVES - DINARIC KARST - CROATIA



-1400 m

SPELEOTHEMS

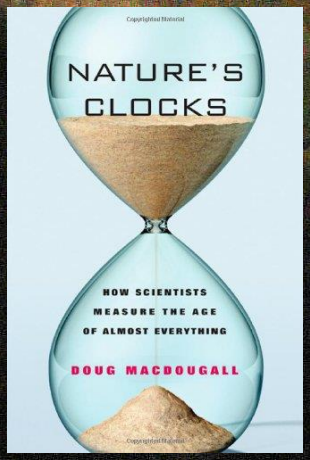
ICP-MS, XRD

quartz
calcite
dolomite

Si Na Sr Ni
Al Mg Ti Cr
Fe K B Pb Zn
V Ba Mn Li
Mo

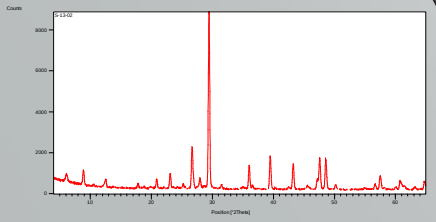
ELEMENTS, MINERALS
PROXY RECORDS?

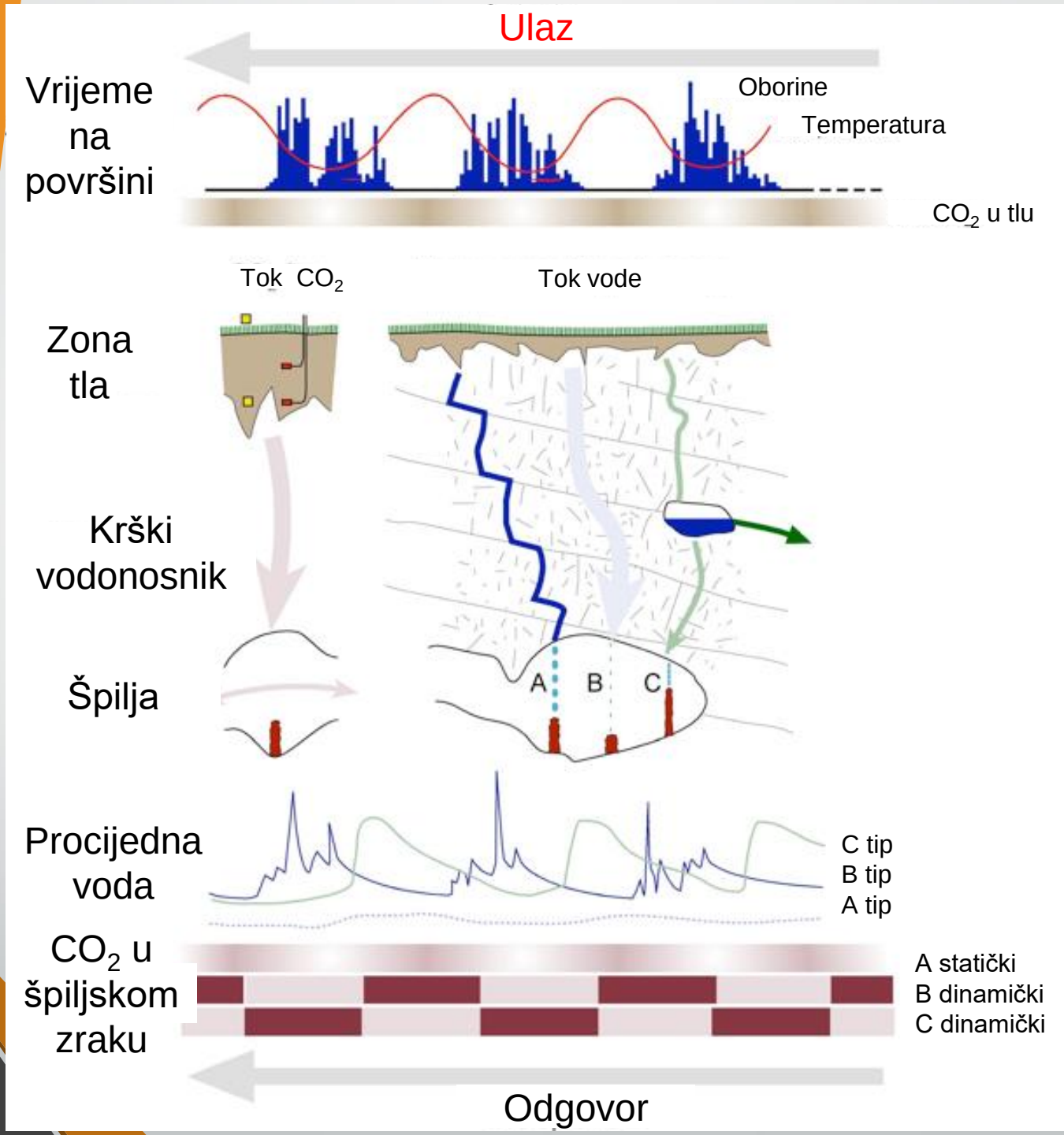
Špiljske rekonstrukcije aktualnih procesa i paleoprocesa



