Spatiotemporal patterns of arsenic, antimony, and lead deposition in a sub-arctic gold mining region of Canada

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

Mining operations at Giant and Con mines (Northwest Territories, Canada) resulted in the release of >20,000 tonnes of arsenic trioxide (As_2O_3) into the atmosphere, mainly during the 1950s, which were deposited on the surrounding landscape. Studies of arsenic concentrations in lake water and sediment have concluded that no potential ecosystem health effects exist beyond a 40-km radius of the mines. However, paleolimnological studies at distances well beyond 100-km have identified elevated arsenic concentrations aligning with the timing of peak emissions. To improve characterization of the legacy footprint of emissions, spatiotemporal patterns of metal deposition were reconstructed from the analysis of sediment cores at lakes located 10-40 km (near-field) and 50-80 km (far-field) along the prevailing northwesterly wind direction (NW) and 20-40 km to the northeast (NE). Results based on concentrations of mining-associated metal(loids) (arsenic, antimony, lead) in radiometrically-dated (^{210}Pb, ^{137}Cs) sediment cores, enrichment factors, and total excess inventories for arsenic and antimony assert that deposition of these pollutants was greatest closest to the mines and along the prevailing wind direction (NW). Enrichment is evident as far as 80-km to the NW (considerable for arsenic; severe for antimony) and 40-km to the NE (considerable for arsenic; severe for antimony) suggesting pollution from the mines likely travelled distances beyond those explored here. Additionally, the presence of elevated metal concentrations in uppermost sediment strata at near-field lakes suggest that deposition of anthropogenic-sourced metals from lake catchments remains ongoing. Differences in the degree of enrichment and stratigraphic profiles among lake groups are likely due to availability of catchment-sourced legacy metals and post-depositional mobilization from stores in lake sediment. Long-term sources of legacy metals in the near-field environment urge further research on metal mobilization linkages between terrestrial and aquatic ecosystems.

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Introduction

1.1 Yellowknife's mining history

Gold mines around the world have sparked the interest of researchers and have led them to investigate their impacts on surface waters (Grosbois et al. 2011, Cai et al. 2017), groundwater (Keshavarzi et al. 2012), fluvial and marine sediments (Posada-Ayala et al. 2016), and lake and wetland sediments (Morra et al. 2015, Kinimo et al. 2018, Sprague and Vermaire 2018). In Canada's subarctic, mining is a significant economic activity. The Northwest Territories is naturally rich in minerals such as gold, zinc, and cobalt (Government of Northwest Territories 2016), which have provided the opportunity for growth and development through the exploration and subsequent exploitation of natural resources. Yellowknife, the capital of the Northwest Territories, was first visited by prospectors in 1896 which eventually led to the establishment of the city (Indigenous and Northern Affairs Canada 2018). The NWT's first mine (uranium, silver, radium) was opened in 1933 on Great Bear Lake (Silke 2009). However, it wasn't until 1935 that gold was found on the northern shores of Great Slave Lake.

Yellowknife's gold is found within arsenopyrite ores of the Archean Supergroup Greenstone volcanic belt in the Slave Geological Province (Hocking et al. 1978, Silke 2009, Fawcett et al. 2015). Here, the deposit is surrounded by the Western Plutonic Complex to the west and the Burwash Formation to the east (Boyle 1960). The discovery of the deposit led to the development of two major gold mines on the eastern shores of Yellowknife Bay, the Consolidated Mining and Smelting Company of Canada Ltd. (Con Mine) in 1938 and Giant Yellowknife Gold Mines Ltd. (Giant Mine) in 1948 (Sandlos and Keeling 2012). Ownership of the mines changed numerous times over their life cycle until Giant Mine was taken over by the Government of Canada in 1999 until its official closure in 2004 (Galloway et al. 2012).

The gold at Giant was refractory (i.e. encapsulated within other grains) and found primarily in quartz-carbonate veins scattered with sulphide mineralization as arsenopyrite (FeAsS) and pyrite (Jamieson 2014, Government of Northwest Territories 2016). To a lesser extent, stibnite and various antimony sulphosalts were also present in the ore (Coleman 1957, Jamieson 2014, Walker et al. 2014). The sulphide ore was not amenable to cyanidation and as a result required high-temperature roasting as a pre-treatment. Antimony-bearing minerals present in the ore further complicated the extraction process (Marsden and House 2006, Fawcett and Jamieson 2011). However, at the time, roasting was the most sophisticated approach available and was deemed appropriate given the lack of resources (SRK Consulting Engineers and Scientists 2002). Roasting began at neighbouring Con mine in 1942 when arsenopyrite was encountered. However, this lasted only several months due to wartime restrictions. Roasting at Con Mine resumed in 1948 and was followed shortly after by Giant Mine in 1949 (Sandlos and Keeling 2012). Roasting occurred at a temperature of 500 degrees Celsius (Walker et al. 2005; 2014, Fawcett et al. 2015), and oxidation of arsenic and sulfur released arsenic trioxide (As_2O_3) and sulfur dioxide (SO_2) into the atmosphere as a by-product (Hocking et al. 1978, Hutchinson et al. 1982). While both arsenic and sulfur were released in large amounts during the roasting process, only arsenic was determined to be of serious concern and deemed a contaminant (Hocking et al. 1978).

Roasting continued until 1999 and released over 20,000 tonnes of arsenic trioxide into the atmosphere - the majority of which was released during the first 3 years of the mine's operation (1949-1951) (Figure 1; Hocking et al. 1978, Galloway et al. 2015, Van Den Berghe et al. 2018). Also incorporated into roaster dusts were antimony and other metals such as lead (SRK Consulting Engineers and Scientists 2002, Indigenous and Northern Affairs Canada 2007). Some of the ore at Giant was free-milling and did not require roasting, however, the supply was exhausted early on (Tait 1961). At Con Mine in contrast, only ~20% of the ore was refractory, resulting in a considerably smaller release of emissions (Hutchinson et al. 1978, Sandlos and Keeling 2012, Galloway et al. 2015). Emissions from Con Mine were as a result much less substantial overall and the ores free-milling nature allowed for the installation of a wet scrubber system in 1949 (Indian and Northern Affairs Canada 2007). Instead, arsenic and sulfur waste were deposited into ponds as a slurry which eventually evolved into the adoption of a pressure-oxidation method further reducing waste in the 1970s (Schuh et al. 2018).

Giant Mine released an estimated 7,800 tonnes of arsenic trioxide emissions between 1949 and 1951 alone and remediation costs are expected to cost over a billion dollars (Jamieson 2014, Thienpont et al. 2016). Prior to 1951, emissions were released directly into the atmosphere (Indian and Northern Affairs Canada 2007). During this time, dust build-up in the roaster stack was routinely cleaned and disposed of in areas 'north of the property', the locations of which were not recorded (SRK Consulting Engineers and Scientists 2002). In the Yellowknife region, studies revealed that mine emissions of arsenic trioxide increased the amount of respiratory, psychoneurotic, and other disorders (De Villiers and Baker 1969, Hocking et al. 1978). While workers at the mine site expressed concerns about potential health risks in 1949 (SRK Consulting Engineers and Scientists 2002), efforts to reduce emissions did not take place until 1951 after the death of two young Dene boys from acute arsenic poisoning (Hutchinson et al. 1982, Sandlos and Keeling 2012, Thienpont et al. 2016). Pollution abatement measures were initially introduced in 1951 with the installation of the first Cottrell precipitator and again in 1955. However, emissions weren't significantly reduced until a bag house dust collector was installed in 1958 (Hocking et al. 1978, Indian and Northern Affairs Canada 2007).

The roasting process created a highly soluble and more toxic form of arsenic (Hutchinson et al. 1982, Jamieson 2014). However, arsenic is also a naturally occurring element and can be equally harmful to living organisms when encountered within the Earth's crust (Matschullat and Deschamps 2011). Therefore, natural processes can also release arsenic into the human environment through a combination of weathering of rock and soil, biological activity, and natural disasters (Bajpai and Upreti 2012). Inorganic arsenic, like that found in the ores at Giant Mine, is also released through the combustion of fossil fuels, the use of fertilizers, in medicine, pigments, glass, and through sewage (Smedley and Kinniburgh 2002). The toxicity of arsenic in the environment does, however, depend on its speciation and the mineralogy of its host (Sharma and Sohn 2009, Palmer et al. 2015, Houben et al. 2016).

The majority (>237,000 dry tonnes) of arsenic trioxide released over the mine's life cycle is now stored underground (Indian and Northern Affairs Canada 2007, Jamieson 2014). More than 56 methods were explored for the storage of the arsenic trioxide dust but a lack of long-term solutions and lack of market for arsenic trioxide led to the adoption of underground storage techniques (SRK Consulting Engineers and Scientists 2002). The benefit of storing arsenic underground was that it was trapped between permafrost layers which would prevent it from flowing through groundwater and eventually to the surface. There have however been concerns expressed about the suitability of these underground stopes and storage areas, given the recent increases in precipitation and temperature (Indian and Northern Affairs Canada 2007).

1.2 Past studies

Arsenic dispersed from the roaster stack and was carried varying distances by wind before depositing onto the landscape surrounding Yellowknife via wet or dry deposition. As a result, the possibility remains that the many lakes, rivers, wetlands, and soils in the region have served as repositories for legacy pollutants, particularly arsenic, released in the 1950s. The aquatic ecosystem effects of mining emissions were identified early in the Yellowknife region (e.g. Pick 1975, Wagemann et al. 1978, Hocking et al. 1978, Hutchinson et al. 1982) with a particular focus on aquatic organisms, soil, vegetation, lake water, and lake sediments. More recently, effects on aquatic organisms were identified by Stewart et al. (2018) and Sivarajah et al. (2020). The focus of most studies in recent years have also been on lake sediment and soils, particularly in the near-field (~40-km) region surrounding Giant Mine. These studies have concluded that arsenic, antimony, and lead found in the Yellowknife region are the product of emissions from the Giant and Con mine roaster stacks (Fawcett et al. 2015, Palmer et al. 2015, Thienpont et al. 2016, Houben et al. 2016, Bromstad et al. 2017, Galloway et al. 2018, Van Den Berghe et al. 2018, Schuh et al. 2018, Palmer et al. 2019, Cheney et al. 2020, Pelletier et al. 2020). Thus, contamination from the mines has been well documented at the local level.

Proximity to the mines has been identified as a key determinant of the presence and severity of metal contamination. Analysis of surface water of lakes as well as soils in the immediate Yellowknife region have indicated a strong relationship between distance and (dissolved) arsenic concentrations (Palmer et al. 2015, Jamieson et al. 2017). The analysis of 98 lakes within a 30 km radius of Yellowknife determined that surface water arsenic concentrations were highest within 5 km of the mine site and decreased dramatically between 17.5 and 30 km (Palmer et al. 2015; Figure 2). Based on the results of the study, lakes located farther than 30 km were suggested to be unimpacted. Within 4 km of the mine site, total arsenic concentrations in lake water ranged between 27 and 136 ug/L (Houben et al. 2016). The role of distance in the dispersal of mining emissions has been further substantiated using lake sediments (Thienpont et al. 2016, Schuh et al. 2018, Van Den Berghe et al. 2018, Cheney et al. 2020). For example, regional surveys of surface sediments identified arsenic concentrations in lakes to range between 6.3 and 10,000 mg/kg (n=95) in the Yellowknife region (~30 km surrounding Giant Mine), the highest of which were found closest to the roaster stack (Galloway et al. 2015). However, it has been suggested that elevated arsenic concentrations found closest to Yellowknife are the result of both anthropogenic (i.e. Giant Mine emissions, land use) and geogenic inputs (Galloway et al. 2015, Sivarajah et al. 2020).

In the Yellowknife region, winds dominantly blow from the southeast to the northwest between May and September (based on data from 1971-2000 in Galloway et al. 2012, Environment Canada 2010; Figure 3). Given that mining-derived metals in the region were atmospherically deposited, it can be assumed that concentrations would be highest in the prevailing wind direction. This has been asserted by several studies in the region using lake water, soils, and sediment (Galloway et al. 2012; 2015; 2018, Palmer et al. 2015, Cheney et al. 2020) demonstrating that the dominant wind direction likely received the bulk of mining emissions. However, this knowledge is limited to a 40 km radius surrounding the mines.

Similar localized impacts from gold mining projects have been identified in other regions around the world in surface water (Grosbois et al. 2011, Cai et al. 2017), groundwater (Keshavarzi et al. 2012), fluvial and marine sediments (Posada-Ayala et al. 2016), mine waste (Haffert et al. 2010), and wetland sediments (Kinimo et al. 2018). Canadian examples include legacy pollution from the Waverley gold mine in Nova Scotia (Mudroch et al. 1986), Cobalt's silver mine in northern Ontario (Sprague and Vermaire, 2018) and near Snow Lake, Manitoba (Simpson et al. 2011).

Lakes and wetlands in particular have proven to serve important roles in the storage of elements, metals, and metalloids (herein collectively referred to as metals) such as arsenic and can effectively document the timing of anthropogenic metal deposition in their sediments (Galloway et al. 2018). Lake sediments provide excellent archives of pollutant deposition and offer the unique opportunity to track metal accumulation and changes in water quality over time as 'paleoenvironmental monitors' (Smol 2008, Thevenon et al. 2011, Zhang et al. 2014, Lintern et al. 2015, Birch 2017). Paleolimnology has proven to be particularly beneficial in tracking mining pollution (e.g., Wiklund et al. 2017, Pelletier et al. 2020, Klemt et al. 2020) as the sediment record can ideally be used to project future changes in ecosystem conditions (Kirk and Gleason 2015). However, interpretation of arsenic in lake sediment profiles is complex due to the potential impact of the surrounding catchment and post-depositional processes. Diagenetic processes for example, can affect the stability of arsenic in lake sediments, over time allowing them to become mobile under oxidizing conditions (Force et al. 2000, Couture et al. 2010). Less mobile elements, also present in anthropogenic emissions, can be used to anchor arsenic concentrations and interpret where and if post-depositional mobility has occurred.

1.3 Research objectives

Conclusions that the area contaminated by Giant and Con mines emissions is limited to a 40-km radius are largely driven by studies of contemporary lake water and surficial lake sediment (Palmer et al. 2015, Galloway et al. 2018) and, as a result, may only be representative of modern conditions immediately surrounding the mine-lease area. However, a study by MacDonald et al. (2016) which sought evidence of pollution from upstream oil sands operations in Alberta, unexpectedly identified elevated arsenic concentrations (~20 mg/kg) in the Slave River Delta, over 140 km south of Giant near Fort Resolution, NT (Figure 4). Radiometric dating of a lake sediment core identified that the timing of arsenic enrichment aligned well with peak emission release from Giant and Con mines in the 1950s, the closest anthropogenic source. Arsenic concentrations deposited during the 1950s exceeded the CCME probable effects level of 17 mg/kg and were additionally supported by a measurable increase in antimony concentrations, also present in the ore at Giant Mine. Sharp decreases in concentrations of both arsenic and antimony in ~1959 in the lake sediment record likely reflected the installation of the bag house dust collector at Giant Mine, which significantly reduced emissions from over 7000 kg/day to ~1000 kg/day (Government of Northwest Territories 1993, Silke 2013).

The unexpected finings of MacDonald et al. (2016), which speculated on far-field atmospheric pollution from Giant and Con mines, led to the development of the Sub-Arctic Metal Mobility Study (SAMMS). As part of Global Water Futures and the Canada First Research Excellence Fund, SAMMS was established to identify how legacy pollution from mining activities in Canada's north (including Giant and Con mines) will behave in response to the expected changes in hydrological and dissolved organic matter (DOM) regimes as a result of climate warming. Six work packages were developed to address the following: 1) terrestrial stores of historical metal deposition, 2) processes governing DOM-bound metal transport, 3) DOM quantity and quality in cold regions, 4) aquatic stores of historical metal deposition, 5) eco-toxicology of historical metal deposition in lake sediments and 6) changes to ecosystem structure and permafrost thaw as a result of climate change.

As part of work package four and to address the need for improved knowledge of historical metal deposition pathways and processes in lake sediments, this study was developed to refine current estimates of the spatiotemporal footprint of emissions from Giant and Con mines. Using paleolimnology, we address the following: 1) Is there evidence of deposition of arsenic, antimony, and lead from Giant and Con mines dispersing beyond the previously determined near-field (40-km) radius? 2) Do the spatiotemporal patterns of concentrations, degree of enrichment, and excess inventories for arsenic and antimony differ with respect to wind direction? 3) Are sediments of near- and far-field (>40-km) lakes continuing to receive pollution from legacy stores in the catchment and lake sediments in present-day?

The sediment core data presented here has also been utilized as part of another Master's thesis project (Leclerc et al. in review). Porewater extracted from lake sediment cores collected here and diagenetic modelling were used to reconstruct and account for post-depositional mobility of arsenic. Collectively, our theses refine estimates of past metal deposition in lakes from mining emissions in the Yellowknife region and are contributions of the SAMMS project.

1.4 Study location

The Yellowknife region is subject to a subarctic continental climate with mild summers and cold winters. Average annual air temperatures are approximately -4.1 degrees Celsius with a mean annual precipitation ranging between 200 and 375 mm, over 40% of which falls as snow (Environment Canada 2010). The lakes explored here fall within Canada's Taiga Shield (Ecosystem Classification Group 2008), the Slave Geological Province (Galloway et al. 2018), and are situated south of the treeline (Wolfe et al. 2016). Additional details regarding individual lake bedrock geology and shoreline characteristics are found in Table 1.

Lakes on the northwest transect in this study fall within the Great Slave Lowland High Boreal Ecoregion and are characterized by low-relief bedrock. The average elevation of the lowland is 175 metres above sea level (masl) with an upper range of 200 masl (Ecosystem Classification Group 2008). The region has some evidence of sedimentary deposits farther north but is predominantly underlain by Precambrian granites (Ecosystem Classification Group 2008, Wolfe et al. 2016) where geogenic arsenic concentrations average 2 ppm (Boyle 1960, Wagemann et al. 1978, Galloway et al. 2018).

Soils are mostly brunisols with some brunisols and gleysols found around sporadic peat plateaus and wet depressions and towards the Yellowknife region become quite shallow (Hocking et al. 1978). Vegetation communities are dominated by black spruce, jack pines and trembling aspen, with some white spruce and birch found in wetter areas (Ecosystem Classification Group 2008). Lake catchments provide important habitat for moose and a spring staging area for migrating aquatic birds like grebes and dabbling ducks.

Lakes on the northeast transect in this study fall within the Great Slave Upland High Boreal Ecoregion. The area is characterized by generally level bedrock with an average elevation of 200-300 masl reaching up to 450 masl in its northernmost sector (Ecosystem Classification Group 2008). Here, bedrock is dominated by fractured and dissected granites with some evidence of Precambrian sedimentary rock where average geogenic arsenic ranges 2-64 ppm (Boyle 1960, Wagemann et al. 1978, Galloway et al. 2015). Soils found within bedrock depressions are generally brunisols and near wetlands transition to organic cryosols and gleysols. Dense forests found between bedrock outcrops are dominated by black spruce, jack pines, and paper birch. Unique to this region are harlequin ducks, typically only present in mountainous areas (Ecosystem Classification Group 2008).

Table 1: Additional basin characteristics of lakes sampled to the northwest and northeast of Yellowknife, Northwest Territories. Bedrock geology is based on Stubley and Irwin (2019) and Wheeler et al. (1997).

Lake	Bedrock Geology	Shoreline characteristics
NW10	Archean intrusive; granodiorite, tonalite, granite, biotite-bearing, rare hornblende	Bedrock border, well forested with some fringe wetlands
NW20	Same as above	Bedrock border with some wetlands
NW30	Archean intrusive; granodiorite/granite, biotite and muscovite, abundance of supracrusts with granite xenoliths	Forested border with large peatland and bedrock zone. Evidence of forest fire
NW40	Same as above	Bedrock border with some intermittent forests. Evidence of forest fire
NW50	Same as above	Well forested border with bedrock. Algal bloom present at time of coring
NW60	Archean intrusive; granite-granodiorite, heterogeneous, biotite-poor, massive to weakly foliated	Steep bedrock border, some forested areas
NW70	Archean intrusive; granite-granodiorite, tonalite, abundant biotite, medium-coarse grained, local megacrysts	Dominated by bedrock. Algal bloom present at time of coring
NW80	Archean sedimentary; medium metaturbidites (cordierite, andalusite, sillimanite, stalurolite)	Limited bedrock, mostly forested border. Evidence of receding water levels
NE20	Archean sedimentary; Metaturbidites, medium and knotted schist, cordierite and andalusite porphyries	Surrounded by bedrock with some intermittent forest
NE40	Same as above	Forested with a slight bedrock border, wetland fringe

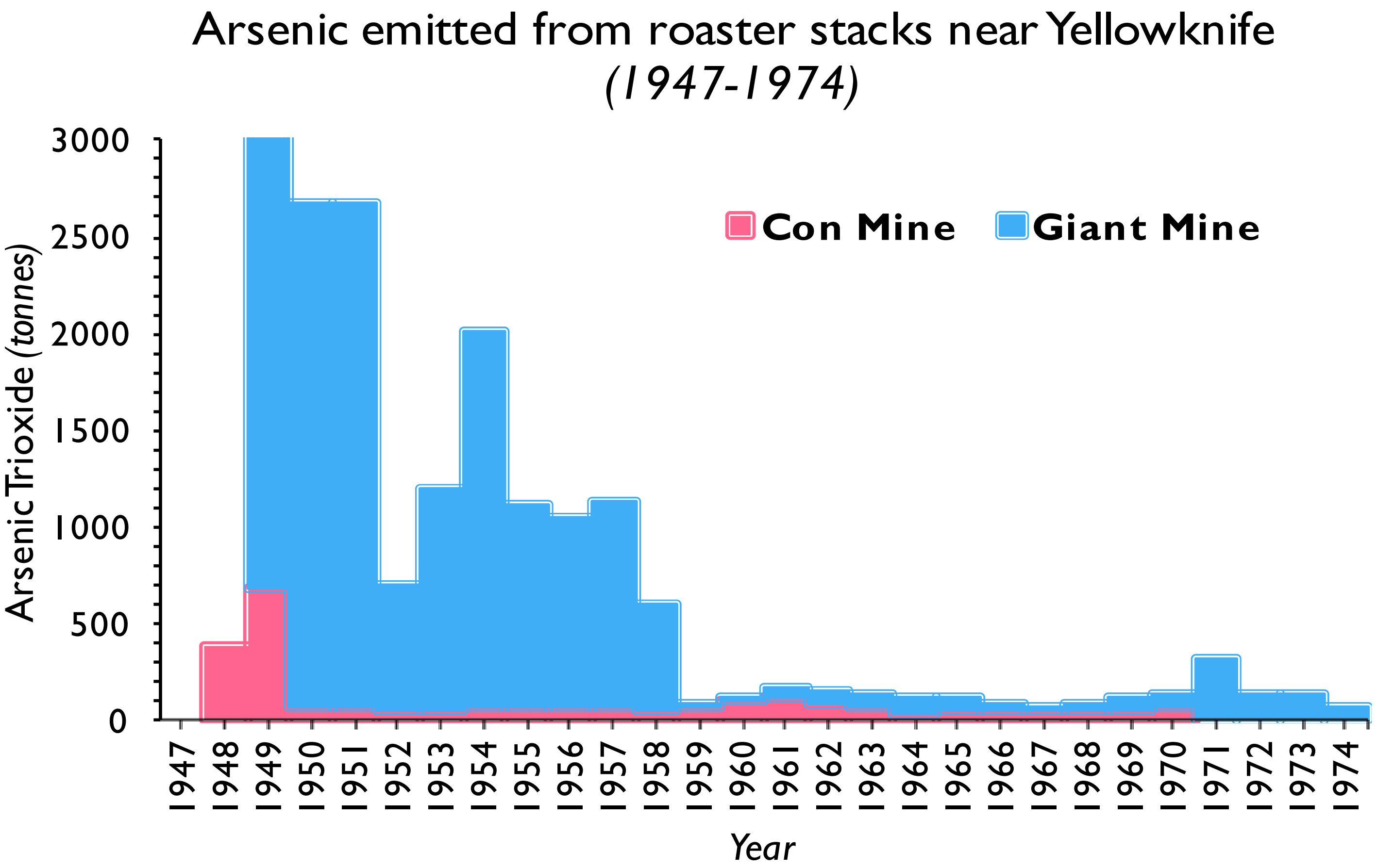

Figure 1: Temporal patterns of arsenic trioxide released into the atmosphere at both Giant and Con mine between the years 1947 and 1974; based on data from Hocking et al. (1978).

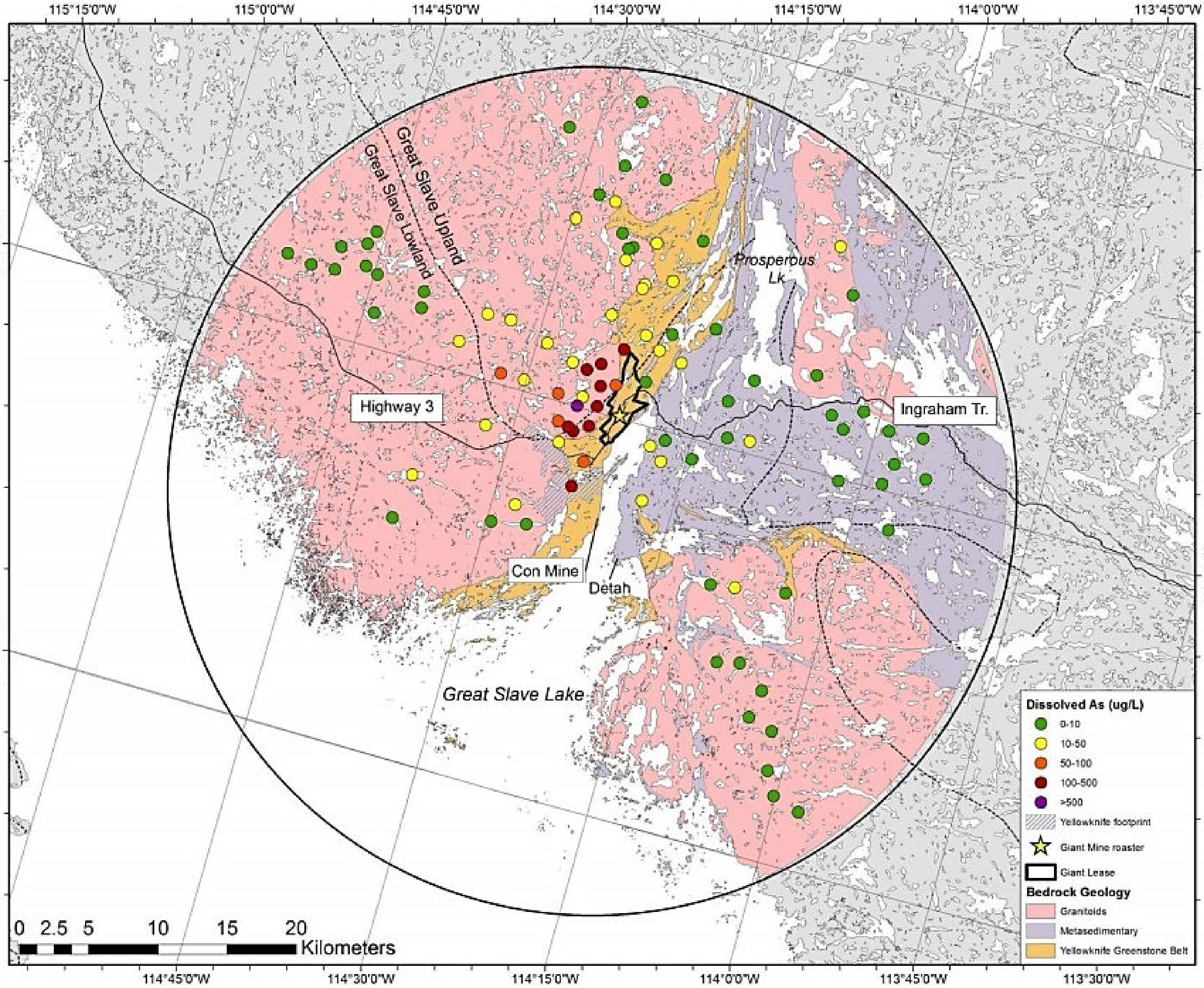

Figure 2: From Palmer et al. (2015, p.7), dissolved arsenic concentrations in surface waters of select lakes within a 30-km radius of Giant Mine shown by respective bedrock geology.

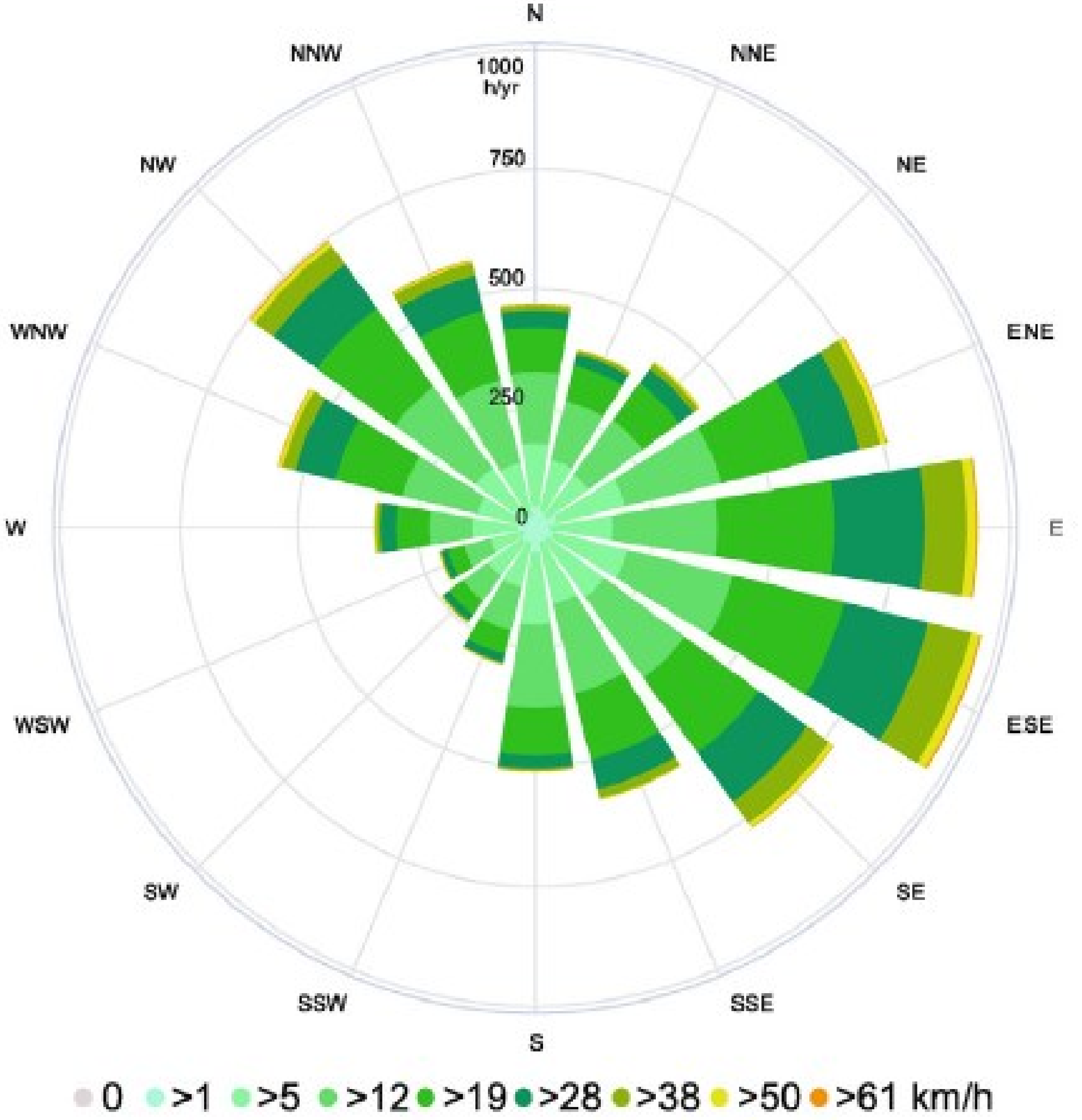

Figure 3: Wind rose taken from Galloway et al. (2018, p.1674) depicting the average annual amount of hours wind is blown from each direction based on data from Environment Canada's climate station in Yellowknife.

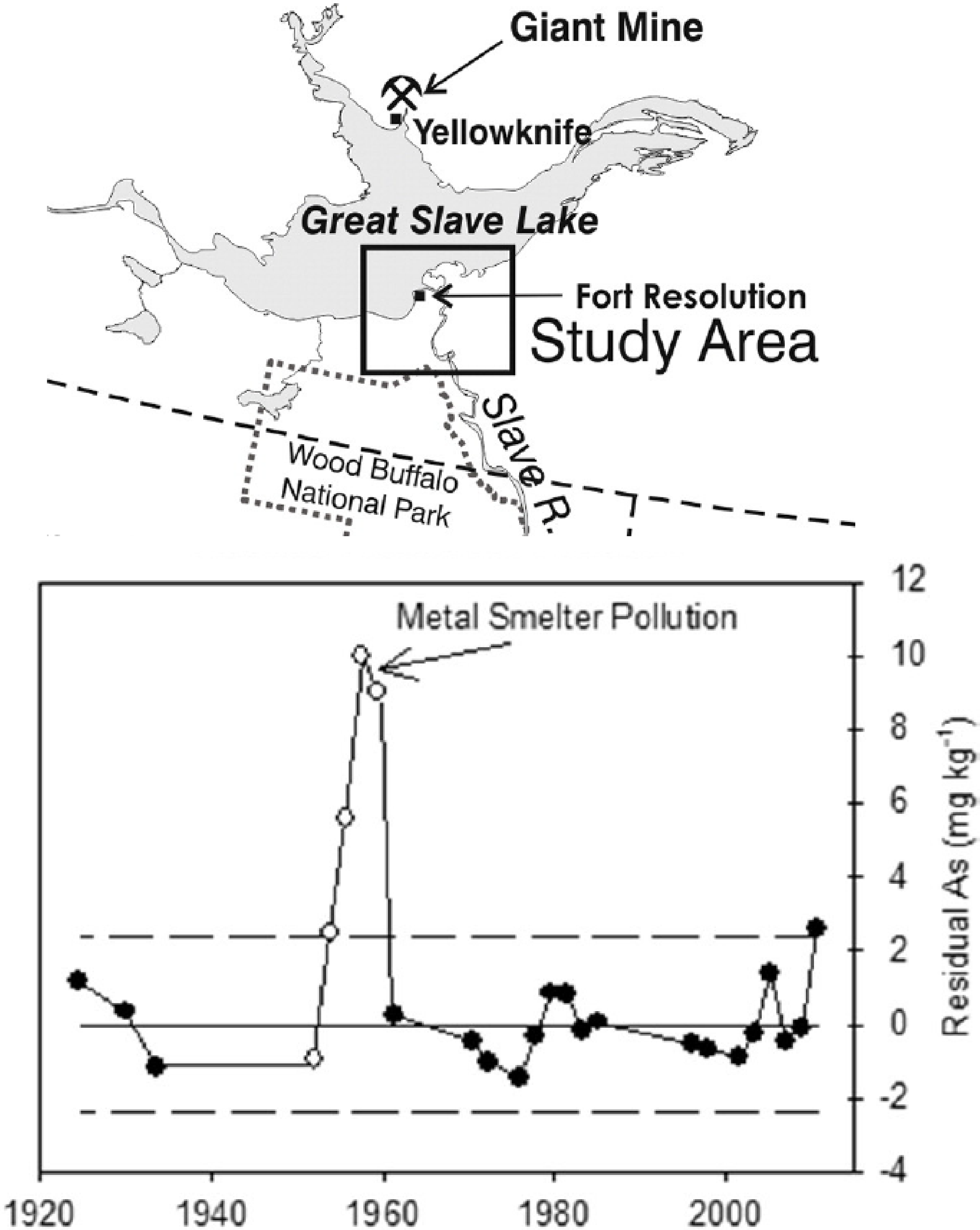

Figure 4: Evidence of arsenic enrichment in lake sediments 140 km from Giant Mine expressed as residuals from the As-Li relationship shown by corresponding Year CE (MacDonald et al. 2016, p.819).

Chapter 2

Research manuscript for submission

Title

Spatiotemporal patterns of arsenic, antimony, and lead deposition in a sub-arctic gold mining region of Canada

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2.1 Introduction

Geological deposits in Canada's North have provided ample opportunity for mineral exploration (Mudroch et al. 1986, Tenkouano et al. 2019). As a result of past-mining activities, a legacy of pollution continues to potentially influence environmental conditions in present-day landscapes. General absence of environmental monitoring prior to, during and after resource development has complicated the environmental assessment process and, consequently, natural or pre-industrial conditions in these regions remain largely unknown (Thevenon et al. 2011, Gawel et al. 2014, Birch 2017, Klemt et al. 2020). As a consequence, it remains challenging to evaluate the extent and persistence of mine-related pollutants in the environment.

The rich history of mining in the Northwest Territories includes the legacy of pollution left behind by two major gold mines: Giant Yellowknife Gold Mines Ltd. (Giant Mine) located ~5 km north of Yellowknife and the Consolidated Mining and Smelting Company (Con Mine) ~2 km south of Yellowknife (Indian and Northern Affairs Canada 2007, Government of Canada 2014a). Here, gold is hosted primarily in arsenopyrite ores and required high temperature roasting (500°C) to create iron oxides amendable to cyanidation (Hocking et al. 1978, Walker et al. 2005, Fawcett et al. 2015). As by-products of the oxidation process, arsenic trioxide (As_2O_3) and sulfur dioxide (SO_2) were released from the roaster stack and deposited onto the landscape surrounding Yellowknife (Hutchinson et al. 1982). Between 1948 and 1999, more than 20,000 tonnes of As_2O_3 were emitted into the atmosphere, the majority of which were released from Giant Mine during its first three years of operations (1949-1951) (Hocking et al. 1978, Indian and Northern Affairs Canada 2007, Sandlos and Keeling 2012, Jamieson 2014, Galloway et al. 2015). Emissions gradually decreased during the next ten years with the introduction of pollution abatement measures, the most effective of which was a baghouse dust collector installed in 1958 (Hocking et al. 1978, Government of Canada 2014b).

A lack of efficient emission controls prior to 1951 resulted in the widespread contamination of the many lakes, rivers, vegetation, and soils surrounding Yellowknife, the aquatic ecosystem effects of which have been well documented at the local level (Wagemann et al. 1978, Hutchinson et al. 1982, Fawcett et al. 2015, Palmer et al. 2015, Thienpont et al. 2016, Houben et al. 2016, Schuh et al. 2018; 2019, Galloway et al. 2018, Cheney et al. 2020, Pelletier et al. 2020). Arsenic remains an element of concern in the region today due to links with increased risks of cancer and respiratory issues in humans (Ng and Gomez-Caminero 2001). At high concentrations, arsenic can also affect the growth and reproductive habits of fish species (Boyle et al. 2008, Erickson et al. 2010, Chetelat et al. 2019). Lakes located downwind of the mines are suggested to have received the greatest deposition of legacy pollution (Jamieson 2014, Schuh et al. 2018, Van Den Berghe et al. 2018, Cheney et al. 2020). Studies thus far have mostly been limited to a 30-km radius from the mines and have ultimately concluded that no potential ecosystem effects exist beyond this distance based mainly on contemporary sampling of surface water and surficial bottom sediment of lakes (Galloway et al. 2012; 2015; 2018, Palmer et al. 2015). However, these conclusions stem from present-day conditions, which may under-represent the extent of the dispersal of legacy emissions during the 1950s. Most recently, a paleolimnological investigation by Cheney et al. (2020) identified that arsenic enrichment during the period of peak emissions can be detected as far as 40-km from the mines during the period of peak emissions. While their study intended on using lakes east and northeast of the mines as unimpacted reference lakes, measurable increases in sediment arsenic concentrations during peak emission release suggested otherwise (Cheney et al. 2020). Additionally, a paleolimnological study by MacDonald et al. (2016) in the Slave River Delta, over 140-km southeast of the mines, identified elevated arsenic concentrations (~20 mg/kg) during the 1950s. Collectively, findings suggest that the extent of the spread of legacy pollution from Giant and Con mines during the 1950s may not yet be fully understood.

