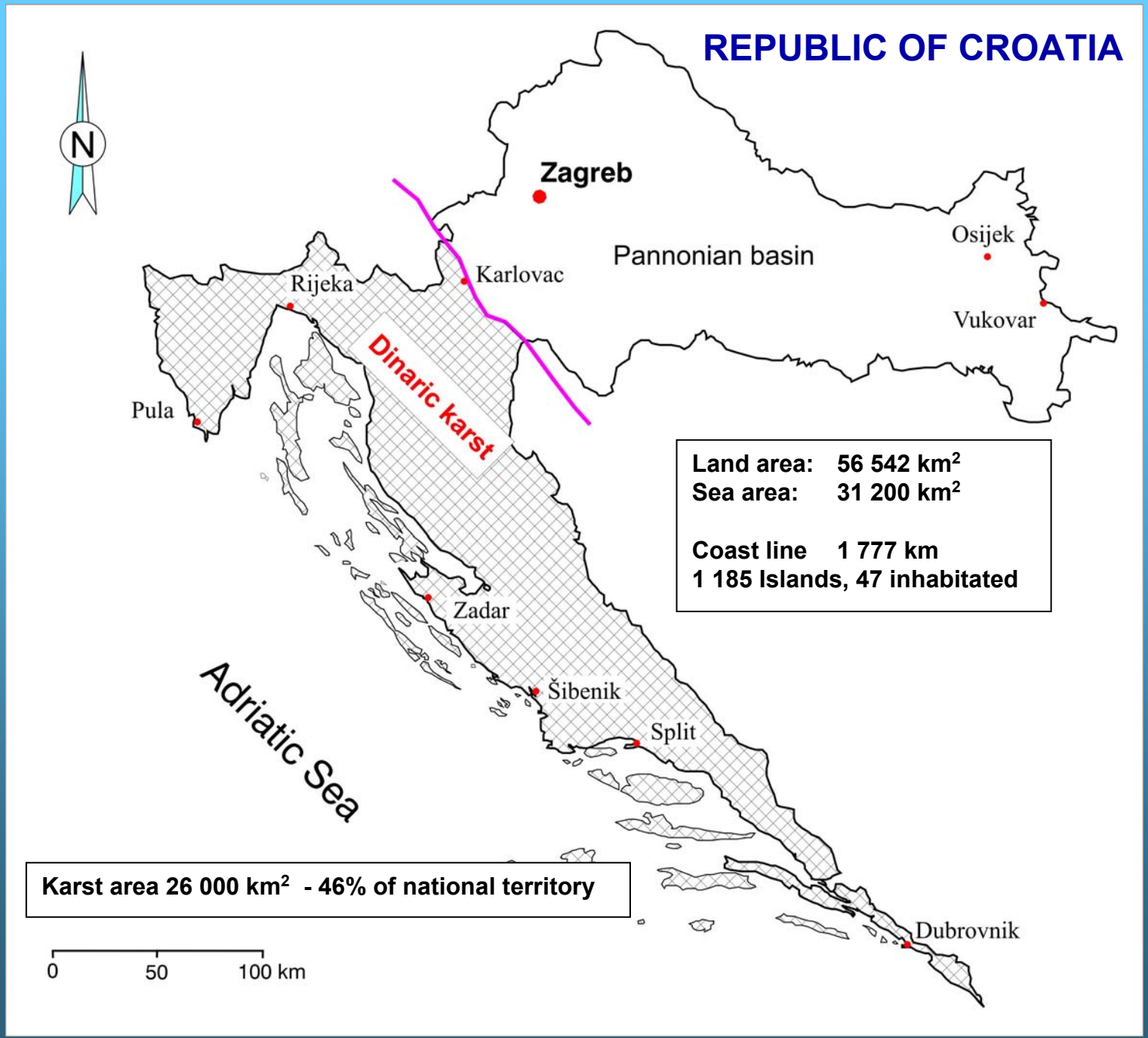
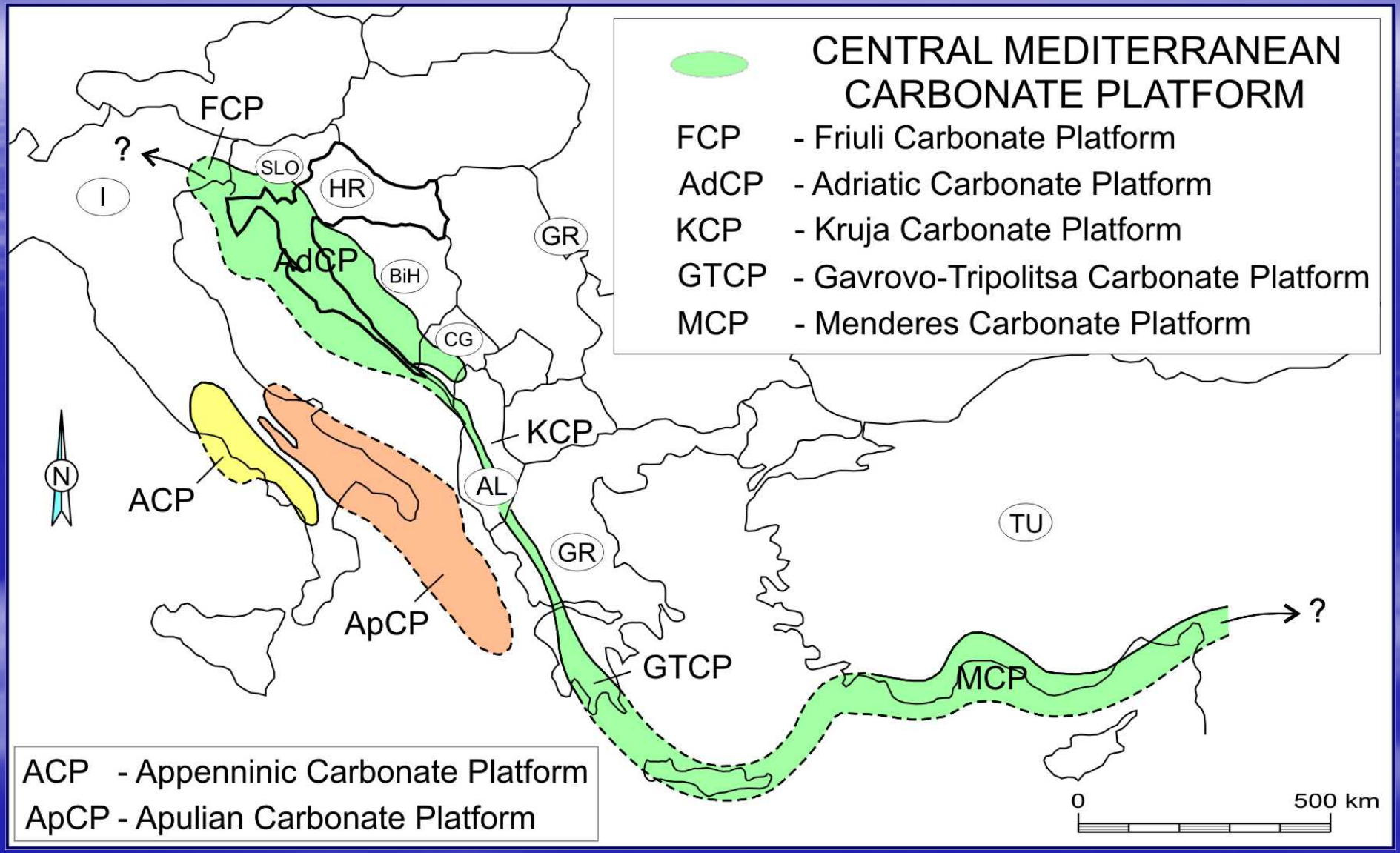
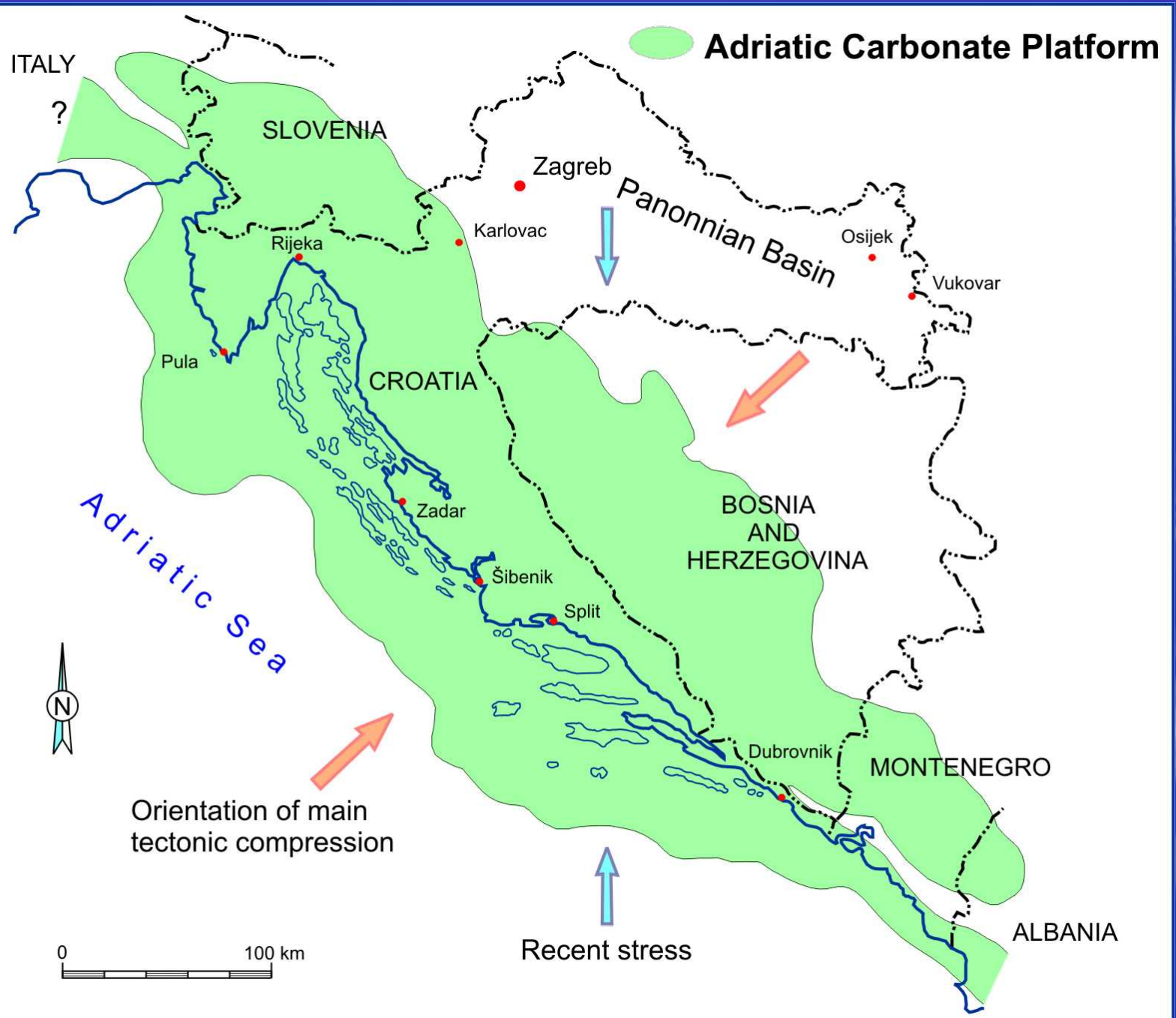
HYDROGEOLOGICAL FEATURES OF THE CROATIAN KARST AREA

