INNOVATIVE METHODOLOGY FOR DETECTION
OF
FRACTURE-CONTROLLED SWEET SPOTS
IN THE
NORTHERN APPALACHIAN BASIN
SEMI-ANNUAL TECHNICAL PROGRESS REPORT

June 1, 2003-December 31, 2003

Dr. Robert Jacobi, Principal Author

February 20, 2004

DE-AC26-00NT40698

CONTRACTOR:

Research Foundation of State University of New York
P. O. Box 9
Albany, New York 12201
on behalf of:
University at Buffalo
The State University of New York
Suite 211, The UB Commons
520 Lee Entrance
Amherst, New York 14228

Dr. Robert Jacobi, Project Director
Dr. John Fountain, Co-Principal Investigator

Mr. Stuart Loewenstein, President, Subcontractor
Quest Energy, Inc.
63 Kenmore Ave.
Amherst, NY 14226

Dr. Bruce Hart, Subcontractor
McGill Seismic Research Group
McGill University
Montreal, QC, CANADA H3A 2A7

Dr. Edward deRidder, Subcontractor
Pearson, deRidder and Johnson, Inc.
12640 West Cedar Drive, Suite 100
Lakewood, CO 80228

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any other agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

ABSTRACT

The primary goal was to enter Phase 2 by analyzing geophysical logs and sidewall cores from a verification well drilled into the Trenton/Black River section along lineaments. However, the well has not yet been drilled; Phase 2 has therefore not been accomplished. Secondary goals, not dependent upon well drilling, were completed. In the structure task, the objectives for this reporting period were to: 1) add additional sites along the west side of Cayuga Lake where we had critical gaps in our data set, and 2) complete analyses of structure data along the west side of Cayuga Lake. We have completed data input and analyses for this goal, and discuss the results.

The additional data from the 2003 field season (and additional revised data from the previous season) demonstrate that zones of closely-spaced NNW- and N-striking fractures (FIDs) occur west of Cayuga Lake. EarthSat (1997) did not recognize NNW- or N-striking Landsat lineaments in this area. Packets of E-and ENE-striking EarthSat (1997) lineaments coincide with FIDs observed in outcrop, but the bedrock FIDs are significantly more numerous than the lineaments. West of Cayuga Lake, NE-striking EarthSat (1997) were not confirmed by FIDs. It appears that Landsat lineaments (EarthSat, 1997) indicate parts of the structural fabric, but the groundtruthing reveals added significant complexity. The E-striking lineaments and FIDs are related to Alleghanian folds and faults (e.g., Firtree Anticline), and the ENE-striking lineaments and FIDs are probably related to reactivated Trenton/Black River faults.

ASTER images, with an order of magnitude higher resolution than Landsat, are presently being analyzed for lineaments. The lineament patterns are more complex than the Landsat lineaments, and include a number of trends not observed in the Landsat data (EarthSat, 1997). These trends include NS, NNW and NNE.

These data continue to demonstrate that integration of aeromagnetic and remote sensing lineaments, surface structure, soil gas and seismic allows us to extrapolate Trenton-Black River trends away from confirmatory seismic lines.

EXECUTIVE SUMMARY

The primary goal for this reporting period was to enter Phase 2 by analyzing geophysical logs and sidewall cores from a verification well drilled into the Trenton/Black River section along lineaments. However, the well has not yet been drilled; Phase 2 has therefore not been accomplished. Secondary goals, not dependent upon well drilling, were completed. In the structure task, the objectives for this reporting period were to: 1) add additional sites along the west side of Cayuga Lake where we had critical gaps in our data set, and 2) complete analyses of structure data along the west side of Cayuga Lake. We have completed data input and analyses for this goal, and discuss the results below.

In order to better ascertain possible spatial relations between fracture intensification domains (FIDs) and Landsat lineaments (as portrayed by EarthSat, 1997), we analyzed each site for the presence of FIDs (defined as > 4 fractures/ m) in the Cayuga Lake area. After eliminating sites without FIDs, the FID data for each site were displayed on the Northern, Central, and Southern combined lineament and FID rose diagram maps as well as in detailed insets.

In the Northern Combined map, the predominate FID trend is NNW, but Earthsat (1997) recognized no NNW-striking Landsat lineaments in that area. In contrast, our analyses of DEMs and traditional topographic map inspection both show prominent NNW trends. The character of the NNW-striking fractures are similar to the Alleghanian cross-strike fractures of Engelder and Geiser (1980), and probably are not release fractures caused by relatively recent processes such as glacial stress removal. A second trend of FIDs not reflected in EarthSat (1997) lineaments for the Northern Combined map area is a NS trend.

The predominate Landsat lineament trend is ENE in the Northern Combined map. The ENE-trending lineaments are coincident with sites that displayed ENE-striking FIDs, but we found additional zones of ENE-striking FIDs that do not have companion EarthSat (1997) lineaments. These additional FID zones suggest that the Landsat lineaments of EarthSat (1997), though indicating the structural trends, cannot be used as a precise one-to-one indication of where FIDs are to be expected. Abutting relationships indicate that some ENE-striking fractures predate the cross-strike fractures, while other ENE-striking fractures may be contemporaneous with the cross-strike fractures and FIDs (or may have developed when the cross-strike fractures were "tight"). In other regions, the ENE-striking FIDs postdate the cross-strike fractures. This range of relative ages is consistent with the observations on seismic lines that some of the Trenton/Black River faults have been multiply-reactivated.

The Northern Combined map also includes one EarthSat (1997) lineament that trends approximately EW. This lineaments does not have a counterpart in outcrop FIDs. The relatively low number of E-striking lineaments in the Northern Combined map is consistent, however, with the relatively low number of E-striking FIDs. Thus, although the specific E-striking FIDs in outcrop are not reflected in specific EarthSat (1997) lineaments (and vice versa), the regional structural grain indicated by the lineaments.

In the Central Combined map, the same FID trends occur that are found in the Northern Combined map area. The NNW- and N-striking FIDs have no counterpart in EarthSat (1997)

lineaments. One NNW-striking FID displayed dextral offset of ENE-striking FIDs.

In the Central Combined map most ENE and NE-striking Landsat lineaments (EarthSat, 1997) are not coincident with similarly-trending FIDs—even though the lineaments pass across outcrops. In contrast, some of the E-striking lineaments in the Central Combined map occur where outcrop FIDs confirm the trends. In some cases, the E-striking lineaments do not pass directly across sites with E-striking FIDs, but outcropping FIDs are located close to the EarthSat (1997) lineaments. Thus, although the specific location of the E-striking lineaments may not be confirmed by FIDs in outcrop, the regional E-striking structural grain in this area is confirmed by both lineaments and FIDs. In this region the E-striking FIDs post-date the Alleghanian cross-strike fractures, and (as discussed in previous reports) the E-striking FIDs in this region are spatially associated with the Alleghanian Firtree anticline.

In the Southern Combined Map area, the dominant FID trend is NNW; most NNW-striking FIDs have no EarthSat (1997) lineament counterpart. Although some ENE-striking FIDs are on-strike with ENE-striking EarthSat (1997) lineaments, additional ENE-striking FIDs were recognized where no Landsat lineaments were identified. None of the E-striking FIDs in this map area are represented by E-striking Earthsat lineaments.

In summary, the greatest number of FIDs trend NNW, parallel to the general Cayuga lakeshore. No Earthsat (1997) NNW-striking lineaments were proposed in this region. The ubiquity of the NNW-striking FIDs may indicate that the general lake outline follows a NNW-striking fault system. N-striking FIDs also occur in the study area, and are prevalent in the Central Combined Map area. Although no N-striking EarthSat (1997) lineaments were recognized in the study area, the N-striking FIDs in the eastern part of the Central Combined Map are on strike with lineaments to the north. Probable N-striking faults are indicated.

Packets of E-and ENE-striking EarthSat (1997) lineaments coincide with FIDs observed in outcrop, but the bedrock FIDs are significantly more numerous than the lineaments. As discussed in previous reports, the E-striking lineaments and FIDs in the Central Combined Map are related to the E-striking Firtree Anticline, and the ENE-striking lineaments may be related to older Iapetan-opening fault trends that were reactivated., many during Trenton/Black River time. It appears that Landsat lineaments (EarthSat, 1997) indicate parts of the structural fabric, but the groundtruthing reveals added significant complexity.

