SEDIMENT CHARACTERISTICS AROUND THE KENYON ISLAND GROUP, GREAT SACANDAGA LAKE (NY): ECONOMIC POTENTIAL OF DREDGING AND LAND RECLAMATION

A thesis presented to the Faculty
of the University at Albany, State University of New York
in partial fulfillment of the requirements
for the degree of

Master of Science
College of Arts and Sciences
Department of Earth and Atmospheric Sciences

Arthur M. Ambrosino
2001

University at Albany, State University of New York

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The thesis for the master's degree submitted by

Arthur M. Ambrosino

under the title

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has been read by the undersigned. It is hereby recommended
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Recommendation accepted by the Dean of Graduate Studies
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ABSTRACT

The Kenyon Island Group lies within the Great Sacandaga Lake's largest and most unnavigable shallow water shoal. The shoal measures approximately 5.0 *mi^2*. The Kenyon Islands, including Mead and Deer Islands, occupy approximately ¾ *mi^2* during the months of annual high lake level. During the late shallow water season of 1998, a NE to SW diagonal transect of nine core samples were collected by a Geoprobe coring device, with recoveries between 8′ and 16′ deep sections. In this study these cores were used to identify the stratigraphy, classify the sediment grain sizes, evaluate the abundance of economic minerals, and calculate the most cost effective and environmentally sound method of deepening the lakebed for navigation and recreational purposes and reconfiguring the new real property created.

Here I present evidence for the existance of a previously unidentified large moraine field, of approximately 12 *mi^2*, located between two different end moraines of the Pleistocene Epoch. Today, about 1/3 of that moraine field surrounds the Kenyon Island Group, within the shorelines of the Great Sacandaga Lake. The south and east end moraine is visible in an arcuate path which includes the two major Kenyon Islands and Deer Island. The south and east end moraine is approximately ¾ mile wide and is confined by the valley walls of the Sacandaga Basin. This end moraine must have been at least 300 feet high during the Pleistocene Epoch. The north and west moraine was deposited before the south and east end moraine and is also visible in exposures around the lake. This forms moraine rock fields in arcuate bands, which are confined by the valley walls of the Sacandaga Basin. The north and west end moraine was originally

½ miles wide and must have stood at least 120 feet high.

The moraine field contains all the classic landmarks including kames, kettle lakes, eskers, drumlins, flutes and fossil streambeds. The moraine field sediments that exist are no more than 45 feet thick beneath the lakebed and 45 to120 feet thick outside the shorelines and above bedrock. The bedrock may be Cambrian (570-510 Ma), including Little Falls Dolomite, Theresa Dolomite and/or Potsdam Sandstone.

This thesis proposes a remedy involving dredging and earth-moving heavy equipment to permanently deepen part of the lakebed of the Great Sacandaga Lake that is currently of little use because the area is typically too shallow for regular lake navigation. If there are minerals within the sediments of the study area that are of current economic importance and have values significant enough to pay for a lakebed deepening, the geochemistry, mineralogy and mineral chemistry will reveal them. These minerals can then be identified and evaluated as the mechanism that will support the tremendous costs associated with such a major deepening effort. The long term outcome of a Great Sacandaga Lake deepening, beside improving the navigational, recreational, and fisheries of the lake will create room for an additional 200 billion gallons of water, which could be priceless in the next frontier.

The moraine field sediment profile in the study area may be unique to the whole of the Great Sacandaga Lake. The question of dredging the lakebed versus simpler earth-moving heavy equipment to reconfigure the lakebed, anywhere else in the Great Sacandaga Lake, will most certainly require further research and could yield different results.

Acknowledgements

I would particularly like to thank Dr. John I. Garver for all the effort he extended this project. He gave of himself and the splendid Union College facilities, far more than would have been expected and his insight and counsel was greatly appreciated.

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CHAPTER 1

INTRODUCTION

Purpose of the study

During the last several decades, there has been an increasing dispute between the downstream "interests" and the "recreational users" of the water of the Great Sacandaga Lake in upstate New York. The downstream "interests" include power generation dams, Hudson River water levels, ocean water/salt front concerns at Poughkeepsie and flood control at Albany, among others.

Large annual water-level variations to accommodate the downstream interests cause large areas of very shallow water in the Great Sacandaga Lake (GSL), especially in midsummer, which is a situation the landowners and boating public find unacceptable. In an effort to reach accommodations to all, an Upper Hudson-Sacandaga Comprehensive Settlement Negotiation Team is presently studying water level remedies (See Appendix A-Permits and History). They have proposed raising the GSL high water mark from 768′ to 770′ over a twenty-year time span. Any remedy they agree upon will be a compromise between upstream and downstream interests.

This thesis proposes a remedy involving dredging and earth-moving heavy equipment to permanently deepen part of the lakebed of the Great Sacandaga Lake that is currently of little use because the area is typically too shallow for regular lake navigation. To accomplish this task it is necessary to identify the stratigraphy of the lakebed sediments at various points within the lake, classify the sediment grain sizes, evaluate the potential economic mineral wealth, and determine the most cost effective and environmentally sound method of deepening the lakebed and reconfigurating existing Islands and shorelines.

The Kenyon Island Group, perhaps the largest and most unnavigable shallow water shoal in the Great Sacandaga Lake, is the ideal location for investigating such a project. The Kenyon Island Group contains the former and now submerged community of Osborne Bridge. To address the above issues a transect of core samples were collected by Geoprobe in the Kenyon Island Group using gravel roads which were serviceable during the late shallow water season of 1998. Nine Geoprobe 1 3/4″ diameter cores were collected, between 8′ and 16′ in length.

Location of study area

The Kenyon Island Group is located in the north central portion of the Great Sacandaga Lake, in the town of Northampton, in northeast Fulton County, New York State (Figure 1.1). The Kenyon Island Group is just over two miles south of Northville, New York. Some portions of the Great Sacandaga Lake are located in Northwest Saratoga County, but are outside this project review. The whole of the lake lies within the perimeter ("Blue Line") of the Adirondack State Park (Figures 1.2).

The 1908 New York State Water Supply Commission Maps, numbers 20 and 21, were digitized, merged and enhanced to show the GPS and coring sites (Figure 1.3). These maps depict the area before the Conklingville Dam was built in 1929, which subsequently flooded the area creating the Sacandaga Reservoir.

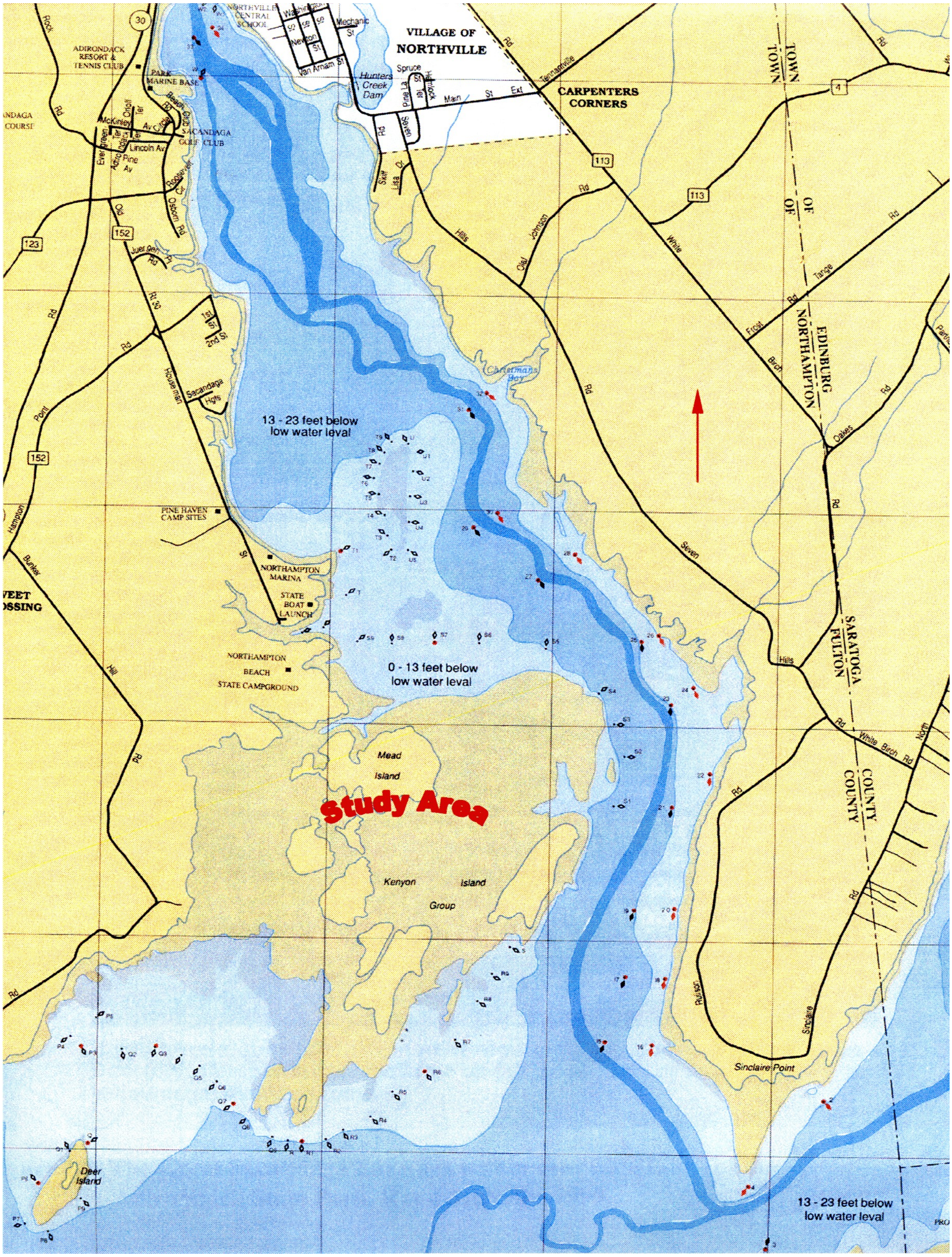


Figure 1.1 The Kenyon Island Group, Great Sacandaga Lake Navigation Map, Jimapco, 1991.

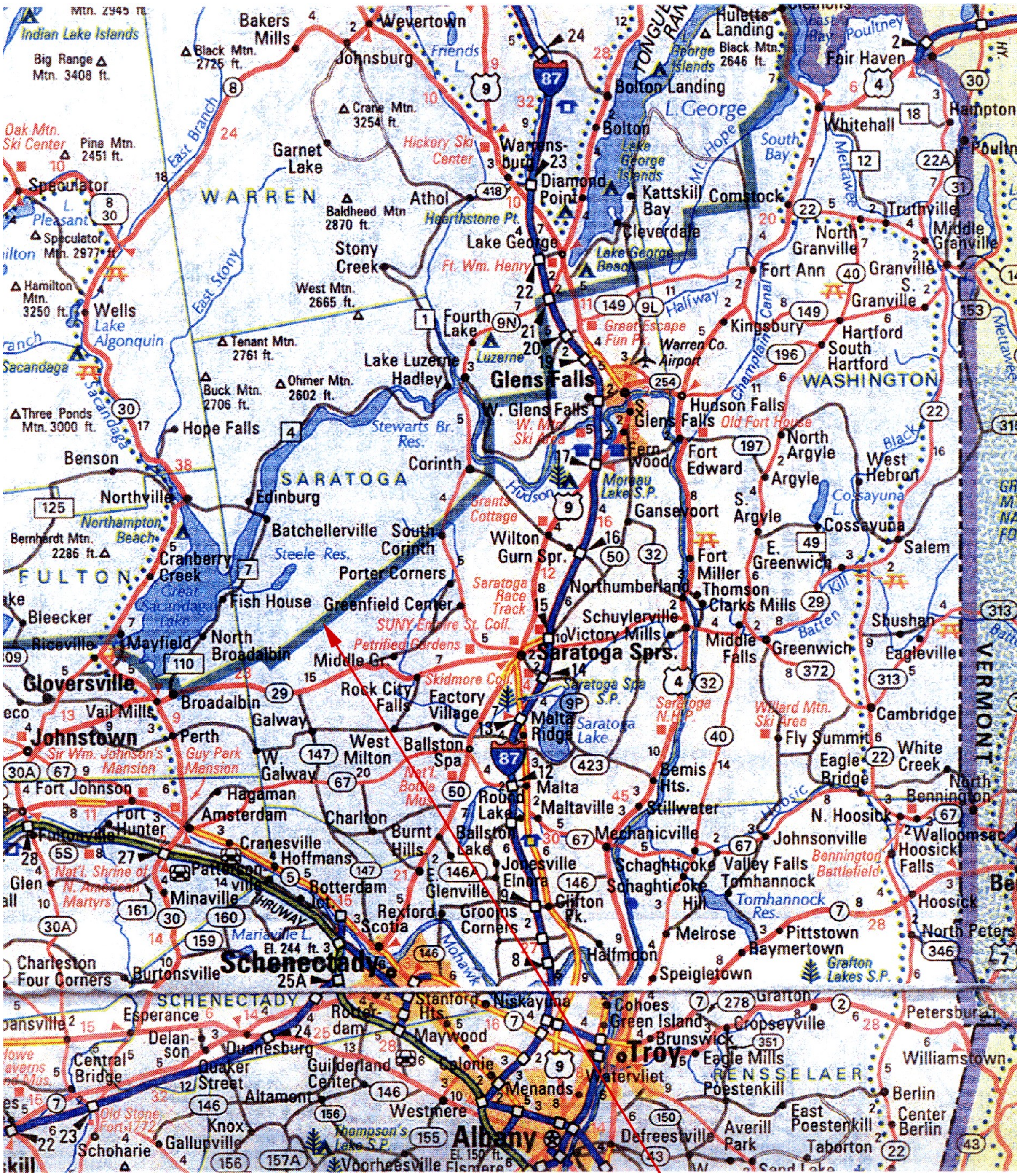


Figure 1.2 The Great Sacandaga Lake lies within the "Blue Line" of the Adirondack State Park, Rand McNally, 1999.

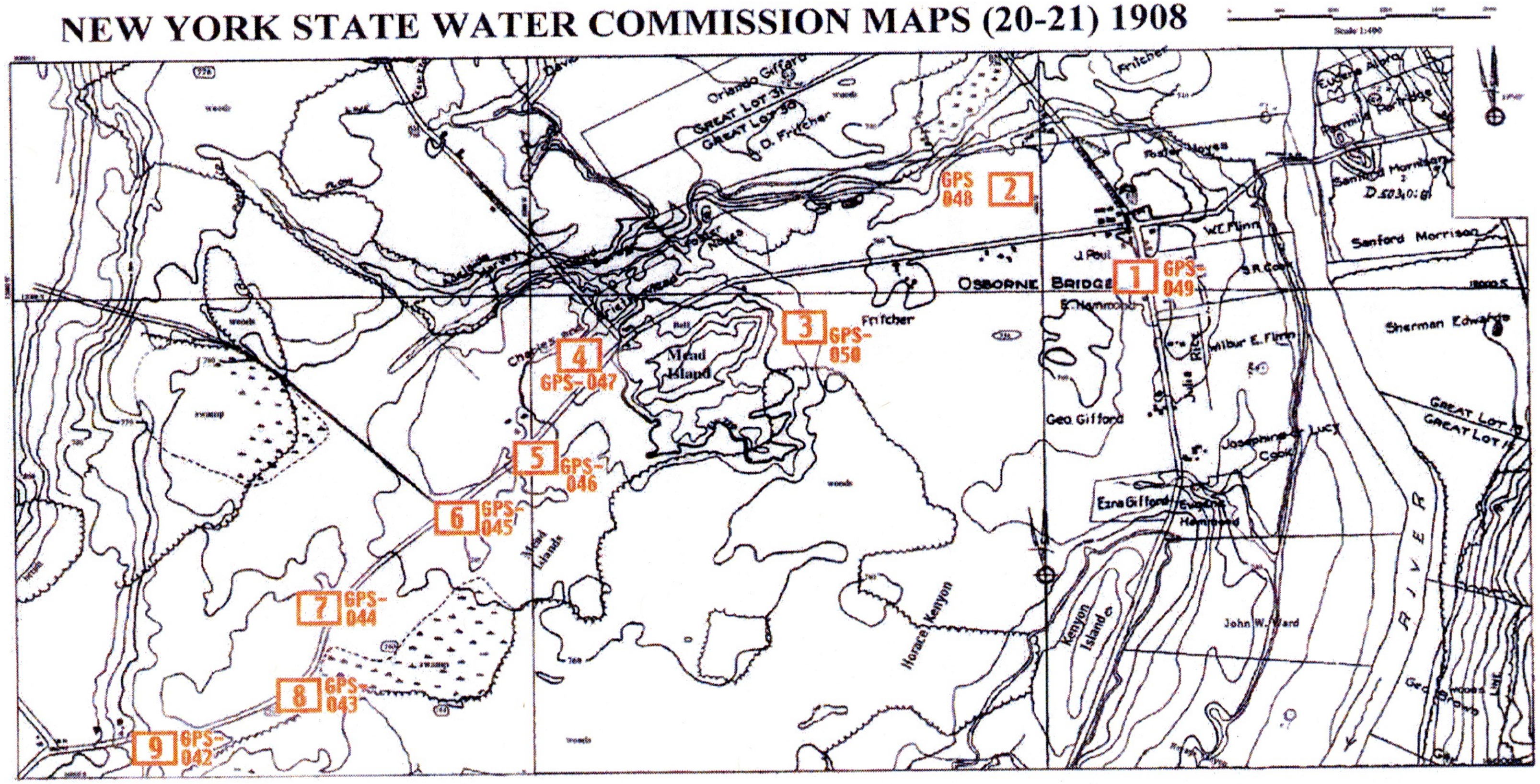


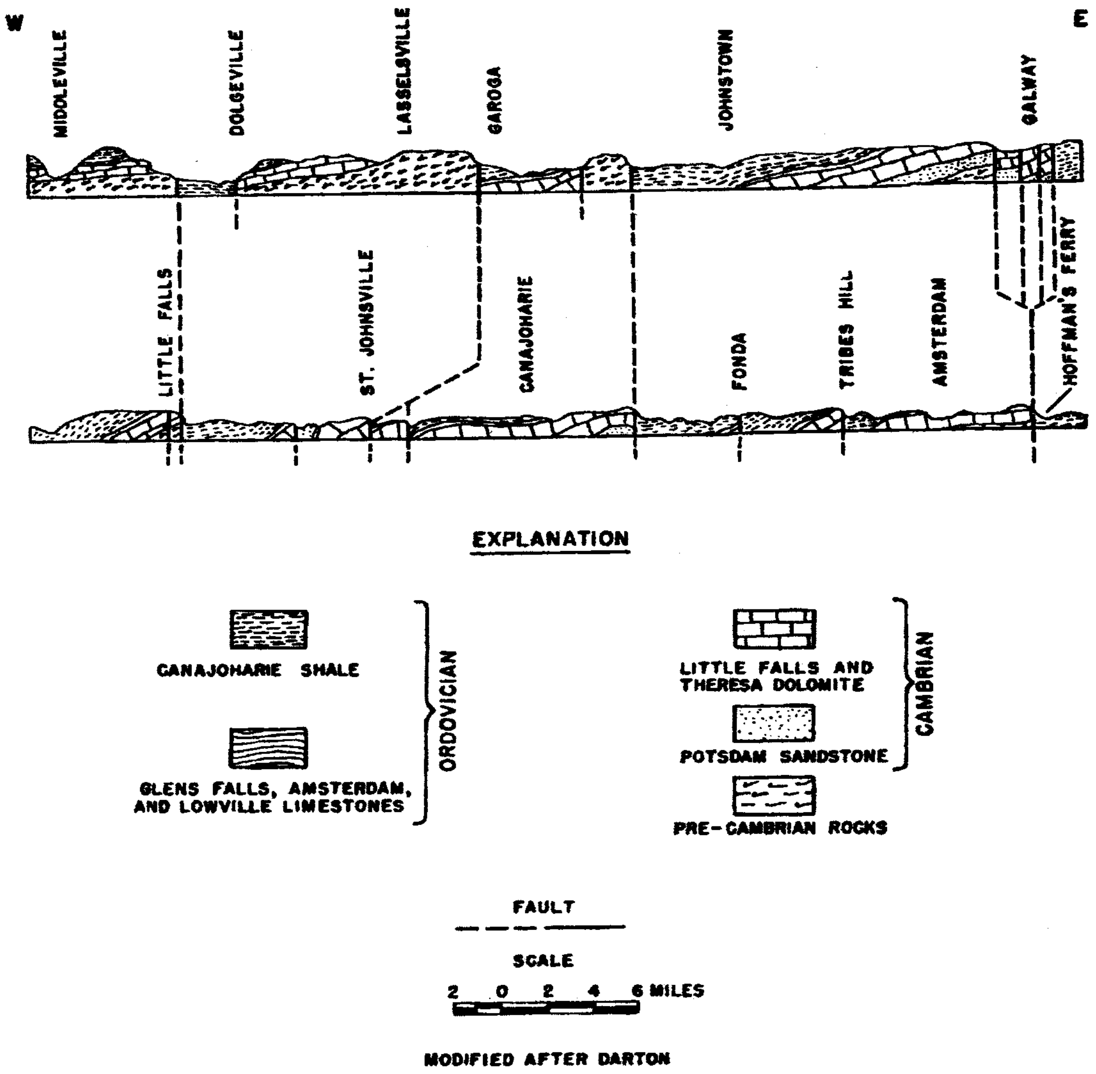
Figure 1.3 The 1908 New York State Water Commission Maps, Numbers 20 and 21, were Digitized, Merged and Enhanced to show the GPS and Coring Sites *in red.*

Regional geology

The geologic structure of the Sacandaga Basin lies on a great sunken block between two Precambrian crystalline blocks of the Mohawk Valley fault series. In the lower Paleozoic Era, during the Taconic Orogeny (~ 450 MA), the region was faulted due to flexure (downwarping). The bedrock across the Mohawk Valley was cut by ten or more northeast trending faults, which have greatly influenced modern topography. The faults are almost vertical with the downdropped block to the east (Figure 1.4). One exception is the fault located in the Sacandaga basin study area (Arnow, 1951).

The Noses Fault crosses Fulton County southwest of Johnstown (New York), trending northeastwardly, crossing the county line northwest of Northville. The upthrown block, at the northern most end, is on the west side of the fault. This side forms the southern-most crystalline rock escarpment of the Adirondack Mountains. Less than 6.5 *mi* to the east of the Noses, the Batchellerville fault forms another escarpment of crystalline rock extending from Batchellerville (in Saratoga County) southward past Northampton (Fish House), and then southeastward.

The Batchellerville fault also has a displacement of about 1500′ but the upthrown block side is to the East. The Sacandaga Reservoir and all the nearby communities, including the submerged town of Osborne Bridge and the Kenyon Islands lie on the plain of this downdropped block, between these two Precambrian crystalline masses (Figure 1.5), (Fisher, Isachsen and Rickard, 1995).



Cross section of faults in the Mohawk Valley, in Fulton and Montgomery Counties.

Figure 1.4 The Ground Water Resources of Fulton County, New York, U.S. Geological Survey, Bulletin GW – 24, Arnow, 1951.

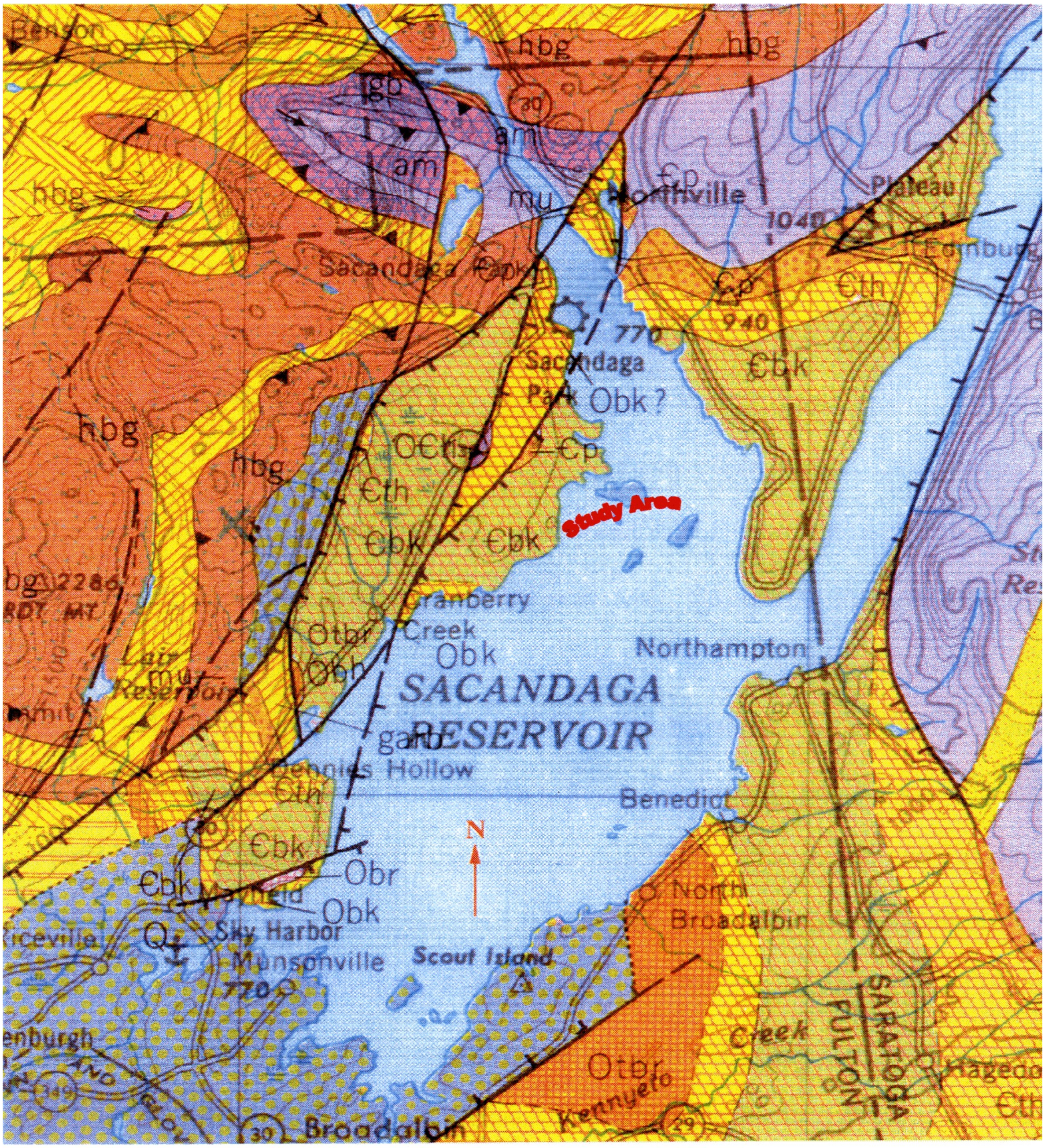


Figure 1.5
Bedrock Geologic Map of New York State, Hudson-Mohawk Sheet #15, New York State Museum and Science Service, 1995.

Єbk	Cbk--Upper Cambrian Beekmantown Group, Tribes Hill Limestone.
Єp	Cp--Cambrian Potsdam Sandstone.
Єth	Cth--Cambrian Theresa Galway Formation Dolostone, Sandstone & Shale.
Obk	Obk--Ordovician Beekmantown Group Tribes Hill, Limestone, Dolostone.
Q	Q--Quaternary-Glacial and Alluvial deposits.

The bedrock of the Sacandaga Basin range from Precambrian crystalline rocks on the east and west escarpments to Cambrian and Ordovician beneath the overburden of the down-dropped block, within which the Kenyon Island Group resides. Perhaps the best characterization of the bedrock comes from the water well logs obtained by the 1951 U.S. Geological Survey of Fulton County Water Resources (Arnow, 1951). The wells that exist within a 2 *mi* circumference suggest that bedrock is from 10-45′ beneath the overburden at the Kenyon Island site and no more than 30-120′ deep closer to the valley walls of the Sacandaga Basin. Since 1951, legislation has been passed such that water well drilling companies are not required to have bedrock tailings examined and only depth and Health Department requirements exist today. No outcrop exposures are available in the study site area.

The 1987 Surficial Geology Map of New York by Donald H. Cadwell indicates that the whole of the Kenyon Island Group is fluvial deltaic sand. Some glacial tills form boundaries existing above the fluvial deltaic sand and north of Northville where outwash sands and gravels exist (Figure 1.6). In 1911 The University of the State of New York, State Museum, Topographic Map, Bulletin #153, by Miller, describes the Kenyon Islands landscape as Quaternary glacial and postglacial sediments. In 1929 The University of the State of New York, State Museum, Glacial/Geographic Map, Bulletin #280, by Brigham, describes the sediments of the Kenyon Island Group and Osborne Bridge as water laid drift (Figure 1.7).

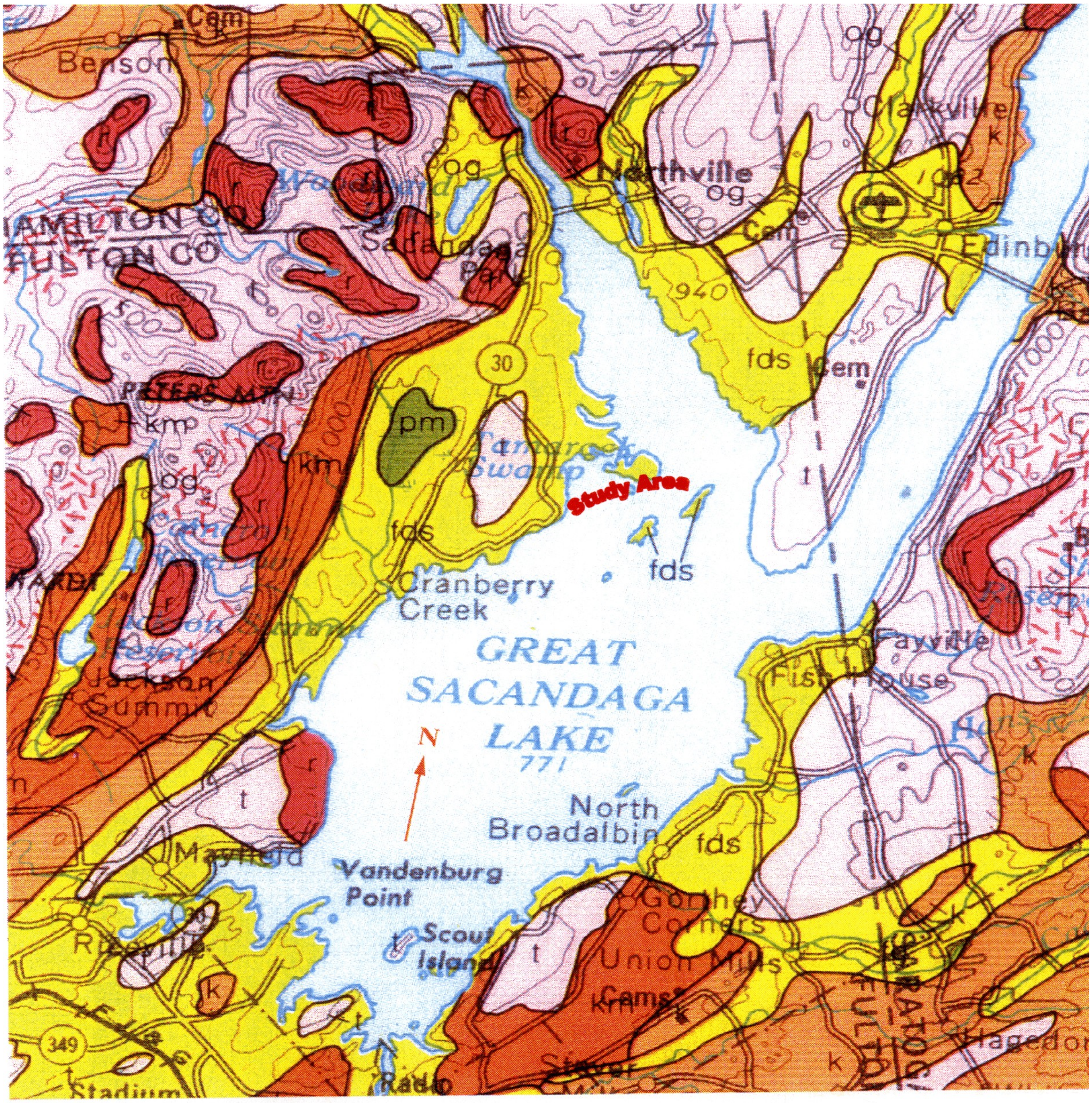


Figure 1.6
Surficial Geologic Map of New York State, Hudson-Mohawk Sheet #40, New York State Museum and Science Service, 1987.

▨ **t--till**

🟨 **fds--fluvial deltaic sand**

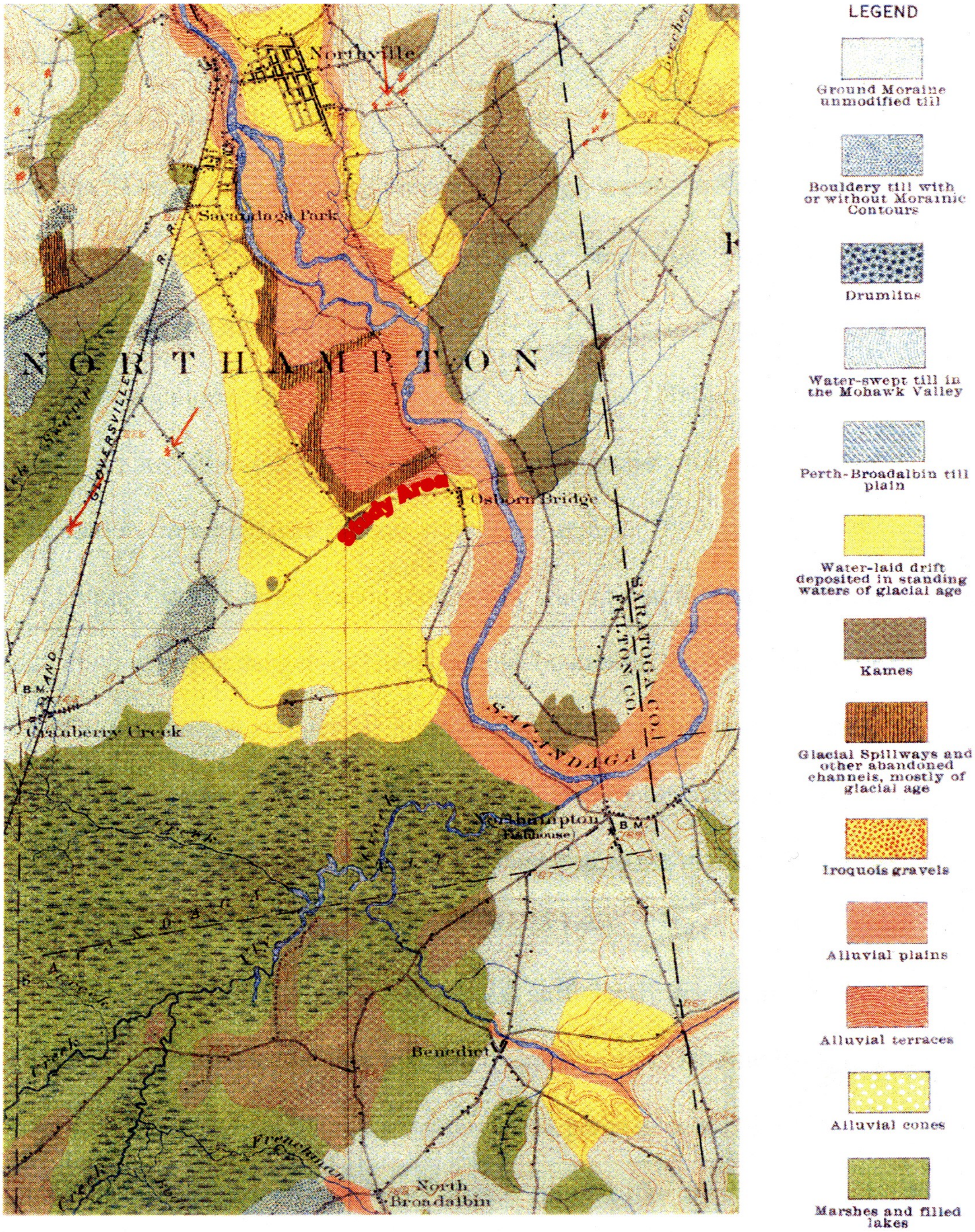


Figure 1.7 The University of the State of New York, State Museum, Glacial/Geographic Map, Bulletin No. 280, with Cropped legend, by Brigham, 1929.

Setting

The spillway at the Conklingville Dam, which was built in 1929 to create the Sacandaga Reservoir is 771′ above sea level. At high water the Kenyon Island Group including Mead and Deer Islands have shorelines at about 768′. The lake level begins to drop in (months). Water is discharged from the reservoirat an average rate of 1 1/2″ per day (~1 billion gallons) and by the low water season over 150 billion gallons of water have been drained from the reservoir. It takes approximately 6 months for the transformation from high water to low water level status.

During the low-water season the shallow water shoal that surrounds the Kenyon Island Group becomes dangerous to recreational boaters on the lake. The situation becomes so serious that almost nine miles of shallow warning buoys are strung around the greater shoal, warning boaters not to enter. This buoy line extends from Deer Island to beyond Northampton Marina. Boaters are relegated to the marked Sacandaga River Channel for much of the boating season in order to by-pass the shallows (Figure 1.8).

The exposed lake bottom at low water is sufficiently dry during the summer season to travel across the old farm roads of the old town of Osborne Bridge. Dozens of remnant foundations where the old farmhouses and barns once stood are visible. Except for the occasional sandbar from anomalous lake currents like the one at core site #8 and ice-rafted sediments from just west of core site #2 to beyond core site #1, there is almost no appreciable new sedimentation across the whole shoal since the Conklingville dam flooded the area in 1929.

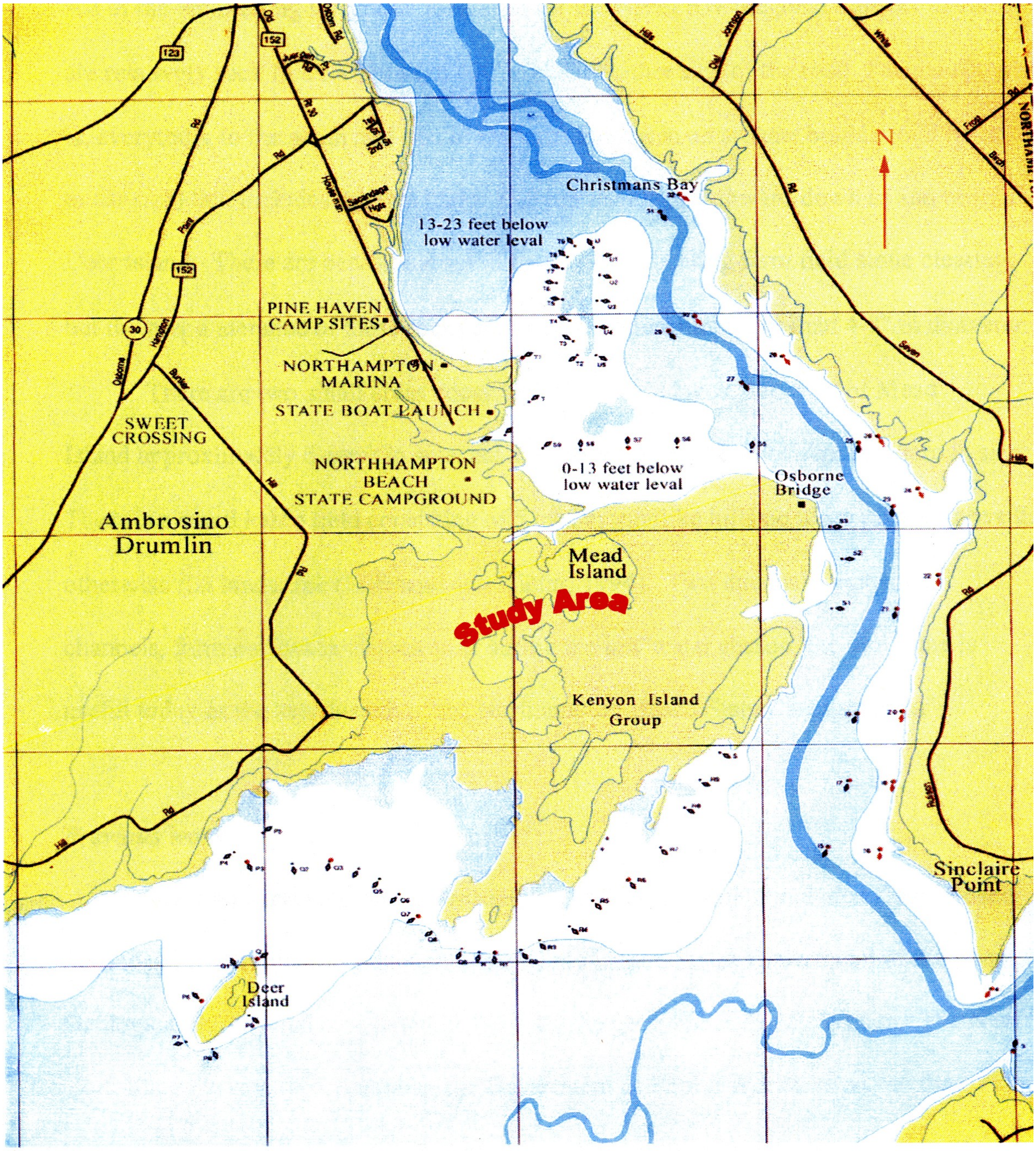


Figure 1.8
The Great Sacandaga Lake Navigation Map, Jimapco, 1991.

All of the lands along the gravel road used for the NE to SW diagonal transect of cores, are relatively rock free for between 400′ and 800′ either side of the road. The exception is, everything to the south and east of Osborne Bridge in an arcuate boulder belt (rocks up to car size) that includes the two major Kenyon Islands, southward down to and beyond Deer Island. There are occasional small rock piles indicating farm field stone clearing, but the preponderance of these rocks are small boulders no bigger than 4-8″ in diameter.

There are two small areas consistent with kettle lakes, one west of Mead Island approximately 6 acres in size and another to its southeast of about an acre in size. There is a small kame field consisting of 5 or 6 moundlike hills no more than 4′ above the otherwise flat landscape (Lillesand and Kiefer, 1994). Two unusual relict stream channels, form backwater depressions during the low water season, the north one is useful today as the boat launch of the Northampton Beach State Campgrounds.

Previous work

The first surveying of the Broadalbin Quadrangle, which included the proposed Sacandaga Reservoir, was begun in 1899 by the United States Department of the Interior Geological Survey and completed in 1911, by the geographer, H. M. Wilson. The New York State Survey, represented by the Department of Public Works, surveyed the triangulations and W. H. Lovell surveyed the topography. Because construction of the Sacandaga Reservoir was anticipated, the proposed lake was stippled in and the shoreline was ambiguous. No attempt was made to depict the geology and neither the Noses fault nor the Batchellerville fault were delineated.

The first surveying and mapping of the Sacandaga terrain was undertaken by decree of the New York State Legislature in 1902. It was performed by John R. Freeman, C. E. and was finished in 1908. This study was undertaken for the purpose of creating a reservoir and only focused on the topography of the region and setting the proposed high water mark ("Flow Line") and the dam site at Conklingville, New York. The projects legacy is the substantial body of work known as the New York State Water Commission Maps of 1908.

