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Note

Distribution Characteristics of Heavy Metals in Soil in the Vicinity of King Sejong Station, King George Island, Antarctica

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To investigate distribution characteristics of heavy metals in soils in the vicinity of King Sejong Station of King George Island, Antarctica, Fe, Mn, Cu, Zn, Pb, Co, Cd, Cr, Ni and Mo contents were investigated under different distances and directions from King Sejong Station. 13 sample sites were distributed from King Sejong Station. In site 4, the Cd content was higher than that in other sites. The Cr content was the highest in site 9, and the Ni and Mn contents were high in site 12. Cu, Co and Zn were highly contained in distance 1~2 km from King Sejong Station. Cd, Cr, Ni and Mo contents were lower, whereas Fe, Mn, Cu, Zn, Pb and Co contents were higher than other heavy metal contents at all sites.

Key words: King Sejong Station, King George Island, Antarctica, Heavy metals characteristics

Introduction

Antarctica is the World's fifth-largest continent measuring approximately 13.6 million km^2, sixty fold of the Korean peninsula. Antarctic Peninsula has been exposed to contamination through increasing human activity at research stations and increased tourism. King George Island that ten research stations are located is the largest island of the South Shetland Islands in West Antarctica. King Sejong Station, one of those ten research stations is located on Barton Peninsula. King George Island, the largest island of the South Shetland Islands, has a cold, oceanic climate characteristic of maritime Antarctica. Barton Peninsula is surrounded by Marian Cove to the north coast and Maxwell Bay to the southwest coast. Barton Peninsula is the exposed ground (about 20 km^2) with melting snow when temperatures became warmer at above zero. The ground is covered by soil, moraine of weathered rock, mosses and lichens (Lee, 1992; Chang 1997, 1999). Most of the ice-free area is covered by relatively abundant vegetation, dominated by cryptogamic species (Kim et al., 2007). The flora comprises two flowering plants, 33 bryophytes, and 62 lichens (Lee, 1992; Kim et al., 2006). Chottaebawi area on the southern coast of the peninsula contains one of the most important penguin colonies (Pygoscelis papua and Pygoscelis antarctica) in the maritime Antarctic region (Fig. 1). The cape area near King Sejong Station is populated by flying seabirds, such as skuas. Previous studies have reported heavy metal concentrations in different components of King George Island, including snow-ice (Hong et al., 2002), soil (Choi et al., 2011; Santos et al., 2005), sediments (Andrade et al., 2001; Santos et al., 2005), and vegetation (Cho et al., 2008ab; Poblet et al., 1997; Hong et al., 1999; Osyczka et al., 2007). The purpose of this study was to investigate distribution characteristics of heavy metals in soil of vicinity of King Sejong Station on Barton Peninsula of King George Island, Antartica.

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Table 1. Information of sampling sites for this study.

Site	Direction	Distance	Soil texture	Characteristics
#1	Marian cove coast regions	0-1 km	S	The soil is widely distributed on coastside. High diversity of lichen and moss.
#2			S	
#3		1-2 km	S	High diversity of lichen and moss.
#4	Inland regions	0-1 km	S	The lichen and moss widely distributed on ridges at the back of King Sejong Station.
#5			S	
#6		1-2 km	S	High diversity of lichen and moss.
#7			LS	
#8		2-3 km	S	High diversity of lichen and moss.
#9			S	
#10	Maxwell bay coast regions	0-1 km	S	High diversity of lichen and moss.
#11			S	
#12			LS	
#13		1-2 km	LS	High diversity of lichen and moss. In Narebski point (Penguin village).

S : Sand, LS : Loamy sand.

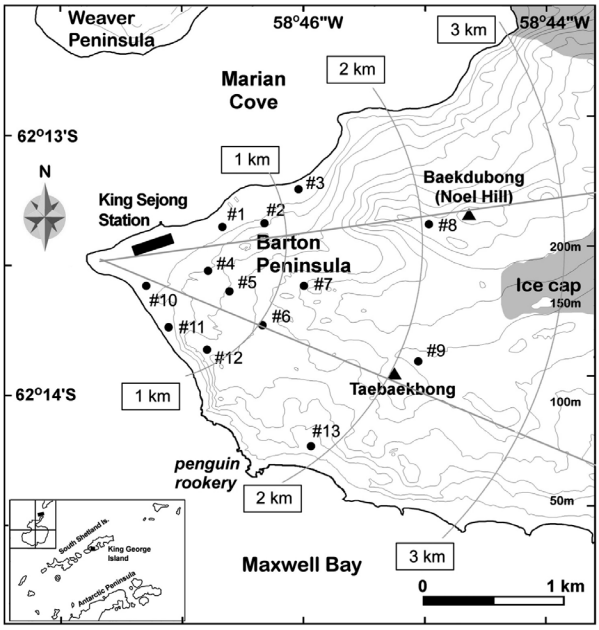

Fig. 1. Sampling sites for soils in the vicinity of King Sejong Station.

Materials and Methods

A field survey was conducted from January to February, 2008. Soil samples were collected from 13 sites in snow-free areas of the peninsula (Fig. 1). Sample sites were distributed from the Sejong Cape (King Sejong Station) under different distances and directions. Soil samples were sieved by 2 mm mesh and oven-dried at 70℃ for 72 h. for transport to laboratory. Soil texture was classified as sandy (10 sites) and loamy sand (3 sites) by USDA textural classification (Table 1). The concentrations of heavy metals in soil were analyzed by inductively coupled plasma-mass spectrometry (ICP-MS, Agilent 7500, Santa Clara, CA) following acid leaching with 0.1 N HCl according to Standard Method (NIAST, 2000).