ASTER images, with an order of magnitude higher resolution than Landsat, are presently being analyzed for lineaments. The lineament patterns are more complex than the Landsat lineaments, and include a number of trends not observed in the Landsat data (EarthSat, 1997). These trends include NS, NNW and NNE.

These data continue to demonstrate that integration of aeromagnetic and remote sensing lineaments, surface structure, soil gas and seismic allows us to extrapolate Trenton-Black River trends away from confirmatory seismic lines.

TABLE OF CONTENTS

	page
DISCLAIMER	1
ABSTRACT	2
EXECUTIVE SUMMARY	3
LIST OF GRAPHICAL MATERIALS	6
1.0 INTRODUCTION	7
2.0 EXPERIMENTAL	9
2.1 FRACTURE ANALYSES SUBTASK	9
2.2 STRATIGRAPHY/WELL LOG ANALYSES SUBTASK	9
2.3 LINEAMENTS SUBTASK	10
2.4 SOIL GAS ANALYSES	10
2.5 SEISMIC DATA ACQUISITION, REPROCESSING, AND INTERPRETATION	11
2.6 ADVANCED SEISMIC ANALYSES	11
2.7 AEROMAGNETIC SURVEY AND ANALYSES	12
2.8 DRILLING AND TESTING OF VERIFICATION WELL	12
3.0 RESULTS AND DISCUSSION	14
3.1 FRACTURE ANALYSES SUBTASK	14
3.2 STRATIGRAPHY/WELL LOG ANALYSES SUBTASK	17
3.3 LINEAMENTS SUBTASK	17
3.4 SOIL GAS ANALYSES	17
3.5 SEISMIC DATA ACQUISITION, REPROCESSING, AND INTERPRETATION	17
3.6 ADVANCED SEISMIC ANALYSES	18
3.7 AEROMAGNETIC SURVEY AND ANALYSES	18
3.8 DRILLING AND TESTING OF VERIFICATION WELL	18
4.0 CONCLUSIONS	19
FIGURE CAPTIONS	20
APPENDIX A. UTM COORDINATES FOR SITES	Appendix A - 1

LIST OF GRAPHICAL MATERIALS

- FIGURE 3.1-1. Inset location map for the Cayuga Lake transect.
FIGURE 3.1-2. Northern Combined FID and Lineament Map.
FIGURE 3.1-3. Central Combined FID and Lineament Map.
FIGURE 3.1-4. Southern Combined FID and Lineament Map.
FIGURE 3.1-5. Explanation for the lower semi-circle on the rose diagrams.
FIGURE 3.1-6. Inset A display of FIDs.
FIGURE 3.1-7. Inset B display of FIDs.
FIGURE 3.1-8. Inset C display of FIDs.
FIGURE 3.1-9. Inset D display of FIDs.
FIGURE 3.1-10. Inset E display of FIDs.
FIGURE 3.1-11. Inset F display of FIDs.
FIGURE 3.1-12. Inset G display of FIDs.
FIGURE 3.1-13. Inset H display of FIDs.
FIGURE 3.1-14. Inset I display of FIDs.
FIGURE 3.1-15. Inset J display of FIDs.
FIGURE 3.1-16. Inset K display of FIDs.
FIGURE 3.1-17. Inset L display of FIDs.
FIGURE 3.1-18. Inset M display of FIDs.
FIGURE 3.1-19. Inset N display of FIDs.
FIGURE 3.1-20. Inset O display of FIDs.
FIGURE 3.1-21. Inset P display of FIDs.
FIGURE 3.1-22. Inset Q display of FIDs.
FIGURE 3.1-23. Inset R display of FIDs.
FIGURE 3.1-24. Inset S display of FIDs.
FIGURE 3.1-25. Inset T display of FIDs.
FIGURE 3.3-1. ASTER image of region surrounding Seneca and Cayuga lakes.
FIGURE 3.3-2. Preliminary lineaments from ASTER image at small magnification.
FIGURE 3.3-3. Southern portion of ASTER image at intermediate magnification.
FIGURE 3.3-4. Preliminary lineaments from intermediate magnification ASTER image.
FIGURE 3.3-5. South-central portion of ASTER image at high magnification.
FIGURE 3.3-6. Preliminary lineaments from high magnification ASTER image.

1.0 INTRODUCTION

3-D seismic analysis is unquestionably one of the premier methods for obtaining information concerning deep structure, including predictions of enhanced fracture porosity in reservoirs. However, the high cost of 3-D seismic makes it economically unfeasible in many basins with *perceived* marginal gas reserves. However, without some advanced technology like 3-D seismic, the deep structure in many basins (like the Appalachian Basin of New York State) cannot be critically evaluated because available seismic reflection profiles and deep well logs provide insufficient control.

This research project demonstrates a cost-effective alternative to 3-D seismic. The project demonstration is a combination of low-cost, innovative technologies that, when integrated, yield near-3-D quality on a regional scale for identification of fractured reservoir prospects. The study area covers about 760 sq. miles, an area that would cost about \$22 million for 3-D seismic coverage alone; our proposal is a fraction of that cost.

The basic premise is that highly productive zones in tight reservoirs are associated with discrete zones of intense fracturing, termed “fracture intensification domains” (FIDs, Jacobi and Fountain, 1996, Jacobi and Xu, 1998). These zones can be identified by integration of surface geology, lineaments, well log data, seismic data and soil gas anomalies. FIDs in the northern Appalachian Basin have been shown to be indicative of fault zones at depth (Jacobi and Fountain, 1996, Jacobi and Xu, 1998). Thus, by identifying and tracing FIDs, we can predict the location of zones of increased fractures in the subsurface.

Because large gas discoveries (estimated 3 bcf/well) have been made recently along fault zones in the New York State portion of the Appalachian Basin, it is important to be able to recognize FIDs. Because of vegetation and surficial deposits, the FIDs cannot be traced continuously in outcrop. In order to trace the FIDs, we have developed an integrated program that involves:

1. surface structure,
2. soil gas analyses,
3. remotely-sensed lineaments,
4. existing (2-D) seismics, and
5. aeromagnetics.

Structural studies on outcrops allow identification of FIDs; then lineaments from aeromagnetic and remotely-sensed data are used to trace the FIDs between outcrops. Soil gas anomalies can confirm that the lineaments are associated with fracturing. Existing well log and seismic data are used to confirm the interpretations. Many of the fault systems in the northern Appalachian basin can be traced with aeromagnetics because the surface faults are reactivated deep faults that are located in the Precambrian basement.

The study area is located in the northern Appalachian Basin in the Finger Lakes region of central New York State, primarily between Seneca and Cayuga lakes. The target is the Ordovician Trenton/Black River groups, although fractured tight sands above the Trenton also occur in this

area. The most prolific gas play in New York State today is the Glodes Corners Road Field, an Ordovician Trenton/Black River play that is located west of Keuka Lake. This field was developed by Columbia Natural Resources (CNR), who estimates that the yield/well is 1.3 bcf. The east-northeast trend of the Glodes Corners Road Field suggests that the Glodes Corners Road Field is located along faults that are reactivated structures related to the older Cambrian Rome Trough, which is assumed to trend approximately east-northeast in regions south of the play (Jacobi et al., 1999). Well logs from the Glodes Corners Road Field indicate a narrow fault zone that increases in stratigraphic offset upsection, increasing to 6 m in the Trenton.

On seismic reflection profiles, the Trenton plays occur along fault zones that appear as narrow (~2000') grabens with small regional offset. These grabens are thought to be a result of a combination of

- ◆ solution collapse,
- ◆ reverse flower structures (along strike-slip faults), and
- ◆ seismic pull-down from the lower velocities associated with dissolution and fault brecciation.

In order to procure and analyze the data necessary for the demonstration project, the integrated research project was divided into seven tasks. These tasks include:

- ◆ Traditional and innovative analyses of fractures (Jacobi),
- ◆ Stratigraphy/well log analyses (Jacobi and Loewenstein),
- ◆ Lineaments (Jacobi),
- ◆ Soil Gas Analyses (Fountain),
- ◆ Seismic Data Acquisition and Interpretation (Loewenstein and Jacobi),
- ◆ Advanced Seismic Analyses (Hart), and
- ◆ Aeromagnetic Survey and Analyses (deRidder).

During the third reporting period, we made significant progress, as outlined in the “Results and Discussion” section.

