

# Nuclear analytical techniques in environmental studies

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Havana, Cuba





Peloids



Urban dust



Beach sands

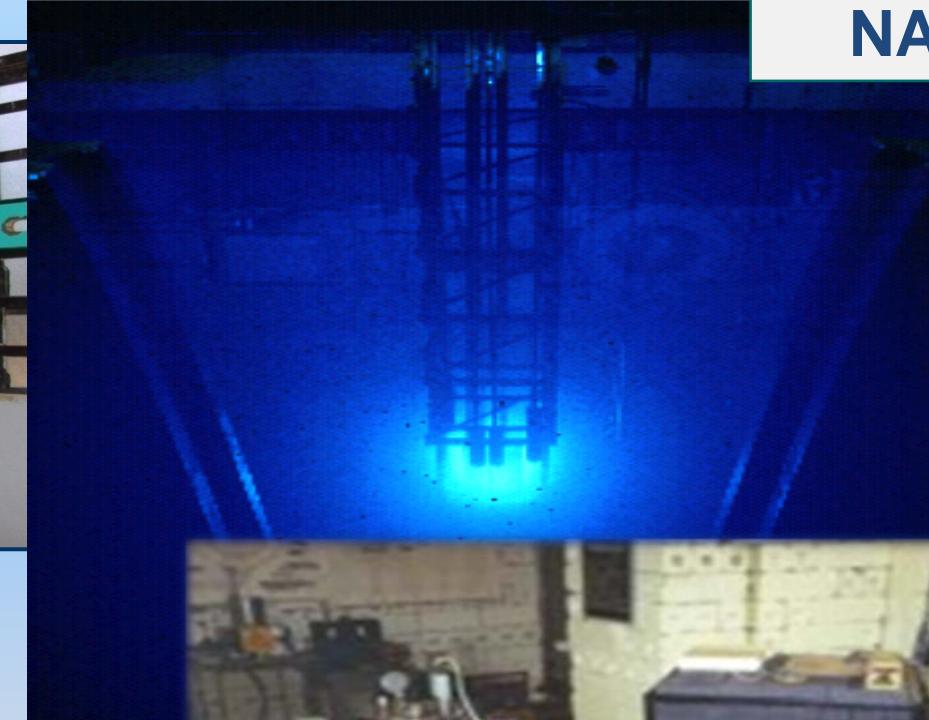
**LBGS**



**XRFA**



**NAA**



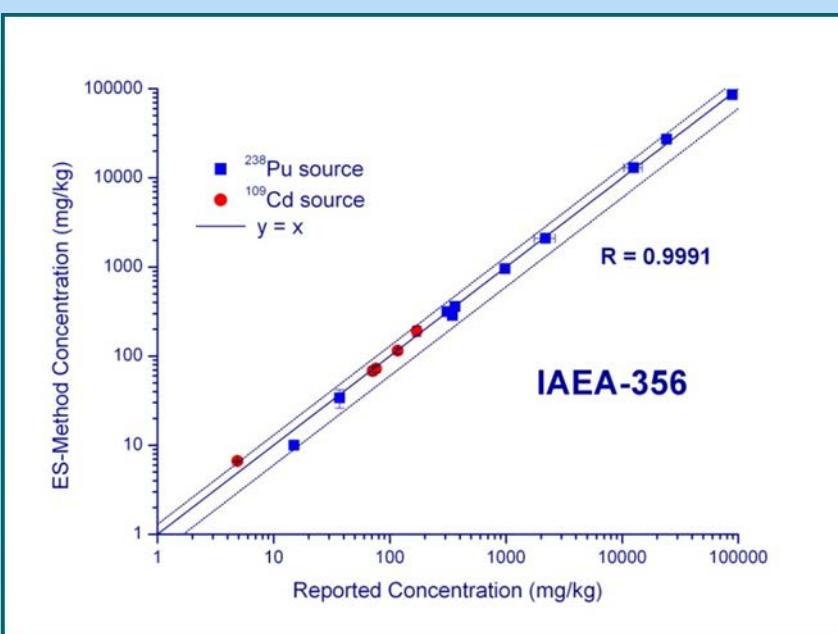
**GAA**



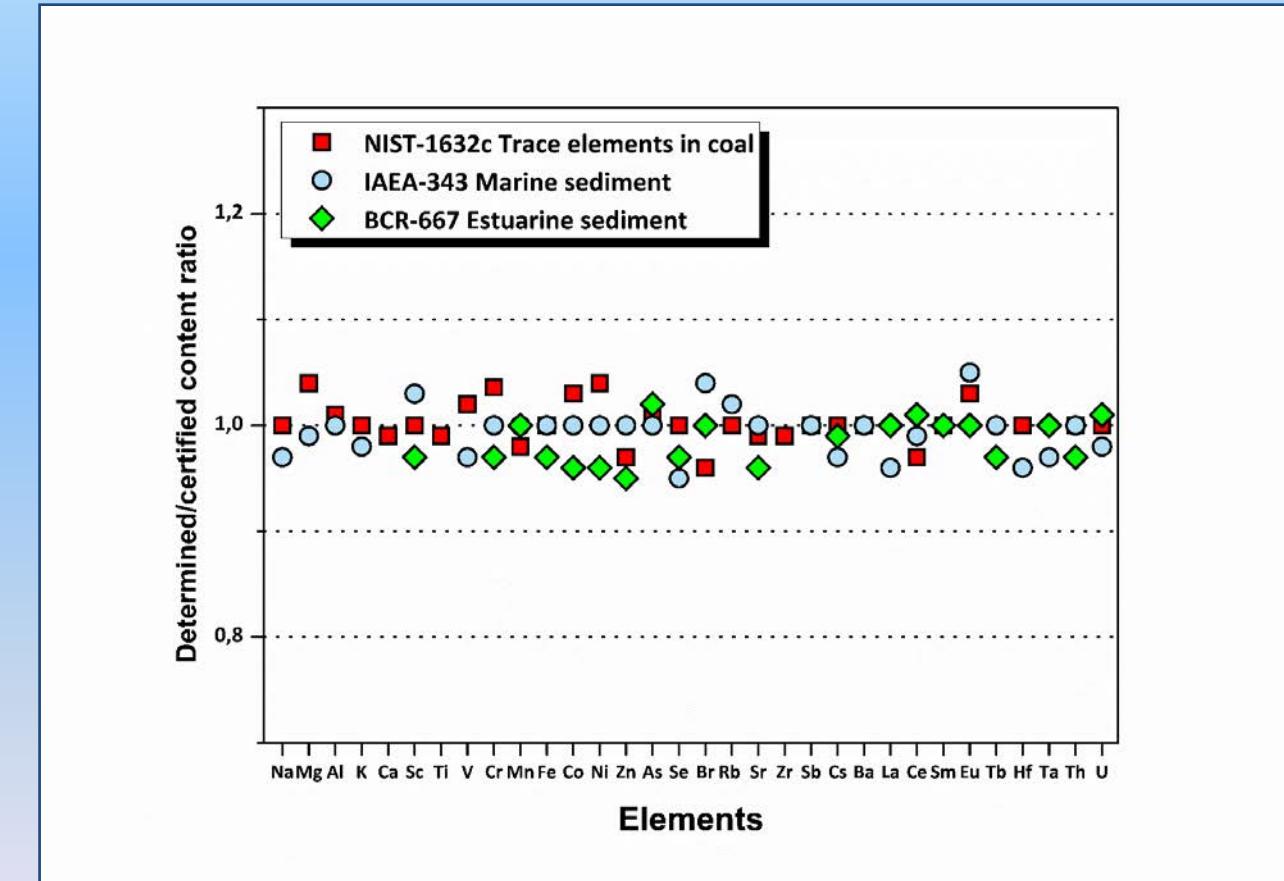
# Peloides

Studied spas





XRF



Nuclide	$^{226}\text{Ra}$	$^{137}\text{Cs}$	$^{232}\text{Th}$	$^{40}\text{K}$
Reference activity	24	45	30	480
Standard deviation (%)	13	4	10	4
Measured activity	25	44	31	460
Standard deviation (%)	8	9	10	7
Deviation from the reference value (%)	4.2	-2.2	3.3	-4.2
SR (%)	21	20	23	18

LBGS

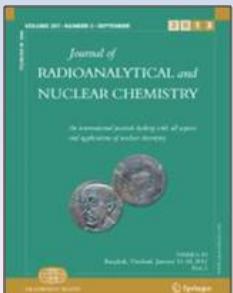
NAA

## Peloides

## Radiological evaluation



**Full body, 30m sessions,  
9 sessions in each trimester**



Locations	$^{226}\text{Ra}$	$^{137}\text{Cs}$	$^{232}\text{Th}$	$^{40}\text{K}$	D (nGy·h <sup>-1</sup> )	$\text{H}_{\text{skin}}$ ( $\mu\text{Sv} \cdot \text{y}^{-1}$ )
San Diego, Cuba	$37 \pm 3$	$5 \pm 1$	$27 \pm 5$	$236 \pm 61$	43	1.0
Elguea, Cuba	$1800 \pm 298$	<1.6	$38 \pm 16$	$115 \pm 16$	859	0.7
Santa Lucía, Cuba	$405 \pm 65$	<1.6	$21 \pm 6$	$365 \pm 40$	215	1.6
Cajío, Cuba	$6 \pm 1$	<1.6	$6 \pm 3$	$47 \pm 7$	8	0.2
Salsomaggio, Italy	30	-	30	659	70	1.3
Eugenian Hills, Italy	286	2	35	423	169	3.0
Safaga, Egypt	25	-	21	618	50	0.9
Hurgada, Egypt	21	-	22	548	46	0.8
Niska Banja, Serbia	259	0.5	253	219	286	5.2
Abano, Italy*	1208	5	580	460	928	16.7
Peruíbe, Brazil**	16	-	31	423	43	0.8
UNSCEAR	33	-	45	420	60	-

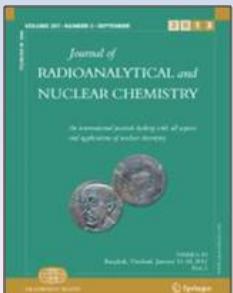
- Peloide with the higher  $^{226}\text{Ra}$  activity reported,
- \*\*- Average Activity of the reported peloides.

## Peloides

## Radiological evaluation



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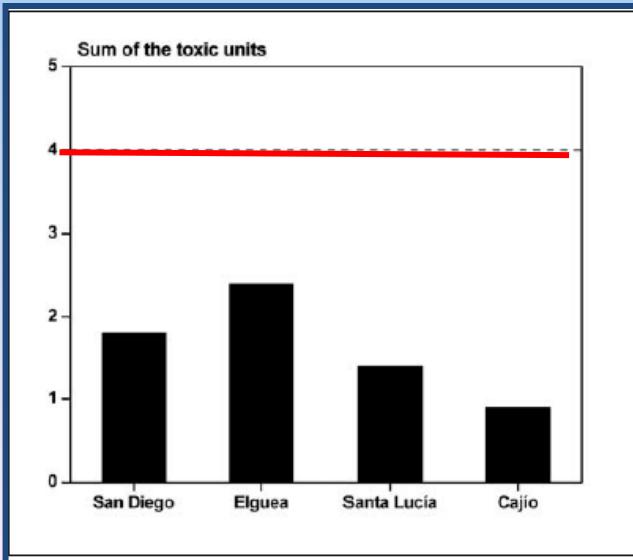
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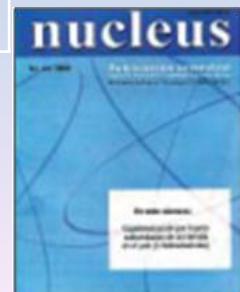
## Peloides



**Full body, 30m sessions,  
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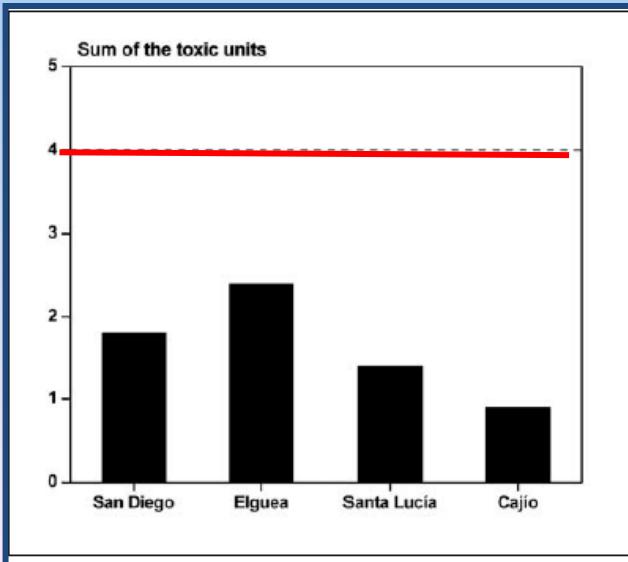


Peloid/Baseline	Co	Ni	Cu	Zn	Pb
San Diego, Cuba	$6,9 \pm 0,6$	$44 \pm 5$	$33 \pm 1$	$73 \pm 4$	$20 \pm 2$
Elguea, Cuba	< 6	$65 \pm 6$	$30 \pm 1$	$97 \pm 4$	$14 \pm 1$
Santa Lucía, Cuba	< 6	$23 \pm 5$	$107 \pm 2$	$57 \pm 4$	$6 \pm 1$
Cajío, Cuba	< 6	$20 \pm 4$	$20 \pm 1$	$25 \pm 3$	$12 \pm 1$
US Pharmacopeia	50	50	50	50	50
Eur. Med. Agency	-	25	250	1300	-
SQG	TEL	-	18	35.7	123
	PEL	-	36	197	315
					91.3

