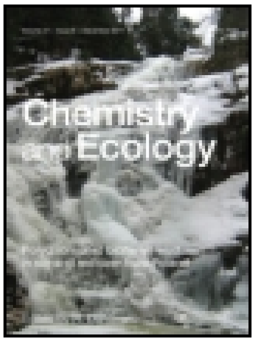

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RESEARCH ARTICLE

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Trace element content in soils of the King George and Elephant islands, maritime Antarctica

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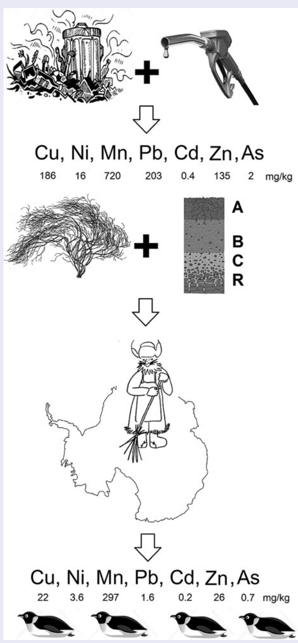
ABSTRACT

Trace element concentrations were studied in soils of the King George and Elephant islands in the maritime part of West Antarctica. The lowest concentrations of Cu, Pb, Cd, Zn, Ni and Mn were typical for the pristine soil of Elephant Island. The highest concentrations of these elements were found in the Fildes Peninsula and revealed the influence of human activities in the area of the Bellingshausen station and adjacent waste disposal sites. Ornithogenic soils of the Fildes Peninsula have shown low concentrations of Cd and As. Using geoaccumulation indexes, all the pristine soils of King George and Elephant islands and ornithogenic soils of the Fildes Peninsula were classified as unpolluted; the human-affected soils were mainly identified as moderately polluted. Obtained data can be used as background concentration levels for further researches.



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Highlights

- Soils of three islands in maritime Antarctica investigated
- Heavy metal pollution assessed
- Human-affected soils are moderately polluted

1. Introduction

Environmental risks in Antarctica have increased significantly in the recent decades due to an increasing number of visitors, formation of waste disposals and spontaneous contamination during different anthropogenic effect. One of the most serious sources of contamination is fuel spills [1] and exhaust from diesel energy stations on the seasonal and wintering stations [2,3]. Up to 200 tons fuel used to be combusted every year by each station per year [2]. This result in the accumulation of heavy fractions of polycyclic aromatic compounds and lead in soil and other environmental components.

Another aspect of environmental pollution is the direct discharge of untreated sewage. This is common in most Antarctic research stations. This results in detectable concentration of polyfluoroalkyl substances in the environment [4]. Also the mercury concentrations were evaluated in soils of Fildes and Ardley peninsulas [5]. However, the most pronounced geochemical effect of human activity is accumulation of the trace metals in soils and plant tissues [6–9]. For example, Hg accumulates more intensively in soils than in mosses, and the increased concentration of trace elements is obtained at the stations on the Fildes Peninsula [6]. In addition, the recent contamination sources show increasing concentrations of Cr, Cu, Ni and Zn [7]. The highest concentrations of Cr and Ni are detected near the recent waste disposal locations.

The average concentrations of key trace elements and major elements were assessed in numerous studies of soils and sediments of the Fildes Peninsula [10–12]. The baseline concentration of Mg and Ni was essentially lower, but the Cu levels were significantly higher than in adjacent areas; Pb, Cd and Hg concentration increased in soils with pronounced anthropogenic activity. One urgent goal was to assess the role of birds in the alteration of chemical composition of soils and sediments [13]. Ornithogenic factors affecting soil formation are common on the Fildes Peninsula [3,14–16]. Studies of the trace element concentrations in guano are of particular interest [17]. Vascular plants can concentrate some trace elements [18] and can also be transported and used by birds for nest building [16]. Therefore, it is possible for trace elements to be accumulated in ornithogenic soils, and these concentrations should be assessed. Unfortunately, data on the accumulation of trace elements in tissues are rare [19–21].