2.0 EXPERIMENTAL

2.1 FRACTURE ANALYSES SUBTASK

Jacobi and students used an abbreviated methodology to collect outcrop structural data during the second and later field seasons. In the abbreviated methodology, Jacobi and assistants identified the fracture sets in the outcrop, and measured the spacing among a minimum of three fractures for each systematic fracture set. They also measured the strike and dip of the fractures, and collected information concerning the abutting relationships, length/height, character of fracture trace (e.g., straight, curvy), and offset along the fracture. They constructed a sketch map in their field notebooks that showed the location of the outcrop and a sketch map of the fracture traces on the outcrop. They indicated the general site location in the field by tying an annotated ribbon to an overhead tree. The sketch map of the site also includes sufficient geographical markers to be able to identify the site location on the topographic base. They annotated the site of the outcrop on the enlarged topographic map base.

Jacobi and students entered all the site data and the fracture data in Excel data spreadsheets. For each site, the next step is to calculate the fracture frequency for each set. As most fractures are very steeply dipping ($80^{\circ}+$), modified rose diagrams can be used to portray the results. In these rose diagrams, fracture frequency is displayed in the top half of the diagram. We generally show three orders of magnitude on the diagram as successively larger concentric circles, with the inner circle representing 0.01 fractures/m, the middle ring representing 0.1 fracture/m, and the outer ring representing 1 fracture/m. Thus, long petals indicate a relatively high number of fractures, as did the old rose diagrams. The advantage of this modified diagram is that it is compatible with scanline data that we collected the first year. We use the lower half of the rose diagram to indicate other features of the fracture sets, commonly either abutting relationships, or length (which is a proxy for abutting relationships). The longest petals in the lower half indicate the master set; the next longest petals indicate the set that abuts the master set, but that is itself master to another fracture set, which is portrayed by even shorter petals.

Advanced analysis techniques, including fractal analysis and geostatistics (see Jacobi et al., 2001, for a review) will be carried out where these techniques will add to the understanding of the fracture development and significance of fractures for identifying deep structure. However, from the first two field seasons, the fracture data look to be very robust, so these techniques may not be necessary. The extent of outcrop was far greater than we had expected, and so the need for these special techniques that we developed especially for areas with limited outcrop, may not be necessary.

2.2 STRATIGRAPHY/WELL LOG ANALYSES SUBTASK

Jacobi and Loewenstein will provide the project with 1) structure contours on bedrock marker beds that outcrop in the study area, and 2) subsurface structure contour maps based on distinctive units identified in well logs. Such maps shall aid in determining fault locations and offset. The construction of these maps is funded by an ongoing NYSERDA project. The contouring will be

accomplished by a subroutine package in Geographix. The stratigraphic tops picked from well logs will follow the industry practice for recognizing each unit top; van Tyne and Foster's (1979) study illustrates such picks.

Jacobi and assistants will provide geological cross-sections across prominent surface structure where outcrops of marker units allow such constructions. The elevations of the marker units will be determined from topographic maps, and/or from altimeters, and/or from surveying from a known elevation.

2.3 LINEAMENTS SUBTASK

Jacobi and Loewenstein will combine lineaments recognized in Landsat images and in 7.5' topographic quadrangle maps. They will integrate Earthsat's (1997) pick of Landsat lineaments in the demonstration area with a reanalyzed Landsat data set. They will also analyze 7.5' topographic maps for lineaments following Jacobi and Fountain's (1996) methodology.

Jacobi will contribute an analysis of digital elevation data available from USGS for the study area. This analysis will include edited topography, a high-pass of the topography, and a horizontal gradient of the high-pass of the topography. We will compare lineaments observed in these gradient maps to those lineaments observed on the Landsat and 7.5' quadrangle maps.

The resulting series of maps of the demonstration area will include 1) Earthsat's Landsat lineament map, 2) our interpretation of lineaments from the Landsat data, 3) lineaments from 7.5' topographic quadrangle maps, 4) lineaments from gradient maps of Pearson, deRidder and Johnson, Inc. and 5) a map integrating all 4 data sets. We will compare the lineaments with the preliminary FID map. Where coincidence occurs between lineaments and FIDs observed in outcrop, we will extend the observed FID along the lineament. After the first iteration, we will compare the lineament/FID map with the soil gas analyses discussed below.

2.4 SOIL GAS ANALYSES

Soil gas surveys will be conducted along primarily north-south profiles, following existing seismic lines, and the general techniques and rationale of Jacobi and Fountain (1996) and Fountain and Jacobi (2000). In this research plan, traverses are conducted along the edge of roads and samples are collected at a distance of 3 to 10 meters from the road, depending on road construction, to avoid the roadbed fill material.

Samples are obtained by driving a stainless steel probe to a depth of 60 cm using a hand-held sledge hammer. Twenty cubic centimeters of air, slightly more than one probe volume, is withdrawn from the probe and discarded with an air tight syringe to purge atmospheric air from the probe. An additional 60 cc of air is then withdrawn with the syringe and injected directly into

a gas chromatograph (GC) equipped with a flame ionization detector for analysis (a Century OVA 128 GC). Gas enters the probe through an array of holes approximately 5 cm above the tip; the holes are covered by a loose sliding collar that minimizes plugging during insertion.

Samples are collected at 10 m intervals. This distance is somewhat arbitrary; however, the results of over 10,000 analyses established that most anomalies are more than 10 m wide (Fountain and Jacobi, 2000), confirming that a 10 m spacing will detect most anomalies.

Linear response of the gas chromatograph is determined by analysis of standard gasses at the start of each day, after four hours of analyses, and at the end of each day. Samples are analyzed in duplicate every 10 samples.

All samples with 10 ppm or greater total organic vapor content are returned to the laboratory for analysis on a laboratory gas chromatograph to determine ethane/methane ratios. The GC is calibrated daily for response and elution times using standard gas mixtures.

2.5 SEISMIC DATA ACQUISITION, REPROCESSING, AND INTERPRETATION

Loewenstein will purchase available seismic lines and subcontract with seismic processors to reprocess the records where necessary. He will evaluate the reprocessing effort and be especially cognizant of statics problems. If such problems appear to exist, he will request that the processor reprocess any section that may exhibit such problems. Loewenstein and Jacobi will interpret the seismic lines for prominent stratigraphic reflectors and faults. Where recognizable, they will pick the reflectors that represent the Tully, Onondaga, Trenton, Black River and Precambrian/Cambrian contacts. They will use accepted industry practices for the reflector recognition (e.g., Jacobi and Fountain, 1996; Jacobi et al., 2000). The interpretation of the 2-D seismic will be displayed along the seismic line in depth (time) sections that show potential faults. These depth displays will be integrated with the surficial FID/soil gas/lineament maps in two ways: 1) the location of surficial FIDs/soil gas anomalies and lineaments will be shown above the depth section for ease in spatial correlation, and 2) the locations of deep structure (faults) as interpreted from the seismic line, will be entered in Geographix so that their locations can be compared in map view with the locations of the surficial FIDs/soil gas anomalies and lineaments.

2.6 ADVANCED SEISMIC ANALYSES

The seismic expression of faults is a function of several variables, including the fault offset and the frequency content of the seismic data. On migrated seismic lines, faults are most easily recognized by reflection offsets, changes in dip, changes in amplitude, etc. Subtle faults are most easily detected in 3-D seismic volumes by deriving and analyzing “horizon” attributes, such as dip, edge detection and azimuth, or “coherency” attributes (e.g., Hart et al., 1996). Additionally, complex trace attributes (e.g., instantaneous frequency, reflection strength) can be

useful for fault detection. In the manner described above, Hart will analyze critical sections of the seismic profiles procured in the preceding subtask.

2.7 AEROMAGNETIC SURVEY AND ANALYSES

Aeromagnetic prospecting is a powerful methodology that can define the basement fault block patterns with detail on a basinal scale. Pearson, deRidder and Johnson, Inc. will acquire, process, and interpret an aeromagnetic survey of the study area. Using both widely available techniques and proprietary methods, Pearson, deRidder and Johnson, Inc. and Jacobi will delineate basement-related structural elements that serve as bounding structures on intra-basement lithology blocks, supra-basement structural relief, and zones of strike-slip faulting that may be associated with fracture swarm development. In addition, the proprietary profile data interpretation tool, STARMAG, licensed by Texaco exclusively to Pearson, deRidder and Johnson, Inc., will be amended, using local constraints, to allow for improved models of magnetic lineaments related to fracture swarms.

Specifications shall be as follows:

Survey area:	710 square miles
Line spacing:	1/3- mile N-S x 1-mile E-W
Line mileage:	3,600 line miles
Ground clearance:	500' above ground level, or as to be decided
Acquisition subcontractor:	Airmag Surveys, Inc., Philadelphia, PA

The data will be processed using an equivalent source method, which compensates for elevation differences at line intersections, taking into account anomalous vertical magnetic gradients. Both profile and grid based interpretation methodologies will be employed to derive the maximum information content of the data set. The resulting maps can be used to infer lineaments related to faults in the basement, and can, in some cases, be used to determine approximate amount of offset on basement. Jacobi and Loewenstein will integrate the aeromagnetic lineaments with the FID/lineament/soil gas maps and seismic attribute studies. Spatial coincidence among aeromagnetic lineaments and the FID/lineament/soil gas/seismic line fractures (seismic attribute) maps will be taken as defining probable fault systems that affected the entire sedimentary section, including the Ordovician targets.

2.8 DRILLING AND TESTING OF VERIFICATION WELL

If at the Decision Point, it is determined to all parties' satisfaction that the project will continue to Task 2.8, the subcontractor, Loewenstein, shall 1) drill an exploratory well at the site judged most likely to exhibit FIDs at depth, and 2) conduct a logging program that shall determine the nature of the intersected fractures. The offeror (Jacobi), subcontractor (Loewenstein), and the Government shall select the drill site, based on all the integrated maps that portray the FIDs in the study area (including outcrop FIDs integrated with topographic and magnetic lineaments, soil

gas anomalies and fracture systems suspected from the reprocessed seismic data). The offeror

(Jacobi), subcontractor (Loewenstein), and the Government shall locate the drill site along a east-northeast trending FID. If north-striking FIDs are found to intersect the east-northeast FIDs, after discussion with the Government at the Decision Point, the offeror (Jacobi) and subcontractor (Loewenstein may choose the intersection point as the optimal drill site.)

The subcontractor (Loewenstein), shall conduct the following logging program

- ◆ Mud Logging – Sample description and gas detection information that identifies mineralogies indicative of healed and partially healed fractures, as well as detection of gas entry points in the well bore at the time of drilling that might indicated fractured zones.
- ◆ Temperature and Acoustic Logs – Identify gas entry points in the well bore to correlate with other logging information.
- ◆ Formation imaging (Schlumberger Formation Micro Scanner) – “Direct” detection of fractured zones.
- ◆ Combinable Magnetic Resonance Logging – Identify zones of higher permeability and movable fluids.

The subcontractor (Loewenstein) shall be responsible for selective coring in the target. The subcontractor (Loewenstein) shall be responsible for obtaining sidewall cores for fracture and reservoir characterization. The offeror (Jacobi) shall digitally image the cores and characterize the fracture spacing, intersections and form (e.g., stylolitic) for each set that occurs in the cored interval.

3.0 RESULTS AND DISCUSSION

3.1 FRACTURE ANALYSES SUBTASK

We had two primary objectives for this reporting period: 1) add additional sites along the west side of Cayuga Lake where we had critical gaps in our data set, and 2) complete analyses of structure data along the west side of Cayuga Lake. Additionally, we redigitized all the site locations in order to have accurate UTM coordinates for each site (Appendix A). We have completed these objectives, and discuss the results below. We are presently entering fracture frequency data in the new site table; the resulting table will allow anyone to construct contour maps of the frequency of any fracture set, or to construct cross sections displaying fracture frequency variations.

In order to better ascertain possible spatial relations between fracture intensification domains (FIDs) and Landsat lineaments (as portrayed by EarthSat, 1997), we analyzed each site for the presence of FIDs (defined as > 4 fractures/ m) in the Cayuga Lake area (Fig. 3.1-1). After eliminating sites without FIDs, the FID data for each site were displayed on the Northern, Central, and Southern combined lineament and FID rose diagram maps (“combined maps”, Figs. 3.1-2 to 3.1-4), as well as in detail in the Insets (Figs. 3.1-6 to 3.1-25).

In the Northern Combined map (Fig. 3.1-2), the predominate FID trend is NNW, although Earthsat (1997) recognized no NNW-striking Landsat lineaments in that area. In contrast, our analyses of DEMs for the region, as well as traditional topographic map inspection, show prominent NNW trends. For example, the shoreline of Cayuga Lake parallels the FIDs. These FIDs generally intersect other fracture sets, but at some sites the FIDs are the master to other fracture trends (e.g., in Insets A and E). The character of these fractures (including trend and master/abutting relationships) are similar to the Alleghanian cross-strike fractures of Engelder and Geiser (1980). We therefore suggest that these FIDs are Alleghanian in age, and are not release fractures caused by modern processes such as glacial stress removal after carving of the valley. If these FIDs consisted of joints that were younger than Alleghanian, i.e., the FID joints abutted other fractures sets such as the strike-parallel fractures, we would then judge these fractures to be candidates for release fractures.

A second trend of FIDs not reflected in EarthSat (1997) lineaments for the Northern Combined map area is a NS trend. In insets C, E, F, and G, multiple sites with N-striking FIDs occur. In Inset C the N-striking FID in the north-central area of the Inset C can be followed 0.25 km across two creeks. Like the NNW-striking FIDs, the N-striking FIDs also intersect or are master to other fracture sets. For example, the N-striking FID in the north-central area of the Inset C intersects an E-striking FID. In the southeast corner of Inset C, the N-striking FID is master to a NNW-striking FID.

The predominate Landsat lineament trend is ENE in the Northern Combined map (Fig. 3.1-2). In Inset A, lineament L1 is coincident with sites that displayed ENE-striking FIDs (Fig. 3.1-2).

Similarly, ENE-striking Landsat lineament L3 in Inset E and L5 in Inset F are coincident with ENE-striking FIDs. However, we found 8 additional zones of ENE-striking FIDs in the Northern Combined map (Fig. 3.1-2). These additional FID zones suggest that the Landsat lineaments of EarthSat (1997), though indicating the structural trends, cannot be used as a precise one-to-one indication of where FIDs are to be expected.

As discussed in an earlier report, the fracture interactions between ENE-striking fractures and cross strike fractures in Northern Combined map are complicated. For example in Inset E at many sites the ENE-striking fractures are both master to, and intersect, the cross-strike (NNW-striking) fractures, but the FIDs only intersect the cross-strike fractures. The inference is that some ENE-striking fractures predate the cross-strike fractures, while other ENE-striking fractures may be contemporaneous with the cross-strike fractures and FIDs (or may have developed when the cross-strike fractures were "tight"). In other regions, the ENE-striking FIDs postdate the cross-strike fractures (in Inset F). This range of relative ages is consistent with the observations on seismic lines that some of the Trenton/Black River faults have been multiply-reactivated.

The Northern Combined map also includes one EarthSat (1997) lineament that trends approximately EW, L4. This lineament does not have a counterpart in outcrop FIDs, although it passes near sites in Inset E and is in-strike with sites in Inset F. The relatively low number of E-striking lineaments in the Northern Combined map is consistent, however, with the relatively low number of E-striking FIDs. Only three unequivocal E-striking FIDs were recognized in the Northern Combined map area. Thus, although again the specific E-striking FIDs in outcrop are not reflected in specific EarthSat (1997) lineaments (and vice versa), the regional structural grain indicated by the lineaments (e.g., few EW trends in the Northern Combined map) is corroborated by the outcrop data.

In the Central Combined map (Fig. 3.1-3), the same FIDs trends occur that are found in the Northern Combined. Like the Northern Combined map, the NNW-striking FIDs have no counterpart in EarthSat (1997) lineaments. One NNW-striking FID displayed dextral offset of ENE-striking FIDs (Inset I). Several N-striking FIDs occur, none of which are indicated by EarthSat (1997) lineaments. In Inset H, the N-striking FIDs occur on strike in two creeks 0.5 km apart. Additional N-striking FIDs were identified in insets I, J, K, L, and M. In inset M, the N-striking FIDs are master to E-striking FIDs and intersect or abut ENE- and NNW-striking FIDs. The FIDs in Inset M are approximately on-strike with N-striking Landsat and topographic lineaments that extend north of Cayuga Lake. This zone of lineaments and FIDs may indicate a N-striking fault.

