



Application of ^{252}Cf -PDMS to characterize airborne particles deposited in an Antarctic glacier

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Abstract

The aim of this study is to apply the ^{252}Cf -PDMS (plasma desorption mass spectrometry) technique to characterize particles deposited in ice samples. This technique allows identification of molecular ions, even large molecules, desorbed from the sample surface, in contrast with PIXE (particle induced X-ray emission) or EDS (energy dispersive spectrometry). Two shallow snow cores obtained from different glacial drainage basins on King George Island ice cap, South Shetland Islands (Antarctica), were analyzed by PDMS. The chemical compounds identified in the ice mass spectra show that the particle contents of both samples were statistically different, indicating a non-homogenous spatial deposition distribution for the deposited particles. The analysis of the ice mass spectra suggests some possible sources for the airborne particles. The mass spectra of ice samples collected at a site exposed directly to air masses coming from the Drake Passage show a significant contribution of particles from crustal and anthropogenic sources. However, the mass spectra of ice samples taken from a site on a slope towards a local inlet point out a high influence of marine aerosol. Therefore, it was concluded that particles deposited onto the ice cap were attributable to different aerosol sources, besides long-range atmospheric transport. The ^{252}Cf -PDMS technique can be considered a powerful tool for studies of snow and ice samples, providing important information for understanding the global atmospheric transport and deposition of airborne particles.

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1. Introduction

Antarctic snow and ice deposits constitute highly preserved environmental information archives on man-made activities as well as the climatological phenomena that occurred throughout the centuries (Pourchet et al., 1983; Delmas and Petit, 1994). Since the late 1950s, aerosol monitoring has been increasing in Antarctica for elemental trace analyses and provides data for modelling the atmospheric circulation (Genthon et al., 1996). Long-term airborne particles deposited onto the Antarctic ice masses have been used for understanding past global climate changes (e.g. Boutron, 1995; Petit et al., 1999). Glaciochemical studies assume that the particles deposited in the snow are related to the composition and size of airborne particles in the troposphere, and equivalence among the elemental composition of the deposited particles and the past atmospheric geochemistry is also assumed.

In recent studies developed by Dalia (2002) the elemental trace analyses of individual airborne particles collected in Chilean Patagonia were compared to the elemental composition of deposited particles in an ice core recovered from King George Island. The results showed a correlation coefficient of 0.95, suggesting that the Chilean Patagonia is the major contributor of airborne particles to the West Antarctica. However, different conclusions about past atmospheric composition would be obtained, if the particle deposition patterns vary significantly on a scale of a few kilometers along the same glacier. It has been assumed that the airborne and deposited ice particles have equivalent chemical composition. It should be pointed out that the homogeneity of distribution of these particles could be affected by the regional geomorphology, terrain slope, summer ice-free areas and katabatic winds. Besides other glaciological aspects of glaciers, knowledge of the influence of local parameters upon atmospheric deposition would provide important information about the best site for further snow and ice coring.

^{252}Cf -PDMS (plasma desorption mass spectrometry) is a mass spectrometric technique based on the time of flight of secondary molecular ions

desorbed from the sample surface that were induced by the collision of fission products from a ^{252}Cf source.

The potential of secondary ion and plasma desorption mass spectrometry (SIMS and PDMS) to provide information about composition has been demonstrated by several studies (Winograd, 1982; Benninghoven, 1975; Vickerman et al., 1989; Van Stipdonk et al., 1993; Van Stipdonk and Schweikert, 1995; Van Stipdonk, 1994; Colton et al., 1985; Balasanmugam et al., 1987; Dias da Cunha and Barros Leite, 2002; Dias da Cunha et al., 2000). The basis of these mass spectrometric techniques is desorption and ionization of secondary ions (SIs). The desorption/ionization process (Busch, 1995; Sundqvist, 1992) is usually initiated through the impact of energetic ions on the sample surface, which causes the emission of atomic, polyatomic, clusters and molecular ion species. PDMS uses high-energy (MeV) fission fragments as the primary probe to electronically excite and sputter secondary ions (SIs). With the advent of new techniques to examine the emission patterns of SIs (Sundqvist, 1992), significant advances have been made in the understanding of the ion formation process in PDMS (Ens et al., 1989; Betz and Wein, 1994). It has been shown theoretically (Johnson et al., 1990; Fenyo et al., 1990) that a pressure pulse (shock wave) induced by the fast heavy ion ultimately leads to desorption of large intact molecular ions. Basic to this desorption model is the creation of an ionized cylindrical region (infra-track) of high energy density, axially symmetric to the direction of the incoming fast heavy ion. Because of the energy gradient created, a pressure pulse emanates from the infra-track and results in a momentum transfer to a region of lower energy density (ultra-track), resulting in the ejection of large molecular ions. This momentum transfer is responsible for the correlation between the direction of the incident fission fragment and the direction of the emission of large molecular ions. Although many cluster studies using the approach of MeV-ion induced desorption have been developed, only a few studies have applied desorption processes for environmental studies (Dias da Cunha et al., 2000; Brinkmalm et al.,

