



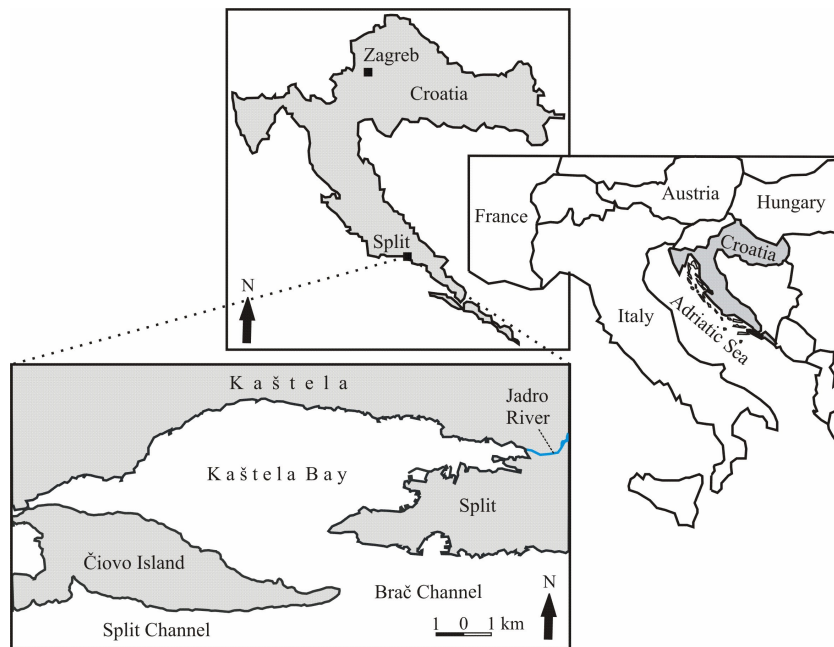
^{238}U in sediments of the Kastela Bay, Adriatic Sea (Croatia)

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WHY KASTEBA BAY?



Geographical location of the Kastela Bay

- the biggest urban agglomeration on the east Adriatic coast
- assumed discharge of the TENORM
 - by-product of the coal burning
 - former “Adriavinil” factory
- radionuclides very poorly researched

