

BIOLOGICAL MONITORING OF EXPOSURE TO POLYCYCLIC AROMATIC HYDROCARBONS (PAHs) AND TO METALLIC ELEMENTS IN ITALIAN NAVY WORKERS OPERATING NEAR THE INDUSTRIAL AREA IN TARANTO (SOUTH ITALY).

MONITORAGGIO BIOLOGICO DELL'ESPOSIZIONE A IDROCARBURI POLICICLICI AROMATICI (IPA) E AD ELEMENTI METALLICI NEI LAVORATORI DELLA MARINA MILITARE ITALIANA CHE LAVORAVANO IN PROSSIMITA' DELL'AREA INDUSTRIALE DI TARANTO (SUD-ITALIA).

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Table A: Urinary concentrations of 1-hydroxypyrene ($\mu\text{g/g creat}$) and 2-naphthol ($\mu\text{g/L}$) in the workers subdivided by group and by residence zone.

Tabella A: Concentrazioni urinarie di 1-idrossipirene ($\mu\text{g/g creat}$) e 2-naftolo ($\mu\text{g/L}$) nei lavoratori suddivisi per gruppo e per zona del domicilio.

Biomarkers	Residence zone in Taranto	EXPOSED WORKERS (N. 145)				INTERNAL CONTROLS (N. 142)			
		N.	Mean \pm SD	Median	Range	N.	Mean \pm SD	Median	Range
1-hydroxypyrene ($\mu\text{g/g creat}$)	Center	86	0.12 \pm 0.15	0.07	<0.03-1.08	61	0.11 \pm 0.11	0.06	<0.03-0.46
	Districts	59	0.12 \pm 0.10	0.08	<0.03-0.43	81	0.10 \pm 0.11	0.06	<0.03-0.63
2-naphthol ($\mu\text{g/L}$)	Center	86	9.3 \pm 10.2	6.0	0.9-74.9	61	10.0 \pm 15.7	5.8	0.5-111.0
	Districts	59	11.2 \pm 16.9	6.5	1.6-104.0	81	8.7 \pm 7.6	5.8	1.5-40.6

- Center vs districts: all not significant.

- Exposed workers vs internal controls: 1-hydroxypyrene, districts $p=0.031$.

Table B: Urinary concentrations of 1-hydroxypyrene ($\mu\text{g/g creat}$) and 2-naphthol ($\mu\text{g/L}$) in the workers subdivided by group and residence area.

Tabella B: Concentrazioni urinarie di 1-idrossipirene ($\mu\text{g/g creat}$) e 2-naftolo ($\mu\text{g/L}$) nei lavoratori suddivisi per gruppo e per area del domicilio.

Biomarkers	Residence area	EXPOSED WORKERS (N. 145)				INTERNAL CONTROLS (N. 142)				EXTERNAL CONTROLS (N. 147)			
		N.	Mean \pm SD	Median	Range	N.	Mean \pm SD	Median	Range	N.	Mean \pm SD	Median	Range
1-hydroxypyrene ($\mu\text{g/g creat}$)	Urban	90	0.12 \pm 0.15	0.06	<0.03-1.08	88	0.11 \pm 0.11	0.06	<0.03-0.46	107	0.12 \pm 0.12	0.07	<0.03-0.65
	Rural	55	0.12 \pm 0.10	0.08	<0.03-0.41	54	0.10 \pm 0.11	0.07	<0.03-0.63	40	0.11 \pm 0.08	0.09	<0.03-0.29
2-naphthol ($\mu\text{g/L}$)	Urban	90	8.8 \pm 9.9	6.0	0.9-74.9	88	9.3 \pm 13.3	5.8	0.5-111.0	107	10.9 \pm 10.8	6.9	0.9-52.1
	Rural	55	12.2 \pm 17.5	6.5	1.6-104.0	54	9.2 \pm 8.9	6.3	1.5-42.8	40	11.7 \pm 9.7	8.9	1.0-41.0

Table C: Urinary concentrations of 1-hydroxypyrene ($\mu\text{g/g creat}$) and 2-naphthol ($\mu\text{g/L}$) in the workers subdivided by group and by the presence of fast roads within 500 m of the home.

Tabella C: Concentrazioni urinarie di 1-idrossipirene ($\mu\text{g/g creat}$) e 2-naftolo ($\mu\text{g/L}$) nei lavoratori suddivisi per gruppo e per presenza di strade ad alto scorrimento entro 500 m dal domicilio.