Simultaneous with the mapping of the Broadalbin Quadrangle by the U. S. Department of the Interior Geological Survey, The University of the State of New York, State Museum, began the first geological survey of the Quadrangle. The work was done by W. H. Miller and completed by 1911 as Bulletin #153 (Miller, 1911). Miller also stippled in the proposed Sacandaga Reservoir layered over the still viable communities within the anticipated "Flow Line." Miller correctly identified the Noses fault to the west of the Sacandaga Basin but failed to identify the Batchellerville fault to the east. His description of the surficial geology was also very broad, calling it Quaternary glacial and postglacial sediments. Later on in his career when he had completed his geological survey of the Gloversville Quadrangle in 1922-23, Miller speculated that the Sacandaga River once drained to the Mohawk River rather than turning northward near Osborne Bridge to drain into the Hudson River, as it does today.

In 1929, The University of the State of New York, State Museum used the same Broadalbin Quadrangle and added the glacial and geographic features. The work was done by A. P. Brigham and presented in Bulletin #280 (Brigham, 1929). Brigham characterized the Kenyon Island Group and Osborne Bridge surficial geology as "water laid drift" deposited in standing waters of glacial age. Brigham suggested that the preglacial Sacandaga River followed the present axis of the Sacandaga Reservoir and then flowed in a southwesterly direction, paralleling the Noses fault line, reaching the Mohawk River just west of Fonda, New York. Geophysical exploration in 1949 by the United States Geological Survey in cooperation with the State of New York, Department of Conservation, Water Power and Control Commission indicate the west edge of a buried escarpment and could possibly confirm Brigham's postulate (Arnow, 1951).

The United States Geological Survey in cooperation with the State of New York, Department of Conservation, Water Power and Control Commission work, done in 1951 by Theodore Arnow, called Bulletin #GW-24 (Arnow, 1951), is the most complete report on the geology of the region. The study began in 1946 as part of a statewide survey of the groundwater resources of the State of New York. It is called "The Groundwater Resources of Fulton County, New York". The study examined the records of 219 water wells in Fulton County, did chemical analysis on water samples, incorporated The University of the State of New York, State Museum geological work, and did the geophysical resistivity and seismic profiles of the overburden east of Gloversville, New York. It did not, however, examine the surficial geology of the County or the Sacandaga Basin, except in cooperation with local water well drilling companies whose well logs and tailings were used during the study period. It recognized in a generic way, Brigham, Miller, and others' work in identifying the Quaternary deposits that mantle the region, but limited its scope to the sources, quantity and quality of the groundwater of Fulton County (Arnow, 1951). This report, however, did correctly interpret the former work of Darton, (1897). Darton (1897) had suggested multiple faulting north of the Hoffman's Ferry fault, east of Amsterdam. However, Darton did not identify the Batchellerville fault. It was later identified by the U. S. Geological Survey, Groundwater Branch workers who conducted the Groundwater Resources of Fulton County study (Arnow et al, 1951). This report and summarized by the work of Darton (1897), Miller (1911) and Wilson (1911), identifies the occurrence of the great sunken block between the Noses and the Batchellerville faults as being due to a regional uplift.

The Geologic Map of New York by The University of the State of New York, State Museum, compiled by (Fisher et al, 1970) and the Surficial Geologic Map of New York compiled by Caldwell and Dineen (1987) are both composites of previous work and aerial photography and should be considered as good references only. Neither is completely definitive nor intended to be.

The General Soils Report of Fulton County, New York (Davis et al,1971) was very important in arriving at the geologic perspectives this thesis espouses. The United States Department of Agriculture Soil Conservation Service prepared this report in cooperation with the Fulton County Soil and Water Conservation District. Most of the work was done using aerial photography and United States Geological Survey maps as working base maps. The report was prepared as a general planning guide, based on definitive soil characteristics, which affect the degree and type of limitations that can be expected for community development, recreational, or farmland use.

A soil association map was compiled with 50 soil-type associations across Fulton County. Each of the 50 soil characteristics were given soil classifications including their suitability for such things as agricultural use, campsites, roadbeds, athletic fields, and septic drainage fields, etc. (see Table 1.1, soil-type associations involving the study area).

GENERAL SOILS REPORT – SOIL ASSOCIATION AND CHARACTERISTICS								
Number	Soil Association	Soil Suitability and Limitations					Sand and Gravel	Drainage Class
		Field Crops	Camp Sites	Streets, Roadbeds	Athletic Fields	Septic Fields		
8	Charlton-Sutton Stony	Slight	Slight	Moderate	Moderate and Stony	Moderate	Not Suitable	Well & Moderate
11	Charlton, Stony and Extremely Stony	Severe Stoniness	Severe Stoniness	Severe Stoniness	Severe Stoniness	Severe Stoniness	Not Suitable	Well
12	Sutton-Leicester Stony	Slight	Moderate	Moderate	Moderate and Stony	Moderate, Wetness	Not Suitable	Moderate & Poorly
14	Leicester Stony	Moderate	Severe & Wetness	Severe & Wetness	Severe & Wetness	Severe Wetness	Not Suitable	Poorly
17	Charlton-Sutton Extremely Stony	Severe Stoniness	Severe Stoniness	Severe Stoniness	Severe Stoniness	Severe Stoniness	Not Suitable	Well & Moderate
32	Sudbury	Moderate	Moderate	Moderate	Moderate	Moderate	Good/Fair	Moderate

Table 1.1 Soil Type Associations in Study Area from 1971 General Soils Report of Fulton County, New York.

Although the work is interpretive and little fieldwork was actually done (Davis et al, 1971), patterns do exist that are quite revealing (Figure 1.9). The work was done in the spring of 1971 during high water level status of the Great Sacandaga Reservoir. Doing the work in the spring distorted the Kenyon Island Group soil-type perspectives and Davis's field workers did not expend the time boating out to the islands. Thus, this report overlooked the forested terrain and the lands adjacent to the Kenyon Islands that form the focus of this thesis.

Finally, the Hudson River-Black River Regulating District (the new District created in 1959 by the New York State Legislature when it combined the Hudson River and Black River Regulating Districts) commissioned a study (Gabrielson, 1982). The purpose of the study was to determine the storage elevation curve of the reservoir to estimate how much sedimentation from stream tributaries and shoreline erosion was affecting the lake capacity. Their conclusion was that after 53 years of operations, the holding capacity of the reservoir had diminished by 1/3 of a billion cubic feet or about 2.6 billion gallons.

Format of this study

In this thesis, I try to present a logical argument for a deepening project in the Great Sacandaga Lake by looking at the subsurface soil stratigraphy using Geoprobe coring in Chapter 2. Core descriptions, access, permits, maps and GPS coordinates, methods and the questions raised are presented.

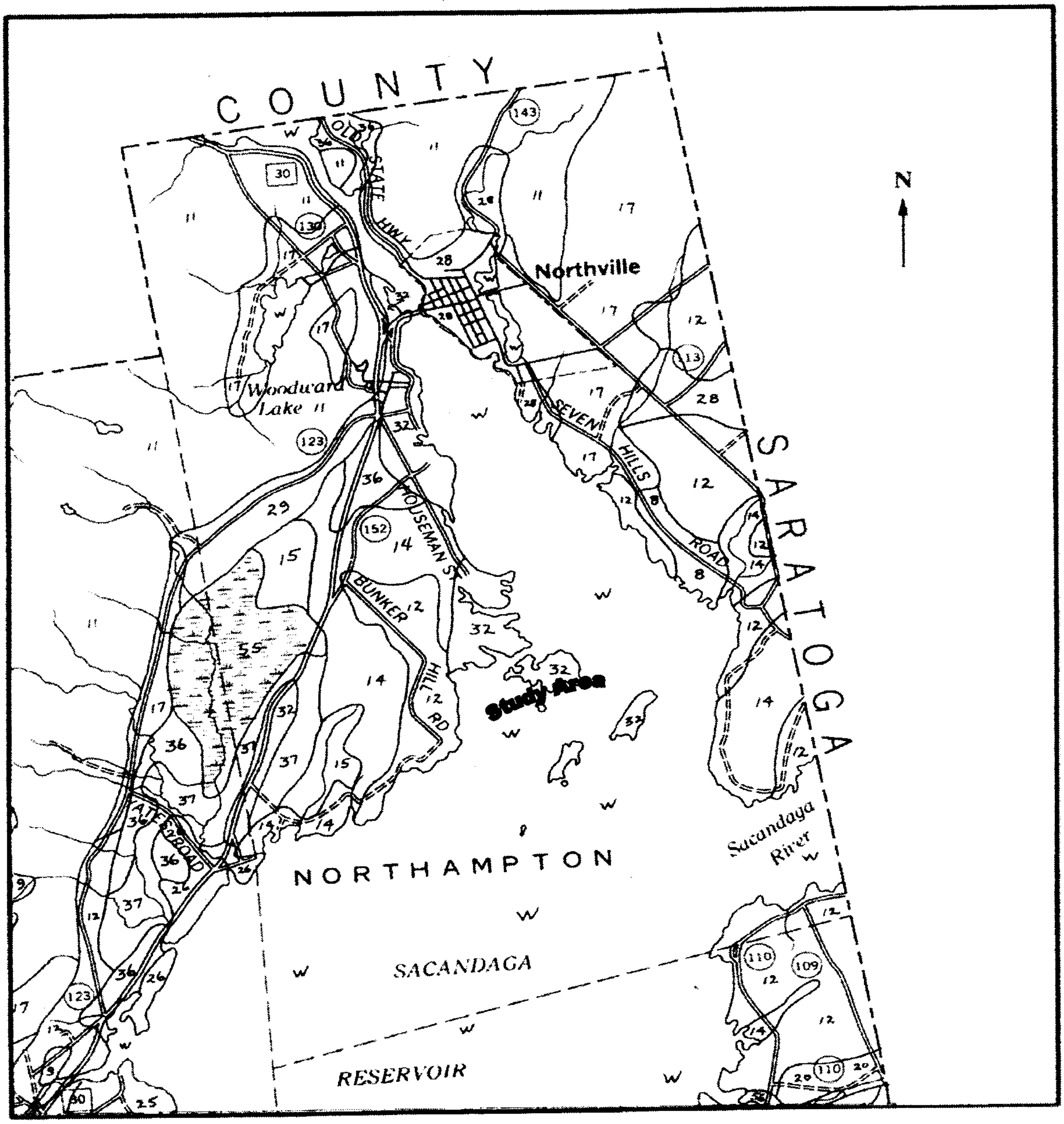


Figure 1.9 Soil Type Associations in Study Area from the General Soils Report of Fulton County, New York, Arnow et al, 1971.

In Chapter 3, a grain size analysis is conducted to try to assist in the interpretation of the cores. I have also examined the clay-sized fractions with X-Ray Diffraction and evaluate using *Ostracodes* to examine lake history. Idrisi software was used on Landsat 4, 5 imagery and isodata clustering during the late shallow water seasons of 1984 and 1988 to evaluate the bathymetry and land cover of the study area.

Some recent and historical accounts of the potential presence of heavy minerals in the sediments or bedrock around and in the reservoir are taken into account in Chapter 4. A trace metal analysis performed on different soil horizons in the geoprobe cores was used to determine which horizon minerals, if any, have value. A total heavy mineral mineralogy on stratigraphically averaged sediments from the cores was also performed. I also try to determine if the heavy minerals were entrained in glacial debris transported from many miles away, or rather, if they are beneath the overburden in the bedrock. The potential mineral resource of the heavy minerals will also be discussed.

In Chapter 5, I take a look at the issues involved in Kenyon Island reconfiguration. They include access and ownership of the lakebed sediments, the planning and geography of the reconfiguration possibilities, the costs of the undertakings, the real property values, and the timetables of the wisest approach to the deepening effort. In accordance with the new field and laboratory evidence, the potential economic impact a deepening project could have is presented and some possible future work and the conclusions are discussed.

CHAPTER 2

GEOPROBE CORING

Geoprobe Coring

Nine sediment cores were collected with a Geoprobe™ in a transect across the Kenyon Island Group. The goal for each core site was to obtain continuous soil/sediment core samples, but this is sometimes not attainable especially if the cutting shoe hits gravel, cobbles or large rocks.

The Geoprobe used for this coring was a model #5400 operated by Environmental Maintenance Technology (Schenectady, New York). The nine Geoprobe core samples were collected along a NE to SW diagonal transect, across the shallow water shoal, which includes the Kenyon Island Group and Mead Island. Access was accomplished during the low-water season of 1998, by driving along the gravel roadbeds of the former village roads of Osborne Bridge, which is submerged during the high water season. Everywhere along the transect of core holes, the ground was generally flat, but the ability to adjust the plumb of the core holes so precisely, made the operations very smooth and effortless. Minimal disturbance to the ground is a great advantage and the probing rate is fast between sections (from 5′ to 25′ per minute depending on the soil/sediment type). Each probe rod section is 48″ long with a drive head at the top and a cutting shoe on the bottom. The outside diameter of the stainless steel probe rod is 2.0125″ and the outside diameter of the cutting shoe is 2.2″ with an inside diameter of exactly 1.8125″. A 44″ CAB (Cellulose Acetate Butyrate) polymer liner, exactly 1 3/4″ OD fits snuggly inside. The liners are approximately 1/32″ thick and have a small flare on the down side to fit over the cutting shoe on the inside of the probe casing. These liners are clear and offer a good view of newly pushed cores, at least until the soil/sediment moisture obscures the view. For clarity the 44″ liners are assigned an added 4″, weighted over the sediment horizons to account for the 4′ penetrations of each probe section. The first 4′ section is pushed and removed. Each successive core is pushed in 4′ more with the aid of 1.25″ solid steel probe extensions. Extensions are added and removed one at a time, so deep cores are more and more time consuming.

Environmental Maintenance Technology's Geoprobe was powerful enough to push aside small rocks, but this never became a significant problem in any of the core holes. Our purpose was to soil/sediment probe as many holes as possible into the subsurface of the shallow water shoal known as the Kenyon Island Group, in one workday. The coring was performed on November 13, 1998, and we recovered a total of nine cores (See figure 1.3).

Core descriptions

In cores #1 and #4 we encountered small rocks in gravel horizons, which were about 2″ in diameter and these rocks blocked the recovery of complete cores until the cutting shoe rounded them enough to accept them (Figure 2.1). Figure 2.1 should be referred to whenever detailed descriptions of the core horizons are being discussed. None of the cores encountered any rocks of enough consequence to force us to relocate the truck for a second push. For a more complete discussion of the core horizons (See Appendix B – Core Descriptions).

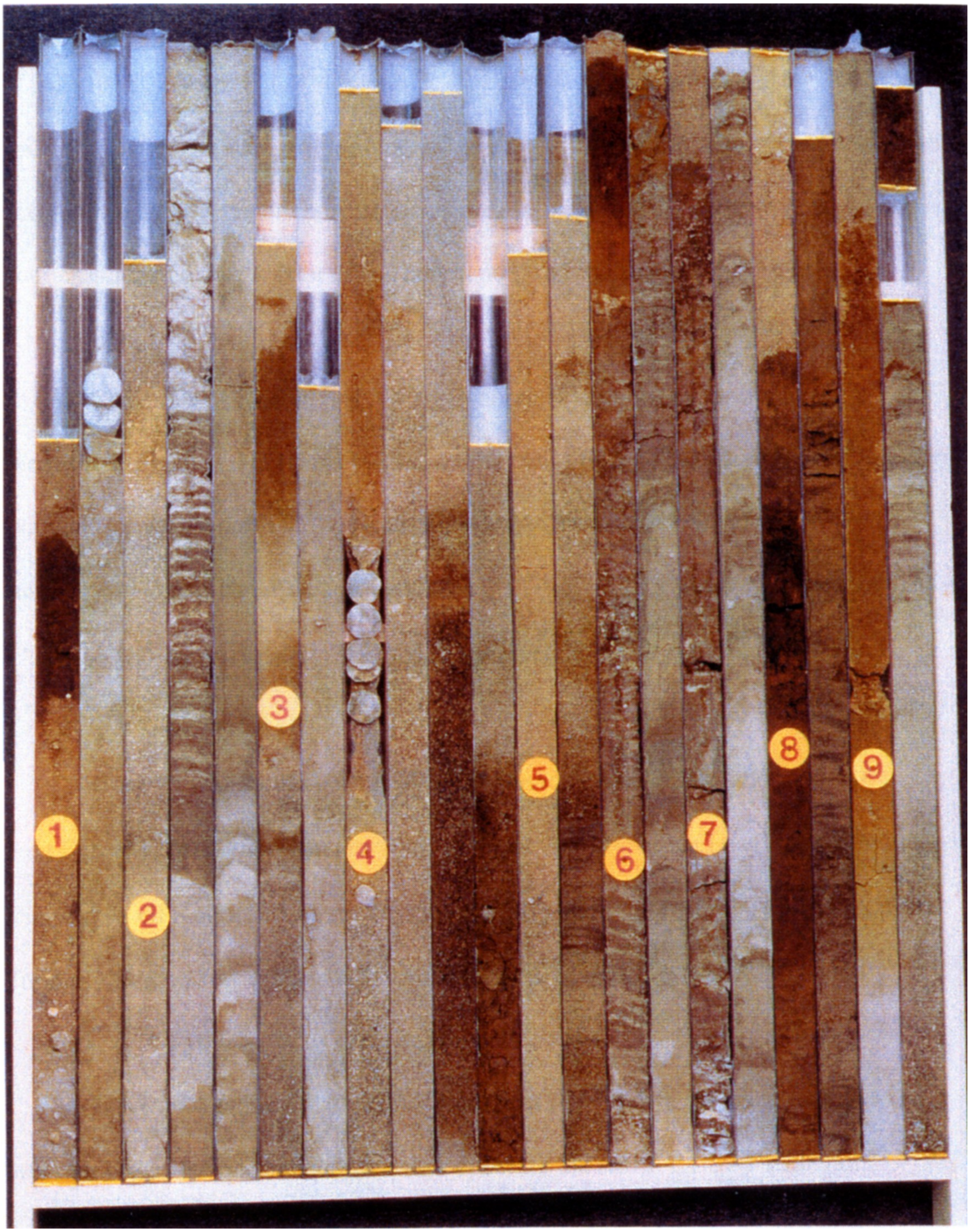


Figure 2.1 Geoprobe Core Horizons.

Core #1 was located just *SSW* of the Four Corners of old downtown Osborne Bridge. Its file number is 049 and its GPS (Global Positioning Satellite) coordinates are *N* (43°-10′-801″) and *W* (74°-08′-998″). The elevation was approximately 766′ above sea level. The site was also just north or on the edge of an end moraine, which was revealed further into the investigation of the study area (see page 53-55). We were probably on the former lands of either J. Paul or E. Hammond (see Figure 1.3).

Core #2 was located just *NW* of Osborne Bridge on the former lands of Foster Noyes (see Figure 1.3). It was located on the banks of the Sacandaga River Floodplain, which is pervasive north to the Northville Bridge, even at low water status. Its file number is 048 and its GPS coordinates are *N* (43°-10′-865″) and *W* (74°-09′-809″). The elevation was approximately 765′ above sea level.

Core #3 was located just *E* of Mead Island on the former lands of L. D. Fritcher (see Figure 1.3). It was at an elevation of about 765′ above sea level. Its file number is 050 and its GPS coordinates are *N* (43°-10′-821″) and *W* (74°-09′-791″). The site was formerly farmed and a few small stone piles existed adjacent to Mead Island.

Core #4 was located at the *NW* corner of Mead Island adjacent to a backwater inlet that faces the Sacandaga River floodplain to the east. Core #4's file number is 047 and its GPS coordinates are *N* (43°-10′-715″) and *W* (74°-10′-252″). Its elevation was precisely at the high water mark of 768′ above sea level. The site was on the former lands of Charles and Arietta Mead (see Figure 1.3).

Core #5 was located *WSW* of Mead Island on the edge of the largest eroded micro-island of a hummock field in the local greater Mead Islands group. The micro-island is usually submerged until late summer. The site was picked just on the eastern edge of the old Osborne Bridge Road and was 765′ above sea level. Its file number is 046 and its GPS coordinates are *N* (43°-10′-527″) and *W* (74°-10′-230″). It is unclear by the 1908 New York State Water Commission Maps who the former owner was but it could have been Horace Kenyon. In a straight line, the site was about 900′ from core site #4 (see Figure 1.3).

Core #6 was located about 800′ further *SW* along the old Osborne Bridge gravel road from site #5 (see Figure 1.3). This site is approximately 760′ above sea level and it is unclear who the former owner was, but was likely to be Horace Kenyon. The site was on the East Side of the road and appears to be a former dirt road heading northwest to an anonymous unimproved road connected to the Bunker Hill road. Its file number is 045 and its GPS coordinates are *N* (43°-10′-431″) and *W* (74°-10′-421″).

Core #7 was located at a bend in the old Osborne Bridge Road, *SW* of core #6 by some 1200′ (see Figure 1.3). It's not perfectly clear from the maps but this property could have been formerly the same lands of Ed Gifford. This site was also at the 760′ elevation above sea level and on the West Side of the road. Its file number was 044 and its GPS coordinates were *N* (43°-10′-332″) and *W* (74°-10′-487″).

Core #8 was sited approximately 800′ further *SW* along the old Osborne Bridge Road. It is on the East Side of the road at 764′ above sea level and was probably the former lands of Ammon Blowers (see Figure 1.3). Its file number is 043 and its GPS coordinates are *N* (43°-10′-262″) and *W* (74°-10′-603″).

Core #9 is located at the high water mark (768′) on the shoreline of the old Green's Beach Campsites. It would be just south of the old Osborne Bridge Road and on the former lands of Ammon Blowers (see Figure 1.3). Its file number is 042 and its GPS coordinates are *N* (43°-10′-182″) and *W* (74°-10′-798″). Core #9 was approximately 1200′ further *SW* along the old Osborne Bridge Road.

Core Analysis

After collecting the cores the ends were taped tight with duct tape to prevent the escape of sediments and moisture. All of the cores were labeled at retrieval with a file number and designated which ends were tops and bottoms. They were then transported to the Earth and Atmospheric Sciences Sediments Laboratory at the University at Albany.

Special racks were built to hold the cores and restrain them one by one for splitting each core liner lengthwise, proximally. The University machine shop built to my specifications a brass-cutting implement to which we attached two roofing knife blades. These were meant to slice the core liners only, at the centers 180° apart along the lengths. Hand handles were fabricated and 50# monofilament fishing line was attached to the handles and used to cut the sediments proximally through the length of the liners. A steel length weight was placed over the already split cores and a flat plastic shim was pulled down through the center of the liners, separating the top and bottom liner and sediments. Once that was done, the top split could be inverted and laid cut side up. The University Graphics Photographer took pictures of the still moist core halves (see Figure 2.1). The remaining halves were covered with clear plastic strips, (44″ x 1¾″) and archived in the Sediment Lab at the University of Albany.

The actual core liner lengths, which are 44″, were adjusted to reflect a 48″ push Geoprobe depth. Each core was given a file number, which referred to the core site no matter what the depth of the pushed core was. The sediment horizons were designated by their status regarding depth. For example, a distinct horizon in core site #1, file number 049, at the bottom of the second section from 78″ to 96″ deep would hereafter be referred to as 0497896. An interesting horizon at core site #4, file number 047, at the bottom of the fourth section from 176″ to 192″ deep would hereafter be referred to as 047176192, etc.

Each distinct horizon, were split and weighed. Portions were used for analysis, of trace metals, particle grain size analysis, pH and conductivity. Read about the purpose and results of the particle grain size study in Chapter 3 and trace metals in Chapter 4. Additionally, plugs were taken at intervals in the varved banding of the fine sand and clay horizons in sites #6 and #7 for identification of the clay constituents and to evaluate the need for a more detailed study of the *Ostracode* fauna.

CHAPTER 3

PARTICLE GRAIN SIZE ANALYSIS

Purpose

The core descriptions in Chapter 2 were based on observation, texture, color and facies changes, which reflect changes in the depositional environment. Facies changes at the top 16″ of core site #8 show the sandbar made by currents during the last 70 years. The top 32″ of modern (<70 years) ice rafted clasts and postglacial glaciofluvial gravels at core site #2 are Recent, due to the annual deltaic flooding at this part of the Sacandaga River as it opens-up to the newly created reservoir. Alignment of the core profiles contiguously by elevation with removal of all the blank spaces failed to allow clear correlation of sediment horizons from one site to another. Similarities can be seen between cores #6 and #7 or between cores #8 and #9, but no correlation exists between cores #5 and #6 and little exists between cores #7 and #8, even though the distances between probes was a mere 800′ in each case.

The depositional environment given the nearby Sacandaga River and/or the observations of the authors of previous work in the study area ie; glaciofluvial (Brigham, 1929), fluvial (Miller, 1909) and floodplain or fluvial deltaic (Cadwell, 1987) did not explain the deposition of the study area sediments. If the deposition of the core section horizons were either glaciofluvial or fluvial, we would expect to see sediment types with several components each related to processes of different flow regimes , characteristic of a polymodal distribution. Historical accounts of the Sacandaga River, before the reservoir was created, indicate numerous floodings and drownings during lumber log jams in the Sacandaga Basin. Even the 1908 Water Commission Maps indicate flood events at 766 feet above sea level, though the Sacandaga River elevation in the study area before the reservoir averaged 740 feet above sea level. River velocities, size and density of clasts and particle shapes would all be variable aspects of transported and entrained sediments, which should be expected to impart some degree of hydrodynamic sorting (Prothero and Schwab, 1996).

If the deposition were that of a floodplain, we would expect to see great variations over both small vertical and small horizontal distances, and the importance of the fine component, which characterizes the lowland suspended load type of rivers. Any fine suspended loads outside of the main channel of the river would have had to come about by the river overtopping its banks (Brown, 1985). Fine suspended loads would appear as layers in the sediment horizons and appear as abundances in core horizon splits.

Finally, if the deposition of the core sediment horizons were those of a lacustrine or lake environment, one would expect the preponderance of the sediments to be clays and silts, less than (0.0625mm/62.5μm) in size and showing sequences of laminae deposited in still water with annual layering reflecting lacustrine conditions (Loizeau et al., 1994). Important clues would be clay, terrestrial organic matter and freshwater crustaceans such as *Ostracodes*. The laminated layers in the clay horizons of cores #2, #6 and #7 looked to be good candidates for such conditions.

Over the last decade or so, several automatic rapid sediment analyzers based on light diffraction have been developed which are ideal for the measurement of the particle grain size of natural sediments, especially fine-grained sediments characteristic of fluvial/glaciofluvial and floodplain or lacustrine sediments. The geology department at

Union College in Schenectady, New York, has a Coulter LS-100 with a laser light source, from Coulter Electronics Ltd (USA) in their core analysis lab. Data from this insrument was used to characterize the particle grain sizes to assist in the interpretation of the depositional environments. Grain-size distributions would be presented in two ways: graphs of grain-size distributions will be plotted and compared; and statistical measures such as mean, median, mode and sorting are arithmetically calculated. In this chapter I will also identify and analyze the clay sized fraction with X-Ray Diffraction. Although an *Ostracode* study of the varved fine sand and clay layers of the core horizons at sites #2, #6 and #7 may not be appropriate for a chapter on grain-size, I did the work and hoped to learn whether (Brigham, 1929) was right to have postulated what he called a former "Glacial Lake Sacandaga" in the basin. The results of the *Ostracode* study will determine if a coherent pollen profile study needs to be undertaken. No bulk density or pore water analysis will be undertaken in the fine sand and clay-sized fraction to estimate the physical or chemical weathering effects on the sediments. All of the horizons examined either for particle grain size or economic worth (see Chapter 4) will be repeats of the most interesting and colorful horizons. References to a pH and Conductivity analysis, in this Chapter, on the core horizons interesting enough to further our overall goal of evaluating the potential economic worth of the sediments for a deepening project, will be discussed in Chapter 4.

Methods and Principles

Core horizons thought most interesting, as described in Chapter 2, page 48, were split and weighed, with approximately 30 dry grams used for particle grain size analysis and pH and Conductivity measurements. Each 30-gram horizon split was dried in a low temperature oven at 50° C (maximum temperature, so as not to lose any volatiles that may have existed). Core splitting revealed that there were no root systems to be removed. Absence of root systems was not assumed to indicate organics were not present, but rather an indication that no aquatic plants or terrestrial plants existed at any of the core sites. Approximately 20 grams were split-out of the 30 gram charge and set aside for the pH and conductivity measurements. Of the roughly 10 grams left, enough of a portion from each core horizon was sieved-out (<2mm) and weighed to about 2 grams (g) and placed in a pan. In each core horizon exactly 0.50g of sieved sample was weighed to the nearest 0.01g and placed in a pre-labeled and weighed centrifuge tube. Labeling recorded the core horizon sample numbers and weights and was used for duplicate records. All of the remaining core horizon (<2mm) fractions were tested with weak sulfuric acid for secondary carbonates, but none whatsoever were detected. Therefore, no carbonate extractions were necessary.

Despite the lack of visible roots, the removal of organic matter is essential, especially because it binds mineral particles together; particularly clay sized particles, and hinders dispersion. For removal of organics, 3 milliliters (ml) of concentrated (30%) H_2O_2 (Hydrogen Peroxide) was added to each centrifuge tube and sample. Each tube and sample was placed under a fume hood and gloves and glasses were used with a calibrated pipette to add the H_2O_2. Each sample was stirred with a glass rod and the rod was rinsed with deionized (DI) water (rinsed back into the centrifuge tube so that no material was lost). Organic matter is oxidized by H_2O_2 and an initial reaction or frothing indicates that organic matter is present. No organic matter was evident in any sample except for very small amounts (as indicated by the extent of frothing) in a few of the surface sediment horizons. Still, to be absolutely sure that all of the organics would be destroyed, each centrifuge tube and sample was placed upright in beakers about half filled with water on a hotplate set to 50° C (none of the tubes were submerged more that 75% in H_20). When the small amount of frothing in any of the tubes was complete enough to ensure that no further loss of fluid in the tubes was occurring, each tube was filled evenly (to about 1½″ deep) with DI water and left overnight on the hotplate in the fume hood to thoroughly digest any remaining organics. The next morning the fluid levels in the tubes were topped off with DI water (to balance the tubes for centrifuging). Caps were placed on each set of centrifuge tubes and samples and they were centrifuged at 5000-7000 RPM for 3 minutes. Each tube supernatant was decanted carefully so that no sediment escaped. The centrifuge tubes were filled to ¾ level and the caps replaced. The tubes and samples were timed and vigorously hand shaken for 30 seconds and re-centrifuged for another 3 minutes.

The removal of biogenic silica is necessary for all lake sediment samples and surface soil developed horizons. Physiological actions of organisms, both because of the study area's history of farming and the lake microorganisms, effect the cycling of the chemical constituents of the core sediment minerals. To do this, 10ml of 1 Molar NaOH (Sodium Hydroxide) was added to the centrifuge tubes and samples. Each tube was left upright in beakers without caps in water and placed back on the hotplate, set at 50° C for at least 4 hours. The samples were not allowed to dry out or cool down during this period. The centrifuge tubes were capped, placed in racks and then in a reciprocating shaker for 30 minutes. After the required time, the centrifuge tubes were put back in the water-filled beakers on the hotplate for another 30 minutes. Each tube was again put in groups for centrifuging at 5000-7000 RPM for another 3 minutes. Each tube supernatant was carefully decanted so as to avoid losing any sample material. Virtually no reaction occurred on any sample during the removal of the biogenic silica, so the tubes were filled evenly to ¾ full with DI water, timed and hand shaken vigorously for 30 seconds apiece and re-centrifuged one more time. Each sample was carefully decanted again, so that no sediment was lost and the tubes were filled to ¾ full.

A chemical dispersant made of non-ionic surfactant (0.3 Molar), sodium hexametaphosphate (5 Molar) and sodium carbonate (1 Molar) was added to each centrifuge tube and sample and stirred with a glass rod. The glass rods were carefully rinsed with DI water back into the tubes to prevent sample contamination and material loss. The samples were then capped and stood upright in racks and placed on the reciprocating shaker table for two hours, after which they were left overnight to await particle size analysis with the Coulter laser diffraction machine. The dispersant is supposed to accomplish three tasks: (a) adding sodium ions to increase the exchangeable sodium and cause a repulsion between particles, (b) adding hexametaphosphate which is adsorbed on to positive electrical charges on the sesquioxides and clays, so preventing attraction to negatively charged clay and (c) adding carbonate to raise the pH of the solution and so remove positive charges (Loizeau et al., 1994).

Using the Coulter Laser (LS) Particle Size Analyzer is essentially automatic. Each centrifuge tube and sample is placed upright in a beaker of water, atop an ultrasonic vibrating machine for 5 minutes prior to run time. Vibrating ensures that dissolved air from stirring and shaking is degassed because bubbles do not interfere with the particle size distributions. The filename and sample information is entered, the sample added after the water column is flushed clear with filtered water. After each sample the Coulter automatically saves the particle size distribution as a log-μm Cumulative Curve that can be grouped as advised (Figures 3.1a and 3.1b). The Volume Statistics generated can be seen in Appendix B. The exact same protocol, ultrasonic degassing, data entry, sample addition and chamber purging follow each sample run.

The principle of the Coulter Laser Grain size analyzer is based on the interaction between light and particles of sediment. Diffraction is the preponderant effect: particles of a given size scatter light through a given angle, the angle increasing with decreasing particle size. A laser beam of monochromatic light (λ = 750nm) is collimated to form a 13 mm diameter beam that passes through the sample cell containing an upwards-moving suspension. After the samples are ultrasonically dispersed, the centrifuge tube and its sample contents are introduced into the fluid module that generates a high-speed suspension stream inside the sample cell. The stream is strong enough to move particles up to 900μm in diameter with a density of up to 4g cm^{-3}. Size results are supplied in terms of equivalent spherical cross-sectional diameter and the Coulter resolves sizes into 72 classes from 0.4 to 900μm with an exact logarithmic progression. The Coulter Laser Particle Size Analyzer does not take into account particles calculated to be smaller than 0.4μm, such as ultra fine clays and silts. The efficiency of their detection is proportional to the actual clay content. For ultra fine sediments containing less than 10% of clay, the efficiency is about 40-45% whereas for clay content greater than about 80% it reaches 100%.

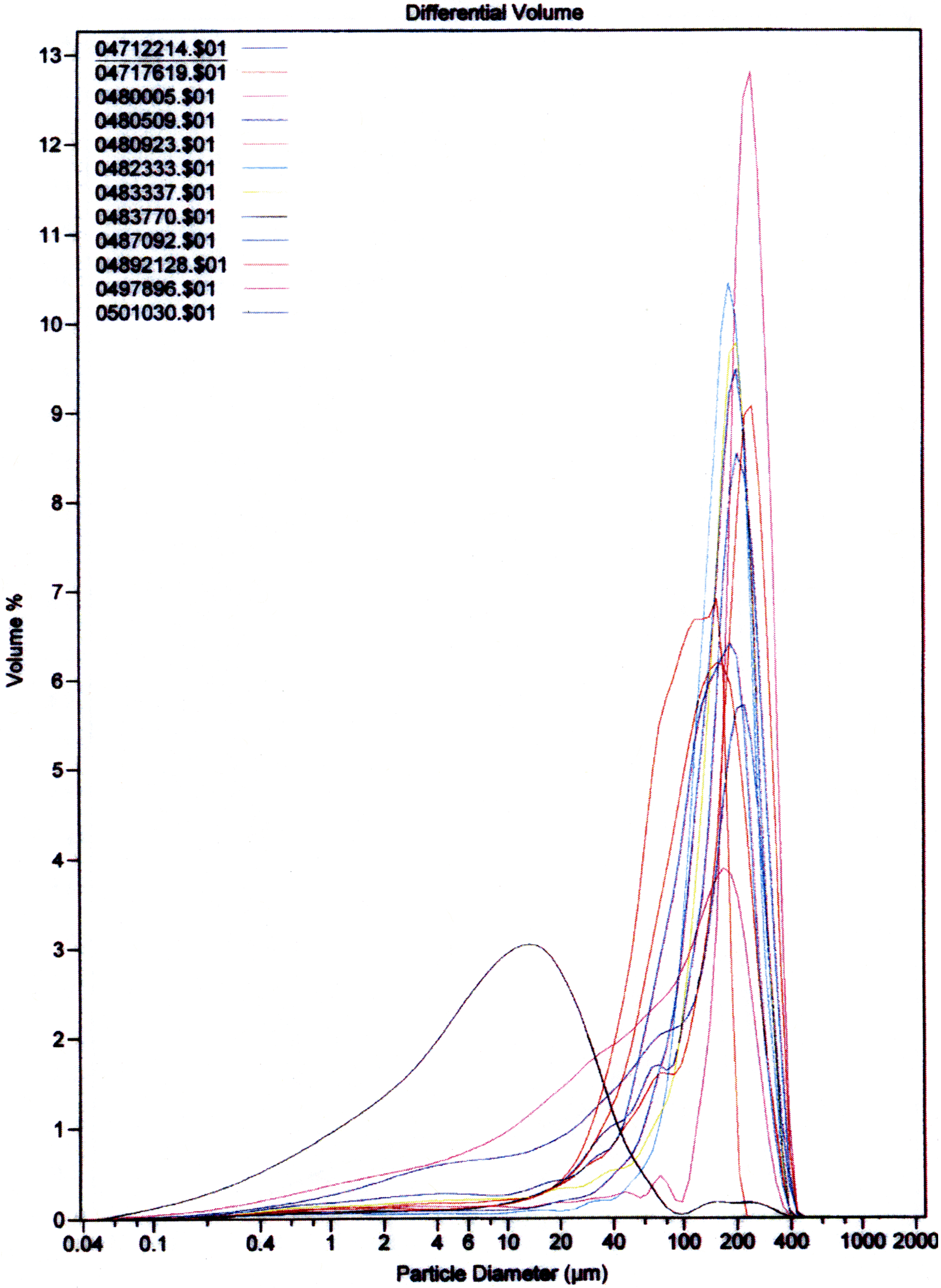


Figure 3.1a Coulter LS Particle Size Analyzer, Sediment/Core Lab, Geology Department, Union College.

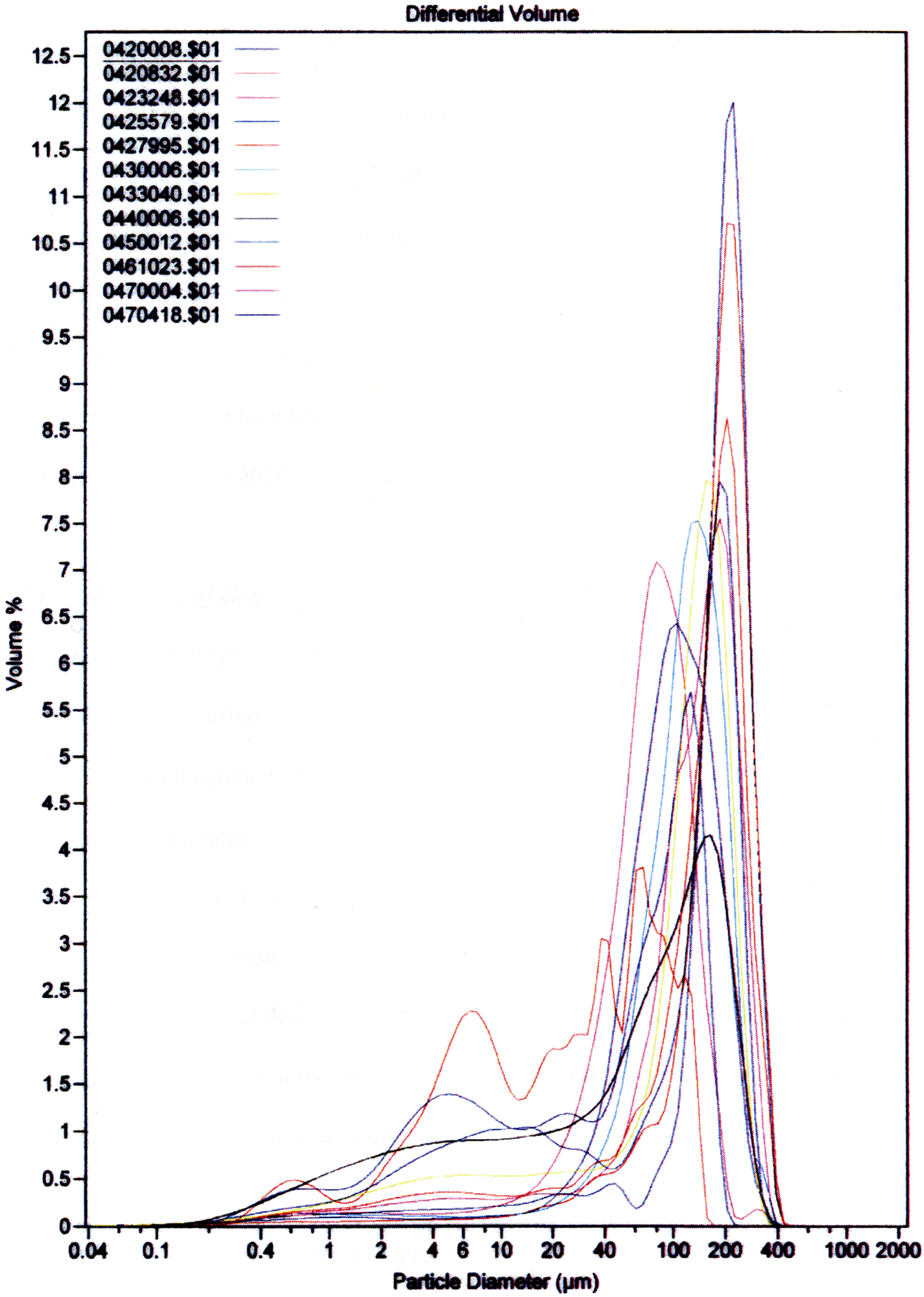


Figure 3.1b Coulter LS Particle Size Analyzer, Sediment/Core Lab, Geology Department, Union College.

The diffracted light is focused by two Fourier lenses, which direct light of identical diffraction angle toward one of three sets of detectors for low, medium and high angles (Figure 3.2 and Table 3.1). Particle location in the sample cell has no influence on the measurement. Consequently, a stream of particles can be passed through the beam to generate a stable diffraction pattern (Loizeau et al., 1994). From all accounts, the Coulter can be expected to measure the distribution of sediment sizes equally or better, and certainly much faster than can be measured by sieving. Laser diffraction computes simultaneously in the whole range of sizes, expressed in volume (or surface) units, whereas sieving results are obtained in weight units.

X-Ray Diffraction of clay sized fractions

Several of the probes showed laminated layer horizons, but apparently the laminated layers occurred mainly in sand fractions. The discovery of two cores, #6 and #7, with laminated layers of what appeared to be solid <50μm to depths of at least 8′ deep and probably more, pose challenges to a potential Great Sacandaga Lake deepening project. Were these new laminated layers solid clay or a mixture of fine sand and clay and to what extent do these horizons exist?

If the clay species discovered were 100% pure and had no superfluous mineral constituents they would be a recoverable resource. Expandable clays such as smectite have a wide array of industrial applications such as catalytical activity and ion exchange. If the clays were Talc or kaolin type clays they would have applications in powders and cosmetics or as paper fillers and coatings.

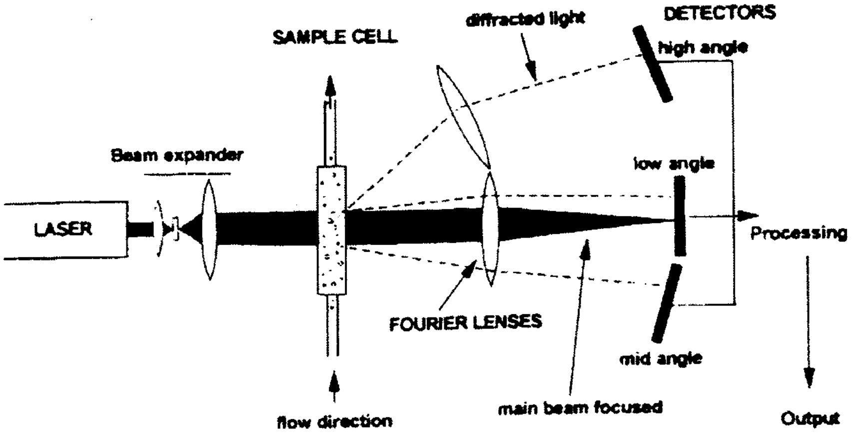


Figure 3.2 Schematic diagram showing the arrangement of the main Components of the Coulter LS-100, after Loizeau, 1994.