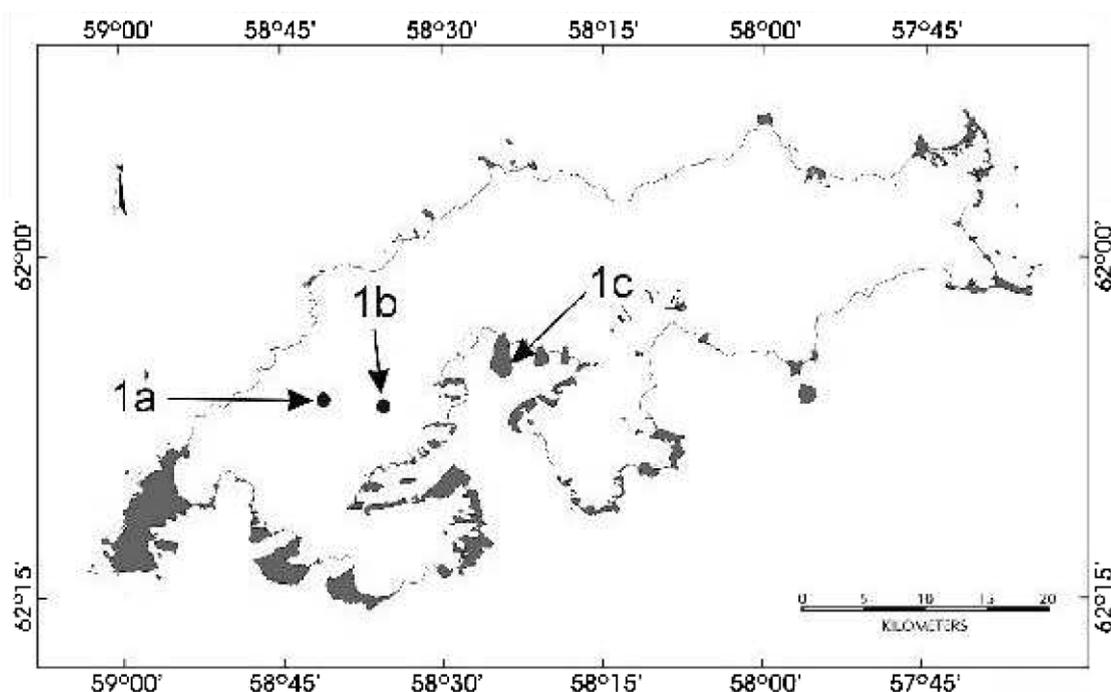


Fig. 1. Map of sampling sites: (a) Drake ice core. (b) Ezcurra ice core. (c) The Brazilian Antarctic Station Comandante Ferraz. Grey color indicates summer ice-free areas.

1992, 1994; Bitensky et al., 1994; Juvet et al., 1991; Nees et al., 1987; Da Silveira et al., 1989; Van Stipdonk et al., 1993; Van Stipdonk, 1994; Van Stipdonk and Schweikert, 1995; Weiland et al., 1989).

In this work, we have employed the ^{252}Cf -PDMS technique to identify chemical compounds present in particles deposited in two shallow snow cores collected at the same glacier (King George Island ice cap, Antarctica) but at different drainage basins.

2. Experimental method

2.1. Site description

King George Island is located at the boundary of winter sea-ice extent off the Antarctic Peninsula west coast and is one of the most sensitive areas to evaluate global climate changes (Skvarca et al., 1998; Fox and Cooper, 1998). The island ice cap

has 3 main domes and 70 glacial drainage basins that cover approximately 93% of its total area. Most of these basins follow an orientation south-east–northwest. A maximum ice thickness of 395 m was measured for the island and its ice surface seems to be controlled by the bedrock topography structure as described by Simões et al. (1999). The island location is shown in Fig. 1.

The predominant regional climate is polar-oceanic with high influence of cyclonic systems that frequently travel along latitude 60° S. South American continent, oceanic and polar influence would be present over the island, depending on the cyclone center trajectory, intensity and seasonal period (Budd, 1981; Pereira, 1990). A typical cyclonic system over the region is shown in Fig. 2 (NOAA-12 satellite; June 3, 1997; 09:51:29 to 10:02:02 UTC; channels 3 and 4). Pereira (1990) and Evangelista et al. (1994), employing ^{222}Rn as an atmospheric tracer, have concluded that cyclone systems are the main meteorological process