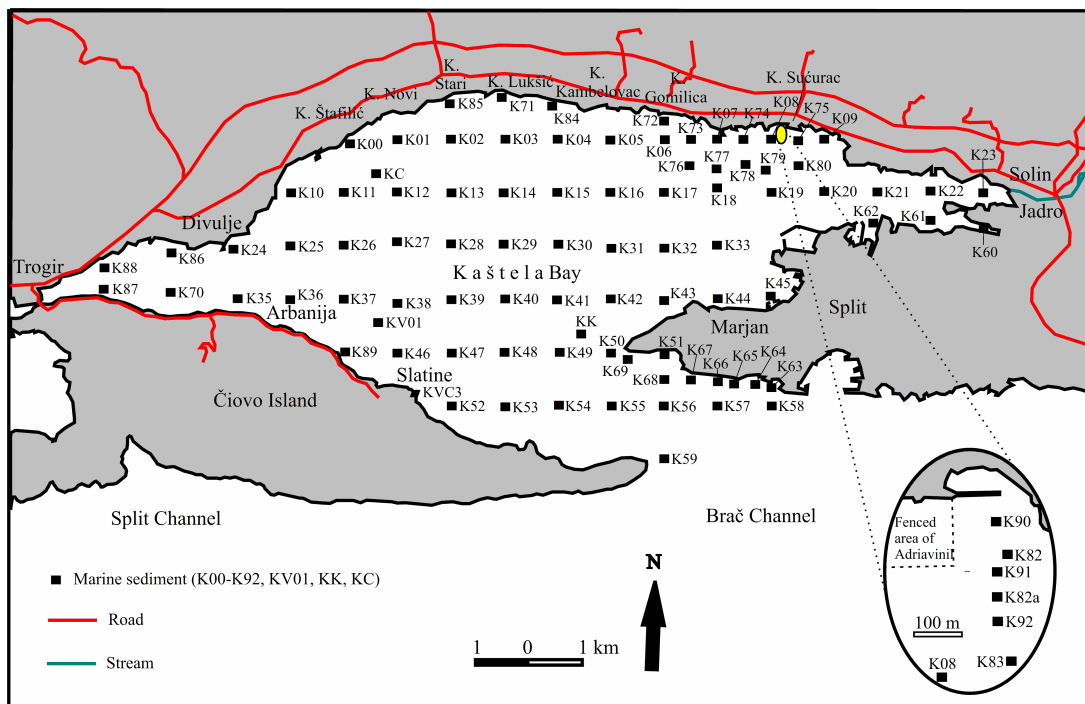


PURPOSE OF THE WORK

- to study a spatial distribution of ^{238}U in the sediment of the Bay
 - horizontal and vertical distribution
 - to a 50 cm depth
- to research a connection between potential ^{238}U sources and its distribution
- to assess anthropogenic influence on the sediments
- to assess the condition of the environment

SAMPLING AND ANALYSING

- sampling: June 2005 – May 2008
- 95 stations, 604 samples



Sampling map of the Kastela Bay sediments

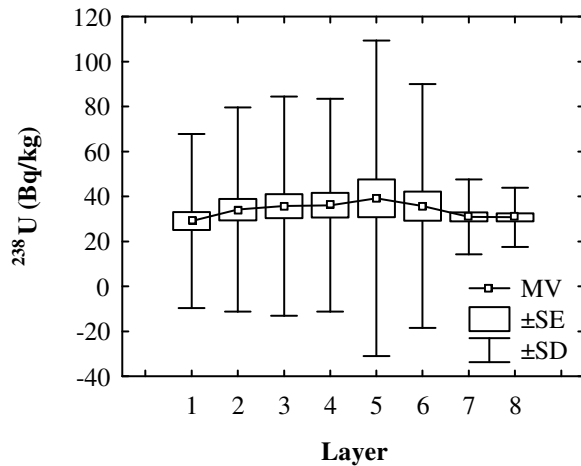
- regular grid 1 × 1 km across the whole Bay
- 500 × 500 m around the “Adriavinil” factory
- a profile next to the factory
- segmenting – 8 segments in a 50 cm sediment core
- gamma-spectrometry – ^{238}U (^{234}Th)

²³⁸U DISTRIBUTION IN SEDIMENTS

Summarized basic statistical parameters of ²³⁸U massic activities in Kastela Bay sediments in eight layers to a 50 cm depth; \bar{x} – mean value; N – number of results, SD – standard deviation