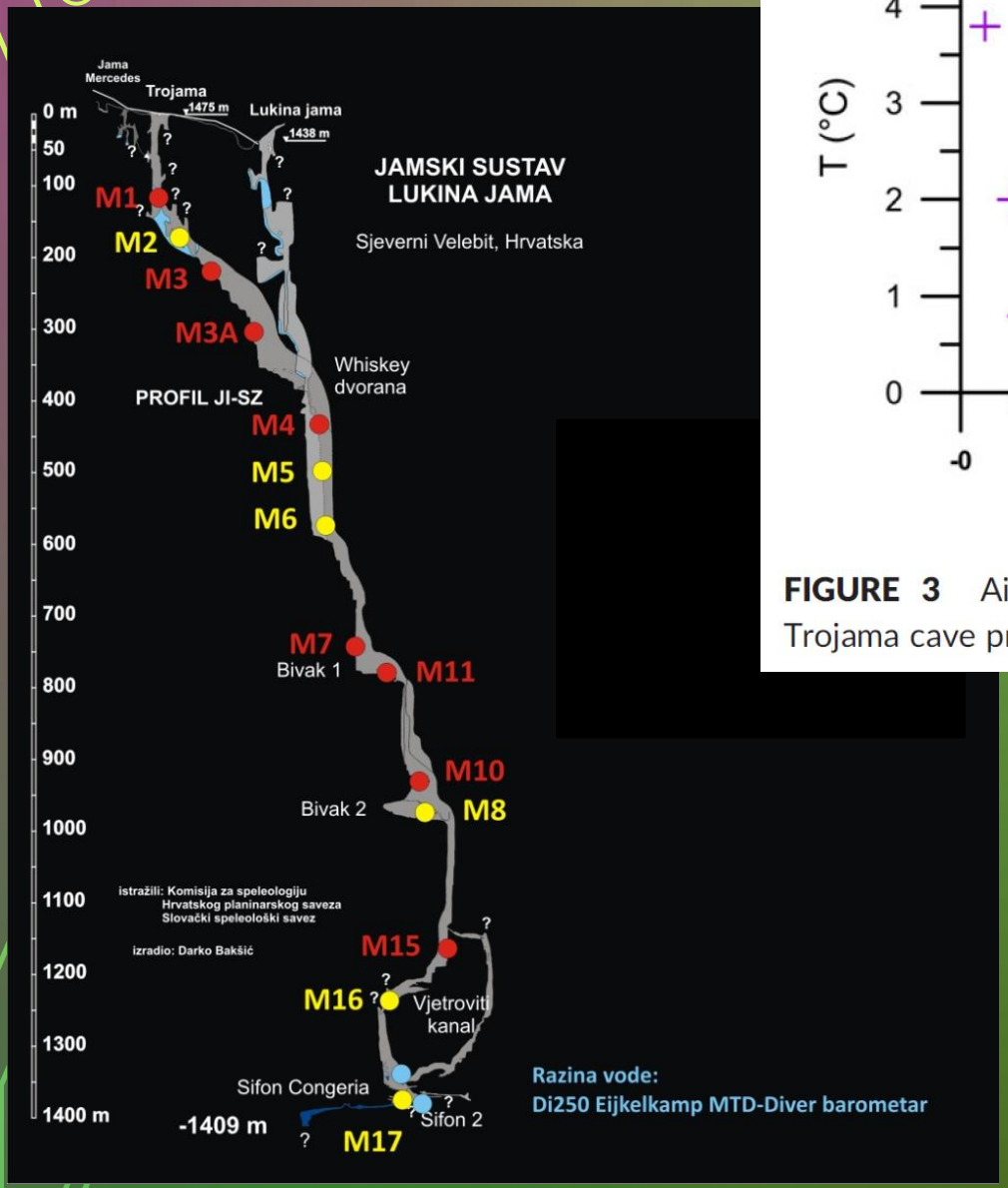
Nova pitanja: što se događa danas ili će biti u budućnosti?

Interakcija klime i drugih površinskih procesa sa špiljama





Mikroklima i hidrologija dubokih jama



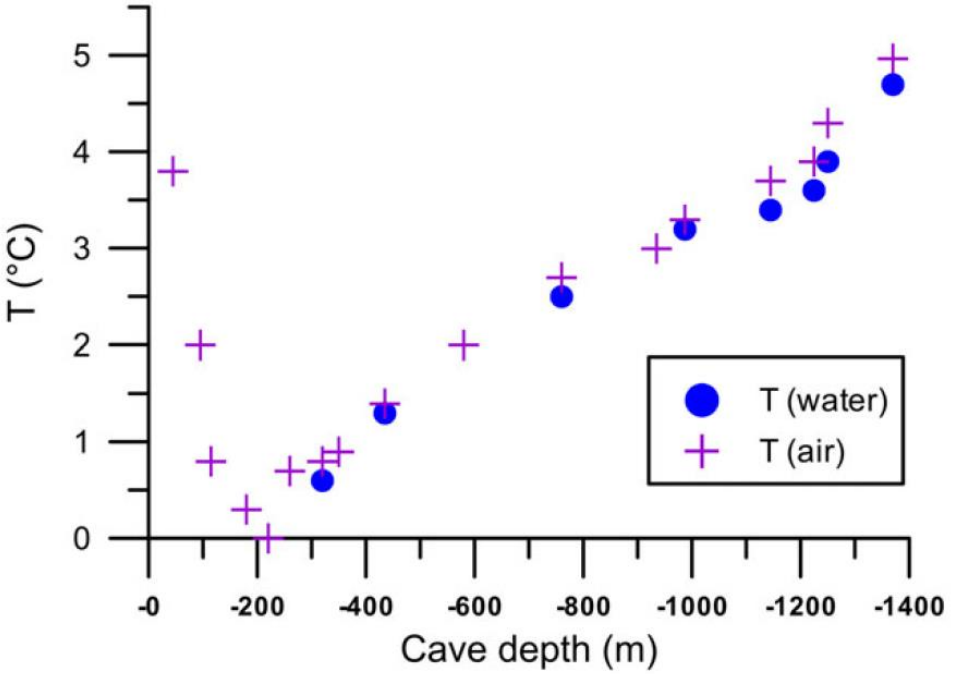
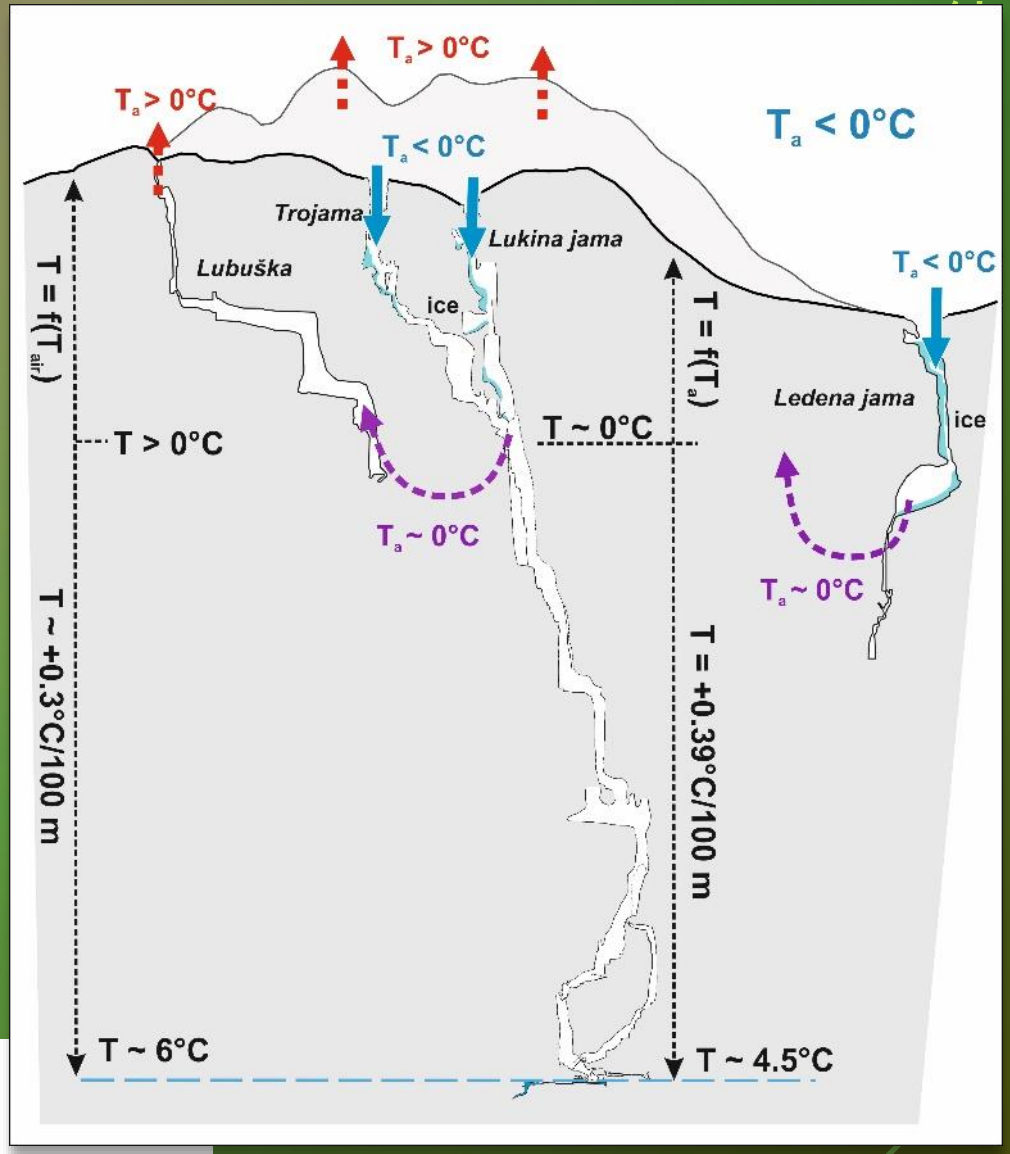