Biomarkers	Fast roads within 500 m of the home	EXPOSED WORKERS (N. 145)				INTERNAL CONTROLS (N. 142)				EXTERNAL CONTROLS (N. 147)			
		N.	Mean \pm SD	Median	Range	N.	Mean \pm SD	Median	Range	N.	Mean \pm SD	Median	Range
1-hydroxypyrene ($\mu\text{g/g creat}$)	yes	18	0.13 \pm 0.13	0.08	<0.03-0.45	29	0.09 \pm 0.10	0.06	<0.03-0.41	17	0.07 \pm 0.04	0.07	<0.03-0.18
	no	127	0.12 \pm 0.13	0.07	<0.03-1.08	113	0.11 \pm 0.11	0.07	<0.03-0.63	130	0.12 \pm 0.11	0.07	<0.03-0.65
2-naphthol ($\mu\text{g/L}$)	yes	18	9.6 \pm 8.0	6.5	1.5-34.7	29	7.7 \pm 6.0	5.8	0.5-29.1	17	6.5 \pm 4.6	5.5	1.0-19.8
	no	127	10.2 \pm 14.0	6.0	0.9-104.0	113	9.6 \pm 12.8	5.8	1.2-111.0	130	11.7 \pm 10.8	7.6	0.9-52.1

Table D: Urinary concentrations of 1-hydroxypyrene ($\mu\text{g/g creat}$) and 2-naphthol ($\mu\text{g/L}$) in the workers subdivided by group and by the consumption of smoked and/or grilled foods within 24 hours of urine collection.

Tabella D: Concentrazioni urinarie di 1-idrossipirene ($\mu\text{g/g creat}$) e 2-naftolo ($\mu\text{g/L}$) nei lavoratori suddivisi per gruppo e per consumo di cibi affumicati e/o cotti alla brace nelle 24 ore precedenti la raccolta delle urine.

Biomarkers	Consumption of smoked and/or grilled foods within 24 hours of urine collection	EXPOSED WORKERS				INTERNAL CONTROLS				EXTERNAL CONTROLS			
		N.	Mean \pm SD	Median	Range	N.	Mean \pm SD	Median	Range	N.	Mean \pm SD	Median	Range
1-hydroxypyrene ($\mu\text{g/g creat}$)	yes	16	0.10 \pm 0.12	0.06	<0.03-0.45	7	0.07 \pm 0.05	0.05	<0.03-0.18	17	0.12 \pm 0.09	0.09	<0.03-0.35
	no	129	0.12 \pm 0.14	0.08	<0.03-1.08	135	0.11 \pm 0.11	0.06	<0.03-0.63	130	0.11 \pm 0.11	0.07	<0.03-0.65
2-naphthol ($\mu\text{g/L}$)	yes	16	7.3 \pm 8.4	3.7	1.9-31.5	7	4.6 \pm 1.9	4.1	2.4-7.3	17	15.1 \pm 14.1	10.3	1.7-52.1
	no	129	10.5 \pm 13.9	6.4	0.9-104.0	135	9.5 \pm 12.0	5.9	0.5-111.0	130	10.6 \pm 9.8	6.9	0.9-49.5

Table E: Correlation between urinary concentrations of 1-hydroxypyrene ($\mu\text{g/g creat}$) and 2-naphthol ($\mu\text{g/L}$) in the workers subdivided by group and by smoking habit verified on urinary cotinine: smokers: ≥ 200 ng/ml; non-smokers: < 200 ng/ml.

Tabella E: Correlazione tra le concentrazioni urinarie di 1-idrossipirene ($\mu\text{g/g creat}$) e di 2-naftolo ($\mu\text{g/L}$) nei lavoratori suddivisi per gruppo e per abitudine tabagica verificata attraverso cotinina urinaria: fumatori: ≥ 200 ng/ml; non fumatori: < 200 ng/ml.

Biomarker	Group	Smoking habit	2-naphthol ($\mu\text{g/L}$)
1-hydroxypyrene ($\mu\text{g/g creat}$)	Exposed workers (N. 145)	Non-smokers	-0.07
		Smokers	0.68 ^b
		Total	0.31 ^b
	Internal controls (N. 142)	Non-smokers	-0.23 ^a
		Smokers	0.41 ^a
		Total	0.12
	External controls (N. 147)	Non-smokers	0.18
		Smokers	0.72 ^b
		Total	0.43 ^b

^a $p < 0.05$, ^b $p < 0.001$

Table F: Urinary concentrations of the metallic elements ($\mu\text{g/L}$) in the workers subdivided by group and residence zone.

Tabella F: Concentrazioni urinarie degli elementi metallici ($\mu\text{g/L}$) nei lavoratori suddivisi per gruppo e per zona del domicilio.

Biomarkers ($\mu\text{g/L}$)	Residence Zone in Taranto	EXPOSED WORKERS (N. 106)				INTERNAL CONTROLS (N. 106)			
		N.	Mean \pm SD	Median	Range	N.	Mean \pm SD	Median	Range
Cr	Center	64	0.18 \pm 0.21	0.10	<0.05-1.30	46	0.22 \pm 0.23	0.16	<0.05-1.19
	Districts	42	0.18 \pm 0.20	0.11	<0.05-0.87	60	0.31 \pm 0.31	0.23	<0.05-1.25
Mn	Center	64	0.87 \pm 0.73	0.70	0.10-3.90	46	0.94 \pm 0.53	0.80	0.20-2.40
	Districts	42	0.89 \pm 0.68	0.70	0.10-2.80	60	0.93 \pm 0.61	0.80	0.10-3.30
Co	Center	64	0.41 \pm 0.25	0.38	0.08-1.11	46	0.57 \pm 0.47	0.45	0.12-2.44
	Districts	42	0.55 \pm 0.62	0.44	0.10-3.40	60	0.41 \pm 0.26	0.34	<0.05-1.46
Cu	Center	64	13.1 \pm 7.7	11.8	2.5-49.0	46	11.4 \pm 7.1	11.1	1.0-31.1
	Districts	42	12.5 \pm 5.5	11.9	2.4-24.6	60	13.0 \pm 6.8	12.6	1.0-32.8
Zn	Center	64	312.2 \pm 264.0	233.0	21.0-1182.0	46	304.5 \pm 229.8	254.5	37.0-1088.0
	Districts	42	327.7 \pm 252.1	289.0	31.0-1117.0	60	318.5 \pm 194.0	308.5	42.0-731.0
Cd	Center	63	0.27 \pm 0.28	0.18	<0.05-1.50	46	0.28 \pm 0.22	0.20	0.06-1.04
	Districts	42	0.29 \pm 0.20	0.26	<0.05-0.95	60	0.32 \pm 0.24	0.28	<0.05-1.23
Hg	Center	64	0.69 \pm 0.87	0.41	0.10-5.20	46	0.62 \pm 0.78	0.34	0.10-4.20
	Districts	42	0.51 \pm 0.35	0.42	0.10-1.20	60	0.48 \pm 0.45	0.36	0.10-2.67
Pb	Center	64	0.48 \pm 0.35	0.41	0.10-1.80	46	0.43 \pm 0.19	0.39	0.10-1.00
	Districts	42	0.60 \pm 0.60	0.44	0.10-3.00	60	0.46 \pm 0.26	0.44	0.10-1.38
As	Center	64	6.7 \pm 8.7	4.2	1.0-57.0	46	5.1 \pm 4.5	3.9	1.0-19.3
	Districts	42	4.8 \pm 5.1	3.4	1.0-21.7	60	5.0 \pm 5.4	3.4	1.0-33.0
Ni	Center	64	0.87 \pm 0.92	0.60	0.10-4.10	46	0.92 \pm 0.98	0.50	0.10-3.50
	Districts	42	0.92 \pm 1.00	0.50	0.10-4.70	60	0.98 \pm 0.89	0.70	0.10-4.40

Center vs districts: exposed workers and internal controls all not significant.

Exposed workers vs internal controls: center: all not significant; districts: Cr p=0.049

Table G: Urinary concentrations of the metallic elements (µg/L) in the workers subdivided by group and residence area.

Tabella G: Concentrazioni urinarie degli elementi metallici (µg/L) nei lavoratori suddivisi per gruppo e per area del domicilio.

