ORIGIN OF TRACE ELEMENTS IN THE VESTFOLD SALINE LAKE WATERS, PRINCESS ELIZABETH LAND (EXTENDED ABSTRACT)

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A large ice-free area, referred to as the Vestfold Hills, exists on the coast of Princess Elizabeth Land, Antarctica (Fig. 1). The ice-free area extends some 400 km^2 which contains several hundred lakes and ponds. Davis Station, an Antarctic base of Australia, occupies the center of the area (68°34′S, 77°58′E).

The chemical features of some lakes and ponds of the area were reported (McLEOD, 1964; KERRY *et al.*, 1977; BURTON and BAKER, 1979). Isotopic studies were undertaken and reported by HORIUCHI *et al.* (1977) and MATSUBAYA *et al.* (1979). MATSUMOTO *et al.* (1983) have made the biogeochemical study. However, there have been few geochemical studies on trace elements of Antarctic lake waters. BOSWELL *et al.* (1967a, b) reported the contents of six trace elements in the bottom waters of six lakes of the Dry Valleys area, Victoria Land, and concluded that some of the trace elements were not derived directly from seawater. MASUDA *et al.* (1982a) reported the vertical distribution of Fe, Cu, Al and Ni in Lake Vanda of the Dry Valleys area. They demonstrated that at least copper came from air-borne particles via glacial meltwater. MASUDA *et al.* (1982b) presented the vertical distribution of 14 trace elements which were analyzed by neutron activation analysis, and concluded that the pathway of these trace elements in Lake Vanda was: tropospheric aerosol particles—precipitation—glacier—glacial melt water—Lake Vanda. In the present study, the origin of trace elements is estimated from the data of 23 chemical elements in the Vestfold saline lakes.

Water samples were taken vertically in the austral summer season of 1983–84 at Ace, Shield and Burton Lakes of the Vestfold Hills. The concentrations of chemical elements in each sample were determined by atomic absorption spectrometry and neutron activation analysis with the TRIGA II reactor of Rikkyo University. For trace element analysis, basically two types of neutron activation analysis were performed. Analysis of copper, manganese and aluminum was performed after solvent extraction to avoid chloride interference. The other trace elements were analyzed with dried up residues of the sample water directly.