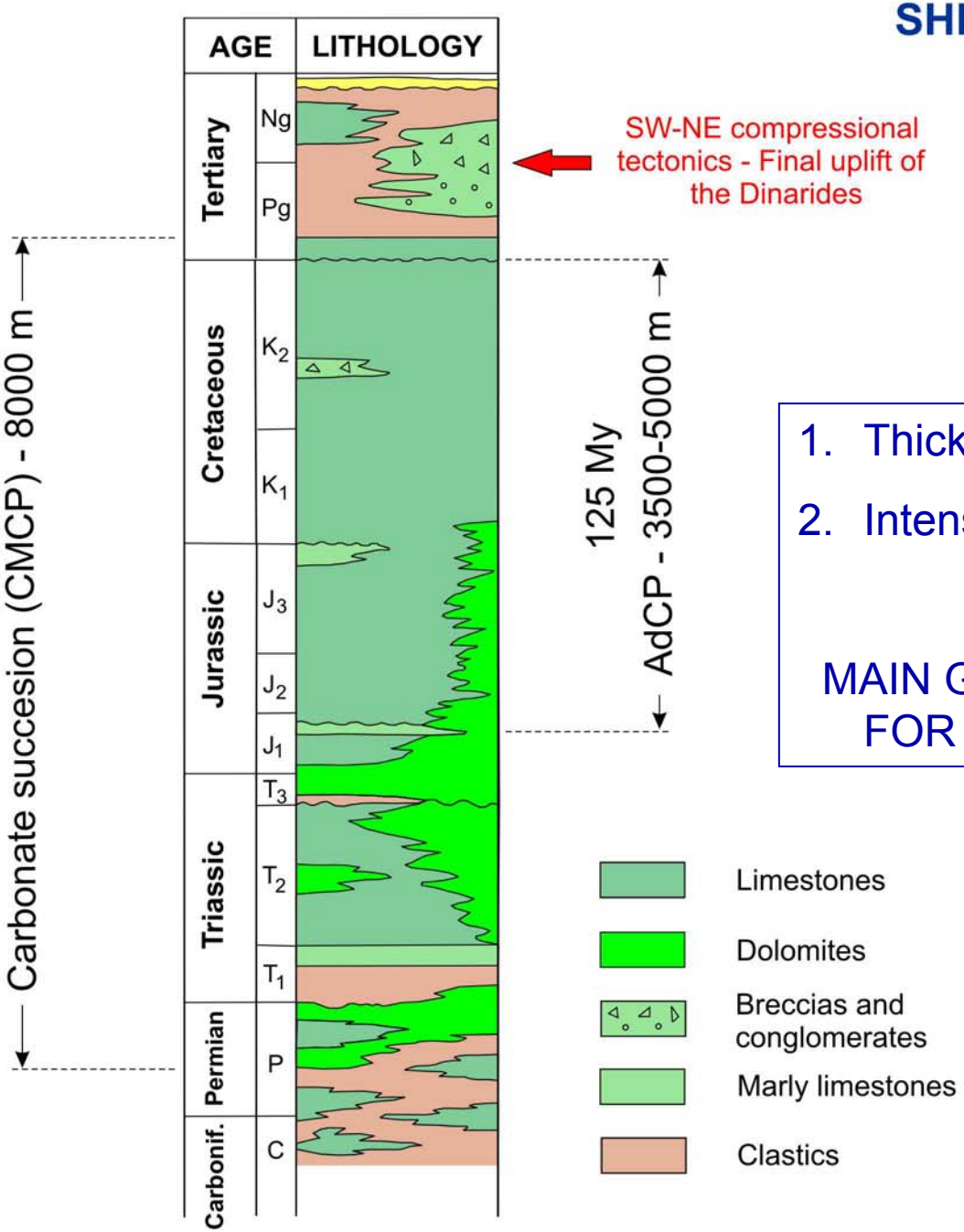
Mladen Kuhta & Tihomir Frangen
CROATIAN GEOLOGICAL SURVEY


REPUBLIC OF CROATIA
N
Zagreb
Pannonian basin
Osijek
Vukovar
Karlovac
Rijeka
Dinaric karst
Pula
Zadar
Šibenik
Split
Dubrovnik
Adriatic Sea
Land area: 56 542 km2
Sea area: 31 200 km2
Coast line 1 777 km
1 185 Islands, 47 inhabitated
Karst area 26 000 km2 - 46% of national territory
0
50
100 km


CENTRAL MEDITERRANEAN CARBONATE PLATFORM
FCP - Friuli Carbonate Platform
AdCP - Adriatic Carbonate Platform
KCP - Kruja Carbonate Platform
GTCP - Gavrovo-Tripolitsa Carbonate Platform
MCP - Menderes Carbonate Platform
FCP
?
SLO
HR
I
AdCP
BiH
GR
CG
KCP
AL
N
ACP
GR
TU
ApCP
GTCP
MCP
?
ACP - Appenninic Carbonate Platform
ApCP - Apulian Carbonate Platform
0
500 km


Adriatic Carbonate Platform
ITALY
?
SLOVENIA
Zagreb
Panonnian Basin
Karlovac
Rijeka
Osijek
Vukovar
Pula
CROATIA
Zadar
BOSNIA
AND
HERZEGOVINA
Adriatic Sea
Šibenik
Split
N
Dubrovnik
MONTENEGRO
Orientation of main
tectonic compression
ALBANIA
0
100 km
Recent stress