Biomarkers (µg/L)	Residence Area	EXPOSED WORKERS (N. 106)				INTERNAL CONTROLS (N. 106)				EXTERNAL CONTROLS (N. 107)			
		N.	Mean±SD	Median	Range	N.	Mean±SD	Median	Range	N.	Mean±SD	Median	Range
Cr	Urban	69	0.18±0.22	0.10	<0.05-1.30	65	0.24±0.25	0.16	<0.05-1.19	80	0.19±0.37	0.10	<0.05-2.99
	Rural	37	0.20±0.17	0.20	<0.05-0.87	41	0.32±0.31	0.22	<0.05-1.25	27	0.18±0.20	0.17	<0.05-0.89
Mn	Urban	69	0.80±0.73	0.60	0.10-3.90	65	0.94±0.60	0.80	0.10-3.3	80	0.71±0.68	0.50	0.10-4.0
	Rural	37	1.02±0.65	1.00	0.10-2.80	41	0.91±0.53	0.90	0.1-2.2	27	0.81±0.97	0.60	0.10-5.30
Co	Urban	69	0.39±0.24	0.36	0.08-1.11	65	0.52±0.42	0.39	<0.05-2.44	80	0.44±0.27	0.42	<0.05-1.33
	Rural	37	0.61±0.64	0.48	0.10-3.40	41	0.41±0.26	0.35	0.11-1.46	27	0.50±0.31	0.47	<0.16-1.80
Cu	Urban	69	11.9±7.5	10.0	2.4-49.0	65	12.17±7.11	11.4	1.0-31.1	80	14.4±6.3	14.2	2.3-37.2
	Rural	37	14.8±5.1	14.5	6.0-24.6	41	12.5±6.6	11.7	1.0-32.8	27	17.8±6.8	17.9	8.2-37.8
Zn	Urban	69	287.0±237.9	231.0	21.0-1182.0	65	316.9±226.9	253.0	37.0-1088.0	80	354.2±288.9	288.5	20.0-1315.0
	Rural	37	376.7±286.8	310.0	31.0-1148.0	41	305.29±180.5	305.0	42.0-731.0	27	472.5±299.9	423.0	95.0-1198.0
Cd	Urban	68	0.25±0.25	0.18	<0.05-1.50	65	0.29±0.22	0.22	0.06-1.04	80	0.33±0.31	0.25	<0.05-2.3
	Rural	37	0.32±0.24	0.30	<0.05-0.95	41	0.31±0.23	0.27	<0.05-1.23	27	0.44±0.71	0.29	0.09-3.90
Hg	Urban	69	0.59±0.80	0.27	0.10-5.20	65	0.56±0.68	0.35	0.10-4.20	80	0.82±0.69	0.63	0.10-3.60
	Rural	37	0.68±0.49	0.55	0.10-2.30	41	0.51±0.50	0.35	0.10-2.67	27	0.81±0.89	0.53	0.10-3.40
Pb	Urban	69	0.45±0.40	0.33	0.10-2.40	65	0.43±0.21	0.38	0.10-1.0	80	0.59±0.56	0.45	0.10-3.90
	Rural	37	0.66±0.55	0.56	0.10-3.00	41	0.47±0.27	0.45	0.10-1.38	27	0.78±0.67	0.54	0.14-3.20
As	Urban	69	5.0±4.8	3.5	1.0-26.9	65	5.58±5.9	3.60	1.0-33.0	80	9.6±10.5	6.6	1.0-64.6
	Rural	37	7.8±10.7	4.2	1.0-57.0	41	4.16±2.9	3.3	1.0-14.0	27	11.11±10.45	6.8	1.8-48.2
Ni	Urban	69	0.82±0.89	0.50	0.10-4.10	65	1.02±0.98	0.70	0.10-3.80	80	0.84±0.64	0.70	0.10-3.60
	Rural	37	1.01±1.05	0.70	0.10-4.70	41	0.82±0.83	0.60	0.10-4.40	27	1.01±0.92	0.90	0.10-4.60

Urban vs rural: Exposed workers: Mn p=0.020, Co p=0.006, Cu p=0.002, Cd p=0.034, Hg p=0.022, Pb p=0.012; Internal controls: all not significant; External controls: Cu p=0.025, Zn p=0.032

Table H: Urinary concentrations of mercury ($\mu\text{g/L}$) in the workers subdivided by group and by dental amalgam fillings.

Tabella H: Concentrazioni urinarie del mercurio ($\mu\text{g/L}$) nei lavoratori suddivisi per gruppo e per presenza di amalgami dentari.