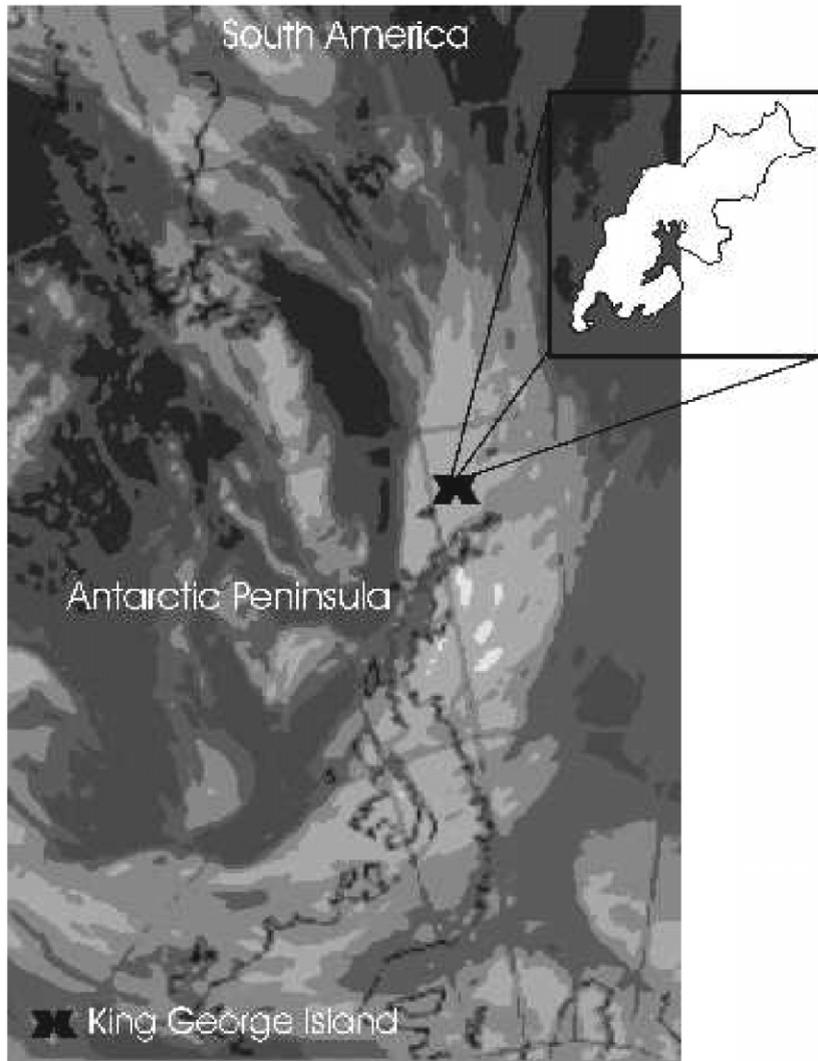


Fig. 2. Cyclonic system at Antarctic Peninsula. Illustration of air mass transport between South America and Antarctic.

responsible for the poleward air movement taking place from South America to the Antarctic Peninsula.

In order to characterize the airborne particles deposit in the glacier, two shallow ice cores of 5.5 m each were sampled. Sampling site locations in King George Island were: Drake snow core ($62^{\circ}06'30''$ S, $58^{\circ}40'00''$ W, 600 m of altitude) at a drainage basin towards Drake Passage, and Ezcurra snow core ($62^{\circ}07'45''$ S, $58^{\circ}35'00''$ W, 575

m of altitude) at a drainage basin towards Ezcurra Inlet (Fig. 1). Drake Passage is the strait between South America and Antarctica and the Drake snow core represents the influence from this region. This site is located on a slope towards the ocean, directly receiving airflow streams from the South American continent, and it is negligibly influenced by local katabatic winds. The second snow core was collected at a site located at a drainage basin that slopes towards the Admiralty Bay, in the inner

part of King George Island (Fig. 1). Water in this inlet (Ezcurra) is partially frozen during winter-time and surrounded by one of the largest ice-free areas in King George Island during austral summers. Three Antarctic scientific stations (Brazil, Poland and Peru) and two refuges (USA and Equator) are located in Admiralty Bay. These stations use diesel generator powers and represent the main local human sources of aerosols.

2.2. Sample collection

A SIPRE-CRREL Auger (a light weight portable snow and fin drill designed by the present Cold Regions Research Engineering Laboratory–US Corps of Engineering) coupled to an electric motor was used to collect the samples. A few minutes after drilling, samples were decontaminated by removing a thin external layer. All samples were kept frozen during transportation to the Laboratório de Pesquisas Antárticas e Glaciológicas (LAPAG) at the Universidade Federal do Rio Grande do Sul (UFRGS) in Porto Alegre, Brazil.

2.3. Sample preparation

The snow samples were melted at room temperature and filtered using Nuclepore filters (0.4 μm pore size). The solid particles were deposited on the filter. The filter was attached to a stainless steel support using a conducting glue and surrounded by silver paint.