Previous use of fossil organic fuels also is a factor in the accumulation of trace elements in soils and sediments [22]. Soils of the Elephant Island are studied less frequently than soils of the King George Island [23]. Some data are published on trace element concentrations in soils from Deception and Penguin islands [24] and about soil concentrations of contaminants after the fire event on the Brazilian station [25]. Many studies have been conducted to evaluate the baseline concentration of trace elements – mainly in soils from the Fildes Peninsula on the King George Island. Our experimental design is different from previous work because this study was aimed not only to compare trace element concentrations in pristine and human-affected soils of the Fildes Peninsula but also to compare concentrations in pristine soils of the Fildes Peninsula with soils of undisturbed environment of the Elephant Island. This environment serves as a reference keysite unaffected by human. A separate objective of the work is to evaluate the concentration rates of the trace elements in bird-affected soils – not just soils affected by guano from the penguin rookeries but also in soils formed under transported plant material from flying birds' nests.

2. Material and methods

2.1. Study sites

King George Island is the largest in the South Shetlands archipelago at about 1400 km^2 (Figure 1). Only about 5% of its area is free of ice [26]. The Fildes Peninsula and Ardley Island together (around 33 km^2) comprise the second largest ice-free area of the South Shetland Islands and the largest on the King George Island. Gentle topography dominates the Fildes Peninsula with a wide central plain and several others at different altitudes. It is a

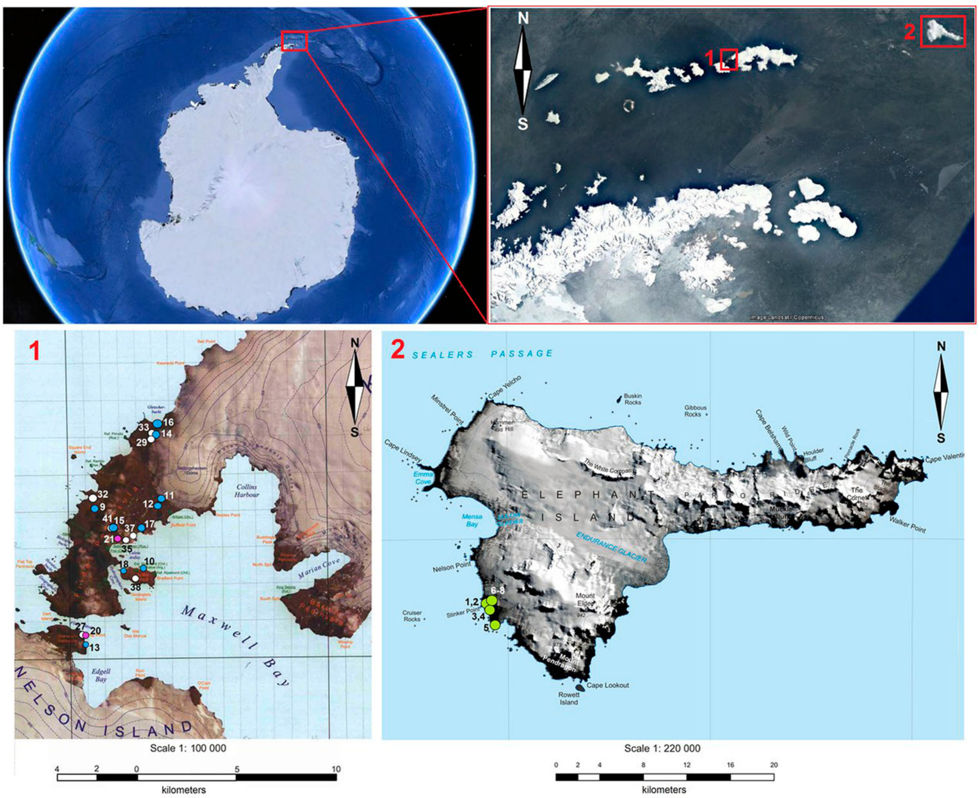

Figure 1. The study sites. 1 – Fildes Peninsula, 2 – Elephant Island. 1 – Fildes Peninsula, Topographic Map (Satellite Image Map) 1:100000 King George Island, South Shetland Islands, Antarctica, Institut für Physische Geographie (IPG), Albert-Ludwigs-Universität Freiburg, Germany. Laboratório de Pesquisas Antárticas e Glaciológicas (LAPAG), Universidad Federal do Rio Grande do Sul (UFRGS), Brasil. Freiburg, November 2001. 2 – Elephant Island. South Shetland Islands. Elephant, Clarence and Gibbs Islands. APC Misc 99, Antarctic Place-names Committee, Foreign and Commonwealth Office, First Edition, May 2009.

tableland made up of old coastal landforms with numerous rocky outcrops and an average height of 30 m a.s.l. [27].