FIGURE 3 Air and water temperature along the Lukina jama–Trojama cave profile (adapted with permission from Paar et al., 2013)



Hydrological Processes

RESEARCH ARTICLE

Water and air dynamics within a deep vadose zone of a karst massif: observations from the Lukina jama-Trojama cave system (-1431 m) in Dinaric karst (Croatia)

Andrej Stroj ✉, Dalibor Paar

Stroj & Paar, 2019.

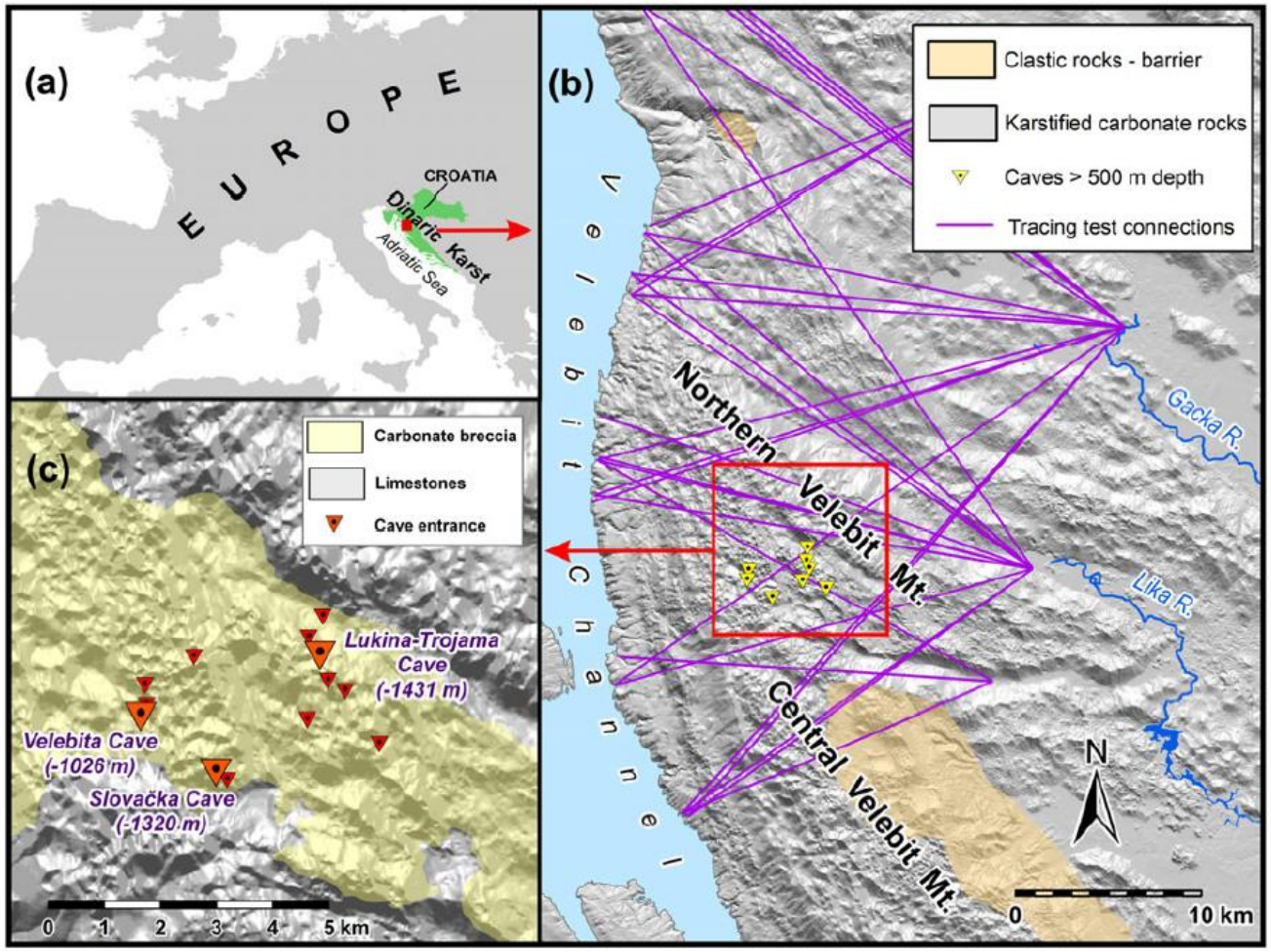
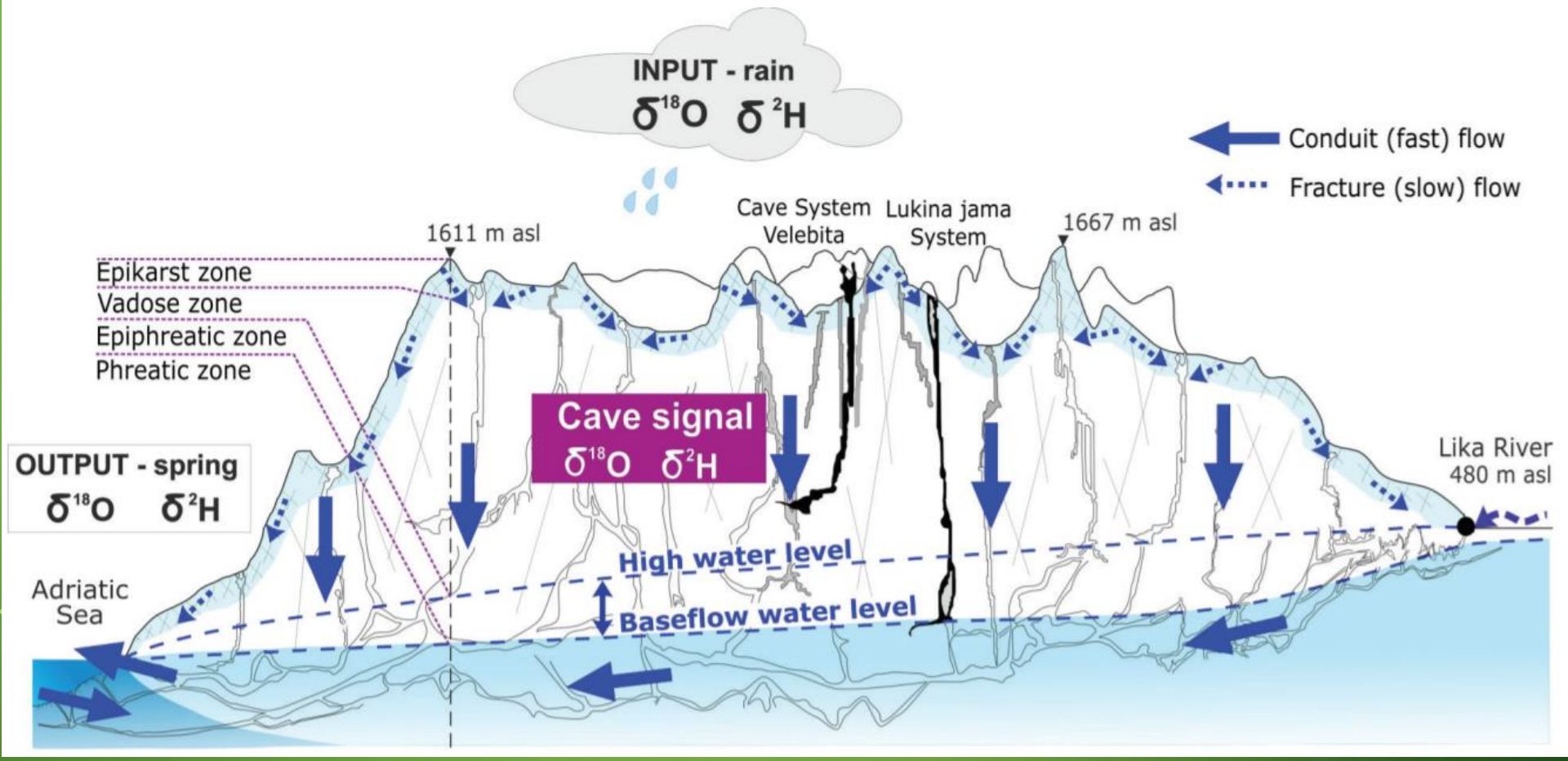


FIGURE 1 (a) Location of the Northern Velebit Mt. within the Dinaric karst area in SE Europe; (b) Northern Velebit karst massif and surroundings; (c) central area of the massif, showing the position of caves deeper than 200 m and the names of caves deeper than 1,000 m



Geologia Croatica
Journal of the Croatian Geological Survey and the Croatian Geological Society
2019 | 72/3 | 205–213 | 8 Figs. | 4 Tabs. | www.geologia-croatica.hr

Northern Velebit (Croatia) karst hydrological system: results of a preliminary ^{2}H and ^{18}O stable isotope study

Dalibor Paar[1], Diana Mance[2]*, Andrej Stroj[3] and Mirja Pavić[3]

[1] University of Zagreb, Faculty of Science, Department of Physics, 10 000 Zagreb, Croatia
[2] University of Rijeka, Department of Physics, 51 000 Rijeka, Croatia; (*diana.mance@uniri.hr)
[3] Croatian Geological Survey, Zagreb, Croatia

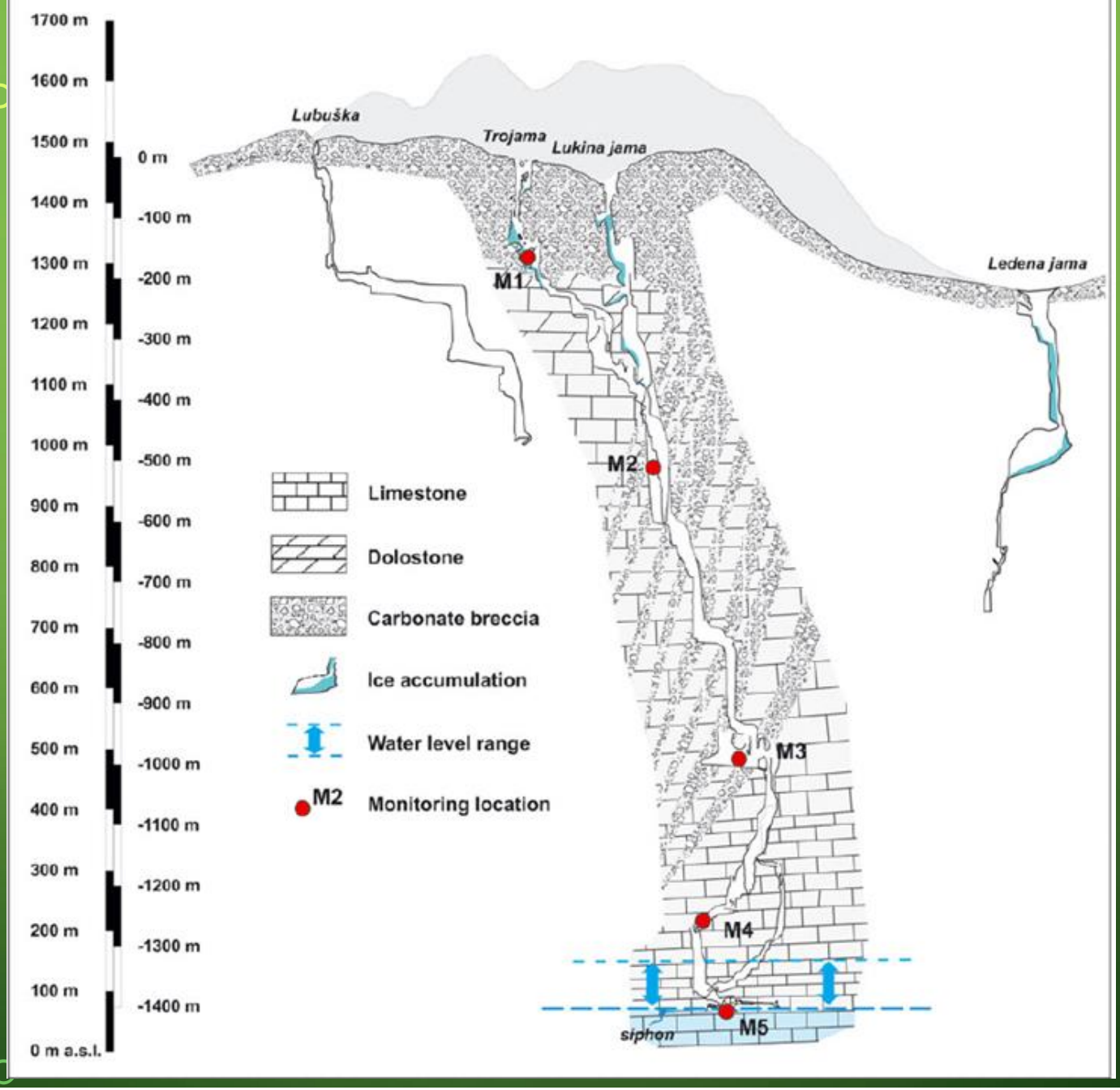


FIGURE 2 Geological profile of the Lukina jama–Trojama cave system, showing monitoring locations (M1–M5), terrain contours, and profiles of nearby Lubuška and Ledena jama caves