Table 3.1 Main characteristics of the laser diffraction grain size analyzer Coulter LS-100, after J-l Loizequ et al., 1994.

Laser type	solid, 4mW
Wave lenght of light	λ=750nm
Number of detectors	127
Size range	0.4-900 μm
Number of size classes	72
Fluid Module capacity	1-2 litres
Weight of sediment needed	0.05-2 g

If the clay has no intrinsic value, it still could have some very practical purpose, as a constituent in topsoil production for the reconstructed island or islands. Several of the smaller outlying Kenyon Islands and Mead Islands are barren with few, if any, trees. The larger islands have trees but most are stunted and are littered with dead and fallen-trees. Good topsoil, depending on the source referenced, has 15-20% clay, 40-45% sand, 35-40% sesquioxides and 5-10% humus. The right proportions necessary to build a topsoil that does not need constant nutrient additions and will support trees and grasses would have to be determined by a soil scientist, but the shallow water shoal sediments (those sediments to be dredged) should have a sufficient contingent of each in the sediment mix. The ideal island that might be reconfigured in a deepening project will be discussed in Chapter 5, but would involve approximately 3-4 million cubic yards (yd^3) of topsoil (12″ deep). Clays of little intrinsic value (between 500,000-800,000 yd^3) could be utilized in topsoil mixtures during island reconstruction.

The extent to which the fine sand and clay horizons exist could not possibly be determined without a much more extensive probe grid work. That may not be necessary though, if the X-Ray Diffraction (XRD) results reveal no potential economically valuable clay fraction and/or it contained superfluous contamination that required separation.
If the clays cannot be determined to be valuable and dredging them is impractical, then earth-moving heavy equipment used to accomplish a deepening project would overcome the clay dilemma wherever necessary.

Clay plugs (1/2″ marble size) were taken from the upper core sections of core #6 and #7 at 36″ of depth. Core #6 includeds a light colored varve layer and core #7 includes a dark colored varve layer. The plugs were sent to Dr. Rossman F. Giese Jr. at the State University of New York at Buffalo, for X-ray diffraction analysis.

The clay fraction is mostly chlorite (>80%) and lepidolite (20%), with the balance having 12Å (angstrom) spacing, suspected of being <4μm common silicates feldspar and quartz. Fine sand and clays accounted for approximately 12% of the samples by weight. There were no expandable clays in the clay fractions. No further X-Ray diffractions were planned because both cores #6 and #7 were so consistent throughout and there were no apparent facies changes evident.

Therefore, I conclude that the <4μm fraction has no intrinsic economic value and are essentially all feldspar and quartz rendering them useful only as a constituent of topsoil and/or fill. One important result of the X-Ray Diffraction is that the clay is from the Chlorite Group and chlorite and lepidolite might help with the interpretation of the rock provenance of the sediments. This also means that the <4μm horizons would have to have been deposited as rock flour (pulverized while being transported). Rock flour is finely comminuted, chemically unweathered material, consisting of silt and clay sized angular particles of rock forming minerals. The extent to which silt and clay sized sediments exist here in the study area provides clues as to the sediment depositional environment and perhaps denudation rates, suggesting that the transport mechanism was a glacier. If the clay fraction is lacustrine, then either an *Ostracode* study or a coherent pollen profile might help with interpreting the environment of deposition.

Ostracode Study

Plugs were removed from cores #2, #6 and #7 at approximately 60″, 36″ and 60″ deep respectively, on the premise that *ostracodes* could be preserved in the sediments. Most *Podocopina* are between 1-2mm, to ensure capture of juveniles or those of smaller stature, each plug was wet sieved at 80µm (0.07mm) and any sediments that passed through the sieve were discarded. The fraction that was saved, larger than 80µm, was washed back into a cup and a small amount of non-ionic surfactant was added. The sediments were mostly very fine sands after sieving out the smaller clay fraction, but did have clumps of clayed particles. The sediments were stirred and the surfactant aided in de-clumping the clayed particles. The cups were covered and left for several days, with occasional stirring. The sediments were dried in an oven at 50° C and examined under the microscope (x 100 magnification).

Absolutely no *Ostracodes* were discovered in any of the core horizons examined. Because of this, it was decided not to do any coherent pollen profiles, which might turn out to be of limited value in this context. The implications are telling and indicate that no surface water exposure to sunlight and photosynthesis, or eolian (wind blown) organics lent a part in living organisms becoming part of the fabric of the depositional environment of the >80µm (often refered to as slimes) core sediments. This could mean that no lake existed in the study area at anytime within the framework of the depths of our coring since the last glacial epoch. Or it could just mean that *Ostracodes* were not preserved or present in our limited analysis. One could argue that three sample plugs are not fully representative, but without *Ostracodes* it could be difficult to make a case that the subsurface sediments were viable to life and living organisms. Other interpretation could be imagined but might be impractical given reasonable alluvial denudation rates in a valley such as the Sacandaga Basin. One would expect the sediments brought about by erosional or due to a fluvial nature would show some degree of rounding and these sediments do not. Therefore, my conclusion is that if a lake existed either now or since the last glacial epoch, life ought to have left a fingerprint, at least some organics would be detected at depth (see page 32 and 33 – methods) and that the total overburden is probably the result of a single glacial event in the late Pleistocene.

Interpretations

In the New York State Museum Bulletin No. 280, 1909, Brigham recognized what he called strong moraine, recessional moraine, outwash terraces and kames in the Sacandaga Valley, north of Northville, New York. He even points out that the Northville Quadrangle Topographic Map adequately shows these features. He was convinced though, that the Sacandaga Vly, represented a former glacial lake he called "Glacial Lake Sacandaga" (Brigham, 1909). Perhaps the basin, covered in trees, grasses and swamps, did not lend itself to easy field work and he was only able to interpret the Sacandaga River shorelines.

The aerial photographs used by the United States Department of Agriculture Soil Conservation Service in preparing the 1971 General Soils Report of Fulton County, New York, tell another story (Davis et al, 1971). Here, the mapping clearly suggest, the existance of remnant end moraine sections forming further arcuate bands south of Northville, New York, particularly at Hampton Point, Northampton Marina and across the Kenyon Island Group.

Landsat Thematic Mapper Imagery, obtained from the Eros Data Center in Sioux Falls, South Dakota also indicate the existance of morainal ramparts (morainal ramparts as described by Jackson, 1997) throughout the Great Sacandaga Lake. I used Thematic Mapper Spectral Bands 1: (0.45 to 0.52µm – blue), 4: (0.76 to 0.90µm – reflective infrared) and 7: (2.08 to 2.35µm – mid-infrared) on Idrisi 32 software to run an Unsupervised Land-Cover Examination with isodata clustering classification to study the land cover around the Great Sacandaga Lake (Jensen, 1996). I also used orthophoto's and the USGS Topographic map to improve the image classifications, obtaining close to 80% accuracy. The images used were obtained on 11/08/1984 and 09/16/1988, during exceptionally low water periods for the reservoir and were in raster format. The land cover classifications are very similar to the bathymetry of the GSL Navigation Maps.

Examination of the Coulter LS Particle Size Distribution Cumulative Curves in Figures 3.2a and 3.2b from 24 different sediment horizons shows that the mean of volume percentages is about 130µm (0.15mm). The consistency is remarkable given the possible range of depositional environments that could be imagined, such as fluvial, glaciofluvial, floodplain or lacustrine. In fact, the particle grain sizes that most reveal the parent material are somewhere between fine sand and very fine sand. The transect of core probing covered over 2 miles in length, diagonally across more than $5mi^2$ of the shallow water shoal study area. Except for horizon (0483770) in core #2, which was almost entirely fine sand with some clay, little variation existed. Glaciers, which erode and deposit sediment in a very distinctive manner may be the reason the deposition appears to be subglacial.

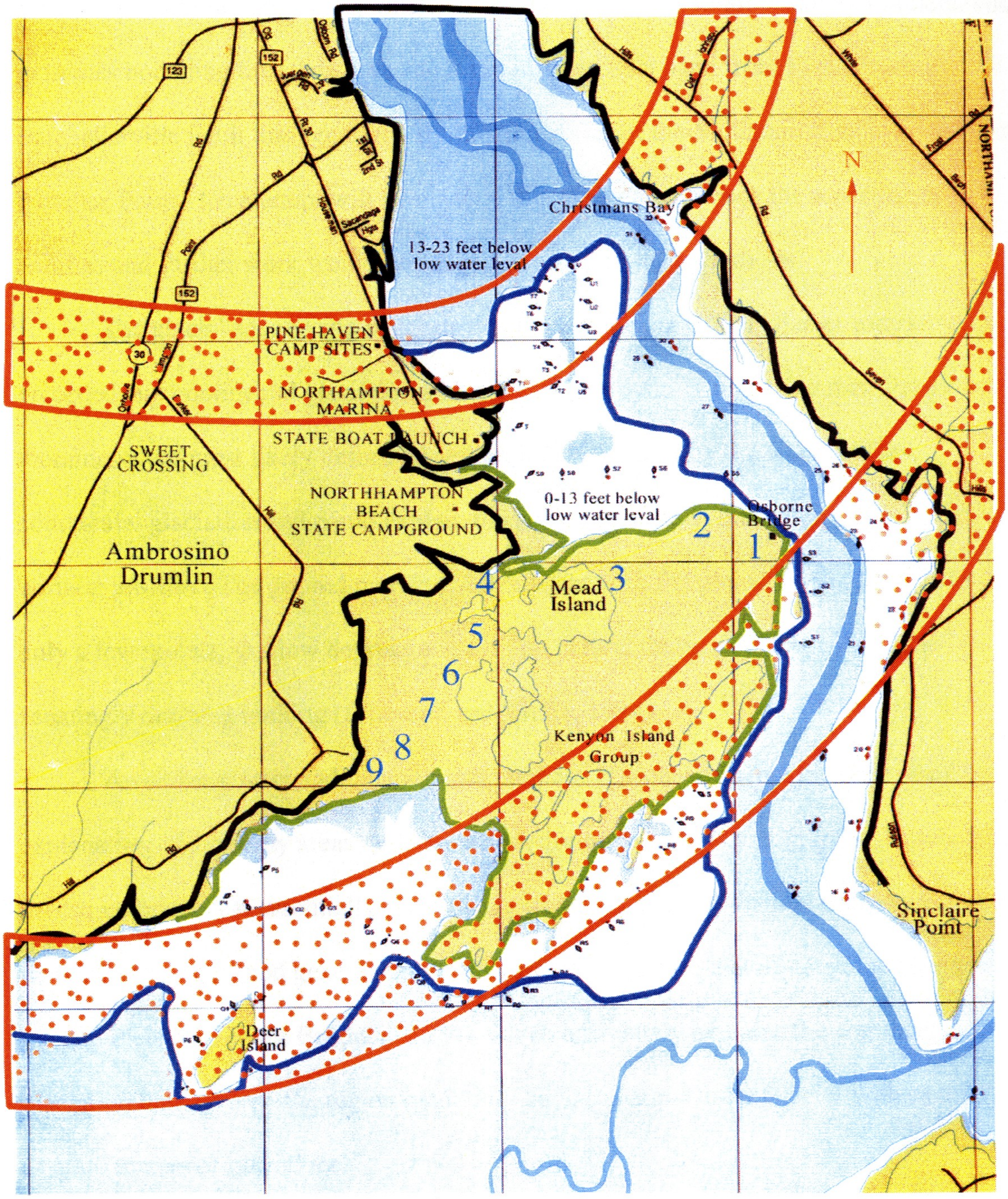
Glacial sediment is entrained in various ways and the mechanisms that transport and deposit clasts by ice make them notoriously poorly sorted, angular and heterogeneous. Clasts of a wide variety of rocks, derived from whatever lithologies lying upstream from the deposit, float in the predominantly <50μm fine sand and clay "rock flour" matrix. The matrix is not the product of normal aqueous flow, but rather, deposited by a mode of mass transport in glacial ice. The sediment mix is generally characterized by a disrupted gravel framework, within which, stones are not generally in contact. The sediment mix is unstratified and notable for containing more matrix than gravel sized clasts (pebbles are less than 10%). All material incorporated on, within or near the base of glacial ice settles out slowly, varying with the seasons. The high viscosity and low velocity of moving ice permit no sorting and little abrasion, although grinding of the bedload against valley walls and floor can generate additional fine-grained sediment. Glacial loads are plastered onto the substrate as ground moraine (lodgement till) or accumulate wherever there is a balance between rates of ice flow and melting. This accumulation produces end, recessional, and terminal moraines (Prothero and Schwab, 1996).

There must be supporting field evidence to identify ground moraine or deformed lodgement till including varved clay sequences (freeze and thaw cycles) and very large boulders forming lateral, end and/or terminal moraines (Prothero and Schwab, 1996). In fact, the shallow water shoal study area has all these features. The transect of cores lies almost entirely within the ground moraine field and its sediments are deformed around the flutes, kames and drumlins as stoss and lee topography. The kettle lake sediments created by the superincumbent glacial ice were deformed by the overlain lobe weight.

The study area may have been part of a sequence of outlet glacier (outlet glaciers as described by Jackson, 1997) advances called morainal ramparts. Each rampart looks as if it were an amphitheatre at the mouth of the valley, whose leading edge develops as an end moraine, its outside edges develop as lateral moraines and its central portion develops as ground moraine or deformed lodgement till (Prothero and Schwab, 1996).

Outlet glaciers, may explain the morainal rampart topography exhibited by the study area. The skeletal end moraine to the south and east which makes an arcuate path south of Osborne Bridge across the Kenyon Islands, Deer Island, past the Ambrosino Drumlin and Cranberry Creek and to the southwest of Tamarack Swamp forms the rampart boundary of the study area to the south. The skeletal end moraine to the north and west makes a smaller arcuate path from the Johnson Road, Christmans Bay, through Northampton Marina, underneath the Ambrosino Drumlin and to the north of the Tamarack Swamp makes up the northern boundary of the study area (Figure 3.5). The greater area ($\sim 12mi^2$) makes up the whole of the area confined by the two skeletal end moraines described (see USGS Topographic Map, Northville Quadrangle, 1970).

These are not all inclusive of the morainal ramparts produced by the Sacandaga Outlet Glacier during the late Pleistocene. At least one other skeletal end moraine can be described farther north of these two. This one occurs in an arcuate path across the valley from Gould Hill to just north of Hampton Point. Perhaps, based on topographic and navigation maps another existed just south of Northville across to the old Scout Island and to the north of the Mountain Road.



DEPTH CONTOURS

🟨 Exposed lake bottom at low water

0 - 13 feet below low water level

13 - 23 feet below low water leval

23 - 33 feet below low water leval

🟦 Original Sacandaga River

0 1/4 1/2 3/4 1 Mile

Figure 3.3 Skeletal End Moraines bounding study area, Jimapco GSL Navigation Map, 1991.

⬛ High water mark

🟦 0-13' below water

🟩 Shallow water shoal

🟥 Skeletal End Moraine

1-9 Geoprobe Boreholes

A terminal moraine most likely existed as the final rampart, south of the two skeletal end moraines bounding the study area and it ran in an arcuate band from Fish House and the Batchellerville Fault through to the southernmost end of the Mountain Road, just north of Paradise Point. No attempt will be made in this report to convince the reader of these realities and further work would be needed to confirm this hypothesis.

The glacial sequencing suggests that the Sacandaga Outlet Glacier may have preceded any continental glaciation and was overlain by it. The ground moraine and end moraines were most likely deformed and probably smeared by the weight of the continental glaciation and could explain the deformation and correlation issues in the core horizon profiles. The ground moraine is consistant with flat plains having local relief of only a few meters, shallow depressions with no natural drainage outlet and gullies seemingly draining nothing (Lillesand and Kiefer, 1994).

An outlet glacier and the morainal ramparts it produced seem the only plausible explanation of the study areas depositional environment and its topography. Microscopic investigations reveal essentially no rounding of grains and they remain sharp and angular throughout. For a good general explanation of the glaciation that affected the region in the late Pleistocene (see Brigham, 1929), which adequately explains the continental glaciation that covered the region including the Sacandaga Outlet Glacier with as much as 1000 meters of glacial ice.

CHAPTER 4

MINERAL WEALTH

Theories behind the study

Any deepening for this part of the Great Sacandaga Lake would involve dredging or earth moving by heavy equipment. Either of these approaches to permanently deepening the lakebed would be very expensive and careful consideration of many variables, especially in the case of dredging, would need to be evaluated. Earth-moving heavy equipment would be easier and less costly, but the only way to recover these costs would be through the new real property created, or Island rebuilding and reconfigured lakefront property values. The current "State of the Art" dredging machines can pump up to 500 cubic yards of material (solids up to 50% content and move objects as large as 8″ in diameter) and are the method of choice in deepening projects, where "heavies" (mineral wealth) need to be recovered. Heavies minerals have a specific gravity greater (usually >2.85) than the surrounding sediments (a detrital mineral less than 1% in most sediments forming a minor constituent or accessory mineral). They typically include magnetite, ilmenite, zircon and noble metals and they may be recovered to offset the cost of operations. Simultaneous to extracting lake bottom sediments and separating heavies, the dredged slurries are pumped as much as 3000-4000′ to be used to rebuild or reconfigure adjacent islands. Dredging machines are particularly ineffective in consolidated sediments such as clays. Dredging and pumping abilities are diminished and additional implements need to be added such as, auger heads with clay degraders or bucketwheel cutterheads to disaggregate the clay. Because clay sized particles remain suspended longer due to their shape and specific gravity, serious turbidity problems could also be encountered if dredging was used. The topic of island rebuilding will be examined more fully in Chapter 5.

Bedrock studies and assays of the slope sediments in the feeder streams to the Great Sacandaga Lake have revealed bedrock units that contain interesting minerals (Miller, 1911). Glaciers in the Sacandaga Valley indicate that the deposition of the sediments of the study area must have come from an up-ice or upstream bedrock and overburden. There are known granite pegmatites (Miller, 1911) around the Sacandaga Valley and glacial erosion probably accounts for the many billions of tons of sediment atop the bedrock of the study area and adjacent morainal ramparts.

Dredging and separating the minerals of the study area is the only method that has the potential to generate profits beyond the altruism of the deepening cause. If the sediments have native elements, oxides, sulfides or even any of the pathfinder elements that could point to bedrock mineralization, I can then evaluate their economic importance. I have found mineral abundances and/or mineralizations using ICP-MS (Inductively Coupled Plasma Mass Spectroscopy), ICP-AES (Plasma Atomic Emission Spectroscopy) or standard "Fire Assay" procedures. The multi-element analysis using ICP-MS requires a tri-acid digestion procedure, which produces "near total", extended sensitivity digestion to selectively leach a much wider spectrum of elements. The Geoprobe core horizons that looked interesting and had the most colorful sediments, after cleaning-off small samples of their coatings with weak acid, were sent off for analysis. One hundred gram samples were split from the liners, marked and sent off, none of which contained any cleaned (no coatings washed-off) horizon sediments.

Multi-element analysis was performed on 26 Geoprobe samples and one nearby bedrock unit sample of the Potsdam Sandstone (from the Ridge Road by Carpenters Corners) as identified by nearby water well records FU 141, 0740900 NAD27 of the USGS, (see Appendix C). Facilities exist between the University at Albany and Rennselear Polytechnical Institute to analyze the samples, but it was decided that due to the potential economic importance of the sediments, more credibility would be attached to the results from an outside independent source. The Assaying and ICP-MS multi-element analyses were performed by ALS Chemex Labs, Inc., in Mississauga, Ontario, Canada and Reno, Nevada (see Appendix D). Forty-Four (44) elements were analyzed and the results are displayed as ppb (parts per billion), ppm (parts per million) or as % (percent).

Occurrences of minerals in much higher abundances and worthy of recovery are not commonly found in glacially derived sediments. If the Sacandaga Outlet Glacier derived its sediments from bedrock that has economically important minerals, we might have deposits of these ore minerals at our disposal. Mineral deposits of economic value in sedimentary deposits (i.e. placers) are those in which minerals are sufficiently high enough to make it economically worthwhile to extract. Because minerals are so widely distributed in many common rocks, the issue of resources and reserves is dominated by costs of recovery and selling price.

In sediments, if the elements are locked-up in mineral ores with specific gravities above 1.8-1.9 and if the particles are no smaller than 20μm, dredging recoveries are commonly greater than 95% after washplant operations (Hartman, 1996). The sediments in my study area have a mean size above 125μm (>0.15mm) as confirmed by the Coulter

Laser Grain-Size analysis. This point is central to our whole study because there is an advantage to dredging unconsolidated sediments and mining them as *placer deposits*. In fact, some mineral deposits in Quaternary sand bodies are currently of greater importance than deposits of any other type. For example, titanium oxides from shoreline deposits account for virtually all-current production and 36% of all identified resources of titanium in the United States and 55% for the entire world. The current economic mineral ore rutile (TiO_2) in placer deposits in Australia, have cutoff grades (0.1% TiO_2) below the average crustal abundances of TiO_2 (Force, 1991). Another advantage accorded to dredge mining is that it is a completely non-chemical extraction and environmentally friendly. Perhaps the greatest advantage though, is the low cost of equipment and operational costs, one-tenth of hard rock mining, making placer mining profitable even with very low-grade mineral ores (Holland and Petersen, 1995).

The trace metal analysis and assay abundances in my core horizon samples are listed in Appendix D. They represent only 44 of the more than 100 fundamental substances that consist of elements of only one kind. The absence of the remaining 66 elements, with a few exceptions, was chosen by design and meant to maximize the potential economic opportunities a specific gravity separation of the elements, such as dredge mining, would offer. Two elements that should be considered in further research include tin (Sn) and zirconium (Zr).

Heavy mineral mineralogy and assays of mineral fractions were used to identify those heavy minerals of economic importance. A thorough, microscopic study has been accorded the sediments of the study area and several elements pointed out in the trace element analysis have been specifically identified in their mineral ores. Several other identification methods were employed in this study such as mineral associations; many minerals exist in sympathy with other minerals and sometimes only with other minerals associated with specific rock types (Chesterman, 1995). Magnetization and fluorescence studies were used to help identify or eliminate suspected mineralogy. A radiological study was used because of rare earth element enrichments discovered in the study area sediments (see Appendix E). Using a Landers, Frary and Clark Radiological Survey Meter (Geiger counter), made by the Victoreen Instrument Company of Cleveland, Ohio (air-ionization chamber) the sediments registered 0.11 R/hr (Roentgens per hour). A Roentgen is a measure of radiation intensity related to the ionization of air. The dose to soft tissue is about 10 milligray when exposure is 1 Roentgen.

Trace elements (those present in amounts less than 0.1% in general) play an important role in defining the nature of rocks and from which igneous partial melts they are derived. They are valuable indicators because the extent to which different minerals incorporate these elements varies sharply as a function of temperature, pressure or composition of the fluid from which the minerals crystallized. Of special interest are barium, rubidium, strontium, zirconium and the rare-earth elements. The incorporation of trace elements in igneous rocks also depends on the crystal structures of the minerals crystallizing from the melt. Minerals such as rubidium, strontium and the rare-earth elements (REE) tend to remain in the melt longer because their ionic radii and charges prevent them from incorporation into simpler structures (Raymond, 1995). Most of the sediments in the study area should be from igneous and metamorphic Grenville gneissic rocks of the Adirondacks. A correlation matrix was incorporated in an attempt to discover the rock provenances of these minerals.

The next important result of the multi-element analysis is the the role played in identifying or dismissing Dispersion Patterns; the patterns of distribution of chemical elements, especially trace elements, in the wall or surface rocks of an ore body or in the surface sediments surrounding it (Smee, 1983). The sediment in the study area lies atop bedrock that could contain mineralizations. A simple pH and ionic conductivity measurement on suitably prepared sediment horizon slurries may be a sufficient indicator of diffusion through the overburden. Any variations to background levels of elements in the sediment horizons over an ore zone would indicate an anomaly (Smee, 1983).

Measurements of soil pH and conductivity on study area soil solution slurries were made following methods of (Rowell, 1994). Trace element dispersion pattern anomalies, did not occur in our sediment horizon samples (see Table 4.1).

Table 4.1

pH and Conductivity Measurements
Great Sacandaga Geoprobe Boreholes

Borehole	Weight (grams)	pH*	Conductivity†
0427995	11.5	6.25	.220
0433040	9.5	6.40	.275
0480005	12.5	6.20	.275
0470418	12.0	6.25	.275
0501030	12.0	6.35	.250
04892128	14.5	6.60	.165
0491832	11.5	6.00	.475
0423248	9.5	6.55	.160
0480509	10.0	6.05	.245
0497896	15.5	6.15 +[6.10]	.235+[.005]
0425579	10.0	6.10 +[6.20]	.135+[.015]
0482333	9.5	6.10	.140
0483770	22.0	6.40 +[6.35]	.180+[.050]
0480923	13.5	6.00	.210
0450012	12.0	6.00	.270
0420832	9.5	6.10	.180
0430006	8.0	5.95 +[5.85]	.195+[.040]
0420008	10.5	5.90	.155
0461023	10.5	5.90	.180
0440006	7.0	5.45	.430
047122140	12.5	6.10	.110
0487092	12.5	6.30	.150
0483337	11.5	6.10	.230
0470004	11.5	6.00	.190
0467896	13.5	6.10	.160

* Hanna Instruments pH Meter (HI 9218) with Stability Indicator
† Solinst Conductivity + Temperature (°C) [measured in (μS x 1000) @ ~ 16.8 °C]
+ variations with agitation

Inductively Coupled Plasma (ICP) Spectroscopy developed in the early 1980's offers a way to carry out simultaneous analysis of large suites of elements including pathfinder elements associated with noble metals. Plasma Mass Spectroscopy (ICP-MS) offers the added advantage of introducing diverse selective extraction procedures for the detection of trace element suites. The object is to isolate and quantify that portion of the element in a sample horizon, which is relatively loosely bound, indicating prior mobility, either from depth (if mineralizations exist in the bedrock below the overburden) or if they were transported from short distances away, as is the case of our study area.

The secondary weathering environment is of fundamental importance and should be examined, because enough time has passed since the last glacial epoch in the study area. Secondary iron and manganese oxides occurring as coatings, concretions or as discrete particles in soils like those of the study area are significant because of their strong scavenging of important ore metals. Fe and Mn are pathfinder elements and are particularly important as scavengers of silver (Ag) and cobalt (Co). Although most sediment contains much greater amounts of Fe oxides than Mn oxides, the later possess greater sorption capability for trace elements. Such reactivity is due to characteristics of Mn such as: (1) it exists in several oxidation states (I, III, IV); (2) it forms non-stoichiometric oxides with different valencies; (3) its higher valence oxides exist in several crystalline (e.g. birnessite, lithiophorite, pyrolusite) or pseudocrystalline (manganite) forms; and (4) it forms co-precipitates and solid solutions with Fe oxides, owing to their similar chemical properties (Chao and Theobald, 1976).

There are various mechanisms of binding labile elements (water-extractable, organic and oxide-bound) in the secondary environment, including physical and chemical sorption, precipitation, chelation and complexation. Phases present in the study area sediments, which are likely to scavenge free elements other than amorphous Mn and Fe oxides, are humic and fulvic acids of soil horizons. The characteristics of the sediment and soil profile depend not only on the parent rock material but also on climate, topography and biological activity, all issues addressed previously in this study. I know from this study that some of the Geoprobe cores had appreciable quantities of fine sands and chlorite clay. Adsorption of metals by soil constituents can be described as specific or non-specific. Specific adsorption implies exchange of cations and anions forming covalent bonds within ionic lattices. Metals most able to form hydroxyl (OH^-) complexes such as hydrous oxides of Fe, Mn and Al are the major constituents that are responsible for this type of adsorption. A soil's cation exchange capacity (CEC) is a measure of its ability to provide sites for non-specific adsorption. The forces involved in the adsorption of ionic species on charged surfaces are electrostatic and governed by Coulumb's Law of Attraction and Repulsion (Press and Siever, 1986). CEC's of most soils range from a few to several hundred meq/100g and far exceeds anion exchange capacity as negative rather than positive charges dominate colloidal surfaces. The distribution of an element between soil solution and solid phases at equilibrium is governed by: (1) the density of surface binding sites for each component (e.g. clay mineral, hydrous oxides); (2) the binding intensity of the metal ion to each component; (3) the abundance of each component; (4) the chemical characteristics (e.g. pH, ligands) and (5) the concentration of other ions, major or trace, competing for binding sites (Hall, 1998). ALS Chemex's quantitative determinations such as by Fire Assay and Extended Sensitivity acid digestion leaches used in ICP-MS are designed to be specific to elemental concentrations in my study area and to exploit elements from mineral ores that have economic potential, in today's markets.

Noble metal mineralizations, besides the obvious and most important native states of these elements, are associated with pathfinder elements such as tellurium (Te), antimony (Sb), arsenic (As), bismuth (Bi) and more rarely mercury (Hg). The trace multi-element analyses were designed to evaluate their potential noble metal complexations in our sediment horizons and also to evaluate the mineral associations of noble metals with lead (Pb), copper (Cu), chromium (Cr) and nickel (Ni). There are almost 75 platinum-group minerals, often derived from deep-seated slow cooling and more fluid ferromagnesian rocks such as gabbro and peridotite, both igneous-plutonic rocks. Because platinum-group minerals include palladium, iridium, osmium and rhodium, they have a wide range of specific gravities; much of the world supply of these metals is derived from clastic placer deposits. If platinum-group metals are found, we would expect to find enrichments in nickel, iron and chromium, which would be indicative of there close association and environment together as elements that crystallize out of a melt first (Cabri, 1976). Gold, because of its general unreactivity, occurs in nature in only about 10 mineral ores, principally with tellurides and pyrites or arsenopyrites, but sometimes with antimony and bismuth (Henley, 1975). Silver is complexed with about 20 mineral ores, mostly sulfides, arsenides, tellurides and sulfosalts. Finding silver would be more important as a guide to mineral associations than for its economic potential.

Rare-earth elements (REE) were known at the turn of the century as monazite sands, but these sands are principally sources of thorium (Th) and uranium (U) for use in mantles in gas lamps and electrodes in arc lamps. The sands are found as littoral deposits and placer mined extensively on the seacoast of Brazil (Hedrick, 1995). The specific gravity of monazite is between 4.9-5.3, its color is yellow and its luster is resinous. The mineral crystals are resistant to weathering, hardness about 5 ½, and are derived from parent rocks of granite pegmatite, and to a lesser extent in carbonatites and gneiss. Monazite possesses slight and low radioactivity due to its Th and U content, which is strong enough to affect undeveloped film and can be measured by Geiger counters (Kithil, 1915). When first discovered, REE were known only in their oxide forms and because they resembled the oxides of the alkaline earths (CaO, BaO, etc.) and did not seem to form common minerals, they were labeled rare earths. REE really do not deserve their name because they are much more abundant than many other geochemically scarce metals and today have wide uses in many diverse applications. The REE are produced mainly from two minerals today, monazite ($CeYPO_4$) and bastnaesite ($CeFCO_3$). Although the formulas of both minerals are written for cerium compounds, all of the REE substitute for cerium in their structures by atomic substitution (Boyle, 1982). There are 15 REE (see Table 4.2), starting with lanthanum and ending with lutetium. They differ only in the number of electrons in their inner electron shells and have very similar chemical properties. I designed our trace element analyses to look for cerium (Ce), lanthanum (La), thorium (Th), uranium (U), phosphorous (P-because of phosphates PO_4) and yttrium (Y-because it behaves like REE) because I was interested in heavy mineral sands of current economic significance, with specific gravities heavy enough to dredge.

Most geochemical evaluations are considered on a population basis. That is, the larger population, like the one we designed for this study, will include multiple sub-populations. Sub-populations include for example, the noble metals, Au, Pt and palladium (Pd) or those elements that noble metals are complexed with (pathfinders) such as As, Sb, Mn, Fe, Te, etc., the REE oxides and all of the elements that are associated with individual rock environments

Table 4.2

The rare-earth elements. The relative amount of REE produced is in proportion to its geochemical abundance in the crust. (From Craig, 1988)

Name	Chemical Symbol	Atomic Number	Geochemical Abundance (% by weight)
Yttrium*	Y	39	0.0035
Lanthanum	La	57	0.005
Cerium	Ce	58	0.0083
Praseodymium	Pr	59	0.013
Neodymium	Nd	60	0.0044
Promethium	Pm	61	0.0000
Samarium	Sm	62	0.00077
Europium	Eu	63	0.00022
Gadolinium	Gd	64	0.00063
Terbium	Tb	65	0.0001
Dysprosium	Dy	66	0.00085
Holmium	Ho	67	0.00016
Erbium	Er	68	0.00036
Thulium	Tm	69	0.000052
Ytterbium	Yb	70	0.00034
Lutetium	Lu	71	0.00008

*Yttrium is commonly classed with the REE because its properties are so similar.

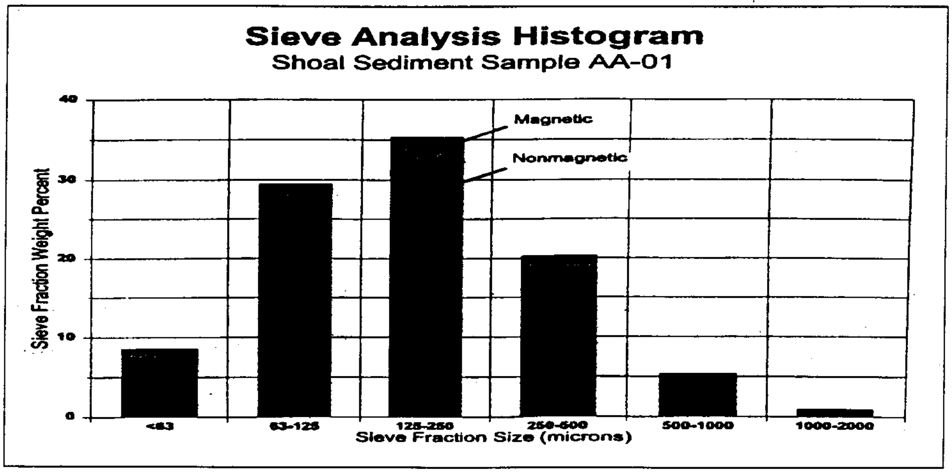
Results and discission

The geochemical results from the Great Sacandaga Lake study area are intriguing and promising. The fact that the sediments are related to glaciation and were locally derived means that the parent rocks deserve some further investigation. With that in mind, a hard rock sample from an adjacent outcrop, thought to be underneath the sediment overburden of the study area (USGS water well logs), was sent along with the Geoprobe core horizon samples to be analyzed by ALS Chemex. The results are listed separately in Appendix D and are not too different from the unconsolidated sediments of our study area. The rock is of course, much more ancient and metamorphosed and those elements that are more mobile like the alkalis Ca and Mg are slightly diminished. Those elements that are more labile like K and Na are slightly enriched and those elements that are more resistant or locked-up in minerals that are durable like those of the REE are about the same. Both the sediment samples of the study area and the hard rock sample would be considered weathered. Throughout this study and the results, the precise geochemical abundance backgrounds for weathered rocks in the literature is difficult to verify, but this hard rock specimen is not sufficiently enriched in any element that approaches ore grade. By incorporating otherwise "un-interesting" sample populations, though, we can get a glimpse outside of any bias the study area sediments may have introduced through secondary mobility of the elements.

The trace multi-element procedures designed for this study have given us a fair chemical analysis, but were only designed to yield the 44 elements (as in Appendix D) that would give us the strongest signals. The procedures avoid the conflicts of weaker signals, which arise using near-total tri-acid digestion. This also means that some of the more resistant minerals and their abundances such as rutile (Ti) and REE like monazite (Ce, La, Th, and Y) may not be fully reported in this study. In further investigations, fusion and X-ray Fluorescence spectroscopy detection can be counted on for total element detection and will likely reveal somewhat higher element abundances in our sediments. Zircon (Zr) and cassiterite (Sn), also resistant minerals, are identified or indicated in the sediments and should also be determined by lithium metaborate fusion/ ICP-MS (absolute total digestion) in further investigations.

Black sands are ubiquitous in my study area sediments and every horizon sample sent-off for analysis included these sands. Rudimentary magnetization tests on these sediments reveal about 10-12% of the black sands are magnetic and less than 5% of the mineral aggregates are magnetic. Sieve analysis performed by myself and by Overburden Drilling Management Limited of Nepean, Ontario, Canada (the principal mineralogy company used for this project) are nearly identical. A histogram showing weight percent plotted against size fractions reveals the extent of the heavy mineral population of the study area sediments (see Table 4.3, below).

Table 4.3



A more thorough radiological survey was done at the Radiation Safety Lab at the University of California at Los Angeles and listed in Appendix G (including a decay scheme). The element isotopes of europium (^{152}Eu, ^{155}Eu), Lead (^{210}Pb), protactinium (^{234}Pa) and thorium (^{234}Th) were slightly elevated. Other lanthanide and actinide elements are also indicated. It was decided not to pursue a grams activity per sample analysis and leach test at this time because the gamma radiation appears to be no problem and the beta radiation has only slightly higher energy. No determination, without a leach test analysis will be speculated, regarding the danger of drinking from local water wells in the Sacandaga Basin. Investigations into dry beach sand recoveries of heavy mineral sands in Australia, containing monazite sands, indicate that air-borne particles have to be carefully damped to keep employees safe from radiological dangers. No such dangers are encountered by wet gravimetric dredge mining recoveries (Uranium Information Center, Ltd., Australia), such as the type we espouse in this report.

Based on a 20′ averaged deepening of the study area total dredged sediment amounts to 92 million yd^3 with all the calculations based on 3.0×10^{11} lbs of sediments (92 million yd^3 X 3000 lbs/yd^3). The sediments actually weighed over 3300 lbs/yd^3, but everywhere, quantities and potential worth were estimated downward and costs were estimated upward. If I was unsure of an element's mineralogy, occurrence or complexation, I opted to take the conservative approach and declare no value for purposes of this study. If we can identify mineral sand ore such as monazite and are unsure of its element mineralogy (REE all substitute for cerium in their structures by atomic substitution), then they were merged into one category because all of the minerals have high specific gravity, are considered quite valuable and are all easily seperated

(Craig, 1988). Some elements of high abundance that exist as constituents of minerals were classed too light, based on their known occurrences, and others whose occurrences are not known but expected to be in minerals too light to be easily seperated, were given a $0 ore grade value until further work is done. Most elements examined, even though their ore minerals have potential economic value, are at or below average crustal abundances. Only those minerals that are clearly identified, to date, and exist in quantities appreciable enough to dredge successfully were assigned an ore grade worth. This does not mean that other dredgeable minerals are not recoverable and worth recovering.

The coatings on the sediments are identified as of this writing from the mineralogy as goethite (hydrogen iron oxide), with substantial amounts of manganese and iron. The coatings are heaviest in the heavy sand and gravely horizons and may well be due to the freer flow of groundwater and the secondary-weathering environment.

There are no dispersion pattern anomalies in any of the sediment horizons and no enrichments of pathfinder elements either. In fact, the relative abundances of noble metals are equal to the average crustal abundances for these elements and no indication of pathfinder elements would be expected in this scenario (Tilling et al, 1973). This means that the overburden does not lie atop any noble metal mineralization and that no nearby up-ice or upstream noble metal bedrock mineralization is likely to be discovered either. This would also hold true for base metal mineralizations.

The pH and conductivity readings are as expected, uneventful as well. A more thorough, much narrower (testing every 100′-rather than every 800′) gridwork of tests would need to be conducted if any anomalies were detected, but that does not seem to be indicated in these sediments. Ionic migration is likely to electrochemically transport through as much as 100-150′ of glacial sediment overburden, since the last glacial epoch, especially in areas of high groundwater content and/or clay sediment (Smee, 1983) and time and thickness should have had no effect on halos or dispersion patterns in our study area sediments.

In the secondary environment, anomalous concentrations of metals, derived from some mineralized source are taken into solution in the generally reducing and slightly acidic environment below the water table. Metal cations are incorporated into the interlayer structure of the phyllosilicates (clay minerals) by ion exchange. Phyllosilicates that have a large open structure and can offer sites to metal cations, even those with 8 and 12 fold coordination such as Cs and Sr with large radius ratios can become enriched. These clays often take on colorations (plaqueing) different than in their normal structures, with increased mass (Bradshaw et al, 1974). This does not appear to have happened to our study area clays and no different or unusual element enrichments or colorations occur in any horizons with elevated clay mineralogy. Cesium (Cs), rubidium (Rb) and lithium (Li) are often associated with lepidolite ores, which were identified in the sediment horizons. Lepidolite is a phyllosilicate mineral with a specific gravity of about 2.8-2.9. Some washplants have been designed with overflow filters to collect phyllosilicates plaqued with noble metals, but for this writing, we chose to ignore this and assigned no ore grade value to them.

The trace multi-element proceedures used on the study area sediments only pointed to element enrichments, but without total heavy mineral (THM) mineralogy done on the separable heavies of the sediments of the study area, we cannot assign any mineral value to the results. Two companies were chosen for their special reputations in the field; Overburden Drilling Management Limited (ODM) of Nepean, Ontario, Canada as mineralogy experts and QIT-Fer et Titane (QIT) of Tracy and Sorel, Ontario, Canada as industry experts. At the University I attended to heavy mineral (heavies) separations in the same manner as these two companies, to isolate the heavies from the bulk sediment, do the sieve analysis for populations size-fractions of heavies and to identify and verify microscopically as best I could, the heavy mineral fractions that they might attain. This first step is accomplished by weighing from the archived sediment cores, collected using Geoprobe, stratigraphically averaged sediments from all the lithologies. I shipped just over 8.3 kilograms to ODM and used 1.0 kilogram for my own separations. Three 9-kilogram bags were shipped to QIT from sites around the Great Sacandaga Lake, including one from the study area, for bulk processing from an industrial perspective. Methylene iodide with a specific gravity greater than 3.2 (after re-use and dilution with acetone) was used by ODM and myself to separate the "heavies". QIT used electrostatic extraction, which separates conductors (oxides) from non-conductors (garnet, pyroxene and amphibole) followed by a magnetic fractionation at different field intensities to separate the various iron and titanium oxides, such as ilmenite, titano-magnetite and rutile, etc.

The results of these studies are all remarkably consistent, withnoted differences (Appendix D). the descriptions can be seen in. Each of the three techniques measured between 8.5% and 12.5% (average 10.5%) THM in the study area sediments. My results and ODM both determined that the THM fraction resides essentially between 45µm and 1000µm, with, 1-2% of the THM residing above or below these fractions. The mean

(193μm) totals approximately 35% of the THM. The estimates of the heavy mineral populations by species of minerals from the ODM mineralogy are listed in Table 4.4, below.