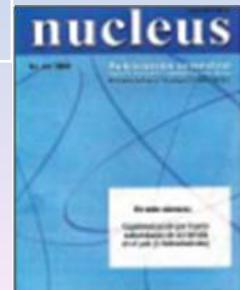




**Full body, 30m sessions,  
9 sessions in each trimester**



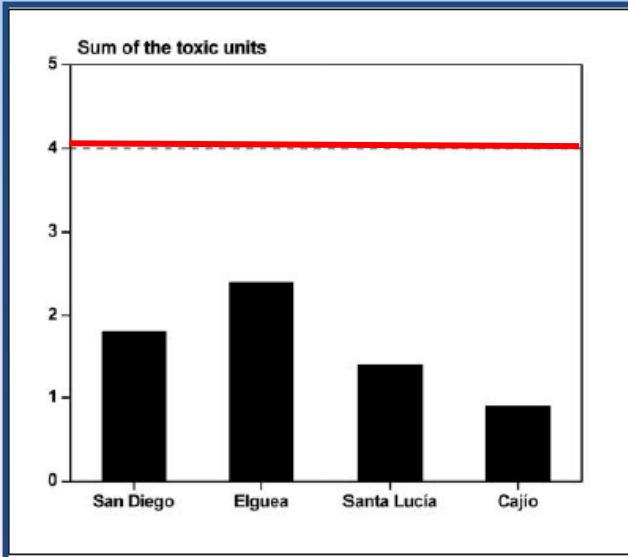
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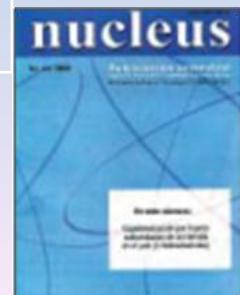
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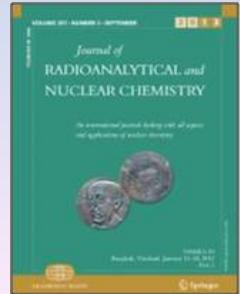
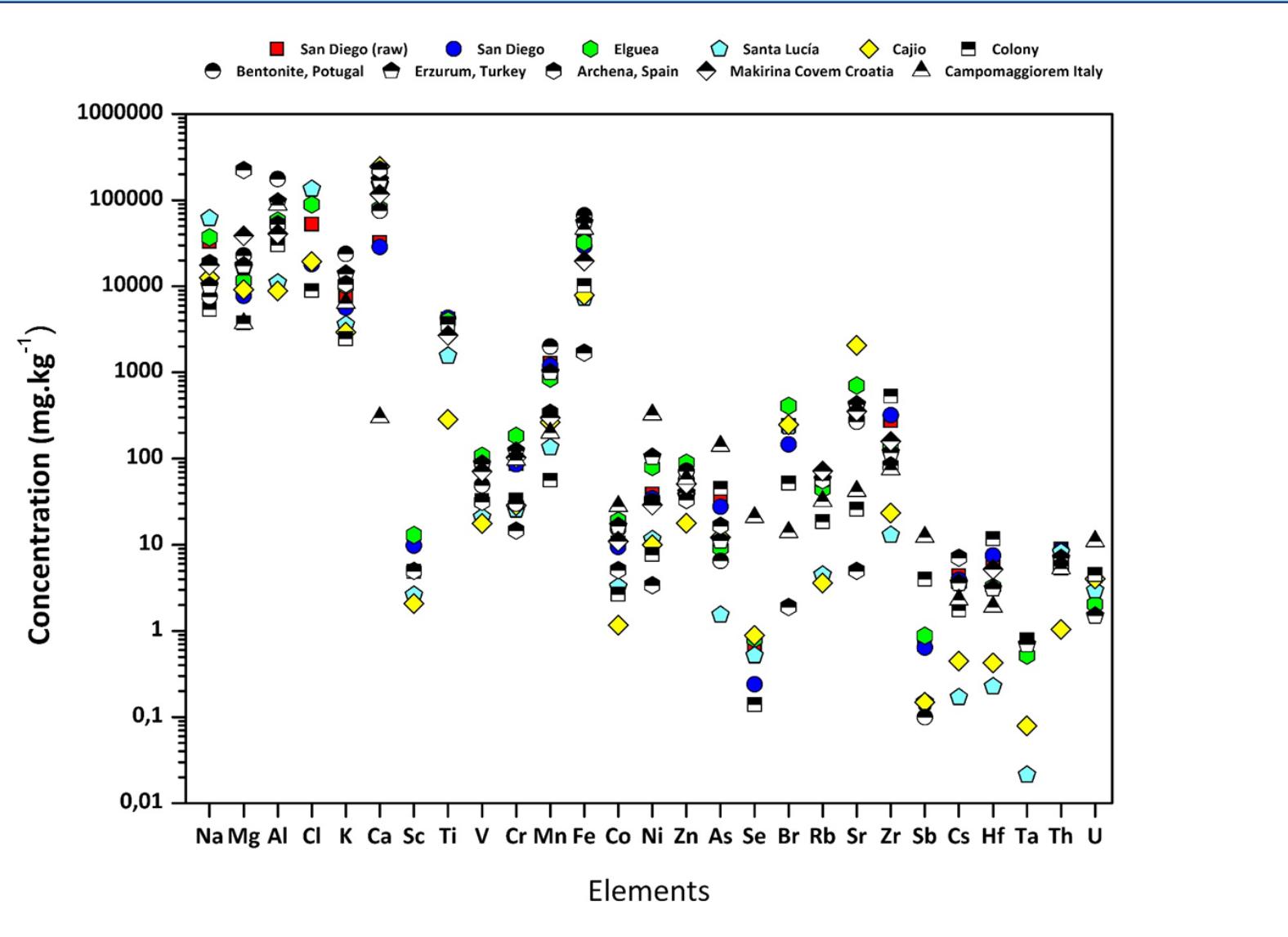
**Full body, 30m sessions,  
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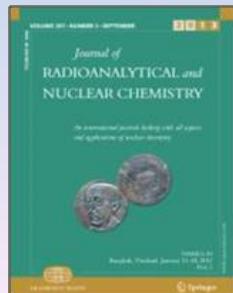
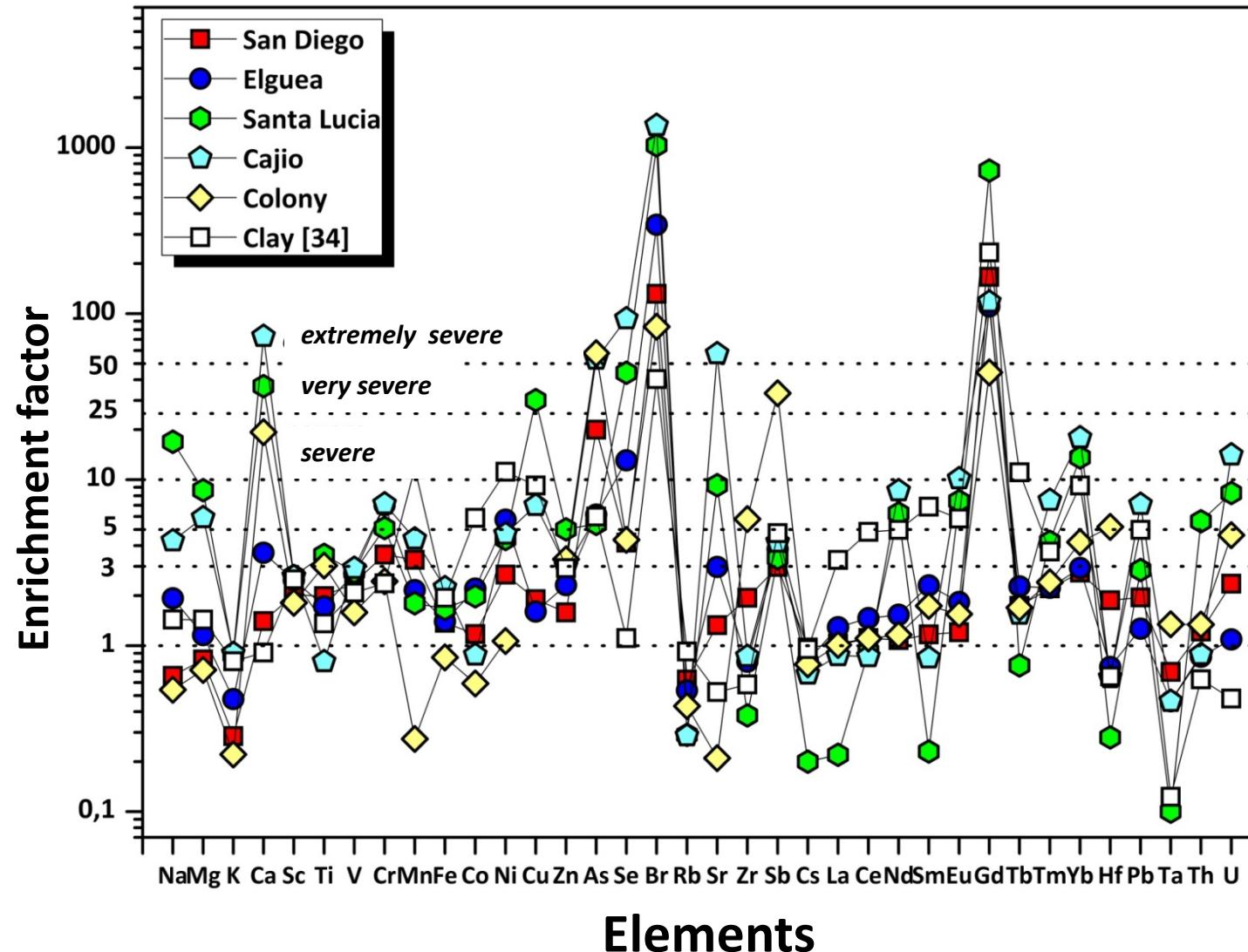


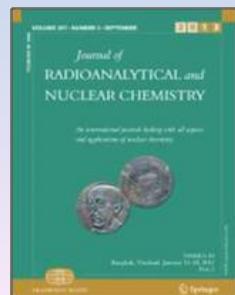
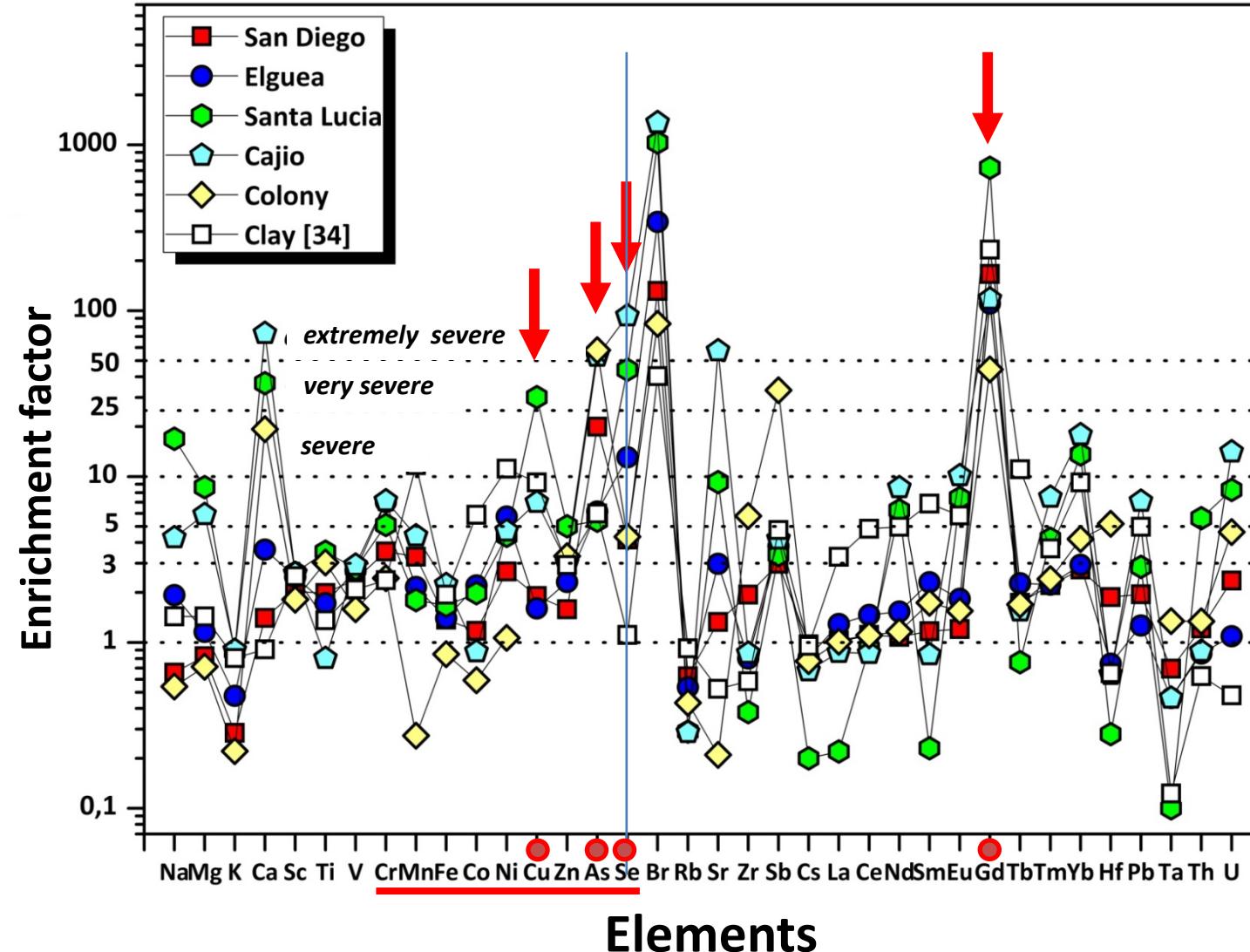
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nucleus					



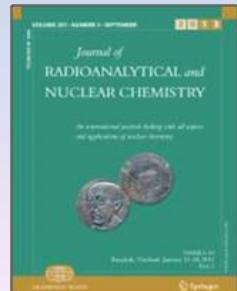
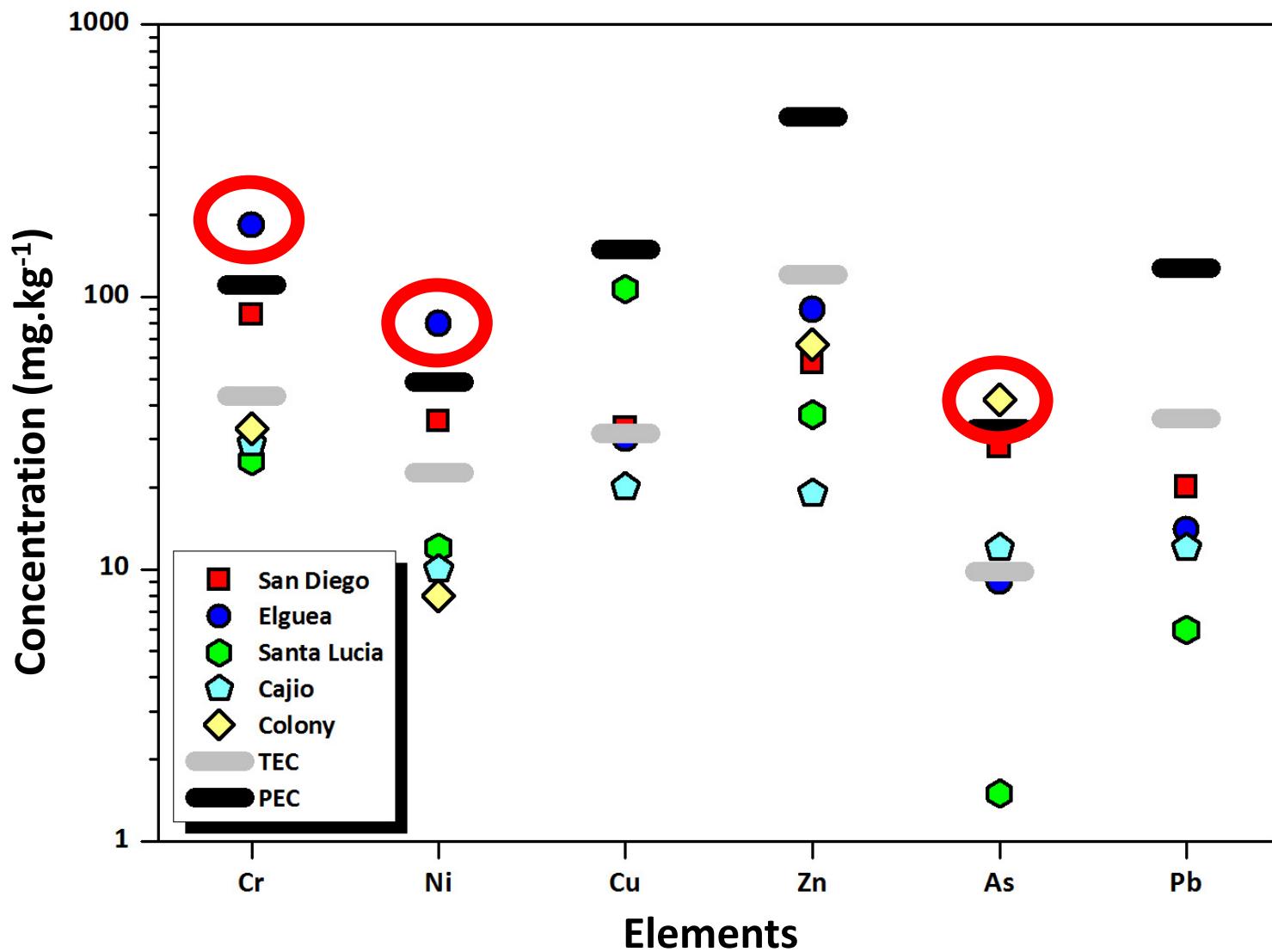
## Peloides