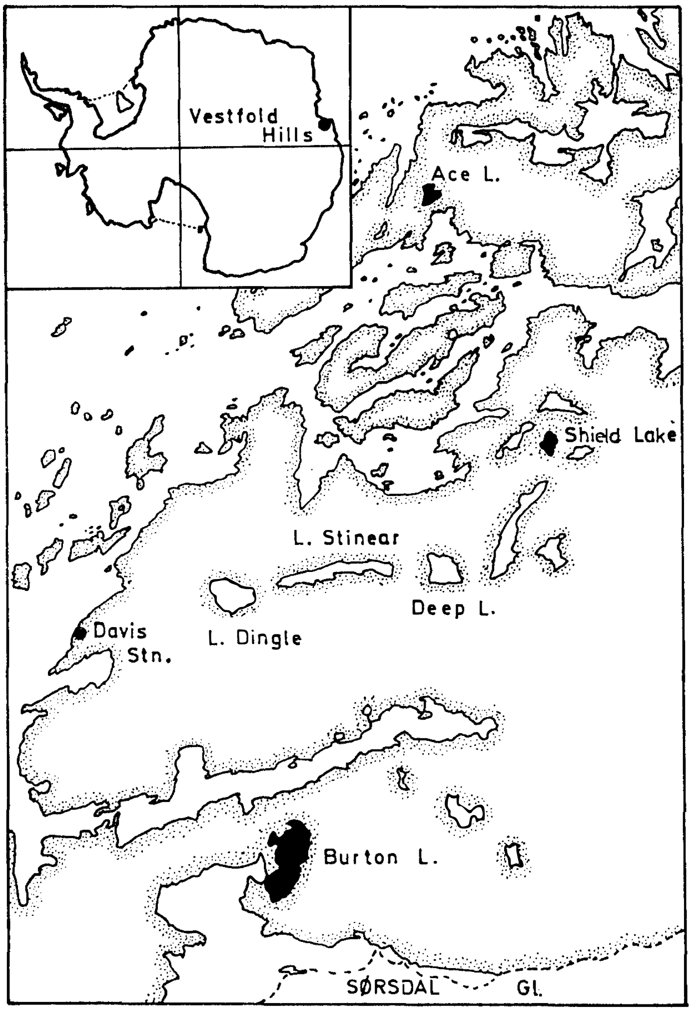

Fig. 1. Location of Ace Lake, Shield Lake and Burton Lake of the Vestfold Hills, Antarctica.

In this study, three possible origins of chemical elements are estimated: 1) seawater, 2) rock weathering, and 3) aerosol particles. The relationship of chemical components of two Vestfold lakes and seawater is presented in Fig. 2. The lakes of the Vestfold Hills are believed to have been isolated from the sea by isostatic uplift following the last glacial period possibly 4000–7000 years before present. Inferred from the high correlations of chloride, sodium, magnesium, calcium and rubidium between lake waters and seawater, the alkali, alkaline earth elements and chloride of these coastal lakes may have been derived from seawater or sea spray. Figure 3 shows the relationship of chemical elements of aerosol particles at the South Pole (MAENHAUT *et al.*, 1979) and in two lake waters. All the elements, except alkali, alkaline earth elements and chloride, have a good agreement with those of the South Pole aerosol particles. The origin of the trace elements seems to be aerosol. Mean residence time of each element at the lake can provide valuable information about the origin. To examine the aerosol origin for trace elements, the residence time of elements in Shield Lake was calculated on the basis of dry fallout contribution. In

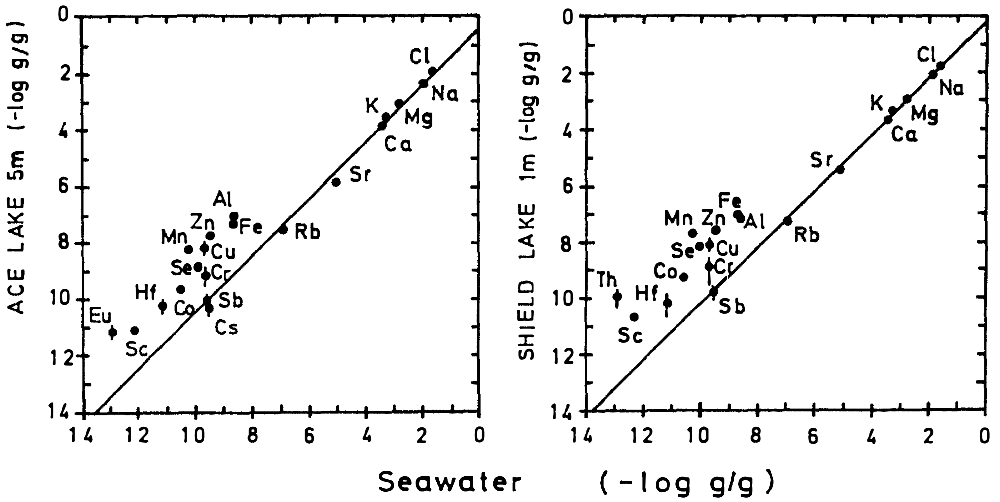

Fig. 2. Relationship of chemical compositions of seawater and two Vestfold saline lake waters. The ranges of the data denote analytical errors.