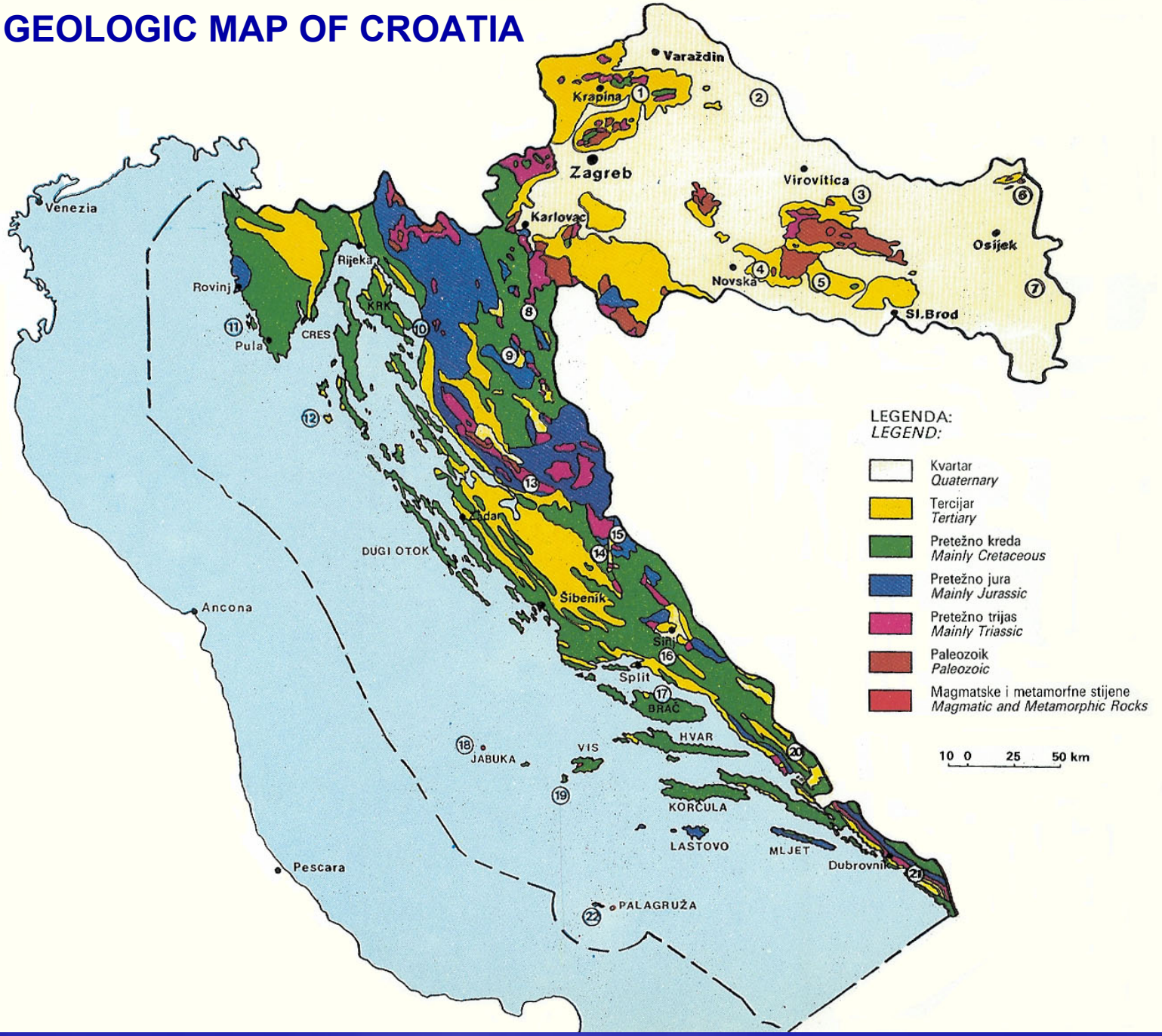
SHEMATIC GEOLOGICAL COLUMN of Karst Dinarides