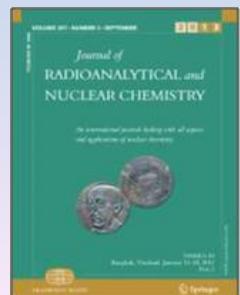
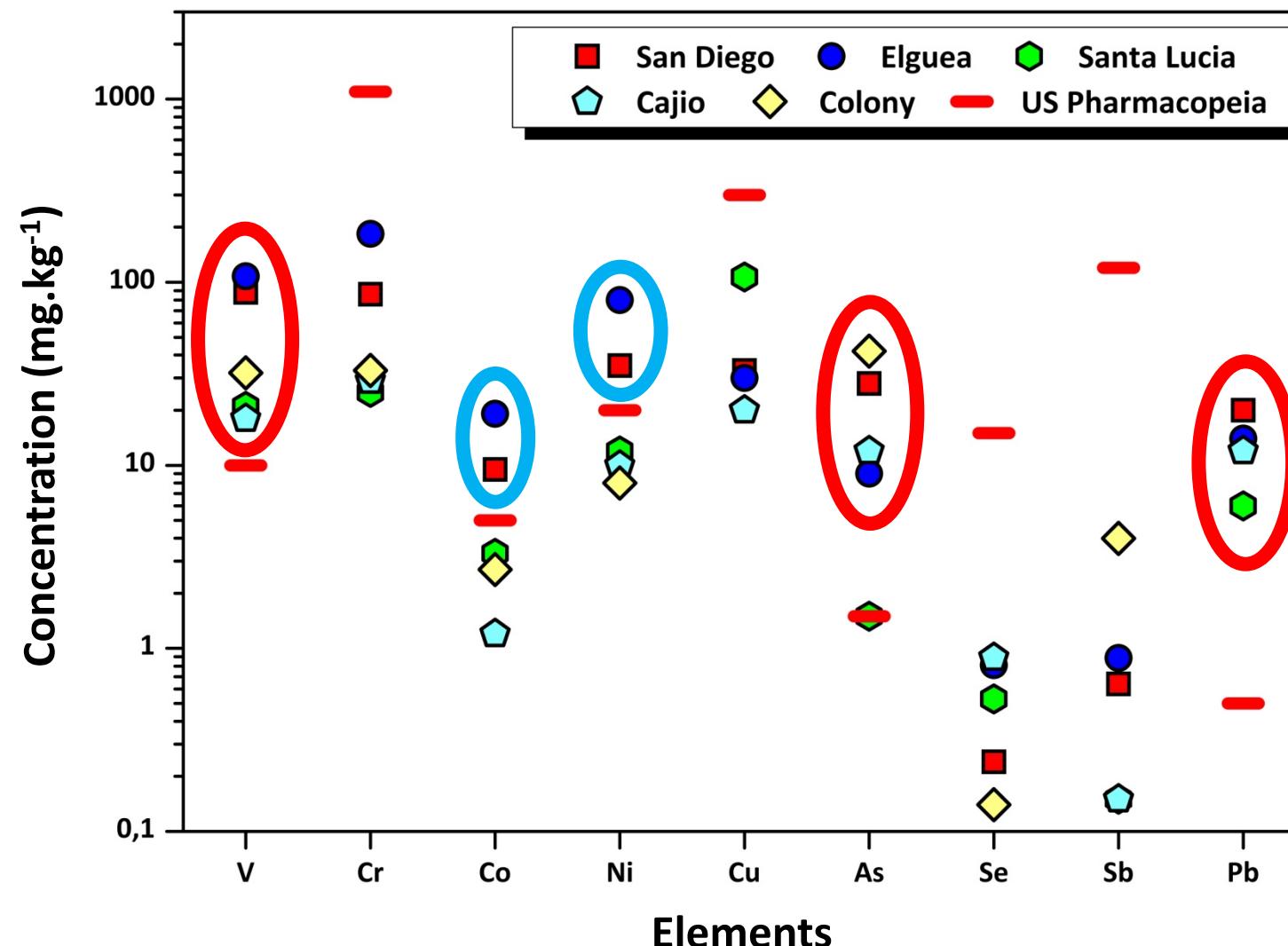






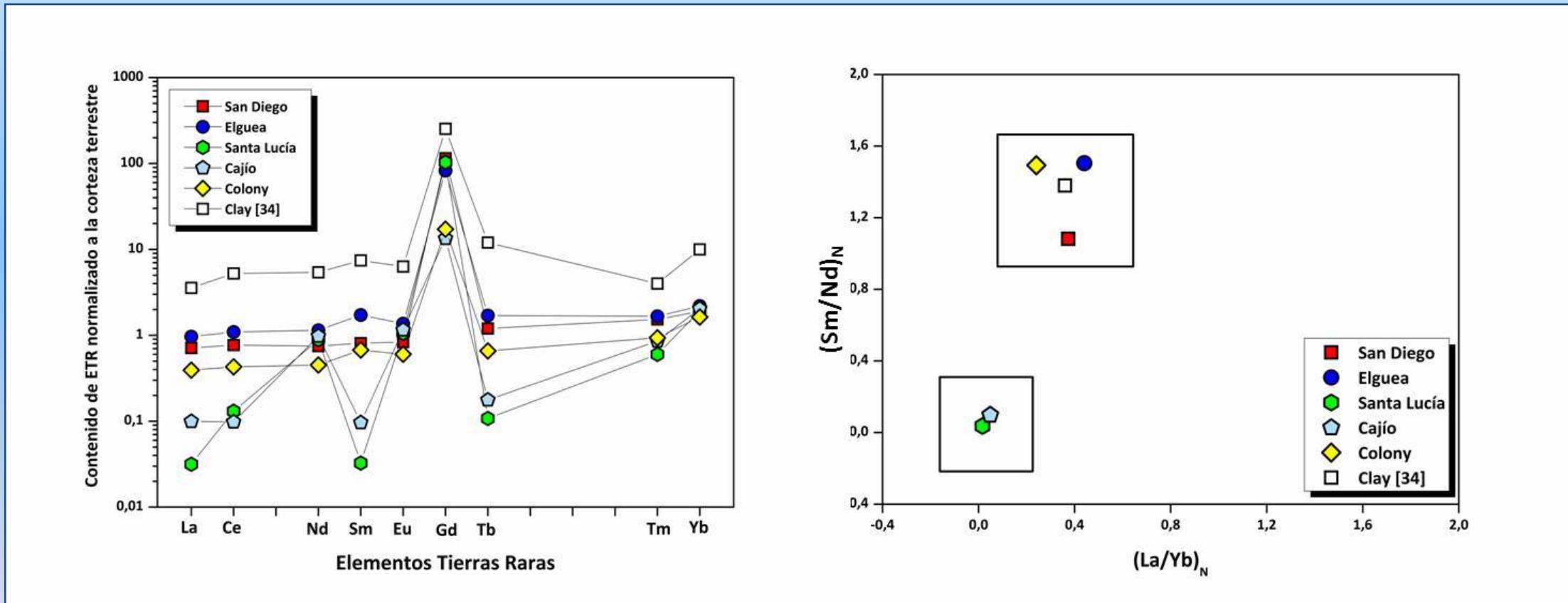
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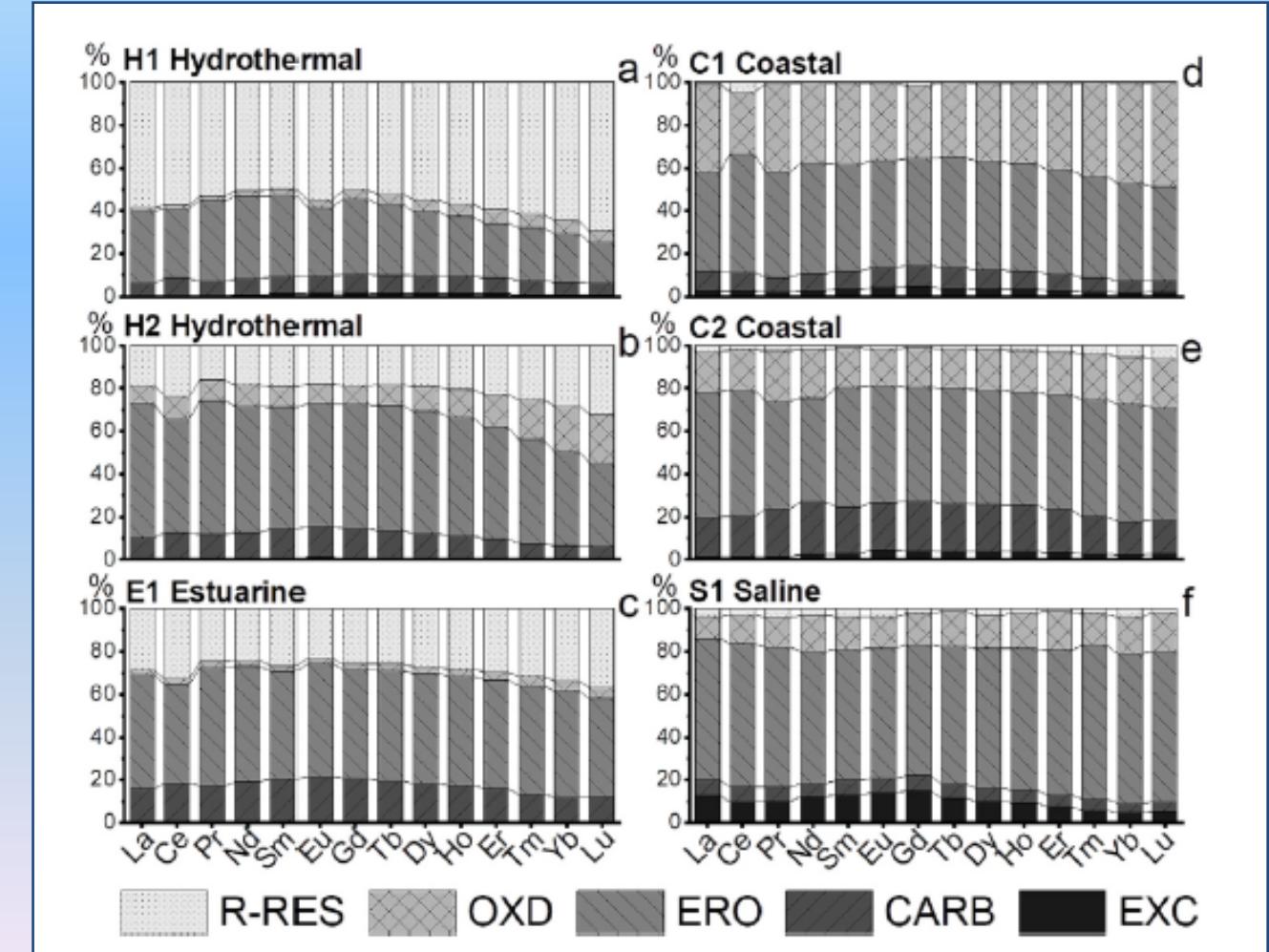
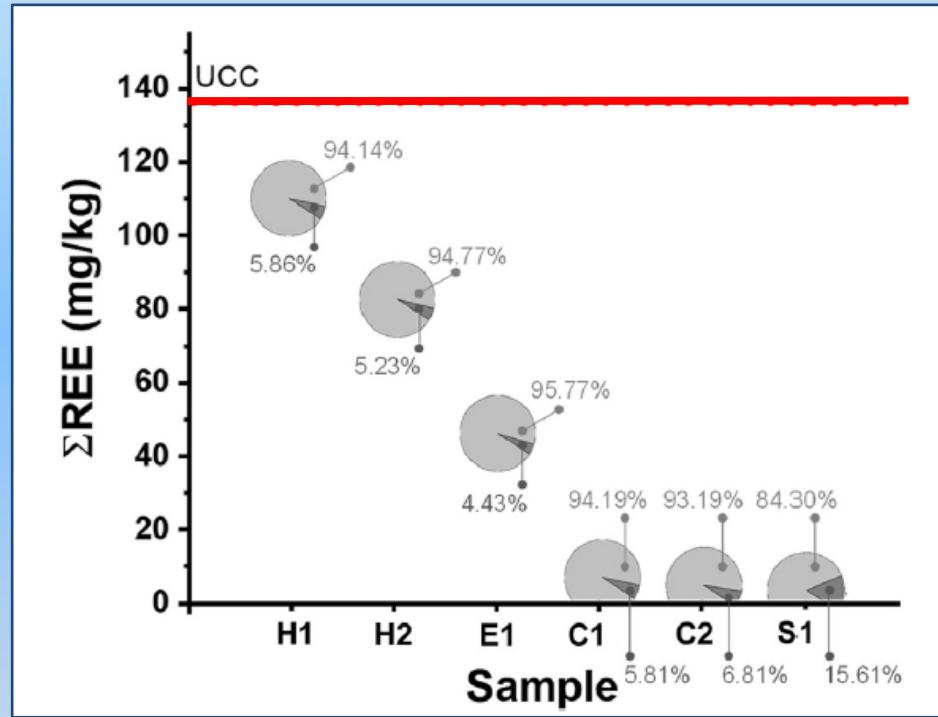




# Peloides

REE





# Peloides

# Hurricanes impact



LBGS+XRF



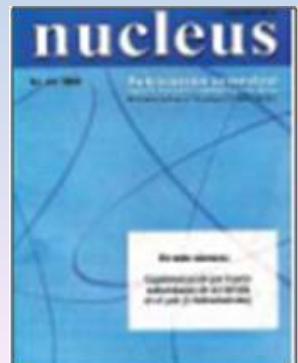
San Diego river

# Peloides

# Peloide



LBGS+XRF



San Diego river

Element	Before	After	EF
K (%)	$1,2 \pm 0,1$	$0,8 \pm 0,1$	0,7
Ca (%)	$1,31 \pm 0,05$	$1,82 \pm 0,05$	1,5
Ti (%)	$0,63 \pm 0,02$	$0,59 \pm 0,02$	1,0
Cr	$79 \pm 18$	$80 \pm 17$	1,1
Mn	$817 \pm 28$	$950 \pm 30$	1,3
Fe (%)	$4,0 \pm 0,1$	$3,6 \pm 0,1$	
Co	$18 \pm 2$	$16 \pm 2$	1,0
Ni	$68 \pm 8$	$62 \pm 8$	1,0
Cu	$56 \pm 2$	$52 \pm 2$	1,0
Zn	$77 \pm 4$	$72 \pm 5$	1,0
Pb	$32 \pm 2$	$28 \pm 2$	1,0

Nuclide	Before	After
$^{238}\text{U}$	$11 \pm 2$	$10 \pm 2$
$^{226}\text{Ra}$	$19 \pm 2$	$22 \pm 2$
$^{137}\text{Cs}$	$5,0 \pm 0,4$	$4,5 \pm 0,4$
$^{232}\text{Th}$	$21 \pm 2$	$18 \pm 2$
$^{40}\text{K}$	$273 \pm 25$	$208 \pm 23$

