Polar Science xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Polar Science

journal homepage: www.elsevier.com/locate/polar

Hydrogeological characteristics of aquifer near Arctowski Polish Antarctic Station on King George Island (South Shetland Islands), Antarctica

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ARTICLE INFO

Keywords:
Henryk Arctowski Antarctic Station
Groundwater
Chemical composition of water
Groundwater system
South Shetland Islands, Antarctica

ABSTRACT

During the Antarctic summer season of 2015/2016, the groundwater studies were performed in the area of Henryk Arctowski Polish Antarctic Station on King George Island (South Shetland Islands) in Admiralty Bay of Antarctica. Rock and groundwater samples were collected from 14 research excavations down to a depth of 0.8–2.5 m b.g.l. Analyses of surface waters were performed on water samples from streams, mossland, and a drinking water reservoir. The scope of hydrochemical studies comprised analyses of temperature, pH, mineralization, phosphates, nitrates, macroelements and selected microelements. Using empirical formulas, granulometric analysis of rock samples from various depths, measurements of sample moisture, and calculations of the hydraulic conductivity were performed.

The groundwater is poorly mineralized, representing chloride-sulfate-bicarbonate-sodium and chloride-bicarbonate-sodium-calcium types. Studies on hydrochemical indicators show a small range of the effect of animal ecosystems on the waters; no effects of organic matter have been identified in the study area. Results of hydrogeochemical studies of waters and observations of groundwater levels in the summer season indicate groundwater recharge in a shallow groundwater circulation system, lateral inflow direction from land toward the seashore, and a low rate of rainwater infiltration. Groundwater drainage occurs through evapotranspiration and water runoff to the sea.

1. Introduction

During the Antarctic summer season of 2015/2016, the studies were conducted in the area of Henryk Arctowski Polish Antarctic Station on King George Island (South Shetland Islands, Antarctica) off the coast of Admiralty Bay. The aim of the studies was the hydrogeochemical characterization of surface and groundwater, identification of the water pollution extent, and determination of the role of factors controlling the groundwater recharge. Results of the hydrochemical studies of water were compared with few previous studies, which made it possible to assess the change in water quality.

The Henryk Arctowski Polish Antarctic Station has been operating continuously since its founding in 1977. The Station is managed by the Institute of Biochemistry and Biophysics of Polish Academy of Sciences. Since 1997 there has been continuous research in the fields of Oceanography, Geology, Geomorphology, Glaciology, Meteorology, Climatology, Seismology, Magnetism, and particularly Ecology (http://sunsite.icm.edu.pl/dab/overview.html; http://www.arctowski.pl).

The hydrochemical and hydrodynamical studies of surface and groundwater were conducted in Antarctica to a limited extent only. Most studies were focused on selected indicators to determine the impact of breeding colonies of penguins on the quality of groundwater. As part of this environmental monitoring program, samples from glaciers, meltwater streams and lakes in West Antarctica were collected for chemical analysis (Welch et al., 1996). Groundwater was sampled during the warmer summer months (December/January) in 2004/2005 at Seabee Hook which is a lying gravel spit adjacent to Cape Hallett, northern Victoria Land, in the Ross Sea region of Antarctica (Hofstee et al., 2006). A similar groundwater system to Seabee Hook was described at Casey Station in the Windmill Islands, East Antarctica, where groundwater has been identified as a major pathway for contaminant transport (Snape et al., 2001a, 2001b, 2005). At the "Old Casey" site, groundwater was present for 2–3 months during the summer season with surface runoff occurring only in several ephemeral streams at Thala Valley and Wilkes Station (Snape et al., 2001a). Shallow groundwater has also been reported at the Larsemann Hills, East Antarctica, where piezometers were used to monitor subsurface water, and to track nutrient flows into freshwater lakes (Kaup and Burgess, 2002). In the environmentally sensitive coastal zone of Antarctica, bromide was used as a tracer to determine groundwater speed

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https://doi.org/10.1016/j.polar.2018.02.005
Received 20 September 2017; Received in revised form 13 December 2017; Accepted 22 February 2018