Table 4.4

MINERALOGY

PERCENT	MINERAL	FORMULA
3	Augite	$Ca, Na (Mg, Fe, Al) (Al, Si)_2 O_6$
3	Diopside	$Ca Mg Si_2 O_6$
32	Horneblende	$(Ca, Na, K)_{2\text{-}3} (Mg, Fe^{2+}, Fe^{3+}, Al_5) (Si Al)_8$
3	Hyperthene	$(Mg, Fe) Si O_3$
2	Zircon	$Zr Si O_4$
2	Titanite	$Ca Ti Si O_4$
7	Magnetite	$Fe_3 O_4$
7	Ilmenite	$Fe Ti O_3$
35	Almandine	$Fe_3^{2+} Al_2 Si_3 O_{12}$
3	Apatite	$Ca_5 (PO_4)_3 (F, Cl, OH, REE)$
3	Luecoxene	$Ti O_2$

ODM and QIT used Scanning Electron Microscopy (SEM) and 200 grain-count methods to evaluate the THM. In addition to the above-mentioned minerals, QIT identified rutile (TiO_2 at <0.4%), monazite ($(Ce, La, Y, Th)PO_4$ at <0.3%) and zircon ($ZrSiO_4$ at ~1.0%). Potentially other minerals could be identified with continued grain-counts, but for practical purposes and given the reputations of the two companies, the results are substantive.

The most abundant mineral of economic significance is the garnet almandine, at nearly 35% of the THM; it represents more than 3.5% of the total sediments in the study area. Almandine is particularly hard (~7.5 Mohs scale) and brittle, with a specific gravity ranging from 3.56-4.32. Almandine generally occurs in Diorite of plutonic rocks (Chesterman, 1995). Examinations of the THM fractions by all the methods discussed above indicate sharp angular grains with essentially no rounding, consistent with glacial sediments. Since the THM's are from averaged lithologies, the inference clearly indicates the transport mechanism is by entrainment in ice and not by fluvial deposition. This is a very positive circumstance for almandine because its principal use today is as an industrial abrasive. Additionally, the almandine exists in perfect size fractions and requires no crushing to be used as an industrial abrasive. In an averaged 20′ deepening of the study area, 8.7 billion pounds of almandine would be recovered at 90% washplant efficiencies. No ore-grade values could be found in Standard and Poor's or Platt's Metal week, but USGS experts claim $0.09-$0.12 per pound Wyoming ore-grade almandine. Phone conversations with industrial mineral officials indicate $0.05-$0.06 per pound. Using $0.09 per pound the mineral almandine is worth $782,000,000 in the study area. Production costs are listed in Chapter 5.

Another of the most abundant and recoverable heavy mineral sands from the study area sediments are the oxides of titanium, principally ilmenite. Titanium minerals account for between 6.5% and as much as 20.8% according to ODM and QIT, respectively, of the THM population (expressed as TiO_2). This represents 0.69% of the total sediments in the study area. A separate assay of the THM's, done again by ALS Chemex, verified this percentage (see Appendix F). The economically important Ti minerals in the study area THM's include; Ilmenite (average 48% TiO_2), titano-magnetite (FeO mineral with up to 15% TiO_2), altered ilmenite (luecoxene, >55% TiO_2), and rutile (>85% TiO_2). Ilmenite deposits of magmatic origin (the anorthosite-ferrodiorite type) are currently the most important types of TiO_2 mineral deposits. Ilmenite from magmatic ferrodioritic sources are known to exist just 30-50 miles north of the study area in Sanford Lake and Tahawus, N.Y. (Force, 1991). In an attempt to identify heavy mineral provenance, the inter-element relationships were examined using a correlation matrix of elements normalized as a percent of total (see Table 4.5). Trace elements such as the noble metal assay results were eliminated. Several elements revealed significant correlations, with rare earth's (likely toexist together) and mafic elements (Ti and Fe), showing significance among themselves. Significance usually means that two elements when compared to each other have coefficients above ~.60. The correlation matrix I generated was too large to fit in this document so I recoded the elements relevant to the THM's and while a fair fit to the regression line emerged, I was disappointed with the histogram and regression formula generated. The recoded correlation matrix (R^2 -values) are presented below in Table 4.5.

Table 4.5

Correlatiom Matrix of Selected Element Geochemistry

	Al	Ca	Fe	Ti	Cr	La	Ce	Y	U	Th
Al	1.000	.218	-.205	-.309	-.731	.494	.555	.018	.454	.319
Ca	.218	1.000	.184	.297	-.049	-.185	-.053	.027	-.103	-.234
Fe	-.205	.184	1.000	.959	.231	.300	.370	.823	.427	.515
Ti	-.309	.297	.959	1.000	.382	.075	.160	.731	.332	.367
Cr	-.731	-.049	.231	.382	1.000	-.598	-.596	-.075	-.410	-.288
La	.494	-.185	.300	.075	-.598	1.000	.970	.662	.743	.823
Ce	.555	-.053	.370	.160	-.596	.970	1.000	.685	.779	.791
Y	.018	.027	.823	.731	-.075	.662	.685	1.000	.719	.746
U	.454	-.103	.427	.332	-.410	.743	.779	.719	1.000	.837
Th	.319	-.234	.515	.367	-.288	.823	.791	.746	.837	1.000

It is my contention that although the essential, accessory and associated minerals of ferrodioritic rocks correlate with the THM's and should be the likely source rocks for these THM's, the correlation matrix does not substantiate my conclusions. The only explanation I have for the inconsistency is that for robust calculations of correlation coefficients, the 28 samples (and 44 element variables) are too few to generate reasonable conclusions. In addition, the sediments may not be mature enough to exhibit clays scavenging mobile ions and as such, the elements do not appear to be correlating with aluminum. Nevertheless, the main purpose of this research was not to discover the rock provenances, but rather to identify minerals with enough economic potential to pay for a deepening of the Great Sacandaga Lake.

The titanium-mineral sands in our study area, principally ilmenite, at 0.69% of the total sediments of the study area equal 1.86 billion pounds at 90% washplant efficiencies. Ore-grade values from Standard and Poor's and Platt's Metal week indicate that these mineral sands are worth $0.45 per pound. Phone conversations with industry officials indicate that prices may be as low as $.15 per pound, until product chemistry has determined the contaminates in the ilmenite. QIT ran the ilmenite product chemistry (see Appendix D - Mineralogy). It shows the best magnetic fractions (using MicroProbe) contain 48% TiO_2, 39% FeTi, ~0.68% Al_2O_3, 0.03% CaO, 0.51% MgO, 0.02%P_2O_5, 0.47% MnO, 0.19% SiO_2, 0.03% Cr_2O_3, 0.26% V_2O_5, and 0.02% ZrO_2.

At a very conservative minimum estimate of $0.15 per pound the ilmenite mineral sands are worth more than $279 million dollars in the study area. Production costs are listed in Chapter 5.

Titanium metal has unique properties (density half that of steel, strength retention and atmospheric corrosion immunity) making it an ideal construction material for engines, airframes and structural purposes. Almost all Ti metal production involves tetrachlorination and reaction with either Mg or Na to form 85% pure metal and pig iron, called sponge. Ti sponge is worth from $2-3.00 dollars per pound (Platt's, 2000). The same beginning process is used to make microcrystalline TiO_2 used for white pigment in paint, plastic and paper and is by far the largest single use of the metal. TiO_2 forms more than 20% by weight of paints and the pigment industry consumes more than 90% of all titanium minerals mined. The two communities of Gloversville and Johnstown with their under-capacity Wastewater Treatment Facilities and failing economies could benefit tremendously from further processing of titanium mineral sands. Benjamin Moore Paint Company has a new and very large facility in Johnstown and another Paint Company is planning to move to the area soon. Again, the titanium mineral sands estimated for the study area, and/or if the whole lake is deepened, do not have to be value added to, or further processed, to be worth what I anticipate to be their in-place value. It should also be pointed out here, that the whole lake may not contain heavy mineral sands such as REE or TiO_2 throughout its sediments in the same concentrations and further research will need to be done to estimate their abundance and potential worth.

The Rare Earth Oxides (REO) in the study area sediments are certainly enriched (see Appendix D). The fact that they exist in ore minerals such as apatite, zircon and monazite (already identified), that are durable and have high specific gravity makes them perfect candidates for dredge mining. Separately, the REO are quite valuable (Hedrick, 1995), worth between $9 to $2500 per pound, but even as a heavy mineral sand, they are worth \$0.45-\$0.55 per pound (Table 4.6). Although REO are separated from one another in high purity by ion exchange methods, some of them, like cerium, are separated by taking advantage of its quadrivalent character. Today, many REO applications use a very substantial amount of the mixed REO just as they are obtained from their minerals ores or with extra cerium added or their lanthanum and cerium removed.

Table 4.6

Rare-Earth Oxide (REO) Prices—by Various Corporations in 2000

Oxide	Percent Purity*	Price per pound
Cerium	96-99.50	\$8.45-16.80
Dysprosium	95-96	\$38-60
Erbium	96-98	\$60-86
Europium	99.99	\$320-450
Gadolinium	99.99	\$55-60
Holmium	99.9	\$230-480
Lanthanum	99.99	\$8.75-10.50
Neodymium	95-99.9	\$11-40
Lutetium	99.99	\$2,000-2,500
Praseodymium	96.0	\$14.50-16.80
Samarium	96.0	\$30-34
Terbium	99.9	\$311-375
Thulium	99.9	\$1,600-1,650
Ytterbium	99.0	\$100-105
Yttrium	99.99	\$40-50

* Purity expressed as percent of total REO (U.S. Department of the Interior, Hedrick, 1995).

Each of the REO has distinct individual properties and they form organic chelates, which are taken advantage of in modern ion-exchange methods of separation (Parker, 1984). Domestic mine production of REO increases every year because of their increasing demand in industrial applications and production is expected to increase substantially in the years to come (Hedrick, 1995). Apatite, zircon and monazite heavy mineral sands account for over 270 million pounds at 90% washplant efficiencies in this study area. Until the pre-feasibility study is completed, however, I will not assign any value to apatite and zircon as potential REO ore-grade minerals. My results indicate that 31 million pounds of monazite heavy mineral sands should be available in the study area at 90% washplant efficiencies with a value of approximately $13 million dollars at $0.45 per pound. Production costs are listed in Chapter 5.

It should be noted here again that the nearby communities of Gloversville and Johnstown in Fulton County could benefit tremendously from the mineral processing of these concentrates. Because of the tremendous capacity of the Gloversville-Johnstown Wastewater Treatment Plant, which was designed to accommodate a much larger leather industry (the leather industry is essentially a metals industry using metals and metal salts to denature rawskins), mineral's processing there should be a natural fit.

The last mineral abundance of economic significance in the study area sediments evaluated in this report are the magnetic fractions of iron, magnetite and titano-magnetite. ODM and QIT estimated between 7.1 – 7.6% (average 7.35%) magnetite in the THM population. This means that 0.77% magnetite exists in the whole sediment overburden of the study area or approximately 2.1 billion pounds at 90% washplant efficiencies.

Even though magnetite does not have significant ore-grade value, Platt's Metals weekly quotes are approximately $35 per metric ton or $0.015 per pound. Since magnetite has a specific gravity of 4.9-5.2 and is magnetic, it is easily obtainable and separable in washplant operations. In the study area, magnetite mineral ore worth exceeds $30 million dollars. Production costs are listed in Chapter 5.

CHAPTER 5

SUMMARY

Island rebuilding and shoreline reconfiguration

The primary goal of this study was to identify potential mineral wealth in the sediments of the Great Sacandaga Lake study area and to evaluate the economic rational for permanently deepening the lakebed as a remedy to water-level fluctuations that many find intolerable. If we chose to deepen with earth-moving heavy equipment, the lake would have to be drained and the costs would have to be covered by the new rebuilt Island property values and the shoreline reconfiguration improvements. A modest beginning project like the one proposed in the study area, with an ideal island configuration to maximize the shoreline worth, would create over 10 miles of shoreline and have a shorefront value of almost $11 million dollars. The Hudson River-Black River Regulating District Board (HHBRRD) would be unable to hire the earth moving, roadwork and access bridges needed to access the property for many times that amount. The Board would need to issue bonds to pay for the costs of earth-moving equipment and apportion the costs along to beneficiaries, but would have to claim the improvements as assets because it couldn't sell the property to a developer at a loss. The downstream beneficiaries would gain a modest benefit due to the increase of more than 18 billion more gallons of water in the reservoir (just in this phase-20′ deep x 4.5 mi^2), but would not be happy with the costs associated with the altruism of a deepening cause. The new lands permit (any newly created shoreline would be leased, like the current shoreline properties) beneficiaries would love the property, but both their permits and the permit tenants on the other side of the lake would not be happy with the tremendous permit fees associated with such a project. Water-level drawdown would have to begin early in the season and the work would have to be done and completed in the coldest part of the year, which would make everyone displeased. And finally, if mineral wealth were available, an earth-moving heavy equipment method of recovering the mineral wealth could not be feasibly completed in a single season in the study area.

The water levels of the Great Sacandaga Lake are fixed historically, to regulate the flow of waters during times of high water and times of drought. The spillway at Conklingville is the point of regulation and it is unlikely that building a newer dam to raise water levels would be wise and in the interests of all involved. The remedy of choice would be to deepen the Lake and find a way to do it that benefits everyone including the HRBRRD. The only prudent method of deepening is to remove some of the lakebed so that the reservoir holds more water. The only plausible way to do this is to find some mechanism that maintains the continued operation of the reservoir and pays for itself at the same time. Therefore, the only logical way to proceed is with *dredge mining and washplant recoveries of the valuable heavies in the sediments of the lakebed.*

The primary investigations of the placer deposits (valuable heavies) have been done, at least in the study area and points upstream in the Sacandaga River. Considerable enrichments in heavy mineral sands that are worth recovering include almandine, ilmenite, magnetite, and the REO (residing in monazite, apatite and zircon heavy mineral sands). There are probably smaller but recoverable quantities of other multiple oxides, but the work to verify them has not been done yet. The heavy mineral concentrate mineralogy has been done and without any further mineral sand beneficiation, the remunerations derived from the project prove that it can be accomplished without costs to anyone, satisfy all of the beneficiaries, and pay-off handsomely (see Table 5.1).

Table 5.1

Heavy mineral sands. Estimated dredge mining worth of study area heavy mineral sands and projected worth after dredging the whole Reservoir.

Mineral	Study Area	Whole Reservoir
Almandine	$782,000,000	$7,042,000,000
Ilmenite	$279,000,000	$2,511,000,000
Magnetite*	$30,640,000	$827,280,000
REE	$13,000,000	$351,000,000
Total Potential Worth	**$1,104,640,000 Φ**	**$10,731,280,000**

Φ Dredge depth 6.6 yd (twenty feet deep x 4.5 square miles) in three seasons (~seven months each).

The costs to operate a successful dredge-mining operation are well known from various sites around the world. In one titanium sands operation in Australia, using 500 tph (tons per hour) cutter-head suction dredges, 12 mo/yr, 7 days/wk, 24 hr/day in unconsolidated sands like Great Sacandaga Lake sediments, it costs $\$0.32/m^3$ without amortization, depletion, depreciation, interest or overhead. Running time is said to be ~95%. Recovery is >92%, determined by tailings, sand sampling and recovery of ore reserves, determined by drilling to be 98%. Floating washplants are used to recover, by specific gravity, rutile, zircon and ilmenite, using MDL spirals and Reichert cones (Hartman, 1996). Inflated estimated costs (in today's dollars) for recovering heavies from the sediments in the study area are listed in Table 5.2.

Table 5.2

Heavy mineral sand dredging costs. Estimated costs to dredge mine the study area mineral sands and the projected costs to dredge the whole Reservoir.

Operation	Study Area	Whole Reservoir
Employees	$11,000,000	$990,000,000
Dredging	$45,000,000	$405,000,000
Dredges	$6,000,000	$12,000,000
Wash Plants	$15,300,000	$30,600,000
Transportation	$40,000,000	$360,000,000
Executive Operations	$1,500,000	$13,500,000
Outside Contracting	$500,000	$4,500,000
Amortization & Interest	$1,550,000	$13,950,000
Insurances	$3,000,000	$27,000,000
Overhead	$4,750,000	$47,250,000
Tax Planning	$5,800,000	$52,200,000
Bridges (two in study area)	$6,000,000	$9,000,000
Total Potential Costs	**$140,400,000Φ**	**$1,965,000,000**

Φ Study area based on three seasons (7 month seasons x 24 hours per day).

The base of the rebuilt island would be shaped in an arcuate band across the islands of Deer and the Kenyon's, which is the skeletal end moraine to the east and south in the study area (see Figure 3.5). The remnants of the north and west skeletal end moraine extending from the Northampton Marina and the New York State Boat Launch would be dredged and removed to the greatest extent possible. End moraines are loaded with large rock debris and a late season heavy earth-moving deepening may be necessary to remove the shallow water threat of the north and west skeletal end moraine. Everything in between the two skeletal end moraines is dredgeable and worth a recovery consideration.

Ideal Island

The ideal island would have more than 10 miles of shoreline and be about 3.5 mi^2 in area. This arcuate ideal island would have as many appendages as practicable to provide as much shoreline, bays and inlets needed to give the new real property charm and character (Figure 5.0). Everything to the north and west would be dredged, the heavies removed and the tailings used to rebuild the island. Three scenarios for bridges could be imagined, no bridges, one bridge and/or two bridges to connect the roads to the building sites. In Table 5.2, the cost of building two bridges in the study area under the ideal island scheme, are included. Anything practical could be built on the ideal island, including a golf course, but it might also include a marina, a water filtration plant, wastewater treatment plant and homesites. A suitable name would be Osborne Crescent. There are 2240 acres in 3.5 mi^2. The shoreline properties, over 530 of them, at 100′ of beachfront and selling at over $200 per beachfront foot would be worth near $11,000,000. If the lots are 100′ x 200′ in length (~1/2 acre), that would use-up about 265 acres of real estate. Figuring about 10 miles of road right-of-ways and driveways (60′ wide), uses-up only another 75 acres of real estate. The balance of the interior lands, some 1900 acres, can be used for anything, including restaurants and shops, parks and trees or even some kind of amusement park or resort. My preference would be to keep as much open space as possible, but I would expect the local people to have ideas of their own about how to successfully manage this newly created real property. The size of the ideal island could be somewhat different than proposed in the study area.

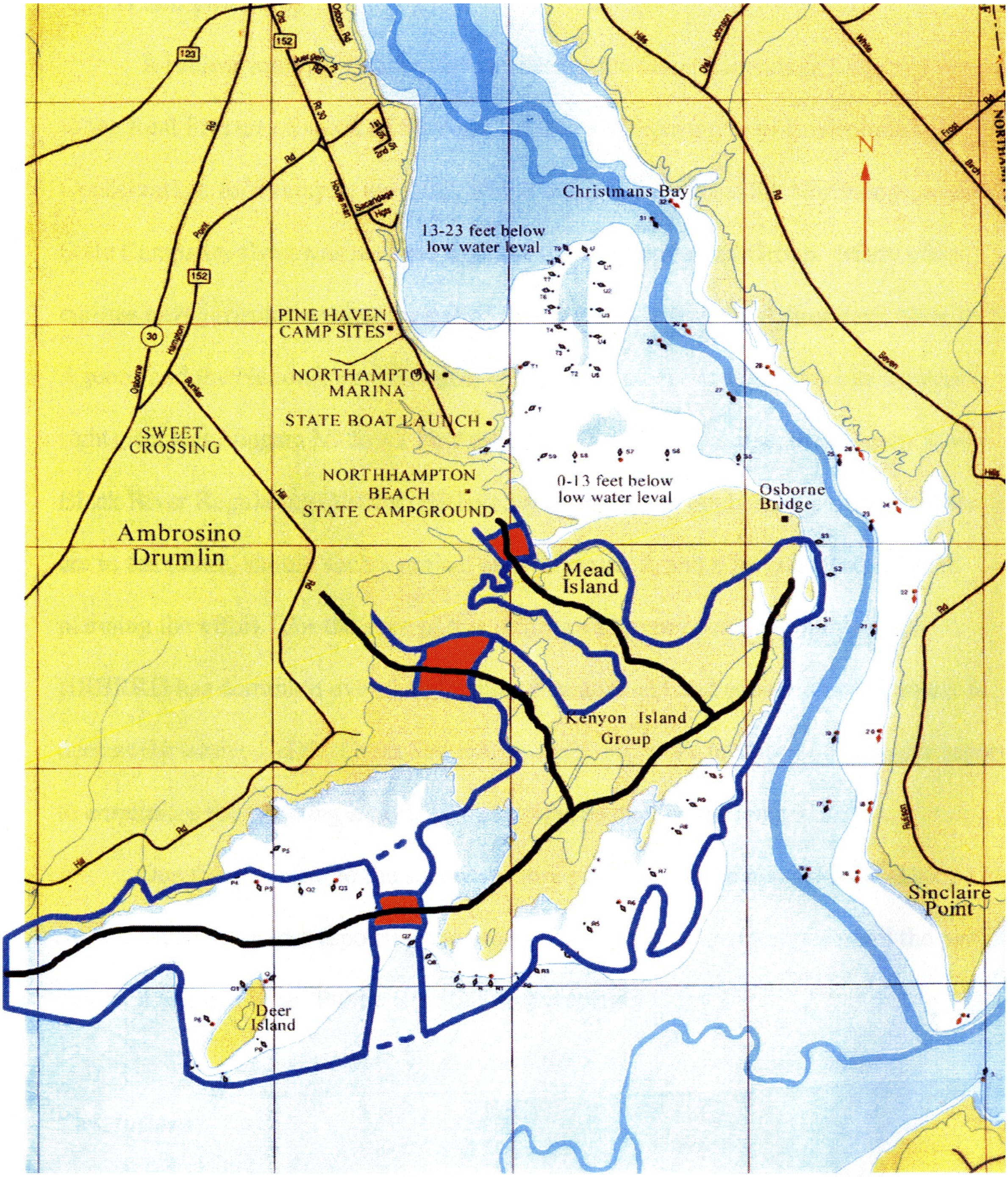


Figure 5.1
Approximate 3.5 square mile "Ideal Island," Jimapco, 1991.

■ Proposed roads minus driveways
■ Ideal Island "Osborne Crescent"
■ Possible Bridges

Access and ownership

It is clear multiple entities have a stake in the Great Sacandaga Lake. According to the Real Property Bureau of the New York State Department of Environmental Conservation, for example, the DEC, which owns and operates the Northampton Beach State Campsite, also owns the land rights to the Kenyon Island Group. Many other entities have jurisdiction over the use of the lands, including the Adirondack State Park Agency and the National Park Service, while many others have interests in the water rights, such as Niagara Mohawk Power Corporation and of course, the Hudson River-Black River Regulating District (HRBRRD). There is no doubt that enormous obstacles are in the future, should such a project ever be realized, and a great deal of work in planning the effort. For the sake of this writing and in my personal opinion, the HRBRRD has dominion over the planning, management and execution of a project to deepen the lakebed of the Great Sacandaga Lake. No work has been done in this report to emphasize the planning aspects of this proposed deepening project.

One thing is clear to the success of any project with the magnitude and scope of work such as this paper espouses; the project has to satisfy the interests of all the parties involved and be in the "Public Benefit" for everyone.

Conclusions

So many years of wrangling and threats of litigation have passed since the vocal opponents of shallow water in the Great Sacandaga Lake began being heard. During all this time, many citizens from both the upstream and downstream interests have tried to come up with a palatable remedy to the navigation and recreational problems at the lake.

In this report, I have tried to show that a deepening project could actually be practical, environmentally sound and profitable at the same time.

All dredging operations are based on 5600 yd^3 per hour, with like washplant operation capacity. That translates to nearly 17,000,000 pounds of lakebed removed, heavies separated and tailings delivered to rebuild the ideal island in the study area per hour. Over 125,000 pounds of heavies would be separated per hour and over 3,000,000 pounds per day. This means over 60 truckloads of heavies will need to be transported to Amsterdam for transport along railways to a smelting plant, unless provisions are set-up to do the smelting in the Gloversville-Johnstown area. No provisions are made in this paper to build a smelting plant in the Gloversville-Johnstown communities, but the potential worth of smelted TiO_2 heavies increases to between $1.8-2.4 billion dollars, just with the first year dredged TiO_2 heavies of the study area. The cost of transporting the heavies and the equipment to do it is estimated in Table 5.2. By the economy of scale, the cost of transportation increases only by the cost of fuel over the life of the project, if the whole reservoir is dredged for heavies. The total potential worth of smelted heavies if the whole reservoir is dredged, is $20 billion dollars (a very conservative estimate).

The dredge pace is set to accomplish the 6.6 yd deep x 1.5 mi^2 task in the study area within a normal high water season, approximately seven months. The whole of the reservoir would take between 25-30 years to dredge and recover heavies. The dredging and washplant systems have been designed for proven efficiency, safety and visibility, operator comfort and particularly for quiet operations. No credit will be given the corporations who build and design this equipment because it can be built and supplied by several such companies.

The reservoir releases about 150 billion gallons of water each season. At >6 billion gallons of increased water capacity each dredging season, the removal of the lakebed will create over 180 billion gallons of drinking water capacity if the whole reservoir is dredged. This extra drinking water capacity, will be a priceless commodity in the new frontier. No attempt will be made in this report to quantify it as an asset. Certainly, a deeper Lake will have profound effects on the well-being of its fish and other fauna. If the deepening continues throughout the Lake, the disruption to the lakebed organisms (estimate 27 like-areas to be dredged) will be completely reversed in each area within a three-year period (based on discussions with local biology professors). The answer to this dilema is to understand what fauna makes a living in soils, 6 months of the year and in water the remaining 6 months of the year?

The study area sediments proved to be extremely consistent throughout the sediment overburden of the study area. The heavy minerals identified are only slightly enriched from typical crustal sediments but as discussed they do have considerable value within the morainal ramparts investigated. It can be expected that at least another area of comparable size with sediments exactly like those of our study area can also be dredged for deepening and recovering heavy mineral sands, up the Sacandaga River. These two areas alone would take 6 seasons to dredge completely and be worth $2.3 billion dollars. If the future studies of the GSL sediments indicate what I believe to be a terminal end moraine to the south and east of the Kenyon Island end moraine, at least another $11 billion dollars worth of heavy mineral sands could potentially be recoverable.

This study has proved that a deepening project begun like the proposed study area project and expanded to include more and more of the lakebed sediments as appropriate, would be a perfect remedy to the dilemma of shallow water in the Great Sacandaga Lake. Furthermore, the public benefit and the economic advantages and spin-off businesses this project would deliver to the upstate economy are the obligation of the HRBRRD and the other regulating entities to allow to be brought to fruition. Much work needs to be done, but this project could develop through the planning phases, begun and start solving all the beneficiaries' problems within the next 5 years. It is my contention, that for future generations and the well-being of the industry of New York State, that an extra 180 billion gallons of drinking water is reason enough to undertake this project!

The next step I intend to take, beginning in the Fall of 2001 is to undertake a pre-feasibility study of the whole of the Great Sacandaga Lake. I intend to investigate the resource and take a more careful look at the methods of extraction and methods of processing the mineral sands. I want to investigate more thouroughly, the potential markets, capacities and costs and look carefully at potential environmental problems and remedies. There is a lot of work ahead to understand reasonably well about the quality and quantity of the mineral resources in the Great Sacandaga Lake. The objectives of this report have been successfully completed, though there is a long road ahead before investors might want to participate in a program to design, seek permits, start operations and begin marketing of these heavy mineral sands.

REFERENCE LIST

Arnow, T., (1951). The Ground-Water Resources of Fulton County, New York. State of New York Department Of Conservation, Water Power And Control Commission; Bulletin GW-24, U. S. Geological Survey, Albany, New York, 41 pp.

Boyle, R. W., (1982). Geochemical Prospecting for Thorium and Uranium Deposits. Geological Survey of Canada, Ottawa, Ontario, Canada; Elsevier Scientific Publications, p. 6-14, 45-46.

Bradshaw, P. M. D., Thomson, I., Smee, B. W., and Larrson, J. O. (1974). The Application of Different Analytical Extractions and Soil Profile Sampling in Exploration Geochemistry: Journal of Geochemical Exploration, v. 3, p. 209-225.

Brewer, T. E., (1999). Board of Hudson River-Black River Regulating District, Albany New York 12204 and the HRBRRD Webpage:http://www.hrbrrd.com.

Brigham, A. P., (1929). Glacial Geology and Geographic Conditions of the Lower Mohawk Valley: New York State Museum, Bulletin 280, 39 pp.

Brown, A. G., (1985). Traditional and Multivariate Techniques in the Interpretation of Floodplain Sediment Grain Size Variations: Earth Surface Processes and Landforms, v. 10, p. 281-291.

Cabri, L. J., (1976). Glossary of Platinum-Group Minerals: Economic Geology, v. 71, p. 1476-1480.

Caldwell, D. H., and Dineen, R. J. (1987). Surficial Geologic Map Of New York State: Hudson-Mohawk Sheet #40, New York State Museum-Geological Survey, The University of the State of New York, The State Education Department, scale 1:250,000.

Chao, T. T., and Theobald, P. K. Jr., (1976). The Significance of Secondary Iron and Manganese Oxides in Geochemical Exploration: Economic Geology, v. 71, p. 1560-1569.

Chesterman, C. W., (1995). The National Audubon Society Field Guide to North American Rocks and Minerals. Alfred A. Knopf, Inc., Chanticleer Press, Inc., 507 pp.

Craig, J. R., Vaughan, D. J., and Skinner, B. J. (1988). Resources of the Earth. Prentice Hall, p. 190-191, 239-243.

Darton, N. H., (1897). A Preliminary Description of the Faulted Region of Herkimer, Fulton, Montgomery and Saratoga Counties: New York State Geological, 14th Annual Report, 41 pp.

Davis, L. B., (1971). General Soils Report, Fulton County, New York. U. S. Department of Agriculture, Soil Conservation Service in Cooperation with the Fulton County Soil and Water Conservation District; Fulton County Planning Department, 36pp.

Eros Data Center, US Department of the Interior, Geological Survey, Sioux Falls, S.D.

Fisher, D. W., Isachsen, Y. W. and Rickard, L. V. (1970). Geologic Map Of New York: Hudson-Mohawk Sheet #15, New York State Museum and Science Service, The University of the State of New York, The State Education Department, scale 1:250,000.

Force, E. R., (1991). Geology of Titanium-Mineral Deposits: Special Paper 259, The Geological Society of America, p. 2-9, 73-75.

Freeman, J. R., (1908). New York State Water Supply Commission-Sacandaga Reservoir Maps, scale 1:1200 and variable.

Gabrielson, P., (1982). Great Sacandaga Lake Study of Elevation VS. Capacity Curve, 165 pp.

Giese, R. F. Jr., (1999). Clay Mineralogy Laboratory, Natural Sciences Building, State University of New York at Buffalo, Buffalo, New York, 14260.

Govett, G. J. S., (1976). Detection of Deeply Buried and Blind Sulphide Deposits by Measurements of H^+ and Conductivity of Closely Spaced Surface Soil Samples: Journal of Geochemical Exploration, v. 6, p. 359-382.

Hall, G. E. M., (1998). Analytical Perspective on Trace Element Species of Interest in Exploration: Journal of Geochemical Exploration, v. 6, p. 1-19.

Hartman, H. L., (1996). SME Mining Engineering Handbook. Society for Mining, Metallurgy and Exploration, Littleton, Colorado, Second Edition, v. 1 and 2, 2260 pp.

Hart, L., (1967). The Sacandaga Story, A Valley of Yesteryear. Larry Hart Printing, Schenectady, New York 12304, 95 pp.

Hedrick, J. B., (1995). Rare Earths. Minerals Yearbook, v. 1, Metals and Minerals, United States Department of the Interior, U. S. Geological Survey, p. 643-653.

Henley, K. J., (1975). Gold-Ore Mineralogy and its Relation to Metallurgical Treatment: Minerals Science Engineering, v. 7, no. 4, p. 289-314.

Holland, H. D. and Petersen, U., (1995). Living Dangerously, The Earth, Its Resources, And The Environment. Princeton University Press, 490 pp.

Jackson, J. A., (1997). Glossary of Geology. Fourth Edition, American Geological Institute, Alexandria, Virginia, 769 pp.

Jensen, J. R., (1996). Introductory Digital Image Processing: A Remote Sensing Perspective. Second Edition, Prentice-Hall, Inc., 318 pp.

Jimapco, Inc., Copyright (1991). Great Sacandaga Lake Navigation Map: Jimapco, Clifton Park, New York 12065, scale 1: 30,000.

Kithil, K. L., (1915). Monazite, Thorium and Mesothorium: Technical Paper 110, United States Department of the Interior, Bureau of Mines, p. 5-27.

Lillesand, T. M. and Kiefer, R. W., (1994). Remote Sensing and Image Interpretation. Third Edition, John Wiley & Sons, Inc., 750 pp.

Loizeau, J. L., Arbouille, D., Santiago, S. and Vernet, J. P., (1994). Evaluation of a Wide Range Laser Diffraction Grain Size Analyser for use with Sediments: Sedimentology, v. 41, p. 353-361.

Miller, W. J., (1911). Geology of the Broadalbin Quadrangle, Fulton-Saratoga Counties, New York: New York State Museum, Bulletin #153, 53 pp.

Moore, D. M. and Reynolds, R. C. Jr., (1997). X-Ray Diffraction and the Identification and Analysis of Clay Minerals. Second Edition, Oxford University Press, 377 pp.

Northampton Beach State Campsite, Copyright (1998). New York State Department of Environmental Conservation, JMF Publishing, New York Mills, New York 13417, no scale: cartoon art.

Parker, S. P., (1984). McGraw-Hill Concise Encyclopedia of Science & Technology. Fifth Edition, McGraw Hill Book Company, 2065 pp.

Platt's Metal's Weekly, (02/21/00). Platt's Metals Week Daily Prices. v. 71, no. 8, p.1-20.

Press, F. and Siever, R., (1986). Earth. Fourth Edition, W. H. Freeman and Company, 656 pp.

Prothero, D. R. and Schwab, F., (1996). Sedimentary Geology. W. H. Freeman and Company, 575 pp.

Rand McNally, (1997). Road Atlas, Eastern New York State. Rand McNally and Company, 128 pp.

Raymond, L. A., (1995). Petrology, The Study of Igneous, Sedimentary and Metamorphic Rocks. Wm. C. Brown Publishers, 742 pp.

Rose, A. W., Hawkes, H. E. and Webb, J. S., (1979). Geochemistry in Mineral Exploration. Academic Press, New York, 655pp.

Roth, W., (1998). The Great Sacandaga Lake Association. 288 Sinclair Road, Northville, New York 12134.

Rowell, D. L., (1996). Soil Science, Methods and Applications. Third Edition, Longman Singapore Publishers, 350 pp.

Smee, B. W., (1983). Laboratory and Field Evidence in Support of the Electrogeochemically Enhanced Migration of Ions Through Glaciolacustrine Sediment: Journal of Geochemical Exploration, v. 19, p. 277-304.

Tilling, R. I., Gottfried, D. and Rowe, J. J., (1973). Gold Abundance in Igneous Rocks: Bearing on Gold Mineralization: Economic Geology, v. 68, p. 168-186.

United States Department of the Interior Geological Survey, (1970). USGS Topographic Map, Northville Quadrangle, U. S. Geological Survey, Reston, Virginia 22092, scale 1:24,000.

Uranium Information Center, (2000). Webpage: http://www.uic.com.au, Nuclear Issues Briefing Paper 25 on Mineral Sands.

Wilson, H. M., (1911). United States Department of the Interior Geological Survey. USGS Topographic Map, Broadalbin Quadrangle.

Appendix A

PERMITS AND HISTORY

New York State Department of Environmental Conservation
Office of Natural Resources, Region 5
Route 86 - P.O. Box 296, Ray Brook, New York 12977
Phone: (518) 897-1276 FAX: (518) 897-1370

John P. Cahill
Commissioner

January 27, 1999

University of Albany
c/o Arthur M. Ambrosino
Dept. of Earth & Atmospheric Sciences
1400 Washington Avenue, Room 351
Albany, NY 12222

Dear Mr. Ambrosino:

Enclosed is a Temporary Revocable Permit which will allow you to take one inch soil cores with a maximum depth of 20', on a portion of the Northampton Campground. This permit is subject to the Terms and Conditions listed. **The permit will expire on April 1, 1999.**

Regional Forester Tom Martin, located in the Ray Brook Office, will act on behalf of the Department of Environmental Conservation as Regional Land Manager. Should you have any questions or concerns, please contact Mr. Martin at 518/897-1276.

Sincerely,

Thomas H Wahl

Thomas H. Wahl
Regional Supervisor of Natural Resources

THW:mb
Enclosure
cc: T. Wolfe
J. Grossman
T. Kapelewski
FR: D. Brooks
ECO: M. Trottier
File: TRP#2 File

New York State Department of Environmental Conservation

Reg 5 TRP 1996

TEMPORARY REVOCABLE PERMIT FOR THE
USE OF STATE LANDS

(see page 2 for standard terms and conditions)

Name: University of Albany

Address: c/o Arthur M. Ambrosino
Dept. of Earth & Atmospheric Sciences
1400 Washington Avenue, Room 351
Albany, NY 12222

Telephone Number: 518/442-4466

State Land Location: **County:** Fulton **Town:** Mayfield

Land Designation: Intensive Use

Patent, Tract, Lot, Etc. Northampton Beach Campground

The Department of Environmental Conservation hereby grants permission to the above named permittee to use these State lands described above and shown on the attached map for the purposes stated on the attached application and as amended below subject to the standard terms and conditions listed on page 2 and to the following special terms and conditions. (Use additional sheet if necessary).

This TRP will allow you to take one inch soil cores with a maximum depth of 20', on a portion of the Northampton Campground.

Unless otherwise suspended or revoked, this permit shall expire on April 1, 1999.

STATE
Museum

APPROVAL 14 Dec 98

Regional Director ________ Date 1/25/99

Central Office ________ Date JAN 15 1999

(If required)

NOTICE OF EXPIRATION OF TEMPORARY REVOCABLE PERMIT

This is to inform you that this permit expired on

and that all conditions of such permit have been satisfactorily met.

Date	**Regional Director**

STANDARD TERMS AND CONDITIONS

1. This permit shall at all times be subject to the approval of the Regional Land Manager and may be suspended or revoked at any time with due cause.

2. The permittee shall notify the Regional Land Manager at least 48 hours prior to commencing use and upon completion of use.

3. The activities authorized under this permit shall not interfere with normal administration of the area by the Department.

4. No damage will be done to State land, State facilities or boundary or survey markers.

5. The permittee is responsible for any inadvertent or deliberate damage caused by the exercise of this permit and will be held responsible for restoration, rehabilitation or repair at the permittee's expense.

6. No trees or other vegetation shall be cut, disturbed or removed unless specifically authorized by the Regional Land Manager.

7. The State land covered by this permit shall be kept free of litter and debris and be left in a condition satisfactory to the Regional Land Manager at the expiration of the permit or on completion of activities authorized by the permit.

THE GREAT SACANDAGA LAKE ISLAND REBUILDING PROJECT: DREDGING AND REBUILDING THE KENYON ISLAND GROUP

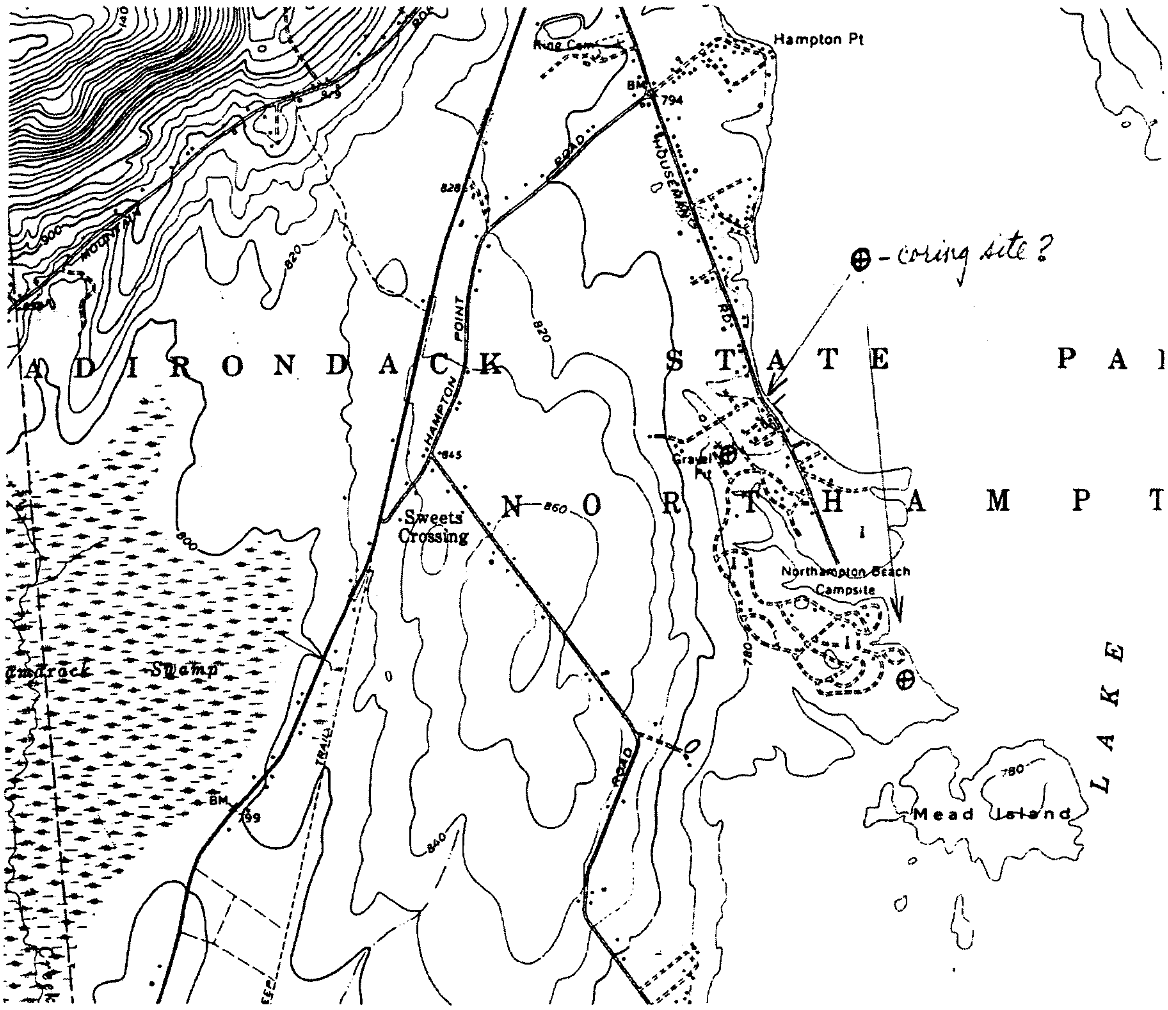
AMBROSINO, Arthur M., Department of Earth and Atmospheric
Sciences, University at Albany, 1400 Washington Avenue,
Albany, N.Y. 12222, aa7148@cnsvax.albany.edu

During the last decade, there has been increasing dispute between the downstream interests and the recreational users of the waters of the Great Sacandaga Lake. The downstream interests make up eleven power generation dams, Hudson River water/ Ocean water salt front concerns at Poughkeepsie, and flood control at Albany, which was the principal reason the Great Sacandaga Lake was created. The recreational users are the landowners/boat operators, around the Lake.

Large water-level variations to accomodate the downstream interests cause large areas of very shallow water in the Great Sacandaga, especially in midsummer, which is a situation the boating public finds unacceptable.

Dredging is the only remedy to deepen the Lake significantly for boating; thus, it is of interest to know the types of sediments at various points in the Lake and what the environmental concerns would be. How many meters of sediments from the erosion of the islands have accumulated since the dam created the Lake in 1930, and how has the Basin filled with sediments since the last glacial epoch?

The Kenyon Island Group, perhaps the largest and most unnavigable shallow water shoal in the Great Sacandaga Lake, is the ideal location for such a possible dredging project. The island group is uninhabited, accessable and appears to be the ideal soil for dredging. The dredged tailings will be used to rebuild the islands. Core sampling should identify the underlying sediment stratigraphy and establish the feasibility of such a project and its worthiness. In addition, sediment cores will be analyzed and interpreted with respect to Climate Change since the last glacial epoch, approximately 15,000 years B.P..