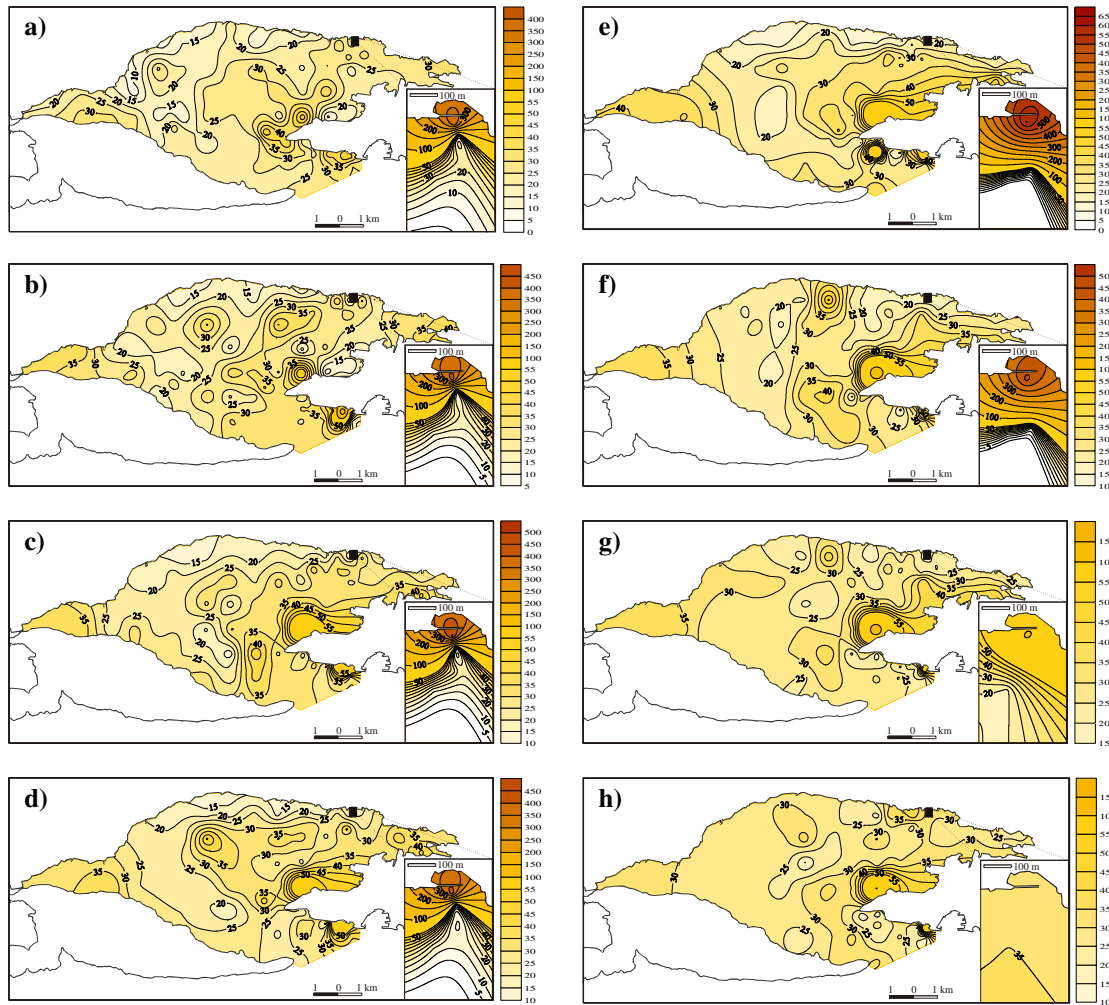
Layer (Depth)	Statistical parameter	²³⁸ U (Bq/kg)
1 - 8 (0 - 50 cm)	\bar{x}	34
	N	604
	SD	46
	Minimum	6.7
	Maximum	603
	Median	28

- wide activity range
 - minimum – layers 2 and 8 (5 – 10 cm and 40 – 50 cm depth)
 - maximum – layer 5 (20 – 25 cm depth)
- massic activities are mostly typical for marine sediments
 - other authors: 8.6 – 49.4 Bq/kg
- some locally elevated activities (“outliers”)



Box & whisker plot of ^{238}U massic activities in Kastela Bay sediments in eight layers to a 50 cm depth; MV – mean value, SE – standard error of the mean value, SD – standard deviation

- mean values almost constant or with a weak trend
- irregular standard deviation ranges → disturbed process stability
- two groups of layers
 - layers 1 – 6
 - wide standard deviation ranges
 - unhomogeneous sediment
 - probable anthropogenic material
 - layers 7 and 8
 - narrow standard deviation ranges
 - homogeneous sediment
 - natural origin of the material