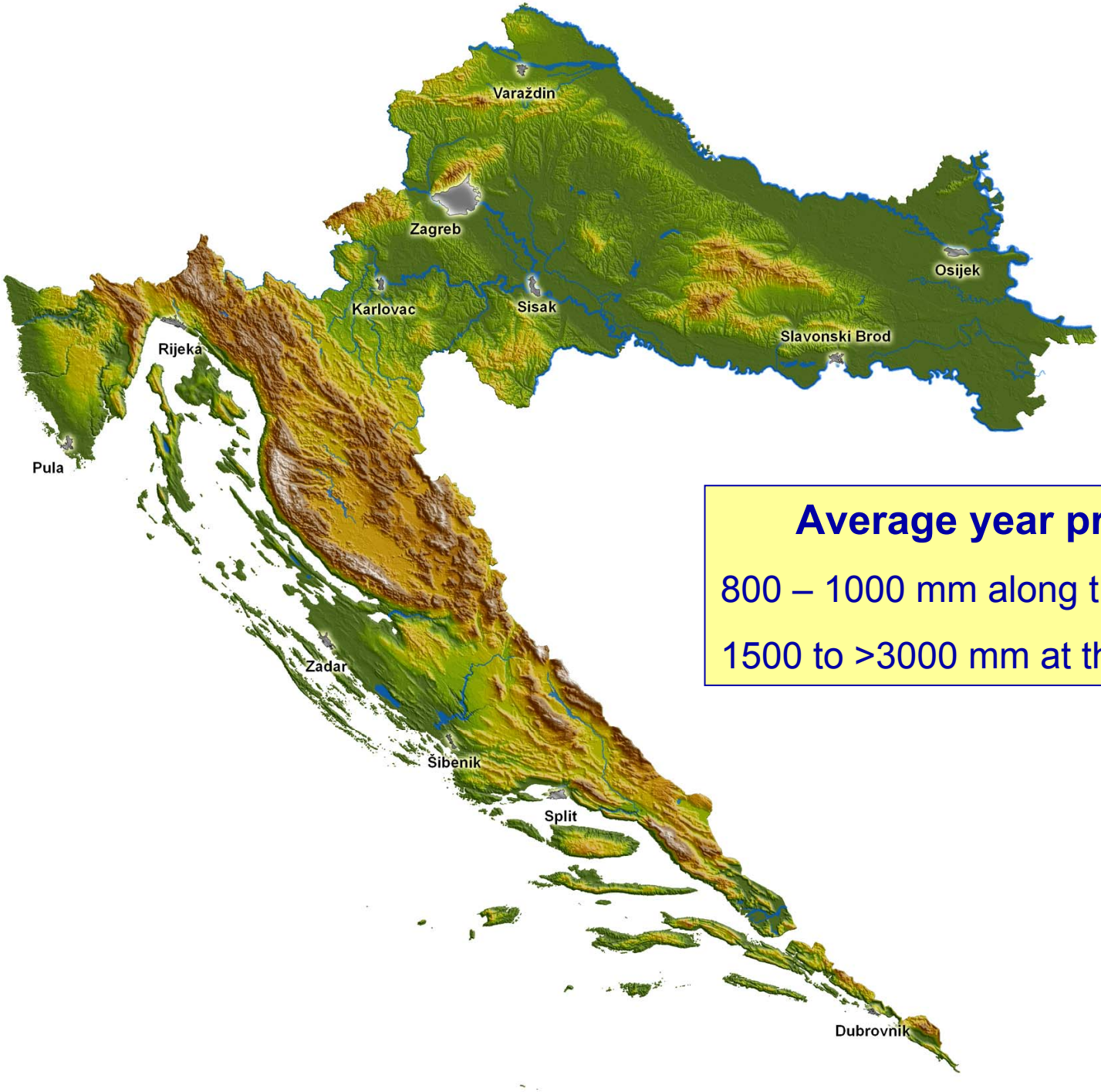


1. Thick carbonate deposits
2. Intense tectonic deformation

MAIN GEOLOGICAL CONDITIONS FOR DEEP KARSTIFICATION

GEOLOGIC MAP OF CROATIA

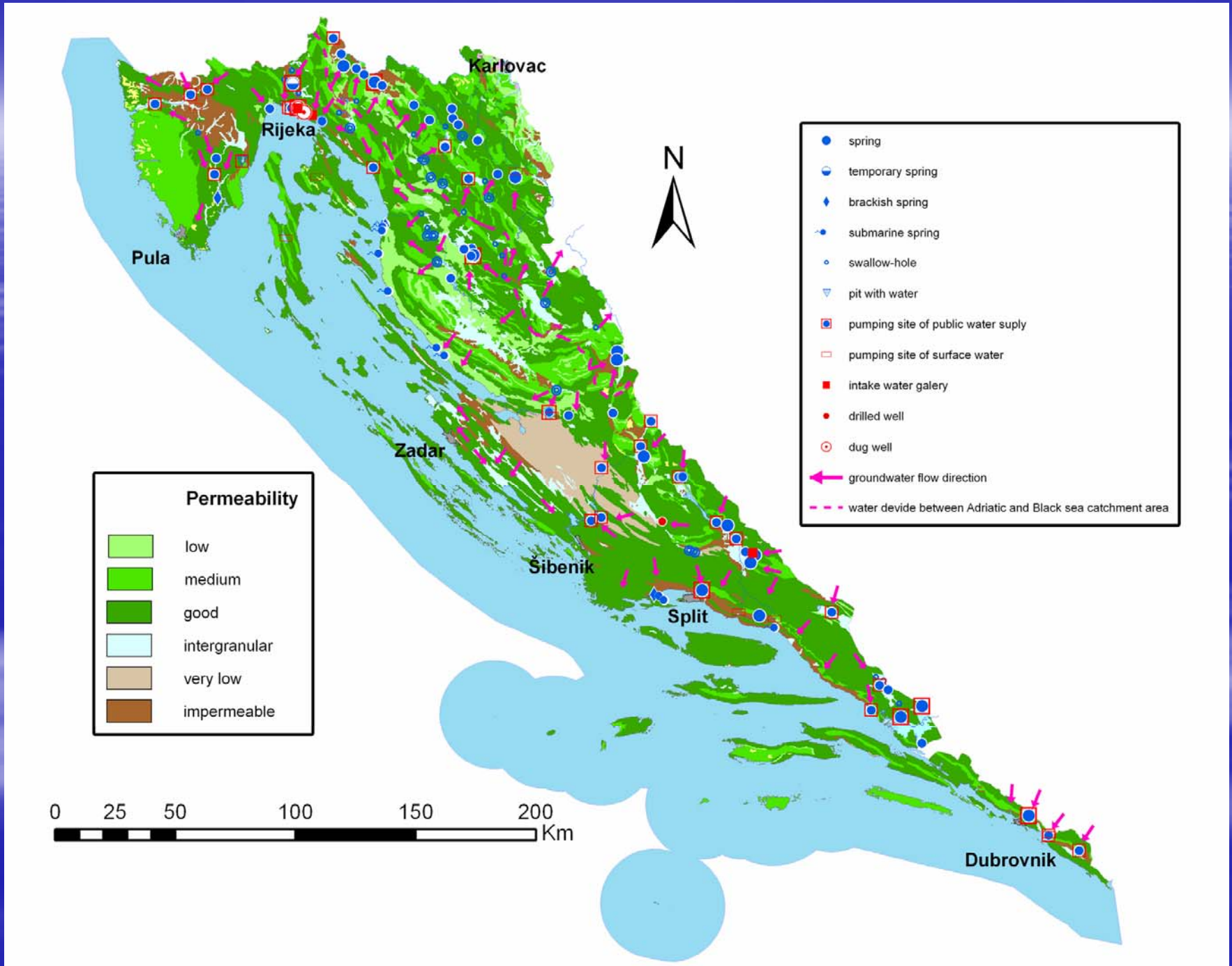




Average year precipitation:

800 – 1000 mm along the coast

1500 to >3000 mm at the mountain area


Karlovac
Rijeka
Pula
Zadar
Šibenik
Split
Dubrovnik
N
spring
temporary spring
brackish spring
submarine spring
swallow-hole
pit with water
pumping site of public water suply
pumping site of surface water
intake water galery
drilled well
dug well
groundwater flow direction
water devide between Adriatic and Black sea catchment area
Permeability
low
medium
good
intergranular
very low
impermeable
0
25
50
100
150
200
Km


KARREN

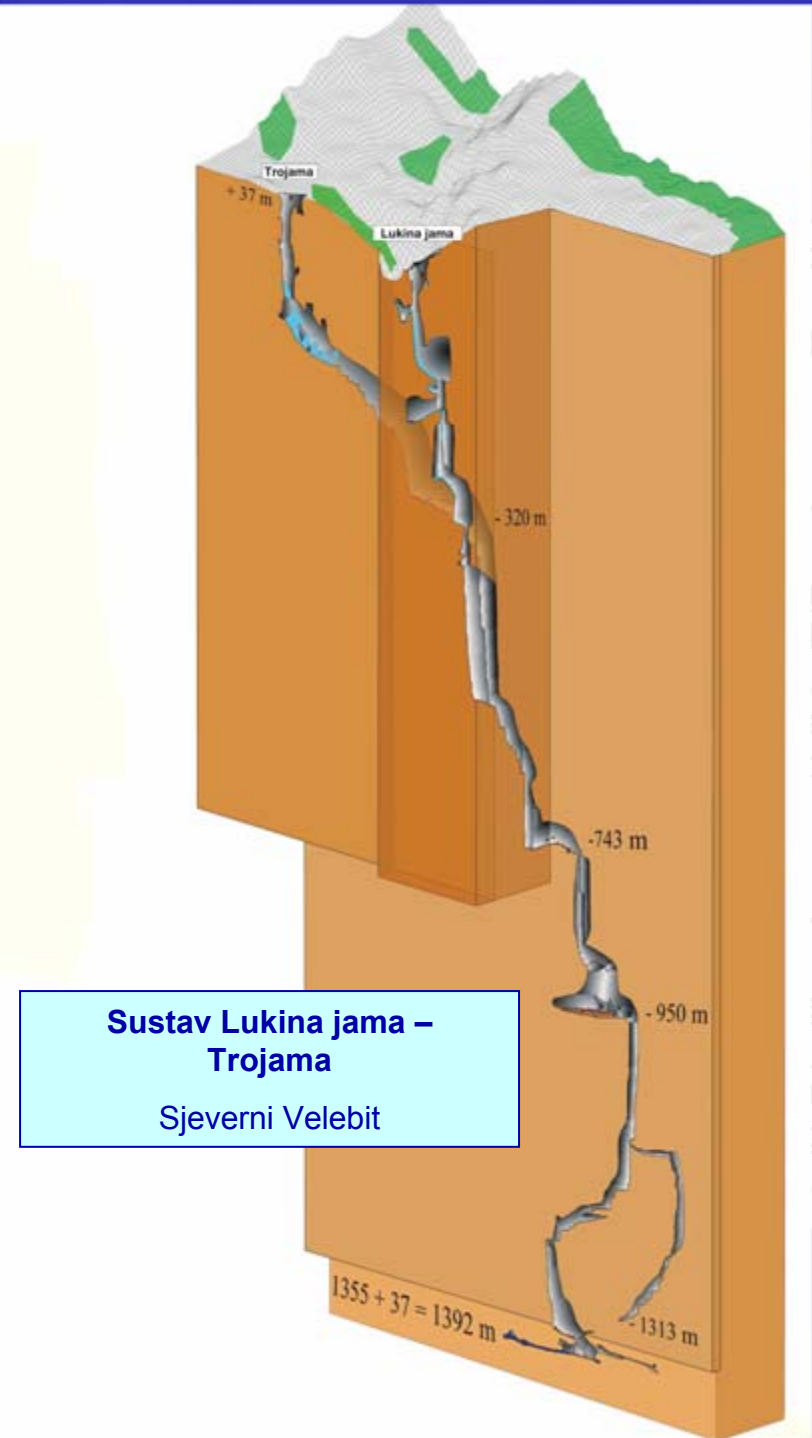

SOLUTION PAN


Large parts of karst cover the mountain area
(Mt. Dinara 1831 m a.s.l.)


In intensively karstified areas the dolinas density can be over 160 per km^2

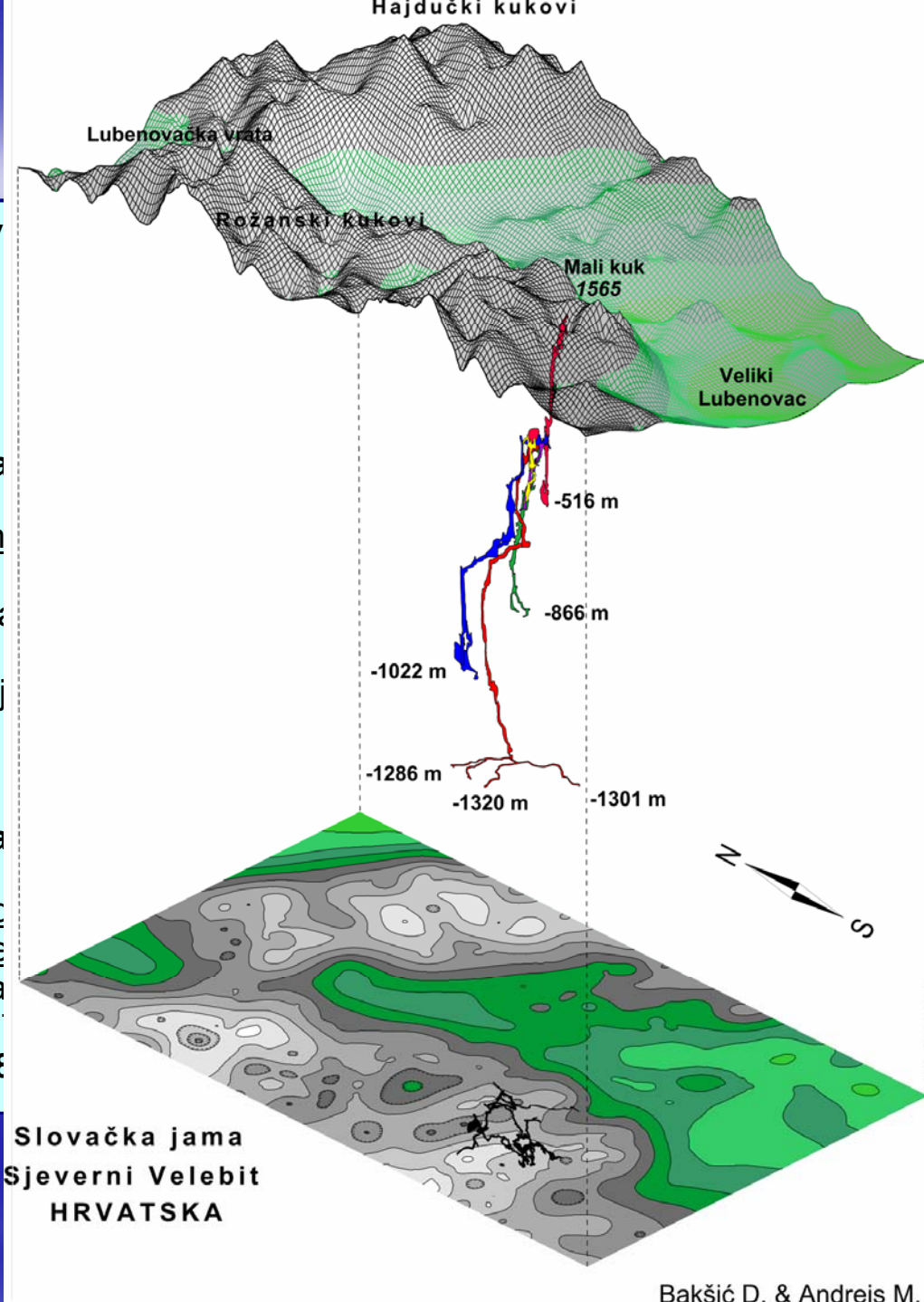

Blind valley


Karst Polje
Fourteen major Karst poljes - surface larger than 10 km2
The largest polje - Ličko polje - 465 km2