Results and Discussion

Cr, Cu, Zn, Cd, Pb, Mn, Fe, Co, Ni and Mo contents in soils in vicinity of King Sejong Station were investigated (Table 2, Fig. 2). Fe, Mn, Cu, Zn, Pb and Co contents were 33~273, 3.5~60.1, 2.02~13.88, 0.3~2.05, 0.01~2.2 and 0.09~1.49 mg kg^{-1}, respectively. In the soils, Cd, Cr, Ni and Mo contents were low, whereas Fe, Mn, Cu, Zn, Pb and Co contents were high. The concentrations of heavy metals were higher in the order of Fe (165.5 mg kg^{-1}) ≫ Mn (21.2 mg kg^{-1}) ≥ Cu (5.2 mg kg^{-1}) > Zn (0.8 mg kg^{-1}) > Pb mg kg^{-1}) > Co (0.54 mg kg^{-1}) > Cr (0.11 mg kg^{-1}) > Ni (0.06 mg kg^{-1}) > Cd (0.03 mg kg^{-1}) = Mo (0.03 mg kg^{-1}). The concentration of Cd in site 4 was higher than that in other sites. The concentration of Cr was the highest in site 9. The concentrations of Ni and Mn were high in site 12. Cu, Co and Zn were highly contained in distance 1~2 km from King Sejong Station. Pb was highly contained in vicinity of King

Table 2. Contents of heavy metals from soils in the vicinity of King Sejong Station in King George Island, Antarctic.

Site	Heavy metals									
	Pb	Cd	Cr	Cu	Co	Zn	Fe	Ni	Mo	Mn
	---------- mg kg^{-1} ----------									
#1	0.38	0.03	0.06	4.72	0.30	0.91	147.5	0.04	0.03	36.86
#2	0.14	0.03	0.06	2.56	0.31	0.54	190.3	0.06	0.04	13.50
#3	2.20	0.03	0.06	11.65	1.40	2.05	137.7	0.09	0.05	29.73
#4	1.16	0.06	0.06	7.46	0.43	0.9	264.8	0.06	0.06	11.13
#5	0.58	<0.001	<0.001	4.84	0.21	0.54	273.4	<0.001	<0.001	6.53
#6	0.51	0.03	0.09	9.13	0.49	1.03	180.4	0.05	0.04	12.32
#7	<0.001	0.03	0.03	5.28	1.19	0.91	33.4	0.04	0.04	26.88
#8	<0.001	0.03	0.11	2.23	0.18	0.37	106.0	0.03	0.04	15.32
#9	<0.001	0.03	0.44	2.52	0.09	0.31	137.0	0.04	0.03	2.32
#10	<0.001	0.03	0.09	2.02	0.09	0.27	129.9	0.03	0.04	3.47
#11	0.24	0.04	0.10	3.71	0.30	0.45	234.8	0.06	0.03	9.37
#12	<0.001	0.03	0.14	7.66	1.49	1.13	135.1	0.16	0.03	60.14
#13	0.07	0.03	0.09	3.12	0.52	0.61	180.8	0.03	0.03	48.16

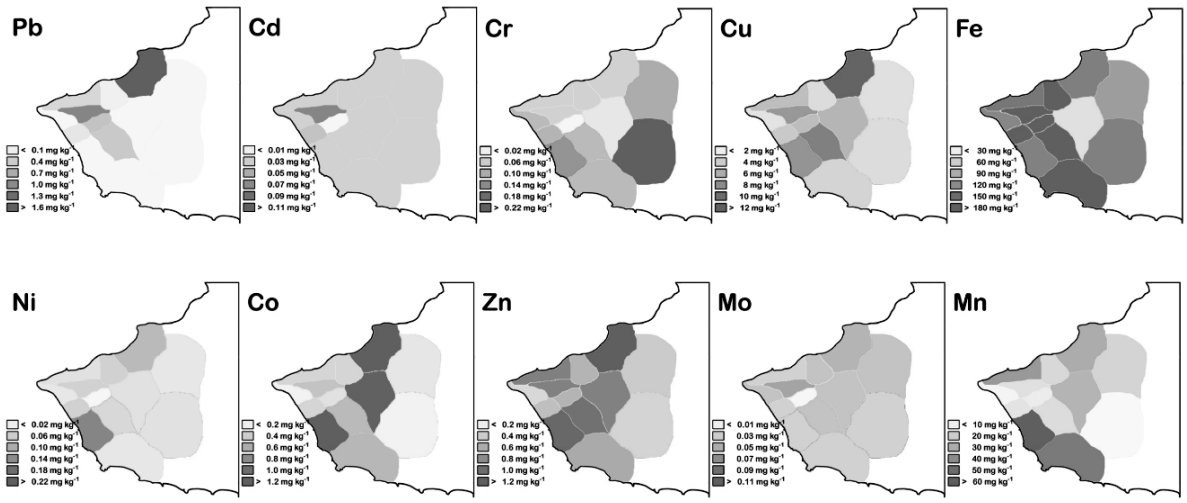

Fig. 2. Distribution characteristics of heavy metals in soil in the vicinity of King Sejong Station.

Sejong Station. As suggested by Hong et al. (1999), the use of leaded gasoline and diesel oil in King Sejong Station are likely sources of Pb. However, additional environmental factors, such as geological characteristics of substratum and distance from the seashore, should also be considered to precisely assess the human influence on heavy metal concentrations in soils. At the same sites in vicinity of King Sejong Station, the amounts of heavy metal contents in soils were different with that in lichen. According to Lim et al. (2009), who investigated heavy metal contents in lichen in vicinity of King Sejong Station, heavy metal contents in lichen were lower as distant increased from King Sejong Station. However, heavy metal contents in soils were low in comparison with heavy metal contents in lichen in this study. It could be not suitable for heavy metals to be adsorbed in soils compared as lichen because snows covering all of the areas interrupt adsorption.

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