While lake sediment profiles preserve a temporal record of pollutant deposition (Smol 2008, Birch 2017), interpretation of stratigraphic variation in arsenic concentration requires an understanding of the complex processes that may influence its deposition and stability within the sediment column (Outridge and Wang 2015). Under reducing conditions, arsenic can dissolve into sediment porewater, mobilize upwards and/or downwards through the sediment column, and potentially be released into overlying surface waters (Smedley and Kinniburgh 2002, Couture et al. 2008). In theory, mining-derived arsenic concentrations in sediment can be anchored using less mobile elements also present in the mined ore that were released into the environment during processing. Antimony is much less mobile in lake sediments than arsenic (Fawcett et al. 2015) and is also present in the ore at Giant Mine (SRK Consulting Engineers and Scientists 2002). Thus, antimony has been used in lake sediment studies in conjunction with arsenic to support identification of mining influence (Houben et al. 2016, Schuh et al. 2018, Palmer et al. 2019). Less commonly, lead has been used in addition to antimony to anchor arsenic concentrations and strengthen evidence of an anthropogenic signature as it was similarly present in the ore, albeit in lesser quantities, and is not considered to be mobile in lake sediments (Thienpont et al. 2016, Cheney et al. 2020, Pelletier et al. 2020).

Here, we employ a paleolimnological approach to quantify the extent of arsenic, antimony and lead deposition from Giant and Con Mine emissions along two transects, one in the dominant wind direction to the northwest and the other in the less frequent wind direction to the northeast (based on data from 1971-2000 in Galloway et al. 2018 and Government of Canada 2019). Arsenic, antimony, and lead concentrations from ten radiometrically-dated sediment cores are used to address the following: 1) Is there evidence of deposition of arsenic, antimony, lead from Giant and Con mines dispersing beyond the previously determined near-field (40-km) radius? 2) Do the spatiotemporal patterns, degree of enrichment, and excess inventories for arsenic and antimony differ with respect to wind direction? 3) Are sediments of near- and far-field (>40-km) lakes continuing to receive pollution from legacy stores in the catchment and lake sediments in present-day? This study expands upon the current understanding of the area affected by emissions from Giant and Con mines and aims to guide future research towards predicting the fate of mining-sourced metals in catchments and stored within lake sediments.

2.2 Methods

2.2.1 Study location

The study area lies within the traditional territory of the Dene, Yellowknives Dene First Nation, and Tlicho Dene (Government of Northwest Territories) within Canada’s Taiga Shield (Ecosystem Classification Group 2008). Here, most lakes are underlain predominantly by granitic bedrock (Stubley and Irwin 2019) where arsenic concentrations average 2 ppm (Boyle 1960) comparable to the worldwide average for granitic rocks (Wagemann et al. 1978). Beyond a distance of ~75 km to the northwest and ~20 km to the northeast, lakes transition to an area of sedimentary bedrock dominated by metaturbidites (average As concentration: 2-64 ppm; Boyle 1960). Lakes selected for this study range in size (0.08-2.72 km^2; average area: 1.0 km^2) and water depth (1.5-24 m; average depth: 6.96 m) and are located at roughly 10 (northwest) and 20 (northeast) km increments from Giant Mine (Table 2; Figure 5). In this study, lakes are grouped into three categories: northwest near-field (NW10-40), northwest far-field (NW50-80), and northeast (NE20, NE40) and are referenced with respect to distance in kilometers from Giant Mine. Near-field lakes are found within the known realm of mining-derived metal deposition, while far-field lakes exist at distances beyond those previously explored.

2.2.2 Field methods

Sediment core collection

Two sediment cores were collected from the pontoon of a helicopter at the deepest part of each lake based on depth-finder measurements in June 2018 (NW transect lakes) and June 2019 (NE transect lakes) using a Uwitec gravity corer fitted with PVC tubes (86-mm internal diameter). Sediment cores obtained from lakes along the NW transect were transported back to a field base in Yellowknife and sectioned within 24 hours of retrieval into 0.5-cm intervals, but were later consolidated into 1.0-cm intervals to obtain sufficient sample mass for all laboratory analyses. As a result, NE lake sediments were directly sectioned into 1.0-cm intervals the following year as it was recognized that more material was needed than available at 0.5-cm increments. Sediment samples were then transported to the University of Waterloo where they were stored in the dark at 4°C prior to analysis.

2.2.3 Laboratory analyses

Radiometric dating

One core from each lake was subject to radiometric analysis to determine temporal patterns of metal deposition. When possible, metals analyses were performed on the same core that was used for dating (NW10, NW30, NW40, NW50, NW60, NE20). To ensure cores at each lake were comparable, a standard loss-on-ignition analyses was performed (Heiri et al. 2001) and instilled confidence in our use of alternate cores for analyses at lakes NW20, NW70, NW80 and NE40 where additional sediment was required to complete analyses. Radioisotopes (^{214}Bi, ^{214}Pb, ^{210}Pb, ^{137}Cs) were measured for all intervals between 0 and 25 cm and at alternating intervals between 25 and 35 cm. For these intervals, 1-2 g of freeze-dried sediment was subsampled and placed into pre-weighed polypropylene tubes to a height of 3.5 cm, sealed with a silicone septum, and 1 cc of 2 Ton Epoxy. One exception to this approach was at lake NW70, where sediment intervals at 0-3 cm, 4-7 cm, and 8-9 cm were combined to obtain sufficient sample mass for analyses in the upper portion of the sediment core. Beyond these depths, sediment was subsampled as described previously and interpolation was used to assign ages to consolidated intervals in the upper portion of the sediment core. After a 21-day waiting period, which allows for parent and daughter isotopes to reach equilibrium, activity of ^{214}Bi, ^{214}Pb, ^{210}Pb, and ^{137}Cs were measured on an Ortec HPGe Digital Gamma Ray Spectrometer at the University of Waterloo for approximately 3-5 days per sample.

Measurements of total ^{210}Pb activity were corrected for decay since the time of core collection and density using standard methods (Schelske et al. 1994). Using measurements of ^{214}Bi and ^{214}Pb as surrogates for ^{226}Ra, supported ^{210}Pb activity was first determined. Total ^{210}Pb activity was then determined and used to estimate sediment ages using the Constant Rate of Supply Model (Binford 1990, Appleby 2001). To supplement the age model based on ^{210}Pb, measurements of ^{137}Cs activity were used to detect a peak associated with above-ground nuclear mass weapon testing in 1963 (Appleby 2001). The dry-mass sedimentation rate was used to extrapolate the sediment chronology beyond the depth where ^{210}Pb background was reached within a core (i.e., where supported ^{210}Pb was equal to total ^{210}Pb).

Focusing factors were determined using ^{210}Pb data and are expressed as a ratio of the measured unsupported ^{210}Pb (i.e., total ^{210}Pb – supported ^{210}Pb) within the sediment core to the expected unsupported ^{210}Pb based on literature on atmospheric fallout near the study location (Wong et al. 1995, Fuller et al. 1999, Muir et al. 2009, Olid et al. 2010).

Metal concentrations

Concentrations of solid-phase metals in sediment were measured at all lakes and all sediment intervals between 0 and 29 cm. Between 0.25 and 0.50 g (±0.05 g) of freeze-dried sediment was finely ground and homogenized using a mortar and pestle, loaded into pre-weighed plastic tubes, and sent to ALS Laboratories Ltd. (Waterloo, Ontario) for analysis. Metals were measured after digestion with aqua-regia and using a Collision/Reaction Cell inductively coupled plasma mass spectrometer (CRC ICP-MS) following EPA standards 200.2/6020A. For samples where 0.50 g (±0.05 g) of freeze-dried sediment was submitted for analysis, duplicates were analyzed every 5 cm to confirm reliability of results. Analytical uncertainties, expressed here as the relative percent difference (RPD) between duplicate samples, were reported by ALS Laboratories as: 2.67% for arsenic (n=15), 5.47% for antimony (n=14), and 3.85% for lead (n=15).

2.2.4 Numerical analyses

Enrichment factors

Enrichment factors (EFs) were used to estimate the magnitude of arsenic and antimony enrichment relative to the pre-industrial background. Background concentrations of arsenic and antimony were determined by visual assessment of the stratigraphic profile for individual lakes and metals. Inconsistencies in the sediment record hindered our ability to establish reliable estimates of lead in the pre-industrial era. Furthermore, the possibility of post-depositional mobility both upwards and downwards within the core (Couture et al. 2008, Leclerc et al. in review) hindered ability to rely on a specific pre-industrial time interval (e.g., 1935, predating operations of both mines) to establish background concentrations. Therefore, when a metal showed a near-constant stratigraphic pattern in the lower portion of the sediment core, ‘pre-industrial background’ was defined as the mean of the concentrations found in the near-constant zone. As a result, 20 background concentrations were constructed across the 10 study lakes for arsenic and antimony and are a reflection of the varying post-depositional behaviour of these metals in each sediment core profile. Background estimates were comprised of a minimum of 3 and maximum of 24 samples per lake, depending on the variability in the sediment record. For metals measured in a core from each lake, sediment core depth of background estimates are comparable (within ±4 cm).

Relationships between concentrations of measured metals in sediment at each lake were explored to identify an appropriate lithogenic element for normalization. However, analysis of both arsenic and antimony concentrations to a suite of lithogenic elements identified poor relationships. As a result, lithogenic elements were not appropriate to use as a normalizing agent, despite the recent use of Al, Li, and Ti by other studies in the Yellowknife region (Sivarajah et al. 2019, Cheney et al. 2020) and in other regions where EFs have been computed from sediment profiles (e.g., Wiklund et al. 2012, Kay et al. 2020).

Instead, EF calculations were not normalized to a lithogenic element, and raw metal concentrations are used in the following equation to compute EF values for each sediment interval:

$$EF = \frac{M_x}{(M_{pre-industrial})}$$

where: M_x is the concentration of a given metal at the interval at x cm depth in a core, and

$M_{pre-industrial}$ is the average of the full range of concentrations in the pre-industrial era (to 1500 CE) for a given element.

Here we adopt recommendations of Birch (2017) for classification of enrichment levels. Metals are considered enriched when an EF is ≥1.5 times the pre-industrial background concentration. It can then be assumed that metal concentrations with an EF less than 1.5 are representative of natural or ‘pristine’ conditions. EF values ranging from 1.5-3 are classified as minimal enrichment, 3-5 are classified as moderate enrichment, 5-10 are classified as considerable enrichment, and >10 are classified as severe enrichment.

Excess flux and total excess inventory calculations

The contribution of anthropogenic sources of arsenic and antimony deposition to the lake sediments was estimated as the excess flux. Calculation of excess flux involved two steps. First, enrichment factors were multiplied by element concentrations in sediment and dry mass sedimentation rates (kg/m^2/year) to determine rates of element flux ($\mathcal{F}$) in units of mg/m^2/year, using the equation (Whitmore et al. 2008, Gomes et al. 2009, Wiklund et al. 2017):

$$\mathcal{F} = \frac{\left[\left(\frac{EF_x - 1}{EF_x}\right) \times SR_x \times C_x\right]}{ff}$$

where: EF_x is the enrichment factor for a given element at interval x,

SR_x is the sedimentation rate in kg/m^2/year at interval x,
C_x is the concentration of the element at interval x and
ff is the ^{210}Pb-based focusing factor for a given lake.

Second, we calculated the inventory of excess flux ($\mathcal{FI}$) of each metal, suggested to provide more accurate estimates of metal fluxes (Bacardit et al. 2012, Wiklund et al. 2020), as:

$$\mathcal{FI} = (A_w - A_x) \times \mathcal{F}_x$$

where: A_w is the age of the sediment interval w,
A_x is the age of the sediment interval x and
$\mathcal{F}_x$ is the rate of flux (mg/m^2/year) at sediment interval x.

To account for lateral redistribution of sediment across the lake basin due to wind and wave action and changes in basin slope, excess flux inventories were corrected for sediment focusing and adjusted using focusing factors. Focusing factors >1 suggest that metal fluxes have been overestimated while focusing factors <1 suggest metal fluxes have been underestimated. By dividing the total excess flux inventory of a metal at a lake by its focusing factor, the flux was then re-expressed as either greater or smaller than the calculated value. Excess flux inventories for all sediment intervals for each lake were then summed and expressed as the total mass and are representative of the total excess inventory of arsenic and antimony.

2.3 Results

2.3.1 Sediment core chronologies

Total ^{210}Pb activity profiles varied among lakes across the two transects (Figure 6). Activity of ^{210}Pb ranged between 0.01 Bq/g and 1.7 Bq/g overall. Stratigraphic profiles of ^{210}Pb activity were similar at lakes NW10, NW20, and NW60, where activity decreased monotonically with increasing depth. In contrast, ^{210}Pb activity was near-constant or declined at the tops of cores from lakes NW30, NW40, NW50, NW70, NW80, NE20 and NE40 before declining down-core between 2 and 12 cm depth. The depths at which background ^{210}Pb activity was reached also varied. Most commonly, background ^{210}Pb activity was reached between 6 and 15 cm in depth (NW10, NW20, NW30, NW40, NW50, NE20). At NW60, NW70 and NW80, however, unsupported ^{210}Pb activity persisted to greater depth, and as deep as 29 cm at NE40. Background ^{210}Pb activity ranged between 0.01 and 0.13 Bq/g. Rates of sedimentation varied by an order of magnitude (0.0016 at NW40 to 0.0156 g/cm^2/year at NW80).

Based on results from CRS modelling of the ^{210}Pb profiles, sediment deposited during the 1950s occurred in the upper 5-10 cm of cores from the study lakes with the exception of NW70 (13 cm), NW80 (15 cm), NE20 (11 cm), and NE40 (15 cm; Figure 6). An increase in ^{137}Cs activity was observed at most lakes (NW40, NW50, NW60, NE20, and NE40) in sediment intervals younger than the 1950s based on ^{210}Pb dating, which is consistent with the record of above-ground nuclear weapon testing (Appleby 2001). The lake sediment cores encompassed a wide range of ages from 207 years to as much as 3220 years (average: 807 years). However, lake NW70 (~3220 years old) revealed sharp changes in sediment composition over time and, as a result, the transition from organic-rich material in the upper 20 cm (~1750 CE) to clay-rich material in the late 1600s (20-21 cm) may have resulted in an overestimation of inferred ages. Given the substantially older basal ages of lakes NW40 (~1390 CE at 30-cm depth) and NW70 (~900 CE at 30-cm depth), metal concentration data presented herein is limited to sediment deposited since ~1500 CE to allow for a more consistent comparison of climatic and environmental conditions among lakes.

2.3.2 Metal stratigraphic profiles

Broad patterns in stratigraphic variation of arsenic, antimony, and lead concentration are evident among the designated groups of lakes (Figure 7). Arsenic and antimony concentrations were typically highest closest to the mine in NW near-field lakes, followed by NW far-field and NE lakes. Lead concentrations, in contrast, were on average higher at NW far-field lakes, followed by NE and NW near-field lakes. Within 40 km of the mine (near-field), arsenic, antimony, and lead concentrations in most lake sediment core profiles demonstrated a continuous increase towards the top of the core, with maxima in uppermost sediments. Beyond this distance (NW far-field) and for the NE lakes, sediment core profiles identified sub-surface peaks aligning closely with timing of maximum emission from Giant and Con mines in the 1950s (with the exception of NW80) and were followed by a general decline in metal concentrations. Further details regarding the stratigraphic profiles in individual lake groups are provided below.

The range of concentrations found in sediment profiles of near-field lakes (NW10-40) varied for arsenic (range: 7.8-1040 ug/g, average: 77.49 ug/g), antimony (range: 0.1-17.5 ug/g, average: 1.71 ug/g), and lead (range: 0.7-8.9 ug/g, average: 3.26 ug/g) (Figure 7). Maximum arsenic and antimony concentrations were highest at lake NW10 (As: 1040 ug/g, Sb: 17.5 ug/g) and decreased with increasing distance from the mine (NW40; As: 33 ug/g, Sb: 2.4 ug/g). Maximum lead concentrations were also highest at lake NW10 (17.5 ug/g), but did not display as strong of a decline with distance (NW40; 6.1 ug/g vs NW30; 5.6 ug/g). Background values ranged from 7.8 to 27.1 ug/g for arsenic (average: 13.91 ug/g) and 0.1 to 0.5 ug/g for antimony (average: 0.24 ug/g). With the exception of the antimony and lead concentration profiles at NW40, which display peak concentrations that are aligned with maximum emissions in the 1950s, the near-field stratigraphic profiles for arsenic, antimony and lead increased towards the top of the sediment records and concentrations are highest in the most recently-deposited sediments.

At far-field lakes (NW50-80), concentrations of arsenic (range: 3.3-240 ug/g, average: 29.30 ug/g), antimony (range: 0-3.8 ug/g, average: 0.71 ug/g), and lead (range: 2.7-17.5 ug/g, average: 8.30 ug/g) similarly spanned a wide range, but were overall lower in arsenic and antimony than near-field lakes. Here, highest arsenic and antimony concentrations were found at lake NW50 (As maximum: 240 ug/g, average: 42.70 ug/g; Sb maximum: 3.8 ug/g, average: 0.75 ug/g) and decreased with increasing distance from the mine (NW80: As maximum: 31.8 ug/g, average: 14.72 ug/g; Sb maximum: 0.7 ug/g, average: 0.21 ug/g). Lead concentrations were highest at NW50 (maximum: 17.4 ug/g, average: 14 ug/g) and exceeded that of all other study lakes. With the exception of NW70 (maximum: 15.7, average: 8.99 ug/g), average lead concentrations decreased beyond a distance of 50 km. Background concentrations at far-field lakes ranged from 3.3 to 29.1 ug/g for arsenic (average: 12.54 ug/g) and from 0 (below detection limit) to 0.4 ug/g for antimony (average: 0.19 ug/g). At far-field lakes (NW50-80), arsenic and antimony concentrations reached their maximum at depth and aligned with or post-dated the 1950s, whereas the deposition of lead was more variable over time and only formed a distinctive sub-surface post-emission peak at lake NW60.

NE lakes (NE20, NE40) possessed metal concentrations that were nearly an order of a magnitude lower in comparison to NW lakes at the same distances. Metal concentrations for the NE lakes ranged from 2.2 to 135 ug/g for arsenic (average: 30.48 ug/g), 0 to 3.5 ug/g for antimony (average: 0.59 ug/g), and 0.8 to 11.3 ug/g for lead (average: 5.09 ug/g). Concentrations of arsenic, antimony, and lead were higher at NE20 (As average: 52.08 ug/g, Sb average: 0.80 ug/g, Pb average: 11.30 ug/g) than at NE40 (As average: 8.88 ug/g, Sb average: 0.40 ug/g, Pb average: 2.29 ug/g). At the NE lakes, background concentrations of arsenic ranged from 2.2 to 27.9 ug/g (average: 18.41 ug/g) and background antimony concentrations ranged from 0 to 0.2 ug/g (average: 0.13 ug/g). Maximum concentration of arsenic, antimony, and lead at NE lakes occurred at depth and aligned with or post-dated the 1950s.

2.3.3 Enrichment factors

Enrichment factors for the NW near-field lakes (NW10-40) ranged from 1.08 to 62.70 for arsenic (average: 7.0) and 1.24 to 44.75 for antimony (average: 11.1; Figure 8). Based on categories identified by Birch (2017), 8% of arsenic samples in near-field lakes were ‘pristine’ or unimpacted, 35% were minimally enriched, 21% were moderately enriched, 24% were considerably enriched, and 10% were severely enriched (Figure 8). For antimony, 2% of samples were unimpacted, 15% were minimally enriched, 21% were moderately enriched, 21% were considerably enriched, and 40% were severely enriched. There was evidence of enrichment above the pre-industrial baseline (EF >1.5) across all near-field study lakes for both metals in sediments deposited during the period of peak emissions (1950s). Consistent with stratigraphic trends observed in near-field metal concentration data, the greatest degree of enrichment occurred in the uppermost sediment layer, with the exception of NW40 where antimony enrichment was greatest during the 1950s. While there is a sharp gradient in the degree of arsenic enrichment at near-field lakes with distance from Giant Mine, enrichment of both arsenic and antimony began to occur well before the onset of mining operations at near-field lakes and is evident as early as the 1700s at lake NW20 because of post-depositional mobility downward in the sediment core record (Leclerc et al. in review).

At the NW far-field lakes, arsenic enrichment factors ranged between 0.84 and 15.25 (average: 5.09; Figure 8). Approximately 21% of samples were identified as unimpacted, 18% were minimally enriched, 16% were moderately enriched, 27% were considerably enriched, and 18% were severely enriched. Enrichment of antimony at far-field sites ranged from 1.33 to 24.85 (average: 8.11). Here, 3% of samples were unimpacted, 21% were minimally enriched, 10% were moderately enriched, 33% were considerably enriched, and 33% were severely enriched. Three of four far-field lakes became enriched in arsenic during the period of peak mine emissions, and all lakes experienced enrichment in antimony at this time. The greatest degree of arsenic and antimony enrichment occurred during or shortly (~30 years) after the introduction of pollution abatement measures. Prior to the 1950s, most lakes appear to have experienced some antimony enrichment (NW50, NW60, NW70) while only NW60 experienced arsenic enrichment. Based on the degree of enrichment present in uppermost sediments and the historical trends of arsenic and antimony deposition, far-field lakes appear to be returning to a pre-industrial state.

For the NE lakes, enrichment factors for arsenic ranged from 1.20 to 8.35 (average: 4.20) and 2.00 to 34.54 for antimony (average: 14.7). With regards to arsenic, 7% of samples were identified as unimpacted, 17% were minimally enriched, 41% were moderately enriched, and 34% were considerably enriched. There was no evidence of severe arsenic enrichment along the NE transect. For antimony, 7% of sediment samples were minimally enriched, 3% were moderately enriched, 18% were considerably enriched, and over 71% were severely enriched. The greatest degree of arsenic and antimony enrichment aligned with or post-dated the 1950s. After the 1950s, arsenic and antimony enrichment declined. Both NE20 and NE40 appear to have experienced some arsenic and antimony enrichment prior to the onset of gold mining in the region due to downward post-depositional mobility (Leclerc et al. in review). EF values decline towards the surface of these cores and approach the pre-industrial state (EF of 1). In comparison to NW lakes at equivalent distances (NW20, NW40), the degree of enrichment of arsenic and antimony at NE20 and NE40 was comparable.

2.3.4 Excess metal inventories

Excess metal inventories demonstrated deposition of anthropogenic arsenic and antimony at all study lakes – at least as far as 80 km to the northwest and 40 km to the northeast (Figure 9). Spatial trends of excess inventories of arsenic and antimony were comparable across each of the three groups of lakes and ranged from 17 to 6929 mg/m^2 for arsenic (average: 1404 mg/m^2) and from 2 to 82 mg/m^2 for antimony (average: 18 mg/m^2). The amount of excess inventory at each lake was generally associated with distance from the mine and wind direction and is further described below according to lake group.

The inventory of excess arsenic at NW near-field lakes (average: 3076 mg/m^2) was on average 9 times that of far-field lakes (average: 342 mg/m^2) and at least 16 times that of NE lakes (average: 182 mg/m^2). A similar trend was evident for excess antimony with near-field lake inventories (average: 34 mg/m^2) far exceeding both far-field (average: 8 mg/m^2) and NE lake inventories (average: 5 mg/m^2). On the NW transect, arsenic inventories were greatest at lakes NW10 (4826 mg/mg^2) and NW20 (6929 mg/m^2) and decreased with increasing distance from the mine (NW70: 17 mg/m^2; NW80: 120 mg/m^2), with the exception of NW50 (995 mg/m^2). Apart from lakes NW30 (30 mg/m^2) and NW50 (18 mg/m^2), inventories of excess antimony displayed a similar decline with increasing distance from the mines (NW10: 82 mg/m^2 vs NW80: 2 mg/m^2). On the NE transect, total excess arsenic decreased markedly from NE20 (318 mg/m^2) to NE40 (46 mg/m^2) and was similarly reflected by inventories of excess antimony (NE20: 7 mg/m^2 vs NE40: 3 mg/m^2). Excess inventory of As at NE20 (318 mg/m^2) was less than 20 times at NW20 (6929 mg/m^2) and less than 2 times at NE40 (46 mg/m^2) compared to NW40 (117 mg/m^2). Transect differences in excess antimony deposition were less pronounced, but

NE inventories of antimony (range: 3-7 mg/m^2, average: 5 mg/m^2) were ~2-3 times less than at the NW lakes at equivalent distances (range: 7-19 mg/m^2, average: 13 mg/m^2).

2.4 Discussion

2.4.1 Delineating the Giant Mine footprint

Stratigraphic records revealed evidence of anthropogenic deposition of arsenic and antimony at all study lakes and were quantified using enrichment factors and total excess metal inventories. The co-deposition and similar stratigraphic patterns of arsenic, antimony, and to a lesser extent lead in sediments reinforces the notion that enrichment of metals in sediments of these lakes are the product of emissions from Giant and Con mines rather than from the chemical weathering of bedrock or some other source. Measurement of dissolved arsenic concentrations in surface waters of lakes of the NW transect reported in Leclerc et al. (in review) are consistent with findings of other researchers in the area and similarly identified a 30-km zone (NW10-30) of expected impact from the mines (Galloway et al. 2012; 2015, Palmer et al. 2015). Yet, maximum concentrations and the enrichment of arsenic and antimony in sediment at lakes beyond 30 km, where preserved at depth, align reasonably well with the operational history of the mines and particularly peak emission release in the 1950s. At NW far-field and NE lakes, arsenic and antimony concentration profiles are characteristic of an isolated anthropogenic event. Sharp decreases towards the sediment surface in arsenic, antimony, as well as lead may reflect the introduction of pollution abatement measures over the mine's life cycle. Minor observed 'lags' in the sediment record between peak emission release and the atmospheric deposition of mining-derived metals at NW far-field and NE lakes, such as the timing of peak arsenic, antimony, and lead concentrations at NE20 (~1960 CE), are likely explained by a combination of sediment mobility, uncertainties associated with the age model, and the delayed delivery of metals from the surrounding catchment to the lake bottom. Unlike conclusions drawn from surface water, sediment metal analyses suggest the emissions footprint from Giant and Con mines have travelled beyond the previously identified radius and at least as far as 80 km to the northwest and 40 km to the northeast. Although determination of the pre-industrial background used as part of enrichment factor and excess inventory calculations was conservative, given the mobile nature of the metals (arsenic, antimony), it remains possible that concentrations were redistributed through the sediment column and confound estimates of enrichment, particularly at NW20 and NW40 (Leclerc et al. in review). Indeed, "if the raw data do not show a clear signal, there is most likely no signal" (Reimann and Caritat 2005, p. 106). However, sediment metals concentration data and excess inventories in this region illustrate a clear signal of Giant and Con mine emissions, even without the use of enrichment factors (Figure 7). Based on our results, the degree of enrichment and amount of excess arsenic and antimony, which we attribute to emissions from Giant and Con mines, have been strongly influenced by two factors: 1) distance from the roaster stack and 2) wind direction.

The degree of enrichment and excess inventories of arsenic and antimony at each lake generally declined with increasing distance from the mines along both NW and NE transects (Figures 8, 9). Enrichment ranged from minimal to severe during the 1950s and was greatest in NW near-field lakes, followed by NW far-field and NE lakes. This pattern was similarly reflected by excess inventories, with the largest quantity of arsenic and antimony deposited closest to the mines

(NW10, NW20, NE20) and the smallest at more distal locations (NW70, NW80, NE40). Within individual lake groups, similar decreases in degree of enrichment and excess inventories were observed with increasing distance. Minor exceptions to these trends are observed between near- and far-field lake groups and are most evident at lake NW50, which is considerably larger and deeper than all other lakes along the transect (Table 1). With respect to NW near-field lakes and NE lakes, results of our sediment metal analyses are largely in agreement with findings of other researchers. Consistent with studies of contemporary surface water (Palmer et al. 2015, Houben et al. 2016), surficial sediment (Galloway et al. 2012; 2015), and soils (Jamieson et al. 2017, Galloway et al. 2018), solid-phase and dissolved arsenic concentrations were highest closest to Giant Mine. Our near-field results also support the findings of other paleolimnological analyses in the Yellowknife region (Thienpont et al. 2016, Schuh et al. 2018, Van Den Berghe et al. 2018, Cheney et al. 2020) that have identified widespread contamination from gold mining in the area. However, past studies have been limited to the near-field region of Yellowknife and the surrounding area and have identified impacts within 5 km (Van Den Berghe et al. 2018), 17 km (Palmer et al. 2015, Houben et al. 2016), 20 km (Sivarajah et al. 2020), 24 km (Pelletier et al. 2020), 30 km (Galloway et al. 2018), and 40 km (Cheney et al. 2020) of the mine. Conversely, NW far-field lake sediment records presented here demonstrate that emissions from the mines are present on the landscape at distances well beyond 40 km, and following the 1950s resulted in considerable to severe metal enrichment at least as far as 80 km in the prevailing wind direction.

Northwest and northeast transects effectively illustrated that in addition to distance from the mines, the deposition of mining-derived metals was strongly dictated by the wind direction. Much like the NW far-field lakes, stratigraphic records of NE lakes (NE20, NE40) exhibited sharp increases in all three metals during and shortly after the 1950s with enrichment ranging from moderate (arsenic) to severe (antimony). However, in comparison to lakes in the northwest at the same distances (NW20, NW40), the total inventory of excess arsenic and antimony at NE20 and NE40 was ~2-20 times lower. Findings are consistent with studies of Palmer et al. (2015) and Galloway et al. (2018) that identified lakes located downwind of Giant Mine exhibited the highest dissolved arsenic concentrations in their surface water and surface sediments, highlighting the role of wind direction in the dispersal of mining emissions. However, the presence of excess arsenic and antimony at lakes in the northeast indicates that lakes in the non-dominant wind direction were not exempt from mining emissions and aligns with paleolimnological data reported by Cheney et al. (2020). Additionally, given the volume of arsenic and antimony deposited in excess at NW80, 79 km NW of the mine (As: 120 mg/m^2, Sb: 2 mg/m^2) and NE40, 41 km NE of the mine (As: 46 mg/m^2, Sb: 3 mg/m^2), it is unlikely that emissions released from Giant and Con mines were limited to an 80-km NW or 40-km NE radius. These results, as well as arsenic enrichment found in a lake in the Slave River Delta located 140 km southeast of the mine (MacDonald et al. 2016), suggest that emissions are likely present on the landscape beyond these distances and in directions not yet fully explored.

Across all lake sediment records, excess arsenic was an order of a magnitude greater than excess antimony. Similar observations were made by Cheney et al. (2020) where lake sediment records in the non-dominant wind direction exhibited smaller increases in antimony in comparison to arsenic. Given that atmospheric residence times of arsenic and antimony have been estimated to be similar (4-10 days and 7-14 days, respectively; Han et al. 2003, Tian et al. 2014, Wai et al. 2016, Herath et al. 2017, Wiklund et al. 2020), such a phenomenon is likely explained by the proportionally smaller release of antimony in comparison to arsenic from the roaster stack (SRK Consulting Engineers and Scientists 2002, Bromstad et al. 2017). Additionally, because lead was released in much smaller quantities than arsenic and antimony (SRK Consulting Engineers and Scientists 2002) and deposition of lead from fossil fuel combustion in the 1960s was widespread, it is not surprising to find the trend of decreasing concentrations with increased distance more subtle for lead than other metals. While it is possible that the Giant and Con mine signal in the lead record has been compromised by the introduction and subsequent ban of leaded gasoline in North America (Peter and Wozniak 2001), the comparable depositional history of all three metals at most lakes across the two transects suggests its influence was likely very minimal.

2.4.2 Influence of catchment and diagenetic processes on metal stratigraphic profiles

The depositional histories and stratigraphic profiles for arsenic and antimony concentrations varied by lake grouping. Arsenic and antimony concentrations increased towards the top of the sediment core records at NW near-field lakes, while maximum concentrations occurred at depth at NW far-field and NE lakes, forming distinctive down-core peaks in close agreement with, or post-dating, maximum emissions during the 1950s (Figure 7). There are three possible explanations for the differences observed in arsenic and antimony concentration profiles across the three lake groups: 1) the supply of terrestrial and within-lake arsenic and antimony is greatest closest to the mine, 2) post-depositional mobility of arsenic and/or antimony has occurred, or 3) a combination of 1) and 2).

Proximity to the mines, which has long been identified as the key determinant for metal enrichment in lakes in the region (e.g., Galloway et al. 2012, Palmer et al. 2015), is likely also a determinant of metal enrichment in the terrestrial environment. An ongoing supply of metals, delivered to the land by mining emissions in the 1950s and mobilized via catchment erosion, has been identified as a potential explanation for the persistence of metal enrichment in near-surface lake sediments, particularly in the extensively-studied 30-40 km radius surrounding the mines (Thienpont et al. 2016, Schuh et al. 2018; 2019, Pelletier et al. 2020). Mining-derived metals may also be supplied via lateral movement of sediment from shallow to deep parts of the basin. However, focusing factors of <1 at near-field lakes NW10, NW20, and NW30 (Figure 6) do not support this. In contrast, NW far-field and NE lake catchments may have rapidly exhausted their lesser supplies of terrestrial legacy metals, which allowed for peak emissions to become discernible in their stratigraphic records. Despite being located at distances equivalent to near-field lakes NW20 and NW40, northeast lakes NE20 and NE40 may have similarly exhausted their comparatively smaller terrestrial supply of legacy metals because less pollutants were deposited on the landscape in non-dominant wind directions. Mining-derived metals at the sediment surface were also identified by Schuh et al. (2018) in lakes ~5 km from Giant Mine and were determined to be in part due to terrestrial loading from the surrounding catchment. Southwest of the mine in Yellowknife Bay, legacy metals (particularly lead) have similarly accumulated at the sediment surface and are likely to have originated from the terrestrial environment or other regions of the Bay (Pelletier et al. 2020).

Mobility of arsenic, and to a lesser extent antimony, in lake sediments has been well documented (Mudroch et al. 1989, Martin and Pederson 2002, Smedley and Kinniburgh 2002, Fawcett et al. 2015, Van Den Berghe et al. 2018, Miller et al. 2019). However, given that lead is considered immobile in lake sediments (Outridge and Wang 2015, Thienpont et al. 2016, Pelletier et al. 2020) and was also emitted from the smelters, we can use the similarities and differences among the three metals to interpret the processes influencing their stratigraphic profiles. For example, the parallel concentrations of arsenic, antimony, and lead at NW10-30 indicate that post-depositional mobility is unlikely to have been the dominant cause of enrichment present in uppermost strata. In contrast, at NW40, where trends of arsenic concentrations were consistent with those observed at lakes NW10-30 (NW40 maximum: 0-1 cm, ~2016), the antimony record formed a distinctive down-core peak in ~1960 (maximum: 2.35 ug/g, 5-6 cm) and behaved more similarly to NW far-field and NE lakes. Given its relatively static nature in comparison to its more mobile co-pollutants, the lead record at NW40 (maximum: 7.06 ug/g, 5-6 cm) suggests that maximum arsenic concentrations found at the sediment surface are the product of post-depositional mobility rather than from the catchment. Similar inferences can be drawn from lake NW20 where a deviation from the lead record by its otherwise parallel co-pollutants (arsenic, antimony) may indicate some post-depositional mobility has occurred. Our inferences of post-depositional arsenic mobility in lake sediments at NW20 and NW40 show strong agreement with results of reactive transport modelling and the reconstruction of diagenetic processes over time (Leclerc et al. in review).

Given that post-depositional mobility and lateral redistribution of sediment from shallow to deep areas was negligible, legacy deposits of arsenic, antimony, and lead from the catchments of NW near-field lakes are the most likely source of rising concentrations in upper sediment strata. Rising concentrations likely mask the down-core peak observed at more distant lakes during mine emissions in the 1950s. A possible mechanism for the rising concentrations is greater runoff and catchment erosion, which may have accelerated under a warming climate and more frequent wildfires (Wang et al. 2015, Abraham et al. 2017, Giesler et al. 2017, Pelletier et al. 2020b).

2.5 Conclusions

Lakes at ~10-km increments in the dominant (NW to 80 km) and non-dominant (NE to 40 km) wind directions were explored to identify the record of near- and far-field transport and deposition of metals from Giant and Con mine emissions. Paleolimnological analysis revealed that mining emissions released in the 1950s dispersed beyond the extensively studied near-field zone (~40 km). Measurable enrichment in arsenic and antimony in lake sediments during, and shortly after the 1950s, ranging from considerable to severe, demonstrate that emissions from the mines are present on the landscape at least as far as 80 km in the NW and 40 km in the NE. Concentrations of the three metals decreased with increasing distance from the mines and are in agreement with existing literature on mining impacts in the near-field region (Palmer et al. 2015, Jaimeson et al. 2017). Despite the focus of previous studies in the NW region (Van Den Berghe et al. 2018), our findings illustrate that mining emissions also spread to the NE and is consistent with recent findings of Cheney et al (2020). The uncontrolled release of emissions in the 1950s resulted in considerable (arsenic) to severe (antimony) enrichment at lakes in the NE. However, comparison of lakes in the NE to lakes in the NW at the same distance revealed that the amount of excess arsenic deposited on the landscape was at least twenty times that of NE20 at NW20, and at least twice that of NE40 at NW40. Given the quantity of excess arsenic and antimony found at lakes NW80 (As: 12 mg/m^2, Sb: 2 mg/m^2) and NE40 (As: 46 mg/m^2, Sb: 3 mg/m^2), located farthest from the mine along each transect, pollution from Giant and Con mines is unlikely to be limited to the NW or NE sector and is expected to be present in all wind directions at distances farther than those explored here.

Metal stratigraphic profiles identified two distinct trends among the lake groups. For lakes on the NW near-field transect, concentrations of arsenic, antimony, and lead gradually increased from the base of the sediment record and were most enriched at the sediment surface. At NW far-field and NE lakes, metal concentrations were most enriched at depth and formed distinctive down-core peaks. The parallel profiles of arsenic, antimony, and lead at lakes in the NW near-field region suggests that, with the exception of NW20 and NW40, post-depositional mobility of arsenic and antimony was unlikely to have occurred within the sediment column and is consistent with reactive transport modelling by Leclerc et al. (in review). Results suggest enriched metal concentrations found closest to the sediment surface are likely sourced from the surrounding terrestrial environment and that deposition of metal pollutants remains ongoing. Lakes located farther away (NW far-field) and in the non-dominant wind direction (NE), in contrast, have exhausted their lesser supply of terrestrial legacy metals and, in turn allowed the period of maximum emission release in the 1950s to become well-preserved in the lake stratigraphic records. As a result, legacy pollution continues to affect lakes at present in the near-field region where terrestrial sources of legacy metals are more abundant.

