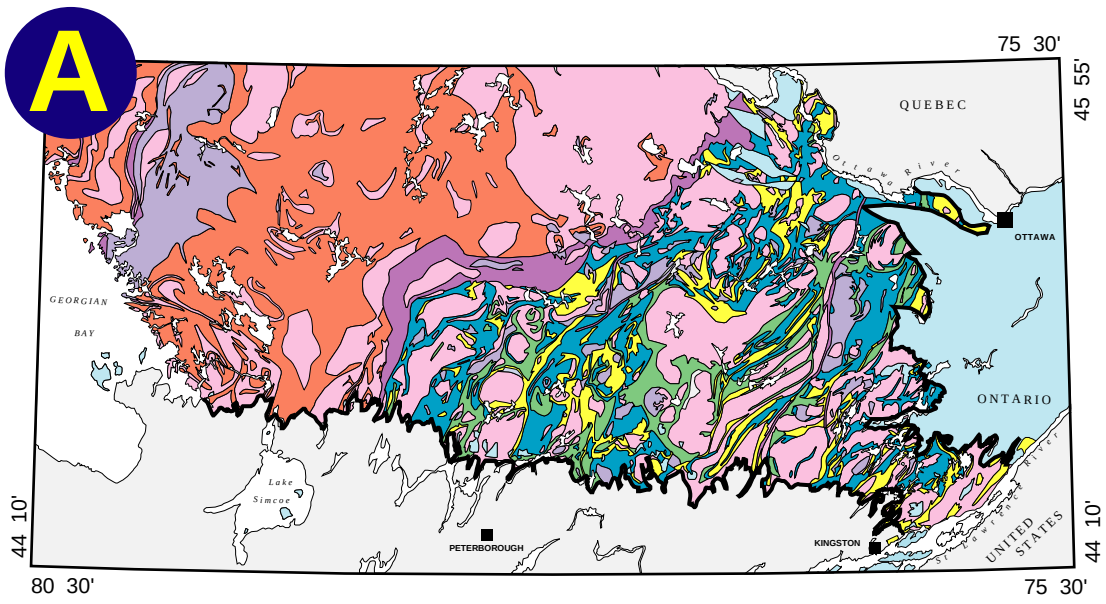
A geological perspective on the effects of acid rain on the environment

To assess the potential effects of acid rain on the environment, the origins and geochemical properties of surficial deposits in the region between Georgian Bay and the Ottawa River Valley were determined. The bedrock geology, abundance of carbonate pebbles, and arsenic concentrations, illustrated here, can be used together as a basis for enviromental management and potential risk assessment.

The study area is underlain by two distinct bedrock terrains: igneous and metamorphic rock of the Precambrian Shield; and Paleozoic sedimentary rock (see Map A). For environmental studies, the physical and chemical differences between the two bedrock terrains are important. The most significant difference relates to the presence of carbonate minerals. Carbonate minerals are highly reactive, serving to buffer pH changes in water and surficial deposits from the effects of acid rain. In the study area, Paleozoic bedrock (light blue on Map A) is dominated by carbonate minerals whereas Precambrian Shield terrain is carbonate-poor, except in areas of marble (dark blue). The bedrock is discontinuously covered by surficial deposits derived from bedrock erosion, transportation, and deposition during the last glaciation.