⊕ - coring site?
Hampton Pt
Ring Camp
BM 794
ROAD
MOUNTAIN
HOUSEMAN RD.
HAMPTON POINT
ADIRONDACK STATE PA
NORTH HAMPT
Gravel Pit
Sweets Crossing
845
860
820
828
800
840
780
Northampton Beach Campsite
Tamarack Swamp
TRAIL
BM 739
LAKE
Mead Island

STATE OF NEW YORK

Board of Hudson River-Black River Regulating District
Sacandaga Field Office
737 Bunker Hill Rd., Mayfield, New York 12117
Phone (518) 661-5535
FAX (518) 661-5720

August 20, 1998

On this date Mr. Arthur Ambrosino was allowed to borrow the original Power Commission maps to have them scanned and will then return them immediately.

Arthur M. Ambrosino
Arthur Ambrosino

STATE OF NEW YORK

Board of Hudson River-Black River Regulating District
Sacandaga Field Office
737 Bunker Hill Rd., Mayfield, New York 12117
Phone (518) 661-5535
FAX (518) 661-5720

September 2, 1998

On this date Mr. Arthur Ambrosino returned the Original Power Commission maps to the Sacandaga Field Office.

Marlene Junquera
Marlene Junquera

STATE OF NEW YORK

Board of Hudson River-Black River Regulating District
350 Northern Boulevard, Albany, New York 12204
Phone (518) 465-3491
FAX (518) 432-2485

FAX COVER SHEET

TO: ARTHUR AMBROSINO

FROM: TOM BREWER

DATE: 11/12/98

SUBJECT: CORE SAMPLES

NO. OF PAGES (including cover sheet): 1

MESSAGE: THIS WILL CONFIRM THAT YOU ARE AUTHORIZED TO COLLECT CORE SEDIMENT SAMPLES IN THE AREA OF THE KENYON ISLANDS AT GREAT SACANDAGA LAKE ON 11/13/98.

Thomas E. Brewer
CHIEF ENGINEER

IF YOU HAVE ANY PROBLEMS OR QUESTIONS RECEIVING,
PLEASE CALL OUR OFFICE IMMEDIATELY.

JIMAPCO

Maps to swear by...not at!

LICENSING AGREEMENT

DATE: 8/25/98

CUSTOMER: Arthur M. Ambrosino - SONY Albany
442-4466

LICENSE NUMBER: C982508 fax 442-5825

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JIMAPCO requires that the most recent edition be used and that the following copy appear on each reproduction:

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This is as one-time license and expires with the one slide.

SPECIAL INSTRUCTIONS:

Please call if you have any questions.

C Fisk
Christina T. Fisk, Vice President

Post Office Box 1137, Route 9, Clifton Park, New York 12065 (518) 899-5091 Fax (518) 899-5093

History of the study area

The Sacandaga Basin has long been an important geopolitical region in the east-central part of New York State, no less important to the Native Americans who named the lowlands "Sacandog," meaning "Land of Waving Grass." As early as the 1860's, the New York State Legislature considered the idea of constructing a dam and building a reservoir in the basin. The Sacandaga Basin contains approximately one third of the waters of the Upper Hudson Watershed. For many years, disastrous floods regularly wreaked havoc in the communities along the Hudson River, from Glens Falls to Albany. In the early 1900's, the Legislature gave its blessing to the New York State Water Supply Commission to survey the basin and identify where a suitable dam should be constructed. In 1908 the Water Supply Commission's task was completed and the proposed "Flow Line" and the site of the dam at Conklingville were identified. The State Legislature established the Hudson River Regulating District in 1922 as a public benefit corporation. The District was given a broad spectrum of legal powers to accomplish this mission, including the authority to build and operate the reservoir, issue bonds and apportion costs on its beneficiaries to finance construction, maintenance and for operations. The District's specific responsibilities are to reduce floods by excess run-off and to augment Hudson River water flow at times of drought or other periods when river flows are low. Work began on the dam in 1927, was completed in 1929 and the valley was flooded by 1930.

The project cost $12,000,000, and the 1100-foot Conklingville Dam retains close to 300 billion gallons of water in the reservoir at the high water mark. 125 miles of shoreline defines the reservoir's 42 square mile surface area. Construction of the reservoir took more than 500 men and several years to complete. It submerged 3872 graves in 22 cemeteries, which required transburial. It submerged 5 miles of the Fonda, Johnstown and Gloversville Railroad, which was never rebuilt. It submerged 67 miles of roads connecting several communities beneath the waters and required more than 50 miles of new highway construction. Five existing bridges were destroyed and 10 new bridges had to be erected. Finally, over 1250 structures were moved, burned or pulled down to make room for the water.

During the last several decades, there has been increasing dispute between the downstream interests and the recreational users of the water of the Great Sacandaga Lake. The downstream interests include 11 power generation dams, Hudson River water/Ocean water salt front concerns at Poughkeepsie and flood control at Albany. Large water-level variations to accommodate the downstream interests cause large areas of very shallow water in the Great Sacandaga, especially in midsummer, which is a situation the landowners and boating public find unacceptable.

The spillway at the Conklingville Dam is 771′ above sea level. At high water the study area (Kenyon Island Group including Mead and Deer Islands) have shorelines at about 768′. The lake levels begin to drop long before the low water season approaches. Water is let out at an average rate of just less than 1 1/2″ per day and by the low water season over 150 billion gallons of water have been drained from the reservoir. It takes approximately 6 months for the transformation from high water to low water level status. As the water is let out at Conklingville at the rate of a little less than 4′ per month, the shallowest parts of the shallow water shoal that surrounds the Kenyon Island Group becomes more and more dangerous to recreational boaters of the lake. The situation becomes so serious that almost nine miles of shallow warning buoys are strung around the greater shoal, warning boaters not to enter. Boaters are relegated to the marine buoyed Sacandaga River Channel for much of the boating season to get around the shallows.

In an effort to reach accommodations to all, an Upper Hudson-Sacandaga Comprehensive Settlement Negotiation Team is presently studying water level remedies (see Table below). The proposed remedy involves raising the high water mark to 770′ over the next twenty years. Any remedy they agree upon will be a compromise to both upstream and downstream interests.

ADIRONDACK BOARDSAILING CLUB
ADIRONDACK COUNCIL
ADIRONDACK HYDRO DEVELOPMENT CORPORATION
ADIRONDACK MOUNTAIN CLUB
ADIRONDACK PARK AGENCY
ADIRONDACK RIVER OUTFITTERS
AMERICAN WHITEWATER ASSOCIATION
FEDERAL ENERGY REGULATING COMMISSION
FEEDER CANAL ALLIANCE
FINCH, PRUYN AND COMPANY, INCORPORATED
FULTON COUNTY
GOMEZ AND SULLIVAN
GREAT SACANDAGA LAKE ASSOCIATION
GREAT SACANDAGA LAKE FISHERIES FEDERATION
GREAT SACANDAGA LAKE MARINAS
HUDSON RIVER RAFTING
HUDSON RIVER-BLACK RIVER REGULATING DISTRICT
INDIVIDUALS
INTERNATIONAL PAPER
MERCER COS
NATIONAL PARK SERVICE
NEW YORK RIVERS UNITED
NEW YORK STATE CONSERVATION COUNCIL
NYS DEPARTMENT OF ENVIRONMENTAL CONSERVATION
NEW YORK STATE ENERGY GRID
NIAGARA MOHAWK
HUDSON RIVER MANAGER
SARATOGA COUNTY
TOWN OF HADLEY
TROUT UNLIMITED
UNITED STATES FISH AND WILDLIFE SERVICE
WILDWATERS, INCORPORATED

Appendix B

PARTICLE SIZE VOLUME STATISTICS

AND

CORING INTERPRETATIONS

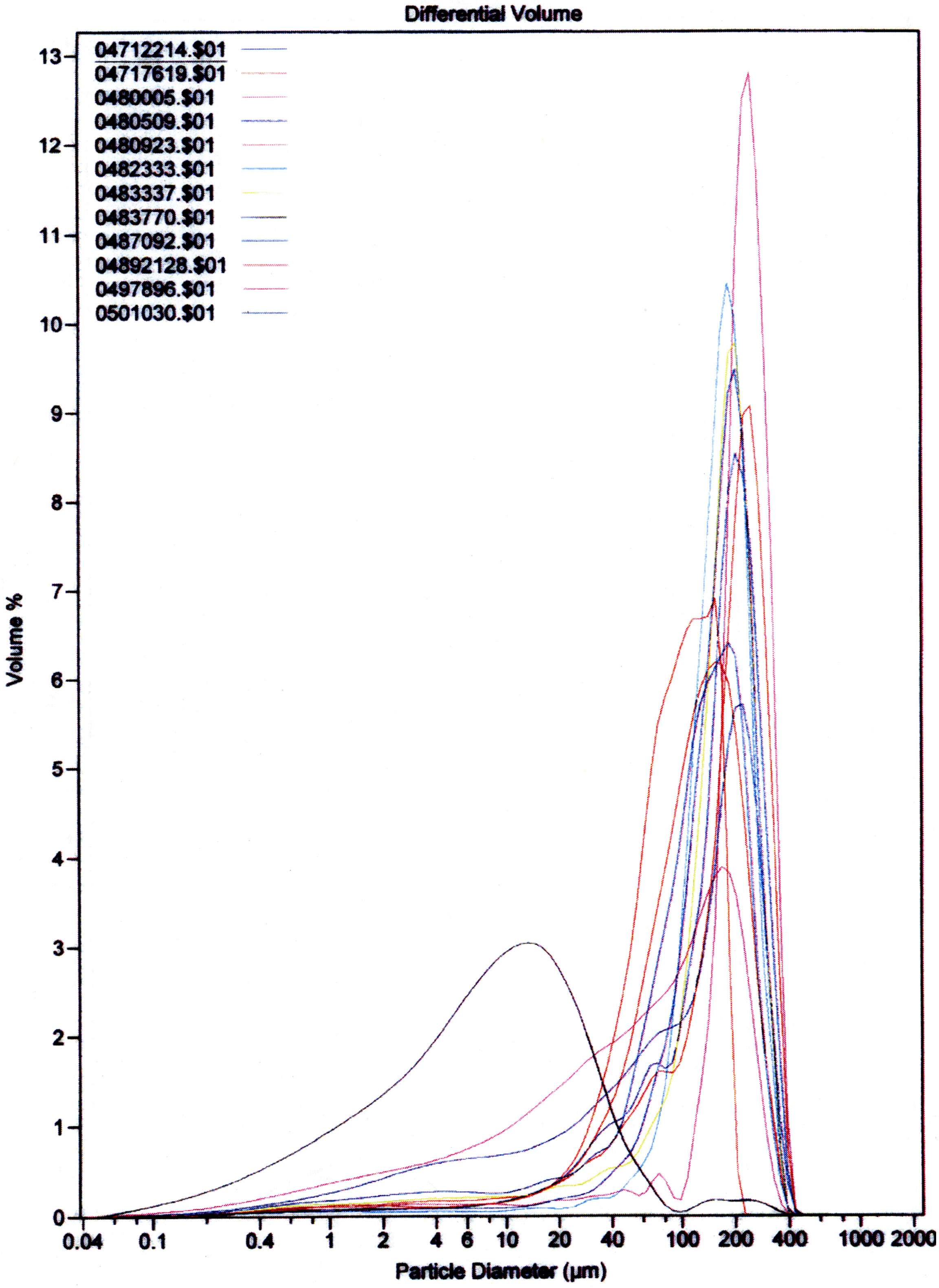

Figure 3.1a Coulter LS Particle Size Analyzer, Sediment/Core Lab, Geology Department, Union College.

COULTER® LS Particle Size Analyzer

6 Jul 1999

SEDIMENT/CORE LAB, GEOLOGY DEPT., UNION COLLEGE

File name: 04712214.$01 Group ID: 047122140
Sample ID:
Operator: Run number: 2
Comments:
Optical model: Fraunhofer PIDS included
LS 230 Fluid Module
Start time: 9:32 30 Jun 1999 Run length: 120 Seconds
Pump speed: 100
Obscuration: 2%
PIDS Obscur: 20%
Fluid: Water
Software: 2.09 Firmware: 2.02 2.02

File name: 04717619.$01 Group ID: 047176192
Sample ID:
Operator: Run number: 12
Comments:
Optical model: Fraunhofer PIDS included
LS 230 Fluid Module
Start time: 11:34 30 Jun 1999 Run length: 119 Seconds
Pump speed: 81
Obscuration: 3%
PIDS Obscur: 26%
Fluid: Water
Software: 2.09 Firmware: 2.02 2.02

File name: 0480005.$01 Group ID: 0480005
Sample ID:
Operator: Run number: 14
Comments:
Optical model: Fraunhofer PIDS included
LS 230 Fluid Module
Start time: 11:51 30 Jun 1999 Run length: 120 Seconds
Pump speed: 81
Obscuration: 2%
PIDS Obscur: 19%
Fluid: Water
Software: 2.09 Firmware: 2.02 2.02

COULTER® LS Particle Size Analyzer

6 Jul 1999

SEDIMENT/CORE LAB, GEOLOGY DEPT., UNION COLLEGE

File name:	0480509.$01	Group ID:	0480509
Sample ID:			
Operator:		Run number:	4
Comments:			
Optical model:	Fraunhofer PIDS included		
LS 230	Fluid Module		
Start time:	10:27 30 Jun 1999	Run length:	119 Seconds
Pump speed:	81		
Obscuration:	6%		
PIDS Obscur:	54%		
Fluid:	Water		
Software:	2.09	Firmware:	2.02 2.02

File name:	0480923.$01	Group ID:	0480923
Sample ID:			
Operator:		Run number:	10
Comments:			
Optical model:	Fraunhofer PIDS included		
LS 230	Fluid Module		
Start time:	11:18 30 Jun 1999	Run length:	120 Seconds
Pump speed:	81		
Obscuration:	2%		
PIDS Obscur:	25%		
Fluid:	Water		
Software:	2.09	Firmware:	2.02 2.02

File name:	0482333.$01	Group ID:	0482333
Sample ID:			
Operator:		Run number:	3
Comments:			
Optical model:	Fraunhofer PIDS included		
LS 230	Fluid Module		
Start time:	10:15 30 Jun 1999	Run length:	119 Seconds
Pump speed:	81		
Obscuration:	1%		
PIDS Obscur:	12%		
Fluid:	Water		
Software:	2.09	Firmware:	2.02 2.02

COULTER® LS Particle Size Analyzer

6 Jul 1999

SEDIMENT/CORE LAB, GEOLOGY DEPT., UNION COLLEGE

File name:	0483337.$01	Group ID:	0483337
Sample ID:			
Operator:		Run number:	5
Comments:			
Optical model:	Fraunhofer PIDS included		
LS 230	Fluid Module		
Start time:	10:35 30 Jun 1999	Run length:	120 Seconds
Pump speed:	81		
Obscuration:	3%		
PIDS Obscur:	30%		
Fluid:	Water		
Software:	2.09	Firmware:	2.02 2.02

File name:	0483770.$01	Group ID:	0483770
Sample ID:			
Operator:		Run number:	15
Comments:			
Optical model:	Fraunhofer PIDS included		
LS 230	Fluid Module		
Start time:	12:00 30 Jun 1999	Run length:	119 Seconds
Pump speed:	81		
Obscuration:	22%		
PIDS Obscur:	91%		
Fluid:	Water		
Software:	2.09	Firmware:	2.02 2.02

File name:	0487092.$01	Group ID:	0487092
Sample ID:			
Operator:		Run number:	1
Comments:			
Optical model:	Fraunhofer PIDS included		
LS 230	Fluid Module		
Start time:	9:53 30 Jun 1999	Run length:	119 Seconds
Pump speed:	81		
Obscuration:	2%		
PIDS Obscur:	16%		
Fluid:	Water		
Software:	2.09	Firmware:	2.02 2.02

```
COULTER®               LS Particle Size Analyzer
                                                                   6 Jul 1999
———————— SEDIMENT/CORE LAB, GEOLOGY DEPT., UNION COLLEGE ————————

File name:       04892128.$01               Group ID:     04892128
Sample ID:
Operator:                                   Run number:   1
Comments:
Optical model:   Fraunhofer  PIDS included
LS 230           Fluid Module
Start time:      9:23  30 Jun 1999          Run length:   120 Seconds
Pump speed:      100
Obscuration:     3%
PIDS Obscur:     23%
Fluid:           Water
Software:        2.09                       Firmware:     2.02  2.02

File name:       0497896.$01                Group ID:     0497896
Sample ID:
Operator:                                   Run number:   16
Comments:
Optical model:   Fraunhofer  PIDS included
LS 230           Fluid Module
Start time:      12:10  30 Jun 1999         Run length:   119 Seconds
Pump speed:      81
Obscuration:     8%
PIDS Obscur:     60%
Fluid:           Water
Software:        2.09                       Firmware:     2.02  2.02

File name:       0501030.$01                Group ID:     0501030
Sample ID:
Operator:                                   Run number:   1
Comments:
Optical model:   Fraunhofer  PIDS included
LS 230           Fluid Module
Start time:      8:41  30 Jun 1999          Run length:   120 Seconds
Pump speed:      81
Obscuration:     5%
PIDS Obscur:     43%
Fluid:           Water
Software:        2.09                       Firmware:     2.02  2.02
```

```
COULTER®                LS Particle Size Analyzer
                                                                6 Jul 1999
———————— SEDIMENT/CORE LAB, GEOLOGY DEPT., UNION COLLEGE ————————

                    Volume Statistics (Arithmetic)          04712214.$01

Calculations from 0.040 µm to 2000 µm

Volume              100.0%
Mean:               168.6 µm         S.D.:              89 µm
Median:             174.2 µm         C.V.:              52.8%
D(3,2):             28.77 µm         Skewness:     0.00299 Right skewed
Mode:               203.5 µm         Kurtosis:     -0.668 Platykurtic

  % <       10       25       50       75       90
  Size µm   39.67    101.6    174.2    231.4    283.5

                    Volume Statistics (Arithmetic)          04717619.$01

Calculations from 0.040 µm to 2000 µm

Volume              100.0%
Mean:               128.8 µm         S.D.:              74.1 µm
Median:             120.6 µm         C.V.:              57.5%
D(3,2):             26.19 µm         Skewness:     0.526 Right skewed
Mode:               153.8 µm         Kurtosis:     -0.108 Platykurtic

  % <       10       25       50       75       90
  Size µm   38.32    72.66    120.6    176.9    230.8

                    Volume Statistics (Arithmetic)          0480005.$01

Calculations from 0.040 µm to 2000 µm

Volume              100.0%
Mean:               218.8 µm         S.D.:              83.3 µm
Median:             226.6 µm         C.V.:              38.1%
D(3,2):             25.56 µm         Skewness:     -0.758 Left skewed
Mode:               245.2 µm         Kurtosis:     0.676 Leptokurtic

  % <       10       25       50       75       90
  Size µm   116.3    181.1    226.6    273.5    316.5
```

```
COULTER®                    LS Particle Size Analyzer
                                                                      6 Jul 1999
————————— SEDIMENT/CORE LAB, GEOLOGY DEPT., UNION COLLEGE —————————

                        Volume Statistics (Arithmetic)          0480509.$01

Calculations from 0.040 µm to 2000 µm

Volume               100.0%
Mean:                124.3 µm          S.D.:            99.8 µm
Median:              111.6 µm          C.V.:            80.3%
D(3,2):              7.889 µm          Skewness:      0.433 Right skewed
Mode:                223.4 µm          Kurtosis:      -0.905 Platykurtic

   % <        10        25        50        75        90
   Size µm    4.735     29.25     111.6     204.2     264.5

                        Volume Statistics (Arithmetic)          0480923.$01

Calculations from 0.040 µm to 2000 µm

Volume               100.0%
Mean:                179.1 µm          S.D.:            96.6 µm
Median:              190.8 µm          C.V.:            53.9%
D(3,2):              22.32 µm          Skewness:      -0.157 Left skewed
Mode:                245.2 µm          Kurtosis:      -0.837 Platykurtic

   % <        10        25        50        75        90
   Size µm    35.12     103.4     190.8     251.0     301.3

                        Volume Statistics (Arithmetic)          0482333.$01

Calculations from 0.040 µm to 2000 µm

Volume               100.0%
Mean:                169.5 µm          S.D.:            67 µm
Median:              168.9 µm          C.V.:            39.5%
D(3,2):              24.61 µm          Skewness:      0.0157 Right skewed
Mode:                185.3 µm          Kurtosis:      0.183 Leptokurtic

   % <        10        25        50        75        90
   Size µm    88.99     126.3     168.9     212.2     254.5
```

```
COULTER®                    LS Particle Size Analyzer
                                                                  6 Jul 1999
———————— SEDIMENT/CORE LAB, GEOLOGY DEPT., UNION COLLEGE ————————

                    Volume Statistics (Arithmetic)          0483337.$01

Calculations from 0.040 µm to 2000 µm

Volume              100.0%
Mean:               162.7 µm          S.D.:            80.5 µm
Median:             169.9 µm          C.V.:            49.5%
D(3,2):             18.45 µm          Skewness:      -0.228 Left skewed
Mode:               203.5 µm          Kurtosis:      -0.389 Platykurtic

  % <        10       25       50       75       90
  Size µm    35.35    114.3    169.9    217.4    262.4

                    Volume Statistics (Arithmetic)          0483770.$01

Calculations from 0.040 µm to 2000 µm

Volume              100.0%
Mean:               15.55 µm          S.D.:            30.2 µm
Median:             8.051 µm          C.V.:            194%
D(3,2):             1.887 µm          Skewness:      6.37 Right skewed
Mode:               13.61 µm          Kurtosis:      50.4 Leptokurtic

  % <        10       25       50       75       90
  Size µm    0.831    2.719    8.051    17.69    31.42

                    Volume Statistics (Arithmetic)          0487092.$01

Calculations from 0.040 µm to 2000 µm

Volume              100.0%
Mean:               166.6 µm          S.D.:            75.7 µm
Median:             169.0 µm          C.V.:            45.4%
D(3,2):             22.49 µm          Skewness:      -0.0467 Left skewed
Mode:               203.5 µm          Kurtosis:      -0.308 Platykurtic

  % <        10       25       50       75       90
  Size µm    65.51    115.6    169.0    218.5    263.8
```

```
COULTER®                    LS Particle Size Analyzer
                                                                  6 Jul 1999
———————— SEDIMENT/CORE LAB, GEOLOGY DEPT., UNION COLLEGE ————————

                Volume Statistics (Arithmetic)          04892128.$01

Calculations from 0.040 µm to 2000 µm

Volume          100.0%
Mean:           93.80 µm        S.D.:           47.4 µm
Median:         91.08 µm        C.V.:           50.6%
D(3,2):         16.01 µm        Skewness:       0.0746 Right skewed
Mode:           153.8 µm        Kurtosis:       -0.762 Platykurtic

  % <       10       25       50       75       90
  Size µm   32.64    58.70    91.08    130.3    160.2

                Volume Statistics (Arithmetic)          0497896.$01

Calculations from 0.040 µm to 2000 µm

Volume          100.0%
Mean:           85.18 µm        S.D.:           79.1 µm
Median:         60.84 µm        C.V.:           92.8%
D(3,2):         5.095 µm        Skewness:       0.851 Right skewed
Mode:           168.8 µm        Kurtosis:       -0.2 Platykurtic

  % <       10       25       50       75       90
  Size µm   3.078    16.14    60.84    141.2    204.7

                Volume Statistics (Arithmetic)          0501030.$01

Calculations from 0.040 µm to 2000 µm

Volume          100.0%
Mean:           129.9 µm        S.D.:           78.7 µm
Median:         126.3 µm        C.V.:           60.6%
D(3,2):         13.02 µm        Skewness:       0.281 Right skewed
Mode:           185.3 µm        Kurtosis:       -0.445 Platykurtic

  % <       10       25       50       75       90
  Size µm   18.55    71.51    126.3    185.5    234.5
```

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Particle Diameter µm	04712214.$01 Volume %	04717619.$01 Volume %	0480005.$01 Volume %	0480509.$01 Volume %	0480923.$01 Volume %	0482333.$ Volume %
1.000	0.455	0.543	0.644	2.46	0.811	0.350
2.000	0.779	0.872	1.23	5.20	1.52	0.457
5.000	2.83	2.75	1.93	10.52	3.27	0.885
20.00	7.90	9.31	2.09	12.04	6.58	1.72
50.00	18.77	37.95	3.95	20.12	16.34	20.17
125.0	49.95	40.92	52.68	34.08	44.98	64.40
250.0	18.60	6.81	36.41	12.88	25.31	11.22
500.0	0	0	0	0	0	0
1,000	0	0	0	0	0	0
2,000	0	0	0	0	0	0

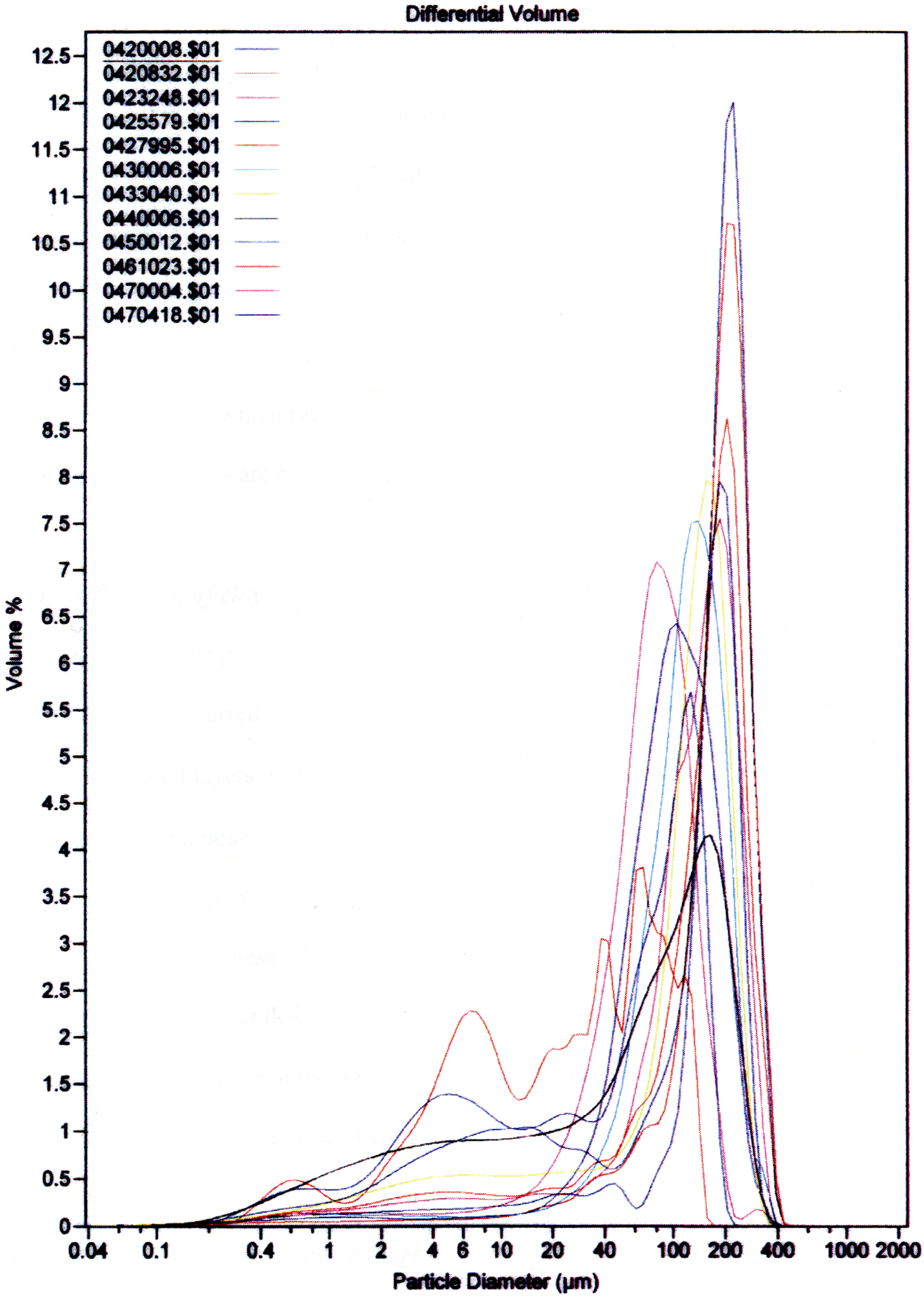

Figure 3.1b Coulter LS Particle Size Analyzer, Sediment/Core Lab, Geology Department, Union College.

```
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File name:        0420008.$01                    Group ID:       0420008
Sample ID:
Operator:                                        Run number:     2
Comments:
Optical model:    Fraunhofer  PIDS included
LS 230            Fluid Module
Start time:       10:06  30 Jun 1999             Run length:     120 Seconds
Pump speed:       81
Obscuration:      2%
PIDS Obscur:      24%
Fluid:            Water
Software:         2.09                           Firmware:       2.02  2.02

File name:        0420832.$01                    Group ID:
Sample ID:        0420832
Operator:                                        Run number:     2
Comments:
Optical model:    Fraunhofer  PIDS included
LS 230            Fluid Module
Start time:       15:04  29 Jun 1999             Run length:     119 Seconds
Pump speed:       81
Obscuration:      14%
PIDS Obscur:      49%
Fluid:            Water
Software:         2.09                           Firmware:       2.02  2.02

File name:        0423248.$01                    Group ID:       0423248
Sample ID:
Operator:                                        Run number:     7
Comments:
Optical model:    Fraunhofer  PIDS included
LS 230            Fluid Module
Start time:       10:50  30 Jun 1999             Run length:     119 Seconds
Pump speed:       81
Obscuration:      4%
PIDS Obscur:      25%
Fluid:            Water
Software:         2.09                           Firmware:       2.02  2.02
```

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```
File name:     0433040.$01            Group ID:     0433040
Sample ID:
Operator:                             Run number:   13
Comments:
Optical model: Fraunhofer  PIDS included
LS 230         Fluid Module
Start time:    11:41  30 Jun 1999     Run length:   120 Seconds
Pump speed:    81
Obscuration:   5%
PIDS Obscur:   49%
Fluid:         Water
Software:      2.09                   Firmware:     2.02  2.02

File name:     0440006.$01            Group ID:     0440006
Sample ID:
Operator:                             Run number:   9
Comments:
Optical model: Fraunhofer  PIDS included
LS 230         Fluid Module
Start time:    11:09  30 Jun 1999     Run length:   120 Seconds
Pump speed:    81
Obscuration:   9%
PIDS Obscur:   73%
Fluid:         Water
Software:      2.09                   Firmware:     2.02  2.02

File name:     0450012.$01            Group ID:     Sacandaga
Sample ID:     a0450012
Operator:      Jaime                  Run number:   3
Comments:
Optical model: Fraunhofer  PIDS included
LS 230         Fluid Module
Start time:    15:24  29 Jun 1999     Run length:   120 Seconds
Pump speed:    81
Obscuration:   19%
PIDS Obscur:   54%
Fluid:         Water
Software:      2.09                   Firmware:     2.02  2.02
```

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File name:	0425579.$01	Group ID:	0425579
Sample ID:			
Operator:	jaime	Run number:	2
Comments:			
Optical model:	Fraunhofer PIDS included		
LS 230	Fluid Module		
Start time:	8:15 30 Jun 1999	Run length:	120 Seconds
Pump speed:	81		
Obscuration:	2%		
PIDS Obscur:	18%		
Fluid:	Water		
Software:	2.09	Firmware:	2.02 2.02

File name:	0427995.$01	Group ID:	0427995
Sample ID:			
Operator:		Run number:	11
Comments:			
Optical model:	Fraunhofer PIDS included		
LS 230	Fluid Module		
Start time:	11:26 30 Jun 1999	Run length:	119 Seconds
Pump speed:	81		
Obscuration:	1%		
PIDS Obscur:	14%		
Fluid:	Water		
Software:	2.09	Firmware:	2.02 2.02

File name:	0430006.$01	Group ID:	0430006
Sample ID:			
Operator:		Run number:	6
Comments:			
Optical model:	Fraunhofer PIDS included		
LS 230	Fluid Module		
Start time:	10:43 30 Jun 1999	Run length:	120 Seconds
Pump speed:	81		
Obscuration:	3%		
PIDS Obscur:	30%		
Fluid:	Water		
Software:	2.09	Firmware:	2.02 2.02

```
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File name:       0461023.$01                  Group ID:      0461023
Sample ID:
Operator:                                     Run number:  8
Comments:
Optical model:   Fraunhofer   PIDS included
LS 230           Fluid Module
Start time:      10:59  30 Jun 1999           Run length:    120 Seconds
Pump speed:      81
Obscuration:     4%
PIDS Obscur:     37%
Fluid:           Water
Software:        2.09                         Firmware:      2.02  2.02

File name:       0470004.$01                  Group ID:      0470004
Sample ID:
Operator:        jaime                        Run number:  1
Comments:
Optical model:   Fraunhofer   PIDS included
LS 230           Fluid Module
Start time:       8:05  30 Jun 1999           Run length:    120 Seconds
Pump speed:      81
Obscuration:     4%
PIDS Obscur:     34%
Fluid:           Water
Software:        2.09                         Firmware:      2.02  2.02

File name:       0470418.$01                  Group ID:
Sample ID:       0470418
Operator:                                     Run number:  1
Comments:
Optical model:   Fraunhofer   PIDS included
LS 230           Fluid Module
Start time:      14:44  29 Jun 1999           Run length:    119 Seconds
Pump speed:      81
Obscuration:     13%
PIDS Obscur:     50%
Fluid:           Water
Software:        2.09                         Firmware:      2.02  2.02
```

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Volume Statistics (Arithmetic)　　　　0461023.$01

Calculations from 0.040 µm to 2000 µm

Volume	100.0%		
Mean:	152.0 µm	S.D.:	88.5 µm
Median:	159.7 µm	C.V.:	58.2%
D(3,2):	14.42 µm	Skewness:	-0.0137 Left skewed
Mode:	203.5 µm	Kurtosis:	-0.635 Platykurtic

% <	10	25	50	75	90
Size µm	13.77	87.32	159.7	214.3	262.0

Volume Statistics (Arithmetic)　　　　0470004.$01

Calculations from 0.040 µm to 2000 µm

Volume	100.0%		
Mean:	140.0 µm	S.D.:	78.8 µm
Median:	140.5 µm	C.V.:	56.3%
D(3,2):	14.82 µm	Skewness:	0.0732 Right skewed
Mode:	185.3 µm	Kurtosis:	-0.562 Platykurtic

% <	10	25	50	75	90
Size µm	20.38	85.75	140.5	195.9	243.7

Volume Statistics (Arithmetic)　　　　0470418.$01

Calculations from 0.040 µm to 2000 µm

Volume	100.0%		
Mean:	117.2 µm	S.D.:	88.7 µm
Median:	129.7 µm	C.V.:	75.7%
D(3,2):	8.060 µm	Skewness:	0.0691 Right skewed
Mode:	185.3 µm	Kurtosis:	-1.3 Platykurtic

% <	10	25	50	75	90
Size µm	3.974	17.02	129.7	190.8	230.9

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Volume Statistics (Arithmetic) 0420008.$01

Calculations from 0.040 µm to 2000 µm

Volume	100.0%		
Mean:	186.9 µm	S.D.:	82.9 µm
Median:	197.0 µm	C.V.:	44.4%
D(3,2):	19.63 µm	Skewness:	-0.536 Left skewed
Mode:	223.4 µm	Kurtosis:	0.0867 Leptokurtic

% <	10	25	50	75	90
Size µm	42.58	147.8	197.0	240.6	282.1

Volume Statistics (Arithmetic) 0420832.$01

Calculations from 0.040 µm to 2000 µm

Volume	100.0%		
Mean:	38.39 µm	S.D.:	37.1 µm
Median:	25.28 µm	C.V.:	96.7%
D(3,2):	5.680 µm	Skewness:	0.949 Right skewed
Mode:	66.44 µm	Kurtosis:	-0.136 Platykurtic

% <	10	25	50	75	90
Size µm	2.857	6.678	25.28	63.12	96.87

Volume Statistics (Arithmetic) 0423248.$01

Calculations from 0.040 µm to 2000 µm

Volume	100.0%		
Mean:	77.98 µm	S.D.:	44.6 µm
Median:	73.86 µm	C.V.:	57.2%
D(3,2):	12.10 µm	Skewness:	1.02 Right skewed
Mode:	80.08 µm	Kurtosis:	3.24 Leptokurtic

% <	10	25	50	75	90
Size µm	25.08	48.25	73.86	103.5	132.9

```
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                    Volume Statistics (Arithmetic)           0425579.$01

Calculations from 0.040 µm to 2000 µm

Volume              100.0%
Mean:               109.0 µm          S.D.:              60.2 µm
Median:             100.1 µm          C.V.:              55.2%
D(3,2):             15.94 µm          Skewness:      0.686 Right skewed
Mode:               105.9 µm          Kurtosis:      0.46 Leptokurtic

   % <       10        25        50        75        90
   Size µm   40.90     65.67     100.1     145.6     191.9

                    Volume Statistics (Arithmetic)           0427995.$01

Calculations from 0.040 µm to 2000 µm

Volume              100.0%
Mean:               185.3 µm          S.D.:              80.3 µm
Median:             191.0 µm          C.V.:              43.4%
D(3,2):             29.66 µm          Skewness:      -0.218 Left skewed
Mode:               203.5 µm          Kurtosis:      -0.179 Platykurtic

   % <       10        25        50        75        90
   Size µm   67.34     137.7     191.0     238.6     284.5

                    Volume Statistics (Arithmetic)           0430006.$01

Calculations from 0.040 µm to 2000 µm

Volume              100.0%
Mean:               125.4 µm          S.D.:              64.9 µm
Median:             121.5 µm          C.V.:              51.7%
D(3,2):             18.62 µm          Skewness:      0.42 Right skewed
Mode:               140.1 µm          Kurtosis:      0.343 Leptokurtic