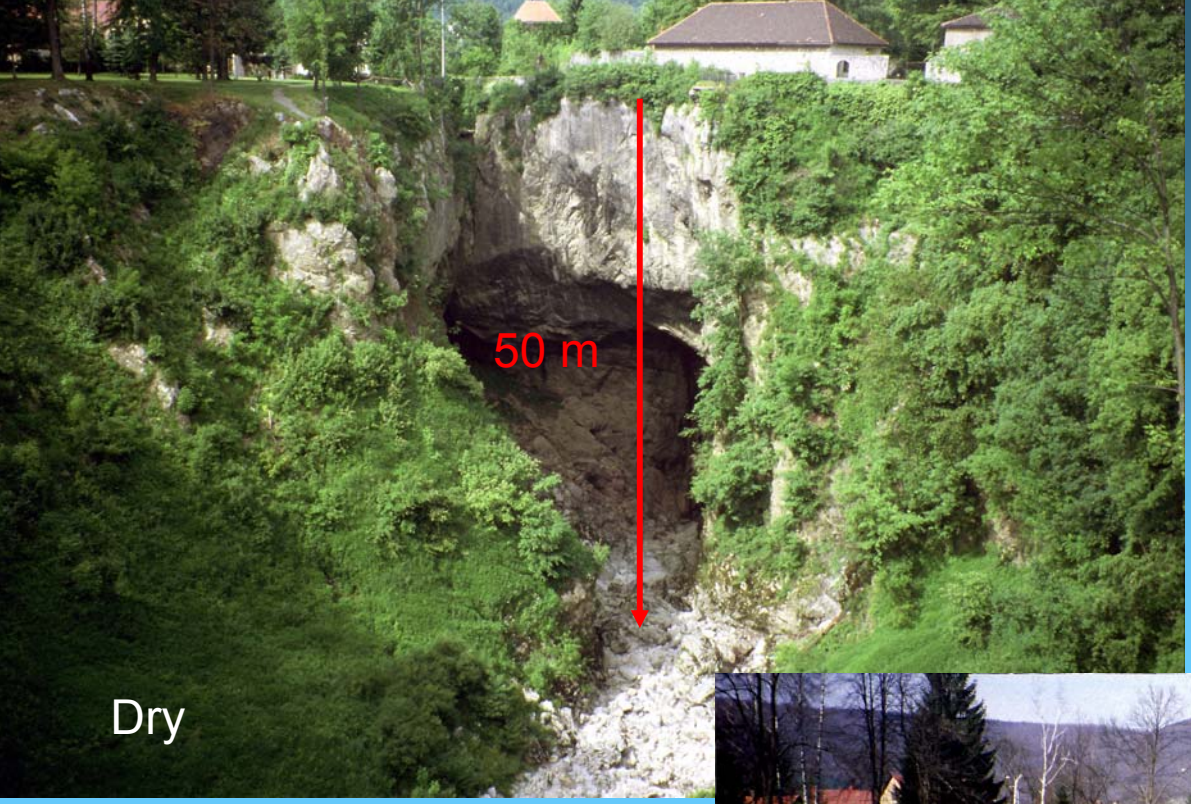
Sustav Lukina jama – Trojama

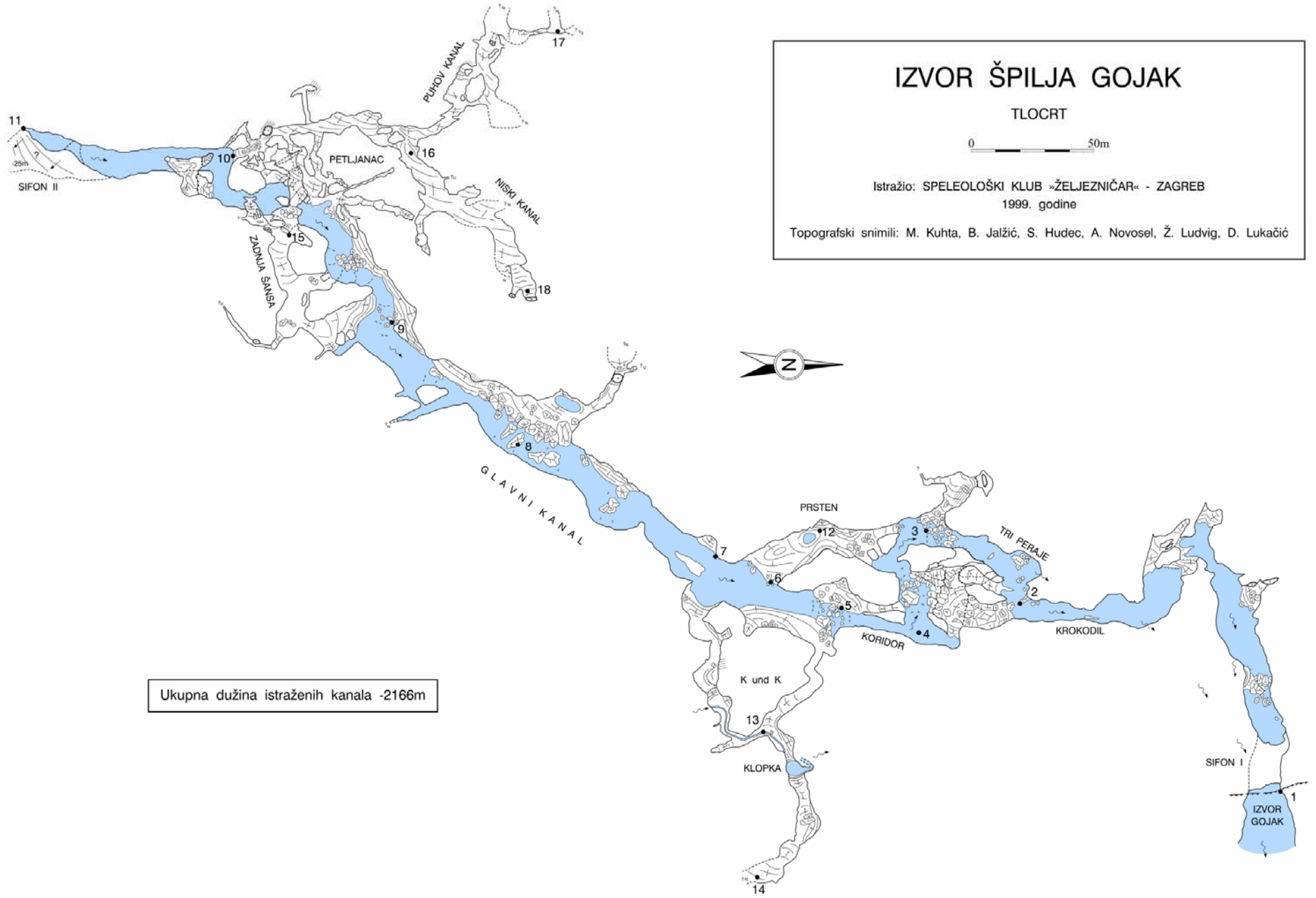
Sjeverni Velebit

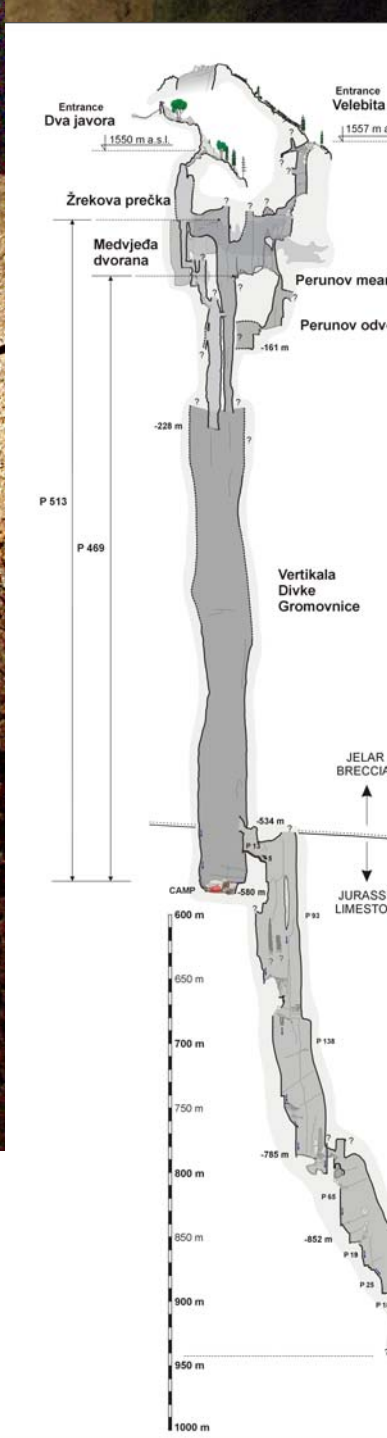


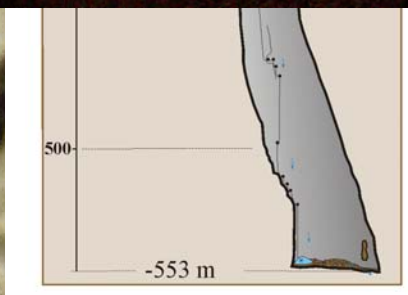
Bakšić D. & Andreis M.