The PDMS experiments were conducted in a stainless steel vacuum chamber and performed exploiting the sputtering phenomenon with subsequent TOF (time of flight) spectrometric identification of emitted SIs (secondary ions) (Macfarlane and Torgerson, 1976; Festa et al., 1985; Park et al., 1990; Sundqvist and Macfarlane, 1985). The geometry of the spectrometer consists of frontal incidence where the incident ions collide on the sample side faced to the flight tube. The TOF mass spectrometer essentially consists of an ion source and a field-free flight tube. The ion source was the ^{252}Cf source. The spontaneous fission of a ^{252}Cf nucleus generates two MeV/u fission fragments emitted in opposite directions. One of the fission fragments is detected by a micro chan-

nel plate detector (MCP) that generates a fast electric signal (start pulse). This pulse initiates the time measurement while the complementary fission fragment strikes a biased sample (kV), stimulating desorption of SIs. The sputtered SIs are accelerated to the flight tube where they are separated according to their velocities. At the end of flight tube there is a second MCP detector generating a stop signal to a timer counter. The secondary ions flight times are proportional to the square root of their mass-to-charge ratio. The analog signals generated at the start and stop MCP detector are sent to a constant fraction discriminator (CFD), which converts them to standard NIM logic pulses that are sent to a time to digital converter (TDC). The TDC transmits the binary words indicative of interval of time between these two pulses to a computer. The masses of the secondary ions are then related to this time by the expression:

$$t = \sqrt{\left(\frac{m(2d+L)^2}{2qU}\right)} \quad (1)$$

where m is the mass of the molecular ion, U is the voltage applied between the target and the flight tube grid, q is the ion charge, L is the length of the tube of flight, d is the distance between the target and the flight tube grid (also called acceleration region) and t is the total time of flight of the ion.

The total time interval between the start and stop signal can be obtained by the expression:

$$t = t_d + t_{\text{TOF}} + t_p \quad (2)$$

where t_d is the time taken by the ion to traverse the acceleration region, t_{TOF} is the time to traverse the region of the flight tube and t_p is the time to traverse the distance between the flight tube and the stop detector. The distance, d , between the target and the flight tube grid was 0.5 cm, the flight tube length $L=90$ cm and the distance between the flight tube and the stop detector (p) is smaller than 0.5 cm. Since $d \ll L$ and $P \ll L$, t_d and t_p are negligible compared to t_{TOF} . So, t could be considered equal to t_{TOF} and was related to the

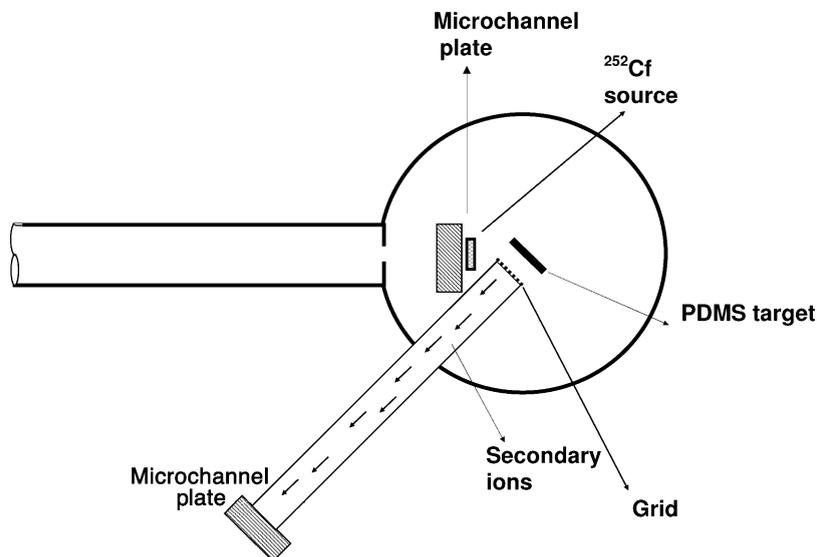


Fig. 3. Experimental arrangement used to analyze the samples by PDMS. The chamber is located at Van de Graaff Accelerator Laboratory at Pontifícia Universidade Católica in Rio de Janeiro (Brazil).

mass of the secondary ions by the expression:

$$t = \frac{L}{\sqrt{2qU}} \sqrt{m}. \quad (3)$$

To take into account all delay times the experimental calibration was performed using the relation:

$$C = A\sqrt{m} + B, \quad (4)$$

where C is the time corresponding to the time of flight measured for an ion mass (m). A and B are parameters determined in the calibration process.

The secondary ions were accelerated towards the flight tube by an electric field of +1 kV/mm (for positive ions mass spectra) and -0.8 kV/mm (for negative ions mass spectra). The PDMS scattering chamber is shown schematically in Fig. 3.

3. Results and discussion

The positive secondary ion mass spectra from the Drake and Ezcurra snow samples are shown

in Figs. 4 and 5, respectively. In these spectra only the main molecular ions are stressed. The molecular ion masses identified are shown in two Tables. The molecular ions identified in the mass spectra of samples from *both* Drake and Ezcurra sites are listed in Table 1, while the molecular ions identified only in the spectra from Ezcurra or Drake snow samples are shown in Table 2.

Both spectra were normalized in relation to the H^+ intensity for comparison. Forty-nine percent (49%) of the total amount of ions identified was present in both mass spectra. The remaining molecular ions were identified in spectra of samples from Drake site or from Ezcurra sites and they could be associated with factors such as: differential deposition patterns induced by geomorphological aspects or to a local conditioning (restricted to Drake or Ezcurra environment). These sets of molecular ions can be of particular interest, since they show the contribution of a variety of factors like marine spray action, ice-free areas weathering and pollution from the scientific stations and their logistic support.