According to Smellie et al. [28], this area mainly consists of lavas with small outcrops of tuffs, volcanic sandstones and agglomerates. The climate here is cold, moist and maritime with mean annual air temperature of −2.2°C and a mean summer air temperatures above 0°C for up to four months [29]. The mean annual precipitation is 350–500 mm/yr. The Fildes Peninsula and Ardley Island are among the first areas in maritime Antarctica to become ice-free after the last glacial maximum [30]. The Fildes Peninsula was covered by glaciers from 8000 to 5000 years BP [27,31]. The basins of most lakes are over-deepened glacial basins, and the valleys of the largest streams are glacial troughs – both are located along fractures. After the glacial erosive phase, glacial retraction led to the Holocene glacioisostatic and tectonic uplift and favoured the occurrence of paraglacial and periglacial processes such as frost weathering, gelifluction, cryoturbation and nivation [32–34].

The patterned ground in these regions dates from 720 to 2640 years BP [35]. In the South Shetland Islands, permafrost is sporadic or non-existent at altitudes below 20 m a.s.l., and occurs more or less discontinuously in altitudes from 30 to 150 m a.s.l. [36]. Mosses, lichens and algae are common here, along with two vascular plants (*Deschampsia antarctica* and *Colobanthus quitensis*). Penguins, seals and seabirds are common in coastal areas and have significant effects on soil development. Major cryogenic surface-forming processes here are frost creep, cryoturbation, frost heaving and sorting, gravity and gelifluction [27]. Eight separate sites on the Fildes Peninsula have been collectively designated an Antarctic Specially Protected Area (ASPA 125) largely because of their paleontological values [37].

Elephant Island is the biggest in the northern group of South Shetland Islands. It lies at the eastern end of the archipelago and is approximately 150 km to the northeast from the King George Island (Figure 1). The island is 40 km long by 24 km wide at its western end. There are no publications describing the climate of Elephant Island. The weather on the island is mostly cloudy and foggy with westerly winds. For most of the year (from April to December), the sea surrounding it is closed by ice. The mean annual air temperature on the island is about 0°C. The warmest period is from January to February with a mean annual summer temperature of about 1.5°C [1]. The island is 95% ice-covered and consists of a plateau with some ridges and isolated mountains up to about 973 m high (Mt. Pendragon) in the southern part. Very steep cliffs form most of the coastline.

The island features well-preserved and extensive marine erosive platforms at 130–150 m a.s.l. These are especially well developed along the western coast. Striations and moraines on the platforms indicate quaternary glacial fluctuations. Periglacial and nival landforms and deposits are relatively scarce but are widely presented at Stinker Point areas like the Holocene raised beaches, paleostacks and moraines. The geological structure of Elephant Island is relatively poorly studied in comparison to other areas in the region.

Elephant Island forms part of the southern branch of the Scotia Arc and is located in a complex tectonic setting near the triple junction of the Scotia, Antarctic and former Phoenix Plates [38]. The metamorphic rocks on the islands of this region were collectively named the Scotia metamorphic complex [39]. These are interpreted as a Mesozoic–Cenozoic subduction complex and are now generally considered to be composed of three different parts with different metamorphic ages [40].

The vegetation of Elephant Island was first studied by J. S. Allison – a participant of the British Joint Services Expedition 1970–1971 [41]. The vegetation of the recently studied Stinker Point area is diverse and especially well developed on the 120 m terrace. Slopes and plateau surfaces are covered by dense communities of fruticose lichens Usnea, Cladonia and Sphaerophorus. Depressions are occupied by crustose nivale lichens Carbonea and Lecidea and by mosses in more humid places. The highest points of the terrace have the most developed vegetation with the highest coverage. Vast 60 m terraces reach from the glacier to the sea and are mostly vegetation-free. Small moss and lichen communities can only exist in the most protected places. In contrast, near the sea there is a rather large space covered by moss and fruticose lichen communities. Rock outcrops near the coast and cliffs host numerous bird nests and are covered by nitrophilous and halophilous lichen vegetation including *Lecania brialmontii*, *Leptogium puberulum*, different Caloplaca *species*, *Ramalina terebrata* and *Xanthoria candelaria*; the penguin rookeries only feature alga *Prasiola crispa* only. In general, the vegetation and flora of the Stinker Point area are rather poor in comparison with the Fildes Peninsula [23,42]. The ornithogenic presence of the Elephant Island is less expressed than that in the Fildes Peninsula [42]