   % <       10        25        50        75        90
   Size µm   45.89     80.49     121.5     166.6     209.4
```

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Volume Statistics (Arithmetic) 0433040.$01

Calculations from 0.040 µm to 2000 µm

Volume	100.0%		
Mean:	119.1 µm	S.D.:	74.4 µm
Median:	127.2 µm	C.V.:	62.5%
D(3,2):	8.611 µm	Skewness:	-0.0549 Left skewed
Mode:	153.8 µm	Kurtosis:	-0.814 Platykurtic

% <	10	25	50	75	90
Size µm	5.488	59.49	127.2	172.9	212.3

Volume Statistics (Arithmetic) 0440006.$01

Calculations from 0.040 µm to 2000 µm

Volume	100.0%		
Mean:	83.70 µm	S.D.:	78.2 µm
Median:	65.34 µm	C.V.:	93.5%
D(3,2):	5.064 µm	Skewness:	0.769 Right skewed
Mode:	168.8 µm	Kurtosis:	-0.31 Platykurtic

% <	10	25	50	75	90
Size µm	1.948	9.899	65.34	140.5	198.8

Volume Statistics (Arithmetic) 0450012.$01

Calculations from 0.040 µm to 2000 µm

Volume	100.0%		
Mean:	61.74 µm	S.D.:	54 µm
Median:	54.09 µm	C.V.:	87.4%
D(3,2):	5.640 µm	Skewness:	0.445 Right skewed
Mode:	127.6 µm	Kurtosis:	-1.1 Platykurtic

% <	10	25	50	75	90
Size µm	2.509	7.543	54.09	108.1	139.9

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Particle Diameter µm	0420008.$01 Volume %	0420832.$01 Volume %	0423248.$01 Volume %	0425579.$01 Volume %	0427995.$01 Volume %	0430006.$ Volume %
1.000	0.979	2.44	1.01	0.654	0.352	0.848
2.000	1.58	11.26	1.21	0.707	0.559	1.01
5.000	3.24	26.94	4.00	1.80	1.65	1.77
20.00	3.51	22.23	18.59	10.11	4.12	6.00
50.00	7.34	29.66	60.40	50.61	13.65	41.10
125.0	61.32	2.85	12.50	32.62	58.74	44.23
250.0	20.61	0	0.542	2.21	20.23	3.47
500.0	0	0	0	0	0	0
1,000	0	0	0	0	0	0
2,000	0	0	0	0	0	0

Core descriptions

In cores #1 and #4 we encountered small rocks in gravel horizons, which were about 2″ in diameter and these rocks blocked the recovery of complete cores until the cutting shoe chewed them up enough to swallow them (Figure 2.1). This Figure should be referred to whenever detailed descriptions of the core horizons are being considered. None of the cores encountered any rocks of enough consequence to force us to relocate the truck for a second push.

Core #1 was located just *SSW* of the four corners of old downtown Osborne Bridge. Its file number is 049 and its GPS (Global Positioning Satellite) coordinates are *N* (43°-10′-801″) and *W* (74°-08′-998″). The elevation was approximately 766′ above sea level. The site was also just north or on the edge of an end moraine, which was revealed further into the investigation of the study area. Every time we encountered any coarse soils/sediments, the cutting shoe plugged to a certain degree and the core recoveries were never complete, such was the case with Core #1. The probe moved down through 6″ of gravel which could have been the remnants of an old road or at least the edge of one. This road could have been the road from Osborne Bridge to Northampton. The old New York State Water Commission Map #20 had not been cleaned-up at that time and no visible sign of an old road was detected at the site. We felt we were on the former lands of either J. Paul or E. Hammond (see Figure 1.5). The probe moved down through another 8″ of developed soil horizon that was also gravely. Both of the above horizons were sampled together for further testing. Then we hit some very coarse gravely clay with stones as large as the cutting shoe, about 5″ into it. Beyond this, the probe was unable to collect any more sediment for the next 18″. The second section continued to push aside the same sediments until it rounded and swallowed the obstructing cobble, more than 16″ further down. It is believed that this horizon was a remnant braided or lateral stream flowing parallel to the adjacent end moraine. The next 13″ were the same coarse gravely clay with smaller cobbles, 1-1 ½″ at the largest. The last 18-19″ of the first 8′ push probe comprised a coated gravely clay. No attempt will be made here to predict the parent environment of this coated horizon but it did stand out from the background with further analysis and was completely saturated and assumed to be the water table. This was not hard to imagine since the site was the closest to the Sacandaga River, flowing just to the Northeast.

Core #2 was located just *NW* of Osborne Bridge on the former lands of Foster Noyes (see Figure 1.5). It was located on the banks of the Sacandaga River Floodplain, which is pervasive north to the Northville Bridge, even at low water status. Its file number is 048 and its GPS coordinates are *N* (43°-10′-865″) and *W* (74°-09′-809″). The elevation was approximately 765′ above sea level. The top 5″ was a very heavy sand indicative of a sandbar, but may also have been involved with ice rafted clast mechanics during spring melt ice jams due to the presence of interspersed pebbles. Next was a small 3″ layer of a developed soil horizon, often referred to as the A-horizon. The probe then pushed through 14″ of light gravel with black sands and another 10″ of heavy gravel with black sands. All of the gravel horizons above could be considered glaciofluvial in nature, related to the annual melts on the front side of a retreating glacier. The bottom of the first section of probe core was approximately 1½ -2″ of fine sand. The top of the next 4′ probe had 2″ of fine gravel with black sands. The next horizon down was 33″ thick and contained alternating layers of light and dark sands with black sands. We first determined them to be varved sands <50μm, deposited in quiet waters within one year, adjacent to a glacier. Upon later investigation, after running a few Ostracode Studies in both light and dark layers, questions were raised as to the real interpretation. Below this very fine sand horizon lay 7″ of fine sand with black sands, 4″ of fine sand without black sands, 7″ more of medium sand with black sands and 4″ of clay and fine sand with black sands. The bottom 36″of this 12″ probed core was fine sand with alternating bands of interspersed black sands. The water table (saturation zone) was encountered at 6′. The last two 4′ sections are indicative of beach or shoreline deposits alternating with quiet water deposition in a lake basin or floodplain influenced by a persistent river. It implies that all of these variations in sediment deposition may have already existed before glaciation or that they arrived after a glacial retreat. Another possibility exists, which is that they could be deformed glaciofluvial sediments of a former outwash plain. This poses more questions, which are talked about throughout the study. Core site #2 revealed a wide variety of core horizons and subsequently, several horizons were examined more thoroughly in this core than in any other. Nearly the whole of the upper 3 feet of the core horizons are probably the result of postglacial, fluvial deposition. Everything below 3′ was consistent with a subglacial environment, typical of a kettle lake deposition.

Core #3 was located just *E* of Mead Island on the former lands of L. D. Fritcher (see Figure 1.5). It was at an elevation of about 765′ above sea level. Its file number is 050 and its GPS coordinates are *N* (43°-10′-821″) and *W* (74°-09′-791″). The site was formerly farmed and a few small stone piles existed adjacent to Mead Island. The top 11″ were a combination of a developing soil horizon and heavy beach sands at the uppermost few inches. This may be due to the nearness of the shoreline of Mead Island, but it is clear, Mr. Fritcher farmed right up to the shore/tree line in his day. As the probe continued down the next 9″ it encountered more heavy sand with black sands and small amounts of clay in the matrix. The next 3″ contained gravel and black sands followed by another 3″ of clayey gravel with black sands. The bottom 10″ of the first section was again heavy sand and gravel with black sands. These soils were coarse enough to again clog the cutting shoe of the probe and another incomplete core was acquired. More gravel, perhaps a little lighter, met the advance of the second probe length and until the cutting shoe chugged its way through this 18″ horizon, more than 15″ was lost. The bottom 15″ were again clayey gravel with black sands and was in the saturated zone. It's never clear where the probe core-cutting shoe gets hung up but the depth of the core bottom is still established. Core #3 is interpreted as stoss and lee topography where lodgement till slopes around an obstacle such as the Mead Island drumlin. This is likely subglacial in nature and could be another clue that everywhere within the study area the sediments could be simply made up of ice-contact deformations.

Core #4 was located at the *NW* corner of Mead Island adjacent to a backwater inlet that faces the Sacandaga River floodplain to the east. At first glance, the inlet appears to be a streambed, but no upstream streambed or water flowing into it exists. Another such structure exists less than ½ mile north at the Northampton Beach State Campsite, which is used as a boat launch. Both of these structures are, in fact, relict streambed outlets and probably connected to the West. There the structures drained a kettle, which today is the Tamarack Swamp, due west about 1 mile. Kettles are subglacial happenings and further evidence that the study area is probably made up of ice-contact deformations.

Core #4's file number is 047 and its GPS coordinates are *N* (43°-10′-715″) and *W* (74°-10′-252″). Its elevation was precisely at the high water mark of 768′ above sea level. The site was on the former lands of Charles and Arietta Mead (see Figure 1.5). The first 4′ of the first core section was medium beach sand with black sands, representative of the high water mark sites. Beneath this was approximately 14″ of developed soil horizon. The next horizon down was very heavy gravel with black sands and cobbles large enough to plug the cutting sole, creating a 12″ blank in the profile. It finally chewed the cobble up enough to swallow it and continued down through another 10″ of light gravel with black sands. The gravel continued to lighten and contained less black sands as the second 4′ section captured the top 8′. Somewhere along the push the remaining 36″ of light gravel was heavy enough to compress the profile so that the sample was 6″ short a complete core section. The same can be said for the next pushed section as it went on to capture 11″ of clayey light gravel with black sands, 8″ of light gravel with black sands and 2″ of red clay light gravel with black sands before hitting the water table at 10′. Somewhere along this section push, probably while capturing the next 18″ of medium gravel with black sand the collected sediments were less than complete. The remaining 4′ in this third section was heavy sand with heavy black sands.

We had prepared for at least one deeply pushed core section and considered the water table at such a site. After we hit the water table at site #4 we installed a pointed cutting sole on the last 4′ before lowering it down the core hole. It was designed to be ridged until the 12′ mark was hit and then released to capture the sediments by the core liner in the same way that the sediments are collected above them. It worked well and we collected the next 14″ of heavy sand with black sands. The remaining 16″ down to the 16″ mark were heavy gravel with up to 1″ stones, which gave us an 18″ blank in this core capture. This horizon was in a matrix of fine sands and black sands. This core site had horizons that are consistent with streambed sediments and reflect a wandering high water flow subglacial drainage system of the kind mentioned earlier, perhaps such as in draining a kettle.

Core #5 was located *WSW* of Mead Island on the edge of the largest eroded micro-island of a hummock field in the local greater Mead Islands group. The micro-island is usually submerged until late summer. The site was picked just on the eastern edge of the old Osborne Bridge Road and was 765′ above sea level. Its file number is 046 and its GPS coordinates are *N* (43°-10′-527″) and *W* (74°-10′-230″). It is unclear by the 1908 New York State Water Commission Maps who the former owner was but it could have been Horace Kenyon. In a straight line, the site was about 900′ from core site #4 (see Figure 1.5). The first section behaved like the previous pushes, with gravel hang-ups at the cutting sole but we collected 80% of the sediments leaving a 10″ blank at the top. The top 13″ recovered was typical soil developed light gravely loam with black sands. We pushed down through 18″ of coated (oxidized) medium gravel with black sands and then another 8″ of coated light gravel with black sands. The second section saw the same gravel compression and recovery was absent 8″ at the top. The top 7″ of this section was the same-coated light gravels with black sands that preceded it. Then we ran into 18″ of heavy sand with black sands and some banded fine sand/clay matrix segments. The bottom 18″ continued to be heavy sand with small bands of clay matrix and heavier black sand layers. The hummocky topography of this site is consistent with kame and kettle microenvironments associated with subglacial ice-contact deformations.

Core #6 was located about 800′ further *SW* along the old Osborne Bridge gravel road from site #5 (see Figure 1.5). This site is approximately 760′ above sea level and it is unclear who the former owner was, but was likely to be Horace Kenyon. The site was on the east side of the road and appears to be a former dirt road heading northwest to an anonymous unimproved road connected to the Bunker Hill road. Its file number is 045 and its GPS coordinates are *N* (43°-10′-431″) and *W* (74°-10′-421″). Both this site and site #7 are similar regarding their sediment profiles. The top 12″ of the first pushed section was developed soil horizon made up of loamy clay. Beneath this was 36″ of densely packed fine sand and clay with what appears to be varved banding. The top 18″ of the second section was more of the same densely packed fine sand/clay with banding. The next deeper horizon was 24″ of fine sand and clay with black sand banding and was completely saturated (water table). The final 6″ was fine sand and clay with black sands (the emphasis on the first component in abundance). This sediment profile is consistent with kettle lake environments, which are subglacial and represent ice-soil contact seasonal melting depositions. In retrospective, we should have marked a direction onto the side of the liners at both this site and core #7. That would have given us a better slump profile of these two sites, which were the only sites whose core horizons could be correlated in the study area.

Core #7 was located at a bend in the old Osborne Bridge Road, *SW* of core #6 by some 1200′ (see Figure 1.5). It's not perfectly clear from the maps but this property could have been formerly the same lands of Ed Gifford. This site was also at the 760′

elevation above sea level and on the west side of the road. Its file number was 044 and its GPS coordinates were *N* (43°-10′-332″) and *W* (74°-10′-487″). The top 6″ of the probe were probably the gravels of the old roadbed. The next 6″ was a typical clayey loam developed soil horizon. The next 36″ of the first section was densely packed fine sand and clay with varved banding. The top 12″ of the second section was the same densely packed fine clay and varved banding. The remaining 36″ of this 8′ deep core was fine sand and clay with black sand banding and was completely saturated (water table). Again, this sediment profile is consistent with a subglacial kettle lake depositional environment.

Core #8 was sited approximately 800′ further *SW* along the old Osborne Bridge Road. It is on the east side of the road at 764′ above sea level and was probably the former lands of Ammon Blowers (see Figure 1.5). Its file number is 043 and its GPS coordinates are *N* (43°-10′-262″) and *W* (74°-10′-603″). The site was chosen because it was an apparent sandbar, which was of interest. The top 16″ was deposited in the last 70 years and consists of heavy coated sand with black sands and a little fine sand and clay in the upper few inches. The next 24″ in the first section consisted of a well-defined soil horizon of sand and light gravel with black sands. The last 8″ was heavy sand and clay with varved banding. The next section of probe compressed somewhere along the push perhaps because of the first 12″ of heavy sand and clay, or more likely because of the dark heavy coated sand and alternating clay bands and black sand banding which made up the last 31″ of sediments. The last 31″ of heavy coated sand horizon was completely saturated (water table). The sediment profile in this 8′ core below the top newly formed sandbar represent alternating quiet water and fast water episodes of deposition. The horizons are interpreted as stoss and lee topography where lodgement till slopes around large obstacles, such as the drumlin just to the *NW* of the site. This drumlin has never been identified, so it is named the *Ambrosino Drumlin.* It has an elevation of 880′ above sea level, just southeast of Sweets Crossing. It is not clear as of this writing, but this drumlin appears to be of continental glaciation, rather than of the outlet or valley glacier type.

Core #9 is located at the high water mark (768′) on the shoreline of the old Green's Beach Campsites. It would be just south of the old Osborne Bridge Road and on the former lands of Ammon Blowers (see Figure 1.5). Its file number is 042 and its GPS coordinates are *N* (43°-10′-182″) and *W* (74°-10′-798″). The top 8″ of the upper 4′ section was coarse heavy beach sand with black sand. The next 6″ down was coated gravel with black sands. Below that was 18″ of loamy heavy coated sand with black sands all showing typical soil development. The last 16″ of the upper section were fine sand and clay mixtures, which lightened downward and contained black sands. This section slipped while in the liner or during splitting in half lengthwise. The bottom 4′ section compressed at the lowest coarse gravel horizon and resulted in about a 7″ blank at the top of the core. In (Figure 2.1) the last core in the rack, to the right of the circled #9, a 4″ plug of dark gravel separated and at the top of the core section is evidenced. This is because during handling at the core site, the whole of the contents of the core slipped toward the bottom and protruded by 4″. To avoid destroying the integrity of the protruded sediment, it was cut-off and slid down into the blank space at the top of the liner. The upper 6″ of this core section consisted of fine sand and clay mixtures and black sands. The next 18″ down was made up of medium sand with varved bands of heavy black sands, especially in the upper half portion of the horizon. The bottom 16″ was progressively coarser gravel going downward with black sands. The last 4″ was darker due to the zone of saturation (water table). Core #9 was approximately 1200′ further *SW* along the old Osborne Bridge Road and although it has the same profile of quiet water alternating fast water depositional character, the sediments seem to have undergone greater than usual secondary weathering. This is evident in the shades of color in the horizons, indicating groundwater's of totally different charge and suspended solids loads. The horizons are interpreted as stoss and lee topography where lodgement till slopes around large obstacles, perhaps such as an Ambrosino drumlin type.

Appendix C

USGS WATER WELL RECORDS

Date: Mon, 21 Jun 1999 09:38:28 -0400
From: "Ronald V Allen, Hydrologic Technician, Troy, NY " <rallen@usgs.gov>
To: aa7148@cnsvax.albany.edu
Cc: "Ronald V Allen, Hydrologic Technician, Troy, NY " <rallen@usgs.gov>
Subject: GWSI database retrieval, well records.

Arthur Ambrosino:

re: well records within 2-miles of: 431000, 0741000.

The 2-mile retrieval located one record (local # FU 137). I re-searched using a 5-mile radius and picked-up 26 records. They are sorted by ascending latitude.

footnotes:

county, 035 = Fulton
lat-long accuracy, F = within 5-seconds
type analysis, B = common ions
Primary use of water, H = domestic
S = stock
N = industrial
C = commercial
aquifer code, 112TILL = pleistocene till
112SAND = " sand
112SDGV = " gravel
371LLFL = Little Falls Dolomite
371PSDM = Potsdam Sandstone
364CNJR = Canajoharie Shale
400PCMB = Precambrian Erathem

lith code, TILL = till
SHLE = shale
DLMT = dolomite
SAND = sand
ROCK = bedrock, undifferentiated
GRVL + gravel

Method constructed, D = dug
C = cable tool

type of finish, W = walled

Please contact me if you have questions.

Ron Allen

U.S. Geological Survey, Water Resources Division

```
U|S   Ron Allen, Information Specialist      Voice: (518)285-5602
-+-   U.S. Geological Survey, WRD            Fax:   (518)285-5601
G|S   425 Jordan Road                        USGS, NY web site,
      Troy, NY  12180-8349                    http://ny.usgs.gov
```

```
1DATE: 06/16/99                 GWSI retrieval, well records within 2
miles of, 43 10 00; 074 10 00.                      PAGE   1a

                 LAT     ALTITUDE

    LAT/LONG     LONG    OF LAND    ALTITUDE    TOPO-
                                                    LATITUDE
LONGITUDE     DATUM    ACCURACY  SURFACE      DATUM    GRAPHIC
    LOCAL WELL NUMBER           SITE-ID      COUNTY  (DEGREES)
(DEGREES)      (CODE)     CODE     (FEET)      (CODE)    SETTING

 FU 135                     430550074105901   035        430550
0741100  NAD27          F        820     NGVD29           -
 FU 148                     430604074095801   035        430605
0741000  NAD27          F       850.00  NGVD29           -
 FU 136                     430612074102801   035        430610
0741030  NAD27          F       780.00  NGVD29           -

 FU 147                     430626074094401   035        430625
0740945  NAD27          F       790.00  NGVD29           -

 FU 146                     430641074092201   035        430640
0740920  NAD27          F       800.00  NGVD29           -

 FU 118                     430728074140501   035        430730
0741405  NAD27          F       780.00  NGVD29           -

 FU 117                     430740074140901   035        430740
0741410  NAD27          F       840.00  NGVD29           -

 FU 115                     430815074142001   035        430815
0741420  NAD27          F       790.00  NGVD29           -

 FU 116                     430817074140901   035        430815
0741410  NAD27          F       790.00  NGVD29           -
 FU 114                     430824074142101   035        430825
0741420  NAD27          F       820.00  NGVD29           -
 FU 145                     430843074075601   035        430845
0740755  NAD27          F       770.00  NGVD29           -
 FU 144                     430848074072601   035        430850
0740725  NAD27          F       790.00  NGVD29           -

 FU 113                     430910074132501   035        430910
0741325  NAD27          F       790.00  NGVD29           -

 FU 138                     431111074115901   035        431110
0741200  NAD27          F       820.00  NGVD29           -
 FU 108                     431133074132301   035        431135
0741325  NAD27          F       840.00  NGVD29           -
 FU 107                     431141074131501   035        431140
0741315  NAD27          F       860.00  NGVD29           -
 FU 143                     431203074080601   035        431205
0740805  NAD27          F       890.00  NGVD29           -


 FU 142                     431229074083401   035        431230
0740835  NAD27          F       930.00  NGVD29           -
 FU 141                     431257074090201   035        431255
0740900  NAD27          F       950.00  NGVD29           -

 FU 139                     431354074112201   035        431355
0741120  NAD27          F       750.00  NGVD29           -

 FU 112                     430925074131001   035        430925
0741310  NAD27          F       785.00  NGVD29           -
```

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 FU 111                                431026074134601   035          431025
0741345  NAD27           F               900.00   NGVD29            -
 FU 110                                431035074134001   035          431035
0741340  NAD27           F               890.00   NGVD29            -
 FU 109                                431048074133901   035          431050
0741340  NAD27           F               880.00   NGVD29            -
 FU 137                                431053074115901   035          431055
0741200  NAD27           F               820.00   NGVD29            -

FU 140                                431355074111101   035          431355
0741110  NAD27           F               750.00   NGVD29            -
1DATE: 06/16/99                            GWSI retrieval, well records within 2
miles of, 43 10 00; 074 10 00.                            PAGE    1b

                                                    PRIMARY
DEPTH      DEPTH                                    BOTTOM   DIAMETER
                                            DEPTH     USE      TYPE              LITH-
 TO          TO       METHOD    TYPE      OF       OF
                                OF WELL    OF       OF      AQUIFER    OLOGY
 TOP       BOTTOM   CONST-     OF      CASING   CASING
    LOCAL  WELL NUMBER          (FEET)    WATER   ANALYSES    CODE       CODE
(FEET)     (FEET)   RUCTED   FINISH    (FEET)    (IN)

 FU 135                          26         H        --      112TILL    TILL
 0          26         D        W        54        --
 FU 148                          67.0       H        --      364CNJR    SHLE
 44.0       --         C        -        --       6.00
 FU 136                          65.0       H        --        --        --
 --         --         -        -        --       --
                                                    --      364CNJR    SHLE
 18.0       --         C        -        --       6.00
 FU 147                          53.0       H        --        --        --
 --         --         C        -        --       6.00

 FU 146                         117         H        --        --        --
 --         --         -        -        --       --
                                                    B        --        --
 --         --         C        -        --       6.00
 FU 118                         134         H        --        --        --
 --         --         -        -        --       --
                                                    B       371LLFL    DLMT
114         --         C        -        --       6.00
 FU 117                         130         S        --      371LLFL    DLMT
 13.0       --         C        -        --       6.00

 FU 115                          77.0       H        --        --        --
 --         --         -        -        --       --
                                                    --      112SAND    SAND
 --         --         C        -        --       6.00
 FU 116                          99.0       H        --      112SAND    SAND
 --         --         C        -        --       6.00
 FU 114                         109         H        --        --        --
 --         --         -        -        --       --
                                                    B       400PCMB    ROCK
 82.0       --         C        -        --       6.00

 FU 145                          10.0       H        --      112SDGV    GRVL
 --         --         D        -        --      24.0
 FU 144                          42.0       H        --        --        --
 --         --         -        -        --       --
                                                    --      371LLFL    DLMT
 --         --         C        -        --       6.00
 FU 113                          73.0       H        --        --        --
 --         --         -        -        --       --
                                                    --      112SAND    SAND
 --         --         C        -        --       6.00
```

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FU 112                          41.0       H          --      112TILL    TILL
 --          --        C        -          --      6.00
 FU 111                          40.0       H          --      112TILL    TILL
 --          --        D         -          --     48.0
 FU 110                          65.0       H          --      371LLFL    DLMT
 --          --        C         -          --      6.00
 FU 109                          19.0       H          --      112TILL    TILL
 --          --        D         -          --     20.0
 FU 137                         186         N          --        --        --
 --          --        -         -          --      --

                                                       --        --        --
 --          --        C         -          --      8.00
 FU 138                         140         C          --      371LLFL    DLMT
 15.0        --        C         -          --      6.00
 FU 108                          38.0       H          --      112TILL    TILL
 --          --        D         -          --      --
 FU 107                          12.0       H          --      112TILL    TILL
 --          --        D         -          --     36.0
 FU 143                          14.0       H          --        --        --
 --          --        -         -          --      --

                                                       --      112SAND    SAND
 --          --        D         -          --      --
 FU 142                          18.0       H          --      112SAND    SAND
 --          --        D         -          --     24.0
 FU 141                          62.0       S          --        --        --
 --          --        -         -          --      --
                                                       B       371PSDM    SNDS
  3.00       --        C         -          --      3.00
 FU 139                         128         C          --        --        --
 --          --        -         -          --      --

                                                       B       112SDGV    GRVL
 --          --        C         -          --      6.00
 FU 140                         125         H          --      400PCMB    ROCK
  4.00       --        C         -          --      6.00
1DATE: 06/16/99                    GWSI retrieval, well records within 2
miles of, 43 10 00; 074 10 00.                PAGE    1c


                                                   DISCHARGE
    LOCAL WELL NUMBER                                 REMARK
                   OWNER                             (GPM)

 FU 135                      100 GPH, HARD WATER, TEMP 51
NYSZCZY, NICK                                        --
 FU 148                      FROM BULL.GW-24. ; 30= AVG.ANN.WL.
HUGHES JOHN                                        12.0
 FU 136                      PUMPED AT 6 GPM
                        --                           --
                             FROM BULL.GW-24. ; 30= AVG.ANN.WL.
MINKLER HARRY                                       6.00
 FU 147                      FROM BULL.GW-24. ; 30= AVG.ANN.WL.
PELCHER JOE                                          --

 FU 146                      Formerly site 430643074092201.
                        --                           --
                             FROM BULL.GW-24. ; 30= AVG.ANN.WL.
FYFE JAMES                                           --
 FU 118                      Formerly site 430723074140601.
                        --                           --
                             FROM BULL.GW-24. ; 30= AVG.ANN.WL.
SART LAUREN                                         5.00
```

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 FU 117                   FROM BULL.GW-24. ; 30= AVG.ANN.WL.
WARNER V. J.                                  6.00

 FU 115                   Formerly site 430816074142001.
                    --                       --
                          FROM BULL.GW-24. ; 30= AVG.ANN.WL.
VAN NOSTRAND DONALD                           --
 FU 116                   FROM BULL.GW-24. ; 30= AVG.ANN.WL.
WOJSKI A.                                     4.00
FU 114                   Formerly site 430826074141001.
                    --                       --
                          FROM BULL.GW-24. ; 30= AVG.ANN.WL.
ZEA EARL                                      2.50

 FU 145                   FROM BULL.GW-24. ; 30= AVG.ANN.WL.
BOICE KATHERN                                 3.00
 FU 144                   Formerly site 430849074073701.
                    --                       --
                          FROM BULL.GW-24. ; 30= AVG.ANN.WL.
HAYDEN RALPH                                  --
 FU 113                   Formerly site 430912074131901.
                    --                       --
                          FROM BULL.GW-24.
FERENCY ESTHER                                --

 FU 112                   FROM BULL.GW-24. ; 30= AVG.ANN.WL.
WARNER BURDETTE                               7.50
 FU 111                   FROM BULL.GW-24. ; 30= AVG.ANN.WL.
WARNER CYRUS                                  3.00
 FU 109                   FROM BULL.GW-24. ; 30= AVG.ANN.WL.
STEWART EDITH                                 --
 FU 137                   NOT USED AT PRESENT
                    --                       --

                          FROM BULL.GW-24. ; 30= AVG.ANN.WL.
U. S. FELDSPAR CORP.                         40.0
 FU 138                   FROM BULL.GW-24. ; 30= AVG.ANN.WL.
FERGUSON AND MITTLSTAEDT                      5.00
 FU 108                   FROM BULL.GW-24. ; 30= AVG.ANN.WL.
SHAW ED                                       --
 FU 107                   FROM BULL.GW-24. ; 30= AVG.ANN.WL.
EDWARDS PALMER                                --
 FU 143                   Formerly site 431203074081001.
                    --                       --

                          FROM BULL.GW-24. ; 30= AVG.ANN.WL.
DARLING M.                                    --
 FU 142                   FROM BULL.GW-24. ; 30= AVG.ANN.WL.
MADISON ANDY                                  --
 FU 141                   Formerly site 431255074090301.
                    --                       --
                          FROM BULL.GW-24. ; 30= AVG.ANN.WL.
LINDSEY M. H.                                 3.00
 FU 139                   Formerly site 431353074112501.
                    --                       --

                          FROM BULL.GW-24. ; 30= AVG.ANN.WL.
HOBBS WILLIAM E.                             13.0
 FU 140                   FROM BULL.GW-24. ; 30= AVG.ANN.WL.
STANDHARDT FRED                               1.00
```

Appendix D

ALS CHEMEX ANALYSES AND MINERALOGY

Chemex Labs, Inc.
Analytical Chemists * Geochemists * Registered Assayers
994 Glendale Ave., Unit 3, Sparks
Nevada, U.S.A. 89431
PHONE: 775-356-5395 FAX: 775-355-0179

To: EARTH & ATMOSPHERIC SCIENCES
SUNY ALBANY
1400 WASHINGTON AVE.
ALBANY, NEW YORK
12222

A9919903

Comments: ATTN. ARTHUR M. AMBROSINO

CERTIFICATE A9919903

:CO) - EARTH & ATMOSPHERIC SCIENCES
oject: G.S.L
O. # : 45855

imples submitted to our lab in Mississauga, ON.
iis report was printed on 22-JUN-1999.

SAMPLE PREPARATION

HEMEX CODE	NUMBER SAMPLES	DESCRIPTION
299	1	Pulp; prepped on other workorder

ANALYTICAL PROCEDURES

CHEMEX CODE	NUMBER SAMPLES	DESCRIPTION	METHOD	DETECTION LIMIT	UPPER LIMIT
9301	1	Al %: ICP + ICP-MS package	ICP	0.01	25.0
9341	1	Sb ppm: ICP + ICP-MS package	ICP-MS	0.1	1000
9302	1	Ba ppm: ICP + ICP-MS package	ICP	10	10000
9303	1	Be ppm: ICP + ICP-MS package	ICP-MS/ICP	0.05	1000
9304	1	Bi ppm: ICP + ICP-MS package	ICP-MS/ICP	0.01	10000
9305	1	Cd ppm: ICP + ICP-MS package	ICP-MS/ICP	0.02	500
9306	1	Ca %: ICP + ICP-MS package	ICP	0.01	25.0
9307	1	Ce ppm: ICP + ICP-MS package	ICP-MS	0.01	500
9308	1	Cs ppm: ICP + ICP-MS package	ICP-MS	0.05	500
9309	1	Cr ppm: ICP + ICP-MS package	ICP	1	10000
9310	1	Co ppm: ICP + ICP-MS package	ICP-MS/ICP	0.2	10000
9311	1	Cu ppm: ICP + ICP-MS package	ICP	1	10000
9312	1	Ga ppm: ICP + ICP-MS package	ICP-MS	0.1	500
9313	1	Ge ppm: ICP + ICP-MS package	ICP-MS	0.1	500
9315	1	Fe %: ICP + ICP-MS package	ICP	0.01	25.0
9316	1	La ppm: ICP + ICP-MS package	ICP-MS	0.5	500
9317	1	Pb ppm: ICP + ICP-MS package	ICP-MS/ICP	0.5	10000
9318	1	Li ppm: ICP + ICP-MS package	ICP-MS	0.2	500
9319	1	Mg %: ICP + ICP-MS package	ICP	0.01	15.00
9320	1	Mn ppm: ICP + ICP-MS package	ICP	5	10000
9321	1	Mo ppm: ICP + ICP-MS package	ICP	0.2	10000
9322	1	Ni ppm: ICP + ICP-MS package	ICP-MS/ICP	0.2	10000
9323	1	Nb ppm: ICP + ICP-MS package	ICP-MS	0.2	500
9324	1	P ppm: ICP + ICP-MS package	ICP	10	10000
9325	1	K %: ICP + ICP-MS package	ICP	0.01	10.00
9326	1	Rb ppm: ICP + ICP-MS package	ICP-MS	0.2	500
9327	1	Ag ppm: ICP + ICP-MS package	ICP-MS/ICP	0.05	100.0
9328	1	Na %: ICP + ICP-MS package	ICP	0.01	10.00
9329	1	Sr ppm: ICP + ICP-MS package	ICP-MS/ICP	0.2	10000
9330	1	Ta ppm: ICP + ICP-MS package	ICP-MS	0.05	100.0
9331	1	Te ppm: ICP + ICP-MS package	ICP-MS	0.05	500
9332	1	Tl ppm: ICP + ICP-MS package	ICP-MS	0.02	500
9333	1	Th ppm: ICP + ICP-MS package	ICP-MS	0.2	500
9334	1	Ti %: ICP + ICP-MS package	ICP	0.01	10.00
9335	1	W ppm: ICP + ICP-MS package	ICP-MS/ICP	0.1	10000
9336	1	U ppm: ICP + ICP-MS package	ICP-MS	0.2	500
9337	1	V ppm: ICP + ICP-MS package	ICP	1	10000
9338	1	Y ppm: ICP + ICP-MS package	ICP-MS	0.1	500
9339	1	Zn ppm: ICP + ICP-MS package	ICP	2	10000

The results of this assay were based solely upon the content of the sample submitted. Any decision to invest should be made only after the potential investment value of the claim or deposit has been determined based on the results of assays of multiple samples of geologic materials collected by the prospective investor or by a qualified person selected by him/her and based on an evaluation of all engineering data which is available concerning any proposed project

Statement required by Nevada State Law NRS 519

Chemex Labs, Inc.
Analytical Chemists * Geochemists * Registered Assayers
994 Glendale Ave., Unit 3, Sparks
Nevada, U.S.A. 89431
PHONE: 775-356-5395 FAX: 775 355-0179

To: EARTH & ATMOSPHERIC SCIENCES
SUNY ALBANY
1400 WASHINGTON AVE.
ALBANY, NEW YORK
12222

Project : G.S.L
Comments: ATTN: ARTHUR M. AMBROSINO

Page Number : 1-A
Total Pages : 1
Certificate Date: 22-JUN-1999
Invoice No. : 19919903
P.O. Number : 45855
Account : RCO

CERTIFICATE OF ANALYSIS A9919903

SAMPLE	PREP CODE		Al % (ICP)	Sb ppm (ICP)	Ba ppm (ICP)	Be ppm (ICP)	Bi ppm (ICP)	Cd ppm (ICP)	Ca % (ICP)	Ce ppm (ICP)	Cs ppm (ICP)	Cr ppm (ICP)	Co ppm (ICP)	Cu ppm (ICP)	Ga ppm (ICP)	Ge ppm (ICP)
0101500	299	--	7.43	0.1	870	2.95	0.02	0.20	1.36	187.0	0.55	186	7.4	6	21.0	1.4

CERTIFICATION:

Chemex Labs, Inc.

Analytical Chemists * Geochemists * Registered Assayers

994 Glendale Ave., Unit 3, Sparks
Nevada, U.S.A. 89431
PHONE: 775 356-5395 FAX: 775-355-0179

To: EARTH & ATMOSPHERIC SCIENCES
SUNY ALBANY
1400 WASHINGTON AVE.
ALBANY, NEW YORK
12222

Project : G.S.L
Comments: ATTN: ARTHUR M. AMBROSINO

Page Number 1-B
Total Pages 1
Certificate Date: 22-JUN-1999
Invoice No. : I9919903
P.O. Number : 45855
Account :RCO

CERTIFICATE OF ANALYSIS A9919903

SAMPLE	PREP CODE	Fe % (ICP)	La ppm (ICP)	Pb ppm (ICP)	Li ppm (ICP)	Mg % (ICP)	Mn ppm (ICP)	Mo ppm (ICP)	Ni ppm (ICP)	Nb ppm (ICP)	P ppm (ICP)	K % (ICP)	Rb ppm (ICP)	Ag ppm (ICP)	Na % (ICP)
0101500	299 --	2.39	81.0	18.0	24.2	0.53	290	1.2	5.8	8.6	950	3.49	88.6	0.25	2.07

CERTIFICATION:

Chemex Labs, Inc.
Analytical Chemists * Geochemists * Registered Assayers
994 Glendale Ave . Unit 3, Sparks
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Project : G.S.L
Comments: ATTN: ARTHUR M. AMBROSINO

Page Number : 1-C
Total Pages : 1
Certificate Date: 22-JUN 1999
Invoice No. : I9919903
P.O Number : 45855
Account : RCO

CERTIFICATE OF ANALYSIS A9919903

SAMPLE	PREP CODE		Sr ppm (ICP)	Ta ppm (ICP)	Te ppm (ICP)	Tl ppm (ICP)	Th ppm (ICP)	Ti % (ICP)	W ppm (ICP)	U ppm (ICP)	V ppm (ICP)	Y ppm (ICP)	Zn ppm (ICP)			
0101500	299	--	266	0.50	< 0.05	0.50	12.0	0.31	0.7	1.0	37	30.7	66			

CERTIFICATION:

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A9919902

Comments: ATTN: ARTHUR M AMBROSINO

CERTIFICATE A9919902

CO) - EARTH & ATMOSPHERIC SCIENCES
oject: G.S.L
O. # : 45855

mples submitted to our lab in Mississauga, ON.
is report was printed on 24-JUN-1999.

SAMPLE PREPARATION

HEMEX ODE	NUMBER SAMPLES	DESCRIPTION
217	1	Geochem ring entire sample
9300	1	T127 special code

ANALYTICAL PROCEDURES

CHEMEX CODE	NUMBER SAMPLES	DESCRIPTION	METHOD	DETECTION LIMIT	UPPER LIMIT
975	1	Au ppb: ICP-fluorescence package	FA-ICP-AFS	2	10000
976	1	Pt ppb: ICP-Fluorescence package	FA-ICP-AFS	5	10000
977	1	Pd ppb: ICP-fluorescence package	FA-ICP-AFS	2	10000
13	1	As ppm: HNO3-aqua regia digest	AAS-HYDRIDE/EDL	1	10000
20	1	Hg ppb: HNO3-HCl digestion	AAS-FLAMELESS	10	100000

The results of this assay were based solely upon the content of the sample submitted. Any decision to invest should be made only after the potential investment value of the claim or deposit has been determined based on the results of assays of multiple samples of geologic materials collected by the prospective investor or by a qualified person selected by him/her and based on an evaluation of all engineering data which is available concerning any proposed project

Statement required by Nevada State Law NRS 519

Chemex Labs, Inc.

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Project : G.S.L
Comments: ATTN: ARTHUR M. AMBROSINO

Page Number 1
Total Pages 1
Certificate Date 24-JUN-1999
Invoice No. I9919902
P.O. Number 45855
Account RCO

CERTIFICATE OF ANALYSIS A9919902

SAMPLE	PREP CODE	Au ppb AFS	Pt ppb AFS	Pd ppb AFS	As ppm	Hg ppb					
0101500	217 9300	< 2	< 5	< 2	4	< 10					

CERTIFICATION:

Chemex Labs, Inc.
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A9919911

Comments: ATTN: ARTHUR M. AMBROSINO

CERTIFICATE A9919911

CO) - EARTH & ATMOSPHERIC SCIENCES
oject: G.S.L
O. # : 45856

mples submitted to our lab in Mississauga, ON.
is report was printed on 22-JUN-1999.

SAMPLE PREPARATION

HEMEX CODE	NUMBER SAMPLES	DESCRIPTION
299	8	Pulp; prepped on other workorder

ANALYTICAL PROCEDURES

CHEMEX CODE	NUMBER SAMPLES	DESCRIPTION	METHOD	DETECTION LIMIT	UPPER LIMIT
9301	8	Al %: ICP + ICP-MS package	ICP	0.01	25.0
9341	8	Sb ppm: ICP + ICP-MS package	ICP-MS	0.1	1000
9302	8	Ba ppm: ICP + ICP-MS package	ICP	10	10000
9303	8	Be ppm: ICP + ICP-MS package	ICP-MS/ICP	0.05	1000
9304	8	Bi ppm: ICP + ICP-MS package	ICP-MS/ICP	0.01	10000
9305	8	Cd ppm: ICP + ICP-MS package	ICP-MS/ICP	0.02	500
9306	8	Ca %: ICP + ICP-MS package	ICP	0.01	25.0
9307	8	Ce ppm: ICP + ICP-MS package	ICP-MS	0.01	500
9308	8	Cs ppm: ICP + ICP-MS package	ICP-MS	0.05	500
9309	8	Cr ppm: ICP + ICP-MS package	ICP	1	10000
9310	8	Co ppm: ICP + ICP-MS package	ICP-MS/ICP	0.2	10000
9311	8	Cu ppm: ICP + ICP-MS package	ICP	1	10000
9312	8	Ga ppm: ICP + ICP-MS package	ICP-MS	0.1	500
9313	8	Ge ppm: ICP + ICP-MS package	ICP-MS	0.1	500
9315	8	Fe %: ICP + ICP-MS package	ICP	0.01	25.0
9316	8	La ppm: ICP + ICP-MS package	ICP-MS	0.5	500
9317	8	Pb ppm: ICP + ICP-MS package	ICP-MS/ICP	0.5	10000
9318	8	Li ppm: ICP + ICP-MS package	ICP-MS	0.2	500
9319	8	Mg %: ICP + ICP-MS package	ICP	0.01	15.00
9320	8	Mn ppm: ICP + ICP-MS package	ICP	5	10000
9321	8	Mo ppm: ICP + ICP-MS package	ICP	0.2	10000
9322	8	Ni ppm: ICP + ICP-MS package	ICP-MS/ICP	0.2	10000
9323	8	Nb ppm: ICP + ICP-MS package	ICP-MS	0.2	500
9324	8	P ppm: ICP + ICP-MS package	ICP	10	10000
9325	8	K %: ICP + ICP-MS package	ICP	0.01	10.00
9326	8	Rb ppm: ICP + ICP-MS package	ICP-MS	0.2	500
9327	8	Ag ppm: ICP + ICP-MS package	ICP-MS/ICP	0.05	100.0
9328	8	Na %: ICP + ICP-MS package	ICP	0.01	10.00
9329	8	Sr ppm: ICP + ICP-MS package	ICP-MS/ICP	0.2	10000
9330	8	Ta ppm: ICP + ICP-MS package	ICP-MS	0.05	100.0
9331	8	Te ppm: ICP + ICP-MS package	ICP-MS	0.05	500
9332	8	Tl ppm: ICP + ICP-MS package	ICP-MS	0.02	500
9333	8	Th ppm: ICP + ICP-MS package	ICP-MS	0.2	500
9334	8	Ti %: ICP + ICP-MS package	ICP	0.01	10.00
9335	8	W ppm: ICP + ICP-MS package	ICP-MS/ICP	0.1	10000
9336	8	U ppm: ICP + ICP-MS package	ICP-MS	0.2	500
9337	8	V ppm: ICP + ICP-MS package	ICP	1	10000
9338	8	Y ppm: ICP + ICP-MS package	ICP-MS	0.1	500
9339	8	Zn ppm: ICP + ICP-MS package	ICP	2	10000

The results of this assay were based solely upon the content of the sample submitted. Any decision to invest should be made only after the potential investment value of the claim or deposit has been determined based on the results of assays of multiple samples of geologic materials collected by the prospective investor or by a qualified person selected by him/her and based on an evaluation of all engineering data which is available concerning any proposed project Statement required by Nevada State Law NRS 519

Chemex Labs, Inc.
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ALBANY, NEW YORK
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Project : G.S.L
Comments: ATTN: ARTHUR M. AMBROSINO

Page Number : 1-A
Total Pages : 1
Certificate Date: 22-JUN 1999
Invoice No. : I9919911
P.O. Number : 45856
Account : RCO

CERTIFICATE OF ANALYSIS A9919911

SAMPLE	PREP CODE		Al % (ICP)	Sb ppm (ICP)	Ba ppm (ICP)	Be ppm (ICP)	Bi ppm (ICP)	Cd ppm (ICP)	Ca % (ICP)	Ce ppm (ICP)	Cs ppm (ICP)	Cr ppm (ICP)	Co ppm (ICP)	Cu ppm (ICP)	Ga ppm (ICP)	Ge ppm (ICP)
0491832	299	--	6.50	0.3	490	1.55	0.06	0.50	2.12	52.7	0.90	294	12.8	< 1	18.9	1.5
0427995	299	--	5.99	< 0.1	400	0.60	0.01	0.14	1.79	36.2	0.50	273	6.8	4	9.8	0.9
0425579	299	--	6.82	0.1	510	1.40	0.02	0.22	2.40	45.5	0.60	273	8.8	4	17.3	1.2
0482333	299	--	6.61	0.1	490	1.15	0.03	0.36	2.63	56.8	0.55	260	11.6	1	16.9	1.2
0423248	299	--	7.50	0.1	590	1.55	0.03	0.38	2.47	62.0	0.85	166	9.6	1	21.7	1.3
0487092	299	--	5.95	< 0.1	510	0.65	0.01	0.22	1.98	36.4	0.65	163	6.2	3	13.9	1.0
0480509	299	--	6.67	0.1	480	1.30	0.08	0.52	2.18	47.2	0.80	267	12.2	1	18.8	1.4
0480005	299	--	6.28	0.1	460	1.55	0.03	0.38	2.46	44.4	0.70	259	13.2	3	18.5	1.4

CERTIFICATION:

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Project : G.S.L
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Page Number : 1-B
Total Pages : 1
Certificate Date: 22-JUN 1999
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P.O. Number : 45856
Account : RCO

CERTIFICATE OF ANALYSIS A9919911

SAMPLE	PREP CODE		Fe % (ICP)	La ppm (ICP)	Pb ppm (ICP)	Li ppm (ICP)	Mg % (ICP)	Mn ppm (ICP)	Mo ppm (ICP)	Ni ppm (ICP)	Nb ppm (ICP)	P ppm (ICP)	K % (ICP)	Rb ppm (ICP)	Ag ppm (ICP)	Na % (ICP)
0491832	299	--	4.86	21.0	22.0	14.0	0.91	810	2.6	13.0	16.8	670	1.98	68.6	0.50	1.49
0427995	299	--	4.36	18.5	9.5	8.8	0.89	895	1.4	7.8	6.6	420	2.14	45.6	0.10	1.52
0425579	299	--	3.27	20.0	14.0	8.2	0.69	535	2.0	15.6	9.6	600	2.28	71.0	0.25	1.99
0482333	299	--	4.32	23.5	15.5	10.6	0.97	715	2.0	11.4	14.2	740	2.12	65.8	0.50	1.78
0423248	299	--	3.17	25.5	17.0	7.2	0.64	485	1.4	10.6	10.4	880	2.51	78.0	0.50	2.29
0487092	299	--	2.82	16.5	15.0	3.4	0.52	460	1.6	62.7	7.6	460	2.49	66.8	0.25	1.86
0480509	299	--	4.11	19.5	58.0	14.4	0.83	615	2.2	13.4	12.6	420	2.06	70.8	0.30	1.58
0480005	299	--	4.78	18.5	70.5	14.2	1.03	765	2.2	14.6	15.0	300	2.07	72.6	0.30	1.60

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Project : G.S.L
Comments: ATTN: ARTHUR M. AMBROSINO

Page Number : 1-C
Total Pages : 1
Certificate Date: 22-JUN-1999
Invoice No. : I9919911
P.O. Number : 45856
Account : RCO

CERTIFICATE OF ANALYSIS A9919911

SAMPLE	PREP CODE		Sr ppm (ICP)	Ta ppm (ICP)	Te ppm (ICP)	Tl ppm (ICP)	Th ppm (ICP)	Ti % (ICP)	W ppm (ICP)	U ppm (ICP)	V ppm (ICP)	Y ppm (ICP)	Zn ppm (ICP)			
0491832	299	--	216	1.05	< 0.05	0.44	7.4	1.02	1.2	1.2	105	32.2	96			
0427995	299	--	175.0	0.50	< 0.05	0.28	4.8	0.69	0.7	0.6	84	26.6	66			
0425579	299	--	279	0.70	< 0.05	0.42	4.4	0.56	1.0	0.8	62	28.9	52			
0482333	299	--	272	1.25	< 0.05	0.40	5.4	0.86	1.0	1.2	92	33.6	62			
0423248	299	--	301	0.75	< 0.05	0.58	5.4	0.50	0.8	1.2	62	32.7	54			
0487092	299	--	228	0.50	< 0.05	0.42	4.0	0.46	0.7	0.8	51	22.8	46			
0480509	299	--	244	0.70	< 0.05	0.44	5.6	0.79	1.1	1.0	84	27.0	88			
0480005	299	--	247	0.75	< 0.05	0.44	4.8	0.96	0.7	0.8	95	35.4	74			

Chemex Labs, Inc.

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To EARTH & ATMOSPHERIC SCIENCES
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12222

A9919909

Comments: ATTN: ARTHUR M AMBROSINO

CERTIFICATE A9919909

CO) - EARTH & ATMOSPHERIC SCIENCES

oject:	G.S.L
).#:	45856

mples submitted to our lab in Mississauga, ON.
is report was printed on 24-JUN-1999.