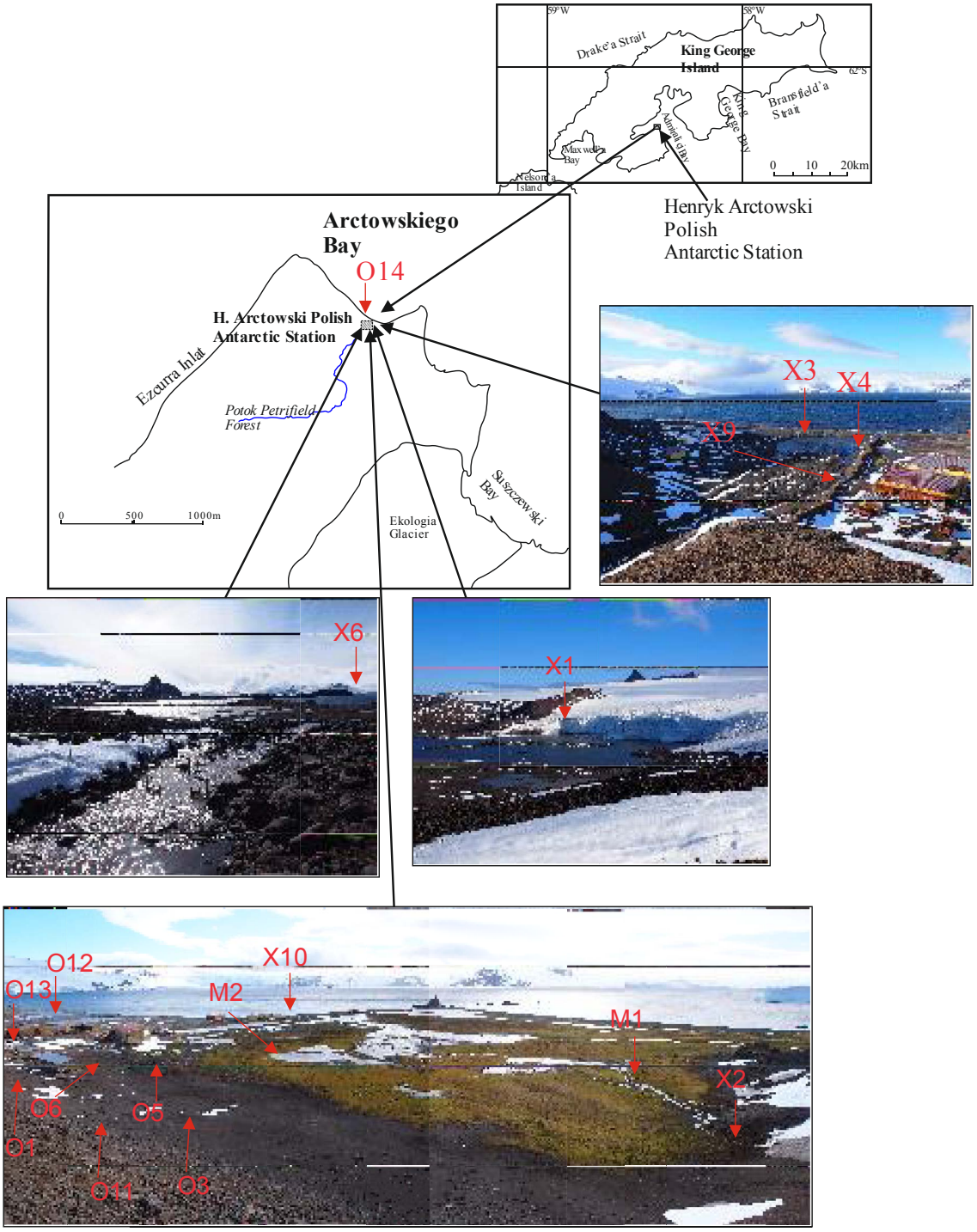

Fig. 1. Location of survey points and sampling sites.

and direction. During environmental assessments of the Seabee Hook area in late January and early February 2003 (Hofstee et al., 2006), groundwater level was identified, traces of which were found in the soils at some sites. Studies on the evolution of biodiversity in Western Antarctic for geochemical characteristics of discharged waters (Eh-pH curves), water temperature and conductivity of the subglacial rivers were conducted in Potter Cove, near the Argentine Antarctic Base Jubany (Eraso and Domínguez, 2007). Some aspects of selected physico-chemical indicators of surface water on King George Island were investigated by Tatur and Myrcha (1983); Rakusa – Suszczewski (2003), Nędzarek and Pociecha (2010).

2. Location of the study area

2.1. Geographical position

Henryk Arctowski Polish Antarctic Station is situated on King George Island (South Shetland Islands) in Admiralty Bay of Antarctica (Fig. 1). Immediately to the south is the Antarctic Specially Protected Area (ASPA) No. 128 "Western Coast of Admiralty Bay."

The Polar Station is separated from the ASPA 128 by a large area of wet mossland under special protection for preservation of wetlands in the polar climate regions.

The Station facilities are located on a flat coastal area of *plateau* type