2.2. Sampling strategy

Soils were sampled from 20 × 20 cm soil pits at depths of 0–10 cm. The Edelman drill (modification for soils) with stainless nozzle (prewashed with acetone) was used for sampling. The samples were stored in double sterile plastic bags, labelled and transported to the laboratory. The samples were air-dried at room temperature separate from roots and debris and passed through a 2 mm plastic sieve prior to chemical analysis. All soil samples were divided into four groups: (1) pristine soils under organic layers of the Fildes Peninsula; (2) pristine soils under organic layers of the Elephant Island; (3) bird-affected soils of the Fildes Peninsula and (4) soils affected directly or indirectly by human (waste disposal, station activity and mechanical disturbance). In total, 41 samples were analysed № 1–8 from the first group, № 9–19 from the second group, № 20–25 from the third group, № 26–41 from the fourth group. Soil types were identified on the base of morphological field description of whole profiles, in spite of the fact that samples were collected only from the superficial layers. Soils from the Elephant Island mostly were presented by Turbic Cryosols and Lithosols [43] under sparse mosses and lichen vegetation cover. The average thickness of the soil profiles is about 15–25 cm. Soils of the King George Island were presented by six soil groups [43]: Leptosols, Cryosols, Fluvisols, Regosols, Histosols and Technosols [44]. This well corresponds with previously published data [35,45].

Ornithogenic soils studied here are mostly presented by polypedons under the transported plant material. Birds use it for nest building and this activity results in accumulation of essential portions of organic matter in the uppermost layers (up to 25%). We suggest that bird transport activity can result in the accumulation of additional portions of trace elements. Background mineral soils without evident bird activity were studied in pristine (Turbic Cryosols, Cambisols, Regoliths, Lithosols) and human-affected environments (Technic Turbic Cryosols and soil in the area of the Bellingshausen station and former waste disposals). Thus, we can compare the levels of trace element accumulation in four groups of soils – two of these serve as the reference (pristine soils of Elephant and

King George) and two of these are affected by geochemical activity of ornithogenic or anthropogenic origin.

2.3. Laboratory analyses

Heavy metals were measured in soil samples: Pb, Cd, Zn, Ni, Mn, Cu and As. Acid-soluble forms of metals (Cu, Pb, Cd, Zn, Ni, As and Hg) were determined using an atomic emission spectrometer with inductively coupled argon plasma (Spectro Ciros, Germany). Before determination of mentioned trace elements of soil, fine earth was digested by Aqua Regia (volumetric ration of nitric and hydrochloric acids was 1:3) [45]. Analytical procedures were done in triplicate. Acid-soluble forms of metals (Cu, Pb, Zn, Ni and Mn) were also determined using an atomic emission spectrometer with inductively coupled argon plasma (Spectro Ciros EOP, Germany).

The anthropogenic input of heavy metals was also evaluated using a geoaccumulation index (I_{geo}). The geoaccumulation index [46] is widely used to study pollution levels of trace metals in soils (Table 1). It enables the assessment of contamination by comparing current and pristine concentrations of the contaminants. Lu et al. used the I_{geo} indexes to estimate the soil contamination rate in Antarctica [12]. I_{geo} index was calculated using the following equation:

$$I_{geo} = \log_2\left[\frac{C_n}{kB_n}\right]. \tag{1}$$

Here, C_n is the concentration of the trace element in the enriched sample [mg/kg]; B_n is the geochemistry background value of the same element in soil [mg/kg], calculated as an average from previously published data on pristine soils and sediments of the investigated region without evident anthropogenic impact, k is a factor introduced to minimise the effect of possible variations of soil background values due to lithogenic effects with a recommended value of 1.5. The degree of soil pollution is assessed according to seven contamination classes [47] in order of increasing numerical value of the index.

2.4. Statistics

Statistical data treatment used STATISTICA 10.0 software (ANOVA, Statistica Base 12.6, Dell, Round Rock, TX, USA). One-way ANOVA was applied to test the statistical significance of differences between obtained data. Method is based on estimation of the significance of average differences between three or more independent groups of data combined by one feature (factor). A post hoc test (Fisher LSD) provides a detailed evaluation of the average differences between the analysed groups of data. A feature of the post hoc

Table 1. Seven classes of geoaccumulation index (I_{geo}) [46].