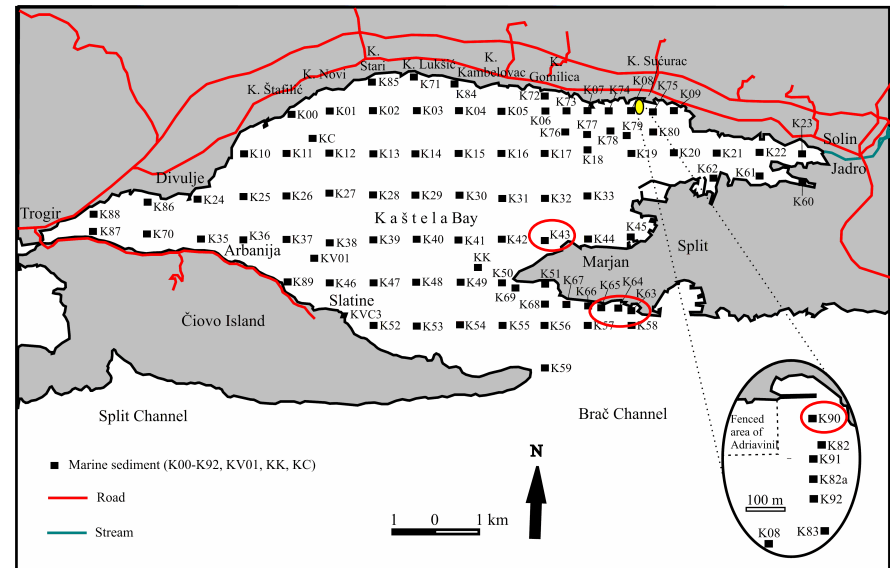
Elevated ^{238}U activities

- north coast of the Split peninsula (K43)
- south coast of the Split peninsula (K63, K64, K65)
- next to the “Adriavinil” factory (K90)
- anthropogenic origin
- higher activities in deeper parts of the Bay
- seabed depth
- sediment mineral composition
- granulometric composition

Map of the ^{238}U massic activities distribution in Kastela Bay sediments in eight layers at 0 – 50 cm depth; **a)** Layer 1 (0 - 5 cm); **b)** Layer 2 (5 - 10 cm); **c)** Layer 3 (10 - 15 cm); **d)** Layer 4 (15 - 20 cm); **e)** Layer 5 (20 - 25 cm); **f)** Layer 6 (25 - 30 cm); **g)** Layer 7 (30 - 40 cm); **h)** Layer 8 (40 - 50 cm); Massic activities are expressed in Bq/kg.



- two groups of elevated ^{238}U massive activities
 - moderately elevated
 - very elevated

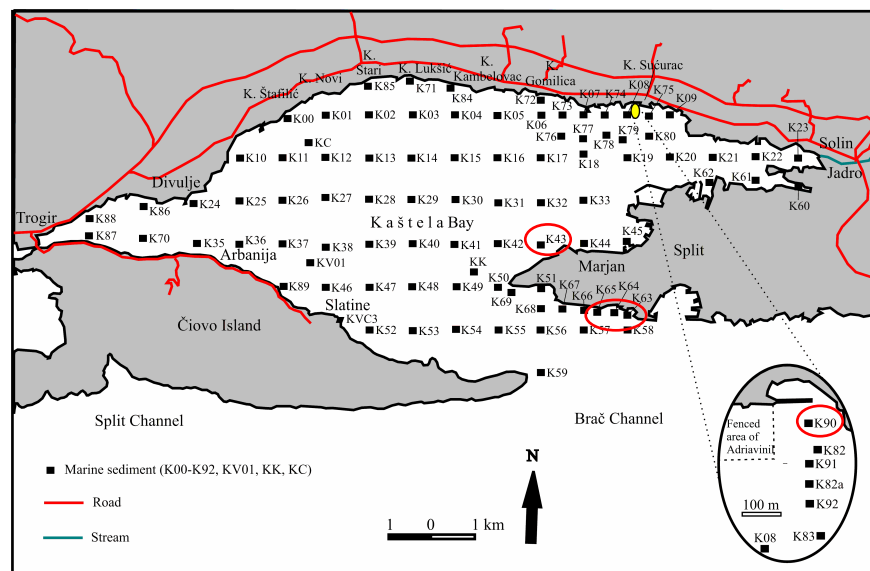


Sampling map of the Kastela Bay sediments; red circles denote stations with elevated ^{238}U massive activities

- comparison of the researched sediment
 - typical Adriatic coastal sediment (AS) – 18.2 Bq/kg
 - average uncontaminated Kastela Bay sediment (KS) – 38.8 Bq/kg