Istraživanja stalnog leda u jamama Velebita


Trojama


Lukina jama

Dubina jame (m)	Najviša točka leda	Najniža točka leda
Lukina jama	45 m	556 m
Patkov gušt	60 m	553 m
Xantipa	70 m	323 m

Elsevier, 2018

CHAPTER

ICE CAVES IN CROATIA

16

Nenad Buzjak*, Neven Bočić*, Dalibor Paar*, Darko Bakšić*, Vinka Dubovečak†
University of Zagreb, Zagreb, Croatia Speleological Association Kraševski zviri, Ivanec, Croatia†*

CHAPTER OUTLINE

Stalni led u jamama Velebita (>230 ledenih jama naVelebitu)

Trojama

Lukina jama

Dubina jame (m)	Najviša točka leda	Najniža točka leda
Lukina jama	45 m	556 m
Patkov gušt	60 m	553 m
Xantipa	70 m	323 m

Glavni faktori koji reguliraju led/snijeg:

1. **Lokalna klima**
2. **Lokalna topografija**
3. **Morfologija jame**

Nenad Buzjak, Dalibor Paar, Darko Bakšić: Geophysical Research Abstracts Wien : EGU , 2011.

Uzorkovanje organskih ostataka iz leda jamama Velebita

^{14}C analize organskih ostataka u ledu Lukine jame i Ledene jame potvrđuju starosti u rasponu 410 – 525 godina, čime se procjenjena starost leda poklapa s Malim ledenim dobom.

D.Paar, N.Buzjak, A.Sironić, N.Horvatinčić: Paleoklimatske arhive dubokih jama Velebita, INQUA 2013

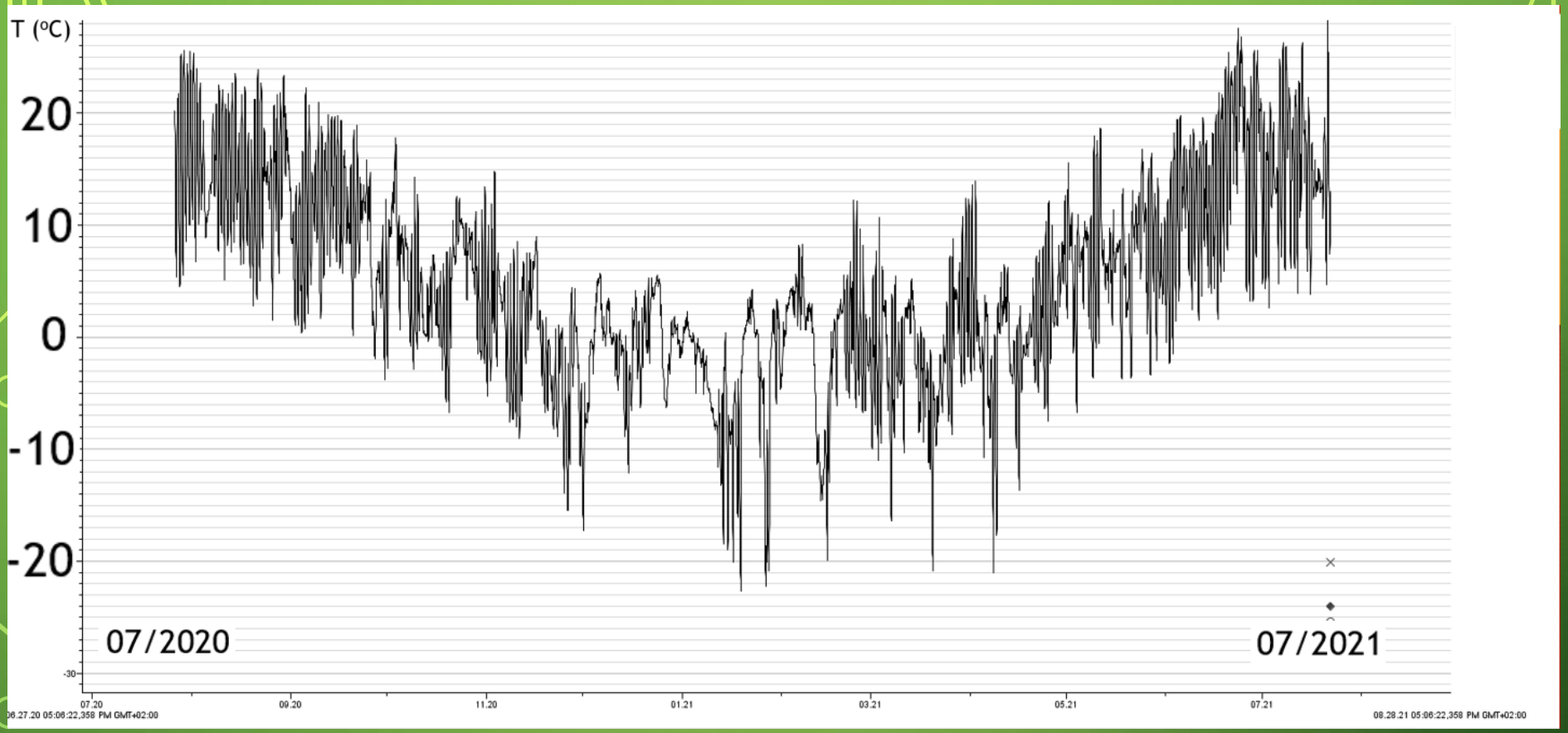
Ulaz Lukina jama zatvoren ledom na dubini oko 60 m od 2000. godine

U jami Trojami koja se sa Lukinom spaja na oko 500 m dubine.