The line intensities identified in both samples spectra were compared using a non-parametric Wilcoxon test and considering a 95% confidence

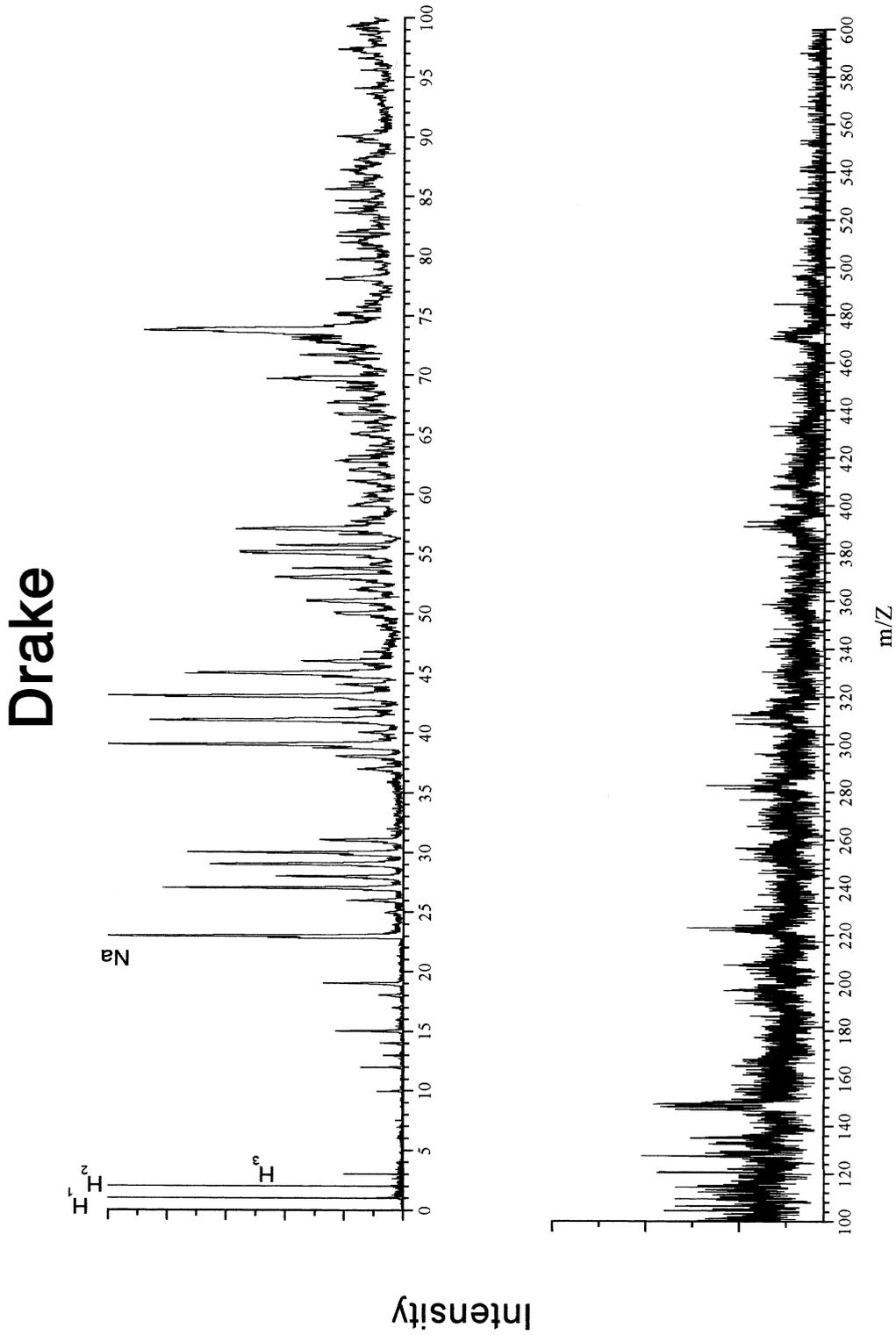


Fig. 4. Positive secondary ion mass spectrum from the Drake ice samples.