Biomarker ($\mu\text{g/L}$)	Dental amalgam fillings	EXPOSED WORKERS (N. 106)				INTERNAL CONTROLS (N. 106)				EXTERNAL CONTROLS (N. 107)			
		N.	Mean \pm SD	Median	Range	N.	Mean \pm SD	Median	Range	N.	Mean \pm SD	Median	Range
Hg	yes	66	0.70 \pm 0.82	0.50	0.10-5.20	67	0.58 \pm 0.65	0.36	0.10-4.20	61	0.89 \pm 0.76	0.66	0.10-3.40
	no	40	0.50 \pm 0.48	0.37	0.10-2.30	39	0.48 \pm 0.55	0.20	0.10-2.80	46	0.74 \pm 0.72	0.51	0.10-3.60

Amalgam fillings yes/no: always not significant.

Table I: Urinary concentrations of arsenic ($\mu\text{g/L}$) in workers subdivided by group and by the consumption of shellfish and/or crustaceans.

Tabella I: Concentrazioni urinarie dell'arsenico ($\mu\text{g/L}$) nei lavoratori suddivisi per gruppo e per consumo di molluschi e/o crostacei.

Biomarker ($\mu\text{g/L}$)	Consumption of shellfish and/or crustaceans	EXPOSED WORKERS (N. 106)				INTERNAL CONTROLS (N. 106)				EXTERNAL CONTROLS (N. 107)			
		N.	Mean \pm SD	Median	Range	N.	Mean \pm SD	Median	Range	N.	Mean \pm SD	Median	Range
As	Last meal within 24 hours of urine collection	8	13.5 \pm 9.4	14.2	1.8-26.9	4	7.6 \pm 9.1	4.2	1.0-21.1	13	22.9 \pm 13.6	23.1	8.4-48.3
	Last meal within 24-48 hours of urine collection	2	7.1 \pm 2.0	7.1	5.7-8.5	10	8.2 \pm 6.1	7.7	1.0-17.5	5	8.3 \pm 7.8	4.8	1.8-20.5
	Last meal within 48-72 hours of urine collection	6	5.9 \pm 4.5	4.0	1.0-12.2	8	3.9 \pm 2.1	4.2	1.0-7.0	8	9.5 \pm 6.5	7.2	1.0-18.5
	No seafood within 72 hours of urine collection	90	5.3 \pm 7.3	3.5	1.0-57.0	84	4.6 \pm 4.7	3.3	1.0-33.0	81	8.1 \pm 8.9	5.6	1.0-64.6

Trend for the consumption of shellfish and/or crustaceans: Exposed workers $p=0.031$, internal controls not significant, external controls $p<0.001$

Table L: Correlations among the urinary concentrations of metallic elements ($\mu\text{g/L}$) in the workers subdivided by group.
 Tabella L: Correlazioni tra le concentrazioni urinarie degli elementi metallici ($\mu\text{g/L}$) nei lavoratori suddivisi per gruppo.