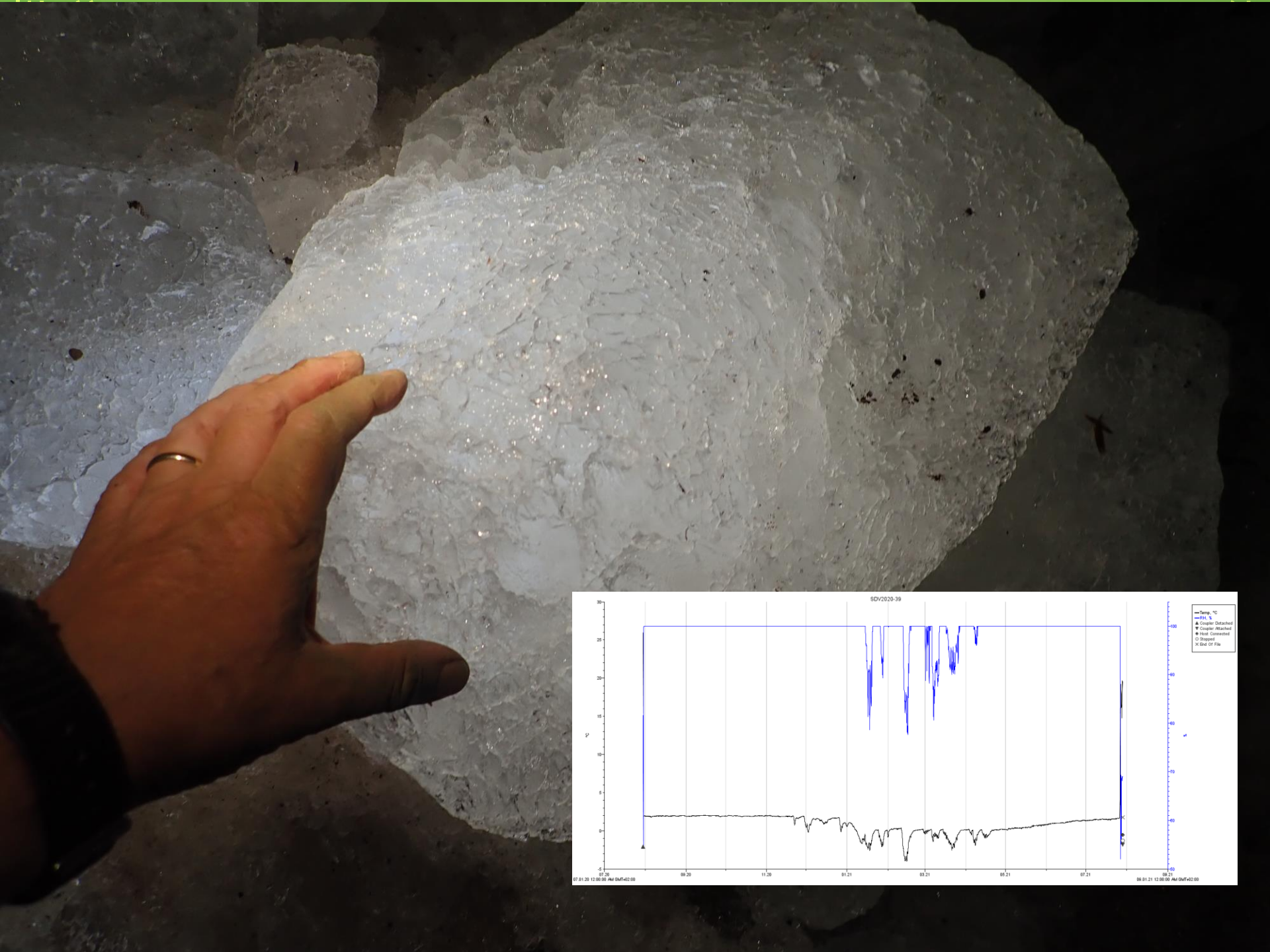
U jami Sireni u kolovozu 2013 otkapali smo zatrpane mjerne instrumente.

Jama Nedam – nova hrvatska tisućica (-1250 m), istraživanja 2021.

Led u jami Nedam akumuliran u većini tijekom prethodne zime (srpanj 2021.)



- Lomska duliba, NP Sjeverni Velebit
- 07/2020 – 07/2021
- Min -22,6 °C
- Max 29,3 °C