In the Central Combined map (Fig. 3.1-3), two Landsat lineament trends predominate: ENE to NE, and EW. Lineaments L7 and L8 strike ENE and pass across several sites in insets K, L, and J. No sites contain FIDs trending ENE. These lineaments are thus unsupported by groundtruthing. Lineament L6 strikes about NE; this lineament also passes across sites in insets K and H. None of these sites displays a NE-striking FID. This specific lineament is also therefore

unsupported by structure data. However, about 0.5 km to the southeast in Inset K, two sites do

have NE-striking FIDs, the only NE-striking FIDs in the Central Combined map. This relatively close association between Lineament L6 and the NE-striking FIDs may indicate that a NE-striking structure does pass through the area, but slightly to the Southeast of that proposed by the EarthSat (1997) lineaments.

In contrast to the unsupported NE-striking lineaments in the Central Combined Map, some of the E-striking lineaments in the Central Combined map occur where outcrop data confirm the trends (Fig. 3.1-3). The southern packet of E-striking lineaments (including L12) is located in a region where three outcrops display E-striking FIDs in insets M and O, with the closest E-striking FID about 0.15 km from the lineament in Inset M. Lineaments in the northern E-striking packet (including L10 and L11) do not pass directly across sites with E-striking FIDs. However, E-striking FIDs in insets J and K are located 0.3 km of the EarthSat (1997) lineaments. Thus, like the area to the north, the specific location of the E-striking lineaments is not confirmed by FIDs in outcrop, but the regional E-striking structural grain in this area is confirmed by both lineaments and FIDs. In all three sites with E-striking FIDs in Inset M, the E-striking FIDs post-date the Alleghanian cross-strike fractures. As discussed in previous reports, the E-striking FIDs in this region are spatially associated the Alleghanian Firtree anticline. If the FIDs resulted from buckling of the anticline, then the anticlinal growth post-dates the development of the cross-strike fractures.

In the Southern Combined Map area, the dominant FID trend is again NNW (Fig. 3.1-4). Every inset displays NNW-striking FIDs which are either master to other fracture sets (e.g. in Inset R), or intersect other sets (e.g., Inset S). NNW-striking FIDs in insets P, Q, R, and S have no EarthSat (1997) counterpart (like the regions to the north). However, in Inset T, a NNW-striking lineament, L4, passes across a site that includes a NNW-striking FID. Other NNW-striking FIDs in Inset T indicate that even here, more FIDs in outcrop occur than indicated from Landsat lineaments. A relatively minimal number of N-striking FIDs were measured in the Southern Combined Map, compared to the Central Combined Map. One N-striking FID occurs in each of the insets P, Q, and R. None occurs in inset T.

N-striking FIDs were found in Insets P, Q, R, and T. The FIDs may consist of relatively short segments in this area, since none of the FIDs were recognized on strike in neighboring streams. No N-striking EarthSat (1997) lineaments are located in the Southern Combined map area.

ENE-striking FIDs occur in insets P and Q; the southern ENE-striking FID in the northern part of Inset Q is approximately on trend with ENE-striking EarthSat (1997) lineament L13. ENE-trending lineament L14 does not pass across any sites, and so cannot be confirmed or denied, but lineament L15 passes across a site which does exhibit an ENE-striking FID in Inset R. Additional ENE-striking FIDs were recognized in Inset S, where no Landsat lineaments were identified (Earthsat, 1997).

E-striking FIDs occur in the southern half of Inset P, in the center of Inset Q. In inset R, E-striking FIDs were recognized on strike in outcrops about 0.5 km apart. Several E-striking FIDs

occur in Inset T. None of these E-striking FIDs is represented by E-striking Earthsat lineaments (as had been noted in previous reports, based on the 2-D transect).

In summary, the greatest number of FIDs trend NNW, parallel to the general Cayuga lakeshore (except where the lakeshore bends in the Central Combined Map area). No Earthsat (1997) NNW-striking lineaments were proposed in this region. The ubiquity of the NNW-striking FIDs may indicate that the general lake outline follows a NNW-striking fault system. N-striking FIDs also occur in the study area, and are prevalent in the Central Combined Map area. Although no N-striking EarthSat (1997) lineaments were recognized in the study area, the N-striking FIDs in the eastern part of the Central Combined Map are on strike with lineaments to the north (both Earthsat, 1997, and topographic/stream lineaments). Probable N-striking faults are indicated. E-striking and ENE-striking FIDs occur in structural domains along the Cayuga Lake transect. In the Northern and Southern Combined Map areas, ENE-striking FIDs are coincident with ENE-trending EarthSat (1997) lineaments. However, at least eight additional FIDs were discovered that are not associated with an ENE-striking EarthSat (1997) lineament. A similar situation exists with the E-striking FIDs and lineaments. The EarthSat (1997) E-striking lineaments generally are confirmed by coincident E-striking FIDs, but additional E-striking FIDs suggest a higher number of E-striking faults. As discussed in previous reports, the E-striking lineaments and FIDs in the Central Combined Map are related to the E-striking Firtree Anticline, and the ENE-striking lineaments may be related to older Iapetan-opening fault trends that were reactivated.

3.2 STRATIGRAPHY/WELL LOG ANALYSES SUBTASK

The results were reported in previous progress reports.

3.3 LINEAMENTS SUBTASK

The initial results were reported in previous progress reports. We are presently analyzing ASTER images for lineaments in the study area. The ASTER image on which we are identifying lineaments is shown in Figure 3.3-1. We have processed this image using routine correction subroutines and principle component analyses in ENVI. We are identifying lineaments on three different magnifications of the image. Figures 3.3-3 to 3.3-6 shows the partially completed lineament identification at these higher magnifications. The higher spatial resolution (about an order of magnitude better than Landsat), coupled with the higher number of bands, allow a much better definition of lineaments. Additionally, the higher spatial resolution of the image allows a better discrimination between cultural and natural lineaments. Our ongoing analysis demonstrates similar trends as those found in earlier data sets (EarthSat, 1997, and our DEM analyses [see earlier progress reports]), but a much higher number of individual lineaments have already been recognized.

3.4 SOIL GAS ANALYSES

The initial results were reported in previous progress reports.

3.5 SEISMIC DATA ACQUISITION, REPROCESSING, AND INTERPRETATION

The results were reported in previous progress reports.

3.6 ADVANCED SEISMIC ANALYSES

The results were reported in previous progress reports.

3.7 AEROMAGNETIC SURVEY AND ANALYSES

The results were reported in previous progress reports.

3.8 DRILLING AND TESTING OF VERIFICATION WELL

The subcontractor (Loewenstein) has an agreement with an operator who is planning to drill a well that will pass through the Trenton/Black River along a set of lineaments. When this well is drilled, all the geophysical tools and coring planned for Phase 2 will be accomplished. At present, DOE funds associated with the verification phase have not been expended.

4.0 CONCLUSIONS

During this reporting period, we analyzed fracture data in order to fill in gaps in the earlier data sets. In structure, analyses of these data show that most of the E- and ENE-striking Landsat lineaments recognized by EarthSat (1997) correspond to FIDs. However, a significant number of additional FIDs trending in these same directions indicate more faults with these trends than previously thought. Similarly, N- and NNW-striking FIDs are prevalent in the study area, but no lineaments correspond to the FIDs. Thus, the groundtruthing supported some of the EarthSat (1997) lineaments, but in addition shows that the structural fabric in the area is considerably more complicated than indicated by the Earthsat (1997) lineaments. Preliminary analyses of ASTER images also suggest a more complicated fracture/fault pattern. Nevertheless, it remains possible to discriminate between FIDs related to the shallow Alleghanian Firtree Anticline and those related to the Trenton/Black River faults. The Trenton/Black River-related FIDs trend ENE in the study area and generally predate the Alleghanian cross-strike fractures. In contrast, the Firtree Anticline-related FIDs trend E-W and postdate the Alleghanian cross-strike fractures in the study area. This discrimination ability allows the Trenton/Black River faults to be recognized and extrapolated away from the seismic lines.

FIGURE CAPTIONS

FIGURE 3.1-1. Inset location map for the Cayuga Lake transect. Green lineaments are Landsat lineaments from EarthSat (1997). The Northern, Central, and Southern map areas are shown in figures 3.1-2, 3.1-3, and 3.1-4, respectively.

