Magnitude and extent of the impact of a small-scale gold-mine on the geochemistry of stream bed and floodplain sediments in the Horsefly catchment, British Columbia, Canada

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1. Introduction

Mining represents a major source of metal contamination for fluvial systems worldwide. Monitoring and understanding the effects on downstream water and sediment quality is essential for effective management of active and abandoned mine sites. This study aims to determine the downstream effects of the abandoned, small-scale hydraulic Black Creek gold mine on the geochemistry of fine (<63 μm) stream bed and floodplain sediments of the Horsefly River system (British Columbia, Canada) (Fig. 1), which is part of the Quesnel watershed. The Black Creek mine was intermittently active from 1930 to 1989.

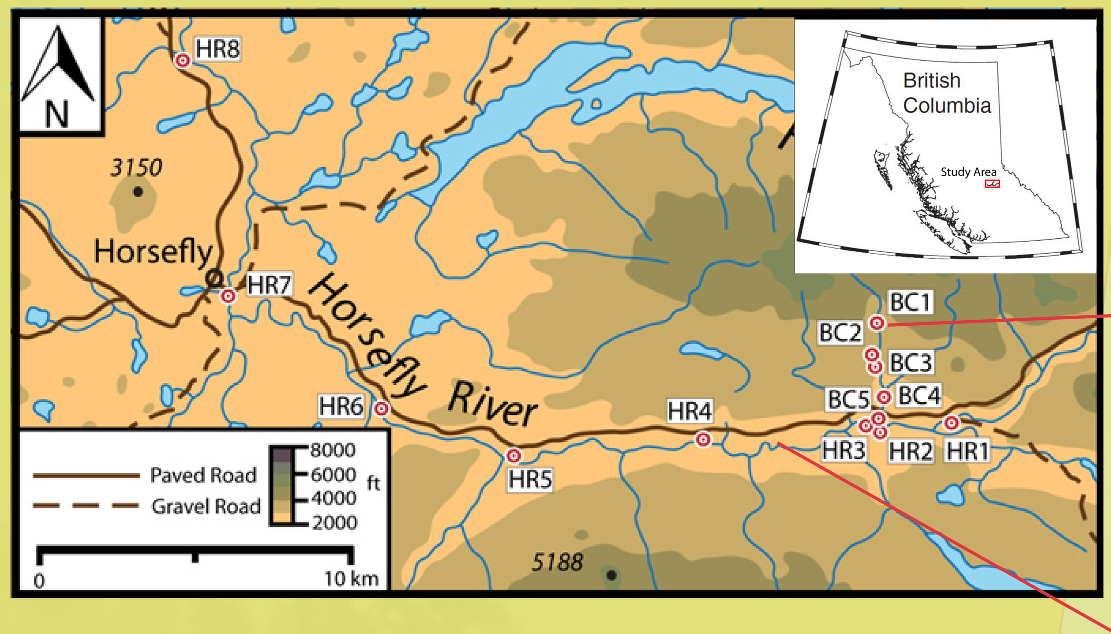

Fig. 1 Location and overview of the study site. The Black Creek Mine is at site BC 2

2. Field sampling

Samples of channel bed sediments were collected from the 2 km long Black Creek and the Horsefly River into which the creek drains (Fig. 1). Furthermore, two ~0.7 m sediment cores were retrieved from the Horsefly River floodplain: one core about 1 km upstream from the mouth of Black Creek and one core about 2 km downstream from the mouth of Black Creek (Fig. 2). The cores were sampled at 1 cm intervals. Concentrations of As, Cd, Cu, Se, and Zn in the fine (<63 μm) particle size fraction of the samples were determined by *aqua regia* digestion followed by ICP optical emission spectrometry or ICP mass spectrometry. Age-depth models for the cores were constructed using excess Pb-210 and Cs-137 activity concentration profiles.