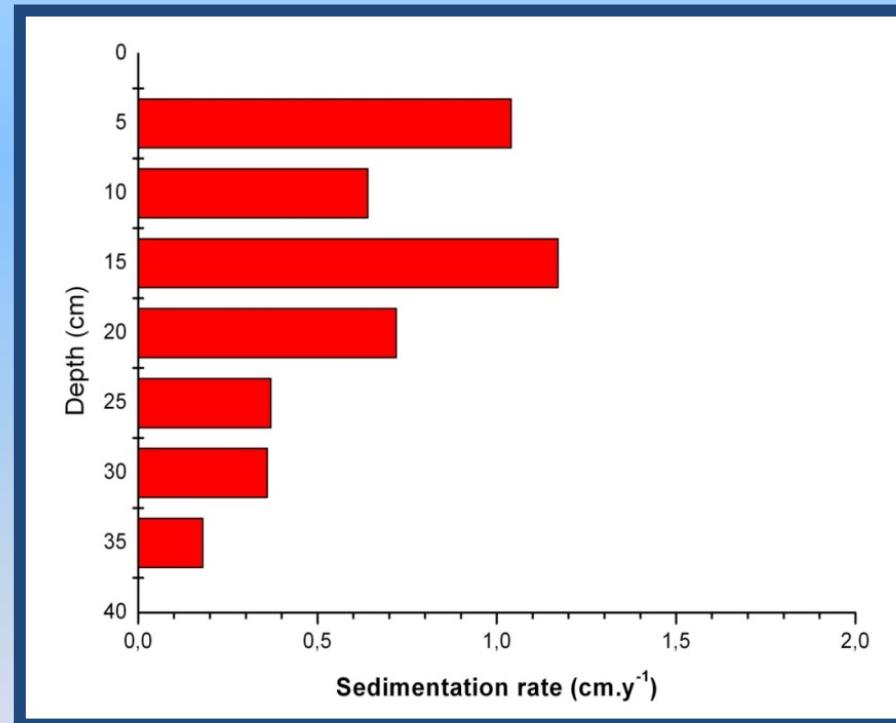
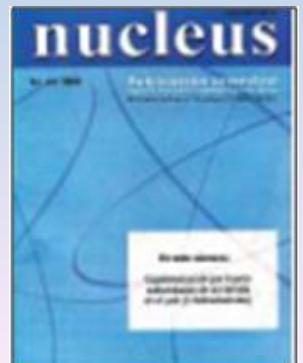
	Before	After
pH	7,4	7,8
Eh (mV)	-207	-180
T (°C)	26,5	24,3
DO (mg-L <sup>-1</sup> )	1,0	0,8
Elec. Cond. (mS.cm <sup>-1</sup> )	12,6	20,1

# Peloides

Peloide



LBGS+XRF

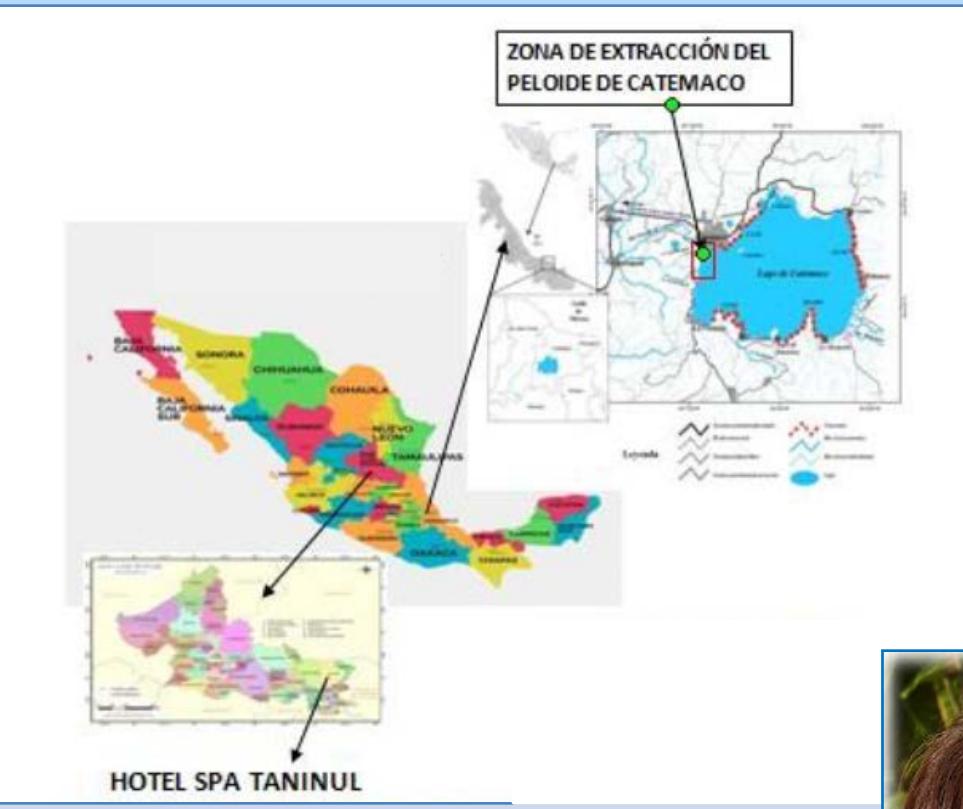


San Diego river

Taking into account the average sedimentation rate (~0,7 cm.y<sup>-1</sup>), the sediment original characteristics will re-established only in **5-7 years**

# Commercials peloides

México



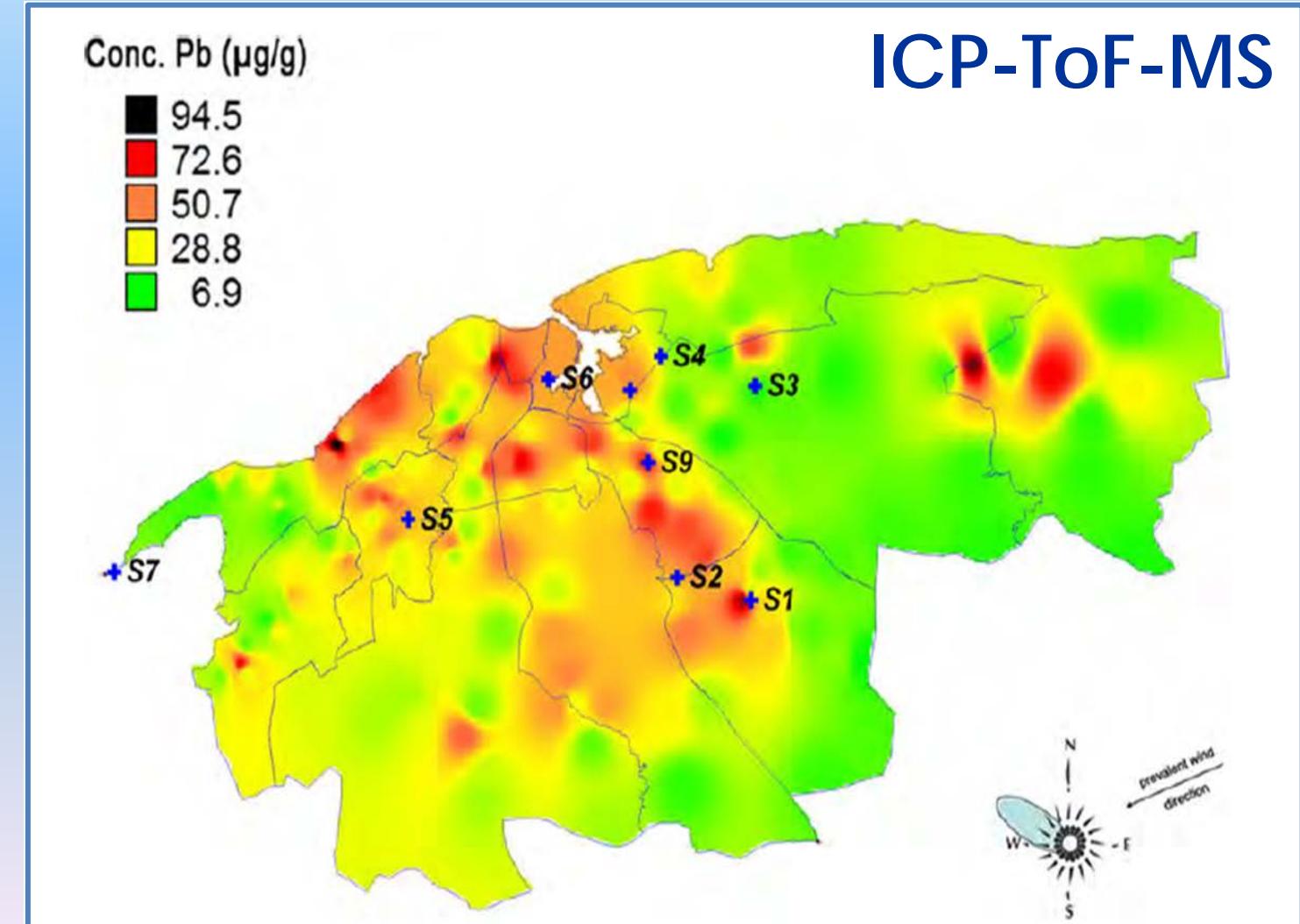
# Urban dust

# Motivation



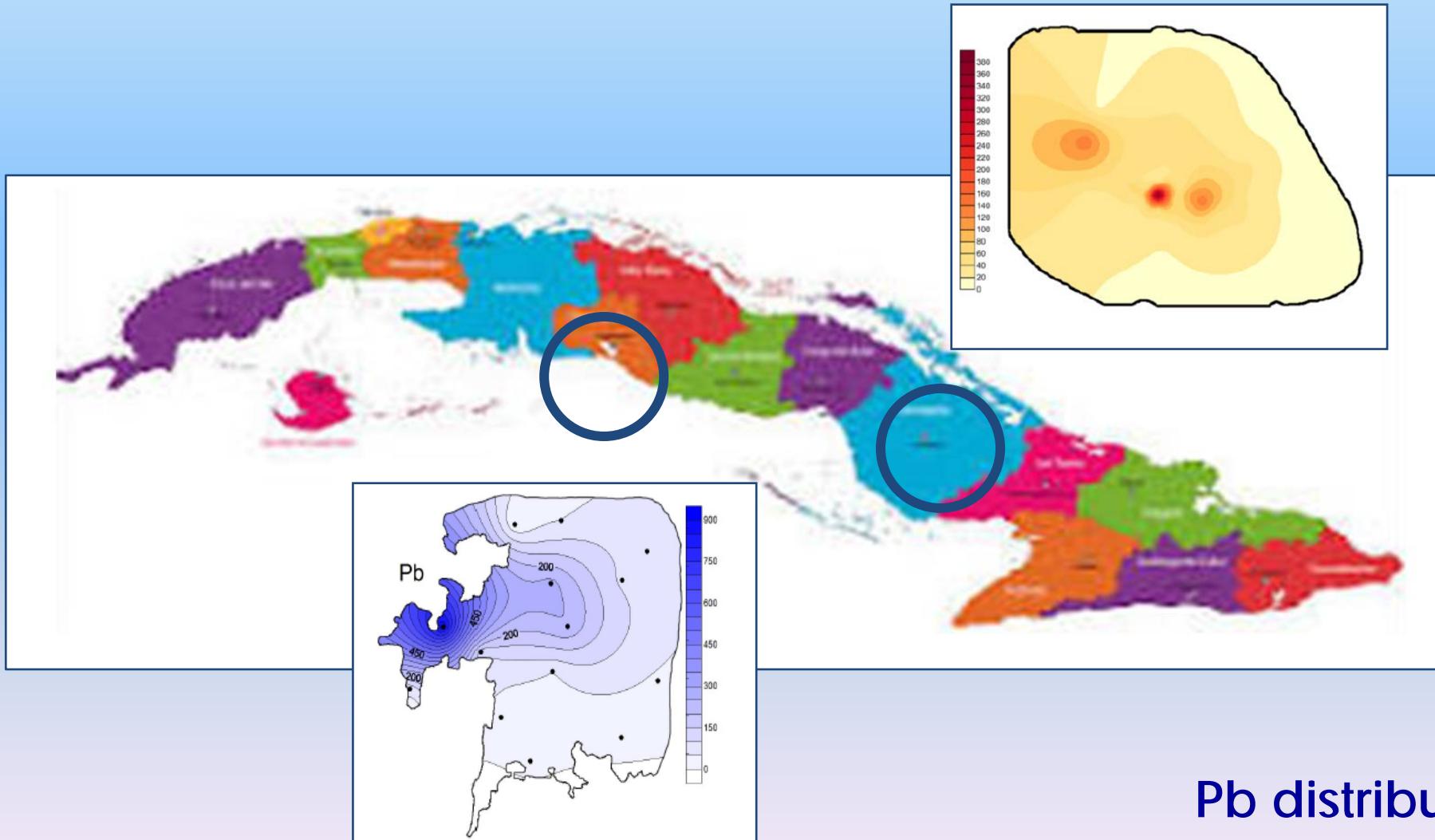
*Physcia alba* (Fée) Müll. Arg.

