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Geochemical markers of soil anthropogenic contaminants in polar scientific stations nearby (Antarctica, King George Island)

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HIGHLIGHTS

- Organic contaminants in Antarctica soils and terrestrial sediments investigated
- GC–MS applied for investigation of extractable compounds of sediments
- Fossil fuels as the main source of organic contaminants

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ABSTRACT

The organic contamination of Antarctic soils and terrestrial sediments from nearby of five polar scientific stations on King George Island (Antarctica) was investigated. Gas chromatography–mass spectrometry (GC–MS) was applied to find composition of dichloromethane extracts of soil and terrestrial sediments. The presence of geochemical markers, such as *n*-alkanes, steranes, pentacyclic triterpenoids, and alkyl PAHs, their distribution types, and values of their ratios indicates the predominating source of organic fossil fuels and products of their refining rather than from the natural Antarctic environment. Fossil fuel-originated compounds well survived in conditions of Antarctic climate over long times thus enabling to characterize geochemical features of source fossil fuel identified as petroleum expelled from kerogen II of algal/bacterial origins deposited in sub-oxic conditions and being in the middle of catagenesis. Both microbial activity and water leaching play an important role in degradation of terrestrial oil spills in the Antarctica climate, and petroleum alteration occurs lowly over long periods of time. Synthetic anthropogenic compounds found in terrestrial Antarctica sediments included diisopropylnaphthalenes, products of their sulfonates degradation in paper combustion, and organophosporus compounds used as retardants and plasticizers.

1. Introduction

The natural environment of Antarctica has been considered to be pristine for many years. However, the last year research indicates the significant anthropogenic impact related to activities of scientific research stations, tourism and fishing. All these operations require vehicle, aircraft, and vessel traffic, fuel storage, refueling, scientific drilling activities, sewage discharge, and waste disposal (Cripps and Priddle, 1991; Green and Nichols, 1995; Aislabie et al., 2004; Martins et al., 2002, 2012). Apart from regular human activity accidental contaminations are also possible as it was in the case of the Brazilian Antarctic Station fire in 2012 (Guerra et al., 2013). Increasing interest in Antarctica and easier access to the region lead to an increase in the number of people visiting the continent. At present there are about 80 research areas located mostly in coastal regions of the continent, comprising of about 53 scientific stations, both permanent and summer ones (Martins et al., 2012; Guerra et al., 2013). Moreover, there are sites of former abandoned stations and waste disposal sites from the past which still store hazardous substances (e.g. *Greenpeace 1992–1993 Antarctic Expedition Report*). Heavy metals, fossil fuels of variable characteristics, particularly their polyaromatic hydrocarbons (PAHs), additives, and polychlorinated organic compounds seem to be of the highest hazard to the Antarctica biosphere (Powell et al., 2005; Miranda-Filho et al., 2007; Ribeiro et al., 2011; Cabrerizo et al., 2012; Guerra et al., 2013).

Petroleum products are particularly persistent in the polar environment. Low temperatures lead to low degradation rates in polar regions thus hydrocarbons from oil, diesel, and lubricant spills can survive for many years in soils and sediments still showing their initial geochemical characteristics and significantly harmful influence to many organisms (Kennicutt et al., 1991; Snape et al., 2001; Powell et al., 2005). Diesel fuel is readily dissipated even in the Antarctica environment as it was

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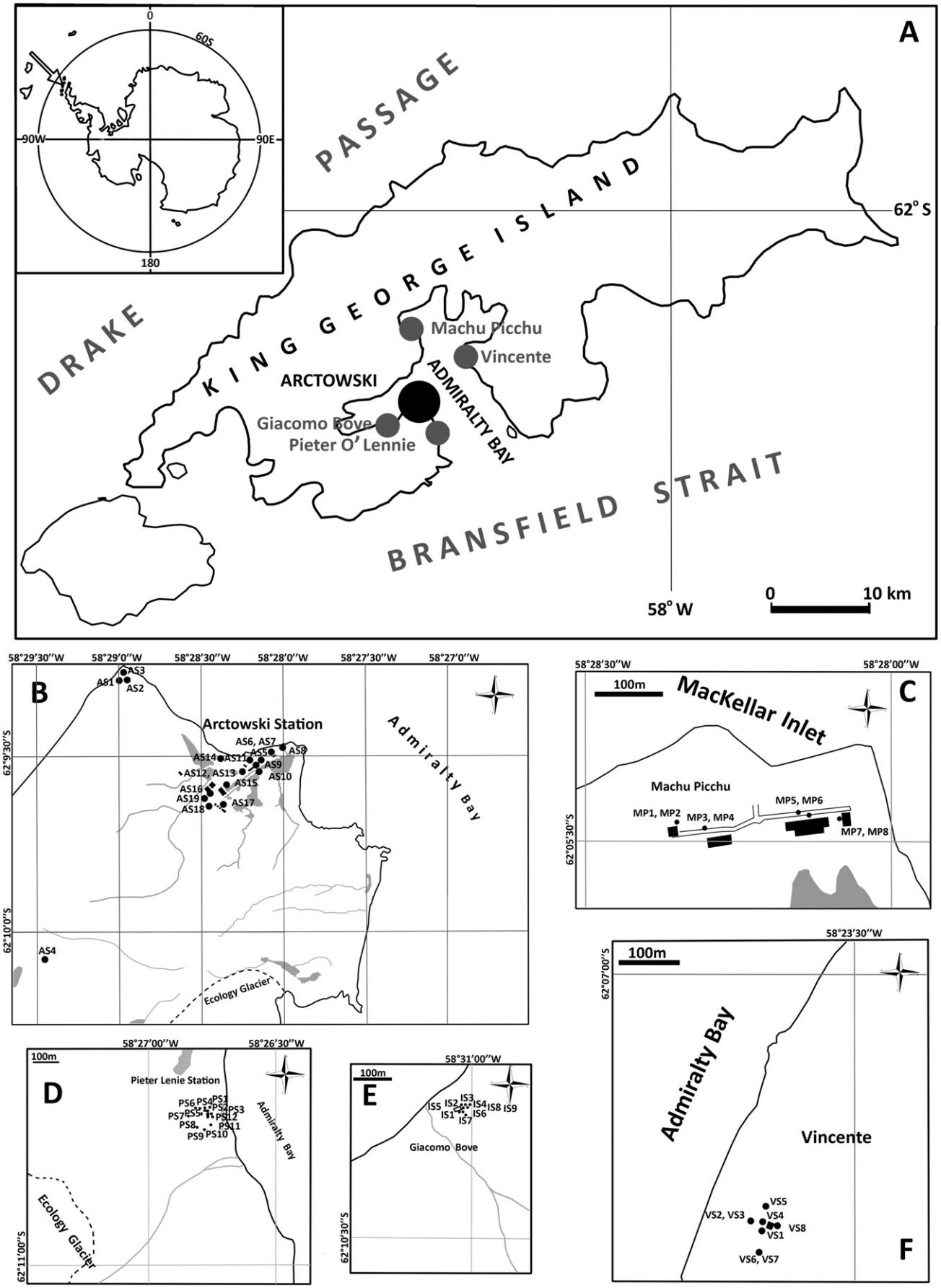

Fig. 1. Map of King George Island (Antarctica), locations of scientific research stations and sampling sites.