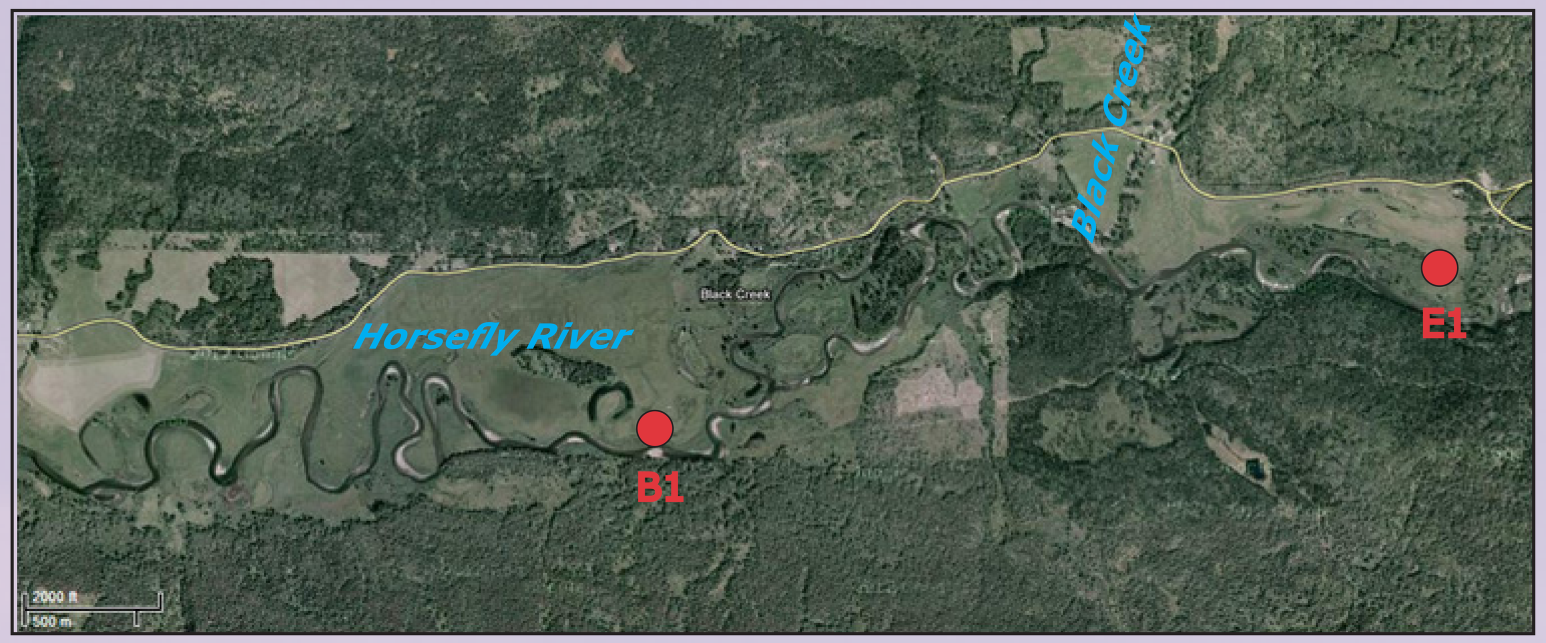

Fig. 2 Sampling locations of the floodplain cores

3. Results

The results from the floodplain cores show that As concentrations just downstream of Black Creek peaked at more than twice the baseline concentration shortly after the beginning of the mining activities, but quickly returned to values close to the baseline concentration (Fig. 3). Since the early 20th century, the sediment in the two cores showed elevated Se concentrations. These cores also contained slightly elevated Zn and Cd concentrations from approximately the 1950s. As the Se, Zn, and Cd concentrations are elevated both upstream and downstream of Black Creek (Fig. 3), these contaminants are likely derived from upstream mine sources.