SAMPLE PREPARATION

HEMEX CODE	NUMBER SAMPLES	DESCRIPTION
217	8	Geochem ring entire sample
9300	8	T127 special code

ANALYTICAL PROCEDURES

CHEMEX CODE	NUMBER SAMPLES	DESCRIPTION	METHOD	DETECTION LIMIT	UPPER LIMIT
975	8	Au ppb: ICP-fluorescence package	FA-ICP-AFS	2	10000
976	8	Pt ppb: ICP-Fluorescence package	FA-ICP-AFS	5	10000
977	8	Pd ppb: ICP-fluorescence package	FA-ICP-AFS	2	10000
13	8	As ppm: HNO3-aqua regia digest	AAS-HYDRIDE/EDL	1	10000
20	8	Hg ppb: HNO3-HCl digestion	AAS-FLAMELESS	10	100000

The results of this assay were based solely upon the content of the sample submitted. Any decision to invest should be made only after the potential investment value of the claim or deposit has been determined based on the results of assays of multiple samples of geologic materials collected by the prospective investor or by a qualified person selected by him/her and based on an evaluation of all engineering data which is available concerning any proposed project Statement required by Nevada State Law NRS 519

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Project : G.S.L
Comments: ATTN: ARTHUR M. AMBROSINO

Page Number : 1
Total Pages : 1
Certificate Date: 24-JUN-1999
Invoice No. : 19919909
P.O. Number : 45856
Account : RCO

CERTIFICATE OF ANALYSIS A9919909

SAMPLE	PREP CODE	Au ppb AFS	Pt ppb AFS	Pd ppb AFS	As ppm	Hg ppb					
0491832	217 9300	< 2	< 5	< 2	< 1	30					
0427995	217 9300	< 2	< 5	< 2	4	< 10					
0425579	217 9300	< 2	< 5	< 2	1	< 10					
0482333	217 9300	< 2	< 5	< 2	2	< 10					
0423248	217 9300	< 2	< 5	< 2	1	< 10					
0487092	217 9300	< 2	< 5	< 2	5	< 10					
0480509	217 9300	< 2	< 5	< 2	1	30					
0480005	217 9300	< 2	< 5	< 2	< 1	< 10					

CERTIFICATION:

Chemex Labs, Inc.
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A9919907

Comments: ATTN. ARTHUR M. AMBROSINO

CERTIFICATE A9919907

:O) - EARTH & ATMOSPHERIC SCIENCES
ject: G.S.L
). #: 45855

mples submitted to our lab in Mississauga, ON.
ls report was printed on 22-JUN-1999.

SAMPLE PREPARATION

EMEX ODE	NUMBER SAMPLES	DESCRIPTION
299	18	Pulp; prepped on other workorder

ANALYTICAL PROCEDURES

CHEMEX CODE	NUMBER SAMPLES	DESCRIPTION	METHOD	DETECTION LIMIT	UPPER LIMIT
9301	18	Al %: ICP + ICP-MS package	ICP	0.01	25.0
9341	18	Sb ppm: ICP + ICP-MS package	ICP-MS	0.1	1000
9302	18	Ba ppm: ICP + ICP-MS package	ICP	10	10000
9303	18	Be ppm: ICP + ICP-MS package	ICP-MS/ICP	0.05	1000
9304	18	Bi ppm: ICP + ICP-MS package	ICP-MS/ICP	0.01	10000
9305	18	Cd ppm: ICP + ICP-MS package	ICP-MS/ICP	0.02	500
9306	18	Ca %: ICP + ICP-MS package	ICP	0.01	25.0
9307	18	Ce ppm: ICP + ICP-MS package	ICP-MS	0.01	500
9308	18	Cs ppm: ICP + ICP-MS package	ICP-MS	0.05	500
9309	18	Cr ppm: ICP + ICP-MS package	ICP	1	10000
9310	18	Co ppm: ICP + ICP-MS package	ICP-MS/ICP	0.2	10000
9311	18	Cu ppm: ICP + ICP-MS package	ICP	1	10000
9312	18	Ga ppm: ICP + ICP-MS package	ICP-MS	0.1	500
9313	18	Ge ppm: ICP + ICP-MS package	ICP-MS	0.1	500
9315	18	Fe %: ICP + ICP-MS package	ICP	0.01	25.0
9316	18	La ppm: ICP + ICP-MS package	ICP-MS	0.5	500
9317	18	Pb ppm: ICP + ICP-MS package	ICP-MS/ICP	0.5	10000
9318	18	Li ppm: ICP + ICP-MS package	ICP-MS	0.2	500
9319	18	Mg %: ICP + ICP-MS package	ICP	0.01	15.00
9320	18	Mn ppm: ICP + ICP-MS package	ICP	5	10000
9321	18	Mo ppm: ICP + ICP-MS package	ICP	0.2	10000
9322	18	Ni ppm: ICP + ICP-MS package	ICP-MS/ICP	0.2	10000
9323	18	Nb ppm: ICP + ICP-MS package	ICP-MS	0.2	500
9324	18	P ppm: ICP + ICP-MS package	ICP	10	10000
9325	18	K %: ICP + ICP-MS package	ICP	0.01	10.00
9326	18	Rb ppm: ICP + ICP-MS package	ICP-MS	0.2	500
9327	18	Ag ppm: ICP + ICP-MS package	ICP-MS/ICP	0.05	100.0
9328	18	Na %: ICP + ICP-MS package	ICP	0.01	10.00
9329	18	Sr ppm: ICP + ICP-MS package	ICP-MS/ICP	0.2	10000
9330	18	Ta ppm: ICP + ICP-MS package	ICP-MS	0.05	100.0
9331	18	Te ppm: ICP + ICP-MS package	ICP-MS	0.05	500
9332	18	Tl ppm: ICP + ICP-MS package	ICP-MS	0.02	500
9333	18	Th ppm: ICP + ICP-MS package	ICP-MS	0.2	500
9334	18	Ti %: ICP + ICP-MS package	ICP	0.01	10.00
9335	18	W ppm: ICP + ICP-MS package	ICP-MS/ICP	0.1	10000
9336	18	U ppm: ICP + ICP-MS package	ICP-MS	0.2	500
9337	18	V ppm: ICP + ICP-MS package	ICP	1	10000
9338	18	Y ppm: ICP + ICP-MS package	ICP-MS	0.1	500
9339	18	Zn ppm: ICP + ICP-MS package	ICP	2	10000

The results of this assay were based solely upon the content of the sample submitted. Any decision to invest should be made only after the potential investment value of the claim or deposit has been determined based on the results of assays of multiple samples of geologic materials collected by the prospective investor or by a qualified person selected by him/her and based on an evaluation of all engineering data which is available concerning any proposed project **Statement required by Nevada State Law NRS 519**

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ALBANY, NEW YORK
12222

Project : G.S.L
Comments: ATTN: ARTHUR M. AMBROSINO

Page Number : 1-A
Total Pages : 1
Certificate Date: 22-JUN-1999
Invoice No. : 19919907
P.O. Number : 45855
Account : RCO

CERTIFICATE OF ANALYSIS A9919907

SAMPLE	PREP CODE		Al % (ICP)	Sb ppm (ICP)	Ba ppm (ICP)	Be ppm (ICP)	Bi ppm (ICP)	Cd ppm (ICP)	Ca % (ICP)	Ce ppm (ICP)	Cs ppm (ICP)	Cr ppm (ICP)	Co ppm (ICP)	Cu ppm (ICP)	Ga ppm (ICP)	Ge ppm (ICP)
0433040	299	--	7.37	0.2	570	2.65	0.05	0.32	1.61	44.6	1.25	208	9.2	1	20.5	1.4
0467896	299	--	6.57	0.2	500	1.75	0.03	0.22	2.08	45.2	0.65	295	10.0	5	17.5	1.4
0461023	299	--	5.90	0.4	490	2.10	0.04	0.24	1.26	42.5	1.00	324	8.2	6	16.9	1.4
047122140	299	--	6.18	0.1	500	1.65	0.03	0.14	1.56	49.4	0.90	274	7.8	7	17.2	1.3
0497896	299	--	6.26	0.2	580	2.70	0.04	0.34	1.44	65.1	1.30	227	10.0	4	19.6	1.5
0420832	299	--	7.14	0.2	540	1.90	0.04	0.40	1.69	54.8	1.05	214	10.0	1	21.0	1.5
0480923	299	--	7.00	0.1	510	1.30	0.02	0.20	2.42	42.2	0.75	271	11.2	3	18.7	1.4
0420008	299	--	5.75	0.1	340	1.40	0.04	0.56	2.05	69.4	0.55	355	17.2	< 1	17.9	2.0
047176192	299	--	6.64	0.1	570	2.25	0.03	0.26	1.78	66.7	1.00	223	10.8	6	19.5	1.6
0501030	299	--	7.34	0.3	550	2.00	0.03	0.30	2.39	50.1	0.80	275	11.6	6	19.3	1.3
0470418	299	--	6.00	0.1	630	1.75	0.06	0.30	1.92	70.7	0.70	247	9.2	1	19.8	1.5
0483770	299	--	8.57	0.4	670	3.70	0.13	0.26	1.67	122.0	3.65	56	19.4	15	28.3	1.9
0470004	299	--	5.75	0.2	500	1.45	0.04	0.30	1.35	35.4	0.85	366	7.4	7	15.7	1.3
0440006	299	--	7.12	0.3	570	2.00	0.08	0.40	1.65	53.6	1.50	219	11.8	4	20.3	1.4
04892128	299	--	7.27	0.1	570	2.50	0.03	0.36	2.37	60.4	0.90	172	8.6	4	20.0	1.4
0483337	299	--	6.81	0.2	540	1.85	0.06	0.22	2.08	57.6	1.10	244	11.2	8	18.4	1.4
0450012	299	--	6.81	0.1	560	1.90	0.06	0.38	1.63	51.7	1.10	225	8.2	< 1	20.0	1.4
0430006	299	--	7.00	0.2	550	1.55	0.04	0.32	1.94	56.4	1.10	218	11.2	4	19.4	1.4

CERTIFICATION:

Chemex Labs, Inc.
Analytical Chemists * Geochemists * Registered Assayers
994 Glendale Ave., Unit 3, Sparks
Nevada, U.S.A. 89431
PHONE: 775-356-5395 FAX: 775-355-0179

To: EARTH & ATMOSPHERIC SCIENCES
SUNY ALBANY
1400 WASHINGTON AVE.
ALBANY, NEW YORK
12222

Project: G.S.L
Comments: ATTN: ARTHUR M. AMBROSINO

Page Number : 1-B
Total Pages : 1
Certificate Date: 22-JUN-1999
Invoice No. : I9919907
P.O Number : 45855
Account : RCO

CERTIFICATE OF ANALYSIS A9919907

SAMPLE	PREP CODE	Fe % (ICP)	La ppm (ICP)	Pb ppm (ICP)	Li ppm (ICP)	Mg % (ICP)	Mn ppm (ICP)	Mo ppm (ICP)	Ni ppm (ICP)	Nb ppm (ICP)	P ppm (ICP)	K % (ICP)	Rb ppm (ICP)	Ag ppm (ICP)	Na % (ICP)
0433040	299 --	3.23	20.5	17.0	18.0	0.56	430	1.6	11.0	10.6	360	2.49	89.6	0.40	1.75
0467896	299 --	3.43	21.0	14.5	16.6	0.74	565	2.0	11.0	10.4	400	2.27	79.2	0.45	1.74
0461023	299 --	2.93	19.0	17.0	17.8	0.52	455	2.0	10.8	8.4	380	2.45	88.6	0.30	1.38
047122140	299 --	2.54	26.0	15.0	20.8	0.59	330	1.6	11.0	6.0	390	2.56	91.2	0.15	1.71
0497896	299 --	3.54	32.5	17.5	16.6	0.55	565	2.0	10.6	13.6	630	2.71	108.0	0.50	1.59
0420832	299 --	3.17	22.5	17.5	18.0	0.59	545	1.6	11.0	10.8	530	2.35	90.0	0.55	1.78
0480923	299 --	3.23	18.0	42.5	21.0	0.84	500	2.0	12.2	8.2	330	2.27	83.2	0.15	1.76
0420008	299 --	8.52	30.0	13.0	15.0	1.18	1495	3.4	13.6	30.0	380	1.65	57.4	0.75	1.14
047176192	299 --	4.08	34.0	17.0	18.2	0.76	645	3.2	12.0	12.8	750	2.67	92.6	0.45	1.85
0501030	299 --	3.60	19.0	16.0	16.8	0.87	585	2.0	19.4	11.0	580	2.27	79.4	0.40	1.80
0470418	299 --	5.03	29.5	17.0	12.6	0.71	810	2.6	6.8	15.0	1530	2.27	71.4	0.35	1.49
0483770	299 --	4.57	57.5	22.5	38.0	0.94	680	1.0	25.8	14.0	920	3.01	145.5	0.35	1.68
0470004	299 --	2.79	16.0	22.5	13.4	0.51	445	2.2	9.8	8.6	210	2.40	83.2	0.40	1.46
0440006	299 --	3.85	24.0	26.0	22.8	0.71	575	1.8	13.8	10.8	580	2.36	89.2	2.95	1.55
04892128	299 --	3.03	27.0	18.5	11.0	0.60	490	1.6	14.2	10.8	840	2.63	90.0	0.60	2.20
0483337	299 --	3.43	24.5	15.0	19.2	0.79	525	2.8	89.5	9.6	460	2.35	81.6	0.25	1.66
0450012	299 --	3.53	22.5	19.0	15.6	0.54	525	1.8	9.2	12.4	510	2.37	83.4	0.50	1.63
0430006	299 --	3.37	23.5	17.0	13.4	0.68	490	1.8	11.4	11.0	600	2.44	85.6	0.55	1.82

CERTIFICATION:

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Comments: ATTN: ARTHUR M. AMBROSINO

Page Number : 1 C
Total Pages : 1
Certificate Date : 22-JUN-1999
Invoice No : 19919907
P.O. Number : 45855
Account : RCO

CERTIFICATE OF ANALYSIS A9919907

SAMPLE	PREP CODE		Sr ppm (ICP)	Ta ppm (ICP)	Te ppm (ICP)	Tl ppm (ICP)	Th ppm (ICP)	Ti % (ICP)	W ppm (ICP)	U ppm (ICP)	V ppm (ICP)	Y ppm (ICP)	Zn ppm (ICP)			
0433040	299	--	226	0.40	< 0.05	0.52	5.2	0.52	0.8	1.0	61	26.8	58			
0467896	299	--	249	0.50	< 0.05	0.44	5.0	0.60	0.9	0.8	65	31.4	54			
0461023	299	--	167.0	0.55	< 0.05	0.52	5.8	0.41	0.9	0.8	49	24.8	62			
047122140	299	--	203	0.45	< 0.05	0.52	7.0	0.30	0.8	0.8	44	24.2	48			
0497896	299	--	175.0	0.75	< 0.05	0.64	7.0	0.54	1.1	1.4	61	46.5	66			
0420832	299	--	230	0.85	< 0.05	0.52	6.2	0.51	0.8	1.2	61	29.6	60			
0480923	299	--	290	0.50	< 0.05	0.48	4.6	0.56	1.0	0.8	66	23.2	56			
0420008	299	--	153.5	1.75	< 0.05	0.34	11.4	1.98	1.5	1.8	162	76.4	92			
047176192	299	--	226	0.60	< 0.05	0.56	9.4	0.67	0.9	1.4	76	40.9	80			
0501030	299	--	286	1.05	< 0.05	0.46	4.8	0.64	0.9	1.0	74	27.8	70			
0470418	299	--	206	0.85	< 0.05	0.50	3.8	0.84	1.0	0.8	55	40.9	112			
0483770	299	--	228	0.90	< 0.05	0.90	13.4	0.52	0.8	2.0	97	54.7	108			
0470004	299	--	183.5	0.40	< 0.05	0.54	4.6	0.44	1.7	1.0	48	23.2	62			
0440006	299	--	230	0.45	< 0.05	0.60	6.4	0.57	0.9	1.2	75	25.7	88			
04892128	299	--	277	0.55	< 0.05	0.56	6.0	0.51	0.8	1.4	58	35.8	54			
0483337	299	--	251	0.40	< 0.05	0.54	6.0	0.54	1.0	1.0	70	27.2	62			
0450012	299	--	216	0.50	< 0.05	0.54	5.8	0.60	1.0	1.4	65	30.1	58			
0430006	299	--	243	0.50	< 0.05	0.54	6.6	0.55	1.0	1.4	67	29.5	56			

CERTIFICATION:

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A9919904

Comments: ATTN: ARTHUR M. AMBROSINO

CERTIFICATE A9919904

O) - EARTH & ATMOSPHERIC SCIENCES
ject: G.S.L
\# : 45855

mples submitted to our lab in Mississauga, ON.
is report was printed on 24-JUN-1999.

SAMPLE PREPARATION

EMEX ODE	NUMBER SAMPLES	DESCRIPTION
217	18	Geochem ring entire sample
9300	18	T127 special code

ANALYTICAL PROCEDURES

CHEMEX CODE	NUMBER SAMPLES	DESCRIPTION	METHOD	DETECTION LIMIT	UPPER LIMIT
975	18	Au ppb: ICP-fluorescence package	FA-ICP-AFS	2	10000
976	18	Pt ppb: ICP-Fluorescence package	FA-ICP-AFS	5	10000
977	18	Pd ppb: ICP-fluorescence package	FA-ICP-AFS	2	10000
13	18	As ppm: HNO3-aqua regia digest	AAS-HYDRIDE/EDL	1	10000
20	18	Hg ppb: HNO3-HCl digestion	AAS-FLAMELESS	10	100000

The results of this assay were based solely upon the content of the sample submitted. Any decision to invest should be made only after the potential investment value of the claim or deposit has been determined based on the results of assays of multiple samples of geologic materials collected by the prospective investor or by a qualified person selected by him/her and based on an evaluation of all engineering data which is available concerning any proposed project

Statement required by Nevada State Law NRS 519

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ALBANY, NEW YORK
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Project : G.S L
Comments: ATTN: ARTHUR M. AMBROSINO

Page Number : 1
Total Pages : 1
Certificate Date: 24-JUN 1999
Invoice No. : I9919904
P.O. Number : 45855
Account : RCO

CERTIFICATE OF ANALYSIS A9919904

SAMPLE	PREP CODE	Au ppb AFS	Pt ppb AFS	Pd ppb AFS	As ppm	Hg ppb
0433040	2179300	< 2	< 5	< 2	4	30
0467896	2179300	< 2	< 5	12	< 1	< 10
0461023	2179300	< 2	< 5	< 2	1	10
047122140	2179300	< 2	< 5	< 2	2	< 10
0497896	2179300	< 2	< 5	< 2	1	< 10
0420832	2179300	< 2	< 5	< 2	3	30
0480923	2179300	< 2	< 5	< 2	2	< 10
0420008	2179300	< 2	< 5	< 2	4	< 10
047176192	2179300	< 2	< 5	< 2	4	< 10
0501030	2179300	< 2	< 5	< 2	< 1	10
0470418	2179300	< 2	< 5	< 2	< 1	40
0483770	2179300	< 2	< 5	< 2	< 1	< 10
0470004	2179300	< 2	< 5	< 2	1	< 10
0440006	2179300	< 2	< 5	< 2	< 1	40
04892128	2179300	< 2	< 5	< 2	1	< 10
0483337	2179300	< 2	< 5	< 2	1	< 10
0450012	2179300	< 2	< 5	< 2	4	30
0430006	2179300	< 2	< 5	< 2	< 1	< 10

CERTIFICATION:

OVERBURDEN DRILLING MANAGEMENT LIMITED

September 07, 2000

Mr. Arthur M. Ambrosino
Trackside I, Apt. 3C2
Johnstown, NY
U.S.A. 12095

Fax: (514) 442-5825

Dear Mr. Ambrosino:

Re: Heavy Mineral Suite of Estuary Sand Sample AA-01, New York

We have completed our heavy mineral processing of the above composited drill core sample and are pleased to report the results.

We extracted the -2.0 mm heavy minerals using a shaking table followed by a heavy liquid separation at S.G. 3.2 (Table 1), performed a ferromagnetic separation to remove magnetite, and sieved off two nonferromagnetic size fractions — medium (0.25-0.5 mm) and fine (0.125-0.25 mm) sand — for mineral logging. To ensure that we would be able to log all of the minerals accurately, we checked their paramagnetic properties beforehand and analyzed representative grains by energy dispersive x-ray spectrometry (EDS; Table 2) using our scanning electron microscope (SEM). These analyses were done on unpolished grains and, although reliable, were not sufficiently precise to be recorded for publication.

The medium and fine sand sized heavy minerals were found to contain 7.1 and 7.6 weight percent magnetite respectively (Table 1). The percentages of nonferromagnetic minerals were determined by counting grains and are therefore expressed in grain percent of the nonferromagnetic fraction, not weight percent of the total concentrate. The minerals were scattered thinly over a lined plate and 200 contiguous grains were counted along the lines. The minimum count of one grain therefore equals 0.5 percent (Table 3).

The major minerals present are almandine, hornblende, two clinopyroxenes (brown to dark green augite and pale green to colourless diopside), orthopyroxene (dark to pale brown hypersthene, bronzite and enstatite) and ilmenite. Minor minerals occurring at the 0.5-2 percent level are titanite, leucoxene, apatite, zircon and goethite. Only a low trace of epidote was observed and hematite, rutile, kyanite and staurolite are conspicuously absent. The general abundance of pyroxene and ilmenite suggests major inputs from a mafic plutonic terrane. If this is the case, the unexamined 1-2 mm fraction of our heavy mineral concentrate may contain gabbro grains.

The fine sand fraction contains significantly more orthopyroxene (16.5 versus 7 percent) and correspondingly less clinopyroxene (17.5 versus 24.5 percent) than the medium sand fraction (Table 3), possibly because the orthopyroxene occurs in less equant, splintery grains, but the proportions of the other major and minor nonferromagnetic minerals and of magnetite (Table 1) are similar. Therefore it may be assumed that the minerals of the -0.125 mm suite, which are too fine-grained to log, are also similar.

I hope these observations are helpful. Please call me if you have any questions.

Sincerely,

Stuart Averill,
President

Bulk Sample Tabling Weights and Descriptions

Sample Number	Weight (kg)				Sample Description												CLASS
					Clasts >2.0 mm					Matrix <2.0 mm							
						Percentage				Distribution				Colour			
	Bulk Rec'd	Table Split	+2 mm Clasts	Table Feed	SIZE	V/S	GR	LS	OT	S/U	SD	ST	CY	SAND	CLAY	O R G	
AA-01	8.4	8.2	0.2	8.0	P	10	90	0	0	U	+	Y	-	B	B		SILTY SAND

HMC Processing Weights

Sample Number	<2.0 mm Table Concentrate															
	Total	Heavy Liquid Separation S.G 3.20														
			Ferromagnetic Fraction (g)							Nonferromagnetic Fraction (g)						
		Heavy Liquid Lights	Total Mag	<0.125 mm	0.125 to 0.25 mm	Wt % of 0.125 to 0.25 mm HMC	0.25 to 0.5 mm	Wt % of 0.25 to 0.5 mm HMC	0.5-2.0 mm	Total	<0.125 mm (wash)	<0.106 mm	0.125 to 0.25 mm	0.25 to 0.5 mm	0.5 to 1.0 mm	1.0-2.0 mm
AA-01	1276.4	696.6	44.4	17.7	15.2	7.5%	8.3	7.1%	3.2	535.4	38.0	168.1	187.8	108.6	28.3	4.6

Table 1 - Sample weights and descriptions.

No. of Grains	Description	Binocular Microscope I.D.	SEM I.D.
1	Dark green	Augite or diopside	Augite
1	Brown	Augite or orthopyroxene	Augite
1	Beige-white	Clinopyroxene	Augite
3	Colourless, elongate	Kyanite or diopside	Diopside
1	Very pale green	Clinopyroxene	Diopside
5	Brown-orange to brown	Orthopyroxene	Hypersthene-bronzite
2	Pale brown to colourless	Enstatite or epidote	Bronzite-enstatite
1	Orange-brown	Leucoxene or goethite	Goethite
1	Colourless to white	Apatite	Apatite

Table 2 - SEM analyses of representative medium sand grains by EDS.

	0.25-0.5 mm		0.125-0.25 mm	
Mineral	No. of Grains	% of Grains	No. of Grains	% of Grains
Almandine	69	34.5	65	32.5
Hornblende	50	25.0	42	21.0
Augite	28	14.0	18	9.0
Diopside	21	10.5	17	8.5
Orthopyroxene	14	7.0	33	16.5
Ilmenite	13	6.5	21	10.5
Titanite	1	0.5	0	0.0
Leucoxene	0	0.0	1	0.5
Apatite	2	1.0	2	1.0
Zircon	1	0.5	0	0.0
Goethite	1	0.5	1	0.5
	200	100	200	100

Table 3 - 200-grain counts of medium and fine sand size fractions.

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A0025777

Comments: ATTN: ARTHUR M. AMBROSINO CC: ARTHUR M. AMBROSINO

CERTIFICATE A0025777

ICO : EARTH & ATMOSPHERIC SCIENCES
oject G.S.L.
O #

imples submitted to our lab in Sparks, NV.
iis report was printed on 29-SEP-2000.

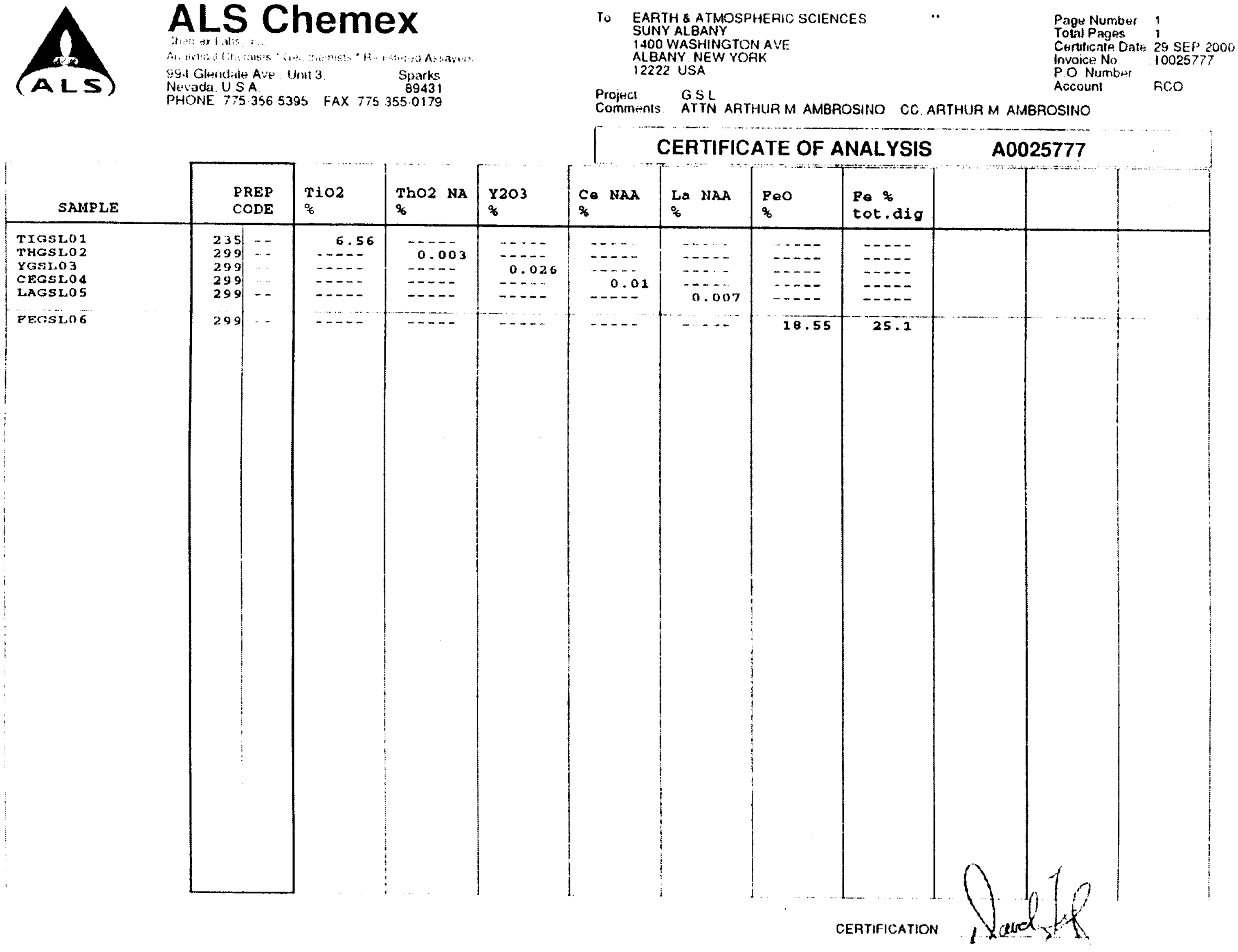
SAMPLE PREPARATION

HEMEX CODE	NUMBER SAMPLES	DESCRIPTION
235	1	Pan con ring to approx 150 mesh
299	5	Pulp; prepped on other workorder

ANALYTICAL PROCEDURES

CHEMEX CODE	NUMBER SAMPLES	DESCRIPTION	METHOD	DETECTION LIMIT	UPPER LIMIT
382	1	TiO2 %: Peroxide fusn-Fe precip	AAS	0.01	100.0
332	1	ThO2 %: Assay	NAA	0.001	100.0
873	1			0.001	100.00
369	1	Ce %: Assay	NAA	0.01	100.0
372	1	La %: Assay	NAA	0.001	100.0
451	1	FeO %: Acid decomposition	TITRATION	0.01	100.0
327	1	Fe %: HClO4-HNO3-HF digestion	AAS	0.01	100.0

The results of this assay were based solely upon the content of the sample submitted. Any decision to invest should be made only after the potential investment value of the claim or deposit has been determined based on the results of assays of multiple samples of geologic materials collected by the prospective investor or by a qualified person selected by him/her and based on an evaluation of all engineering data which is available concerning any proposed project. Statement required by Nevada State Law NRS 519



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Page Number: 1
Total Pages: 1
Certificate Date: 29-SEP-2000
Invoice No.: I0025777
P.O. Number:
Account: RCO

CERTIFICATE OF ANALYSIS A0025777

SAMPLE	PREP CODE		TiO2 %	ThO2 NA %	Y2O3 %	Ce NAA %	La NAA %	FeO %	Fe % tot.dig
TIGSL01	235	--	6.56	-----	-----	-----	-----	-----	-----
THGSL02	299	--	-----	0.003	-----	-----	-----	-----	-----
YGSL03	299	--	-----	-----	0.026	-----	-----	-----	-----
CEGSL04	299	--	-----	-----	-----	0.01	-----	-----	-----
LAGSL05	299	--	-----	-----	-----	-----	0.007	-----	-----
FEGSL06	299	--	-----	-----	-----	-----	-----	18.55	25.1

CERTIFICATION

Test T871 - Sacandaga Lake, New York

SAMPLE:	**T871A** **20101**		**T871B** **20102**		**T871C** **20103**	
Slimes(%)	18.5		7.7		11.1	
THM (%)	8.5		4.1		4.3	
THM d_{50} (µm)	193		190		301	
THM MINERALOGY	Calc.	SEM	Calc	SEM	Calc.	SEM
Titanomag	7.2	1.2	5.9	1.6	5.7	-
Altered Ilmenite		1.2		-		0.8
Ilmenite	16.8	20.8	13.7	14.8	9.4	9.2
Ilm./Silicate/Fe oxide		2.8		1.2		2.0
Rutile	0.3	-	0.4	-	0.3	0.4
Other Ti Minerals	4.7		4.4		3.7	
Zircon	0.6	0.8	0.6	1.2	0.3	0.4
Monazite	0.2	-	0.3	-	0.3	-
Other Heavy Minerals	70.1	73.2	74.7	81.2	80.2	87.2

ILMENITE PRODUCT CHEMISTRY

	Best Mag Fractions	MicroProbe	BMF	MP	BMF	MP
TiO_2	44.11	47.53	42.00	48.00	37.22	47.28
FeT	37.12	39.04	34.94	38.50	33.90	39.26
Al_2O_3	0.68		1.41		2.16	
CaO	0.54	0.03	1.26	0.01	1.65	0.09
MgO	0.74	0.51	0.93	0.44	1.58	0.42
P_2O_5	0.02		0.03		0.08	
MnO	0.79	0.47	0.94	0.58	0.81	0.56
SiO_2	2.81	0.19	6.17	0.28	9.80	0.23
Cr_2O_3	0.04	0.03	0.03	0.03	0.05	0.03
V_2O_5	0.26		0.21		0.24	
ZrO_2	0.02		0.01		0.01	

ILMENITE PRODUCT (Conductor)

As % of conductor fraction	54.8	35.7	31.4
As % of THM	14.6	10.5	7.5
As % of sample	1.2	0.4	0.3

Note: MicroProbe average oxide values for 83, 88 and 66 grains respectively.

Appendix E

RADIOLOGICAL SAFETY DATA

```
EG&G ORTEC G V - I ( 191) WAN32  I4W02.74  07-MAR-00 14:30:38   Page
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U.C.L.A. Radiation Safety        Spectrum name: AN1E202.AN1


 Sample description
      Monsanite Sand Samples; 03/06/2000


 Spectrum Filename: An1E202.An1

 Acquisition information
      Start time           06-Mar-00   10:34:46
      Live time                  3600
      Real time                 3608
      Dead time                 .23%
      Detector/Geometry IDs         0 &         0

 Detector system
      CHS-GAMMA SPEC1 MCB 9


 Calibration
      Filename: An1E202.An1
      Created: 10-Feb-00 15:58:22 & 15-Feb-00 16:20:38
      I-129 Calibration; 10/20/99; charcoal cartridge- 2" from the det
      e
      Zero offset      .797 keV;  Gain       .301 keV/channel

 Library Files
      Main analysis library:          C:\USER\WYCHCTER.LIB

 Analysis parameters
      Start channel             10 for an energy of     3.81keV
      Stop channel            8144 for an energy of  2455.19keV
      Peak rejection level      50.000%
      Activity scaling factor   1.0000E+00/(  3.7000E+04*  1.0000E+00)
                                                           =    2.7027
E-05
      Detection limit method:
           MDA - EG&G ORTEC method

      Additional random error:          1.0000000E+00
      Additional systematic error:      1.0000000E+00
      Background width: average of five points.


 Corrections                                Status        Comments
      Decay correct to date                  YES       15-Feb-00 12:00:00
```

```
      Decay during acquisition           NO
      Peaked background correction  ·    YES        C:\USER\BKG1.Pbc

                                                    14-Jul-99 14:02:21
      Absorption (Internal)              NO
      Geometry correction                NO
      Random summing                     NO



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   2
  U.C.L.A. Radiation Safety       Spectrum name: AN1E202.AN1


  Energy calibration normalized difference:      .1313

  ************ U N I D E N T I F I E D    P E A K    S U M M A R Y ****
 ********
    PEAK CENTROID  BACKGROUND NET AREA  EFFICIENCY  UNCERT   FWHM  SUSPE
 CTED
  CHANNEL    ENERGY    COUNTS      COUNTS    * AREA    1 SIGMA %  keV   NUCL
 IDE
  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
 +-+-+-+
     53.02     16.76       1810.        2035. 6.944E+04     3.70   1.461  -
       D
     64.34     20.17       1702.        1799. 7.238E+04     4.01   1.467  -
       D
   2451.09   739.02        184.        1985. 0.000E+00     2.44   2.394  -
       D
   2578.47   777.39        210.         899. 0.000E+00     4.04   2.419  -
       D

   s Peak fails shape tests.
   D Peak area deconvoluted.

 ----------------------------------------------------------------
  This section based on library: C:\USER\WYCHCTER.LIB


  ************** I D E N T I F I E D   P E A K   S U M M A R Y ********
 ******
  NUCLIDE     PEAK CENTROID  BACKGROUND  NET AREA   INTENSITY   UNCERT
  FWHM
            CHANNEL    ENERGY    COUNTS      COUNTS      CTS/SEC  1 SIGMA %
  keV
  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
 +-+-+-+
```

```
  ZN-65      24.36     8.13         0.        0.     .000     .00
.000D
  BI-207     32.56    10.60         1.        0.     .000     .00
.000D
  PB-214     33.22    10.80      1025.        0.     .000     .00   1
.449D
  PB-210     33.22    10.80         1.        0.     .000  123.29
.000D
  TH-234     41.53    13.30       912.     2881.     .800    2.38   1
.454D
  PA-234     42.52    13.60      3713.      278.     .077   31.60   1
.455D
  Y-88       44.35    14.15      4157.      379.     .105   24.62   1
.456D
  CO-57      45.21    14.41      1343.        0.     .000     .00
.288D
  Y-88       49.83    15.80      4392.      501.     .139   19.25   1
.459D
  SN-113     77.06    24.00      2544.     1073.     .298    7.32   1
.474D
  SN-113     77.76    24.21      3097.      514.     .143   15.95   1
.475D
  SN-113     88.02    27.30      2767.      799.     .222    9.95   1
.481D
  SN-113     90.01    27.90      2868.      672.     .187   11.92   1
.482D
  CS-137    103.03    31.82      2542.      845.     .235    9.11   1
.489D
  CS-137    104.26    32.19      3062.      308.     .086   26.05   1
.490D
  CS-137    118.24    36.40      2467.      836.     .232    9.09   1
.498D
  EU-152    128.61    39.52      2950.      359.     .100   22.05   1
.504D
  BI-212    129.73    39.86      3314.        0.     .000     .00   1
.504D
  EU-152    130.60    40.12      3065.      319.     .089   25.17   1
.505D
  EU-155    137.87    42.31      1726.        0.     .000     .00
.778D
  EU-154    137.87    42.31       674.        0.     .000  162.12
.417D
  EU-155    140.16    43.00      1105.        0.     .000     .00
.513D
  EU-154    140.16    43.00      1105.        0.     .000  318.02
.513D
  EU-155    147.80    45.30      1994.        0.     .000     .00
.000D
  EU-152    148.13    45.40      3326.      283.     .079   29.38   1
.514D
  PB-210    151.85    46.52      3724.        0.     .000     .00   1
.517D
```

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 EU-152     152.12     46.60       3469.         255.         .071     33.21    1
.517D

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 U.C.L.A. Radiation Safety        Spectrum name: AN1E202.AN1


 Nuclide  Channel     Energy  Background  Net area Cnts/sec    Uncert  FWH
M
 EU-155    159.09     48.70       3085.          0.      .000       .00
.277D
 EU-154    159.09     48.70       2635.          0.      .000    372.03
.000D
 EU-154    163.41     50.00       3695.        149.      .041     58.34    1
.523D
 PB-214    174.04     53.20       3270.         19.      .005    422.44    1
.529D
 EU-155    196.65     60.01       5078.          0.      .000       .00    1
.145D
 PA-234    207.25     63.20       4528.          0.      .000       .00    1
.547
 TH-234    208.35     63.53       2819.        115.      .032     62.53
.692s
 TL-208    239.13     72.80       6538.        725.      .201     16.20    1
.565D
 BI-207    239.13     72.80       1854.          0.      .000     44.84
.478D
 PB-214    245.81     74.81       8074.        148.      .041     86.30    1
.568D
 PB-212    245.81     74.81       5239.          0.      .000  10736.27
.727D
 TL-208    246.34     74.97       6811.       1373.      .381      8.92    1
.569D
 BI-207    246.34     74.97       5199.          0.      .000  10790.98
.447D
 PB-214    253.44     77.11       6128.        158.      .044     70.32    1
.572D
 PB-212    253.44     77.11       2558.          0.      .000    491.34
.000D
 TL-208    278.98     84.80       5501.        573.      .159     18.78    1
.586D
 BI-207    278.98     84.80       1767.          0.      .000     68.70
.314D
 EU-155    284.46     86.45       6921.         17.      .005    674.48    1
.589D
 PB-214    286.95     87.20       6148.        287.      .080     39.02    1
.591D
 PB-212    286.95     87.20       4190.          0.      .000    299.61
.247D
```

```
  BI-207    287.28    87.30     4549.      0.    .000     .00
 .217D
  PB-214    295.59    89.80     6197.    129.    .036   86.67   1
 .595D
  PB-212    295.59    89.80     1091.      0.    .000   49.66
 .156D
  U-235     296.12    89.96     2113.      0.    .000     .00
 .245D
  TH-234    304.16    92.38     6127.    106.    .029  104.74   1
 .600D
  TH-234    305.55    92.80     6013.    231.    .064   47.91   1
 .601D
  U-235     307.38    93.35     3993.      0.    .000     .00
 .497D
  PA-234    311.76    94.67     6158.     64.    .018  173.00   1
 .604D
  PA-234    324.28    98.44     5718.     58.    .016  184.25   1
 .611D
  AC-228    327.63    99.45     5720.      0.    .000     .00   1
 .612D
  PA-234    328.46    99.70     5679.      0.    .000     .00   1
 .613D
  U-235     346.07   105.00     1977.      0.    .000     .00
 .000D
  EU-155    347.10   105.31     5495.    122.    .034   86.63   1
 .623D
  U-235     359.81   109.14     1255.      0.    .000     .00
 .000D
  PA-234    365.99   111.00     5600.    101.    .028  104.87   1
 .633D
  PA-234    377.61   114.50     5198.     98.    .027  104.95   1
 .639D
  EU-152    401.79   121.78     4001.      9.    .003  962.13   1
 .651D
  CO-57     402.75   122.07     4010.      0.    .000     .00   1
 .652D
  EU-154    406.17   123.10     5062.     39.    .011  256.91   1
 .654D
  PA-234    413.48   125.30     4688.      0.    .000     .00   1
 .657D
  AC-228    426.10   129.10     4801.      0.    .000     .00   1
 .664D
  PA-234    433.34   131.28     4393.     60.    .017  156.81   1
 .668D
  CO-57     450.44   136.43     4205.      0.    .000     .00   1
 .676D
  FE-59     471.10   142.65     4212.     48.    .013  192.96   1
 .687D
  U-235     474.78   143.76     3170.      0.    .000     .00
 .000D
  PA-234    496.00   150.15     2874.     98.    .027   92.28
 .000s
```

```
  U-235      545.11    164.94       3414.        231.       .064     51.01
 .372s
  U-235      614.12    185.72       1269.         13.       .004    375.20    1
 .758D


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  U.C.L.A. Radiation Safety       Spectrum name: AN1E202.AN1