Bedrock Geology

Paleozoic

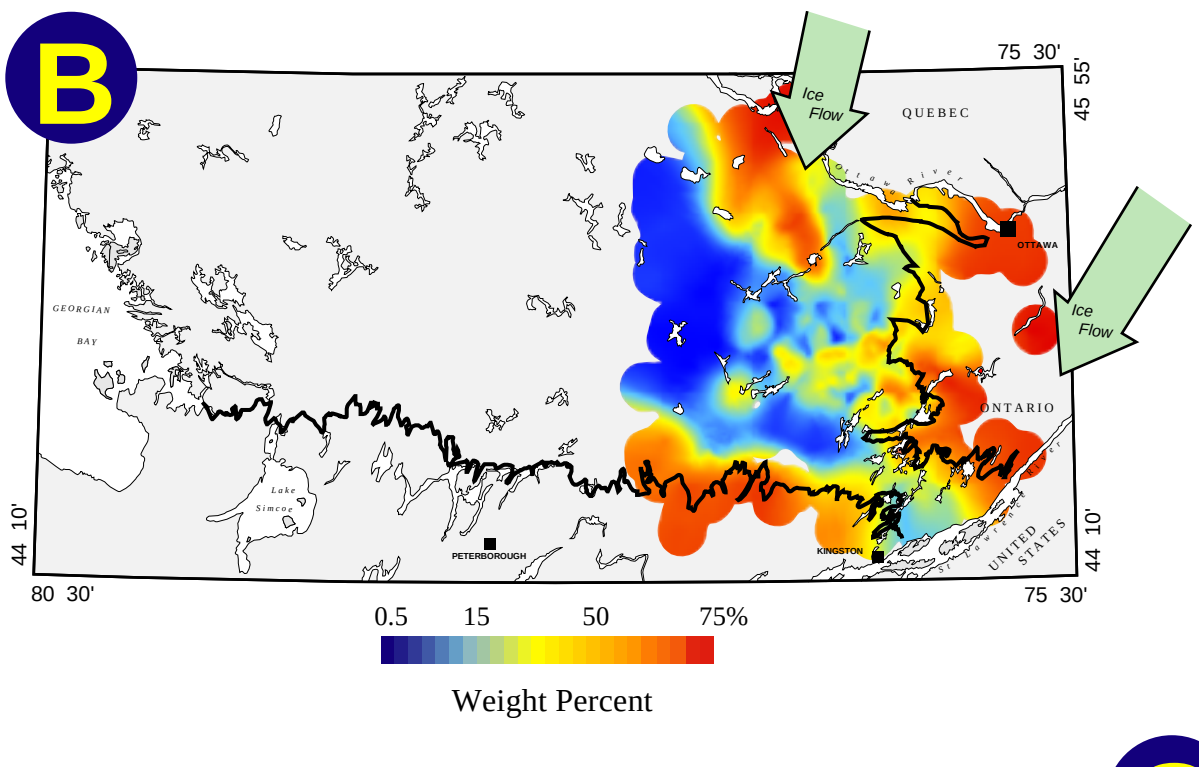
- Limestone, dolostone

Precambrian Shield

- Tectonite
- Granite
- Mafic intrusive
- Marble
- Clastic metasediment
- Metavolcanic
- Gneiss

The distribution of Paleozoic carbonate pebbles in surficial deposits is displayed in Map B. As a result of southwestward glacial transport (see ice flow arrows), Paleozoic carbonate pebbles are widely distributed beyond their bedrock source areas. Trace quantities of Paleozoic carbonate pebbles occur on Precambrian Shield terrain more than one hundred kilometres, from their bedrock source . On Precambrian Shield terrain of the north-central part of the coloured area (Map B), Paleozoic carbonate pebbles occur in concentrations up to 50 weight per cent (red colour), tens of kilometres south and southwest of their bedrock source underlying the Ottawa River Valley.

Paleozoic Carbonate Pebbles in Surficial Deposits



Where carbonate pebble concentrations are high, there is less likely to be a significant decrease in soil pH through acid rain than in areas where carbonate pebble concentrations are low. Trace elements such as lead, zinc, cadmium, and arsenic occur naturally in the environment. Above 'threshold' concentrations, which are determined by regulatory agencies, they can have an adverse affect on agriculture and wildlife, and represent a potential risk to human and animal health. A decrease in soil pH could promote the mobilization of trace elements in both surface and groundwaters. and their bioavailability. The carbonate

pebbles act as a buffer to acidification and reduce the mobility of trace metals.

Arsenic in Surficial Deposits

Map C displays the geochemical analyses of arsenic in surficial deposits. Similar to the carbonate pebbles, the arsenic-rich surficial deposits are derived by glacial erosion of Precambrian Shield bedrock. Due to the effects of glacial transport and dispersal, the extent of arsenic enrichment is greater than the arsenic-rich bedrock source. The geological and geochemical maps can be used together by comparing areas of arsenic concentrations to those of carbonate pebble concentrations to estimate the potential for greatest acidification and trace element mobilization. High risk of element mobilization will occur in areas of low carbonate pebble concentration and high element concentrations.