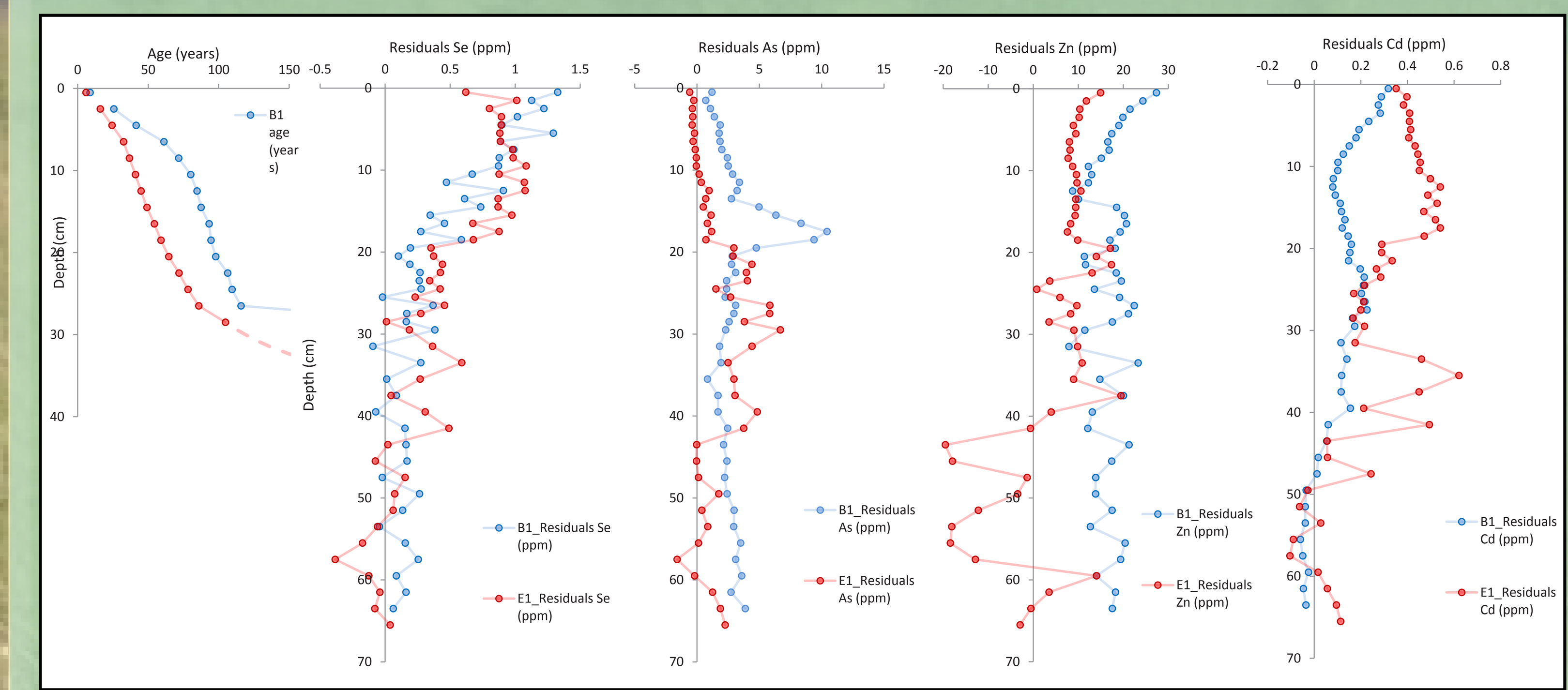

Fig. 3 Depth profiles for Se, As, Zn, Cd residual concentration (actual concentration - baseline concentration)

3. Results (continued)

The stream bed sediment samples show local increases in As concentrations along the Black Creek up to more than three times the baseline concentration, but the As concentration in the stream bed sediments of the Horsefly River are close to the baseline. The stream bed sediments of the Horsefly River contain slightly higher Zn (up to 1.3 times the baseline value) and Cd (up to twice the baseline value) concentrations than the baseline level, which is in line with the results from the floodplain cores.

Fig. 4 Standardised As, Cd, and Zn concentrations in the bed sediments of the Black Creek and Horsefly River

4. Conclusions and implications

- The Black Creek mine caused local As contamination of the Horsefly River floodplain during the first years of operation
- At present the As contamination is contained in the Black Creek.
- No further recent mining effects of the Black Creek mine were observed along the Horsefly River, likely due to the mine's inactive status and small size.
- Nevertheless, we identified continued elevated concentrations of Se, Zn and Cd, which are likely derived from historic upstream mining activities.