Metallic elements ($\mu\text{g/L}$)	Group	Cr	Mn	Co	Cu	Zn	Cd	Hg	Pb	As
Mn	Exposed workers	0.41 ^c	-							
	Internal Controls	0.33 ^c	-							
	External Controls	0.49 ^c	-							
Co	Exposed workers	0.27 ^b	0.67 ^c	-						
	Internal Controls	0.21 ^a	0.60 ^c	-						
	External Controls	0.36 ^c	0.74 ^c	-						
Cu	Exposed workers	0.18	0.59 ^c	0.72 ^c	-					
	Internal Controls	0.38 ^c	0.45 ^c	0.43 ^c	-					
	External Controls	0.32 ^b	0.37 ^c	0.45 ^c	-					
Zn	Exposed workers	0.20 ^a	0.53 ^c	0.56 ^c	0.62 ^c	-				
	Internal Controls	0.12	0.38 ^c	0.38 ^c	0.35 ^c	-				
	External Controls	0.36 ^c	0.49 ^c	0.60 ^c	0.47 ^c	-				
Cd	Exposed workers	0.17	0.52 ^c	0.57 ^c	0.62 ^c	0.59 ^c	-			
	Internal Controls	0.28 ^b	0.30 ^b	0.43 ^c	0.48 ^c	0.47 ^c	-			
	External Controls	0.30 ^b	0.40 ^c	0.51 ^c	0.45 ^c	0.55 ^c	-			
Hg	Exposed workers	0.24 ^a	0.45 ^c	0.50 ^c	0.54 ^c	0.50 ^c	0.56 ^c	-		
	Internal Controls	-0.08	0.08	0.20 ^a	0.19	0.33 ^b	0.24 ^a	-		
	External Controls	0.28 ^b	0.25 ^a	0.42 ^c	0.31 ^b	0.28 ^b	0.42 ^c	-		
Pb	Exposed workers	0.16	0.50 ^c	0.61 ^c	0.58 ^c	0.62 ^c	0.65 ^c	0.50 ^c	-	
	Internal Controls	0.13	0.28 ^b	0.36 ^c	0.34 ^c	0.49 ^c	0.43 ^c	0.20 ^a	-	
	External Controls	0.33 ^b	0.39 ^c	0.54 ^c	0.36 ^c	0.54 ^c	0.54 ^c	0.30 ^b	-	
As	Exposed workers	0.17	0.17	0.32 ^c	0.52 ^c	0.40 ^c	0.30 ^b	0.43 ^c	0.25 ^b	-
	Internal Controls	0.15	0.16	0.11	0.27 ^b	0.05	0.09	0.10	0.09	-
	External Controls	0.12	0.16	0.37 ^c	0.24 ^a	0.23 ^a	0.14	0.34 ^c	0.37 ^c	-
Ni	Exposed workers	0.21 ^a	0.29 ^b	0.44 ^c	0.42 ^c	0.25 ^a	0.35 ^c	0.26 ^b	0.34 ^c	0.24 ^a
	Internal Controls	0.21 ^a	0.14	0.42 ^c	0.31 ^b	0.31 ^b	0.31 ^b	0.35 ^c	0.24 ^a	-0.04
	External Controls	0.20 ^a	0.35 ^c	0.52 ^c	0.38 ^c	0.33 ^b	0.28 ^b	0.27 ^b	0.44 ^c	0.40 ^c

^ap<0.05, ^bp<0.01, ^cp<0.001

Table M: Reference values for urinary 1-hydroxypyrene ($\mu\text{g/g creat}$) and 2-naphthol ($\mu\text{g/L}$).

Tabella M: Valori di riferimento dell'1-idrossipirene ($\mu\text{g/g creat}$) e del 2-naftolo ($\mu\text{g/L}$) urinari.

Biomarkers	SIVR Reference values (List 2017) 5 th - 95 th percentile (24)	US NHANES 2011-2012 (537 smoker males and 612 non smoker males - aged more than 20 years) 95 th percentile (29)	Korea National Survey 2012 (1484 males - aged more than 20 years) 95 th percentile (39)	German Environmental Survey 1998 (573 males – aged 18-69 years 95 th percentile) (48)
1-hydroxypyrene ($\mu\text{g/g creat}$)				
- smokers	0.05-0.46*	0.80	0.72	0.73
- non smokers	<0.05-0.23*	0.32	0.43	0.26
- total	-	-	0.51	0.48
2-naphthol ($\mu\text{g/L}$)				
- smokers	nd-49.4**	51.6	45.7	-
- non smokers	nd-18.3**	15.8	25.3	-
- total	-	-	33.7	-

*Unpublished data collected in Tuscany (Italy); **Taken from NHANES US data including both males and females.

Table N: Reference values of the metallic elements ($\mu\text{g/L}$).

Tabella N: Valori di riferimento degli elementi metallici urinari ($\mu\text{g/L}$).

Biomarkers ($\mu\text{g/L}$)	SIVR Reference value (List 2017) 5 th -95 th percentile (24)	US NHANES 2013-2014 (1811 males and females - age >20 anni) 95 th percentile (29)	UK HSE Survey 2014 (132 males and females - adults) 95 th percentile (28)	Belgian Survey 2013 (1022 males and females - adults) 95 th percentile (18)	French IMEPOGE Study 2008-2010 (942 males - adults) 95 th percentile (32)
Cr	0.05-0.60	-	0.79	0.45	1.54
Mn	0.04-1.5	0.28	0.46	0.36	1.07
Co	0.08-2.2	1.23	1.04	1.00	1.52
Cu	5.01-24.0	-	19.33	19.6	-
Zn	nd-1048	-	730	1050	1101
Cd	0.1-0.9	0.97	0.52	1.06	1.36
Hg	0.1-5.0	1.76	2.81	1.88	6.84
Pb	0.17-2.64	1.27	7.63	2.81	4.26
As	nd-16.1	14.8	-	-	-
Ni	0.37-4.44	-	6.35	4.73	5.78