Ponors – Swalow holes




IZVOR ŠPILJA GOJAK
TLOCRT
0
50m
Istražio: SPELEOLOŠKI KLUB »ŽELJEZNIČAR« - ZAGREB
1999. godine
Topografski snimili: M. Kuhta, B. Jalžić, S. Hudec, A. Novosel, Ž. Ludvig, D. Lukačić
Ukupna dužina istraženih kanala -2166m
SIFON II
-25m
PUHOV KANAL
PETLJANAC
NISKI KANAL
ZADNJA ŠANSA
GLAVNI KANAL
PRSTEN
TRI PERAJE
KORIDOR
KROKODIL
K und K
KLOPKA
SIFON I
IZVOR GOJAK
11
10
17
16
15
18
9
8
7
12
3
6
5
2
4
13
14
1
Z

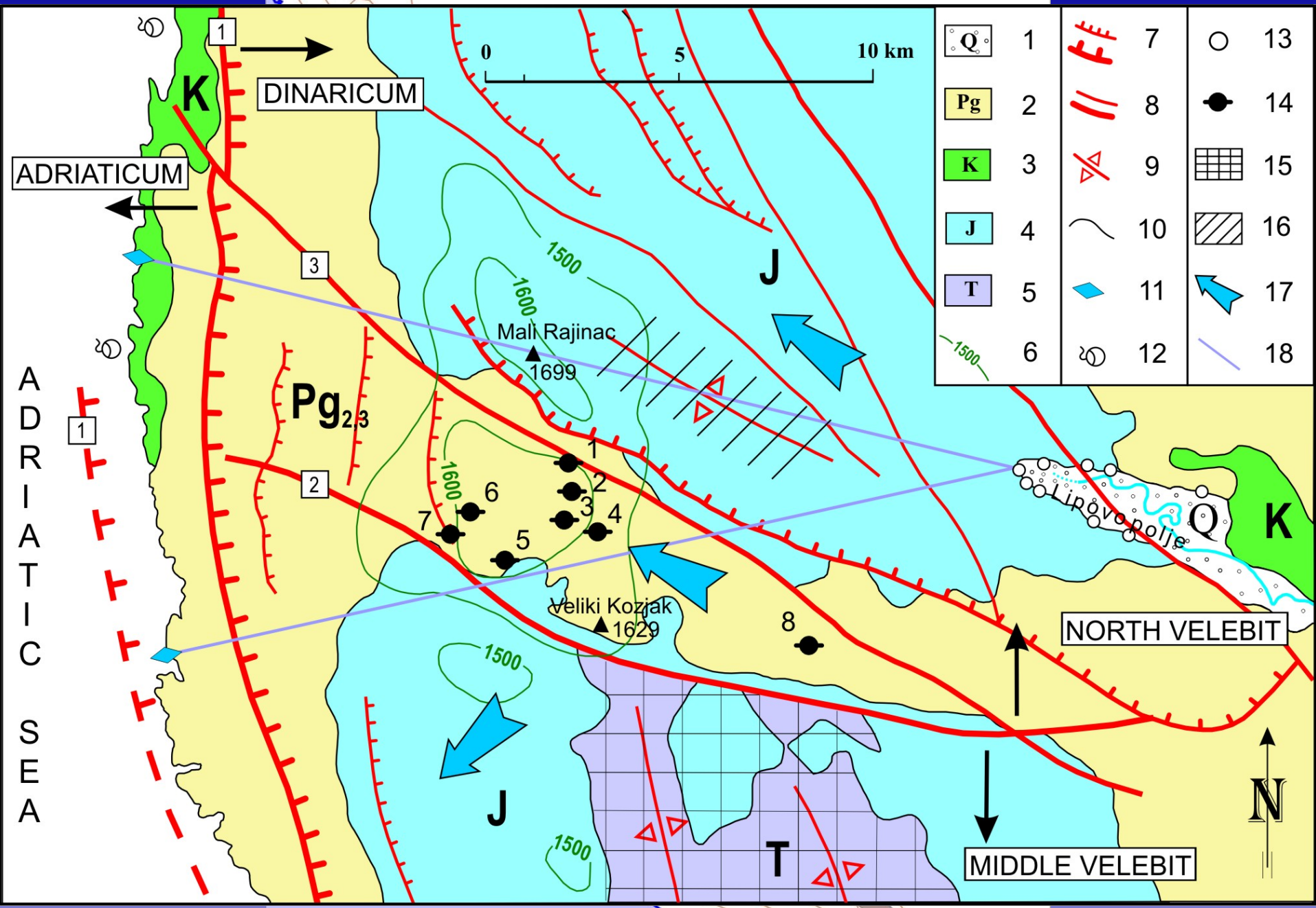




Depth: -941 m
Length: 614 m
Poligon length: 2020 m


Caves mostly dry – 1850 caves with water (periodically or permanently)


KARST AREA
Adriatic-Black Sea Waterdivide
Adriatic Sea Watershed
+ Island Aquifers
Represents the wider area of
Coastal Aquifers
of about 21.000 km2
Black Sea Watershed
Area of about 6.000 km2
25 Main Catchment Areas
(River Basin Districts - WFD)
Karlovac
Rijeka
Pula
Zadar
Šibenik
Split
Dubrovnik
Adriatic Sea
N
0
50
100 km

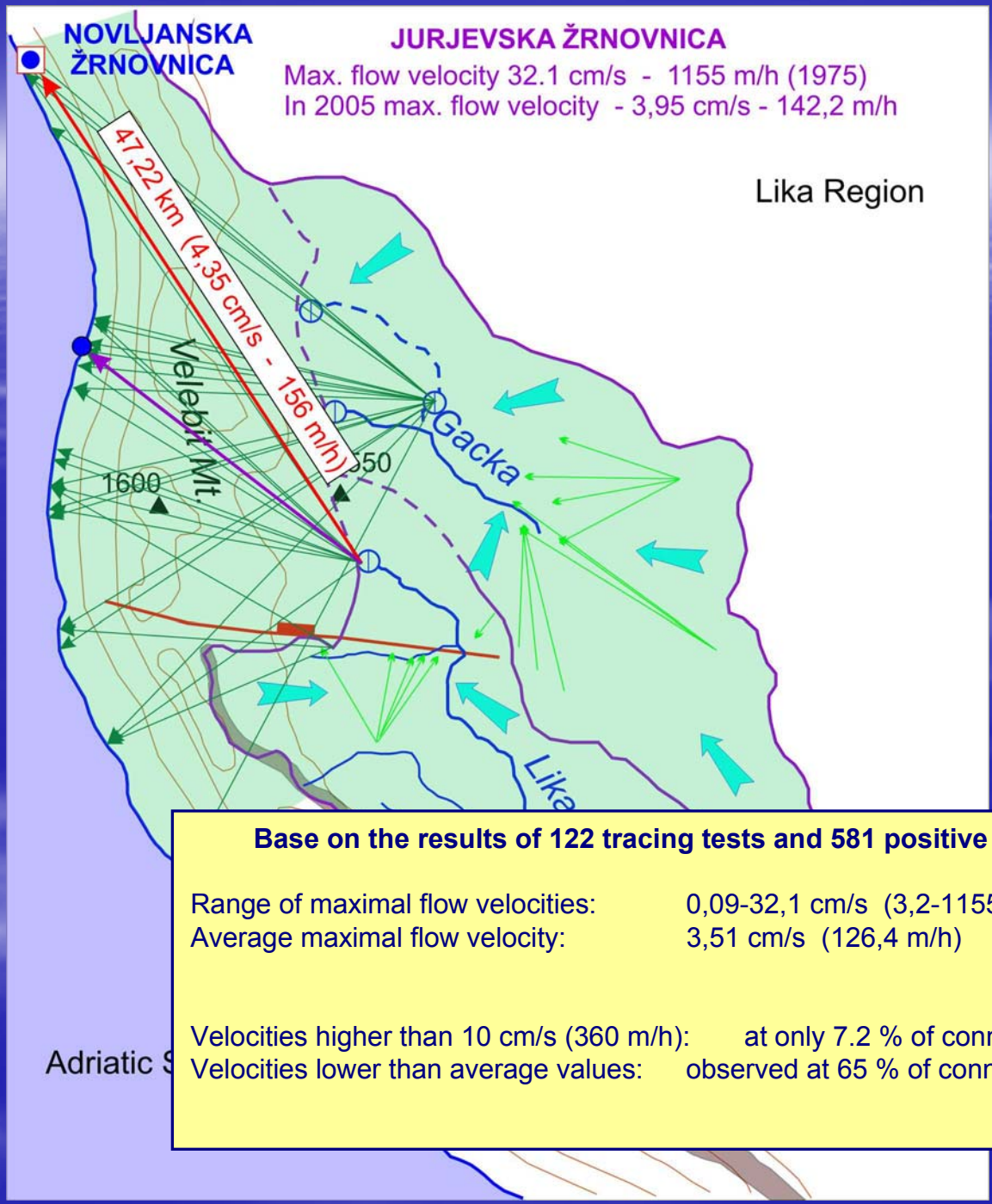

0
5
10 km
Q 1
Pg 2
K 3
J 4
T 5
1500 6
7
8
9
10
11
12
13
14
15
16
17
18
DINARICUM
ADRIATICUM
K
J
T
Pg2,3
Mali Rajinac
1699
Veliki Kozjak
1629
1500
1600
Lipovo polje
Q
NORTH VELEBIT
MIDDLE VELEBIT
N
ADRIATIC SEA
1
2
3
4
5
6
7
8