Lichens

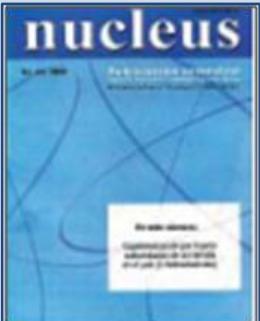


# Urban dust

# First experiences

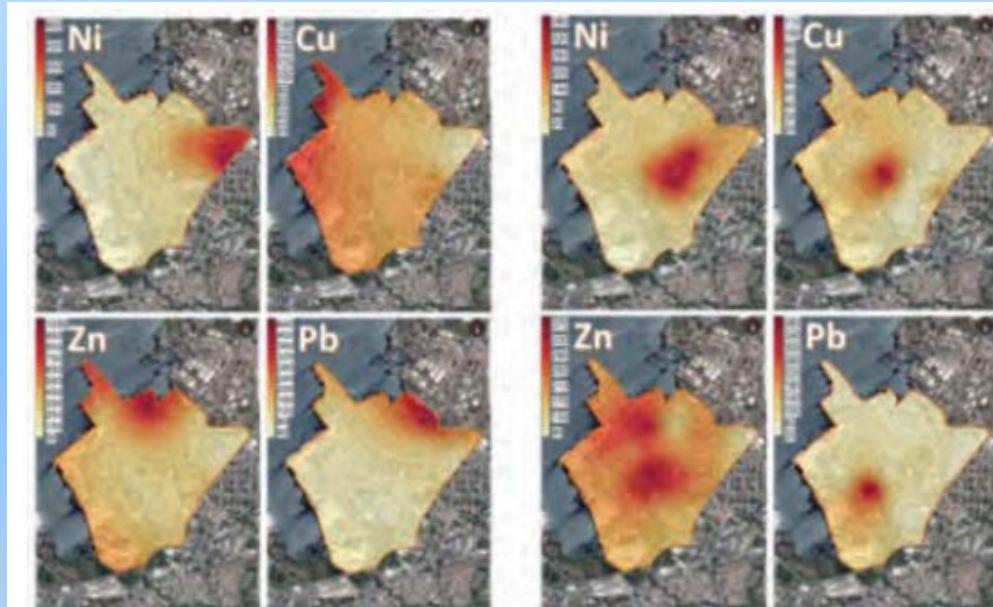


Pb distribution



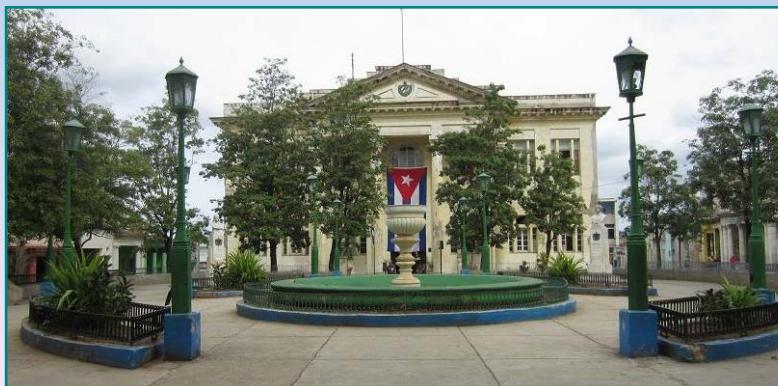
# Urban dust

Regla

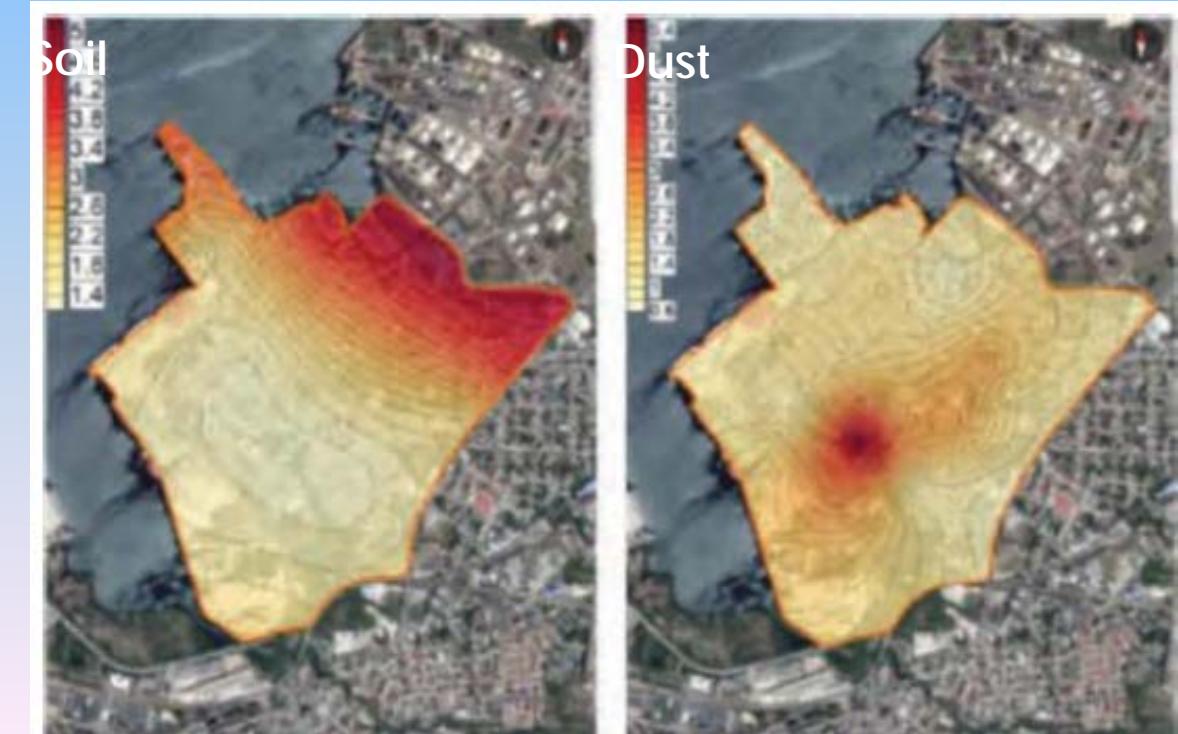
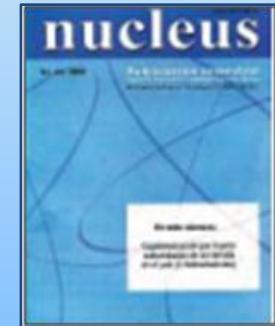
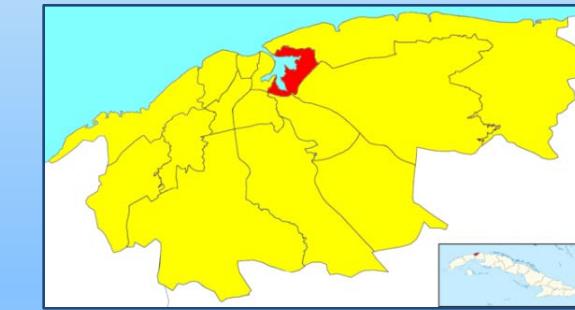


Soil

Dust



IPI

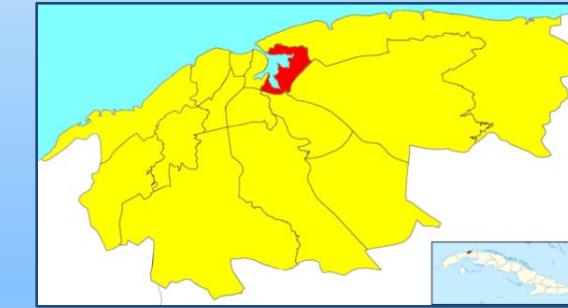


# Urban dust

Regla



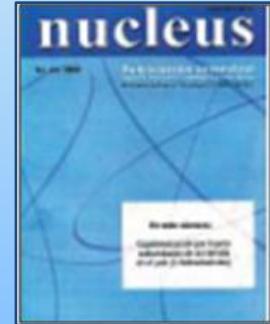
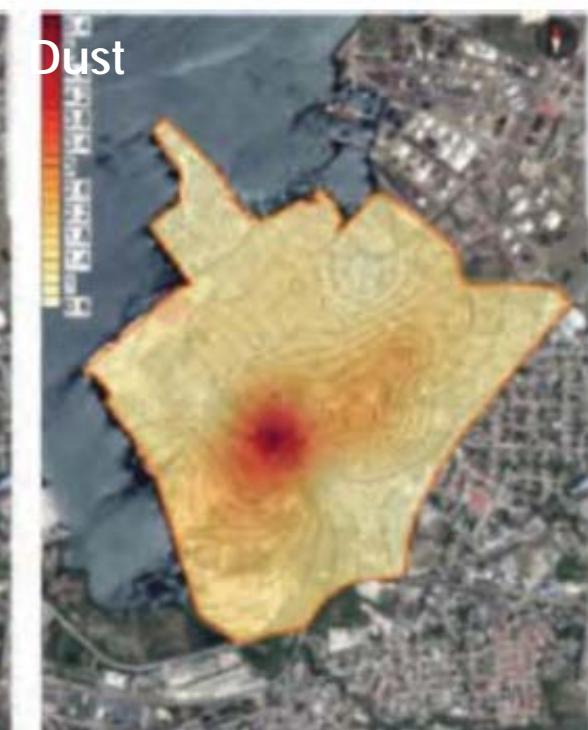
IPI



Soil

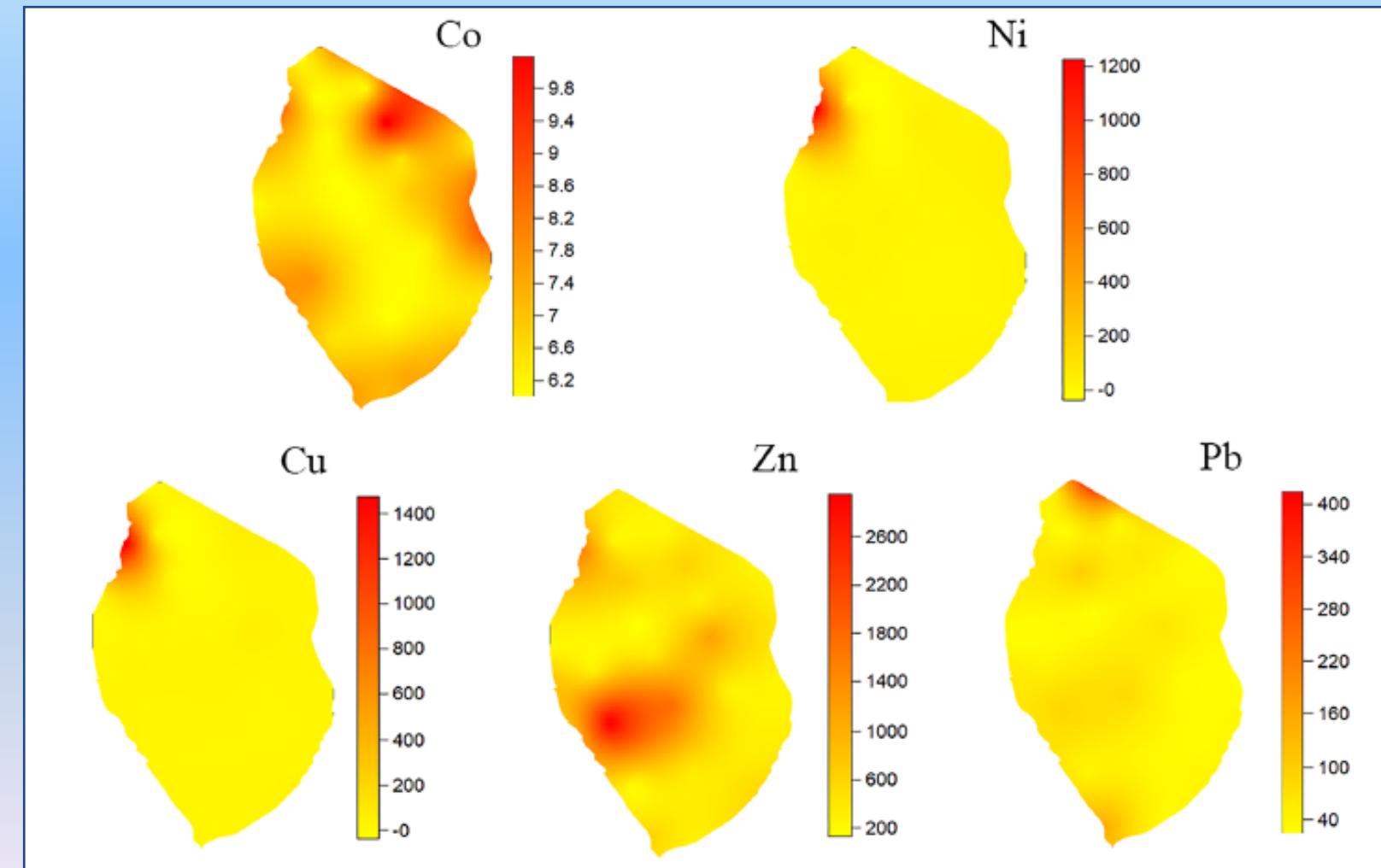


Dust



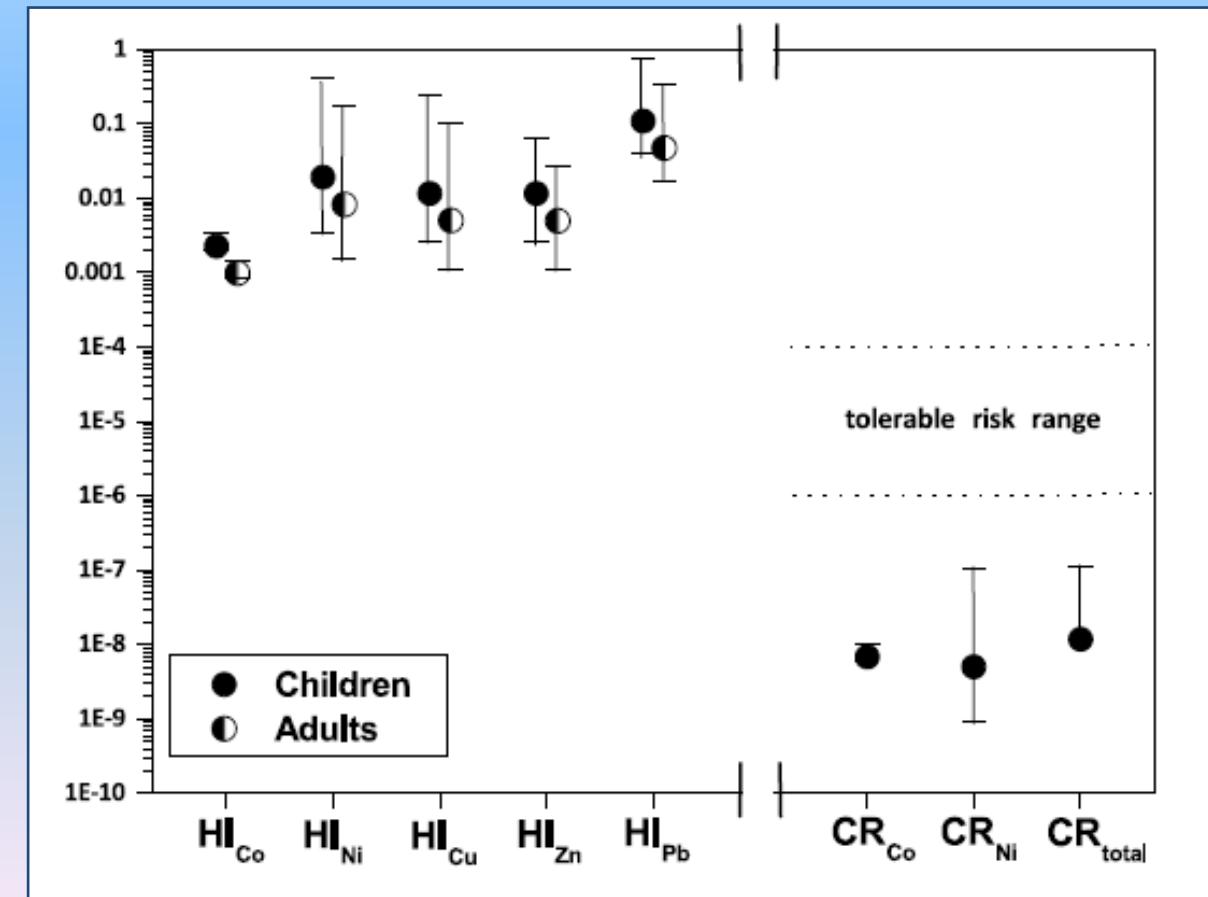
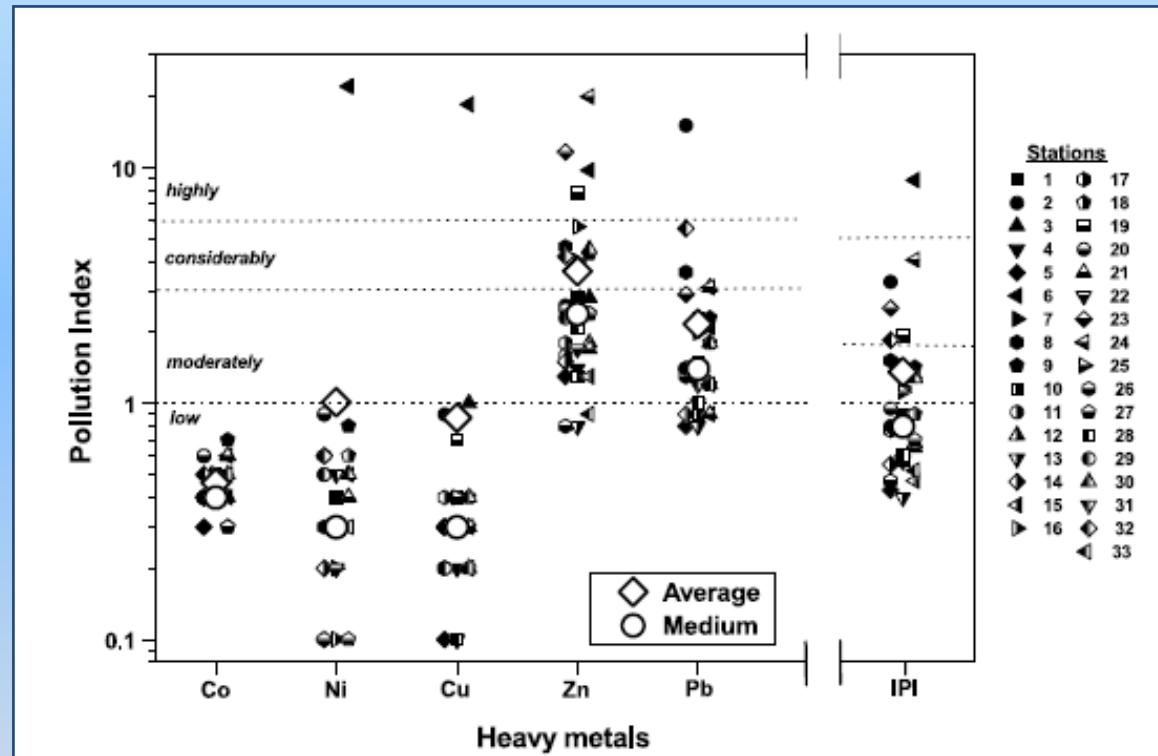
# Urban dust