Concentrations of dissolved arsenic remain elevated in surface water (NW10-NW30), which may suggest that moderate to severely enriched arsenic and antimony concentrations found in uppermost sediment intervals are acting as a source of arsenic to overlying surface water (Leclerc et al. in review). The possibility of lake sediment remaining a long-term source of arsenic to the water column urges further research to be conducted on the movement of legacy metals through sediment porewater. Additionally, given the likelihood that catchments in the near-field region (~40 km of the mine) have been burdened with legacy metals since the 1950s, future research should aim to characterize terrestrial stores of legacy metals to better understand processes governing the movement of legacy metals from terrestrial to aquatic systems. Confounding impacts from late 20th century climate warming, such as changes in precipitation and wildfire frequency, may accelerate transport of legacy metals and warrant further study (Pelletier et al. 2020b).

The findings presented here are important for Indigenous peoples, natural resource managers, and government agencies to understand the consequences of legacy mining operations, and to guide research aimed at better understanding the processes that may increase transport of legacy metal pollution from land to adjacent aquatic ecosystems. Our historical account of mining impacts on lakes in the Northwest Territories will better inform the decision-making of stakeholders and have considerable implications for mining developments that have closed, are currently operating, and are proposed.

Table 2: Selected basin characteristics of study lakes to the northwest and northeast of Giant Mine.

Lake	Coordinates (Lat., Long.)	Distance from Giant Mine (km)	Size (km^2)	Depth (m)
NW10	62.552889, -114.52625	10.5	0.21	1.5
NW20	62.608333, -114.605278	17.8	1.12	4.0
NW30	62.672278, -114.812028	29.8	0.08	3.0
NW40	62.738889, -114.958333	40.6	2.60	8.0
NW50	62.825556, -115.009639	49.6	2.72	24.0
NW60	62.834694, -115.158417	55.7	1.56	3.5
NW70	62.951111, -115.367222	72.5	0.44	5.0
NW80	63.002056, -115.444528	79.0	0.08	7.0
NE20	62.598334, -114.017256	20.9	1.05	10.6
NE40	62.705842, -113.682029	41.2	0.20	3.0

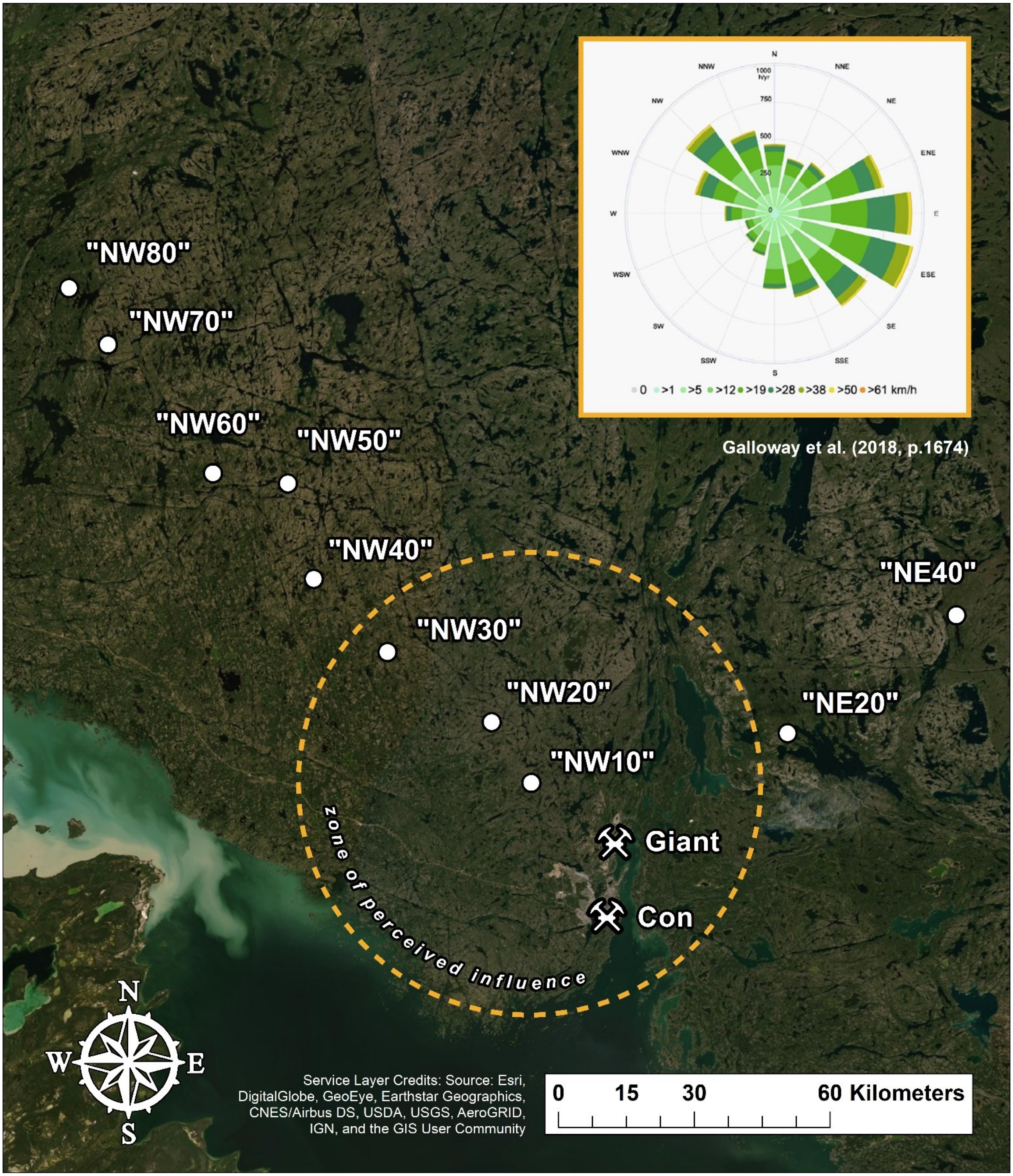

Figure 5: Map showing locations of the study lakes relative to the area of influence of Giant Mine emissions identified by Palmer et al. (2015). Top-right inset provides a wind rose illustrating winds that dominantly blow from southeast to the northwest in this region (Galloway et al. 2018, p.1674).

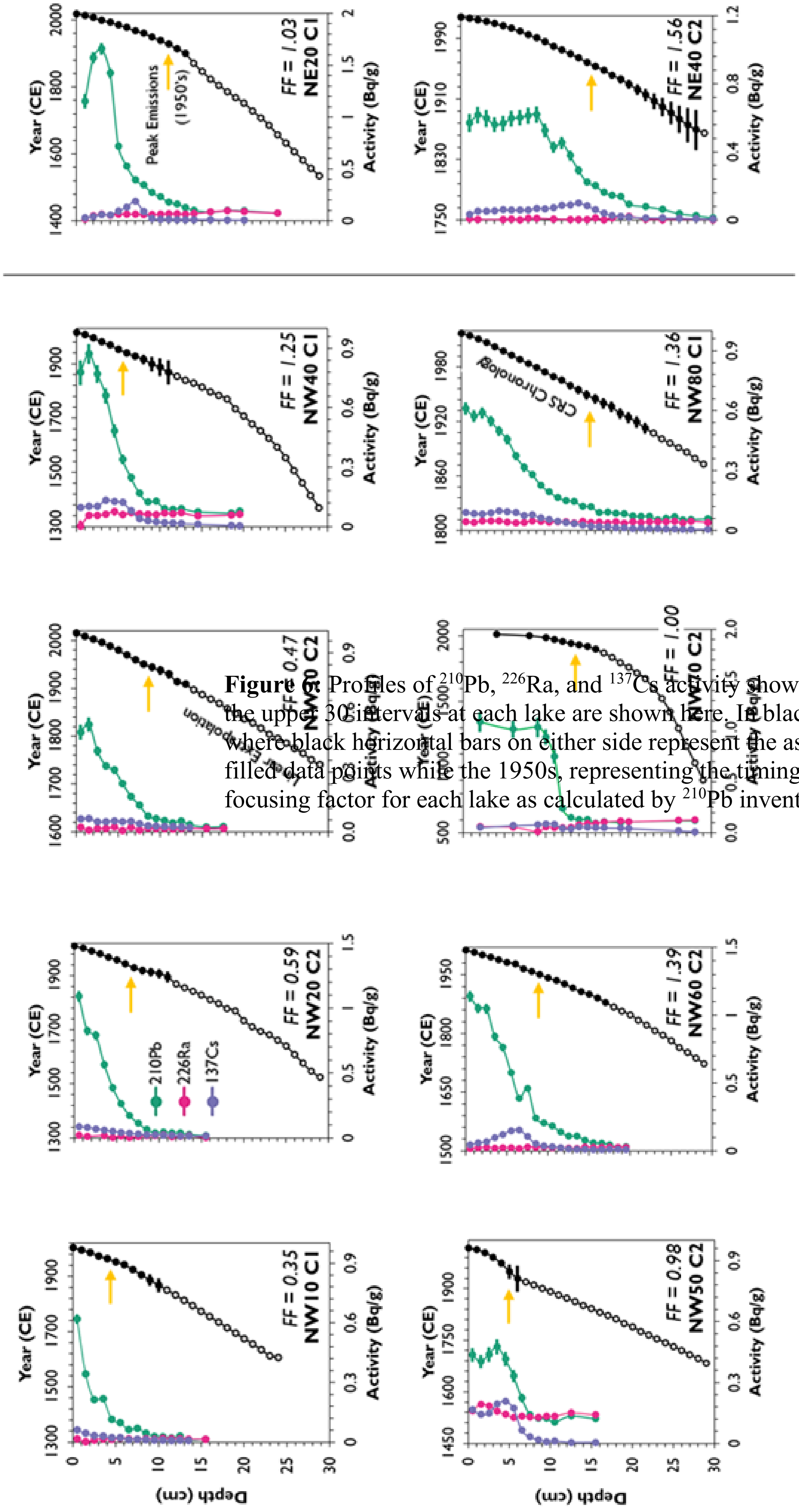

Figure 6: Profiles of ^{210}Pb, ^{226}Ra, and ^{137}Cs activity shown stratigraphically for lakes along the northwes
the upper 30 intervals at each lake are shown here. In black, the CRS-based age model depicts the corres
where black horizontal bars on either side represent the associated error (±2 sigma). Extrapolations of th
filled data points while the 1950s, representing the timing of peak emissions from Giant and Con mines,
focusing factor for each lake as calculated by ^{210}Pb inventories is denoted by "FF" above the lake name.

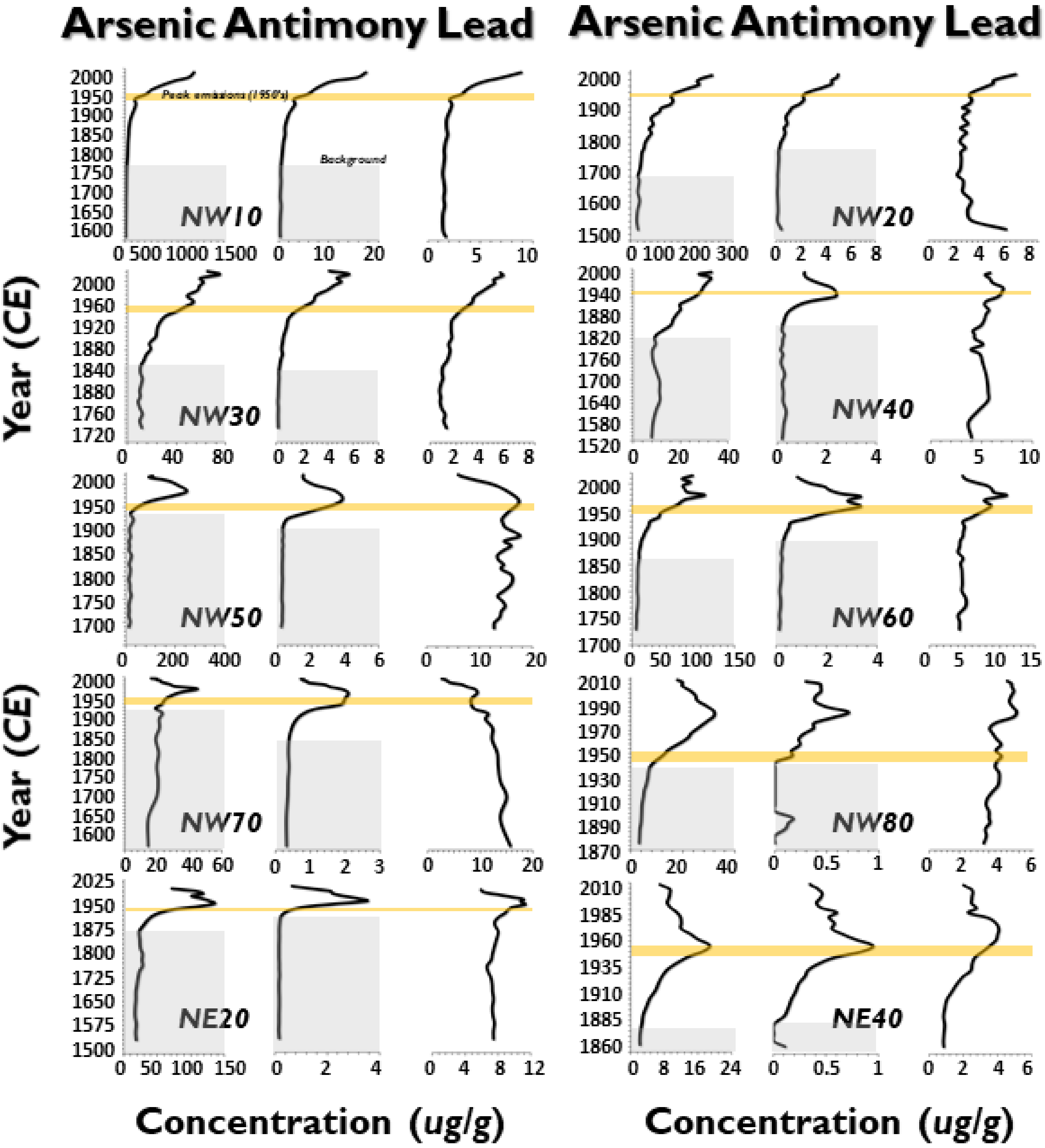

Figure 7: Stratigraphic profiles of arsenic, antimony, and lead concentrations for lakes across the northwest and northeast transects. Results are presented to 1500 CE where available. The period of peak emissions is highlighted in yellow (i.e., 1950s) while the grey shaded areas represent the period identified as 'pre-industrial' or background.

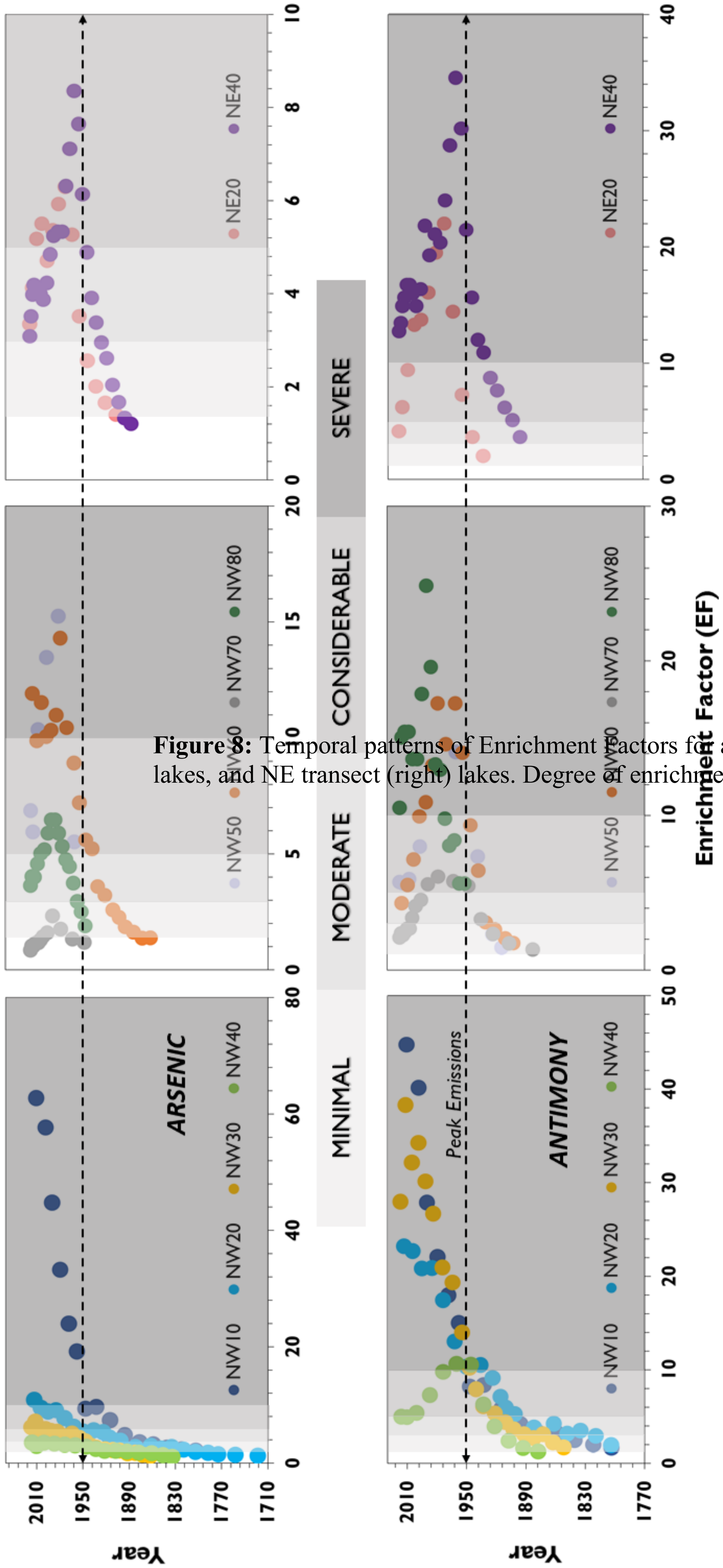

Figure 8: Temporal patterns of Enrichment Factors for arsenic (top) and antimony (bottom) at NW transe
lakes, and NE transect (right) lakes. Degree of enrichment is shown relative to the categories identified by

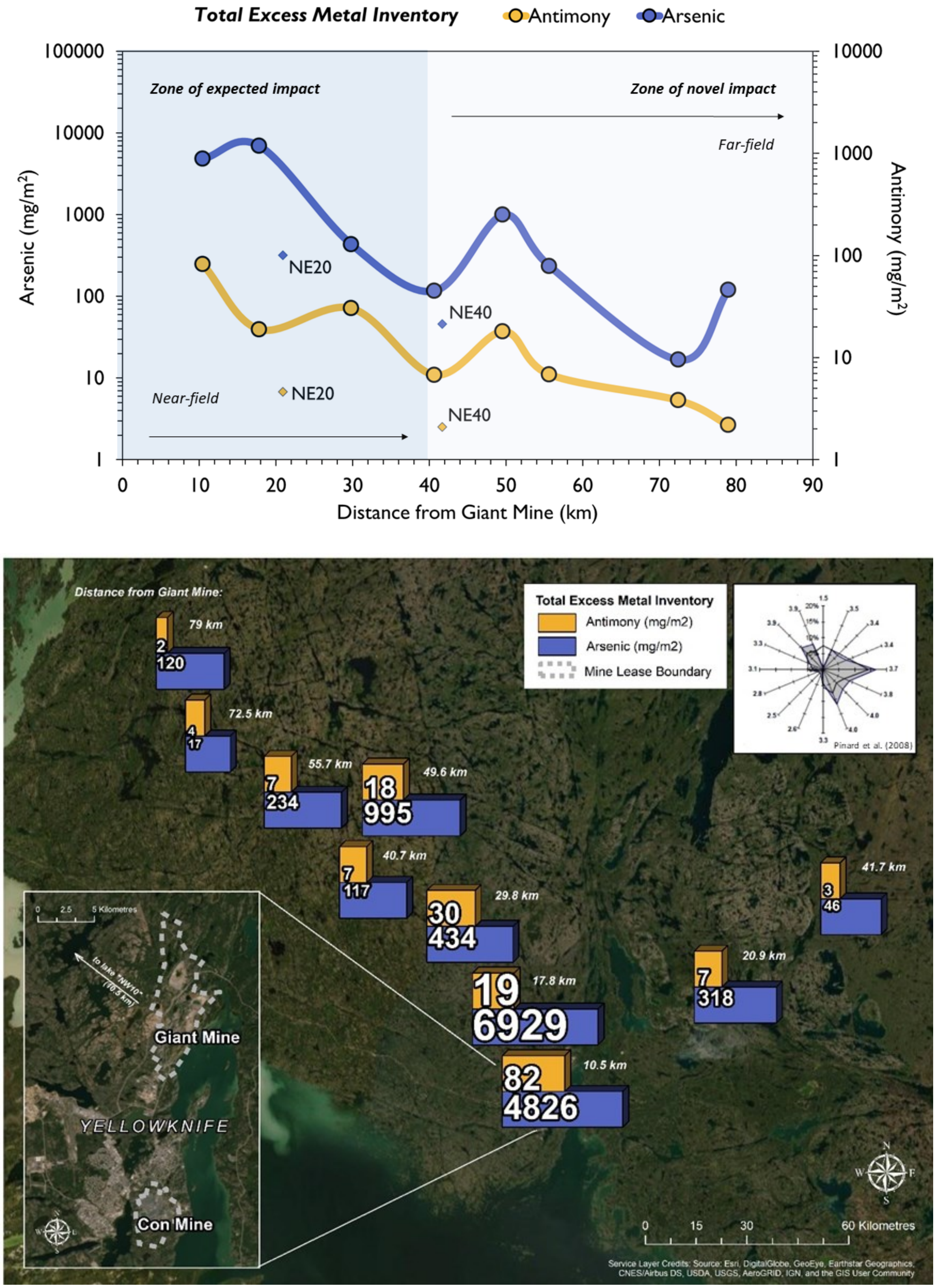

Figure 9: Calculated excess metal inventories for arsenic and antimony at all study lakes. Metal concentrations were focus-factor corrected and either increased (FF<1: NW10, NW20, NW30, NW50) or decreased (FF>1: NW40, NW60, NW70, NW80, NE20, NE40) the estimated excess metal inventory. Top: arsenic and antimony inventories are shown according to distance from Giant Mine. Bottom: metal inventories are shown relative to wind direction.

Chapter 3
Conclusions

3.1 Key findings and relevance of research

Measurement of metal concentrations in radiometrically-dated lake sediment cores collected along two transects (NW, NE) identify that pollution from Giant and Con mines is present well-outside the Yellowknife vicinity, and is not limited to the prevailing or north-easterly wind direction. Enrichment in arsenic and antimony during peak emission release in the 1950s was recorded as far as 80 km from Giant Mine to the northwest, and 40 km to the northeast. Based on the inventories of arsenic and antimony present at the most distal sites along each transect (i.e., NW80 and NE40), it is unlikely that results presented here have captured the full spatial footprint from mining emissions.

The systematic approach of obtaining lake sediment cores along transects in the dominant and non-dominant wind directions provided the unique opportunity to quantify the relative proportion of mining emissions that were deposited in each respective wind direction. Comparison of total excess metal inventories at sites at 20 and 40 km has shown several orders of a magnitude difference in the amount of arsenic and antimony deposited on the landscape in each direction. Our results are consistent with those presented by Cheney et al. (2020) and highlight that lakes in the northeast were not exempt from the uncontrolled release of mining emissions. Moreover, metal enrichment in NE lakes has illustrated that despite their location in the non-dominant wind direction, during peak emission release, sediments were considerably (arsenic) and severely (antimony) enriched.

Unexpectedly, our study identified two distinct stratigraphic patterns in sediments of lakes that received pollution from Giant and Con mines. NW transect near-field lakes exhibited upward-trending increases in metal (arsenic, antimony, lead) concentrations, which in turn placed maximum concentrations at the sediment surface. In contrast, at NW far-field and NE lakes, the historical impact of peak emission release in the 1950s was well-preserved, forming a distinctive down-core peak where maximum concentrations occurred at depth. In line with the findings of recent studies in the Yellowknife region (Thienpont et al. 2016, Schuh et al. 2018; 2019, Pelletier et al. 2020), NW near-field lakes appear to be receiving a continuous supply of legacy metals from their surrounding catchments. Given their more distal locations, catchments of NW far-field lakes have exhausted the majority of their legacy metals. In the same regard, because the northeast wind direction received less metal pollution overall, terrestrial supplies of legacy metals at NE lakes have also likely been largely exhausted, thus the period of peak emissions is well-preserved in their stratigraphic records. Our use of the relatively immobile element lead as a tracker of potential post-depositional mobility in lakes (Thienpont et al. 2016, Pelletier et al. 2020) identified that with the exception of NW20 and NW40, metal mobility was minimal and the anthropogenic signal from Giant and Con mines has been well-preserved, in agreement with porewater modelling studies of Leclerc et al. (in review).

At lakes NW10-30, the continued deposition of legacy metals following the 1950s may have been accelerated by a shift in climatic conditions in the latter half of the 1900s. Northern Canada has warmed at a disproportionately faster rate than the rest of the continent and since 1948 has experienced an increase of at least 2°C Celsius in average air temperatures (Bush and Lemmen 2019). A recent study by Sivarajah et al. (2020) identified that a considerable shift in average annual air temperatures occurred in the mid- to late 1950s in the Yellowknife region. This shift may be reflected in the sediment core record at NW near-field lakes in the form of increased loading from the terrestrial catchment as warmer air temperatures have resulted in an increase in precipitation in the form of rain which would have in turn increased rates of catchment erosion. Additionally, increased wildfire frequency may have contributed to catchment erosion and the liberation of legacy metals.

3.2 Future recommendations

Our study identified that despite the closure of the roasting facilities in 1999, concentrations of metals incorporated into roaster emissions are continuing to rise in upper strata of sediments of lakes within 30 km of Yellowknife. Elevated dissolved arsenic concentrations in the surface water of these lakes (Leclerc et al. in review) suggest that sediments, and the surrounding terrestrial environment, are continuing to provide a source of legacy metals to these lakes in present day. Thus, our analysis of metal concentrations in the surface sediments of these lakes suggests that arsenic, antimony, and lead emitted from the roaster stack is not getting buried downcore. Given that the toxicity of inorganic arsenic in sediments is dependent on its chemical form, the potential risks associated with arsenic trapped in the surface sediments of these lakes would be an important direction of inquiry, thus future studies at lakes NW10-30 should include arsenic speciation. Such an approach has proven to be useful in the Yellowknife region when attempting to discern arsenic from anthropogenic versus natural sources (e.g., Schuh et al. 2018, Van Den Berghe et al. 2018).

While our analyses and collaborative research with Leclerc et al. (in review) did not identify considerable evidence of post-depositional metal mobility at lakes NW10-30, sediment cores collected as part of this study are representative only of the open-water season (May-September). The depths of these lakes (>4 m) suggest they are likely ice-covered for much of the year, which can lead to the development of anoxic conditions and, in turn, mediate the reductive dissolution of iron (oxy)hydroxides and subsequent release of arsenic to overlying porewater (Palmer et al. 2020). Increased runoff as a result of climate warming is also expected to result in an increase in the delivery of organic matter to lakes which, in its labile form, can serve as the electron donor and facilitate mobility of arsenic from sediments to the water column (Miller et al. 2020). Recent studies by Miller et al. (2020) suggest increases in organic matter production will lead to an increase in the development of anoxic conditions in lakes, particularly in upper sediment strata where metals are most enriched at lakes NW10-30. However, the impacts of expected changes to lake biogeochemistry on the mobility and stability of arsenic in lake sediments is not well understood and further research is needed to determine the impacts of increased aquatic productivity on mining-impacted lakes. Future studies should investigate the impacts of seasonality on lakes in the extensively studied near-field region.

The terrestrial environment may continue to influence lakes affected by mining pollution for years to come. And, given expected changes to precipitation patterns in the North as a result of climate warming (NWT Climate Change Impacts and

Adaptation Report 2008, Bush and Lemmen 2019), we may observe an increase in runoff from terrestrial to aquatic environments (Zhang et al. 2018). Evidence of metal enrichment in lakes as far as 80 km in the NW, 40 km in the NE, and 140 km in the SE (MacDonald et al. 2016) indicates that pollution from Giant and Con mines in the 1950s has been widespread and further research is needed to fully characterize the emissions footprint. Based on our findings, it is recommended that additional lake sediment core transects are developed in wind directions not yet explored and at distances farther than those explored here (>80 km).

In order to more effectively determine the extent of pollution from Giant and Con mines, multiple components of the ecosystem in these regions should be studied in tandem. Lakes selected for future studies should provide ample opportunity to collect wetland and soil cores from their surrounding catchments as the behaviour and fate of legacy metals stored in the terrestrial environment remains poorly understood. Identifying terrestrial stores of legacy metals will be essential to better understand relations between the terrestrial and aquatic environment. Given that climate change is expected to continue to alter the environment in these regions, the impacts of climate warming on the stability of legacy metals in the terrestrial environment should be further investigated to better determine the processes that may prompt additional mobility from terrestrial to aquatic systems.

Additionally, future studies should aim to determine the role of catchment size and landcover type on the retention of mining-derived metals in lake sediments. The possibility remains that the area of land drained by each lake is influencing both the quantity of excess metals in sediments and the persistence of legacy metals at the sediment surface in lakes. Bathymetric studies and the collection of multiple sediment cores from different regions of each lake (i.e., shallow vs. deep) would also aid interpretation of the differences in metal depositional profiles observed here.

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Appendix A

Study site information

Table A1: Lake sediment core collection locations.

Lake name	Latitude	Longitude
NW10	62.552889	-114.52625
NW20	62.608333	-114.605278
NW30	62.672278	-114.812028
NW40	62.738889	-114.958333
NW50	62.825556	-115.009639
NW60	62.834694	-115.158417
NW70	62.951111	-115.367222
NW80	63.002056	-115.444528
NE20	62.598334	-114.017256
NE40	62.705842	-113.682029

Table A2: Collected sediment core lengths.

Lake	Core Length (cm)	
NW10	24.5	21
NW20	46	47
NW30	40	43.5
NW40	35	32.5
NW50	42	42.5
NW60	46	45
NW70	48.5	47
NW80	50.5	49
NE20	39	36
NE40	33	39

Appendix B

Chronology information

Table B1: Measured ^{210}Pb, ^{137}Cs, and ^{226}Ra values (dpm/g) and CRS-based chronology for lake NW10. Grey cells represent extrapolated values and yellow cells represent interpolated values.

Sediment depth interval (cm)	CRS Chronology	CRS Error ± 2 sigma	210Pb dpm/g	210Pb error (1 std. dev.) dpm/g	137Cs dpm/g	137Cs error (1 std. dev.) dpm/g	226Ra dpm/g	226Ra error (1 std. dev.) dpm/g
0	2002.93	1.28	37.0745	1.4291	3.5859	0.2126	0.9244	0.2253
1	1994.05	1.73	20.4874	1.0357	2.6089	0.2169	0.0430	0.2551
2	1986.06	2.20	12.7428	0.7615	1.9199	0.1662	0.5755	0.2154
3	1972.90	3.12	13.0540	0.7752	1.8263	0.1570	0.9414	0.2547
4	1963.85	3.95	6.8019	0.4865	1.2990	0.1164	0.7625	0.2331
5	1951.96	5.28	5.7971	0.4239	1.3063	0.0999	1.1570	0.2096
6	1941.47	6.37	3.7911	0.3709	0.7361	0.0986	0.9344	0.1853
7	1924.00	9.57	4.0472	0.3664	0.8241	0.0919	0.8111	0.1601
8	1905.46	14.50	2.6846	0.2626	0.7176	0.0732	0.9291	0.1758
9	1885.94	21.26	1.6596	0.1981	0.5045	0.0631	0.8344	0.1576
10	1867.26	25.20	1.5432	0.1824	0.5143	0.0570	1.0906	0.1613
11	1850.19		1.1172	0.1570	0.4502	0.0648	0.9470	0.1774
12	1831.64		1.7516	0.1899	0.5367	0.0585	0.9664	0.1569
13	1812.47		0.6095	0.1111	0.3763	0.0707	0.8524	0.1567
14	1794.83		0.7125	0.1748				
15	1773.95		0.8263	0.1349	0.3789	0.0586	0.8320	0.1447
16	1754.18							
17	1734.05							
18	1713.85							
19	1694.34							
20	1674.17							
21	1655.49							
22	1634.24							
23	1612.66							
24	1606.03							

Table B2: Measured ^{210}Pb, ^{137}Cs, and ^{226}Ra values (dpm/g) and CRS-based chronology for lake NW20. Grey cells represent extrapolated values and yellow cells represent interpolated values.

Sediment depth interval (cm)	CRS Chronology	CRS Error ± 2 sigma	210Pb dpm/g	210Pb error (1 std. dev.) dpm/g	137Cs dpm/g	137Cs error (1 std. dev.) dpm/g	226Ra dpm/g	226Ra error (1 std. dev.) dpm/g
0	2008.22	0.84	65.4450	2.5035	5.0130	0.2933	1.1366	0.2634
1	2000.84	1.20	49.4680	2.0452	4.7236	0.2710	0.7001	0.2002
2	1989.66	1.88	47.3543	2.1374	4.0903	0.2927	0.8718	0.4779
3	1980.44	2.59	33.9023	1.8079	3.5789	0.2700	1.0434	0.5982
4	1967.36	3.76	23.1014	1.7118	2.8958	0.2808	0.1308	0.3590
5	1956.80	5.19	15.7680	1.2120	2.4981	0.2090	0.8471	0.2185

6	1943.06	7.70	10.2496	0.9535	2.1331	0.1715	0.0732	0.0365
7	1928.89	11.20	6.6886	0.9172	1.6349	0.1692	0.6598	0.3584
8	1918.73	14.29	3.8655	0.7817	1.3658	0.1497	0.9570	0.2065
9	1912.82	15.54	2.2718	0.7794	1.3596	0.1503	0.9420	0.2080
10	1907.89	17.02	2.6269	0.7230	1.2383	0.1417	1.3128	0.3940
11	1894.88	20.96	2.1825	0.7436	1.1124	0.1429	0.4577	0.3553
12	1868.95		2.2564	0.9050	0.9009	0.1681	0.6599	0.1647
13	1854.69		1.5388	0.7479	0.8585	0.1437	0.9571	0.4992
14	1841.90		1.2577	1.0666				
15	1827.88		1.0132	0.7605	0.8912	0.1397	0.0947	0.2639
16	1810.96							
17	1796.87							
18	1778.47							
19	1770.29							
20	1734.21							
21	1711.74							
22	1694.08							
23	1680.71							
24	1660.74							
25	1640.10							
26	1608.05							
27	1576.48							
28	1546.35							
29	1523.86							
30	1504.12							
31	1486.48							
32	1468.24							
33	1460.94							
34	1431.76							
35	1409.36							
36	1387.13							
37	1363.93							
38	1345.21							
39	1319.35							
40	1286.95							
41	1253.92							
42	1228.50							
43	1211.91							
44	1182.52							
45	1164.45							
46	1143.09							
47	1118.57							
48	1100.70							
49	1075.70							

Table B3: Measured ^{210}Pb, ^{137}Cs, and ^{226}Ra values (dpm/g) and CRS-based chronology for lake NW30. Grey cells represent extrapolated values and yellow cells represent interpolated values.

Sediment depth interval (cm)	CRS Chronology	CRS Error ± 2 sigma	210Pb dpm/g	210Pb error (1 std. dev.) dpm/g	137Cs dpm/g	137Cs error (1 std. dev.) dpm/g	226Ra dpm/g	226Ra error (1 std. dev.) dpm/g
0	2015.34	0.49	29.3975	2.2634	3.2635	0.3678	0.6891	0.2249
1	2008.28	1.08	31.7128	2.1341	3.3673	0.3532	-0.2081	0.0897
2	2002.25	1.43	23.7234	1.4292	2.4138	0.2176	0.3173	0.1237
3	1995.26	1.89	19.2508	1.0670	2.4529	0.1650	0.3553	0.1185
4	1988.11	2.47	18.0355	1.2521	2.6457	0.2122	0.8540	0.2294
5	1979.44	3.30	13.9145	1.0900	2.4575	0.1878	-0.2566	0.1944
6	1969.45	4.37	10.0005	1.0829	2.5389	0.2011	0.7428	0.2078
7	1958.95	5.82	7.4325	0.8478	1.7335	0.1575	-0.2022	0.1492
8	1950.22	7.16	4.1597	0.7137	1.2398	0.1350	0.4616	0.1325
9	1943.81	8.31	3.3791	0.7330	1.0893	0.1393	0.3757	0.1149
10	1937.03	9.45	2.8067	0.7941	0.9549	0.1499	0.2675	0.0819
11	1929.18	9.05	2.1191	0.9627	0.9086	0.1776	0.1639	0.0561
12	1913.67	7.28	2.7367	0.8309	0.8264	0.1547	0.2682	0.0875
13	1908.51	6.56	1.5020	0.5232	0.6296	0.0971	0.4386	0.1101
14	1896.67		1.1263	0.7636				
15	1887.23		0.8191	0.5562			0.3248	0.0885
16	1877.14		0.8850	0.7626				
17	1868.31		0.9543	0.5217			0.3679	0.0957
18	1857.05							
19	1846.83							

20	1835.74							
21	1827.86							
22	1816.48							
23	1804.21							
24	1795.32							
25	1785.03							
26	1774.07							
27	1764.18							
28	1750.35							
29	1740.13							
30	1729.14							
31	1719.28							
32	1707.95							
33	1694.45							
34	1684.55							
35	1665.54							
36	1645.18							
37	1626.92							
38	1605.20							
39	1592.39							
40	1581.76							
41	1571.71							
42	1561.22							

Table B4: Measured ^{210}Pb, ^{137}Cs, and ^{226}Ra values (dpm/g) and CRS-based chronology for lake NW40. Grey cells represent extrapolated values and yellow cells represent interpolated values.

Sediment depth interval (cm)	CRS Chronology	CRS Error ± 2 sigma	210Pb dpm/g	210Pb error (1 std. dev.) dpm/g	137Cs dpm/g	137Cs error (1 std. dev.) dpm/g	226Ra dpm/g	226Ra error (1 std. dev.) dpm/g
0	2013.74	0.86	46.5858	3.8273	5.7050	0.4159	0.0562	1.8660
1	2006.79	1.33	52.3046	2.9797	6.1091	0.3061	3.3034	1.0784
2	1994.47	2.22	46.2176	2.7430	6.1521	0.3117	3.2820	1.0145
3	1979.67	3.40	39.6261	2.3810	7.9003	0.3306	3.7170	1.0144
4	1967.80	4.68	28.9936	1.9732	7.5738	0.3137	4.4945	1.1787
5	1952.56	7.00	20.3446	1.5353	7.2827	0.2825	3.5703	0.8758
6	1938.93	9.99	14.8739	1.2520	4.8379	0.2097	4.1762	0.9350
7	1927.28	13.62	10.0886	0.8103	2.3962	0.1110	3.7690	0.9274
8	1916.31	17.67	7.3749	0.7935	1.8145	0.1085	3.6777	0.8363
9	1898.75	27.28	7.6234	0.8092	1.3628	0.1047	3.6265	0.9337
10	1887.11	33.00	5.4392	0.7061	1.2184	0.0917	4.0872	0.7831
11	1868.15	44.15	5.1877	0.6852	1.0832	0.0875	3.8616	0.7876
12	1853.40		5.3817	0.6366	0.8740	0.0786	4.1259	0.8165
13	1839.33		4.8967	0.8311				
14	1828.70		4.4418	0.5343	0.6962	0.0643	3.2729	0.7457
15	1813.41		4.3501	0.9356				
16	1796.65		4.2597	0.7681				
17	1783.85		4.1706	0.9457				
18	1770.71		4.0827	0.5518	0.3266	0.0639	3.4609	0.7859
19	1732.98		4.6119	0.5983	0.1978	0.0717	3.6759	0.8776

20	1707.13							
21	1678.49							
22	1652.79							
23	1625.03							
24	1593.43							
25	1553.79							
26	1507.16							
27	1460.90							
28	1415.15							
29	1369.56							
30	1319.66							
31	1256.73							

Table B5: Measured ^{210}Pb, ^{137}Cs, and ^{226}Ra values (dpm/g) and CRS-based chronology for lake NW50. Grey cells represent extrapolated values and yellow cells represent interpolated values.

Sediment depth interval (cm)	CRS Chronology	CRS Error ± 2 sigma	210Pb dpm/g	210Pb error (1 std. dev.) dpm/g	137Cs dpm/g	137Cs error (1 std. dev.) dpm/g	226Ra dpm/g	226Ra error (1 std. dev.) dpm/g
0	2016.47	0.57	26.1368	2.0582	9.8806	0.3478	9.4924	0.7353
1	2012.30	1.62	24.1750	2.0152	8.4825	0.3401	11.5200	0.8961
2	2003.49	3.23	26.2746	2.1713	8.8400	0.3547	11.0238	0.8613
3	1990.60	5.40	28.5089	2.3014	11.6006	0.4244	9.4394	0.7440
4	1972.72	9.73	24.9142	2.1201	12.4211	0.4574	8.5187	0.6838
5	1948.99	20.48	19.8600	1.7906	10.3275	0.3963	7.5774	0.6130
6	1928.49	38.22	13.4555	1.2831	3.8312	0.1935	7.9999	0.6276

7	1919.29		8.4464	0.9277	1.8830	0.1372	7.7527	0.6045
8	1909.54		7.3604	0.8131	1.0250	0.1050	7.5747	0.5860
9	1900.34		7.4325	0.8632	0.4320	0.1077	7.9117	0.6162
10	1890.94		6.2818	0.7542	0.6209	0.1023	7.9248	0.6135
11	1880.85		7.1328	1.1366				
12	1871.44		8.0574	0.8503	0.2349	0.0865	8.9446	0.6867
13	1861.35							
14	1850.85							
15	1841.40		7.2383	0.8167	0.2328	0.0906	8.3526	0.6452
16	1830.90							
17	1821.45							
18	1811.37							
19	1798.32							
20	1788.23							
21	1775.18							
22	1764.79							
23	1753.09							
24	1742.70							
25	1731.00							
26	1720.12							
27	1707.23							
28	1696.35							
29	1683.46							
30	1667.82							
31	1650.89							

32	1635.26							
33	1618.32							
34	1608.63							
35	1595.20							
36	1585.50							
37	1572.08							
38	1557.09							
39	1545.87							
40	1530.89							
41	1519.67							
42	1506.27							
43	1492.98							
44	1479.58							

Table B6: Measured ^{210}Pb, ^{137}Cs, and ^{226}Ra values (dpm/g) and CRS-based chronology for lake NW60. Grey cells represent extrapolated values and yellow cells represent interpolated values.

Sediment depth interval (cm)	CRS Chronology	CRS Error ± 2 sigma	210Pb dpm/g	210Pb error (1 std. dev.) dpm/g	137Cs dpm/g	137Cs error (1 std. dev.) dpm/g	226Ra dpm/g	226Ra error (1 std. dev.) dpm/g
0	2012.31	0.43	68.2456	2.3410	2.6373	0.2411	1.0337	0.4242
1	2006.53	0.59	63.0049	2.1403	3.3761	0.2489	1.2221	0.2787
2	2000.26	0.74	62.7703	2.1645	3.9845	0.2779	1.4775	0.3781
3	1994.58	0.87	50.5045	1.8728	5.8301	0.3838	1.1929	0.3348
4	1987.65	1.05	45.6771	1.6904	7.1109	0.3966	1.2601	0.3587
5	1980.98	1.25	34.5077	1.2724	8.8287	0.4228	1.2210	0.3052
6	1977.29	1.37	23.2651	1.1850	9.0773	0.4823	0.9723	0.3113

7	1964.57	1.72	27.5024	1.1591	6.1904	0.3244	1.6699	0.2979
8	1958.06	1.99	14.3379	0.6955	3.0457	0.1753	1.4945	0.2784
9	1950.55	2.29	12.1959	0.6748	2.0509	0.1518	1.6243	0.2752
10	1941.39	2.74	10.9778	0.6497	1.7076	0.1366	1.2441	0.2542
11	1934.57	3.18	8.2486	0.5308	1.3145	0.1189	1.2479	0.2500
12	1926.72	3.75	6.4378	0.4482	0.7847	0.1007	1.0884	0.2506
13	1915.80	4.67	6.4126	0.4780	0.5945	0.1098	0.9919	0.2639
14	1906.09	5.50	4.6874	0.3563	0.5651	0.0749	1.5995	0.2529
15	1899.73	5.91	3.3869	0.3201	0.5438	0.0839	1.4481	0.2476
16	1890.14	6.44	3.3503	0.3272	0.5146	0.0864	1.3803	0.2677
17	1878.69		2.7000	0.2684	0.5507	0.0690	1.6634	0.2738
18	1867.67		1.3900	0.2009	0.5538	0.0767	1.4807	0.2482
19	1857.26		1.7504	0.2250	0.3949	0.0699	1.5046	0.2700
20	1847.49							
21	1834.29							
22	1821.67							
23	1806.84							
24	1795.41							
25	1780.83							
26	1763.54							
27	1750.99							
28	1736.88							
29	1722.93							
30	1708.87							
31	1696.37							

32	1682.20							
33	1667.54							
34	1654.08							
35	1641.19							
36	1629.79							
37	1619.77							
38	1609.59							
39	1597.98							
40	1587.37							
41	1577.93							
42	1566.13							
43	1554.93							
44	1541.93							
45	1529.72							
46	1516.90							
47	1503.47							
48	1490.38							
49	1476.21							

Table B7: Measured ^{210}Pb, ^{137}Cs, and ^{226}Ra values (dpm/g) and CRS-based chronology for lake NW70. Grey cells represent extrapolated values and yellow cells represent interpolated values.

Sediment depth interval (cm)	CRS Chronology	CRS Error ± 2 sigma	210Pb dpm/g	210Pb error (1 std. dev.) dpm/g	137Cs dpm/g	137Cs error (1 std. dev.) dpm/g	226Ra dpm/g	226Ra error (1 std. dev.) dpm/g
4	2011.23	1.34	65.3982	5.8078	3.0689	0.5757	3.5879	0.7905
8	1999.31	2.36	61.0035	5.1079	4.1741	0.4703	3.2052	0.4371

10	1985.49	3.20	62.1998	5.9260	4.7367	0.6740	0.7113	0.5254
11	1971.80	4.27	56.4496	4.5714	5.1897	0.4297	3.3385	0.4030
12	1954.84	6.20	45.0005	4.0543	5.0266	0.4962	2.9666	0.4197
13	1941.37	8.89	14.3069	1.1872	2.5200	0.1338	2.8780	0.2387
14	1929.25	12.05	8.9935	0.9545	2.1835	0.1484	3.2581	0.2742
15	1916.96	15.68	7.8139	0.9311	3.3163	0.1889	4.7121	0.3824
16	1896.80	23.11	7.8879	0.8221	3.1980	0.1557	5.4026	0.4142
17	1869.12		5.6837	0.6252	2.9430	0.1300	5.4914	0.4118
18	1834.92		6.4537	0.7298	2.8452	0.1441	6.3978	0.4812
19	1794.77		6.3159	1.0045				
20	1758.95		6.1800	0.6902	2.6737	0.1328	6.8916	0.5128
21	1717.03		6.4556	0.6735	2.4674	0.1190	6.5386	0.4851
22	1672.23							
23	1600.65							
24	1522.11							
25	1422.24							
26	1297.10							
27	1161.36		7.1656	0.7664	1.1507	0.1016	7.3582	0.5473
28	1031.91							
29	901.16		7.1694	0.7202	0.5627	0.0782	7.6456	0.5622
30	683.93							
31	542.44							
32	359.70							
33	178.55							

34	4.08							
35	-169.97 BC							
36	-360.90 BC							
37	-560.29 BC							
38	-745.26 BC							
39	-916.42 BC							
40	-1208.55 BC							

Table B8: Measured ^{210}Pb, ^{137}Cs, and ^{226}Ra values (dpm/g) and CRS-based chronology for lake NW80. Grey cells represent extrapolated values and yellow cells represent interpolated values.

Sediment depth interval (cm)	CRS Chronology	CRS Error ± 2 sigma	210Pb dpm/g	210Pb error (1 std. dev.) dpm/g	137Cs dpm/g	137Cs error (1 std. dev.) dpm/g	226Ra dpm/g	226Ra error (1 std. dev.) dpm/g
0	2016.76	0.20	36.6193	1.9064	5.3239	0.3030	2.5773	0.3365
1	2014.43	0.35	34.2933	1.7916	4.9440	0.2836	2.3447	0.5821
2	2010.58	0.57	35.2894	1.6650	4.8695	0.2539	2.7815	0.3331
3	2006.73	0.76	32.8246	1.5609	5.2391	0.2525	2.7980	0.3010
4	2002.13	0.99	29.8860	1.5433	5.8240	0.2660	2.7621	0.3315
5	1997.33	1.24	27.3500	1.5082	5.6170	0.2641	2.4450	0.3567
6	1992.84	1.49	22.3472	1.2464	5.3456	0.2288	2.2606	0.2533
7	1988.36	1.76	18.9077	1.3420	4.4432	0.2462	2.3687	0.3097
8	1983.62	2.07	16.7548	1.0267	4.5974	0.1933	2.8067	0.3594
9	1979.16	2.40	13.4645	0.9268	3.6641	0.1747	2.7057	0.2721
10	1974.26	2.78	11.5860	0.8690	3.2854	0.1621	2.4404	0.3338
11	1969.25	3.18	9.8037	0.8300	2.6988	0.1526	2.5538	0.3890

12	1965.22	3.56	8.9351	0.7214	2.3275	0.1315	2.5080	0.4174
13	1959.31	4.12	8.6587	0.8561	1.9811	0.1539	2.2456	0.3041
14	1954.82	4.54	7.2217	0.8078	1.5550	0.1482	2.6377	0.3264
15	1949.14	5.13	7.0672	0.7972	1.1989	0.1395	2.2790	0.3838
16	1944.87	5.46	5.3397	0.7420	1.0479	0.1356	2.4186	0.3506
17	1940.02	5.76	5.4549	0.8476	1.0094	0.1482	2.2747	0.4001
18	1936.13	6.06	5.1208	0.7229	0.7621	0.1265	2.5792	0.3867
19	1928.72	5.94	5.0385	0.8129	0.7610	0.1492	2.0633	0.4619
20	1924.22	6.16	4.2440	0.5152	0.5421	0.0883	2.5151	0.2490
21	1919.21	6.34	4.1489	0.5545	0.5569	0.0957	2.3209	0.2463
22	1912.55	6.05	4.1970	0.5522	0.5050	0.0914	2.5249	0.1850
23	1907.30		3.1338	0.4553	0.4896	0.0792	2.5376	0.1950
24	1900.81		3.6111	0.4254	0.3679	0.0744	2.5551	0.2843
25	1896.19		4.1104	0.4582	0.4219	0.0773	2.6370	0.2181
26	1891.15		3.1768	0.4519	0.2680	0.0777	2.2007	0.1617
27	1885.95		3.2942	0.4541	0.2390	0.0793	2.7084	0.1792
28	1879.30		3.3654	0.6322				
29	1872.86		3.4377	0.4399	0.2833	0.0773	2.3651	0.2348
30	1866.81		3.2584	0.6114				
31	1861.06		3.0856	0.4247	0.1753	0.0731	2.6522	0.1895
32	1854.35		3.1086	0.3927	0.1456	0.0662	2.2161	0.1770
33	1847.80							
34	1840.61							
35	1833.51		3.0127	0.3492	0.0993	0.0576	3.0005	0.1744
36	1826.25							

37	1818.79							
38	1811.83							
39	1803.95							
40	1796.34							
41	1788.51							
42	1781.05							
43	1773.81							
44	1767.39							
45	1760.57							
46	1753.66							
47	1746.03							
48	1739.70							
49	1732.32							

Table B9: Measured ^{210}Pb, ^{137}Cs, and ^{226}Ra values (dpm/g) and CRS-based chronology for lake NE20. Grey cells represent extrapolated values and yellow cells represent interpolated values.

Sediment depth interval (cm)	CRS Chronology	CRS Error ± 2 sigma	210Pb dpm/g	210Pb error (1 std. dev.) dpm/g	137Cs dpm/g	137Cs error (1 std. dev.) dpm/g	226Ra dpm/g	226Ra error (1 std. dev.) dpm/g
0	2018.02	0.20	69.1450	4.1294	1.5917	0.5474	0.9413	0.3649
1	2012.75	0.44	94.2344	3.2619	2.3523	0.2582	2.8330	0.5613
2	2006.75	0.65	99.3981	3.3184	3.5204	0.2512	3.6018	0.5370
3	1999.11	0.92	85.2641	2.9401	3.3004	0.2439	3.0764	0.3290
4	1993.24	1.14	42.9836	1.6541	5.4646	0.2184	3.7699	0.2544
5	1984.68	1.49	31.4679	1.3964	7.8204	0.2497	3.7078	0.2498
6	1977.80	1.80	23.5569	1.2094	11.0946	0.2836	3.6564	0.2439

7	1967.68	2.39	20.5715	0.8550	5.1776	0.1400	3.5064	0.2029
8	1960.03	2.98	16.2517	0.7723	1.2240	0.0969	3.4909	0.2910
9	1949.00	3.98	13.9423	0.7368	0.7268	0.0931	3.5980	0.1908
10	1938.69	4.77	10.5998	0.8601	0.6708	0.1154	3.8757	0.2187
11	1927.16	6.35	9.5138	0.5784	0.6125	0.0824	3.8668	0.1844
12	1913.88	8.39	7.5663	0.5971	0.5797	0.0859	3.5843	0.1820
13	1899.10	7.42	5.9990	0.5711	0.4911	0.0840	4.0352	0.1850
14	1871.08		6.2532	0.6821				
15	1845.77		4.9379	0.5508	0.4764	0.0823	4.9470	0.1958
16	1823.53		5.3815	0.7532				
17	1804.29		5.8509	0.5138	0.3308	0.0783	5.6787	0.3552
18	1786.12		5.7309	0.7497				
19	1768.19		5.6125	0.5460	0.2179	0.0783	5.2351	0.1977
20	1751.97		5.2941	0.9263				
21	1728.82		4.9881	0.7483				
22	1707.50		4.6941	0.9065				
23	1684.92		4.4118	0.5117	0.0637	0.0772	4.3327	0.2251
24	1656.95							
25	1632.41							
26	1606.95							
27	1581.21							
28	1555.87							
29	1534.45							
30	1510.59							
31	1490.40							

32	1463.11							
33	1437.12							
34	1410.21							
35	1385.79							
36	1364.29							
37	1332.71							
38	1300.33							
39	1268.54							

Table B10: Measured ^{210}Pb, ^{137}Cs, and ^{226}Ra values (dpm/g) and CRS-based chronology for lake NE40. Grey cells represent extrapolated values and yellow cells represent interpolated values.

Sediment depth interval (cm)	CRS Chronology	CRS Error ± 2 sigma	210Pb dpm/g	210Pb error (1 std. dev.) dpm/g	137Cs dpm/g	137Cs error (1 std. dev.) dpm/g	226Ra dpm/g	226Ra error (1 std. dev.) dpm/g
0	2017.76	0.31	34.1614	3.2585	1.8916	0.3244	0.4435	0.1811
1	2016.06	0.41	36.9551	2.9587	3.0659	0.2319	0.1177	0.1195
2	2014.26	0.52	35.7514	3.0406	2.9881	0.2908		
3	2012.15	0.62	33.5611	2.6576	3.2225	0.2088		
4	2009.47	0.75	33.9966	2.7453	3.5919	0.2506	0.1020	0.1198
5	2006.53	0.88	35.7231	2.8570	3.4528	0.2495	0.2576	0.0929
6	2003.26	1.01	36.0016	2.7324	3.4363	0.1913	0.0037	0.0031
7	1999.07	1.18	36.7711	2.9093	3.4200	0.2398	0.5010	0.1396
8	1994.35	1.35	37.1708	2.8895	4.0328	0.2413	0.5979	0.2919
9	1990.20	1.51	31.5660	2.4506	3.8221	0.2059		
10	1985.23	1.69	25.6579	2.0454	4.2276	0.2045	0.3120	0.0784

11	1979.20	1.93	27.2218	2.1216	5.0519	0.2191		
12	1974.25	2.16	22.6657	1.8506	5.2161	0.2300	0.1566	0.0538
13	1969.17	2.42	17.5041	1.5306	5.8533	0.2455	0.1224	0.1044
14	1964.24	2.71	13.3109	1.2404	4.9122	0.2099	0.0743	0.1731
15	1957.92	3.13	12.0636	1.0982	3.5198	0.1546	0.7231	0.2034
16	1952.76	3.53	9.7643	1.0280	2.2990	0.1469	0.0301	0.0115
17	1947.69	4.01	8.7194	0.9469	1.5189	0.1242	0.6792	0.1444
18	1941.01	4.72	8.2546	0.9277	1.2482	0.1193		
19	1935.64	5.38	5.4817	0.7769	0.9818	0.1164	1.1817	0.1755
20	1929.15	5.96	5.0427	1.0279				
21	1922.03	7.10	4.6277	0.6731	0.7353	0.0940	0.2953	0.0750
22	1915.25	8.17	4.1470	0.8927				
23	1906.85	10.19	3.7008	0.5865	0.6645	0.0859	0.0340	0.0197
24	1899.21	12.10	2.9075	0.7436				
25	1891.40	14.97	2.2366	0.4572	0.5785	0.0796		
26	1882.99	18.20	1.8369	0.5913				
27	1875.34	22.59	1.4880	0.3750	0.4149	0.0791		
28	1868.94	26.57	1.0755	0.4444				
29	1864.85		0.7474	0.2384	0.3318	0.0710	0.0488	0.0332
30	1860.07							
31	1855.08							
32	1849.58							
33	1844.81							
34	1839.40							
35	1834.36							

36	1828.06							
37	1822.93							
38	1816.50							
39	1810.45							

Appendix C

Carbon and nitrogen elemental and isotopic analysis

Table C1: Carbon and nitrogen elemental and isotopic composition values for lake NW20.

Depth (cm)	%Carbon	%Nitrogen	$\delta^{13}C$ ‰	$\delta^{15}N$ ‰
0	37.13	3.29	-27.89	2.02
1	36.30	3.21	-27.96	1.50
2	36.69	3.20	-27.83	2.09
3	33.00	2.84	-27.68	1.64
4	35.55	3.00	-27.36	1.81
5	35.70	3.03	-27.44	1.84
6	28.85	2.43	-27.20	1.48
7	35.87	3.00	-27.32	1.94
8	35.93	2.98	-27.10	1.86
9	36.86	3.07	-26.90	1.30
9	36.59	3.05	-26.83	1.21
10	37.36	3.14	-26.91	1.51
11	34.08	2.83	-26.53	1.63
12	35.91	2.94	-26.28	0.92
13	36.48	3.01	-26.10	1.23
14	37.35	3.19	-25.97	0.83
15	36.08	3.05	-25.77	0.38
16	36.03	2.97	-26.17	1.10
17	35.72	2.98	-26.30	1.14
18	35.98	3.01	-26.56	0.80
19	34.86	2.97	-26.58	0.69
19	36.31	3.06	-26.66	1.20
20	32.06	2.59	-26.11	0.58
21	36.23	2.96	-26.60	1.45
22	35.42	2.91	-26.65	1.22
23	35.50	2.93	-26.58	0.50

24	30.40	2.48	-26.25	0.41
25	29.14	2.46	-26.08	0.73
26	21.68	1.87	-25.11	0.56
28	20.94	1.77	-22.90	0.19
29	33.27	2.83	-22.62	-0.14
29	24.56	2.09	-22.47	0.51

Table C2: Carbon and nitrogen elemental and isotopic composition values for lake NW20.

Depth (cm)	%Carbon	%Nitrogen	$\delta^{13}C$ ‰	$\delta^{15}N$ ‰
0	20.32	1.57	-27.11	4.86
1	28.17	2.39	-29.16	4.79
2	28.16	2.37	-28.92	5.32
3	27.74	2.29	-28.53	4.50
4	28.01	2.18	-28.19	5.42
5	26.52	2.02	-27.37	4.97
6	25.78	2.00	-27.94	5.38
7	26.44	2.03	-27.40	5.13
8	25.56	1.93	-27.27	4.80
9	27.08	2.04	-27.37	4.60
9	26.68	2.00	-27.10	5.09
10	22.15	1.66	-27.23	5.47
11	25.44	1.93	-26.86	4.70
12	20.51	1.54	-26.65	4.81
13	21.55	1.61	-26.52	4.74
14	20.44	1.52	-26.44	4.79
15	17.32	1.31	-26.58	4.58
16	23.27	1.70	-26.64	5.08
17	22.87	1.65	-26.76	4.57
18	14.54	1.06	-26.94	5.58
19	19.60	1.44	-26.99	5.08
19	13.35	0.99	-26.97	4.83

20	9.31	0.71	-27.24	5.07
21	13.43	1.02	-26.83	3.90
22	10.23	0.80	-26.63	5.07
23	13.16	1.03	-26.42	4.23
24	12.15	0.95	-26.71	5.03
25	10.09	0.79	-26.39	4.76
26	3.16	0.25	-26.18	4.86
27	3.13	0.25	-25.81	5.06
28	6.88	0.54	-24.29	4.66
29	13.26	0.99	-23.56	3.81
29	13.92	1.02	-23.43	3.57

Appendix D

Loss-on-ignition

Table D1: Measured loss-on-ignition values for sediment dry weight, water content, organic matter content, mineral matter content (including carbonates), mineral matter content (excluding carbonates), and carbonate content at lake NW10.

Depth (cm)	Dry Weight (g)	%H2O (g/g wet wt.)	%OM (% dry wt)	%MM+CaCO3 (%dry wt)	%MM (%dry wt)	%CaCO3 (% dry wt)
0	2.31	96.29	66.43	33.57	30.75	2.82
1	1.59	96.55	65.02	34.98	29.38	5.59
2	1.85	96.35	67.03	32.97	29.76	3.21
3	2.21	95.68	67.44	32.56	29.75	2.81
4	2.15	95.75	67.18	32.82	27.46	5.35
5	2.66	95.18	70.11	29.89	25.40	4.49
6	2.69	94.74	71.35	28.65	27.13	1.53
7	2.57	95.36	73.45	26.55	25.69	0.86
8	2.88	94.44	71.11	28.89	24.74	4.14
9	3.57	93.61	71.57	28.43	25.34	3.09
10	3.43	93.76	72.38	27.62	24.43	3.19
11	3.14	93.44	73.82	26.18	23.24	2.94
12	3.41	93.59	76.27	23.73	21.77	1.97
13	3.52	93.53	71.94	28.06	23.83	4.23
14	3.24	93.89	71.87	28.13	25.18	2.95
15	3.84	93.24	73.17	26.83	24.64	2.19
16	3.63	93.35	72.18	27.82	24.95	2.86
17	3.70	93.50	73.80	26.20	22.29	3.91
18	3.71	93.62	73.08	26.92	24.45	2.47
19	3.59	93.55	73.81	26.19	23.93	2.25
20	3.71	93.07	73.45	26.55	23.54	3.01

21	3.43	93.18	74.06	25.94	23.35	2.59
22	3.91	92.93	73.10	26.90	21.51	5.39
23	3.97	93.18	74.72	25.28	20.65	4.63
24	1.22	94.22	73.31	26.69	24.39	2.30

Table D2: Measured loss-on-ignition values for sediment dry weight, water content, organic matter content, mineral matter content (including carbonates), mineral matter content (excluding carbonates), and carbonate content at lake NW20.

Depth (cm)	Dry Weight (g)	%H2O (g/g wet wt.)	%OM (% dry wt)	%MM+CaCO3 (%dry wt)	%MM (%dry wt)	%CaCO3 (% dry wt)
0	1.54	97.31	70.15	29.85	27.84	2.00
1	1.12	97.69	71.82	28.18	27.42	0.76
2	1.34	97.36	68.57	31.43	25.23	6.21
3	1.12	97.67	67.38	32.62	26.18	6.44
4	1.67	97.21	68.33	31.67	29.33	2.34
5	1.35	97.14	68.29	31.71	28.76	2.96
6	1.91	96.62	67.86	32.14	28.12	4.02
7	2.03	96.43	66.83	33.17	27.14	6.03
8	2.02	96.02	68.14	31.86	27.13	4.73
9	2.06	96.72	65.89	34.11	30.01	4.10
10	1.47	96.59	69.24	30.76	24.37	6.39
11	2.25	96.02	67.59	32.41	26.93	5.47
12	2.69	95.87	67.04	32.96	29.30	3.65
13	2.05	95.85	67.79	32.21	29.92	2.29
14	1.84	96.29	70.09	29.91	28.38	1.53
15	2.02	96.22	67.10	32.90	27.95	4.94
16	2.43	96.05	65.65	34.35	27.50	6.86
17	2.03	96.17	67.10	32.90	26.86	6.04
18	2.65	95.57	66.57	33.43	29.79	3.64
19	1.18	97.51	67.51	32.49	29.58	2.91

20	5.19	91.37	65.72	34.28	30.78	3.50
21	3.23	94.79	67.91	32.09	28.28	3.81
22	2.54	95.17	64.55	35.45	31.91	3.54
23	1.92	96.94				
24	2.87	95.24	62.89	37.11	33.83	3.29
25	2.97	94.06	46.13	53.87	51.29	2.58
26	4.61	91.50	36.23	63.77	60.13	3.64
27	4.54	91.34	32.03	67.97	65.41	2.56
28	4.33	92.44	33.85	66.15	62.85	3.29
29	3.24	94.40	50.27	49.73	48.03	1.70

Table D3: Measured loss-on-ignition values for sediment dry weight, water content, organic matter content, mineral matter content (including carbonates), mineral matter content (excluding carbonates), and carbonate content at lake NW30.

Depth (cm)	Dry weight (g)	%H2O (g/g wet wt.)	%OM (% dry wt)	%MM+CaCO3 (%dry wt)	%MM (%dry wt)	%CaCO3 (% dry wt)
0	0.99	98.09	74.83	25.17	22.97	2.19
1	1.79	97.06	74.32	25.68	23.38	2.29
2	1.69	96.68	74.50	25.50	23.15	2.35
3	1.99	96.51	74.57	25.43	24.32	1.12
4	1.76	96.32	75.41	24.59	24.70	-0.11
5	2.16	96.15	73.52	26.48	22.66	3.82
6	2.49	95.96	76.60	23.40	22.44	0.96
7	2.59	95.52	77.12	22.88	21.18	1.71
8	2.98	95.04	68.16	31.84	27.42	4.42
9	2.37	95.45	75.71	24.29	20.62	3.67
10	2.31	96.02	75.82	24.18	23.24	0.94
11	2.73	95.78	74.98	25.02	23.75	1.28
12	2.98	95.87	74.02	25.98	24.06	1.92
13	1.73	95.90	75.21	24.79	22.31	2.48

14	3.18	95.21	71.94	28.06	24.72	3.35
15	2.56	95.38	72.69	27.31	25.04	2.26
16	2.71	95.26	72.21	27.79	24.62	3.17
17	2.42	95.63	70.53	29.47	26.67	2.79
18	3.03	95.47	70.16	29.84	28.07	1.77
19	2.77	95.33	72.07	27.93	26.17	1.76
20	3.10	94.79	75.33	24.67	22.22	2.45
21	2.19	95.46	75.00	25.00	22.40	2.59
22	1.54	95.25	74.86	25.14	23.42	1.72
23	2.85	94.94	77.53	22.47	20.80	1.67
24	2.70	94.93	76.26	23.74	22.69	1.05
25	3.05	95.24	76.19	23.81	22.96	0.86
26	2.77	95.23	75.17	24.83	23.16	1.68
27	2.92	95.31	74.07	25.93	23.57	2.36
28	3.72	93.82	73.20	26.80	21.41	5.39
29	2.70	94.93	74.77	25.23	22.89	2.33

Table D4: Measured loss-on-ignition values for sediment dry weight, water content, organic matter content, mineral matter content (including carbonates), mineral matter content (excluding carbonates), and carbonate content at lake NW40.

Depth (cm)	Dry weight (g)	%H2O (g/g wet wt.)	%OM (% dry wt)	%MM+CaCO3 (%dry wt)	%MM (%dry wt)	%CaCO3 (% dry wt)
0	2.44	96.05	53.06	46.94	45.95	0.99
1	2.92	95.02	52.51	47.49	46.66	0.82
2	3.96	92.96	41.64	58.36	56.28	2.08
3	3.88	94.43	45.13	54.87	53.95	0.91
4	3.46	93.23	40.27	59.73	57.42	2.31
5	3.71	93.46	41.86	58.14	55.01	3.13
6	4.69	92.39	41.27	58.73	56.66	2.07
7	4.58	92.80	42.26	57.74	55.98	1.75
8	4.97	91.91	34.89	65.11	60.46	4.65
9	4.23	92.74	40.44	59.56	57.43	2.13

10	5.00	92.38	40.83	59.17	59.14	0.03
11	5.26	90.59	35.99	64.01	62.67	1.35
12	9.33	89.45	35.64	64.36	63.40	0.95
13	6.05	89.48	31.12	68.88	64.40	4.47
14	7.09	88.53	29.34	70.66	68.81	1.84
15	8.73	86.77	29.36	70.64	68.77	1.87
16	9.43	86.75	28.36	71.64	70.06	1.58
17	7.42	86.16	27.28	72.72	71.49	1.22
18	8.80	84.37	26.08	73.92	72.46	1.46
19	12.21	82.77	24.99	75.01	73.39	1.63
20	8.32	85.76	24.70	75.30	73.36	1.95
21	9.76	82.93	23.04	76.96	75.59	1.37
22	8.46	86.03	27.42	72.58	70.31	2.27
23	9.09	85.76	25.93	74.07	71.69	2.39
24	10.12	82.57	22.98	77.02	75.44	1.58
25	12.95	81.76	15.30	84.70	83.21	1.49
26	15.24	77.55	16.76	83.24	82.10	1.14
27	15.03	78.59	17.07	82.93	82.37	0.56
28	14.96	77.33	16.53	83.47	82.34	1.13
29	15.00	77.66	16.79	83.21	81.09	2.11

Table D5: Measured loss-on-ignition values for sediment dry weight, water content, organic matter content, mineral matter content (including carbonates), mineral matter content (excluding carbonates), and carbonate content at lake NW50.

Depth (cm)	Dry weight (g)	%H2O (g/g wet wt.)	%OM (% dry wt)	%MM+CaCO3 (%dry wt)	%MM (%dry wt)	%CaCO3 (% dry wt)
0	2.62	93.75	30.23	69.77	63.28	6.49
1	6.64	88.58	25.26	74.74	70.60	4.13
2	8.97	86.46	26.10	73.90	69.70	4.20
3	7.49	88.33	26.27	73.73	69.56	4.17
4	7.66	88.23	23.99	76.01	70.42	5.60
5	7.20	88.84	23.89	76.11	69.58	6.53

6	6.95	89.43	26.00	74.00	69.32	4.68
7	6.55	89.97	24.69	75.31	68.48	6.84
8	6.70	89.55	25.47	74.53	70.87	3.66
9	7.12	89.01	24.43	75.57	70.63	4.94
10	7.42	88.58	23.60	76.40	71.52	4.88
11	6.79	89.30	23.84	76.16	73.43	2.73
12	7.12	89.10	22.88	77.12	72.28	4.84
13	9.16	86.88	22.13	77.87	72.95	4.93
14	7.56	87.78	22.09	77.91	74.66	3.25
15	8.27	87.97	21.48	78.52	74.63	3.88
16	7.89	86.64	19.80	80.20	76.33	3.87
17	9.16	86.52	20.12	79.88	76.26	3.62
18	10.86	81.55	14.96	85.04	81.77	3.27
19	11.47	87.22	21.24	78.76	74.44	4.32
20	7.05	87.78	20.03	79.97	75.81	4.16
21	9.46	86.46	19.72	80.28	74.68	5.60
22	10.44	86.27	20.52	79.48	74.13	5.35
23	8.09	86.65	20.34	79.66	74.75	4.91
24	9.59	85.06	20.08	79.92	73.82	6.09
25	9.35	86.55	19.85	80.15	75.21	4.94
26	9.57	85.89	20.74	79.26	75.08	4.18
27	9.26	85.64	20.90	79.10	74.29	4.81
28	9.70	87.57	21.79	78.21	72.59	5.62
29	6.60	88.96	17.86	82.14	79.87	2.28

Table D6: Measured loss-on-ignition values for sediment dry weight, water content, organic matter content, mineral matter content (including carbonates), mineral matter content (excluding carbonates), and carbonate content at lake NW60.

Depth (cm)	Dry weight (g)	%H2O (g/g wet wt.)	%OM (% dry wt)	%MM+CaCO3 (%dry wt)	%MM (%dry wt)	%CaCO3 (% dry wt)
0	2.37	96.36	68.08	31.92	30.31	1.61
1	2.00	97.19	64.97	35.03	31.00	4.04

2	1.85	96.87	63.17	36.83	32.35	4.48
3	1.72	96.79	61.78	38.22	35.09	3.13
4	1.90	96.75	59.76	40.24	36.32	3.92
5	1.99	96.45	58.58	41.42	38.75	2.67
6	1.46	96.49	58.18	41.82	37.57	4.25
7	3.21	95.30	55.00	45.00	42.50	2.50
8	2.44	96.14	55.49	44.51	42.18	2.33
9	2.75	95.28	54.42	45.58	42.45	3.13
10	2.82	95.53	51.56	48.44	43.53	4.90
11	2.25	95.94	53.10	46.90	43.69	3.21
12	2.73	95.68	51.39	48.61	41.16	7.45
13	2.85	94.98	51.67	48.33	41.37	6.96
14	3.14	95.28	49.28	50.72	45.86	4.86
15	2.61	95.17	48.67	51.33	45.07	6.26
16	2.98	95.17	52.55	47.45	43.97	3.48
17	3.57	94.35	52.05	47.95	46.00	1.96
18	3.47	94.21	48.81	51.19	46.87	4.33
19	3.31	94.33	49.24	50.76	47.62	3.14
20	3.11	94.52	47.75	52.25	45.94	6.31
21	4.15	93.40	48.80	51.20	47.39	3.80
22	4.00	93.57	46.01	53.99	48.64	5.34
23	4.61	93.07	47.65	52.35	48.67	3.68
24	3.67	93.50	47.14	52.86	47.37	5.49
25	4.59	93.01	47.27	52.73	48.37	4.36
26	5.37	92.39	48.42	51.58	46.39	5.18
27	4.00	92.06	48.96	51.04	47.54	3.50
28	4.48	92.25	49.54	50.46	45.51	4.94
29	4.34	92.81	50.58	49.42	45.85	3.57

Table D7: Measured loss-on-ignition values for sediment dry weight, water content, organic matter content, mineral matter content (including carbonates), mineral matter content (excluding carbonates), and carbonate content at lake NW70.

Depth (cm)	Dry weight (g)	%H2O (g/g wet wt.)	%OM (% dry wt)	%MM+CaCO3 (%dry wt)	%MM (%dry wt)	%CaCO3 (% dry wt)
0	0.52	99.47	84.81	15.19	12.48	2.70
1	0.50	99.17	86.27	13.73	11.81	1.92
2	0.56	99.06	85.53	14.47	11.71	2.76
3	0.60	99.05	84.75	15.25	12.75	2.50
4	0.59	98.99	84.07	15.93	12.93	3.00
5	0.62	98.88	83.00	17.00	14.09	2.91
6	0.61	98.76	79.95	20.05	16.75	3.31
7	0.99	98.49	75.82	24.18	20.51	3.67
8	1.05	98.32	70.18	29.82	26.74	3.08
9	1.09	98.00	66.23	33.77	30.06	3.71
10	1.52	97.59	58.49	41.51	37.98	3.53
11	1.54	97.07	47.66	52.34	48.67	3.66
12	2.76	95.46	36.53	63.47	60.21	3.26
13	3.50	94.32	30.16	69.84	65.27	4.57
14	3.88	93.69	30.42	69.58	66.48	3.10
15	4.83	92.29	29.55	70.45	67.13	3.32
16	4.83	91.60	28.78	71.22	67.86	3.36
17	5.91	90.54	26.46	73.54	68.79	4.74
18	6.85	90.54	25.28	74.72	71.04	3.68
19	6.19	89.98	24.67	75.33	71.94	3.39
20	7.25	88.83	22.55	77.45	74.19	3.26
21	7.73	87.84	18.79	81.21	77.86	3.35
22	12.13	83.06	14.84	85.16	81.86	3.30
23	13.50	80.63	11.74	88.26	85.14	3.12
24	17.13	76.59	9.90	90.10	86.72	3.38
25	21.28	70.99	7.33	92.67	89.84	2.84

26	23.23	67.86	6.81	93.19	90.68	2.50
27	22.12	68.80	6.29	93.71	90.65	3.06
28	22.40	67.79	5.42	94.58	91.74	2.84
29	36.58	66.06	4.24	95.76	93.16	2.59

Table D8: Measured loss-on-ignition values for sediment dry weight, water content, organic matter content, mineral matter content (including carbonates), mineral matter content (excluding carbonates), and carbonate content at lake NW80.

Depth (cm)	Dry weight (g)	%H2O (g/g wet wt.)	%OM (% dry wt)	%MM+CaCO3 (%dry wt)	%MM (%dry wt)	%CaCO3 (% dry wt)
0	1.39	97.70	58.46	41.54	35.46	6.08
1	1.78	96.46	58.64	41.36	36.41	4.95
2	2.36	95.56	58.04	41.96	35.12	6.84
3	2.75	95.40	58.95	41.05	36.32	4.73
4	2.98	95.16	60.71	39.29	34.41	4.88
5	3.25	94.71	54.25	45.75	39.08	6.67
6	2.69	95.35	56.95	43.05	39.89	3.15
7	3.19	94.77	54.89	45.11	39.57	5.54
8	3.85	93.70	55.56	44.44	39.15	5.29
9	3.48	94.02	53.75	46.25	39.88	6.38
10	3.54	93.81	54.33	45.67	39.56	6.12
11	4.09	93.05	52.64	47.36	42.56	4.80
12	3.91	93.96	51.73	48.27	37.62	10.65
13	4.19	93.30	51.37	48.63	43.38	5.25
14	4.03	93.40	51.68	48.32	42.13	6.19
15	4.03	93.22	52.94	47.06	41.54	5.52
16	3.30	93.94	54.11	45.89	42.02	3.87
17	3.88	93.31	55.61	44.39	39.93	4.46
18	3.46	94.11	53.68	46.32	41.48	4.84
19	4.02	92.95	54.06	45.94	41.31	4.63
20	4.20	93.63	53.90	46.10	40.62	5.48
21	4.11	93.84	55.10	44.90	38.80	6.10

22	4.48	93.02	54.27	45.73	39.16	6.56
23	3.92	93.25	53.40	46.60	41.31	5.30
24	4.77	91.80	55.68	44.32	39.99	4.33
25	3.58	94.37	56.07	43.93	38.44	5.48
26	4.51	93.22	53.99	46.01	38.84	7.17
27	4.40	93.36	55.10	44.90	40.12	4.78
28	4.58	92.42	55.40	44.60	39.71	4.89
29	4.83	92.18	55.52	44.48	39.17	5.31

Table D9: Measured loss-on-ignition values for sediment dry weight, water content, organic matter content, mineral matter content (including carbonates), mineral matter content (excluding carbonates), and carbonate content at lake NE20.

Depth (cm)	Dry weight (g)	%H2O (g/g wet wt.)	%OM (% dry wt)	%MM+CaCO3 (%dry wt)	%MM (%dry wt)	%CaCO3 (% dry wt)
0	1.18	98.91	51.85	48.15	48.15	0.00
1	1.05	98.19	50.00	50.00	48.49	1.51
2	1.20	97.73	49.56	50.44	49.24	1.20
3	1.11	97.82	49.09	50.91	49.67	1.24
4	1.45	97.49	36.00	64.00	57.47	6.53
5	2.38	95.66	36.87	63.13	58.75	4.39
6	2.48	95.40	37.66	62.34	54.10	8.24
7	2.77	95.17	38.68	61.32	56.28	5.04
8	2.62	95.28	36.17	63.83	58.04	5.79
9	2.82	95.17	35.80	64.20	59.16	5.04
10	2.97	94.65	35.96	64.04	60.99	3.06
11	3.36	94.11	34.24	65.76	61.61	4.15
12	3.06	94.59	31.87	68.13	62.15	5.98
13	4.47	92.27	25.84	74.16	68.89	5.27
14	6.56	88.92	20.91	79.09	75.88	3.21
15	5.93	90.30	23.72	76.28	72.66	3.62
16	5.21	90.95	27.94	72.06	67.84	4.22
17	4.51	92.28	30.75	69.25	65.03	4.22
18	4.26	92.92	31.73	68.27	62.11	6.16

19	4.20	92.35	32.46	67.54	63.62	3.92
20	3.80	93.15	32.56	67.44	63.49	3.95
21	5.42	91.20	28.47	71.53	68.12	3.41
22	5.00	91.34	27.78	72.22	69.39	2.83
23	5.29	91.08	26.67	73.33	70.01	3.32
24	6.55	88.95	24.86	75.14	70.97	4.17
25	5.75	89.46	26.57	73.43	70.60	2.84
26	5.96	90.01	24.25	75.75	73.04	2.70
27	6.03	90.04	25.86	74.14	70.84	3.30
28	5.93	89.92	26.43	73.57	69.81	3.76
29	5.02	91.61	28.20	71.80	68.26	3.55

Table D10: Measured loss-on-ignition values for sediment dry weight, water content, organic matter content, mineral matter content (including carbonates), mineral matter content (excluding carbonates), and carbonate content at lake NE40.

Depth (cm)	Dry weight (g)	%H2O (g/g wet wt.)	%OM (% dry wt)	%MM+CaCO3 (%dry wt)	%MM (%dry wt)	%CaCO3 (% dry wt)
0	1.03	98.69	83.33	16.67	12.55	4.12
1	1.53	97.35	82.58	17.42	12.27	5.15
2	1.40	97.41	84.47	15.53	10.25	5.28
3	1.71	96.87	82.05	17.95	14.46	3.49
4	1.64	97.01	82.67	17.33	13.71	3.63
5	1.90	96.69	81.82	18.18	15.71	2.47
6	1.83	96.79	82.61	17.39	10.63	6.76
7	2.03	96.47	82.39	17.61	12.20	5.41
8	1.82	96.72	83.64	16.36	13.89	2.47
9	2.08	96.38	82.87	17.13	14.87	2.25
10	1.82	96.84	83.65	16.35	15.50	0.86
11	2.17	96.22	84.13	15.87	15.15	0.72
12	2.15	96.26	82.89	17.11	15.66	1.45
13	2.00	96.52	82.08	17.92	13.99	3.93
14	2.12	96.38	83.43	16.57	12.07	4.51
15	2.13	95.92	82.76	17.24	15.90	1.34

16	2.46	95.67	82.57	17.43	8.70	8.73
17	2.63	96.02	83.84	16.16	14.79	1.37
18	3.00	95.34	83.19	16.81	15.64	1.17
19	1.88	96.68	80.61	19.39	13.62	5.77
20	2.61	96.21	81.05	18.95	16.80	2.15
21	2.23	96.07	80.20	19.80	17.04	2.76
22	2.83	95.49	82.22	17.78	11.73	6.04
23	2.52	96.23	81.48	18.52	11.32	7.20
24	2.34	95.74	82.16	17.84	16.56	1.28
25	2.63	96.11	84.10	15.90	9.62	6.28
26	2.18	96.60	81.29	18.71	13.15	5.57
27	2.73	95.82	82.21	17.79	16.48	1.31
28	2.64	95.53	78.22	21.78	20.57	1.21
29	2.94	95.63	79.26	20.74	18.86	1.88

Appendix E

Exploration of the use of generalized additive models (GAMs) to establish sediment background concentrations

In an attempt to strengthen our determination of the near-constant metals concentration portion of the stratigraphic records, a generalized additive model (GAM) was run in R (version 4.0.0; R Core Team 2020) using the package mgcv (version 1.8-31; Wood 2017). GAMs are an alternate approach to standardizing temporal data and have been particularly recognized for their benefits in paleolimnology (Simpson 2018). In the section below, the first derivative from the estimated trend was used to identify periods of significant change in metal profiles and supplement our visual assessment of the data. In particular, first derivatives were used to identify where the initial departure from the average trend of the data occurred (i.e., departure from background). Visually-determined arsenic baselines for NW and NE lakes were on average within ±27 years of the GAM-identified baselines. The largest difference in visual vs. GAM-identified arsenic baselines (±68 years) was at lake NW60 (Visual: 1852 vs. GAM-identified: 1920). The GAM was not able to determine a departure from background for the lake NW70 arsenic dataset. Visually-determined antimony baselines for NW and NE lakes were on average within ±42 years of the GAM-identified baseline (n=20). Differences in the two approaches were more pronounced for antimony overall. Generalized additive models were explored in this study with the aim of identifying statistically-significant periods of change which would in turn identify the beginning and end of the pre-industrial or undisturbed period. In most cases, the GAMs identified that our visual determination of the pre-industrial period was comparable and, in some instances, considered more appropriate than the GAM approach. Thus, our study proceeded with the use of visually-determined backgrounds rather than GAM-identified backgrounds. The efforts of this exploration are shown below. Notably, very similar arsenic and antimony total excess inventories were generated using both approaches for defining background concentrations (Table E1).

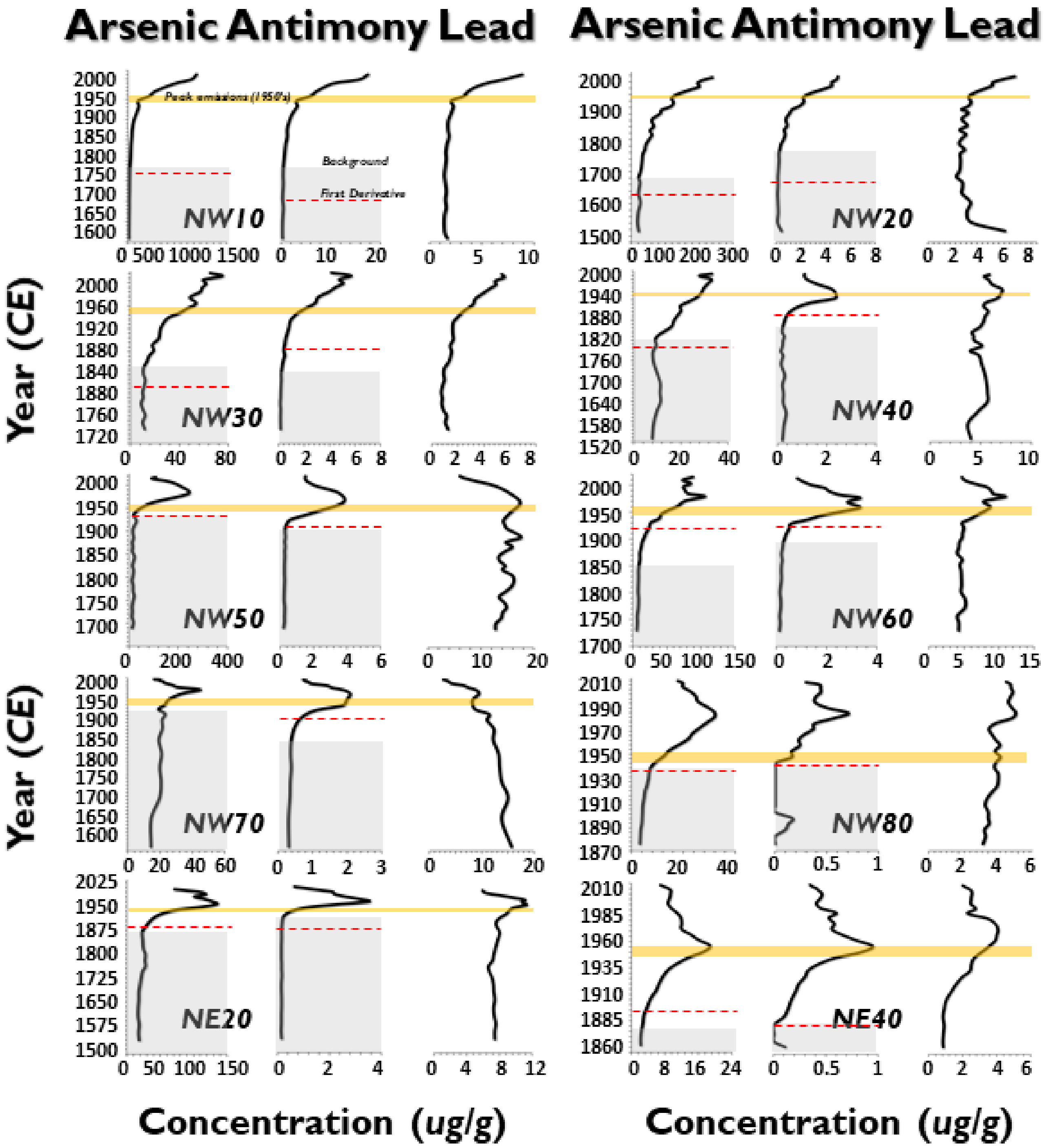

Figure E1: Stratigraphic profiles of arsenic, antimony, and lead for lakes across the northwest and northeast transects. Results are presented to 1500 CE where available. The period of peak emissions is highlighted in yellow (i.e, 1950s) while the grey shaded areas represent the period identified as 'pre-industrial' or background. A red dashed line shows the first derivative of the data set as identified by generalized additive modelling in R.

Table E1: Arsenic and antimony total excess inventories shown by varying baseline approach. GAM-based inventories refer to inventories calculated using the first-derivative defined baselines whereas original inventories are those previously described in Figure E1.

Lake	Arsenic GAM-based Inventory (mg/m^2)	Arsenic Original Inventory (mg/m^2)	Difference (±mg/m^2)	Antimony GAM-based Inventory (mg/m^2)	Antimony Original Inventory (mg/m^2)	Difference (mg/m^2)
NW10	4872	4826	45.93	83	82	1.33
NW20	7194	6929	265.26	19	19	0.28
NW30	441	434	6.93	29	30	1.55
NW40	116	117	0.75	7	7	0.19
NW50	995	995	0.00	15	18	3.28
NW60	211	234	23.68	7	7	0.22
NW70	N/A	17	N/A	3	4	0.45
NW80	123	120	2.83	2	2	0.00
NE20	309	318	8.87	7	7	0.07
NE40	44	46	1.70	2	3	0.06

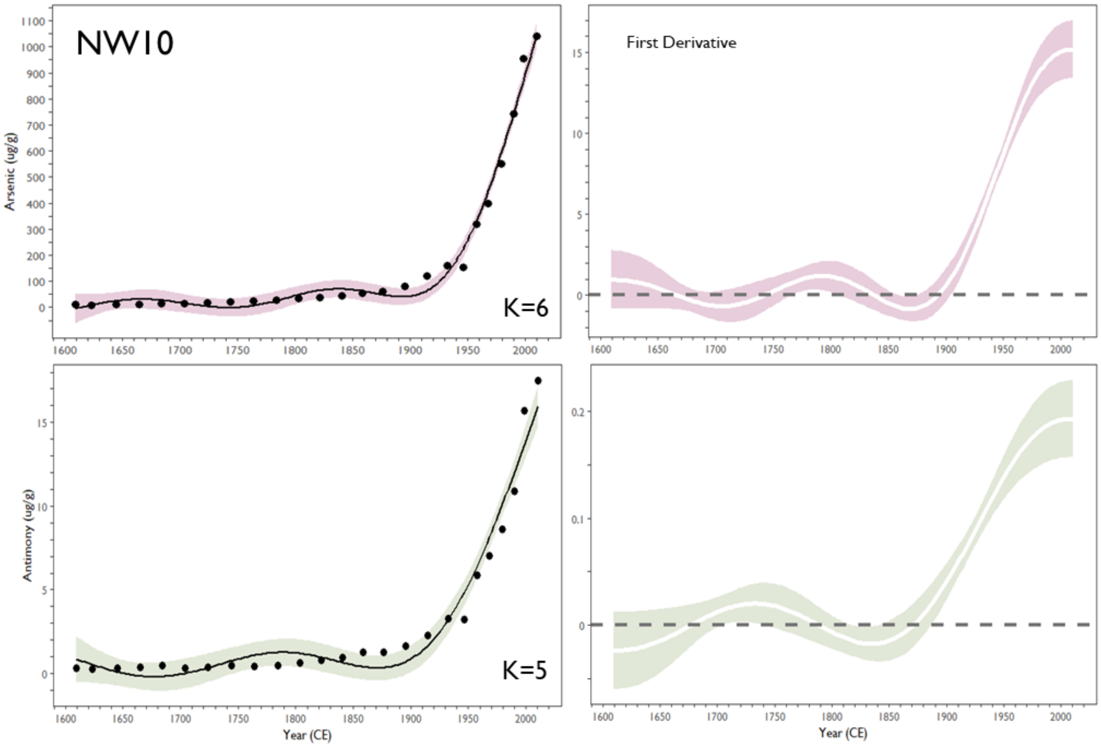

Figure E2: Outputs of generalized additive model and first derivative plots for lake NW10 for arsenic (top) and antimony (bottom).

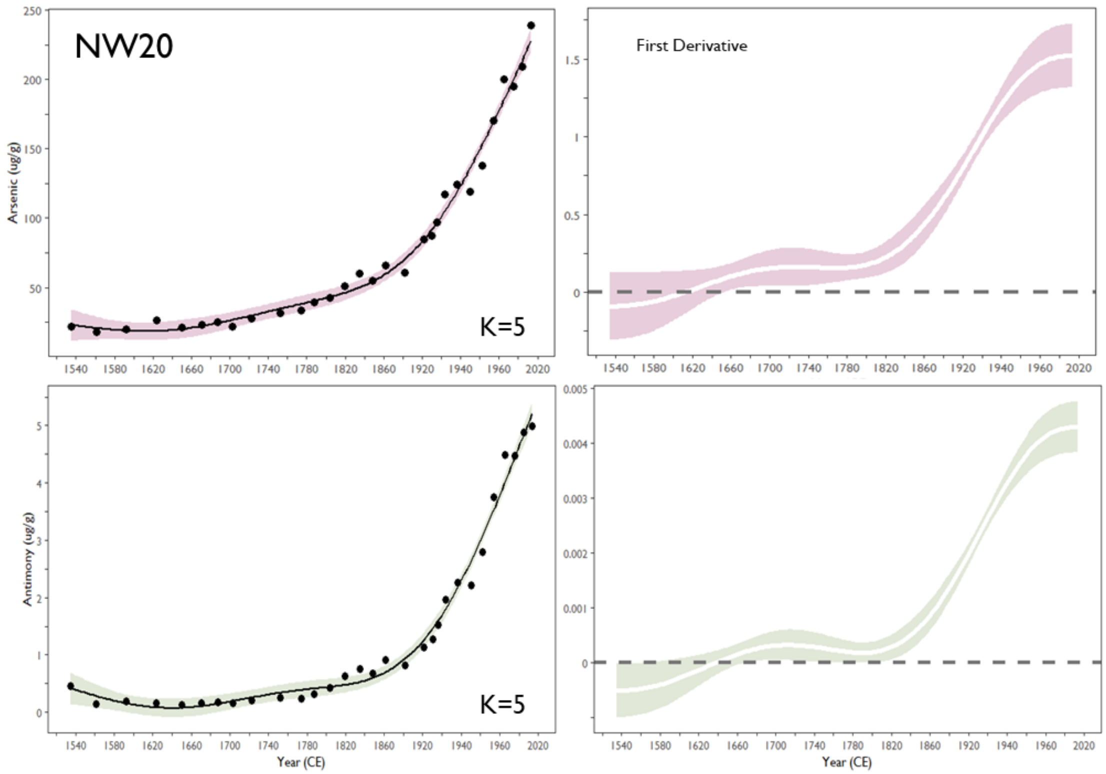

Figure E3: Outputs of generalized additive model and first derivative plots for lake NW20 for arsenic (top) and antimony (bottom).

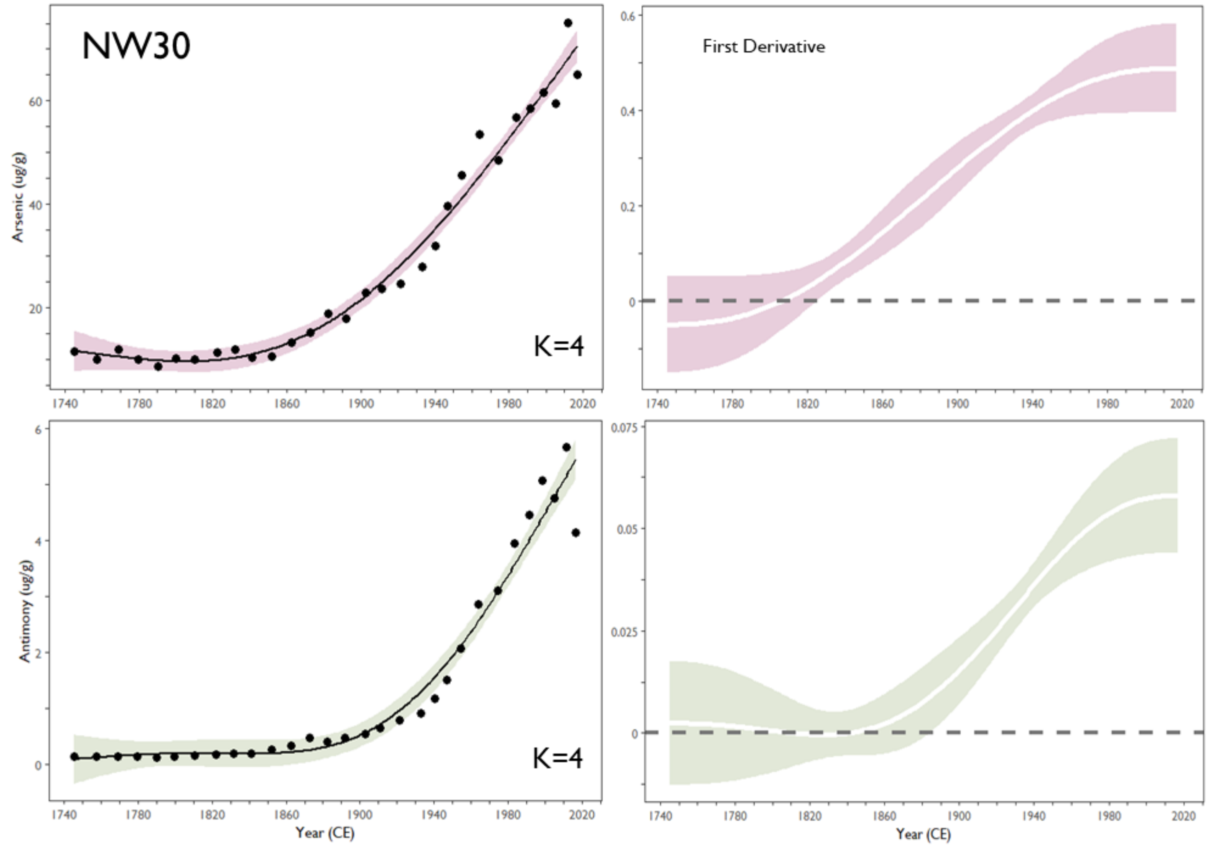

Figure E4: Outputs of generalized additive model and first derivative plots for lake NW30 for arsenic (top) and antimony (bottom).

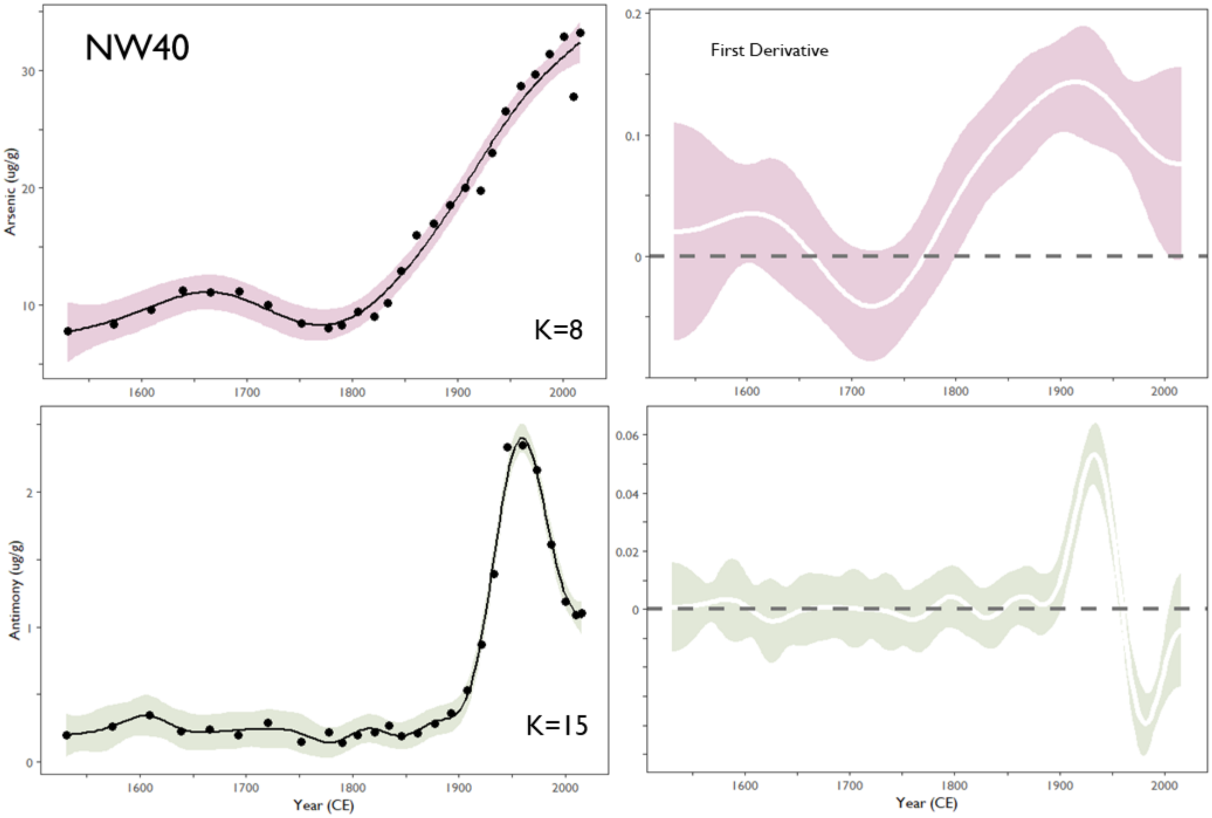

Figure E5: Outputs of generalized additive model and first derivative plots for lake NW40 for arsenic (top) and antimony (bottom).

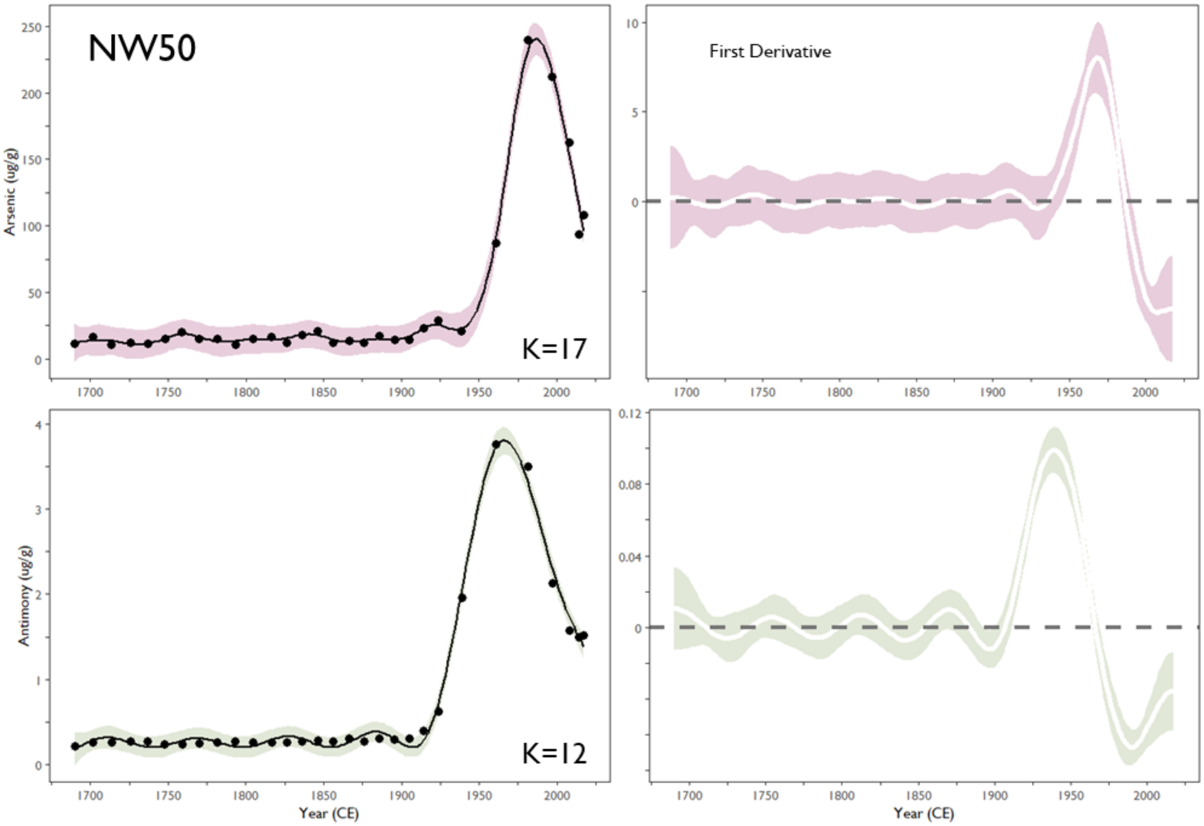

Figure E6: Outputs of generalized additive model and first derivative plots for lake NW50 for arsenic (top) and antimony (bottom).

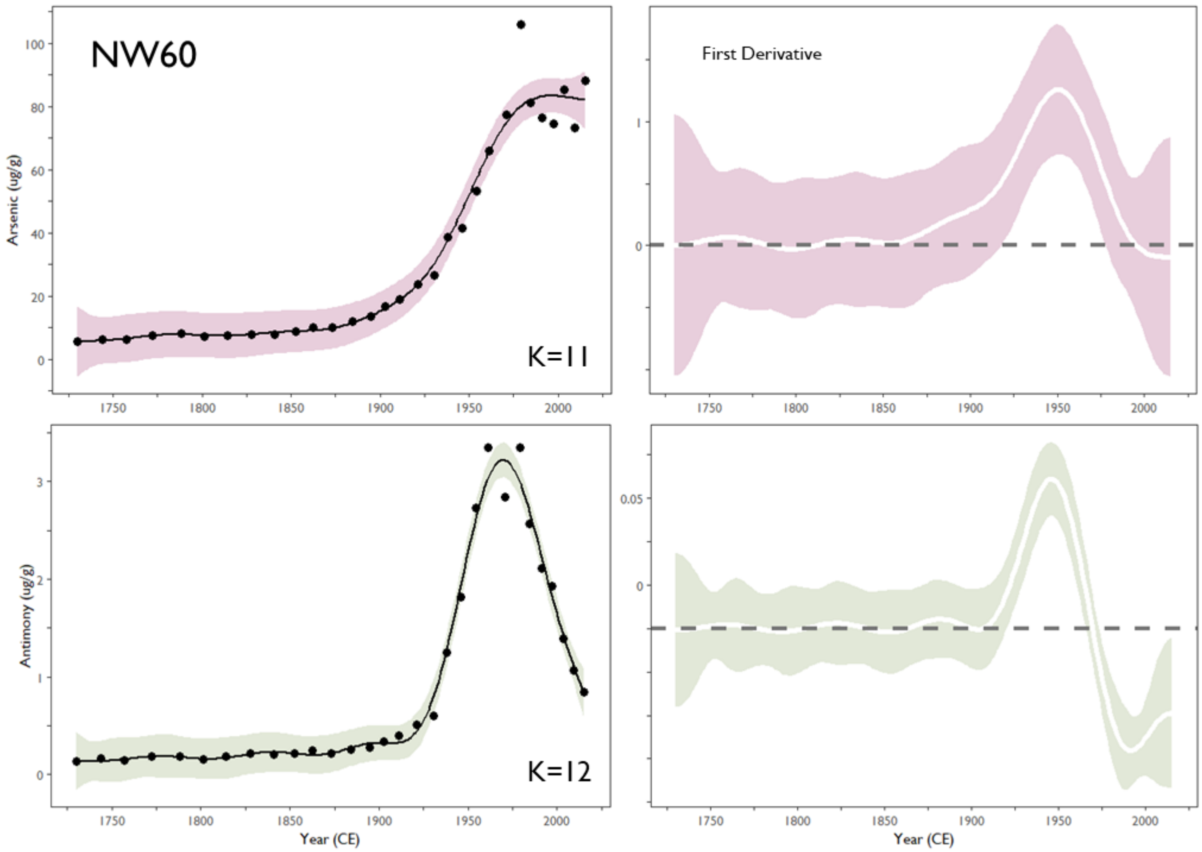

Figure E7: Outputs of generalized additive model and first derivative plots for lake NW60 for arsenic (top) and antimony (bottom).

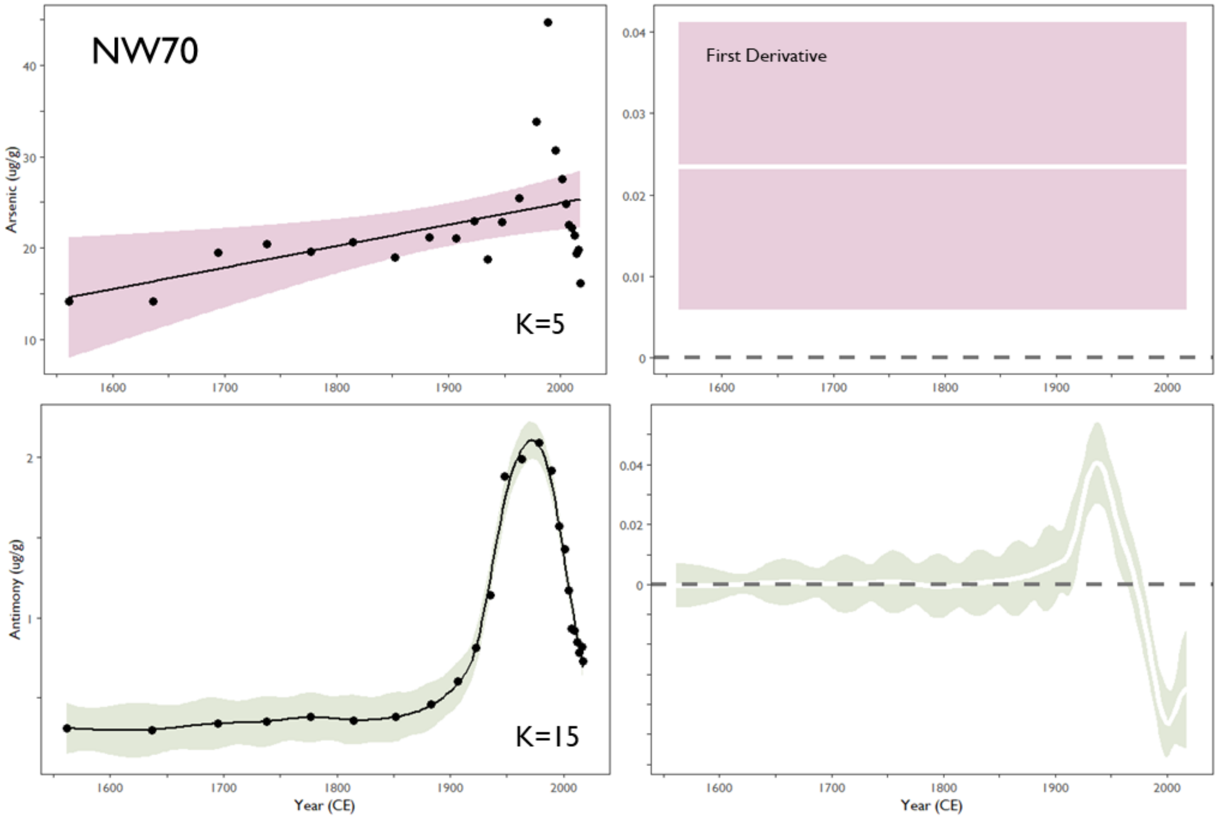

Figure E8: Outputs of generalized additive model and first derivative plots for lake NW70 for arsenic (top) and antimony (bottom).

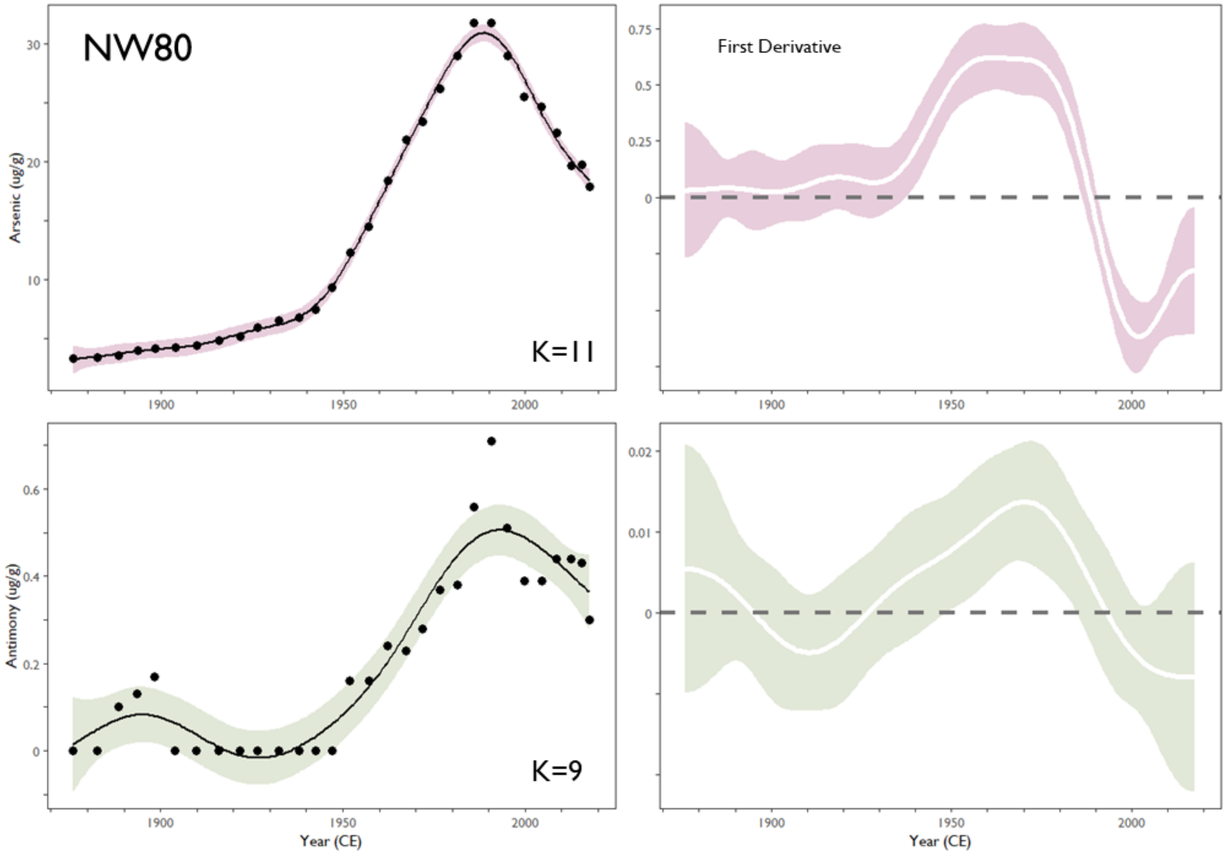

Figure E9: Outputs of generalized additive model and first derivative plots for lake NW80 for arsenic (top) and antimony (bottom).

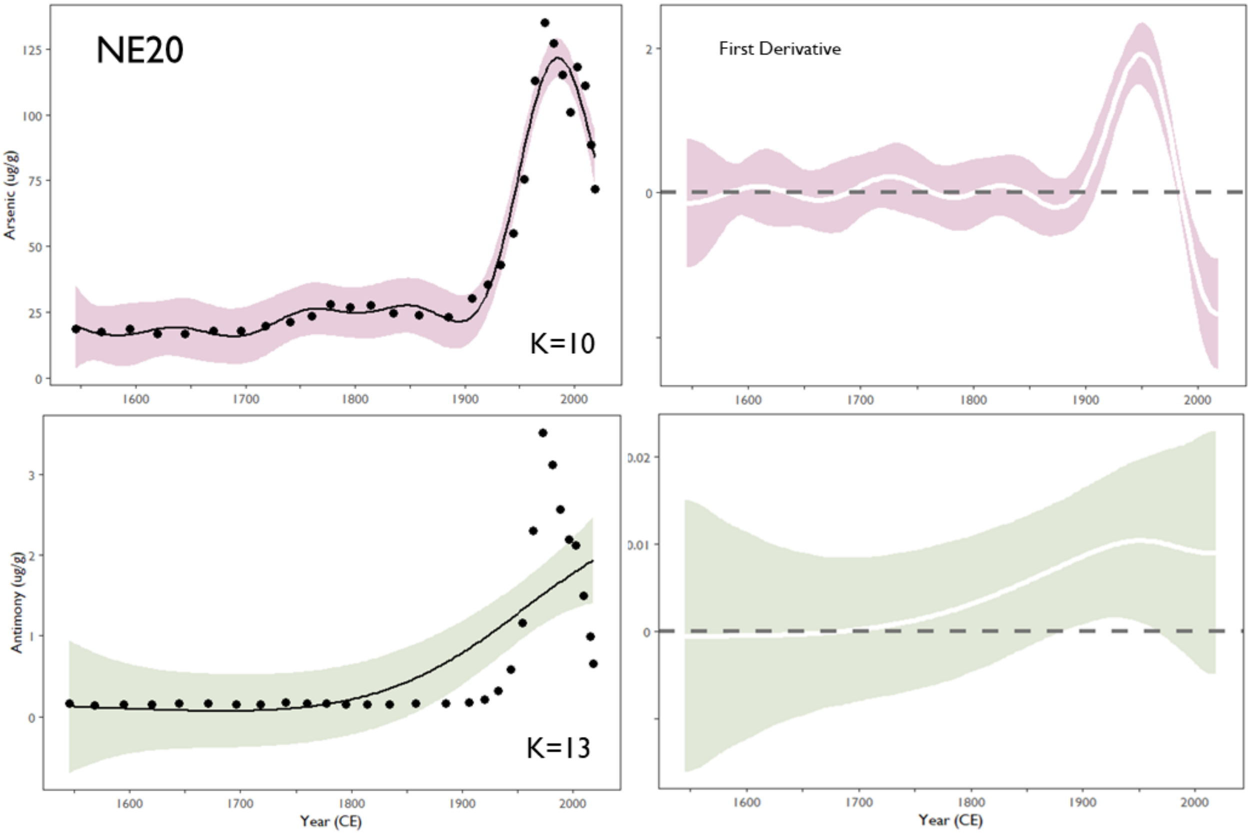

Figure E10: Outputs of generalized additive model and first derivative plots for lake NE20 for arsenic (top) and antimony (bottom).

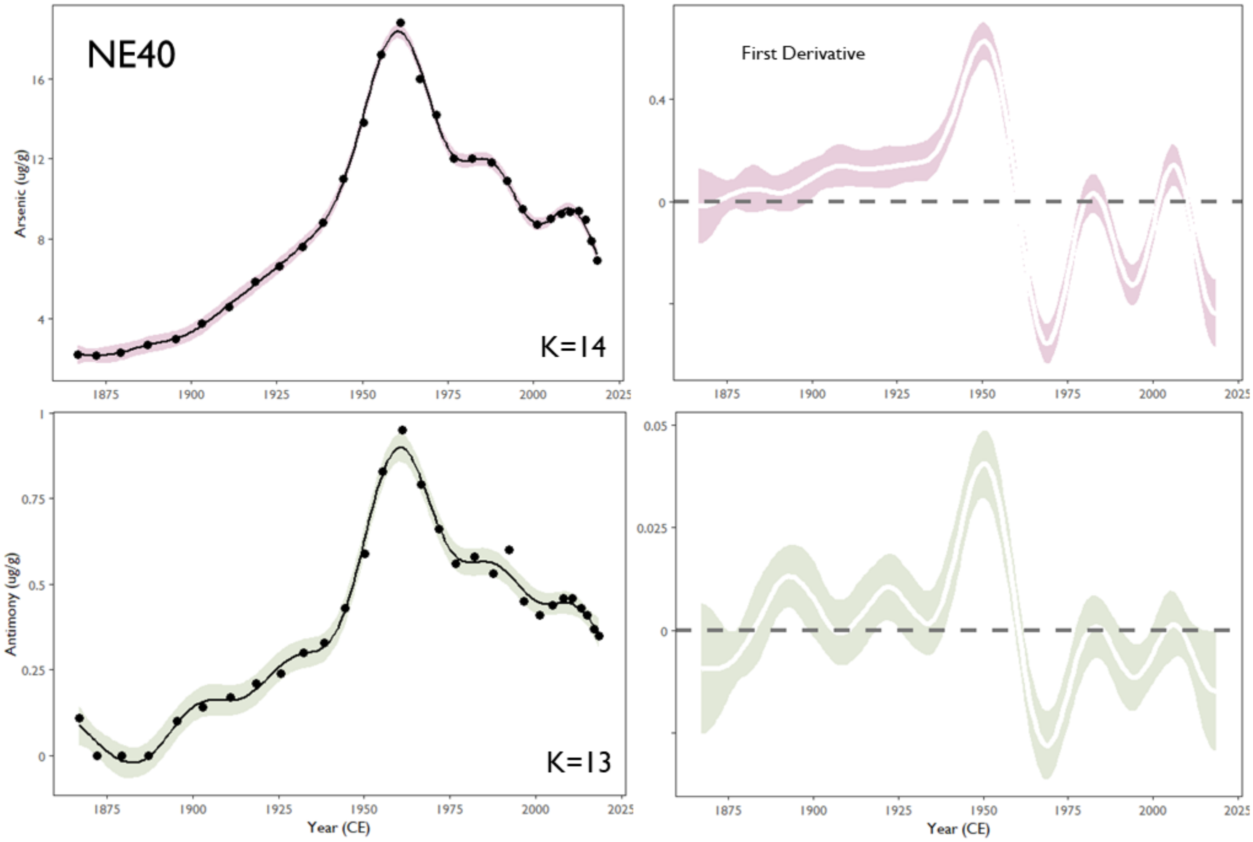

Figure E11: Outputs of generalized additive model and first derivative plots for lake NE40 for arsenic (top) and antimony (bottom).

Appendix F

Reported solid-phase metal concentrations measured on 1 cm intervals of study lakes at ALS Laboratories (Waterloo, ON)

Table F1: NW10

NW10	Al	Sb	As	Ba	Be	Bi	B	Cd	Ca	Cr	Co
0-1 cm	6390.00	17.50	1040.00	97.40	0.17	<0.20	15.60	0.71	10900.00	11.30	7.84
1-2 cm	6440.00	15.70	956.00	93.40	0.19	<0.20	11.10	0.67	9340.00	11.00	8.14
2-3 cm	7070.00	10.90	742.00	97.90	0.18	<0.20	9.60	0.71	9510.00	12.10	9.15
3-4 cm	7150.00	8.63	551.00	93.40	0.20	<0.20	9.00	0.70	8860.00	12.30	9.29
4-5 cm	7550.00	7.03	397.00	96.90	0.22	<0.20	8.60	0.77	9490.00	13.10	10.10
5-6 cm	8010.00	5.87	318.00	101.00	0.23	<0.20	8.70	0.83	9790.00	14.00	11.50
6-7 cm	7180.00	3.21	155.00	88.00	0.24	<0.20	6.70	0.80	8610.00	13.00	11.60
7-8 cm	8270.00	3.27	160.00	99.70	0.27	<0.20	7.10	0.85	9550.00	14.90	13.40
8-9 cm	8490.00	2.29	122.00	103.00	0.28	<0.20	6.90	0.91	9600.00	15.20	13.70
9-10 cm	7780.00	1.64	80.20	91.20	0.23	<0.20	6.30	0.82	8750.00	13.70	12.50
10-11 cm	8370.00	1.26	59.80	96.60	0.27	<0.20	6.60	0.89	9380.00	15.60	13.50
11-12 cm	9010.00	1.26	53.70	105.00	0.29	<0.20	7.20	1.04	10000.00	17.00	15.00
12-13 cm	8450.00	0.96	43.80	99.10	0.28	<0.20	6.70	0.90	9310.00	16.00	14.20
13-14 cm	8030.00	0.78	39.10	96.00	0.26	<0.20	6.50	0.90	9450.00	15.10	13.40
14-15 cm	8420.00	0.65	35.20	103.00	0.26	<0.20	6.30	0.95	9290.00	15.60	14.10
15-16 cm	7890.00	0.49	27.10	92.80	0.25	<0.20	5.70	0.84	8730.00	14.90	13.10
16-17 cm	7180.00	0.42	23.10	86.40	0.24	<0.20	5.50	0.80	7970.00	13.50	12.00

17-18 cm	7530.00	0.48	20.90	90.10	0.24	<0.20	6.20	0.82	8570.00	14.20	12.90
18-19 cm	8320.00	0.38	19.50	101.00	0.28	<0.20	6.70	0.89	9280.00	15.60	14.50
19-20 cm	7490.00	0.34	15.40	89.70	0.26	<0.20	6.00	0.83	8270.00	14.30	13.00
20-21 cm	8430.00	0.49	15.60	95.50	0.31	<0.20	7.80	0.93	9240.00	16.30	15.30
21-22 cm	7490.00	0.38	12.50	86.10	0.27	<0.20	7.30	0.91	8620.00	14.80	14.30
22-23 cm	7300.00	0.31	11.20	84.20	0.26	<0.20	6.60	0.88	8340.00	14.20	13.70
23-24 cm	7190.00	0.29	9.36	82.00	0.29	<0.20	6.90	0.91	8580.00	14.80	13.70
24-25 cm	8680.00	0.33	11.10	101.00	0.34	<0.20	8.00	1.03	9930.00	16.90	16.60

NW10	Cu	Fe	Pb	Li	Mg	Mn	Mo	Ni	P	K	Se
0-1 cm	26.60	4460.00	8.88	<2.0	1670.00	251.00	1.62	19.00	1180.00	350.00	1.13
1-2 cm	29.30	3420.00	7.04	<2.0	1430.00	173.00	1.81	19.50	817.00	250.00	1.24
2-3 cm	33.10	3410.00	5.52	<2.0	1400.00	168.00	1.78	20.90	743.00	220.00	1.24
3-4 cm	33.10	3260.00	4.33	<2.0	1290.00	164.00	1.84	20.90	708.00	220.00	1.14
4-5 cm	34.40	3370.00	3.64	<2.0	1340.00	164.00	1.87	21.30	698.00	230.00	1.17
5-6 cm	38.30	3600.00	3.23	2.00	1400.00	169.00	2.17	22.30	742.00	240.00	1.39
6-7 cm	37.00	3330.00	2.10	<2.0	1240.00	148.00	2.20	20.60	673.00	200.00	1.33
7-8 cm	42.00	3730.00	2.27	<2.0	1330.00	154.00	2.57	23.50	791.00	210.00	1.48
8-9 cm	44.70	3630.00	2.03	<2.0	1290.00	160.00	2.62	24.60	780.00	190.00	1.37
9-10 cm	41.50	3300.00	1.76	<2.0	1290.00	159.00	2.74	22.20	725.00	190.00	1.29

10-11 cm	45.50	3430.00	1.75	<2.0	1370.00	152.00	2.80	24.30	766.00	220.00	1.47
11-12 cm	49.30	3790.00	1.85	2.00	1480.00	171.00	3.35	26.80	821.00	240.00	1.66
12-13 cm	47.20	3660.00	1.66	<2.0	1430.00	169.00	3.38	25.50	762.00	210.00	1.51
13-14 cm	44.00	3630.00	1.54	<2.0	1460.00	169.00	3.03	24.30	735.00	210.00	1.48
14-15 cm	45.40	3600.00	1.57	<2.0	1350.00	166.00	2.91	25.10	743.00	200.00	1.54
15-16 cm	42.40	3390.00	1.49	<2.0	1280.00	161.00	2.75	24.00	682.00	180.00	1.39
16-17 cm	38.80	3190.00	1.40	<2.0	1190.00	140.00	2.71	21.90	644.00	190.00	1.29
17-18 cm	41.80	3550.00	1.50	<2.0	1300.00	153.00	3.02	23.00	705.00	220.00	1.40
18-19 cm	45.80	3990.00	1.58	2.10	1370.00	164.00	3.23	25.70	761.00	210.00	1.59
19-20 cm	42.90	3530.00	1.50	<2.0	1190.00	147.00	3.02	23.40	652.00	190.00	1.60
20-21 cm	51.10	4520.00	1.57	<2.0	1330.00	165.00	3.68	25.80	860.00	240.00	1.61
21-22 cm	47.80	4380.00	1.41	<2.0	1230.00	148.00	3.68	23.90	806.00	210.00	1.75
22-23 cm	47.00	4450.00	1.38	<2.0	1160.00	147.00	3.44	23.30	812.00	180.00	1.57
23-24 cm	46.80	4700.00	1.44	<2.0	1220.00	145.00	3.39	22.90	744.00	200.00	1.73
24-25 cm	55.70	5630.00	1.68	<2.0	1360.00	173.00	4.15	27.80	911.00	250.00	1.86

NW10	Ag	Na	Sr	S	Tl	Sn	Ti	W	U	V	Zn	Zr
0-1 cm	0.11	140.00	41.20	6700.00	0.11	<2.0	76.20	<0.50	2.90	12.60	124.00	1.90
1-2 cm	0.10	118.00	36.90	5700.00	0.11	<2.0	78.30	<0.50	2.98	13.60	125.00	1.80
2-3 cm	0.10	105.00	36.40	5700.00	0.11	<2.0	83.80	<0.50	3.40	15.40	148.00	2.10
3-4 cm	0.10	100.00	34.50	5500.00	0.11	<2.0	82.20	<0.50	3.41	14.60	155.00	2.10
4-5 cm	<0.10	114.00	36.50	5700.00	0.15	<2.0	88.40	<0.50	3.69	15.00	191.00	2.10
5-6 cm	0.11	123.00	36.90	6400.00	0.18	<2.0	91.50	<0.50	3.98	15.50	226.00	2.20
6-7 cm	<0.10	114.00	32.20	6100.00	0.19	<2.0	82.50	<0.50	3.76	14.20	213.00	2.20
7-8 cm	0.12	111.00	39.00	6600.00	0.20	<2.0	92.00	<0.50	4.43	16.30	229.00	2.50
8-9 cm	0.24	95.00	37.50	6200.00	0.21	<2.0	94.30	<0.50	4.46	17.00	236.00	2.80
9-10 cm	0.11	114.00	33.80	5600.00	0.20	<2.0	85.90	<0.50	4.19	16.30	211.00	2.60
10-11 cm	0.12	105.00	36.70	6100.00	0.19	<2.0	94.40	0.56	4.65	17.50	224.00	2.50
11-12 cm	0.14	117.00	42.00	6900.00	0.24	<2.0	98.80	<0.50	5.25	19.00	239.00	2.70
12-13 cm	0.13	117.00	38.20	7100.00	0.22	<2.0	91.90	<0.50	4.94	18.30	220.00	2.60
13-14 cm	0.12	133.00	36.50	7400.00	0.21	<2.0	87.20	<0.50	4.66	17.60	208.00	2.50
14-15 cm	0.12	92.00	37.60	6300.00	0.19	<2.0	90.40	<0.50	4.80	18.20	210.00	2.60
15-16 cm	0.12	92.00	35.30	6000.00	0.18	<2.0	84.00	<0.50	4.76	17.50	198.00	2.50
16-17 cm	0.11	88.00	32.50	5600.00	0.17	<2.0	80.00	<0.50	4.32	15.90	183.00	2.20
17-18 cm	0.13	109.00	36.80	6700.00	0.20	<2.0	83.40	<0.50	4.76	16.90	194.00	2.10

18-19 cm	0.13	102.00	38.00	6900.00	0.18	<2.0	90.80	<0.50	5.08	18.40	216.00	2.40
19-20 cm	0.12	84.00	32.50	6000.00	0.17	<2.0	83.60	<0.50	4.88	16.80	216.00	2.20
20-21 cm	0.16	102.00	38.10	7600.00	0.19	<2.0	90.80	<0.50	5.07	19.60	230.00	2.50
21-22 cm	0.13	96.00	36.30	7500.00	0.16	<2.0	79.10	<0.50	4.91	17.80	216.00	2.40
22-23 cm	0.14	89.00	34.70	7000.00	0.15	<2.0	71.90	<0.50	4.66	17.50	209.00	2.50
23-24 cm	0.13	100.00	36.10	7600.00	0.16	<2.0	77.40	<0.50	4.85	17.90	202.00	2.60
24-25 cm	0.16	110.00	42.30	9500.00	0.19	<2.0	88.20	<0.50	5.69	21.10	241.00	2.80

Table F2: NW20

NW20	Al	Sb	As	Ba	Be	Bi	B	Cd	Ca	Cr	Co
0-1 cm	10200.00	4.99	239.00	81.90	0.32	<0.20	11.50	0.68	8220.00	12.80	7.20
1-2 cm	9750.00	4.88	209.00	76.70	0.31	<0.20	10.40	0.59	7300.00	11.60	6.80
2-3 cm	10900.00	4.48	195.00	80.40	0.34	<0.20	10.20	0.57	7590.00	12.70	7.12
3-4 cm	11800.00	4.49	200.00	86.30	0.36	<0.20	10.80	0.57	8250.00	13.70	7.82
4-5 cm	11700.00	3.75	170.00	83.50	0.37	<0.20	9.60	0.54	7850.00	12.70	7.54
5-6 cm	10400.00	2.80	138.00	75.30	0.32	<0.20	8.50	0.44	6960.00	11.50	6.66
6-7 cm	10900.00	2.22	119.00	77.40	0.34	<0.20	7.70	0.45	6980.00	11.90	6.96
7-8 cm	12200.00	2.26	124.00	85.20	0.37	<0.20	8.80	0.54	7720.00	13.40	8.00
8-9 cm	12100.00	1.96	117.00	84.40	0.38	<0.20	8.70	0.56	7850.00	13.60	8.12
9-10 cm	11600.00	1.53	97.20	81.30	0.37	<0.20	8.70	0.56	7460.00	13.30	7.90
10-11 cm	11500.00	1.28	87.20	78.20	0.37	<0.20	7.90	0.58	7330.00	13.60	8.39
11-12 cm	13600.00	1.13	84.80	90.40	0.42	<0.20	8.40	0.73	8410.00	16.30	10.40
12-13 cm	11600.00	0.82	60.70	76.50	0.36	<0.20	7.00	0.63	7170.00	13.60	8.57

13-14 cm	12500.00	0.91	65.60	83.30	0.39	<0.20	7.50	0.73	7870.00	14.70	9.55
14-15 cm	11300.00	0.68	55.00	74.10	0.33	<0.20	6.40	0.60	6720.00	12.90	8.98
15-16 cm	12300.00	0.75	60.30	80.60	0.40	<0.20	8.00	0.62	7980.00	13.30	9.39
16-17 cm	11700.00	0.63	51.00	82.30	0.35	<0.20	7.30	0.50	7350.00	12.90	8.32
17-18 cm	11000.00	0.42	42.60	78.70	0.33	<0.20	7.20	0.51	7100.00	12.50	8.09
18-19 cm	11700.00	0.32	39.30	80.60	0.39	<0.20	7.90	0.64	7630.00	14.10	9.03
19-20 cm	10500.00	0.24	33.50	73.30	0.34	<0.20	7.00	0.61	6670.00	12.40	8.42
20-21 cm	11100.00	0.25	31.40	76.10	0.34	<0.20	7.40	0.55	6670.00	13.00	8.87
21-22 cm	10800.00	0.20	27.50	72.10	0.35	<0.20	7.40	0.53	6430.00	13.20	8.42
22-23 cm	9130.00	0.16	21.50	62.10	0.33	<0.20	6.30	0.46	5840.00	10.60	6.96
23-24 cm	11400.00	0.17	25.00	76.20	0.40	<0.20	7.40	0.64	6470.00	15.00	9.17
24-25 cm	10800.00	0.16	23.10	73.60	0.40	<0.20	7.30	0.64	6250.00	14.30	9.07
25-26 cm	11200.00	0.13	21.00	77.80	0.42	<0.20	6.80	0.55	6120.00	17.80	8.94
26-27 cm	14400.00	0.16	26.30	96.90	0.56	<0.20	8.50	0.75	7300.00	20.10	11.00
27-28 cm	12800.00	0.19	19.80	81.40	0.49	<0.20	7.20	0.63	5570.00	17.10	9.74
28-29 cm	12600.00	0.14	17.80	76.10	0.52	<0.20	5.50	0.65	4850.00	18.00	9.84
29-30 cm	13800.00	0.46	21.50	100.00	0.53	0.20	7.60	0.71	3580.00	24.70	11.00

NW20	Cu	Fe	Pb	Li	Mg	Mn	Mo	Ni	P	K	Se
0-1 cm	25.00	10300.00	6.35	3.70	1610.00	228.00	2.49	15.80	1640.00	910.00	1.15
1-2 cm	21.00	9670.00	5.46	3.70	1370.00	202.00	2.55	14.50	1500.00	480.00	1.07
2-3 cm	22.70	10800.00	4.76	3.90	1390.00	212.00	3.07	15.40	1500.00	430.00	1.12
3-4 cm	25.00	10600.00	4.68	4.00	1400.00	225.00	3.49	17.10	1540.00	430.00	1.32
4-5 cm	24.50	10000.00	4.04	3.90	1380.00	218.00	3.47	16.70	1450.00	380.00	1.33

5-6 cm	22.20	9000.00	3.36	3.60	1160.00	191.00	3.10	14.90	1290.00	350.00	1.20
6-7 cm	22.60	9300.00	2.98	3.50	1200.00	199.00	3.12	15.70	1290.00	340.00	1.14
7-8 cm	25.80	10200.00	3.14	3.90	1340.00	213.00	3.58	17.30	1390.00	380.00	1.41
8-9 cm	26.10	10400.00	3.01	4.10	1380.00	221.00	3.45	17.00	1410.00	390.00	1.34
9-10 cm	25.20	10100.00	2.67	4.30	1360.00	218.00	3.23	16.40	1300.00	400.00	1.45
10-11 cm	25.80	9780.00	2.48	4.40	1380.00	204.00	3.07	16.00	1190.00	400.00	1.32
11-12 cm	31.70	11300.00	2.95	5.40	1640.00	228.00	4.00	19.00	1380.00	460.00	1.52
12-13 cm	26.50	9700.00	2.49	4.40	1370.00	201.00	3.59	16.40	1180.00	380.00	1.29
13-14 cm	29.60	10600.00	2.86	4.60	1430.00	214.00	4.04	17.90	1280.00	370.00	1.49
14-15 cm	26.40	9310.00	2.33	3.70	1220.00	181.00	3.67	16.20	1170.00	340.00	1.23
15-16 cm	29.00	9900.00	2.76	3.90	1260.00	203.00	4.53	17.70	1340.00	320.00	1.42
16-17 cm	27.10	9460.00	2.43	3.50	1220.00	192.00	3.59	17.30	1260.00	330.00	1.27
17-18 cm	26.20	9070.00	2.29	3.50	1170.00	178.00	3.30	16.30	1200.00	310.00	1.30
18-19 cm	27.50	10100.00	2.68	4.50	1390.00	199.00	3.70	17.10	1210.00	390.00	1.37
19-20 cm	26.00	9000.00	2.36	4.30	1260.00	178.00	4.05	15.00	1090.00	360.00	1.21

20-21 cm	25.50	9080.00	2.38	4.40	1360.00	191.00	4.44	15.80	1190.00	410.00	1.03
21-22 cm	23.80	9160.00	2.32	5.10	1460.00	178.00	3.98	15.50	1060.00	450.00	0.99
22-23 cm	19.20	7540.00	2.09	4.40	1140.00	138.00	3.12	12.60	888.00	340.00	0.91
23-24 cm	24.40	10100.00	2.50	6.20	1650.00	193.00	3.91	16.50	1030.00	580.00	1.00
24-25 cm	24.80	10100.00	2.53	6.80	1720.00	185.00	4.09	16.30	917.00	570.00	1.06
25-26 cm	25.10	10700.00	2.50	8.10	1940.00	189.00	4.24	17.20	861.00	670.00	0.97
26-27 cm	28.40	14600.00	3.11	11.80	2670.00	221.00	5.04	20.90	1140.00	1000.00	1.20
27-28 cm	24.90	12700.00	2.85	10.20	2310.00	186.00	3.92	18.50	972.00	850.00	1.04
28-29 cm	27.10	14300.00	3.19	12.70	2610.00	184.00	4.28	18.90	898.00	950.00	0.93
29-30 cm	39.10	19800.00	5.62	20.60	3990.00	197.00	6.38	25.20	572.00	1790.00	1.05

NW20	Ag	Na	Sr	S	Tl	Sn	Ti	W	U	V	Zn	Zr
0-1 cm	<0.10	538.00	42.00	6200.00	0.09	<2.0	91.10	<0.50	6.65	18.20	168.00	1.80
1-2 cm	<0.10	189.00	36.60	5800.00	0.09	<2.0	88.00	<0.50	6.50	18.00	131.00	1.70
2-3 cm	<0.10	179.00	39.90	6100.00	0.09	<2.0	81.40	<0.50	7.54	20.20	125.00	1.70
3-4 cm	<0.10	171.00	43.90	6700.00	0.09	<2.0	91.70	<0.50	8.53	22.20	118.00	1.80
4-5 cm	<0.10	167.00	41.80	6400.00	0.08	<2.0	90.00	<0.50	8.30	22.20	109.00	1.70
5-6 cm	<0.10	154.00	37.40	6000.00	0.07	<2.0	87.30	<0.50	7.47	20.50	91.20	1.50
6-7 cm	<0.10	168.00	37.50	5900.00	0.07	<2.0	70.70	<0.50	7.42	21.70	93.20	1.60
7-8 cm	<0.10	162.00	41.60	6400.00	0.08	<2.0	89.80	<0.50	8.46	23.90	115.00	1.70

8-9 cm	<0.10	178.00	42.70	6600.00	0.08	<2.0	87.50	<0.50	8.29	23.50	118.00	1.80
9-10 cm	<0.10	165.00	40.60	6200.00	0.08	<2.0	97.50	<0.50	8.00	22.00	115.00	1.60
10-11 cm	<0.10	150.00	40.20	6000.00	0.08	<2.0	94.60	<0.50	8.05	21.00	118.00	1.50
11-12 cm	0.11	185.00	46.70	6800.00	0.10	<2.0	118.00	<0.50	9.90	24.90	159.00	1.90
12-13 cm	<0.10	165.00	40.40	5900.00	0.09	<2.0	101.00	<0.50	9.17	22.30	135.00	1.80
13-14 cm	0.10	187.00	45.60	6900.00	0.12	<2.0	98.10	<0.50	10.40	24.30	166.00	2.00
14-15 cm	<0.10	149.00	38.90	6100.00	0.11	<2.0	72.40	<0.50	8.49	20.80	131.00	1.60
15-16 cm	0.10	152.00	47.00	7100.00	0.11	<2.0	76.10	<0.50	9.91	22.80	129.00	2.10
16-17 cm	0.10	143.00	43.30	6800.00	0.10	48.60	71.00	<0.50	8.61	22.10	98.90	2.00
17-18 cm	<0.10	143.00	42.30	6800.00	0.09	<2.0	70.00	<0.50	8.44	20.60	88.30	2.00
18-19 cm	<0.10	160.00	45.00	6800.00	0.09	<2.0	79.30	<0.50	9.27	22.20	124.00	1.90
19-20 cm	<0.10	146.00	39.50	5800.00	0.08	<2.0	75.00	<0.50	8.30	19.70	135.00	1.60
20-21 cm	<0.10	140.00	39.50	5400.00	0.08	<2.0	95.00	<0.50	8.05	21.10	112.00	1.70
21-22 cm	<0.10	142.00	37.90	5000.00	0.09	<2.0	87.50	<0.50	7.45	20.70	103.00	1.50
22-23 cm	<0.10	127.00	34.20	4600.00	0.08	<2.0	59.80	<0.50	6.55	16.90	89.40	1.50
23-24 cm	<0.10	172.00	39.90	5100.00	0.11	<2.0	113.00	<0.50	7.56	22.30	135.00	2.80

24-25 cm	<0.10	151.00	38.00	4900.00	0.13	<2.0	108.00	<0.50	7.83	21.60	155.00	1.70
25-26 cm	<0.10	148.00	37.70	4600.00	0.13	<2.0	119.00	<0.50	8.01	22.80	129.00	1.60
26-27 cm	<0.10	207.00	44.70	5700.00	0.20	<2.0	201.00	<0.50	9.70	30.10	161.00	2.70
27-28 cm	<0.10	264.00	34.90	5000.00	0.19	<2.0	150.00	<0.50	7.95	25.60	148.00	1.70
28-29 cm	<0.10	165.00	30.50	4100.00	0.22	<2.0	201.00	<0.50	9.13	26.40	154.00	1.90
29-30 cm	0.11	329.00	25.20	3500.00	0.39	<2.0	363.00	0.56	13.50	30.90	138.00	2.80

Table F3: NW30

NW30	Al	Sb	As	Ba	Be	Bi	B	Cd	Ca	Cr	Co
0-1 cm	3140.00	4.14	65.10	72.80		<0.20	9.60	0.47	11300.00	9.93	5.36
1-2 cm	3710.00	5.67	75.10	58.70	0.12	<0.20	11.80	0.52	12600.00	42.80	6.85
2-3 cm	3440.00	4.76	59.50	43.90	0.11	<0.20	10.50	0.48	11500.00	8.86	6.56
3-4 cm	3790.00	5.07	61.70	45.70	0.12	<0.20	11.30	0.50	12800.00	9.58	6.99
4-5 cm	3700.00	4.46	58.60	49.00	0.12	<0.20	10.70	0.45	12000.00	10.60	7.07
5-6 cm	3760.00	3.95	56.70	45.90	0.13	<0.20	10.50	0.48	12200.00	9.38	7.39
6-7 cm	3430.00	3.10	48.60	40.80		<0.20	9.30	0.44	12000.00	8.38	6.97
7-8 cm	4600.00	2.86	53.60	56.70	0.14	<0.20	11.80	0.62	14800.00	12.90	10.40
8-9 cm	4650.00	2.07	45.70	57.70	0.14	<0.20	11.90	0.61	15100.00	11.90	10.90
9-10 cm	5050.00	1.51	39.70	61.20	0.17	<0.20	11.40	0.65	15200.00	18.70	12.20
10-11 cm	4970.00	1.17	31.90	57.60	0.16	<0.20	10.80	0.65	15000.00	12.60	11.90
11-12 cm	4850.00	0.90	27.90	57.50	0.13	<0.20	10.30	0.63	14300.00	12.40	11.60

12-13 cm	4690.00	0.79	24.70	54.70	0.14	<0.20	9.80	0.59	13300.00	11.80	10.90
13-14 cm	5380.00	0.65	23.70	62.40	0.18	<0.20	10.80	0.62	15100.00	14.90	12.20
14-15 cm	6050.00	0.54	22.80	72.80	0.18	<0.20	12.30	0.68	17300.00	14.00	13.40
15-16 cm	5280.00	0.46	17.90	60.90	0.14	<0.20	9.40	0.57	14100.00	11.90	11.10
16-17 cm	5950.00	0.40	18.80	68.80	0.16	<0.20	9.60	0.65	14700.00	12.20	12.60
17-18 cm	5490.00	0.46	15.20	59.00	0.14	<0.20	9.00	0.60	14000.00	11.30	11.40
18-19 cm	5060.00	0.33	13.30	54.10	0.12	<0.20	9.10	0.54	13500.00	10.20	11.50
19-20 cm	4260.00	0.25	10.60	48.00	0.10	<0.20	7.80	0.45	11100.00	8.94	9.87
20-21 cm	4050.00	0.18	10.40	46.90	0.10	<0.20	8.20	0.46	10600.00	8.80	10.30
21-22 cm	4540.00	0.19	11.90	56.40	0.12	<0.20	8.60	0.54	12100.00	10.10	11.40
22-23 cm	4250.00	0.17	11.30	53.10	0.12	<0.20	8.00	0.50	11300.00	10.20	10.50
23-24 cm	3780.00	0.15	9.90	46.00		<0.20	7.10	0.46	9800.00	8.20	10.30
24-25 cm	4060.00	0.14	10.20	50.20	0.12	<0.20	7.60	0.46	10700.00	9.20	11.40
25-26 cm	4130.00	0.11	8.58	50.70	0.10	<0.20	6.70	0.45	10700.00	9.40	11.60
26-27 cm	4460.00	0.14	10.00	54.50	0.14	<0.20	8.10	0.55	11400.00	10.90	13.60

27-28 cm	5870.00	0.13	11.90	69.80	0.17	<0.20	10.00	0.70	14000.00	14.40	17.60
28-29 cm	4890.00	0.13	9.93	58.90	0.14	<0.20	8.90	0.58	12300.00	12.30	13.20
29-30 cm	5850.00	0.14	11.50	71.90	0.19	<0.20	11.10	0.70	14800.00	14.40	14.30

NW30	Cu	Fe	Pb	Li	Mg	Mn	Mo	Ni	P	K	Se
0-1 cm	16.80	5050.00	5.38	<2.0	1720.00	247.00	2.29	15.30	1700.00	500.00	0.80
1-2 cm	20.60	4940.00	5.56	<2.0	2210.00	266.00	3.80	21.20	1700.00	510.00	0.84
2-3 cm	19.40	3970.00	4.87	<2.0	1860.00	231.00	2.88	19.40	1520.00	390.00	0.78
3-4 cm	20.60	4030.00	4.91	<2.0	2030.00	234.00	3.14	19.00	1450.00	390.00	0.79
4-5 cm	19.90	3970.00	4.43	<2.0	2080.00	228.00	2.91	19.80	1360.00	380.00	0.88
5-6 cm	19.70	3990.00	3.94	<2.0	2130.00	225.00	2.54	18.40	1320.00	320.00	0.84
6-7 cm	17.50	3540.00	3.35	<2.0	1960.00	206.00	2.24	16.50	1140.00	280.00	0.75
7-8 cm	23.20	4890.00	3.15	<2.0	2540.00	274.00	2.82	22.10	1430.00	340.00	1.00
8-9 cm	22.70	4930.00	2.56	<2.0	2590.00	275.00	2.53	21.60	1400.00	330.00	1.08
9-10 cm	23.00	5360.00	2.18	<2.0	2660.00	286.00	2.64	24.60	1410.00	330.00	1.06
10-11 cm	21.80	5350.00	1.92	<2.0	2550.00	286.00	2.53	22.80	1380.00	310.00	1.00
11-12 cm	20.80	5120.00	1.64	<2.0	2500.00	276.00	2.34	22.70	1380.00	310.00	1.07
12-13 cm	20.10	5070.00	1.59	<2.0	2420.00	269.00	2.48	21.70	1210.00	300.00	1.00
13-14 cm	21.90	5720.00	1.61	<2.0	2580.00	308.00	2.68	24.90	1340.00	310.00	1.11
14-15 cm	23.70	6300.00	1.63	<2.0	2830.00	349.00	2.90	26.00	1470.00	340.00	1.20

15-16 cm	20.10	5540.00	1.40	<2.0	2410.00	293.00	2.48	21.80	1160.00	270.00	1.00
16-17 cm	22.50	5930.00	1.49	<2.0	2540.00	317.00	2.49	24.30	1300.00	350.00	0.99
17-18 cm	20.20	5370.00	1.42	<2.0	2300.00	279.00	2.30	22.60	1130.00	290.00	0.96
18-19 cm	17.70	4990.00	1.26	<2.0	2100.00	259.00	2.09	21.50	1050.00	280.00	0.94
19-20 cm	14.10	4390.00	0.94	<2.0	1740.00	216.00	1.67	18.40	880.00	230.00	0.73
20-21 cm	13.90	4500.00	0.90	<2.0	1690.00	222.00	1.87	17.90	857.00	220.00	0.79
21-22 cm	15.80	5290.00	0.95	<2.0	1890.00	250.00	2.57	19.00	924.00	210.00	0.90
22-23 cm	15.50	5290.00	0.81	<2.0	1810.00	236.00	3.48	16.80	805.00	200.00	0.90
23-24 cm	14.00	4480.00	0.71	<2.0	1570.00	211.00	3.16	15.00	782.00	180.00	0.66
24-25 cm	13.80	4850.00	0.78	<2.0	1640.00	228.00	2.99	17.10	748.00	200.00	0.81
25-26 cm	13.50	4970.00	0.75	<2.0	1650.00	233.00	2.61	17.70	802.00	190.00	0.82
26-27 cm	16.80	5380.00	0.86	<2.0	1730.00	256.00	2.84	19.70	911.00	200.00	0.97
27-28 cm	20.00	7060.00	1.11	<2.0	2220.00	317.00	3.09	25.20	1040.00	280.00	1.08
28-29 cm	16.00	6080.00	1.02	<2.0	1920.00	278.00	2.43	20.80	942.00	260.00	0.88
29-30 cm	19.40	7520.00	1.22	<2.0	2250.00	337.00	2.79	24.40	1060.00	280.00	1.11

NW30	Ag	Na	Sr	S	Tl	Sn	Ti	W	U	V	Zn	Zr
0-1 cm	<0.10	118.00	47.80	5500.00	0.08	<2.0	34.90	<0.50	6.30	5.71	122.00	1.80
1-2 cm	<0.10	156.00	52.40	6200.00	0.10	<2.0	42.70	<0.50	7.67	7.37	145.00	2.10
2-3 cm	<0.10	120.00	46.20	5500.00	0.09	<2.0	38.50	<0.50	7.50	6.50	145.00	1.90
3-4 cm	<0.10	132.00	49.10	5900.00	0.09	<2.0	44.40	<0.50	8.01	7.06	149.00	2.50
4-5 cm	<0.10	149.00	48.70	6000.00	0.08	<2.0	41.20	<0.50	7.60	6.50	136.00	2.20
5-6 cm	<0.10	140.00	50.40	5700.00	0.08	<2.0	42.40	<0.50	7.79	6.36	143.00	2.20
6-7 cm	<0.10	140.00	45.20	5000.00	0.07	<2.0	38.40	<0.50	7.27	5.72	133.00	2.30
7-8 cm	<0.10	155.00	59.50	6800.00	0.09	<2.0	56.90	<0.50	10.00	7.87	209.00	2.90
8-9 cm	<0.10	167.00	58.50	6700.00	0.09	<2.0	56.20	<0.50	10.40	7.89	227.00	2.90
9-10 cm	<0.10	149.00	61.00	6800.00	0.10	<2.0	64.30	<0.50	11.70	8.86	249.00	3.10
10-11 cm	<0.10	156.00	58.70	6700.00	0.09	<2.0	61.00	<0.50	11.40	8.62	231.00	3.80
11-12 cm	<0.10	179.00	58.40	6300.00	0.08	<2.0	57.70	<0.50	10.60	8.30	221.00	3.70
12-13 cm	<0.10	193.00	57.20	5900.00	0.09	<2.0	58.60	<0.50	9.66	8.09	196.00	3.90
13-14 cm	<0.10	177.00	64.10	6400.00	0.09	<2.0	70.30	<0.50	10.80	9.05	187.00	3.90
14-15 cm	<0.10	212.00	66.70	6900.00	0.09	<2.0	82.80	<0.50	11.50	9.78	210.00	4.50
15-16 cm	<0.10	193.00	58.90	5800.00	0.08	<2.0	70.10	<0.50	9.18	7.95	179.00	4.40
16-17 cm	<0.10	240.00	64.60	6000.00	0.08	<2.0	93.40	<0.50	9.93	8.30	192.00	4.60
17-18 cm	<0.10	230.00	64.90	5500.00	0.08	<2.0	84.40	<0.50	9.25	7.20	164.00	5.40

18-19 cm	<0.10	210.00	55.00	5200.00	0.06	<2.0	73.00	<0.50	8.83	6.71	134.00	4.20
19-20 cm	<0.10	167.00	44.60	4000.00	0.06	<2.0	56.30	<0.50	7.34	5.88	120.00	3.20
20-21 cm	<0.10	140.00	44.70	4500.00	0.08	<2.0	48.10	<0.50	7.95	6.23	135.00	2.90
21-22 cm	<0.10	124.00	51.20	5100.00	0.10	<2.0	48.40	<0.50	10.30	7.53	179.00	2.90
22-23 cm	<0.10	149.00	46.70	4600.00	0.13	<2.0	38.30	<0.50	11.00	8.58	224.00	2.10
23-24 cm	<0.10	131.00	41.20	4200.00	0.10	<2.0	32.80	<0.50	10.70	7.47	179.00	1.80
24-25 cm	<0.10	127.00	44.60	4600.00	0.09	<2.0	37.50	<0.50	12.00	7.95	171.00	2.30
25-26 cm	<0.10	125.00	44.70	4400.00	0.08	<2.0	37.80	<0.50	11.90	7.58	146.00	2.60
26-27 cm	<0.10	111.00	48.50	5200.00	0.09	<2.0	47.50	<0.50	14.00	7.98	170.00	2.80
27-28 cm	<0.10	156.00	59.60	6400.00	0.13	<2.0	64.80	<0.50	18.10	10.60	223.00	3.70
28-29 cm	<0.10	164.00	51.80	5300.00	0.09	<2.0	54.10	<0.50	14.50	9.59	188.00	3.10
29-30 cm	<0.10	187.00	62.90	6400.00	0.10	<2.0	63.30	<0.50	16.20	12.60	238.00	3.90

Table F4: NW40

NW40	Al	Sb	As	Ba	Be	Bi	B	Cd	Ca	Cr	Co
0-1 cm	12200.00	1.10	33.20	158.00	0.48	<0.20	19.10	0.26	9240.00	25.20	8.57

1-2 cm	9980.00	1.09	27.80	126.00	0.47	<0.20	18.50	0.22	8050.00	19.50	7.17
2-3 cm	11800.00	1.19	32.90	149.00	0.48	<0.20	16.50	0.25	7560.00	23.50	8.65
3-4 cm	14300.00	1.61	31.40	164.00	0.48	<0.20	14.10	0.31	6750.00	28.70	10.20
4-5 cm	14600.00	2.16	29.70	158.00	0.54	<0.20	14.90	0.29	7460.00	28.40	10.20
5-6 cm	15000.00	2.35	28.70	155.00	0.54	<0.20	13.40	0.31	7160.00	28.80	10.30
6-7 cm	14900.00	2.33	26.50	165.00	0.55	<0.20	12.70	0.32	6910.00	29.30	10.60
7-8 cm	15000.00	1.39	23.00	149.00	0.54	<0.20	11.20	0.31	6380.00	29.70	10.70
8-9 cm	14800.00	0.87	19.80	142.00	0.58	<0.20	11.00	0.30	6240.00	28.60	10.60
9-10 cm	16500.00	0.53	20.00	156.00	0.60	<0.20	11.50	0.31	6400.00	31.10	11.40
10-11 cm	16000.00	0.36	18.50	144.00	0.62	<0.20	12.20	0.31	6840.00	30.40	11.30
11-12 cm	16400.00	0.28	17.00	155.00	0.60	<0.20	11.40	0.31	6200.00	31.10	11.60
12-13 cm	17900.00	0.21	16.00	167.00	0.58	<0.20	10.30	0.31	5830.00	33.00	12.00
13-14 cm	15000.00	0.19	12.90	146.00	0.49	<0.20	8.60	0.27	5100.00	29.30	10.40
14-15 cm	12800.00	0.27	10.20	122.00	0.45	<0.20	7.90	0.26	4700.00	24.40	9.09
15-16 cm	12400.00	0.22	9.03	121.00	0.45	<0.20	7.60	0.26	4630.00	24.40	8.53

16-17 cm	15200.00	0.20	9.45	148.00	0.58	<0.20	8.20	0.28	5460.00	28.80	9.42
17-18 cm	15100.00	0.14	8.33	144.00	0.45	<0.20	6.20	0.25	4320.00	28.30	9.01
18-19 cm	14400.00	0.22	8.03	137.00	0.52	<0.20	8.20	0.25	5010.00	27.60	8.92
19-20 cm	14900.00	0.15	8.46	144.00	0.56	<0.20	7.50	0.26	5060.00	29.20	9.60
20-21 cm	14000	0.29	10	144	0.6	<0.20	8.6	0.216	4850	29.8	9.41
21-22 cm	14400	0.2	11.2	147	0.58	<0.20	8.4	0.222	4960	30.5	9.67
22-23 cm	14300	0.24	11.1	146	0.61	<0.20	9.1	0.219	5040	29.9	9.49
23-24 cm	14600	0.23	11.3	144	0.63	<0.20	9.3	0.213	4950	30.7	9.69
24-25 cm	11500	0.35	9.64	117	0.53	<0.20	8.4	0.184	4300	24.8	7.89
25-26 cm	8690	0.26	8.37	88.2	0.41	<0.20	5.6	0.144	3320	19.8	6.54
26-27 cm	8690	0.2	7.83	84.9	0.42	<0.20	6.1	0.15	3280	19.9	6.6
27-28 cm	10400	0.14	7.46	102	0.43	<0.20	5.6	0.145	2860	23	6.84
28-29 cm	14600	0.21	9.58	150	0.66	<0.20	7.1	0.17	3770	32.2	9
29-30 cm	20300	0.26	13.9	208	0.9	0.28	10.1	0.213	4780	44.3	11.9

NW40	Cu	Fe	Pb	Li	Mg	Mn	Mo	Ni	P	K	Se
0-1 cm	20.80	20800.00	5.83	14.70	4700.00	1010.00	1.67	22.60	1630.00	1910.00	0.53
1-2 cm	16.10	17100.00	5.32	14.60	3470.00	854.00	1.62	18.20	1290.00	1520.00	0.48
2-3 cm	19.70	20100.00	5.78	14.60	4080.00	988.00	1.78	22.30	1430.00	1710.00	0.46
3-4 cm	23.10	20600.00	6.10	15.90	4970.00	779.00	2.16	26.30	1290.00	1900.00	0.55
4-5 cm	23.40	19700.00	7.06	18.80	4900.00	683.00	2.84	25.90	1110.00	1870.00	0.52
5-6 cm	24.60	19800.00	6.97	18.50	5100.00	684.00	3.07	26.30	977.00	1860.00	0.56
6-7 cm	25.40	19500.00	6.58	19.30	5090.00	630.00	3.22	27.00	903.00	1890.00	0.52
7-8 cm	24.70	19500.00	5.48	19.70	4890.00	621.00	2.80	26.50	872.00	1880.00	0.54
8-9 cm	24.00	19200.00	5.28	19.40	4760.00	591.00	2.69	25.70	746.00	1760.00	0.53
9-10 cm	25.30	20500.00	5.70	23.60	5140.00	613.00	2.69	27.30	803.00	1970.00	0.57
10-11 cm	24.90	20200.00	5.41	25.40	5170.00	574.00	2.88	26.80	786.00	1930.00	0.59
11-12 cm	26.00	20400.00	5.25	25.40	5020.00	598.00	2.81	27.00	750.00	1950.00	0.58
12-13 cm	27.00	21200.00	4.90	28.20	5490.00	612.00	2.63	28.50	771.00	2070.00	0.61
13-14 cm	23.10	19600.00	4.16	17.20	4790.00	548.00	2.18	24.80	648.00	1810.00	0.46
14-15 cm	19.50	17200.00	4.27	15.30	4080.00	487.00	2.13	21.10	579.00	1510.00	0.37
15-16 cm	21.00	16100.00	4.34	17.00	4250.00	448.00	1.95	21.60	574.00	1520.00	0.46
16-17 cm	24.50	17700.00	5.10	18.90	4790.00	472.00	2.09	25.10	581.00	1800.00	0.56
17-18 cm	23.20	16500.00	3.95	16.70	4700.00	444.00	1.51	24.50	546.00	1770.00	0.56
18-19 cm	22.30	16000.00	4.79	20.50	4610.00	458.00	1.79	24.10	531.00	1760.00	0.48

19-20 cm	23.80	16700.00	5.06	23.30	4830.00	459.00	2.01	25.70	515.00	1900.00	0.53
20-21 cm	22.2	17500	5.39	23.5	5120	372	2.31	25.9	475	2280	0.57
21-22 cm	22.7	18000	5.56	23.1	5340	373	2.22	26.4	495	2370	0.57
22-23 cm	22.5	17800	5.64	23.1	5400	377	2.31	26.9	503	2490	0.49
23-24 cm	22.5	17900	5.62	22.9	5550	382	2.35	28.4	488	2550	0.5
24-25 cm	18.3	14700	4.66	18.5	4410	305	2.12	22.4	417	2020	0.39
25-26 cm	14.7	11900	3.7	14.2	3490	249	1.71	18.1	340	1530	0.3
26-27 cm	13.8	11800	3.99	14.5	3510	234	1.58	18	357	1540	0.27
27-28 cm	14.7	13100	4.37	15.1	4130	241	1.21	19.1	390	1900	0.3
28-29 cm	19	18200	6.69	22.6	6010	318	1.29	24.6	371	2820	0.36
29-30 cm	24.8	24600	8.91	30	8300	419	1.9	33.1	472	4130	0.46

NW40	Ag	Na	Sr	S	Tl	Sn	Ti	W	U	V	Zn	Zr
0-1 cm	<0.10	384.00	44.70	3900.00	0.11	<2.0	209.00	<0.50	11.30	26.60	95.10	2.40
1-2 cm	<0.10	280.00	41.00	3800.00	0.11	<2.0	171.00	<0.50	10.00	22.00	66.30	2.20
2-3 cm	<0.10	313.00	40.00	3900.00	0.11	3.80	192.00	<0.50	10.70	26.10	74.80	2.30
3-4 cm	<0.10	331.00	36.90	4000.00	0.13	<2.0	251.00	<0.50	11.90	31.00	79.60	2.50
4-5 cm	<0.10	322.00	40.50	3900.00	0.14	<2.0	261.00	<0.50	13.60	30.50	78.90	3.20
5-6 cm	<0.10	320.00	39.40	3700.00	0.14	<2.0	253.00	<0.50	13.80	31.00	80.60	3.20

6-7 cm	<0.10	299.00	38.20	3900.00	0.14	<2.0	268.00	<0.50	13.90	31.60	83.70	2.90
7-8 cm	<0.10	302.00	32.00	3600.00	0.13	<2.0	256.00	<0.50	12.10	31.30	84.00	2.40
8-9 cm	<0.10	296.00	34.20	3400.00	0.13	<2.0	251.00	<0.50	13.50	30.00	84.60	2.20
9-10 cm	<0.10	310.00	38.50	3700.00	0.16	<2.0	296.00	<0.50	17.40	33.00	88.50	2.50
10-11 cm	<0.10	298.00	33.40	3600.00	0.15	<2.0	294.00	<0.50	11.00	32.00	86.60	2.80
11-12 cm	<0.10	303.00	36.90	3600.00	0.16	<2.0	305.00	<0.50	17.60	32.80	90.00	2.80
12-13 cm	<0.10	297.00	32.60	3700.00	0.15	<2.0	335.00	<0.50	14.50	35.00	93.60	2.60
13-14 cm	<0.10	256.00	28.60	2900.00	0.15	<2.0	316.00	<0.50	9.04	31.30	82.70	1.90
14-15 cm	<0.10	255.00	25.70	2300.00	0.15	<2.0	256.00	<0.50	8.83	26.60	71.90	2.00
15-16 cm	<0.10	228.00	25.60	2500.00	0.16	<2.0	290.00	<0.50	9.49	25.80	71.00	1.90
16-17 cm	<0.10	243.00	29.00	3000.00	0.19	<2.0	341.00	<0.50	11.10	30.00	75.60	2.70
17-18 cm	<0.10	232.00	24.40	3000.00	0.14	<2.0	331.00	<0.50	9.16	28.80	70.40	2.40
18-19 cm	<0.10	280.00	27.10	2800.00	0.18	<2.0	341.00	<0.50	10.70	28.60	68.00	2.80
19-20 cm	<0.10	245.00	29.30	3200.00	0.18	<2.0	362.00	<0.50	10.90	30.40	73.40	3.30
20-21 cm	<0.10	325	28.5	3400	0.205	<2.0	399	<0.50	9.99	31	66	6.7
21-22 cm	<0.10	295	30.3	4200	0.194	<2.0	420	<0.50	10.3	31.7	66.6	6.5
22-23 cm	<0.10	338	31.6	4300	0.2	<2.0	433	<0.50	10.1	31.2	65.1	6.9

23-24 cm	<0.10	328	32	4200	0.206	<2.0	453	<0.50	9.76	32	63.8	7.2
24-25 cm	<0.10	356	26.3	3500	0.171	<2.0	364	<0.50	8.41	26.3	54.8	5.8
25-26 cm	<0.10	227	18.3	2700	0.128	<2.0	278	<0.50	6.59	21.7	44.9	4
26-27 cm	<0.10	233	18.9	2200	0.143	<2.0	314	<0.50	6.49	21.9	44.6	4
27-28 cm	<0.10	204	18.6	1700	0.145	<2.0	371	<0.50	5.83	25	44.8	5.4
28-29 cm	<0.10	251	28.8	2000	0.202	<2.0	530	<0.50	7.22	34.6	54.7	10.8
29-30 cm	0.11	337	39.9	3100	0.258	<2.0	752	<0.50	9.57	49	70.5	17.5

Table F5: NW50

NW50	Al	Sb	As	Ba	Be	Bi	B	Cd	Ca	Cr	Co
0-1 cm	10800	1.52	108.00	4990	0.47	<0.20	8.6	0.524	8550	24.1	16.7
1-2 cm	12200	1.50	93.50	5300	0.51	<0.20	10.0	0.518	8240	27.1	16.1
2-3 cm	15600	1.57	163.00	3690	0.65	<0.20	13.9	0.391	7640	34.0	15.9
3-4 cm	19900	2.13	212.00	1830	0.92	0.21	17.7	0.361	6850	42.3	10.7
4-5 cm	22700	3.50	240.00	1350	0.99	0.25	17.9	0.528	6680	45.3	10.4
5-6 cm	26200	3.76	86.80	1000	1.12	0.30	19.3	0.570	6290	53.7	12.1
6-7 cm	27200	1.96	20.60	850	1.10	0.32	18.3	0.444	5910	57.1	13.3
7-8 cm	28000	0.62	29.10	841	1.04	0.31	18.4	0.527	5750	58.4	16.7
8-9 cm	28100	0.39	23.20	955	1.06	0.28	17.5	0.430	5420	57.7	16.1
9-10 cm	28600	0.30	14.60	917	1.17	0.29	19.4	0.456	5950	58.9	12.9
10-11 cm	27800	0.29	14.20	836	1.25	0.31	17.7	0.522	5630	57.9	16.0
11-12 cm	29400	0.31	17.30	901	1.31	0.32	17.6	0.519	5800	58.8	21.0
12-13 cm	28600	0.27	11.90	849	1.12	0.30	17.7	0.456	5390	58.7	13.3

13-14 cm	29800	0.30	13.60	831	1.11	0.33	19.0	0.461	5520	61.8	14.9
14-15 cm	29500	0.27	12.00	818	1.03	0.30	17.6	0.489	5290	61.6	21.7
15-16 cm	28900	0.28	20.80	750	0.93	0.28	17.2	0.375	5130	61.2	16.3
16-17 cm	27200	0.27	18.10	692	1.01	0.28	17.9	0.425	4920	56.5	16.0
17-18 cm	28900	0.26	12.30	749	1.02	0.31	18.0	0.504	5130	61.8	16.8
18-19 cm	27900	0.26	16.90	684	1.03	0.29	17.6	0.511	4880	57.5	17.1
19-20 cm	27600	0.26	15.20	675	1.08	0.30	19.7	0.529	5070	56.8	14.7
20-21 cm	28000	0.27	11.00	756	1.04	0.31	17.2	0.598	4970	59.8	20.7
21-22 cm	27500	0.26	14.90	731	1.07	0.30	17.9	0.658	5060	55.1	21.0
22-23 cm	27100	0.25	15.20	746	1.02	0.29	19.3	0.597	5290	55.8	16.8
23-24 cm	23100	0.24	19.90	687	0.88	0.25	17.0	0.668	4780	47.9	16.4
24-25 cm	25900	0.24	14.80	701	0.96	0.27	17.3	0.660	4890	52.4	17.2
25-26 cm	26500	0.27	11.30	733	0.97	0.28	16.7	0.505	5140	62.6	22.0
26-27 cm	26700	0.27	12.10	756	1.04	0.29	18.5	0.646	5120	56.2	15.8
27-28 cm	26600	0.26	11.00	746	1.04	0.28	19.3	0.522	5300	56.5	23.6
28-29 cm	26000	0.26	16.40	689	1.03	0.25	20.1	0.757	5100	53.1	18.7
29-30 cm	25300	0.21	11.30	700	0.94	0.25	18.0	0.449	4850	53.9	16.1

NW50	Cu	Fe	Pb	Li	Mg	Mn	Mo	Ni	P	K	Se
0-1 cm	24.0	92500	6.02	11.1	4270	158000	159	36.5	2020	3040	0.69
1-2 cm	26.9	75500	6.57	13.6	4740	167000	156	39.0	1810	3340	0.72
2-3 cm	31.8	120000	8.63	17.3	5460	79000	113	37.6	3250	3160	1.04
3-4 cm	39.5	121000	12.50	21.5	6210	22000	51.5	35.9	5110	3280	1.06
4-5 cm	44.6	120000	15.30	21.8	6380	14000	44.2	41.9	6590	3430	1.18
5-6 cm	52.5	76600	17.40	25.8	7520	8660	21.2	50.8	4070	4030	1.30
6-7 cm	55.5	49200	15.50	27.6	7980	5550	15.3	51.7	2730	4430	1.12
7-8 cm	58.1	51600	14.30	27.6	8470	4580	18.1	56.0	2590	4660	1.31
8-9 cm	57.0	53900	14.40	26.9	8070	7480	18.5	64.1	2780	4460	1.26
9-10 cm	56.7	47200	14.90	29.9	8490	6290	10.3	51.1	2610	4670	1.11
10-11 cm	55.9	49600	16.50	28.7	8580	4170	11.0	59.1	2730	4510	1.22
11-12 cm	56.8	51100	17.50	30.3	8440	4380	13.2	68.9	2940	4520	1.21

12-13 cm	53.6	40800	14.70	30.5	8450	4050	8.12	51.6	2280	4630	1.11
13-14 cm	56.5	43900	15.90	33.4	9120	4010	9.15	61.7	2090	5030	1.01
14-15 cm	55.4	44600	14.50	32.6	9270	6260	8.12	65.9	1890	5010	0.96
15-16 cm	52.9	60600	13.40	30.9	9160	6360	10.8	60.1	1930	4990	0.96
16-17 cm	49.6	71700	13.50	28.4	8720	6950	8.16	61.2	2180	4470	0.96
17-18 cm	53.2	56700	14.50	33.6	9270	5460	5.62	58.2	1810	5120	0.93
18-19 cm	51.3	72800	14.10	29.7	8830	6510	7.82	62.7	2590	4930	1.03
19-20 cm	52.0	77000	15.90	30.1	8360	6910	7.33	58.5	4080	4510	1.10
20-21 cm	56.1	54300	16.20	30.6	8850	4220	7.59	70.4	2130	4450	1.05
21-22 cm	53.5	70900	15.80	28.7	8370	7640	10.0	74.3	2220	4300	1.04
22-23 cm	54.6	72300	14.60	30.8	8330	11000	6.85	62.3	2820	4500	1.16
23-24 cm	46.9	96200	13.40	24.2	7390	19500	6.58	61.0	4500	3730	1.06
24-25 cm	52.1	77200	14.30	27.7	7850	9640	6.66	61.2	4690	4030	0.99
25-26 cm	52.2	63200	14.80	30.3	8670	3800	9.03	69.7	2190	4310	1.17
26-27 cm	52.4	66200	14.10	29.9	8460	4660	8.13	56.4	2780	4320	1.07
27-28 cm	54.6	58200	13.80	30.6	8530	3540	10.2	71.9	2000	4380	1.23
28-29 cm	52.6	84400	12.80	26.5	7770	5580	8.99	62.3	3740	4070	1.24
29-30 cm	49.1	65100	12.70	27.0	7740	3700	5.93	55.6	2270	4020	1.05

NW50	Ag	Na	Sr	S	Tl	Sn	Ti	W	U	V	Zn	Zr
0-1 cm	<0.10	213	122	1000	0.267	<2.0	247	<0.50	37.6	22.3	97.1	1.2
1-2 cm	<0.10	224	127	1300	0.293	<2.0	268	<0.50	39.9	24.3	101	1.7
2-3 cm	<0.10	246	93.7	1700	0.253	<2.0	356	<0.50	44.1	31.8	94.3	1.0
3-4 cm	<0.10	289	64.9	1800	0.220	<2.0	444	0.56	53.8	41.7	104	1.1
4-5 cm	0.10	301	58.6	3100	0.248	<2.0	448	0.61	57.9	49.4	138	1.6
5-6 cm	0.13	347	54.3	4700	0.325	<2.0	525	<0.50	68.2	55.4	144	1.9
6-7 cm	0.13	367	48.8	4100	0.367	<2.0	563	<0.50	65.5	57.2	139	2.1
7-8 cm	0.14	375	51.3	4000	0.372	<2.0	581	<0.50	61.8	58.1	149	2.1
8-9 cm	0.12	356	51.9	3600	0.348	<2.0	590	<0.50	59.3	58.8	148	2.1
9-10 cm	0.12	391	51.7	2700	0.335	<2.0	617	<0.50	60.6	60.4	161	2.3
10-11 cm	0.13	374	49.8	3200	0.350	<2.0	574	<0.50	60.9	61.5	168	2.8

11-12 cm	0.13	379	48.9	3700	0.381	<2.0	612	<0.50	65.7	62.9	170	2.7
12-13 cm	0.13	385	48.6	2100	0.357	<2.0	592	<0.50	55.3	59.3	148	2.5
13-14 cm	0.13	385	49.0	2200	0.391	<2.0	690	<0.50	56.3	61.2	163	2.6
14-15 cm	0.12	375	48.3	2200	0.391	<2.0	684	<0.50	48.0	59.6	144	2.6
15-16 cm	0.12	391	47.6	2300	0.369	<2.0	717	<0.50	47.3	59.8	145	2.8
16-17 cm	0.11	390	45.7	2200	0.352	<2.0	765	<0.50	51.9	57.4	146	2.2
17-18 cm	0.13	398	47.8	1800	0.351	<2.0	745	<0.50	40.9	59.9	154	3.3
18-19 cm	0.11	407	46.0	2400	0.371	<2.0	697	<0.50	45.8	58.7	152	3.1
19-20 cm	0.12	423	46.6	2600	0.396	<2.0	752	<0.50	59.4	59.9	171	2.5
20-21 cm	0.13	382	46.6	3100	0.385	<2.0	690	<0.50	49.6	59.6	168	2.7
21-22 cm	0.12	386	45.9	3700	0.408	<2.0	675	<0.50	53.0	58.4	162	2.6
22-23 cm	0.13	397	45.3	2700	0.384	<2.0	732	<0.50	51.6	58.2	161	2.0
23-24 cm	0.11	356	41.3	2600	0.349	<2.0	589	<0.50	48.1	52.6	143	2.0
24-25 cm	0.12	358	41.8	2900	0.408	<2.0	607	<0.50	62.3	54.4	161	2.7
25-26 cm	0.11	369	43.0	3700	0.374	<2.0	649	<0.50	60.2	57.9	160	3.1
26-27 cm	0.12	365	44.5	3300	0.369	<2.0	718	<0.50	59.4	57.8	174	2.8
27-28 cm	0.12	368	46.1	4000	0.405	<2.0	647	<0.50	63.8	56.9	163	2.9
28-29 cm	0.11	389	43.4	4000	0.356	<2.0	648	<0.50	63.2	56.4	187	2.3
29-30 cm	0.11	369	43.1	2700	0.328	<2.0	579	<0.50	67.3	55.9	137	2.8

Table F6: NW60

NW60	Al	Sb	As	Ba	Be	Bi	B	Cd	Ca	Cr	Co
0-1 cm	8530.00	0.84	88.30	140.00	0.56	<0.20	27.70	0.26	13400.00	14.80	6.04
1-2 cm	9660.00	1.07	73.20	112.00	0.57	<0.20	24.40	0.28	10100.00	16.60	7.26
2-3 cm	11300.00	1.39	85.40	125.00	0.67	<0.20	27.40	0.32	9660.00	19.80	8.38
3-4 cm	12000.00	1.93	74.60	101.00	0.69	<0.20	20.60	0.38	8630.00	21.50	9.13
4-5 cm	11400.00	2.11	76.60	94.30	0.67	<0.20	18.70	0.38	8080.00	20.80	8.88
5-6 cm	12200.00	2.57	81.40	94.60	0.62	<0.20	18.70	0.40	7630.00	22.50	8.56
6-7 cm	15600.00	3.35	106.00	116.00	0.74	<0.20	21.90	0.49	9240.00	29.70	10.50
7-8 cm	11800.00	2.84	77.40	101.00	0.61	<0.20	20.60	0.38	7400.00	21.60	7.63
8-9 cm	15400.00	3.35	66.10	113.00	0.68	<0.20	18.50	0.48	7890.00	28.70	9.18

9-10 cm	15300.00	2.73	53.40	108.00	0.73	<0.20	18.10	0.44	7710.00	28.10	9.18
10-11 cm	12500.00	1.82	41.50	89.40	0.73	<0.20	16.00	0.42	6780.00	21.80	7.93
11-12 cm	12600.00	1.25	38.70	83.50	0.66	<0.20	15.00	0.38	6360.00	22.40	8.16
12-13 cm	10000.00	0.60	26.60	69.20	0.56	<0.20	12.40	0.34	5700.00	18.10	6.90
13-14 cm	11900.00	0.51	23.80	83.60	0.63	<0.20	14.20	0.41	6310.00	22.20	7.99
14-15 cm	13300.00	0.40	19.10	92.20	0.65	<0.20	16.60	0.36	6750.00	24.90	8.32
15-16 cm	12900.00	0.34	16.70	92.00	0.64	<0.20	14.60	0.37	6670.00	25.20	7.70
16-17 cm	12600.00	0.28	13.70	86.60	0.61	<0.20	13.20	0.31	5910.00	23.00	7.30
17-18 cm	12800.00	0.25	12.00	86.40	0.68	<0.20	12.80	0.33	5640.00	23.60	7.97
18-19 cm	11500.00	0.21	10.10	78.60	0.61	<0.20	11.60	0.31	5300.00	21.00	7.81
19-20 cm	13500.00	0.24	10.20	92.50	0.65	<0.20	12.70	0.36	5700.00	25.50	8.62
20-21 cm	12800.00	0.21	8.88	89.20	0.64	<0.20	11.80	0.37	5300.00	24.00	8.22
21-22 cm	12700.00	0.20	7.98	89.90	0.60	<0.20	12.20	0.36	5580.00	24.40	8.21
22-23 cm	14000.00	0.21	8.05	93.40	0.69	<0.20	12.30	0.41	5240.00	25.80	9.10
23-24 cm	13400.00	0.18	7.66	85.60	0.69	<0.20	11.20	0.42	5420.00	24.50	8.77

24-25 cm	14800.00	0.15	7.41	92.90	0.77	<0.20	11.90	0.44	5720.00	24.40	8.78
25-26 cm	16900.00	0.18	8.22	106.00	0.87	<0.20	13.10	0.47	6870.00	27.70	10.60
26-27 cm	16600.00	0.18	7.77	107.00	0.83	<0.20	14.10	0.45	6900.00	28.50	9.92
27-28 cm	12700.00	0.14	6.21	85.10	0.66	<0.20	10.40	0.34	5680.00	21.40	8.40
28-29 cm	12900.00	0.16	6.36	84.90	0.67	<0.20	11.40	0.33	5860.00	22.80	9.28
29-30 cm	12200.00	0.13	5.58	83.20	0.62	<0.20	10.30	0.33	5520.00	22.10	8.33

NW60	Cu	Fe	Pb	Li	Mg	Mn	Mo	Ni	P	K	Se
0-1 cm	14.40	47500.00	4.70	5.80	3220.00	1060.00	2.26	15.20	2000.00	1530.00	0.75
1-2 cm	15.90	40500.00	5.14	6.90	3160.00	702.00	2.44	17.30	1830.00	1420.00	0.68
2-3 cm	20.10	43400.00	6.52	8.10	3590.00	715.00	3.23	21.30	1930.00	1560.00	0.90
3-4 cm	23.10	36700.00	8.20	9.10	3400.00	493.00	4.04	22.70	1470.00	1410.00	0.89
4-5 cm	22.80	35700.00	8.81	9.20	3290.00	448.00	4.39	22.20	1320.00	1320.00	0.85
5-6 cm	26.10	34000.00	9.19	10.30	3540.00	411.00	4.63	23.10	1220.00	1470.00	0.97
6-7 cm	33.50	41600.00	10.90	12.50	4490.00	520.00	5.43	30.30	1470.00	1780.00	1.17
7-8 cm	25.00	34700.00	7.82	10.30	3340.00	466.00	4.23	21.90	1270.00	1400.00	0.79
8-9 cm	31.30	35500.00	8.70	13.20	4170.00	417.00	4.94	27.60	1160.00	1800.00	1.05

9-10 cm	31.60	33400.00	8.16	13.20	4040.00	355.00	5.29	27.20	1140.00	1740.00	1.18
10-11 cm	27.00	29100.00	6.98	11.30	2970.00	279.00	5.20	22.80	908.00	1230.00	1.04
11-12 cm	28.80	30400.00	5.91	9.60	2950.00	276.00	4.99	23.00	993.00	1270.00	0.96
12-13 cm	24.20	24700.00	4.73	7.60	2440.00	232.00	3.78	19.40	806.00	990.00	0.81
13-14 cm	28.30	26500.00	4.94	9.60	2920.00	259.00	4.24	22.10	940.00	1260.00	0.84
14-15 cm	30.00	26700.00	4.77	12.50	3540.00	274.00	4.76	23.50	1020.00	1530.00	0.91
15-16 cm	30.50	26400.00	4.70	11.80	3420.00	277.00	4.95	24.30	970.00	1320.00	0.81
16-17 cm	26.30	26800.00	4.33	11.30	3050.00	255.00	5.17	21.60	861.00	1300.00	0.84
17-18 cm	26.10	26700.00	4.22	11.50	3080.00	254.00	4.99	21.40	871.00	1340.00	0.79
18-19 cm	25.10	25300.00	4.02	11.00	3020.00	233.00	4.58	20.00	751.00	1340.00	0.75
19-20 cm	27.90	28400.00	4.71	13.00	3350.00	260.00	5.30	23.10	823.00	1460.00	0.88
20-21 cm	27.80	25200.00	4.38	12.40	3250.00	243.00	4.65	23.20	758.00	1370.00	0.83
21-22 cm	29.10	25400.00	4.55	13.20	3290.00	230.00	5.08	23.80	770.00	1440.00	0.85
22-23 cm	30.10	27800.00	4.60	13.50	3280.00	234.00	5.81	25.30	797.00	1490.00	0.91
23-24 cm	28.10	29400.00	4.63	12.50	3150.00	238.00	5.40	23.40	754.00	1380.00	0.67

24-25 cm	27.00	32900.00	4.56	12.80	3230.00	263.00	5.21	23.10	798.00	1410.00	0.81
25-26 cm	29.60	39700.00	5.12	14.30	3710.00	316.00	5.70	25.60	954.00	1610.00	0.93
26-27 cm	28.90	38400.00	5.09	14.30	3780.00	322.00	5.45	25.60	957.00	1630.00	0.78
27-28 cm	23.00	32300.00	4.05	10.80	2870.00	261.00	4.81	20.40	758.00	1220.00	0.66
28-29 cm	24.10	32900.00	4.22	11.40	2990.00	268.00	5.06	21.40	798.00	1310.00	0.58
29-30 cm	22.20	30800.00	4.21	10.90	3170.00	265.00	4.72	19.80	703.00	1370.00	0.66

NW60	Ag	Na	Sr	S	Tl	Sn	Ti	W	U	V	Zn	Zr
0-1 cm	<0.10	410.00	73.70	4900.00	0.05	<2.0	165.00	<0.50	7.53	23.20	73.50	1.90
1-2 cm	<0.10	411.00	54.20	5100.00	0.07	<2.0	182.00	<0.50	9.28	25.70	61.60	2.00
2-3 cm	<0.10	439.00	55.90	5900.00	0.09	<2.0	216.00	<0.50	11.80	30.60	71.60	2.50
3-4 cm	<0.10	452.00	44.40	6300.00	0.11	<2.0	229.00	<0.50	13.70	32.10	77.80	3.20
4-5 cm	<0.10	417.00	41.50	6300.00	0.10	<2.0	216.00	<0.50	13.80	32.30	78.90	3.60
5-6 cm	<0.10	413.00	39.70	6400.00	0.11	<2.0	253.00	<0.50	14.60	32.90	79.90	3.50
6-7 cm	<0.10	515.00	47.70	8800.00	0.13	<2.0	320.00	<0.50	18.70	41.50	99.10	4.40
7-8 cm	<0.10	349.00	41.80	6700.00	0.11	<2.0	250.00	<0.50	15.80	31.60	76.90	3.20
8-9 cm	<0.10	471.00	42.70	7800.00	0.14	<2.0	322.00	<0.50	21.10	38.70	95.00	2.70

9-10 cm	<0.10	426.00	42.90	7900.00	0.14	<2.0	307.00	<0.50	22.50	39.20	91.70	2.80
10-11 cm	<0.10	333.00	37.80	6600.00	0.12	<2.0	230.00	<0.50	21.40	32.70	81.70	3.10
11-12 cm	<0.10	396.00	35.20	6500.00	0.11	<2.0	222.00	<0.50	18.20	33.30	79.30	2.90
12-13 cm	<0.10	297.00	31.50	5500.00	0.08	<2.0	163.00	<0.50	14.00	27.70	68.60	2.40
13-14 cm	<0.10	331.00	36.10	6100.00	0.09	<2.0	224.00	<0.50	15.00	32.80	82.00	3.00
14-15 cm	<0.10	398.00	38.70	6400.00	0.13	<2.0	267.00	<0.50	17.10	37.00	82.80	3.00
15-16 cm	<0.10	334.00	37.50	5700.00	0.13	<2.0	186.00	<0.50	18.00	36.20	82.70	2.30
16-17 cm	<0.10	301.00	34.30	5700.00	0.12	<2.0	186.00	<0.50	16.70	36.40	74.10	1.50
17-18 cm	<0.10	303.00	32.90	4800.00	0.13	<2.0	203.00	<0.50	15.20	36.60	72.10	2.20
18-19 cm	<0.10	332.00	30.40	4500.00	0.12	<2.0	192.00	<0.50	13.70	33.50	67.40	2.00
19-20 cm	<0.10	263.00	33.20	5500.00	0.14	<2.0	240.00	<0.50	16.40	37.60	80.30	2.30
20-21 cm	<0.10	288.00	31.00	5400.00	0.14	<2.0	221.00	0.62	16.30	34.40	79.40	2.10
21-22 cm	<0.10	282.00	32.70	5600.00	0.13	<2.0	221.00	<0.50	17.10	34.10	81.40	1.90
22-23 cm	<0.10	306.00	32.10	6000.00	0.15	<2.0	240.00	<0.50	16.50	36.30	91.30	1.70
23-24 cm	<0.10	265.00	31.20	4900.00	0.14	<2.0	205.00	<0.50	15.90	37.20	90.30	1.90

24-25 cm	<0.10	271.00	32.80	4500.00	0.13	<2.0	211.00	<0.50	16.60	39.90	91.80	1.50
25-26 cm	<0.10	332.00	38.40	4400.00	0.14	<2.0	228.00	<0.50	19.00	46.10	108.00	1.90
26-27 cm	<0.10	321.00	38.90	4400.00	0.13	<2.0	262.00	<0.50	18.30	45.10	105.00	1.30
27-28 cm	<0.10	244.00	31.10	3300.00	0.11	<2.0	187.00	<0.50	15.10	36.00	87.50	1.70
28-29 cm	<0.10	248.00	32.10	3900.00	0.12	<2.0	211.00	<0.50	15.10	37.60	90.70	2.00
29-30 cm	<0.10	259.00	30.30	3600.00	0.11	<2.0	209.00	<0.50	13.80	36.10	83.80	1.60

Table F7: NW70

NW70	Al	Sb	As	Ba	Be	Bi	B	Cd	Ca	Cr	Co
0-1 cm	2300	0.73	16.2	169	0.12	<0.20	26.7	0.198	8930	5.31	2.32
1-2 cm	2890	0.82	19.8	207	0.14	<0.20	27	0.21	9070	7.14	2.77
2-3 cm	2990	0.78	19.4	203	0.16	<0.20	25.2	0.231	8720	6.7	2.96
3-4 cm	3330	0.85	21.4	220	0.19	<0.20	26.8	0.252	9050	7.44	3.26
4-5 cm	3480	0.92	22.2	213	0.2	<0.20	26.8	0.261	9260	7.74	3.39
5-6 cm	3580	0.93	22.5	200	0.19	<0.20	24.2	0.265	8670	8.3	3.46
6-7 cm	4280	1.17	24.8	184	0.25	<0.20	23.8	0.297	8690	9.53	3.99
7-8 cm	5390	1.43	27.6	175	0.34	<0.20	22.4	0.37	8890	12.3	4.64
8-9 cm	6250	1.57	30.7	151	0.36	<0.20	18.8	0.367	7800	14.2	5.39
9-10 cm	7880	1.92	44.7	180	0.44	<0.20	20.1	0.453	8620	18.1	6.86
10-11 cm	9830	2.09	33.8	165	0.5	<0.20	16.9	0.446	7820	22.6	8.01
11-12 cm	10300	1.99	25.5	151	0.52	<0.20	13.2	0.413	6350	23.1	8.03
12-13 cm	12000	1.88	22.8	153	0.61	<0.20	11	0.446	5390	26.8	9.07
13-14 cm	13500	1.14	18.8	154	0.67	0.21	9.6	0.386	5330	29.8	10.2
14-15 cm	17800	0.81	23	198	0.89	0.27	9.8	0.473	5450	38.1	13.3
15-16 cm	17400	0.6	21.1	187	0.87	0.27	9.4	0.46	5220	37.3	13.3
16-17 cm	19200	0.46	21.2	208	0.98	0.3	9.5	0.502	5590	41.2	14.3

17-18 cm	19500	0.38	19	205	0.98	0.3	9.9	0.514	5570	42.3	14.2
18-19 cm	21500	0.36	20.7	217	1.06	0.33	11.2	0.536	5940	46.6	15.4
19-20 cm	21500	0.38	19.6	218	1.07	0.34	11.4	0.525	5770	46.8	15.5
20-21 cm	22800	0.35	20.4	227	1.11	0.34	12.5	0.509	5620	48.8	16
21-22 cm	24400	0.34	19.5	236	1.18	0.38	13.3	0.456	5830	52.9	16.7
22-23 cm	23000	0.3	14.2	221	1.13	0.35	12.1	0.377	5000	49.3	15.1
23-24 cm	25700	0.31	14.2	241	1.25	0.41	13	0.399	5320	55.3	16.8
24-25 cm	26100	0.3	13.4	247	1.23	0.41	13.6	0.395	5200	56.2	16.5
25-26 cm	27900	0.29	11.4	263	1.34	0.42	15.3	0.414	5270	58.6	16.6
26-27 cm	27100	0.27	7.76	264	1.39	0.43	15	0.348	5480	57.2	14.5
27-28 cm	29500	0.28	9.13	290	1.39	0.41	15.7	0.353	5190	60	15.7
28-29 cm	30700	0.29	9.99	304	1.39	0.4	17.4	0.387	5340	62	16.5
29-30 cm	31200	0.29	8.99	318	1.41	0.41	16.7	0.326	5450	64	16.5

NW70	Cu	Fe	Pb	Li	Mg	Mn	Mo	Ni	P	K	Se
0-1 cm	7.88	10700	2.66	2.7	2100	375	0.51	5.54	1260	1180	0.71
1-2 cm	8.55	11900	3.24	3	2130	318	0.69	6.61	1410	1190	0.85
2-3 cm	8.83	11800	3.5	2.9	2060	294	0.65	6.86	1490	1080	0.91
3-4 cm	9.93	12700	3.55	3.2	2190	305	0.76	7.47	1630	1120	0.76
4-5 cm	12.7	13300	3.92	3.4	2260	304	0.77	7.67	1700	1140	0.99
5-6 cm	10.7	13600	4.15	3.5	2180	289	0.8	8.27	1590	1060	0.92
6-7 cm	13.7	14200	5.34	4.4	2360	283	0.91	9.72	1640	1140	1
7-8 cm	16.3	15900	6.6	6.4	2680	304	1.16	11.9	1610	1230	0.96
8-9 cm	19.6	16600	7.46	8.4	2960	283	1.41	13.9	1320	1270	0.96
9-10 cm	23.8	22400	8.96	10.7	3600	341	1.74	17.2	1500	1520	1.15
10-11 cm	29	20900	9.39	15	4430	325	2.1	20.9	1150	1930	1.25
11-12 cm	29.4	20100	8.25	16.6	4600	302	2.12	21	835	2010	1.02
12-13 cm	33.8	21600	8.25	19.6	5160	302	2.63	24	700	2420	1.04
13-14 cm	38.4	20700	8.88	23.7	6000	291	3.33	27.6	479	2700	1.07
14-15 cm	50	25900	11.4	30.6	7640	345	4.58	37.1	517	3650	1.3
15-16 cm	48.5	25300	11	30.2	7590	332	4.4	38.2	453	3630	1.26

16-17 cm	52.7	27100	12.3	32.8	8340	367	4.75	40.9	448	3970	1.39
17-18 cm	52.8	27100	12.2	33.7	8470	372	4.48	38.5	454	4060	1.17
18-19 cm	55.8	29500	13.2	36.5	9260	415	4.96	41.7	481	4520	1.32
19-20 cm	54.2	29500	13.4	35.8	9110	412	5.05	42	500	4510	1.28
20-21 cm	52.7	31100	13.8	37.4	9580	421	5.2	43.1	501	4800	1.19
21-22 cm	50.2	33900	15	41.3	10300	447	5.24	45.4	564	5110	1.1
22-23 cm	42.4	25600	13.8	38.8	9790	394	4.13	42.5	506	4840	0.74
23-24 cm	44.6	35900	15.7	43.7	10900	438	4.6	46.7	567	5500	0.92
24-25 cm	41.4	36100	15.7	44.3	11200	435	4.25	48	574	5620	0.82
25-26 cm	41.1	36800	16.8	47.1	11700	440	3.33	47.4	614	6010	0.72
26-27 cm	36.7	34600	16.6	48.4	11500	415	2.04	39.5	599	5920	0.68
27-28 cm	37.7	36900	16.5	50.1	12000	423	2.46	42.3	635	6270	0.57
28-29 cm	39.8	37400	16.7	51.3	12300	430	3.28	43.4	655	6530	0.56
29-30 cm	38.3	38000	17.7	51.9	12600	435	2.81	43.2	703	6600	0.51

NW70	Ag	Na	Sr	S	Tl	Sn	Ti	W	U	V	Zn	Zr
0-1 cm	<0.10	1020	78.6	3900	0.068	<2.0	48.2	<0.50	2.2	5.54	305	<1.0
1-2 cm	<0.10	922	85.6	4700	0.066	<2.0	63.3	<0.50	2.98	6.74	124	1.5
2-3 cm	<0.10	817	82.7	4700	0.062	<2.0	59.5	<0.50	3.21	7.06	91	<1.0
3-4 cm	<0.10	760	89.4	5200	0.069	<2.0	67.9	<0.50	3.8	8.12	79.1	1.1
4-5 cm	<0.10	757	90.4	5400	0.072	<2.0	68.7	<0.50	4.04	8.67	83.4	1
5-6 cm	<0.10	660	83.9	5200	0.079	<2.0	73.1	<0.50	4.24	8.97	78.4	1.1
6-7 cm	<0.10	622	78	5700	0.095	<2.0	92	<0.50	5.1	10.9	77.5	1.3
7-8 cm	<0.10	558	76.7	6100	0.118	<2.0	111	<0.50	6.42	14.6	88.3	1.6
8-9 cm	<0.10	501	64.5	6300	0.14	<2.0	155	<0.50	6.92	17	82.9	2
9-10 cm	<0.10	505	71.1	7600	0.185	<2.0	192	<0.50	8.17	21.4	109	2.8
10-11 cm	<0.10	481	64.3	7000	0.188	<2.0	284	<0.50	9.97	26.9	99	4.3
11-12 cm	<0.10	415	52.8	5600	0.194	<2.0	352	<0.50	9.85	28	104	5.5

12-13 cm	<0.10	438	47	5000	0.226	<2.0	436	<0.50	12.1	33.5	86.4	8.9
13-14 cm	0.12	404	47.6	5600	0.234	<2.0	529	<0.50	13.7	38.4	68.2	15.1
14-15 cm	0.15	411	54.5	6000	0.266	<2.0	656	<0.50	17.7	50.8	82.5	24.3
15-16 cm	0.16	397	52.3	5700	0.262	<2.0	680	<0.50	16.4	49.3	80.4	24.8
16-17 cm	0.17	417	56.7	5700	0.281	<2.0	736	<0.50	17.4	53.4	85.8	28.2
17-18 cm	0.18	419	56.5	5200	0.28	<2.0	776	<0.50	17.3	55.2	85.8	30.2
18-19 cm	0.19	453	61.8	5600	0.301	<2.0	861	<0.50	18.3	60.6	94	33.1
19-20 cm	0.2	447	62.6	5000	0.322	<2.0	901	<0.50	16.6	63	93	35
20-21 cm	0.2	481	64.7	5100	0.337	<2.0	941	<0.50	15.2	64.8	93.2	37.6
21-22 cm	0.21	482	69.7	4400	0.347	<2.0	1030	<0.50	14	68	93.3	40.6
22-23 cm	0.18	440	63.5	2000	0.313	<2.0	961	<0.50	10.3	60.2	83.1	35.7
23-24 cm	0.2	480	70.3	2800	0.372	<2.0	1090	<0.50	10.7	65.3	90.1	39.5
24-25 cm	0.2	483	72.1	2300	0.374	<2.0	1120	<0.50	9.88	64.3	86.6	40.4
25-26 cm	0.2	519	79.4	1500	0.425	<2.0	1200	<0.50	10.5	70	88.4	44.1
26-27 cm	0.21	523	84.8	<1000	0.394	<2.0	1170	<0.50	10.2	66.2	84.3	44.3

27-28 cm	0.19	549	88.7	1000	0.417	<2.0	1230	<0.50	10.1	66.8	89	35.7
28-29 cm	0.19	560	93.5	1200	0.417	<2.0	1270	<0.50	10.4	67.9	91.2	32.2
29-30 cm	0.19	560	95.7	<1000	0.416	<2.0	1270	<0.50	9.81	69.4	93	34.2

Table F8: NW80

NW80	Al	Sb	As	Ba	Be	Bi	B	Cd	Ca	Cr	Co
0-1 cm	11900	0.3	17.9	141	0.46	<0.20	9.9	0.218	9790	22.6	8.36
1-2 cm	11700	0.43	19.8	132	0.45	<0.20	11.9	0.208	9180	22.4	8.38
2-3 cm	10800	0.44	19.7	120	0.46	<0.20	11.2	0.199	9170	25.4	7.81
3-4 cm	11100	0.44	22.5	120	0.45	<0.20	10.4	0.191	9170	39.8	8.18
4-5 cm	11600	0.39	24.7	118	0.47	<0.20	9.4	0.201	9270	22.4	8.17
5-6 cm	11200	0.39	25.5	115	0.45	<0.20	9	0.204	8890	22	7.98
6-7 cm	11800	0.51	29	121	0.45	<0.20	8.8	0.214	9310	23.8	8.61
7-8 cm	11800	0.71	31.8	125	0.47	<0.20	11.1	0.211	9150	23.8	8.44
8-9 cm	11600	0.56	31.8	116	0.47	<0.20	9.5	0.213	9040	23.9	8.25
9-10 cm	11000	0.38	29	103	0.46	<0.20	6.8	0.217	8840	23.6	8.46
10-11 cm	11000	0.37	26.2	94.5	0.45	<0.20	6.5	0.209	8850	23	8.18
11-12 cm	10800	0.28	23.4	98.7	0.42	<0.20	6.4	0.193	8730	22.8	8.16
12-13 cm	11600	0.23	21.9	105	0.44	<0.20	6.3	0.21	8510	24.1	8.62
13-14 cm	11800	0.24	18.4	112	0.44	<0.20	7.9	0.198	8820	24.8	8.55
14-15 cm	11600	0.16	14.5	109	0.44	<0.20	6.5	0.193	8610	26.1	8.56
15-16 cm	12400	0.16	12.3	124	0.47	<0.20	8.8	0.211	8840	25.8	8.97

16-17 cm	12200	0	9.32	112	0.46	<0.20	6.5	0.199	8940	24.4	8.82
17-18 cm	11600	0	7.47	117	0.43	<0.20	6.9	0.196	8600	24.4	8.48
18-19 cm	11800	0	6.84	121	0.45	<0.20	8.2	0.199	8870	25.1	8.64
19-20 cm	12200	0	6.53	123	0.46	<0.20	8.8	0.194	8960	25.5	8.82
20-21 cm	12000	0	5.93	125	0.46	<0.20	8.9	0.2	8950	25	8.65
21-22 cm	11600	0	5.21	116	0.46	<0.20	7.5	0.206	8620	23.7	8.62
22-23 cm	11200	0	4.89	111	0.45	<0.20	7.6	0.205	8290	23	8.51
23-24 cm	11000	0	4.39	109	0.45	<0.20	6.5	0.213	7910	22.9	8.89
24-25 cm	11400	0	4.26	122	0.45	<0.20	8.6	0.211	8360	23.4	9.07
25-26 cm	11800	0.17	4.15	117	0.48	<0.20	7.8	0.23	8720	24.3	9.39
26-27 cm	12100	0.13	3.99	117	0.49	<0.20	8	0.216	8780	24.5	9.51
27-28 cm	11500	0.1	3.59	107	0.46	<0.20	6.3	0.219	8300	23	9.13
28-29 cm	11800	0	3.45	108	0.48	<0.20	6.6	0.223	8760	23.6	9.36
29-30 cm	12000	0	3.3	106	0.48	<0.20	6.1	0.236	8760	24.1	10.3

NW80	Cu	Fe	Pb	Li	Mg	Mn	Mo	Ni	P	K	Se
0-1 cm	23.7	20300	5.22	15	4510	573	1.01	25.4	1490	1860	0.56

1-2 cm	24.3	20100	5.5	14.8	4270	490	1.14	25.6	1490	1890	0.58
2-3 cm	23.7	18700	5.54	14.5	4060	467	1.14	24.5	1290	1720	0.53
3-4 cm	24.3	18900	5.66	14.8	4040	462	1.39	30.9	1250	1730	0.54
4-5 cm	24.1	19200	5.49	15	4210	457	1.14	25.2	1290	1690	0.59
5-6 cm	23.7	18500	5.36	14.5	4130	431	1.04	25.5	1270	1640	0.54
6-7 cm	25.4	20000	5.6	15.5	4440	440	1.03	27.4	1310	1660	0.58
7-8 cm	26.2	20300	5.85	16.2	4330	408	0.99	26.8	1170	1840	0.62
8-9 cm	25.4	20100	5.62	16.5	4280	391	1	26.8	1180	1770	0.61
9-10 cm	24	19800	4.49	15.3	4270	392	0.91	27	1070	1440	0.56
10-11 cm	24.4	19300	4.06	15.7	4190	376	0.95	26.8	1030	1400	0.53
11-12 cm	23.6	19400	4.24	15.8	4050	367	1.03	26.7	956	1380	0.57
12-13 cm	25.2	20800	4.48	16.1	4190	376	1.09	28.1	993	1440	0.61
13-14 cm	26.6	20200	4.79	16.8	4230	378	1.16	28.2	1030	1730	0.57
14-15 cm	26.3	19600	4.46	16.2	4200	389	1.14	29	952	1450	0.59
15-16 cm	28	19900	4.81	17.2	4500	404	1.12	33.7	1010	1800	0.6
16-17 cm	26.1	18500	4.5	17.3	4340	405	1.09	29.1	964	1520	0.59
17-18 cm	26	17800	4.42	16.2	4150	401	0.97	27.9	912	1530	0.55
18-19 cm	26.6	17900	4.65	16.4	4190	408	0.96	28.6	928	1700	0.57
19-20 cm	27.7	18100	4.68	17	4310	418	0.98	29.3	1000	1780	0.64

20-21 cm	27.3	18000	4.59	16.6	4160	428	0.99	28.5	971	1770	0.65
21-22 cm	26.5	17400	4.27	16.2	3980	408	0.94	27.7	957	1550	0.58
22-23 cm	24.3	17600	3.93	15.7	3730	392	0.94	26.4	938	1540	0.6
23-24 cm	23.5	18200	3.79	15	3550	394	0.95	26.6	1000	1360	0.62
24-25 cm	25	18600	3.99	15.4	3720	412	0.9	27.2	1060	1570	0.66
25-26 cm	25	19100	4	15.5	3900	428	0.95	28	1100	1590	0.66
26-27 cm	24.9	19400	4.05	16	3860	440	0.99	27.8	1150	1600	0.64
27-28 cm	24.2	18800	3.75	14.8	3650	415	0.92	27.1	1120	1380	0.63
28-29 cm	23.9	19400	3.81	15.8	3840	441	0.92	27.4	1140	1430	0.65
29-30 cm	23.6	19300	3.64	15.7	3890	433	0.91	28.1	1110	1460	0.61

NW80	Ag	Na	Sr	S	Tl	Sn	Ti	W	U	V	Zn	Zr
0-1 cm	<0.10	549	51	9700	0.099	<2.0	176	<0.50	2.14	30.2	95.6	6.6
1-2 cm	<0.10	450	46.8	10100	0.114	<2.0	181	<0.50	2.26	30.5	74.5	5.9
2-3 cm	<0.10	422	46.8	10100	0.11	<2.0	159	<0.50	2.27	28.2	76.1	6.2
3-4 cm	<0.10	401	46.2	10800	0.106	<2.0	165	<0.50	2.29	28.5	69.9	6
4-5 cm	<0.10	430	47.2	11100	0.092	<2.0	173	<0.50	2.29	29.1	70	6.4
5-6 cm	<0.10	386	44.3	11200	0.094	<2.0	168	<0.50	2.21	28	69.6	6.1
6-7 cm	<0.10	406	46.2	12500	0.098	<2.0	179	<0.50	2.39	29.1	73.3	6.9
7-8 cm	<0.10	384	46.2	13000	0.117	<2.0	187	<0.50	2.6	28.6	93.5	6.4
8-9 cm	<0.10	369	45.3	13100	0.118	<2.0	185	<0.50	2.65	27.7	69.8	6.8

9-10 cm	<0.10	321	43.3	13400	0.082	<2.0	151	<0.50	2.47	26.9	70.4	6.8
10-11 cm	<0.10	330	43.4	13800	0.081	<2.0	153	<0.50	2.61	26.4	70.8	6.9
11-12 cm	<0.10	321	43	13500	0.079	<2.0	159	<0.50	2.66	25.9	68.1	6.9
12-13 cm	<0.10	316	42.8	13800	0.077	<2.0	179	<0.50	2.82	27.6	71.6	7.3
13-14 cm	<0.10	336	44.3	13300	0.11	<2.0	207	<0.50	2.94	28.3	70.6	7.2
14-15 cm	<0.10	321	43.3	12500	0.084	<2.0	188	<0.50	2.85	28.2	76	7.9
15-16 cm	<0.10	358	44.7	12100	0.112	<2.0	221	<0.50	3	30.4	75.5	7.7
16-17 cm	<0.10	325	45.4	11800	0.09	<2.0	201	<0.50	2.92	29.4	71.6	8
17-18 cm	<0.10	316	43.8	10600	0.093	<2.0	191	<0.50	2.77	28.6	69.5	7.5
18-19 cm	<0.10	333	44.2	10700	0.108	<2.0	201	<0.50	2.95	29.2	72.4	7.5
19-20 cm	<0.10	344	46.3	11400	0.117	<2.0	226	<0.50	2.94	30.3	74.9	7.5
20-21 cm	<0.10	347	45.9	11100	0.114	<2.0	210	<0.50	2.9	30.4	75	7.4
21-22 cm	<0.10	351	44.7	10700	0.099	<2.0	194	<0.50	2.7	28.6	72.5	7.2
22-23 cm	<0.10	332	42.6	11200	0.1	<2.0	185	<0.50	2.64	27.2	72.7	6.7
23-24 cm	<0.10	302	40.7	11000	0.091	<2.0	166	<0.50	2.59	26.3	75	7.1

24-25 cm	<0.10	334	43.3	11400	0.11	<2.0	182	<0.50	2.64	27.2	77.2	6.6
25-26 cm	<0.10	360	45.8	12100	0.111	<2.0	190	<0.50	2.63	27.9	81.1	7.2
26-27 cm	<0.10	369	45.6	12100	0.109	<2.0	193	<0.50	2.58	28.1	82.8	6.8
27-28 cm	<0.10	330	43.1	12000	0.083	<2.0	172	<0.50	2.38	26.3	81	6.6
28-29 cm	<0.10	337	45.2	12300	0.09	<2.0	176	<0.50	2.48	27.1	80	7.1
29-30 cm	<0.10	336	45	12400	0.083	<2.0	180	<0.50	2.43	27.1	81.5	7.5

Table F9: NE20

NE20	Al	Sb	As	Ba	Be	Bi	B	Cd	Ca	Cr	Co
0-1 cm	14800	0.66	71.8	230	0.72	0.21	18.9	0.36	8520	26.4	8.54
1-2 cm	12800	0.99	88.5	172	0.75	0.21	15	0.346	7750	23.1	8.47
2-3 cm	15200	1.5	111	174	0.91	0.24	13.6	0.383	8050	26	9.86
3-4 cm	17300	2.12	118	180	0.93	0.27	16.2	0.379	8360	27.8	11.1
4-5 cm	17300	2.19	101	168	0.88	0.27	13.3	0.331	6960	30.8	11.9
5-6 cm	16200	2.56	115	161	0.8	0.26	12.2	0.362	7060	29.6	11
6-7 cm	15400	3.11	127	166	0.8	0.25	11.9	0.368	7070	28.9	9.93
7-8 cm	15400	3.51	135	165	0.78	0.26	11.4	0.401	6950	28.9	9.48
8-9 cm	15600	2.3	113	155	0.74	0.25	10.7	0.377	6750	30.1	9.43
9-10 cm	17000	1.16	75.4	174	0.86	0.27	14.6	0.39	7350	31.2	10.3
10-11 cm	18700	0.58	54.9	192	0.91	0.3	14.8	0.417	7330	33.4	11
11-12 cm	17700	0.32	43.1	183	0.88	0.29	12.3	0.366	7310	32.6	11.1
12-13 cm	17600	0.21	35.5	181	0.86	0.28	11.2	0.334	6610	33.5	11.1

13-14 cm	17400	0.18	30.1	185	0.83	0.28	10.3	0.293	6090	35.6	11.4
14-15 cm	20700	0.16	23.1	231	0.87	0.28	10.6	0.265	5920	40.5	12.1
15-16 cm	21000	0.16	23.8	238	0.97	0.29	12.6	0.297	6210	38.8	12
16-17 cm	21200	0.15	24.5	251	1.05	0.28	12.2	0.364	6960	38.1	12.2
17-18 cm	20800	0.15	27.7	255	1.04	0.3	11.5	0.414	7170	35.7	12.3
18-19 cm	20100	0.15	27	254	1.04	0.29	11	0.401	7370	34.5	13.6
19-20 cm	19200	0.16	27.9	229	0.97	0.27	10.1	0.404	7130	35	14.4
20-21 cm	19200	0.16	23.4	238	0.94	0.3	11.5	0.369	7250	33.4	11.6
21-22 cm	18600	0.17	21.4	213	0.87	0.29	11.5	0.337	6660	33.7	11.8
22-23 cm	18900	0.15	19.7	229	0.91	0.29	10.8	0.325	6560	35.1	12
23-24 cm	18800	0.15	18.1	225	0.86	0.28	9.3	0.324	6470	35.5	11.8
24-25 cm	18500	0.16	18	221	0.84	0.28	10.3	0.288	6350	35.8	11.6
25-26 cm	18000	0.16	16.9	219	0.83	0.27	9.8	0.283	6210	34.7	11.1
26-27 cm	18200	0.15	16.8	228	0.84	0.27	10.2	0.307	6300	35.5	11.4
27-28 cm	19200	0.15	18.6	245	0.85	0.29	10.8	0.314	6530	36.8	12

28-29 cm	19200	0.14	17.7	230	0.85	0.28	12.1	0.304	6370	35.7	11.6
29-30 cm	19800	0.16	18.5	231	0.88	0.29	12.6	0.31	6620	36.4	11.7

NE20	Cu	Fe	Pb	Li	Mg	Mn	Mo	Ni	P	K	Se
0-1 cm	53.6	15300	5.93	21.1	6310	1020	1.66	41.8	3080	2960	0.93
1-2 cm	57.4	14200	5.98	17	4810	1120	1.92	45.9	2730	2090	0.73
2-3 cm	64.7	17300	6.49	19.1	4940	1230	2.08	50.7	2700	2100	0.78
3-4 cm	60.3	19300	8.17	21.3	5140	1190	2.02	50.2	2480	2390	0.87
4-5 cm	50.6	21600	9.66	26.4	5990	1050	1.58	45.5	1850	2810	0.75
5-6 cm	54.1	20200	11.1	23.1	5590	1010	1.81	48.2	1760	2530	0.73
6-7 cm	58.7	18900	10.7	22.9	5500	985	1.92	47.6	1760	2430	0.76
7-8 cm	59.8	18300	11.3	22.4	5280	973	2.17	47.3	1600	2370	0.8
8-9 cm	53.4	18200	9.7	22.8	5570	939	1.88	45.7	1520	2400	0.73
9-10 cm	55.3	19300	9.17	26.9	5610	945	1.79	47.1	1690	2690	0.79
10-11 cm	62.2	19700	8.8	24.7	5780	1000	1.85	49.1	1970	2750	0.72
11-12 cm	57.7	20000	8.1	29	6020	945	1.75	48.1	1700	2630	0.72
12-13 cm	51.6	20700	7.61	29	6310	914	1.77	46.7	1470	2640	0.71
13-14 cm	47.4	23600	7.58	29.1	6420	829	1.76	46.2	1230	3010	0.7
14-15 cm	46.3	24300	7.99	33.3	7620	847	1.51	44.5	1230	3440	0.47
15-16 cm	49.8	23600	7.73	31.1	6930	869	1.27	45	1480	3370	0.62
16-17 cm	55.4	22100	7.47	33.6	6780	948	1.28	47.6	1920	3060	0.65

17-18 cm	60.9	21800	7.28	29.7	6060	1030	1.47	48.1	2410	2890	0.74
18-19 cm	58.7	22500	7.12	28.3	5910	1010	1.47	46.4	2480	2710	0.7
19-20 cm	57.3	24700	6.64	27.5	5980	991	1.27	49.8	2440	2670	0.78
20-21 cm	53.1	21400	6.74	27.9	5800	926	1.27	44	2410	2810	0.72
21-22 cm	48.2	22200	7.07	28	6000	859	1.25	43.1	2020	2940	0.68
22-23 cm	48.2	22400	7.24	29	6310	855	1.17	42.5	1960	2980	0.62
23-24 cm	46.3	22200	7.29	29	6490	835	1.15	42	1710	2950	0.62
24-25 cm	44.2	23300	7.4	29.7	6570	794	1.27	42.6	1560	3090	0.61
25-26 cm	43.8	22400	7.27	29	6410	773	1.18	42.1	1430	2990	0.64
26-27 cm	43.6	21900	7.33	28.5	6450	784	1.12	41.7	1580	3020	0.6
27-28 cm	46.6	23300	7.52	29.3	6590	807	1.16	43.2	1700	3130	0.63
28-29 cm	44.8	22000	7.39	28	6360	764	1.06	40.7	1740	3180	0.64
29-30 cm	46.6	22400	7.41	27.8	6430	787	1.15	41.3	1860	3190	0.62

NE20	Ag	Na	Sr	S	Tl	Sn	Ti	W	U	V	Zn	Zr
0-1 cm	<0.10	816	44.1	12000	0.163	<2.0	223	1.59	8.2	27.9	153	1.8
1-2 cm	0.11	502	39.4	12700	0.148	<2.0	141	1.25	10.8	25.4	78.7	2.3
2-3 cm	0.14	494	44.6	15000	0.154	<2.0	157	1.12	11.3	27.8	82.9	2.6

3-4 cm	0.14	539	46.2	16900	0.174	<2.0	249	1.2	11.8	30.9	89.5	1.8
4-5 cm	0.13	468	40.8	15300	0.199	<2.0	291	0.94	10.7	33.7	87.1	2.3
5-6 cm	0.14	435	40	15200	0.194	<2.0	231	1.01	11.8	32.8	95	2.6
6-7 cm	0.17	439	40.2	14100	0.179	<2.0	188	0.93	12.1	31.4	89.1	2.3
7-8 cm	0.19	423	36.2	13700	0.188	<2.0	183	1.01	12.1	31.9	90.5	2.3
8-9 cm	0.17	429	36.8	13100	0.184	<2.0	203	0.99	11.5	32.6	86.9	2.6
9-10 cm	0.17	460	40.7	13900	0.206	<2.0	311	1.06	11.5	34.2	95.1	2.2
10-11 cm	0.18	478	44.4	13200	0.205	<2.0	328	1.12	12.6	36.8	100	2
11-12 cm	0.17	442	42.1	13400	0.195	<2.0	248	0.9	11.8	36.9	93.7	2.7
12-13 cm	0.16	427	37.4	13100	0.199	<2.0	256	0.86	11.5	38.9	90.3	2.7
13-14 cm	0.15	420	36.1	14600	0.228	<2.0	318	0.7	10.4	39.5	85.7	3
14-15 cm	0.15	474	41.5	10100	0.247	<2.0	442	0.57	9.03	42.9	87.5	3.7
15-16 cm	0.16	482	42.8	11800	0.242	<2.0	466	0.73	10.1	41.2	92.4	2.4
16-17 cm	0.17	487	45	10700	0.221	<2.0	369	0.8	11.2	40.9	101	2.6
17-18 cm	0.16	484	45.9	13000	0.218	<2.0	305	0.97	12.3	39.9	106	2.6
18-19 cm	0.14	427	46	14100	0.215	<2.0	282	0.96	12.3	38.4	102	2.4
19-20 cm	0.15	413	44.5	17100	0.199	<2.0	263	0.92	11.8	37.9	103	2.7
20-21 cm	0.14	414	43.7	14000	0.204	<2.0	307	1	10.9	37.8	94.2	2.2

21-22 cm	0.14	395	42.1	13900	0.211	<2.0	334	0.83	10.5	37.6	89.2	2.9
22-23 cm	0.15	392	42.3	12500	0.207	<2.0	343	0.78	10.2	38.5	90.2	2.9
23-24 cm	0.14	391	40.5	12000	0.209	<2.0	287	0.69	10.2	38.8	91.4	3.3
24-25 cm	0.14	391	39.4	12300	0.216	<2.0	362	0.81	10	39.9	88.1	3
25-26 cm	0.14	393	38.5	11500	0.212	<2.0	333	0.73	10.2	38.9	86	3.2
26-27 cm	0.14	395	39.4	10700	0.21	<2.0	342	0.66	10	39	88.1	3.1
27-28 cm	0.15	409	42.2	11500	0.211	<2.0	384	0.74	10.2	40.6	92.8	3.1
28-29 cm	0.13	418	43.7	11300	0.209	<2.0	443	0.74	9.8	39	89.7	2.6
29-30 cm	0.14	429	43.8	11300	0.214	<2.0	451	0.79	10	40.4	88.8	2.6

Table F10: NE40

NE40	Al	Sb	As	Ba	Be	Bi	B	Cd	Ca	Cr	Co
0-1 cm	3060	0.35	6.95	82.4	0.11	<0.20	24.5	0.22	18300	8.77	4.38
1-2 cm	3210	0.37	7.91	70	0.12	<0.20	24	0.232	16400	9.55	4.79
2-3 cm	3360	0.41	8.95	58.2	0.12	<0.20	24.8	0.248	16500	10.2	5.02
3-4 cm	3500	0.43	9.42	56	0.13	<0.20	24	0.255	16500	10.3	5.16
4-5 cm	3300	0.46	9.34	52.8	0.12	<0.20	23.4	0.246	15400	9.73	4.93
5-6 cm	3400	0.46	9.24	51.1	0.12	<0.20	23.1	0.248	15200	9.81	4.99
6-7 cm	3460	0.44	8.99	46.9	0.14	<0.20	24.4	0.234	15800	10.2	4.97
7-8 cm	3560	0.41	8.71	45.1	0.13	<0.20	23.2	0.255	16000	10.8	5.11
8-9 cm	3580	0.45	9.52	43.5	0.14	<0.20	23.4	0.268	15800	10.8	5.44
9-10 cm	3770	0.6	10.9	42.4	0.13	<0.20	21.4	0.273	14600	11.2	5.68

10-11 cm	3960	0.53	11.8	42.3	0.15	<0.20	24.4	0.314	14900	11.3	5.74
11-12 cm	3790	0.58	12	42.2	0.16	<0.20	23.7	0.323	14900	11.1	5.78
12-13 cm	3540	0.56	12	40.3	0.13	<0.20	22	0.298	14400	10.3	5.45
13-14 cm	3710	0.66	14.2	41.4	0.15	<0.20	21.8	0.325	14600	10.9	5.74
14-15 cm	3690	0.79	16	42.8	0.15	<0.20	21.7	0.315	14900	10.9	5.92
15-16 cm	3950	0.95	18.8	45.1	0.15	<0.20	20.9	0.335	15300	11.1	6.2
16-17 cm	3970	0.83	17.2	50.9	0.16	<0.20	19.9	0.327	15300	11.1	5.97
17-18 cm	4130	0.59	13.8	46.9	0.17	<0.20	20.5	0.32	15800	11.7	6.09
18-19 cm	4070	0.43	11	45.1	0.18	<0.20	18.8	0.343	14700	11.7	6.46
19-20 cm	4010	0.33	8.8	42.4	0.16	<0.20	19.6	0.364	14100	11.5	6.8
20-21 cm	3920	0.3	7.6	40.8	0.17	<0.20	19.7	0.363	13400	11.3	6.84
21-22 cm	4080	0.24	6.64	42.9	0.17	<0.20	20.5	0.35	14900	11.5	6.79
22-23 cm	4070	0.21	5.88	43.4	0.16	<0.20	19.9	0.343	14800	11.4	6.3
23-24 cm	3730	0.17	4.59	41.3	0.15	<0.20	18.5	0.289	13900	10.4	5.44
24-25 cm	3570	0.14	3.76	41.1	0.15	<0.20	16.3	0.271	13900	9.78	5.01

25-26 cm	3820	0.1	2.99	42.4	0.14	<0.20	16.1	0.285	14700	10.1	5.09
26-27 cm	4130	0	2.71	44.1	0.15	<0.20	16.3	0.34	14400	10.9	5.71
27-28 cm	4240	0	2.32	43	0.16	<0.20	16.5	0.328	14400	10.8	5.76
28-29 cm	4260	0	2.2	42.8	0.15	<0.20	16.5	0.289	14100	11.2	5.88
29-30 cm	4480	0.11	2.23	42.6	0.14	<0.20	17	0.329	14100	12.1	6.67

NE40	Cu	Fe	Pb	Li	Mg	Mn	Mo	Ni	P	K	Se
0-1 cm	23.6	2570	2.01	<2.0	3360	199	0.72	25.3	1860	830	0.67
1-2 cm	23.6	2940	2.18	<2.0	3200	196	0.75	27	1490	610	0.7
2-3 cm	24.8	3140	2.41	<2.0	3230	166	0.8	28.6	1270	460	0.77
3-4 cm	25.1	3230	2.52	<2.0	3130	162	0.81	29.1	1240	440	0.72
4-5 cm	24	3020	2.54	<2.0	3030	148	0.78	27.8	1100	410	0.74
5-6 cm	24.4	3050	2.5	<2.0	3050	149	0.81	27.8	1120	400	0.78
6-7 cm	24.9	2860	2.48	<2.0	3240	151	0.8	28.5	1060	390	0.73
7-8 cm	23.8	2940	2.48	<2.0	3280	159	0.75	29.3	1060	370	0.7
8-9 cm	24	3290	2.75	<2.0	3220	151	0.74	29.7	1010	330	0.77
9-10 cm	24.3	4540	2.29	<2.0	3300	149	0.79	31.1	966	310	0.74
10-11 cm	26.4	4090	3.44	<2.0	3300	148	0.78	32.6	936	310	0.81
11-12 cm	26.6	3560	3.93	<2.0	3190	141	0.83	32.4	870	300	0.82
12-13 cm	25	3430	4.06	<2.0	3150	137	0.75	31	793	270	0.73
13-14 cm	26.1	4050	3.99	<2.0	3170	142	0.73	31.8	800	260	0.78

14-15 cm	26.8	4170	3.89	<2.0	3320	148	0.78	32.1	785	260	0.83
15-16 cm	29	4800	3.5	<2.0	3520	158	0.85	34.1	764	270	0.86
16-17 cm	28.9	4240	3.04	<2.0	3490	156	0.85	34.1	774	260	0.84
17-18 cm	30.2	4240	2.65	<2.0	3520	163	0.84	34.2	749	260	0.84
18-19 cm	30.1	4320	2.5	<2.0	3300	153	0.92	35.1	731	250	0.8
19-20 cm	32.5	4390	2.42	<2.0	3090	144	0.98	37.4	752	240	0.84
20-21 cm	35.5	3650	1.96	<2.0	2880	136	1.1	38.4	743	250	0.9
21-22 cm	36.5	3190	1.6	<2.0	3190	149	1.11	39.6	752	250	0.89
22-23 cm	36.3	3010	1.32	<2.0	3070	149	1.07	38.6	728	240	0.96
23-24 cm	32.5	3030	1.03	<2.0	2920	140	0.93	34.7	703	230	0.84
24-25 cm	29.6	3060	0.91	<2.0	2560	140	0.92	32.4	634	200	0.78
25-26 cm	27.2	2810	0.84	<2.0	2820	156	0.87	31.1	646	210	0.78
26-27 cm	29.8	3110	0.9	<2.0	2780	153	0.95	35	645	230	0.93
27-28 cm	30.2	2940	0.86	<2.0	2750	150	1.05	33.3	637	240	0.87
28-29 cm	31.7	2940	0.83	<2.0	2480	142	1.08	33.8	656	240	0.9

29-30 cm	35.7	2730	0.85	<2.0	2690	146	1.22	36.9	727	260	0.87

NE40	Ag	Na	Sr	S	Tl	Sn	Ti	W	U	V	Zn	Zr
0-1 cm	<0.10	355	72.6	12300	<0.050	<2.0	51.8	<0.50	1.04	4.99	44.5	2.1
1-2 cm	<0.10	300	65.5	12500	<0.050	<2.0	46.6	<0.50	1.05	5.3	46.5	2.3
2-3 cm	<0.10	304	64.4	13600	<0.050	<2.0	47.5	<0.50	1.11	5.7	48.8	2.7
3-4 cm	<0.10	287	62.5	13300	<0.050	<2.0	51.2	<0.50	1.11	5.86	48.9	2.8
4-5 cm	<0.10	277	58.9	13200	<0.050	<2.0	56.1	<0.50	1.09	5.66	46.3	2.7
5-6 cm	<0.10	280	59.9	13400	<0.050	<2.0	59.4	<0.50	1.11	5.85	45.2	2.9
6-7 cm	<0.10	298	61.5	12800	<0.050	<2.0	61.2	<0.50	1.15	5.82	43.5	3.1
7-8 cm	<0.10	279	61.3	13300	<0.050	<2.0	48	<0.50	1.12	5.81	43	3
8-9 cm	<0.10	274	60.5	13500	<0.050	<2.0	51.2	<0.50	1.16	5.63	44.8	3.1
9-10 cm	<0.10	269	57.8	15300	<0.050	<2.0	48.1	<0.50	1.04	5.9	51.6	3.2
10-11 cm	<0.10	262	57.9	15300	0.05	<2.0	59.2	<0.50	1.13	6.1	55.6	3.3
11-12 cm	<0.10	263	58.3	14500	0.202	<2.0	55.1	<0.50	1.2	6.18	59.7	3.1
12-13 cm	<0.10	255	56.8	14600	0.054	<2.0	50.4	<0.50	1.11	5.63	56.4	3
13-14 cm	<0.10	237	55.8	15300	0.061	<2.0	54.4	<0.50	1.16	5.88	57.6	3.1
14-15 cm	<0.10	245	58.8	15900	0.072	<2.0	54.8	<0.50	1.21	6.23	58.3	3
15-16 cm	<0.10	250	60	17100	0.068	<2.0	62.3	<0.50	1.26	6.82	62.8	3.3
16-17 cm	<0.10	240	60.9	16400	0.095	<2.0	62.6	<0.50	1.27	6.83	61.4	3.3
17-18 cm	<0.10	235	62.6	16400	0.082	<2.0	65.1	<0.50	1.34	7.01	58.9	3.3

18-19 cm	<0.10	233	60.6	16100	0.156	<2.0	59.8	<0.50	1.29	7.01	59.1	3.3
19-20 cm	<0.10	222	57.5	15700	0.077	<2.0	55.3	<0.50	1.25	6.93	71.1	3.2
20-21 cm	<0.10	227	54.9	14700	0.188	<2.0	55.2	<0.50	1.27	7.45	81.5	3.1
21-22 cm	<0.10	239	59.1	15900	0.096	<2.0	57.2	<0.50	1.31	8.05	82.6	3.3
22-23 cm	<0.10	223	59.5	15800	0.075	<2.0	60.9	<0.50	1.26	7.97	78.9	3.3
23-24 cm	<0.10	222	55	14700	0.056	<2.0	57.6	<0.50	1.18	7.14	65.8	2.8
24-25 cm	<0.10	174	55	13700	0.057	<2.0	51.8	<0.50	1.12	7.06	62.8	2.6
25-26 cm	<0.10	197	56.8	14300	0.056	<2.0	52.6	<0.50	1.11	7.08	63.4	2.5
26-27 cm	<0.10	206	57.4	15100	0.067	<2.0	62.5	<0.50	1.23	7.27	71.5	2.8
27-28 cm	<0.10	222	56.9	15100	0.068	<2.0	63.1	<0.50	1.27	7.37	72.1	3
28-29 cm	<0.10	190	54.3	14200	0.071	<2.0	64.3	<0.50	1.33	7.41	68.1	2.8
29-30 cm	<0.10	236	56.2	14700	0.074	<2.0	64.2	<0.50	1.39	7.8	72.3	3