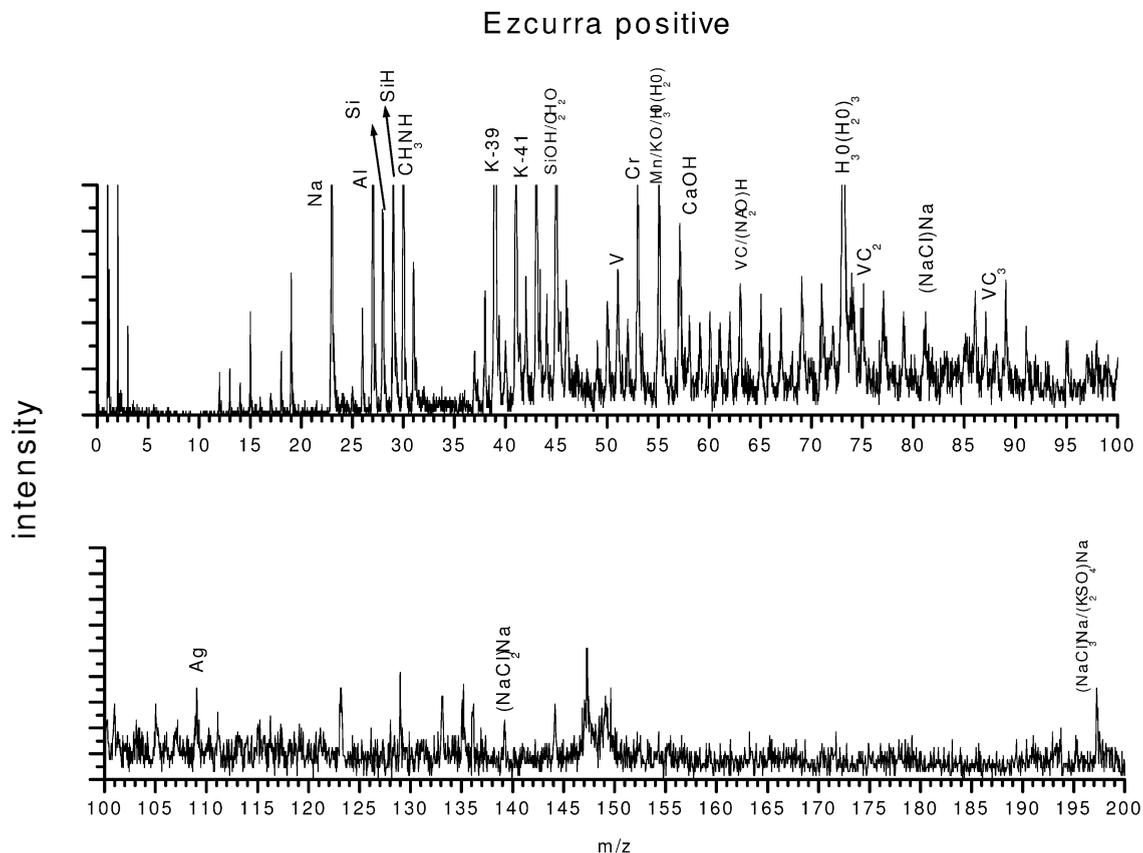


Fig. 5. Positive secondary ion mass spectrum from Ezcurra ice samples.

level (Remington and Scork, 1985). The results show that both set of lines are similar, suggesting that the particles containing these molecules were probably from the same aerosol source and that they could be associated with equivalent atmospheric events.

One of the most important metal identified was vanadium because it is present in crude oil as organic complexes (Weast, 1981). The lines of V^+ and VC_n^+ indicate the contribution of crude oil particles that could be generated in South America by different processes and then transported to Antarctica or in local research stations by oil burning to produce energy. The presence of CF_n^+ clusters suggests the presence of anthropogenic particles in Antarctica. The identification of Cr^+ , $Cr(OH)_2^+$ and Mn^+ clusters also suggests particles

from anthropogenic sources, while the presence of Si^+ , $AlSi^+$, Si compounds, K^+ , Ni^+ and Ni compounds, characterize the transport of soil particles mainly from South America and on a minor scale from local sources of ice-free areas and 'nunataks' (rocks). KCl and Na compounds indicate the presence of marine particles while Ca^+ , Zn^+ ions could be due to the deposition of marine or of soil particles. The presence of N^+ and CN compounds characterize the deposition of biogenous particles. The Ag^+ ion, identified in both spectra, is due to the silver paint used in our experimental arrangement to bias the sample.

The mass spectrum of the ice samples from the Drake site shows Fe compounds, Mg associated to Si, K oxide, Al associated to Ni, indicating the predominance of soil particles. The Ezcurra spec-

Table 1

Molecular ions identified by PDMS technique in the positive mass spectra from the samples. Results correspond to co-occurrence of molecular ions at Drake and Ezcurra cores