Old Havana



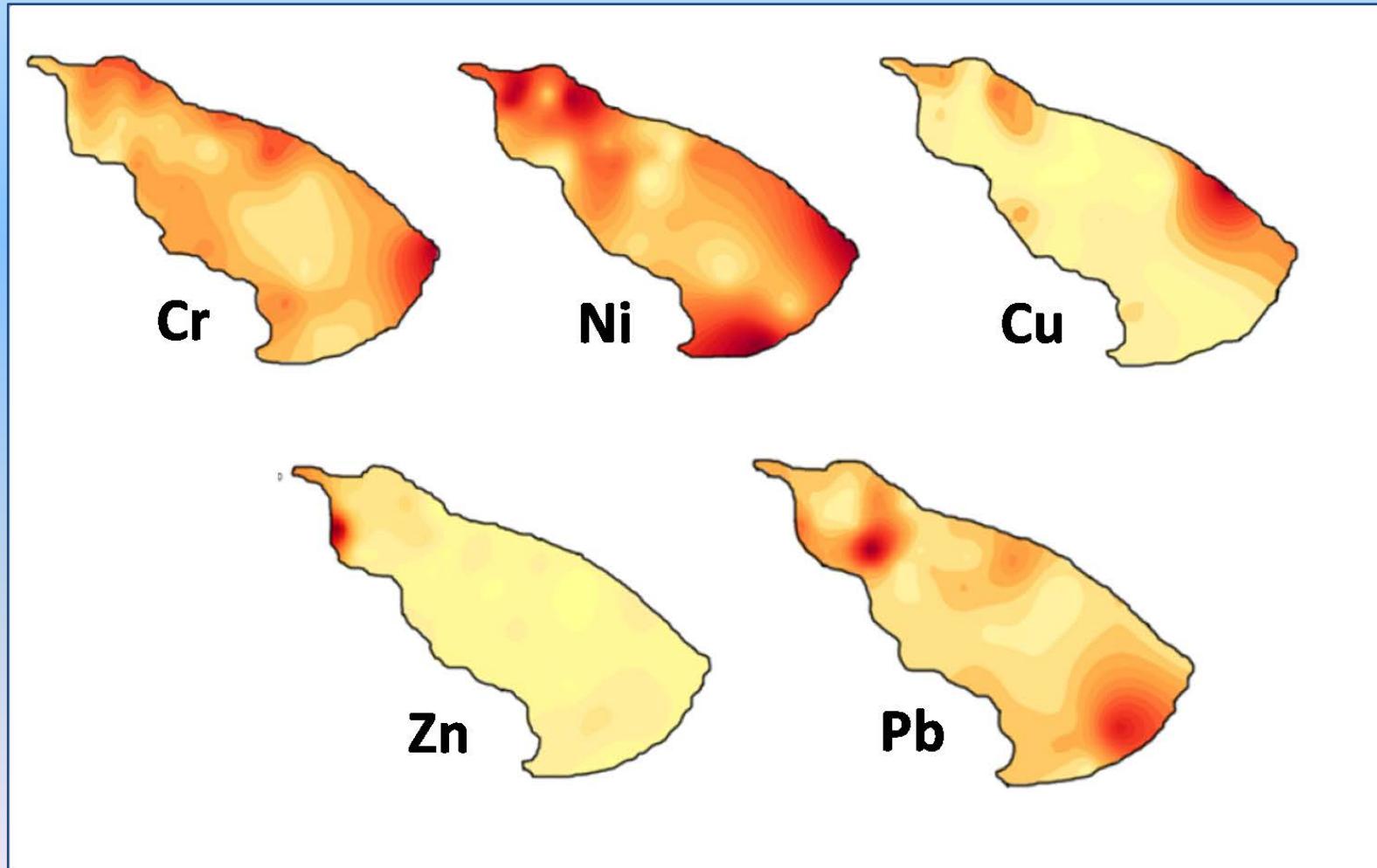
# Urban dust

Old Havana



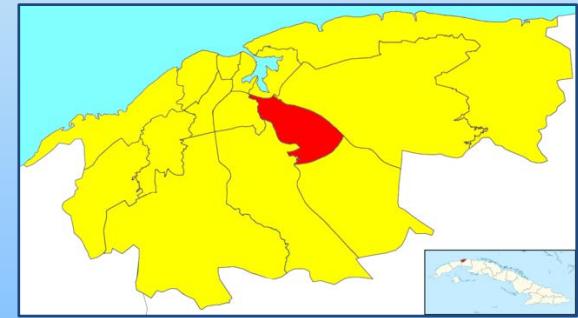
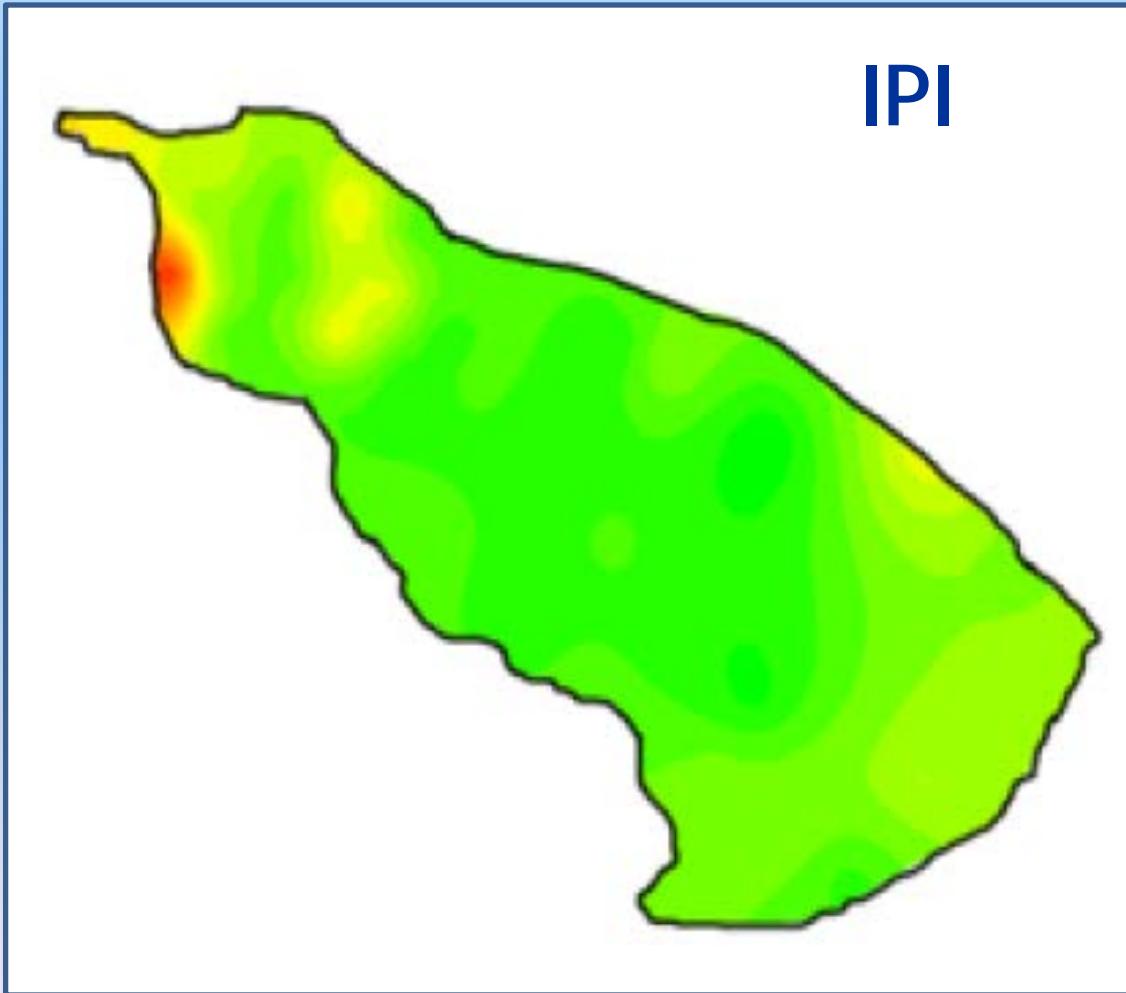
# Urban dust

# San Miguel del Padrón



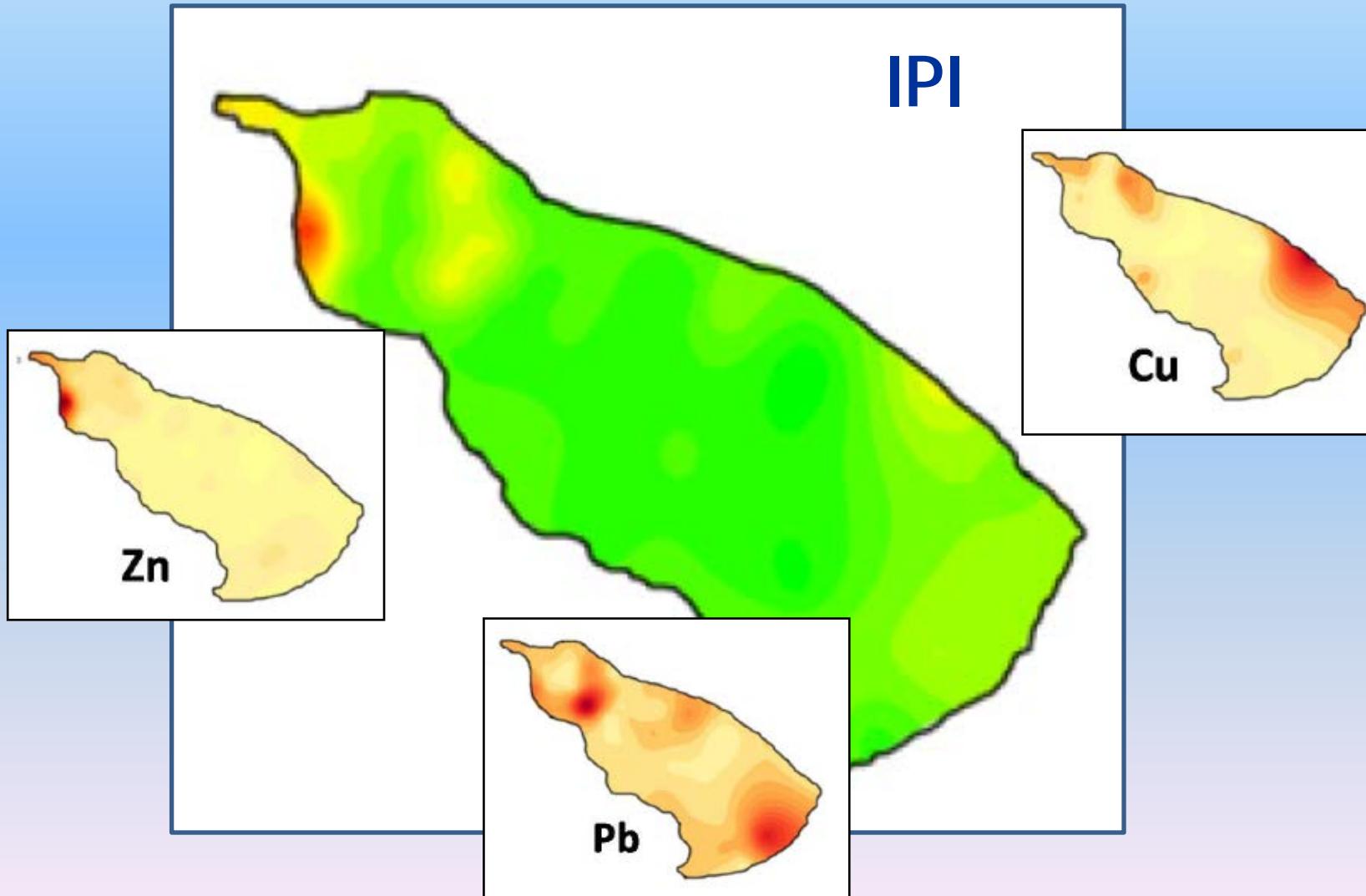
# Urban dust

# San Miguel del Padrón



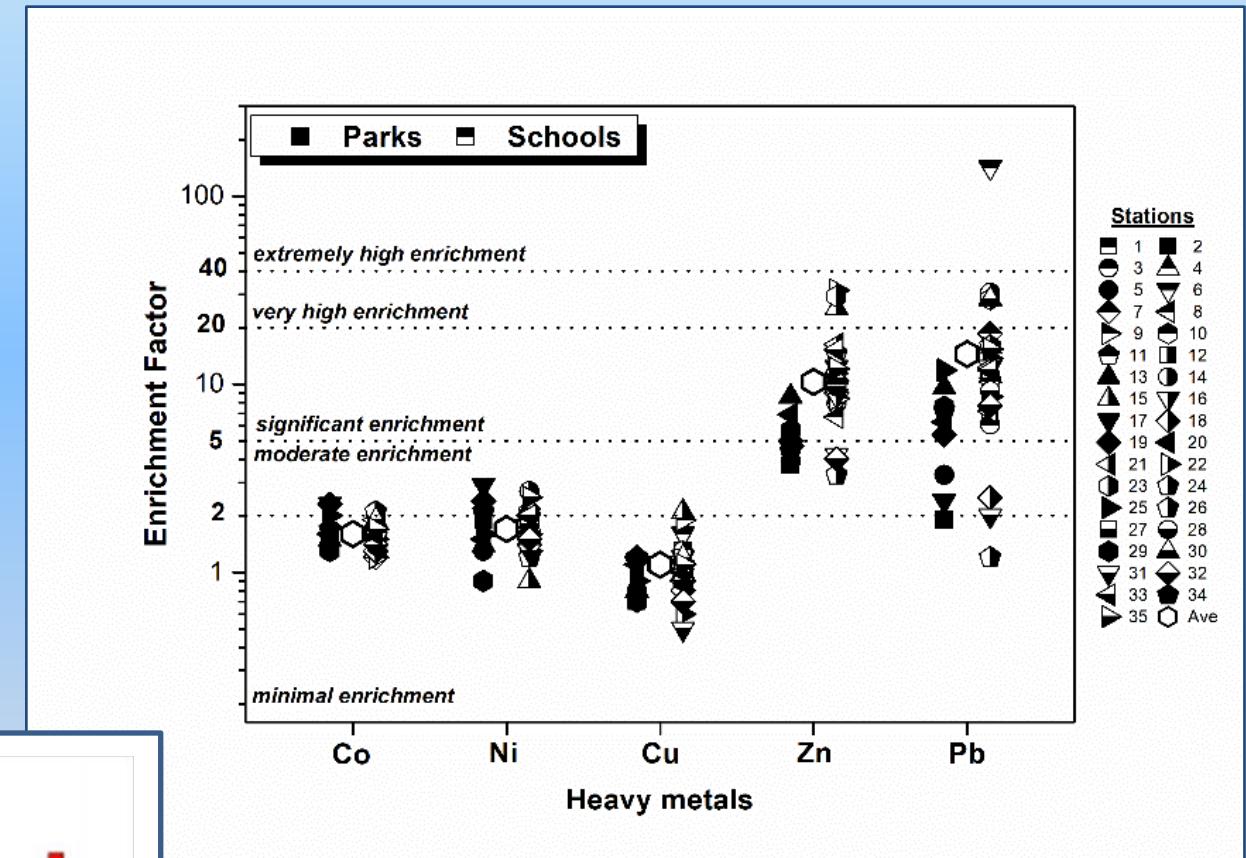
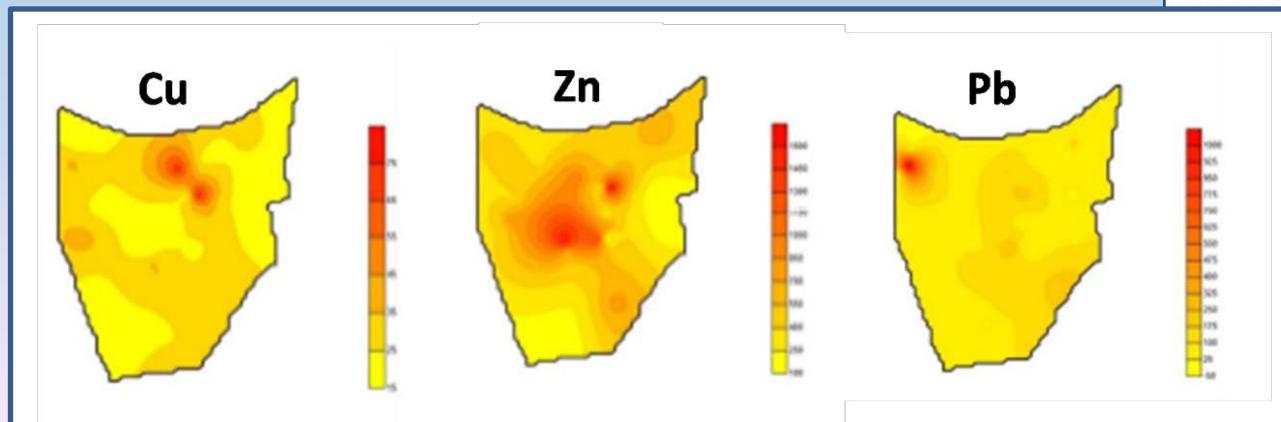
# Urban dust