SDV2020-39
Temp, °C
RH, %
Coupler Detached
Coupler Attached
Host Connected
Stopped
End Of File
°C
%
30
25
20
15
10
5
0
-5
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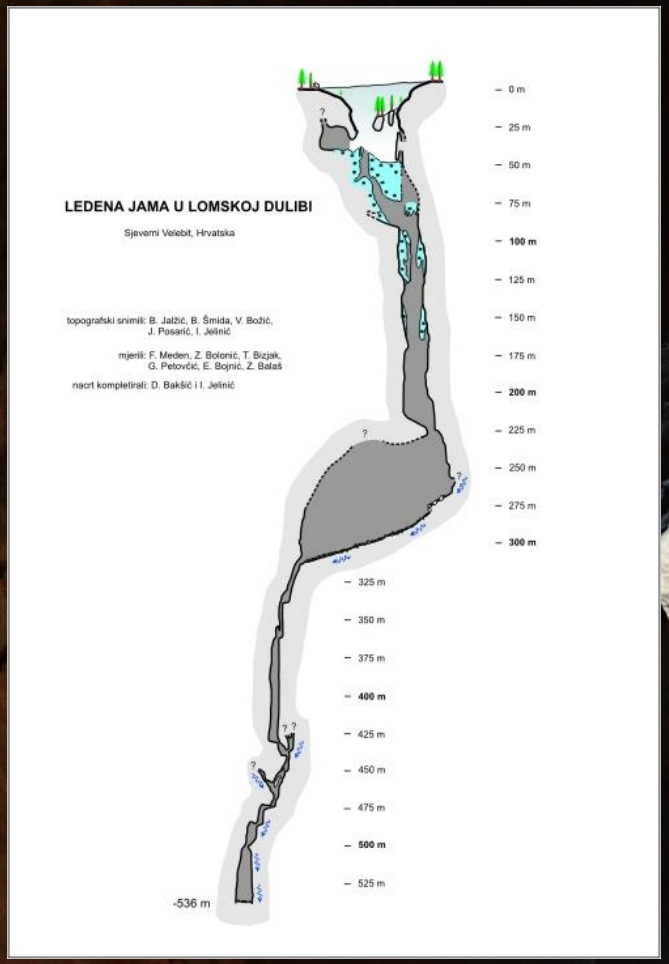
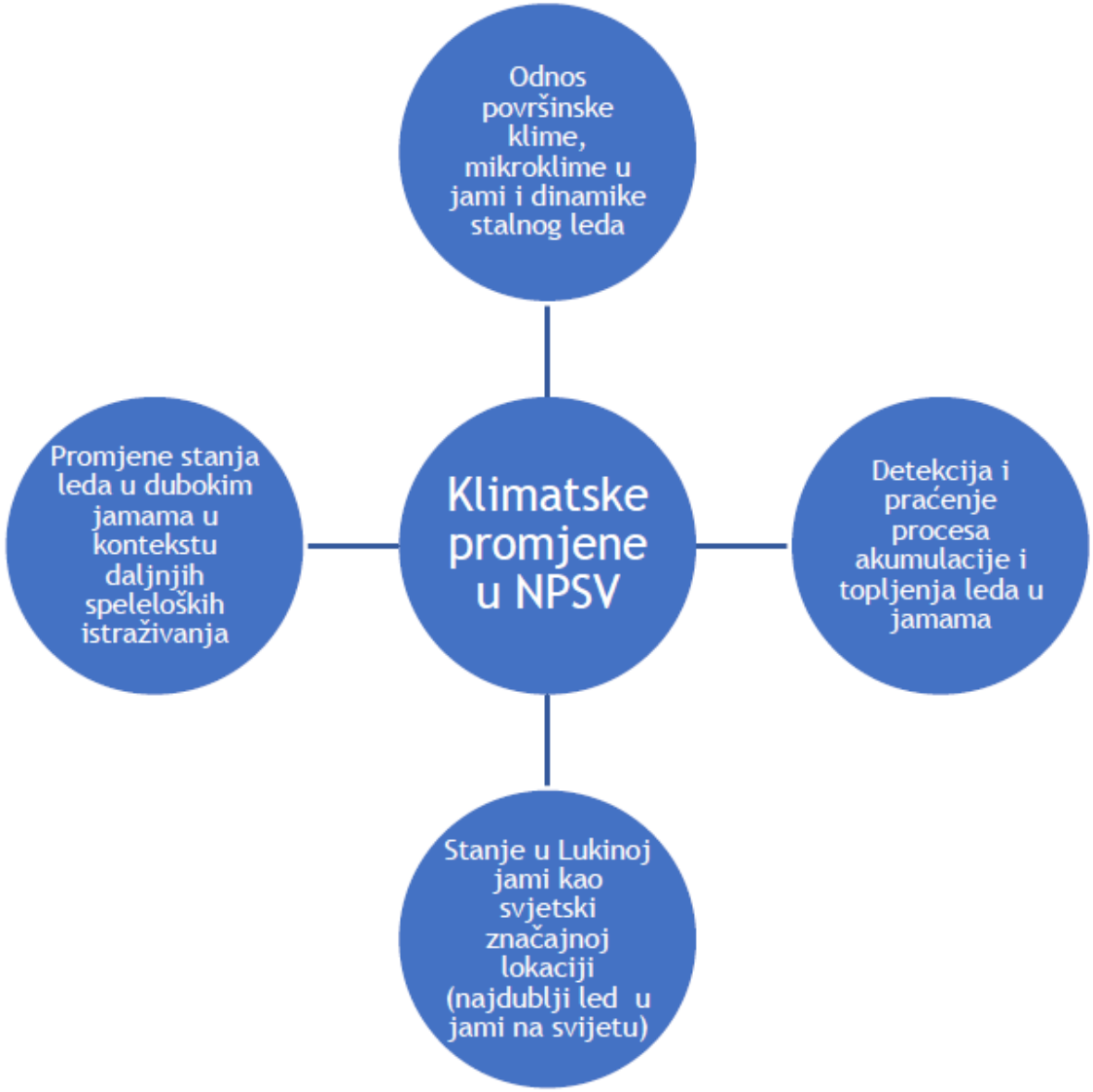


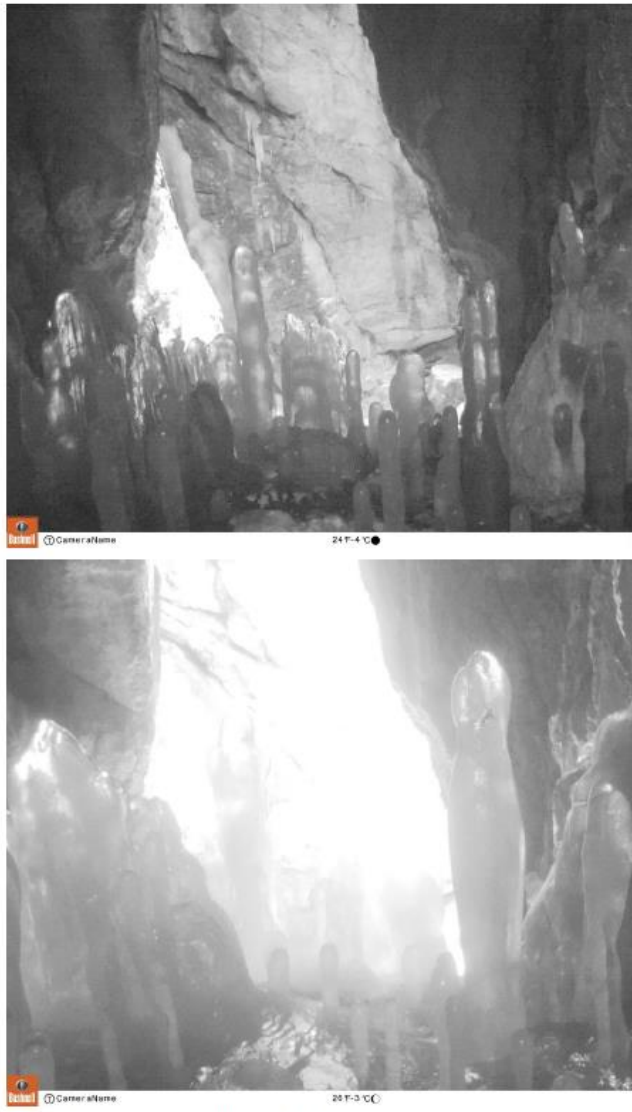
U Ledenoj jami u Lomskoj dulibi opaženo je povećanje količine leda 2021. godine