Sample label	a (^{238}U) (Bq/kg)	Elevated ^{238}U massic activities	
		Compared to AS	Compared to KS
K4302	66	4	2
K4303	89	5	2
K4304	84	5	2
K4305	96	5	2
K4306	127	7	3
K4307	123	7	3
K4308	102	6	3
K6303	71	4	2
K6304	62	3	2
K6305	80	4	2
K6306	69	4	2
K6307	62	3	2
K6308	78	4	2
K6402	191	10	5
K6403	75	4	2
K6404	92	5	2
K6503	56	3	1,5
K6504	67	4	2
K9007	102	6	3



Sampling map of the Kastela Bay sediments; red circles denote stations with moderately elevated ^{238}U massic activities

- moderately elevated activities
- at stations K43, K63, K64, K65 and K90
 - compared to AS: 3 – 10 times
 - compared to KS: 1,5 – 5 times

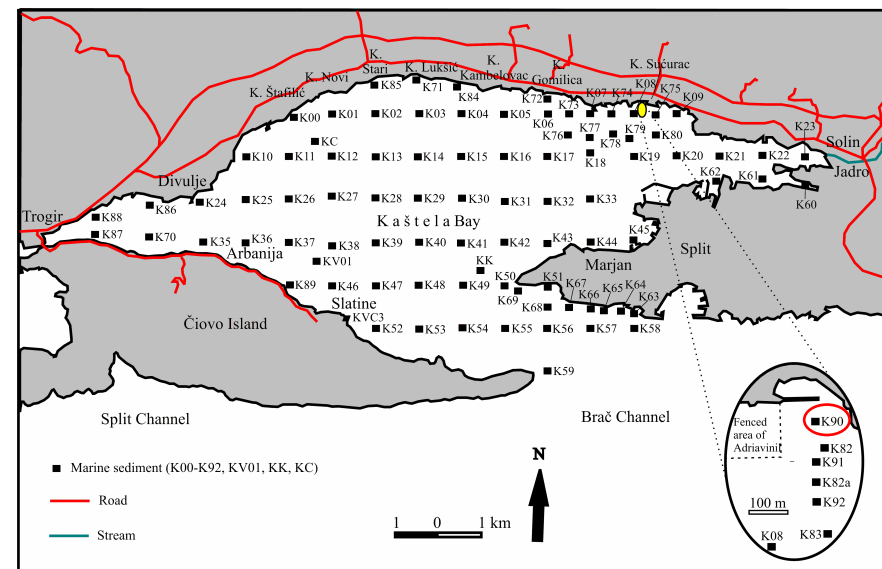
Comparison of moderately elevated ^{238}U massic activities in Kastela Bay sediments with massic activities in typical Adriatic coastal sediments (AS) and in average Kastela Bay sediment (KS)



Comparison of very elevated ^{238}U massic activities in Kastela Bay sediments with massic activities in typical Adriatic coastal sediments (AS) and in average Kastela Bay sediment (KS)

Sample label	a (^{238}U) (Bq/kg)	Elevated ^{238}U massic activities	
		Compared to AS	Compared to KS
K9001	392	22	10
K9002	419	23	11
K9003	456	25	12
K9004	420	23	11
K9005	603	33	16
K9006	462	25	12

- very elevated activities
- only at station K90 (layers 1 – 6)
 - compared to AS: 22 – 33 times
 - compared to KS: 10 – 16 times



Sampling map of the Kastela Bay sediments; red circle denotes a station with very elevated ^{238}U massic activities



CONCLUSION

- detectable anthropogenic influence
 - local discharge of the TENORM (coal bottom ash) into the sea
- only locally elevated ^{238}U massic activities
 - five stations – around the Split peninsula and next to the “Adriavinil” factory
 - area around the factory is the most influenced
- Kastela Bay sediment has a naturally higher ^{238}U activities than the typical Adriatic coastal sediment



THANK YOU FOR
YOUR ATTENTION!

QUESTIONS?