# San Miguel del Padrón



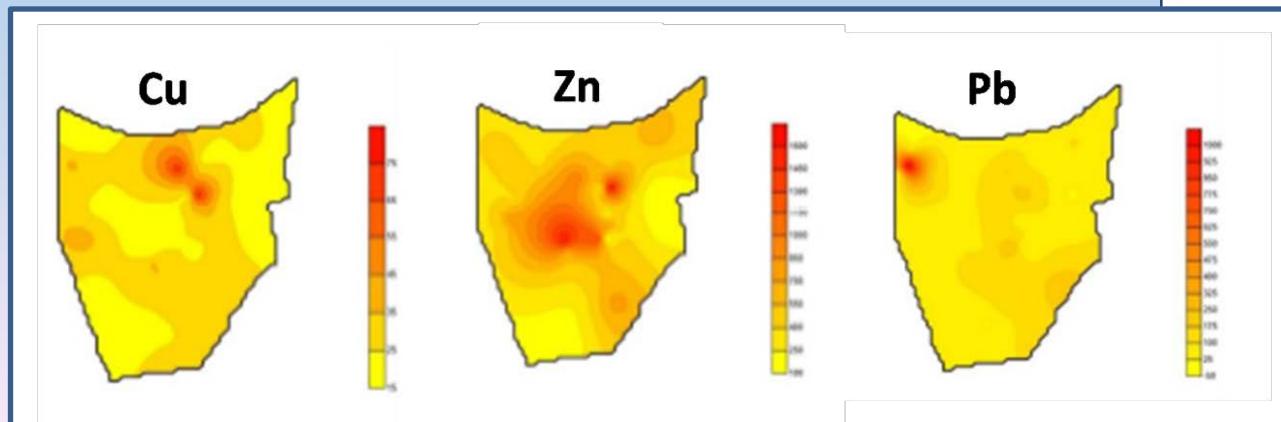
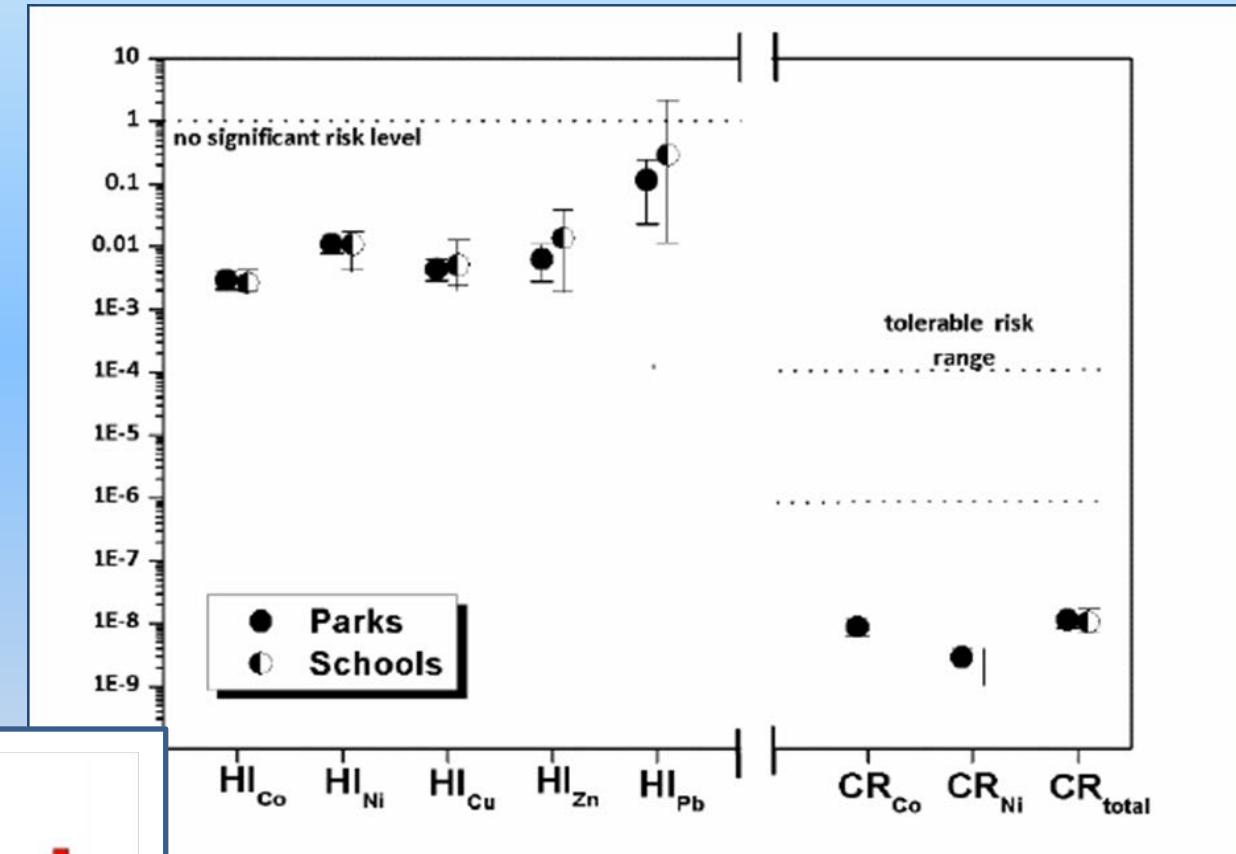
# Urban dust

# Centro Habana



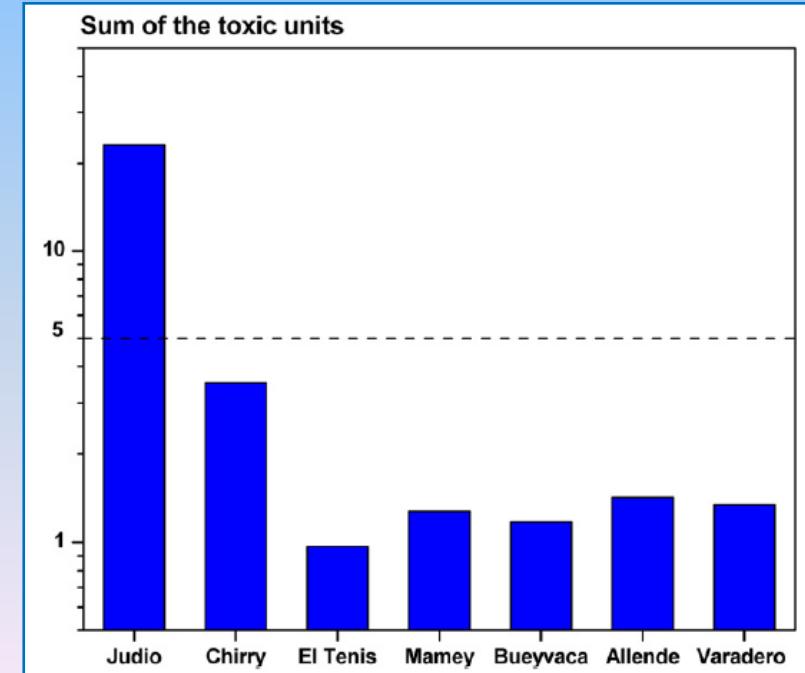
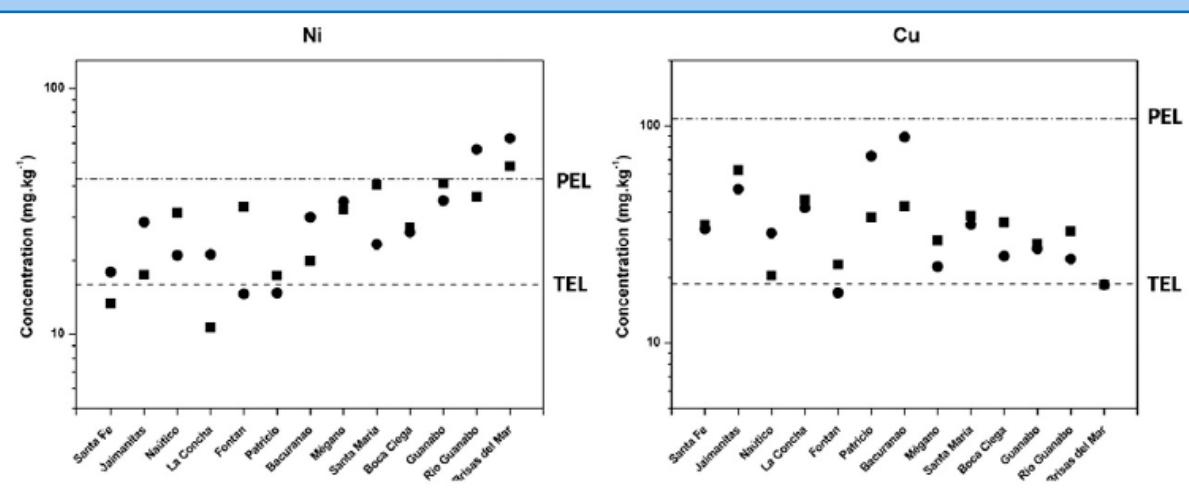
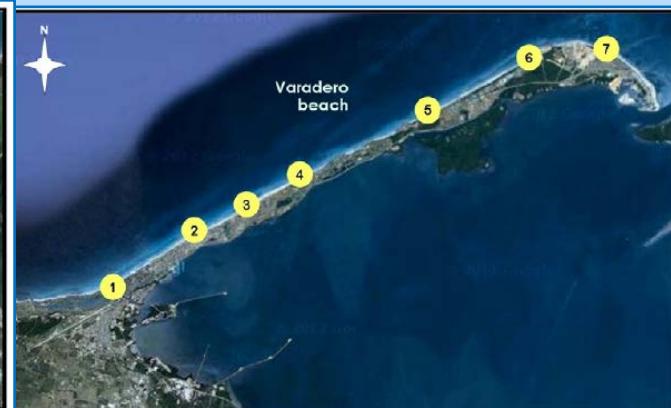
# Urban dust

Centro Habana



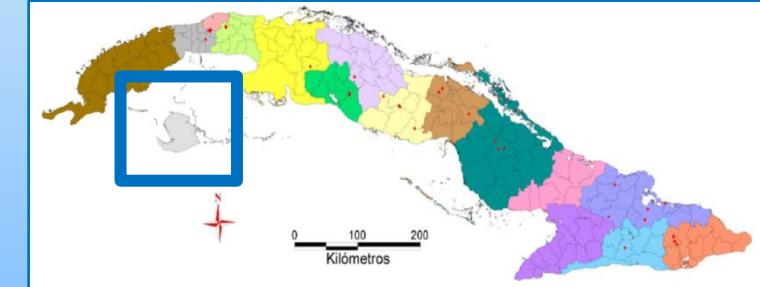
# Beach sands

First studies

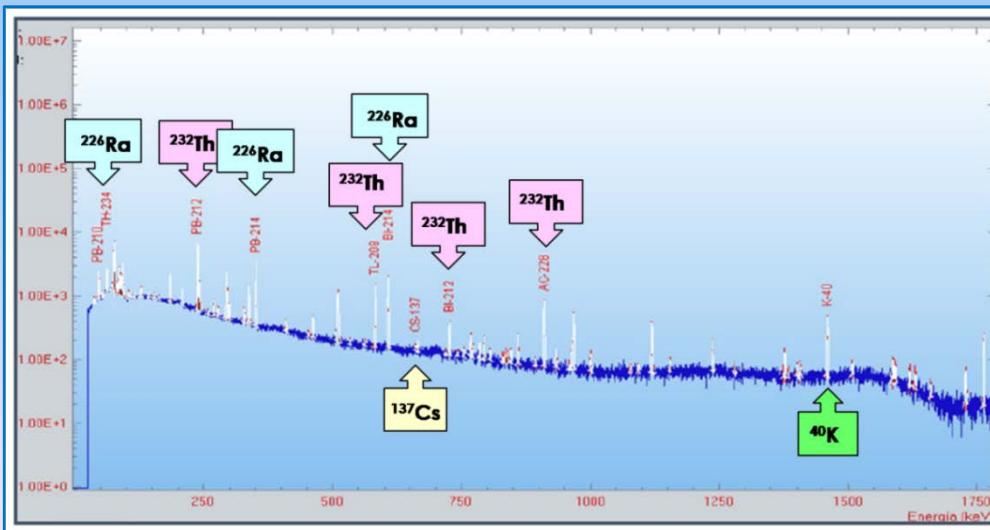


# Black sands

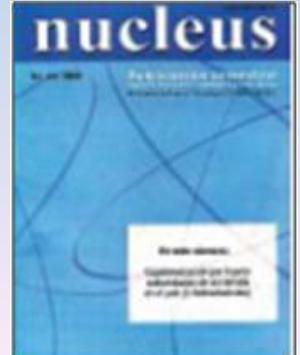
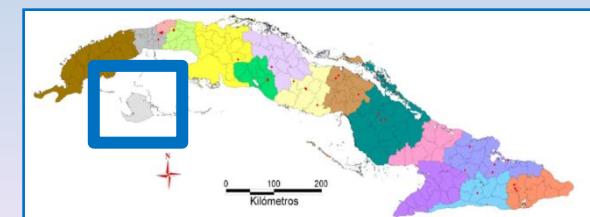
# Bibijagua beach