Mass (u.m.a)	Ice sample Drake and Ezcurra	Probable origin of airborne particles
1	H ⁺	
2	H ₂ ⁺	
3	H ₃ ⁺	
12	C ⁺	
13	CH ⁺	
14	CH ₂ ⁺ /N ⁺	
15	CH ₃ ⁺	
18	H ₂ O ⁺	
19	(H ₂ O)H ⁺	Marine
23	Na ⁺	Marine
26	C ₂ H ₂ ⁺ / ²⁶ Al	Cosmogenic
27	C ₂ H ₃ ⁺ /Al	Crustal
28	Si/CHNH/N ₂ ⁺	Crustal/Biogenous
29	C ₂ H ₅ ⁺ /SiH ⁺	Biogenous
30	CH ₃ NH ⁺	Biogenous
31	CH ₃ O/P ⁺ /CF ⁺	Biogenous/Crustal/Anthropogenic
37	(H ₂ O)H ₃ O ⁺	Marine
38	C ₃ H ₂ ⁺	
39	K ⁺ /C ₃ H ₃ ⁺	Crustal/Biogenous/Marine
40	Ca ⁺ /CH ₂ CN ⁺	Crustal/Biogenous
41	K ⁺ /C ₃ H ₅ ⁺	Crustal/Biogenous
42	²⁶ AlO ⁺	Crustal
43	AlO ⁺ /C ₂ H ₃ O ⁺ /CH ₃ Si ⁺ /C ₃ H ₇	Biogenous
44	SiO ⁺ /NH ₄ CN ⁺	Crustal/Biogenous
45	SiOH ⁺ /C ₂ H ₂ O ⁺	Crustal/Marine
46	Na ₂ ⁺	Marine
50	CF ₂ ⁺	Anthropogenic
51	V ⁺	Anthropogenic
52	Cr ⁺ / ²⁶ Al ₂ ⁺ /CaC ⁺	Anthropogenic/Crustal/Biogenous
53	C ₄ H ₅ ⁺	
55	Mn ⁺ /KO ⁺ /(H ₂ O) ₂ H ₃ O ⁺	Anthropogenic/Crustal/Marine
57	CaOH ⁺	Crustal/Marine/Biogenous
60	Na ₂ N ⁺	Marine
61	C ₅ H ⁺	
63	VC ⁺ /Cu ⁺ /(Na ₂ O)H ⁺ /CaC ₂ ⁺	Anthropogenic/Marine/Biogenous
65	Cu ⁺ /NaCNO ⁺	Anthropogenic/Marine
66	C ₅ H ₆ ⁺	
67	VO ⁺	Anthropogenic
69	CF ₃ ⁺ /C ₄ H ₅ O/CrOH ⁺	Anthropogenic/Crustal
71	KO ₂ ⁺ /MnO ⁺	Anthropogenic/Crustal
72	FeO ⁺ /(SiO)Si ⁺ /Na ₂ CN ⁺	Crustal/Biogenous
74	KCl ⁺ /Ca(OH) ₂ ⁺	Anthropogenic/Marine
75		Anthropogenic
81	C ₆ H ₉ ⁺	
86	Cr(OH) ₂ ⁺ /MnP ⁺	Anthropogenic/Biogenous
87	VC ₃ ⁺	Anthropogenic
88	(SiO ₂)Si ⁺ /Na ₂ CNO ⁺ /FeS ⁺	Crustal/Biogenous/Marine
98	CuCl ⁺	Marine
109	Ag ⁺ /Ni(OH) ₃ ⁺	Instrumentation/Crustal
111	Not identified	
207	Not identified	

Table 2

Molecular ions identified in the positive mass spectra from the samples collected at Drake and Ezcurra sites

Mass (u.m.a)	Ice Sample			
	Drake		Ezcurra	
	Probable airborne particles source		Probable airborne particles source	
10	^{10}Be	Cosmogenic	–	
14	CH_2^+/N^+			
17	OH_2^+		–	
25	C_2H^+	Biogenous	–	
47	PO^+/CFO	Biogenous/Anthropogenic	–	
49	NaCN^+	Marine/Biogenous	–	
54	Al_2^+	Crustal	–	
56	$\text{Fe}^+/\text{MgS}^+/\text{CaO}^+$	Crustal/Marine	–	
57	FeH^+	Crustal	–	
58	Ni^+	Crustal	NaCl^+	Marine
59	–		$\text{MgCl}^+/\text{Co}^+/\text{(CH}_3)_2\text{SiH}^+$ $/\text{C}_3\text{H}_7\text{O}^+$	Crustal/ Anthropogenic/ Marine/Biogenous
60	Ni^+	Crustal	–	
64	$\text{Zn}^+/\text{Mg(MgO)}^+$	Crustal/Marine	–	
		Anthropogenic		
66	Zn^+	Crustal/Marine	–	
68	$\text{Zn}^+/\text{C}_5\text{H}_8^+/\text{CrO}^+$	Crustal/Marine	–	
		Anthropogenic		
70	$(\text{AlO})\text{Al}^+$	Crustal	–	
72	FeO^+	Crustal/Anthropogenic	–	
74	NiO^+			Anthropogenic
75			CoO^+	Anthropogenic
76	Mg_2Si^+	Crustal	–	
77	–		C_6H_5^+	
79	–		C_6H_7^+	
80	$\text{Mg(MgS)}^+/\text{ZnO}^+/\text{CuOH}^+$		–	Crustal
81	ZnOH^+	Biogenous/Crustal	$(\text{NaCl})\text{Na}^+$	Marine
82	$\text{C}_6\text{H}_{10}^+/\text{AlN}_2^+$	Biogenous	–	
84	$\text{FeSi}^+/\text{MgSiO}_2^+/\text{CrO}_2^+/\text{CrS}^+$	Crustal	–	
85	$\text{KNO}_2^+/\text{AlNi}^+$	Biogenous/Crustal	–	
89	–		$(\text{AlCl})\text{Al}^+$	Marine
90	Fe(OH)_2^+	Biogenous/Crustal	–	
91	–		$(\text{H}_2\text{O})_4\text{H}_3\text{O}^+/\text{CoS}^+$	
94	$(\text{KO})\text{K}^+$	Biogenous	–	
95	–		$\text{C}_7\text{H}_{11}^+$	
96	$(\text{CaSi})\text{Si}^+/\text{Na}_2\text{CNO}^+/\text{FeS}^+$	Crustal	–	
97	C_7H_3^+		$\text{C}_7\text{H}_3^+/\text{(NaCl)K}^+$	Marine
99	VC_4^+	Anthropogenic	–	
101	–		KNO_3^+	Biogenous
105	Not identified		–	
107	Fe(OH)_3^+	Crustal	–	
110	$(\text{KO}_2)\text{K}^+/\text{CaCl}_2^+/\text{Ni(NC)}_2^+$	Biogenous/Marine/ Crustal	–	
113	$(\text{KCl})\text{K}^+$	Marine		
115	$\text{Cu(CN)}_2^+/\text{MnCO}_3^+$	Biogenous		
121	$(\text{CrOH})\text{Cr}^+/\text{CuCNS}^+$	Crustal/Biogenous	–	