Lika Region
BIKINA JAMA
Velebit Mt.
1600
550
Gacka
MARKOV PONOR
Lika River
Adriatic Sea


MARKOV PONOR

OR – PONOR OF THE LOST RIVER LIKA

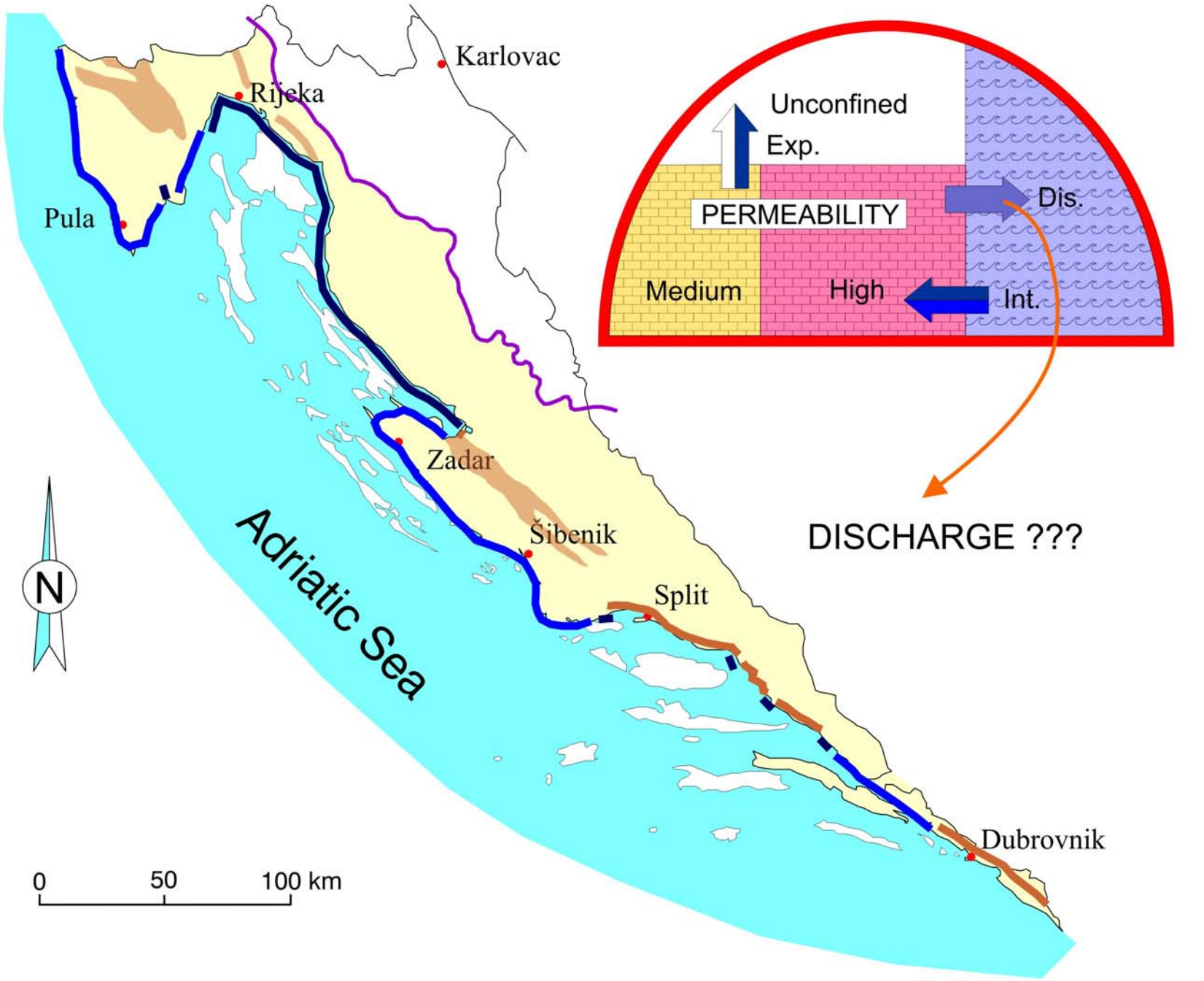
BIKINA JAMA – PONOR OF THE LOST RIVER GACKA



Base on the results of 122 tracing tests and 581 positive connections

Range of maximal flow velocities: 0,09-32,1 cm/s (3,2-1155,6 m/h)
Average maximal flow velocity: 3,51 cm/s (126,4 m/h)

Velocities higher than 10 cm/s (360 m/h): at only 7.2 % of connections
Velocities lower than average values: observed at 65 % of connections


Karlovac
Rijeka
Pula
Zadar
Šibenik
Split
Dubrovnik
Adriatic Sea
N
0
50
100 km
Unconfined
Exp.
PERMEABILITY
Dis.
Medium
High
Int.
DISCHARGE ???

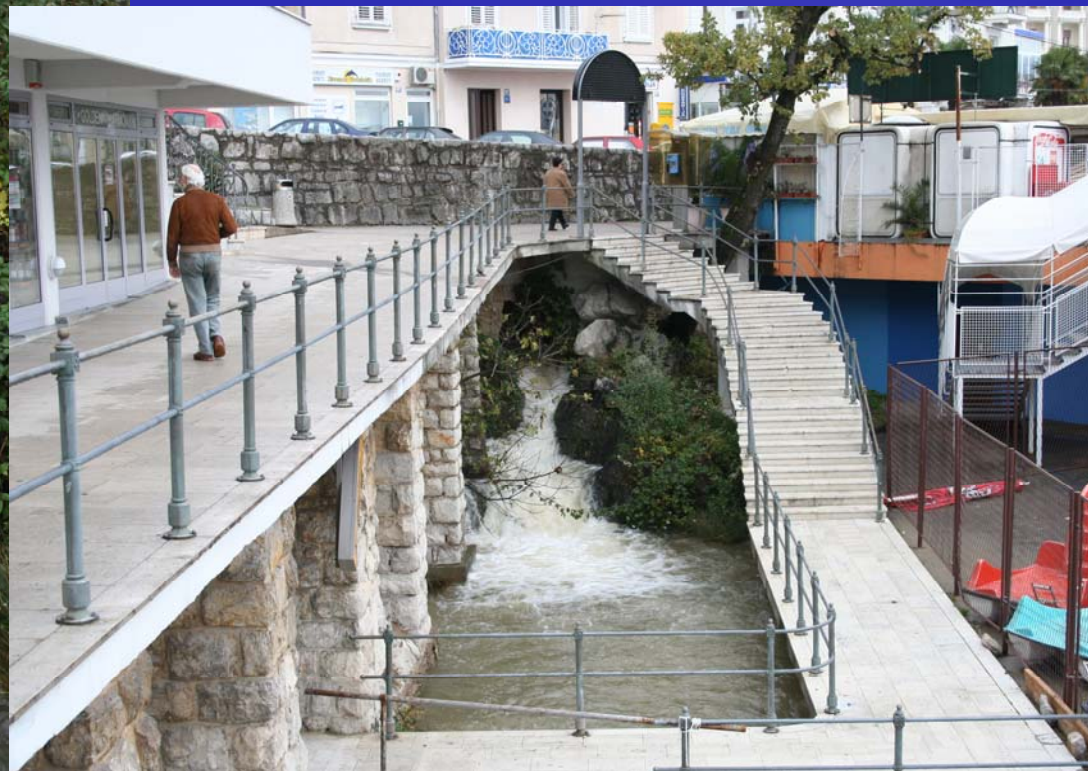
VRULJA ZEČICA

VRULJA IKA


UVALA MUROSKA


ADMIRAL SPRING

SLATINA SPRING



KRISTAL SPRING


UNA SPRING


RJEČINA SPRING

IZVOR ZVIR

M 1: 200

0 10 20 m

Top. snimili: Jalžić B., Lukačić D., Kuhta M., Novosel A.