I_{geo} class	I_{geo}	Soil pollution level
I	$I_{geo} < 0$	Practically unpolluted
II	$0 \le I_{geo} < 1$	Practically unpolluted to moderately polluted
III	$1 \le I_{geo} < 2$	Moderately polluted
IV	$2 \le I_{geo} < 3$	Moderately polluted to highly polluted
V	$3 \le I_{geo} < 4$	Highly polluted
VI	$4 \le I_{geo} < 5$	Highly polluted to extremely polluted
VII	$I_{geo} > 5$	Extremely polluted

test is the application of intra-group mean squares for the assessment of any pair averages. Differences were significant at the 95% confidence level. Concentrations of organic and inorganic contaminants were analysed with at least three replicates. The calculated average concentrations were provided with standard deviations ($a \pm b$).

3. Results and discussion

The ranges of trace metal concentrations for the samples are shown in Tables 2 and 3. The contents of investigated elements were 0.50–690.0 (Pb), 0.10–0.90 (Cd), 3.50–340.0 (Zn), 0.53–26.0 (Ni), 64–1000 (Mn), 0.17–12.0 (As) and 2.60–140.0 (Cu) mg/kg. The lowest average concentrations of trace elements were detected in pristine soils on

Table 2. Trace element concentration in individual samples of soils of various groups, mg/kg.

No.	Pb	Cd	Zn	Ni	Mn	As	Cu
Elephant Island, pristine soils							
1	1.03	<0.10	3.50	0.53	430	0.24	2.60
2	1.50	0.16	24.00	2.80	97	0.80	17.00
3	1.02	0.12	5.70	0.55	490	0.16	5.50
4	1.20	0.12	5.10	0.58	400	0.17	13.20
5	3.10	<0.10	48.00	11.00	270	1.30	40.00
6	1.70	0.54	49.00	0.74	210	1.30	26.00
7	1.60	0.46	55.00	0.50	180	1.50	28.00
8	1.50	0.20	14.10	12.00	300	0.24	46.00
Fildes Peninsula, ornithogenic soils							
9	2.60	0.16	43.00	10.00	240	1.30	37.00
10	3.20	0.90	80.00	4.60	380	8.00	80.00
11	4.80	0.47	39.00	7.90	760	12.00	64.00
12	3.70	0.14	38.00	9.00	710	0.56	63.00
13	<0.50	0.56	20.00	11.00	420	0.51	21.00
14	3.30	0.26	38.00	3.70	720	5.70	55.00
15	6.40	0.18	34.00	12.00	550	0.70	48.00
16	2.10	0.80	51.00	6.30	330	2.00	58.00
17	3.00	0.25	40.00	6.10	250	3.10	53.00
18	<0.50	0.13	11.30	2.80	64	1.00	10.80
19	4.50	0.14	39.00	14.00	480	0.90	50.00
Fildes Peninsula, human-affected soils							
20	17.00	0.41	110.00	12.00	650	2.90	370.00
21	10.00	0.19	41.00	19.00	710	0.80	70.00
22	17.00	0.41	110.00	12.00	650	2.90	370.00
23	35.00	0.80	87.00	20.00	780	1.00	100.00
24	690.00	0.57	340.00	22.00	980	1.20	140.00
25	450.00	0.27	120.00	9.00	550	3.30	68.00
Fildes Peninsula, pristine soils							
26	2.20	0.22	30.00	11.00	210	1.90	46.00
27	4.70	0.70	51.00	17.00	820	8.00	120.00
28	4.30	0.47	62.00	26.00	580	5.50	117.00
29	5.80	0.27	46.00	7.30	950	3.00	84.00
30	1.60	0.12	19.00	5.90	340	1.00	21.00
31	5.40	0.31	45.00	7.40	920	3.30	82.00
32	1.70	0.16	36.00	10.00	680	3.90	90.00
33	4.70	0.30	50.00	3.70	970	4.60	75.00
34	4.90	0.32	50.00	3.60	1000	4.50	77.00
35	10.30	0.16	60.00	19.00	710	1.00	64.00
36	21.00	0.27	69.00	22.00	670	1.00	63.00
37	4.90	0.16	38.00	5.90	560	2.70	45.00
38	2.10	0.11	9.40	3.00	120	0.60	15.00
39	1.40	0.16	14.20	2.80	120	1.20	26.00
40	14.00	0.10	54.00	22.00	700	0.70	67.00
41	6.50	0.20	40.00	13.00	510	0.90	48.00

Table 3. Average concentration of trace elements, mg/kg, ±Δ standard deviation and one-way ANOVA results.