Jama Pozoj


PETZL

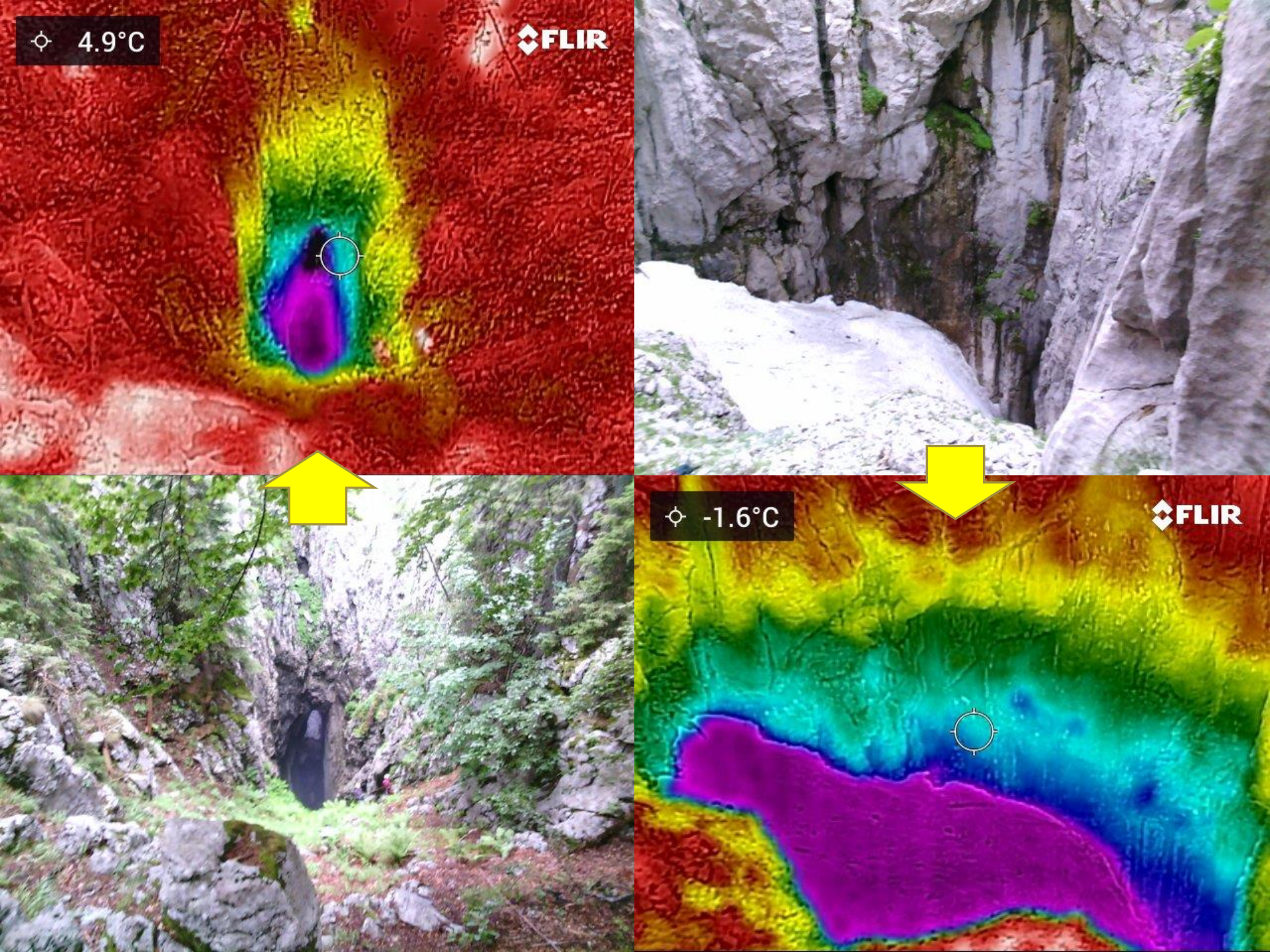


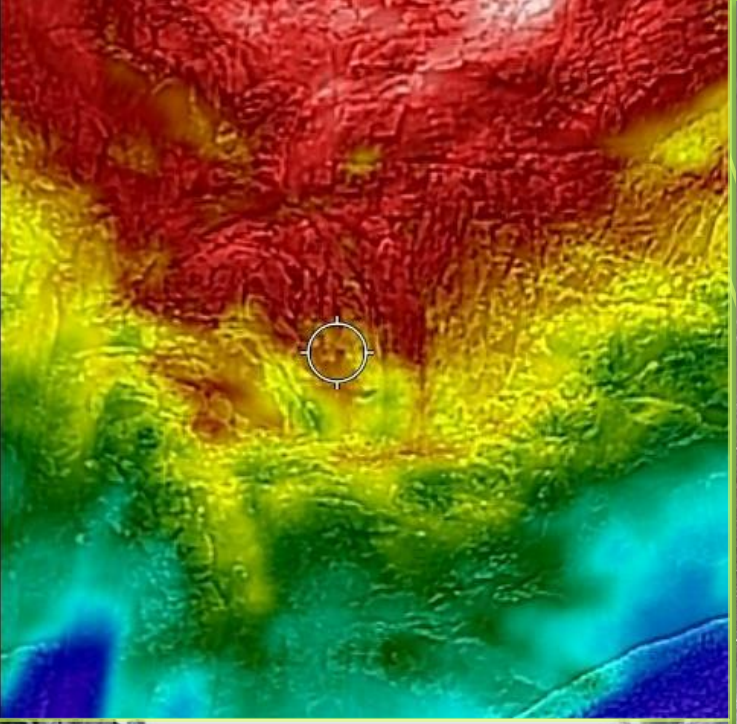
Slika 22 Ciljevi speleoloških i znanstvenih istraživanja u kontekstu klimatskih promjena.

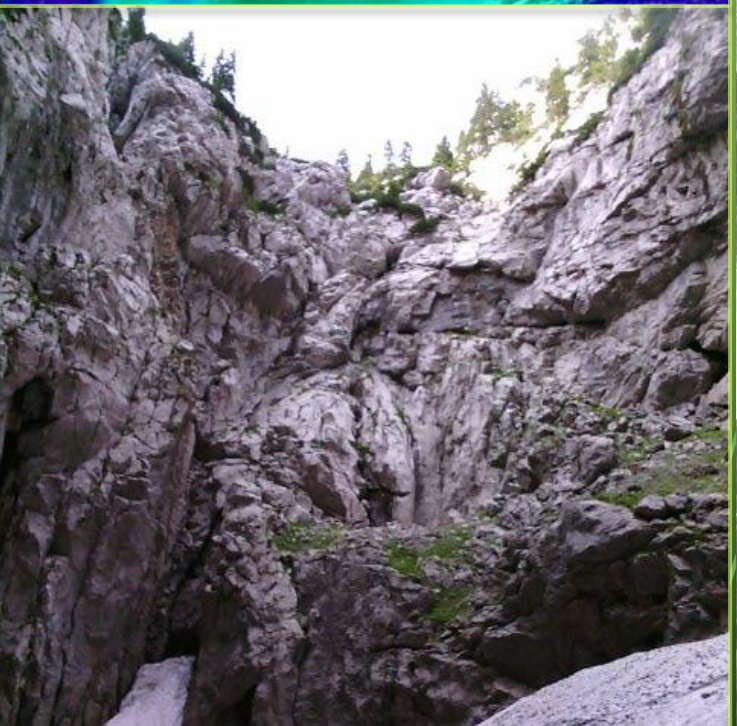


Slika 18 Ledene sige zabilježene stalno postavljenom kamerom u Ledenoj veljača 2019., dolje travanj 2019.)


25°C


4.9°C
FLIR
-1.6°C
FLIR






Bushnell
LED
19°F-7°C
01-10-2021 11:53:03

ZAKLJUČAK

- Duboke jame Sjevernog Velebita predstavljaju potencijal za klimatološka istraživanja
- Brojna pitanja i zanimljivost lokacija otvaraju mogućnosti razvoja edukativnih programa

PMF Centar za klimatološka istraživanja