Table 2 (Continued)

Mass (u.m.a)	Ice Sample		Ezcurra	
	Drake		Probable airborne particles source	
	Probable airborne particles source		Probable airborne particles source	
123	–		CoS ₂ ⁺	Marine
128	(FeO)Fe ⁺ /NiCl ⁺	Crustal	–	
129	?		CoCl ₂ ⁺	
133	CuCl ₂ ⁺	Marine	–	
135	–		–	
136	–		CaSO ₄ ⁺	Marine
139	–		(NaCl) ₂ Na ⁺	Marine
144	–		Not identified	
147	(CH ₃) ₅ Si ₂ O ⁺	Crustal	CoC ₂ O ₄ ⁺	Crustal
149	?		(Na ₂ SO ₃)Na ⁺ /Co ₂ P ⁺	Marine
197	–		(K ₂ SO ₄)Na ⁺ /NaCl ₃ Na ⁺	Marine
224	PbO ⁺	Anthropogenic	–	
278	CaAl ₂ SiO ₈ ⁺ /PbCl ₂ ⁺	Crustal	–	
284	PbSiO ₃ ⁺ /CrS ₄ ⁺	Crustal	–	
310	FeK ₂ (C ₂ O ₄) ₄ ⁺	Crustal	–	
312	FeI ₂ ⁺	Crustal	–	

trum shows NaCl clusters, which characterize marine aerosols. Pb compounds and Zn ions are observed only in the Drake samples. Based on these results, we concluded that the mass spectra from Drake ice samples show a more intense contribution of crustal airborne particles than in the Ezcurra core, despite the fact that the latter site is located closer to an ice-free area during the summer period (4 months). This observation indicates that the contribution of fine particles from outcrop areas in King George Island may be negligible. In this case, two parameters inhibit local dust production: first a geological formation composed mainly by large size gravel; second, intense surface winds during cyclonic systems passages, normally accompanied by precipitation of snow or rain, result in an intense washout process. These results are of particular interest, since a higher influence of crustal aerosols was expected at the Ezcurra site compared with the Drake site, due to the proximity of ice-free areas and scientific stations to the former.

The results show that the majority of particles deposited on the glacier facing South America were due to particulates transported by the air streams from land-continental regions. These par-

ticles characterize the atmospheric transport events towards the Antarctic Peninsula observed on King George Island.

The mass spectra from Ezcurra snow samples showed that the majority of the particles deposited in the glacier were from marine spray. This unexpected source might result from the geography of the sampling site. It is located at the inner part of the island, surrounded by glaciers that may act as shelters against the direct air flow streams coming from the open sea. The same ion molecules identified in the mass spectra from both samples indicate that only fine airborne dust particles from the continent would have a high a probability of settling on the surface, having therefore low dependence on geomorphology.

These results corroborate previous studies (Pereira, 1990; Evangelista, 1998; Dalia, 2002), which have also concluded that there is transport of airborne particles from South America to Antarctica.

4. Conclusions

The application of the ²⁵²Cf-PDMS technique to the analysis of two different ice samples from

King George Island allows identification of the compounds present in each sample. This provides important information for identification of the possible sources of particles deposited in the ice. These results show that the PDMS technique is a powerful tool for analysis of snow and ice samples.

The mass spectra of two ice cores, taken from the same ice mass on King George Island, show that the particle composition is highly influenced by local conditions, resulting in a non-homogeneous spatial distribution. The majority of the molecular ions identified in both ice cores characterize airborne particles from anthropogenic sources. The predominance of particles from crustal and anthropogenic sources is observed in the samples collected in the slope towards the open sea (Drake core), while the sample collected in the slope towards the bay (Ezcure core) show a high influence of marine aerosols. We concluded that samples from the Drake snow core have a higher concentration of particles representative of the regional synoptic regime (i.e. of the long range atmospheric transport by large scale cyclonic systems).

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