directly influence Fe-scavenging. Interaction between DOC and Fe is important in determining the rate of Fe-scavenging in surface waters because complexation of metals by DOC increases metal stability (Curtis, 1993). DOC has a high affinity for $Fe(OH)_{3(s)}$ and can be effectively scavenged by adsorption (Davis & Gloor, 1981; Gu et al., 1994, 1995). However, the capacity of DOC to complex trace metals generally appears to be in excess of metal concentration for many surface waters (Urban et al., 1990).

Here we report on systematic changes in the potential for interaction between DOC and synthetic $Fe(OH)_{3(s)}$. We collected surface water samples along a hydrologic flowpath of about 80 yr to attain a gradient of DOC from environmental loading and transformation/fractionation processes. Further, we include and compare samples of allochthonous and autochthonous DOC.

Site description

Samples were collected from a headwater creek (unnamed) and three downstream lakes (Duck, Wood and Kalamalka Lakes) in the Okanagan Lake watershed of the upper Columbia River (Southern Interior of British Columbia, Canada, Fig. 1). Cumulative hydrologic residence time (CHRT) increases along the flowpath because hydrology of the lake chains is discharge dominated, as the climate at the elevation of the lakes is semi-arid (Fig. 1). Thus, the lakes are analogous to batch reactors positioned in series.

The headwater creek sample, with a CHRT of less than 1 yr, is operationally considered as allochthonous DOC, being derived almost entirely from terrestrial
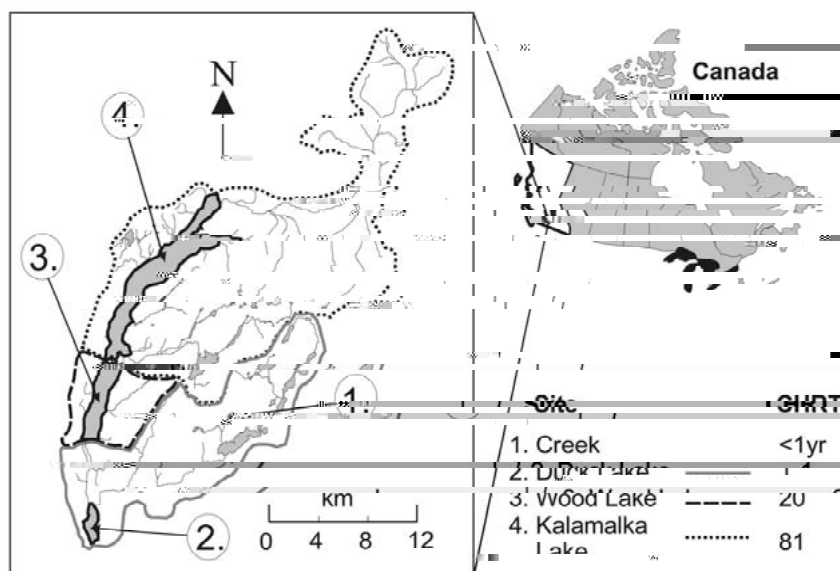
Fig   e 1. Map of the study area showing hydrologic flowpath (1 through 4), drainage basins and cumulative hydrologic resident time (CHRT) for each system that was sampled.
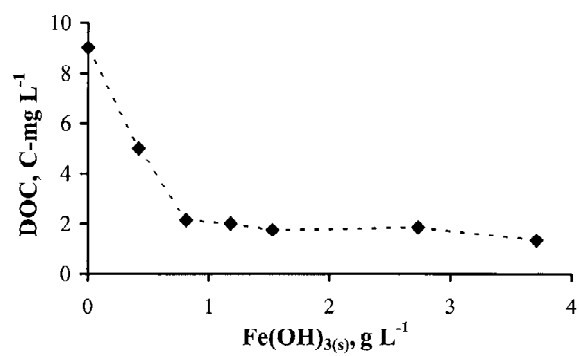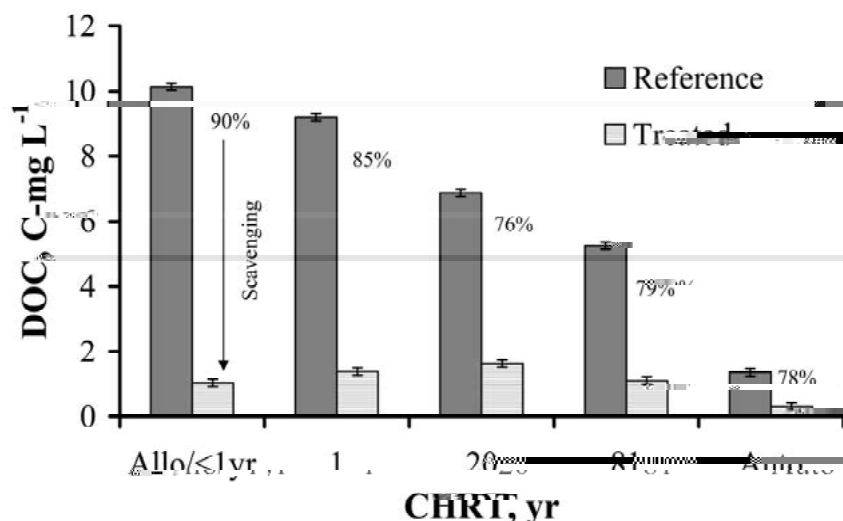

Fig   e 2.

F g e 4. Concentration of dissolved organic carbon (DOC) for reference and Fe(OH)$_{3(s)}$ treated samples from the hydrologic flowpath (< 1 – 81 yr) and for samples of allochthonous (Allo) and autochthonous (Auto) DOC. The difference between reference and treated samples is equal to the concentration of DOC lost to adsorptive fractionation by Fe(OH)$_{3(s)}$ (percent change from reference solution is shown).

DOC (Stewart & Wetzel, 1980; Davis & Gloor, 1981; McKnight et al., 1992; McKnight et al., 2001). The fraction of DOC that is not Fe(OH)$_{3(s)}$-reactive appears to be persistent in surface waters (approximately 1 C-mg l^{-1}, SD = 0.50, n = 5).

Concentrations of autochthonous DOC produced in the mesocosm were much lower than from surface waters, reaching a maximum concentration of only 1.36 C-mg l^{-1} after 4 months at levels of algal biomass corresponding to eutrophic conditions. In contrast to surface waters dominated by allochthonous DOC, only 78% of autochthonous DOC was scavenged by Fe(OH)$_{3(s)}$. Such low reactivity towards Fe(OH)$_{3(s)}$ is consistent with the relatively weak interaction between autochthonous-like DOC and other trace metals (Richards et al., 2001).

The relatively high proportional affinity of DOC for Fe(OH)$_{3(s)}$ in surface waters suggests that

Conclusions

A large proportion of dissolved organic carbon (DOC) was $Fe(OH)_{3\,(s)}$-reactive suggesting that scavenging of DOC by $Fe(OH)_{3\,(s)}$ is limited in the majority of surface freshwaters by metal loading. Approximately 1 C-mg $l^{\check{S}1}$ of DOC was resistant to scavenging, but this refractory fraction of DOC appears to be persistent in surface waters. The upper and lower extreme of $Fe(OH)_{3\,(s)}$-reactivity and DOC loading correspond to allochthonous and autochthonous sources of DOC respectively. Therefore, the bulk of $Fe(OH)_{3\,(s)}$-reactive DOC is likely from allochthonous sources, whereas autochthonous DOC may contribute to the persistence of refractory DOC in surface waters.

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