  Nuclide  Channel    Energy  Background  Net area Cnts/sec    Uncert  FWH
 M
  RA-226    615.02    185.99       1408.         0.       .000       .00    1
 .759D
  PA-234    615.05    186.00       1116.         0.       .000    223.58
 .000D
  FE-59     636.11    192.34       2019.       106.       .029     60.68    1
 .769D
  PA-234    664.20    200.80       1342.         0.       .000       .00    1
 .782D
  U-235     668.58    202.12       1783.        24.       .007    250.65    1
 .785D
  PA-234    671.17    202.90       2108.        53.       .015    122.21    1
 .786D
  U-235     679.18    205.31       2249.        10.       .003    650.38    1
 .790D
  AC-228    692.76    209.40       2126.       123.       .034     53.82    1
 .796D
  PA-234    750.77    226.87       1306.        26.       .007    235.23
 .290D
  PA-234    750.77    226.87       1320.         0.       .000    342.39
 .000D
  PB-212    789.82    238.63       1718.       422.       .117     14.72    1
 .841D
  RA-224    797.69    241.00       2030.        30.       .008    210.26    1
 .845D
  PB-214    800.74    241.92       1728.       113.       .031     52.96    1
 .846D
  EU-152    809.88    244.67       1713.         6.       .002    928.67    1
 .851D
  EU-154    821.07    248.04       1632.        14.       .004    403.50    1
 .856D
  PA-234    823.92    248.90       1615.        40.       .011    143.11    1
 .857D
  SN-113    844.31    255.04       1210.        34.       .009    146.92    1
 .866D
  AC-228    894.98    270.30       1357.        50.       .014    104.80    1
 .889D
  PA-234    900.96    272.10       1355.        26.       .007    199.97    1
 .892D
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  TL-208     918.42    277.36      1114.       43.      .012   111.40   1
 .899D
  PA-234     972.68    293.70       759.       25.      .007   159.80   1
 .923D
  PB-214     977.73    295.22       960.       86.      .024    52.07   1
 .925D
  PB-212     993.90    300.09       878.       52.      .015    81.16   1
 .932D
  CR-51     1055.46    318.63      1034.       93.      .026    73.27   1
 .108s
  AC-228    1088.00    328.43       128.        2.      .001   403.70
 .000s
  AC-228    1121.10    338.40       774.      134.      .037    30.66   1
 .985D
  EU-152    1140.69    344.30       907.       35.      .010   124.24   1
 .993D
  PB-214    1165.03    351.63       952.      308.      .086    23.51   1
 .613
  PA-234    1224.70    369.60       760.       61.      .017    65.46   2
 .027D
  PA-234    1233.33    372.20       744.       25.      .007   156.39   2
 .030D
  SN-113    1301.51    392.74       553.       70.      .019    63.51
 .652s
  AC-228    1356.84    409.40       718.       55.      .015    70.23   2
 .078D
  EU-152    1362.45    411.09       659.       25.      .007   148.44   2
 .080D
  EU-152    1468.55    443.05       272.       37.      .010    65.15
 .550s
  PA-234    1520.19    458.60       368.       20.      .005   139.96   2
 .137D
  AC-228    1534.80    463.00       639.       51.      .014    70.91   2
 .142D
  CS-134    1570.95    473.89       267.        0.      .000  2310.84
 .253s
  PA-234    1680.22    506.80       707.       51.      .014    75.30   2
 .190D
  TL-208    1693.23    510.72       665.      212.      .059    18.52   2
 .195D
  PA-234    1702.79    513.60       726.       50.      .014    77.83   2
 .198D
  PA-234    1726.03    520.60       617.        0.      .000      .00   2
 .205D
  PA-234    1727.36    521.00       524.       59.      .016    56.45   2
 .205D
  CS-134    1867.65    563.26       427.       10.      .003   286.50   2
 .248D
  PA-234    1878.41    566.50       501.       22.      .006   145.02   2
 .252D
  PA-234    1885.71    568.70       518.       19.      .005   167.38   2
 .254D
```

```
 PA-234    1887.57    569.26        549.          0.       .000        .00   2
.254D
 PA-234    1887.57    569.26         64.          0.       .000     661.21
.000D
 CS-134    1887.67    569.29        549.          0.       .000        .00   2
.254D


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 U.C.L.A. Radiation Safety       Spectrum name: AN1E202.AN1


 Nuclide  Channel    Energy  Background  Net area Cnts/sec   Uncert  FWH
M
 BI-207    1888.93    569.67        580.          0.       .000        .00   2
.255D
 PA-234    1903.31    574.00        323.         13.       .004     196.94   2
.259D
 TL-208    1933.65    583.14        462.        188.       .052      17.76   2
.268D
 EU-154    1962.07    591.70        273.         16.       .004     150.60   2
.276D
 PA-234    1998.92    602.80        268.          7.       .002     329.98   2
.286D
 CS-134    2005.09    604.66        407.          9.       .003     302.35   2
.287D
 BI-214    2020.56    609.32        392.        198.       .055      15.79   2
.292D
 PA-234    2065.25    622.78        196.         39.       .011      62.17
.348s
 PA-234    2166.23    653.20        380.         20.       .006     137.15   2
.330D
 CS-137    2194.18    661.62        359.         19.       .005     140.61   2
.337D
 PA-234    2204.07    664.60        395.          2.       .000    1596.98   2
.339D
 BI-214    2206.89    665.45        380.          0.       .000        .00   2
.340D
 PA-234    2211.04    666.70        380.         20.       .006     138.66   2
.341D
 PA-234    2221.33    669.80        223.         16.       .005     130.34   2
.343D
 PA-234    2296.68    692.50        305.         21.       .006     119.13   2
.361D
 EU-154    2296.68    692.50        112.          0.       .000     127.81
.550D
 PA-234    2318.59    699.10        343.         40.       .011      67.68   2
.366D
 NB-94     2329.88    702.50        319.         38.       .011      68.70   2
.368D
```

```
 PA-234    2717.90   819.40      176.        13.      .004   151.59   2
.444D
 PA-234    2735.49   824.70      182.        20.      .006    98.93   2
.446D
 PA-234    2740.80   826.30      183.         0.      .000      .00   2
.447D
 PA-234    2756.74   831.10      138.        10.      .003   168.08   2
.450D


 EG&G ORTEC G V - I ( 191) WAN32  I4W02.74  07-MAR-00 14:30:38   Page
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 U.C.L.A. Radiation Safety        Spectrum name: AN1E202.AN1


 Nuclide   Channel   Energy  Background  Net area Cnts/sec   Uncert  FWH
M
 MN-54     2769.05   834.81      123.         0.      .000      .00   2
.452D
 AC-228    2771.67   835.60       93.         9.      .002   157.88   2
.452D
 MN-56     2808.18   846.60      105.         0.      .000      .00   2
.458
 CO-56     2805.00   845.64       27.         6.      .002   102.85
.000s
 TL-208    2854.22   860.47      126.        23.      .006    71.73   2
.465D
 EU-152    2877.19   867.39      149.        15.      .004   117.11   2
.468D
 NB-94     2889.50   871.10      144.         0.      .000      .00   2
.470D
 EU-154    2896.47   873.20      145.         0.      .000      .00   2
.471D
 PA-234    2908.09   876.70      140.        11.      .003   158.70   2
.472D
 PA-234    2920.73   880.51      159.         0.      .000      .00   2
.474D
 PA-234    2920.73   880.51       35.         0.      .000   357.07
.000D
 PA-234    2929.79   883.24      135.        21.      .006    81.00   2
.475D
 SC-46     2949.77   889.26       56.         0.      .000      .00
.407D
 Y-88      2978.85   898.02      128.        13.      .004   123.37   2
.481D
 PA-234    2980.77   898.60      125.         0.      .000      .00   2
.481D
 AC-228    3020.85   910.68      109.       165.      .046    16.42   2
.051
 PA-234    3067.06   924.60       94.        10.      .003   146.25   2
.492D
```

```
  PA-234   3074.03   926.70      131.        7.     .002   240.84   2
 .492D
  BI-214   3098.43   934.05      124.       35.     .010    47.36   2
 .495D
  PA-234   3136.67   945.57       76.       29.     .008    61.47
 .502s
  PA-234   3148.04   949.00       90.        0.     .000      .00   2
 .500
  EU-152   3197.83   964.00      113.        0.     .000      .00   2
 .505D
  AC-228   3199.82   964.60      127.       18.     .005    91.98   2
 .505D
  AC-228   3214.09   968.90      127.       92.     .025    20.28   2
 .506D
  CO-56    3242.50   977.46       86.        0.     .000      .00
 .368D
  PA-234   3246.94   978.80      122.        7.     .002   238.01   2
 .509D
  PA-234   3252.58   980.50      129.        2.     .001   868.99   2
 .509D
  PA-234   3262.21   983.40      104.       12.     .003   125.87   2
 .510D
  EU-154   3305.02   996.30       62.        7.     .002   167.90   2
 .514D
  EU-154   3333.23  1004.80      119.       21.     .006    76.02   2
 .516D
  CO-56    3442.84  1037.83       29.        0.     .000      .00
 .645D
  CS-134   3443.50  1038.03        8.        0.     .000      .00
 .316s
  BI-207   3523.81  1062.23       41.        6.     .002   164.58
 .404s
  RB-86    3571.60  1076.63       82.       14.     .004    98.29   2
 .528D
  EU-152   3602.04  1085.80       99.       24.     .007    62.72   2
 .529D
  EU-152   3615.38  1089.82      110.       26.     .007    60.23   2
 .529D
  FE-59    3646.57  1099.22       63.       11.     .003   110.19   2
 .530D
  EU-152   3689.21  1112.07       89.       20.     .005    71.36   2
 .531D
  ZN-65    3700.66  1115.52      133.        0.     .000      .00   2
 .531D
  BI-214   3716.45  1120.28       97.       77.     .021    21.44   2
 .531D
  SC-46    3717.25  1120.52      167.        0.     .000      .00   2
 .531D
  BI-214   3835.05  1156.02       47.       17.     .005    68.52
 .262s
  CS-134   3871.65  1167.05       76.       45.     .013    44.03
 .514s
```

```
 CO-60     3892.16   1173.23          86.          0.         .000        .00
.301D
 CO-56     3898.46   1175.13          70.          0.         .000        .00
.306D
 EU-152    4025.92   1213.54          76.         14.         .004     124.29
.510s
 BI-214    4107.44   1238.11         121.         40.         .011      42.23    2
.523D
 CO-56     4108.01   1238.28          76.          0.         .000        .00
.252D


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 Nuclide   Channel    Energy  Background  Net area Cnts/sec   Uncert  FWH
M
 NA-22     4228.32   1274.54          43.          0.         .000        .00   2
.516D
 EU-154    4229.18   1274.80          41.          9.         .002     109.19   2
.516D
 BI-214    4249.62   1280.96          74.         13.         .003     101.32   2
.515D
 FE-59     4284.79   1291.56          58.         14.         .004      83.95   2
.512D
 EU-152    4310.11   1299.19          53.         15.         .004      73.37   2
.510D
 CO-60     4415.33   1330.90          54.         39.         .011      48.85   1
.078s
 PA-234    4488.64   1353.00          45.         19.         .005      54.11   2
.493D
 CO-56     4512.60   1360.22           6.          0.         .000        .00
.497D
 CS-134    4528.89   1365.13          33.         10.         .003      84.75   2
.489D
 NA-24     4540.24   1368.55          45.          9.         .003     107.68   2
.488D
 BI-214    4570.43   1377.65          34.         27.         .008      35.84   2
.484D
 PA-234    4625.00   1394.10          25.          7.         .002     116.30   2
.477D
 EU-154    4637.28   1397.80          38.          6.         .002     144.67   2
.476D
 BI-214    4649.55   1401.50          32.         19.         .005      46.62   2
.474D
 BI-214    4671.05   1407.98          22.         26.         .007      31.78   2
.471D
 EU-152    4671.38   1408.08          47.          0.         .000        .00   2
.471D
```

```
  PA-234    4819.09   1452.60          21.          3.        .001    264.09   2
 .449D
  AC-228    4840.98   1459.20        1036.        127.        .035     37.01   2
 .446D
  K-40      4846.12   1460.75         210.        973.        .270      3.83   2
 .445D
  AC-228    4954.90   1493.54           7.         40.        .011     24.05
 .362s
  BI-214    5016.44   1512.09           0.         34.        .009     17.15
 .452s
  AC-228    5283.55   1592.61          21.         40.        .011     34.19
 .442s
  EU-154    5299.79   1597.50           3.          6.        .002     56.68
 .407s
  BI-212    5377.64   1620.97           4.         30.        .008     25.07
 .435s
  AC-228    5408.19   1630.18           4.         13.        .004     38.31
 .420s
  BI-214    5511.34   1661.28           4.          2.        .001    136.31   2
 .303D
  PA-234    5535.29   1668.50           8.          9.        .003     53.56   2
 .296D
  PA-234    5617.29   1693.22           0.         14.        .004     26.73
 .377s
  BI-214    5735.94   1728.99           2.         23.        .006     25.41   1
 .271s
  BI-214    5852.31   1764.08           7.         66.        .018     14.71   1
 .006s
  BI-207    5872.68   1770.22           3.          0.        .000       .00
 .362D
  CO-56     5876.90   1771.49           3.          0.        .000       .00
 .374D
  MN-56     6008.60   1811.20           1.          0.        .000       .00
 .302s
  Y-88      6091.00   1836.04           1.          0.        .000     87.18
 .241s
  BI-214    6126.93   1846.88           8.          9.        .002     65.50
 .480s
  CO-56     6684.00   2014.85           0.          1.        .000     95.92
 .129s
  CO-56     6748.00   2034.15           0.          2.        .001     70.71
 .302s
  MN-56     7008.13   2112.60           2.          0.        .000       .00
 .559D
  BI-214    7023.00   2117.08           1.          1.        .000    141.42
 .257s
  BI-214    7314.32   2204.94          10.          2.        .001    232.70
 .309s
  BI-214    8118.00   2447.35          12.          2.        .001    281.07
 .000s

  s Peak fails shape tests.
```

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 D Peak area deconvoluted.


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 *****   S U M M A R Y   O F   L I B R A R Y   P E A K   U S A G E   **
***
 NUCLIDE       AVERAGE      ------------- PEAK ---------------
               ACTIVITY   ENERGY    ACTIVITY CODE     MDA VALUE
              microCi       keV    microCi         microCi       COMMENTS
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
+-+-+-+


 NA-22     0.00000E+00    1274.54    0.000E+00 !(    0.0000E+00   9.50E+02
9.99E+01

 NA-24     0.00000E+00    1368.55    0.000E+00 %     0.0000E+00   6.26E-01
1.00E+02
                          2754.10    0.000E+00 =     0.0000E+00

9.98E+01

 K-40      0.00000E+00    1460.75    0.000E+00  (    0.0000E+00   4.68E+11
1.07E+01

 SC-46     0.00000E+00    1120.52    0.000E+00 !(    0.0000E+00   8.38E+01
1.00E+02
                           889.26    0.000E+00 &(    0.0000E+00

1.00E+02

 CR-51     0.00000E+00     320.07    0.000E+00 &     0.0000E+00   2.77E+01
9.83E+00

 MN-54     0.00000E+00     834.81    0.000E+00 !(    0.0000E+00   3.12E+02
1.00E+02

 MN-56     0.00000E+00     846.60    0.000E+00  (    0.0000E+00   1.07E-01
9.90E+01
                          1811.20    0.000E+00 %     0.0000E+00

2.72E+01
                          2112.60    0.000E+00 ?(    0.0000E+00

1.43E+01

 FE-59     0.00000E+00    1099.22    0.000E+00 %     0.0000E+00   4.51E+01
5.65E+01
                          1291.56    0.000E+00 %     0.0000E+00

4.32E+01
                           192.34    0.000E+00 %     0.0000E+00
```

```
 3.11E+00
                            142.65   0.000E+00 %    0.0000E+00
 1.03E+00

  CO-56    0.00000E+00      846.75   0.000E+00 %    0.0000E+00  7.73E+01
 1.00E+02
                           1238.28   0.000E+00 ?    0.0000E+00
 6.76E+01
                           2598.58   0.000E+00 =    0.0000E+00
 1.69E+01
                           1771.49   0.000E+00 ?    0.0000E+00
 1.57E+01
                           1037.83   0.000E+00 ?    0.0000E+00
 1.40E+01
                           2034.92   0.000E+00 %    0.0000E+00
 7.89E+00
                           3253.64   0.000E+00 =    0.0000E+00
 7.41E+00
                           1360.22   0.000E+00 ?    0.0000E+00
 4.33E+00
                           2015.36   0.000E+00 %    0.0000E+00
 3.08E+00
                           3202.30   0.000E+00 =    0.0000E+00
 3.04E+00
                           1175.13   0.000E+00 ?    0.0000E+00
 2.28E+00
                           3273.19   0.000E+00 =    0.0000E+00
 1.75E+00
                            977.46   0.000E+00 ?    0.0000E+00
 1.44E+00
                           3010.20   0.000E+00 =    0.0000E+00
 1.00E+00

  CO-57    0.00000E+00      122.07   0.000E+00 !(   0.0000E+00  2.70E+02
 8.56E+01
                            136.43   0.000E+00 !(   0.0000E+00
 1.06E+01
                             14.41   0.000E+00 ?(   2.5799E-04
 9.50E+00

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  Nuclide  Ave activity   Energy   Activity  Code Peak MDA  Comments


  CO-58    0.00000E+00      810.75   0.000E+00 %    0.0000E+00  7.08E+01
 9.94E+01
```

```
  CO-60    0.00000E+00    1332.51    0.000E+00 &(    0.0000E+00   1.93E+03
 1.00E+02
                          1173.23    0.000E+00 ?(    0.0000E+00

 9.99E+01

  ZN-65    0.00000E+00    1115.52    0.000E+00 !(    0.0000E+00   2.44E+02
 5.08E+01
                             8.13    0.000E+00 ?(    1.9134E-06

 3.87E+01

  RB-86    0.00000E+00    1076.63    0.000E+00 %     0.0000E+00   1.86E+01
 8.76E+00

  Y-88     0.00000E+00    1836.01    0.000E+00 %     0.0000E+00   1.07E+02
 9.94E+01
                           898.02    0.000E+00 %     0.0000E+00

 9.40E+01
                            14.15    1.656E-04       8.4177E-05

 5.25E+01
                            15.80    1.414E-03       5.6452E-04

 8.70E+00

  NB-94    0.00000E+00     871.10    0.000E+00 !(    0.0000E+00   7.41E+06
 1.00E+02
                           702.50    0.000E+00 %     0.0000E+00

 1.00E+02

  NB-95    0.00000E+00     765.82    0.000E+00  (    0.0000E+00   3.52E+01
 9.90E+01

  SN-113   0.00000E+00     391.71    0.000E+00 %     0.0000E+00   1.15E+02
 6.42E+01
                            24.21    5.050E-04       1.6907E-04

 3.90E+01
                            24.00    1.959E-03       3.1440E-04

 2.07E+01
                            27.30    3.508E-03       7.5013E-04

 1.10E+01
                            27.90    1.626E-02       4.1225E-03

 2.10E+00
                           255.04    0.000E+00 %     0.0000E+00

 2.07E+00

  CS-134   0.00000E+00     604.66    0.000E+00 %     0.0000E+00   7.53E+02
 9.76E+01
                           795.76    0.000E+00 %     0.0000E+00

 8.54E+01
                           569.29    0.000E+00 !     0.0000E+00

 1.54E+01
                           801.84    0.000E+00 !     0.0000E+00

 8.73E+00
```

```
                             563.26   0.000E+00 %    0.0000E+00
 8.38E+00
                            1365.13   0.000E+00 %    0.0000E+00
 3.04E+00
                            1167.86   0.000E+00 ?    0.0000E+00
 1.80E+00
                             475.35   0.000E+00 &    0.0000E+00
 1.46E+00
                            1038.50   0.000E+00 %    0.0000E+00
 1.00E+00

  CS-137   0.00000E+00       661.62   0.000E+00 %    0.0000E+00  1.10E+04
 8.46E+01
                              32.19   6.810E-03      3.6768E-03
 3.70E+00
                              31.82   3.423E-02      6.7480E-03
 1.92E+00
                              36.40   6.601E-02      1.2997E-02
 1.04E+00

  EU-152   7.38047E-04        40.12   7.380E-04  (   3.6687E-04  4.64E+03
 3.00E+01
                             121.78   0.000E+00 %    0.0000E+00
 2.92E+01
                             344.30   0.000E+00 %    0.0000E+00
 2.70E+01
                            1408.08   0.000E+00 -    0.0000E+00
 2.12E+01
                              39.52   1.596E-03 +    7.3273E-04
 1.60E+01

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 Nuclide  Ave activity   Energy    Activity  Code Peak MDA  Comments

                             964.00   0.000E+00 -    0.0000E+00
 1.46E+01
                            1112.07   0.000E+00 %    0.0000E+00
 1.36E+01
                             778.90   0.000E+00 %    0.0000E+00
 1.30E+01
                            1085.80   0.000E+00 %    0.0000E+00
 1.03E+01
                              45.40   1.791E-03 +    1.0865E-03
 9.00E+00
                             244.67   0.000E+00 %    0.0000E+00
 7.62E+00
```

```
                         867.39   0.000E+00 %    0.0000E+00
 4.18E+00
                         444.00   0.000E+00 %    0.0000E+00
 2.84E+00
                         411.09   0.000E+00 %    0.0000E+00
 2.26E+00
                          46.60   6.644E-03 +    4.5427E-03
 2.10E+00
                        1089.82   0.000E+00 %    0.0000E+00
 1.72E+00
                        1299.19   0.000E+00 %    0.0000E+00
 1.71E+00
                        1212.89   0.000E+00 %    0.0000E+00
 1.45E+00

  EU-154   0.00000E+00   123.10   0.000E+00 %    0.0000E+00  3.10E+03
 4.05E+01
                        1274.80   0.000E+00 %    0.0000E+00
 3.55E+01
                         723.30   0.000E+00 %    0.0000E+00
 1.97E+01
                        1004.80   0.000E+00 %    0.0000E+00
 1.76E+01
                          43.00   0.000E+00 %    4.5412E-04 Energy dup
 lication
                         873.20   0.000E+00 !    0.0000E+00
 1.13E+01
                         996.30   0.000E+00 %    0.0000E+00
 1.07E+01
                          42.31   0.000E+00 %    6.5748E-04 Energy dup
 lication
                         248.04   0.000E+00 %    0.0000E+00
 6.60E+00
                         591.70   0.000E+00 %    0.0000E+00
 4.60E+00
                          48.70   0.000E+00 %    1.7911E-03 Energy dup
 lication
                         756.70   0.000E+00 %    0.0000E+00
 4.10E+00
                        1597.30   0.000E+00 %    0.0000E+00
 1.70E+00
                         692.50   0.000E+00 %    0.0000E+00 Energy dup
 lication
                        1397.80   0.000E+00 %    0.0000E+00
 1.60E+00
                          50.00   0.000E+00 %    8.7175E-03
 1.00E+00

  EU-155   0.00000E+00    86.45   0.000E+00 %    1.7177E-04  1.81E+03
 3.27E+01
                         105.31   0.000E+00 %    0.0000E+00
 2.18E+01
```

```
                              43.00    0.000E+00 ?     4.6009E-04 Energy dup
lication
                              42.31    0.000E+00 ?     1.1056E-03 Energy dup
lication
                              48.70    0.000E+00 ?     2.0873E-03 Energy dup
lication
                              45.30    0.000E+00 ?     5.4037E-03
1.36E+00
                              60.01    0.000E+00 !     6.3765E-03
1.21E+00

 TL-208    0.00000E+00       583.14    0.000E+00  (    0.0000E+00  2.15E-03
8.60E+01
                             510.72    0.000E+00  (    0.0000E+00
2.25E+01
                             860.47    0.000E+00 %     0.0000E+00
1.20E+01
                             277.36    0.000E+00 %     0.0000E+00
6.50E+00
                              74.97    1.110E-02 +     2.0843E-03 Energy dup
lication
                              72.80    1.065E-02 +     3.5695E-03 Energy dup
lication
                             763.30    0.000E+00 !(    0.0000E+00
1.70E+00
                              84.80    1.157E-02 +     4.4931E-03 Energy dup
lication


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 Nuclide  Ave activity   Energy    Activity  Code Peak MDA  Comments


 PB-210   0.00000E+00     10.80    0.000E+00 %    4.7401E-06  7.45E+03
2.43E+01
                          46.52    0.000E+00 !    2.3912E-03
4.00E+00

 PB-212   0.00000E+00    238.63    0.000E+00  (   0.0000E+00  4.43E-01
4.31E+01
                          77.11    0.000E+00 %    2.2626E-04 Energy dup
lication
                          74.81    0.000E+00 %    6.1086E-04 Energy dup
lication
                          87.20    0.000E+00 %    6.8807E-04 Energy dup
lication
                         300.09    0.000E+00 %    0.0000E+00
```

```
3.27E+00
                         89.80   0.000E+00 ?(   1.2324E-03 Energy dup
lication

 PB-214   0.00000E+00   351.99   0.000E+00 ?(   0.0000E+00  1.86E-02
3.71E+01
                        295.22   0.000E+00 %    0.0000E+00
1.92E+01
                         10.80   0.000E+00 !(   1.3785E-04 Energy dup
lication
                         77.11   0.000E+00 %    5.7718E-04 Energy dup
lication
                        241.92   0.000E+00 %    0.0000E+00
7.47E+00
                         74.81   0.000E+00 %    1.1583E-03 Energy dup
lication
                         87.20   1.819E-03 +    1.4489E-03 Energy dup
lication
                         53.20   0.000E+00 %    6.7038E-03
1.10E+00
                        785.95   0.000E+00 !(   0.0000E+00
1.09E+00
                         89.80   0.000E+00 %    4.9786E-03 Energy dup
lication

 BI-207   0.00000E+00   569.67   0.000E+00 !(   0.0000E+00  1.39E+04
9.80E+01
                       1063.62   0.000E+00 &    0.0000E+00
7.70E+01
                         74.97   0.000E+00 %    1.5093E-04 Energy dup
lication
                         10.60   0.000E+00 ?(   3.1394E-06
3.50E+01
                         72.80   0.000E+00 ?(   1.5808E-04 Energy dup
lication
                         84.80   0.000E+00 %    2.0935E-04 Energy dup
lication
                       1770.22   0.000E+00 ?(   0.0000E+00
7.00E+00
                         87.30   0.000E+00 ?(   1.1271E-03
4.00E+00

 BI-212   0.00000E+00   727.17   0.000E+00 %    0.0000E+00  4.20E-02
1.18E+01
                       1620.56   0.000E+00 ?    0.0000E+00
2.75E+00
                        785.42   0.000E+00 !    0.0000E+00
2.00E+00
                         39.86   0.000E+00 !    1.0513E-02
1.10E+00

 BI-214   0.00000E+00   609.32   0.000E+00  (   0.0000E+00  1.38E-02
```

```
4.61E+01
                          1764.51   0.000E+00  (    0.0000E+00
1.59E+01
                          1120.28   0.000E+00  (    0.0000E+00
1.50E+01
                          1238.11   0.000E+00  (    0.0000E+00
5.92E+00
                          2204.12   0.000E+00 &     0.0000E+00
4.99E+00
                           768.36   0.000E+00  (    0.0000E+00
4.89E+00
                          1377.65   0.000E+00  (    0.0000E+00
4.02E+00
                           934.05   0.000E+00  (    0.0000E+00
3.16E+00
                          1729.60   0.000E+00 ?(    0.0000E+00
3.05E+00
                          1407.98   0.000E+00  (    0.0000E+00
2.48E+00
                          1509.19   0.000E+00 &(    0.0000E+00
2.19E+00
                          1847.44   0.000E+00 %     0.0000E+00
2.12E+00

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 Nuclide  Ave activity    Energy    Activity  Code Peak MDA  Comments

                          1155.19   0.000E+00 %     0.0000E+00
1.69E+00
                           665.45   0.000E+00 !(    0.0000E+00
1.56E+00
                          2447.71   0.000E+00 %     0.0000E+00
1.55E+00
                          1280.96   0.000E+00 %     0.0000E+00
1.47E+00
                          1401.50   0.000E+00  (    0.0000E+00
1.39E+00
                           806.17   0.000E+00 !(    0.0000E+00
1.23E+00
                          2118.54   0.000E+00 &     0.0000E+00
1.21E+00
                          1661.28   0.000E+00 %     0.0000E+00
1.15E+00

 RA-224   0.00000E+00      241.00   0.000E+00 %     0.0000E+00   3.66E+00
3.90E+00
```

```
 RA-226   0.00000E+00      185.99    0.000E+00 !(    0.0000E+00   5.84E+05
3.28E+00

 AC-228   0.00000E+00      911.07    0.000E+00  (    0.0000E+00   2.55E-01
2.90E+01
                           968.90    0.000E+00  (    0.0000E+00
1.75E+01
                           338.40    0.000E+00  (    0.0000E+00
1.20E+01
                           964.60    0.000E+00 %     0.0000E+00
5.45E+00
                           794.80    0.000E+00 !(    0.0000E+00
4.84E+00
                           463.00    0.000E+00 %     0.0000E+00
4.64E+00
                           209.40    0.000E+00 %     0.0000E+00
4.55E+00
                           270.30    0.000E+00 %     0.0000E+00
3.77E+00
                          1587.90    0.000E+00 &(    0.0000E+00
3.71E+00
                           328.00    0.000E+00 %     0.0000E+00
3.36E+00
                           129.10    0.000E+00 !(    0.0000E+00
2.93E+00
                           409.40    0.000E+00 %     0.0000E+00
2.23E+00
                          1630.40    0.000E+00 ?(    0.0000E+00
1.95E+00
                           835.60    0.000E+00 %     0.0000E+00
1.82E+00
                           772.10    0.000E+00 %     0.0000E+00
1.62E+00
                            99.45    0.000E+00 !(    3.1646E-03
1.36E+00
                           755.20    0.000E+00 !(    0.0000E+00
1.10E+00
                          1495.80    0.000E+00 &(    0.0000E+00
1.05E+00
                          1459.20    0.000E+00  (    0.0000E+00
1.04E+00

 TH-234   6.52686E-03       13.30    6.527E-03  (    1.9815E-04   2.41E+01
9.80E+00
                            63.29    0.000E+00 %     1.4047E-03
3.90E+00
                            92.80    1.672E-03 -     1.6318E-03
3.00E+00
                            92.38    0.000E+00 %     1.9137E-03
2.57E+00
```

```
 PA-234   5.47395E-05       13.60   5.474E-05  (    3.4359E-05  2.79E-01
1.14E+02
                            98.44   0.000E+00 %    1.7480E-04
2.51E+01
                           946.00   0.000E+00 %    0.0000E+00
2.00E+01
                           131.28   0.000E+00 %    0.0000E+00
2.00E+01
                            94.67   0.000E+00 %    3.0778E-04
1.55E+01
                           883.24   0.000E+00 %    0.0000E+00
1.20E+01
                           926.70   0.000E+00 %    0.0000E+00
1.10E+01
                           569.26   0.000E+00 %    0.0000E+00 Energy dup
lication
                           111.00   0.000E+00 %    0.0000E+00
8.55E+00
                           733.00   0.000E+00 %    0.0000E+00
8.50E+00

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 U.C.L.A. Radiation Safety       Spectrum name: AN1E202.AN1


 Nuclide  Ave activity   Energy    Activity  Code Peak MDA  Comments

                           949.00   0.000E+00 -    0.0000E+00
7.80E+00
                           152.70   0.000E+00 &    0.0000E+00
7.20E+00
                           880.51   0.000E+00 %    0.0000E+00 Energy dup
lication
                           226.87   0.000E+00 &    0.0000E+00 Energy dup
lication
                           831.10   0.000E+00 %    0.0000E+00
5.60E+00
                           808.10   0.000E+00 -    0.0000E+00
4.90E+00
                            99.70   0.000E+00 -    9.1173E-04
4.70E+00
                           699.10   0.000E+00 %    0.0000E+00
4.60E+00
                           880.51   0.000E+00 -    0.0000E+00 Energy dup
lication
                           898.60   0.000E+00 -    0.0000E+00
4.00E+00
                          1394.10   0.000E+00 %    0.0000E+00
3.90E+00
```

```
                        226.87   0.000E+00 &     0.0000E+00 Energy dup
  lication
                        824.70   0.000E+00 %     0.0000E+00
  3.60E+00
                        796.20   0.000E+00 -     0.0000E+00
  3.40E+00
                        805.50   0.000E+00 %     0.0000E+00
  3.30E+00
                        826.30   0.000E+00 -     0.0000E+00
  3.20E+00
                        706.00   0.000E+00 %     0.0000E+00
  3.20E+00
                        293.70   0.000E+00 %     0.0000E+00
  3.20E+00
                        114.50   0.000E+00 %     0.0000E+00
  3.15E+00
                        569.26   0.000E+00 -     0.0000E+00 Energy dup
  lication
                        248.90   0.000E+00 %     0.0000E+00
  3.10E+00
                         63.20   0.000E+00 -     2.1941E-03
  3.10E+00
                        742.81   0.000E+00 %     0.0000E+00
  3.00E+00
                        568.70   0.000E+00 %     0.0000E+00
  3.00E+00
                        924.60   0.000E+00 %     0.0000E+00
  2.80E+00
                        369.60   0.000E+00 %     0.0000E+00
  2.80E+00
                        876.70   0.000E+00 %     0.0000E+00
  2.70E+00
                        983.40   0.000E+00 %     0.0000E+00
  2.40E+00
                        980.50   0.000E+00 %     0.0000E+00
  2.20E+00
                        819.40   0.000E+00 %     0.0000E+00
  2.20E+00
                        574.00   0.000E+00 %     0.0000E+00
  2.00E+00
                        186.00   0.000E+00 &     0.0000E+00 Energy dup
  lication
                       1353.00   0.000E+00 %     0.0000E+00
  1.70E+00
                        566.50   0.000E+00 %     0.0000E+00
  1.70E+00
                        786.27   0.000E+00 %     0.0000E+00
  1.60E+00
                        780.80   0.000E+00 -     0.0000E+00
  1.60E+00
                        793.60   0.000E+00 %     0.0000E+00
  1.50E+00
```

```
                         669.80   0.000E+00 %    0.0000E+00
1.50E+00
                         666.70   0.000E+00 %    0.0000E+00
1.50E+00
                         664.60   0.000E+00 %    0.0000E+00
1.50E+00
                         458.60   0.000E+00 %    0.0000E+00
1.50E+00
                         372.20   0.000E+00 %    0.0000E+00
1.50E+00
                         978.80   0.000E+00 %    0.0000E+00
1.40E+00
                         754.80   0.000E+00 %    0.0000E+00
1.40E+00
                         506.80   0.000E+00 %    0.0000E+00
1.40E+00
                        1694.00   0.000E+00 -    0.0000E+00
1.30E+00
                         692.50   0.000E+00 %    0.0000E+00 Energy dup
lication
                         653.20   0.000E+00 %    0.0000E+00
1.30E+00

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 U.C.L.A. Radiation Safety       Spectrum name: AN1E202.AN1


 Nuclide  Ave activity   Energy    Activity  Code Peak MDA  Comments

                         602.80   0.000E+00 %    0.0000E+00
1.30E+00
                        1452.60   0.000E+00 %    0.0000E+00
1.20E+00
                         521.00   0.000E+00 %    0.0000E+00
1.20E+00
                         520.60   0.000E+00 -    0.0000E+00
1.20E+00
                         513.60   0.000E+00 %    0.0000E+00
1.20E+00
                         272.10   0.000E+00 %    0.0000E+00
1.20E+00
                         202.90   0.000E+00 %    0.0000E+00
1.10E+00
                         125.30   0.000E+00 -    0.0000E+00
1.10E+00
                         200.80   0.000E+00 -    0.0000E+00
1.08E+00
                        1668.50   0.000E+00 %    0.0000E+00
1.06E+00
```

```
                            623.50    0.000E+00 %    0.0000E+00
1.00E+00

 U-235    0.00000E+00       185.72    0.000E+00 %    0.0000E+00   1.39E+09
5.40E+01
                            143.76    0.000E+00 &    0.0000E+00
1.05E+01
                            205.31    0.000E+00 %    0.0000E+00
4.70E+00
                            163.35    0.000E+00 &    0.0000E+00
4.70E+00
                             93.35    0.000E+00 ?    1.5583E-03
2.50E+00
                            109.14    0.000E+00 ?    0.0000E+00
1.50E+00
                             89.96    0.000E+00 ?    1.9844E-03
1.50E+00
                            202.12    0.000E+00 %    0.0000E+00
1.00E+00
                            105.00    0.000E+00 &    0.0000E+00
1.00E+00
   ( - This peak used in the nuclide activity average.

   * - Peak is too wide, but only one peak in library.
   ! - Peak is part of a multiplet and this area went
       negative during deconvolution.
   ? - Peak is too narrow.
   @ - Peak is too wide at FW25M, but ok at FWHM.
   % - Peak fails sensitivity test.
   $ - Peak identified, but first peak of this nuclide
       failed one or more qualification tests.
   + - Peak activity higher than counting uncertainty range.
   - - Peak activity lower than counting uncertainty range.
   = - Peak outside analysis energy range.
   & - Calculated peak centroid is not close enough to the
       library energy centroid for positive identification.
   P - Peakbackground subtraction

 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

 *****   S U M M A R Y   O F   N U C L I D E S   I N   S A M P L E   **
***
           TIME OF COUNT  TIME CORRECTED  UNCERTAINTY  1 SIGMA
 NUCLIDE      ACTIVITY       ACTIVITY        COUNTING      TOTAL

               uCi/grams      uCi/grams

 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
+-+-+-+
 NA-22    <      0.00E+00      0.00E+00
 NA-24    <      0.00E+00 >12 HALFLIVES
 K-40     <      0.00E+00      0.00E+00
```

```
SC-46    <       0.00E+00        0.00E+00
CR-51    <       0.00E+00        0.00E+00
MN-54    <       0.00E+00        0.00E+00


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U.C.L.A. Radiation Safety       Spectrum name: AN1E202.AN1

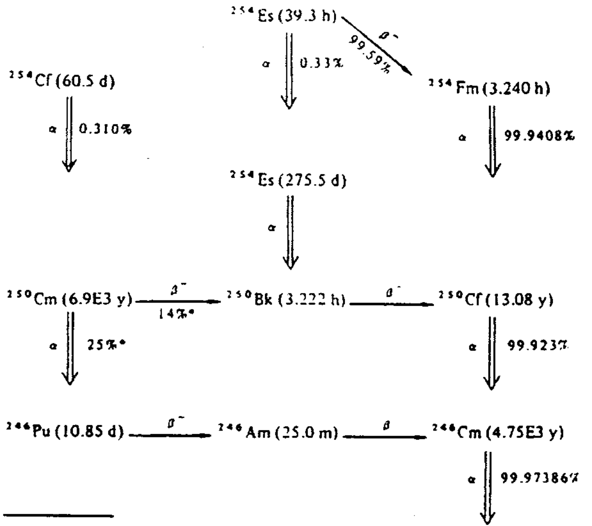


MN-56    <       0.00E+00 >12 HALFLIVES
FE-59    <       0.00E+00        0.00E+00
CO-56    <       0.00E+00        0.00E+00
CO-57    <       0.00E+00        0.00E+00
CO-58    <       0.00E+00        0.00E+00
CO-60    <       0.00E+00        0.00E+00
ZN-65    <       0.00E+00        0.00E+00
RB-86    <       0.00E+00        0.00E+00
Y-88     <       0.00E+00        0.00E+00
NB-94    <       0.00E+00        0.00E+00
NB-95    <       0.00E+00        0.00E+00
SN-113   <       0.00E+00        0.00E+00
CS-134   <       0.00E+00        0.00E+00
CS-137   <       0.00E+00        0.00E+00
EU-152         1:9947E-08    2.0007E-08         25.17%          25.30%
EU-154   <       0.00E+00        0.00E+00
EU-155   <       4.64E-09        4.68E-09
TL-208   <       0.00E+00 >12 HALFLIVES
PB-210   <       1.28E-10        1.28E-10
PB-212   <       0.00E+00 >12 HALFLIVES
PB-214   <       0.00E+00 >12 HALFLIVES
BI-207   <       0.00E+00        0.00E+00
BI-212   <       0.00E+00 >12 HALFLIVES
BI-214   <       0.00E+00 >12 HALFLIVES
RA-224   <       0.00E+00        0.00E+00
RA-226   <       0.00E+00        0.00E+00
AC-228   <       0.00E+00 >12 HALFLIVES
TH-234         1.7640E-07    3.1303E-07          2.38%           3.48%
PA-234         1.4794E-09 >12 HALFLIVES         31.60%          31.70%
U-235    <       0.00E+00        0.00E+00
-----------------------------  S U M M A R Y  ----------------------
------
TOTAL ACTIVITY (    3.8 to  2455.2 keV) 3.3303310E-07  uCi/grams


The library has energies which are not separable.

Analyzed by: ________________________________________
                    MFH
```

Uranium Series



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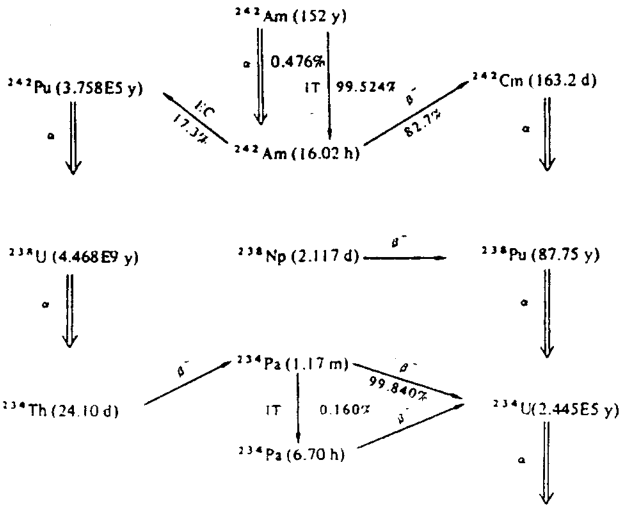
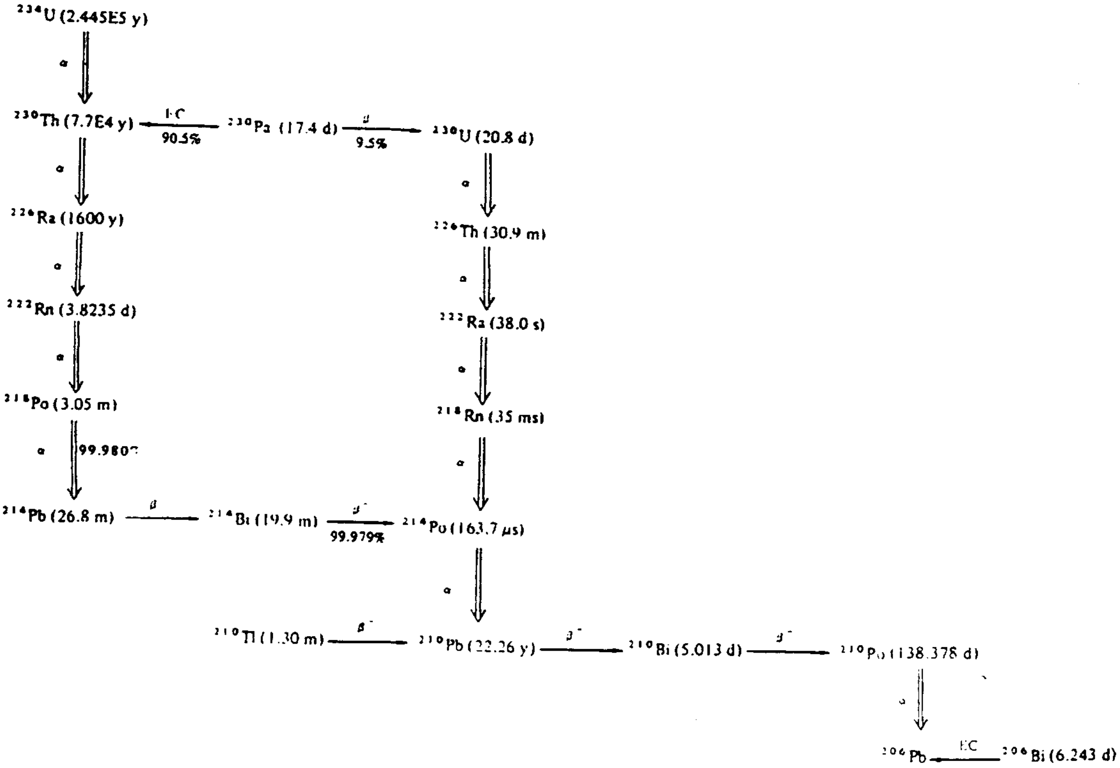
*Branching ratio based on systematics: decay has not been deserved.



(continued)



DIAGRAMS OF RADIOACTIVE DECAY CHAINS