FIGURE 3.1-2. Northern Combined Map. Although all sites are shown, the map displays rose diagrams for only fracture intensification domains (FIDs). See Figure 3.1-5 for explanation of the lower semi-circle on the rose diagrams. Solid green lineaments are Landsat lineaments from EarthSat (1997) that are confirmed by nearby FIDs. See Figure 3.1-1 for location of figure.

FIGURE 3.1-3. Central Combined Map. Although all sites are shown, the map displays rose diagrams for only fracture intensification domains (FIDs). See Figure 3.1-5 for explanation of the lower semi-circle on the rose diagrams. Solid green lineaments are Landsat lineaments from EarthSat (1997) that are confirmed by nearby FIDs. See Figure 3.1-1 for location of figure.

FIGURE 3.1-4. Southern Combined Map. Although all sites are shown, the map displays rose diagrams for only fracture intensification domains (FIDs). See Figure 3.1-5 for explanation of the lower semi-circle on the rose diagrams. Solid green lineaments are Landsat lineaments from EarthSat (1997) that are confirmed by nearby FIDs. See Figure 3.1-1 for location of figure.

FIGURE 3.1-5. Explanation for the lower semi-circle on the rose diagrams.

FIGURE 3.1-6. Inset A display of FIDs. For location, see Figure 3.1-1. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 3.1-5 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-7. Inset B display of FIDs. For location, see Figure 3.1-1. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 3.1-5 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-8. Inset C display of FIDs. For location, see Figure 3.1-1. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 3.1-5 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-9. Inset D display of FIDs. For location, see Figure 3.1-1. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships

in the lower half. See Figure 3.1-5 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-10. Inset E display of FIDs. For location, see Figure 3.1-1. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 3.1-5 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-11. Inset F display of FIDs. For location, see Figure 3.1-1. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 3.1-5 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-12. Inset G display of FIDs. For location, see Figure 3.1-1. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 3.1-5 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-13. Inset H display of FIDs. For location, see Figure 3.1-1. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 3.1-5 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-14. Inset I display of FIDs. For location, see Figure 3.1-1. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 3.1-5 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-15. Inset J display of FIDs. For location, see Figure 3.1-1. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 3.1-5 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-16. Inset K display of FIDs. For location, see Figure 3.1-1. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 3.1-5 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-17. Inset L display of FIDs. For location, see Figure 3.1-1. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 3.1-5 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-18. Inset M display of FIDs. For location, see Figure 3.1-1. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 3.1-5 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-19. Inset N display of FIDs. For location, see Figure 3.1-1. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 3.1-5 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-20. Inset O display of FIDs. For location, see Figure 3.1-1. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 3.1-5 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-21. Inset P display of FIDs. For location, see Figure 3.1-1. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 3.1-5 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-22. Inset Q display of FIDs. For location, see Figure 3.1-1. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 3.1-5 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-23. Inset R display of FIDs. For location, see Figure 3.1-1. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 3.1-5 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-24. Inset S display of FIDs. For location, see Figure 3.1-1. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 3.1-5 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-25. Inset T display of FIDs. For location, see Figure 3.1-1. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 3.1-5 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.3-1. ASTER image of region surrounding Seneca Lake (on left) and Cayuga Lake (on right).

FIGURE 3.3-2. Preliminary lineaments from ASTER image at small magnification.

FIGURE 3.3-3. Southern portion of ASTER image that is shown in Figure 3.3-1; this image is at intermediate magnification. Note Seneca Lake in the upper left.

FIGURE 3.3-4. Preliminary lineaments from intermediate magnification of southern portion of ASTER image that is shown in Figure 3.3-1.

FIGURE 3.3-5. South-central portion of ASTER image that is shown in Figure 3.3-3; this image is at high magnification.

FIGURE 3.3-6. Preliminary lineaments from high magnification of south-central portion of ASTER image that is shown in Figure 3.3-3.

CAYUGA LAKE LOCATION MAP FOR INSETS

FIGURE 3.1-1

FIGURE 3.1-2

FIGURE 3.1-4

FIGURE 3.1-5

FIGURE 3.1-6

FIGURE 3.1-7

FIGURE 3.1-8

FIGURE 3.1-9

FIGURE 3.1-10

FIGURE 3.1-11

FIGURE 3.1-12

FIGURE 3.1-13

FIGURE 3.1-14

FIGURE 3.1-15

FIGURE 3.1-16

FIGURE 3.1-17

FIGURE 3.1-18

FIGURE 3.1-19

FIGURE 3.1-20

FIGURE 3.1-21

FIGURE 3.1-22

FIGURE 3.1-23

FIGURE 3.1-24

FIGURE 3.1-25

Map Scale 1:200,000

FIGURE 3.3-1

Map Scale 1:200,000

FIGURE 3.3-2

Map Scale 1:50,000

Figure 3.3-3

Map Scale 1:50,000

Figure 3.3-4.

Map Scale 1:25,000

FIGURE 3.3-5

FIGURE 3.3-6

APPENDIX A

Seneca Lake					
				UTM	
SITE	No Data	LATITUDE	LONGITUDE	Easting	Northing
4		42.532883	-76.847024	348314.42	4710597.5
5 ?		42.53653	-76.836221	349210.41	4710983.2
5		42.417762	-76.863103	346713.1	4697843
6		42.535415	-76.854596	347699	4710892
7		42.535694	-76.860653	347201.96	4710934.1
7		42.431989	-76.870352	346151.47	4699435.9
8		42.536273	-76.879127	345686.25	4711031.9
8		42.536917	-76.87	346437.36	4711086.8
9		42.536144	-76.879768	345633.29	4711018.7
9		42.538097	-76.851975	347920.47	4711185.3
10		42.536359	-76.880816	345547.76	4711044.5
11		42.536831	-76.866273	346743.21	4711070.5
12		42.530855	-76.879467	345644.98	4710430.9
13		42.531112	-76.880996	345520.04	4710462.2
14		42.531252	-76.881418	345485.73	4710478.5
15		42.496834	-76.865122	346740	4706627
16		42.497081	-76.86697	346588.75	4706657.8
17		42.424779	-76.862435	346785.16	4698620.9
18		42.424532	-76.86168	346846.67	4698592.2
19		42.493658	-76.884682	345124.82	4706309.9
20		42.493744	-76.884944	345103.51	4706319.9
21		42.563181	-76.878226	345826.5	4714018.2
22		42.561808	-76.878662	345787.33	4713866.6
23		42.612298	-76.848395	348394.36	4719418.6
25		42.602234	-76.85798	347583.63	4718318.2
26		42.602309	-76.858228	347563.47	4718327
27		42.599316	-76.823282	350423.12	4717932.3
28		42.599144	-76.822962	350448.96	4717912.6
29		42.581785	-76.873331	346274.04	4716075.2
30		42.581828	-76.872981	346302.86	4716079.4
31		42.584853	-76.874555	346181.13	4716418.1
32		42.497413	-76.827318	349847.89	4706623.7
33		42.497413	-76.826867	349884.95	4706622.9
35		42.60232	-76.858781	347518.13	4718329.2
36		42.61263	-76.855713	347794.92	4719468.6
37		42.612598	-76.855247	347833.07	4719464.2
38		42.612748	-76.855057	347849.02	4719480.5
39		42.613145	-76.854022	347934.88	4719522.7
53		42.64443	-76.860952	347442.91	4723009.3
54		42.644559	-76.860865	347450.36	4723023.4
61		42.647671	-76.87001	346708.3	4723385.6
62		42.637864	-76.870788	346620.42	4722297.9
63		42.636523	-76.871123	346589.66	4722149.6
65		42.637006	-76.862329	347311.87	4722187.4
66		42.636995	-76.862607	347289.05	4722186.6
67		42.636298	-76.869315	346737.35	4722121.4
73		42.444584	-76.871782	346064.69	4700837.1