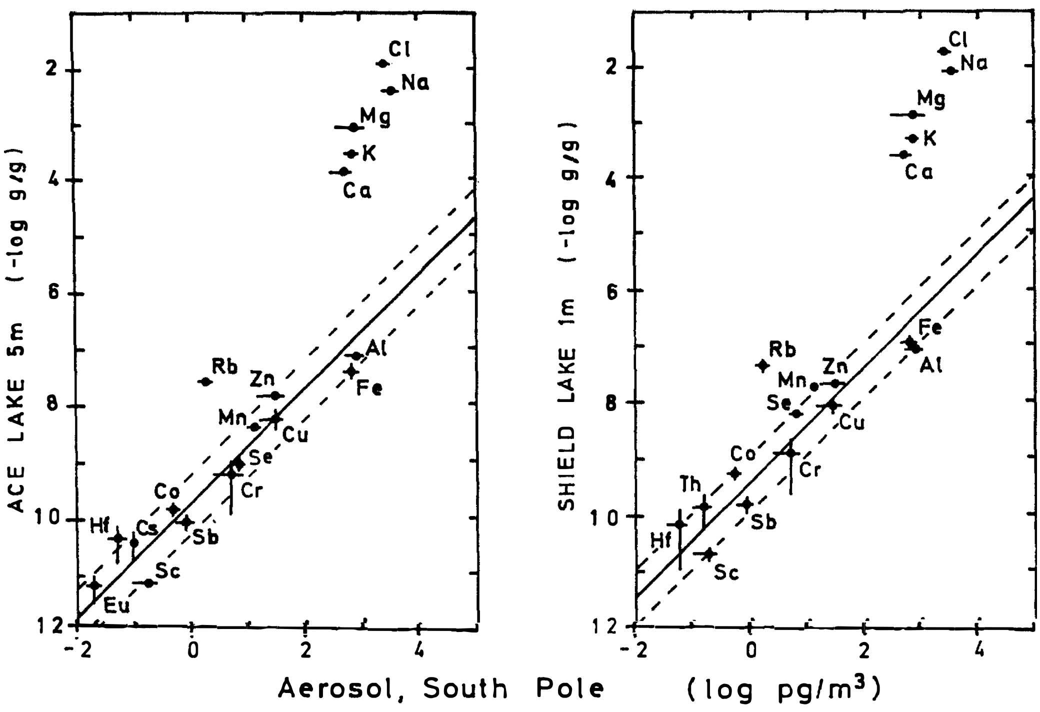

Fig. 3. Relationship of chemical compositions of aerosol particles at the South Pole and in two Vestfold saline lake waters. The ranges of the data denote analytical errors.

calculation, the aerosol data of the Dry Valleys region was used as a reference value of Antarctic coastal oases. The mean residence time is presented in Table 1. Sodium, chloride, calcium and magnesium demand more than three million years of annual deposition from the atmosphere. These values are able to confirm the seawater origin for major cations and chloride in the Vestfold lakes. Aluminum, zinc, iron and cobalt need only 60–90 year aerosol deposition for satisfying the total

Table 1. Mean residence time.

	Input rate* (μg/dm^2·yr)	Residence time (yr)
Na	700	1.6×10^7
Cl	1300	1.9×10^7
Ca	530	6.0×10^6
Mg	480	3.5×10^6
Al	1600	58
Fe	1840	85
Zn	180	79
Co	10	67
Mn	110	320

Mean residence time (in steady state)=Inventory/Input rate.
Deposition velocity: 1.0 cm/s.
* Aerosol data of the Dry Valleys region were used.

amount of these metals in Shield Lake. This estimated value represents the maximum. The aerial flux is based on only the lake surface area and if catchment area was considered, the mean residence time for trace elements should come to be shorter. If the marine origin were taken for trace elements, more than a hundred-fold concentration would be required (67.2 μg-Zn/kg at a depth of 24 m of Shield Lake, 0.39 μg-Zn/kg mean seawater). The residence time calculation indicates that aerosol deposition is more reasonable than seawater origin or rock weathering origin for trace elements of the area.

The aerosol particles played a major role in the origin of trace elements in inland lakes, such as Lake Vanda and Canopus Pond of the Wright Valley, Victoria Land (MASUDA *et al.*, 1984). The aerosol particles also take a major part in the trace element origin even in the coastal oases, such as Vestfold saline lakes. This conclusion may be extended to other Antarctic lakes.

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