Pb	Cd	Zn	Ni	Mn	As	Cu
Elephant Island, pristine soils						
1.58 ± 0.40	0.22 ± 0.10	25.55 ± 5.31	3.58 ± 1.25	297.12 ± 88.62	0.71 ± 0.35	22.28 ± 4.40
Fildes Peninsula, ornithogenic soils						
3.14 ± 0.75	0.36 ± 0.17	39.39 ± 8.02	7.94 ± 2.72	445.81 ± 117.18	3.25 ± 1.62	49.07 ± 9.92
Fildes Peninsula, human-affected soils						
203.16 ± 49.91	0.44 ± 0.22	134.67 ± 26.50	15.66 ± 5.50	720.00 ± 218.33	2.01 ± 0.98	186.33 ± 36.00
Fildes Peninsula, pristine soils						
5.96 ± 1.50	0.25 ± 0.13	42.10 ± 8.48	11.22 ± 3.93	616.25 ± 183.75	2.73 ± 1.37	65.00 ± 13.00
p, one-way ANOVA						
<.006	<.001	<.001	<.001	<.001	<.140	<.002

the Elephant Island, while the highest concentrations were detected in anthropogenic soils. Ornithogenic soils do not show high concentrations of trace elements in comparison with the pristine soil of the Fildes Peninsula. Only the concentration of Pb and As was higher in ornithogenic soils than in organo-mineral pristine ones. The most pronounced differences between soil groups were obtained by Cu content. The high concentration of Cu was previously reported by Lu et al. [12] for the soils of the Antarctic Peninsula. Baseline concentrations of Mn were very high for all samples in comparison to other samples and comparable with Mn concentration reported by Lu et al. [12]. The high concentration of Mn is typical for soils in humid regions where stagnic conditions and overmoisturing processes result in the additional accumulation of Mn. At the same time, the content of Mn was essentially higher in human-affected soils relative to the others. This indicates the possible anthropogenic accumulation of this pollutant. The analysis of Zn and As concentration has shown similar results.

Comparison of the revealed trace element concentrations with the average for the Antarctic Peninsula [48] shows that the Pb content was higher and Ni was equal or higher in all the soils than the average baseline concentration; Zn, Mn and Cu content was lower in soils of all four studied plots. Human-affected soils revealed higher values of Mn and Cu relative to pristine soils. Comparing our data with previous results on trace element content in the sediment of Admiralty Bay [22], we conclude that there is much more Pb, Cu and Zn content in anthropogenic soils. The concentrations of As and Mn are lower than in natural ones.

Accumulation of Pb and Zn in the area near the Bellingshausen station and adjacent waste disposal became evident upon comparison with pristine soils on the Fildes Peninsula. They were obtained in the current study and also were reported by Amaro et al. [6]. The authors suppose that the higher amounts of Pb are caused by hydrocarbon spills. This environmental impact is not unique for the Russian station only and is obtained in adjacent areas as well. Previously, the areas around the Brazilian station 'Comandante Ferraz' were shown to have hydrocarbon and sewage pollution [9]. At the same time, our data for Pb content – even in the waste disposals and technogenic grounds of the Bellingshausen station (samples No. 26–42) – were lower than those reported by Dalfior et al. [10]. Another data comparison with Deception and Penguin islands [24] indicates that all soils of the Fildes Peninsula are rich in Cu and Zn content and are comparable or poor in Mn. The highest values of Zn content were revealed in human-affected soils. Data obtained are comparable also with those published previously [49].

Statistical analysis (post hoc) test (Table 4) showed significant differences in measured data between the following pairs of soil groups. For Lead: between Elephant and Fildes anthropogenic and pristine soils ($p < .002$), between Fildes ornithogenic–anthropogenic ($p < .003$), ornithogenic–pristine ($p < .050$) and anthropogenic–pristine soils ($p < .002$); for Cadmium only between Elephant pristine and Fildes ornithogenic ($p < .001$); for Zinc and Ni for all compared pairs with exception for Elephant–Fildes pristine soils. Manganese contents were essentially different for Elephant–Fildes ornithogenic soils ($p < .003$), Fildes ornithogenic–anthropogenic soils ($p < .003$), Fildes ornithogenic–pristine ($p < .001$) and Fildes anthropogenic–pristine soils ($p < .001$). Copper contents were essentially different for Elephant–Fildes ornithogenic ($p < .003$), Fildes ornithogenic–anthropogenic ($p < .001$) and Fildes anthropogenic–pristine ($p < .001$) pairs. Statistical analysis shows that Pb, Zn and Ni contents are the most variable between the studied soil groups. There is also possible accumulation of Cu in human-affected soil in comparison to both groups of pristine soils. Some accumulation of Mn appears in human-affected and ornithogenic soils in comparison with pristine ones. The Cd content is also higher in ornithogenic soil relative to both groups of pristine soils.

We calculated I_{geo} of −2.42 to 0.97 for Cu in soils of Elephant Island and human-affected soils of the Fildes Peninsula (Table 5). This indicates that only in human-affected areas soils fit the category of 'unpolluted–moderately polluted'. The same trend was revealed for Pb, Cd and Zn. Nevertheless human-affected soils were classified as unpolluted by the I_{geo} index calculated for Ni and Mn. These results coincide with Lu et al. [12] published for the King George Island. It is interesting that the Cd content increased in bird-affected soils. This is an indicator of slight accumulation of this heavy metal in birds' by-products. There is no excess from the zero level of I_{geo} values that were revealed for all pristine soils, which indicates a low degree of pollution.

Table 4. Results of post hoc test (significant values when $p < .05$, bolded).

	Pb	Cd	Zn	Ni	Mn	Cu
Elephant I./Fildes P. ornithogenic soils	<.062	**<.001**	**<.003**	**<.001**	**<.003**	**<.003**
Elephant I./Fildes P. human-affected soil	**<.003**	<.996	**<.001**	**<.015**	<.078	<.078
Elephant I./Fildes P. pristine soils	**<.002**	<.987	<.001	<.161	<.971	<.971
Fildes P. ornithogenic/human-affected soil	**<.003**	<.996	**<.001**	**<.015**	**<.001**	**<.001**
Fildes P. ornithogenic/pristine soils	**<.050**	**<.001**	**<.003**	**<.001**	**<.001**	<.163
Fildes P. human-affected/pristine soils	**<.002**	<.900	**<.001**	**<.040**	<.090	**<.001**

Table 5. Geoaccumulation indexes (I_{geo}) for trace elements in soils (average values).

Cu	Pb	Cd	Zn	Ni	Mn
Elephant Island, pristine soils					
−2.42	−2.46	−0.32	−2.26	−3.39	−3.45
Fildes Peninsula, ornithogenic soils					
−0.75	−1.72	0.33	−1.11	−1.12	−1.54
Fildes Peninsula, human-affected soils					
0.97	2.78	0.82	0.51	−0.06	−1.63
Fildes Peninsula, pristine soils					
−0.37	−0.87	−0.04	−1.04	−0.82	−1.40

4. Conclusions

Trace element concentrations were studied in soils of the King George and Elephant islands in West Antarctica. The contents of trace elements (mg/kg) in studied soils were 0.50–690 for Pb, 0.10–0.90 for Cd, 3.50–340.0 for Zn, 0.53–26.0 for Ni, 64–1000 for Mn, 0.17–12.0 for As and 2.60–140.0 for Cu. The lower concentrations of Cu, Pb, Cd, Zn, Ni and Mn were typical for the pristine soil of the Elephant Island. The highest concentrations of those elements were revealed for human-affected soils (area of the Bellingshausen station and adjacent waste disposals) on the Fildes Peninsula. Ornithogenic soils have low levels of Cd and As. On the base of the geoaccumulation indexes (I_{geo}), all pristine soils and ornithogenic soils were classified as unpolluted; the human-affected soils were classified mainly as moderately polluted. I_{geo} indexes were negative for Ni and Mn in all soils, negative for Cu, Pb, Cd and Zn for all pristine and ornithogenic soils and positive for this group of elements for Fildes Peninsula human-affected soils. Therefore, these soils show accumulation of Cu, Cd and Zn. At the same time, some accumulation of Cd is evident in ornithogenic soils. Data obtained can be used as background concentration levels for different types of polar environments of maritime Antarctic for further researches.

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