Abstract. Thirty-one peatlands from two areas of central Ontario were sampled to assess the influence of acid deposition on peatland water chemistry. Factor analysis differentiated peatland water chemistry along three major axes of chemical variation, interpreted as axes of organic concentration, mineral concentration, and deposition influence. Water from the surface mats had a higher organic concentration than water from open pools. Mineral influence in peatland waters was reflected by higher concentrations of Ca, Mg, Na, and silica in fen pools compared to bog pools. The influence of high acid deposition in the Wanapitei study area was indicated by high concentrations of sulphate, Ni, Mn, and Cu, and lower pH compared to an area that has received less acidic deposition (Ranger). Regression analyses indicated that H\(^+\) variation in bogs could be largely explained by organic C concentration, but that sulphate concentration was also positively associated with acidity, while Ca was negatively associated with acidity.

1. Introduction

Recently attention has been focussed on the extent to which peatland waters (i.e., bogs and fens), which often contain high amounts of natural acidity, are subject to further acidification through acid precipitation (Gorham et al., 1984). In Europe, peatland waters near industrialized areas were found to have a predominance of sulphate among the anions, and strong correlations between sulphate and H\(^+\) concentrations (Gorham, 1958; Van Dam et al., 1980; Vangenechten et al., 1981b; Gorham et al., 1985). In eastern North America, studies of peatland acidity have demonstrated that pH is controlled by weak organic acids (Hemond, 1980; Gorham et al., 1985; McKnight et al., 1985; Urban et al., 1985). Although mineral acids deposited in peatlands can be neutralized through sulphate reduction and nitrate uptake (Hemond, 1980, 1983; Bayley and Schindler, 1985; Urban and Bayley, 1986), the relatively slow rate of sulphate uptake may allow increased acidity of surface waters following inputs of acid sulphate (Urban and Bayley, 1986). Sulphate concentrations in bog water increase from west to east in eastern North America in relation to a similar gradient in sulphate deposition (Gorham et al., 1985; Urban et al., 1985). It has been hypothesized that the natural succession from fen peatlands to bogs may be accelerated by acidification of fen surface water through acid deposition (Gorham et al., 1984).

As part of a study on the effects of acid deposition on wetland-dwelling wildlife in central Ontario (Blancher and McNicol, 1986), we were interested in assessing the influence of acid deposition on peatland water chemistry. Our approach was to compare water sampled in similar peatland communities from two study areas that differed in

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inputs of acid deposition. However, the concentrations of organic and mineral acids in colored waters are influenced by factors other than acid deposition, including seasonal changes in water flow and weather conditions (Gorham, 1956; LaZerte and Dillon, 1984; Kerekes et al., 1986), location of water sampling sites in relation to open water (Sjors, 1959; Vitt and Bayley, 1984; McKnight et al., 1985), and the type of peatland sampled (Bay, 1967; Clausen and Brooks, 1983; Gorham et al., 1985). For this reason, sampling in each study area included three seasons (May – high water, August – low water, November – prior to freezeup), two locations within each peatland (surface mat water, open pool water), and two types of peatlands (nearly ombrotrophic bogs, poorly minerotrophic fens).

2. Study Areas and Wetlands

The Ranger study area is centered around Ranger Lake at 46°55' N latitude, 83°35' W longitude, 40 to 70 km northeast of Sault Ste. Marie, Ontario. The Wanapitei study area lies north of Lake Wanapitei, centered at 46°55' N latitude, 80°45' W longitude, 40 to 65 km northeast of Sudbury, Ontario, and approximately 225 km east of Ranger Lake. Both lie on precambrian granitic bedrock of the Canadian shield, with low to insignificant buffering capacity. Both areas fall within the Great Lakes–St. Lawrence lowland forest region (Rowe, 1972) comprised of mixed hardwood forests, though elements of the boreal forest are also present. The two study areas are located within the ‘low boreal wetland region’ of Canada (Zoltai and Pollett, 1983) where wetlands comprise 5 to 25% of land area. Characteristic wetlands of this region are small, bowl-shaped, bogs and fens (i.e., peatlands), often tree-covered (Monenco Ontario Ltd., 1981; Zoltai and Pollett, 1983).

Acid deposition is generally highest in the southeastern parts of Ontario and declines to the northwest (Memorandum of Intent, 1983). As the Wanapitei study area lies east of Ranger, it consequently receives a slightly greater loading of sulphate and H+ from long-range transport. In addition, the area surrounding Sudbury has historically received high deposition of S compounds and metals from local smelting activities (Jeffries, 1984; Keller and Pitblado, 1986). Thompson and Hutton (1985) reported wet SO4 deposition values of 76 meq m⁻² yr⁻¹ for Sudbury, and 41 meq m⁻² yr⁻¹ for Turkey Lakes, the latter area located 50 km west of Ranger Lake. Waterbodies immediately adjacent to Sudbury have strongly elevated concentrations of sulphate and several metals (Cu, Ni, Mn, Al, Zn) (Gorham and Gordon, 1960, 1963; Dillon et al., 1980; Keller et al., 1980; Pitblado et al., 1980), though water quality is improving with recent reductions in smelter emissions (Dillon et al., 1986; Hutchinson and Havas, 1986; Keller and Pitblado, 1986; Keller et al., 1986). The Wanapitei study area is outside the zones of greatest impact from the Sudbury smelters (Pitblado et al., 1980). Nevertheless, many lakes at Wanapitei are acidic (pH < 5, McNicol et al., 1987) and show evidence of an historical impact from smelter emissions (Pitblado et al., 1980).

Fifteen peatlands were studied at Ranger, sixteen at Wanapitei. All had central pools of open water and at least 3 m depth of organic peat. We selected two types of wetlands: