PHYSICAL INDICATORS OF ICE-JAM INDUCED FLOODING AND THE HISTORY OF FLOOD FREQUENCY IN CORES TAKEN FROM LAKES WITHIN THE PEACE-ATHABASCA DELTA, NORTHERN ALBERTA, CANADA

by

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A thesis

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In partial fulfillment of the requirements

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THE UNIVERSITY OF MANITOBA

FACULTY OF GRADUATE STUDIES

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A Thesis/Practicum submitted to the Faculty of Graduate Studies of The University of Manitoba in partial fulfillment of the requirement of the degree

Of

MASTER OF SCIENCE

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Abstract

Ice-jam induced flooding of the Peace-Athabasca Delta (PAD) in northern Alberta, Canada is thought to be the primary mechanism for the recharging of hydrologically isolated basins within the delta. Core analyses from lakes selected on the basis of sensitivity to flooding indicate that dark-colored laminations within the cores are coarser, have higher magnetic susceptibilities, lower moisture content, plus higher quartz, feldspar and carbonate content than lighter laminations. These dark-colored laminations reflect non-flood deposition, whereas the finer-grained, lighter-colored laminations signify flood deposition. Sequences from highly flood sensitive lakes display well-defined laminations and bedding features that contain clear evidence of changing energy conditions, exhibit the highest rates of deposition, and record the highest lamination counts. In basins that likely experience less frequent flooding, laminations and bedding features become less well-defined, there is less variability in grain size and organic content, deposition rates decline, laminae frequency decreases, and the average thickness of individual laminations increases. Variability of laminae frequency and thickness within the sequences clearly illustrates the role of climate change in the delta. Variations in texture and mineralogy not only demonstrate the role of climate change within the delta, but also suggest changes in the conditions of individual lakes indicating that the regulation of Peace River water flow by the W.A.C. Bennett Dam may have accelerated the effects of climate change within some portions the PAD.

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Chapter 1

Introduction

Purpose and General Description of the Study

The Peace-Athabasca Delta (PAD), in northern Alberta, Canada, is a site recognized by the Ramsar Convention in 1982 as an internationally significant waterfowl habitat (Frazier, 1999). A drying trend within the delta has been observed since 1968, when the W.A.C. Bennett Dam first began to regulate the flow of the Peace River near Hudson's Hope, British Columbia, approximately 1100 km upstream from the PAD (PADPG, 1972 and 1973). Concern for the PAD has led to an investigation into the impact of flow regulation on the delta within the context of the overall effects of climate change and variability within the region. This study presents some of the work that was done as a part of this investigation.

Ice-jam induced flooding of the PAD is thought to be the primary mechanism for recharging perched (hydrologically isolated) basins within the delta (Prowse and Lalonde, 1996). Ice-jam induced flooding is therefore important to the local ecosystem that depends on seasonal and annual water fluctuations, along with periodic flooding of the major lakes and perched basins, to maintain the delta's high biodiversity and productivity. Separating the role that man-made changes to hydrology have had on the PAD from the overall impact of climate change is a difficult task. This study has two main purposes: the first is to determine if physical indicators can be used to designate deposits of flood and non-flood origins within the cores; the second is to decipher the history of ice-jam floods in four isolated basins within the delta. These objectives were accomplished through mineralogical, geomagnetic and digital image analyses of PAD lake sediment cores.

Location

The Peace-Athabasca Delta is located mainly within the confines of Wood Buffalo National Park, in northern Alberta (Figure 1). Cores were taken from perched basins within the PAD that were selected to provide a broad range of sensitivities to ice-jam flood events. This study considers only the four locations within the PAD that provided cores with clear laminations and sedimentary structures (Figure 2). Lake 233, where PAD 54 was collected, is a flood-sensitive cut-off meander of Chenal des Quatre Fourches located on National Topographic Survey System (NTS) map 74L/13 at N 6525093, E 0467268. PAD 15 was recovered from Lake 555, a flood-sensitive ox-bow lake that was once a meander of Revillon Coupé, and which lies on the border of NTS 74/13 and 74/14 at N 6534074, E 0471879. PAD 8 was obtained from Lake 582, a site with average flood-sensitivity, connected by a creek to Rivière des Rochers and located on NTS 74L/14 at N 6518895, E 0479477. Greenstar Lake, where PAD 18 was recovered, is only affected by extreme flood events, and is located on NTS 74L/14 at N 6529625, E 0479462.

Previous Work

Early studies of the Mackenzie River Basin were conducted by Kindle (1918), Camsell and Malcolm (1921), and Hume (1924). A detailed geological investigation of the PAD was not carried out until after the construction of the W.A.C. Bennett Dam.

Much of the previous work on the PAD has been done from two major perspectives, one which has emphasized the role that climate change has played within the region, and a second that has focused on the effect of man-made hydrological changes on water levels within the delta. The major problem that plagues many of these studies is that although both climate change and man-made hydrological changes influence the delta, it is very difficult to separate the extent of each individual effect.

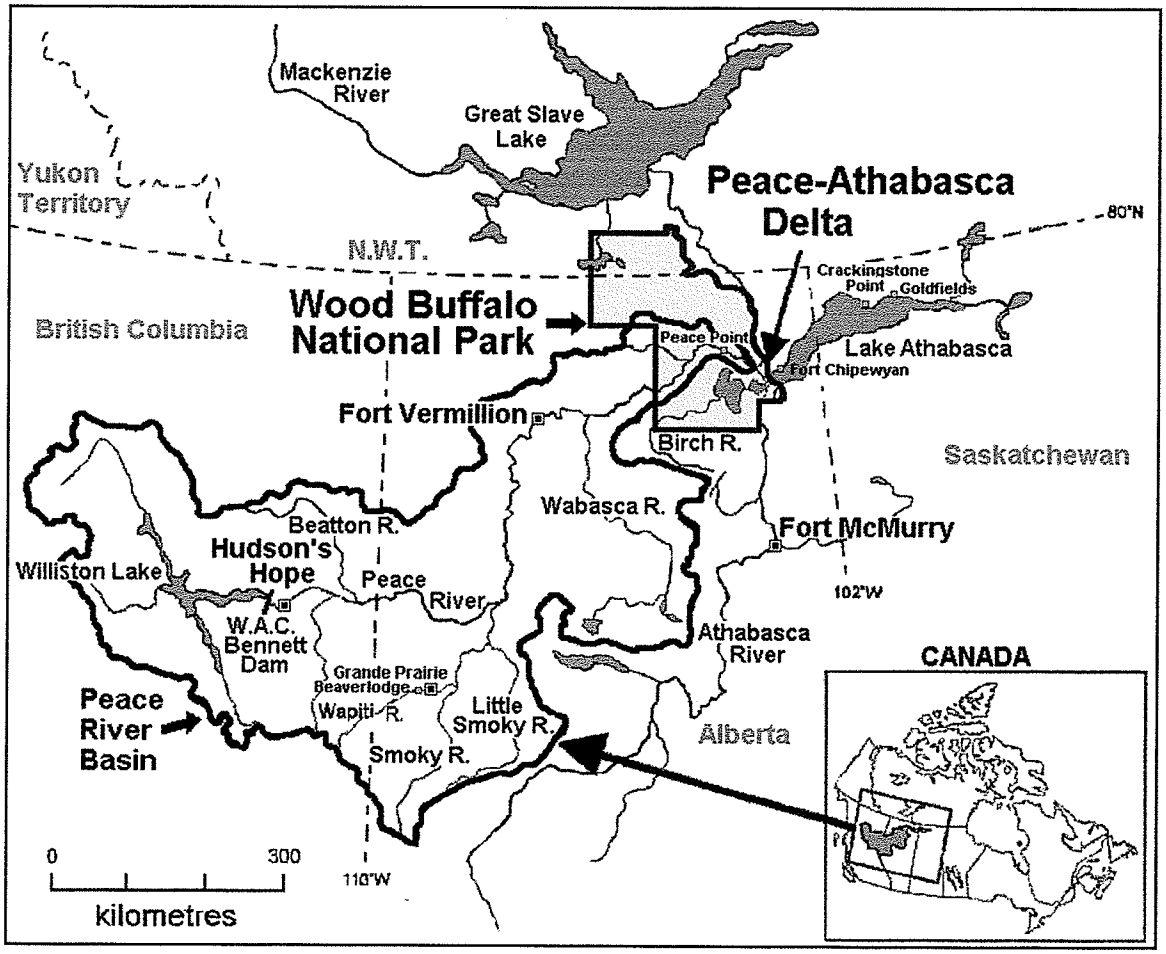

Figure 1. The location of the Peace-Athabasca Delta in northern Alberta, Canada (modified from Prowse and Lalonde, 1996).

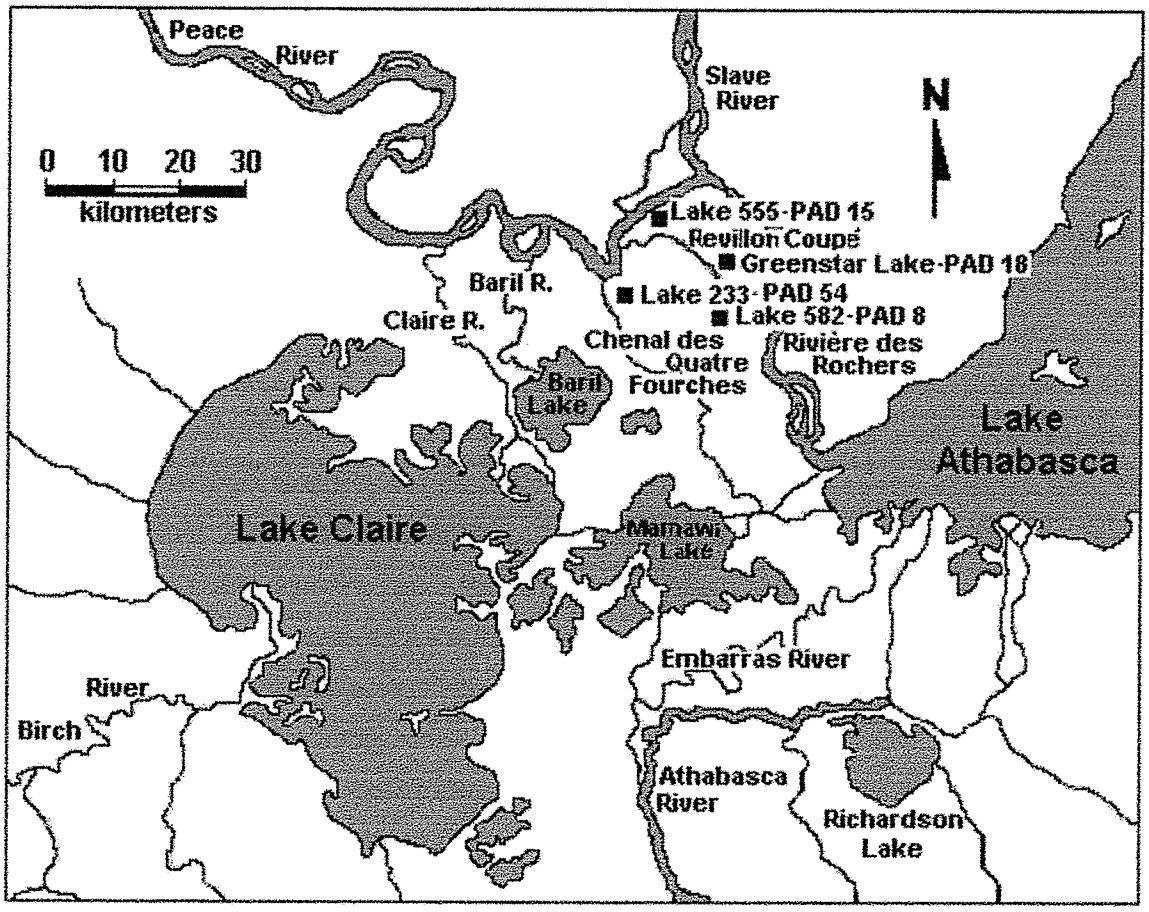

Figure 2. Locations of core sites within the Peace-Athabasca Delta (modified from Prowse and Lalonde, 1996).

In anticipation of possible changes to the PAD, Novakowski (1967) documented water conditions and floral composition of the delta before regulation of the Peace River began in 1968 so that future hydrological and biological changes to the delta could be recognized and evaluated from this initial point of reference.

Within two years of the W.A.C. Bennett Dam's initial regulation of the Peace River, scientists began to express concern over the possible role of regulation in depriving Lake Athabasca and the PAD of flood waters needed to sustain the delta ecology. The Peace Athabasca Delta Project Group (1972, 1973), an interdisciplinary task force, was established in 1971 to investigate the causes of reduced water levels in the PAD, determine possible remedies, and to forecast probable side effects of any remedial work to be done. A number of works were published by participants in this group. Bayrock and Root (1972) conducted the first detailed study of the bedrock and surficial geology of the PAD, with emphasis on the sedimentation rates and patterns within the delta. Nielsen (1972) investigated the groundwater regime of the delta, and evaluated changes in groundwater movement subsequent to regulation. Bennett et al. (1973) compiled and correlated data on Lake Athabasca in order to simulate regulated and non-regulated water levels for Lake Athabasca. The Peace Athabasca Project Group (1972, 1973) came to the conclusion that upstream flow regulation of the Peace River had reduced summertime peak flows, generated increased winter flows, and had caused a net decline in PAD water levels. This study recommended the construction of rock weirs in order to restrict the northward flow of water out of Lake Athabasca via Revillon Coupé and Rivière des Rochers.

Bray and Kellerhals (1979) completed their study on the effect of man-made hydrological changes to rivers shortly after the twelfth and final generating station had been installed at the W.A.C. Bennett Dam. Their work documents the effects of reduced peak flow levels of the Peace River in reducing the ability of the river to transport gravel

bed material, resulting in the deposition of gravel along the river channel, forming small deltas where tributaries connect with the main channel.

Gerard (1981) examined ice-scars dated from 1910 to 1980 on trees found along the Peace River near Fort Vermillion. This study found much higher levels of scarring prior to regulation of the Peace River.

Muzik (1985) looked at the magnitude of changes in the discharge of the Peace River along with the changes in water levels and water balance of Lake Athabasca subsequent to regulation. This study also considered the effectiveness of submerged rock weirs constructed following the recommendations of the Peace Athabasca Delta Project Group (1972, 1973). Muzik (1985) found that while remedial measures had had some effect in raising Lake Athabasca levels, historic conditions in the delta had not been achieved.

Prowse et al. (1996a) also considered the effectiveness of weirs within the PAD and determined that the restricted northward flow of water had helped restore peak summertime levels within much of the delta.

Prowse and Lalonde (1996) considered the reasons for the failure of remedial measures such as weirs, along with the failure of the largest open-water flow event recorded during the last 35 years in 1990, to inundate perched basins within the PAD. Open-water events occur as a result of increased amounts of water flowing in from upstream sources. Ice-jam induced flooding occurs when water cannot flow downstream because ice blocks the way, causing water to back up over the delta. Prowse and Lalonde (1996) gave evidence to show the importance of ice-jam flooding as the historical source of high water levels capable of recharging perched basins. Water levels produced by ice-jam induced flooding were shown to exceed levels produced by the 1990 open-water flow event biennially during the 1960's before

regulation, while only four significant events occurred over a period of 25 post-regulation years.

The Northern River Basins Study (1996), and its companion initiative, PAD Technical Studies (1996) were launched in response to concerns about the effects of regulation on the PAD as well as with concerns regarding the effects of new industrial development on northern waterways. New options for restoring historical PAD water levels were considered by these studies. Some of the major findings of the many works that contributed to these studies (such as Prowse et al., 1996b; 1996c; and Andres, 1996) include: the understanding that ice-jam induced flooding on the Peace and Athabasca Rivers in the spring is essential for the recharging of isolated perched basins; and that the frequency of significant spring flooding of the PAD has decreased since regulation began due to the effects of both regulation and climate variability. This study recommended changes in the flow regulation scheme employed by the W.A.C. Bennett Dam so that increases in flow would be made in years where the downstream tributary flow was forecast to be high.

The Mackenzie Basin Impact Study (1997) was concerned primarily with the potential impacts of global climatic changes within an extensive area of northern Canada. This study concluded that climatic changes would likely lead to increased precipitation, which would be more than compensated for by increased evaporation and evapotranspiration, leading to lower water levels with decreased flows, earlier spring breakups, and higher early-spring flows (Kerr, 1997). The role of the W.A.C. Bennett Dam is also discussed in this study, where consideration is given to the effect of regulation in lowering summertime flow levels of the Peace River acting in concert with reduced inflows due to climate change.

Timoney et al. (1997) conducted a flood history analysis of the PAD for the period 1826 to 1995 using a statistical approach to determine if any patterns were

present in the spring flooding of the delta. They found that the period 1860 to 1880 was a time of infrequent flooding, and that the period 1915 to 1950 was a time of unusually frequent flooding. Timoney et al. (1997) concluded that the temporal pattern of flooding is non-random and that it is influenced primarily by climatic changes.

Prowse and Conly (1998) attempted to determine if change had occurred within the major hydrometeorological conditions controlling the break-up of the Peace River that could account for the dramatic contrast in the frequency of large ice-jam induced flooding of the PAD before and after regulation. They concluded that regulation influences the occurrence of ice-jam induced flood events as a result of higher winter flows and freeze-up elevations. They also determined that the production of severe ice-jams and break-ups in the Peace River has become more dependent on tributary inflow below the point of regulation.

Leconte et al. (2001) attempted to define the role of an enhanced reservoir release in combination with the prevailing hydroclimatic conditions that had led to the summer 1996 open-water flood event on the PAD. They found that a precautionary drawdown release of the Williston Reservoir had helped to produce the flood of 1996, and had also temporarily restored a hydrodynamic regime to the PAD similar to that of unregulated conditions.

Peters and Prowse (2001) quantified the effects of regulation on the Peace River based on comparison between pre-regulated, regulated and naturalized flow regimes. They found that regulation of the Peace River has led to increased average winter flows, decreased annual peaks in water levels, and has reduced the overall variability of downstream flow.

Prowse et al. (2002) considered the effectiveness of the 1996 drawdown spill of the Williston Reservoir in restoring the water regime of the PAD. They concluded that by increasing flow from the reservoir when hydrometeorological conditions favored ice-jam

formation, it was possible to significantly increase the height of the maximum stage of ice-jam flooding of the delta.

Beltaos (2002) used numerical modeling to investigate the threshold flows required to produce significant flooding of the PAD at times when ice-jams were in place. It was concluded that at least 4,000 m^3/s is required to produce significant flooding of the PAD.

A number of studies have been done in contribution to the *Multi-Century Flood, Climatic, and Ecological History of the Peace-Athabasca Delta, Northern Alberta, Canada* project including Wolfe et al. (2001, 2002a, 2002b, 2002c, 2002d), Karst et al. (2002), McGowan et al. (2002), Black et al. (2003) and Karst-Riddoch et al. (2003). The emphasis of these works is that a multidisciplinary multi-proxy approach can be used to understand the present and past hydrology of the PAD. These studies demonstrated that climatic change may produce hydrological variability within the delta that can be seen as variability in biological, chemical and physical proxies.

Physiographic Setting

Novakowski (1967) divided the PAD and the surrounding area within Wood Buffalo National Park into four physiographic units (Figure 3), which are referred to here as the Birch Mountains, Morainic Hills, PAD and West Shore Units. The Birch Mountains Unit comprises the area of the park south of the Birch River to the boundary of the Birch Mountains. The Morainic Hills Unit can be found north of the Birch River to the Peace River, ending approximately 8 km from the west shore of Lake Claire. The PAD Unit, which includes the four core locations discussed in this thesis, is enclosed in a basin bounded by the Birch Mountains on the south, morainic deposits on the west, and the higher north banks of the Peace River to the north. The West Shore Unit refers to

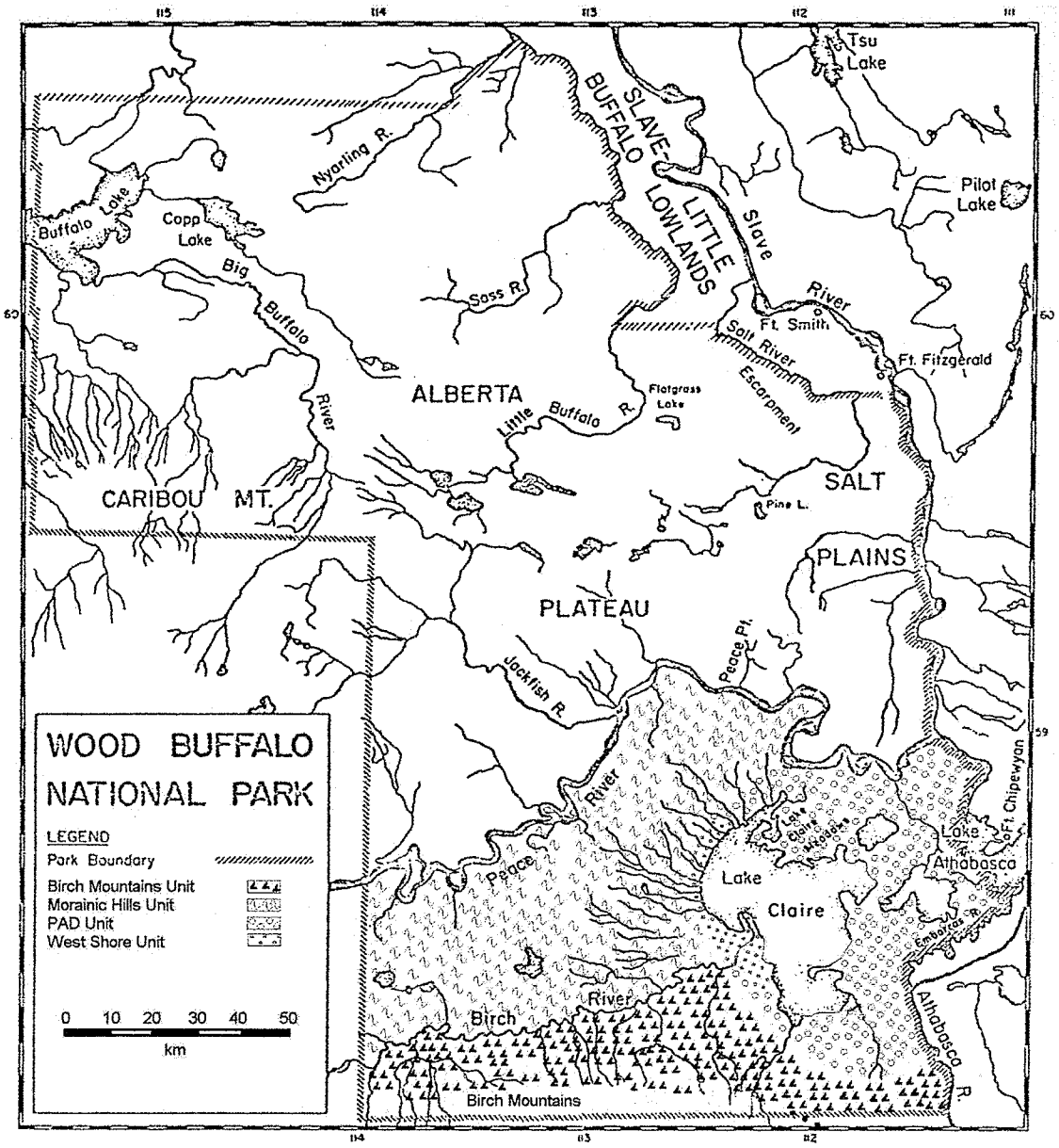

Figure 3. Physiographic units within Wood Buffalo National Park, northern Alberta, Canada (modified from Novakowski, 1967).

the western shore of Lake Claire, which is receding due to levee formation as a result of ice-action.

The Birch Mountains were formed towards the end of the Cretaceous as extensive seas withdrew from northeast Alberta, subjecting the landscape to continuous erosion (Bayrock and Root, 1972). Erosion was less severe in the Birch Mountains than in the surrounding area, so that bedrock of Cretaceous age remained here while areas west of the Slave River were scoured down to Devonian formations and the Fort Chipewyan region was stripped down to Precambrian Shield rocks (Bayrock and Root, 1972). The Birch Mountains were formed about the same time as the PAD, and were not significantly altered by glaciation during the Pleistocene (Novakowski, 1967). The mountains rise to approximately 700 m asl, which is roughly 500 m above the level of the PAD. The Birch River starts its journey toward Lake Claire flowing swiftly down the mountains, reaches base level approximately 60 km from Lake Claire, and forms a delta where it flows into the west shore of the lake.

The Morainic Hills Unit is characterized by hills of sand, low-lying ponds and sloughs, and poorly developed drainage systems (Novakowski, 1967). The moraines are oriented from northwest to southeast, and were likely deposited as the Laurentide Glacier retreated during the last glacial epoch. The hills are typically less than about 45 m in height, and cover an overall area of approximately 6,000 km^2. A lowering in the level of Lake Claire might decrease the water levels in the ponds and sloughs of this unit.

The PAD area is thought to once have been covered by glacial Lake McConnell (Bednarski, 1999). The PAD Unit is a delta complex composed of three smaller deltas: the Athabasca, Peace, and Birch River Deltas. Fluvial sediments from the Athabasca River have largely contributed to the formation of the PAD (Novakowski, 1967). The delta complex is a relatively flat, 3900 km^2 area, occupied by a number of lakes (Prowse

and Conly, 1998). Lakes Claire, Mamawi, Baril, and Richardson (Figure 2) are large, shallow basins found within the interior of the PAD, and are connected to the major rivers by a series of channels. These lakes, along with a number of smaller lakes, form the "open-drainage" component of the delta complex. The "closed-drainage" component of the delta complex is comprised of a number of isolated, perched basins that are recharged when high water levels inundate previously abandoned water channels, or produce overland flow that floods into these basins periodically. Groundwater flow into these basins is negligible (Nielsen, 1972), so periodic flooding is the only way to sustain water levels within the perched basins (Prowse and Conly, 1998).

The PAD drains eastward into Lake Athabasca, with the exception of drainage by way of the northward flowing Baril River, which drains into the Peace River (Novakowski, 1967). Lake Claire drains eastward into Mamawi Lake, which in turn drains towards the northwest through the Chenal des Quatre Fourches, into the Peace River. The west side of Lake Athabasca is drained northward by the Chenal des Quatre Fourches, Revillon Coupé and Rivière des Rochers. Water levels on the "open-drainage" network are normally highest during the spring and summer months, receding during the late autumn and winter. In the spring, as the Peace River reaches its highest levels, the direction of flow in Chenal des Quatre Fourches, Revillon Coupé and Rivière des Rochers can be reversed back towards Lake Athabasca if the water level of the Peace River rises above the level of Lake Athabasca (Novakowski, 1967; PADPG, 1972). Prior to regulation, the springtime water levels of the Peace River were typically sufficient to slow down or reverse the outward flow of Lake Athabasca, allowing excess water in the lake to flood the delta (PADPG, 1972). Upstream flow regulation by the W.A.C. Bennett Dam has reduced the flow during the summer months and increased the flow during the winter, leading to an overall lowering of delta lake water levels (PADPG, 1973).

Novakowski's (1967) fourth physiographic unit, along the receding western shore of Lake Claire, is an area where levees have been covered by soil formed as a result of the breakdown of the organic components of lush plant growth combined with delta silt. Levee formation extends up to 6 to 8 km to the west, suggesting that this process has been ongoing for many years. Sedimentation rates may be higher in this area, although it is also possible that uplift along the west shore of Lake Athabasca may be a contributing factor of the recession.

Geologic Setting

Bedrock Lithology

The PAD, which is situated at the edge of exposed Canadian Precambrian Shield, is underlain by Canadian Shield granites and gneisses, Athabasca Sandstone, plus Devonian limestone and gypsum (Bayrock and Root, 1972). Precambrian rocks are found east and north of the delta, Paleozoic gypsum and limestone are seen to the west, while the Mesozoic rocks of the Birch Mountains are to be found towards the southwest (Bayrock and Root, 1972). The four PAD cores sites used in this study are in an area determined by Bayrock and Root (1972) to be underlain by Precambrian granite.

The Precambrian Shield complex belongs to the Churchill Province, and consists of plutonic metamorphic-igneous rocks that were affected by the Hudsonian orogeny approximately 1800 million years BP (Bayrock and Root, 1972). The Precambrian rock complex displays a distinct northeasterly trend that is demonstrated in the alignment of lenses and bands in gneisses, and in the elongation of granite plutons and major faults. Two fault zones are situated parallel to the regional trend (Bayrock and Root, 1972).

The migmatitic gneisses of the Precambrian Shield complex include biotite and hornblende bearing phases with small lenses of metasedimentary rock and amphibolite (Bayrock and Root, 1972). The metasedimentary rocks consist of impure quartzites,

phyllites and schists which may contain minor amounts of amphibolite (Bayrock and Root, 1972).

Athabasca Sandstone is seen in outcrops along the eastern part of the south shore of Lake Athabasca (Bayrock and Root, 1972). The sandstone consists typically of fine to medium-grained quartz, with uncommon thin conglomerate and shale stringers, and variable amounts of cementation.

Formation of the Lake Athabasca Basin and the Peace-Athabasca Delta

The Lake Athabasca Basin formed towards the end of the Cretaceous as extensive seas withdrew from northeastern Alberta, exposing the area to continuous erosion (Bayrock and Root, 1972). Precambrian and Devonian formations were left exposed throughout the basin as most of the Cretaceous strata were eroded away. The only Cretaceous strata left behind now forms the Birch Mountains (Bayrock and Root, 1972).

By the start of the Quaternary, most of what would now be recognized as the landscape surrounding the PAD was already in place (Bayrock and Root, 1972). Rivers that flowed essentially along the present-day courses of the Peace and Athabasca Rivers joined a third river that flowed through the present-day basin of Lake Athabasca to converge and surge northward along the current Slave River route. The third river may have been gouged out as Pleistocene continental glaciers followed along its course, eroding and overdeepening the preglacial river valley to form Lake Athabasca (Alcock, 1920; Bayrock and Root, 1972).

The Peace-Athabasca Delta began to form roughly 10,000 years ago, after glacial recession and the draining of proglacial lakes had been completed (Bayrock and Root, 1972). Deposits of glaciolacustrine and glacial outwash sediments can be found in the lowlands surrounding the PAD, along with sediments of nonglacial origin (inwash)

deposited by the Peace and Athabasca Rivers (Bayrock and Root, 1972). Inwash can be distinguished from glacial sediments in the PAD by the inclusion of coal and bituminous sand originating from the south and west of the delta (Bayrock and Root, 1972).

The PAD currently forms an inland bird's foot delta, comprised of the Peace, Athabasca and Birch River deltas (Bayrock and Root, 1972). It occupies approximately 3800 km^2 and extends in size roughly 1 km^2 every 5 years. The Athabasca and Birch deltas are active, while the Peace Delta is effectively inactive since it only receives sediment when the Peace River is at high flood levels. This is due to the fact that typically the Peace River bypasses the Peace Delta, carrying sediment downstream into the Slave River rather than depositing it in the delta. When flooding occurs, high water levels may reverse the flow of the Peace, allowing floodwaters to reach the delta.

Sediment Regime

Surface deposits in the PAD are predominantly comprised of silt, along with minor amounts of sand and clay (Bayrock and Root, 1972). Bayrock and Root (1972) found that silt and clay covers most of the inactive areas of sedimentation, while active parts of the delta displayed substantial quantities of fine-grained sand. They attributed the occurrence of silt and clay found throughout the inactive areas of the PAD to periodic inundation by sediment-laden floodwaters. L.A. Bayrock observed flooding of the PAD in 1971 that inundated much of the delta with sediment laden waters, depositing silt and clay in the inactive areas, and fine to medium-grained sand in active parts of the delta (Bayrock and Root, 1972).

The Peace River is unusual in that the headwaters above the W.A.C. Bennett Dam are not the major source of sediment (Church et al., 1989; Prowse and Conly, 1997). The Smoky and Beatton Rivers are major contributors to the mean annual

sediment load, along with variable contributions from the Wabasca River which supplies major amounts of sediment during years of high runoff (Carson, 1992; Prowse and Conly, 1997).

The majority of the Peace River's bedload is carried downstream to the Slave River, due to the fact that the Peace River typically bypasses the Peace Delta (Bayrock and Root, 1972). Only during high flood stages does water from the Peace River flow towards Lake Athabasca through the Baril River, Chenal des Quatre Fourches, Rivière des Rochers and Revillon Coupé. During high water stages, perched basins within the PAD may receive silt and clay that has been suspended in flood waters, while coarser sediment settles out on the levees.

Chapter 2

Methods

Field Work

Introduction

Field work on this project was carried out in March 2001 by: Drs. R.I. Hall, B.B. Wolfe and Edwards from the University of Waterloo; Dr. M.C. English from Wilfred Laurier University; and Dr. J. Rusak from the University of Regina. The methods used by the field crew have been previously described by Hall and Wolfe (2001a). Core sites throughout the PAD were chosen to provide a broad range of sensitivities to flood events derived from ice-jams on the Peace River. Elevation and distance from river channels were important considerations in the choice of core sites. Site selections were made based on observations of a reconnaissance survey conducted in October 2000, along with preliminary results from the surface-sediment samples (Hall and Wolfe, 2001a; 2001b). Although more than 60 sites within the PAD delta have been sampled as a part of the *Multi-Century Flood, Climatic, and Ecological History of the Peace-Athabasca Delta, Northern Alberta, Canada* project, this work only considers the four sites from which cores were used for subsequent image analysis at the University of Manitoba. The sites chosen for image analysis work were selected on the basis that laminations were clearly visible in the cores. These sites represented various sensitivities to ice-jam flooding.

Sediment cores were collected through lake-ice (Hall and Wolfe, 2001a). A total of four undisturbed gravity cores of approximately 20-30 cm of the uppermost sediment as well as two undisturbed long core sequences were obtained at each of the four sites. The field crew also took measurements of the ice thickness and lake water depth prior to coring. Lake water samples were collected for measurements of pH, conductivity,

salinity, total dissolved solids, as well as oxygen and hydrogen stable isotope analysis. Descriptions of the cores were made on site.

Glew Gravity Cores

Four Glew gravity cores (Glew, 1989) were obtained from each lake to provide sufficient material for both multi-proxy analyses and archival use (Hall and Wolfe, 2001a). Approximately 20-30 cm of upper unconsolidated surface sediments were recovered from each site using a 7.5 cm diameter gravity core. The cores were sectioned into 0.5 cm intervals and samples were sent to the University of Manitoba. Loss-on–ignition (LOI) analysis was performed on the core sub-samples to determine moisture, organic and minerogenic contents (Last, 2001a). These measures were to allow for correlation between the stratigraphic horizons in the gravity sediment cores, and also to be used to establish the amount of stratigraphic overlap for the uppermost Russian core section (described below) from each lake. Based on the results of LOI measurements, representative cores from each lake were then sub-sampled for ^{210}Pb dating. Alternating 0.5 cm intervals from all cores were sub-sampled and sent to laboratories participating in the *Multi-Century Flood, Climatic, and Ecological History of the Peace-Athabasca Delta, Northern Alberta, Canada* project for multi-proxy analysis in order to collect detailed physical, biological and geochemical information.

Russian Cores

A 10 cm Russian peat corer with extension rods was used to recover approximately 3.5-4 m long sediment cores of more compacted deeper sediments from each site (Hall and Wolfe, 2001a). Sediment recovery was excellent. Approximately 1 m core sections were collected each time the Russian corer was deployed. In order to ensure the recovery of complete sedimentary sequences, and to allow for correlation of

adjacent core sections, it was necessary to overlap core sections. The field crew collected adjacent 1 m core sections that contained an approximately 30 cm overlap with the section immediately above. Adjacent 1 m core sections were recovered alternately from one of two holes 1 m apart in the ice. After recovery, core sections were wrapped in plastic sheets, put into PVC trays, secured with tape and labeled. Wrapped core sections were then taped together in pairs, secured in aluminum boxes lined with foam, and kept cool, but not frozen.

Two complete Russian core sequences were taken from each lake, one as a working core and one as an archive core. The cores were then transported to the University of Waterloo before being taken to Queen's University for x-radiography. Sub-samples taken from the working cores were submitted to the University of Waterloo's Environmental Isotope Laboratory for ^{14}C dating. Two samples were taken from each core to provide a preliminary chronology and to act as a guide for subsequent sub-sampling. Digital image analysis and visual core logging were conducted on the working cores after the preliminary ^{14}C sampling. Finally, sediment core sectioning and sub-sampling were carried out, followed by multi-proxy analyses by laboratories participating in the *Multi-Century Flood, Climatic, and Ecological History of the Peace-Athabasca Delta, Northern Alberta, Canada* project (University of Manitoba, Winnipeg, Manitoba; University of Waterloo, Waterloo, Ontario; University of Regina, Regina, Saskatchewan; and Queen's University, Kingston, Ontario).

Laboratory Procedures

Introduction

Image and sediment analyses completed at the University of Manitoba were done for this thesis as part of the *Multi-Century Flood, Climatic, and Ecological History of the Peace-Athabasca Delta, Northern Alberta, Canada* project. Image analysis was

done on digitally stored x-ray images of the cores to provide detailed information on the number and thickness of laminations, and to record the relative lightness or darkness of the core at any given depth. Samples were taken from along the length of each core at increments and analyzed to provide information on magnetic susceptibility, grain size, mineralogy, organic matter and moisture content, as well as to establish a cesium chronology for each core.

Sediment Analysis

Analysis of mineralogy, organic matter content, moisture content, and grain size was carried out on the upper portions (approximately 1 m) of cores PAD 54, 15 and 8. Magnetic susceptibility measurements were taken on approximately the upper 1 m of PAD 54 and 15, as well as the upper 30 cm of PAD 18.

Standard x-ray diffraction (XRD) techniques were used to determine the bulk mineralogy of samples (Hardy and Tucker, 1988; Bish, 1996; Moore and Reynolds, 1977; Last, 2001b). Automated search-match software (Marquart, 1986) aided mineral identification. Mineral percentages were determined using the weight intensity of the strongest peaks from diffractograms for individual minerals (Schultz, 1964; Shang and Last, 1999; Last, 2001b). Dolomite and calcite compositions were determined by considering the amount of displacement of the d104 peak in XRD scans (Goldsmith and Graf, 1958). This work was carried out at the University of Manitoba.

Organic matter and moisture content of samples was determined by procedures outlined in Last (2001a). This work was carried out at the University of Manitoba.

Measurements of particle size of sediments were taken using a Galai CIS particle size analyzer (Last, 2001a; Syvitski, 1991) at the Department of Geological Sciences, University of Manitoba.

Magnetic susceptibility measurements were taken of the cores (Sandgren and Snowball, 2001) at the Department of Geography, Queen's University, Kingston, Ontario.

Image Analysis

Light photography (Appendix A), x-radiography (Appendix B) and digital imagery were conducted at the University of Waterloo following the procedures outlined in Hamblin (1962), Bouma (1969), Pike and Kemp (1996), and Kemp (2000).

Image analysis was carried out using SigmaScan and Scion Image software on digital images of x-ray photographs taken of PAD 08 LC-2, PAD 15 LC-1, PAD 18 LC-1 and PAD 54 LC-1 Russian cores (Figure 4). Uncompressed TIFF image files of Russian core sections were then spliced together using SigmaScan image software to form complete core section images.

Automated counting methods were attempted, but did not provide accurate results. This was the result of two main problems: first, the overall faintness of the laminations within each individual photograph; and second, major jumps in pixel intensities (becoming suddenly lighter or darker) at points where photographs of adjacent sections with different overall light intensities were spliced together (Figure 5). Automated methods of counting laminations can work reasonably well when there is enough contrast between the colors of adjacent laminations and when lamination contacts are reasonably sharp. Unfortunately, this was not the case with the PAD core images, which displayed relatively little contrast between laminations and which had contacts that were often gradational over several millimeters. Automated lamination counts were not able to detect all of the laminations due to the faintness of the images, resulting in inaccurately low lamination counts. The splices where photographs were joined together often were "seen" by the computer as lamination boundaries, resulting in

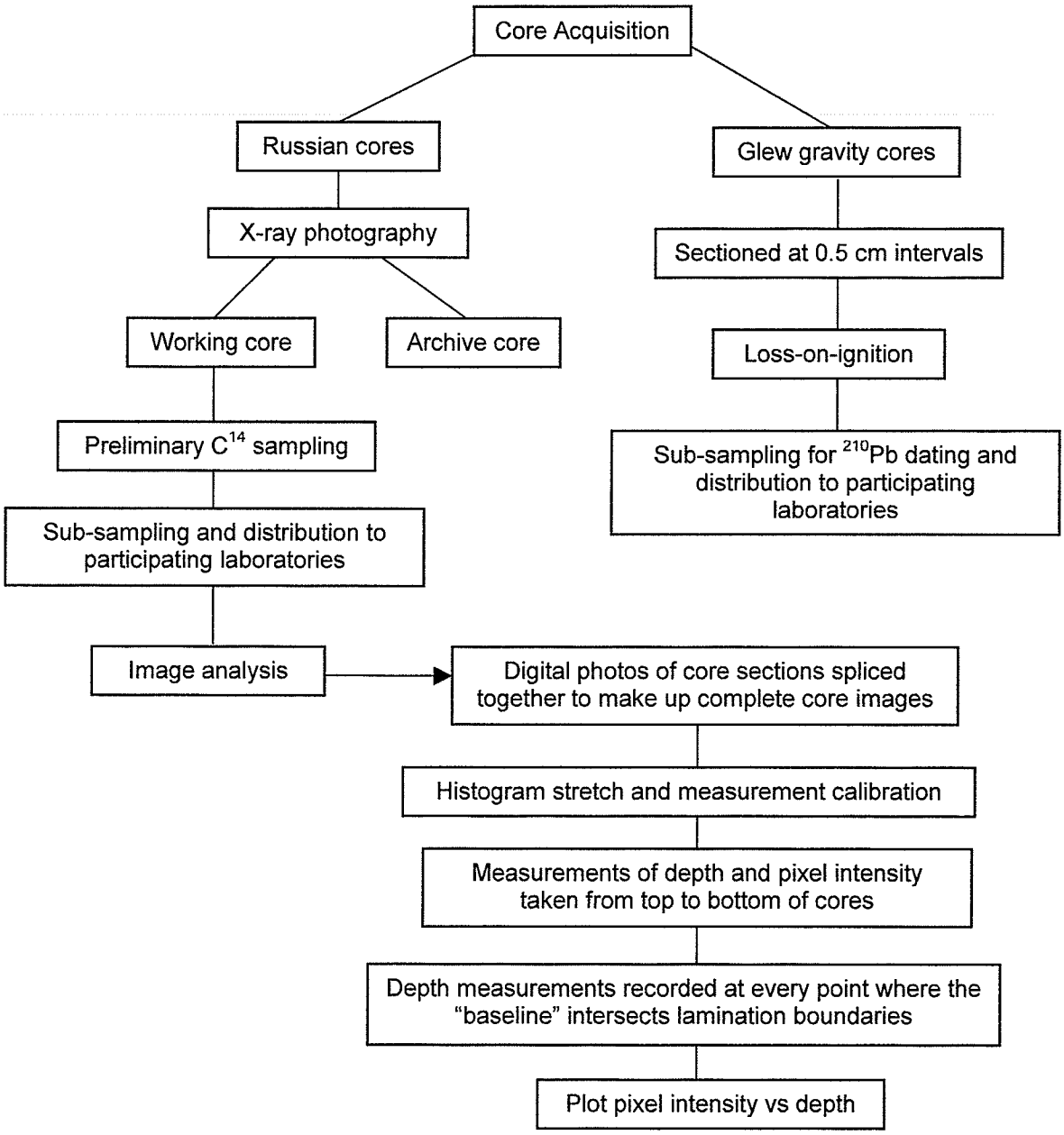

Figure 4. Lake sediment core work plan leading up to image analysis (modified from Hall and Wolfe, 2001a).

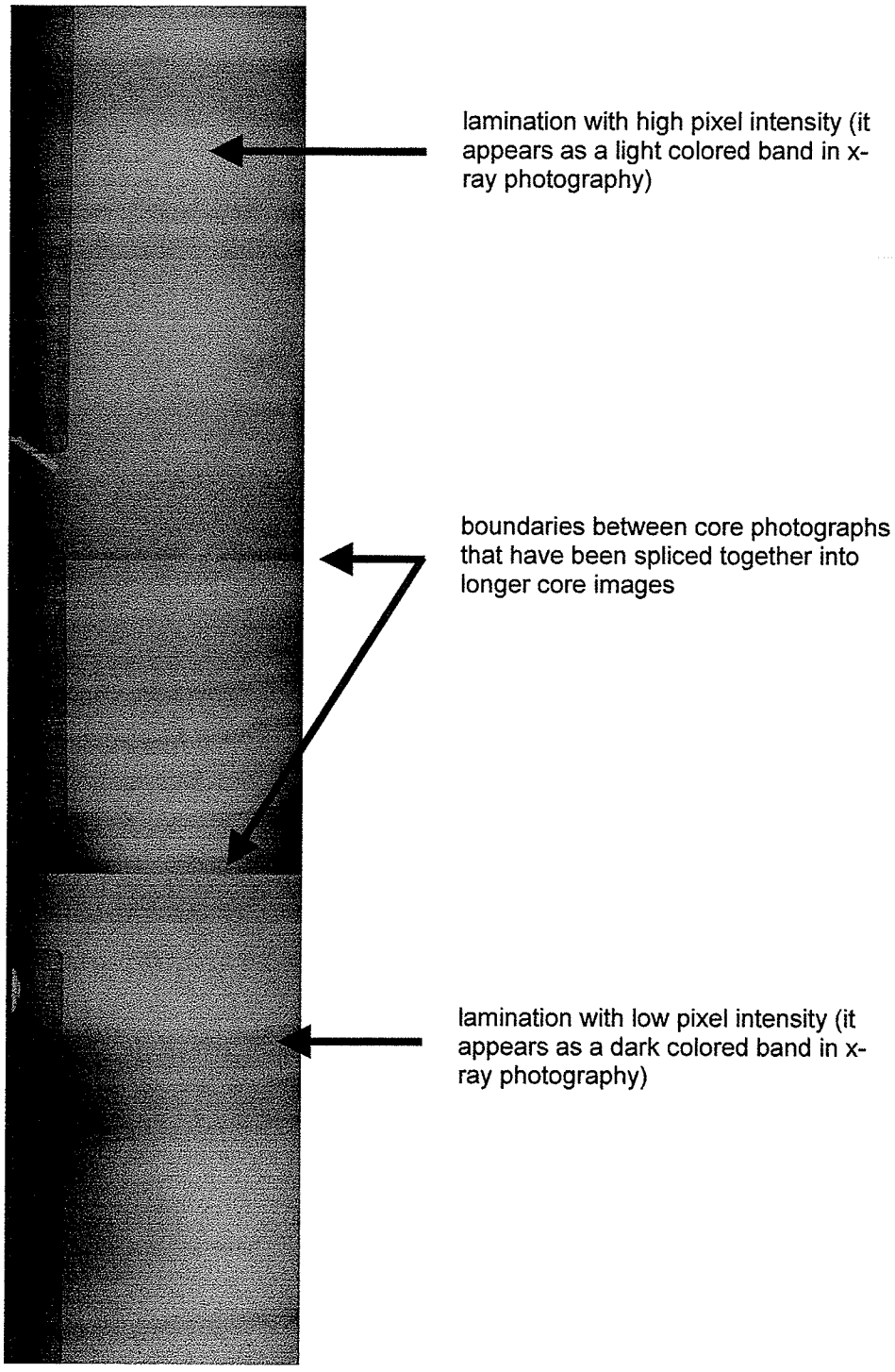

Figure 5. X-ray photographs of PAD 15 core that have been spliced together.

false lamination counts. Various statistical methods, such as SigmaPlot's autosplicing module, trend averaging and sequence averaging, were attempted in an effort to circumvent this problem, however, none gave satisfactory results. To get more accurate results, a mixture of automated and manual methods had to be employed.

First, a histogram stretch using SigmaScan software was done to maximize the contrast in all of the complete core images (Figure 6). Next, the calibration of pixel numbers to actual distance was done so that measurements taken could be correlated to core depth. Then, SigmaScan software was used to take measurements of depth and pixel intensity (relative lightness/darkness) in a straight line starting at the top and finishing at the bottom of each core. This provided a "baseline" of 1 pixel in width on each image to serve as a reference for subsequent measurements (Figure 7). Lamination boundaries were then manually measured along the length of the "baseline" by taking a measurement at each point where the baseline crossed a lamination boundary. Determinations of lamination boundaries had to be done visually (Figure 6), based on changes in relative lightness/darkness. This method provided information on the number and thickness of laminations (Appendix C) as well as a record of relative lightness or darkness (pixel intensity) of the core at any given depth.

Calibration of distance was done using the scales provided in the images; however, limitations in the accuracy of calibrated units over the length of the TIFF images made it necessary to adjust the distance measurements in the final results.

Chronological Analyses

Chronological analysis (Appendix D) was done on cores from sites PAD 54, 15 and 8. Measurements of ^{14}C were determined at Isotrace Laboratories (Toronto) and converted to calendar years using INTCAL98 (Stuiver et al., 1988). Chronological controls for the past 150 years for each core were determined and converted to calendar

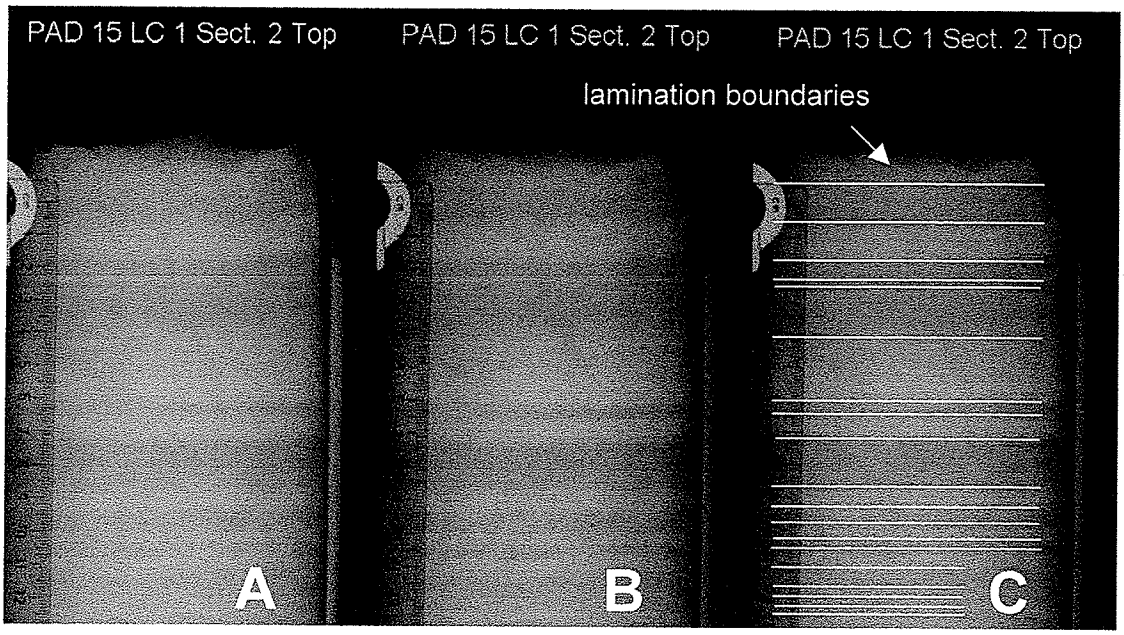

Figure 6. To improve the contrast in a digital grayscale image it is possible to change the way that pixels with specific pixel intensities (values assigned to a given lightness or darkness) are plotted on the image's intensity histogram in SigmaScan software. The contrast of an image can be improved by assigning a wider range of grayscale values to the pixel intensities found in an image. Image A has a low range of grayscale values and it is difficult to see the laminations. In image B the contrast has been improved by re-plotting the grayscale values over larger range, making it easier to visually determine lamination boundaries (C). This is referred to as a histogram stretch.

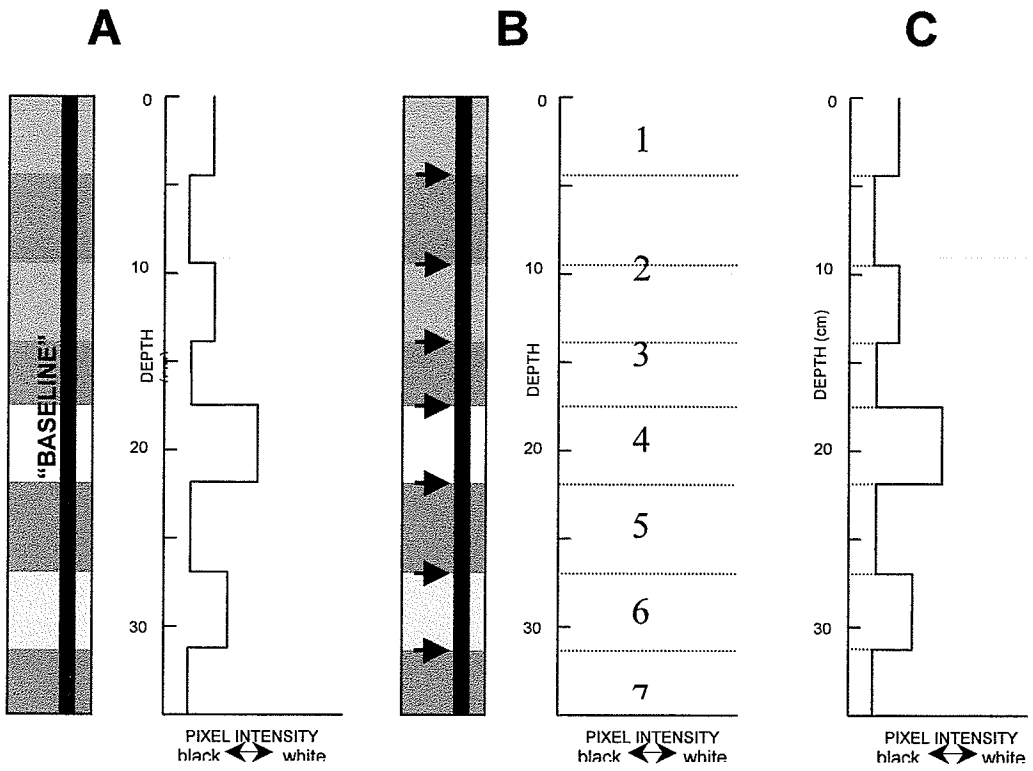

Figure 7. Image analysis technique. A) Measurements of pixel intensity (relative lightness/darkness) and depth were taken continuously along a straight line from top to bottom of the core image, forming a reference or "baseline" from which to take other measurements. B) Measurements of depth were taken where the "baseline" crossed lamination boundaries (black arrows). This provided information on the number and thickness of laminations. C) Information from both sets of measurements could then be plotted together so that changes in thickness, lamination frequency, and pixel intensity could be observed.

years on the basis of ^{210}Pb dating (Appleby and Oldfield, 1978) on 15 samples per core which were carried out at MyCore Scientific, Deep River, Ontario. Approximate chronologies were established for PAD 54, 15 and 8 figures throughout this work by first using the data to determine sedimentation rates for each location, and then converting depths to calendar years based on the sedimentation rates.

Statistical Analysis

Statistical analysis of core data was carried out using Microsoft Excel's correlation analysis tool to calculate the correlation coefficients (r) between data sets. For the purposes of this work, correlation coefficients ≤ -0.4 and ≥ 0.4 were considered to be significant.

Chapter 3

Core descriptions

PAD 54

Lake 233 (PAD 54) is a relatively deep (3.34 m at core location), cut-off meander basin of Chenal des Quatre Fourches which is thought to be a major site of ice-jams and highly sensitive to flood events (Hall and Wolfe 2001a). Core depths of 8 to 363.5 cm were recovered at the PAD 54 site. Core descriptions (Table 1, Figure 8) indicate that the sediments are well laminated. The sedimentation rate here is the highest of the four study locations, approximately 2.1 cm/year before 1968 (Table 2). The sedimentation rate decreases slightly to 1.9 cm/year after 1968.

This core is characterized by laminations that vary in thickness, grain size, and color. The thicknesses of laminations range from less than 2 mm up to 4 cm. Grain size ranges from coarse sand to very fine-grained silt, with lighter laminations being finer-grained than darker ones. Two graded beds were identified at about 180 cm depth. Sandy layers occurred from roughly 150 cm to 330 cm depth. A bed displaying coarse sand was found located at approximately 240 cm depth. Black laminations occurred at depths of approximately 280 cm, and 355 cm. The overall color of the sediment is generally gray and contacts are generally gradational.

PAD 15

Lake 555 (PAD 15), a 4 m deep oxbow lake formed as a meander cut-off from Revillon Coupé, is probably also very sensitive to ice-jam flood events (Hall and Wolfe 2001a). Core descriptions (Table 3, Figure 8) indicate that this core is similar to PAD 54, in that the sediments are well laminated. The sedimentation rate (1.4 cm/year) is lower than that of PAD 54 and did not change significantly after 1968 (Table 2).

Table 1. Field description of core PAD 54 LC-1 (modified from Hall and Wolfe 2001a).

core section	depth (cm) of sediments recovered	comments
1	**8-90**	laminated
2	**60-160**	laminated
3	**130-230**	laminated • fine sandy bed located at 151-155 cm depth • graded beds located at 176.5 – 178 cm depth and 184-185 cm depth
4	**200-300**	laminated • coarse bed located at 239-240.5 cm depth • black lamination located at 280.7 cm depth
5	**263.5-363.5**	laminated • black lamination at 281.5 cm depth • fine sandy laminations located at 305.5-306.5 and 315.5-316.5 cm depth • 2 mm thick sandy bed located at 327.5 cm depth • black laminations from 354.5-356 cm depth

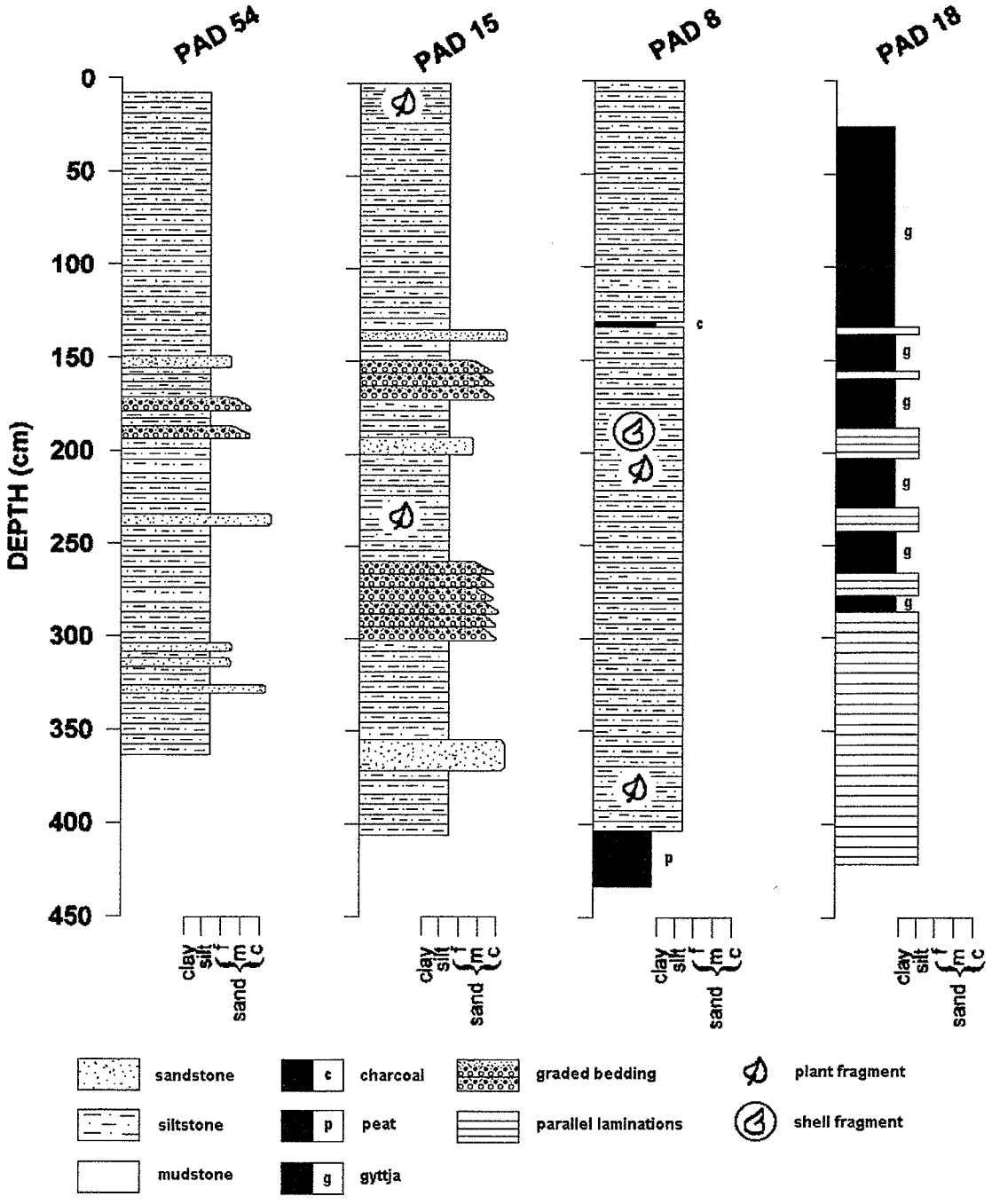

Figure 8. PAD 54, 15, 8 and 18 stratigraphic sections.

Table 2. Sedimentation rates of PAD sites based on chronological analysis.

	sedimentation rate before 1968 (cm/year)	sedimentation rate after 1968 (cm/year)
PAD 54	2.1	1.9
PAD 15	1.4	1.4
PAD 8	0.2	0.2

Table 3. Field description of core PAD 15 LC-1 (modified from Hall and Wolfe 2001a).

core section	depth (cm) of sediments recovered	comments
1	**0-92**	laminated • organic matter visible at surface
2	**62-162**	laminated • coarse sandy bed at 137 cm depth
3	**132-232**	laminated • graded beds from 150-170 cm depth • massive bed at 189.5-197 cm depth
4	**202-302**	laminated • organic fragments at 236.5 cm depth • several graded beds from 260-286 cm depth
5	**272-372**	laminated • graded beds at 272-300 cm depth • massive bed at 357-372 cm depth
6	**306-406**	laminated • black laminations located at 399.5-400 cm depth

This core is characterized by laminations that vary in thickness, grain size, and color. The thicknesses of laminations mentioned range from fine layers to massive beds up to 15 cm thick. Grain size ranges from coarse sand to very fine-grained silt, with lighter laminations being finer grained than darker ones. The upper portion of the core sequence has organic matter visible at the upper surface. A coarse-grained bed was found at roughly 140 cm depth. Graded beds were found grouped at depths of approximately 150-170 cm and 260-300 cm. Two thick massive beds were found in the core at depths of around 190 cm and 360 cm. The color of the core is generally gray. Contacts are generally gradational.

PAD 8

Lake 582 (PAD 8) is a 1 m deep lake connected by a creek to Rivière des Rochers that is probably through flowing during floods (Hall and Wolfe 2001a). Core descriptions (Table 4, Figure 8) indicate that the sediments are laminated, with poorly defined contacts. PAD 8 is generally less well laminated than PAD 15 and 54. The sedimentation rate is lower than those of PAD 54 and PAD 15, approximately 0.2 cm/year (Table 2).

This core is characterized by gray and black laminations that vary in thickness, grain size, and color, but not to the same extent as seen in PAD 54 and 15. The thicknesses of laminations range from fine layers (0.5 to 5.0 cm thick), to a very thick segment of peat that makes up the lower 25 cm of core. Charcoal, plant material, a shell fragment, wood and peat were found within this core. At a depth of about 360 cm, the color of the sediment changes from gray and black to a browner hue. Below 408 cm depth, the core entirely consists of peat.

Table 4. Field description of core PAD 8 LC-2 (modified from (Hall and Wolfe 2001a).

core section	depth (cm) of sediments recovered	comments
1	**0-98**	laminated, gray and black
2	**68-168**	laminated, gray and black • charcoal located at 130-131 cm depth
3	**138-238**	laminated, gray and black • shell fragment at 191 cm depth • plant matter at 202 cm depth • marked black bed at 235-238 cm depth
4	**208-308**	laminated, gray and black
5	**278-378**	laminated • gray and black from 278-358 • browner sediment from 358-378
6	**333-433**	generally laminated • large piece of wood at 377-381 cm depth • peat found at 408-433 cm depth

PAD 18

Greenstar Lake (PAD 18) is a deep (greater than 7 m) lake completely enclosed in a bedrock basin, which is probably only affected by extreme flooding events (Hall and Wolfe 2001a). Core descriptions (Table 5, Figure 8) indicate that there is very little variability in grain size or organic content. This core is distinguished from the others by a predominance of gyttja, with only a few intervals that contain noticeable laminations. The sedimentation rate here is probably the lowest of the four study locations; however, no ^{14}C or other dating have yet been done to confirm this. The upper portions of this core (approximately 25-250 cm) consist of mainly gyttja, which gives way to faint laminations below 250 cm depth.

Table 5. Field description of core PAD 18 LC-1 (modified from (Hall and Wolfe 2001a).

core section	depth (cm) of sediments recovered	comments
1	**25-75**	brown gyttja
2	**45-145**	brown gyttja
3	**115-215**	brown gyttja, light and dark beds
4	**185-285**	brown gyttja, light and dark beds
5	**255-355**	laminated • light laminations located at 324.5 and 347.5 cm depth
6	**309-409**	laminated • light laminations located at 351.5 and 386 cm depth
7	**396-421**	laminated

Chapter 4

Sediment composition

Introduction

When floodwater inundates the perched basins of the Peace-Athabasca Delta, these lakes receive the sediment-laden waters of the Peace and Athabasca Rivers (Bayrock and Root, 1972). Coarse material generally settles out on the delta's levees, while water containing suspended silt and clay enters the isolated basins. Bayrock and Root (1972) contend that the sediment-rich waters remain in these basins long enough for the silt and clay to settle out, allowing the clay to form a uniform, impermeable lining on the bottom of the deltaic lakes.

The source of much of the suspended-load of the Peace River comes from tributaries that are located downstream of the W.A.C. Bennett Dam (Church et al, 1989). Carson (1992) determined that over one half of the mean suspended-sediment load was derived from the Smoky River, and one third was from the Beatton River. In years of high runoff, the Wabasca River appears to also be a major sediment supplier (Carson, 1992; Prowse and Conly, 1997). Prowse and Conly (1997) proposed that the buildup of gravel at tributary junctions might infer that the transport of gravel in the Peace River has diminished since regulation.

Since the silt and clay suspended-sediment load of the Peace comes primarily from tributaries downstream of the Williston Reservoir (Church et al., 1989), it is unlikely that the source of these sediments has been interrupted by the regulation of the Peace River. However, changes in the frequency of flooding, or in delta hydrology due to climate change or river regulation may result in either gradual trends or sudden changes in sediment texture and mineralogical composition.

Moisture Content

PAD 54 and 15 have similar moisture contents, with both averaging around 40% (Figure 9, Table 6). PAD 8 displays a higher overall moisture content than what is seen in PAD 54 and 15, starting at above 50% at 90 cm depth, and increasing gradually towards the surface (Figure 9). There is a trend towards slightly higher moisture content upward in the cores. The average percentage moisture content from sediment deposited after 1968 in all of the cores is higher than that of sediments deposited before 1968 (Tables 7, 8 and 9). PAD 8 displays a much more gradual trend of increasing moisture towards the surface, with only a few peaks within the overall trend. PAD 54 and 15 both exhibit many more peaks within the sediment sequence. There is a positive correlation for moisture and clay minerals content in PAD 54 (Table 10). In PAD 15, moisture content is positively correlated to both clay minerals and organic matter content (Table 11). In PAD 8, moisture content has a negative correlation with clay minerals content and a positive correlation with organic matter and sulfate minerals content (Table 12).

Organic Matter

In PAD 54 and 15, the organic matter content comprises less than 8% of the average material in both cores, and does not change significantly from before to after regulation of the Peace River (Figure 10; Tables 6, 7 and 8). PAD 8 contains overall higher amounts of organic matter, with an increase in content from an average of approximately 10% before regulation to 20% after regulation (Figure 10; Tables 6 and 9). A strong jump in organic matter is seen at 2 cm depth in PAD 15 (Figure 10). In PAD 54, the organic matter content does not show any significant correlation to any of the other constituents of the sediment (Table 10). In PAD 15, quartz, total feldspars, calcite

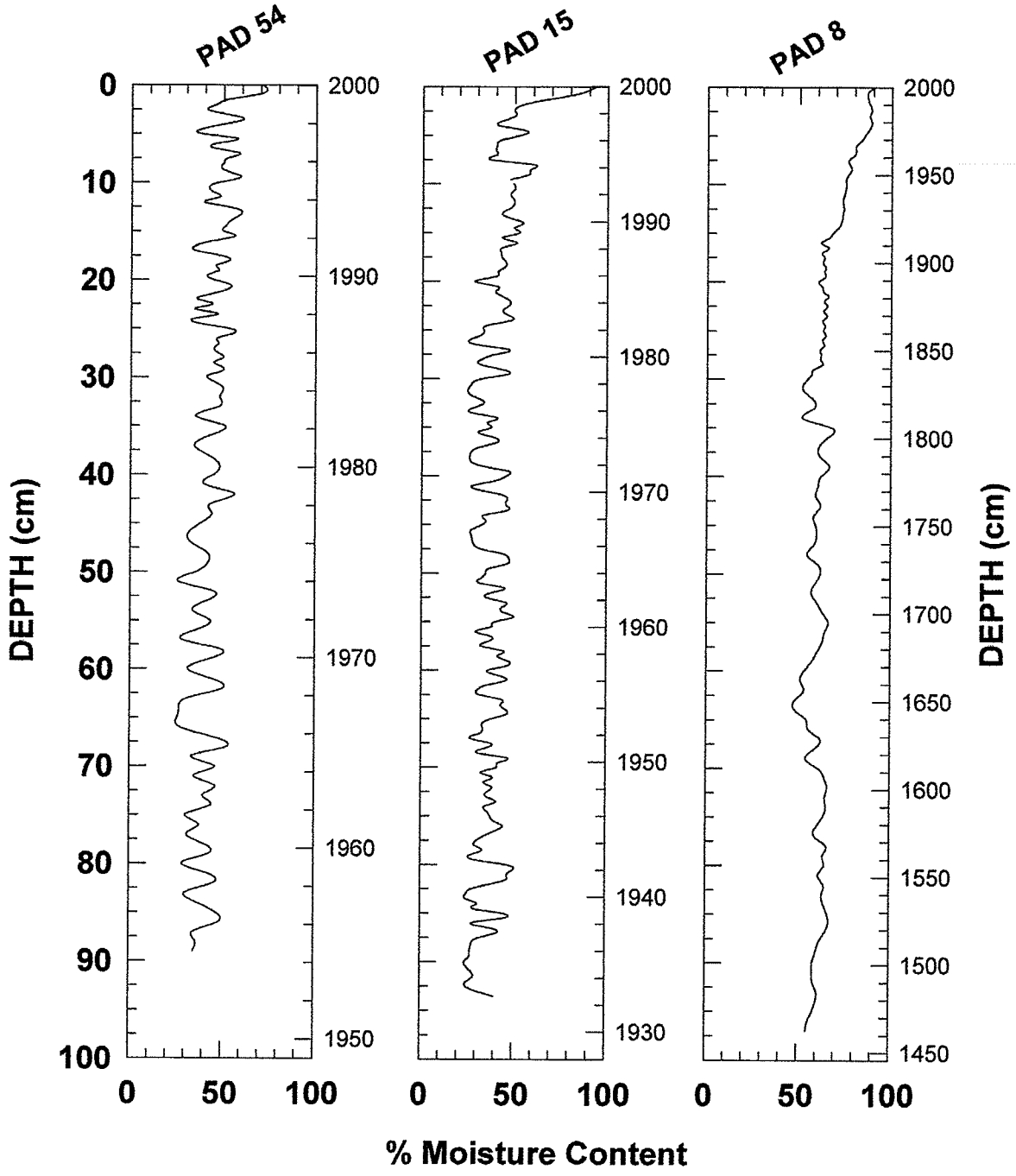

Figure 9. Stratigraphic variations in percentages of moisture content for PAD 54, 15 and 8.

Table 6. Mean values for PAD 54, 15 and 8 sediment components.

	PAD 54	PAD 15	PAD 8
% moisture content	44.3	39.4	65.5
% organic matter	7.5	5.9	11.1
mean grain size (μm)	4.9	5.8	4.4
% clay-size grains	41.4	40.8	43.9
% sand-size grains	8.9	4.8	2.2
% silt-size grains	49.7	54.4	53.9
% quartz	17.7	20.9	9.8
% k-feldspar	0.2	0.4	0.0
% plagioclase	5.3	6.0	3.5
% total feldspars	5.5	6.4	3.5
% total clay minerals	68.0	62.9	81.9
% total siliciclastics	91.1	90.3	95.2
% calcite	1.2	2.4	0.1
% Mg-calcite	1.9	1.4	1.2
% total calcite	3.1	3.7	1.2
molar % $MgCO_3$ in calcite	7.0	2.9	2.4
molar % $MgCO_3$ in Mg-calcite	16.9	16.2	16.2
% protodolomite	0.1	0.2	0.1
% dolomite	3.8	4.4	0.8
molar % $CaCO_3$ in protodolomite	78.6	77.1	78.6
molar % $CaCO_3$ in dolomite	46.2	48.7	47.1
% total carbonate minerals	7.1	8.4	2.1
% total sulfate minerals	1.8	1.5	2.8

Table 7. Mean values for PAD 54 sediment components before and after regulation of the Peace River in 1968.

	before 1968	after 1968
% moisture content	38.6	45.8
% organic matter	7.0	7.7
mean grain size (μm)	4.8	5.0
% clay size grains	41.6	41.3
% sand size grains	9.2	8.9
% silt size grains	49.2	49.8
% quartz	17.3	17.8
% k-feldspar	0.4	0.2
% plagioclase	5.8	5.2
% total feldspars	6.2	5.4
% total clay minerals	59.4	69.3
% total siliciclastics	82.9	92.4
% calcite	1.7	1.0
% Mg-calcite	2.1	1.9
% total calcite	3.8	2.9
molar % $MgCO_3$ in calcite	13.8	4.3
molar % $MgCO_3$ in Mg-calcite	23.2	15.2
% protodolomite	0.2	0.1
% dolomite	4.2	3.8
molar % $CaCO_3$ in protodolomite	78.3	78.8
molar % $CaCO_3$ in dolomite	40.6	47.7
% total carbonate minerals	8.2	6.8
% total sulfate minerals	5.4	0.8

Table 8. Mean values for PAD 15 sediment components before and after regulation of the Peace River in 1968.

	before 1968	after 1968
% moisture content	36.3	42.8
% organic matter	5.4	6.4
mean grain size (μm)	5.8	5.8
% clay size grains	40.8	40.9
% sand size grains	4.8	4.8
% silt size grains	54.4	54.4
% quartz	21.3	20.5
% k-feldspar	0.4	0.5
% plagioclase	6.2	5.8
% total feldspars	6.6	6.3
% total clay minerals	62.3	63.6
% total siliciclastics	90.2	90.4
% calcite	2.5	2.1
% Mg-calcite	1.4	1.3
% total calcite	3.9	3.5
molar % $MgCO_3$ in calcite	3.2	2.5
molar % $MgCO_3$ in Mg-calcite	16.7	15.8
% protodolomite	0.3	0.1
% dolomite	4.6	4.2
molar % $CaCO_3$ in protodolomite	76.0	79.6
molar % $CaCO_3$ in dolomite	48.7	48.8
% total carbonate minerals	8.9	7.8
% total sulfate minerals	1.1	1.8

Table 9. Mean values for PAD 8 sediment components before and after regulation of the Peace River in 1968.

	before 1968	after 1968
% moisture content	62.7	85.5
% organic matter	9.9	19.8
mean grain size (μm)	4.6	2.9
% clay size grains	43.7	45.6
% sand size grains	2.1	2.4
% silt size grains	54.2	52.0
% quartz	10.1	7.3
% k-feldspar	0.0	0.0
% plagioclase	3.7	2.1
% total feldspars	3.7	2.1
% total clay minerals	83.0	74.4
% total siliciclastics	96.9	83.7
% calcite	0.1	0.0
% Mg-calcite	1.3	0.3
% total calcite	1.4	0.3
molar % $MgCO_3$ in calcite	2.4	N/A
molar % $MgCO_3$ in Mg-calcite	16.2	17.9
% protodolomite	0.1	0.1
% dolomite	0.6	1.8
molar % $CaCO_3$ in protodolomite	78.7	78.3
molar % $CaCO_3$ in dolomite	49.3	42.2
% total carbonate minerals	2.1	2.2
% total sulfate minerals	1.2	14.1

Table 10. Correlation coefficients (r) for PAD 54 texture and mineralogy.

	moisture (%)	organic matter (%)	grain size (μm)	quartz (%)	total feldspars (%)	total clay minerals (%)	total siliciclastics (%)
moisture (%)	1.0						
organic matter (%)	0.0	1.0					
grain size (μm)	-0.3	-0.1	1.0				
quartz (%)	-0.6	0.0	0.4	1.0			
total feldspars (%)	-0.6	0.1	0.6	0.4	1.0		
total clay minerals (%)	0.7	0.0	-0.4	-0.7	-0.5	1.0	
total siliciclastics (%)	0.4	0.0	0.0	0.0	-0.1	0.7	1.0
calcite (%)	-0.4	-0.1	0.1	0.1	0.2	-0.4	-0.4
Mg-calcite (%)	-0.3	0.1	0.1	0.3	0.1	-0.3	-0.1
dolomite (%)	-0.6	0.0	0.4	0.5	0.5	-0.6	-0.2
proto-dolomite (%)	-0.1	-0.1	0.1	0.1	-0.1	0.0	0.0
total carbonate minerals (%)	-0.7	-0.1	0.3	0.4	0.5	-0.6	-0.4
total sulfate minerals (%)	0.0	0.0	-0.1	-0.2	-0.1	-0.5	-0.9

	calcite (%)	Mg-calcite (%)	dolomite (%)	proto-dolomite (%)	total carbonate minerals (%)	total sulfate minerals (%)
calcite (%)	1.0					
Mg-calcite (%)	-0.2	1.0				
dolomite (%)	0.3	0.2	1.0			
proto-dolomite (%)	-0.1	0.1	0.0	1.0		
total carbonate minerals (%)	0.7	0.4	0.7	0.2	1.0	
total sulfate minerals (%)	0.1	-0.1	-0.1	-0.1	-0.1	1.0

Table 11. Correlation coefficients (r) for PAD 15 texture and mineralogy.

	moisture (%)	organic matter (%)	grain size (μm)	quartz (%)	total feldspars (%)	total clay minerals (%)	total siliciclastics (%)
moisture (%)	1.0						
organic matter (%)	0.9	1.0					
grain size (μm)	-0.2	-0.1	1.0				
quartz (%)	-0.7	-0.6	0.3	1.0			
total feldspars (%)	-0.5	-0.5	0.4	0.5	1.0		
total clay minerals (%)	0.7	0.6	-0.3	-0.9	-0.6	1.0	
total siliciclastics (%)	0.1	0.1	0.0	-0.2	-0.1	0.6	1.0
calcite (%)	-0.6	-0.5	0.0	0.5	0.4	-0.6	-0.3
Mg-calcite (%)	0.2	0.3	-0.2	-0.2	-0.2	0.2	0.0
dolomite (%)	-0.5	-0.5	0.1	0.5	0.3	-0.5	-0.2
proto-dolomite (%)	-0.1	-0.1	0.1	0.0	-0.1	-0.1	-0.1
total carbonate minerals (%)	-0.6	-0.5	0.0	0.5	0.3	-0.6	-0.3
total sulfate minerals (%)	0.2	0.2	-0.1	-0.1	-0.1	-0.3	-0.9

	calcite (%)	Mg-calcite (%)	dolomite (%)	proto-dolomite (%)	total carbonate minerals (%)	total sulfate minerals (%)
calcite (%)	1.0					
Mg-calcite (%)	-0.2	1.0				
dolomite (%)	0.4	-0.3	1.0			
proto-dolomite (%)	-0.1	-0.1	0.3	1.0		
total carbonate minerals (%)	0.7	0.1	0.8	0.4	1.0	
total sulfate minerals (%)	-0.1	-0.1	-0.1	-0.1	-0.2	1.0

Table 12. Correlation coefficients (r) for PAD 8 texture and mineralogy.

	moisture (%)	organic matter (%)	grain size (μm)	quartz (%)	total feldspars (%)	total clay minerals (%)	total siliciclastics (%)
moisture (%)	1.0						
organic matter (%)	0.9	1.0					
grain size (μm)	-0.7	-0.7	1.0				
quartz (%)	-0.8	-0.7	0.7	1.0			
total feldspars (%)	-0.5	-0.5	0.7	0.5	1.0		
total clay minerals (%)	-0.5	-0.6	0.3	0.3	0.2	1.0	
total siliciclastics (%)	-0.7	-0.7	0.6	0.6	0.5	0.9	1.0
calcite (%)	-0.2	-0.2	0.0	0.1	0.0	-0.1	0.0
Mg-calcite (%)	-0.4	-0.4	0.4	0.5	0.3	-0.1	0.1
dolomite (%)	0.0	0.3	-0.2	0.0	-0.3	-0.6	-0.5
proto-dolomite (%)	0.1	0.1	0.0	-0.1	-0.1	-0.1	-0.1
total carbonate minerals (%)	-0.2	0.0	0.1	0.2	-0.1	-0.5	-0.3
total sulfate minerals (%)	0.8	0.8	-0.6	-0.7	-0.5	-0.9	-1.0

	calcite (%)	Mg-calcite (%)	dolomite (%)	proto-dolomite (%)	total carbonate minerals (%)	total sulfate minerals (%)
calcite (%)	1.0					
Mg-calcite (%)	0.3	1.0				
dolomite (%)	0.2	0.0	1.0			
proto-dolomite (%)	0.0	-0.2	0.2	1.0		
total carbonate minerals (%)	0.5	0.5	0.8	0.3	1.0	
total sulfate minerals (%)	-0.1	-0.3	0.3	0.1	0.1	1.0

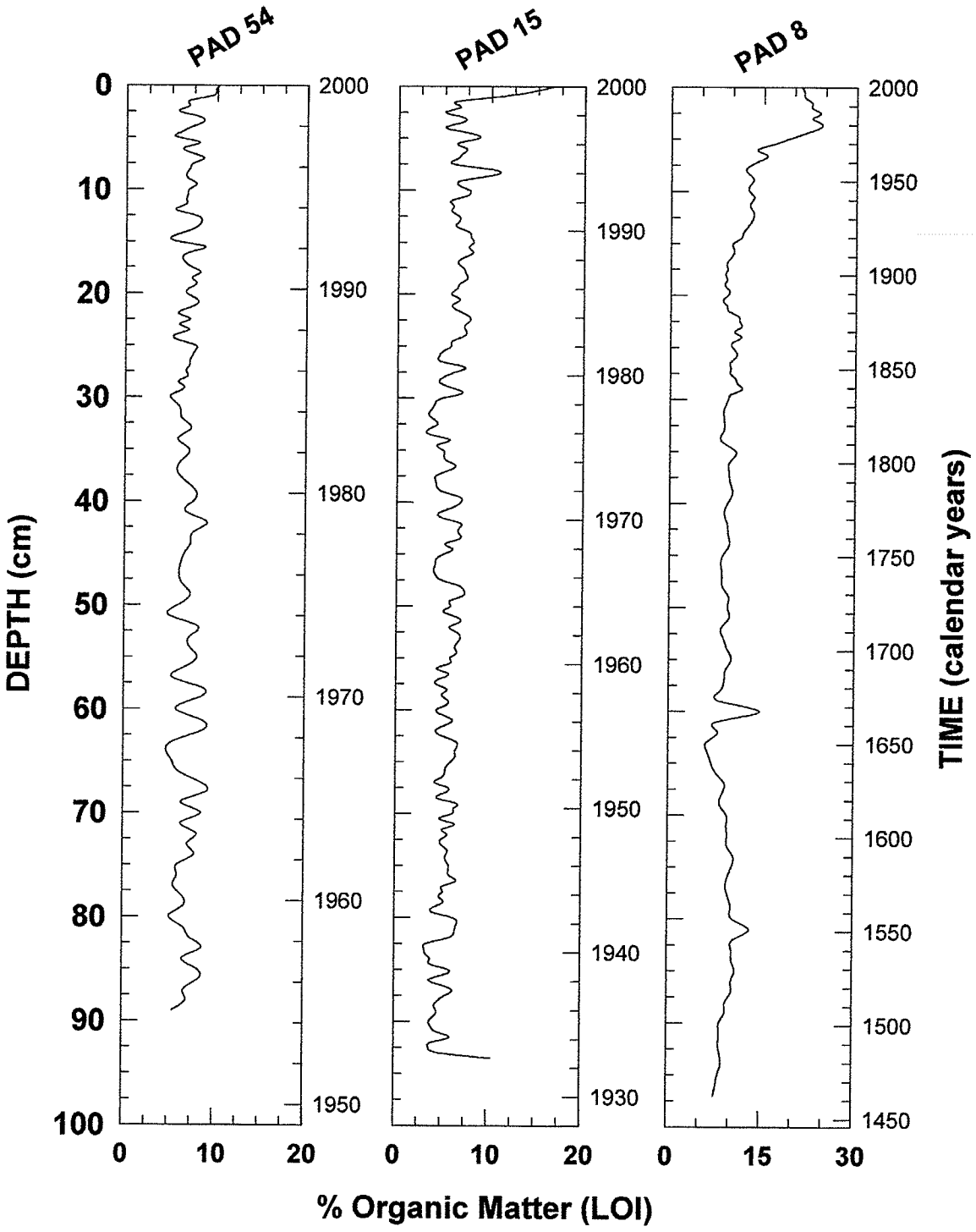

Figure 10. Stratigraphic variations in percentages of organic matter for PAD 54, 15 and 8.

and dolomite content all display a negative correlation with organic matter content, while total clay minerals content shows a positive correlation (Table 11). In PAD 8, quartz, total feldspars, total clay minerals and Mg-calcite content as well as grain size, show a negative correlation with organic matter content, while sulfate minerals content is positively correlated (Table 12). As previously mentioned, in both PAD 15 and 8 there is a strong positive correlation between moisture and organic matter content.

Grain Size

PAD 54

The mean grain size recorded in the Pad 54 core varies from approximately 2 to 7 μm, with an average mean grain size of 4.93 μm (Figure 11, Table 6). Silt- and clay-size particles form the major constituents of this core, accounting for approximately 90% of the sediment. Sand-size particles form the smallest fraction of material, contributing less than 10% to the total. No significant change in grain size is seen when comparing sediments deposited before to those deposited after the regulation of the Peace River (Table 7).

PAD 15

The mean grain size found in the PAD 15 core varies from approximately 3 to just over 12 μm, averaging at 5.8 μm (Figure 12, Table 6). Silt- and clay-size particles form the major constituents of this core, accounting for approximately 95% of the sediment. Sand-size particles form the smallest fraction of material, approximately 5%. No significant change in grain size is seen when comparing sediments deposited before to those deposited after the regulation of the Peace River in 1968 (Table 8).

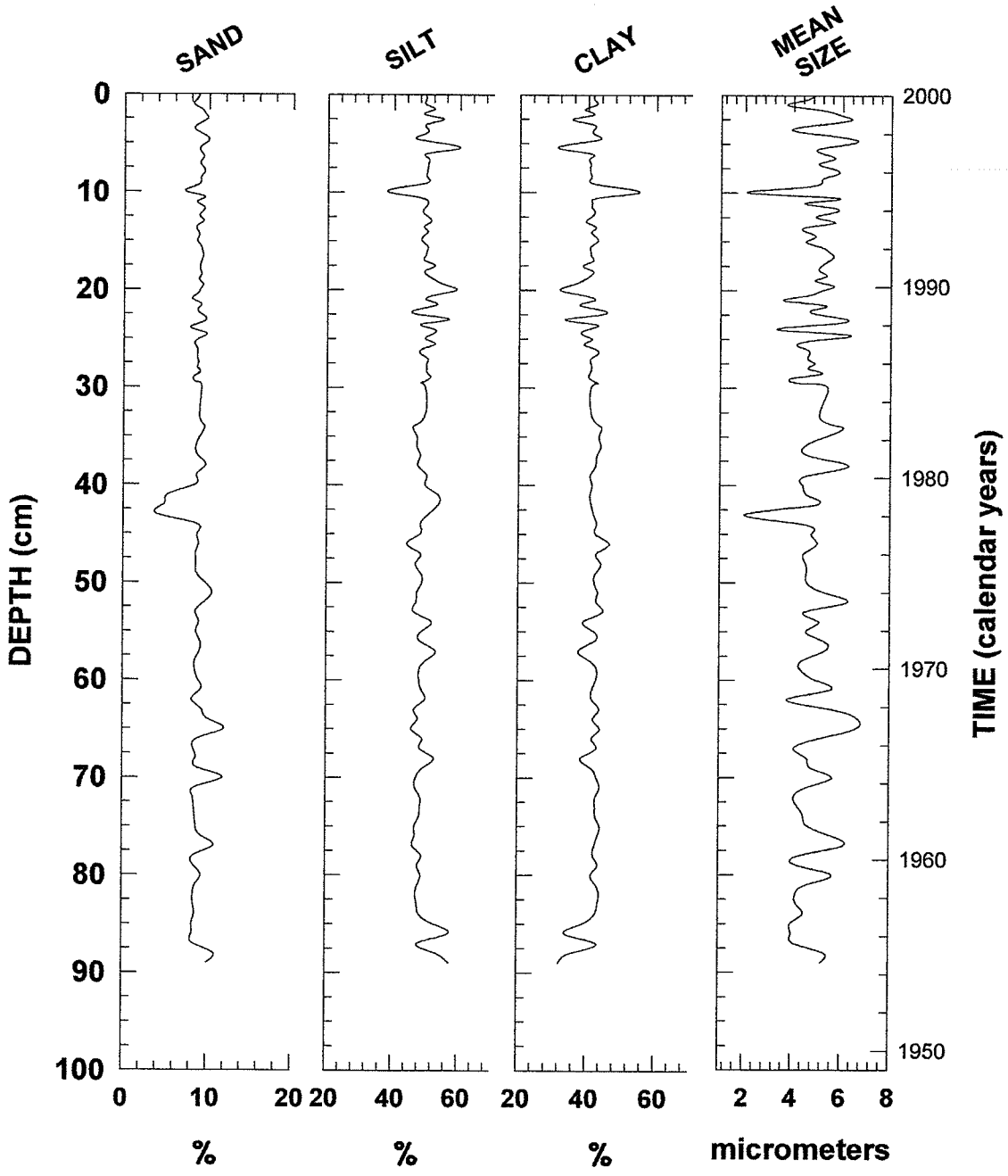

Figure 11. Percentages of sand, silt and clay-size grains, plus mean grain size for PAD 54.

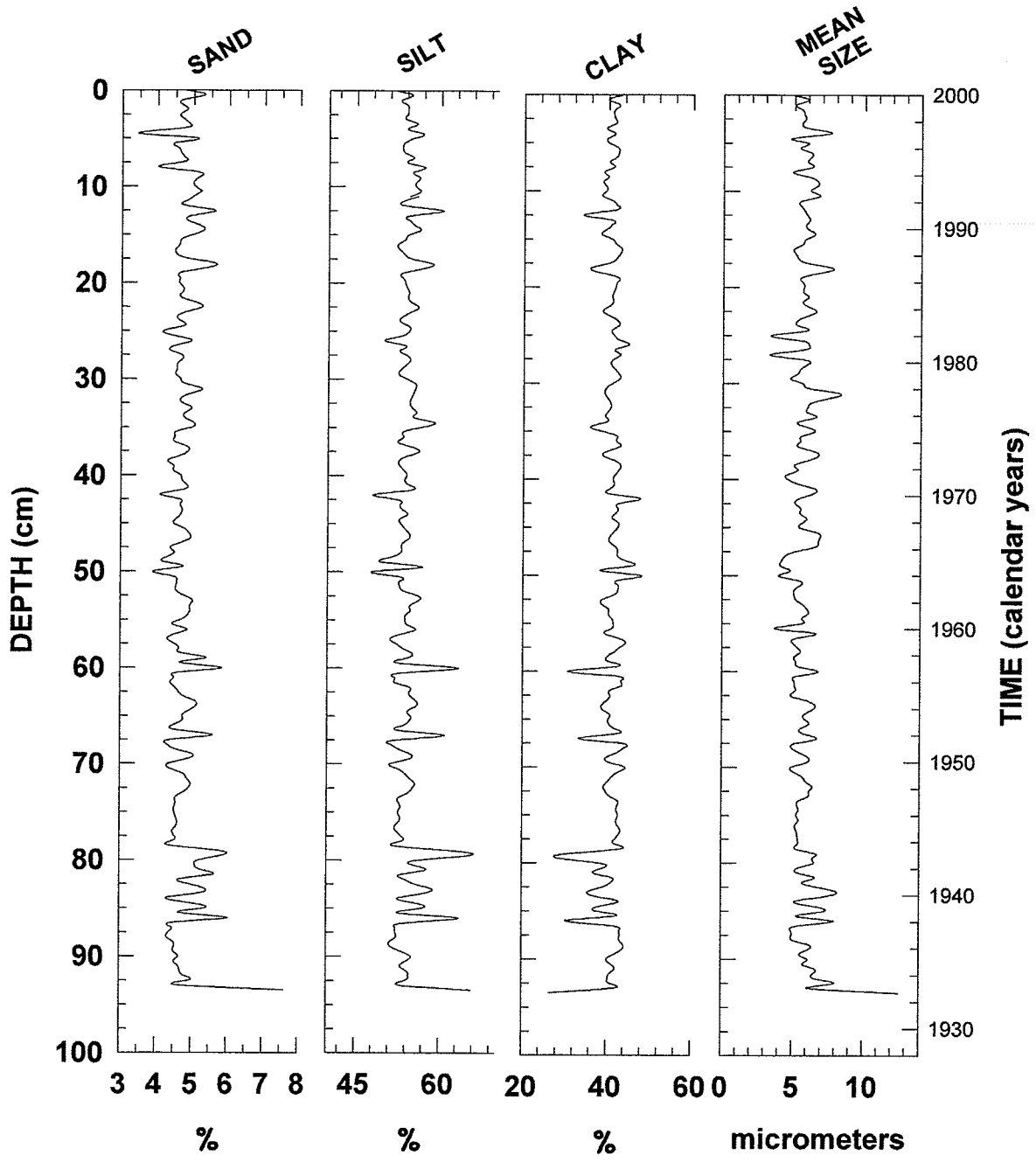

Figure 12. Percentages of sand, silt and clay-size grains, plus mean grain size for PAD 15.

PAD 8

The mean grain size that is found in the PAD 8 core varies from approximately 2 to 6 μm, averaging at 4.4 μm (Figure 13, Table 6). The mean grain size is smaller in sediment deposited after regulation, averaging at 2.9 μm compared to an average mean grain size of 4.6 μm before river regulation (Table 9). Silt- and clay-size particles account for the major percentage of this core, accounting for about 98% of material. Sand-size particles only make up approximately 2% of the grains in this core.

Siliciclastic Mineralogy

PAD 54

Clay minerals form the largest fraction of siliciclastics in the PAD 54 core, accounting for close to 70% of the average total mineral count (Figure 14, Table 6). There is an increase in the average percentage of clay minerals after regulation of the Peace River (Table 7). Quartz is the next largest fraction of the sediment, consistently forming just under 20% of the composition throughout the entire core sequence. Plagioclase makes the most significant contribution to the feldspar fraction, along with rare occurrences of potassic feldspars. Total feldspar amounts average at around 5% of mineral composition. The average percent of total siliciclastics increased from approximately 83% before regulation to roughly 92% after regulation (Table 7), due mainly to increases in the amount of clay minerals in the core sequence.

PAD 15

Clay minerals form the largest fraction of siliciclastics in the PAD 15 core, accounting for more than 60% of the average total sediment composition (Figure 15, Table 6). Quartz forms the next largest constituent of the siliciclastics, accounting for roughly 20% of the average total sediment composition. Potassic feldspars are a more

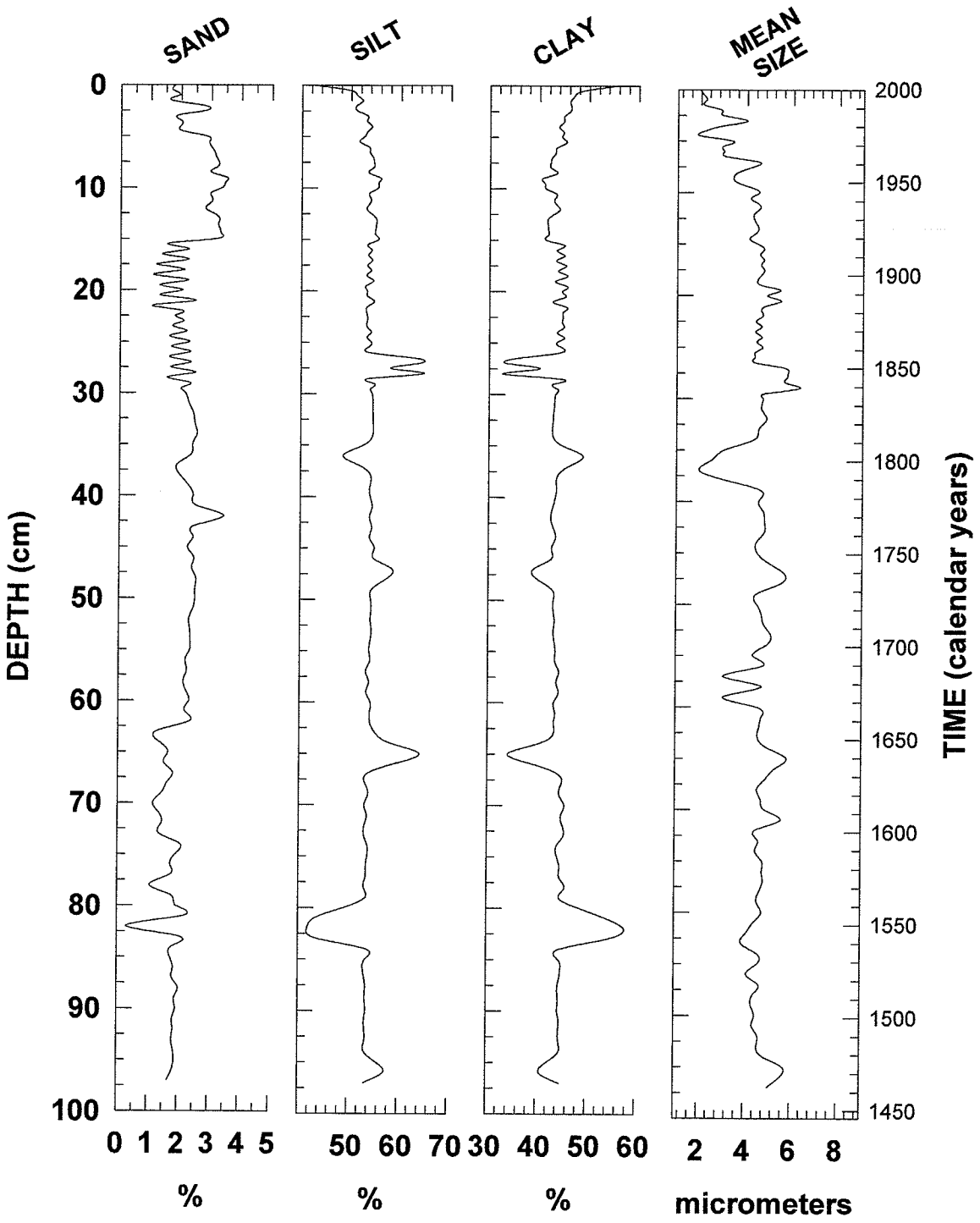

Figure 13. Percentages of sand, silt and clay-size grains, plus mean grain size for PAD 8.

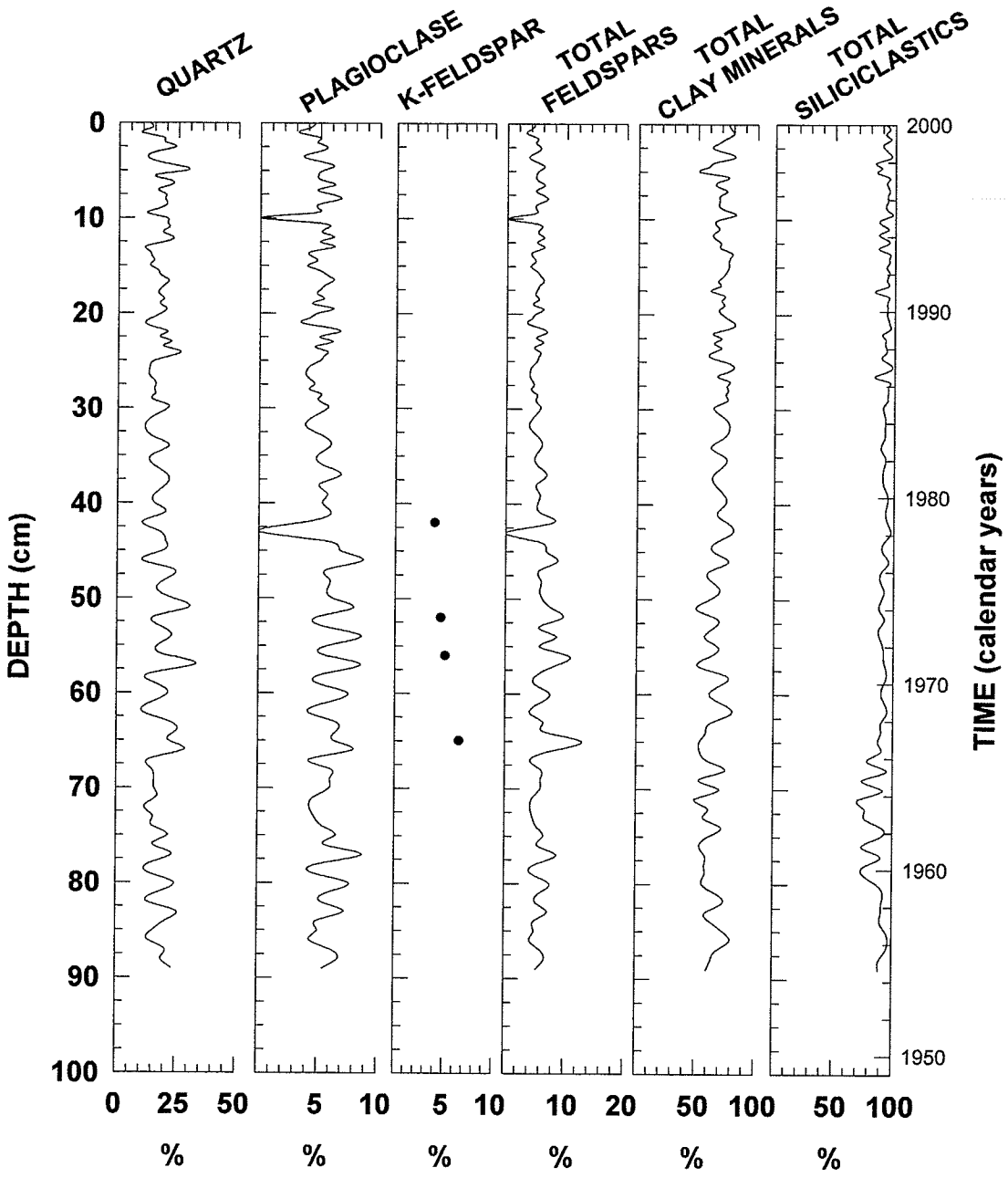

Figure 14. Percentages of siliciclastic minerals in PAD 54.

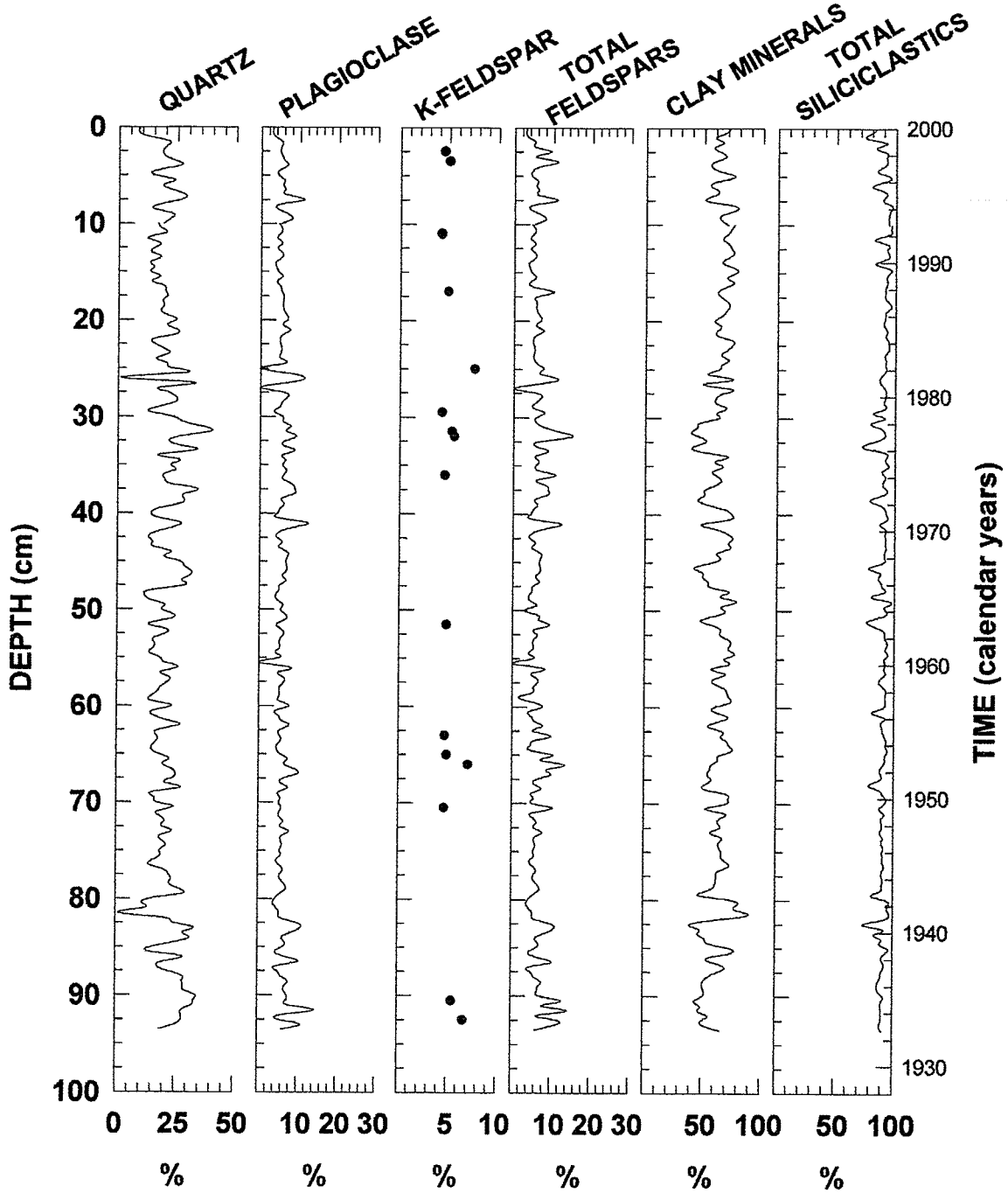

Figure 15. Percentages of siliciclastic minerals found in PAD 15.

common occurrence in this core than in the PAD 54 core, although they still only contribute a minor amount to the total feldspar fraction. Total feldspars account for just over 5% of the total composition. Average amounts of siliciclastic minerals stayed relatively consistent throughout the overall core sequence, showing no significant changes after river regulation (Table 8).

PAD 8

Total amounts of clay minerals in the PAD 8 core are greater than amounts found in the PAD 54 and 15 cores, averaging approximately 80% of total sediment composition (Figure 16, Table 6). The average amount of clay minerals decreased by almost 10% after river regulation (Table 9). Quartz forms a smaller fraction of the total siliciclastics than it did in the Pad 54 and 15 cores, and displays a small decrease from an average of approximately 10% of sediment content before regulation to roughly 7% after river regulation. Plagioclase forms the entire constituent of the total feldspars fraction, which contributes between 2-4% towards the average amount of total siliciclastics, roughly half of that found in PAD 54 and 15. The amount of average total siliciclastics decreases from approximately 97% before to 84% after regulation of the Peace River (Table 9) due to the decreases in the average amounts of quartz and clay minerals.

Carbonate Mineralogy

PAD 54

The occurrence of Mg-calcite is fairly constant throughout the PAD 54 core, contributing an average of 1.9% towards the total carbonate mineral fraction (Figure 17, Table 6). The average amount of calcite within the core decreased slightly from 1.7% before to 1.0% after regulation of the Peace River (Table 7). The composition of

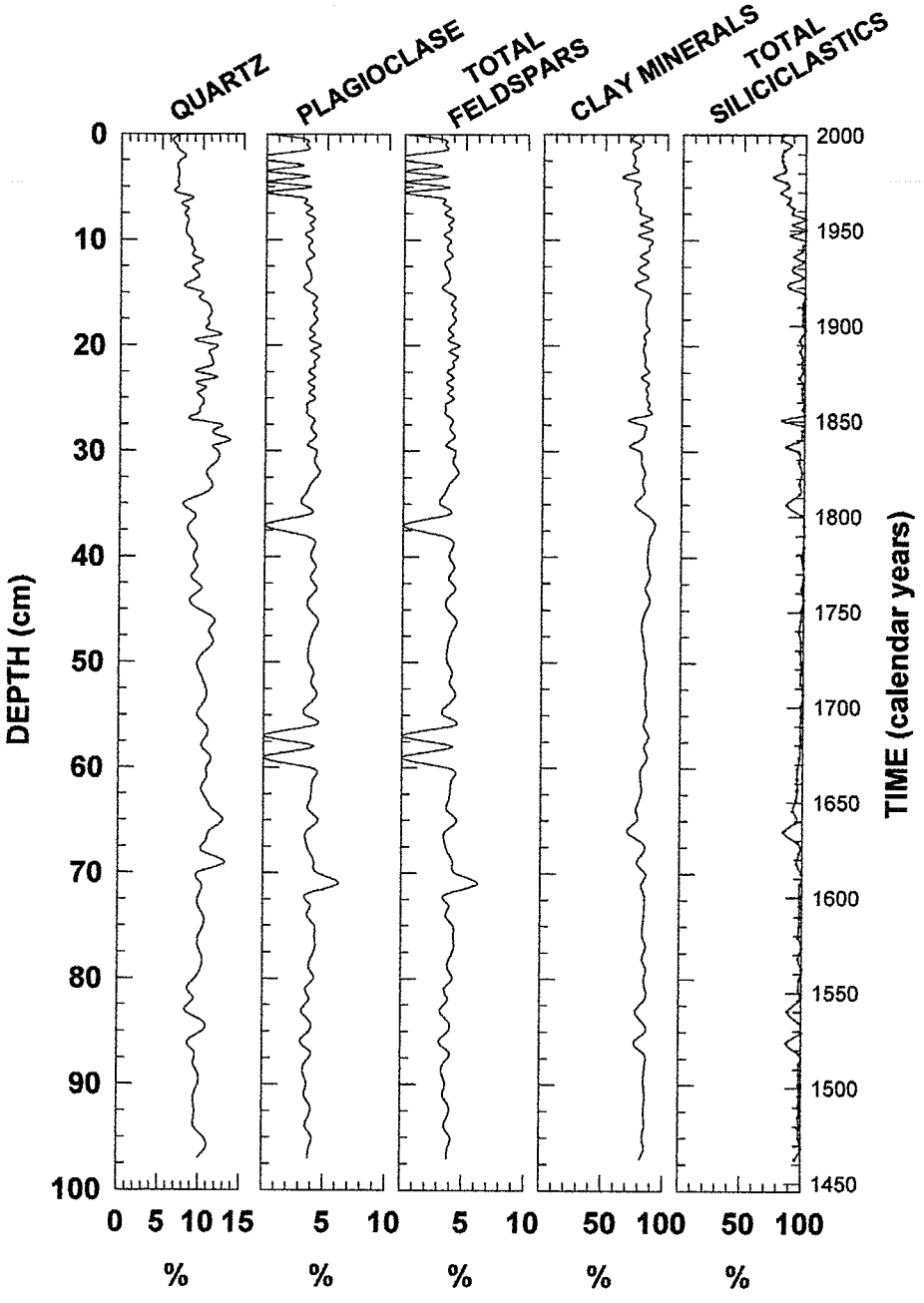

Figure 16. Percentages of siliciclastic minerals in PAD 8.

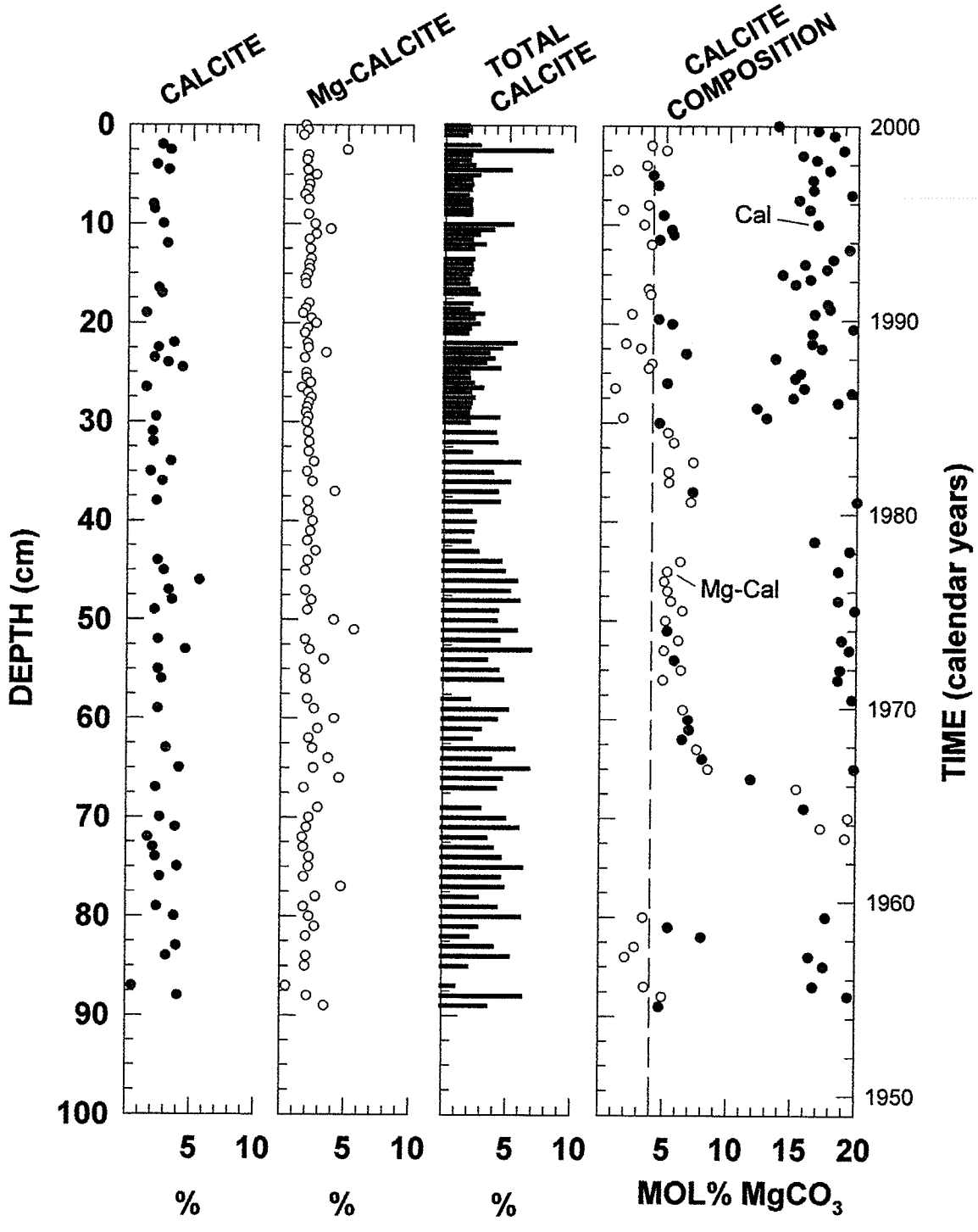

Figure 17. Percentages of calcite, Mg-calcite, and total calcite, plus the calcite composition of PAD 54.

Mg-calcite jumps from approximately 5 mol% to 20 mol% $MgCO_3$ at around 1960, then gradually decreased back to approximately 5 mol% $MgCO_3$ by the mid-1980's and remained constant at that composition until the present (Figure 17). The composition of calcite varies throughout this core. Both calcite and Mg-calcite show decreased average molar percentages of $MgCO_3$ after river regulation.

Average dolomite abundance within the carbonate fraction were fairly consistent throughout the PAD 54 core sequence at around 4%, with occasional occurrences of protodolomite (Figure 18). The composition of dolomite jumped from approximately 50 mol% to 30 mol% $CaCO_3$ at around 1960, then gradually increased back to approximately 50 mol% $CaCO_3$ by the mid 1980's and remained constant until the present. The average molar percentage of $CaCO_3$ in dolomite increased after regulation (Table 7).

The average percentage of total carbonate minerals found in PAD 54 remains relatively constant at approximately 7% of the total mineral composition (Figure 19, Table 7).

PAD 15

The occurrences of calcite and Mg-calcite in the PAD 15 core sequence are both relatively consistent, with the total calcite comprising approximately 4% of the mineral composition (Figure 20, Table 6). Mg-calcite makes up a smaller portion of the total calcite (~1%) than was the case in the PAD 54 sequence. The composition of Mg-calcite and calcite remains consistent throughout the core, with Mg-calcite containing and average of 17mol% $MgCO_3$ and calcite containing an average of 3 mol% $MgCO_3$.

Dolomite contributions towards the total carbonate minerals fraction are relatively consistent at around 4%, with protodolomite occurring more often than in PAD 54 (Figure 21). The composition of dolomite and protodolomite remains constant

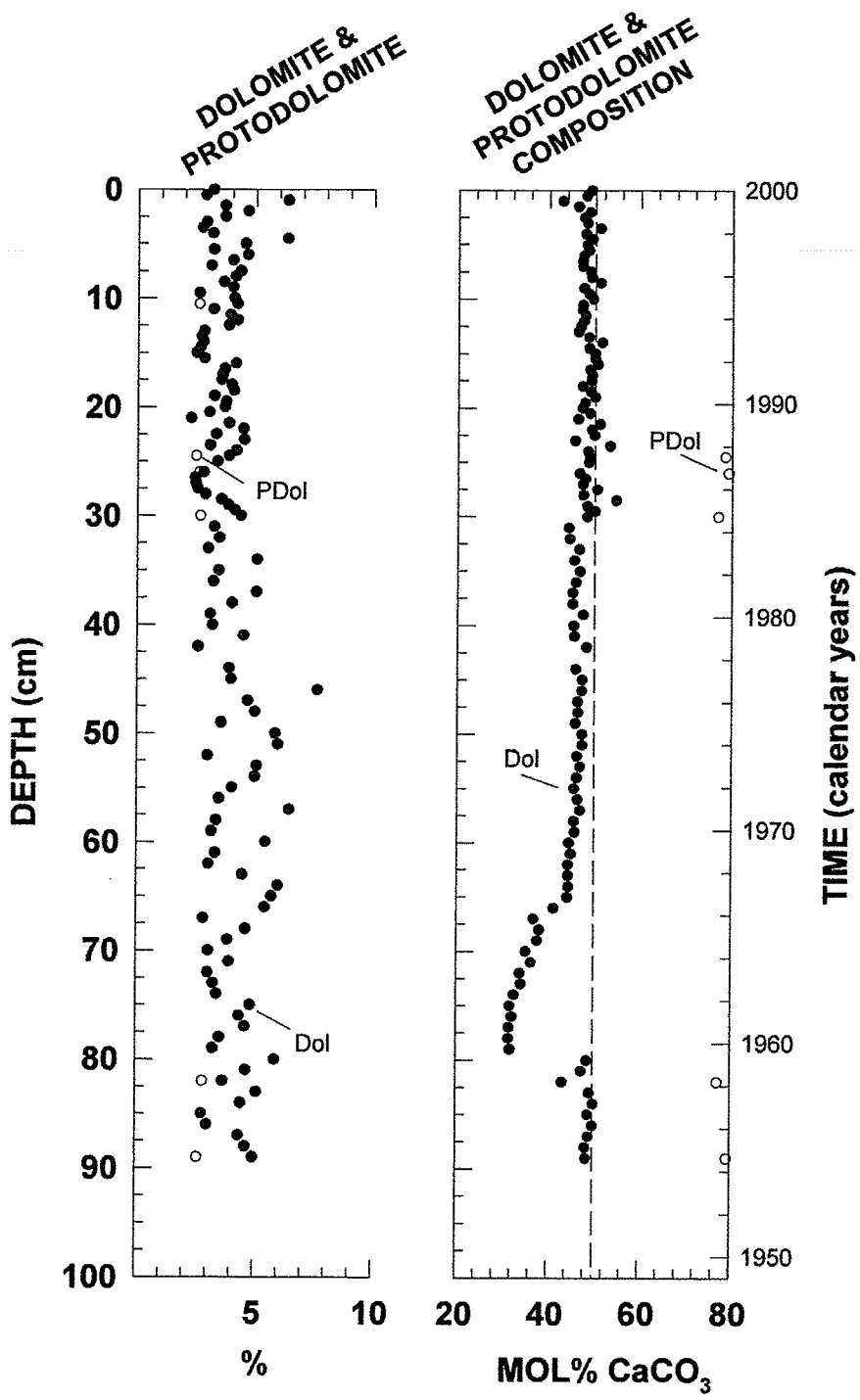

Figure 18. Percentages of dolomite and protodolomite, plus the composition of dolomite and protodolomite in PAD 54.

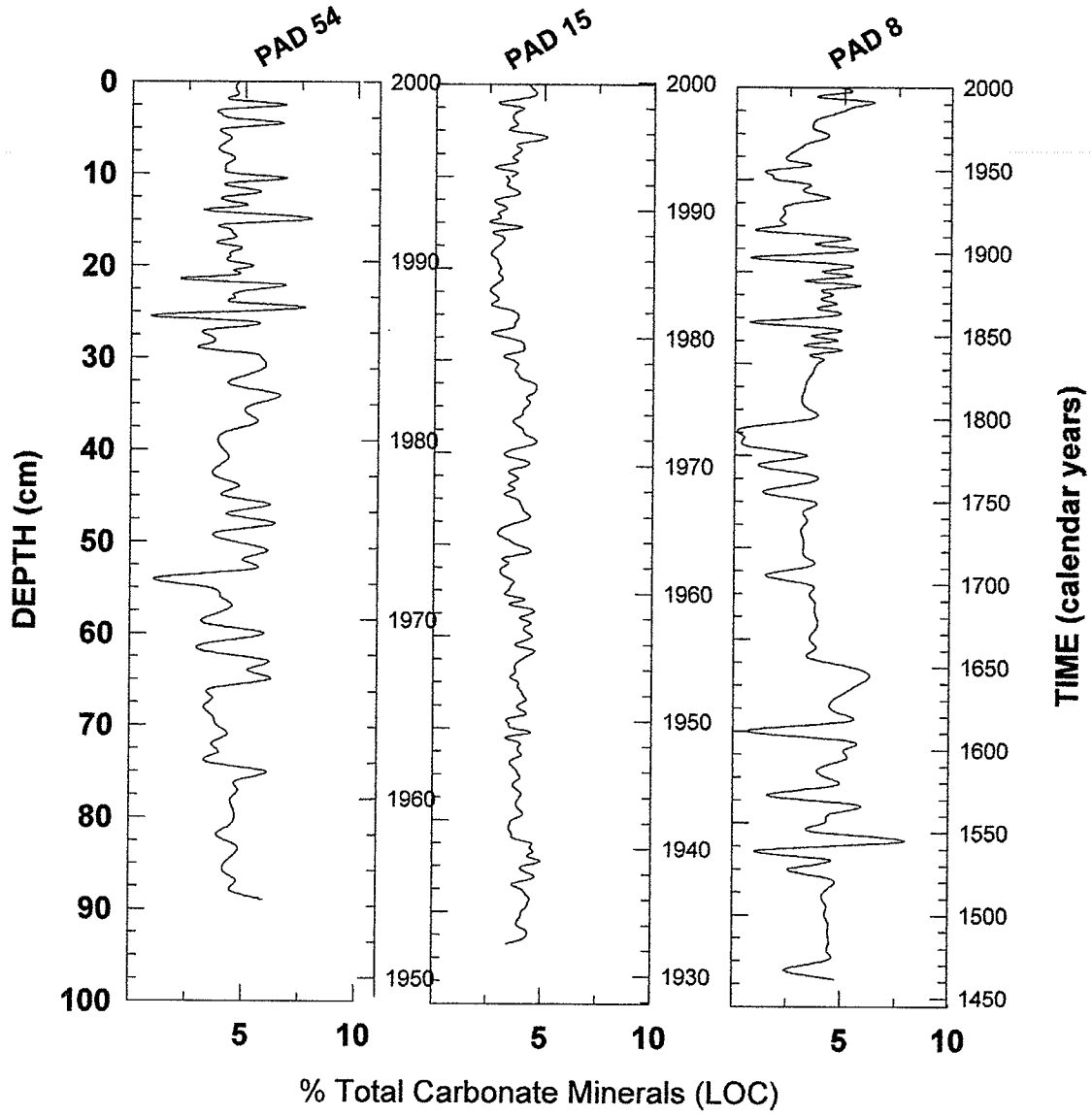

Figure 19. Percentages of total carbonates for PAD 54, 15 and 8.

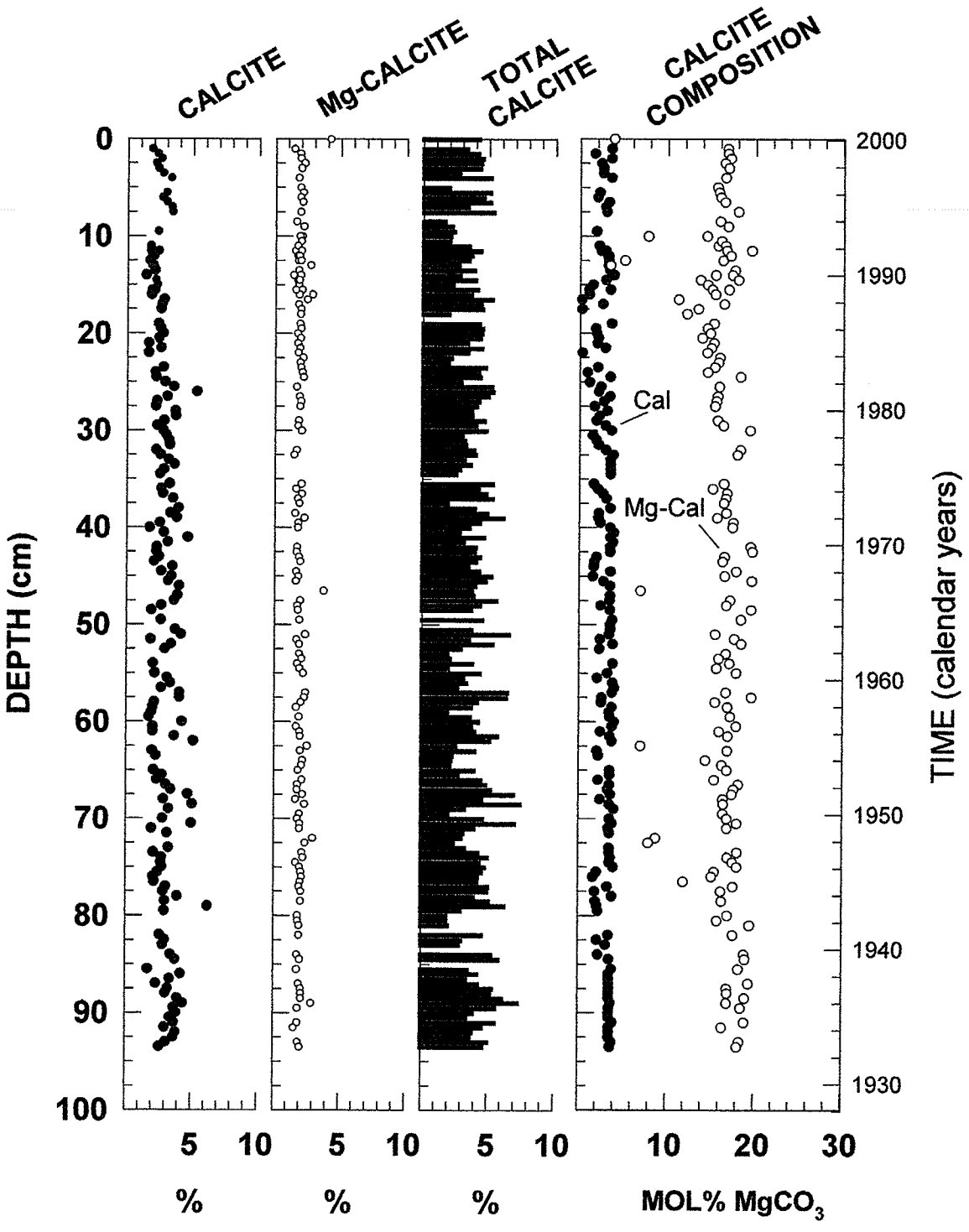

Figure 20. Percentages of calcite, Mg-calcite and total calcite, plus the composition of calcite for PAD 15.

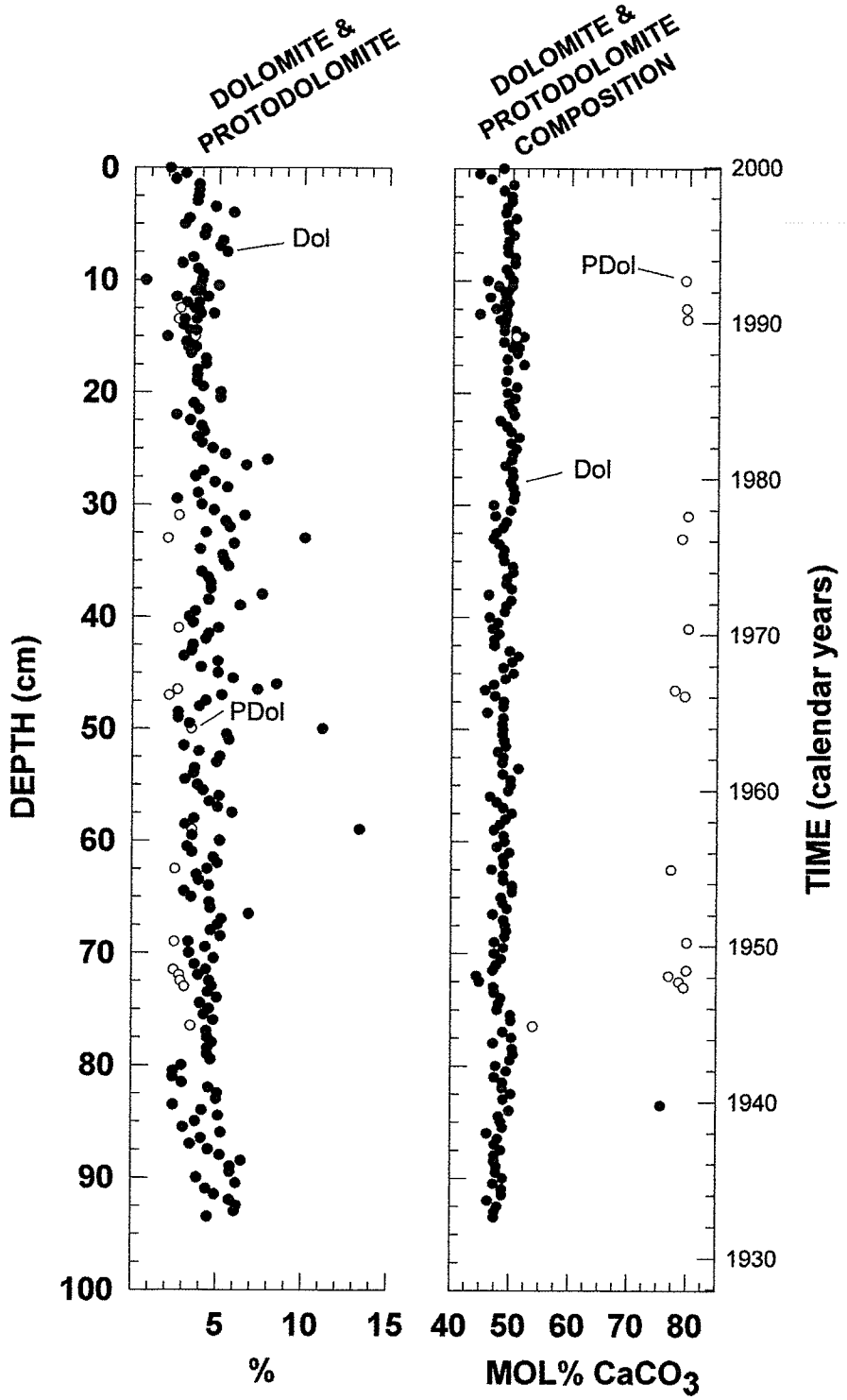

Figure 21. Percentages of dolomite and protodolomite, plus the composition of dolomite and protodolomite in PAD 15.

throughout the core, with dolomite containing an average of just under 50 mol% $CaCO_3$, and protodolomite containing close to 80 mol% $CaCO_3$.

The average percentage of total carbonate minerals at approximately 8% is comparable to that of PAD 54 (Figure 19, Table 6).

PAD 8

Mg-calcite provides the major component of the total calcite fraction, which is quite variable throughout the core sequence, only making up approximately 1% of the total mineral composition (Figure 22, Table 6). Very little total calcite is apparent after regulation of the Peace River (Table 9). The Mg-calcite composition in this sequence averages at 16.2 mol% $MgCO_3$. Calcite composition averages at 2.4 mol% $MgCO_3$.

Dolomite is found clustered sporadically down the depth of the PAD 8 sequence (Figure 23). When dolomite is present it forms about 2 % of the total minerals. Dolomite composition before river regulation contains an average of 49.3 mol% $CaCO_3$. After regulation, the average amount of $CaCO_3$ drops to 42.2 mol%. Protodolomite is uncommon in occurrence in this core, with an average composition of 78.6 mol% $CaCO_3$.

Total carbonate minerals in the PAD 8 core sequence only form an average of 2.1% of the total mineral fraction, which is less than that found in the PAD 54 and 15 cores (Figure 19, Table 6).

Sulfate Minerals

Anhydrite, gypsum and thenardite are the major components of the total sulfate minerals found in the PAD 54, 15 and 8 core sequences (Figure 24). In PAD 54, anhydrite, gypsum and thenardite occur sporadically throughout the sequence, varying

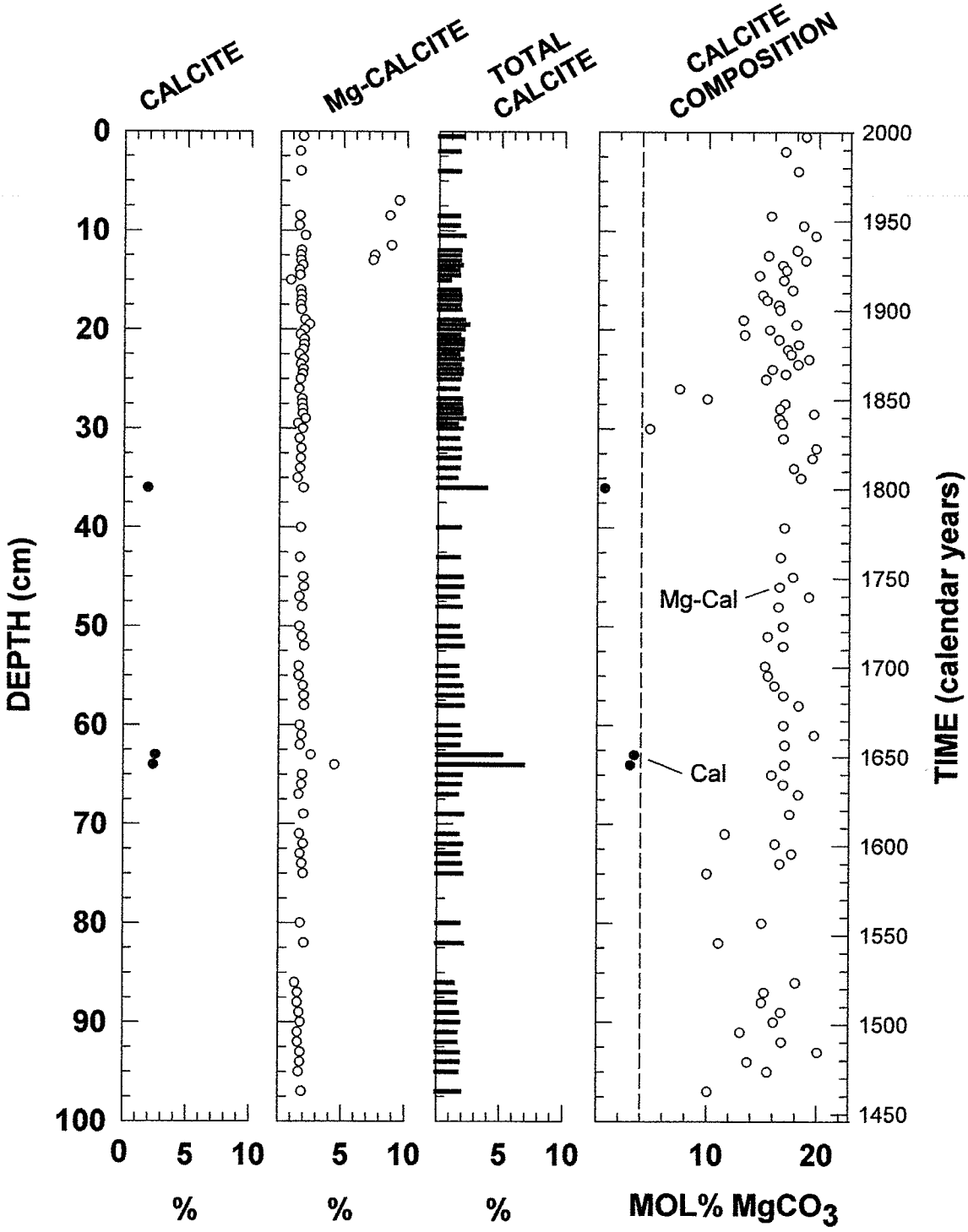

Figure 22. Percentages of calcite, Mg-calcite and total calcite, plus the calcite composition of PAD 8.

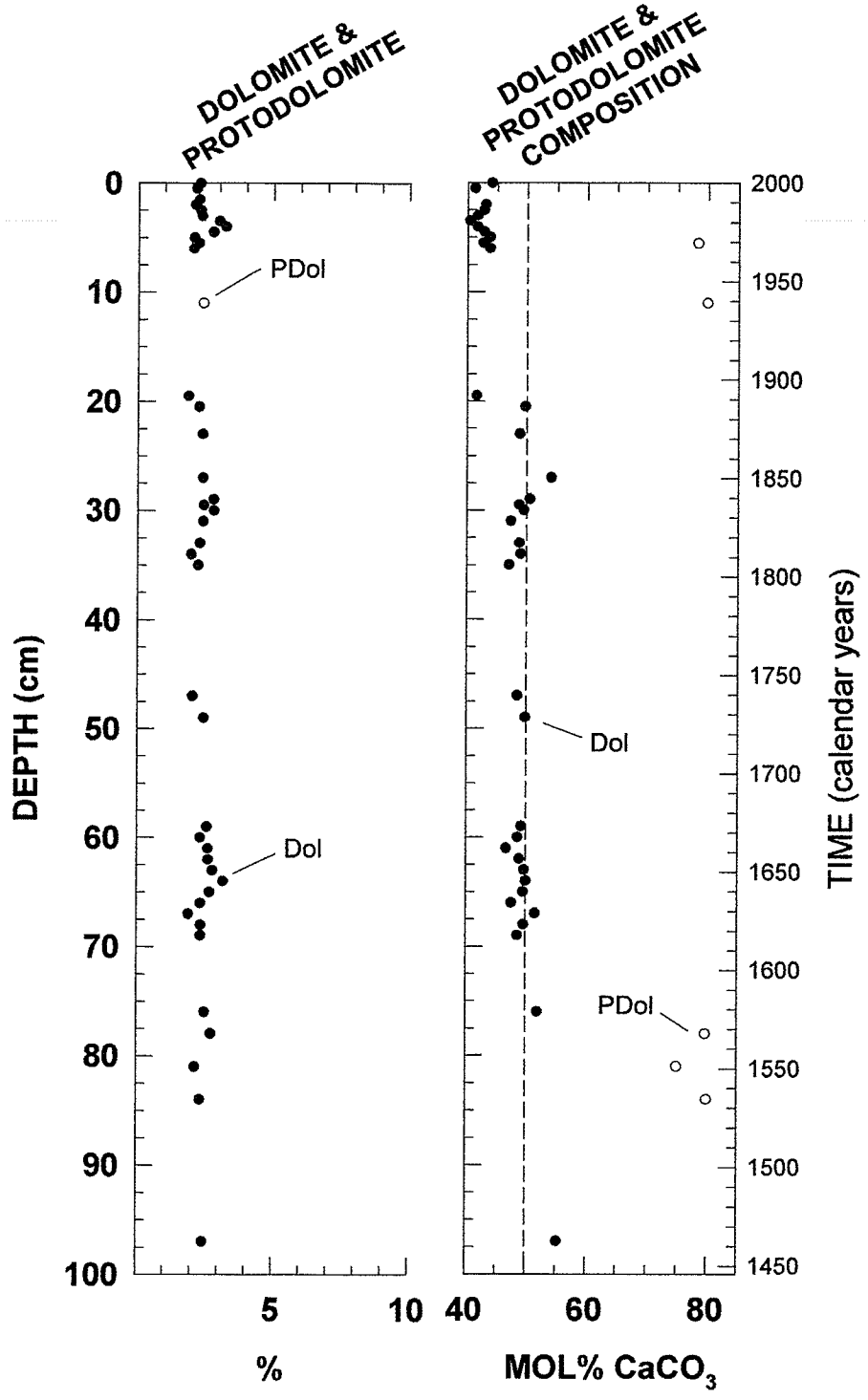

Figure 23. Percentages of dolomite and protodolomite, plus the composition of dolomite and protodolomite for PAD 8.

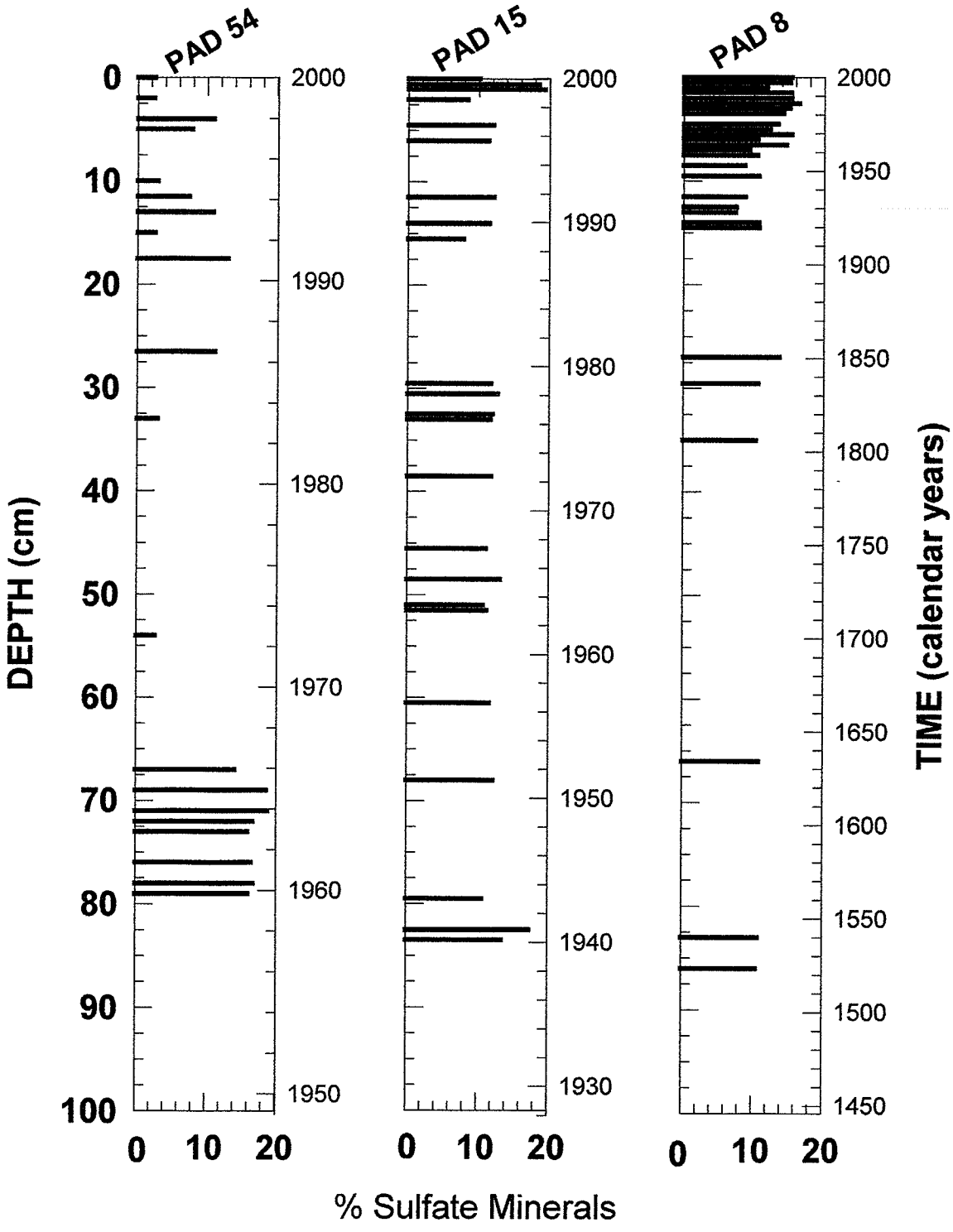

Figure 24. Percentages of sulfate minerals for PAD 54, 15 and 8.

from small amounts (2%) to close to 20% of the total mineral composition. In PAD 15, anhydrite occurs sporadically, forming approximately 10% of the total mineralogy wherever there is an occurrence. In PAD 8, gypsum is the major sulfate mineral present, and it is much more prevalent after river regulation (Table 9), increasing from an average of 1.2% to 14.1% of the core composition. In all of the PAD cores, sulfate minerals content correlates negatively with total siliciclastics content (Tables 10, 11 and 12).

Interpretation

Mineral and Textural Associations

Mineral and textural associations can be observed throughout the core sequences. Moisture content negatively correlates to total feldspars content (Tables 10, 11 and 12). Sections of the cores with lower percentages of quartz and feldspars are therefore likely to be higher in moisture content, which suggests that these sections may be the result of deposition of sediments that have settled out from silt and clay rich floodwaters.

In PAD 54 and 15, moisture content has a positive correlation with clay minerals content that is not demonstrated in PAD 8 (Tables 10, 11 and 12). Since PAD 8 was recovered from a lake that is thought to be through flowing during flooding (Lake 582), it is possible that there is more opportunity for clay minerals to settle out of the floodwaters in this location. Lakes 233 and 555, where PAD 54 and 15 were recovered, are not through flowing. Floodwater with only a finite amount of suspended load reaches these lakes, the sediment then settles out of the water and forms distinct laminae boundaries which can be seen in the PAD 54 and 15 cores. These more distinct laminations represent specific flood events. Lake 582, in contrast, has a continuous supply of suspended sediment during the periods of high water levels, forming less distinct

laminae boundaries as seen within the PAD 8 core. Clay minerals would also be deposited in the channels where water flows into Lake 582 during floods. These sediments would likely be transported into Lake 582 (PAD 8) along with the larger grained sediments containing higher percentages of quartz during periods without flooding. This explains why there is no clear relationship between percentages of water content and total clay minerals content for PAD 8 as well as explaining the generally higher percentages of clay minerals found there.

In PAD 15 and 8, moisture content has a positive correlation with organic matter content that is not seen in PAD 54 (Tables 10, 11 and 12). PAD 8 and 15 experience an increase in organic matter production as a result of the increased moisture levels available at times of high water levels. PAD 54 may have adequate moisture levels to keep organic matter production constant regardless of flood activity, or conversely, flood levels may not be adequate to increase organic matter production in this lake.

Mineral Provenance

Siliciclastic minerals found within the PAD cores are detrital in origin, with most of the material transported to the delta via the Peace, Smoky, Beatton and Wabasca Rivers (Carson, 1992; Prowse and Conly, 1997).

The origin of carbonate minerals tends to be much more difficult to prove in comparison to siliciclastics, because carbonates can result from detrital, endogenic or authigenic origins, or any combination of these origins. Potential sources of carbonates include the Slave Point Formation, which can be seen in outcrop near the Birch River Delta, plus the Keg River and Muskeg Formations which are thought to form the bedrock of the PAD west of Lakes Mamawi and Baril (Bayrock and Root, 1972). Given that much of the sediment deposited in the PAD lakes is of detrital origin, and that there are sources of carbonates within the PAD watershed, it seems reasonable to assume that at

least some of the carbonate material within the PAD cores is detrital in origin. This does not mean, however, that all of the carbonates are detrital in origin. Localized differences in calcite or dolomite composition would favor endogenic or authigenic origins for part of the carbonate material.

Dolomite, protodolomite and Mg-calcite have similar average compositions throughout the PAD locations considered, indicating a similar detrital origin for much of this material (Table 6). PAD 54 shows much higher average percentages of $MgCO_3$ in calcite than the other cores (Table 6), as well as a fairly wide range of calcite compositions (Figure 17), suggesting that a portion of the calcite may be more localized in origin (endogenic or authigenic). The similar compositions of calcite in PAD 15 and 8 suggests that a part of the calcite being deposited in the delta is from a matching detrital origin. PAD 54 also displays a change in dolomite composition during the 1960's, with a return to the previous composition levels from the 1970's to the present (Figure 18). The drop in the percentage of CaCO3 within the dolomite for such a specific period of time suggests more saline conditions in the vicinity of PAD 54 during this time, and also suggests an endogenic origin for some of the dolomite deposited at PAD 54. Given all of these circumstances, it seems likely that carbonates within the PAD come from a combination of detrital, endogenic and possibly authigenic origins.

Since there are sources of sulfates within the PAD watershed, and much of the sediment deposited in the PAD lakes is of detrital origin, it seems reasonable to assume that at a portion of the sulfate material within the PAD cores is detrital in origin. The different sulfate minerals found within each of the PAD cores, however, suggest that the sulfates are mainly endogenic in origin. It is possible that the most of the sulfates were formed in areas of the PAD delta subject to drying out in between flood periods. PAD 54 shows a very low correlation between percentage moisture content and total sulfate minerals content (Table 10), indicating that sulfate minerals are not generally transported

to PAD 54 via overland flooding. This suggests that the thenardite, anhydrite and gypsum form close to PAD 54, in areas of the delta prone to drying out between floods. The metastable, highly soluble nature of thenardite also supports this premise, since transport over long distances would make it unlikely that the mineral would even endure until deposition took place. In PAD 15, the total sulfate minerals content, which is constituted mainly by anhydrite, has a low correlation with moisture content (Table 11), indicating that sulfate minerals are not generally transported to PAD 54 via overland flooding. In PAD 8, the total sulfate minerals content, which is constituted mainly by gypsum, has a positive correlation with moisture content (Table 12), indicating that deposition may be the result of remobilization of localized deposits of sulfate minerals during periods of flooding.

Changes to Core Composition after River Regulation

PAD 54 shows changes in core texture, composition and chemistry after regulation of the Peace River in 1968. Average moisture content and total clay minerals content increased after regulation, while average total carbonate minerals and sulfate minerals content decreased (Table 7). Both calcite and Mg-calcite experienced a drop in the average molar percentages of $MgCO_3$ after regulation, while dolomite displayed an increase in the average molar percentage of $CaCO_3$.

PAD 15 displays the fewest changes after river regulation of all of the core locations, with increased moisture content and a slight increase in organic matter content.

PAD 8 shows the greatest number of changes in core texture, composition and chemistry after regulation of the Peace River in 1968 (Table 9). Textural changes are increased average moisture and organic matter content along with a decrease in average mean grain size. A decrease in average total siliciclastic content, due to

decreases in average quartz and total clay minerals content is evident. The average molar percentage of $MgCO_3$ in Mg-calcite increases slightly, while the average molar percentage of $CaCO_3$ in dolomite decreases after regulation. A large jump in the average percentage of total sulfate minerals also occurs after regulation of the Peace River in 1968.

Chapter 5

Magnetic Susceptibility

Introduction

Magnetic susceptibility is a property of rock and/or sediment that typically indicates the concentrations of ferro- and/or ferri-magnetic minerals within the rock (Reynolds, 1997). Carbonate-rich sediments are generally very low in these minerals, and therefore tend to have low magnetic susceptibilities. Rocks or sediments high in quartz and evaporites typically have low values of magnetic susceptibility, while igneous rocks characteristically have much higher susceptibilities. Increased moisture and organic matter content normally lowers the magnetic susceptibility of sediments.

PAD 54

The average value of magnetic susceptibility for PAD 54 is 149 SI units (Figure 25, Table 13). The average value of magnetic susceptibility drops by almost half after regulation of the Peace River (Table 13). Magnetic susceptibility displays a negative correlation with total siliciclastics content (Table 14).

PAD 15

PAD 15 demonstrates generally higher overall magnetic susceptibilities than PAD 54, with an average of 197 SI units (Figure 25, Table 13). The average value of magnetic susceptibility drops after regulation of the Peace River (Table 13). Magnetic susceptibility negatively corresponds to moisture, organic matter, and total clay minerals content (Table 14). Magnetic susceptibility positively corresponds to quartz, total feldspars, calcite and total carbonate minerals content.

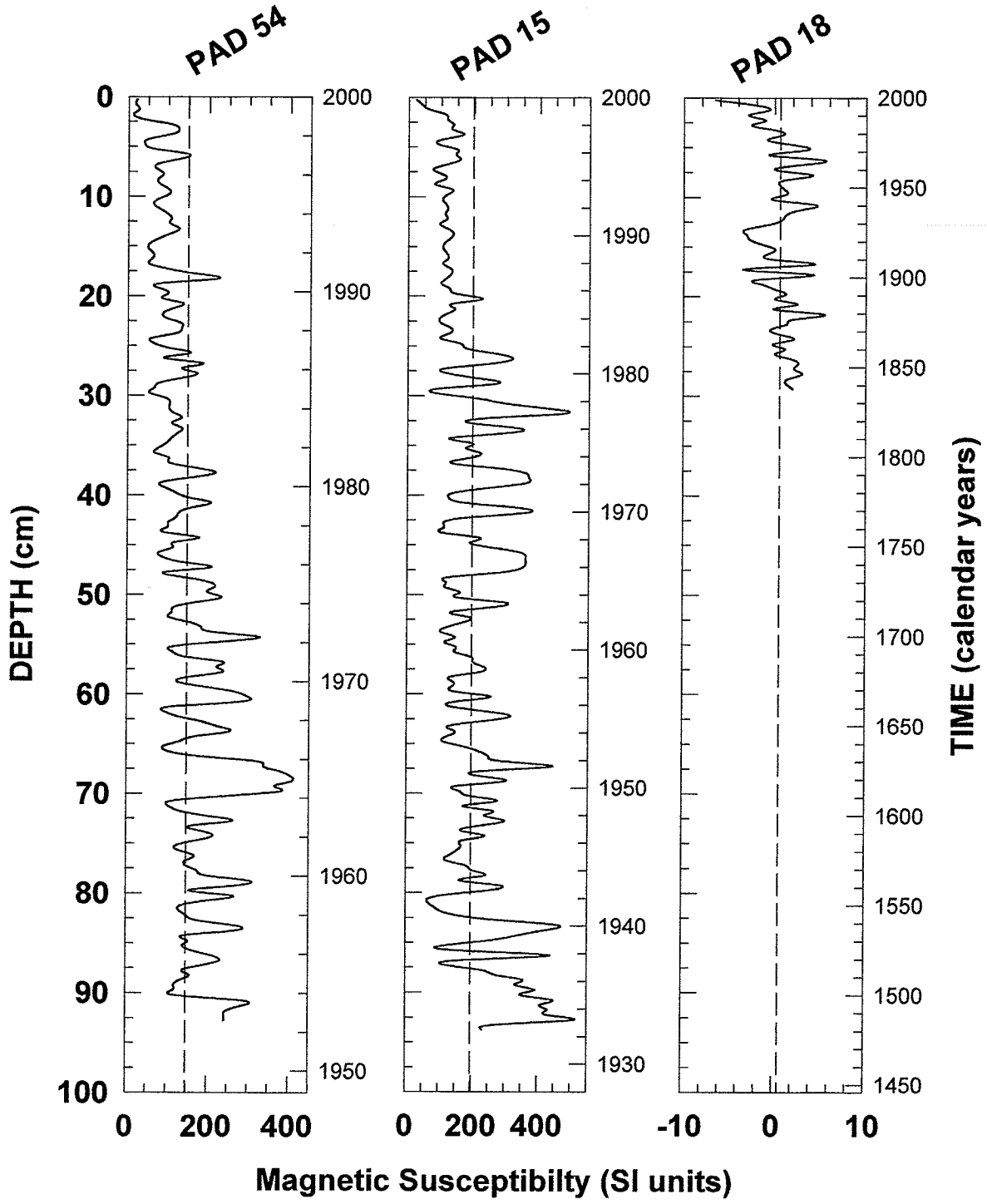

Figure 25. The stratigraphic variation of magnetic susceptibility for PAD 54, 15 and 18. Values for mean magnetic susceptibility are shown as dotted lines on each graph.

Table 13. Mean values of magnetic susceptibility for PAD 54, 15 and 18.

	mean magnetic susceptibility (SI)	mean magnetic susceptibility (SI) before 1968	mean magnetic susceptibility (SI) after 1968
PAD 54	149	197	102
PAD 15	197	226	165
PAD 18	1	N/A	N/A

Table 14. Correlation coefficients (r) for PAD 54 and 15 magnetic susceptibility with texture and mineralogy.

	PAD 54	PAD 15
moisture (%)	-0.3	-0.6
organic matter (%)	0.0	-0.5
grain size (μm)	-0.1	0.2
quartz (%)	-0.2	0. 6
total feldspars (%)	0.2	0.4
total clay minerals (%)	-0.2	-0.6
total siliciclastics (%)	-0.4	-0.2
calcite (%)	0.2	0.4
Mg-calcite (%)	0.1	-0.1
dolomite (%)	0.1	0.4
protodolomite (%)	0.0	0.1
total carbonate minerals (%)	0.2	0.4
total sulfate minerals (%)	0.3	0.0

PAD 18

Values of magnetic susceptibility for PAD 18 (Figure 25) are much lower than what was seen in PAD 54 and 15. PAD 18 has an average magnetic susceptibility of 1 SI units (Table 13). This is likely due to high percentages of organic matter.

PAD 8

No information on magnetic susceptibility for this core sequence was available for inclusion in this work.

Summary

Peaks in magnetic susceptibility for PAD 15 tend to correspond with the sediment composition characteristic of non-flood deposits (low percentages of moisture, organic matter and total clay minerals, plus higher percentages of quartz and feldspars). Both PAD 54 and 15 show a decrease in average values of magnetic susceptibility after regulation of the Peace River in 1968 (Table 13).

Chapter 6

Image Analysis

Introduction

X-ray photography was used to produce images of laminations found within the PAD core sequences. Light colored beds within these sequences generally appear as dark bands in the x-ray photographs (Figure 26). Photographs of the cores taken in normal light do not always correspond exactly to what is shown in the x-ray images. In the lower portion of the core in Figure 26, the normal light image shows laminations that are not visible in the x-ray image. This is due to the fact that each kind of image provides a different type of information. The light image shows the changes in color visible on the surface of the core as would be seen in normal light. The x-ray image gives us a visual representation of density changes within the core.

X-ray photography creates images in which denser material appears lighter in color than less dense material. A common example of this is in medical x-ray images, where dense human bones appear relatively white in contrast to the less dense soft tissues surrounding the bones that appear grayish in color. Image analysis of x-ray core photographs gives information on changes in the relative density of the sediment throughout the core sequences. Flood deposits contain higher percentages of moisture than non-flood deposits, which should be exhibited as relative decreases in density throughout each core. The relative lightness or darkness of the x-ray images, which is referred to as the pixel intensity in image analysis, can therefore be used to help decipher the history of flood deposits in a core.

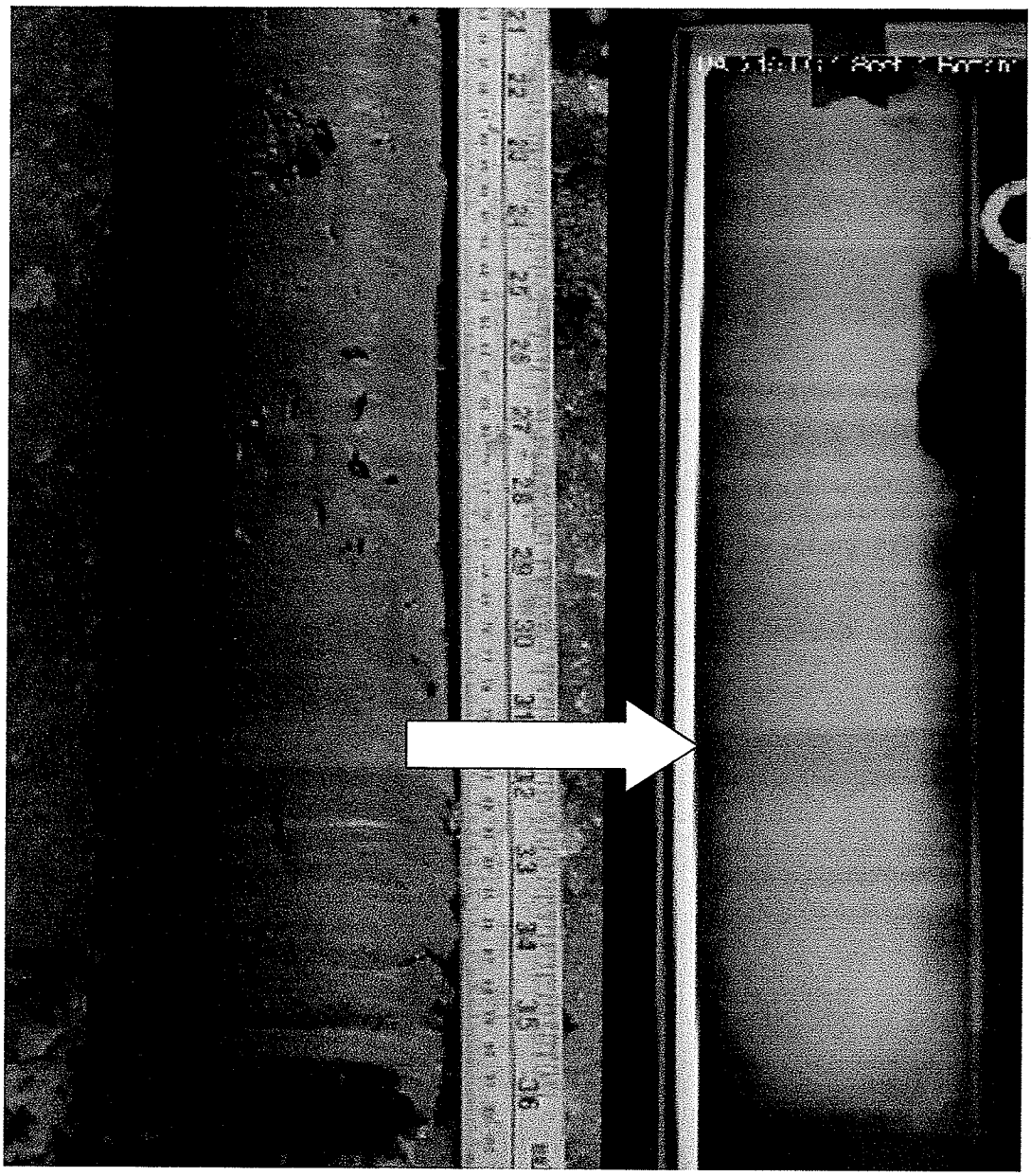

Figure 26. PAD 15 LC-1 section1 as it appears in normal light on the left, the x-ray image of the core on the right.

Figure 27 shows the plots of relative pixel intensities and lamination boundaries for the four PAD cores. Jumps in pixel intensity value that do not correspond to lamination boundaries are due to changes in relative lightness/darkness where images have been sliced together. Actual numerical values of pixel intensity do not give any mineralogical or textural information about the cores, however the relative changes in intensity do correspond to changes in magnetic susceptibility, texture and mineralogy. This facilitates interpretation of the upper approximately 90 cm of the cores in conjunction with the available magnetic, textural and mineralogical data, while allowing for interpretation of the lower sections of core based on the magnetic, textural and mineralogical associations observed from the upper sections.

The top portions of the PAD 54 and 18 cores used for image analysis were not recovered when the cores were collected (Figure 27). The upper portions of all of the cores lack visible laminations, probably due to difficulties in recovering the upper portion of sediment close to the sediment/water interface. Because of this, the upper portions of each of the PAD cores were not used to determine information regarding lamination thicknesses. The bottom laminations of each PAD core were also not considered in calculations regarding lamination thicknesses because it is likely that these sections are incomplete.

The boundary between "thin" and "thick" laminations has been set at 35 mm in order to simply descriptions due to the small values of mean lamination size in PAD 54 and 15.

Chronologies established for the image analysis plots were extrapolated from information obtained from the upper core depths. No chronological information was available for PAD 18.

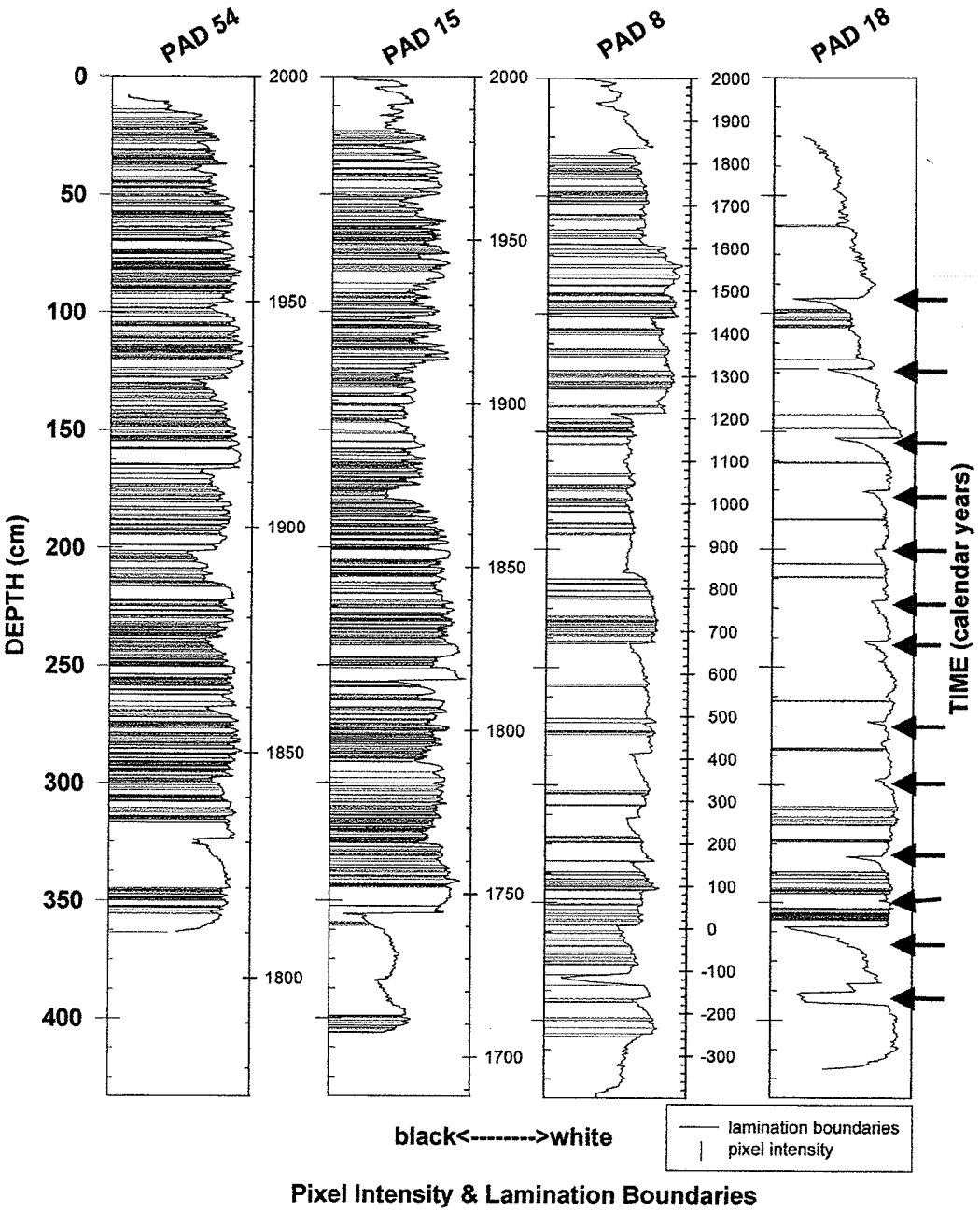

Figure 27. Pixel intensity verses depth with lamination boundaries for PAD 54, 15, 8 and 18. Jumps in pixel intensity due to changes in relative lightness/darkness where core images have been joined together are indicated with arrows for PAD 18. Calendar years in the positive range are years AD, while years in the negative range are years BC.

PAD 54

Image analysis of the PAD 54 core shows that this core exhibits the highest number of laminations (506) and the lowest mean lamination thickness (6.7 mm) of the four cores considered, with most laminations less than 5 mm thick (Figure 28). Figure 29 shows the distributions of lamination thickness throughout the core sequence in relation to depth and time. Thicker laminations (≥ 35 mm thick) occur approximately every 20 years in the early part of the 20th century, with no thicker laminations occurring after the mid-1960's. During the late 19th century the periods of time between laminations ≥ 35 mm thick ranged from approximately 10 to 60 years. The occurrence of laminae ≥ 35 mm in thickness is 3.4 laminae/century (Table 15), or approximately once every 30 years. PAD 54 has the highest frequency of laminations (2.90 laminae/year), with most laminae representing less than a years worth of deposition (Figure 30).

Pixel intensity for PAD 54 displays a weak positive correspondence to total feldspars, total carbonate minerals and total sulfate minerals content, and a more significant positive correlation to magnetic susceptibility (Table 16). Pixel intensity displays a significant negative correspondence to moisture, and a less significant negative relationship to total clay minerals and total siliciclastics content (Table 16).

PAD 15

The PAD 15 core is similar to the PAD 54 core in that it contains a high number of laminations (504) with a low mean lamination thickness (7.6 mm), and also has laminations generally less than 5 mm thick (Figure 31). Figure 29 shows the distributions of lamination thickness throughout the core sequence in relation to depth and time. Laminations ≥ 35 mm thick occur approximately every 30 years in PAD 15 (Table 15), with a variation of approximately 5 to 50 years between the occurrences of thicker laminations (Figure 29). PAD 15 has the second highest frequency of

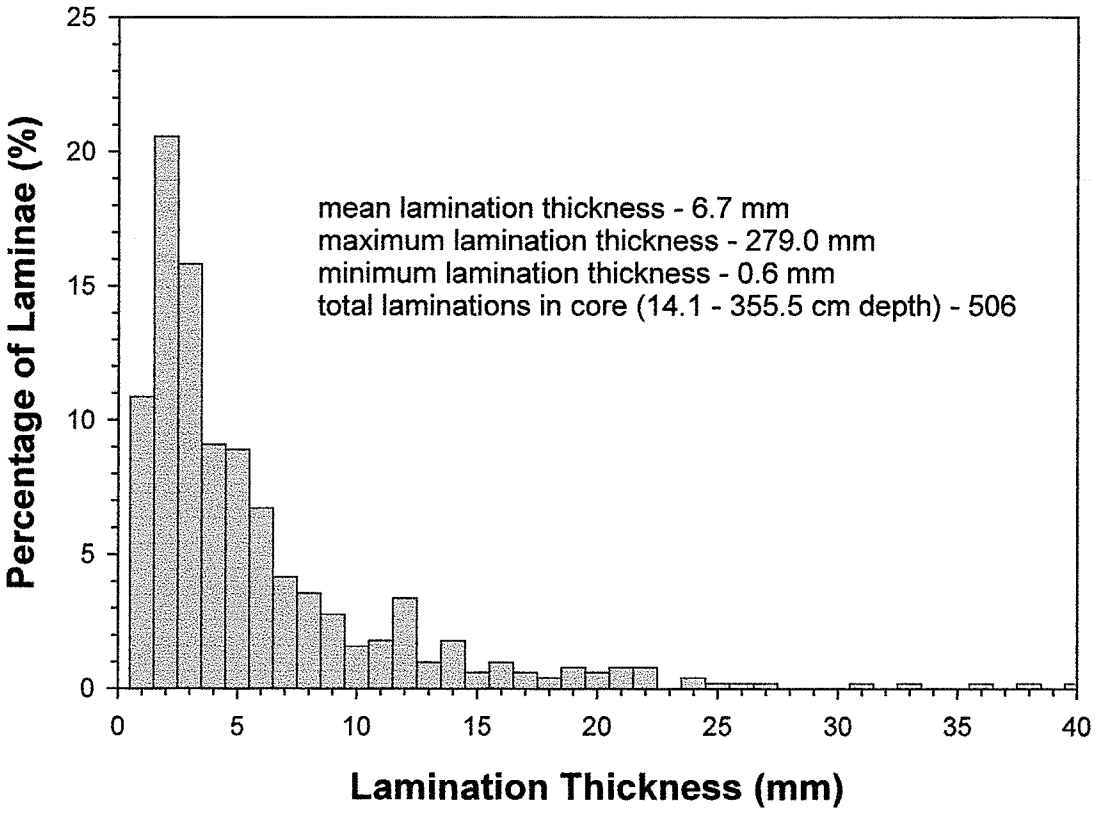

Figure 28. Percentage of laminae of various thicknesses for PAD 54. Laminae over 40 mm in thickness account for only 1% of the laminations within this core, and are not shown in this graph.

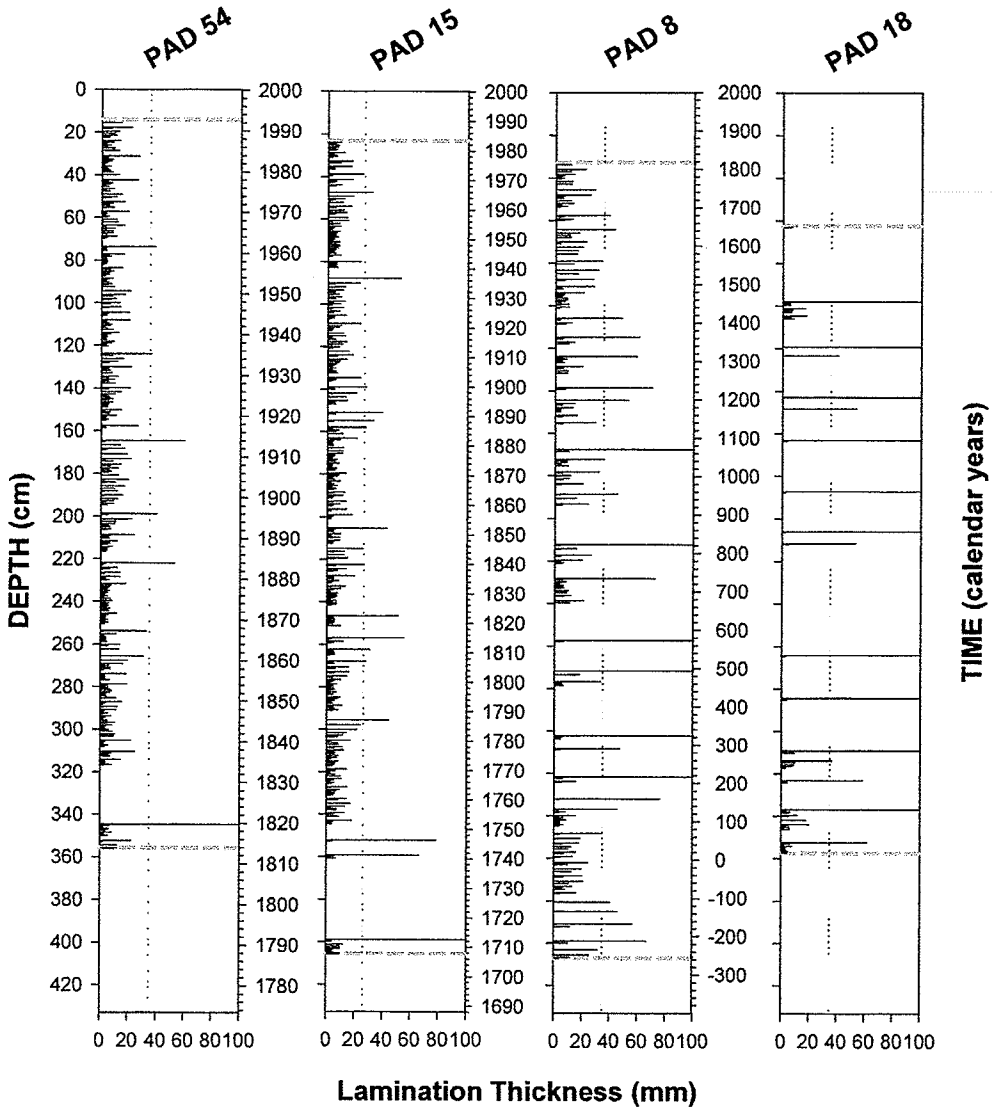

Figure 29. The distributions of lamination thickness throughout the core sequence in relation to depth and time for PAD 54, 15, 8 and 18. The boundary between "thin" and "thick" laminations is indicated by the dotted reference line at 35 mm. Thickness over 100 mm is not shown on graphs. The upper and lower boundaries of the portions of the cores used for lamination counts are marked with gray dashed lines.

Table 15. Percentage and frequency of laminae ≥ 35 mm, median and mean in thickness for PAD 54, 15, 8 and 18.

	PAD 54	PAD 15	PAD 8	PAD 18
laminae ≥ 35 mm (%)	1.2	1.8	10.3	20.5
laminae ≥ median (%)	50.4	22.2	49.6	48.7
laminae ≥ mean (%)	27.3	23.4	21.9	18.0
frequency of laminae ≥ 35 mm per century	3.4	3.3	1.1	N/A
frequency of laminae ≥ median per century	146.5	40.7	5.4	N/A
frequency of laminae ≥ mean per century	79.3	42.9	2.4	N/A

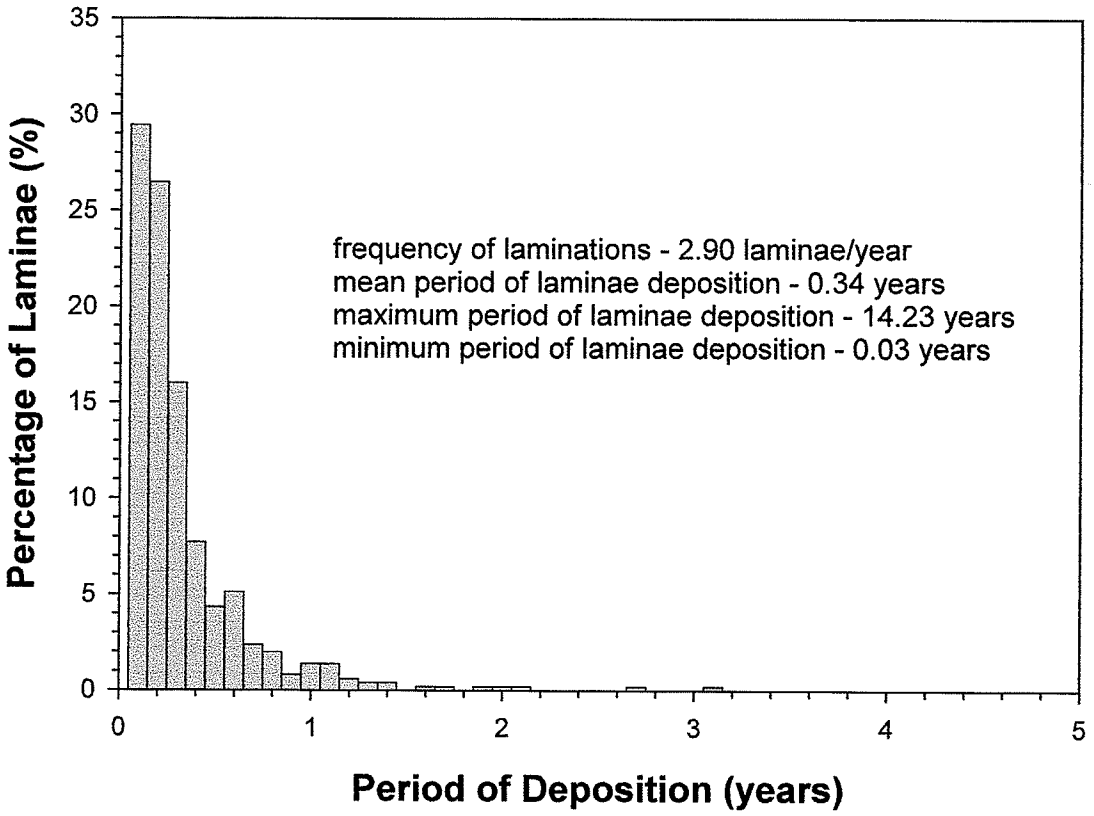

Figure 30. Percentage of laminae of deposited over various time periods for PAD 54. Laminae deposited in periods of greater than 5 years account for less than 1% of the total laminations within this core, and are not shown in this graph.

Table 16. Correlation coefficients (r) for PAD 54, 15 and 8 pixel intensity with texture, mineralogy and magnetic susceptibility.

	PAD 54	PAD 15	PAD 8
moisture (%)	-0.5	-0.5	-0.6
organic matter (%)	0.0	-0.5	-0.6
grain size (μm)	0.0	0.1	0.5
quartz (%)	0.0	0.2	0.4
total feldspars (%)	0.3	0.2	0.3
total clay minerals (%)	-0.3	-0.1	0.4
total siliciclastics (%)	-0.3	0.1	0.5
calcite (%)	0.2	0.2	0.0
Mg-calcite (%)	0.2	-0.1	0.2
dolomite (%)	0.2	0.2	-0.1
protodolomite (%)	0.0	0.2	0.1
total carbonate minerals (%)	0.3	0.2	0.0
total sulfate minerals (%)	0.1	-0.2	-0.5
magnetic susceptibility (SI)	0.5	0.4	N/A

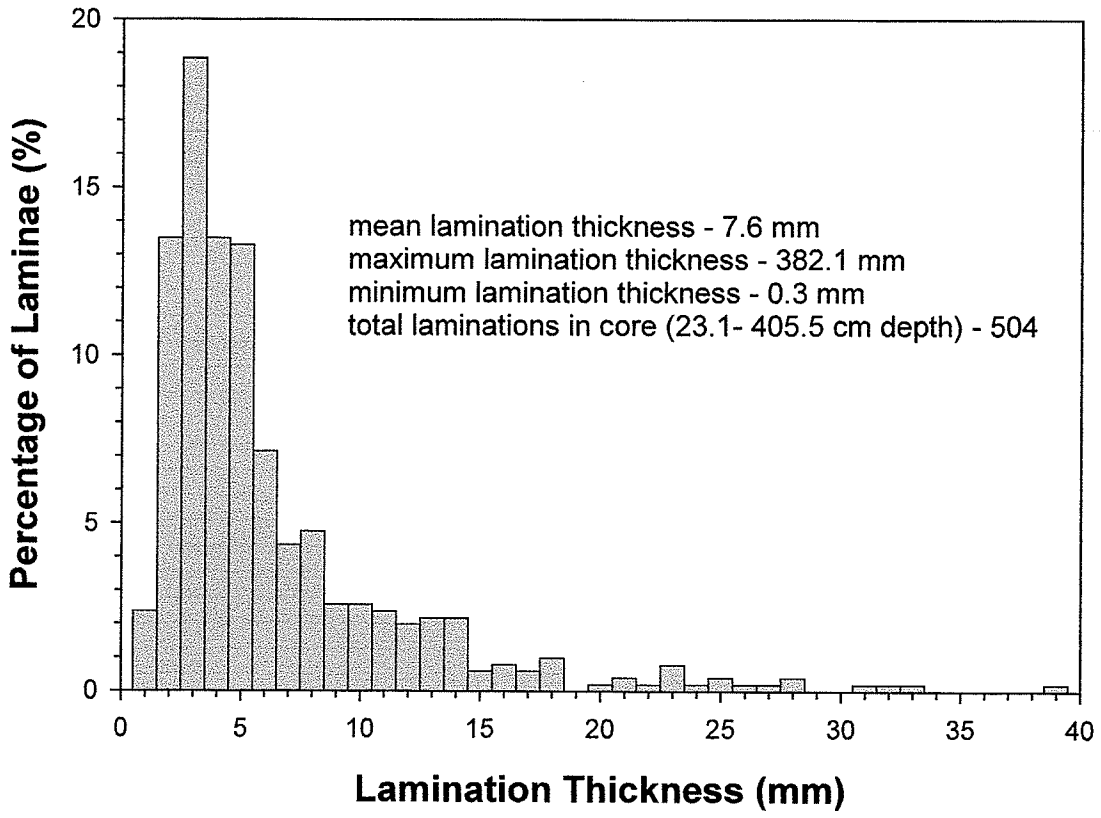

Figure 31. Percentage of laminae of various thicknesses for PAD 15. Laminae over 40 mm in thickness account for less than 2% of the total laminations within this core, and are not shown in this graph.

laminations at 1.83 laminae/year, with the laminae generally representing less than one year of deposition (Figure 32).

Pixel intensity for PAD 15 positively corresponds to magnetic susceptibility (Table 16). Pixel intensity negatively corresponds to moisture and organic matter content (Table 16).

PAD 8

The PAD 8 core contains roughly half the number of laminations which have more than twice the mean thickness found in PAD 54 and 15 (Figure 33). The highest percentage of laminations found in PAD 8 are less than 10 mm thick (Figure 33). Figure 29 shows the distributions of lamination thickness throughout the core sequence in relation to depth and time. Laminations ≥ 35 mm thick occur approximately once every 100 years in PAD 8 (Table 15), with a variation of approximately 20 to 200 years between the occurrences of these thicker laminations (Figure 29). PAD 8 has the lowest frequency of laminations at 0.11 laminae/year, with laminae that generally represent less than 10 years of deposition (Figure 34).

Pixel intensity for PAD 8 positively corresponds to quartz, total clay minerals, and total siliciclastics content, as well as to grain size (Table 16). Pixel intensity negatively corresponds to moisture, organic matter and total sulfate minerals content (Table 16).

PAD 18

The PAD 18 sequence contains the fewest laminations of the four cores (78) with the greatest mean lamination thickness (37.8 mm) (Figure 35). Laminations ≥ 35 mm in

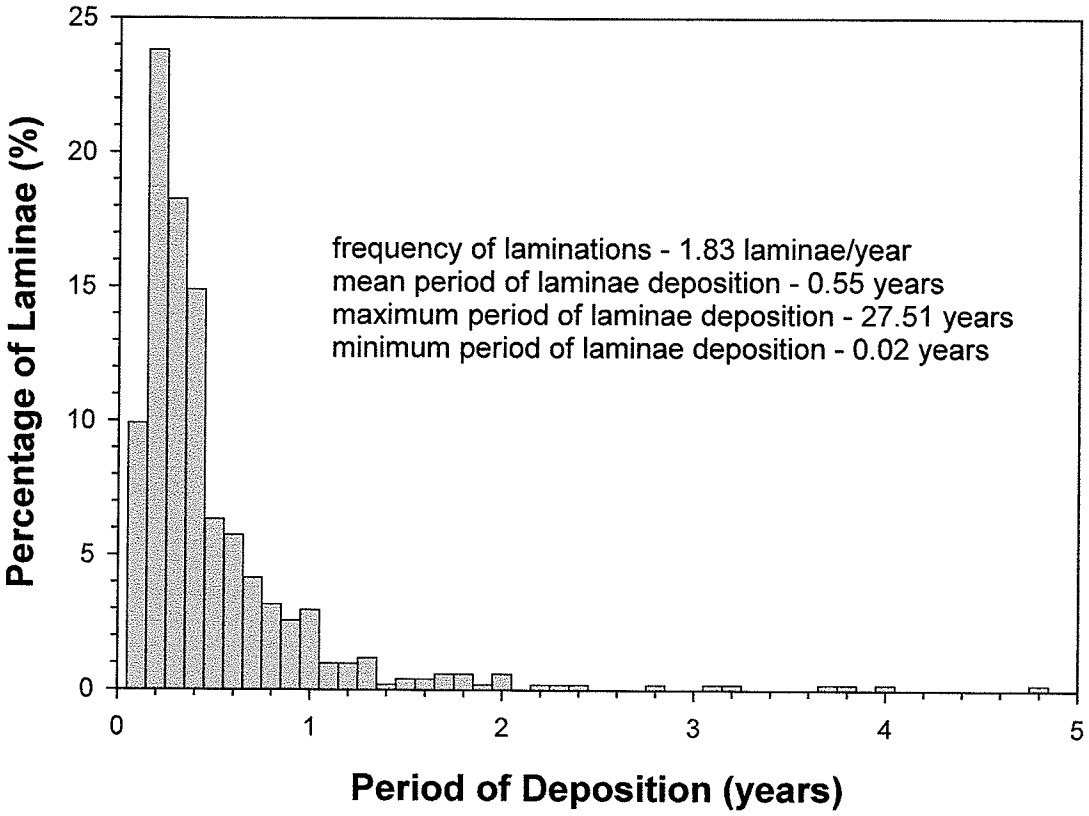

Figure 32. Percentage of laminae of deposited over various time periods for PAD 15. Laminae deposited in periods of greater than 5 years account for less than 1% of the total laminations within this core, and are not shown in this graph.

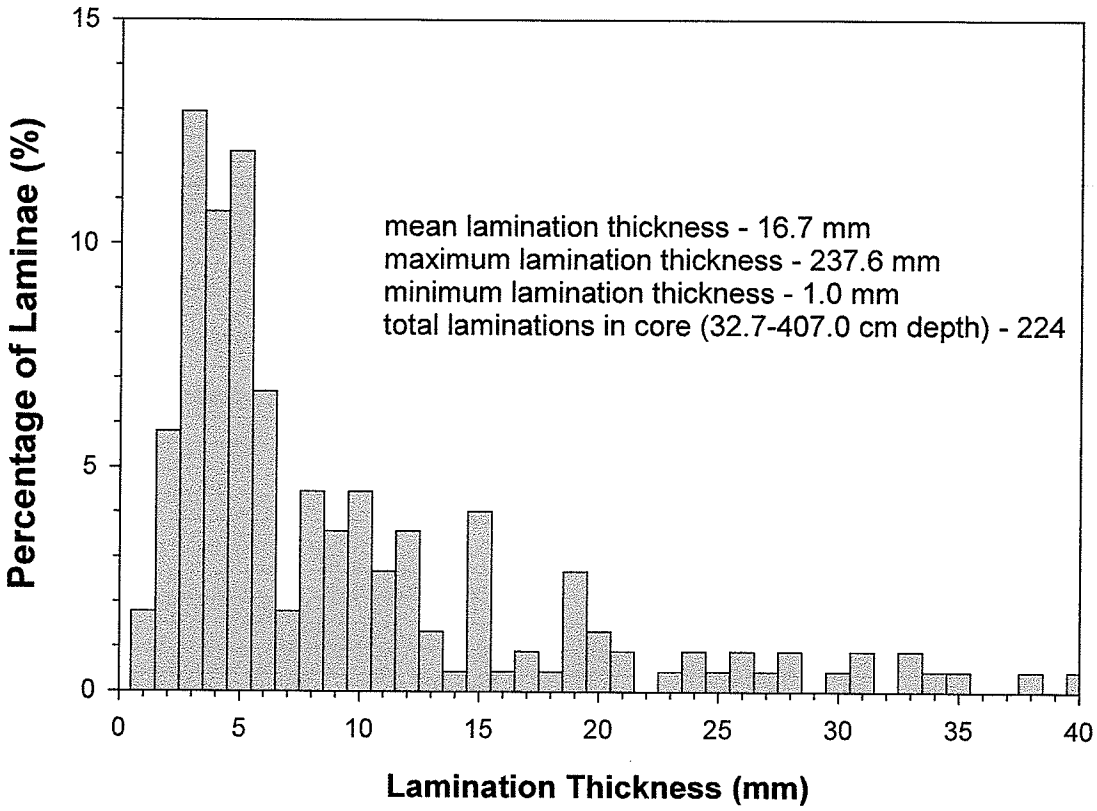

Figure 33. Percentage of laminae of various thicknesses for PAD 8. Laminae over 40 mm in thickness account for only 9% of the total laminations within this core, and are not shown in this graph.

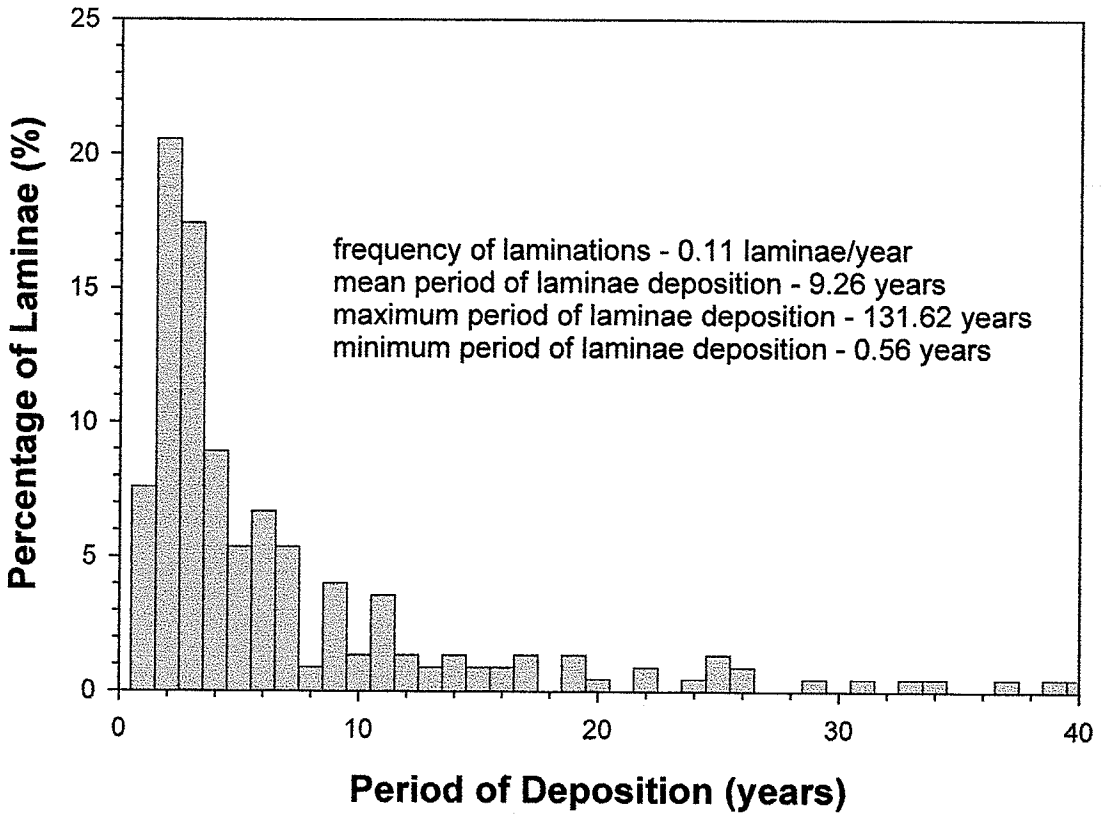

Figure 34. Percentage of laminae of deposited over various time periods for PAD 8. Laminae deposited over periods of greater than 40 years account for only 4% of the total laminations within this core, and are not shown in this graph.

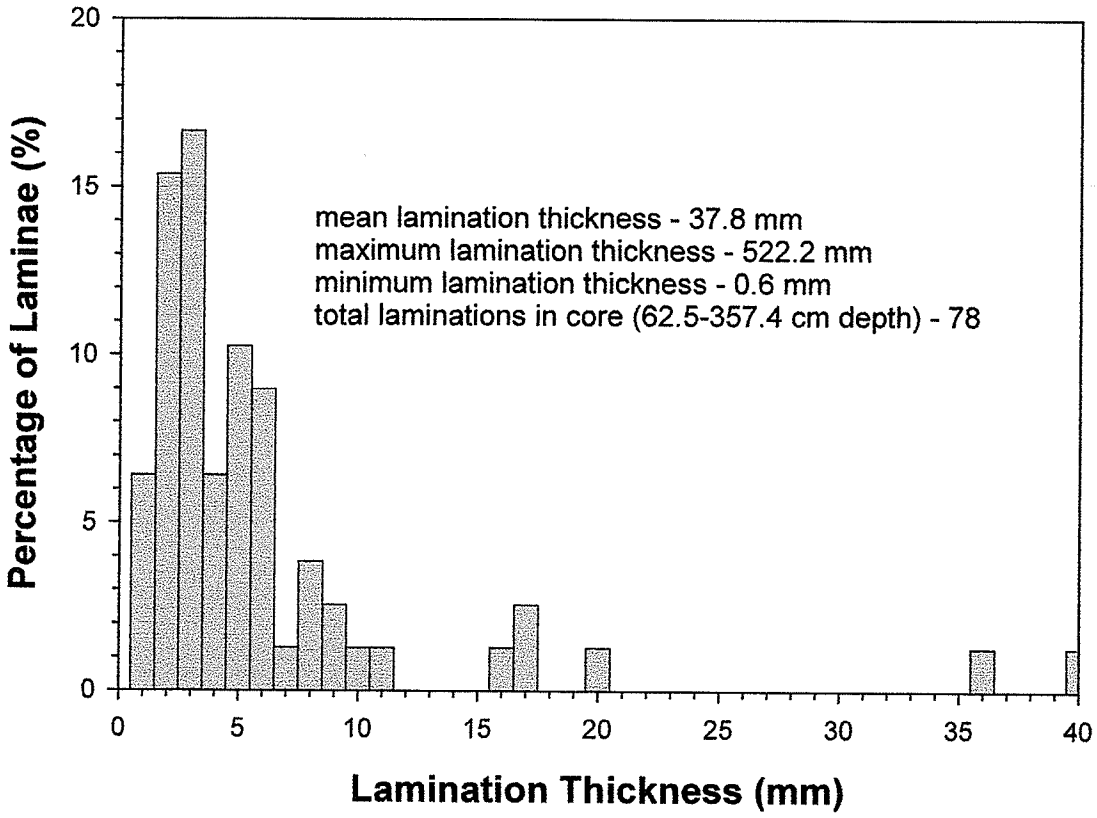

Figure 35. Percentage of laminae of various thicknesses for PAD 18. Laminae over 40 mm in thickness account for less than 20% of the total laminations within this core, and are not shown in this graph.

thickness are the most common in this core, accounting for 20.5 % of the total laminations (Table 15).

Using Pixel Intensity and Lamination Thickness to Determine Flood Deposition

Pixel intensity negatively corresponds to high moisture content, which is an important indicator of flood deposition (Table 16). Pixel intensity generally corresponds to texture, mineralogy and magnetic susceptibility (Table 17). This means that pixel intensity can be used to help determine the frequency of flood deposits within each of the study locations.

It is difficult to measure the correlation between pixel intensity and lamination thickness in the PAD cores because of the strongly positive correlation between pixel intensity and depth (Table 18). In other words, as depth increases, so does the pixel intensity, which means that a lamination that is at a lower depth will tend to have a higher pixel intensity than a lamination that is closer to the surface, regardless of thickness.

Another obstacle to measuring the correlation between pixel intensity and lamination thickness is that both light and dark (high pixel intensity and low pixel intensity) laminae occur in varying sizes, with no gradual change in pixel intensity from thinnest to thickest laminations.

Despite the problems in measuring any correlation between pixel intensity and lamination thickness, it is possible to make some generalizations based on visual observations of the x-ray images of the PAD cores (Figure 36). PAD 54 and 15 both appear to have a number of very thick laminae with relatively high pixel intensities (appearing lighter in grayscale). This suggests that in PAD 54 and 15, very thick laminae are an indication of a long period with relatively dry conditions, while thinner laminae indicate more variable conditions that include more frequent flooding. In PAD 8

Table 17. Correlation coefficients (r) for PAD 54, 15 and 8 pixel intensity and moisture content with texture, mineralogy and magnetic susceptibility.

	PAD 54		PAD 15		PAD 8	
	pixel intensity	moisture content	pixel intensity	moisture content	pixel intensity	moisture content
moisture (%)	-0.5	1.0	-0.5	1.0	-0.6	1.0
organic matter (%)	0.0	0.0	-0.5	0.9	-0.6	0.9
grain size (μm)	0.0	-0.3	0.1	-0.2	0.5	-0.7
total carbonate minerals (%)	0.3	-0.7	0.2	-0.6	0.1	0.0
quartz (%)	0.0	-0.6	0.2	-0.7	0.4	-0.8
k-feldspar (%)	0.2	-0.1	0.0	-0.1	N/A	N/A
plagioclase (%)	0.3	-0.6	0.3	-0.6	0.3	-0.5
total clay minerals (%)	-0.3	0.7	-0.1	0.7	0.4	-0.5
total siliciclastics (%)	-0.3	0.4	0.1	0.1	0.5	-0.7
total sulfate minerals (%)	0.1	0.0	-0.2	0.2	-0.5	0.8
magnetic susceptibility (SI)	0.5	-0.5	0.4	-0.8	N/A	N/A

Table 18. Correlation coefficients (r) for PAD 54, 15, 8 and 18 average lamination pixel intensity with depth and lamination thickness.

	PAD 54	PAD 15	PAD 8	PAD 18
depth (cm)	0.7	0.5	0.9	0.9
thickness (cm)	-0.1	0.1	0.0	-0.1

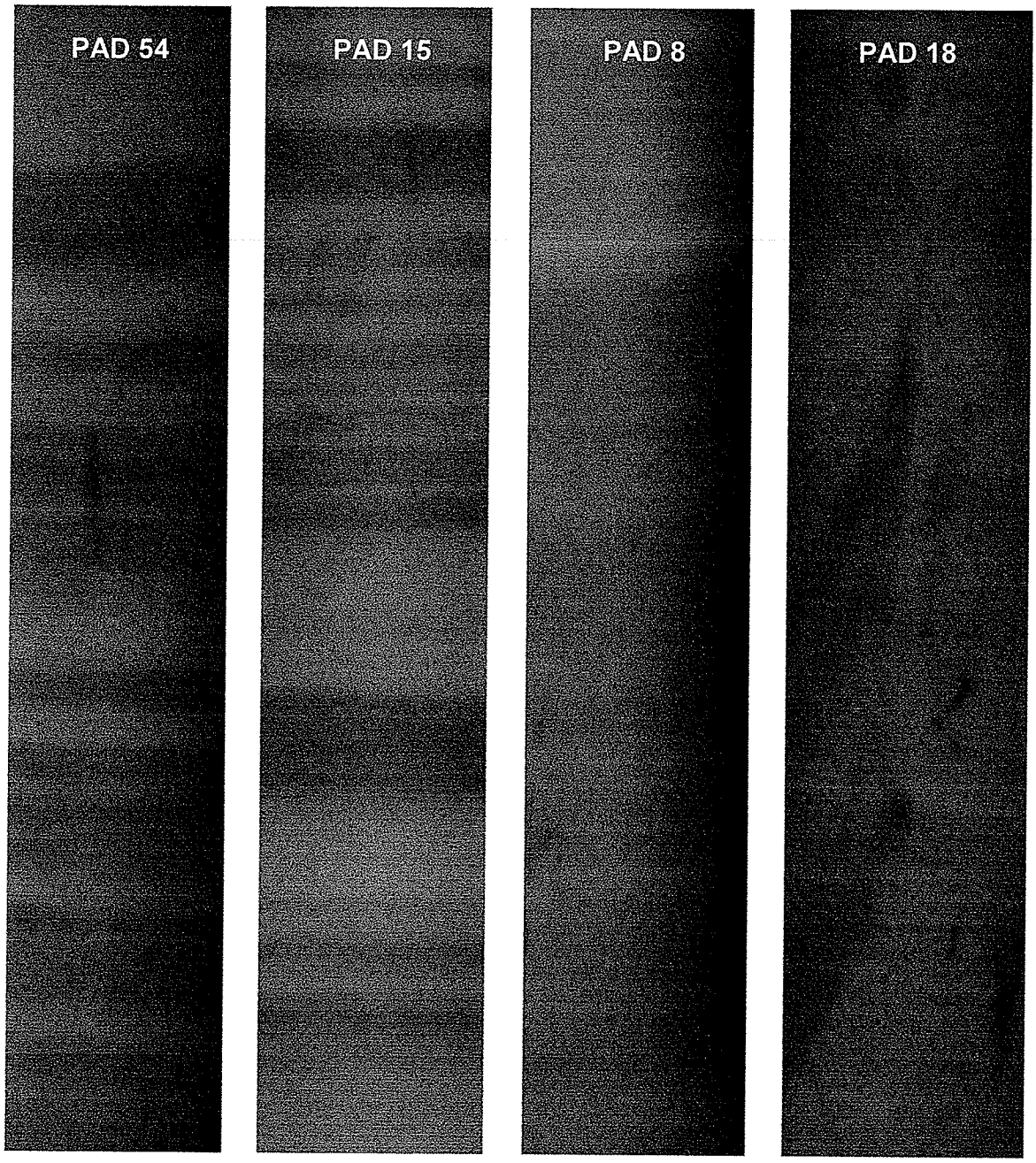

Figure 36. X-ray images of portions of the PAD 54, 15, 8 and 18 cores. Complete core images are shown in Appendix B.

and 18, wider laminae generally appear to have lower values of pixel intensity than thinner laminae, suggesting generally wetter settings that are periodically interrupted by dryer conditions. In all of the cores, it seems likely that sections of core with many small laminations indicate periods of continually changing energy conditions, with more frequent flooding taking place. Sections of core with thicker laminae indicate periods of generally stable conditions. This is supported by the variations in texture and mineralogy that correspond to changes in pixel intensity.

Chapter 7

Discussion

Introduction

Ice-jam induced flooding of the Peace-Athabasca Delta is thought to be the primary mechanism for recharging hydrologically isolated (perched) basins within the delta (Prowse and Lalonde, 1996). Flooding occurs within the PAD when water flow in the Peace River reverses due to either ice-jams or sustained high flows from the Peace River (PADTS, 1996; Leconte et al., 2001). Although some floods caused by sustained high flows, such as the one that occurred in the summer of 1996, may result in the inundation of perched basins, typically, this is not the case. In 1990, the largest sustained high flow event on record for the Peace River was unable to flood restricted and isolated perched basin environments (PADTS, 1996). Spring breakup ice-jams are associated with much higher water levels produced by much lower flows than summertime high flow events (PADTS, 1996), and consequently play a more significant role in maintaining water levels in perched basins.

Physical Indicators of Ice-Jam Induced Flooding

The first objective of this study was to determine if physical indicators could be used to differentiate between flood and non-flood deposits. When flooding occurs in the PAD, the delta is inundated by sediment-laden floodwaters, resulting in surficial deposits of silt- and clay-size grains that are found throughout the delta (Bayrock and Root, 1972). These flood deposits are seen within x-ray images of the lake basin core sequences as finer-grained, dark-colored (less dense) laminations in contrast to the coarser-grained, light-colored (denser) non-flood deposits. Flood deposits read as being less dense in x-rays because of the higher moisture content, due to the ability of organic

matter and some clay minerals to retain water. Although it may seem counter-intuitive to describe flood deposits as being finer-grained than non-flood deposits, it is important to consider how the perched lake basins studied in this work receive the floodwaters of the Peace River. First, the waters of the Peace River overflow the river's banks, depositing sand on the levees. The velocity of the water then slows down as it spreads out over the delta. By the time the floodwaters reach the intervening lakes and marshes, mainly silt and clay size particles remain in the suspended load. Typically the floodwaters remain in the perched basins long enough to allow for the settling out of the silt and clay (Bayrock and Root, 1972).

Variations in grain size, plus mineral and textural associations can be related to the differences between flood and non-flood deposits. Flood deposits contain lower percentages of quartz, total feldspars and total carbonate minerals, combined with a higher moisture content, plus a generally smaller mean grain size. Non-flood deposits, as a consequence of reduced detrital influx, consist of coarser sediments with higher percentages of quartz, total feldspars and total carbonate, plus lower percentages of moisture content.

PAD 15 and 8 show an increase in organic matter content in association with flood deposits, suggesting an increase in lake productivity during periods of flooding. PAD 54 does not display any significant increase or decrease in organic matter content during flooding, suggesting that flooding is not a major influence on lake productivity there.

PAD 54 and 15 both show an increase in the percentage of total clay minerals in association with flood deposits that is not seen in PAD 8. In contrast to Lakes 233 (PAD 54) and 555 (PAD 15), Lake 582 (PAD 8) is thought to be through flowing during flooding. When floodwater reaches Lakes 233 and 555, only a finite amount of suspended load is carried into these basins, which then settles out of the water and

forms distinct laminae boundaries as seen in PAD 54 and 15. Lake 582 has a more continual supply of suspended sediment during the times it is through flowing, producing the less distinct laminae boundaries and higher percentages of clay minerals that distinguish the PAD 8 core. Clay minerals would also be deposited in relatively high percentages in the channels where water flows into and out of Lake 582 during flooding, providing a source of clay minerals during drier periods. This explains why PAD 8 shows no clear relationship between water content and total clay minerals content.

Magnetic susceptibility can also be used to differentiate between flood and non-flood deposition, since flood deposits contain higher percentages of moisture, which has a low magnetic susceptibility. Peaks in magnetic susceptibility are associated with increases in the percentages of quartz, total feldspars and total carbonate minerals, and decreases in the percentage of total clay minerals. This means that peaks in magnetic susceptibility correspond to indications of non-flood deposition.

X-ray photography provides images of the laminations within the core sequences. Light colored beds (flood deposits) appear as dark bands in the x-ray photographs, and correspond to sections which are generally finer-grained, have lower magnetic susceptibilities, higher moisture contents and lower densities than darker laminations. Non-flood deposits, due to their greater density, appear as light bands in the x-ray images.

Image analysis of the x-ray photographs provides a numerical record of the relative lightness or darkness of the images. Since flood deposits appear as dark bands in the x-ray images, drops in pixel intensity are an indication of flood deposition. Relative increases in pixel intensity correspond to increases in magnetic susceptibility and in the percentages of total carbonate minerals, quartz and plagioclase content, as well as to decreases in moisture content. Therefore, relative increases in pixel intensity values correspond to indications of non-flood deposition.

Flood Frequency

The second objective of the study was to decipher the history of ice-jam floods in the four core locations within the delta. Since relative decreases in pixel intensity and magnetic susceptibility, decreased percentages of quartz and feldspars, and increased moisture content are indications of flood deposition, this information was plotted to determine the depths and approximate dates of flood deposits found within the upper portions (~0-90 cm) of the PAD cores (Figures 37, 38 and 39). PAD 54 and 15 display increases in the amounts of total clay minerals corresponding to increases in water content, so the amount of total clay minerals were also plotted for these locations. PAD 15 and 8 both display increases in organic matter content corresponding to increases in water content, so the percentages of organic matter were also considered for these locations. Only image analysis data were used to determine the frequency of flood deposits in the lower portions of the PAD cores (Figures 40, 41 and 42).

Sections of the PAD cores characterized by many thin laminations tend to display more frequent changes in pixel intensity than sections consisting of thick laminations. This suggests that core sections characterized by thinner laminations are from locations that have experienced more frequent changes in conditions and therefore more frequent flooding during the period of deposition. The distribution of lamination thicknesses within the PAD cores (Figure 43) can therefore be used to determine when flooding occurs more or less often in relation to other time frames and locations.

PAD 54 displays the smallest average lamination thickness (6.7 mm) of the four PAD locations, and the fewest laminations greater than 35 mm (figure 43), indicating that it floods more frequently than the other locations. Figure 44 shows the number of floods per decade for PAD 54. The period of fewest floods (1-4 floods/decade) occurred from the 1820's through the 1840's. From the second half of the 19th century to the present, the frequency of flooding appears to be generally greater that what was determined to

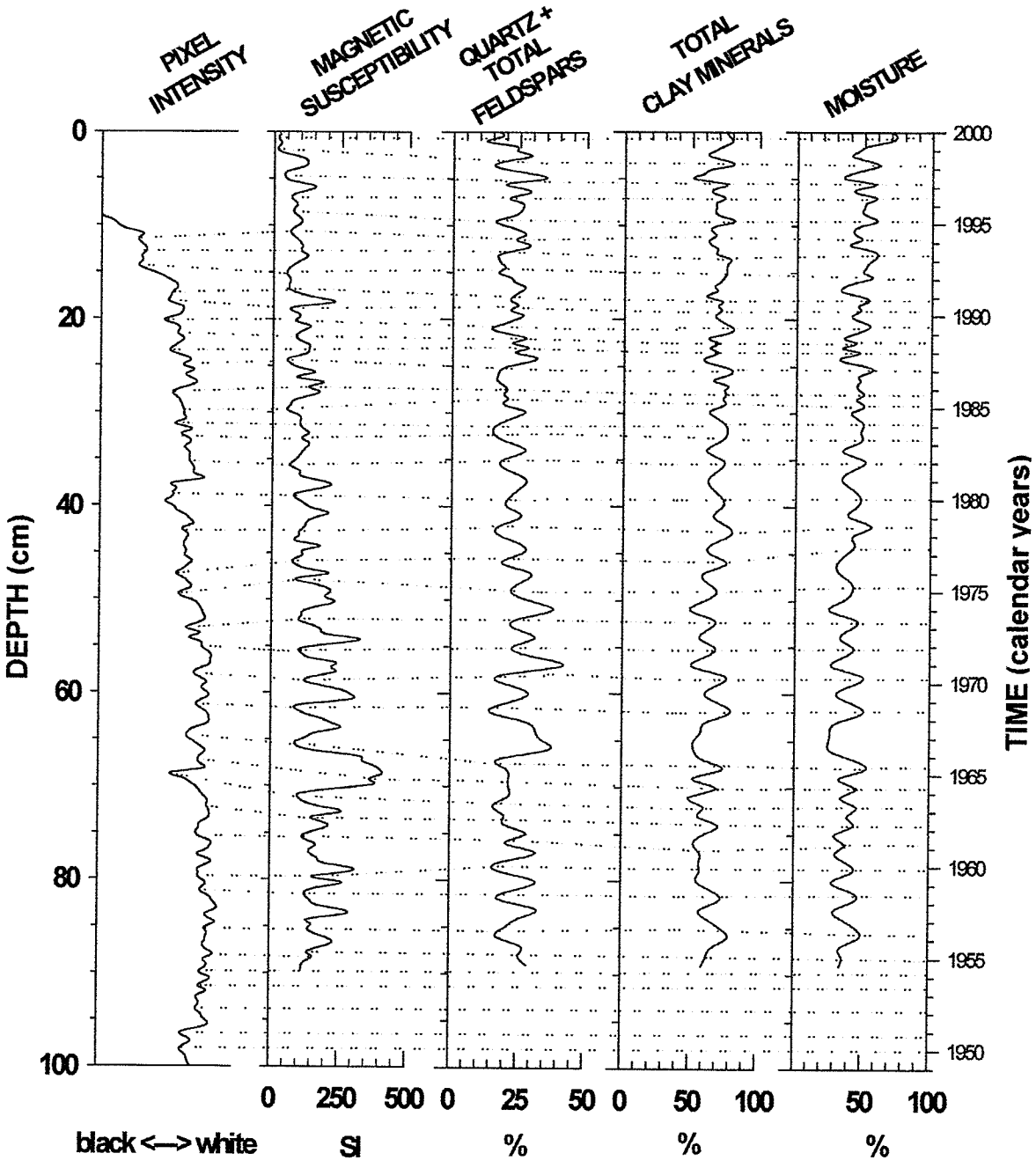

Figure 37. Using pixel intensity and magnetic susceptibility, plus percentages of quartz plus total feldspars, total clay minerals and moisture content to indicate flood events (dotted lines) in PAD 54.

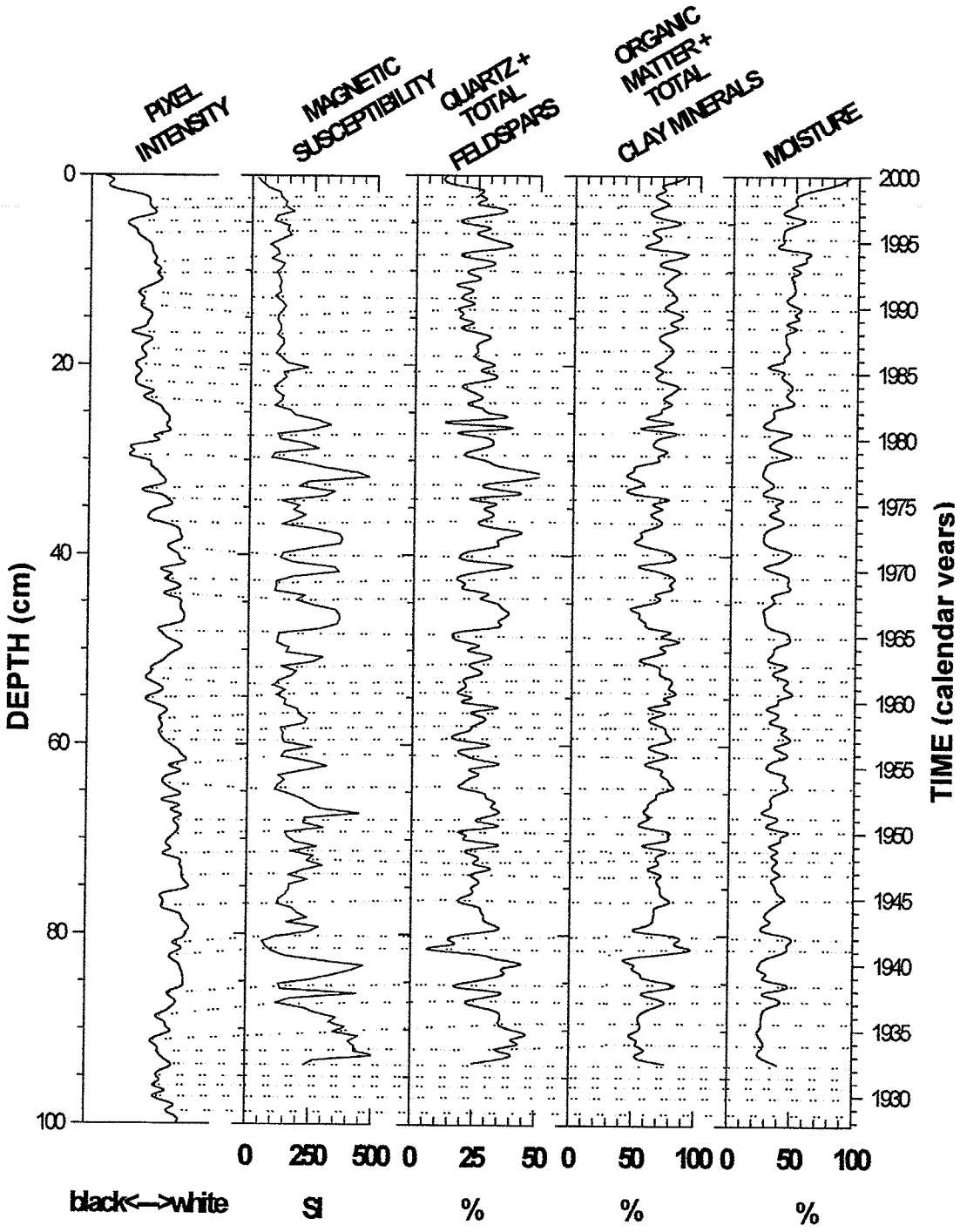

Figure 38. Using pixel intensity and magnetic susceptibility, plus percentages of quartz plus total feldspars, organic matter plus total clay minerals, and moisture content to indicate flood events (dotted lines) in PAD 15.

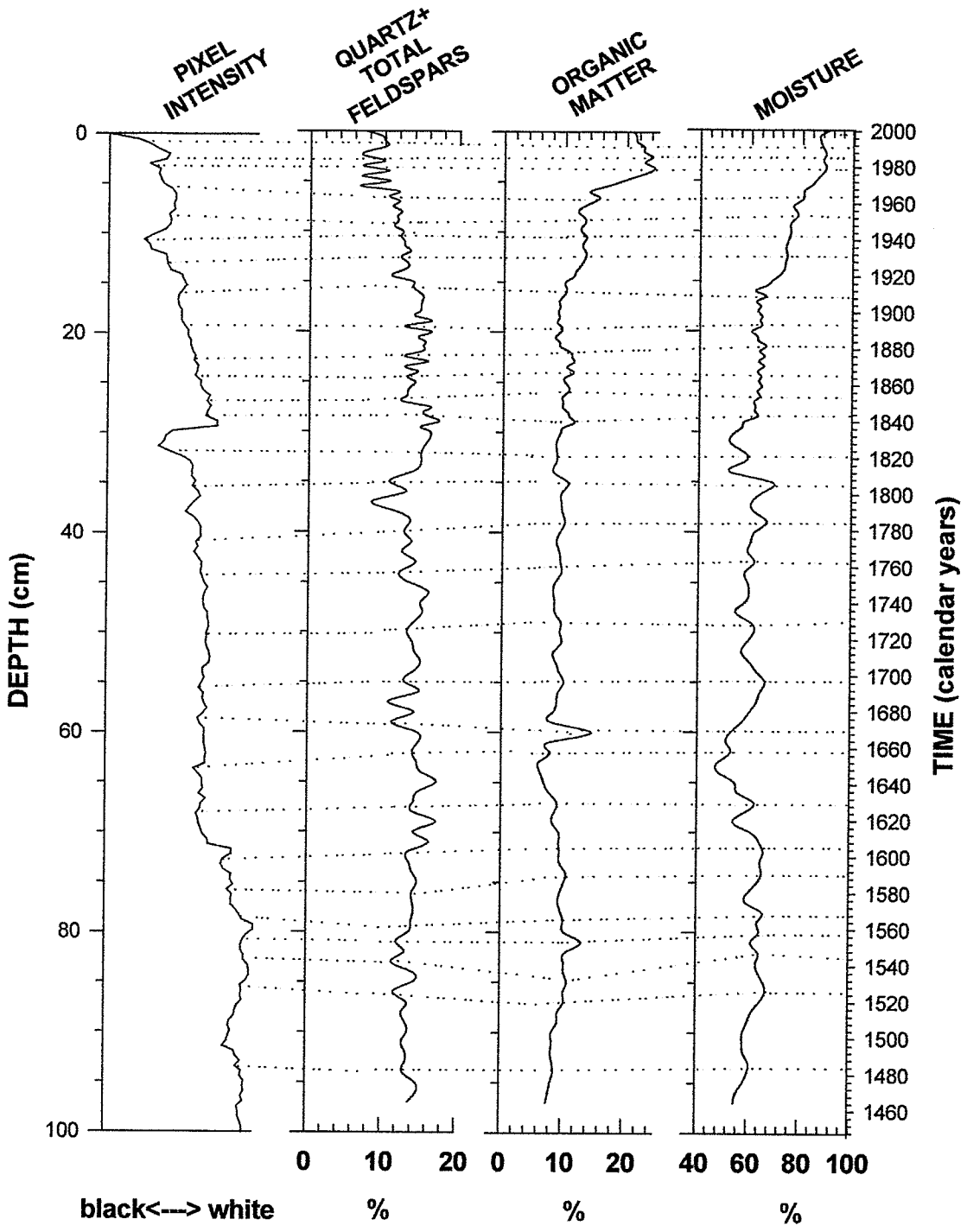

Figure 39. Using pixel intensity, plus percentages of quartz plus total feldspars, organic matter and moisture content to indicate flood events (dotted lines) in PAD 8.

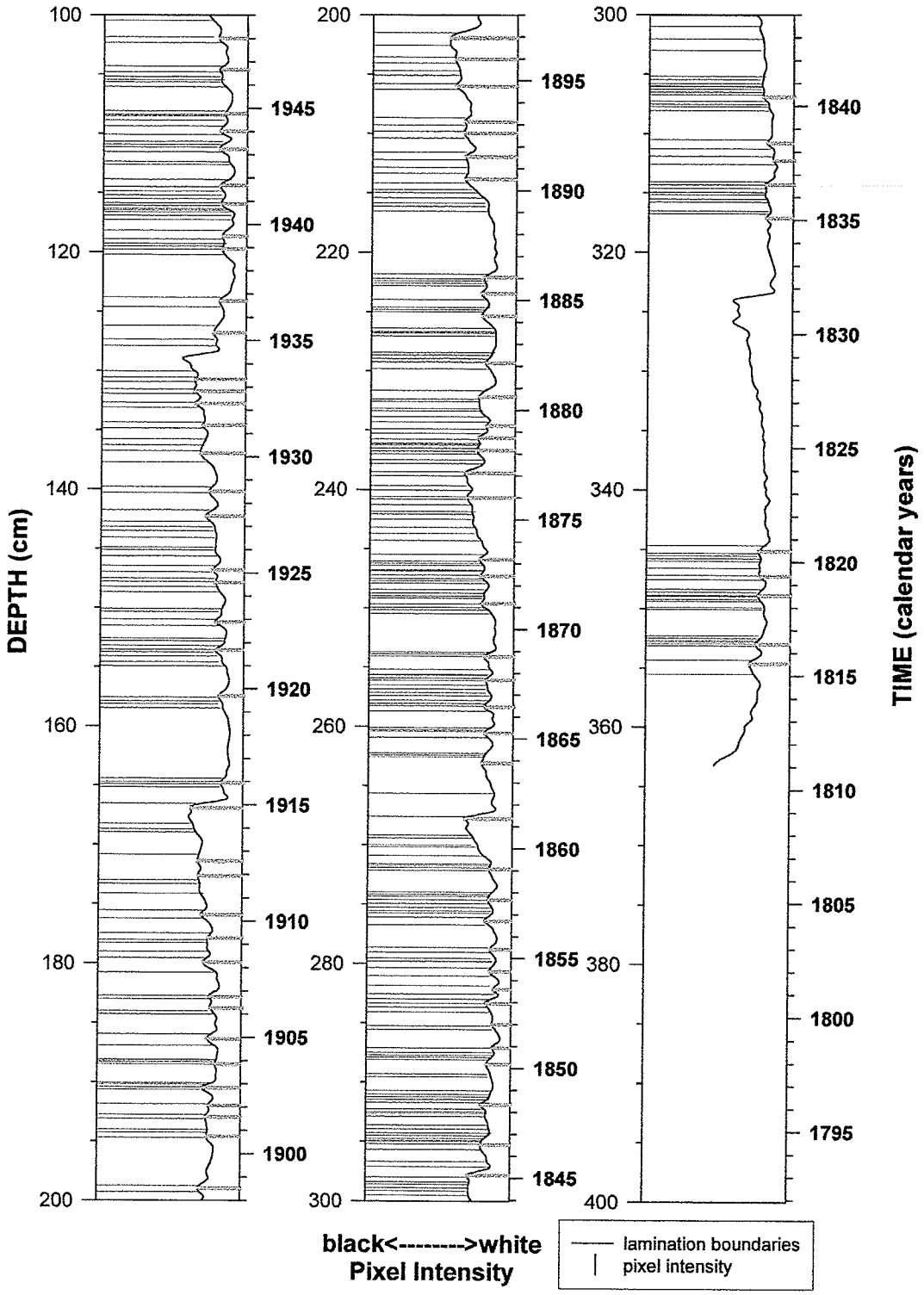

Figure 40. Using pixel intensity to indicate flood events (gray lines) in PAD 54.

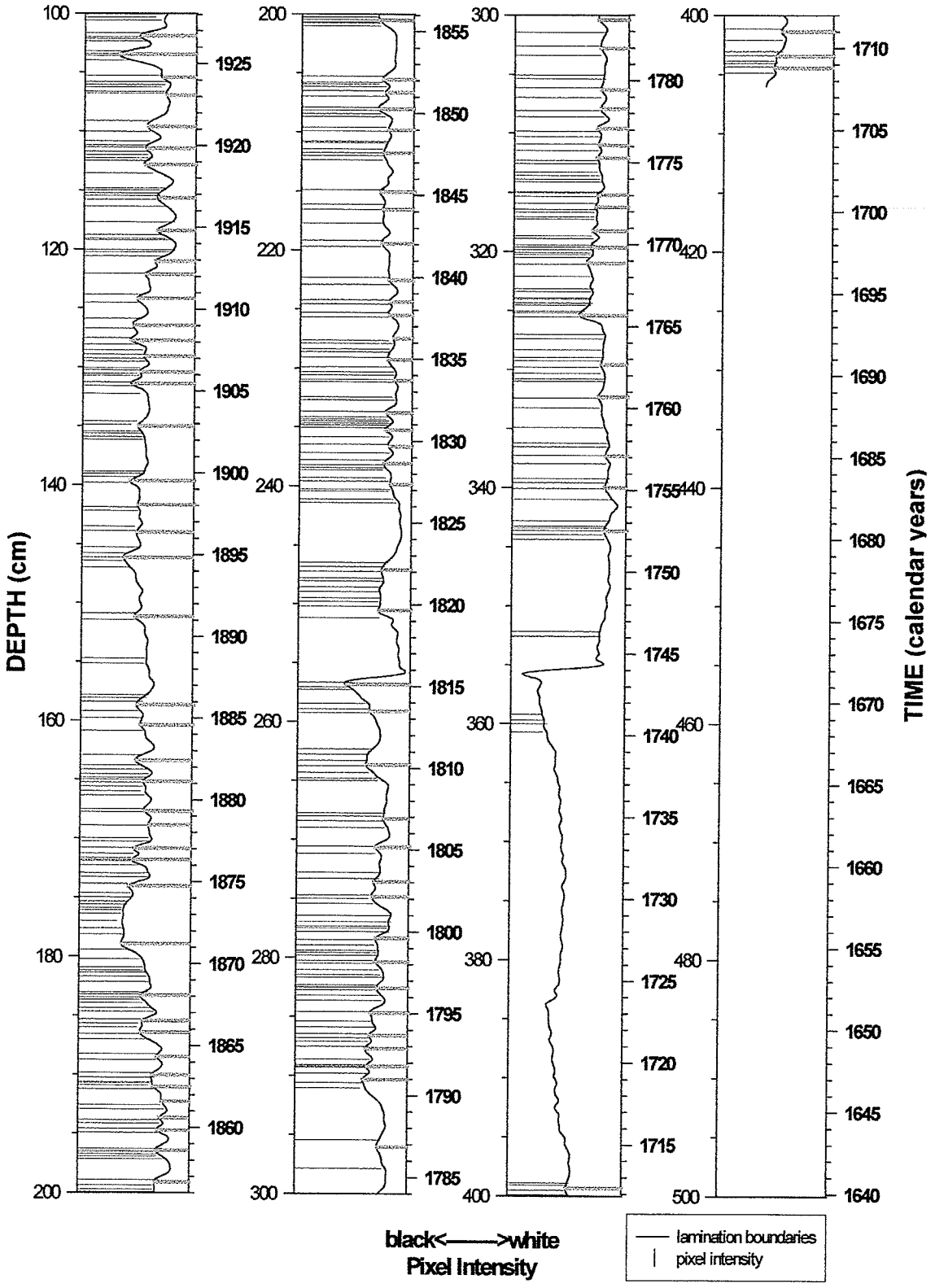

Figure 41. Using pixel intensity to indicate flood events (gray lines) in PAD 15.

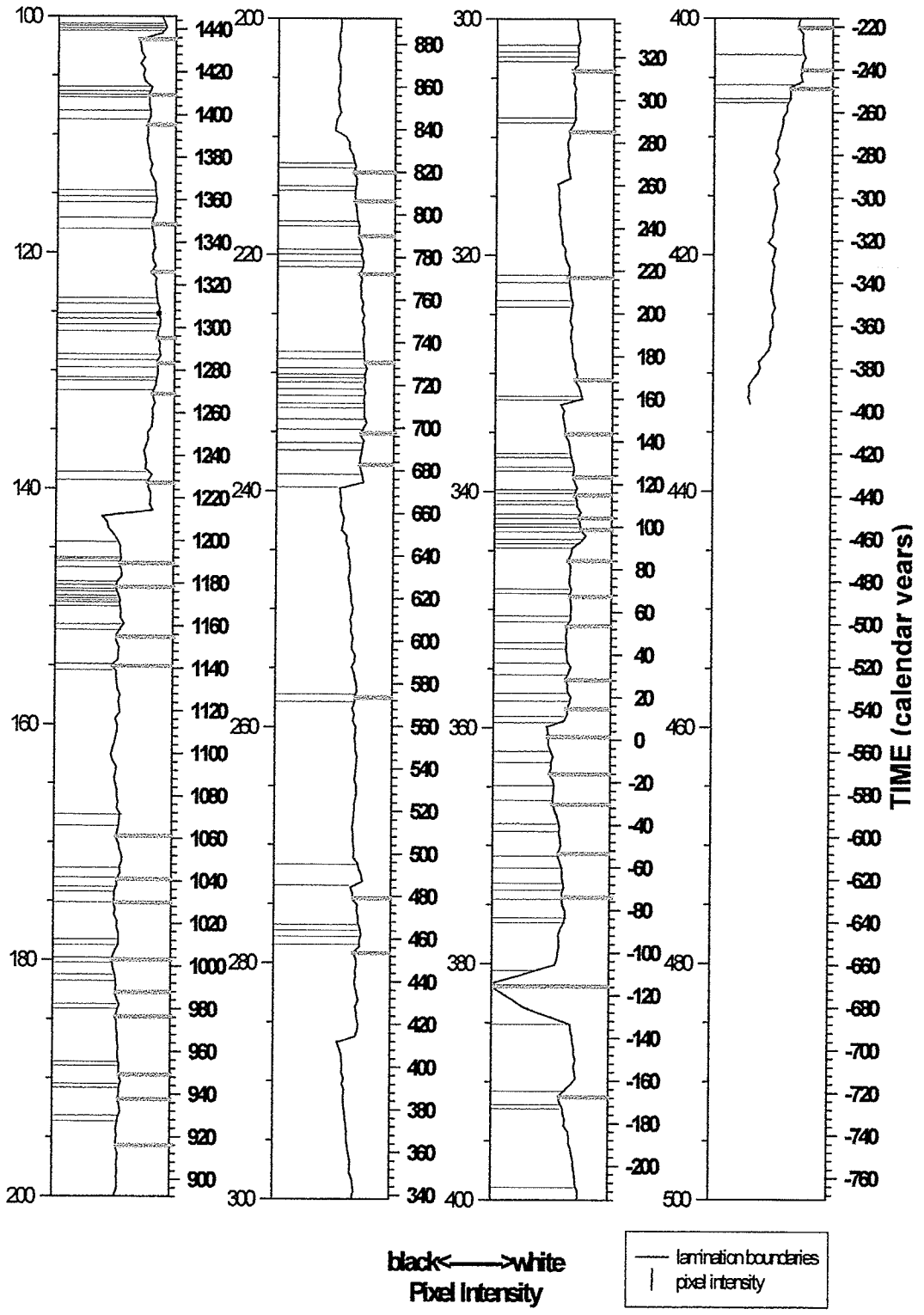

Figure 42. Using pixel intensity to indicate flood events (gray lines) in PAD 8.

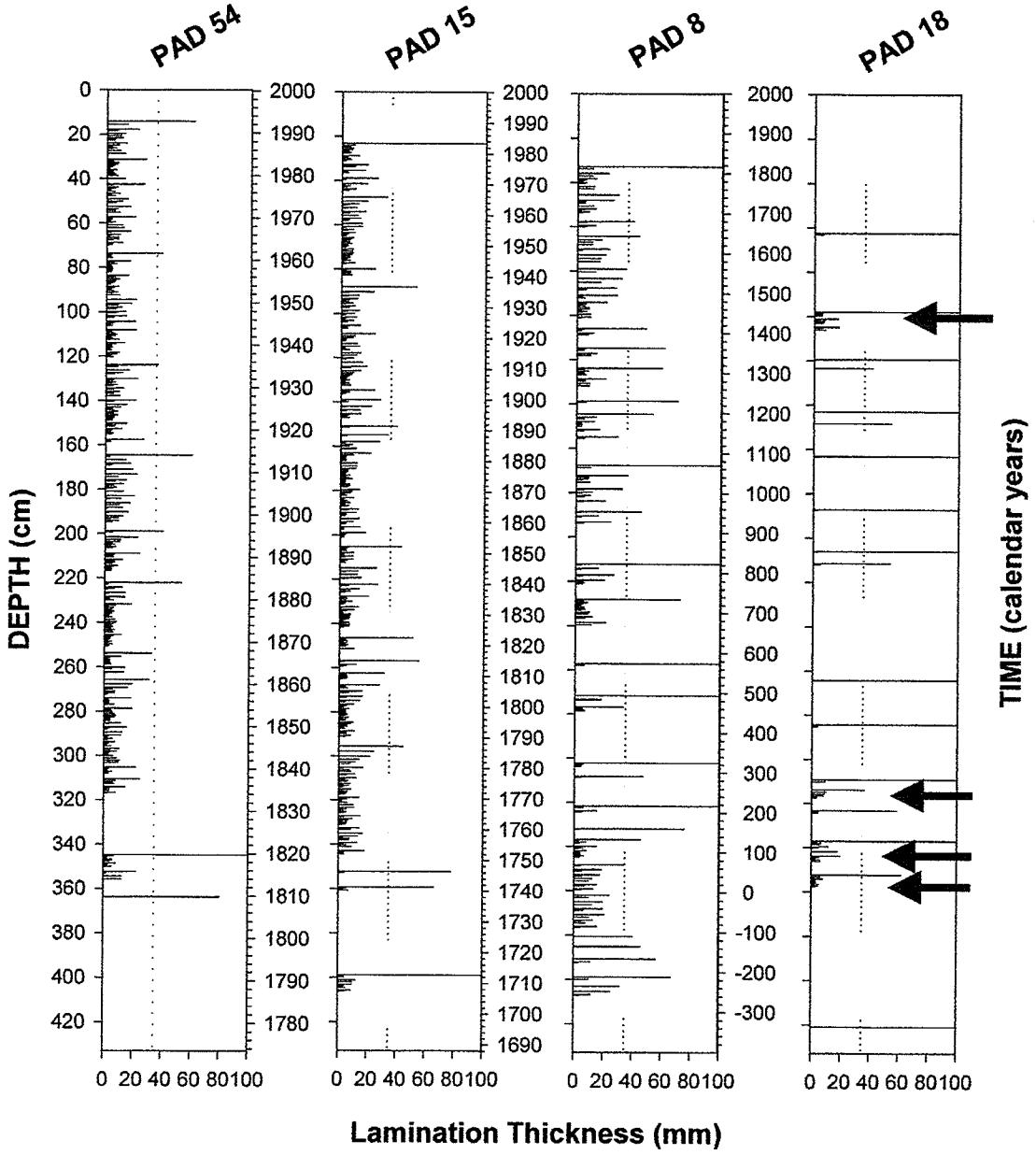

Figure 43. Using lamination thickness to indicate periods of increased flooding in PAD 54, 15, 8 and 18. Black arrows point out periods of changing energy conditions indicating increased flood deposition in the PAD 18 core.

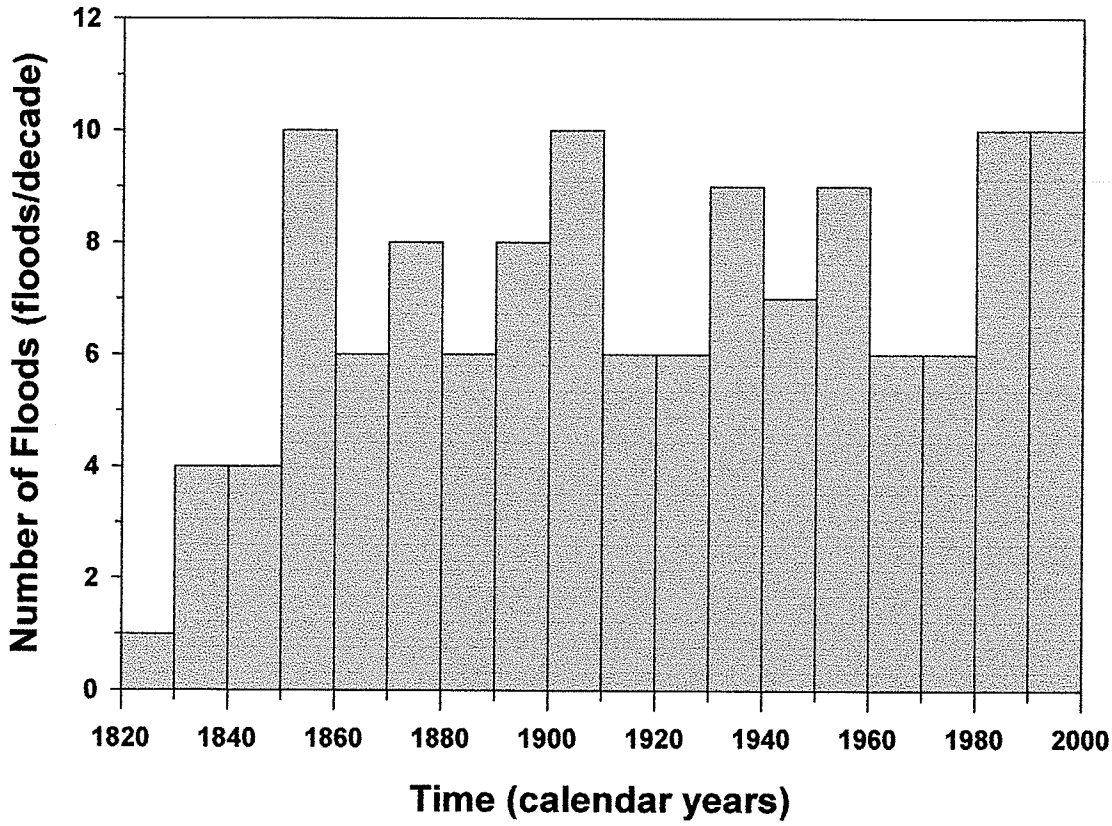

Figure 44. Flood frequency per decade for PAD 54.

be the case for the early 19th century. The lowest frequencies in the 20th century (6 floods/decade) are seen from 1910 through the 1920's, and from 1960 to the end of the 1970's.

PAD 15 has the second smallest average lamination thickness (7.6 mm) of the four PAD sites, and few laminations over 35 mm (Figure 43), indicating that flooding occurs relatively frequently here. Figure 45 shows the number of floods per decade for PAD 15. The early 18th century displays the fewest floods per decade at this location. The first half of the 19th century generally shows fewer floods per decade than are seen from the 1850's to the present. The lowest frequency seen in the 20th century occurred during the 1970's.

PAD 8 has a larger average lamination thickness (16.7 mm) than PAD 54 and 15, indicating that flooding is less frequent here. Figure 46A shows the number of floods per decade for the 18th, 19th and 20th centuries for PAD 8. PAD 8 has fewer floods than either PAD 54 or 15, with no higher frequency than 1 flood/decade. The first half of the 19th shows fewer floods than seen in the second half of the 19th century. During the 20th century, no flooding occurred from 1910 to the end of the 1920's in this location. Figure 46B shows the number of floods per 50 years for the entire time scale represented by PAD 8. The second half of the 20th century displays the greatest flood frequency found in this core. Periods without flooding occurred from 400 to 250 BC, 350 to 450 AD, 600 to 650 AD and from 850 to 900 AD.

PAD 18 exhibits the greatest average thickness of laminations (49.5 mm), and the most laminations greater than 35 mm, indicating that flooding occurs less often here than it does at the other PAD locations. No chronology was available in order to provide a time scale for this core. Core sections where numerous small laminations suggest

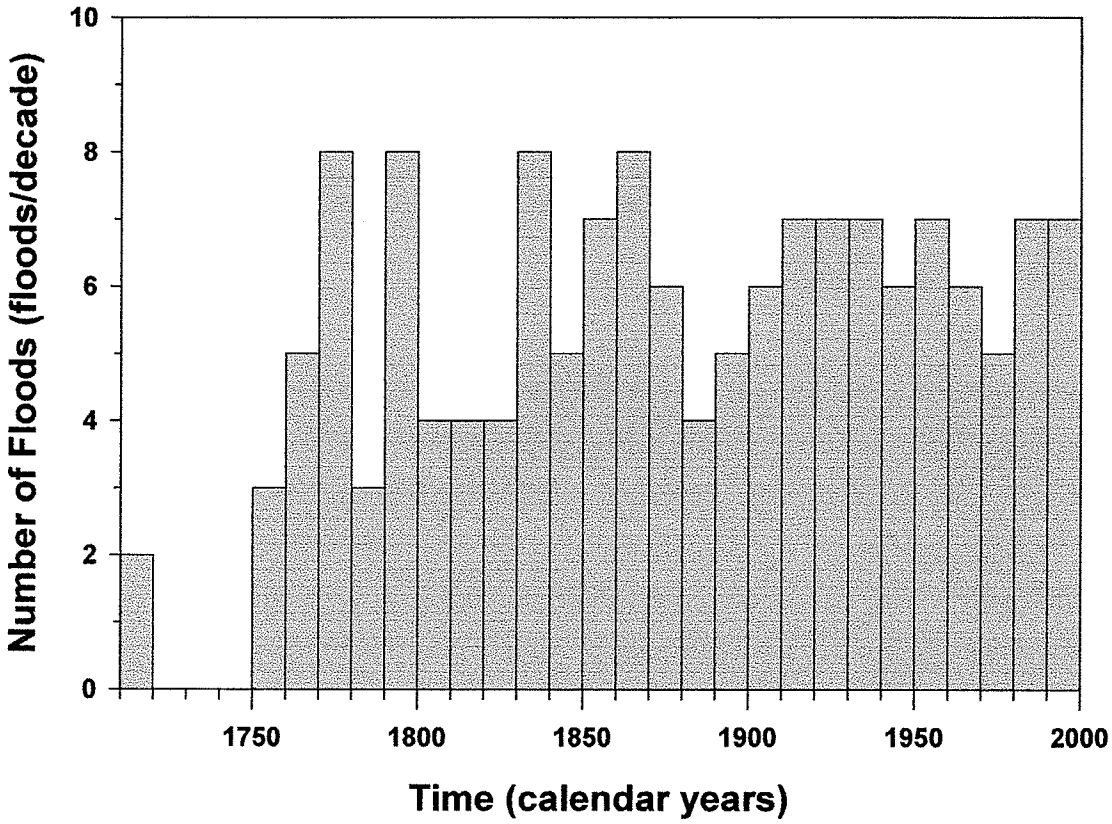

Figure 45. Flood frequency per decade for PAD 15.

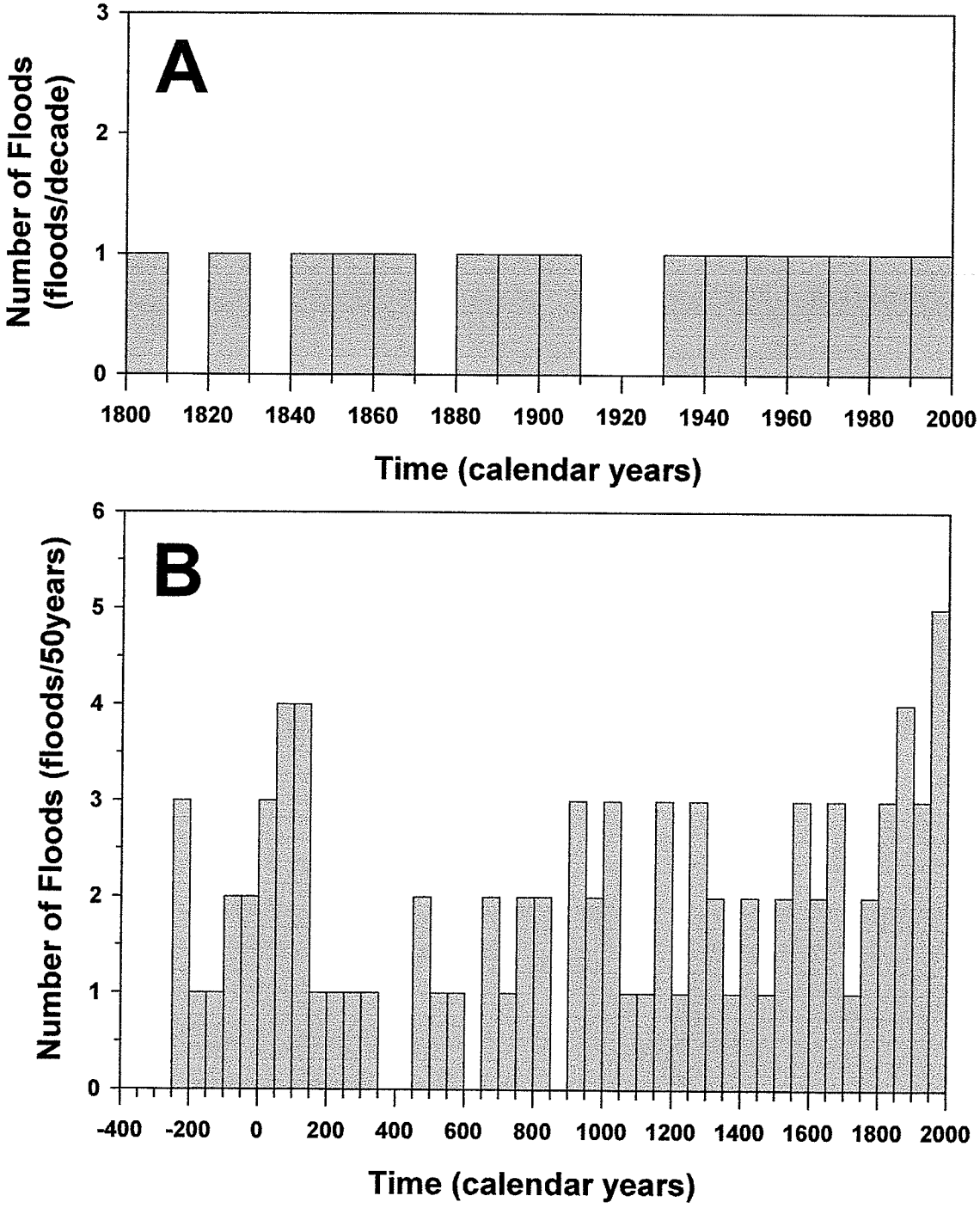

Figure 46. A) Flood frequency per decade for PAD 8. B) Flood frequency per 50 years for PAD 8.

flood deposition are located at approximately 100, 315, 340 and 355 cm depth (Figure 41).

Figure 47 shows PAD 54, 15 and 8 flood frequency per decade data, along with flood frequency per decade of observed Peace River large magnitude spring ice-jam flooding (data from Timoney et al., 1997), plus variations in Lake Athabasca water levels averaged per decade (dendrochronological data from Stockton and Fritts, 1973). Although the correlations (Table 19) between the PAD lakes flood frequencies, the Peace River flood frequencies, and the Lake Athabasca water levels are not strong, there do appear to be a number of coinciding changes in flood frequencies and water levels. PAD 54, 15, the Peace River and Lake Athabasca curves all peak in the 1830's. PAD 54, 8 and Lake Athabasca curves all peak in the 1850's. PAD 8, the Peace River and Lake Athabasca values display a drop during the 1870's. PAD 54, 8, the Peace River and Lake Athabasca values peak in the 1900's, followed by a dip in values during the 1910's. During the 1940's there are low values for PAD 54 and 15 flood frequencies and Lake Athabasca water levels.

Flooding on the Peace River does not automatically indicate that the PAD locations should also experience flooding, and neither does high water levels for Lake Athabasca. It is interesting to note that there appears to be the most agreement between all of the locations when flood frequencies and water levels are at their lowest. This suggests that without large magnitude spring ice-jam flooding of the Peace River, there is less likelihood of flooding in the PAD lakes. Since PAD 54 and 15 appear to flood with greater frequency than the large magnitude spring ice-jam floods of the Peace River that were used for comparison, it seems likely that Peace River floods of lower magnitude are also able to recharge these basins. PAD 8 floods with lower frequency than the major spring ice-jam floods of the Peace River, suggesting that it would take a flood of substantial magnitude to recharge this basin.

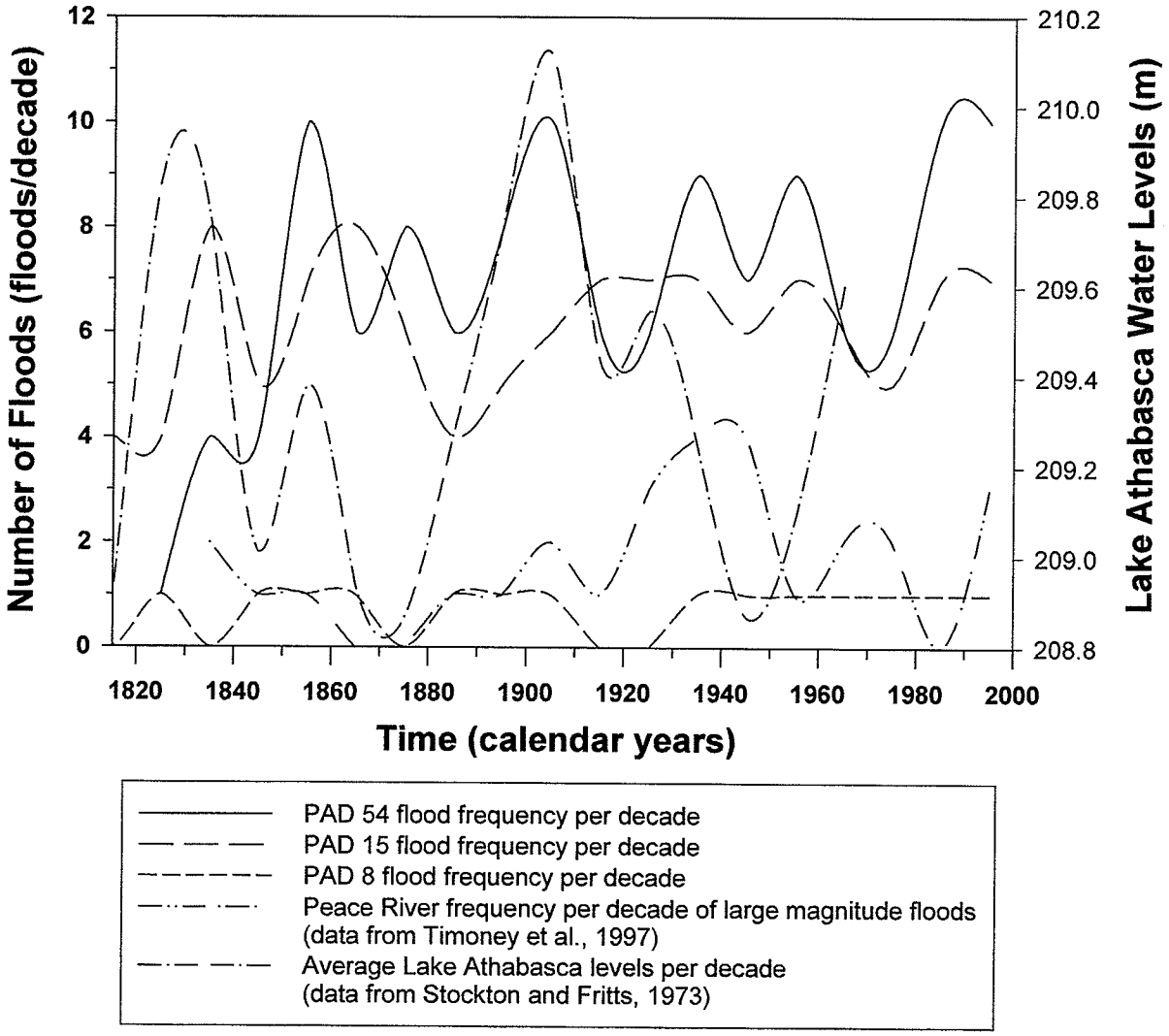

Figure 47. Flood frequency per decade for PAD 54, PAD 15, PAD 8 and the Peace River (data from Timoney et al., 1997), plus average Lake Athabasca water levels per decade determined by means of dendrochronology (data from Stockton and Frittz, 1973).

Table 19. Correlation coefficients (r) for PAD 54, 15, 8 and Peace River flood frequencies (Peace River data from Timoney et al., 1997), plus Lake Athabasca water levels (Stockton and Fritts, 1973).

	PAD 54	PAD 15	PAD 8	Peace River	Lake Athabasca
PAD 54 (floods/ decade)	1.0				
PAD 15 (floods/ decade)	0.4	1.0			
PAD 8 (floods/ decade)	0.2	-0.4	1.0		
Peace River (recorded frequency of large magnitude floods/ decade)	0.0	0.1	0.1	1.0	
Lake Athabasca (average water levels/ decade)	0.1	0.0	-0.1	0.2	1.0

The Effect of Climate on Flood Frequency

Temperature

Temperature data (Appendix H) recorded at weather stations in Grande Prairie (station ID 3072910) and Beaverlodge (station ID 3070560) (Figure 1), Alberta were used to determine average monthly temperatures per decade. This information was then compared with flood frequency per decade for each of the PAD locations. Table 20 shows the correlation between the average monthly temperatures per decade and flood frequencies per decade. The most notable positive correlation is that between increased flood frequencies and warm May temperatures (Figure 48). A negative correlation can be seen between increased flood frequencies and October temperatures (Figure 49). This suggests that decades with higher than normal average May temperatures and lower than normal average October temperatures should experience greater frequencies of flooding at each of the PAD locations. This is in agreement with previous works that have determined that warm spring temperatures are favorable for ice-jam flooding (Prowse and Conly, 1998; Prowse et al., 2002).

Figure 50 compares average temperatures per decade for May and October. The 1930's, 1950's, 1980's and the 1990's were decades with high average May and low average October temperatures. PAD 54 and 15 display high flood frequencies during these decades (Figure 51). The 1940's, 1960's and 1970's were decades with low average May and high average October temperatures (Figure 50). PAD 54 and 15 show decreased flood frequencies during these decades. PAD 8 values from the 1930's to the present are constant. The 1920's and 1930's were decades with low average temperatures for both May and October. PAD 54 and 8 show decreased flood frequencies for these decades. PAD 15 does not show a decrease in flood frequencies for these decades.

Table 20. Correlation coefficients (r) for PAD 54, 15 and 8 flood frequencies with average monthly temperatures for Grande Prairie and Beaverlodge, Alberta.

Grande Prairie, station ID - 3072910						
	JAN	FEB	MAR	APR	MAY	JUNE
PAD 54	0.0	-0.1	0.3	0.3	0.7	0.0
PAD 15	-0.2	0.0	0.1	0.1	0.2	0.3
PAD 8	0.3	-0.4	-0.1	-0.2	0.6	-0.7
	JULY	AUG	SEPT	OCT	NOV	DEC
PAD 54	0.3	0.1	0.1	-0.7	-0.2	0.7
PAD 15	-0.2	0.2	0.1	-0.5	0.5	0.8
PAD 8	0.9	0.1	0.2	-0.2	-0. 9	0.0
Beaverlodge, station ID – 3070560						
	JAN	FEB	MAR	APR	MAY	JUNE
PAD 54	0.1	0.2	0.3	0.5	0.8	0.5
PAD 15	0.1	0.4	0.2	0.0	0.6	0.2
PAD 8	-0.2	-0.4	-0.2	0.4	0.2	0.0
	JULY	AUG	SEPT	OCT	NOV	DEC
PAD 54	0.0	0.3	0.5	-0.6	0.0	0.8
PAD 15	0.4	0.2	0.1	-0.6	0.4	0.8
PAD 8	-0.5	0.2	0.5	-0.1	-0.4	0.0

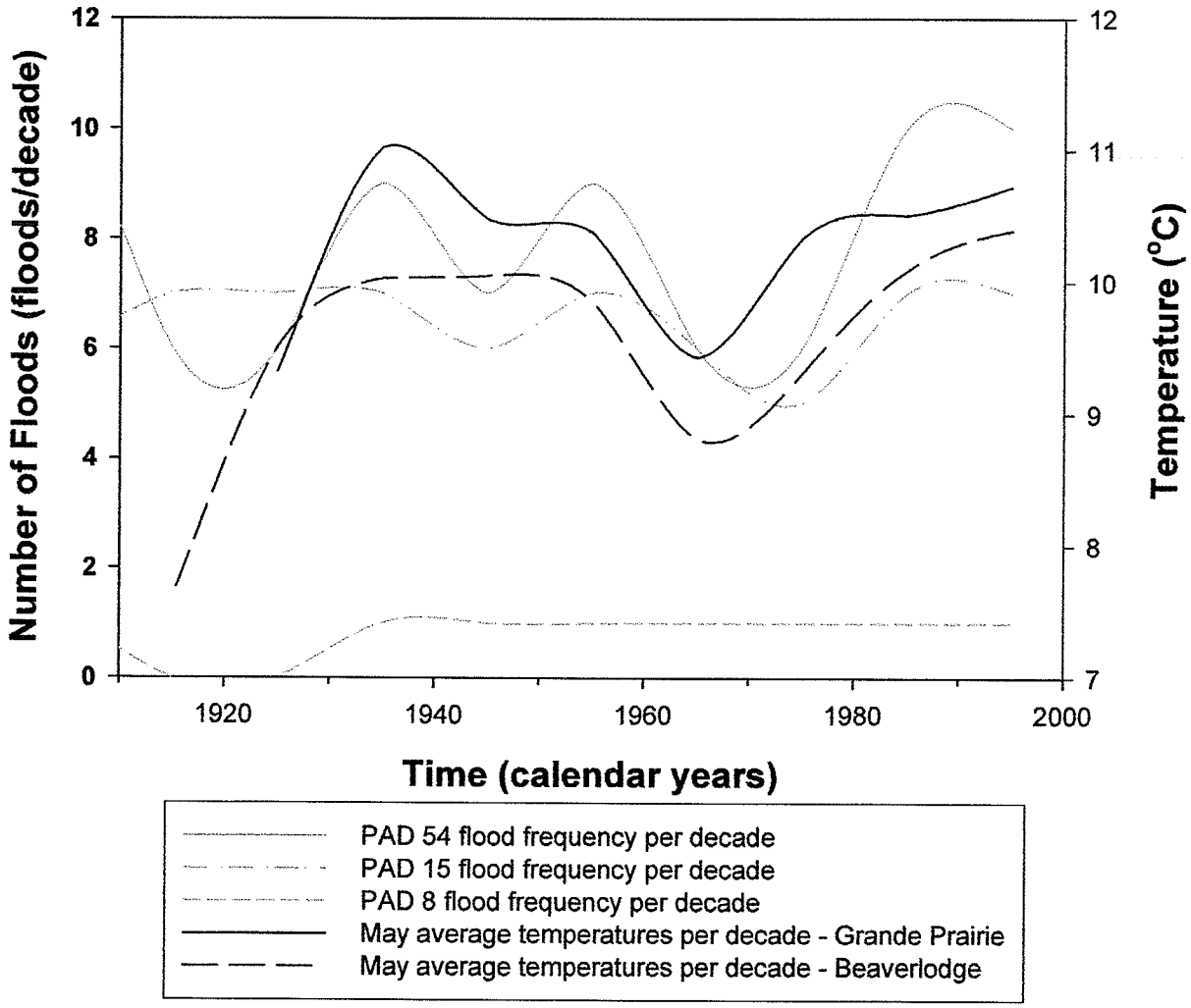

Figure 48. Comparison of changes in average May temperatures recorded at Grande Prairie (station ID 3072910) and Beaverlodge (station ID 3070560), Alberta with variations in flood frequencies for PAD 54, 15 and 8.

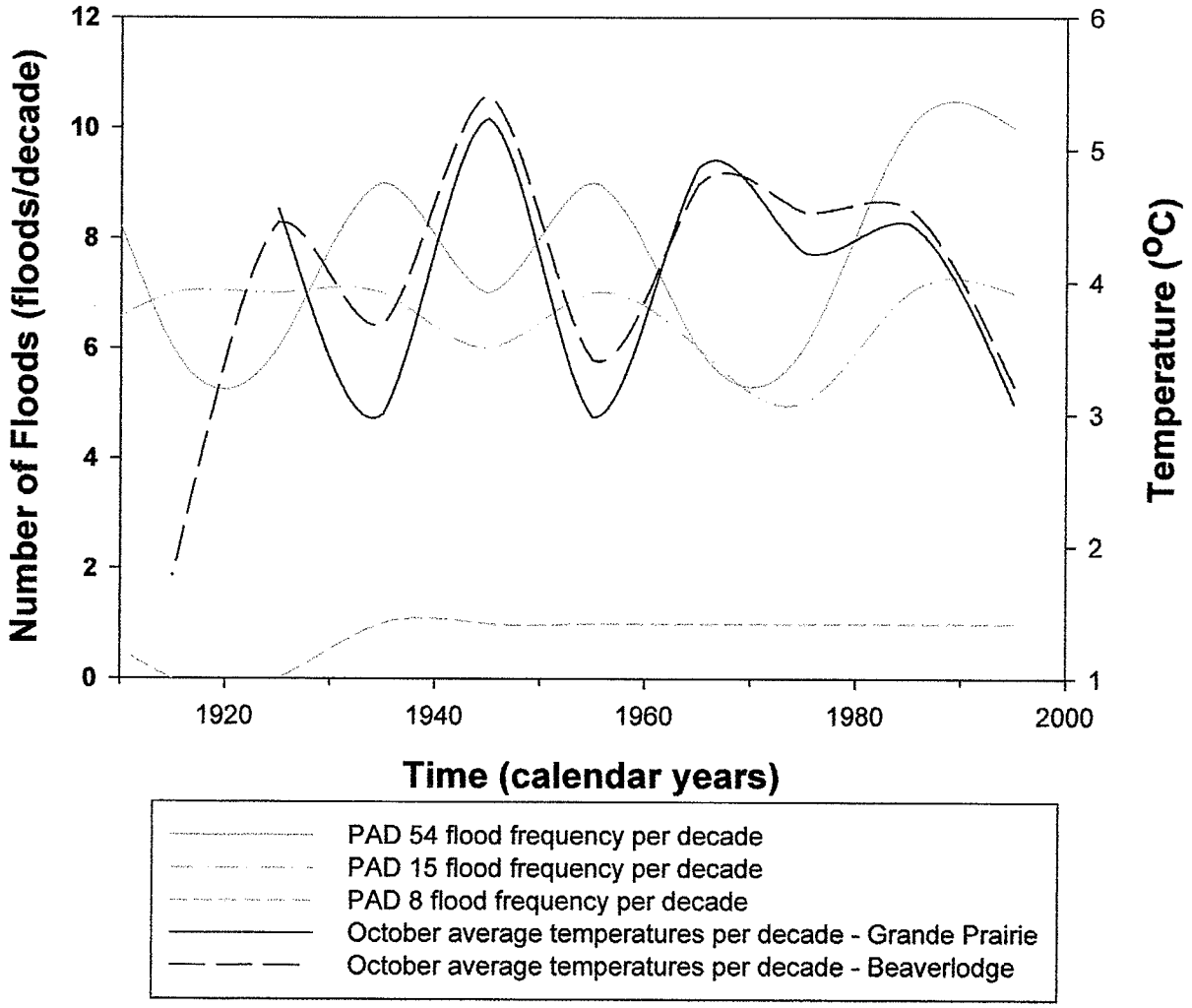

Figure 49. Comparison of changes in average October temperatures recorded at Grande Prairie (station ID 3072910) and Beaverlodge (station ID 3070560), Alberta with variations in flood frequencies for PAD 54, 15 and 8.

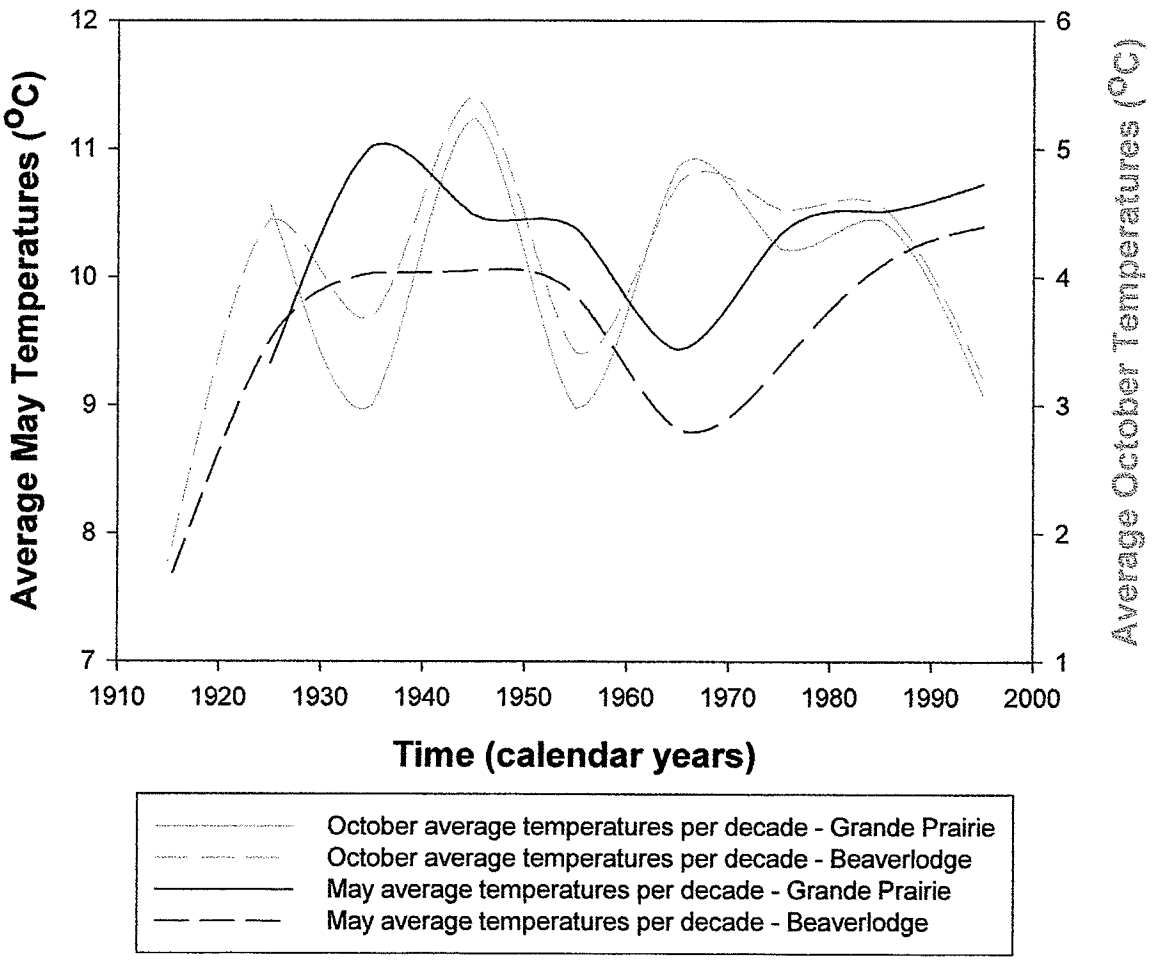

Figure 50. Average May and October temperatures per decade recorded at Grande Prairie (station ID 3072910) and Beaverlodge (station ID 3070560), Alberta, Canada.

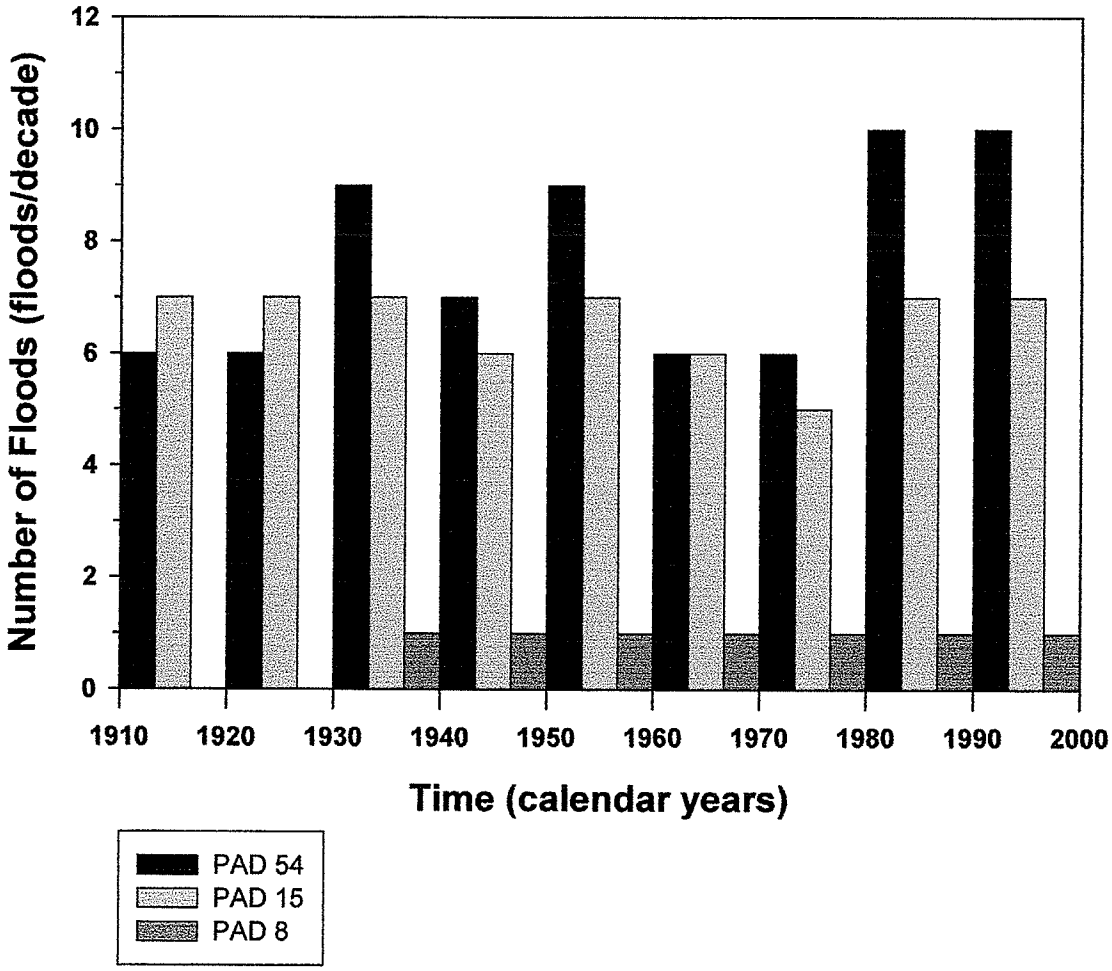

Figure 51. Frequency of floods per decade for PAD 54, 15 and 8.

PAD 54 appears to be the most sensitive to the effects of climate of all of the PAD locations, followed by PAD 15, and with PAD 8 being the least sensitive. The PAD locations were influenced the most by the effect of warm May temperatures leading to rapid melting and early break-ups of ice on the Peace River. Cold October temperatures have less of an influence on flood frequency, but probably work in combination with warm May temperatures. An early winter with a longer period of snow accumulation, combined with a rapid melt and early spring break-up, appear to be the ideal conditions for recharging the PAD basins. Cold average May temperatures result in lowered flood frequencies even if combined with cold average October temperatures. This suggests that while an early winter with more time for snow accumulation may contribute to flood conditions, without a rapid spring break-up there is a lower chance of flooding than if there is a shorter winter (warm October) with a rapid spring break-up (warm May).

Precipitation

Precipitation levels (Appendix I) recorded at weather stations in Grande Prairie (station ID 3072910) and Beaverlodge (station ID 3070560), Alberta were used to determine average precipitation levels per decade. This information was then compared with flood frequency per decade for each of the PAD locations. Table 21 shows the correlation between the average precipitation levels per decade and flood frequencies per decade. The correlation between precipitation levels and flood frequencies is not as strong as the correlation between average May temperatures and flood frequencies, although it does appear that increased average precipitation occurs with increased flood frequencies (Figure 52).

During the 1960's reasonably high precipitation levels occurred (Figure 52), but with low average May temperatures (Figure 48) and low flood frequencies (Figure 51). This suggests that while increased precipitation can contribute to the possibility of

Table 21. Correlation coefficients (r) for PAD 54, 15 and 8 flood frequencies with the average precipitation levels for Grande Prairie and Beaverlodge, Alberta.

	Grande Prairie station ID - 3072910 average precipitation (mm/decade)	Beaverlodge station ID – 3070560 average precipitation (mm/decade)
PAD 54 flood frequency (floods/decade)	0.3	0.2
PAD 15 flood frequency (floods/decade)	0.5	0.0
PAD 8 flood frequency (floods/decade)	0.0	0.5

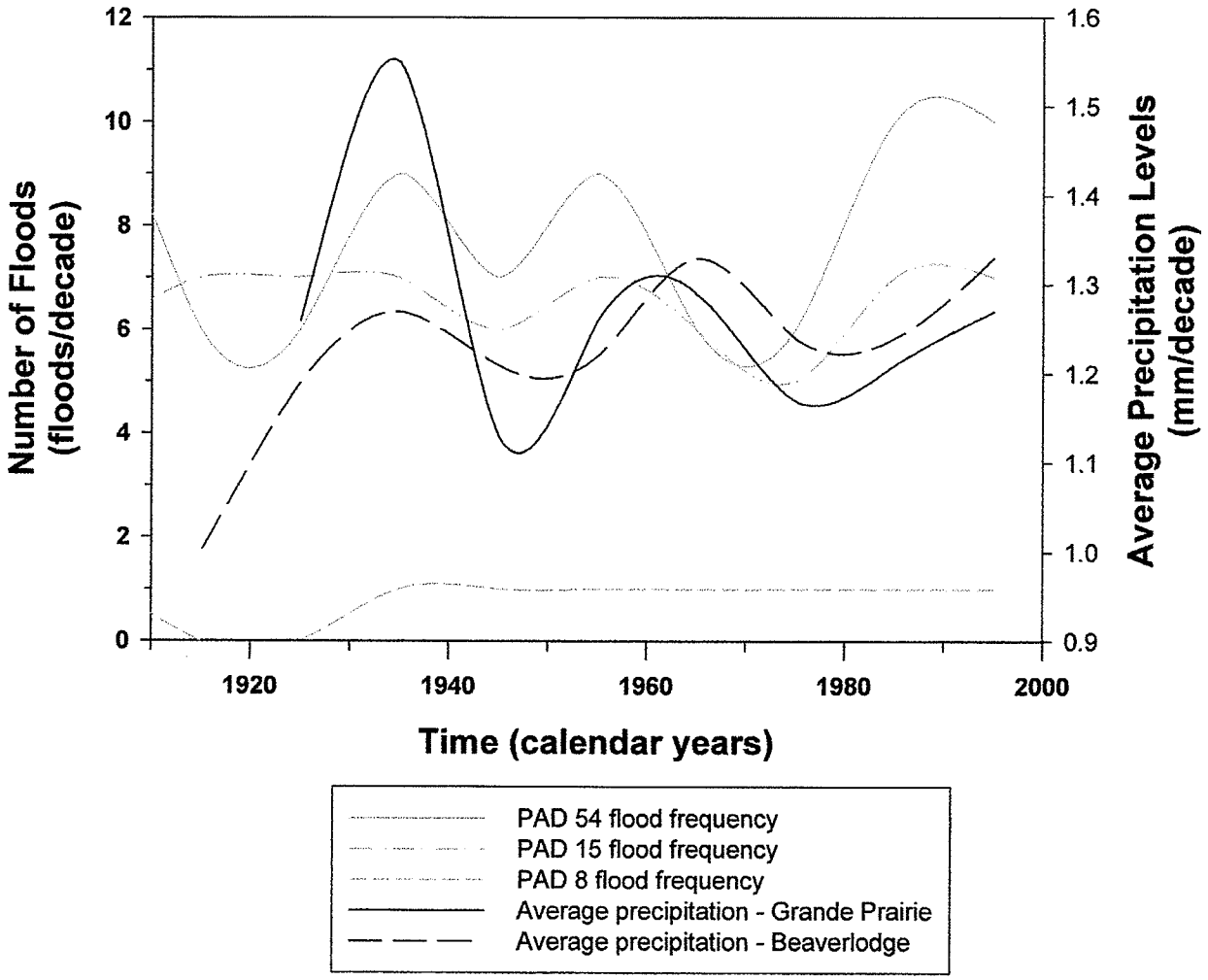

Figure 52. Comparison of changes in average precipitation levels recorded at Grande Prairie (station ID 3072910) and Beaverlodge (station ID 3070560), Alberta with variations in flood frequencies for PAD 54, 15 and 8.

flooding, there is still a need for a rapid spring melt to actually produce flooding. During the 1970's average May temperatures increased (Figure 48), but with low precipitation levels (Figure 52) and low flood frequencies (Figure 51). This suggests, in agreement with the works of Prowse and Conly (1998), and Prowse et al. (2002), that both adequate precipitation levels leading to large amounts of snow pack, plus high May temperatures sufficient to generate rapid spring melting are required for increased ice-jam flooding.

The Effect of Peace River Flow Levels on Flood Frequency

Peace River water flow levels (Appendix J) recorded at Peace Point, Alberta (Figure 1) were used to determine average monthly water flow levels. This information was then compared to PAD 54 and 15 flood frequencies (Table 22). Increased water flow during the summer months (May to August) has a strongly positive correlation with increased flood frequency, while increased water flow during the rest of the year has a distinctly negative correlation to flood frequency. This suggests that when the Peace River experiences very high summer flow levels with very low winter flow levels, that conditions for flooding are optimal.

After regulation began on the Peace River in 1968, there was a sudden drop in summer flow levels (Figure 53), with a concurrent increase in winter flow levels (Figure 54). PAD 54 and 15 both demonstrated low flood frequencies in the decade after regulation (Figure 51). The 1960's also displayed lower flood frequencies for PAD 54 and 15, probably due to a combination of cold average May temperatures during this decade (Figure 48), plus the effect of river regulation towards the end of the decade. Both climate and regulation may have played a role in decreased flood frequencies during the 1970's (Figure 51). Low precipitation levels (Figure 52), plus artificially low

Table 22. Correlation coefficients (r) for PAD 54 and 15 flood frequencies with average monthly water flow of the Peace River as measured at Peace Point, Alberta.

Peace River water flow (cms)	PAD 54	PAD 15
JAN	-0.7	-0.6
FEB	-0.7	-0.6
MAR	-0.7	-0.6
APR	-0.7	-0.5
MAY	0.8	0.9
JUNE	0.7	0.7
JULY	0.7	0.7
AUG	0.9	0.7
SEPT	-0.4	-0.6
OCT	-0.7	-0.8
NOV	-0.7	-0.7
DEC	-0.7	-0.6

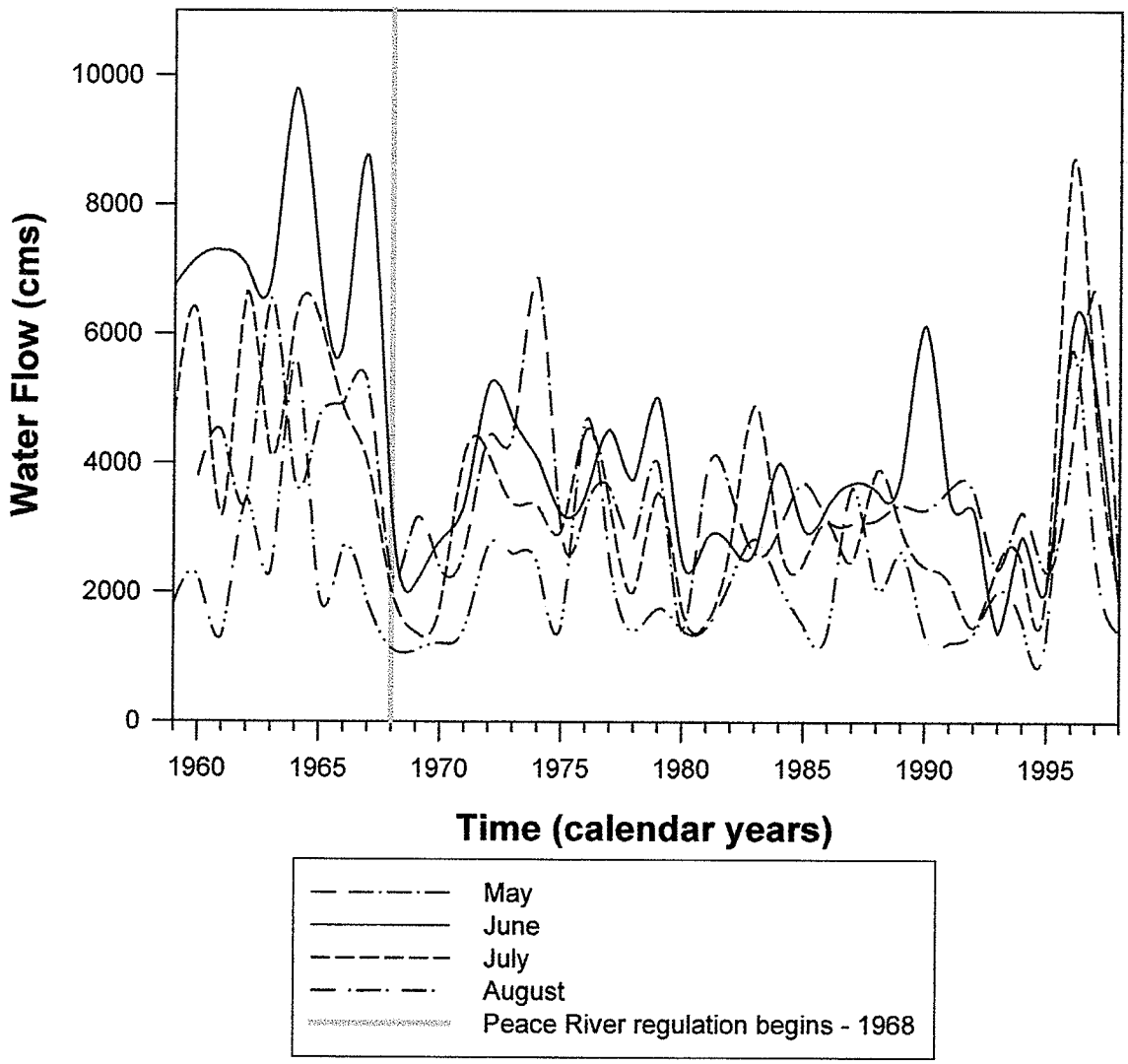

Figure 53. Average summer monthly flow levels of the Peace River measured at Peace Point, Alberta.

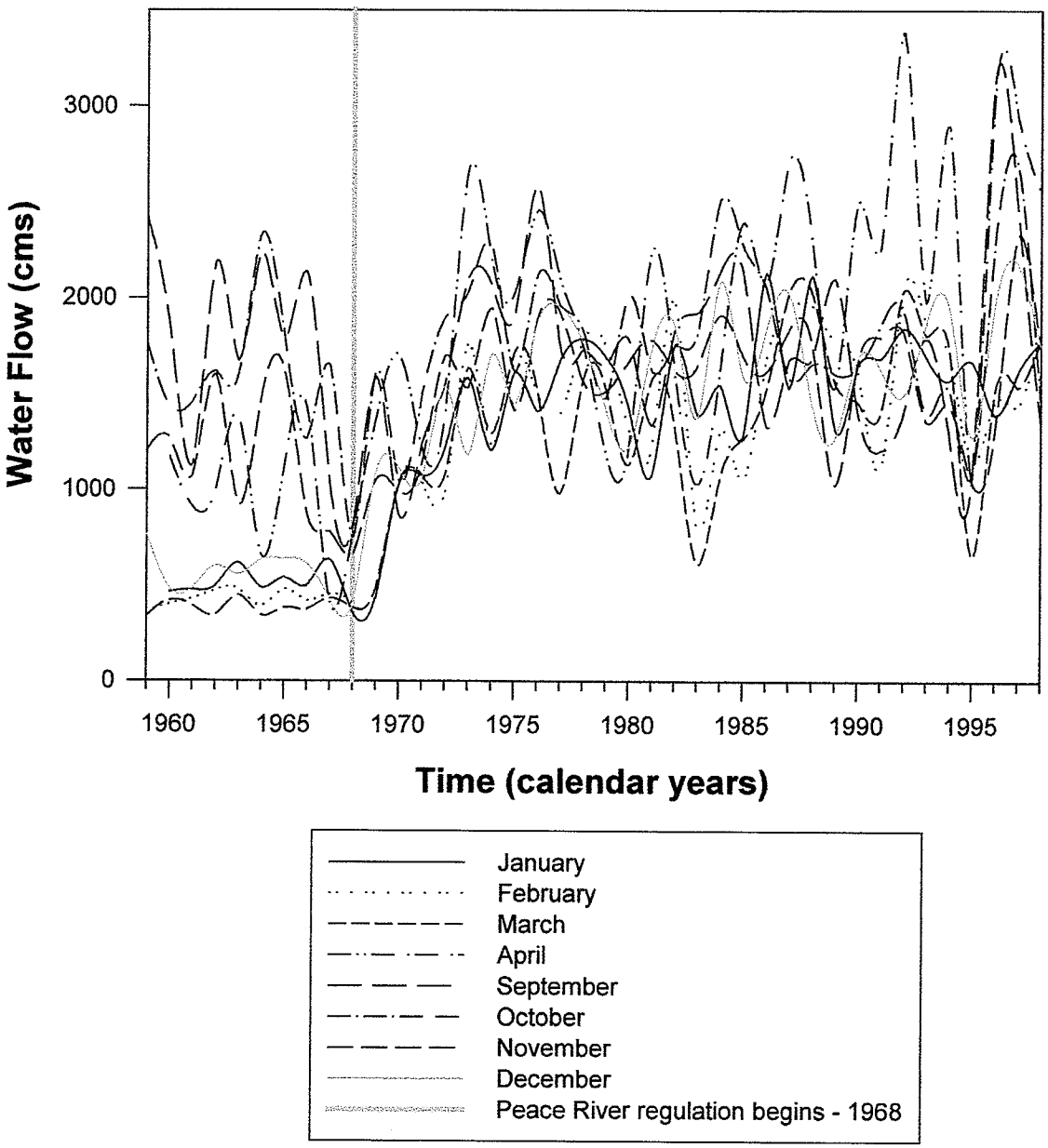

Figure 54. Average fall, winter and spring monthly flow levels of the Peace River measured at Peace Point, Alberta.

summer flow levels (Figure 53), and high winter flow levels (Figure 54) during this decade all resulted in decreased flooding (Figure 51). During the 1980's the effects of river regulation appear to have been overridden by favorable May temperatures and increases in precipitation, with increased flood frequencies at PAD 54 and 15 despite altered river flow patterns. During the 1990's, flood frequencies remained high due to a combination of increased summer flows and ideal climate conditions.

Interpreting Climate Change using Flood Frequency

During the 1980's favorable climatic conditions produced increases in flood frequencies despite unfavorable Peace River flow levels caused by regulation. This suggests that climate variability is the main driving force behind flood frequency in the PAD. Since the unregulated flow patterns of the Peace River, with generally low winter flow levels and much higher flow levels from May to August, are favorable to flooding, it is possible to interpret flood frequency variations before regulation in terms of primarily climatic conditions.

Both adequate precipitation and warm spring temperatures are required to produce flooding in the PAD. This suggests that periods of increased flooding occurred when precipitation was higher and May temperatures were warmer than during periods of decreased flooding. The PAD 8 core therefore provides a record of more than 2000 years of climate change in the PAD region (Figure 46). The last 200 years have had very favorable conditions for flooding. From approximately 50 AD to 150 AD, conditions were also very favorable for flooding. Much drier and/or cooler conditions occurred within the PAD from approximately 150 AD to 900 AD, followed by relatively average conditions from approximately 900 AD to 1800 AD.

Textural and Mineralogical Changes in Core Composition after Regulation

After regulation of the Peace River, all of the PAD cores display changes in texture and mineralogy that indicate increased flood frequencies (Tables 7, 8 and 9). PAD 54 displays an increase in average moisture content and total clay minerals content, along with decreases in average total carbonate minerals and total sulfate minerals content. PAD 15 shows an increase in average moisture and organic matter content. PAD 8 demonstrates increases in average moisture and organic matter content, plus a decrease in mean grain size as well as in average total siliciclastic content.

Surprisingly, there are also indications of generally drier, more saline conditions within the PAD delta after river regulation despite the increased flood frequencies of the PAD lakes in this study. PAD 54 experienced changes in calcite, Mg-calcite and dolomite composition, with lower molar percentages of $MgCO_3$ in calcite and Mg-calcite, and higher molar percentages of $CaCO_3$ in dolomite, suggesting drier, more saline conditions within the area surrounding PAD 54 (Table 7, Figures 17 and 18). These changes appear to be most severe during the 1960's, however, with compositions returning to close to pre-regulation conditions during the 1980's. Generally drier conditions within the delta could also have led to evaporitic and more saline conditions in the vicinity of PAD 8, explaining the increased occurrence of sulfates (gypsum) around 1920, which increases again at 1940, with further increases after 1960 (Figure 24). PAD 54 also shows an increase in the occurrence of sulfates during the 1960's, with decreased occurrences during the 1970's and 1980's, and a slight increase again during the 1990's (Figure 24). The drier delta conditions were probably the result of decreased flooding of the Peace River during the 1920's, 1940's and 1960's. Although many of the changes in mineralogy started before the regulation of the Peace River began, in the

case of sulfate occurrence for PAD 8, it appears that after regulation, changes may have been accelerated to some degree.

Conclusions

Physical indicators can be used to differentiate between flood and non-flood deposits. Flood deposits contain lower percentages of quartz, total feldspars and total carbonate minerals, combined with higher percentages of moisture content, plus a generally smaller mean grain size. Non-flood deposits consist of coarser sediments with higher percentages of quartz, total feldspars and total carbonate minerals, combined with lower percentages of moisture content. Flood deposits have lower magnetic susceptibility and pixel intensity measurements than non-flood deposits.

Sequences from cores with evidence of high frequencies of ice-jam flooding display well defined laminations, contain clear evidence of changing energy conditions, exhibit the highest rates of deposition, and record the highest lamination counts. As frequency of flooding declines, laminations become less well defined, there is less variability in grain size and organic matter content, deposition rates decline, laminae frequency decreases, and the average thickness of individual laminations increases.

Climate variability is an important influence behind changes to the frequency of flooding within the Peace-Athabasca Delta. Ideal conditions for flooding consist of adequate precipitation to ensure a large winter snow accumulation with warm May temperatures to ensure a rapid spring melt.

Variations in water flow in the Peace River also influence changes in flood frequency within the PAD. High flow levels from May to August, with low flow levels during the rest of the year, are the optimal conditions to produce increased flooding in the delta. After regulation of the Peace River by the W.A.C. Bennett Dam, flow levels were changed so that summer levels were reduced and winter levels were increased.

This resulted in decreased flood frequencies during the late 1960's and throughout the 1970's.

Climate variability appears to be the main driving force behind changes to the frequency of flooding within the Peace-Athabasca Delta. This is demonstrated by increased flood frequencies during the 1980's, when climatic conditions were favorable for flooding, but when river flow levels were unfavorable due to regulation. During the 1960's and 1970's, both climatic and flow conditions were adverse to flooding, so that the effect of climate may have been intensified by the added effect of river regulation. This would explain the generally dry overall conditions within the PAD after 1960, as evidenced by increased sulfate occurrences in PAD 8 from 1960 to the present, despite the overall increase in flood frequencies after 1980.

In 1996 flow levels were adjusted in order to produce more favorable conditions for flooding in concert with favorable climatic conditions, resulting in the first flood of such a major magnitude in over 20 years (Prowse et al., 2002). This suggests that the cumulative effects of climate plus river regulation can also lead to increased frequency as well as increased magnitudes of flooding within the Peace-Athabasca Delta.

It is possible to interpret flood frequency variations before regulation in terms of primarily climatic conditions. Both adequate precipitation and warm spring temperatures are required to produce flooding, suggesting that periods of low flood frequencies have lower precipitation levels and/or cooler spring temperatures.

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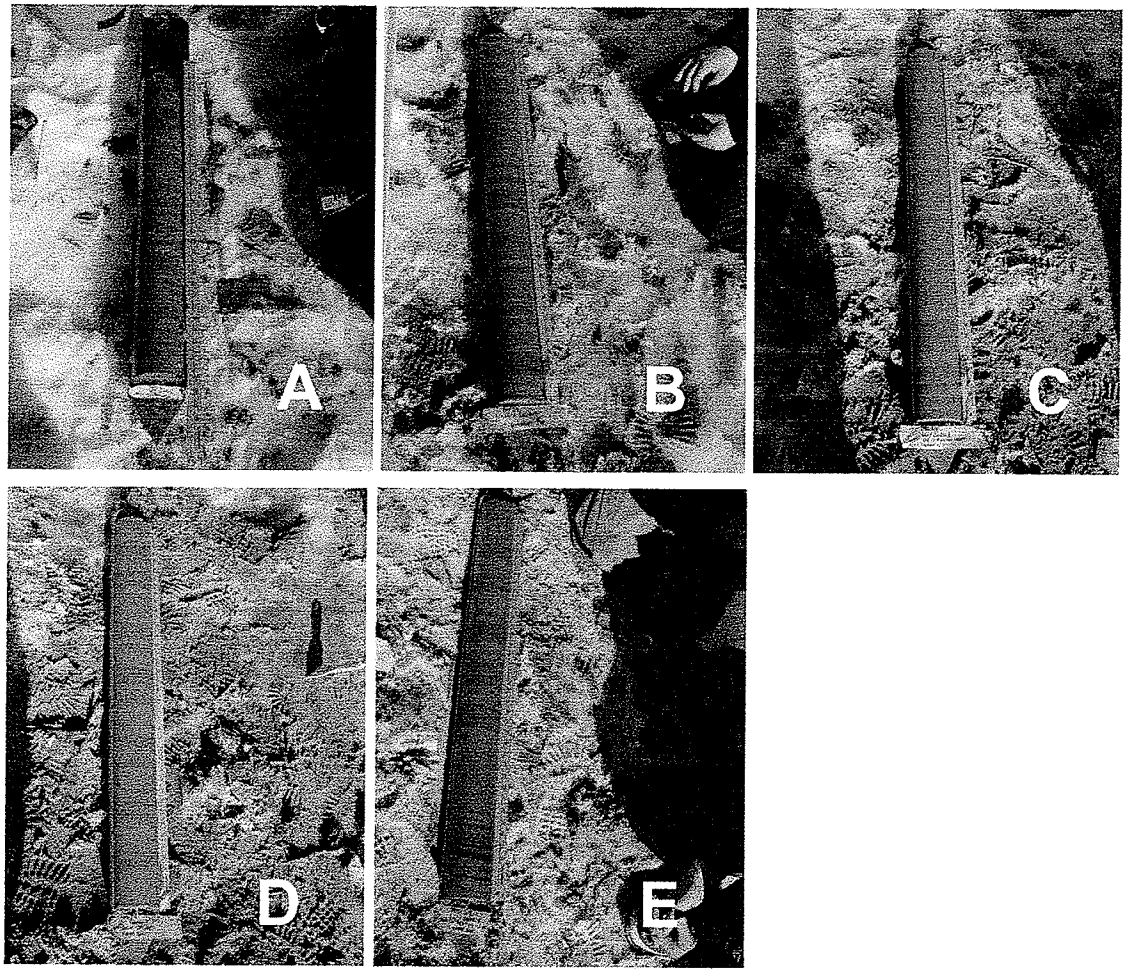
Appendix A

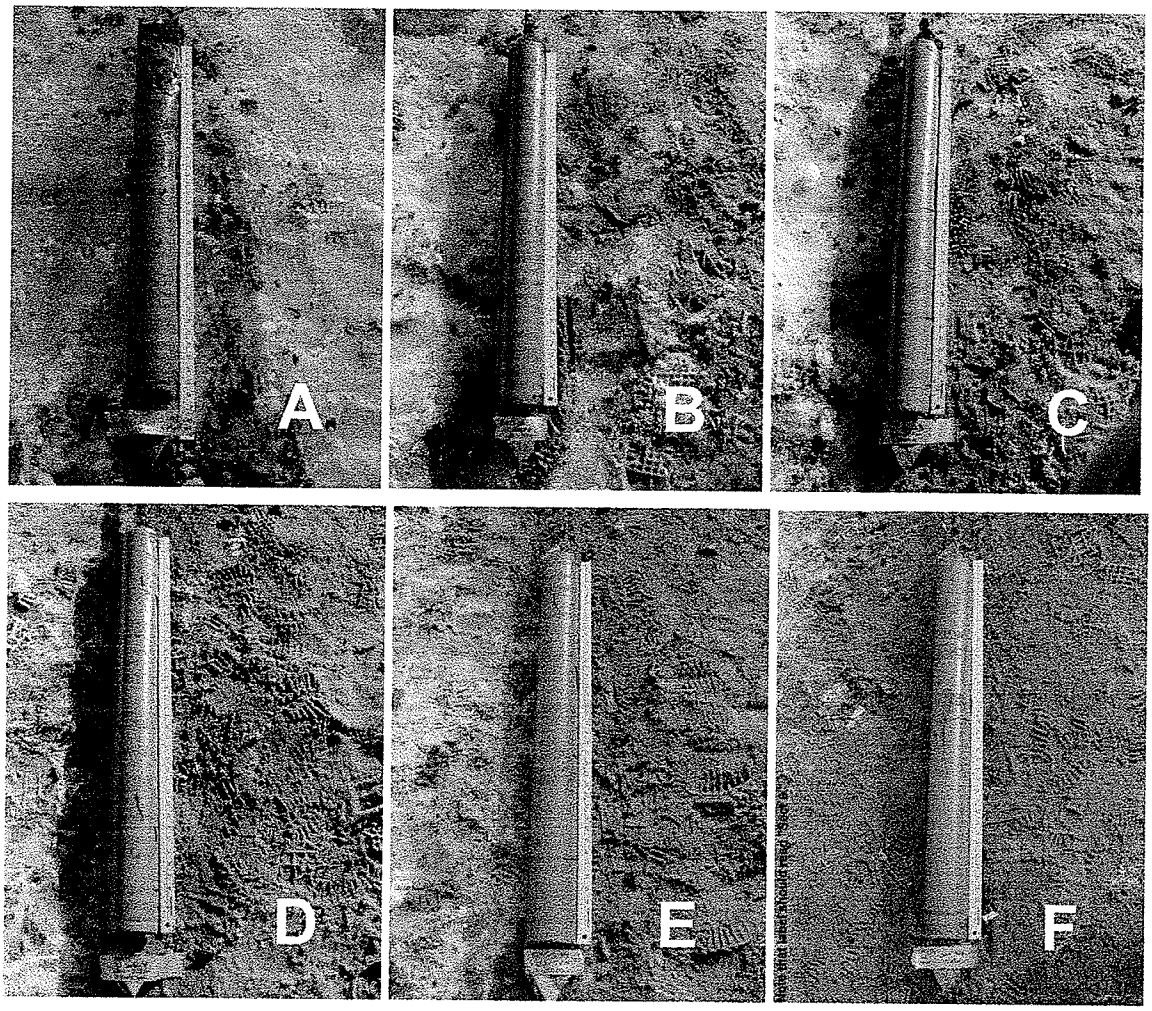
PAD Core Photographs

PAD 54



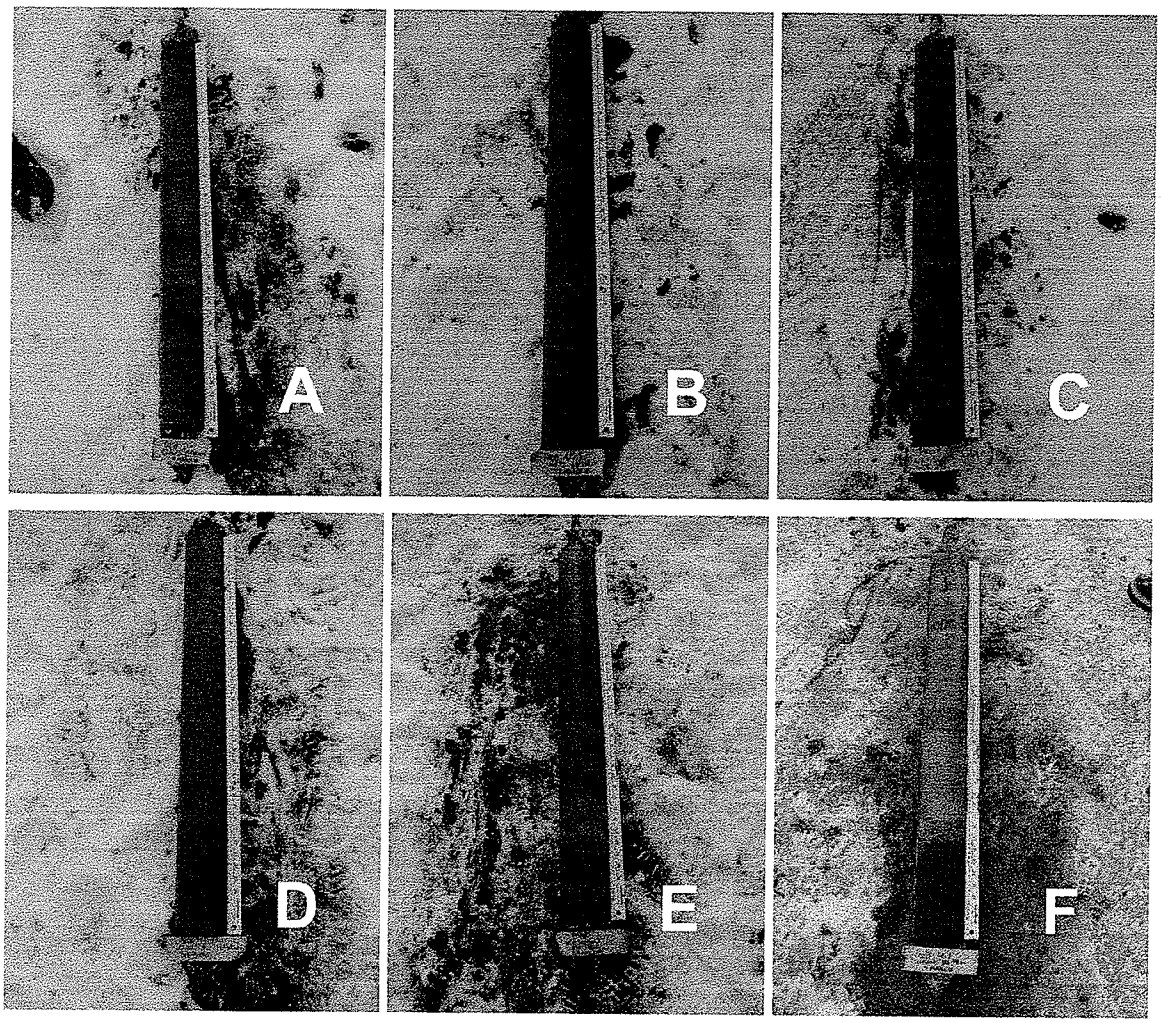
A) PAD 54 LC-1, section 1
B) PAD 54 LC-1, section 2
C) PAD 54 LC-1, section 3
D) PAD 54 LC-1, section 4
E) PAD 54 LC-1, section 5

PAD 15



A) PAD 15 LC-1, section 1
B) PAD 15 LC-1, section 2
C) PAD 15 LC-1, section 3
D) PAD 15 LC-1, section 4
E) PAD 15 LC-1, section 5
F) PAD 15 LC-1, section 6

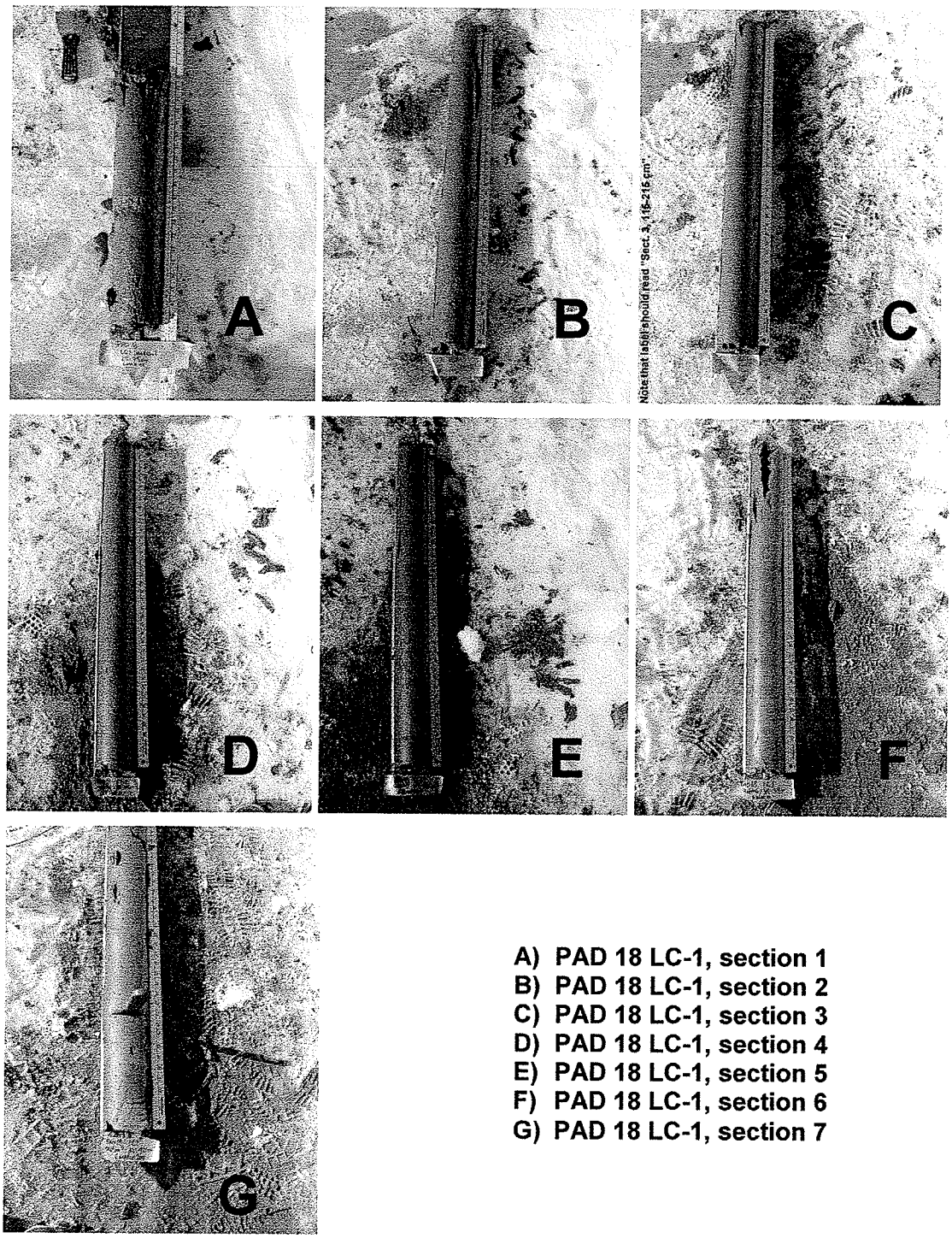
PAD 8



A) PAD 8 LC-1, section 1
B) PAD 8 LC-1, section 2
C) PAD 8 LC-1, section 3
D) PAD 8 LC-1, section 4
E) PAD 8 LC-1, section 5
F) PAD 8 LC-1, section 6

Note: PAD 8 LC-2, sections 1-6 were used for analysis in this study. PAD 8 LC-1, sections 1-6 were archived. No pictures were available of PAD 8 LC-2.

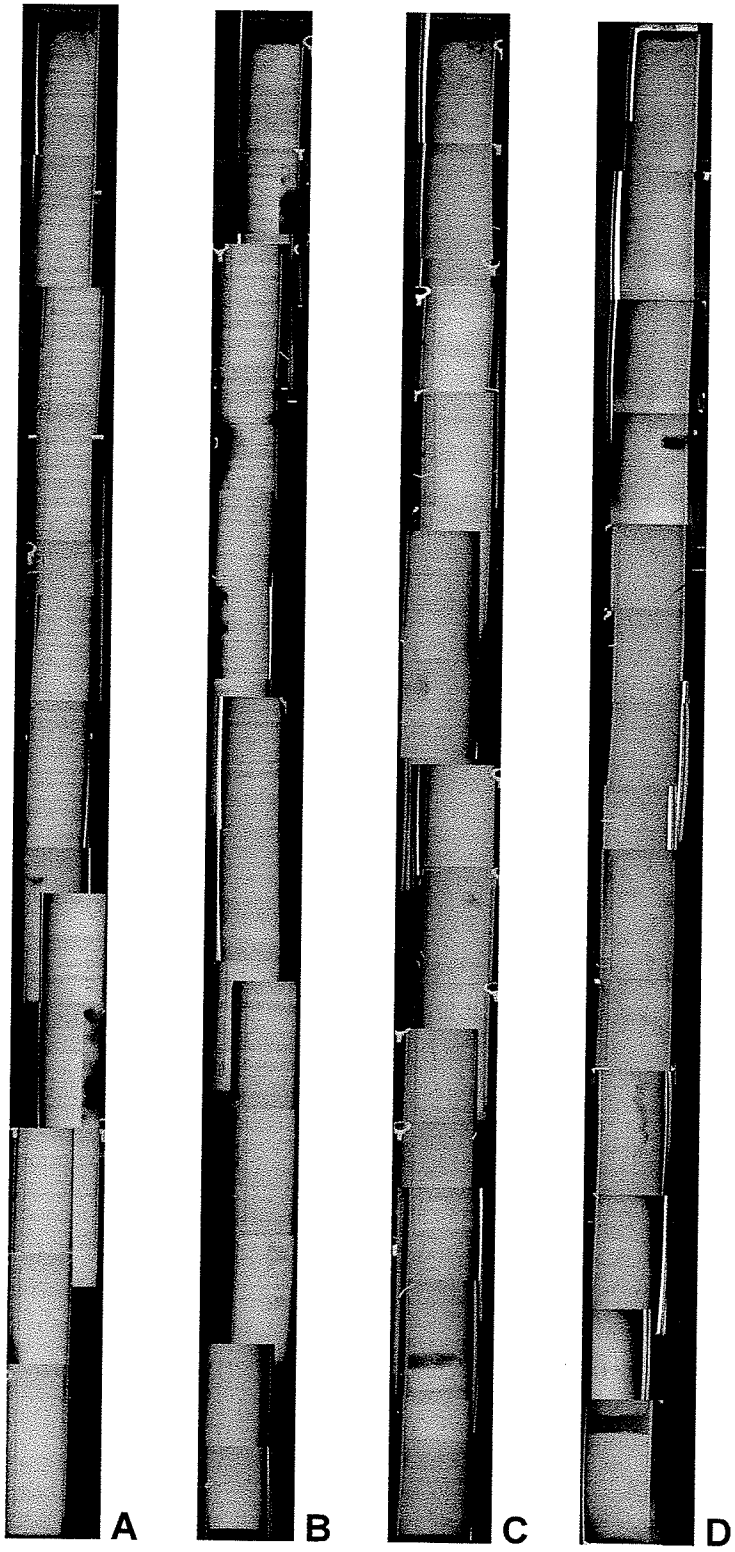
PAD 18



A) PAD 18 LC-1, section 1
B) PAD 18 LC-1, section 2
C) PAD 18 LC-1, section 3
D) PAD 18 LC-1, section 4
E) PAD 18 LC-1, section 5
F) PAD 18 LC-1, section 6
G) PAD 18 LC-1, section 7

Appendix B

X-ray Images of PAD Russian Cores (Long Cores)



A) PAD 54 LC-1

B) PAD 15 LC-1

C) PAD 8 LC-2

D) PAD 18 LC-1

Appendix C

Lamination Data

PAD 54

lamination number	lamination thickness (cm)	depth of lower boundary (cm)
1	6.05	14.05
2	1.42	15.47
3	2.13	17.60
4	0.71	18.31
5	1.23	19.54
6	0.94	20.48
7	1.04	21.52
8	0.55	22.07
9	0.48	22.56
10	1.33	23.88
11	0.81	24.69
12	0.16	24.85
13	0.19	25.05
14	0.32	25.37
15	0.61	25.98
16	0.36	26.34
17	0.91	27.25
18	1.23	28.47
19	2.68	31.16
20	0.32	31.48
21	0.42	31.90
22	0.78	32.68
23	0.71	33.39
24	0.48	33.87
25	0.32	34.20
26	0.32	34.52
27	0.23	34.75
28	0.10	34.84
29	0.13	34.97
30	0.10	35.07
31	0.16	35.23
32	0.61	35.85
33	0.19	36.04
34	0.13	36.17
35	0.39	36.56
36	0.29	36.85
37	0.45	37.30
38	0.58	37.88
39	0.74	38.63
40	1.23	39.86
41	2.55	42.41

lamination number	lamination thickness (cm)	depth of lower boundary (cm)
42	0.42	42.83
43	0.74	43.57
44	0.58	44.16
45	0.19	44.35
46	0.13	44.48
47	0.26	44.74
48	0.19	44.94
49	0.16	45.10
50	0.52	45.61
51	0.87	46.49
52	0.26	46.75
53	0.28	47.03
54	0.55	47.57
55	1.45	49.03
56	1.07	50.10
57	0.61	50.71
58	0.19	50.90
59	1.62	52.52
60	0.78	53.30
61	0.39	53.69
62	0.55	54.24
63	0.87	55.11
64	0.13	55.24
65	1.94	57.18
66	0.19	57.37
67	0.29	57.66
68	0.36	58.02
69	0.29	58.31
70	0.10	58.41
71	0.26	58.67
72	0.19	58.86
73	0.55	59.41
74	0.39	59.80
75	1.07	60.86
76	1.13	62.00
77	1.62	63.62
78	0.26	63.87
79	0.26	64.13
80	0.91	65.04
81	0.32	65.36
82	0.16	65.52
83	0.78	66.30
84	0.13	66.42
85	0.78	67.20
86	0.36	67.56
87	1.07	68.63
88	0.39	69.02
89	0.26	69.28
90	0.36	69.63

lamination number	lamination thickness (cm)	depth of lower boundary (cm)
91	0.16	69.79
92	3.85	73.64
93	0.36	74.00
94	0.29	74.29
95	0.19	74.48
96	0.29	74.78
97	0.10	74.87
98	0.23	75.10
99	0.36	75.46
100	1.62	77.07
101	0.48	77.56
102	0.68	78.24
103	0.10	78.33
104	0.26	78.59
105	0.19	78.79
106	0.29	79.08
107	0.32	79.40
108	0.23	79.63
109	0.16	79.79
110	0.36	80.15
111	0.39	80.54
112	0.36	80.89
113	0.16	81.05
114	0.32	81.38
115	0.29	81.67
116	0.10	81.77
117	0.16	81.93
118	0.13	82.06
119	1.49	83.55
120	0.62	84.16
121	0.87	85.04
122	0.62	85.65
123	0.49	86.14
124	0.52	86.66
125	0.32	86.98
126	0.13	87.11
127	0.26	87.38
128	0.23	87.60
129	0.81	88.41
130	0.49	88.90
131	0.33	89.23
132	0.29	89.52
133	0.26	89.78
134	0.45	90.23
135	0.74	90.98
136	0.46	91.44
137	0.91	92.34
138	2.07	94.41
139	1.68	96.09

lamination number	lamination thickness (cm)	depth of lower boundary (cm)
140	0.78	96.87
141	1.03	97.90
142	0.65	98.55
143	1.29	99.84
144	0.61	100.46
145	1.36	101.82
146	0.48	102.30
147	1.97	104.27
148	0.52	104.79
149	0.39	105.18
150	0.26	105.44
151	0.19	105.63
152	0.39	106.02
153	2.04	108.06
154	0.29	108.35
155	0.16	108.51
156	0.36	108.87
157	0.49	109.35
158	0.71	110.07
159	0.58	110.65
160	0.26	110.91
161	0.23	111.14
162	0.39	111.52
163	0.84	112.36
164	0.23	112.59
165	1.23	113.82
166	0.65	114.47
167	0.36	114.82
168	0.36	115.18
169	0.29	115.47
170	0.39	115.86
171	0.19	116.05
172	0.26	116.31
173	0.13	116.44
174	0.16	116.60
175	0.29	116.89
176	0.36	117.25
177	0.91	118.16
178	0.71	118.87
179	0.39	119.26
180	0.23	119.48
181	0.26	119.74
182	0.45	120.19
183	3.59	123.78
184	0.81	124.59
185	1.58	126.17
186	1.16	127.34
187	0.55	127.89
188	2.13	130.02

lamination number	lamination thickness (cm)	depth of lower boundary (cm)
189	0.52	130.54
190	0.39	130.93
191	0.62	131.54
192	0.39	131.93
193	0.74	132.68
194	0.45	133.13
195	1.20	134.32
196	0.52	134.84
197	0.91	135.75
198	0.49	136.23
199	0.52	136.75
200	0.94	137.69
201	2.07	139.76
202	0.52	140.27
203	1.42	141.70
204	1.00	142.70
205	0.45	143.15
206	0.32	143.48
207	0.58	144.06
208	0.81	144.87
209	0.23	145.09
210	0.52	145.61
211	0.81	146.42
212	0.52	146.94
213	0.55	147.48
214	0.29	147.78
215	0.42	148.20
216	0.45	148.65
217	1.42	150.07
218	0.23	150.30
219	0.65	150.94
220	0.55	151.49
221	1.07	152.56
222	0.20	152.77
223	0.42	153.19
224	0.32	153.51
225	0.23	153.74
226	0.32	154.06
227	0.49	154.55
228	0.36	154.91
229	2.65	157.56
230	0.29	157.85
231	0.26	158.11
232	0.32	158.43
233	5.98	164.41
234	0.29	164.70
235	0.16	164.86
236	0.26	165.12
237	1.39	166.51

lamination number	lamination thickness (cm)	depth of lower boundary (cm)
238	1.71	168.23
239	0.45	168.68
240	0.26	168.94
241	1.88	170.82
242	2.17	172.98
243	0.29	173.27
244	0.84	174.11
245	1.42	175.54
246	0.68	176.22
247	1.23	177.44
248	0.58	178.03
249	0.23	178.25
250	0.74	179.00
251	0.52	179.51
252	1.23	180.74
253	1.97	182.72
254	0.26	182.98
255	1.04	184.01
256	0.26	184.27
257	1.68	185.95
258	0.97	186.92
259	1.16	188.08
260	0.13	188.21
261	0.13	188.34
262	0.16	188.50
263	1.55	190.06
264	0.13	190.19
265	0.23	190.41
266	0.23	190.64
267	1.20	191.83
268	0.91	192.74
269	0.36	193.10
270	0.91	194.00
271	0.26	194.26
272	0.45	194.71
273	4.01	198.72
274	0.52	199.24
275	2.23	201.47
276	1.07	202.54
277	1.00	203.54
278	0.48	204.03
279	0.65	204.67
280	0.39	205.06
281	0.71	205.78
282	0.48	206.26
283	2.39	208.65
284	0.61	209.27
285	0.52	209.78
286	0.58	210.37

lamination number	lamination thickness (cm)	depth of lower boundary (cm)
287	1.20	211.56
288	0.61	212.18
289	0.65	212.82
290	0.49	213.31
291	0.84	214.15
292	0.55	214.70
293	0.26	214.96
294	0.42	215.38
295	0.45	215.83
296	0.29	216.12
297	0.39	216.51
298	5.30	221.81
299	0.39	222.20
300	0.19	222.40
301	0.19	222.59
302	0.19	222.78
303	1.20	223.98
304	0.65	224.63
305	0.16	224.79
306	0.19	224.98
307	1.39	226.37
308	0.29	226.67
309	0.13	226.80
310	0.26	227.05
311	1.36	228.41
312	0.23	228.64
313	0.32	228.96
314	0.26	229.23
315	0.58	229.81
316	1.81	231.62
317	0.74	232.36
318	0.19	232.56
319	0.61	233.17
320	0.19	233.36
321	0.48	233.85
322	0.42	234.27
323	0.62	234.89
324	0.36	235.24
325	0.49	235.73
326	0.36	236.08
327	0.13	236.21
328	0.29	236.50
329	0.26	236.76
330	0.23	236.99
331	0.48	237.47
332	0.29	237.77
333	0.71	238.48
334	0.36	238.83
335	0.81	239.64

lamination number	lamination thickness (cm)	depth of lower boundary (cm)
336	0.36	240.00
337	0.58	240.58
338	0.23	240.81
339	0.45	241.26
340	0.55	241.81
341	0.26	242.07
342	0.42	242.49
343	0.68	243.17
344	0.52	243.69
345	0.58	244.27
346	1.16	245.43
347	0.58	246.01
348	0.19	246.21
349	0.16	246.37
350	0.39	246.76
351	0.10	246.86
352	0.32	247.18
353	0.32	247.50
354	0.16	247.66
355	0.23	247.89
356	0.52	248.41
357	0.32	248.73
358	0.23	248.96
359	0.16	249.12
360	0.52	249.64
361	0.29	249.93
362	0.20	250.13
363	0.30	250.43
364	3.27	253.70
365	0.16	253.86
366	0.19	254.05
367	1.13	255.18
368	0.42	255.60
369	0.06	255.67
370	0.23	255.89
371	0.19	256.09
372	0.39	256.48
373	0.36	256.83
374	0.32	257.16
375	0.23	257.39
376	0.39	257.78
377	0.29	258.07
378	0.16	258.23
379	0.45	258.68
380	1.39	260.07
381	0.20	260.27
382	0.13	260.40
383	0.52	260.92
384	1.33	262.24

lamination number	lamination thickness (cm)	depth of lower boundary (cm)
385	0.16	262.40
386	0.16	262.57
387	3.07	265.64
388	1.94	267.58
389	1.58	269.16
390	0.26	269.42
391	0.58	270.00
392	0.16	270.17
393	0.71	270.88
394	0.71	271.59
395	0.16	271.75
396	0.16	271.91
397	0.23	272.14
398	1.84	273.98
399	0.16	274.15
400	0.16	274.31
401	0.29	274.60
402	0.32	274.92
403	0.33	275.25
404	0.29	275.54
405	0.19	275.74
406	0.32	276.06
407	0.65	276.71
408	1.91	278.62
409	0.39	279.01
410	0.52	279.52
411	0.26	279.78
412	0.55	280.34
413	0.71	281.05
414	0.81	281.86
415	0.68	282.54
416	0.42	282.96
417	0.39	283.35
418	0.32	283.67
419	0.42	284.09
420	1.13	285.23
421	0.32	285.55
422	1.55	287.10
423	0.36	287.46
424	0.23	287.69
425	0.16	287.85
426	0.23	288.08
427	1.23	289.31
428	0.20	289.51
429	1.17	290.67
430	0.32	291.00
431	0.23	291.22
432	0.23	291.45
433	0.23	291.67

lamination number	lamination thickness (cm)	depth of lower boundary (cm)
434	0.55	292.22
435	0.26	292.48
436	0.16	292.64
437	0.23	292.87
438	0.74	293.62
439	0.29	293.91
440	0.36	294.27
441	0.23	294.49
442	0.23	294.72
443	0.16	294.89
444	0.10	294.98
445	0.20	295.18
446	0.46	295.64
447	1.03	296.68
448	0.43	297.10
449	0.87	297.97
450	0.39	298.36
451	0.23	298.59
452	0.29	298.88
453	0.26	299.14
454	0.36	299.50
455	0.59	300.08
456	0.87	300.96
457	1.07	302.02
458	0.97	302.99
459	2.17	305.16
460	0.29	305.45
461	0.32	305.78
462	0.20	305.97
463	0.06	306.04
464	0.23	306.26
465	0.23	306.49
466	0.23	306.72
467	0.55	307.27
468	0.26	307.52
469	0.19	307.72
470	0.32	308.04
471	2.46	310.50
472	0.78	311.27
473	0.58	311.86
474	0.71	312.57
475	1.45	314.02
476	0.26	314.28
477	0.29	314.57
478	0.36	314.93
479	0.19	315.12
480	0.36	315.48
481	0.26	315.74
482	0.78	316.52

lamination number	lamination thickness (cm)	depth of lower boundary (cm)
483	0.23	316.74
484	27.90	344.65
485	0.65	345.29
486	0.23	345.52
487	0.23	345.75
488	0.23	345.97
489	0.58	346.56
490	0.58	347.14
491	0.39	347.53
492	0.81	348.34
493	0.23	348.56
494	0.29	348.86
495	0.06	348.92
496	0.26	349.18
497	0.16	349.34
498	0.55	349.89
499	0.13	350.02
500	2.23	352.25
501	0.23	352.48
502	0.19	352.67
503	0.10	352.77
504	0.16	352.93
505	0.16	353.09
506	1.23	354.32
507	1.23	355.55
508	8.02	363.57

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lamination number	lamination thickness (cm)	depth of lower boundary (cm)
1	23.12	23.12
2	0.87	23.98
3	0.55	24.54
4	0.76	25.30
5	0.69	25.99
6	0.45	26.44
7	0.62	27.07
8	0.52	27.58
9	1.18	28.76
10	0.17	28.93
11	0.35	29.28
12	0.52	29.80
13	0.62	30.42
14	0.07	30.49
15	0.28	30.77
16	0.24	31.01
17	1.77	32.78
18	0.87	33.64

lamination number	lamination thickness (cm)	depth of lower boundary (cm)
19	1.63	35.27
20	0.38	35.65
21	0.28	35.93
22	0.45	36.38
23	2.49	38.87
24	0.28	39.15
25	0.17	39.32
26	0.24	39.56
27	1.73	41.29
28	0.21	41.50
29	0.10	41.60
30	0.55	42.16
31	0.38	42.54
32	0.31	42.85
33	0.93	43.78
34	0.48	44.27
35	3.15	47.42
36	1.80	49.22
37	1.14	50.36
38	0.52	50.88
39	0.24	51.12
40	1.00	52.13
41	0.28	52.40
42	1.63	54.03
43	0.52	54.55
44	1.11	55.66
45	1.28	56.94
46	0.52	57.46
47	0.42	57.87
48	1.38	59.26
49	1.42	60.68
50	0.28	60.95
51	0.31	61.27
52	0.80	62.06
53	0.38	62.44
54	0.90	63.34
55	0.35	63.69
56	0.42	64.11
57	0.24	64.35
58	0.28	64.62
59	0.28	64.90
60	0.80	65.70
61	0.62	66.32
62	0.52	66.84
63	0.28	67.12
64	0.52	67.64
65	0.69	68.33
66	0.38	68.71
67	0.21	68.92

lamination number	lamination thickness (cm)	depth of lower boundary (cm)
68	0.45	69.37
69	0.31	69.68
70	0.31	70.00
71	0.80	70.79
72	0.28	71.07
73	0.76	71.83
74	0.80	72.63
75	0.69	73.32
76	0.52	73.84
77	0.55	74.39
78	0.45	74.84
79	0.24	75.08
80	0.35	75.43
81	0.55	75.98
82	0.18	76.16
83	0.90	77.06
84	0.28	77.34
85	0.21	77.55
86	2.32	79.87
87	0.28	80.14
88	0.59	80.73
89	0.62	81.36
90	0.55	81.91
91	0.69	82.60
92	5.19	87.79
93	2.25	90.04
94	0.48	90.53
95	1.21	91.74
96	0.45	92.19
97	1.11	93.30
98	0.52	93.82
99	0.24	94.06
100	0.49	94.55
101	0.80	95.34
102	0.28	95.62
103	0.93	96.56
104	0.31	96.87
105	0.52	97.39
106	1.21	98.60
107	0.38	98.98
108	0.90	99.88
109	0.17	100.05
110	0.28	100.33
111	0.24	100.57
112	1.07	101.64
113	0.35	101.99
114	0.14	102.13
115	0.21	102.34
116	0.83	103.17

lamination number	lamination thickness (cm)	depth of lower boundary (cm)
117	0.24	103.41
118	0.17	103.58
119	0.38	103.96
120	1.32	105.28
121	0.49	105.76
122	0.24	106.01
123	0.21	106.21
124	0.42	106.63
125	0.14	106.77
126	2.32	109.09
127	0.93	110.02
128	0.80	110.82
129	0.35	111.16
130	0.14	111.30
131	0.35	111.65
132	0.31	111.96
133	0.28	112.24
134	0.21	112.45
135	1.11	113.56
136	1.25	114.80
137	0.17	114.98
138	0.24	115.22
139	0.24	115.46
140	0.31	115.77
141	0.55	116.33
142	1.35	117.68
143	1.07	118.75
144	0.31	119.06
145	0.14	119.20
146	0.83	120.03
147	0.17	120.21
148	0.35	120.55
149	1.49	122.04
150	1.80	123.84
151	0.66	124.50
152	1.35	125.85
153	0.87	126.71
154	0.76	127.47
155	0.59	128.06
156	0.45	128.51
157	0.38	128.89
158	0.35	129.24
159	0.28	129.52
160	0.55	130.07
161	0.17	130.24
162	0.28	130.52
163	0.18	130.70
164	0.55	131.25
165	0.31	131.56

lamination number	lamination thickness (cm)	depth of lower boundary (cm)
166	0.66	132.22
167	2.32	134.54
168	0.35	134.89
169	0.55	135.44
170	0.15	135.59
171	0.31	135.90
172	0.21	136.11
173	2.73	138.84
174	0.17	139.02
175	0.28	139.30
176	0.48	139.78
177	2.08	141.86
178	0.31	142.17
179	1.32	143.48
180	0.38	143.86
181	1.38	145.25
182	0.52	145.77
183	0.38	146.15
184	0.24	146.39
185	0.55	146.94
186	3.91	150.86
187	0.55	151.41
188	3.29	154.70
189	0.42	155.11
190	2.70	157.81
191	0.24	158.06
192	0.31	158.37
193	0.80	159.17
194	0.59	159.76
195	1.07	160.83
196	2.08	162.90
197	0.87	163.77
198	0.38	164.15
199	0.38	164.53
200	0.31	164.84
201	0.11	164.95
202	0.28	165.23
203	0.35	165.58
204	0.38	165.96
205	0.38	166.34
206	1.14	167.48
207	0.28	167.76
208	1.11	168.86
209	1.07	169.94
210	0.31	170.25
211	0.52	170.77
212	0.49	171.25
213	0.38	171.64
214	0.14	171.78

lamination number	lamination thickness (cm)	depth of lower boundary (cm)
215	0.14	171.92
216	0.35	172.26
217	0.66	172.92
218	0.35	173.27
219	0.55	173.82
220	0.80	174.62
221	0.35	174.96
222	0.35	175.31
223	0.24	175.56
224	0.31	175.87
225	0.17	176.04
226	0.31	176.35
227	0.62	176.98
228	0.62	177.60
229	0.49	178.09
230	1.32	179.40
231	0.80	180.20
232	0.69	180.89
233	0.25	181.14
234	0.17	181.31
235	0.35	181.67
236	0.45	182.12
237	0.90	183.02
238	0.18	183.19
239	0.24	183.44
240	0.21	183.65
241	0.24	183.89
242	0.45	184.34
243	0.31	184.65
244	0.66	185.31
245	0.35	185.65
246	0.31	185.97
247	0.59	186.55
248	0.45	187.00
249	1.25	188.25
250	0.48	188.73
251	1.11	189.84
252	0.38	190.22
253	0.42	190.64
254	0.08	190.72
255	0.17	190.89
256	0.35	191.24
257	1.32	192.55
258	0.38	192.93
259	0.90	193.83
260	0.31	194.15
261	0.42	194.57
262	0.35	194.91
263	1.35	196.26

lamination number	lamination thickness (cm)	depth of lower boundary (cm)
264	0.21	196.47
265	0.10	196.58
266	0.14	196.71
267	0.21	196.92
268	0.24	197.16
269	1.77	198.93
270	0.45	199.38
271	0.35	199.73
272	0.21	199.93
273	0.24	200.18
274	0.10	200.28
275	0.17	200.45
276	0.21	200.66
277	0.07	200.73
278	0.24	200.97
279	4.26	205.23
280	0.52	205.75
281	0.14	205.89
282	0.21	206.10
283	0.38	206.48
284	0.45	206.93
285	0.94	207.87
286	0.24	208.11
287	0.31	208.42
288	0.24	208.67
289	0.90	209.57
290	0.31	209.88
291	0.90	210.78
292	0.10	210.88
293	0.52	211.40
294	0.32	211.72
295	0.24	211.97
296	0.38	212.35
297	2.53	214.87
298	1.25	216.12
299	0.42	216.54
300	1.18	217.71
301	1.46	219.17
302	0.50	219.66
303	2.63	222.30
304	0.59	222.89
305	1.35	224.24
306	0.31	224.55
307	0.73	225.27
308	0.38	225.65
309	1.97	227.63
310	0.25	227.88
311	0.49	228.37
312	0.24	228.61

lamination number	lamination thickness (cm)	depth of lower boundary (cm)
313	0.45	229.06
314	0.83	229.89
315	0.42	230.31
316	0.28	230.59
317	0.35	230.94
318	0.22	231.16
319	1.28	232.44
320	0.24	232.68
321	0.97	233.65
322	0.48	234.13
323	0.18	234.31
324	0.14	234.45
325	0.17	234.62
326	0.17	234.80
327	0.24	235.04
328	0.76	235.80
329	0.66	236.46
330	0.69	237.15
331	0.62	237.78
332	0.42	238.19
333	0.24	238.44
334	0.17	238.61
335	0.66	239.27
336	0.29	239.55
337	0.69	240.25
338	0.17	240.42
339	0.66	241.08
340	0.31	241.39
341	5.09	246.48
342	0.31	246.79
343	0.45	247.24
344	0.52	247.76
345	0.28	248.04
346	0.52	248.56
347	0.38	248.94
348	0.55	249.49
349	0.28	249.77
350	0.42	250.18
351	0.97	251.15
352	5.50	256.66
353	0.39	257.04
354	0.21	257.25
355	1.18	258.43
356	0.48	258.91
357	0.31	259.22
358	3.08	262.31
359	0.45	262.76
360	0.52	263.28
361	0.48	263.76

lamination number	lamination thickness (cm)	depth of lower boundary (cm)
362	0.55	264.31
363	0.49	264.80
364	0.17	264.97
365	2.77	267.74
366	0.24	267.98
367	0.45	268.43
368	0.55	268.99
369	1.56	270.55
370	0.62	271.17
371	1.59	272.76
372	0.52	273.28
373	1.42	274.70
374	0.31	275.01
375	0.42	275.43
376	1.00	276.43
377	0.52	276.95
378	0.38	277.33
379	0.14	277.47
380	0.31	277.79
381	0.69	278.48
382	0.45	278.93
383	0.45	279.38
384	0.21	279.59
385	0.21	279.79
386	0.45	280.24
387	0.24	280.49
388	0.55	281.04
389	0.42	281.45
390	0.21	281.66
391	0.66	282.32
392	0.18	282.50
393	0.03	282.53
394	0.21	282.74
395	0.45	283.19
396	0.42	283.61
397	0.97	284.58
398	0.80	285.37
399	0.52	285.89
400	0.55	286.44
401	0.35	286.79
402	0.31	287.10
403	0.42	287.52
404	1.07	288.59
405	0.48	289.08
406	0.10	289.18
407	0.10	289.28
408	0.52	289.80
409	0.80	290.60
410	0.42	291.01

lamination number	lamination thickness (cm)	depth of lower boundary (cm)
411	4.43	295.44
412	2.42	297.87
413	2.15	300.01
414	1.42	301.44
415	1.14	302.58
416	0.80	303.38
417	1.66	305.04
418	0.31	305.35
419	0.76	306.12
420	0.83	306.95
421	1.11	308.05
422	0.52	308.58
423	1.21	309.79
424	0.48	310.27
425	0.62	310.90
426	0.55	311.45
427	0.80	312.25
428	0.31	312.56
429	0.69	313.25
430	0.31	313.56
431	0.31	313.87
432	0.21	314.08
433	0.83	314.91
434	0.10	315.02
435	0.31	315.33
436	0.59	315.92
437	0.52	316.44
438	0.21	316.64
439	0.42	317.06
440	0.18	317.24
441	1.42	318.66
442	0.21	318.86
443	0.59	319.45
444	0.17	319.62
445	0.21	319.83
446	0.24	320.08
447	0.17	320.25
448	0.21	320.46
449	0.59	321.05
450	1.01	322.06
451	1.08	323.13
452	0.24	323.38
453	0.52	323.90
454	0.14	324.03
455	0.31	324.35
456	0.17	324.52
457	0.52	325.04
458	0.14	325.18
459	0.35	325.52

lamination number	lamination thickness (cm)	depth of lower boundary (cm)
460	1.49	327.01
461	0.35	327.36
462	0.93	328.30
463	0.66	328.95
464	0.28	329.23
465	0.55	329.79
466	0.52	330.30
467	0.45	330.76
468	0.21	330.96
469	1.42	332.38
470	0.83	333.21
471	1.66	334.87
472	1.32	336.19
473	0.31	336.50
474	0.73	337.23
475	0.69	337.92
476	1.28	339.20
477	0.35	339.55
478	0.52	340.07
479	0.90	340.97
480	1.80	342.77
481	0.45	343.22
482	0.14	343.36
483	0.24	343.60
484	0.35	343.94
485	0.38	344.32
486	7.82	352.15
487	0.42	352.56
488	6.61	359.17
489	0.52	359.69
490	0.31	360.00
491	0.67	360.67
492	38.21	398.88
493	0.17	399.05
494	0.42	399.47
495	0.42	399.88
496	1.21	401.09
497	0.97	402.06
498	0.97	403.03
499	0.35	403.38
500	0.45	403.83
501	0.17	404.00
502	0.31	404.32
503	0.52	404.84
504	0.90	405.74
505	0.17	405.91
506	0.45	406.36

PAD 8

lamination number	lamination thickness (cm)	depth of lower boundary (cm)
1	32.74	32.74
2	1.04	33.79
3	2.12	35.91
4	1.04	36.95
5	1.28	38.23
6	0.57	38.80
7	0.41	39.21
8	0.30	39.51
9	0.58	40.09
10	0.37	40.46
11	1.14	41.60
12	1.11	42.71
13	2.79	45.50
14	2.46	47.96
15	0.57	48.53
16	0.44	48.97
17	0.50	49.47
18	1.08	50.55
19	1.25	51.80
20	0.41	52.20
21	0.24	52.44
22	0.77	53.21
23	0.24	53.45
24	0.27	53.72
25	3.87	57.59
26	0.57	58.16
27	1.21	59.37
28	0.57	59.94
29	4.24	64.18
30	1.65	65.83
31	1.01	66.84
32	1.04	67.89
33	2.19	70.07
34	0.30	70.38
35	0.30	70.68
36	1.92	72.60
37	1.58	74.18
38	1.48	75.66
39	3.33	78.99
40	1.25	80.24
41	3.06	83.30
42	1.58	84.88
43	2.66	87.54
44	0.61	88.15
45	2.73	90.87
46	0.34	91.21
47	0.34	91.55

lamination number	lamination thickness (cm)	depth of lower boundary (cm)
48	0.50	92.05
49	2.02	94.07
50	0.61	94.68
51	0.34	95.01
52	0.51	95.52
53	0.81	96.33
54	0.81	97.14
55	0.27	97.41
56	0.67	98.08
57	0.37	98.45
58	0.91	99.36
59	0.30	99.67
60	0.94	100.61
61	0.17	100.78
62	0.20	100.98
63	0.24	101.22
64	4.74	105.96
65	0.37	106.33
66	0.27	106.60
67	0.27	106.87
68	1.11	107.98
69	0.74	108.72
70	6.02	114.75
71	0.51	115.25
72	0.47	115.73
73	1.35	117.07
74	0.94	118.01
75	5.86	123.87
76	0.48	124.34
77	0.77	125.12
78	0.47	125.59
79	0.47	126.06
80	0.61	126.67
81	1.95	128.62
82	0.51	129.13
83	0.58	129.71
84	0.88	130.59
85	0.24	130.82
86	0.84	131.66
87	6.93	138.60
88	0.67	139.27
89	5.25	144.52
90	1.35	145.87
91	0.10	145.97
92	0.20	146.17
93	0.50	146.67
94	1.21	147.88
95	0.30	148.19
96	0.30	148.49

lamination number	lamination thickness (cm)	depth of lower boundary (cm)
97	0.20	148.69
98	0.37	149.06
99	0.24	149.30
100	0.17	149.47
101	0.17	149.64
102	0.34	149.98
103	1.55	151.52
104	0.47	152.00
105	2.86	154.86
106	0.54	155.39
107	12.25	167.64
108	0.98	168.62
109	3.53	172.15
110	0.84	173.00
111	0.81	173.80
112	0.40	174.21
113	0.91	175.12
114	3.13	178.25
115	0.50	178.75
116	1.08	179.83
117	0.40	180.23
118	0.98	181.21
119	0.54	181.75
120	1.95	183.70
121	0.40	184.10
122	4.48	188.58
123	0.34	188.91
124	1.51	190.43
125	0.37	190.80
126	2.36	193.15
127	0.51	193.66
128	18.58	212.24
129	0.40	212.64
130	1.55	214.19
131	0.37	214.56
132	2.59	217.15
133	0.44	217.59
134	1.95	219.54
135	0.40	219.94
136	0.61	220.55
137	0.47	221.02
138	7.20	228.22
139	0.57	228.80
140	0.81	229.61
141	0.50	230.11
142	0.30	230.41
143	0.37	230.78
144	0.57	231.36
145	0.57	231.93

lamination number	lamination thickness (cm)	depth of lower boundary (cm)
146	0.64	232.57
147	0.41	232.97
148	0.94	233.92
149	0.84	234.76
150	1.14	235.90
151	0.64	236.54
152	2.05	238.59
153	1.08	239.67
154	17.53	257.21
155	0.64	257.85
156	13.80	271.64
157	1.78	273.43
158	3.33	276.76
159	0.47	277.23
160	0.54	277.77
161	0.67	278.44
162	23.76	302.20
163	0.57	302.77
164	0.40	303.18
165	0.44	303.62
166	4.71	308.33
167	0.44	308.76
168	12.92	321.69
169	0.61	322.30
170	1.55	323.84
171	0.50	324.35
172	7.57	331.92
173	0.30	332.22
174	4.54	336.77
175	0.34	337.10
176	0.81	337.91
177	0.37	338.28
178	1.55	339.83
179	0.34	340.17
180	0.64	340.81
181	0.27	341.08
182	0.81	341.88
183	0.37	342.25
184	0.44	342.69
185	0.30	342.99
186	0.40	343.40
187	0.64	344.04
188	0.37	344.41
189	0.37	344.78
190	3.43	348.21
191	0.40	348.61
192	1.88	350.50
193	0.51	351.00
194	1.75	352.75

lamination number	lamination thickness (cm)	depth of lower boundary (cm)
195	0.54	353.29
196	1.21	354.50
197	1.01	355.51
198	1.55	357.06
199	0.68	357.74
200	1.31	359.06
201	0.51	359.56
202	2.42	361.98
203	0.98	362.96
204	1.95	364.91
205	1.25	366.16
206	1.99	368.14
207	0.64	368.78
208	2.09	370.87
209	1.04	371.91
210	1.28	373.19
211	0.57	373.76
212	0.77	374.54
213	1.58	376.12
214	0.40	376.53
215	4.04	380.56
216	4.58	385.14
217	5.65	390.79
218	1.14	391.94
219	0.34	392.28
220	6.66	398.95
221	1.01	399.95
222	3.13	403.08
223	2.52	405.61
224	1.18	406.79
225	0.37	407.16
226	25.98	433.14

PAD 18

lamination number	lamination thickness (cm)	depth of lower boundary (cm)
1	37.49	62.49
2	0.60	63.08
3	34.96	98.04
4	0.54	98.57
5	0.51	99.08
6	0.51	99.59
7	1.61	101.19
8	0.68	101.88
9	0.63	102.51
10	0.57	103.07
11	1.70	104.77
12	0.54	105.30
13	0.77	106.08
14	13.28	119.36
15	4.02	123.38
16	19.59	142.97
17	5.33	148.30
18	14.83	163.13
19	0.33	163.45
20	23.79	187.24
21	0.24	187.48
22	18.55	206.03
23	0.24	206.27
24	5.30	211.57
25	0.48	212.05
26	52.22	264.27
27	0.27	264.54
28	19.77	284.31
29	0.27	284.58
30	0.39	284.97
31	0.36	285.32
32	23.94	309.26
33	0.92	310.19
34	3.60	313.79
35	0.99	314.78
36	0.86	315.64
37	0.77	316.41
38	0.33	316.74
39	0.27	317.01
40	0.09	317.10
41	0.27	317.38
42	5.84	323.21
43	0.21	323.42
44	0.39	323.81
45	0.42	324.23
46	12.71	336.94
47	0.33	337.27

lamination number	lamination thickness (cm)	depth of lower boundary (cm)
48	0.63	337.89
49	0.54	338.43
50	1.13	339.56
51	0.48	340.04
52	1.76	341.79
53	1.97	343.76
54	0.51	344.27
55	0.30	344.56
56	0.21	344.77
57	0.09	344.86
58	0.57	345.43
59	0.18	345.61
60	0.57	346.17
61	6.16	352.34
62	0.27	352.60
63	0.60	353.20
64	0.15	353.35
65	0.77	354.13
66	0.30	354.43
67	0.21	354.64
68	0.21	354.84
69	0.27	355.12
70	0.24	355.36
71	0.30	355.66
72	0.18	355.84
73	0.18	356.02
74	0.45	356.47
75	0.18	356.64
76	0.06	356.70
77	0.12	356.82
78	0.42	357.24
79	0.21	357.45
80	63.57	421.02

Appendix D

PAD Chronology Data

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
0.25	1999.9	0.25	1999.8	0.25	2000
0.75	1999.6	0.75	1999.5	0.75	1999
1.25	1999.4	1.25	1999.1	1.25	1997
1.75	1999.1	1.75	1998.7	1.75	1996
2.25	1998.9	2.25	1998.4	2.25	1994
2.75	1998.6	2.75	1998.0	2.75	1992
3.25	1998.4	3.25	1997.7	3.25	1990
3.75	1998.1	3.75	1997.3	3.75	1988
4.25	1997.9	4.25	1996.9	4.25	1986
4.75	1997.6	4.75	1996.6	4.75	1984
5.25	1997.4	5.25	1996.2	5.25	1982
5.75	1997.1	5.75	1995.9	5.75	1979
6.25	1996.9	6.25	1995.5	6.25	1977
6.75	1996.6	6.75	1995.1	6.75	1974
7.25	1996.4	7.25	1994.8	7.25	1972
7.75	1996.1	7.75	1994.4	7.75	1969
8.25	1995.9	8.25	1994.1	8.25	1966
8.75	1995.6	8.75	1993.7	8.75	1963
9.25	1995.4	9.25	1993.3	9.25	1960
9.75	1995.1	9.75	1993.0	9.75	1957
10.25	1994.9	10.25	1992.6	10.25	1954
10.75	1994.6	10.75	1992.3	10.75	1951
11.25	1994.4	11.25	1991.9	11.25	1947
11.75	1994.1	11.75	1991.5	11.75	1944
12.25	1993.9	12.25	1991.2	12.25	1940
12.75	1993.6	12.75	1990.8	12.75	1937
13.25	1991.9	13.25	1990.5	13.25	1932
13.75	1991.6	13.75	1990.1	13.75	1928
14.25	1991.4	14.25	1989.7	14.25	1925
14.75	1991.1	14.75	1989.4	14.75	1921
15.25	1990.9	15.25	1989.0	15.25	1918
15.75	1990.6	15.75	1988.7	15.75	1913
16.25	1990.4	16.25	1988.3	16.25	1909
16.75	1990.1	16.75	1987.9	16.75	1905
17.25	1989.9	17.25	1987.6	17.25	1904
17.75	1989.6	17.75	1987.2	17.75	1903
18.25	1989.4	18.25	1986.9	18.25	1902
18.75	1989.1	18.75	1986.5	18.75	1899
19.25	1988.9	19.25	1986.2	19.25	1896
19.75	1988.6	19.75	1985.8	19.75	1893
20.25	1988.4	20.25	1985.4	20.25	1890
20.75	1988.1	20.75	1985.1	20.75	1887
21.25	1987.9	21.25	1984.7	21.25	1884
21.75	1987.6	21.75	1984.4	21.75	1881
22.25	1987.4	22.25	1984.0	22.25	1878

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
22.75	1987.1	22.75	1983.6	22.75	1875
23.25	1986.9	23.25	1983.3	23.25	1872
23.75	1986.6	23.75	1982.9	23.75	1869
24.25	1986.4	24.25	1982.6	24.25	1866
24.75	1986.1	24.75	1982.2	24.75	1863
25.25	1985.9	25.25	1981.8	25.25	1860
25.75	1985.6	25.75	1981.5	25.75	1857
26.25	1985.4	26.25	1981.1	26.25	1854
26.75	1985.1	26.75	1980.8	26.75	1851
27.25	1984.9	27.25	1980.4	27.25	1848
27.75	1984.6	27.75	1980.0	27.75	1845
28.25	1984.4	28.25	1979.7	28.25	1842
28.75	1984.1	28.75	1979.3	28.75	1839
29.25	1983.9	29.25	1979.0	29.25	1836
29.75	1983.6	29.75	1978.6	29.75	1833
30.25	1983.4	30.25	1978.2	30.25	1830
30.75	1983.1	30.75	1977.9	30.75	1827
31.25	1982.9	31.25	1977.5	31.25	1824
31.75	1982.6	31.75	1977.2	31.75	1821
32.25	1982.4	32.25	1976.8	32.25	1818
32.75	1982.1	32.75	1976.4	32.75	1815
33.25	1981.9	33.25	1976.1	33.25	1812
33.75	1981.6	33.75	1975.7	33.75	1809
34.25	1981.4	34.25	1975.4	34.25	1806
34.75	1981.1	34.75	1975.0	34.75	1803
35.25	1980.9	35.25	1974.6	35.25	1800
35.75	1980.6	35.75	1974.3	35.75	1797
36.25	1980.4	36.25	1973.9	36.25	1794
36.75	1980.1	36.75	1973.6	36.75	1791
37.25	1979.9	37.25	1973.2	37.25	1788
37.75	1979.6	37.75	1972.8	37.75	1785
38.25	1979.4	38.25	1972.5	38.25	1782
38.75	1979.1	38.75	1972.1	38.75	1779
39.25	1978.9	39.25	1971.8	39.25	1776
39.75	1978.6	39.75	1971.4	39.75	1773
40.25	1978.4	40.25	1971.0	40.25	1770
40.75	1978.1	40.75	1970.7	40.75	1767
41.25	1977.9	41.25	1970.3	41.25	1764
41.75	1977.6	41.75	1970.0	41.75	1761
42.25	1977.4	42.25	1969.6	42.25	1758
42.75	1977.1	42.75	1969.2	42.75	1755
43.25	1976.9	43.25	1968.9	43.25	1752
43.75	1976.6	43.75	1968.5	43.75	1749
44.25	1976.4	44.25	1968.2	44.25	1746
44.75	1976.1	44.75	1967.8	44.75	1743
45.25	1975.9	45.25	1967.4	45.25	1740
45.75	1975.6	45.75	1967.1	45.75	1737
46.25	1975.4	46.25	1966.7	46.25	1734
46.75	1975.1	46.75	1966.4	46.75	1731
47.25	1974.9	47.25	1966.0	47.25	1728

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
47.75	1974.6	47.75	1965.6	47.75	1725
48.25	1974.4	48.25	1965.3	48.25	1722
48.75	1974.1	48.75	1964.9	48.75	1719
49.25	1973.9	49.25	1964.6	49.25	1716
49.75	1973.6	49.75	1964.2	49.75	1713
50.25	1973.4	50.25	1963.8	50.25	1710
50.75	1973.1	50.75	1963.5	50.75	1707
51.25	1972.9	51.25	1963.1	51.25	1704
51.75	1972.6	51.75	1962.8	51.75	1701
52.25	1972.4	52.25	1962.4	52.25	1698
52.75	1972.1	52.75	1962.1	52.75	1695
53.25	1971.9	53.25	1961.7	53.25	1692
53.75	1971.6	53.75	1961.3	53.75	1689
54.25	1971.4	54.25	1961.0	54.25	1686
54.75	1971.1	54.75	1960.6	54.75	1683
55.25	1970.9	55.25	1960.3	55.25	1681
55.75	1970.6	55.75	1959.9	55.75	1678
56.25	1970.4	56.25	1959.5	56.25	1675
56.75	1970.1	56.75	1959.2	56.75	1672
57.25	1969.9	57.25	1958.8	57.25	1669
57.75	1969.6	57.75	1958.5	57.75	1666
58.25	1969.4	58.25	1958.1	58.25	1663
58.75	1969.1	58.75	1957.7	58.75	1660
59.25	1968.9	59.25	1957.4	59.25	1657
59.75	1968.6	59.75	1957.0	59.75	1654
60.00	1970.0	60.25	1956.7	60.25	1651
60.20	1969.9	60.75	1956.3	60.75	1648
60.40	1969.8	61.25	1955.9	61.25	1645
60.60	1969.7	61.75	1955.6	61.75	1642
60.80	1969.6	62.00	1955.4	62.25	1639
61.00	1969.5	62.20	1955.3	62.75	1636
61.20	1969.4	62.40	1955.1	63.25	1633
61.40	1969.3	62.60	1955.0	63.75	1630
61.60	1969.2	62.80	1954.8	64.25	1627
61.80	1969.1	63.00	1954.7	64.75	1624
62.00	1969.0	63.20	1954.5	65.25	1621
62.20	1968.9	63.40	1954.4	65.75	1618
62.40	1968.8	63.60	1954.2	66.25	1615
62.60	1968.7	63.80	1954.1	66.75	1612
62.80	1968.6	64.00	1954.0	67.25	1609
63.00	1968.5	64.20	1953.8	67.75	1606
63.20	1968.4	64.40	1953.7	68.25	1603
63.40	1968.3	64.60	1953.5	68.75	1600
63.60	1968.2	64.80	1953.4	69.25	1597
63.80	1968.1	65.00	1953.2	69.75	1594
64.00	1968.0	65.20	1953.1	70.25	1591
64.20	1967.9	65.40	1952.9	70.75	1588
64.40	1967.8	65.60	1952.8	71.25	1585
64.60	1967.7	65.80	1952.7	71.75	1582
64.80	1967.6	66.00	1952.5	72.25	1579

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
65.00	1967.5	66.20	1952.4	72.75	1576
65.20	1967.4	66.40	1952.2	73.25	1573
65.40	1967.3	66.60	1952.1	73.75	1570
65.60	1967.2	66.80	1951.9	74.25	1567
65.80	1967.1	67.00	1951.8	74.75	1564
66.00	1967.0	67.20	1951.7	75.25	1561
66.20	1966.9	67.40	1951.5	75.75	1558
66.40	1966.8	67.60	1951.4	76.25	1555
66.60	1966.7	67.80	1951.2	76.75	1552
66.80	1966.6	68.00	1951.1	77.25	1549
67.00	1966.5	68.20	1950.9	77.75	1546
67.20	1966.4	68.40	1950.8	78.25	1543
67.40	1966.3	68.60	1950.6	78.75	1540
67.60	1966.2	68.80	1950.5	79.25	1537
67.80	1966.1	69.00	1950.4	79.75	1534
68.00	1966.0	69.20	1950.2	80.25	1531
68.20	1965.9	69.40	1950.1	80.75	1528
68.40	1965.8	69.60	1949.9	81.25	1525
68.60	1965.7	69.80	1949.8	81.75	1522
68.80	1965.6	70.00	1949.6	82.25	1519
69.00	1965.5	70.20	1949.5	82.75	1516
69.20	1965.4	70.40	1949.4	83.25	1513
69.40	1965.3	70.60	1949.2	83.75	1510
69.60	1965.2	70.80	1949.1	84.25	1507
69.80	1965.1	71.00	1948.9	84.75	1504
70.00	1965.0	71.20	1948.8	85.25	1501
70.20	1964.9	71.40	1948.6	85.75	1498
70.40	1964.8	71.60	1948.5	86.25	1495
70.60	1964.7	71.80	1948.3	86.75	1492
70.80	1964.6	72.00	1948.2	87.25	1489
71.00	1964.5	72.20	1948.1	87.75	1486
71.20	1964.4	72.40	1947.9	88.25	1483
71.40	1964.3	72.60	1947.8	88.75	1480
71.60	1964.2	72.80	1947.6	89.25	1477
71.80	1964.1	73.00	1947.5	89.75	1474
72.00	1964.0	73.20	1947.3	90.25	1471
72.20	1963.9	73.40	1947.2	90.75	1468
72.40	1963.8	73.60	1947.1	91.25	1465
72.60	1963.7	73.80	1946.9	91.75	1462
72.80	1963.6	74.00	1946.8	92.25	1459
73.00	1963.5	74.20	1946.6	92.75	1456
73.20	1963.4	74.40	1946.5	93.25	1453
73.40	1963.3	74.60	1946.3	93.75	1450
73.60	1963.2	74.80	1946.2	94.25	1447
73.80	1963.1	75.00	1946.0	94.75	1444
74.00	1963.0	75.20	1945.9	95.25	1441
74.20	1962.9	75.40	1945.8	95.75	1438
74.40	1962.8	75.60	1945.6	96.25	1435
74.60	1962.7	75.80	1945.5	96.75	1432
74.80	1962.6	76.00	1945.3	97.25	1429

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
75.00	1962.5	76.20	1945.2	97.75	1426
75.20	1962.4	76.40	1945.0		
75.40	1962.3	76.60	1944.9		
75.60	1962.2	76.80	1944.7		
75.80	1962.1	77.00	1944.6		
76.00	1962.0	77.20	1944.5		
76.20	1961.9	77.40	1944.3		
76.40	1961.8	77.60	1944.2		
76.60	1961.7	77.80	1944.0		
76.80	1961.6	78.00	1943.9		
77.00	1961.5	78.20	1943.7		
77.20	1961.4	78.40	1943.6		
77.40	1961.3	78.60	1943.5		
77.60	1961.2	78.80	1943.3		
77.80	1961.1	79.00	1943.2		
78.00	1961.0	79.20	1943.0		
78.20	1960.9	79.40	1942.9		
78.40	1960.8	79.60	1942.7		
78.60	1960.7	79.80	1942.6		
78.80	1960.6	80.00	1942.4		
79.00	1960.5	80.20	1942.3		
79.20	1960.4	80.40	1942.2		
79.40	1960.3	80.60	1942.0		
79.60	1960.2	80.80	1941.9		
79.80	1960.1	81.00	1941.7		
80.00	1960.0	81.20	1941.6		
80.20	1959.9	81.40	1941.4		
80.40	1959.8	81.60	1941.3		
80.60	1959.7	81.80	1941.2		
80.80	1959.6	82.00	1941.0		
81.00	1959.5	82.20	1940.9		
81.20	1959.4	82.40	1940.7		
81.40	1959.3	82.60	1940.6		
81.60	1959.2	82.80	1940.4		
81.80	1959.1	83.00	1940.3		
82.00	1959.0	83.20	1940.1		
82.20	1958.9	83.40	1940.0		
82.40	1958.8	83.60	1939.9		
82.60	1958.7	83.80	1939.7		
82.80	1958.6	84.00	1939.6		
83.00	1958.5	84.20	1939.4		
83.20	1958.4	84.40	1939.3		
83.40	1958.3	84.60	1939.1		
83.60	1958.2	84.80	1939.0		
83.80	1958.1	85.00	1938.8		
84.00	1958.0	85.20	1938.7		
84.20	1957.9	85.40	1938.6		
84.40	1957.8	85.60	1938.4		
84.60	1957.7	85.80	1938.3		
84.80	1957.6	86.00	1938.1		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
85.00	1957.5	86.20	1938.0		
85.20	1957.4	86.40	1937.8		
85.40	1957.3	86.60	1937.7		
85.60	1957.2	86.80	1937.6		
85.80	1957.1	87.00	1937.4		
86.00	1957.0	87.20	1937.3		
86.20	1956.9	87.40	1937.1		
86.40	1956.8	87.60	1937.0		
86.60	1956.7	87.80	1936.8		
86.80	1956.6	88.00	1936.7		
87.00	1956.5	88.20	1936.5		
87.20	1956.4	88.40	1936.4		
87.40	1956.3	88.60	1936.3		
87.60	1956.2	88.80	1936.1		
87.80	1956.1	89.00	1936.0		
88.00	1956.0	89.20	1935.8		
88.20	1955.9	89.40	1935.7		
88.40	1955.8	89.60	1935.5		
88.60	1955.7	89.80	1935.4		
88.80	1955.6	90.00	1935.3		
89.00	1955.5	90.20	1935.1		
89.20	1955.4	90.40	1935.0		
89.40	1955.3	90.60	1934.8		
89.60	1955.2	90.80	1934.7		
89.80	1955.1	91.00	1934.5		
90.00	1955.0	91.20	1934.4		
90.20	1954.9	91.40	1934.2		
90.40	1954.8	91.60	1934.1		
90.60	1954.7	91.80	1934.0		
90.80	1954.6	92.00	1933.8		
91.00	1954.5	92.20	1933.7		
91.20	1954.4	92.40	1933.5		
91.40	1954.3	92.60	1933.4		
91.60	1954.2	92.80	1933.2		
91.80	1954.1	93.00	1933.1		
92.00	1954.0	93.20	1932.9		
92.20	1953.9	93.40	1932.8		
92.40	1953.8	93.60	1932.7		
92.60	1953.7	93.80	1932.5		
92.80	1953.6	94.00	1932.4		
93.00	1953.5	94.20	1932.2		
93.20	1953.4	94.40	1932.1		
93.40	1953.3	94.60	1931.9		
93.60	1953.2	94.80	1931.8		
93.80	1953.1	95.00	1931.7		
94.00	1953.0	95.20	1931.5		
94.20	1952.9	95.40	1931.4		
94.40	1952.8	95.60	1931.2		
94.60	1952.7	95.80	1931.1		
94.80	1952.6	96.00	1930.9		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
95.00	1952.5	96.20	1930.8		
95.20	1952.4	96.40	1930.6		
95.40	1952.3	96.60	1930.5		
95.60	1952.2	96.80	1930.4		
95.80	1952.1	97.00	1930.2		
96.00	1952.0	97.20	1930.1		
96.20	1951.9	97.40	1929.9		
96.40	1951.8	97.60	1929.8		
96.60	1951.7	97.80	1929.6		
96.80	1951.6	98.00	1929.5		
97.00	1951.5	98.20	1929.4		
97.20	1951.4	98.40	1929.2		
97.40	1951.3	98.60	1929.1		
97.60	1951.2	98.80	1928.9		
97.80	1951.1	99.00	1928.8		
98.00	1951.0	99.20	1928.6		
98.20	1950.9	99.40	1928.5		
98.40	1950.8	99.60	1928.3		
98.60	1950.7	99.80	1928.2		
98.80	1950.6	100.00	1928.1		
99.00	1950.5	100.20	1927.9		
99.20	1950.4	100.40	1927.8		
99.40	1950.3	100.60	1927.6		
99.60	1950.2	100.80	1927.5		
99.80	1950.1	101.00	1927.3		
100.00	1950.0	101.20	1927.2		
100.20	1949.9	101.40	1927.1		
100.40	1949.8	101.60	1926.9		
100.60	1949.7	101.80	1926.8		
100.80	1949.6	102.00	1926.6		
101.00	1949.5	102.20	1926.5		
101.20	1949.4	102.40	1926.3		
101.40	1949.3	102.60	1926.2		
101.60	1949.2	102.80	1926.0		
101.80	1949.1	103.00	1925.9		
102.00	1949.0	103.20	1925.8		
102.20	1948.9	103.40	1925.6		
102.40	1948.8	103.60	1925.5		
102.60	1948.7	103.80	1925.3		
102.80	1948.6	104.00	1925.2		
103.00	1948.5	104.20	1925.0		
103.20	1948.4	104.40	1924.9		
103.40	1948.3	104.60	1924.7		
103.60	1948.2	104.80	1924.6		
103.80	1948.1	105.00	1924.5		
104.00	1948.0	105.20	1924.3		
104.20	1947.9	105.40	1924.2		
104.40	1947.8	105.60	1924.0		
104.60	1947.7	105.80	1923.9		
104.80	1947.6	106.00	1923.7		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
105.00	1947.5	106.20	1923.6		
105.20	1947.4	106.40	1923.5		
105.40	1947.3	106.60	1923.3		
105.60	1947.2	106.80	1923.2		
105.80	1947.1	107.00	1923.0		
106.00	1947.0	107.20	1922.9		
106.20	1946.9	107.40	1922.7		
106.40	1946.8	107.60	1922.6		
106.60	1946.7	107.80	1922.4		
106.80	1946.6	108.00	1922.3		
107.00	1946.5	108.20	1922.2		
107.20	1946.4	108.40	1922.0		
107.40	1946.3	108.60	1921.9		
107.60	1946.2	108.80	1921.7		
107.80	1946.1	109.00	1921.6		
108.00	1946.0	109.20	1921.4		
108.20	1945.9	109.40	1921.3		
108.40	1945.8	109.60	1921.2		
108.60	1945.7	109.80	1921.0		
108.80	1945.6	110.00	1920.9		
109.00	1945.5	110.20	1920.7		
109.20	1945.4	110.40	1920.6		
109.40	1945.3	110.60	1920.4		
109.60	1945.2	110.80	1920.3		
109.80	1945.1	111.00	1920.1		
110.00	1945.0	111.20	1920.0		
110.20	1944.9	111.40	1919.9		
110.40	1944.8	111.60	1919.7		
110.60	1944.7	111.80	1919.6		
110.80	1944.6	112.00	1919.4		
111.00	1944.5	112.20	1919.3		
111.20	1944.4	112.40	1919.1		
111.40	1944.3	112.60	1919.0		
111.60	1944.2	112.80	1918.8		
111.80	1944.1	113.00	1918.7		
112.00	1944.0	113.20	1918.6		
112.20	1943.9	113.40	1918.4		
112.40	1943.8	113.60	1918.3		
112.60	1943.7	113.80	1918.1		
112.80	1943.6	114.00	1918.0		
113.00	1943.5	114.20	1917.8		
113.20	1943.4	114.40	1917.7		
113.40	1943.3	114.60	1917.6		
113.60	1943.2	114.80	1917.4		
113.80	1943.1	115.00	1917.3		
114.00	1943.0	115.20	1917.1		
114.20	1942.9	115.40	1917.0		
114.40	1942.8	115.60	1916.8		
114.60	1942.7	115.80	1916.7		
114.80	1942.6	116.00	1916.5		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
115.00	1942.5	116.20	1916.4		
115.20	1942.4	116.40	1916.3		
115.40	1942.3	116.60	1916.1		
115.60	1942.2	116.80	1916.0		
115.80	1942.1	117.00	1915.8		
116.00	1942.0	117.20	1915.7		
116.20	1941.9	117.40	1915.5		
116.40	1941.8	117.60	1915.4		
116.60	1941.7	117.80	1915.3		
116.80	1941.6	118.00	1915.1		
117.00	1941.5	118.20	1915.0		
117.20	1941.4	118.40	1914.8		
117.40	1941.3	118.60	1914.7		
117.60	1941.2	118.80	1914.5		
117.80	1941.1	119.00	1914.4		
118.00	1941.0	119.20	1914.2		
118.20	1940.9	119.40	1914.1		
118.40	1940.8	119.60	1914.0		
118.60	1940.7	119.80	1913.8		
118.80	1940.6	120.00	1913.7		
119.00	1940.5	120.20	1913.5		
119.20	1940.4	120.40	1913.4		
119.40	1940.3	120.60	1913.2		
119.60	1940.2	120.80	1913.1		
119.80	1940.1	121.00	1912.9		
120.00	1940.0	121.20	1912.8		
120.20	1939.9	121.40	1912.7		
120.40	1939.8	121.60	1912.5		
120.60	1939.7	121.80	1912.4		
120.80	1939.6	122.00	1912.2		
121.00	1939.5	122.20	1912.1		
121.20	1939.4	122.40	1911.9		
121.40	1939.3	122.60	1911.8		
121.60	1939.2	122.80	1911.7		
121.80	1939.1	123.00	1911.5		
122.00	1939.0	123.20	1911.4		
122.20	1938.9	123.40	1911.2		
122.40	1938.8	123.60	1911.1		
122.60	1938.7	123.80	1910.9		
122.80	1938.6	124.00	1910.8		
123.00	1938.5	124.20	1910.6		
123.20	1938.4	124.40	1910.5		
123.40	1938.3	124.60	1910.4		
123.60	1938.2	124.80	1910.2		
123.80	1938.1	125.00	1910.1		
124.00	1938.0	125.20	1909.9		
124.20	1937.9	125.40	1909.8		
124.40	1937.8	125.60	1909.6		
124.60	1937.7	125.80	1909.5		
124.80	1937.6	126.00	1909.4		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
125.00	1937.5	126.20	1909.2		
125.20	1937.4	126.40	1909.1		
125.40	1937.3	126.60	1908.9		
125.60	1937.2	126.80	1908.8		
125.80	1937.1	127.00	1908.6		
126.00	1937.0	127.20	1908.5		
126.20	1936.9	127.40	1908.3		
126.40	1936.8	127.60	1908.2		
126.60	1936.7	127.80	1908.1		
126.80	1936.6	128.00	1907.9		
127.00	1936.5	128.20	1907.8		
127.20	1936.4	128.40	1907.6		
127.40	1936.3	128.60	1907.5		
127.60	1936.2	128.80	1907.3		
127.80	1936.1	129.00	1907.2		
128.00	1936.0	129.20	1907.1		
128.20	1935.9	129.40	1906.9		
128.40	1935.8	129.60	1906.8		
128.60	1935.7	129.80	1906.6		
128.80	1935.6	130.00	1906.5		
129.00	1935.5	130.20	1906.3		
129.20	1935.4	130.40	1906.2		
129.40	1935.3	130.60	1906.0		
129.60	1935.2	130.80	1905.9		
129.80	1935.1	131.00	1905.8		
130.00	1935.7	131.20	1905.6		
130.20	1935.6	131.40	1905.5		
130.40	1935.5	131.60	1905.3		
130.60	1935.4	131.80	1905.2		
130.80	1935.3	132.00	1905.0		
131.00	1935.2	132.20	1904.9		
131.20	1935.1	132.40	1904.7		
131.40	1935.0	132.60	1904.6		
131.60	1934.9	132.80	1904.5		
131.80	1934.8	133.00	1904.3		
132.00	1934.7	133.20	1904.2		
132.20	1934.6	133.40	1904.0		
132.40	1934.5	133.60	1903.9		
132.60	1934.4	133.80	1903.7		
132.80	1934.3	134.00	1903.6		
133.00	1934.2	134.20	1903.5		
133.20	1934.1	134.40	1903.3		
133.40	1934.0	134.60	1903.2		
133.60	1933.9	134.80	1903.0		
133.80	1933.8	135.00	1902.9		
134.00	1933.7	135.20	1902.7		
134.20	1933.6	135.40	1902.6		
134.40	1933.5	135.60	1902.4		
134.60	1933.4	135.80	1902.3		
134.80	1933.3	136.00	1902.2		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
135.00	1933.2	136.20	1902.0		
135.20	1933.1	136.40	1901.9		
135.40	1933.0	136.60	1901.7		
135.60	1932.9	136.80	1901.6		
135.80	1932.8	137.00	1901.4		
136.00	1932.7	137.20	1901.3		
136.20	1932.6	137.40	1901.2		
136.40	1932.5	137.60	1901.0		
136.60	1932.4	137.80	1900.9		
136.80	1932.3	138.00	1900.7		
137.00	1932.2	138.20	1900.6		
137.20	1932.1	138.40	1900.4		
137.40	1932.0	138.60	1900.3		
137.60	1931.9	138.80	1900.1		
137.80	1931.8	139.00	1900.0		
138.00	1931.7	139.20	1899.9		
138.20	1931.6	139.40	1899.7		
138.40	1931.5	139.60	1899.6		
138.60	1931.4	139.80	1899.4		
138.80	1931.3	140.00	1899.3		
139.00	1931.2	140.20	1899.1		
139.20	1931.1	140.40	1899.0		
139.40	1931.0	140.60	1898.8		
139.60	1930.9	140.80	1898.7		
139.80	1930.8	141.00	1898.6		
140.00	1930.7	141.20	1898.4		
140.20	1930.6	141.40	1898.3		
140.40	1930.5	141.60	1898.1		
140.60	1930.4	141.80	1898.0		
140.80	1930.3	142.00	1897.8		
141.00	1930.2	142.20	1897.7		
141.20	1930.1	142.40	1897.6		
141.40	1930.0	142.60	1897.4		
141.60	1929.9	142.80	1897.3		
141.80	1929.8	143.00	1897.1		
142.00	1929.7	143.20	1897.0		
142.20	1929.6	143.40	1896.8		
142.40	1929.5	143.60	1896.7		
142.60	1929.4	143.80	1896.5		
142.80	1929.3	144.00	1896.4		
143.00	1929.2	144.20	1896.3		
143.20	1929.1	144.40	1896.1		
143.40	1929.0	144.60	1896.0		
143.60	1928.9	144.80	1895.8		
143.80	1928.8	145.00	1895.7		
144.00	1928.7	145.20	1895.5		
144.20	1928.6	145.40	1895.4		
144.40	1928.5	145.60	1895.3		
144.60	1928.4	145.80	1895.1		
144.80	1928.3	146.00	1895.0		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
145.00	1928.2	146.20	1894.8		
145.20	1928.1	146.40	1894.7		
145.40	1928.0	146.60	1894.5		
145.60	1927.9	146.80	1894.4		
145.80	1927.8	147.00	1894.2		
146.00	1927.7	147.20	1894.1		
146.20	1927.6	147.40	1894.0		
146.40	1927.5	147.60	1893.8		
146.60	1927.4	147.80	1893.7		
146.80	1927.3	148.00	1893.5		
147.00	1927.2	148.20	1893.4		
147.20	1927.1	148.40	1893.2		
147.40	1927.0	148.60	1893.1		
147.60	1926.9	148.80	1892.9		
147.80	1926.8	149.00	1892.8		
148.00	1926.7	149.20	1892.7		
148.20	1926.6	149.40	1892.5		
148.40	1926.5	149.60	1892.4		
148.60	1926.4	149.80	1892.2		
148.80	1926.3	150.00	1892.1		
149.00	1926.2	150.20	1891.9		
149.20	1926.1	150.40	1891.8		
149.40	1926.0	150.60	1891.7		
149.60	1925.9	150.80	1891.5		
149.80	1925.8	151.00	1891.4		
150.00	1925.7	151.20	1891.2		
150.20	1925.6	151.40	1891.1		
150.40	1925.5	151.60	1890.9		
150.60	1925.4	151.80	1890.8		
150.80	1925.3	152.00	1890.6		
151.00	1925.2	152.20	1890.5		
151.20	1925.1	152.40	1890.4		
151.40	1925.0	152.60	1890.2		
151.60	1924.9	152.80	1890.1		
151.80	1924.8	153.00	1889.9		
152.00	1924.7	153.20	1889.8		
152.20	1924.6	153.40	1889.6		
152.40	1924.5	153.60	1889.5		
152.60	1924.4	153.80	1889.4		
152.80	1924.3	154.00	1889.2		
153.00	1924.2	154.20	1889.1		
153.20	1924.1	154.40	1888.9		
153.40	1924.0	154.60	1888.8		
153.60	1923.9	154.80	1888.6		
153.80	1923.8	155.00	1888.5		
154.00	1923.7	155.20	1888.3		
154.20	1923.6	155.40	1888.2		
154.40	1923.5	155.60	1888.1		
154.60	1923.4	155.80	1887.9		
154.80	1923.3	156.00	1887.8		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
155.00	1923.2	156.20	1887.6		
155.20	1923.1	156.40	1887.5		
155.40	1923.0	156.60	1887.3		
155.60	1922.9	156.80	1887.2		
155.80	1922.8	157.00	1887.1		
156.00	1922.7	157.20	1886.9		
156.20	1922.6	157.40	1886.8		
156.40	1922.5	157.60	1886.6		
156.60	1922.4	157.80	1886.5		
156.80	1922.3	158.00	1886.3		
157.00	1922.2	158.20	1886.2		
157.20	1922.1	158.40	1886.0		
157.40	1922.0	158.60	1885.9		
157.60	1921.9	158.80	1885.8		
157.80	1921.8	159.00	1885.6		
158.00	1921.7	159.20	1885.5		
158.20	1921.6	159.40	1885.3		
158.40	1921.5	159.60	1885.2		
158.60	1921.4	159.80	1885.0		
158.80	1921.3	160.00	1884.9		
159.00	1921.2	160.20	1884.7		
159.20	1921.1	160.40	1884.6		
159.40	1921.0	160.60	1884.5		
159.60	1920.9	160.80	1884.3		
159.80	1920.8	161.00	1884.2		
160.00	1920.7	161.20	1884.0		
160.20	1920.6	161.40	1883.9		
160.40	1920.5	161.60	1883.7		
160.60	1920.4	161.80	1883.6		
160.80	1920.3	162.00	1883.5		
161.00	1920.2	162.20	1883.3		
161.20	1920.1	162.40	1883.2		
161.40	1920.0	162.60	1883.0		
161.60	1919.9	162.80	1882.9		
161.80	1919.8	163.00	1882.7		
162.00	1919.7	163.20	1882.6		
162.20	1919.6	163.40	1882.4		
162.40	1919.5	163.60	1882.3		
162.60	1919.4	163.80	1882.2		
162.80	1919.3	164.00	1882.0		
163.00	1919.2	164.20	1881.9		
163.20	1919.1	164.40	1881.7		
163.40	1919.0	164.60	1881.6		
163.60	1918.9	164.80	1881.4		
163.80	1918.8	165.00	1881.3		
164.00	1918.7	165.20	1881.2		
164.20	1918.6	165.40	1881.0		
164.40	1918.5	165.60	1880.9		
164.60	1918.4	165.80	1880.7		
164.80	1918.3	166.00	1880.6		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
165.00	1918.2	166.20	1880.4		
165.20	1918.1	166.40	1880.3		
165.40	1918.0	166.60	1880.1		
165.60	1917.9	166.80	1880.0		
165.80	1917.8	167.00	1879.9		
166.00	1917.7	167.20	1879.7		
166.20	1917.6	167.40	1879.6		
166.40	1917.5	167.60	1879.4		
166.60	1917.4	167.80	1879.3		
166.80	1917.3	168.00	1879.1		
167.00	1917.2	168.20	1879.0		
167.20	1917.1	168.40	1878.8		
167.40	1917.0	168.60	1878.7		
167.60	1916.9	168.80	1878.6		
167.80	1916.8	169.00	1878.4		
168.00	1916.7	169.20	1878.3		
168.20	1916.6	169.40	1878.1		
168.40	1916.5	169.60	1878.0		
168.60	1916.4	169.80	1877.8		
168.80	1916.3	170.00	1877.7		
169.00	1916.2	170.20	1877.6		
169.20	1916.1	170.40	1877.4		
169.40	1916.0	170.60	1877.3		
169.60	1915.9	170.80	1877.1		
169.80	1915.8	171.00	1877.0		
170.00	1915.7	171.20	1876.8		
170.20	1915.6	171.40	1876.7		
170.40	1915.5	171.60	1876.5		
170.60	1915.4	171.80	1876.4		
170.80	1915.3	172.00	1876.3		
171.00	1915.2	172.20	1876.1		
171.20	1915.1	172.40	1876.0		
171.40	1915.0	172.60	1875.8		
171.60	1914.9	172.80	1875.7		
171.80	1914.8	173.00	1875.5		
172.00	1914.7	173.20	1875.4		
172.20	1914.6	173.40	1875.3		
172.40	1914.5	173.60	1875.1		
172.60	1914.4	173.80	1875.0		
172.80	1914.3	174.00	1874.8		
173.00	1914.2	174.20	1874.7		
173.20	1914.1	174.40	1874.5		
173.40	1914.0	174.60	1874.4		
173.60	1913.9	174.80	1874.2		
173.80	1913.8	175.00	1874.1		
174.00	1913.7	175.20	1874.0		
174.20	1913.6	175.40	1873.8		
174.40	1913.5	175.60	1873.7		
174.60	1913.4	175.80	1873.5		
174.80	1913.3	176.00	1873.4		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
175.00	1913.2	176.20	1873.2		
175.20	1913.1	176.40	1873.1		
175.40	1913.0	176.60	1872.9		
175.60	1912.9	176.80	1872.8		
175.80	1912.8	177.00	1872.7		
176.00	1912.7	177.20	1872.5		
176.20	1912.6	177.40	1872.4		
176.40	1912.5	177.60	1872.2		
176.60	1912.4	177.80	1872.1		
176.80	1912.3	178.00	1871.9		
177.00	1912.2	178.20	1871.8		
177.20	1912.1	178.40	1871.7		
177.40	1912.0	178.60	1871.5		
177.60	1911.9	178.80	1871.4		
177.80	1911.8	179.00	1871.2		
178.00	1911.7	179.20	1871.1		
178.20	1911.6	179.40	1870.9		
178.40	1911.5	179.60	1870.8		
178.60	1911.4	179.80	1870.6		
178.80	1911.3	180.00	1870.5		
179.00	1911.2	180.20	1870.4		
179.20	1911.1	180.40	1870.2		
179.40	1911.0	180.60	1870.1		
179.60	1910.9	180.80	1869.9		
179.80	1910.8	181.00	1869.8		
180.00	1910.7	181.20	1869.6		
180.20	1910.6	181.40	1869.5		
180.40	1910.5	181.60	1869.4		
180.60	1910.4	181.80	1869.2		
180.80	1910.3	182.00	1869.1		
181.00	1910.2	182.20	1868.9		
181.20	1910.1	182.40	1868.8		
181.40	1910.0	182.60	1868.6		
181.60	1909.9	182.80	1868.5		
181.80	1909.8	183.00	1868.3		
182.00	1909.7	183.20	1868.2		
182.20	1909.6	183.40	1868.1		
182.40	1909.5	183.60	1867.9		
182.60	1909.4	183.80	1867.8		
182.80	1909.3	184.00	1867.6		
183.00	1909.2	184.20	1867.5		
183.20	1909.1	184.40	1867.3		
183.40	1909.0	184.60	1867.2		
183.60	1908.9	184.80	1867.1		
183.80	1908.8	185.00	1866.9		
184.00	1908.7	185.20	1866.8		
184.20	1908.6	185.40	1866.6		
184.40	1908.5	185.60	1866.5		
184.60	1908.4	185.80	1866.3		
184.80	1908.3	186.00	1866.2		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
185.00	1908.2	186.20	1866.0		
185.20	1908.1	186.40	1865.9		
185.40	1908.0	186.60	1865.8		
185.60	1907.9	186.80	1865.6		
185.80	1907.8	187.00	1865.5		
186.00	1907.7	187.20	1865.3		
186.20	1907.6	187.40	1865.2		
186.40	1907.5	187.60	1865.0		
186.60	1907.4	187.80	1864.9		
186.80	1907.3	188.00	1864.7		
187.00	1907.2	188.20	1864.6		
187.20	1907.1	188.40	1864.5		
187.40	1907.0	188.60	1864.3		
187.60	1906.9	188.80	1864.2		
187.80	1906.8	189.00	1864.0		
188.00	1906.7	189.20	1863.9		
188.20	1906.6	189.40	1863.7		
188.40	1906.5	189.60	1863.6		
188.60	1906.4	189.80	1863.5		
188.80	1906.3	190.00	1863.3		
189.00	1906.2	190.20	1863.2		
189.20	1906.1	190.40	1863.0		
189.40	1906.0	190.60	1862.9		
189.60	1905.9	190.80	1862.7		
189.80	1905.8	191.00	1862.6		
190.00	1905.7	191.20	1862.4		
190.20	1905.6	191.40	1862.3		
190.40	1905.5	191.60	1862.2		
190.60	1905.4	191.80	1862.0		
190.80	1905.3	192.00	1861.9		
191.00	1905.2	192.20	1861.7		
191.20	1905.1	192.40	1861.6		
191.40	1905.0	192.60	1861.4		
191.60	1904.9	192.80	1861.3		
191.80	1904.8	193.00	1861.2		
192.00	1904.7	193.20	1861.0		
192.20	1904.6	193.40	1860.9		
192.40	1904.5	193.60	1860.7		
192.60	1904.4	193.80	1860.6		
192.80	1904.3	194.00	1860.4		
193.00	1904.2	194.20	1860.3		
193.20	1904.1	194.40	1860.1		
193.40	1904.0	194.60	1860.0		
193.60	1903.9	194.80	1859.9		
193.80	1903.8	195.00	1859.7		
194.00	1903.7	195.20	1859.6		
194.20	1903.6	195.40	1859.4		
194.40	1903.5	195.60	1859.3		
194.60	1903.4	195.80	1859.1		
194.80	1903.3	196.00	1859.0		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
195.00	1903.2	196.20	1858.8		
195.20	1903.1	196.40	1858.7		
195.40	1903.0	196.60	1858.6		
195.60	1902.9	196.80	1858.4		
195.80	1902.8	197.00	1858.3		
196.00	1902.7	197.20	1858.1		
196.20	1902.6	197.40	1858.0		
196.40	1902.5	197.60	1857.8		
196.60	1902.4	197.80	1857.7		
196.80	1902.3	198.00	1857.6		
197.00	1902.2	198.20	1857.4		
197.20	1902.1	198.40	1857.3		
197.40	1902.0	198.60	1857.1		
197.60	1901.9	198.80	1857.0		
197.80	1901.8	199.00	1856.8		
198.00	1901.7	199.20	1856.7		
198.20	1901.6	199.40	1856.5		
198.40	1901.5	199.60	1856.4		
198.60	1901.4	199.80	1856.3		
198.80	1901.3	200.00	1856.1		
199.00	1901.2	200.20	1856.0		
199.20	1901.1	200.40	1855.8		
199.40	1901.0	200.60	1855.7		
199.60	1900.9	200.80	1855.5		
199.80	1900.8	201.00	1855.4		
200.00	1899.3	201.20	1855.3		
200.20	1899.2	201.40	1855.1		
200.40	1899.1	201.60	1855.0		
200.60	1899.0	201.80	1854.8		
200.80	1898.9	202.00	1854.7		
201.00	1898.8	202.20	1854.5		
201.20	1898.7	202.40	1854.4		
201.40	1898.6	202.60	1854.2		
201.60	1898.5	202.80	1854.1		
201.80	1898.4	203.00	1854.0		
202.00	1898.3	203.20	1853.8		
202.20	1898.2	203.40	1853.7		
202.40	1898.1	203.60	1853.5		
202.60	1898.0	203.80	1853.4		
202.80	1897.9	204.00	1853.2		
203.00	1897.8	204.20	1853.1		
203.20	1897.7	204.40	1852.9		
203.40	1897.6	204.60	1852.8		
203.60	1897.5	204.80	1852.7		
203.80	1897.4	205.00	1852.5		
204.00	1897.3	205.20	1852.4		
204.20	1897.2	205.40	1852.2		
204.40	1897.1	205.60	1852.1		
204.60	1897.0	205.80	1851.9		
204.80	1896.9	206.00	1851.8		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
205.00	1896.8	206.20	1851.7		
205.20	1896.7	206.40	1851.5		
205.40	1896.6	206.60	1851.4		
205.60	1896.5	206.80	1851.2		
205.80	1896.4	207.00	1851.1		
206.00	1896.3	207.20	1850.9		
206.20	1896.2	207.40	1850.8		
206.40	1896.1	207.60	1850.6		
206.60	1896.0	207.80	1850.5		
206.80	1895.9	208.00	1850.4		
207.00	1895.8	208.20	1850.2		
207.20	1895.7	208.40	1850.1		
207.40	1895.6	208.60	1849.9		
207.60	1895.5	208.80	1849.8		
207.80	1895.4	209.00	1849.6		
208.00	1895.3	209.20	1849.5		
208.20	1895.2	209.40	1849.4		
208.40	1895.1	209.60	1849.2		
208.60	1895.0	209.80	1849.1		
208.80	1894.9	210.00	1848.9		
209.00	1894.8	210.20	1848.8		
209.20	1894.7	210.40	1848.6		
209.40	1894.6	210.60	1848.5		
209.60	1894.5	210.80	1848.3		
209.80	1894.4	211.00	1848.2		
210.00	1894.3	211.20	1848.1		
210.20	1894.2	211.40	1847.9		
210.40	1894.1	211.60	1847.8		
210.60	1894.0	211.80	1847.6		
210.80	1893.9	212.00	1847.5		
211.00	1893.8	212.20	1847.3		
211.20	1893.7	212.40	1847.2		
211.40	1893.6	212.60	1847.1		
211.60	1893.5	212.80	1846.9		
211.80	1893.4	213.00	1846.8		
212.00	1893.3	213.20	1846.6		
212.20	1893.2	213.40	1846.5		
212.40	1893.1	213.60	1846.3		
212.60	1893.0	213.80	1846.2		
212.80	1892.9	214.00	1846.0		
213.00	1892.8	214.20	1845.9		
213.20	1892.7	214.40	1845.8		
213.40	1892.6	214.60	1845.6		
213.60	1892.5	214.80	1845.5		
213.80	1892.4	215.00	1845.3		
214.00	1892.3	215.20	1845.2		
214.20	1892.2	215.40	1845.0		
214.40	1892.1	215.60	1844.9		
214.60	1892.0	215.80	1844.7		
214.80	1891.9	216.00	1844.6		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
215.00	1891.8	216.20	1844.5		
215.20	1891.7	216.40	1844.3		
215.40	1891.6	216.60	1844.2		
215.60	1891.5	216.80	1844.0		
215.80	1891.4	217.00	1843.9		
216.00	1891.3	217.20	1843.7		
216.20	1891.2	217.40	1843.6		
216.40	1891.1	217.60	1843.5		
216.60	1891.0	217.80	1843.3		
216.80	1890.9	218.00	1843.2		
217.00	1890.8	218.20	1843.0		
217.20	1890.7	218.40	1842.9		
217.40	1890.6	218.60	1842.7		
217.60	1890.5	218.80	1842.6		
217.80	1890.4	219.00	1842.4		
218.00	1890.3	219.20	1842.3		
218.20	1890.2	219.40	1842.2		
218.40	1890.1	219.60	1842.0		
218.60	1890.0	219.80	1841.9		
218.80	1889.9	220.00	1841.7		
219.00	1889.8	220.20	1841.6		
219.20	1889.7	220.40	1841.4		
219.40	1889.6	220.60	1841.3		
219.60	1889.5	220.80	1841.2		
219.80	1889.4	221.00	1841.0		
220.00	1889.3	221.20	1840.9		
220.20	1889.2	221.40	1840.7		
220.40	1889.1	221.60	1840.6		
220.60	1889.0	221.80	1840.4		
220.80	1888.9	222.00	1840.3		
221.00	1888.8	222.20	1840.1		
221.20	1888.7	222.40	1840.0		
221.40	1888.6	222.60	1839.9		
221.60	1888.5	222.80	1839.7		
221.80	1888.4	223.00	1839.6		
222.00	1888.3	223.20	1839.4		
222.20	1888.2	223.40	1839.3		
222.40	1888.1	223.60	1839.1		
222.60	1888.0	223.80	1839.0		
222.80	1887.9	224.00	1838.8		
223.00	1887.8	224.20	1838.7		
223.20	1887.7	224.40	1838.6		
223.40	1887.6	224.60	1838.4		
223.60	1887.5	224.80	1838.3		
223.80	1887.4	225.00	1838.1		
224.00	1887.3	225.20	1838.0		
224.20	1887.2	225.40	1837.8		
224.40	1887.1	225.60	1837.7		
224.60	1887.0	225.80	1837.6		
224.80	1886.9	226.00	1837.4		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
225.00	1886.8	226.20	1837.3		
225.20	1886.7	226.40	1837.1		
225.40	1886.6	226.60	1837.0		
225.60	1886.5	226.80	1836.8		
225.80	1886.4	227.00	1836.7		
226.00	1886.3	227.20	1836.5		
226.20	1886.2	227.40	1836.4		
226.40	1886.1	227.60	1836.3		
226.60	1886.0	227.80	1836.1		
226.80	1885.9	228.00	1836.0		
227.00	1885.8	228.20	1835.8		
227.20	1885.7	228.40	1835.7		
227.40	1885.6	228.60	1835.5		
227.60	1885.5	228.80	1835.4		
227.80	1885.4	229.00	1835.3		
228.00	1885.3	229.20	1835.1		
228.20	1885.2	229.40	1835.0		
228.40	1885.1	229.60	1834.8		
228.60	1885.0	229.80	1834.7		
228.80	1884.9	230.00	1834.5		
229.00	1884.8	230.20	1834.4		
229.20	1884.7	230.40	1834.2		
229.40	1884.6	230.60	1834.1		
229.60	1884.5	230.80	1834.0		
229.80	1884.4	231.00	1833.8		
230.00	1884.3	231.20	1833.7		
230.20	1884.2	231.40	1833.5		
230.40	1884.1	231.60	1833.4		
230.60	1884.0	231.80	1833.2		
230.80	1883.9	232.00	1833.1		
231.00	1883.8	232.20	1832.9		
231.20	1883.7	232.40	1832.8		
231.40	1883.6	232.60	1832.7		
231.60	1883.5	232.80	1832.5		
231.80	1883.4	233.00	1832.4		
232.00	1883.3	233.20	1832.2		
232.20	1883.2	233.40	1832.1		
232.40	1883.1	233.60	1831.9		
232.60	1883.0	233.80	1831.8		
232.80	1882.9	234.00	1831.7		
233.00	1882.8	234.20	1831.5		
233.20	1882.7	234.40	1831.4		
233.40	1882.6	234.60	1831.2		
233.60	1882.5	234.80	1831.1		
233.80	1882.4	235.00	1830.9		
234.00	1882.3	235.20	1830.8		
234.20	1882.2	235.40	1830.6		
234.40	1882.1	235.60	1830.5		
234.60	1882.0	235.80	1830.4		
234.80	1881.9	236.00	1830.2		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
235.00	1881.8	236.20	1830.1		
235.20	1881.7	236.40	1829.9		
235.40	1881.6	236.60	1829.8		
235.60	1881.5	236.80	1829.6		
235.80	1881.4	237.00	1829.5		
236.00	1881.3	237.20	1829.4		
236.20	1881.2	237.40	1829.2		
236.40	1881.1	237.60	1829.1		
236.60	1881.0	237.80	1828.9		
236.80	1880.9	238.00	1828.8		
237.00	1880.8	238.20	1828.6		
237.20	1880.7	238.40	1828.5		
237.40	1880.6	238.60	1828.3		
237.60	1880.5	238.80	1828.2		
237.80	1880.4	239.00	1828.1		
238.00	1880.3	239.20	1827.9		
238.20	1880.2	239.40	1827.8		
238.40	1880.1	239.60	1827.6		
238.60	1880.0	239.80	1827.5		
238.80	1879.9	240.00	1827.3		
239.00	1879.8	240.20	1827.2		
239.20	1879.7	240.40	1827.1		
239.40	1879.6	240.60	1826.9		
239.60	1879.5	240.80	1826.8		
239.80	1879.4	241.00	1826.6		
240.00	1879.3	241.20	1826.5		
240.20	1879.2	241.40	1826.3		
240.40	1879.1	241.60	1826.2		
240.60	1879.0	241.80	1826.0		
240.80	1878.9	242.00	1825.9		
241.00	1878.8	242.20	1825.8		
241.20	1878.7	242.40	1825.6		
241.40	1878.6	242.60	1825.5		
241.60	1878.5	242.80	1825.3		
241.80	1878.4	243.00	1825.2		
242.00	1878.3	243.20	1825.0		
242.20	1878.2	243.40	1824.9		
242.40	1878.1	243.60	1824.7		
242.60	1878.0	243.80	1824.6		
242.80	1877.9	244.00	1824.5		
243.00	1877.8	244.20	1824.3		
243.20	1877.7	244.40	1824.2		
243.40	1877.6	244.60	1824.0		
243.60	1877.5	244.80	1823.9		
243.80	1877.4	245.00	1823.7		
244.00	1877.3	245.20	1823.6		
244.20	1877.2	245.40	1823.5		
244.40	1877.1	245.60	1823.3		
244.60	1877.0	245.80	1823.2		
244.80	1876.9	246.00	1823.0		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
245.00	1876.8	246.20	1822.9		
245.20	1876.7	246.40	1822.7		
245.40	1876.6	246.60	1822.6		
245.60	1876.5	246.80	1822.4		
245.80	1876.4	247.00	1822.3		
246.00	1876.3	247.20	1822.2		
246.20	1876.2	247.40	1822.0		
246.40	1876.1	247.60	1821.9		
246.60	1876.0	247.80	1821.7		
246.80	1875.9	248.00	1821.6		
247.00	1875.8	248.20	1821.4		
247.20	1875.7	248.40	1821.3		
247.40	1875.6	248.60	1821.2		
247.60	1875.5	248.80	1821.0		
247.80	1875.4	249.00	1820.9		
248.00	1875.3	249.20	1820.7		
248.20	1875.2	249.40	1820.6		
248.40	1875.1	249.60	1820.4		
248.60	1875.0	249.80	1820.3		
248.80	1874.9	250.00	1820.1		
249.00	1874.8	250.20	1820.0		
249.20	1874.7	250.40	1819.9		
249.40	1874.6	250.60	1819.7		
249.60	1874.5	250.80	1819.6		
249.80	1874.4	251.00	1819.4		
250.00	1874.3	251.20	1819.3		
250.20	1874.2	251.40	1819.1		
250.40	1874.1	251.60	1819.0		
250.60	1874.0	251.80	1818.8		
250.80	1873.9	252.00	1818.7		
251.00	1873.8	252.20	1818.6		
251.20	1873.7	252.40	1818.4		
251.40	1873.6	252.60	1818.3		
251.60	1873.5	252.80	1818.1		
251.80	1873.4	253.00	1818.0		
252.00	1873.3	253.20	1817.8		
252.20	1873.2	253.40	1817.7		
252.40	1873.1	253.60	1817.6		
252.60	1873.0	253.80	1817.4		
252.80	1872.9	254.00	1817.3		
253.00	1872.8	254.20	1817.1		
253.20	1872.7	254.40	1817.0		
253.40	1872.6	254.60	1816.8		
253.60	1872.5	254.80	1816.7		
253.80	1872.4	255.00	1816.5		
254.00	1872.3	255.20	1816.4		
254.20	1872.2	255.40	1816.3		
254.40	1872.1	255.60	1816.1		
254.60	1872.0	255.80	1816.0		
254.80	1871.9	256.00	1815.8		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
255.00	1871.8	256.20	1815.7		
255.20	1871.7	256.40	1815.5		
255.40	1871.6	256.60	1815.4		
255.60	1871.5	256.80	1815.3		
255.80	1871.4	257.00	1815.1		
256.00	1871.3	257.20	1815.0		
256.20	1871.2	257.40	1814.8		
256.40	1871.1	257.60	1814.7		
256.60	1871.0	257.80	1814.5		
256.80	1870.9	258.00	1814.4		
257.00	1870.8	258.20	1814.2		
257.20	1870.7	258.40	1814.1		
257.40	1870.6	258.60	1814.0		
257.60	1870.5	258.80	1813.8		
257.80	1870.4	259.00	1813.7		
258.00	1870.3	259.20	1813.5		
258.20	1870.2	259.40	1813.4		
258.40	1870.1	259.60	1813.2		
258.60	1870.0	259.80	1813.1		
258.80	1869.9	260.00	1812.9		
259.00	1869.8	260.20	1812.8		
259.20	1869.7	260.40	1812.7		
259.40	1869.6	260.60	1812.5		
259.60	1869.5	260.80	1812.4		
259.80	1869.4	261.00	1812.2		
260.00	1869.3	261.20	1812.1		
260.20	1869.2	261.40	1811.9		
260.40	1869.1	261.60	1811.8		
260.60	1869.0	261.80	1811.7		
260.80	1868.9	262.00	1811.5		
261.00	1868.8	262.20	1811.4		
261.20	1868.7	262.40	1811.2		
261.40	1868.6	262.60	1811.1		
261.60	1868.5	262.80	1810.9		
261.80	1868.4	263.00	1810.8		
262.00	1868.3	263.20	1810.6		
262.20	1868.2	263.40	1810.5		
262.40	1868.1	263.60	1810.4		
262.60	1868.0	263.80	1810.2		
262.80	1867.9	264.00	1810.1		
263.50	1868.3	264.20	1809.9		
263.70	1868.2	264.40	1809.8		
263.90	1868.1	264.60	1809.6		
264.10	1868.0	264.80	1809.5		
264.30	1867.9	265.00	1809.4		
264.50	1867.8	265.20	1809.2		
264.70	1867.7	265.40	1809.1		
264.90	1867.6	265.60	1808.9		
265.10	1867.5	265.80	1808.8		
265.30	1867.4	266.00	1808.6		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
265.50	1867.3	266.20	1808.5		
265.70	1867.2	266.40	1808.3		
265.90	1867.1	266.60	1808.2		
266.10	1867.0	266.80	1808.1		
266.30	1866.9	267.00	1807.9		
266.50	1866.8	267.20	1807.8		
266.70	1866.7	267.40	1807.6		
266.90	1866.6	267.60	1807.5		
267.10	1866.5	267.80	1807.3		
267.30	1866.4	268.00	1807.2		
267.50	1866.3	268.20	1807.1		
267.70	1866.2	268.40	1806.9		
267.90	1866.1	268.60	1806.8		
268.10	1866.0	268.80	1806.6		
268.30	1865.9	269.00	1806.5		
268.50	1865.8	269.20	1806.3		
268.70	1865.7	269.40	1806.2		
268.90	1865.6	269.60	1806.0		
269.10	1865.5	269.80	1805.9		
269.30	1865.4	270.00	1805.8		
269.50	1865.3	270.20	1805.6		
269.70	1865.2	270.40	1805.5		
269.90	1865.1	270.60	1805.3		
270.10	1865.0	270.80	1805.2		
270.30	1864.9	271.00	1805.0		
270.50	1864.8	271.20	1804.9		
270.70	1864.7	271.40	1804.7		
270.90	1864.6	271.60	1804.6		
271.10	1864.5	271.80	1804.5		
271.30	1864.4	272.00	1804.7		
271.50	1864.3	272.20	1804.9		
271.70	1864.2	272.40	1805.1		
271.90	1864.1	272.60	1805.3		
272.10	1864.0	272.80	1805.5		
272.30	1863.9	273.00	1805.7		
272.50	1863.8	273.20	1805.9		
272.70	1863.7	273.40	1806.1		
272.90	1863.6	273.60	1806.3		
273.10	1863.5	273.80	1806.5		
273.30	1863.4	274.00	1806.7		
273.50	1863.3	274.20	1806.9		
273.70	1863.2	274.40	1807.1		
273.90	1863.1	274.60	1807.3		
274.10	1863.0	274.80	1807.5		
274.30	1862.9	275.00	1807.7		
274.50	1862.8	275.20	1807.9		
274.70	1862.7	275.40	1808.1		
274.90	1862.6	275.60	1808.3		
275.10	1862.5	275.80	1808.5		
275.30	1862.4	276.00	1808.7		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
275.50	1862.3	276.20	1808.9		
275.70	1862.2	276.40	1809.1		
275.90	1862.1	276.60	1809.3		
276.10	1862.0	276.80	1809.5		
276.30	1861.9	277.00	1809.7		
276.50	1861.8	277.20	1809.9		
276.70	1861.7	277.40	1810.1		
276.90	1861.6	277.60	1810.3		
277.10	1861.5	277.80	1810.5		
277.30	1861.4	278.00	1810.7		
277.50	1861.3	278.20	1810.9		
277.70	1861.2	278.40	1811.1		
277.90	1861.1	278.60	1811.3		
278.10	1861.0	278.80	1811.5		
278.30	1860.9	279.00	1811.7		
278.50	1860.8	279.20	1811.9		
278.70	1860.7	279.40	1812.1		
278.90	1860.6	279.60	1812.3		
279.10	1860.5	279.80	1812.5		
279.30	1860.4	280.00	1812.7		
279.50	1860.3	280.20	1812.9		
279.70	1860.2	280.40	1813.1		
279.90	1860.1	280.60	1813.3		
280.10	1860.0	280.80	1813.5		
280.30	1859.9	281.00	1813.7		
280.50	1859.8	281.20	1813.9		
280.70	1859.7	281.40	1814.1		
280.90	1859.6	281.60	1814.3		
281.10	1859.5	281.80	1814.5		
281.30	1859.4	282.00	1814.7		
281.50	1859.3	282.20	1814.9		
281.70	1859.2	282.40	1815.1		
281.90	1859.1	282.60	1815.3		
282.10	1859.0	282.80	1815.5		
282.30	1858.9	283.00	1815.7		
282.50	1858.8	283.20	1815.9		
282.70	1858.7	283.40	1816.1		
282.90	1858.6	283.60	1816.3		
283.10	1858.5	283.80	1816.5		
283.30	1858.4	284.00	1816.7		
283.50	1858.3	284.20	1816.9		
283.70	1858.2	284.40	1817.1		
283.90	1858.1	284.60	1817.3		
284.10	1858.0	284.80	1817.5		
284.30	1857.9	285.00	1817.7		
284.50	1857.8	285.20	1817.9		
284.70	1857.7	285.40	1818.1		
284.90	1857.6	285.60	1818.3		
285.10	1857.5	285.80	1818.5		
285.30	1857.4	286.00	1818.7		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
285.50	1857.3	286.20	1818.9		
285.70	1857.2	286.40	1819.1		
285.90	1857.1	286.60	1819.3		
286.10	1857.0	286.80	1819.5		
286.30	1856.9	287.00	1819.7		
286.50	1856.8	287.20	1819.9		
286.70	1856.7	287.40	1820.1		
286.90	1856.6	287.60	1820.3		
287.10	1856.5	287.80	1820.5		
287.30	1856.4	288.00	1820.7		
287.50	1856.3	288.20	1820.9		
287.70	1856.2	288.40	1821.1		
287.90	1856.1	288.60	1821.3		
288.10	1856.0	288.80	1821.5		
288.30	1855.9	289.00	1821.7		
288.50	1855.8	289.20	1821.9		
288.70	1855.7	289.40	1822.1		
288.90	1855.6	289.60	1822.3		
289.10	1855.5	289.80	1822.5		
289.30	1855.4	290.00	1822.7		
289.50	1855.3	290.20	1822.9		
289.70	1855.2	290.40	1823.1		
289.90	1855.1	290.60	1823.3		
290.10	1855.0	290.80	1823.5		
290.30	1854.9	291.00	1823.7		
290.50	1854.8	291.20	1823.9		
290.70	1854.7	291.40	1824.1		
290.90	1854.6	291.60	1824.3		
291.10	1854.5	291.80	1824.5		
291.30	1854.4	292.00	1824.7		
291.50	1854.3	292.20	1824.9		
291.70	1854.2	292.40	1825.1		
291.90	1854.1	292.60	1825.3		
292.10	1854.0	292.80	1825.5		
292.30	1853.9	293.00	1825.7		
292.50	1853.8	293.20	1825.9		
292.70	1853.7	293.40	1826.1		
292.90	1853.6	293.60	1826.3		
293.10	1853.5	293.80	1826.5		
293.30	1853.4	294.00	1826.7		
293.50	1853.3	294.20	1826.9		
293.70	1853.2	294.40	1827.1		
293.90	1853.1	294.60	1827.3		
294.10	1853.0	294.80	1827.5		
294.30	1852.9	295.00	1827.7		
294.50	1852.8	295.20	1827.9		
294.70	1852.7	295.40	1828.1		
294.90	1852.6	295.60	1828.3		
295.10	1852.5	295.80	1828.5		
295.30	1852.4	296.00	1828.7		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
295.50	1852.3	296.20	1828.9		
295.70	1852.2	296.40	1829.1		
295.90	1852.1	296.60	1829.3		
296.10	1852.0	296.80	1829.5		
296.30	1851.9	297.00	1829.7		
296.50	1851.8	297.20	1829.9		
296.70	1851.7	297.40	1830.1		
296.90	1851.6	297.60	1830.3		
297.10	1851.5	297.80	1830.5		
297.30	1851.4	298.00	1830.7		
297.50	1851.3	298.20	1830.9		
297.70	1851.2	298.40	1831.1		
297.90	1851.1	298.60	1831.3		
298.10	1851.0	298.80	1831.5		
298.30	1850.9	299.00	1831.7		
298.50	1850.8	299.20	1831.9		
298.70	1850.7	299.40	1832.1		
298.90	1850.6	299.60	1832.3		
299.10	1850.5	299.80	1832.5		
299.30	1850.4	300.00	1832.7		
299.50	1850.3	300.20	1832.9		
299.70	1850.2	300.40	1833.1		
299.90	1850.1	300.60	1833.3		
300.10	1850.0	300.80	1833.5		
300.30	1849.9	301.00	1833.7		
300.50	1849.8	301.20	1833.9		
300.70	1849.7	301.40	1834.1		
300.90	1849.6	301.60	1834.3		
301.10	1849.5	301.80	1834.5		
301.30	1849.4	302.00	1834.7		
301.50	1849.3	302.20	1834.9		
301.70	1849.2	302.40	1835.1		
301.90	1849.1	302.60	1835.3		
302.10	1849.0	302.80	1835.5		
302.30	1848.9	303.00	1835.7		
302.50	1848.8	303.20	1835.9		
302.70	1848.7	303.40	1836.1		
302.90	1848.6	303.60	1836.3		
303.10	1848.5	303.80	1836.5		
303.30	1848.4	304.00	1836.7		
303.50	1848.3	304.20	1836.9		
303.70	1848.2	304.40	1837.1		
303.90	1848.1	304.60	1837.3		
304.10	1848.0	304.80	1837.5		
304.30	1847.9	305.00	1837.7		
304.50	1847.8	305.20	1837.9		
304.70	1847.7	305.40	1838.1		
304.90	1847.6	305.60	1838.3		
305.10	1847.5	305.80	1838.5		
305.30	1847.4	306.00	1838.7		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
305.50	1847.3	306.20	1838.9		
305.70	1847.2	306.40	1839.1		
305.90	1847.1	306.60	1839.3		
306.10	1847.0	306.80	1839.5		
306.30	1846.9	307.00	1839.7		
306.50	1846.8	307.20	1839.9		
306.70	1846.7	307.40	1840.1		
306.90	1846.6	307.60	1840.3		
307.10	1846.5	307.80	1840.5		
307.30	1846.4	308.00	1840.7		
307.50	1846.3	308.20	1840.9		
307.70	1846.2	308.40	1841.1		
307.90	1846.1	308.60	1841.3		
308.10	1846.0	308.80	1841.5		
308.30	1845.9	309.00	1841.7		
308.50	1845.8	309.20	1841.9		
308.70	1845.7	309.40	1842.1		
308.90	1845.6	309.60	1842.3		
309.10	1845.5	309.80	1842.5		
309.30	1845.4	310.00	1842.7		
309.50	1845.3	310.20	1842.9		
309.70	1845.2	310.40	1843.1		
309.90	1845.1	310.60	1843.3		
310.10	1845.0	310.80	1843.5		
310.30	1844.9	311.00	1843.7		
310.50	1844.8	311.20	1843.9		
310.70	1844.7	311.40	1844.1		
310.90	1844.6	311.60	1844.3		
311.10	1844.5	311.80	1844.5		
311.30	1844.4	312.00	1844.7		
311.50	1844.3	312.20	1844.9		
311.70	1844.2	312.40	1845.1		
311.90	1844.1	312.60	1845.3		
312.10	1844.0	312.80	1845.5		
312.30	1843.9	313.00	1845.7		
312.50	1843.8	313.20	1845.9		
312.70	1843.7	313.40	1846.1		
312.90	1843.6	313.60	1846.3		
313.10	1843.5	313.80	1846.5		
313.30	1843.4	314.00	1846.7		
313.50	1843.3	314.20	1846.9		
313.70	1843.2	314.40	1847.1		
313.90	1843.1	314.60	1847.3		
314.10	1843.0	314.80	1847.5		
314.30	1842.9	315.00	1847.7		
314.50	1842.8	315.20	1847.9		
314.70	1842.7	315.40	1848.1		
314.90	1842.6	315.60	1848.3		
315.10	1842.5	315.80	1848.5		
315.30	1842.4	316.00	1848.7		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
315.50	1842.3	316.20	1848.9		
315.70	1842.2	316.40	1849.1		
315.90	1842.1	316.60	1849.3		
316.10	1842.0	316.80	1849.5		
316.30	1841.9	317.00	1849.7		
316.50	1841.8	317.20	1849.9		
316.70	1841.7	317.40	1850.1		
316.90	1841.6	317.60	1850.3		
317.10	1841.5	317.80	1850.5		
317.30	1841.4	318.00	1850.7		
317.50	1841.3	318.20	1850.9		
317.70	1841.2	318.40	1851.1		
317.90	1841.1	318.60	1851.3		
318.10	1841.0	318.80	1851.5		
318.30	1840.9	319.00	1851.7		
318.50	1840.8	319.20	1851.9		
318.70	1840.7	319.40	1852.1		
318.90	1840.6	319.60	1852.3		
319.10	1840.5	319.80	1852.5		
319.30	1840.4	320.00	1852.7		
319.50	1840.3	320.20	1852.9		
319.70	1840.2	320.40	1853.1		
319.90	1840.1	320.60	1853.3		
320.10	1840.0	320.80	1853.5		
320.30	1839.9	321.00	1853.7		
320.50	1839.8	321.20	1853.9		
320.70	1839.7	321.40	1854.1		
320.90	1839.6	321.60	1854.3		
321.10	1839.5	321.80	1854.5		
321.30	1839.4	322.00	1854.7		
321.50	1839.3	322.20	1854.9		
321.70	1839.2	322.40	1855.1		
321.90	1839.1	322.60	1855.3		
322.10	1839.0	322.80	1855.5		
322.30	1838.9	323.00	1855.7		
322.50	1838.8	323.20	1855.9		
322.70	1838.7	323.40	1856.1		
322.90	1838.6	323.60	1856.3		
323.10	1838.5	323.80	1856.5		
323.30	1838.4	324.00	1856.7		
323.50	1838.3	324.20	1856.9		
323.70	1838.2	324.40	1857.1		
323.90	1838.1	324.60	1857.3		
324.10	1838.0	324.80	1857.5		
324.30	1837.9	325.00	1857.7		
324.50	1837.8	325.20	1857.9		
324.70	1837.7	325.40	1858.1		
324.90	1837.6	325.60	1858.3		
325.10	1837.5	325.80	1858.5		
325.30	1837.4	326.00	1858.7		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
325.50	1837.3	326.20	1858.9		
325.70	1837.2	326.40	1859.1		
325.90	1837.1	326.60	1859.3		
326.10	1837.0	326.80	1859.5		
326.30	1836.9	327.00	1859.7		
326.50	1836.8	327.20	1859.9		
326.70	1836.7	327.40	1860.1		
326.90	1836.6	327.60	1860.3		
327.10	1836.5	327.80	1860.5		
327.30	1836.4	328.00	1860.7		
327.50	1836.3	328.20	1860.9		
327.70	1836.2	328.40	1861.1		
327.90	1836.1	328.60	1861.3		
328.10	1836.0	328.80	1861.5		
328.30	1835.9	329.00	1861.7		
328.50	1835.8	329.20	1861.9		
328.70	1835.7	329.40	1862.1		
328.90	1835.6	329.60	1862.3		
329.10	1835.5	329.80	1862.5		
329.30	1835.4	330.00	1862.7		
329.50	1835.3	330.20	1862.9		
329.70	1835.2	330.40	1863.1		
329.90	1835.1	330.60	1863.3		
330.10	1835.0	330.80	1863.5		
330.30	1834.9	331.00	1863.7		
330.50	1834.8	331.20	1863.9		
330.70	1834.7	331.40	1864.1		
330.90	1834.6	331.60	1864.3		
331.10	1834.5	331.80	1864.5		
331.30	1834.4	332.00	1864.7		
331.50	1834.3	332.20	1864.9		
331.70	1834.2	332.40	1865.1		
331.90	1834.1	332.60	1865.3		
332.10	1834.0	332.80	1865.5		
332.30	1833.9	333.00	1865.7		
332.50	1833.8	333.20	1865.9		
332.70	1833.7	333.40	1866.1		
332.90	1833.6	333.60	1866.3		
333.10	1833.5	333.80	1866.5		
333.30	1833.4	334.00	1866.7		
333.50	1833.3	334.20	1866.9		
333.70	1833.2	334.40	1867.1		
333.90	1833.1	334.60	1867.3		
334.10	1833.0	334.80	1867.5		
334.30	1832.9	335.00	1867.7		
334.50	1832.8	335.20	1867.9		
334.70	1832.7	335.40	1868.1		
334.90	1832.6	335.60	1868.3		
335.10	1832.5	335.80	1868.5		
335.30	1832.4	336.00	1868.7		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
335.50	1832.3	336.20	1868.9		
335.70	1832.2	336.40	1869.1		
335.90	1832.1	336.60	1869.3		
336.10	1832.0	336.80	1869.5		
336.30	1831.9	337.00	1869.7		
336.50	1831.8	337.20	1869.9		
336.70	1831.7	337.40	1870.1		
336.90	1831.6	337.60	1870.3		
337.10	1831.5	337.80	1870.5		
337.30	1831.4	338.00	1870.7		
337.50	1831.3	338.20	1870.9		
337.70	1831.2	338.40	1871.1		
337.90	1831.1	338.60	1871.3		
338.10	1831.0	338.80	1871.5		
338.30	1830.9	339.00	1871.7		
338.50	1830.8	339.20	1871.9		
338.70	1830.7	339.40	1872.1		
338.90	1830.6	339.60	1872.3		
339.10	1830.5	339.80	1872.5		
339.30	1830.4	340.00	1872.7		
339.50	1830.3	340.20	1872.9		
339.70	1830.2	340.40	1873.1		
339.90	1830.1	340.60	1873.3		
340.10	1830.0	340.80	1873.5		
340.30	1829.9	341.00	1873.7		
340.50	1829.8	341.20	1873.9		
340.70	1829.7	341.40	1874.1		
340.90	1829.6	341.60	1874.3		
341.10	1829.5	341.80	1874.5		
341.30	1829.4	342.00	1874.7		
341.50	1829.3	342.20	1874.9		
341.70	1829.2	342.40	1875.1		
341.90	1829.1	342.60	1875.3		
342.10	1829.0	342.80	1875.5		
342.30	1828.9	343.00	1875.7		
342.50	1828.8	343.20	1875.9		
342.70	1828.7	343.40	1876.1		
342.90	1828.6	343.60	1876.3		
343.10	1828.5	343.80	1876.5		
343.30	1828.4	344.00	1876.7		
343.50	1828.3	344.20	1876.9		
343.70	1828.2	344.40	1877.1		
343.90	1828.1	344.60	1877.3		
344.10	1828.0	344.80	1877.5		
344.30	1827.9	345.00	1877.7		
344.50	1827.8	345.20	1877.9		
344.70	1827.7	345.40	1878.1		
344.90	1827.6	345.60	1878.3		
345.10	1827.5	345.80	1878.5		
345.30	1827.4	346.00	1878.7		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
345.50	1827.3	346.20	1878.9		
345.70	1827.2	346.40	1879.1		
345.90	1827.1	346.60	1879.3		
346.10	1827.0	346.80	1879.5		
346.30	1826.9	347.00	1879.7		
346.50	1826.8	347.20	1879.9		
346.70	1826.7	347.40	1880.1		
346.90	1826.6	347.60	1880.3		
347.10	1826.5	347.80	1880.5		
347.30	1826.4	348.00	1880.7		
347.50	1826.3	348.20	1880.9		
347.70	1826.2	348.40	1881.1		
347.90	1826.1	348.60	1881.3		
348.10	1826.0	348.80	1881.5		
348.30	1825.9	349.00	1881.7		
348.50	1825.8	349.20	1881.9		
348.70	1825.7	349.40	1882.1		
348.90	1825.6	349.60	1882.3		
349.10	1825.5	349.80	1882.5		
349.30	1825.4	350.00	1882.7		
349.50	1825.3	350.20	1882.9		
349.70	1825.2	350.40	1883.1		
349.90	1825.1	350.60	1883.3		
350.10	1825.0	350.80	1883.5		
350.30	1824.9	351.00	1883.7		
350.50	1824.8	351.20	1883.9		
350.70	1824.7	351.40	1884.1		
350.90	1824.6	351.60	1884.3		
351.10	1824.5	351.80	1884.5		
351.30	1824.4	352.00	1884.7		
351.50	1824.3	352.20	1884.9		
351.70	1824.2	352.40	1885.1		
351.90	1824.1	352.60	1885.3		
352.10	1824.0	352.80	1885.5		
352.30	1823.9	353.00	1885.7		
352.50	1823.8	353.20	1885.9		
352.70	1823.7	353.40	1886.1		
352.90	1823.6	353.60	1886.3		
353.10	1823.5	353.80	1886.5		
353.30	1823.4	354.00	1886.7		
353.50	1823.3	354.20	1886.9		
353.70	1823.2	354.40	1887.1		
353.90	1823.1	354.60	1887.3		
354.10	1823.0	354.80	1887.5		
354.30	1822.9	355.00	1887.7		
354.50	1822.8	355.20	1887.9		
354.70	1822.7	355.40	1888.1		
354.90	1822.6	355.60	1888.3		
355.10	1822.5	355.80	1888.5		
355.30	1822.4	356.00	1888.7		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
355.50	1822.3	356.20	1888.9		
355.70	1822.2	356.40	1889.1		
355.90	1822.1	356.60	1889.3		
356.10	1822.0	356.80	1889.5		
356.30	1821.9	357.00	1889.7		
356.50	1821.8	357.20	1889.9		
356.70	1821.7	357.40	1890.1		
356.90	1821.6	357.60	1890.3		
357.10	1821.5	357.80	1890.5		
357.30	1821.4	358.00	1890.7		
357.50	1821.3	358.20	1890.9		
357.70	1821.2	358.40	1891.1		
357.90	1821.1	358.60	1891.3		
358.10	1821.0	358.80	1891.5		
358.30	1820.9	359.00	1891.7		
358.50	1820.8	359.20	1891.9		
358.70	1820.7	359.40	1892.1		
358.90	1820.6	359.60	1892.3		
359.10	1820.5	359.80	1892.5		
359.30	1820.4	360.00	1892.7		
359.50	1820.3	360.20	1892.9		
359.70	1820.2	360.40	1893.1		
359.90	1820.1	360.60	1893.3		
360.10	1820.0	360.80	1893.5		
360.30	1819.9	361.00	1893.7		
360.50	1819.8	361.20	1893.9		
360.70	1819.7	361.40	1894.1		
360.90	1819.6	361.60	1894.3		
361.10	1819.5	361.80	1894.5		
361.30	1819.4	362.00	1894.7		
361.50	1819.3	362.20	1894.9		
361.70	1819.2	362.40	1895.1		
361.90	1819.1	362.60	1895.3		
362.10	1819.0	362.80	1895.5		
362.30	1818.9	363.00	1895.7		
362.50	1818.8	363.20	1895.9		
362.70	1818.7	363.40	1896.1		
362.90	1818.6	363.60	1896.3		
363.10	1818.5	363.80	1896.5		
363.30	1818.4	364.00	1896.7		
363.50	1818.3	364.20	1896.9		
		364.40	1897.1		
		364.60	1897.3		
		364.80	1897.5		
		365.00	1897.7		
		365.20	1897.9		
		365.40	1898.1		
		365.60	1898.3		
		365.80	1898.5		
		366.00	1898.7		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
		366.20	1898.9		
		366.40	1899.1		
		366.60	1899.3		
		366.80	1899.5		
		367.00	1899.7		
		367.20	1899.9		
		367.40	1900.1		
		367.60	1900.3		
		367.80	1900.5		
		368.00	1900.7		
		368.20	1900.9		
		368.40	1901.1		
		368.60	1901.3		
		368.80	1901.5		
		369.00	1901.7		
		369.20	1901.9		
		369.40	1902.1		
		369.60	1902.3		
		369.80	1902.5		
		370.00	1902.7		
		370.20	1902.9		
		370.40	1903.1		
		370.60	1903.3		
		370.80	1903.5		
		371.00	1903.7		
		371.20	1903.9		
		371.40	1904.1		
		371.60	1904.3		
		371.80	1904.5		
		372.00	1904.7		
		372.20	1904.9		
		372.40	1905.1		
		372.60	1905.3		
		372.80	1905.5		
		373.00	1905.7		
		373.20	1905.9		
		373.40	1906.1		
		373.60	1906.3		
		373.80	1906.5		
		374.00	1906.7		
		374.20	1906.9		
		374.40	1907.1		
		374.60	1907.3		
		374.80	1907.5		
		375.00	1907.7		
		375.20	1907.9		
		375.40	1908.1		
		375.60	1908.3		
		375.80	1908.5		
		376.00	1908.7		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
		376.20	1908.9		
		376.40	1909.1		
		376.60	1909.3		
		376.80	1909.5		
		377.00	1909.7		
		377.20	1909.9		
		377.40	1910.1		
		377.60	1910.3		
		377.80	1910.5		
		378.00	1910.7		
		378.20	1910.9		
		378.40	1911.1		
		378.60	1911.3		
		378.80	1911.5		
		379.00	1911.7		
		379.20	1911.9		
		379.40	1912.1		
		379.60	1912.3		
		379.80	1912.5		
		380.00	1912.7		
		380.20	1912.9		
		380.40	1913.1		
		380.60	1913.3		
		380.80	1913.5		
		381.00	1913.7		
		381.20	1913.9		
		381.40	1914.1		
		381.60	1914.3		
		381.80	1914.5		
		382.00	1914.7		
		382.20	1914.9		
		382.40	1915.1		
		382.60	1915.3		
		382.80	1915.5		
		383.00	1915.7		
		383.20	1915.9		
		383.40	1916.1		
		383.60	1916.3		
		383.80	1916.5		
		384.00	1916.7		
		384.20	1916.9		
		384.40	1917.1		
		384.60	1917.3		
		384.80	1917.5		
		385.00	1917.7		
		385.20	1917.9		
		385.40	1918.1		
		385.60	1918.3		
		385.80	1918.5		
		386.00	1918.7		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
		386.20	1918.9		
		386.40	1919.1		
		386.60	1919.3		
		386.80	1919.5		
		387.00	1919.7		
		387.20	1919.9		
		387.40	1920.1		
		387.60	1920.3		
		387.80	1920.5		
		388.00	1920.7		
		388.20	1920.9		
		388.40	1921.1		
		388.60	1921.3		
		388.80	1921.5		
		389.00	1921.7		
		389.20	1921.9		
		389.40	1922.1		
		389.60	1922.3		
		389.80	1922.5		
		390.00	1922.7		
		390.20	1922.9		
		390.40	1923.1		
		390.60	1923.3		
		390.80	1923.5		
		391.00	1923.7		
		391.20	1923.9		
		391.40	1924.1		
		391.60	1924.3		
		391.80	1924.5		
		392.00	1924.7		
		392.20	1924.9		
		392.40	1925.1		
		392.60	1925.3		
		392.80	1925.5		
		393.00	1925.7		
		393.20	1925.9		
		393.40	1926.1		
		393.60	1926.3		
		393.80	1926.5		
		394.00	1926.7		
		394.20	1926.9		
		394.40	1927.1		
		394.60	1927.3		
		394.80	1927.5		
		395.00	1927.7		
		395.20	1927.9		
		395.40	1928.1		
		395.60	1928.3		
		395.80	1928.5		
		396.00	1928.7		

PAD 54		PAD 15		PAD 8	
depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)	depth (cm)	age (cal yr BP)
		396.20	1928.9		
		396.40	1929.1		
		396.60	1929.3		
		396.80	1929.5		
		397.00	1929.7		
		397.20	1929.9		
		397.40	1930.1		
		397.60	1930.3		
		397.80	1930.5		
		398.00	1930.7		
		398.20	1930.9		
		398.40	1931.1		
		398.60	1931.3		
		398.80	1931.5		
		399.00	1931.7		
		399.20	1931.9		
		399.40	1932.1		
		399.60	1932.3		
		399.80	1932.5		
		400.00	1932.7		
		400.20	1932.9		

Appendix E

Texture Data

PAD 54

depth (cm)	moisture (%)	organic matter (%)	clay (%)	sand (%)	silt (%)	mean grain size (μm)
0.0	70.99	10.19	41.67	8.86	49.47	4.84
0.5	73.22	9.79	41.71	8.62	49.67	4.45
1.0	67.60	9.44	42.30	8.18	49.52	3.73
1.5	51.74	6.88	38.88	9.04	52.08	5.13
2.0	45.96	6.86	41.51	9.52	48.97	5.90
2.5	40.93	5.73	35.30	9.80	54.90	6.34
3.0	51.43	7.84	41.11	8.98	49.91	5.03
3.5	60.65	8.48	41.68	8.29	50.03	3.91
4.0	50.26	7.17	41.62	9.00	49.38	5.06
4.5	38.56	6.01	43.49	9.92	46.59	6.51
5.0	37.47	5.45	35.64	9.72	54.64	6.20
5.5	57.24	8.02	31.45	8.96	59.59	5.01
6.0	46.09	6.35	40.74	9.11	50.15	5.25
6.5	45.08	7.07	40.35	9.37	50.28	5.66
7.0	58.57	8.52	40.67	8.97	50.36	5.03
7.5	52.00	7.39	40.51	9.31	50.18	5.57
8.0	50.01	6.99	40.61	9.48	49.91	5.83
8.5	48.54	6.61	40.83	9.08	50.09	5.20
9.0	53.91	6.83	41.02	9.02	49.96	5.10
9.5	58.96	7.72	49.64	8.31	42.05	3.94
10.0	47.18	6.95	54.50	7.24	38.26	2.15
10.5	42.19	6.76	43.10	9.48	47.42	5.83
11.0	44.29	6.58	41.17	8.63	50.20	4.47
11.5	47.57	6.50	41.08	9.35	49.57	5.63
12.0	39.59	5.44	41.91	9.33	48.76	5.60
12.5	52.28	7.62	40.82	8.91	50.27	4.92
13.0	59.78	8.30	39.47	9.38	51.15	5.68
13.5	57.56	8.00	42.25	8.64	49.11	4.49
14.0	53.12	6.87	41.03	8.69	50.28	4.57
14.5	51.07	5.24	42.25	8.89	48.86	4.90
15.0	49.85	5.44	42.77	8.66	48.57	4.52
15.5	56.07	8.65	40.83	9.02	50.15	5.10
16.0	43.81	7.25	40.77	9.24	49.99	5.44
16.5	34.99	6.25	41.01	9.36	49.63	5.65
17.0	34.53	6.45	41.41	9.22	49.37	5.42
17.5	48.04	7.24	38.52	9.04	52.44	5.12
18.0	53.19	8.20	41.38	9.01	49.61	5.09
18.5	46.05	7.31	40.66	9.17	50.17	5.35
19.0	47.47	7.78	38.54	8.90	52.56	4.90
19.5	41.51	7.04	34.94	9.36	55.70	5.64
20.0	44.92	6.69	31.95	9.05	59.00	5.14
20.5	53.66	7.69	38.57	8.70	52.73	4.58
21.0	51.59	7.90	42.01	8.11	49.88	3.61
21.5	42.64	6.69	37.69	9.15	53.16	5.31

depth (cm)	moisture (%)	organic matter (%)	clay (%)	sand (%)	silt (%)	mean grain size (μm)
22.0	35.90	5.82	44.02	8.80	47.18	4.74
22.5	44.08	7.09	43.60	9.09	47.31	5.21
23.0	34.53	5.89	33.45	9.75	56.80	6.26
23.5	47.04	6.98	42.59	8.99	48.42	5.05
24.0	34.26	5.50	39.90	7.98	52.12	3.39
24.5	37.26	5.71	38.37	9.75	51.88	6.26
25.0	53.41	7.66	41.32	9.05	49.63	5.14
25.5	55.34	7.69	38.94	8.44	52.62	4.15
26.0	46.82	7.40	42.25	8.67	49.08	4.54
26.5	47.46	7.09	43.06	8.75	48.19	4.67
27.0	45.05	7.02	40.99	8.72	50.29	4.61
27.5	47.11	6.67	41.01	8.89	50.10	4.89
28.0	49.98	6.84	41.16	8.74	50.10	4.64
28.5	44.93	5.82	40.71	9.07	50.22	5.18
29.0	49.85	6.49	40.60	8.28	51.12	3.90
29.5	47.32	5.76	43.08	8.59	48.33	4.40
30.0	41.23	4.98	41.03	9.23	49.74	5.44
31.0	49.68	6.03	0.00	0.00	0.00	0.00
32.0	48.09	6.22	0.00	0.00	0.00	0.00
33.0	48.00	7.30	41.48	9.02	49.50	5.10
34.0	35.18	5.80	44.25	9.63	46.12	6.06
35.0	51.01	7.09	43.50	9.15	47.35	5.31
36.0	42.66	6.34	44.12	8.64	47.24	4.48
37.0	34.64	5.76	42.84	8.82	48.34	4.77
38.0	41.91	6.58	42.61	9.78	47.61	6.30
39.0	48.05	7.83	40.98	8.69	50.33	4.56
40.0	45.12	7.61	41.54	8.61	49.85	4.44
41.0	40.15	6.73	40.90	5.30	53.80	4.62
42.0	56.43	9.09	41.33	4.86	53.81	4.88
43.0	43.44	7.59	42.04	3.91	54.05	2.01
44.0	44.29	7.33	42.90	8.67	48.43	4.53
45.0	38.04	6.62	42.73	8.82	48.45	4.78
46.0	31.57	6.20	46.72	8.98	44.30	5.03
47.0	33.13	6.04	42.84	8.64	48.52	4.48
48.0	41.71	6.46	44.28	8.68	47.04	4.55
49.0	42.36	7.30	42.68	8.70	48.62	4.58
50.0	35.69	5.95	42.28	9.70	48.02	4.62
51.0	26.07	4.98	43.34	10.57	46.09	5.35
52.0	45.45	8.12	42.97	9.75	47.28	6.26
53.0	41.12	7.34	44.77	8.64	46.59	4.49
54.0	34.14	72.33	39.08	9.03	51.89	5.11
55.0	43.56	8.09	42.41	8.69	48.90	4.57
56.0	35.89	6.67	42.26	9.16	48.58	5.33
57.0	28.35	5.40	37.68	9.16	53.16	5.33
58.0	49.90	8.80	41.22	8.59	50.19	4.41
59.0	42.19	8.06	43.19	8.58	48.23	4.39
60.0	31.52	5.77	42.83	8.96	48.21	5.00
61.0	44.50	8.45	41.73	9.32	48.95	5.57
62.0	50.10	8.86	41.80	8.22	49.98	3.80
63.0	31.37	5.81	43.92	9.38	46.70	5.67
64.0	26.77	4.73	42.06	10.05	47.89	6.72

depth (cm)	moisture (%)	organic matter (%)	clay (%)	sand (%)	silt (%)	mean grain size (μm)
65.0	25.79	5.37	44.11	12.05	43.84	6.60
66.0	27.30	6.06	41.70	9.03	49.27	5.12
67.0	45.40	8.40	43.12	8.40	48.48	4.09
68.0	52.33	9.15	38.45	8.72	52.83	4.62
69.0	33.47	6.39	41.64	8.83	49.53	4.79
70.0	46.38	8.64	43.20	11.92	44.88	5.67
71.0	34.87	6.36	44.13	8.74	47.13	4.65
72.0	46.59	8.15	42.86	8.40	48.74	4.10
73.0	39.76	7.08	42.80	8.51	48.69	4.27
74.0	44.35	7.90	42.94	8.64	48.42	4.49
75.0	30.44	6.00	44.22	8.77	47.01	4.69
76.0	37.94	6.01	43.52	9.38	47.10	5.67
77.0	31.14	5.58	42.64	10.89	46.47	6.11
78.0	40.61	6.56	42.27	8.57	49.16	4.37
79.0	43.02	6.68	43.59	8.49	47.92	4.24
80.0	28.65	5.17	41.64	9.38	48.98	5.67
81.0	42.52	6.68	43.20	8.74	48.06	4.65
82.0	45.41	7.43	44.13	8.46	47.41	4.19
83.0	30.48	8.76	43.66	8.48	47.86	4.23
84.0	36.70	6.60	42.80	8.64	48.56	4.49
85.0	46.92	8.26	38.94	8.33	52.73	3.98
86.0	48.53	8.44	34.22	8.35	57.43	4.01
87.0	34.91	6.81	43.52	8.42	48.06	4.12
88.0	36.28	7.05	35.54	10.91	53.55	5.37
89.0	34.74	5.56	32.27	10.13	57.60	5.23

PAD 15

depth (cm)	moisture (%)	organic matter (%)	clay (%)	sand (%)	silt (%)	mean grain size (μm)
0.0	93.19	16.76	43.66	4.71	51.63	4.75
0.5	87.51	14.31	39.89	5.30	54.81	5.99
1.0	77.12	10.76	42.39	4.73	52.88	5.09
1.5	62.05	6.02	41.47	4.67	53.87	5.50
2.0	51.99	6.61	41.17	4.82	54.01	5.67
2.5	49.77	4.96	41.46	4.62	53.92	5.77
3.0	49.95	6.88	41.58	4.72	53.71	5.53
3.5	43.28	6.70	39.42	4.87	55.71	6.13
4.0	41.66	5.03	41.39	4.65	53.96	7.56
4.5	55.90	7.66	39.82	3.45	56.73	4.76
5.0	52.38	8.55	40.00	5.08	54.93	5.98
5.5	42.23	6.33	42.17	4.50	53.33	5.40
6.0	40.30	7.27	42.31	4.57	53.12	6.19
6.5	39.50	6.81	41.80	4.64	53.56	6.16
7.0	39.76	6.25	40.19	4.75	55.06	5.96
7.5	36.96	5.93	41.35	4.70	53.95	6.28
8.0	60.00	10.20	38.92	4.01	57.08	4.89
8.5	58.56	10.28	39.93	5.08	54.99	5.98
9.0	57.62	7.03	38.71	5.17	56.12	6.65
9.5	47.62	6.44	39.41	5.01	55.58	6.61

depth (cm)	moisture (%)	organic matter (%)	clay (%)	sand (%)	silt (%)	mean grain size (μm)
10.0	49.38	7.66	36.36	5.64	58.00	7.37
10.5	50.09	7.41	35.79	5.68	58.53	7.76
11.0	47.70	5.61	39.13	5.01	55.86	6.24
11.5	49.15	5.92	42.00	4.81	53.19	5.39
12.0	49.67	5.71	41.28	4.75	53.97	5.72
12.5	47.29	6.53	34.06	5.60	60.34	5.92
13.0	43.14	6.50	40.48	5.02	54.50	6.10
13.5	47.67	6.28	40.74	4.82	54.44	5.84
14.0	54.56	7.58	39.61	5.15	55.24	6.04
14.5	49.82	7.83	38.36	5.30	56.34	6.48
15.0	52.57	8.10	40.78	5.01	54.21	5.81
15.5	43.24	7.63	41.74	4.67	53.59	5.60
16.0	51.12	8.04	43.11	4.62	52.27	4.97
16.5	43.37	6.95	42.88	4.51	52.61	5.09
17.0	42.63	6.45	41.96	4.52	53.52	5.29
17.5	43.01	7.04	40.21	4.86	54.93	6.03
18.0	45.23	7.28	35.85	5.63	58.52	7.75
18.5	44.87	7.45	38.05	5.30	56.65	6.81
19.0	40.87	6.62	42.32	4.64	53.04	5.49
19.5	39.71	6.31	42.11	4.62	53.27	5.63
20.0	28.34	5.75	41.73	4.61	53.66	5.70
20.5	40.47	6.66	41.28	4.72	54.00	5.66
21.0	39.64	5.88	40.95	4.70	54.35	6.04
21.5	43.12	6.30	41.16	4.65	54.19	5.62
22.0	47.44	7.45	40.19	5.03	54.78	6.04
22.5	46.91	7.79	38.68	5.26	56.06	6.59
23.0	43.68	7.21	40.45	4.85	54.70	5.86
23.5	47.11	7.32	42.24	4.56	53.20	5.23
24.0	48.35	7.17	42.56	4.66	52.78	5.32
24.5	35.31	5.87	40.86	4.75	54.39	5.89
25.0	33.38	5.73	41.42	4.19	54.39	3.36
25.5	31.81	4.83	42.66	4.44	52.90	5.42
26.0	25.90	4.47	44.98	4.96	50.06	6.06
26.5	29.55	4.77	41.66	4.57	53.77	5.63
27.0	47.11	7.23	42.91	4.35	52.74	3.29
27.5	39.25	6.11	41.31	4.68	54.01	5.71
28.0	32.22	4.91	40.70	4.69	54.61	5.99
28.5	31.11	4.55	41.56	4.56	53.88	5.48
29.0	42.39	5.87	42.53	4.56	52.91	5.26
29.5	46.75	6.96	42.85	4.52	52.63	4.76
30.0	32.05	4.86	41.13	4.66	54.21	5.67
30.5	27.09	4.06	39.62	4.77	55.61	6.07
31.0	25.24	3.75	39.20	5.26	55.54	8.24
31.5	25.20	3.40	39.84	4.97	55.19	7.60
32.0	30.13	3.85	40.56	4.68	54.76	6.29
32.5	33.63	4.33	40.73	4.71	54.56	6.00
33.0	27.98	3.39	39.98	4.97	55.05	5.96
33.5	26.90	3.57	39.44	4.81	55.75	6.60
34.0	40.91	5.67	39.82	4.77	55.41	5.29
34.5	35.51	4.33	35.99	5.01	59.00	5.90
35.0	37.71	4.95	38.67	5.00	56.33	6.51

depth (cm)	moisture (%)	organic matter (%)	clay (%)	sand (%)	silt (%)	mean grain size (μm)
35.5	30.49	5.04	42.19	4.54	53.27	5.53
36.0	38.70	5.33	42.02	4.51	53.47	5.50
36.5	40.93	6.29	43.08	4.48	52.44	5.27
37.0	31.78	5.36	40.30	4.83	54.87	6.37
37.5	26.95	4.16	38.83	4.89	56.28	6.79
38.0	25.95	4.16	41.36	4.65	53.99	6.03
38.5	26.70	4.28	43.04	4.31	52.65	5.05
39.0	33.55	4.97	42.69	4.47	52.84	5.29
39.5	47.16	6.78	41.87	4.46	53.67	4.48
40.0	45.96	6.87	41.25	4.67	54.08	4.66
40.5	39.23	6.02	41.55	4.71	53.74	5.47
41.0	27.14	4.60	40.50	4.84	54.66	6.60
41.5	33.23	4.88	40.48	4.75	54.77	6.32
42.0	44.88	6.82	47.87	4.10	48.03	5.37
42.5	46.27	6.73	42.92	4.64	52.44	5.14
43.0	46.06	6.69	42.46	4.66	52.88	5.52
43.5	46.71	6.77	41.98	4.72	53.30	5.47
44.0	33.98	5.21	41.09	4.68	54.23	5.93
44.5	34.77	6.03	42.57	4.57	52.86	5.63
45.0	32.63	5.04	42.44	4.48	53.08	5.47
45.5	27.09	4.27	41.46	4.76	53.78	6.71
46.0	26.79	4.17	40.55	4.91	54.54	6.91
46.5	27.47	3.99	40.50	4.96	54.54	6.79
47.0	28.33	4.22	41.85	4.72	53.43	6.57
47.5	32.77	4.89	42.41	4.39	53.20	5.09
48.0	44.55	6.70	42.50	4.50	53.00	4.37
48.5	47.55	7.29	44.57	4.30	51.13	4.14
49.0	46.63	7.19	45.97	4.20	49.83	4.14
49.5	36.65	5.75	38.35	4.75	56.90	4.80
50.0	34.79	5.85	48.12	3.93	47.95	4.00
50.5	32.19	5.09	42.64	4.45	52.91	5.44
51.0	31.82	6.38	42.62	4.57	52.81	5.49
51.5	45.28	6.88	42.52	4.56	52.92	5.09
52.0	37.70	5.74	41.75	4.56	53.69	5.07
52.5	35.52	6.54	38.92	4.78	56.30	5.21
53.0	45.95	6.92	38.77	5.02	56.21	5.70
53.5	43.89	6.63	40.35	4.95	54.70	6.01
54.0	44.64	6.33	40.26	4.95	54.79	6.08
54.5	50.00	6.51	41.16	4.89	53.95	5.62
55.0	39.46	5.83	41.41	4.71	53.88	5.59
55.5	37.97	5.82	41.21	4.46	54.33	3.72
56.0	29.52	4.41	39.35	4.87	55.78	6.59
56.5	38.02	5.66	42.43	4.56	53.01	5.26
57.0	36.35	4.73	44.46	4.32	51.22	5.00
57.5	32.65	4.35	43.07	4.51	52.42	5.34
58.0	44.99	5.51	41.68	4.64	53.68	5.52
58.5	41.41	4.98	40.07	4.71	55.22	5.09
59.0	46.90	5.52	40.54	5.41	54.05	5.23
59.5	46.62	5.50	42.27	4.67	53.06	5.47
60.0	36.12	4.41	30.71	5.85	63.44	6.82
60.5	41.77	5.13	42.16	4.64	53.20	5.24

depth (cm)	moisture (%)	organic matter (%)	clay (%)	sand (%)	silt (%)	mean grain size (μm)
61.0	46.20	6.11	43.36	4.51	52.13	5.10
61.5	35.70	5.28	43.52	4.40	52.08	5.12
62.0	30.56	4.35	40.70	4.52	54.78	5.18
62.5	31.91	5.03	40.74	4.63	54.63	4.87
63.0	44.04	6.42	40.16	4.79	55.05	5.91
63.5	43.32	6.67	38.88	5.11	56.01	6.61
64.0	45.89	6.41	39.05	5.12	55.83	6.41
64.5	46.46	6.43	40.73	4.92	54.35	5.81
65.0	37.84	5.95	40.33	4.74	54.93	5.89
65.5	33.25	5.49	40.57	4.75	54.68	6.16
66.0	33.57	5.34	41.97	4.49	53.54	5.52
66.5	31.53	5.01	42.48	4.59	52.93	5.85
67.0	26.87	4.28	33.43	5.59	60.98	6.72
67.5	38.18	5.69	43.44	4.44	52.12	5.22
68.0	34.57	5.32	44.10	4.33	51.57	4.99
68.5	31.16	4.53	42.42	4.55	53.03	5.58
69.0	47.16	6.62	39.88	5.04	55.08	6.17
69.5	41.96	6.30	40.74	4.87	54.39	5.95
70.0	40.89	6.14	44.40	4.37	51.23	4.90
70.5	32.63	4.80	42.85	4.40	52.75	5.15
71.0	39.24	6.43	41.25	4.76	53.99	5.72
71.5	34.20	5.12	40.25	4.87	54.88	5.98
72.0	38.81	5.62	39.29	4.98	55.73	6.44
72.5	36.01	4.95	39.76	4.93	55.31	6.19
73.0	35.89	5.03	40.71	4.77	54.52	6.15
73.5	40.93	5.65	42.63	4.56	52.81	5.43
74.0	34.77	5.50	42.59	4.56	52.85	5.36
74.5	36.04	5.50	42.34	4.53	53.13	5.44
75.0	37.84	5.81	42.75	4.53	52.72	5.28
75.5	40.00	5.78	42.35	4.57	53.08	5.46
76.0	44.75	5.95	42.53	4.61	52.86	5.21
76.5	40.70	6.60	43.29	4.58	52.13	5.27
77.0	34.86	5.12	42.99	4.48	52.53	5.37
77.5	30.57	5.20	42.11	4.53	53.36	5.39
78.0	29.52	4.78	42.07	4.51	53.42	5.40
78.5	33.53	5.28	43.51	4.39	52.10	5.30
79.0	27.10	4.26	31.64	5.76	62.60	6.73
79.5	29.78	4.15	28.58	5.90	65.52	6.45
80.0	47.30	6.23	38.48	5.25	56.27	6.52
80.5	50.40	6.76	39.34	5.11	55.55	5.38
81.0	47.24	6.57	37.03	5.27	57.70	5.48
81.5	46.86	6.45	41.26	5.62	53.12	6.63
82.0	37.50	5.68	41.22	4.70	54.08	5.74
82.5	27.65	3.49	39.15	4.93	55.92	6.93
83.0	25.04	3.26	35.72	5.40	58.88	8.20
83.5	24.66	3.39	38.02	5.15	56.83	7.07
84.0	30.88	3.89	42.99	4.31	52.70	5.18
84.5	28.71	3.94	38.70	4.98	56.32	6.64
85.0	45.00	5.85	37.75	5.40	56.85	7.23
85.5	44.66	5.36	42.32	4.67	53.01	5.32
86.0	27.93	3.78	30.35	6.04	63.61	7.98

depth (cm)	moisture (%)	organic matter (%)	clay (%)	sand (%)	silt (%)	mean grain size (μm)
86.5	38.30	5.11	41.00	4.55	54.45	5.46
87.0	41.41	6.28	43.17	4.47	52.36	4.96
87.5	31.99	5.49	43.31	4.39	52.30	4.98
88.0	28.25	4.76	43.24	4.33	52.43	5.10
88.5	27.46	4.35	44.16	4.51	51.33	6.28
89.0	26.98	4.59	43.82	4.54	51.64	6.13
89.5	26.76	4.27	41.95	4.52	53.53	5.56
90.0	24.26	3.81	40.19	4.66	55.15	6.13
90.5	25.43	4.04	41.25	4.53	54.22	5.79
91.0	27.85	4.67	42.10	4.65	53.25	6.68
91.5	28.80	6.03	40.89	4.70	54.41	6.53
92.0	25.61	4.06	40.53	4.80	54.67	6.67
92.5	24.93	3.77	41.04	4.96	54.00	7.98
93.0	30.91	4.84	42.00	4.61	53.39	6.14
93.5	39.93	10.42	26.60	7.61	65.79	12.59

PAD 8

depth (cm)	moisture (%)	organic matter (%)	clay (%)	sand (%)	silt (%)	mean grain size (μm)
0.0	90.58	21.08	55.80	1.81	42.39	1.96
0.5	87.01	21.44	48.60	1.70	49.70	2.10
1.0	86.82	21.61	46.90	1.94	51.16	2.23
1.5	87.37	22.72	46.07	1.64	52.29	2.13
2.0	88.46	22.76	46.25	2.71	51.04	2.90
2.5	88.87	24.06	46.01	2.78	51.21	2.94
3.0	87.93	22.84	44.84	1.87	53.29	3.99
3.5	88.95	24.29	44.85	1.99	53.16	2.97
4.0	88.68	23.56	43.89	1.97	54.14	2.19
4.5	87.06	21.17	44.76	2.02	53.22	1.98
5.0	85.20	18.77	44.50	2.85	52.65	3.38
5.5	83.43	16.27	45.39	2.92	51.69	2.94
6.0	80.76	13.91	43.48	2.98	53.54	3.00
6.5	80.52	15.41	43.20	3.09	53.71	3.09
7.0	79.53	14.43	42.46	3.15	54.39	4.48
7.5	76.59	12.80	42.20	3.24	54.56	4.23
8.0	77.36	12.08	42.32	3.17	54.51	3.63
8.5	78.13	12.88	43.50	2.98	53.52	3.40
9.0	76.38	13.25	40.60	3.50	55.90	3.55
9.5	75.15	12.62	41.05	3.45	55.50	4.17
10.0	75.38	12.63	41.25	3.35	55.40	4.52
10.5	75.06	13.39	43.36	2.98	53.66	4.15
11.0	74.41	12.98	43.02	3.02	53.96	4.44
11.5	73.66	12.80	43.30	2.96	53.74	4.56
12.0	73.61	13.31	44.07	2.80	53.13	4.32
12.5	74.07	13.29	42.82	3.07	54.11	4.29
13.0	73.55	12.87	41.66	3.26	55.08	4.40
13.5	73.21	12.30	41.68	3.23	55.09	4.49
14.0	72.51	11.64	41.75	3.28	54.97	4.34
14.5	70.75	11.29	41.76	3.33	54.91	4.11
15.0	68.15	10.02	41.38	3.11	55.51	4.49

depth (cm)	moisture (%)	organic matter (%)	clay (%)	sand (%)	silt (%)	mean grain size (μm)
15.5	65.82	10.13	45.08	1.55	53.37	4.73
16.0	61.75	10.10	43.53	2.26	54.21	4.57
16.5	65.79	9.53	45.08	1.38	53.54	4.73
17.0	62.28	9.01	43.42	2.26	54.32	4.61
17.5	63.69	9.18	45.43	1.19	53.38	4.74
18.0	62.71	8.84	43.78	2.12	54.10	4.62
18.5	64.24	9.08	45.71	1.09	53.20	4.46
19.0	63.62	8.74	43.18	2.25	54.57	4.65
19.5	64.06	9.43	45.69	1.30	53.01	5.45
20.0	60.43	9.21	44.60	2.06	53.34	4.88
20.5	62.44	8.45	45.30	1.31	53.39	5.48
21.0	63.04	9.10	42.74	2.50	54.76	4.82
21.5	65.93	9.33	45.55	1.06	53.39	4.64
22.0	63.50	10.94	44.80	2.05	53.15	4.68
22.5	65.32	11.15	44.81	1.82	53.37	4.40
23.0	63.13	11.47	44.60	2.10	53.30	4.65
23.5	65.11	10.34	44.97	1.73	53.30	4.38
24.0	62.66	11.44	43.65	2.20	54.15	4.65
24.5	64.04	10.06	45.08	1.63	53.29	4.44
25.0	63.10	10.06	43.49	2.30	54.21	4.69
25.5	64.38	10.67	44.86	1.70	53.44	4.36
26.0	62.63	10.51	43.64	2.33	54.03	4.36
26.5	63.56	9.61	35.60	1.63	62.77	4.36
27.0	61.41	9.76	33.70	2.35	63.95	5.59
27.5	61.91	9.68	40.20	1.68	58.12	5.79
28.0	61.67	10.53	32.70	2.50	64.80	5.75
28.5	62.72	10.88	44.64	1.56	53.80	5.72
29.0	57.75	11.56	42.85	2.31	54.84	6.29
29.5	56.76	9.81	43.92	2.04	54.04	4.82
30.0	54.50	9.41	43.40	2.17	54.43	4.72
31.0	52.02	8.70	43.18	2.29	54.53	4.65
32.0	57.29	8.77	42.96	2.44	54.60	4.88
33.0	57.93	8.70	42.84	2.49	54.67	4.54
34.0	52.10	8.31	42.89	2.56	54.55	4.34
35.0	68.23	10.68	44.90	2.41	52.69	3.05
36.0	65.47	9.67	49.00	2.36	48.64	2.50
37.0	60.86	9.60	46.00	1.90	52.10	1.98
38.0	61.84	9.77	43.78	2.00	54.22	3.24
39.0	66.68	10.17	43.66	2.28	54.06	4.69
40.0	61.98	9.35	43.43	2.44	54.13	4.55
41.0	60.50	8.86	42.91	2.56	54.53	4.76
42.0	59.27	9.34	42.55	3.45	54.00	4.80
43.0	61.89	9.50	43.10	2.44	54.46	4.80
44.0	58.28	9.68	43.52	2.45	54.03	4.45
45.0	59.24	8.64	42.70	2.26	55.04	4.50
46.0	59.81	8.36	42.67	2.47	54.86	5.00
47.0	58.35	8.55	39.00	2.40	58.60	5.67
48.0	54.69	8.62	40.10	2.54	57.36	5.50
49.0	60.50	9.65	42.96	2.51	54.53	4.46
50.0	61.83	9.46	43.16	2.51	54.33	4.49
51.0	59.08	9.74	43.15	2.45	54.40	4.69

depth (cm)	moisture (%)	organic matter (%)	clay (%)	sand (%)	silt (%)	mean grain size (μm)
52.0	57.10	8.41	43.41	2.32	54.27	4.80
53.0	60.26	8.85	43.17	2.35	54.48	5.10
54.0	63.21	9.44	43.36	2.36	54.28	4.90
55.0	66.34	10.13	43.60	2.36	54.04	4.33
56.0	64.38	9.20	43.56	2.21	54.23	4.76
57.0	63.03	8.99	44.33	2.26	53.41	3.04
58.0	60.27	8.39	43.80	2.15	54.05	4.71
59.0	57.30	8.25	44.28	2.23	53.49	3.05
60.0	53.11	14.73	43.31	2.34	54.35	4.52
61.0	51.30	7.71	43.60	2.19	54.21	4.70
62.0	53.11	8.03	43.34	2.37	54.29	4.61
63.0	48.20	6.13	43.30	1.28	55.42	4.56
64.0	48.39	6.38	40.12	1.35	58.53	5.00
65.0	54.68	6.96	34.10	1.66	64.24	5.80
66.0	55.72	7.82	39.40	1.51	59.09	5.30
67.0	62.26	9.16	44.49	1.82	53.69	4.90
68.0	58.74	8.71	44.87	1.63	53.50	4.54
69.0	54.26	8.38	44.58	1.46	53.96	4.70
70.0	61.22	9.51	45.58	1.17	53.25	4.87
71.0	64.53	9.49	44.86	1.38	53.76	5.57
72.0	66.17	9.61	45.27	1.45	53.28	4.45
73.0	64.87	9.60	45.38	1.38	53.24	4.60
74.0	65.48	10.64	43.99	2.08	53.93	4.47
75.0	63.71	10.35	44.19	1.92	53.89	4.78
76.0	60.21	9.72	44.64	1.75	53.61	4.77
77.0	59.43	9.43	44.64	1.75	53.61	4.81
78.0	65.82	9.90	45.71	1.07	53.22	4.65
79.0	63.83	10.27	44.59	1.79	53.62	4.56
80.0	64.58	10.54	48.80	1.94	49.26	4.76
81.0	61.44	13.26	54.30	2.20	43.50	4.41
82.0	64.38	10.66	57.80	0.30	41.90	4.10
83.0	63.49	10.43	54.20	2.06	43.74	3.90
84.0	64.40	10.44	44.52	1.81	53.67	4.59
85.0	66.47	10.96	44.60	1.76	53.64	4.59
86.0	67.09	10.38	44.94	1.86	53.20	4.12
87.0	64.63	10.44	44.65	1.82	53.53	4.66
88.0	61.64	9.46	44.37	2.03	53.60	4.41
89.0	60.05	9.40	44.53	1.90	53.57	4.34
90.0	58.46	8.49	44.39	1.94	53.67	4.48
91.0	58.41	8.54	44.73	1.84	53.43	4.38
92.0	58.83	8.39	44.59	1.86	53.55	4.63
93.0	60.81	8.65	44.67	1.82	53.51	4.59
94.0	60.26	8.80	44.64	1.87	53.49	4.85
95.0	58.47	8.33	42.20	1.90	55.90	5.70
96.0	56.04	8.01	40.80	1.84	57.36	5.60
97.0	55.15	7.68	44.85	1.68	53.47	5.05

Appendix F

Mineralogy Data

PAD 54 Siliciclastic Mineralogy

depth (cm)	quartz (%)	k-feldspar (%)	plagioclase (%)	total feldspars (%)	total clay minerals (%)	total siliciclastics (%)
0.0	12.88	0.00	4.52	4.52	75.28	92.68
0.5	13.64	0.00	4.08	4.08	77.54	95.26
1.0	9.39	0.00	3.17	3.17	79.54	92.10
1.5	18.34	0.00	4.93	4.93	73.06	96.33
2.0	19.21	0.00	4.74	4.74	66.50	90.45
2.5	23.73	0.00	5.52	5.52	62.14	91.39
3.0	16.06	0.00	4.83	4.83	74.32	95.21
3.5	11.95	0.00	3.60	3.60	79.92	95.47
4.0	15.33	0.00	4.80	4.80	63.66	83.79
4.5	24.62	0.00	6.11	6.11	57.98	88.71
5.0	28.44	0.00	5.20	5.20	51.50	85.14
5.5	15.35	0.00	4.81	4.81	74.68	94.84
6.0	20.81	0.00	5.10	5.10	67.42	93.33
6.5	21.94	0.00	6.20	6.20	65.95	94.09
7.0	16.46	0.00	4.78	4.78	74.01	95.25
7.5	19.43	0.00	5.88	5.88	68.39	93.70
8.0	19.43	0.00	6.65	6.65	67.91	93.99
8.5	20.07	0.00	4.98	4.98	67.25	92.30
9.0	16.92	0.00	4.82	4.82	72.31	94.05
9.5	11.81	0.00	4.16	4.16	81.44	97.41
10.0	19.82	0.00	0.00	0.00	68.08	87.90
10.5	20.38	0.00	4.71	4.71	64.49	89.58
11.0	21.14	0.00	5.62	5.62	67.50	94.26
11.5	18.58	0.00	5.18	5.18	62.96	86.72
12.0	22.56	0.00	6.13	6.13	64.09	92.78
12.5	20.07	0.00	5.00	5.00	68.97	94.04
13.0	11.52	0.00	6.19	6.19	68.71	86.42
13.5	12.77	0.00	4.29	4.29	78.11	95.17
14.0	13.76	0.00	4.26	4.26	77.20	95.22
14.5	14.76	0.00	4.73	4.73	75.83	95.32
15.0	13.24	0.00	3.94	3.94	75.92	93.10
15.5	16.56	0.00	4.95	4.95	73.96	95.47
16.0	17.51	0.00	5.58	5.58	70.99	94.08
16.5	20.79	0.00	6.13	6.13	67.03	93.95
17.0	19.78	0.00	5.50	5.50	68.56	93.84
17.5	17.56	0.00	5.05	5.05	60.88	83.49
18.0	17.01	0.00	4.78	4.78	72.25	94.04
18.5	19.07	0.00	5.31	5.31	69.79	94.17
19.0	17.38	0.00	4.37	4.37	72.10	93.85
19.5	20.05	0.00	6.10	6.10	67.92	94.07
20.0	18.35	0.00	4.84	4.84	70.57	93.76
20.5	14.48	0.00	4.15	4.15	76.43	95.06
21.0	11.31	0.00	3.46	3.46	81.28	96.05

depth (cm)	quartz (%)	k-feldspar (%)	plagioclase (%)	total feldspars (%)	total clay minerals (%)	total siliciclastics (%)
21.5	14.87	0.00	5.68	5.68	75.59	96.14
22.0	20.7	0.00	6.62	6.62	62.73	90.05
22.5	17.51	0.00	4.98	4.98	69.85	92.34
23.0	22.27	0.00	6.09	6.09	63.76	92.12
23.5	18.88	0.00	4.61	4.61	69.69	93.18
24.0	25.6	0.00	5.60	5.60	61.52	92.72
24.5	22.96	0.00	5.37	5.37	61.12	89.45
25.0	15.68	0.00	5.05	5.05	74.03	94.76
25.5	13.41	0.00	4.26	4.26	80.48	98.15
26.0	13.03	0.00	3.92	3.92	75.47	92.42
26.5	12.99	0.00	3.86	3.86	66.74	83.59
27.0	14.77	0.00	4.24	4.24	76.58	95.59
27.5	15.83	0.00	4.56	4.56	74.83	95.22
28.0	15.2	0.00	4.16	4.16	75.74	95.10
28.5	15.56	0.00	5.12	5.12	73.85	94.53
29.0	14.22	0.00	4.88	4.88	75.25	94.35
29.5	18.85	0.00	5.36	5.36	67.51	91.72
30.0	21.18	0.00	5.68	5.68	64.24	91.10
31.0	14.23	0.00	4.36	4.36	74.22	92.84
32.0	11.47	0.00	3.95	3.95	77.00	92.48
33.0	14.58	0.00	5.44	5.44	72.02	92.04
34.0	21.47	0.00	5.91	5.91	61.74	89.12
35.0	14.24	0.00	4.86	4.86	73.74	92.84
36.0	15.04	0.00	5.37	5.37	71.32	91.73
37.0	20.7	0.00	6.84	6.84	63.32	90.86
38.0	20.69	0.00	5.04	5.04	66.00	91.73
39.0	15.99	0.00	5.72	5.72	73.14	94.85
40.0	15.51	0.00	5.31	5.31	73.58	94.40
41.0	20.07	0.00	6.01	6.01	67.19	93.27
42.0	10.48	4.00	3.82	7.82	77.12	95.42
43.0	17.71	0.00	0.00	0.00	79.66	97.37
44.0	20.26	0.00	5.73	5.73	65.71	91.70
45.0	19.49	0.00	6.83	6.83	65.02	91.34
46.0	1.03	0.00	8.73	8.73	76.95	86.71
47.0	23.59	0.00	5.68	5.68	60.94	90.21
48.0	20.78	0.00	5.93	5.93	62.46	89.17
49.0	16.74	0.00	5.77	5.77	69.74	92.25
50.0	22.96	0.00	6.23	6.23	60.87	90.06
51.0	30.18	0.00	7.93	7.93	50.27	88.38
52.0	15.63	4.67	4.88	9.55	67.54	92.72
53.0	18.42	0.00	5.62	5.62	64.12	88.16
54.0	22.88	0.00	8.63	8.63	57.50	89.01
55.0	17.31	0.00	5.77	5.77	68.66	91.74
56.0	20.16	5.14	5.58	10.72	61.03	91.91
57.0	33.03	0.00	8.56	8.56	51.94	93.53
58.0	13.7	0.00	5.39	5.39	75.49	94.58
59.0	16.23	0.00	5.03	5.03	70.58	91.84
60.0	21.57	0.00	7.51	7.51	61.33	90.41
61.0	14.87	0.00	5.77	5.77	73.16	93.80
62.0	10.9	0.00	4.17	4.17	79.70	94.77

depth (cm)	quartz (%)	k-feldspar (%)	plagioclase (%)	total feldspars (%)	total clay minerals (%)	total siliciclastics (%)
63.0	21.62	0.00	6.43	6.43	61.91	89.96
64.0	25.31	0.00	6.59	6.59	58.41	90.31
65.0	21.67	6.58	6.34	12.92	53.00	87.59
66.0	28.54	0.00	7.92	7.92	53.58	90.04
67.0	13.89	0.00	4.30	4.30	60.76	78.95
68.0	14.74	0.00	6.10	6.10	74.52	95.36
69.0	15.9	0.00	6.03	6.03	52.64	74.57
70.0	15.95	0.00	5.99	5.99	70.18	92.12
71.0	17.04	0.00	4.67	4.67	49.63	71.34
72.0	11.84	0.00	4.33	4.33	60.67	76.84
73.0	15.49	0.00	4.72	4.72	56.66	76.87
74.0	14.96	0.00	5.41	5.41	71.69	92.06
75.0	21.95	0.00	6.55	6.55	60.48	88.98
76.0	15.39	0.00	5.60	5.60	53.63	74.62
77.0	23.55	0.00	8.76	8.76	58.34	90.65
78.0	14.18	0.00	5.14	5.14	57.58	76.90
79.0	13.85	0.00	4.71	4.71	57.90	76.46

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depth (cm)	quartz (%)	k-feldspar (%)	plagioclase (%)	total feldspars (%)	total clay minerals (%)	total siliciclastics (%)
0.0	9.05	0.00	3.08	3.08	71.53	83.66
0.5	8.36	0.00	2.83	2.83	67.34	78.53
1.0	12.40	0.00	3.53	3.53	59.01	74.94
1.5	21.18	0.00	5.28	5.28	65.63	92.09
2.0	20.24	0.00	5.18	5.18	57.97	83.39
2.5	18.70	4.45	4.85	9.30	63.91	91.91
3.0	19.49	0.00	5.35	5.35	67.18	92.02
3.5	23.67	4.98	5.99	10.97	57.91	92.55
4.0	26.52	0.00	6.76	6.76	55.83	89.11
4.5	16.20	0.00	4.55	4.55	64.00	84.75
5.0	15.12	0.00	4.44	4.44	75.59	95.15
5.5	23.66	0.00	5.89	5.89	61.22	90.77
6.0	18.99	0.00	5.63	5.63	55.37	79.99
6.5	22.18	0.00	6.15	6.15	61.43	89.76
7.0	28.05	0.00	6.28	6.28	57.28	91.61
7.5	26.78	0.00	10.90	10.90	51.57	89.25
8.0	18.11	0.00	4.96	4.96	73.48	96.55
8.5	14.73	0.00	4.28	4.28	76.55	95.56
9.0	22.78	0.00	6.77	6.77	64.59	94.14
9.5	22.04	0.00	7.85	7.85	63.77	93.66
10.0	16.64	0.00	4.56	4.56	75.41	96.61
10.5	18.11	0.00	5.35	5.35	72.65	96.11
11.0	19.93	0.00	5.07	5.07	69.41	94.41
11.5	12.21	0.00	4.20	4.20	65.65	82.06
12.0	17.33	0.00	5.40	5.40	70.54	93.27
12.5	15.59	0.00	4.32	4.32	73.13	93.04

depth (cm)	quartz (%)	k-feldspar (%)	plagioclase (%)	total feldspars (%)	total clay minerals (%)	total siliciclastics (%)
13.0	13.96	0.00	5.36	5.36	74.89	94.21
13.5	18.03	0.00	5.40	5.40	69.04	92.47
14.0	13.48	0.00	3.79	3.79	65.54	82.81
14.5	15.04	0.00	3.97	3.97	76.00	95.01
15.0	13.51	0.00	4.48	4.48	76.74	94.73
15.5	17.68	0.00	5.54	5.54	69.29	92.51
16.0	14.20	0.00	4.11	4.11	74.86	93.17
16.5	19.42	0.00	4.97	4.97	67.08	91.47
17.0	19.89	4.86	5.28	10.14	61.39	91.42
17.5	20.81	0.00	5.83	5.83	64.62	91.26
18.0	18.87	0.00	5.76	5.76	69.72	94.35
18.5	19.44	0.00	5.67	5.67	71.17	96.28
19.0	18.03	0.00	5.92	5.92	68.12	92.07
19.5	20.67	0.00	6.66	6.66	64.16	91.49
20.0	24.78	0.00	6.88	6.88	58.83	90.49
20.5	20.83	0.00	5.69	5.69	64.07	90.59
21.0	24.75	0.00	7.52	7.52	60.89	93.16
21.5	24.14	0.00	5.70	5.70	61.91	91.75
22.0	15.00	0.00	4.94	4.94	74.17	94.11
22.5	15.57	0.00	5.09	5.09	73.89	94.55
23.0	19.55	0.00	5.33	5.33	69.23	94.11
23.5	21.41	0.00	5.08	5.08	64.66	91.15
24.0	16.10	0.00	5.17	5.17	70.81	92.08
24.5	20.75	0.00	6.19	6.19	64.70	91.64
25.0	22.35	7.58	0.00	7.58	62.57	92.50
25.5	28.58	0.00	6.93	6.93	53.91	89.42
26.0	0.99	0.00	11.24	11.24	74.61	86.84
26.5	32.22	0.00	6.90	6.90	49.31	88.43
27.0	18.13	0.00	0.00	0.00	73.53	91.66
27.5	21.16	0.00	5.96	5.96	65.20	92.32
28.0	24.59	0.00	6.88	6.88	60.07	91.54
28.5	24.27	0.00	5.59	5.59	60.90	90.76
29.0	17.67	0.00	5.00	5.00	68.90	91.57
29.5	12.92	4.31	3.53	7.84	60.84	81.60
30.0	22.72	0.00	5.77	5.77	62.73	91.22
30.5	27.21	0.00	5.80	5.80	46.49	79.50
31.0	35.27	0.00	7.85	7.85	44.45	87.57
31.5	39.84	5.31	6.71	12.02	39.47	91.33
32.0	28.29	5.55	9.26	14.81	47.38	90.48
32.5	21.90	0.00	6.65	6.65	51.13	79.68
33.0	26.45	0.00	6.02	6.02	40.48	72.95
33.5	33.23	0.00	8.91	8.91	48.33	90.47
34.0	17.00	0.00	5.69	5.69	70.58	93.27
34.5	26.14	0.00	6.51	6.51	59.58	92.23
35.0	22.63	0.00	5.77	5.77	66.24	94.64
35.5	24.72	0.00	6.70	6.70	57.68	89.10
36.0	19.51	4.60	6.19	10.79	61.44	91.74
36.5	20.03	0.00	5.95	5.95	64.81	90.79
37.0	22.70	0.00	8.30	8.30	59.14	90.14
37.5	34.03	0.00	8.91	8.91	50.57	93.51

depth (cm)	quartz (%)	k-feldspar (%)	plagioclase (%)	total feldspars (%)	total clay minerals (%)	total siliciclastics (%)
38.0	28.92	0.00	8.76	8.76	50.78	88.46
38.5	28.10	0.00	5.55	5.55	45.22	78.87
39.0	27.15	0.00	6.22	6.22	54.24	87.61
39.5	18.09	0.00	5.20	5.20	68.72	92.01
40.0	14.35	0.00	4.51	4.51	74.29	93.15
40.5	17.42	0.00	4.77	4.77	71.47	93.66
41.0	26.78	0.00	12.31	12.31	48.53	87.62
41.5	23.55	0.00	8.32	8.32	60.53	92.40
42.0	16.08	0.00	4.90	4.90	70.71	91.69
42.5	13.24	0.00	4.36	4.36	74.92	92.52
43.0	15.02	0.00	5.76	5.76	71.45	92.23
43.5	15.22	0.00	4.89	4.89	72.82	92.93
44.0	22.95	0.00	7.01	7.01	61.53	91.49
44.5	19.94	0.00	7.20	7.20	64.54	91.68
45.0	26.60	0.00	6.80	6.80	56.36	89.76
45.5	28.56	0.00	7.01	7.01	42.63	78.20
46.0	31.40	0.00	6.92	6.92	49.20	87.52
46.5	30.88	0.00	5.85	5.85	49.50	86.23
47.0	27.52	0.00	6.80	6.80	54.40	88.72
47.5	28.84	0.00	5.18	5.18	56.09	90.11
48.0	14.64	0.00	4.99	4.99	72.05	91.68
48.5	11.69	0.00	4.13	4.13	64.63	80.45
49.0	14.10	0.00	4.61	4.61	78.59	97.30
49.5	20.27	0.00	6.08	6.08	65.76	92.11
50.0	19.15	0.00	5.51	3.00	68.87	93.52
50.5	23.94	0.00	6.70	6.70	60.11	90.75
51.0	22.35	0.00	6.79	6.79	47.92	77.06
51.5	13.46	4.84	4.51	9.35	59.37	82.18
52.0	20.35	0.00	5.51	5.51	64.94	90.80
52.5	20.87	0.00	6.37	6.37	64.67	91.91
53.0	15.57	0.00	5.48	5.48	72.05	93.10
53.5	15.89	0.00	5.20	5.20	73.14	94.23
54.0	15.43	0.00	5.26	5.26	71.94	92.63
54.5	13.88	0.00	4.28	4.28	76.79	94.95
55.0	18.43	0.00	5.28	5.28	68.07	91.78
55.5	20.29	0.00	0.00	0.00	72.44	92.73
56.0	26.08	0.00	8.11	8.11	57.37	91.56
56.5	18.74	0.00	5.10	5.10	68.97	92.81
57.0	22.16	0.00	6.22	6.22	60.15	88.53
57.5	21.93	0.00	6.46	6.46	59.37	87.76
58.0	18.92	0.00	5.36	5.36	67.93	92.21
58.5	17.21	0.00	5.20	5.20	70.78	93.19
59.0	14.72	0.00	5.20	1.73	72.80	92.72
59.5	14.72	0.00	5.20	5.20	72.91	92.83
60.0	23.41	0.00	7.71	7.71	59.45	90.57
60.5	15.66	0.00	4.28	4.28	61.42	81.36
61.0	15.83	0.00	5.04	5.04	71.65	92.52
61.5	21.04	0.00	5.79	5.79	62.70	89.53
62.0	26.90	0.00	7.79	7.79	55.18	89.87
62.5	17.93	0.00	5.41	5.41	67.17	90.51

depth (cm)	quartz (%)	k-feldspar (%)	plagioclase (%)	total feldspars (%)	total clay minerals (%)	total siliciclastics (%)
63.0	16.80	4.71	5.24	9.95	65.44	92.19
63.5	17.45	0.00	5.74	5.74	70.62	93.81
64.0	15.65	0.00	4.80	4.80	72.84	93.29
64.5	14.89	0.00	4.66	4.66	75.26	94.81
65.0	17.94	4.91	5.61	10.52	64.12	92.58
65.5	22.50	0.00	7.40	7.40	62.81	92.71
66.0	19.77	7.09	6.52	13.61	57.52	90.90
66.5	23.04	0.00	8.99	8.99	56.28	88.31
67.0	25.16	0.00	10.04	10.04	54.33	89.53
67.5	24.05	0.00	6.47	6.47	57.50	88.02
68.0	20.63	0.00	5.71	5.71	52.27	78.61
68.5	27.35	0.00	7.51	7.51	52.51	87.37
69.0	15.13	0.00	5.04	5.04	70.74	90.91
69.5	16.30	0.00	5.62	5.62	71.78	93.70
70.0	16.93	0.00	5.26	5.26	69.82	92.01
70.5	24.50	4.69	5.85	10.54	53.11	88.15
71.0	17.59	0.00	5.40	5.40	69.37	92.36
71.5	18.99	0.00	5.43	5.43	65.61	90.03
72.0	20.57	0.00	6.36	6.36	63.35	90.28
72.5	19.52	0.00	5.69	5.69	64.94	90.15
73.0	23.93	0.00	7.85	7.85	57.14	88.92
73.5	18.70	0.00	6.06	6.06	66.49	91.25
74.0	19.68	0.00	5.84	5.84	64.49	90.01
74.5	21.16	0.00	6.05	6.05	64.39	91.60
75.0	18.74	0.00	5.52	5.52	66.41	90.67
75.5	19.02	0.00	5.82	5.82	66.39	91.23
76.0	16.22	0.00	4.68	4.68	70.03	90.93
76.5	14.04	0.00	5.43	5.43	72.86	92.33
77.0	20.37	0.00	6.32	6.32	63.87	90.56
77.5	22.53	0.00	5.64	5.64	62.42	90.59
78.0	23.61	0.00	5.76	5.76	61.97	91.34
78.5	22.94	0.00	6.81	6.81	60.71	90.46
79.0	26.87	0.00	7.16	7.16	55.27	89.30
79.5	28.28	0.00	5.58	5.58	47.88	81.74
80.0	15.28	0.00	4.42	4.42	75.50	95.20
80.5	11.36	0.00	3.91	3.91	80.40	95.67
81.0	12.06	0.00	4.79	4.79	78.73	95.58
81.5	1.30	0.00	5.42	5.42	90.29	97.01
82.0	20.36	0.00	5.87	5.87	64.66	90.89
82.5	24.48	0.00	10.15	10.15	39.99	74.62
83.0	33.38	0.00	10.98	10.98	47.81	92.17
83.5	28.69	0.00	8.55	8.55	46.80	84.04
84.0	31.54	0.00	6.21	6.21	52.82	90.57
84.5	25.75	0.00	6.95	6.95	56.35	89.05
85.0	15.88	0.00	6.37	6.37	73.96	96.21
85.5	14.34	0.00	4.54	4.54	74.56	93.44
86.0	28.46	0.00	7.05	7.05	54.98	90.49
86.5	20.84	0.00	10.37	10.37	61.31	92.52
87.0	17.86	0.00	4.55	4.55	69.82	92.23
87.5	21.92	0.00	5.12	5.12	63.08	90.12

depth (cm)	quartz (%)	k-feldspar (%)	plagioclase (%)	total feldspars (%)	total clay minerals (%)	total siliciclastics (%)
88.0	28.48	0.00	5.96	5.96	55.12	89.56
88.5	28.45	0.00	7.73	7.73	51.25	87.43
89.0	28.82	0.00	7.01	7.01	51.07	86.90
89.5	29.35	0.00	6.78	6.78	52.48	88.61
90.0	34.16	0.00	7.51	7.51	50.56	92.23
90.5	33.41	5.52	7.43	12.95	44.06	90.42
91.0	32.61	0.00	8.00	8.00	49.43	90.04
91.5	28.51	0.00	14.54	14.54	47.44	90.49
92.0	28.01	0.00	6.60	6.60	55.76	90.37
92.5	28.03	6.70	5.45	12.15	49.96	90.14
93.0	25.68	0.00	11.03	11.03	52.20	88.91
93.5	18.82	0.00	6.29	6.29	65.77	90.88

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depth (cm)	quartz (%)	k-feldspar (%)	plagioclase (%)	total clay minerals (%)	total siliciclastics (%)
0.0	7.24	0.00	0.00	75.11	82.35
0.5	6.32	0.00	3.21	71.42	80.95
1.0	6.69	0.00	3.28	78.22	88.19
1.5	7.04	0.00	3.23	72.18	82.45
2.0	7.86	0.00	0.00	73.17	81.03
2.5	7.21	0.00	0.00	74.08	81.29
3.0	6.89	0.00	2.99	72.67	82.55
3.5	7.04	0.00	0.00	75.78	82.82
4.0	7.00	0.00	3.46	63.62	74.08
4.5	6.92	0.00	0.00	76.97	83.89
5.0	6.99	0.00	3.63	75.08	85.70
5.5	6.66	0.00	0.00	73.62	80.28
6.0	8.75	0.00	2.92	75.74	87.41
6.5	7.45	0.00	3.10	74.87	85.42
7.0	8.19	0.00	3.74	78.69	90.62
7.5	7.80	0.00	3.27	78.47	89.54
8.0	8.20	0.00	3.97	87.83	100.00
8.5	8.08	0.00	3.59	78.15	89.82
9.0	7.95	0.00	3.82	88.23	100.00
9.5	8.05	0.00	3.21	76.62	87.88
10.0	8.65	0.00	3.75	87.60	100.00
10.5	8.63	0.00	3.52	85.87	98.02
11.0	9.03	0.00	3.58	84.99	97.60
11.5	8.80	0.00	3.90	78.53	91.23
12.0	10.07	0.00	3.35	84.92	98.34
12.5	8.86	0.00	3.38	78.70	90.94
13.0	9.20	0.00	3.59	78.24	91.03
13.5	9.50	0.00	3.68	85.04	98.22
14.0	8.46	0.00	3.54	75.84	87.84
14.5	7.94	0.00	3.10	76.68	87.72
15.0	10.00	0.00	3.66	85.51	99.17

depth (cm)	quartz (%)	k-feldspar (%)	plagioclase (%)	total clay minerals (%)	total siliciclastics (%)
15.5	9.58	0.00	4.16	86.26	100.00
16.0	10.60	0.00	3.83	83.96	98.39
16.5	11.01	0.00	4.16	83.16	98.33
17.0	11.10	0.00	3.92	83.33	98.35
17.5	10.71	0.00	4.18	83.51	98.40
18.0	10.82	0.00	3.93	83.57	98.32
18.5	10.59	0.00	3.61	85.80	100.00
19.0	12.27	0.00	4.01	81.76	98.04
19.5	9.11	0.00	3.60	83.12	95.83
20.0	11.75	0.00	4.49	81.82	98.06
20.5	10.92	0.00	3.69	81.50	96.11
21.0	11.09	0.00	4.36	82.63	98.08
21.5	11.26	0.00	3.98	82.87	98.11
22.0	10.97	0.00	4.06	83.13	98.16
22.5	9.22	0.00	3.51	85.73	98.46
23.0	11.83	0.00	4.05	79.86	95.74
23.5	9.32	0.00	3.47	85.57	98.36
24.0	10.50	0.00	4.00	83.67	98.17
24.5	9.50	0.00	3.58	85.13	98.21
25.0	10.05	0.00	4.06	84.24	98.35
25.5	10.16	0.00	3.43	86.41	100.00
26.0	9.71	0.00	3.43	85.35	98.49
26.5	9.52	0.00	3.43	87.05	100.00
27.0	8.54	0.00	3.99	69.67	82.20
27.5	12.31	0.00	3.85	82.08	98.24
28.0	11.53	0.00	3.81	82.86	98.20
28.5	11.85	0.00	4.15	82.20	98.20
29.0	13.47	0.00	3.87	77.82	95.16
29.5	11.44	0.00	3.48	70.55	85.47
30.0	11.97	0.00	4.22	79.18	95.37
31.0	11.85	0.00	4.04	80.11	96.00
32.0	10.61	0.00	4.48	83.19	98.28
33.0	11.24	0.00	3.80	80.99	96.03
34.0	10.47	0.00	3.41	82.51	96.39
35.0	7.75	0.00	3.03	75.20	85.98
36.0	9.28	0.00	3.69	85.13	98.10
37.0	8.45	0.00	0.00	91.55	100.00
38.0	8.67	0.00	3.23	88.10	100.00
39.0	9.52	0.00	4.07	86.41	100.00
40.0	9.02	0.00	3.78	85.48	98.28
41.0	9.56	0.00	4.22	86.22	100.00
42.0	8.80	0.00	3.75	87.44	99.99
43.0	10.09	0.00	4.29	83.97	98.35
44.0	8.67	0.00	3.62	87.71	100.00
45.0	9.74	0.00	3.70	84.67	98.11
46.0	11.71	0.00	4.41	81.94	98.06
47.0	11.02	0.00	4.07	81.25	96.34
48.0	11.57	0.00	3.78	82.82	98.17
49.0	10.58	0.00	3.63	83.33	97.54
50.0	9.59	0.00	3.67	85.12	98.38

depth (cm)	quartz (%)	k-feldspar (%)	plagioclase (%)	total clay minerals (%)	total siliciclastics (%)
51.0	9.90	0.00	4.07	84.21	98.18
52.0	10.44	0.00	3.85	83.72	98.01
53.0	10.77	0.00	4.35	84.89	100.00
54.0	10.31	0.00	3.74	84.37	98.42
55.0	9.61	0.00	3.37	85.43	98.41
56.0	10.66	0.00	4.22	83.21	98.09
57.0	10.81	0.00	0.00	87.21	98.02
58.0	10.17	0.00	4.12	83.70	97.99
59.0	11.29	0.00	0.00	86.12	97.41
60.0	10.81	0.00	3.77	81.41	95.99
61.0	10.78	0.00	4.13	80.65	95.56
62.0	10.14	0.00	3.94	81.58	95.66
63.0	10.78	0.00	3.87	80.00	94.65
64.0	11.56	0.00	3.69	77.11	92.36
65.0	12.84	0.00	4.51	78.07	95.42
66.0	11.26	0.00	3.61	70.13	85.00
67.0	10.77	0.00	3.50	82.20	96.47
68.0	10.36	0.00	3.78	83.48	97.62
69.0	13.10	0.00	4.19	78.33	95.62
70.0	9.83	0.00	4.45	85.72	100.00
71.0	10.20	0.00	6.19	81.93	98.32
72.0	10.02	0.00	3.59	84.44	98.05
73.0	9.80	0.00	3.89	84.60	98.29
74.0	10.47	0.00	3.63	84.05	98.15
75.0	10.54	0.00	4.26	83.23	98.03
76.0	9.93	0.00	4.25	83.28	97.46
77.0	9.88	0.00	4.32	85.80	100.00
78.0	10.36	0.00	4.00	82.88	97.24
79.0	10.23	0.00	3.81	85.96	100.00
80.0	9.55	0.00	4.21	84.50	98.26
81.0	8.55	0.00	3.52	85.75	97.82
82.0	9.36	0.00	3.85	84.75	97.96
83.0	8.26	0.00	3.21	77.73	89.20
84.0	10.39	0.00	3.87	83.39	97.65
85.0	10.46	0.00	3.86	85.69	100.00
86.0	8.61	0.00	3.13	76.39	88.13
87.0	9.51	0.00	4.01	84.93	98.45
88.0	9.35	0.00	3.51	85.60	98.46
89.0	9.95	0.00	3.39	85.00	98.34
90.0	9.94	0.00	3.66	84.63	98.23
91.0	9.43	0.00	3.46	85.57	98.46
92.0	9.45	0.00	3.95	85.03	98.43
93.0	9.50	0.00	3.86	84.87	98.23
94.0	9.46	0.00	3.59	85.20	98.25
95.0	10.61	0.00	4.09	83.66	98.36
96.0	11.00	0.00	3.89	85.11	100.00
97.0	9.98	0.00	3.81	81.87	95.66

PAD 54 Carbonate and Evaporite Mineralogy

PAD 54 Calcite and Mg-calcite

depth (cm)	calcite (%)	Mg-calcite (%)	total calcite (%)	$MgCO_3$ in calcite (mol %)	$MgCO_3$ in Mg-calcite (mol %)
0.0	0.00	1.73	1.73	0.00	13.72
0.5	0.00	1.88	1.88	0.00	16.82
1.0	0.00	1.57	1.57	0.00	18.12
1.5	0.00	0.00	0.00	0.00	0.00
2.0	2.57	0.00	2.57	3.83	0.00
2.5	3.23	4.93	8.16	5.00	18.86
3.0	0.00	1.91	1.91	0.00	15.65
3.5	0.00	1.82	1.82	0.00	16.72
4.0	2.16	0.00	2.16	3.46	0.00
4.5	3.10	1.87	4.97	1.15	17.76
5.0	0.00	2.55	2.55	0.00	3.97
5.5	0.00	1.97	1.97	0.00	16.46
6.0	0.00	2.03	2.03	0.00	4.37
6.5	0.00	1.90	1.90	0.00	16.49
7.0	0.00	1.66	1.66	0.00	19.48
7.5	0.00	1.97	1.97	0.00	15.38
8.0	1.89	0.00	1.89	3.60	0.00
8.5	1.96	0.00	1.96	1.62	16.20
9.0	0.00	1.94	1.94	0.00	4.77
9.5	0.00	0.00	0.00	0.00	0.00
10.0	2.68	2.46	5.14	3.26	16.85
10.5	0.00	3.66	3.66	0.00	5.43
11.0	0.00	2.55	2.55	0.00	5.57
11.5	0.00	2.01	2.01	0.00	4.47
12.0	3.01	0.00	3.01	3.87	0.00
12.5	0.00	2.12	2.12	0.00	19.32
13.0	0.00	0.00	0.00	0.00	0.00
13.5	0.00	2.14	2.14	0.00	18.05
14.0	0.00	2.00	2.00	0.00	15.84
14.5	0.00	2.04	2.04	0.00	17.57
15.0	0.00	1.90	1.90	0.00	14.08
15.5	0.00	1.71	1.71	0.00	16.26
16.0	0.00	1.78	1.78	0.00	15.09
16.5	2.37	0.00	2.37	3.63	0.00
17.0	2.58	0.00	2.58	3.80	0.00
17.5	0.00	0.00	0.00	0.00	0.00
18.0	0.00	2.00	2.00	0.00	17.63
18.5	0.00	1.77	1.77	0.00	17.82
19.0	1.38	1.53	2.91	2.36	16.62
19.5	0.00	2.20	2.20	0.00	4.43
20.0	0.00	2.56	2.56	0.00	5.47
20.5	0.00	1.91	1.91	0.00	19.64
21.0	0.00	1.70	1.70	0.00	16.46
21.5	0.00	0.00	0.00	0.00	0.00
22.0	3.54	1.92	5.46	1.89	16.43

depth (cm)	calcite (%)	Mg-calcite (%)	total calcite (%)	$MgCO_3$ in calcite (mol %)	$MgCO_3$ in Mg-calcite (mol %)
22.5	2.33	1.99	4.32	3.06	17.18
23.0	0.00	3.36	3.36	0.00	6.60
23.5	2.03	1.72	3.75	0.00	13.59
24.0	3.10	0.00	3.10	3.93	0.00
24.5	4.20	0.00	4.20	3.66	0.00
25.0	0.00	1.84	1.84	0.00	15.52
25.5	0.00	1.85	1.85	0.00	15.12
26.0	0.00	2.18	2.18	0.00	5.13
26.5	1.42	1.46	2.88	1.08	15.81
27.0	0.00	1.96	1.96	0.00	19.54
27.5	0.00	2.23	2.23	0.00	14.99
28.0	0.00	2.02	2.02	0.00	18.47
28.5	0.00	1.90	1.90	0.00	12.14
29.0	0.00	1.80	1.80	0.00	20.16
29.5	2.17	1.99	4.16	1.72	12.90
30.0	0.00	1.85	1.85	0.00	4.53
31.0	1.91	1.99	3.90	5.20	22.86
32.0	1.96	2.08	4.04	5.67	20.90
33.0	0.00	2.04	2.04	0.00	21.09
34.0	3.34	2.46	5.80	7.19	21.25
35.0	1.77	1.93	3.70	5.27	22.44
36.0	2.69	2.35	5.04	5.30	20.90
37.0	0.00	4.09	4.09	0.00	7.16
38.0	2.24	2.00	4.24	7.03	19.99
39.0	0.00	2.05	2.05	0.00	20.99
40.0	0.00	2.39	2.39	0.00	20.48
41.0	0.00	2.22	2.22	0.00	20.90
42.0	0.00	1.99	1.99	0.00	16.69
43.0	0.00	2.63	2.63	0.00	19.44
44.0	2.36	2.03	4.39	6.23	20.22
45.0	2.84	1.83	4.67	5.20	18.57
46.0	5.62	0.00	5.62	4.97	0.00
47.0	3.24	1.85	5.09	5.23	20.87
48.0	3.50	2.32	5.82	5.47	18.57
49.0	2.15	2.02	4.17	6.40	19.87
50.0	0.00	4.06	4.06	5.07	0.00
51.0	0.00	5.63	5.63	0.00	5.20
52.0	2.42	1.85	4.27	6.10	18.86
53.0	4.55	2.20	6.75	4.97	19.44
54.0	0.00	3.32	3.32	0.00	5.77
55.0	2.43	1.79	4.22	6.30	18.73
56.0	2.69	1.91	4.60	4.90	18.57
57.0	0.00	0.00	0.00	0.00	0.00
58.0	0.00	2.04	2.04	0.00	19.67
59.0	2.43	2.56	4.99	6.46	20.12
60.0	0.00	4.12	4.12	0.00	6.86
61.0	0.00	2.86	2.86	0.00	6.96
62.0	0.00	2.16	2.16	0.00	6.43
63.0	3.07	2.47	5.54	3.57	21.09
64.0	0.00	3.69	3.69	0.00	7.99

depth (cm)	calcite (%)	Mg-calcite (%)	total calcite (%)	$MgCO_3$ in calcite (mol %)	$MgCO_3$ in Mg-calcite (mol %)
65.0	4.11	2.55	6.66	8.45	19.87
66.0	0.00	4.52	4.52	0.00	11.78
67.0	2.29	1.81	4.10	15.38	28.00
68.0	0.00	0.00	0.00	0.00	0.00
69.0	0.00	2.91	2.91	0.00	15.97
70.0	2.60	2.20	4.80	19.41	32.84
71.0	3.84	2.02	5.86	17.27	32.74
72.0	1.68	1.72	3.40	19.19	32.87
73.0	2.09	1.79	3.88	20.28	33.88
74.0	2.26	2.24	4.50	21.16	35.54
75.0	3.98	2.19	6.17	22.03	40.33
76.0	2.63	1.83	4.46	22.03	36.25
77.0	0.00	4.73	4.73	0.00	22.99
78.0	0.00	2.75	2.75	0.00	23.09
79.0	2.40	1.80	4.20	24.66	37.47
80.0	3.78	2.25	6.03	3.46	17.70
81.0	0.00	2.70	2.70	0.00	5.40
82.0	0.00	2.02	2.02	0.00	7.99
83.0	3.94	0.00	3.94	2.80	0.00
84.0	3.15	2.04	5.19	2.06	16.39
85.0	0.00	1.95	1.95	0.00	17.53
86.0	0.00	0.00	0.00	0.00	0.00
87.0	0.48	0.49	0.98	3.56	16.72
88.0	4.05	2.10	6.15	4.93	19.44
89.0	0.00	3.46	3.46	0.00	4.73

PAD 54 Dolomite and Protodolomite

depth (cm)	protodolomite (%)	dolomite (%)	CaCO3 in protodolomite (mol %)	CaCO3 in dolomite (mol %)	total carbonate minerals (%)
0.0	0.00	3.18	0.00	49.15	4.91
0.5	0.00	2.86	0.00	48.06	4.74
1.0	0.00	6.34	0.00	42.90	7.91
1.5	0.00	3.67	0.00	46.25	3.67
2.0	0.00	4.65	0.00	48.85	7.22
2.5	0.00	3.68	0.00	47.61	11.84
3.0	0.00	2.89	0.00	48.24	4.80
3.5	0.00	2.71	0.00	51.12	4.53
4.0	0.00	3.15	0.00	47.88	5.31
4.5	0.00	6.32	0.00	49.36	11.29
5.0	0.00	4.54	0.00	48.15	7.09
5.5	0.00	3.19	0.00	48.54	5.16
6.0	0.00	4.64	0.00	47.46	6.67
6.5	0.00	4.01	0.00	47.22	5.91
7.0	0.00	3.09	0.00	47.25	4.75
7.5	0.00	4.34	0.00	49.00	6.31
8.0	0.00	4.12	0.00	49.18	6.01
8.5	0.00	3.62	0.00	51.15	5.58

depth (cm)	protodolomite (%)	dolomite (%)	CaCO3 in protodolomite (mol %)	CaCO3 in dolomite (mol %)	total carbonate minerals (%)
9.0	0.00	4.01	0.00	47.52	5.95
9.5	0.00	2.59	0.00	48.54	2.59
10.0	0.00	4.07	0.00	49.45	9.21
10.5	2.58	4.19	80.01	47.25	10.43
11.0	0.00	3.19	0.00	47.22	5.74
11.5	0.00	3.91	0.00	47.88	5.92
12.0	0.00	4.21	0.00	47.49	7.22
12.5	0.00	3.85	0.00	46.88	5.97
13.0	0.00	2.80	0.00	46.34	2.80
13.5	0.00	2.69	0.00	48.66	4.83
14.0	0.00	2.77	0.00	51.57	4.77
14.5	0.00	2.64	0.00	48.69	4.68
15.0	0.00	2.48	0.00	50.03	4.38
15.5	0.00	2.81	0.00	50.00	4.52
16.0	0.00	4.15	0.00	50.63	5.93
16.5	0.00	3.69	0.00	48.91	6.06
17.0	0.00	3.58	0.00	49.30	6.16
17.5	0.00	3.54	0.00	49.21	3.54
18.0	0.00	3.97	0.00	47.28	5.97
18.5	0.00	4.06	0.00	49.06	5.83
19.0	0.00	3.24	0.00	49.97	6.15
19.5	0.00	3.73	0.00	47.79	5.93
20.0	0.00	3.68	0.00	47.28	6.24
20.5	0.00	3.03	0.00	48.91	4.94
21.0	0.00	2.25	0.00	46.34	3.95
21.5	0.00	3.86	0.00	51.09	3.86
22.0	0.00	4.48	0.00	49.33	9.94
22.5	0.00	3.33	0.00	49.91	7.65
23.0	0.00	4.51	0.00	45.68	7.87
23.5	0.00	3.07	0.00	53.34	6.82
24.0	0.00	4.18	0.00	48.57	7.28
24.5	2.48	3.87	78.59	48.91	10.55
25.0	0.00	3.39	0.00	48.69	5.23
25.5	0.00	0.00	0.00	0.00	1.85
26.0	2.61	2.79	79.33	46.67	7.58
26.5	0.00	2.43	0.00	47.97	5.31
27.0	0.00	2.46	0.00	47.43	4.42
27.5	0.00	2.54	0.00	50.54	4.77
28.0	0.00	2.88	0.00	47.55	4.90
28.5	0.00	3.56	0.00	54.78	5.46
29.0	0.00	3.85	0.00	48.39	5.65
29.5	0.00	4.12	0.00	50.06	8.28
30.0	2.67	4.38	77.14	48.39	8.90
31.0	0.00	3.26	0.00	44.39	7.16
32.0	0.00	3.48	0.00	44.57	7.52
33.0	0.00	3.01	0.00	46.70	5.05
34.0	0.00	5.07	0.00	45.62	10.87
35.0	0.00	3.46	0.00	46.82	7.16
36.0	0.00	3.23	0.00	45.98	8.27
37.0	0.00	5.05	0.00	45.26	9.14

depth (cm)	protodolomite (%)	dolomite (%)	CaCO3 in protodolomite (mol %)	CaCO3 in dolomite (mol %)	total carbonate minerals (%)
38.0	0.00	4.02	0.00	45.29	8.26
39.0	0.00	3.10	0.00	47.58	5.15
40.0	0.00	3.20	0.00	45.53	5.59
41.0	0.00	4.51	0.00	45.65	6.73
42.0	0.00	2.59	0.00	48.33	4.58
43.0	0.00	0.00	0.00	0.00	2.63
44.0	0.00	3.91	0.00	46.04	8.30
45.0	0.00	3.99	0.00	47.40	8.66
46.0	0.00	7.66	0.00	47.37	13.28
47.0	0.00	4.70	0.00	46.46	9.79
48.0	0.00	5.00	0.00	46.49	10.82
49.0	0.00	3.57	0.00	45.98	7.74
50.0	0.00	5.87	0.00	47.43	9.93
51.0	0.00	5.99	0.00	47.46	11.62
52.0	0.00	3.01	0.00	46.31	7.28
53.0	0.00	5.08	0.00	47.01	11.83
54.0	0.00	5.00	0.00	46.28	8.32
55.0	0.00	4.04	0.00	45.71	8.26
56.0	0.00	3.49	0.00	46.40	8.09
57.0	0.00	6.46	0.00	46.97	6.46
58.0	0.00	3.38	0.00	45.65	5.42
59.0	0.00	3.18	0.00	45.80	8.17
60.0	0.00	5.47	0.00	44.60	9.59
61.0	0.00	3.34	0.00	45.02	6.20
62.0	0.00	3.06	0.00	44.45	5.22
63.0	0.00	4.49	0.00	44.45	10.03
64.0	0.00	6.00	0.00	44.51	9.69
65.0	0.00	5.74	0.00	44.33	12.40
66.0	0.00	5.45	0.00	41.32	9.97
67.0	0.00	2.85	0.00	36.94	6.95
68.0	0.00	4.64	0.00	38.21	4.64
69.0	0.00	3.88	0.00	37.79	6.79
70.0	0.00	3.07	0.00	35.23	7.87
71.0	0.00	3.94	0.00	36.41	9.80
72.0	0.00	3.05	0.00	33.97	6.45
73.0	0.00	3.27	0.00	34.23	7.15
74.0	0.00	3.43	0.00	32.74	7.93
75.0	0.00	4.85	0.00	31.81	11.02
76.0	0.00	4.39	0.00	32.33	8.85
77.0	0.00	4.62	0.00	31.64	9.35
78.0	0.00	3.56	0.00	31.58	6.31
79.0	0.00	3.28	0.00	31.90	7.48
80.0	0.00	5.89	0.00	48.69	11.92
81.0	0.00	4.68	0.00	47.55	7.38
82.0	2.84	3.70	77.27	43.35	8.57
83.0	0.00	5.13	0.00	49.30	9.07
84.0	0.00	4.46	0.00	50.12	9.65
85.0	0.00	2.80	0.00	49.00	4.75
86.0	0.00	3.04	0.00	50.03	3.04
87.0	0.00	4.38	0.00	49.12	5.35

depth (cm)	protodolomite (%)	dolomite (%)	CaCO3 in protodolomite (mol %)	CaCO3 in dolomite (mol %)	total carbonate minerals (%)
88.0	0.00	4.65	0.00	48.45	10.80
89.0	2.63	4.98	79.39	48.57	11.06

PAD 54 Sulfate Minerals

depth (cm)	thenardite (%)	anhydrite (%)	gypsum (%)	total sulfates (%)
0.0	2.42	0.00	0.00	2.42
0.5	0.00	0.00	0.00	0.00
1.0	0.00	0.00	0.00	0.00
1.5	0.00	0.00	0.00	0.00
2.0	2.33	0.00	0.00	2.33
2.5	0.00	0.00	0.00	0.00
3.0	0.00	0.00	0.00	0.00
3.5	0.00	0.00	0.00	0.00
4.0	0.00	10.90	0.00	10.9
4.5	0.00	0.00	0.00	0.00
5.0	0.00	0.00	7.77	7.77
5.5	0.00	0.00	0.00	0.00
6.0	0.00	0.00	0.00	0.00
6.5	0.00	0.00	0.00	0.00
7.0	0.00	0.00	0.00	0.00
7.5	0.00	0.00	0.00	0.00
8.0	0.00	0.00	0.00	0.00
8.5	0.00	0.00	0.00	0.00
9.0	0.00	0.00	0.00	0.00
9.5	0.00	0.00	0.00	0.00
10.0	2.88	0.00	0.00	2.88
10.5	0.00	0.00	0.00	0.00
11.0	0.00	0.00	0.00	0.00
11.5	0.00	0.00	7.36	7.36
12.0	0.00	0.00	0.00	0.00
12.5	0.00	0.00	0.00	0.00
13.0	0.00	10.78	0.00	10.78
13.5	0.00	0.00	0.00	0.00
14.0	0.00	0.00	0.00	0.00
14.5	0.00	0.00	0.00	0.00
15.0	2.51	0.00	0.00	2.51
15.5	0.00	0.00	0.00	0.00
16.0	0.00	0.00	0.00	0.00
16.5	0.00	0.00	0.00	0.00
17.0	0.00	0.00	0.00	0.00
17.5	0.00	12.97	0.00	12.97
18.0	0.00	0.00	0.00	0.00
18.5	0.00	0.00	0.00	0.00
19.0	0.00	0.00	0.00	0.00
19.5	0.00	0.00	0.00	0.00
20.0	0.00	0.00	0.00	0.00
20.5	0.00	0.00	0.00	0.00
21.0	0.00	0.00	0.00	0.00

depth (cm)	thenardite (%)	anhydrite (%)	gypsum (%)	total sulfates (%)
21.5	0.00	0.00	0.00	0.00
22.0	0.00	0.00	0.00	0.00
22.5	0.00	0.00	0.00	0.00
23.0	0.00	0.00	0.00	0.00
23.5	0.00	0.00	0.00	0.00
24.0	0.00	0.00	0.00	0.00
24.5	0.00	0.00	0.00	0.00
25.0	0.00	0.00	0.00	0.00
25.5	0.00	0.00	0.00	0.00
26.0	0.00	0.00	0.00	0.00
26.5	0.00	11.10	0.00	11.10
27.0	0.00	0.00	0.00	0.00
27.5	0.00	0.00	0.00	0.00
28.0	0.00	0.00	0.00	0.00
28.5	0.00	0.00	0.00	0.00
29.0	0.00	0.00	0.00	0.00
29.5	0.00	0.00	0.00	0.00
30.0	0.00	0.00	0.00	0.00
31.0	0.00	0.00	0.00	0.00
32.0	0.00	0.00	0.00	0.00
33.0	2.91	0.00	0.00	2.91
34.0	0.00	0.00	0.00	0.00
35.0	0.00	0.00	0.00	0.00
36.0	0.00	0.00	0.00	0.00
37.0	0.00	0.00	0.00	0.00
38.0	0.00	0.00	0.00	0.00
39.0	0.00	0.00	0.00	0.00
40.0	0.00	0.00	0.00	0.00
41.0	0.00	0.00	0.00	0.00
42.0	0.00	0.00	0.00	0.00
43.0	0.00	0.00	0.00	0.00
44.0	0.00	0.00	0.00	0.00
45.0	0.00	0.00	0.00	0.00
46.0	0.00	0.00	0.00	0.00
47.0	0.00	0.00	0.00	0.00
48.0	0.00	0.00	0.00	0.00
49.0	0.00	0.00	0.00	0.00
50.0	0.00	0.00	0.00	0.00
51.0	0.00	0.00	0.00	0.00
52.0	0.00	0.00	0.00	0.00
53.0	0.00	0.00	0.00	0.00
54.0	2.68	0.00	0.00	2.68
55.0	0.00	0.00	0.00	0.00
56.0	0.00	0.00	0.00	0.00
57.0	0.00	0.00	0.00	0.00
58.0	0.00	0.00	0.00	0.00
59.0	0.00	0.00	0.00	0.00
60.0	0.00	0.00	0.00	0.00
61.0	0.00	0.00	0.00	0.00
62.0	0.00	0.00	0.00	0.00
63.0	0.00	0.00	0.00	0.00

depth (cm)	thenardite (%)	anhydrite (%)	gypsum (%)	total sulfates (%)
64.0	0.00	0.00	0.00	0.00
65.0	0.00	0.00	0.00	0.00
66.0	0.00	0.00	0.00	0.00
67.0	0.00	14.11	0.00	14.11
68.0	0.00	0.00	0.00	0.00
69.0	0.00	18.64	0.00	18.64
70.0	0.00	0.00	0.00	0.00
71.0	0.00	18.86	0.00	18.86
72.0	0.00	16.71	0.00	16.71
73.0	0.00	15.98	0.00	15.98
74.0	0.00	0.00	0.00	0.00
75.0	0.00	0.00	0.00	0.00
76.0	0.00	16.52	0.00	16.52
77.0	0.00	0.00	0.00	0.00
78.0	0.00	16.79	0.00	16.79
79.0	0.00	16.05	0.00	16.05
80.0	0.00	0.00	0.00	0.00
81.0	0.00	0.00	0.00	0.00
82.0	0.00	0.00	0.00	0.00
83.0	0.00	0.00	0.00	0.00
84.0	0.00	0.00	0.00	0.00
85.0	0.00	0.00	0.00	0.00
86.0	0.00	0.00	0.00	0.00
87.0	0.00	0.00	0.00	0.00
88.0	0.00	0.00	0.00	0.00
89.0	0.00	0.00	0.00	0.00

PAD 15 Carbonate and Evaporite Mineralogy

PAD 15 Calcite and Mg-calcite

depth (cm)	calcite (%)	Mg-calcite (%)	total calcite (%)	MgCO3 in calcite (mol %)	MgCO3 in Mg-calcite (mol %)
0.0	0.00	4.16	4.16	0.00	3.83
0.5	0.00	0.00	0.00	0.00	0.00
1.0	1.83	1.41	3.24	3.50	16.75
1.5	2.23	1.88	4.11	1.62	16.79
2.0	2.54	1.92	4.46	3.50	17.11
2.5	2.14	2.20	4.34	2.39	16.46
3.0	2.31	1.96	4.27	2.59	16.88
3.5	2.67	0.00	2.67	2.56	0.00
4.0	3.29	1.77	5.06	3.50	16.53
4.5	0.00	0.00	0.00	0.00	0.00
5.0	0.00	1.90	1.90	0.00	15.61
5.5	2.93	2.09	5.02	2.16	15.78
6.0	2.63	1.90	4.53	1.96	15.97
6.5	2.97	2.06	5.03	3.23	16.46
7.0	3.33	0.00	3.33	2.86	0.00
7.5	3.39	1.90	5.29	2.96	17.99
8.0	0.00	0.00	0.00	0.00	0.00

depth (cm)	calcite (%)	Mg-calcite (%)	total calcite (%)	MgCO3 in calcite (mol %)	MgCO3 in Mg-calcite (mol %)
8.5	0.00	1.60	1.60	0.00	15.91
9.0	0.00	2.14	2.14	0.00	16.82
9.5	2.30	0.00	2.30	1.82	0.00
10.0	0.00	2.03	2.03	0.00	7.72
10.5	0.00	0.00	0.00	0.00	0.00
11.0	0.00	1.71	1.71	0.00	15.68
11.5	1.79	1.53	3.32	2.36	19.54
12.0	1.94	1.69	3.63	3.10	16.95
12.5	1.67	1.74	3.41	3.20	16.26
13.0	1.90	0.00	1.90	3.16	0.00
13.5	2.05	1.79	3.84	3.33	17.63
14.0	1.38	1.38	2.76	3.80	15.42
14.5	0.00	1.68	1.68	0.00	13.69
15.0	0.00	1.79	1.79	0.00	14.50
15.5	2.04	2.04	4.08	1.02	15.06
16.0	1.79	1.82	3.61	1.02	15.38
16.5	2.76	2.43	5.19	0.18	11.19
17.0	2.59	1.77	4.36	2.56	16.39
17.5	2.53	1.97	4.50	0.21	13.46
18.0	0.00	1.93	1.93	0.00	12.18
18.5	0.00	0.00	0.00	0.00	0.00
19.0	2.33	1.89	4.22	3.56	15.22
19.5	2.49	1.97	4.46	1.76	14.50
20.0	2.70	1.72	4.42	1.89	14.83
20.5	2.38	1.93	4.31	2.06	13.91
21.0	1.61	1.71	3.32	1.96	15.22
21.5	2.54	1.89	4.43	2.86	14.96
22.0	1.61	1.77	3.38	0.28	14.50
22.5	0.00	2.13	2.13	0.00	15.94
23.0	0.00	1.90	1.90	0.00	15.78
23.5	2.73	1.97	4.70	2.02	15.35
24.0	2.12	2.08	4.20	0.85	14.54
24.5	2.18	2.16	4.34	3.46	18.31
25.0	2.86	0.00	2.86	1.08	0.00
25.5	3.55	1.64	5.19	2.39	15.87
26.0	5.29	0.00	5.29	2.13	0.00
26.5	3.06	1.88	4.94	3.43	15.71
27.0	2.25	1.98	4.23	2.76	15.55
27.5	2.14	1.90	4.04	1.66	15.38
28.0	3.67	0.00	3.67	3.13	0.00
28.5	3.71	0.00	3.71	2.23	0.00
29.0	2.80	1.82	4.62	1.92	15.71
29.5	2.26	1.77	4.03	2.93	16.36
30.0	2.73	2.04	4.77	3.60	19.41
30.5	2.97	0.00	2.97	1.49	0.00
31.0	3.18	0.00	3.18	1.89	0.00
31.5	3.24	0.00	3.24	2.16	0.00
32.0	2.20	1.65	3.85	2.96	18.31
32.5	2.52	1.47	3.99	3.83	17.99
33.0	3.15	0.00	3.15	3.50	0.00

depth (cm)	calcite (%)	Mg-calcite (%)	total calcite (%)	MgCO3 in calcite (mol %)	MgCO3 in Mg-calcite (mol %)
33.5	3.59	0.00	3.59	3.50	0.00
34.0	2.80	0.00	2.80	3.50	0.00
34.5	2.50	0.00	2.50	3.50	0.00
35.0	0.00	0.00	0.00	0.00	0.00
35.5	3.24	2.04	5.28	1.62	16.43
36.0	2.60	1.63	4.23	2.09	15.16
36.5	2.72	2.07	4.79	2.66	16.79
37.0	3.49	1.77	5.26	3.06	16.69
37.5	0.00	1.89	1.89	0.00	16.46
38.0	3.93	0.00	3.93	3.50	0.00
38.5	3.29	1.56	4.85	2.19	16.72
39.0	3.80	2.27	6.07	2.13	15.68
39.5	2.50	1.82	4.32	2.39	17.53
40.0	1.73	1.79	3.52	3.50	17.47
40.5	2.80	0.00	2.80	3.90	0.00
41.0	4.63	0.00	4.63	3.50	0.00
41.5	3.11	0.00	3.11	3.83	0.00
42.0	2.28	1.73	4.01	3.50	19.54
42.5	2.25	1.69	3.94	3.50	19.74
43.0	2.45	1.87	4.32	1.96	16.53
43.5	2.07	1.97	4.04	1.72	16.33
44.0	3.48	0.00	3.48	1.66	0.00
44.5	2.62	1.67	4.29	3.56	17.89
45.0	3.39	1.81	5.20	1.56	16.59
45.5	3.15	1.63	4.78	2.76	19.67
46.0	4.00	0.00	4.00	3.50	0.00
46.5	0.00	3.75	3.75	0.00	7.00
47.0	3.86	0.00	3.86	3.50	0.00
47.5	3.60	1.97	5.57	3.46	17.18
48.0	2.63	1.75	4.38	2.43	16.75
48.5	1.90	1.80	3.70	3.50	19.61
49.0	0.00	0.00	0.00	0.00	0.00
49.5	2.61	1.91	4.52	3.77	18.44
50.0	0.00	0.00	0.00	3.50	0.00
50.5	3.71	0.00	3.71	3.56	0.00
51.0	4.15	2.37	6.52	3.43	15.52
51.5	1.83	1.70	3.53	2.39	17.70
52.0	3.40	1.90	5.30	3.83	18.47
52.5	2.92	0.00	2.92	2.33	0.00
53.0	0.00	1.93	1.93	0.00	16.72
53.5	0.00	2.09	2.09	0.00	15.91
54.0	2.01	1.76	3.77	3.83	17.14
54.5	0.00	1.94	1.94	0.00	15.65
55.0	2.15	2.23	4.38	3.23	17.92
55.5	3.10	0.00	3.10	2.09	0.00
56.0	3.34	0.00	3.34	3.83	0.00
56.5	2.65	0.00	2.65	4.00	0.00
57.0	4.05	2.39	6.44	3.77	16.72
57.5	4.04	2.31	6.35	2.59	19.67
58.0	2.11	2.05	4.16	2.53	15.52

depth (cm)	calcite (%)	Mg-calcite (%)	total calcite (%)	MgCO3 in calcite (mol %)	MgCO3 in Mg-calcite (mol %)
58.5	2.00	1.69	3.69	3.73	16.92
59.0	1.91	0.00	1.91	3.43	0.00
59.5	1.73	1.91	3.64	3.50	17.24
60.0	4.25	0.00	4.25	4.00	0.00
60.5	2.01	1.70	3.71	3.77	17.92
61.0	2.01	1.95	3.96	2.43	15.97
61.5	3.66	2.02	5.68	3.50	16.98
62.0	5.11	0.00	5.11	3.77	0.00
62.5	0.00	2.53	2.53	0.00	7.03
63.0	1.97	2.02	3.99	2.06	16.92
63.5	2.26	0.00	2.26	2.23	0.00
64.0	0.00	2.19	2.19	0.00	14.44
64.5	0.00	2.11	2.11	0.00	16.30
65.0	2.08	1.84	3.92	3.50	16.85
65.5	2.72	0.00	2.72	3.50	0.00
66.0	2.33	2.15	4.48	2.23	15.45
66.5	3.01	1.81	4.82	3.50	18.21
67.0	3.40	1.79	5.19	3.30	17.63
67.5	4.71	2.19	6.90	3.60	17.47
68.0	2.84	1.68	4.52	2.46	16.43
68.5	5.04	2.36	7.40	3.50	16.49
69.0	3.23	0.00	3.23	4.00	0.00
69.5	0.00	1.96	1.96	0.00	16.43
70.0	2.78	1.81	4.59	3.50	16.88
70.5	4.98	2.02	7.00	3.83	18.05
71.0	1.95	1.99	3.94	3.40	16.92
71.5	3.13	0.00	3.13	3.50	0.00
72.0	0.00	2.97	2.97	0.00	8.78
72.5	0.00	2.41	2.41	0.00	7.96
73.0	3.24	0.00	3.24	3.50	0.00
73.5	2.10	2.17	4.27	3.50	18.08
74.0	2.71	2.25	4.96	3.63	16.98
74.5	2.66	1.70	4.36	3.50	17.57
75.0	2.75	2.02	4.77	3.97	18.08
75.5	2.42	2.10	4.52	2.09	15.48
76.0	2.08	2.15	4.23	1.69	15.16
76.5	2.14	2.05	4.19	0.19	11.95
77.0	3.05	1.97	5.02	3.30	17.66
77.5	2.84	2.11	4.95	1.89	16.26
78.0	3.92	0.00	3.92	3.83	0.00
78.5	2.97	2.09	5.06	1.96	16.33
79.0	6.23	0.00	6.23	2.13	0.00
79.5	2.94	0.00	2.94	2.26	0.00
80.0	0.00	1.85	1.85	0.00	17.01
80.5	0.00	1.86	1.86	0.00	15.81
81.0	0.00	1.98	1.98	0.00	19.54
81.5	0.00	0.00	0.00	0.00	0.00
82.0	2.60	1.96	4.56	3.46	17.66
82.5	2.97	0.00	2.97	2.13	0.00
83.0	2.82	0.00	2.82	3.13	0.00

depth (cm)	calcite (%)	Mg-calcite (%)	total calcite (%)	MgCO3 in calcite (mol %)	MgCO3 in Mg-calcite (mol %)
83.5	0.00	0.00	0.00	0.00	0.00
84.0	3.44	1.83	5.27	2.29	18.93
84.5	3.78	2.04	5.82	3.50	19.02
85.0	0.00	0.00	0.00	0.00	0.00
85.5	1.69	1.81	3.50	3.83	18.28
86.0	4.22	0.00	4.22	3.50	0.00
86.5	3.37	0.00	3.37	3.50	0.00
87.0	2.32	1.95	4.27	3.50	19.41
87.5	3.21	2.12	5.33	3.50	16.95
88.0	3.06	2.14	5.20	3.50	17.01
88.5	3.97	2.13	6.10	3.50	19.02
89.0	4.37	2.90	7.27	3.70	16.95
89.5	3.68	1.88	5.56	3.50	18.54
90.0	3.90	0.00	3.90	3.50	0.00
90.5	3.41	0.00	3.41	3.50	0.00
91.0	3.69	1.86	5.55	3.90	18.96
91.5	3.00	1.58	4.58	3.50	16.39
92.0	3.82	0.00	3.82	3.50	0.00
92.5	3.68	0.00	3.68	3.50	0.00
93.0	3.10	1.90	5.00	3.83	18.41
93.5	2.58	2.04	4.62	3.66	18.15

PAD 15 Dolomite and Protodolomite

depth (cm)	protodolomite (%)	dolomite (%)	CaCO3 in protodolomite (mol %)	CaCO3 in dolomite (mol %)	total carbonate minerals (%)
0.0	0.00	2.10	0.00	48.36	6.26
0.5	0.00	3.01	0.00	44.36	3.01
1.0	0.00	2.43	0.00	46.28	5.67
1.5	0.00	3.80	0.00	50.09	7.91
2.0	0.00	3.79	0.00	48.45	8.25
2.5	0.00	3.74	0.00	49.78	8.08
3.0	0.00	3.70	0.00	49.84	7.97
3.5	0.00	4.78	0.00	49.00	7.45
4.0	0.00	5.84	0.00	48.76	10.90
4.5	0.00	3.22	0.00	50.51	3.22
5.0	0.00	2.95	0.00	49.12	4.85
5.5	0.00	4.21	0.00	49.24	9.23
6.0	0.00	4.11	0.00	50.15	8.64
6.5	0.00	5.21	0.00	49.27	10.24
7.0	0.00	5.05	0.00	49.06	8.38
7.5	0.00	5.46	0.00	49.15	10.75
8.0	0.00	3.45	0.00	50.36	3.45
8.5	0.00	2.83	0.00	50.36	4.43
9.0	0.00	3.73	0.00	48.88	5.87
9.5	0.00	4.04	0.00	49.36	6.34
10.0	0.67	0.69	79.33	45.74	3.39
10.5	0.00	3.89	0.00	47.58	3.89
11.0	0.00	3.88	0.00	48.60	5.59

depth (cm)	protodolomite (%)	dolomite (%)	CaCO3 in protodolomite (mol %)	CaCO3 in dolomite (mol %)	total carbonate minerals (%)
11.5	0.00	2.49	0.00	46.16	5.81
12.0	0.00	3.10	0.00	48.66	6.73
12.5	0.00	3.56	0.00	48.88	6.97
13.0	0.00	3.90	0.00	44.45	5.80
13.5	0.00	3.68	0.00	48.82	7.52
14.0	0.00	2.91	0.00	48.63	5.67
14.5	0.00	3.30	0.00	50.54	4.98
15.0	0.00	3.47	0.00	51.88	5.26
15.5	0.00	3.40	0.00	50.51	7.48
16.0	0.00	3.21	0.00	51.15	6.82
16.5	0.00	3.35	0.00	50.82	8.54
17.0	0.00	4.23	0.00	49.09	8.59
17.5	0.00	4.23	0.00	51.97	8.73
18.0	0.00	3.73	0.00	49.21	5.66
18.5	0.00	3.72	0.00	21.10	3.72
19.0	0.00	3.70	0.00	48.91	7.92
19.5	0.00	4.05	0.00	50.72	8.51
20.0	0.00	5.10	0.00	49.15	9.52
20.5	0.00	5.10	0.00	50.45	9.41
21.0	0.00	3.52	0.00	49.36	6.84
21.5	0.00	3.82	0.00	49.97	8.25
22.0	0.00	2.51	0.00	50.39	5.89
22.5	0.00	3.32	0.00	47.97	5.45
23.0	0.00	3.99	0.00	49.09	5.89
23.5	0.00	4.14	0.00	49.87	8.84
24.0	0.00	3.72	0.00	51.21	7.92
24.5	0.00	4.01	0.00	49.84	8.35
25.0	0.00	4.65	0.00	50.69	7.51
25.5	0.00	5.38	0.00	50.12	10.57
26.0	0.00	7.87	0.00	49.91	13.16
26.5	0.00	6.64	0.00	48.85	11.58
27.0	0.00	4.10	0.00	50.09	8.33
27.5	0.00	3.64	0.00	50.18	7.68
28.0	0.00	4.79	0.00	49.75	8.46
28.5	0.00	5.52	0.00	50.21	9.23
29.0	0.00	3.81	0.00	50.51	8.43
29.5	0.00	2.56	0.00	50.30	6.59
30.0	0.00	4.01	0.00	46.91	8.78
30.5	0.00	4.75	0.00	49.81	7.72
31.0	2.70	6.55	79.91	47.25	12.43
31.5	0.00	5.44	0.00	49.12	8.68
32.0	0.00	5.68	0.00	48.54	9.53
32.5	0.00	4.28	0.00	47.37	8.27
33.0	2.05	10.10	78.94	46.97	15.31
33.5	0.00	5.94	0.00	47.85	9.53
34.0	0.00	3.93	0.00	48.72	6.73
34.5	0.00	5.27	0.00	48.57	7.77
35.0	0.00	5.36	0.00	48.76	5.36
35.5	0.00	5.62	0.00	50.21	10.90
36.0	0.00	4.03	0.00	50.33	8.26

depth (cm)	protodolomite (%)	dolomite (%)	CaCO3 in protodolomite (mol %)	CaCO3 in dolomite (mol %)	total carbonate minerals (%)
36.5	0.00	4.42	0.00	49.27	9.21
37.0	0.00	4.59	0.00	49.12	9.85
37.5	0.00	4.59	0.00	50.06	6.48
38.0	0.00	7.61	0.00	46.16	11.54
38.5	0.00	4.45	0.00	49.97	9.30
39.0	0.00	6.30	0.00	49.12	12.37
39.5	0.00	3.68	0.00	48.91	8.00
40.0	0.00	3.33	0.00	46.34	6.85
40.5	0.00	3.54	0.00	47.76	6.34
41.0	2.70	5.04	80.04	46.88	12.37
41.5	0.00	4.48	0.00	47.94	7.59
42.0	0.00	4.30	0.00	47.16	8.31
42.5	0.00	3.54	0.00	47.19	7.48
43.0	0.00	3.46	0.00	49.75	7.78
43.5	0.00	3.02	0.00	51.24	7.06
44.0	0.00	5.02	0.00	50.21	8.50
44.5	0.00	4.03	0.00	48.72	8.32
45.0	0.00	5.03	0.00	50.42	10.23
45.5	0.00	5.91	0.00	49.06	10.69
46.0	0.00	8.48	0.00	47.10	12.48
46.5	2.66	7.36	77.85	45.65	13.77
47.0	2.16	5.26	79.49	47.31	11.28
47.5	0.00	4.31	0.00	48.76	9.88
48.0	0.00	3.94	0.00	48.72	8.32
48.5	0.00	2.70	0.00	46.07	6.40
49.0	0.00	2.70	0.00	48.72	2.70
49.5	0.00	3.36	0.00	48.57	7.88
50.0	3.48	11.17	0.00	48.69	14.65
50.5	0.00	5.55	0.00	48.63	9.26
51.0	0.00	5.69	0.00	48.88	12.21
51.5	0.00	3.03	0.00	49.12	6.56
52.0	0.00	3.91	0.00	47.82	9.21
52.5	0.00	5.16	0.00	48.76	8.08
53.0	0.00	4.97	0.00	48.63	6.90
53.5	0.00	3.67	0.00	51.33	5.76
54.0	0.00	3.60	0.00	48.69	7.37
54.5	0.00	3.11	0.00	50.00	5.05
55.0	0.00	3.85	0.00	50.03	8.23
55.5	0.00	4.17	0.00	49.60	7.27
56.0	0.00	5.11	0.00	46.55	8.45
56.5	0.00	4.54	0.00	47.67	7.19
57.0	0.00	5.03	0.00	48.76	11.47
57.5	0.00	5.88	0.00	50.21	12.23
58.0	0.00	3.63	0.00	49.18	7.79
58.5	0.00	3.12	0.00	48.21	6.81
59.0	3.53	13.38	0.00	47.28	18.82
59.5	0.00	3.53	0.00	48.88	7.17
60.0	0.00	5.17	0.00	49.00	9.42
60.5	0.00	3.25	0.00	47.73	6.96
61.0	0.00	3.53	0.00	49.87	7.49

depth (cm)	protodolomite (%)	dolomite (%)	CaCO3 in protodolomite (mol %)	CaCO3 in dolomite (mol %)	total carbonate minerals (%)
61.5	0.00	4.80	0.00	48.82	10.48
62.0	0.00	5.02	0.00	48.97	10.13
62.5	2.53	4.42	77.27	46.85	9.48
63.0	0.00	3.81	0.00	48.79	7.80
63.5	0.00	3.93	0.00	48.88	6.19
64.0	0.00	4.53	0.00	50.36	6.72
64.5	0.00	3.08	0.00	50.33	5.19
65.0	0.00	3.50	0.00	48.45	7.42
65.5	0.00	4.57	0.00	48.72	7.29
66.0	0.00	4.62	0.00	49.45	9.10
66.5	0.00	6.88	0.00	47.07	11.70
67.0	0.00	5.28	0.00	48.88	10.47
67.5	0.00	5.07	0.00	49.18	11.97
68.0	0.00	4.66	0.00	49.39	9.18
68.5	0.00	5.23	0.00	49.09	12.63
69.0	2.52	3.34	79.97	47.37	9.09
69.5	0.00	4.34	0.00	48.91	6.30
70.0	0.00	3.39	0.00	47.37	7.98
70.5	0.00	4.84	0.00	48.54	11.84
71.0	0.00	3.71	0.00	47.70	7.65
71.5	2.47	4.37	79.94	47.13	9.97
72.0	2.82	3.93	76.98	44.39	9.72
72.5	2.89	4.57	78.72	44.84	9.87
73.0	3.11	4.73	79.49	47.28	11.08
73.5	0.00	4.49	0.00	47.37	8.76
74.0	0.00	5.03	0.00	48.48	9.99
74.5	0.00	4.04	0.00	48.12	8.40
75.0	0.00	4.56	0.00	47.85	9.33
75.5	0.00	4.27	0.00	50.12	8.79
76.0	0.00	4.83	0.00	50.21	9.06
76.5	3.49	0.00	53.95	0.00	7.68
77.0	0.00	4.42	0.00	48.85	9.44
77.5	0.00	4.46	0.00	50.33	9.41
78.0	0.00	4.75	0.00	47.25	8.67
78.5	0.00	4.48	0.00	50.48	9.54
79.0	0.00	4.46	0.00	50.63	10.69
79.5	0.00	4.67	0.00	50.09	7.61
80.0	0.00	2.96	0.00	47.67	4.81
80.5	0.00	2.47	0.00	49.48	4.33
81.0	0.00	2.44	0.00	47.46	4.42
81.5	0.00	2.99	0.00	48.85	2.99
82.0	0.00	4.55	0.00	48.79	9.11
82.5	0.00	5.07	0.00	50.24	8.04
83.0	0.00	5.01	0.00	48.97	7.83
83.5	0.00	2.47	0.00	75.63	2.47
84.0	0.00	4.16	0.00	49.94	9.43
84.5	0.00	5.13	0.00	48.18	10.95
85.0	0.00	3.79	0.00	48.57	3.79
85.5	0.00	3.06	0.00	48.85	6.56
86.0	0.00	5.29	0.00	46.19	9.51

depth (cm)	protodolomite (%)	dolomite (%)	CaCO3 in protodolomite (mol %)	CaCO3 in dolomite (mol %)	total carbonate minerals (%)
86.5	0.00	4.12	0.00	48.00	7.49
87.0	0.00	3.49	0.00	47.52	7.76
87.5	0.00	4.55	0.00	48.57	9.88
88.0	0.00	5.24	0.00	47.46	10.44
88.5	0.00	6.47	0.00	47.43	12.57
89.0	0.00	5.84	0.00	47.82	13.11
89.5	0.00	5.83	0.00	47.79	11.39
90.0	0.00	3.87	0.00	48.91	7.77
90.5	0.00	6.17	0.00	47.31	9.58
91.0	0.00	4.40	0.00	48.76	9.95
91.5	0.00	4.92	0.00	48.79	9.50
92.0	0.00	5.81	0.00	46.37	9.63
92.5	0.00	6.20	0.00	47.97	9.88
93.0	0.00	6.09	0.00	47.52	11.09
93.5	0.00	4.50	0.00	47.46	9.12

PAD 15 Sulfate Minerals

depth (cm)	total sulfates (%)
0.0	10.09
0.5	18.47
1.0	19.37
1.5	0.00
2.0	8.36
2.5	0.00
3.0	0.00
3.5	0.00
4.0	0.00
4.5	12.02
5.0	0.00
5.5	0.00
6.0	11.37
6.5	0.00
7.0	0.00
7.5	0.00
8.0	0.00
8.5	0.00
9.0	0.00
9.5	0.00
10.0	0.00
10.5	0.00
11.0	0.00
11.5	12.14
12.0	0.00
12.5	0.00
13.0	0.00
13.5	0.00
14.0	11.52
14.5	0.00

depth (cm)	total sulfates (%)
15.0	0.00
15.5	0.00
16.0	0.00
16.5	0.00
17.0	0.00
17.5	0.00
18.0	0.00
18.5	0.00
19.0	0.00
19.5	0.00
20.0	0.00
20.5	0.00
21.0	0.00
21.5	0.00
22.0	0.00
22.5	0.00
23.0	0.00
23.5	0.00
24.0	0.00
24.5	0.00
25.0	0.00
25.5	0.00
26.0	0.00
26.5	0.00
27.0	0.00
27.5	0.00
28.0	0.00
28.5	0.00
29.0	0.00
29.5	11.81
30.0	0.00
30.5	12.77
31.0	0.00
31.5	0.00
32.0	0.00
32.5	12.05
33.0	11.75
33.5	0.00
34.0	0.00
34.5	0.00
35.0	0.00
35.5	0.00
36.0	0.00
36.5	0.00
37.0	0.00
37.5	0.00
38.0	0.00
38.5	11.84
39.0	0.00
39.5	0.00
40.0	0.00

depth (cm)	total sulfates (%)
40.5	0.00
41.0	0.00
41.5	0.00
42.0	0.00
42.5	0.00
43.0	0.00
43.5	0.00
44.0	0.00
44.5	0.00
45.0	0.00
45.5	11.12
46.0	0.00
46.5	0.00
47.0	0.00
47.5	0.00
48.0	0.00
48.5	13.16
49.0	0.00
49.5	0.00
50.0	0.00
50.5	0.00
51.0	10.73
51.5	11.25
52.0	0.00
52.5	0.00
53.0	0.00
53.5	0.00
54.0	0.00
54.5	0.00
55.0	0.00
55.5	0.00
56.0	0.00
56.5	0.00
57.0	0.00
57.5	0.00
58.0	0.00
58.5	0.00
59.0	0.00
59.5	0.00
60.0	0.00
60.5	11.67
61.0	0.00
61.5	0.00
62.0	0.00
62.5	0.00
63.0	0.00
63.5	0.00
64.0	0.00
64.5	0.00
65.0	0.00
65.5	0.00

depth (cm)	total sulfates (%)
66.0	0.00
66.5	0.00
67.0	0.00
67.5	0.00
68.0	12.21
68.5	0.00
69.0	0.00
69.5	0.00
70.0	0.00
70.5	0.00
71.0	0.00
71.5	0.00
72.0	0.00
72.5	0.00
73.0	0.00
73.5	0.00
74.0	0.00
74.5	0.00
75.0	0.00
75.5	0.00
76.0	0.00
76.5	0.00
77.0	0.00
77.5	0.00
78.0	0.00
78.5	0.00
79.0	0.00
79.5	10.66
80.0	0.00
80.5	0.00
81.0	0.00
81.5	0.00
82.0	0.00
82.5	17.35
83.0	0.00
83.5	13.50
84.0	0.00
84.5	0.00
85.0	0.00
85.5	0.00
86.0	0.00
86.5	0.00
87.0	0.00
87.5	0.00
88.0	0.00
88.5	0.00
89.0	0.00
89.5	0.00
90.0	0.00
90.5	0.00
91.0	0.00

depth (cm)	total sulfates (%)
91.5	0.00
92.0	0.00
92.5	0.00
93.0	0.00
93.5	0.00

PAD 8 Carbonate and Evaporite Mineralogy

PAD 8 Calcite and Mg-calcite

depth (cm)	calcite (%)	Mg-calcite (%)	total calcite (%)	MgCO3 in calcite (mol %)	MgCO3 in Mg-calcite (mol %)
0.0	0.00	0.00	0.00	0.00	0.00
0.5	0.00	1.79	1.79	0.00	18.80
1.0	0.00	0.00	0.00	0.00	0.00
1.5	0.00	0.00	0.00	0.00	0.00
2.0	0.00	1.54	1.54	0.00	16.92
2.5	0.00	0.00	0.00	0.00	0.00
3.0	0.00	0.00	0.00	0.00	0.00
3.5	0.00	0.00	0.00	0.00	0.00
4.0	0.00	1.59	1.59	0.00	18.08
4.5	0.00	0.00	0.00	0.00	0.00
5.0	0.00	0.00	0.00	0.00	0.00
5.5	0.00	0.00	0.00	0.00	0.00
6.0	0.00	0.00	0.00	0.00	0.00
6.5	0.00	0.00	0.00	0.00	0.00
7.0	0.00	0.00	0.00	0.00	0.00
7.5	0.00	0.00	0.00	0.00	0.00
8.0	0.00	0.00	0.00	0.00	0.00
8.5	0.00	1.53	1.53	0.00	15.65
9.0	0.00	0.00	0.00	0.00	0.00
9.5	0.00	1.49	1.49	0.00	18.57
10.0	0.00	0.00	0.00	0.00	0.00
10.5	0.00	1.97	1.97	0.00	19.70
11.0	0.00	0.00	0.00	0.00	0.00
11.5	0.00	0.00	0.00	0.00	0.00
12.0	0.00	1.66	1.66	0.00	18.02
12.5	0.00	1.60	1.60	0.00	15.42
13.0	0.00	1.63	1.63	0.00	18.80
13.5	0.00	1.78	1.78	0.00	16.72
14.0	0.00	1.51	1.51	0.00	17.05
14.5	0.00	1.56	1.56	0.00	14.60
15.0	0.00	0.83	0.83	0.00	16.79
15.5	0.00	0.00	0.00	0.00	0.00
16.0	0.00	1.62	1.62	0.00	17.60
16.5	0.00	1.67	1.67	0.00	14.93
17.0	0.00	1.66	1.66	0.00	15.29
17.5	0.00	1.60	1.60	0.00	16.36
18.0	0.00	1.68	1.68	0.00	16.46
18.5	0.00	0.00	0.00	0.00	0.00

depth (cm)	calcite (%)	Mg-calcite (%)	total calcite (%)	MgCO3 in calcite (mol %)	MgCO3 in Mg-calcite (mol %)
19.0	0.00	1.96	1.96	0.00	13.13
19.5	0.00	2.31	2.31	0.00	17.95
20.0	0.00	1.94	1.94	0.00	15.55
20.5	0.00	1.61	1.61	0.00	13.26
21.0	0.00	1.92	1.92	0.00	16.39
21.5	0.00	1.89	1.89	0.00	18.15
22.0	0.00	1.84	1.84	0.00	17.18
22.5	0.00	1.54	1.54	0.00	17.47
23.0	0.00	1.86	1.86	0.00	19.12
23.5	0.00	1.65	1.65	0.00	18.12
24.0	0.00	1.83	1.83	0.00	15.78
24.5	0.00	1.79	1.79	0.00	16.98
25.0	0.00	1.64	1.64	0.00	15.22
25.5	0.00	0.00	0.00	0.00	0.00
26.0	0.00	1.51	1.51	0.00	7.39
26.5	0.00	0.00	0.00	0.00	0.00
27.0	0.00	1.75	1.75	0.00	9.91
27.5	0.00	1.76	1.76	0.00	16.95
28.0	0.00	1.80	1.80	0.00	16.49
28.5	0.00	1.80	1.80	0.00	19.57
29.0	0.00	2.03	2.03	0.00	16.43
29.5	0.00	1.44	1.44	0.00	16.72
30.0	0.00	1.81	1.81	0.00	4.70
31.0	0.00	1.57	1.57	0.00	16.79
32.0	0.00	1.72	1.72	0.00	19.80
33.0	0.00	1.66	1.66	0.00	19.44
34.0	0.00	1.62	1.62	0.00	17.76
35.0	0.00	1.43	1.43	0.00	18.41
36.0	1.89	1.89	3.78	0.65	0.00
37.0	0.00	0.00	0.00	0.00	0.00
38.0	0.00	0.00	0.00	0.00	0.00
39.0	0.00	0.00	0.00	0.00	0.00
40.0	0.00	1.71	1.71	0.00	16.95
41.0	0.00	0.00	0.00	0.00	0.00
42.0	0.00	0.00	0.00	0.00	0.00
43.0	0.00	1.65	1.65	0.00	16.62
44.0	0.00	0.00	0.00	0.00	0.00
45.0	0.00	1.89	1.89	0.00	17.73
46.0	0.00	1.95	1.95	0.00	16.53
47.0	0.00	1.61	1.61	0.00	19.19
48.0	0.00	1.83	1.83	0.00	16.43
49.0	0.00	0.00	0.00	0.00	0.00
50.0	0.00	1.62	1.62	0.00	16.85
51.0	0.00	1.82	1.82	0.00	15.45
52.0	0.00	1.99	1.99	0.00	16.85
53.0	0.00	0.00	0.00	0.00	0.00
54.0	0.00	1.57	1.57	0.00	15.22
55.0	0.00	1.58	1.58	0.00	15.48
56.0	0.00	1.90	1.90	0.00	16.07
57.0	0.00	1.98	1.98	0.00	16.88

depth (cm)	calcite (%)	Mg-calcite (%)	total calcite (%)	MgCO3 in calcite (mol %)	MgCO3 in Mg-calcite (mol %)
58.0	0.00	2.00	2.00	0.00	18.28
59.0	0.00	0.00	0.00	0.00	0.00
60.0	0.00	1.67	1.67	0.00	16.88
61.0	0.00	1.81	1.81	0.00	19.67
62.0	0.00	1.69	1.69	0.00	17.01
63.0	2.54	2.54	5.08	3.40	0.00
64.0	2.38	4.43	6.81	3.03	17.01
65.0	0.00	1.88	1.88	0.00	15.84
66.0	0.00	1.81	1.81	0.00	16.88
67.0	0.00	1.60	1.60	0.00	18.25
68.0	0.00	0.00	0.00	0.00	0.00
69.0	0.00	2.00	2.00	0.00	17.47
70.0	0.00	0.00	0.00	0.00	0.00
71.0	0.00	1.66	1.66	0.00	11.62
72.0	0.00	1.95	1.95	0.00	16.17
73.0	0.00	1.71	1.71	0.00	17.66
74.0	0.00	1.85	1.85	0.00	16.62
75.0	0.00	1.97	1.97	0.00	10.01
76.0	0.00	0.00	0.00	0.00	0.00
77.0	0.00	0.00	0.00	0.00	0.00
78.0	0.00	0.00	0.00	0.00	0.00
79.0	0.00	0.00	0.00	0.00	0.00
80.0	0.00	1.75	1.75	0.00	14.99
81.0	0.00	0.00	0.00	0.00	0.00
82.0	0.00	2.04	2.04	0.00	11.06
83.0	0.00	0.00	0.00	0.00	0.00
84.0	0.00	0.00	0.00	0.00	0.00
85.0	0.00	0.00	0.00	0.00	0.00
86.0	0.00	1.33	1.33	0.00	18.05
87.0	0.00	1.54	1.54	0.00	15.22
88.0	0.00	1.53	1.53	0.00	14.99
89.0	0.00	1.67	1.67	0.00	16.72
90.0	0.00	1.78	1.78	0.00	16.07
91.0	0.00	1.54	1.54	0.00	13.03
92.0	0.00	1.56	1.56	0.00	16.79
93.0	0.00	1.76	1.76	0.00	20.06
94.0	0.00	1.75	1.75	0.00	13.69
95.0	0.00	1.64	1.64	0.00	15.52
96.0	0.00	0.00	0.00	0.00	0.00
97.0	0.00	1.88	1.88	0.00	10.07

PAD 8 Dolomite and Protodolomite

depth (cm)	protodolomite (%)	dolomite (%)	CaCO3 in protodolomite (mol %)	CaCO3 in dolomite (mol %)	total carbonate minerals (%)
0.0	0.00	2.28	0.00	44.03	2.28
0.5	0.00	2.15	0.00	41.20	3.94
1.0	0.00	0.00	0.00	0.00	0.00
1.5	0.00	2.25	0.00	39.24	2.25

depth (cm)	protodolomite (%)	dolomite (%)	CaCO3 in protodolomite (mol %)	CaCO3 in dolomite (mol %)	total carbonate minerals (%)
2.0	0.00	2.11	0.00	42.99	3.65
2.5	0.00	2.30	0.00	42.75	2.30
3.0	0.00	2.35	0.00	41.65	2.35
3.5	0.00	2.98	0.00	40.37	2.98
4.0	0.00	3.23	0.00	41.59	4.82
4.5	0.00	2.77	0.00	42.75	2.77
5.0	0.00	2.07	0.00	43.73	2.07
5.5	2.15	2.23	78.26	42.60	4.38
6.0	0.00	2.05	0.00	43.73	2.05
6.5	0.00	0.00	0.00	0.00	0.00
7.0	0.00	0.00	0.00	0.00	0.00
7.5	0.00	0.00	0.00	0.00	0.00
8.0	0.00	0.00	0.00	0.00	0.00
8.5	0.00	0.00	0.00	0.00	1.53
9.0	0.00	0.00	0.00	0.00	0.00
9.5	0.00	0.00	0.00	0.00	1.49
10.0	0.00	0.00	0.00	0.00	0.00
10.5	0.00	0.00	0.00	0.00	1.97
11.0	2.41	0.00	79.88	0.00	2.41
11.5	0.00	0.00	0.00	0.00	0.00
12.0	0.00	0.00	0.00	0.00	1.66
12.5	0.00	0.00	0.00	0.00	1.60
13.0	0.00	0.00	0.00	0.00	1.63
13.5	0.00	0.00	0.00	0.00	1.78
14.0	0.00	0.00	0.00	0.00	1.51
14.5	0.00	0.00	0.00	0.00	1.56
15.0	0.00	0.00	0.00	0.00	0.83
15.5	0.00	0.00	0.00	0.00	0.00
16.0	0.00	0.00	0.00	0.00	1.62
16.5	0.00	0.00	0.00	0.00	1.67
17.0	0.00	0.00	0.00	0.00	1.66
17.5	0.00	0.00	0.00	0.00	1.60
18.0	0.00	0.00	0.00	0.00	1.68
18.5	0.00	0.00	0.00	0.00	0.00
19.0	0.00	0.00	0.00	0.00	1.96
19.5	0.00	1.87	0.00	41.56	4.18
20.0	0.00	0.00	0.00	0.00	1.94
20.5	0.00	2.27	0.00	49.75	3.88
21.0	0.00	0.00	0.00	0.00	1.92
21.5	0.00	0.00	0.00	0.00	1.89
22.0	0.00	0.00	0.00	0.00	1.84
22.5	0.00	0.00	0.00	0.00	1.54
23.0	0.00	2.40	0.00	48.82	4.26
23.5	0.00	0.00	0.00	0.00	1.65
24.0	0.00	0.00	0.00	0.00	1.83
24.5	0.00	0.00	0.00	0.00	1.79
25.0	0.00	0.00	0.00	0.00	1.64
25.5	0.00	0.00	0.00	0.00	0.00
26.0	0.00	0.00	0.00	0.00	1.51
26.5	0.00	0.00	0.00	0.00	0.00

depth (cm)	protodolomite (%)	dolomite (%)	CaCO3 in protodolomite (mol %)	CaCO3 in dolomite (mol %)	total carbonate minerals (%)
27.0	2.42	2.42	0.00	54.05	6.59
27.5	0.00	0.00	0.00	0.00	1.76
28.0	0.00	0.00	0.00	0.00	1.80
28.5	0.00	0.00	0.00	0.00	1.80
29.0	0.00	2.81	0.00	50.51	4.84
29.5	0.00	2.45	0.00	48.76	3.89
30.0	0.00	2.82	0.00	49.51	4.63
31.0	0.00	2.43	0.00	47.37	4.00
32.0	0.00	0.00	0.00	0.00	1.72
33.0	0.00	2.31	0.00	48.82	3.97
34.0	0.00	1.99	0.00	49.03	3.61
35.0	0.00	2.25	0.00	47.10	3.68
36.0	0.00	0.00	0.00	0.00	3.78
37.0	0.00	0.00	0.00	0.00	0.00
38.0	0.00	0.00	0.00	0.00	0.00
39.0	0.00	0.00	0.00	0.00	0.00
40.0	0.00	0.00	0.00	0.00	1.71
41.0	0.00	0.00	0.00	0.00	0.00
42.0	0.00	0.00	0.00	0.00	0.00
43.0	0.00	0.00	0.00	0.00	1.65
44.0	0.00	0.00	0.00	0.00	0.00
45.0	0.00	0.00	0.00	0.00	1.89
46.0	0.00	0.00	0.00	0.00	1.95
47.0	0.00	2.05	0.00	48.51	3.66
48.0	0.00	0.00	0.00	0.00	1.83
49.0	0.00	2.47	0.00	49.87	2.47
50.0	0.00	0.00	0.00	0.00	1.62
51.0	0.00	0.00	0.00	0.00	1.82
52.0	0.00	0.00	0.00	0.00	1.99
53.0	0.00	0.00	0.00	0.00	0.00
54.0	0.00	0.00	0.00	0.00	1.57
55.0	0.00	0.00	0.00	0.00	1.58
56.0	0.00	0.00	0.00	0.00	1.90
57.0	0.00	0.00	0.00	0.00	1.98
58.0	0.00	0.00	0.00	0.00	2.00
59.0	0.00	2.59	0.00	49.21	2.59
60.0	0.00	2.35	0.00	48.63	4.02
61.0	0.00	2.63	0.00	46.70	4.44
62.0	0.00	2.65	0.00	48.94	4.34
63.0	0.00	2.80	0.00	49.72	7.88
64.0	0.00	3.20	0.00	50.00	10.01
65.0	0.00	2.70	0.00	49.57	4.58
66.0	0.00	2.37	0.00	47.61	4.18
67.0	0.00	1.92	0.00	51.54	3.52
68.0	0.00	2.38	0.00	49.63	2.38
69.0	0.00	2.38	0.00	48.66	4.38
70.0	0.00	0.00	0.00	0.00	0.00
71.0	0.00	0.00	0.00	0.00	1.66
72.0	0.00	0.00	0.00	0.00	1.95
73.0	0.00	0.00	0.00	0.00	1.71

depth (cm)	protodolomite (%)	dolomite (%)	CaCO3 in protodolomite (mol %)	CaCO3 in dolomite (mol %)	total carbonate minerals (%)
74.0	0.00	0.00	0.00	0.00	1.85
75.0	0.00	0.00	0.00	0.00	1.97
76.0	0.00	2.53	0.00	51.97	2.53
77.0	0.00	0.00	0.00	0.00	0.00
78.0	2.76	2.76	79.81	0.00	5.52
79.0	0.00	0.00	0.00	0.00	0.00
80.0	0.00	0.00	0.00	0.00	1.75
81.0	2.17	2.17	75.06	0.00	4.34
82.0	0.00	0.00	0.00	0.00	2.04
83.0	0.00	0.00	0.00	0.00	0.00
84.0	2.36	2.36	80.01	0.00	4.72
85.0	0.00	0.00	0.00	0.00	0.00
86.0	0.00	0.00	0.00	0.00	1.33
87.0	0.00	0.00	0.00	0.00	1.54
88.0	0.00	0.00	0.00	0.00	1.53
89.0	0.00	0.00	0.00	0.00	1.67
90.0	0.00	0.00	0.00	0.00	1.78
91.0	0.00	0.00	0.00	0.00	1.54
92.0	0.00	0.00	0.00	0.00	1.56
93.0	0.00	0.00	0.00	0.00	1.76
94.0	0.00	0.00	0.00	0.00	1.75
95.0	0.00	0.00	0.00	0.00	1.64
96.0	0.00	0.00	0.00	0.00	0.00
97.0	0.00	2.46	0.00	55.27	4.34

PAD 8 Sulfate Minerals

depth (cm)	total sulfates (%)
0.0	15.36
0.5	15.11
1.0	11.81
1.5	15.29
2.0	15.32
2.5	16.41
3.0	15.10
3.5	14.19
4.0	21.10
4.5	13.34
5.0	12.22
5.5	15.34
6.0	10.54
6.5	14.58
7.0	9.38
7.5	10.46
8.0	0.00
8.5	8.65
9.0	0.00
9.5	10.63

depth (cm)	total sulfates (%)
10.0	0.00
10.5	0.00
11.0	0.00
11.5	8.78
12.0	0.00
12.5	7.46
13.0	7.35
13.5	0.00
14.0	10.66
14.5	10.72
15.0	0.00
15.5	0.00
16.0	0.00
16.5	0.00
17.0	0.00
17.5	0.00
18.0	0.00
18.5	0.00
19.0	0.00
19.5	0.00
20.0	0.00
20.5	0.00
21.0	0.00
21.5	0.00
22.0	0.00
22.5	0.00
23.0	0.00
23.5	0.00
24.0	0.00
24.5	0.00
25.0	0.00
25.5	0.00
26.0	0.00
26.5	0.00
27.0	13.65
27.5	0.00
28.0	0.00
28.5	0.00
29.0	0.00
29.5	10.64
30.0	0.00
31.0	0.00
32.0	0.00
33.0	0.00
34.0	0.00
35.0	10.35
36.0	0.00
37.0	0.00
38.0	0.00
39.0	0.00
40.0	0.00

depth (cm)	total sulfates (%)
41.0	0.00
42.0	0.00
43.0	0.00
44.0	0.00
45.0	0.00
46.0	0.00
47.0	0.00
48.0	0.00
49.0	0.00
50.0	0.00
51.0	0.00
52.0	0.00
53.0	0.00
54.0	0.00
55.0	0.00
56.0	0.00
57.0	0.00
58.0	0.00
59.0	0.00
60.0	0.00
61.0	0.00
62.0	0.00
63.0	0.00
64.0	0.00
65.0	0.00
66.0	10.83
67.0	0.00
68.0	0.00
69.0	0.00
70.0	0.00
71.0	0.00
72.0	0.00
73.0	0.00
74.0	0.00
75.0	0.00
76.0	0.00
77.0	0.00
78.0	0.00
79.0	0.00
80.0	0.00
81.0	0.00
82.0	0.00
83.0	10.80
84.0	0.00
85.0	0.00
86.0	10.53
87.0	0.00
88.0	0.00
89.0	0.00
90.0	0.00
91.0	0.00

depth (cm)	total sulfates (%)
92.0	0.00
93.0	0.00
94.0	0.00
95.0	0.00
96.0	0.00
97.0	0.00

Appendix G

Magnetic Susceptibility Data

depth (cm)	PAD 54 magnetic susceptibility (SI units)	PAD 15 magnetic susceptibility (SI units)	PAD 18 magnetic susceptibility (SI units)
0.25	21.96	23.42	-6.54
0.75	17.83	40.52	-2.01
1.25	26.32	63.75	-0.66
1.75	12.60	112.43	-2.90
2.25	35.73	117.67	-1.04
2.75	104.14	136.32	-2.58
3.25	124.38	133.00	0.09
3.75	108.35	166.43	0.83
4.25	49.49	101.87	-0.79
4.75	40.92	91.49	2.21
5.25	64.96	147.26	3.36
5.75	147.08	143.44	-0.59
6.25	127.17	156.41	5.39
6.75	72.43	115.06	2.60
7.25	71.13	73.97	0.09
7.75	86.13	103.09	4.11
8.25	74.01	109.60	1.22
8.75	78.62	80.40	0.54
9.25	98.49	130.76	1.09
9.75	101.29	119.26	1.11
10.25	75.16	103.56	-0.17
10.75	62.67	113.19	4.47
11.25	78.14	118.95	2.84
11.75	96.81	111.51	1.31
12.25	106.67	116.39	0.84
12.75	103.50	95.24	-0.69
13.25	125.96	121.90	-3.33
13.75	103.59	136.19	-3.13
14.25	74.79	124.00	-2.77
14.75	53.22	107.77	-1.35
15.25	50.31	106.53	0.03
15.75	62.30	117.52	-0.87
16.25	58.99	119.16	-0.14
16.75	51.23	105.47	4.25
17.25	93.09	129.43	-3.50
17.75	163.51	129.59	4.25
18.25	221.83	113.70	-1.77
18.75	81.42	100.53	-1.38
19.25	78.52	126.51	0.01
19.75	99.30	144.92	1.24
20.25	84.58	224.90	0.09
20.75	135.79	133.38	2.51
21.25	112.04	141.69	-0.09

depth (cm)	PAD 54 magnetic susceptibility (SI units)	PAD 15 magnetic susceptibility (SI units)	PAD 18 magnetic susceptibility (SI units)
21.75	87.22	117.41	5.46
22.25	95.48	95.28	2.09
22.75	132.07	102.63	1.34
23.25	133.07	131.62	-0.41
23.75	120.11	123.64	0.47
24.25	58.31	98.68	2.11
24.75	64.72	158.72	-0.19
25.25	100.95	178.10	1.16
25.75	154.21	267.89	0.05
26.25	89.24	317.34	1.87
26.75	184.77	249.32	2.59
27.25	134.27	112.49	2.16
27.75	171.14	121.39	3.03
28.25	134.00	219.63	1.47
28.75	77.08	270.40	1.30
29.25	65.48	100.11	2.03
29.75	53.79	87.10	
30.25	92.95	211.91	
30.75	103.94	295.54	
31.25	102.43	428.40	
31.75	113.84	474.76	
32.25	133.45	233.81	
32.75	109.26	196.42	
33.25	133.81	336.07	
33.75	125.17	297.62	
34.25	109.57	128.01	
34.75	96.59	196.24	
35.25	77.44	176.36	
35.75	66.75	221.13	
36.25	101.33	185.74	
36.75	103.86	131.52	
37.25	168.69	265.82	
37.75	216.86	357.57	
38.25	155.49	369.33	
38.75	83.61	361.44	
39.25	92.38	243.58	
39.75	119.39	138.24	
40.25	151.64	125.31	
40.75	206.29	173.92	
41.25	159.19	340.28	
41.75	128.19	356.63	
42.25	120.05	175.87	
42.75	101.09	109.86	
43.25	98.36	109.96	
43.75	91.24	104.05	
44.25	177.76	220.52	
44.75	116.62	189.74	
45.25	113.28	258.45	
45.75	78.77	344.16	

depth (cm)	PAD 54 magnetic susceptibility (SI units)	PAD 15 magnetic susceptibility (SI units)	PAD 18 magnetic susceptibility (SI units)
46.25	89.31	359.90	
46.75	137.58	360.50	
47.25	206.86	350.35	
47.75	93.77	279.22	
48.25	140.81	121.29	
48.75	203.82	117.92	
49.25	215.20	114.71	
49.75	199.80	160.64	
50.25	232.90	150.86	
50.75	171.75	294.56	
51.25	116.89	258.00	
51.75	110.70	132.27	
52.25	103.19	189.83	
52.75	151.70	171.35	
53.25	183.93	122.26	
53.75	213.45	103.83	
54.25	327.23	146.20	
54.75	224.91	114.57	
55.25	110.60	149.58	
55.75	113.37	144.29	
56.25	144.79	195.64	
56.75	237.62	200.62	
57.25	222.00	232.81	
57.75	236.67	224.42	
58.25	156.54	131.24	
58.75	125.21	140.17	
59.25	191.15	137.08	
59.75	265.60	146.08	
60.25	298.81	254.60	
60.75	281.69	148.71	
61.25	114.24	135.14	
61.75	93.28	245.53	
62.25	127.18	314.30	
62.75	186.22	219.01	
63.25	226.74	124.24	
63.75	254.80	146.75	
64.25	169.53	122.90	
64.75	131.75	110.34	
65.25	91.58	171.14	
65.75	102.13	219.18	
66.25	180.41	249.34	
66.75	323.10	288.92	
67.25	337.94	442.88	
67.75	378.92	228.53	
68.25	405.51	222.68	
68.75	407.02	301.40	
69.25	365.90	151.67	
69.75	381.41	161.17	
70.25	245.67	190.20	

depth (cm)	PAD 54 magnetic susceptibility (SI units)	PAD 15 magnetic susceptibility (SI units)	PAD 18 magnetic susceptibility (SI units)
70.75	113.54	275.71	
71.25	104.29	172.60	
71.75	131.25	262.97	
72.25	200.68	238.51	
72.75	260.55	299.46	
73.25	157.37	219.87	
73.75	185.23	167.56	
74.25	213.02	239.48	
74.75	169.23	170.93	
75.25	122.55	167.31	
75.75	132.90	153.82	
76.25	168.87	130.74	
76.75	147.99	120.88	
77.25	149.01	181.34	
77.75	175.93	201.82	
78.25	200.34	240.43	
78.75	301.80	162.22	
79.25	268.71	285.40	
79.75	156.43	248.15	
80.25	262.95	113.34	
80.75	200.50	64.77	
81.25	136.43	76.69	
81.75	131.95	100.57	
82.25	149.08	151.46	
82.75	178.39	286.24	
83.25	270.83	464.22	
83.75	266.84	422.44	
84.25	143.61	344.28	
84.75	152.82	258.09	
85.25	141.23	131.50	
85.75	164.29	137.54	
86.25	212.45	438.18	
86.75	230.82	177.69	
87.25	185.86	119.97	
87.75	140.01	229.09	
88.25	158.07	273.91	
88.75	133.04	357.10	
89.25	119.18	333.41	
89.75	117.65	392.88	
90.25	123.03	348.91	
90.75	284.63	446.07	
91.25	291.43	408.85	
91.75	250.68	431.32	
92.25	243.26	430.38	
92.75	243.10	510.89	
93.25		269.55	
93.75		233.52	

Appendix H

Temperature Data

Grande Prairie, Alberta (Station ID 3072920)

Decade	January average daily temperature (°C)	February average daily temperature (°C)	March average daily temperature (°C)	April average daily temperature (°C)
1990	-16.48	-10.63	-3.87	4.63
1980	-12.64	-10.33	-4.09	4.34
1970	-16.47	-10.99	-6.41	3.54
1960	-15.83	-11.27	-7.93	2.40
1950	-19.94	-12.75	-8.76	1.34
1940	-11.99	-12.96	-6.60	2.60
1930	-16.21	-13.57	-9.24	3.04
1920	-17.54	-10.45	-6.39	3.65

	May average daily temperature (°C)	June average daily temperature (°C)	July average daily temperature (°C)	August average daily temperature (°C)
1990	10.73	14.25	15.99	15.37
1980	10.51	14.23	16.03	14.69
1970	10.33	13.99	15.63	14.50
1960	9.43	13.73	16.26	15.44
1950	10.38	13.65	15.69	14.45
1940	10.48	13.79	16.18	14.80
1930	11.02	13.78	15.83	15.18
1920	9.33	14.59	14.87	14.85

	September average daily temperature (°C)	October a verage daily temperature (°C)	November average daily temperature (°C)	December average daily temperature (°C)
1990	10.74	3.08	-7.67	-13.01
1980	9.63	4.44	-6.90	-12.60
1970	9.46	4.22	-7.27	-14.37
1960	10.09	4.86	-7.22	-14.60
1950	10.12	2.98	-5.56	-12.52
1940	10.60	5.24	-7.26	-12.89
1930	9.20	3.00	-5.53	-12.54
1920	9.66	4.55	-2.45	-13.19

Beaverlodge, Alberta (Station ID 3070560)

Decade	January average daily temperature (°C)	February average daily temperature (°C)	March average daily temperature (°C)	April average daily temperature (°C)
1990	-13.93	-8.59	-2.89	4.44
1980	-10.22	-9.16	-4.15	4.22
1970	-14.83	-10.87	-5.16	3.02
1960	-15.69	-9.77	-6.71	2.52
1950	-18.27	-10.56	-6.59	1.56
1940	-10.64	-11.12	-4.11	3.63
1930	-12.82	-11.36	-6.14	3.25
1920	-12.56	-9.15	-4.39	2.16
1910	-16.00	-13.74	-8.40	3.36

	May average daily temperature (°C)	June average daily temperature (°C)	July average daily temperature (°C)	August average daily temperature (°C)
1990	10.39	13.73	15.48	15.05
1980	10.09	13.65	15.65	14.45
1970	9.31	13.21	15.00	14.13
1960	8.81	12.99	15.33	14.56
1950	9.85	13.18	15.45	13.87
1940	10.05	13.58	16.00	14.58
1930	10.03	13.01	15.37	14.58
1920	9.52	13.31	15.94	14.27
1910	7.60	12.21	14.00	13.87

	September average daily temperature (°C)	October average daily temperature (°C)	November average daily temperature (°C)	December average daily temperature (°C)
1990	10.73	3.22	-6.32	-10.81
1980	9.57	4.56	-5.81	-10.38
1970	9.46	4.53	-5.84	-12.19
1960	9.53	4.74	-5.98	-12.25
1950	9.92	3.41	-4.62	-9.64
1940	10.58	5.41	-5.11	-11.30
1930	9.81	3.68	-3.78	-10.32
1920	9.09	4.45	-4.40	-11.04
1910	9.61	1.78	-3.82	-13.01

Appendix I

Precipitation Data

Grande Prairie, Alberta (Station ID 3072920)

Decade	average daily precipitation (mm)
1990	1.27
1980	1.21
1970	1.17
1960	1.29
1950	1.26
1940	1.13
1930	1.55
1920	1.26

Beaverlodge, Alberta (Station ID 3070560)

Decade	average daily precipitation (mm)
1990	1.33
1980	1.24
1970	1.24
1960	1.33
1950	1.22
1940	1.21
1930	1.27
1920	1.19
1910	1.00

Appendix J

Peace River Water Flow Data

Peace Point, Alberta

Year	January average daily flow (cms)	February average daily flow (cms)	March average daily flow (cms)	April average daily flow (cms)	May average daily flow (cms)	June average daily flow (cms)
1959		365	337			6760
1960	466	400	420	1170	3808	7193
1961	477	431	396	912	4481	7288
1962	496	474	346	992	3455	7031
1963	618	482	448	1384	6545	6865
1964	488	392	344	661	3715	9795
1965	543	479	383	1127	4736	7001
1966	499	421	374	1421	4947	5947
1967	634	454	432	414	5217	8740
1968	359	408	385	775	2282	3232
1969	436	435	482	1366	3146	2154
1970	1028	1038	1031	1701	2384	2797
1971	1075	1045	1075	1219	2631	3389
1972	1217	984	1077	1400	4442	5230
1973	1582	1763	1634	2674	4448	4673
1974	1205	1231	1293	2200	6862	4068
1975	1608	1674	1715	2026	2941	3223
1976	1411	1502	1516	2457	3304	3513
1977	1677	1396	981	2094	3615	4523
1978	1787	1779	1571	1751	2849	3758
1979	1689	1744	1523	1192	4003	5010
1980	1426	1320	1130	1205	1428	2484
1981	1073	1216	1571	2245	3859	2836
1982	1756	1986	1332	1620	3563	2745
1983	1392	787	612	1031	2610	2644
1984	1545	1309	1063	1625	2968	4006
1985	1283	1043	1264	2394	3697	2988
1986	2131	1681	1519	2076	3126	3351
1987	1532	1948	2028	2722	3069	3693
1988	2116	1963	2025	2297	3127	3584
1989	1315	1773	1559	1536	3354	3827
1990	1645	1619	1459	2499	3286	6145
1991	1685	1108	1399	2259	3609	3449
1992	1842	2061	2039	3387	3569	3276
1993	1693	1872	1806	1980	2365	1384
1994	1572	1708	1735	2892	3248	2880
1995	1668	1131	650	1053	2324	2074
1996	1391	1458	1507	3087	4155	6088
1997	1610	1435	1535	2945	6681	5136
1998	1774	1811	1779	2559	2395	1861

Year	July average daily flow (cms)	August average daily flow (cms)	September average daily flow (cms)	October average daily flow (cms)	November average daily flow (cms)	December average daily flow (cms)
1959	4728	1819	2420	1766	1204	766
1960	6277	2257	1846	1433	1268	487
1961	3188	1326	1131	1459	1076	483
1962	6646	3461	2187	1615	1600	601
1963	4110	2334	1674	1598	925	558
1964	6266	5656	2246	2335	1488	635
1965	6225	1975	1785	1796	1620	639
1966	4858	2718	2126	1269	875	612
1967	4005	1870	1036	1641	778	429
1968	2040	1144	804	749	663	405
1969	1388	1102	1586	1619	1049	1092
1970	1760	1217	869	1044	989	1111
1971	4146	1431	1237	1494	1134	1059
1972	4127	2741	1554	1899	1699	1537
1973	3378	2600	2102	2035	1534	1182
1974	3352	2475	2072	2275	1946	1705
1975	2966	1484	1907	1618	1416	1448
1976	4519	4680	2589	2121	1893	1878
1977	3381	2517	1745	1960	1919	1950
1978	2015	1415	1729	1832	1567	1765
1979	3548	1753	1644	1479	1515	1413
1980	1761	1427	1784	2015	1668	1222
1981	1538	1455	1336	1621	1779	1735
1982	2758	2179	1830	1751	1623	1848
1983	4905	2834	1924	1818	1645	1376
1984	2792	2132	2139	2514	1911	2086
1985	2465	1500	2132	2269	1697	1588
1986	3095	1406	1336	2052	1616	1836
1987	2479	3627	1677	1585	1834	2021
1988	3894	2052	1683	1656	1757	1441
1989	3001	2640	2098	1603	1027	1271
1990	2404	1345	1405	1642	1669	1683
1991	2165	1231	1207	1857	1795	1625
1992	1465	1372	1403	1938	1822	1494
1993	2426	2007	1788	1385	1357	1867
1994	2452	1547	1287	1525	1442	1948
1995	2076	1336	1048	1067	1043	1274
1996	8660	5754	3141	2279	1291	1963
1997	4883	2557	2467	2695	2323	2179
1998	1973	1380	1356	1471	1734	1751