74		42.451966	-76.872539	346020.51	4701658.2
75		42.473627	-76.875997	345789.35	4704069.7
76		42.493905	-76.88522	345081.22	4706338.3
77		42.494001	-76.881612	345377.97	4706342.4
78		42.529256	-76.876773	345862.31	4710248.4
100		42.532346	-76.841724	348748.39	4710528.4
101		42.532947	-76.840443	348855.05	4710592.8
102		42.532969	-76.839511	348931.64	4710593.6
104		42.534857	-76.837444	349105.95	4710799.6
105		42.535071	-76.855615	347614.19	4710855.9
106		42.534878	-76.856634	347530.03	4710836.3
107		42.53402	-76.857071	347492.05	4710741.8
108		42.536767	-76.872243	346252.79	4711074.2
109		42.53726	-76.87367	346136.82	4711131.6
110		42.536895	-76.875865	345955.66	4711095
111		42.536294	-76.852674	347858.68	4710986.4
192		42.553954	-76.800158	352213.09	4712854.4
193		42.554598	-76.802954	351985.07	4712930.8
200		42.533741	-76.838318	349031.48	4710677.2
201		42.534599	-76.856809	347514.98	4710805.6
202		42.534127	-76.857857	347427.77	4710755.1
203		42.536895	-76.871078	346348.78	4711086.3
203		42.558117	-76.800216	352218.16	4713316.8
204		42.53756	-76.852004	347916.78	4711125.8
204		42.557731	-76.793051	352805.45	4713261.5
318		42.528033	-76.831097	349610.81	4710030.5
319		42.527218	-76.830864	349628	4709939.6
342		42.474861	-76.807397	351431.49	4704084.3
343		42.469518	-76.809279	351264.13	4703494.3
410		42.529449	-76.832029	349537.67	4710189.4
437		42.52102	-76.88393	345254.47	4709346.5
438		42.515727	-76.884741	345174.47	4708760.6
439		42.51547	-76.883169	345302.97	4708729.2
440		42.511468	-76.885105	345134.04	4708288.3
441		42.511479	-76.88378	345242.93	4708287.1
442		42.419329	-76.849753	347815.3	4697993
443		42.418878	-76.850436	347758.02	4697944.1
444		42.422923	-76.854277	347451.8	4698400.2
445		42.43745	-76.871792	346046.4	4700044.9
446		42.446698	-76.871671	346079	4701071.6
447		42.445464	-76.871332	346103.85	4700934
449		42.456944	-76.866412	346536.51	4702199.8
450		42.456794	-76.866906	346495.53	4702184.1
451		42.45674	-76.867503	346446.31	4702179.1
452		42.456247	-76.873247	345972.79	4702134.8
452		42.495761	-76.855324	347542.53	4706490.2
453		42.496276	-76.856692	347431.37	4706549.8
454		42.574897	-76.874671	346147.13	4715312.8
455		42.574897	-76.869834	346544.11	4715304
456		42.575154	-76.870358	346501.74	4715333.5

19A		42.493851	-76.885002	345099.01	4706331.9
1 B		42.39432	-76.856624	347189.28	4695228.2
2 A		42.391015	-76.855225	347296.41	4694858.7
2 B		42.390854	-76.854993	347315.12	4694840.4
34 + 34b		42.581763	-76.874059	346214.24	4716074.1
3 B		42.418106	-76.866475	346436.5	4697887.3
411a		42.529836	-76.833077	349452.53	4710234.3
436 & RDJ 202b		42.567258	-76.80074	352196.73	4714332.8
45 K		42.606804	-76.868596	346723.95	4718844.9
49&50/RDJ12		42.619153	-76.865446	347012.58	4720210.5
cml1		42.53226	-76.842278	348702.69	4710519.8
cml2		42.532346	-76.842656	348671.85	4710530
cml3		42.53226	-76.844869	348489.89	4710524.4
cml4		42.386016	-76.853782	347403.07	4694301
cml5		42.532969	-76.847723	348257.22	4710608.3
2-3		42.504215	-76.838902	348912.38	4707399.6
2-4		42.503765	-76.839076	348896.99	4707349.9
2-5		42.503357	-76.839367	348872.1	4707305.1
2-6		42.50282	-76.83928	348877.96	4707245.3
2-7		42.502456	-76.839746	348838.79	4707205.7
2-8		42.500374	-76.841841	348661.63	4706978.3
2-9		42.497638	-76.844455	348440.23	4706679.1
2-10		42.498797	-76.842883	348572.21	4706805
2-11		42.499709	-76.842577	348599.55	4706905.8
2-17		42.543869	-76.800683	352146.18	4711735.5
2-19		42.543826	-76.804469	351835.21	4711737.3
2-20		42.543826	-76.803887	351882.99	4711736.3
2-39		42.496791	-76.841835	348653.48	4706580.4
2-40		42.496179	-76.840729	348742.89	4706510.5
2-41		42.482135	-76.812208	351053.27	4704900.5
2-42		42.480054	-76.812431	351030.01	4704669.8
2-43		42.399577	-76.859888	346933.41	4695817.9
2-44		42.396251	-76.858731	347020.54	4695446.4
2-45		42.401154	-76.861704	346787.78	4695996.3
2-46		42.571807	-76.852914	347925.26	4714930.3
2-47		42.572	-76.854449	347799.73	4714954.5
2-48		42.572783	-76.854988	347757.41	4715042.4
2-49		42.57332	-76.855614	347707.34	4715103.2
2-50		42.57347	-76.855935	347681.35	4715120.4
2-51		42.573481	-76.856168	347662.25	4715122.1
2-52		42.574296	-76.855187	347744.75	4715210.8
2-53		42.557924	-76.879536	345706.01	4713436.9
2-54		42.556872	-76.879886	345674.68	4713320.7
2-55		42.555563	-76.880002	345661.93	4713175.5
2-56		42.556872	-76.878284	345806.2	4713317.8
2-57		42.476588	-76.778972	353772.12	4704226.7
2-58		42.475526	-76.777546	353886.86	4704106.3
2-59		42.474475	-76.777488	353889.19	4703989.5

2-60		42.474228	-76.777474	353889.76	4703962.1
2-68		42.544127	-76.781005	353762.59	4711730
2-69		42.477522	-76.780223	353671.47	4704332.6
2-70		42.477779	-76.781459	353570.47	4704363.2
2-71		42.478563	-76.782158	353514.84	4704451.5
1 RDJ 40		42.601537	-76.86948	346638.51	4718261.6
10 RDJ 44 c		42.618102	-76.86896	346721.8	4720100.1
11 A RDJ		42.618703	-76.867386	346852.37	4720164
11 RDJ 45 c		42.618413	-76.867721	346824.18	4720132.4
13 A RDJ 46 c		42.618703	-76.864003	347129.83	4720157.9
13 RDJ 47		42.618746	-76.864163	347116.8	4720163
14 RDJ		42.618392	-76.863026	347209.19	4720121.6
15 A RDJ 60		42.647016	-76.866889	346962.54	4723307.2
15 B RDJ 59 A, 59 B		42.646952	-76.866714	346976.73	4723299.8
16 RDJ 57		42.64649	-76.86543	347080.85	4723246.1
17 RDJ 58		42.645847	-76.864278	347173.72	4723172.6
18 RDJ 56, 56 A		42.645128	-76.863038	347273.62	4723090.6
19 RDJ 55		42.64472	-76.861769	347376.65	4723042.9
2 RDJ 51		42.602534	-76.869917	346605.1	4718373.1
200 A		42.55743	-76.800915	352159.15	4713241.8
200B		42.557302	-76.800042	352230.52	4713226
201 A B		42.564468	-76.800623	352199.74	4714022.8
202A		42.566743	-76.800682	352200.27	4714275.5
2-18A		42.54374	-76.804935	351796.74	4711728.6
2-18B		42.544041	-76.804935	351797.45	4711762
22 RDJ		42.636749	-76.862854	347268.2	4722159.8
23 RDJ		42.636727	-76.863044	347252.56	4722157.7
24 ?		42.612051	-76.848016	348424.84	4719390.5
24 RDJ		42.636631	-76.863365	347226.01	4722147.6
2-47 A		42.572021	-76.854143	347824.9	4714956.3
25 RDJ		42.636566	-76.864561	347127.79	4722142.5
2-57 A		42.476406	-76.778797	353786.08	4704206.2
2-59 A		42.474861	-76.777445	353893.63	4704032.3
26 RDJ		42.636008	-76.868819	346777.3	4722088.3
27 RDJ		42.636094	-76.86828	346821.7	4722096.8
28 RDJ		42.635998	-76.867478	346887.23	4722084.7
2-9 A		42.498518	-76.843596	348512.94	4706775.3
29 RDJ		42.636641	-76.865159	347078.94	4722151.9
3 RJD		42.602749	-76.871302	346492.01	4718399.5
30 RDJ		42.636309	-76.866398	346976.54	4722117.3
31 RDJ		42.636287	-76.866836	346940.58	4722115.7
32 RDJ		42.632897	-76.86911	346745.81	4721743.3
33 RDJ		42.632908	-76.869635	346702.79	4721745.5
34 RDJ		42.632908	-76.870744	346611.86	4721747.5
35 RDJ		42.63265	-76.867856	346848.02	4721713.6
36 RDJ		42.632575	-76.867638	346865.72	4721704.9
37 RDJ		42.632307	-76.866281	346976.33	4721672.7
38 RDJ		42.632468	-76.86265	347274.45	4721684
39 RDJ		42.632672	-76.861148	347398.11	4721703.9
4 RJD		42.602856	-76.871448	346480.29	4718411.6