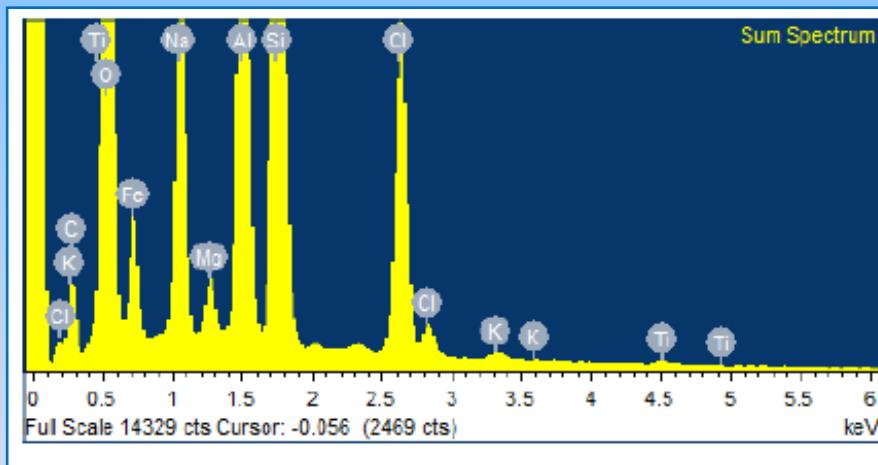
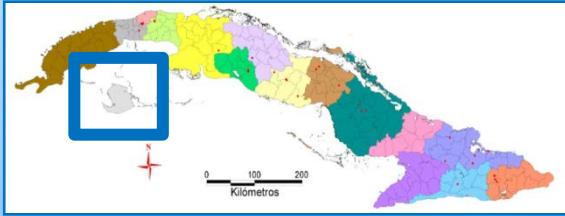
## Black sands



Locations	D (nGy.h <sup>-1</sup> )	R <sub>a</sub> <sub>eq</sub> (Bq.kg <sup>-1</sup> )	H <sub>ex</sub>	I <sub>γ</sub>	AEDE (μSv.y <sup>-1</sup> )
Bibijagua, Cuba	49	131	0.3	0.4	60
Mandena, Madagascar	10841	26586	68.5	88.2	13296
Baltim, Egypt	190	597	1.2	1.5	233
Areia Preta, Brazil	3739	8972	23.9	30.9	4586
Rashid, Egypt	156	677	0.9	1.2	191
Miami Bay, Malaysia	1748	4299	10.6	14.0	2144
Temsa Lake, Egypt	26	279	0.1	0.2	31
Permissible levels	51	370	≤ 1	≤ 1	70

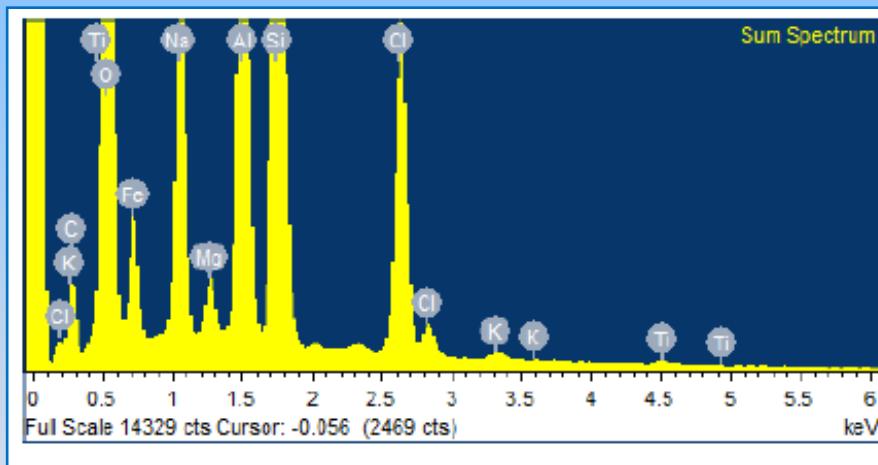
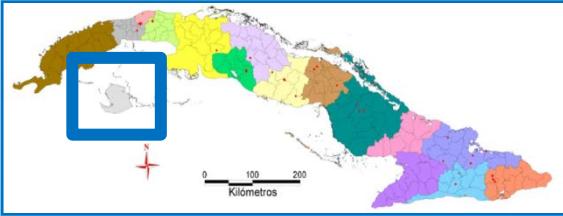


## Black sands



Locations	Cr	Mn	Ni	Cu	Zn	Pb
Bibijagua, Cuba	165	1019	20	11	804	11
Nile Delta, Egypt	1814	--	--	--	672	--
Langkawi, Malaysia	34	451	--	12	--	--
Nile Valley, Egypt	176	836	48	--	69	--
Abe Kashaba, Egypt	2515	596	--	--	250	--
Mandena, Madagascar	2515	2320	1.4	5.7	14	61
Garanbeta, India	280	1052	226	--	606	385
USEPA (2001)	LEL	26	460	16	16	120
	SEL	110	1100	75	110	820
						250

## Black sands



Locations	Cr	Mn	Ni	Cu	Zn	Pb
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	SEL	110	1100	75	110	820
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# Beach sands

# Study areas





Cayo Coco

Locations	$^{232}\text{Th}$	$^{226}\text{Ra}$	$^{40}\text{K}$	$^{137}\text{Cs}$
La Coloma	$37 \pm 1$	$19 \pm 1$	$40 \pm 8$	$0.6 \pm 0.2$
Cajío	$6 \pm 3$	$6 \pm 1$	$47 \pm 7$	$< 0.4$
Rancho Luna	$2.6 \pm 0.5$	$4.5 \pm 0.7$	$274 \pm 12$	$< 0.4$
Cayo Coco	$4.6 \pm 0.6$	$12 \pm 1$	$10.6 \pm 0.7$	$0.8 \pm 0.1$
Cayo Guillermo	$2.1 \pm 0.4$	$5.7 \pm 0.7$	$135 \pm 8$	$< 0.4$
Guardalavaca	$1.5 \pm 0.4$	$2.1 \pm 0.7$	$15 \pm 7$	$0.6 \pm 0.2$
Xiamen, China	$11 \pm 8$	$15 \pm 4$	$396 \pm 75$	NR
Tamil Nadú, India	$6 \pm 1$	$13 \pm 4$	$379 \pm 4$	NR
El Inglés, Spain	$31 \pm 2$	$23 \pm 1$	$736 \pm 32$	NR
Penang, Malasya	$38 \pm 6$	$21 \pm 8$	$369 \pm 17$	NR
UNSCEAR	30	35	400	-



Cayo Coco

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UNSCEAR	30	35	400	-



Rancho Luna

Locations	D (nGy.h <sup>-1</sup> )	Ra <sub>eq</sub> (Bq.kg <sup>-1</sup> )	H <sub>ex</sub>	I <sub>γ</sub>	AEDE (μSv.y <sup>-1</sup> )
La Coloma	30	93	0.18	0.23	37
Cajío	8	51	0.2	0.05	10
Rancho Luna	15	219	0.09	0.12	18
Cayo Coco	8	26	0.05	0.06	10
Cayo Guillermo	10	113	0.05	0.07	12
Guardalavaca	3	16	0.01	0.02	3
Xiamen, China	30	335	0.16	0.34	37
Tamil Nadú, India	25	313	0.14	0.20	31
El Inglés, Spain	59	626	0.33	0.47	73
Penang, Malasya	51	367	0.30	0.41	63
Permissible levels	51	370	≤ 1	< 1	70



Guardalavaca

Locations	Ni	Cu	Zn	Pb
Cajío	10	20	19	12
Rancho Luna	22	13	30	23
Cayo Coco	13	11	4.2	7.3
Cayo Guillermo	17	22	6.0	7.8
Guardalavaca	16	6.2	5.3	8.4
Varadero, Cuba	19	42	16	6.0
Santa María, Cuba	41	39	20	4.2
Acapulco, México	3.4	6.3	19	3.8
Lutong, Malaysia	18	29	18	13
USEPA (2001)	LEL	16	16	120
	SEL	75	110	820
				250

## Beach sands



Guardalavaca

Locations		Ni	Cu	Zn	Pb
Cajío		10	20	19	12
Rancho Luna		22	13	30	23
Cayo Coco		13	11	4.2	7.3
Cayo Guillermo		17	22	6.0	7.8
Guardalavaca		16	6.2	5.3	8.4
Varadero, Cuba		19	42	16	6.0
Santa María, Cuba		41	39	20	4.2
Acapulco, México		3.4	6.3	19	3.8
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USEPA (2001)	LEL	16	16	120	31
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*Granma*

(/)

ÓRGANO OFICIAL DEL COMITÉ CENTRAL DEL  
PARTIDO COMUNISTA DE CUBA

## Cuba emplea, por primera vez, la tecnología nuclear para el estudio de arenas de playas

Es un proyecto del programa Sectorial Tecnologías de aplicaciones nucleares, el láser, la óptica y la ultrasónica para producir bienes y servicios, bajo dirección de la STECNU.

Autor: Ortelio González Martínez  
(mailto:internet@granma.cu)  
31 de marzo de 2023 14:03:

d\*cuba

[INICIO](#) > [ACTUALIDAD](#) > ESTUDIA CUBA POR PRIMERA VEZ NIVELES DE RADIOACTIVIDAD EN LAS ARENAS DE SUS PLAYAS

Noticias de Cuba

## Estudia Cuba por Primera Vez Niveles de Radioactividad en las Arenas de sus Playas



Playas de Jardines del Rey son seguras, según estudio científico

Turismo por Rosy Amaro - 8 abril, 2023



Las playas del destino turístico Jardines del Rey, al norte de Ciego de Ávila, son seguras para los visitantes, certificó un estudio científico con el empleo de tecnologías nucleares.

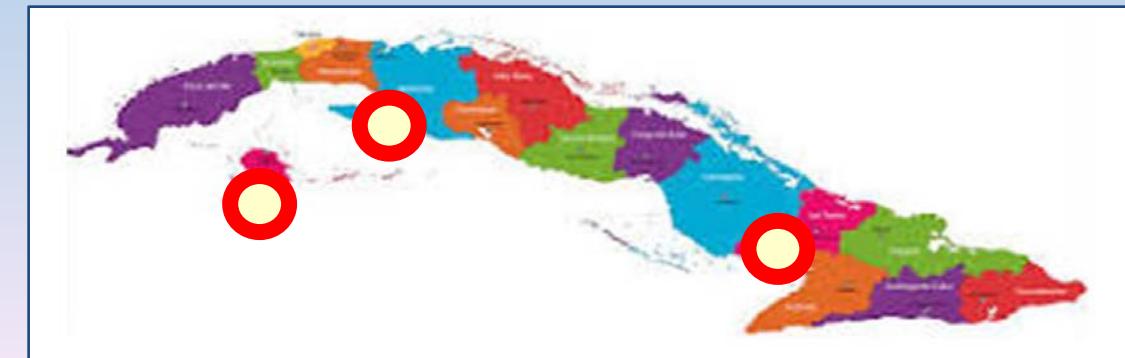
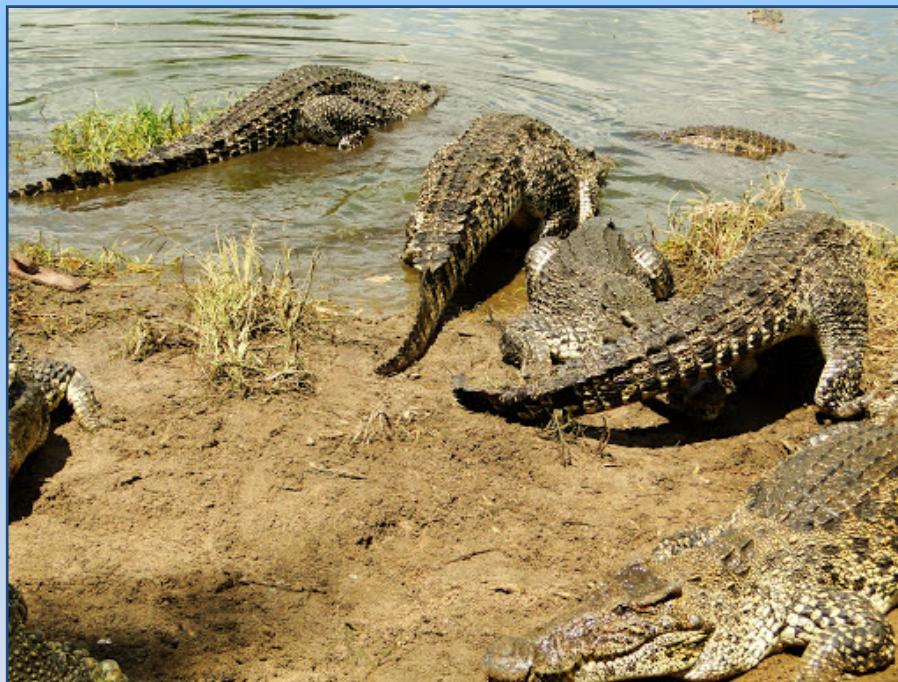
La investigación determinó que los niveles de metales pesados y radiactividad en arenas de las mencionadas playas no son nocivos al ser humano ni a las especies de la fauna que

habitan en ese lugar, informó el gobierno local en su portal en Facebook.

# Beach sands

2024-2025





**Thanks, and see you in Havana!!!**



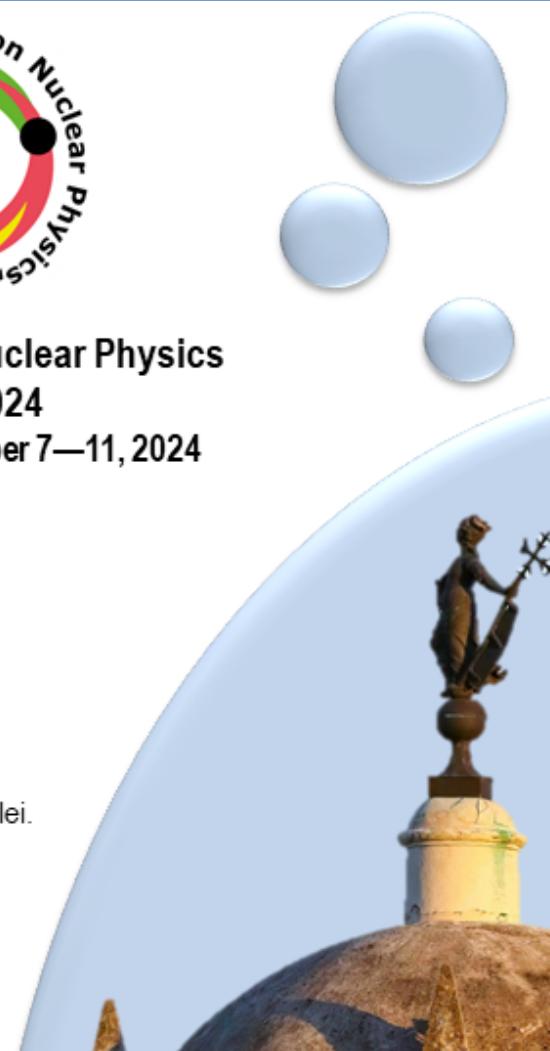
**XIX Workshop on Nuclear Physics  
WONP-2024  
Havana, Cuba, October 7–11, 2024**

**TOPICS**

- High Energy Physics, Astrophysics and Cosmology.
- Medical Physics and Radiation Protection.
- Nuclear Analytical Techniques and Applications.
- Nuclear Instrumentation and Facilities.
- Nuclear Structure, Nuclear Reactions, and Exotic Nuclei.
- Fundamental Interactions and Neutrino physics.

**CALL FOR ABSTRACTS**

- Abstracts Deadline: September 1st, 2024
- Official language: English



**CONTACT and WEB PAGE**

Inquiries related to the conference should be sent to [wonp@instec.uh.cu](mailto:wonp@instec.uh.cu). The official conference website is <http://wonp.instituto.cu>



**We hope to see you in Havana on the occasion of  
WONP-2024**