Institut za geološka istraživanja, SK Željezničar, 28. lipnja 2000.

Digitalna obrada: Novosel A.

Tlocrt

N

LEGENDA

Profil

ZVIR SPRING


OMBLA SPRING

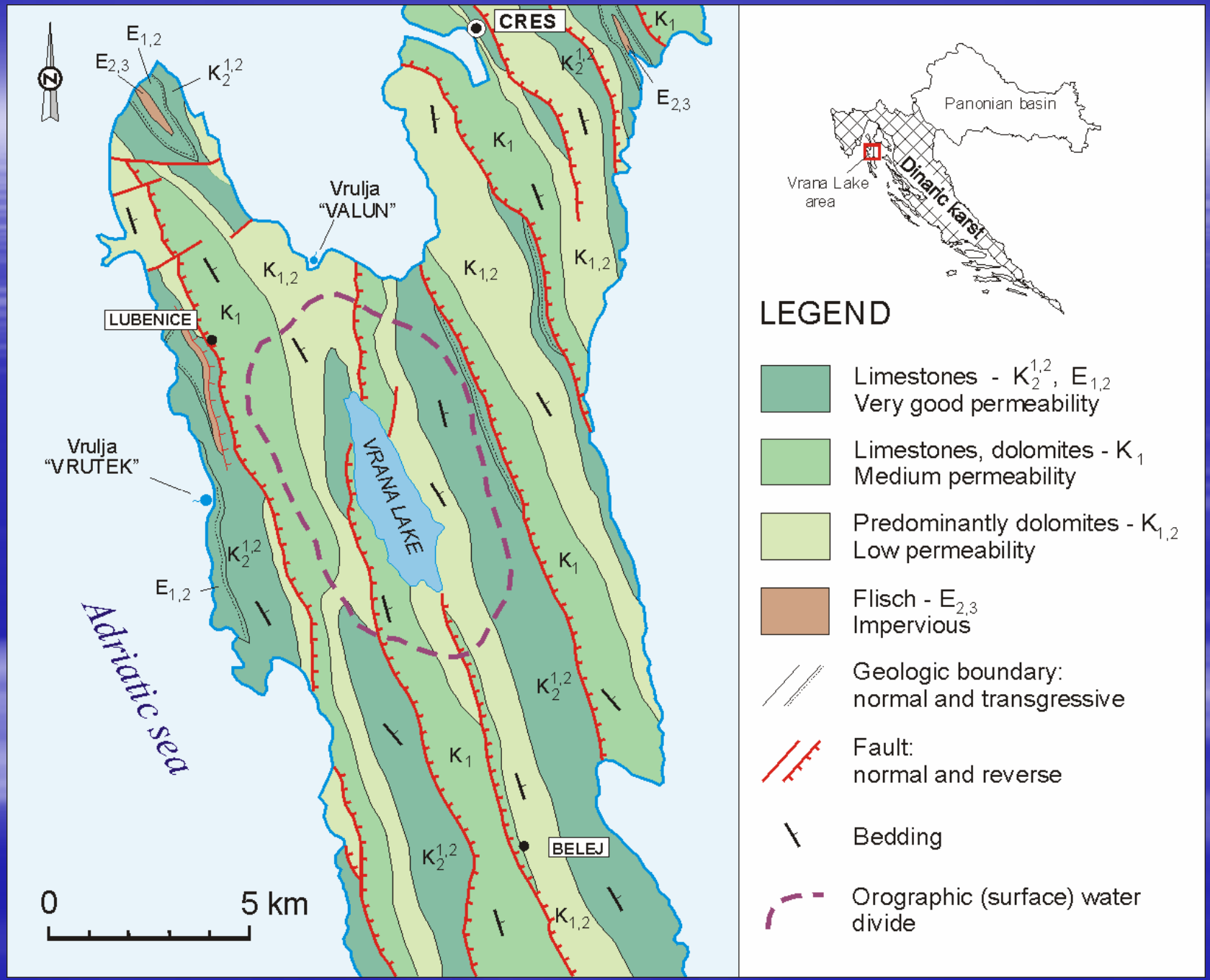

$Q_{min.}$ = 3.0 m^3/s
$Q_{max.}$ = 138 (160) m^3/s
$Q_{ave.}$ = 24.4 m^3/s
Catchment area: 600 km^2

CRVENO JEZERO – RED LAKE

250 m

282 m

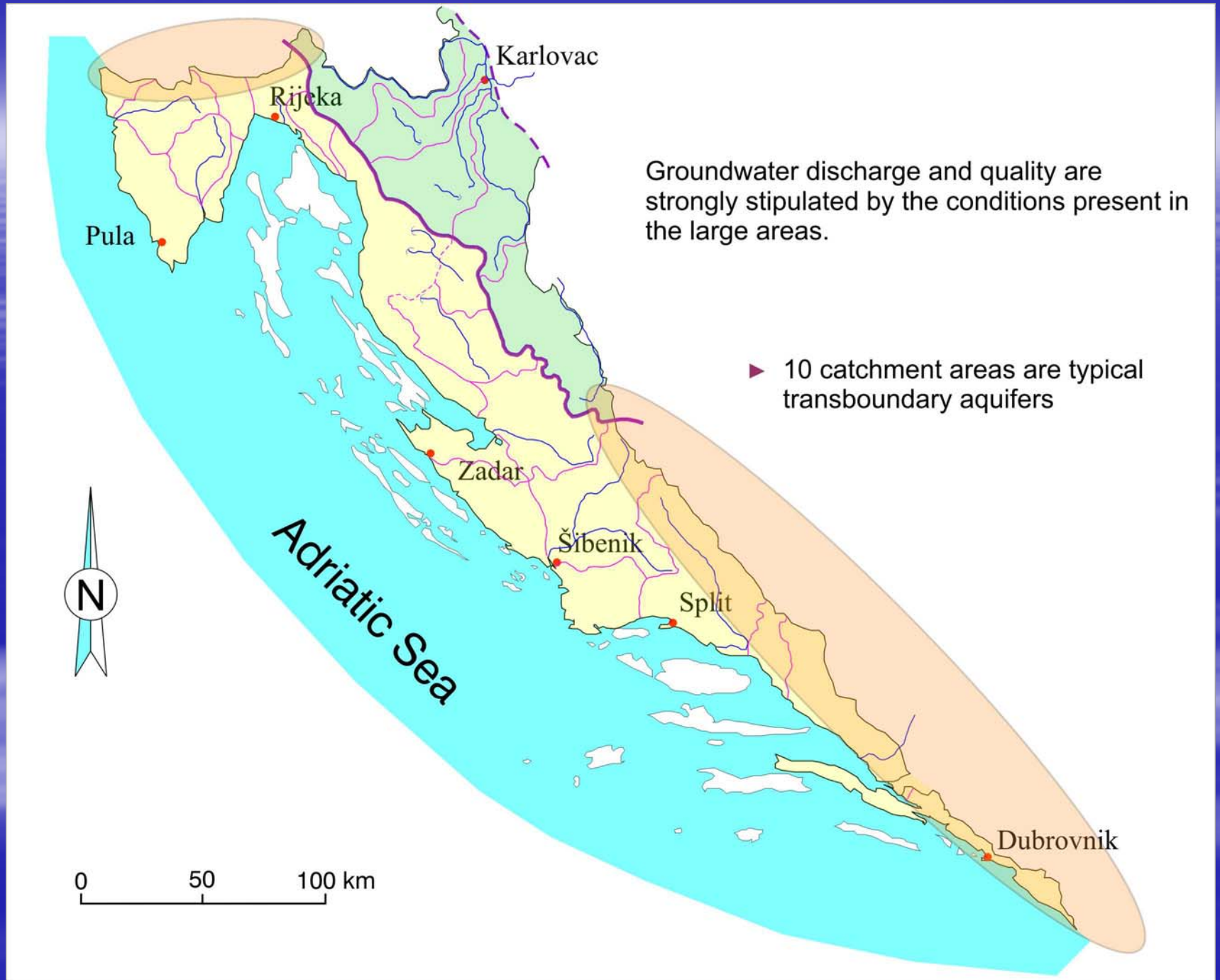
-532 m


CRES
LUBENICE
Vrulja "VALUN"
Vrulja "VRUTEK"
VRANA LAKE
BELEJ
Adriatic sea
0
5 km
Panonian basin
Dinaric karst
Vrana Lake area
LEGEND
Limestones - $K_2^{1,2}$, $E_{1,2}$
Very good permeability
Limestones, dolomites - K_1
Medium permeability
Predominantly dolomites - $K_{1,2}$
Low permeability
Flisch - $E_{2,3}$
Impervious
Geologic boundary:
normal and transgressive
Fault:
normal and reverse
Bedding
Orographic (surface) water divide

VRANA LAKE ON CRES ISLAND

Vrana Lake on Cres Island stores 220 million m3 of fresh water of excellent quality.

The maximum depth of the lake is 72 m (60 m below the sea level).



Groundwater discharge and quality are strongly stipulated by the conditions present in the large areas.

- 10 catchment areas are typical transboundary aquifers

THANK YOU FOR ATTENTION