40 ?		42.613328	-76.853045	348015.46	4719541.3
40 RDJ		42.631642	-76.85339	348031.73	4721575.6
41 RDJ		42.631695	-76.854207	347964.86	4721583
42 RDJ		42.631749	-76.855198	347883.73	4721590.7
43 RDJ		42.631813	-76.855825	347832.48	4721599
44 RDJ		42.631899	-76.856511	347776.44	4721609.8
45 RDJ		42.631985	-76.85689	347745.57	4721620
46 A		42.571893	-76.853322	347891.97	4714940.6
47 RDJ		42.6322	-76.857736	347676.73	4721645.4
48 RDJ		42.632468	-76.859033	347571.03	4721677.5
49 RDJ		42.667809	-76.874218	346412.93	4725629.5
5 RDJ 42		42.607899	-76.871263	346507.86	4718971.3
50 RDJ		42.667519	-76.872598	346544.97	4725594.3
503(108)		42.537367	-76.872825	346206.47	4711141.9
51 RDJ		42.665384	-76.874145	346412.93	4725360
52 k		42.644398	-76.860836	347452.34	4723005.5
52 RDJ		42.657273	-76.868761	346834.26	4724449.6
53 RDJ		42.657402	-76.870205	346716.21	4724466.5
54 RDJ		42.657112	-76.871606	346600.68	4724436.8
55 RDJ		42.658828	-76.869199	346802.17	4724623
57 RDJ		42.657391	-76.868498	346856.11	4724462.2
58 RDJ		42.658174	-76.869009	346816.14	4724550.1
59 RDJ		42.654494	-76.86684	346984.89	4724137.5
6 = 72		42.431935	-76.870745	346121	4699434
6 RDJ 44 K		42.606965	-76.869354	346662.16	4718864.1
60 RDJ		42.664815	-76.873926	346429.48	4725296.4
64 A		42.637092	-76.861396	347388.58	4722195.2
64 B		42.63692	-76.861732	347360.61	4722176.7
7 RDJ 41		42.607963	-76.873187	346350.2	4718981.9
73 A		42.443748	-76.872277	346021.93	4700745.1
73 B		42.444541	-76.872306	346021.49	4700833.2
74 A		42.452331	-76.869965	346233.08	4701694
74 D		42.452298	-76.87155	346102.66	4701693.2
75A		42.474099	-76.874775	345890.95	4704119.9
8 RDJ 43		42.606858	-76.867342	346826.94	4718848.6
9 RDJ 48		42.618145	-76.871978	346474.38	4720110.4
????					
436 A		42.469261	-76.811402	351088.99	4703469.5
Cayuga Lake					
UTM					
SITE	No Data	LATITUDE	LONGITUDE	Easting	Northing
1-10		42.532486	-76.644737	364926.7	4710211
1-11		42.529482	-76.652089	364316.36	4709889.2
1-12		42.527872	-76.653181	364223.19	4709712.2
1-13		42.528623	-76.654601	364108.23	4709797.9
1-14		42.565928	-76.643539	365097.09	4713922.6
1-15		42.513764	-76.54944	372715.05	4707984.6
1-16		42.510545	-76.547039	372905.79	4707623.6

1-17		42.510438	-76.547366	372878.67	4707612.2
1-18		42.474282	-76.541618	373277.97	4703588.7
1-19		42.475086	-76.539836	373426.07	4703675.4
1-20		42.475381	-76.538672	373522.32	4703706.4
1-22		42.457271	-76.525043	374606.53	4701675.2
1-23		42.457054	-76.528609	374312.85	4701656.4
1-24		42.456861	-76.533615	373900.85	4701642.3
1-25		42.416266	-76.520823	374871.9	4697115.7
1-26		42.410999	-76.515788	375275.77	4696523.5
1-26A		42.411073	-76.516007	375257.83	4696532
1-27		42.412651	-76.517646	375126.15	4696709.7
1-112		42.529348	-76.631196	366032	4709841.1
1-112b		42.529106	-76.628357	366264.66	4709809.8
1-113		42.529294	-76.622752	366725.43	4709821.8
1-114		42.532083	-76.619367	367009.36	4710126.2
1-115		42.533398	-76.617911	367131.72	4710269.9
1-116		42.536831	-76.609684	367814.6	4710638.3
1-117		42.538655	-76.604151	368272.8	4710832.2
1-118		42.545468	-76.616602	367264.82	4711608.1
1-119		42.545736	-76.61642	367280.33	4711637.6
1-120		42.54595	-76.616311	367289.75	4711661.3
1-121		42.546138	-76.616165	367302.1	4711681.9
1-122		42.546996	-76.6154	367366.7	4711776
1-123		42.552087	-76.624982	366590.83	4712356.4
1-125		42.550242	-76.622427	366796.66	4712147.4
1-126		42.550671	-76.621917	366839.42	4712194.3
1-127		42.55169	-76.621772	366853.54	4712307.2
1-128		42.551932	-76.621735	366857.04	4712334
1-129	x	42.552119	-76.621735	366857.44	4712354.8
1-130		42.555392	-76.632468	365983.3	4712735.1
1-131		42.553933	-76.627866	366358.03	4712565.8
1-132		42.554576	-76.626759	366450.27	4712635.6
1-132		42.542388	-76.66005	363690.63	4711335.2
1-133 (c)		42.542281	-76.657429	363905.62	4711319.1
1-133A		42.547855	-76.614781	367419.34	4711870.3
1-134		42.552736	-76.621007	366918.54	4712422.2
1-134		42.552629	-76.621299	366894.39	4712410.7
1-135		42.530903	-76.640551	365267.06	4710028.6
1-136		42.530394	-76.640696	365254.01	4709972.3
1-137	x	42.532191	-76.642007	365150.26	4710173.9
1-138		42.531815	-76.646411	364787.75	4710139.2
1-139		42.531064	-76.648122	364645.62	4710058.6
1-140		42.530474	-76.649068	364566.63	4709994.6
1-141		42.592428	-76.668193	363131.43	4716904.9
1-141A		42.592878	-76.667348	363201.77	4716953.6
1-142		42.591827	-76.669359	363050.18	4716856.4
1-143		42.591312	-76.670874	362908.97	4716785.3
1-144		42.591548	-76.670379	362950.15	4716810.7
1-145		42.583823	-76.658605	363899.42	4715933.9
1-146		42.583716	-76.660674	363729.4	4715925.4

1-147		42.583566	-76.661985	363621.46	4715910.8
1-149		42.584274	-76.657701	363974.53	4715982.5
1-150		42.515266	-76.583982	369880.55	4708203.8
1-151		42.518511	-76.578487	370338.64	4708555.8
1-152		42.529991	-76.567387	371274.03	4709813.6
1-153		42.535543	-76.584093	369913.47	4710455.7
1-154		42.536321	-76.584312	369897.15	4710542.4
1-155		42.528436	-76.572337	370864.3	4709648.4
1-156		42.540237	-76.592793	369208.83	4710990.3
1-157		42.538789	-76.594103	369098.19	4710831.5
1-158		42.536858	-76.595123	369010.46	4710618.6
1-159		42.526263	-76.569644	371081.02	4709403.1
1-160		42.52519	-76.570117	371039.96	4709284.7
1-161		42.519397	-76.556427	372152.59	4708620.6
1-162		42.51878	-76.557628	372052.68	4708553.9
1-163		42.518002	-76.559374	371907.6	4708470.2
1-164		42.518619	-76.558355	371992.57	4708537.1
1-166		42.5165	-76.562322	371662.39	4708307.8
1-167		42.503035	-76.544529	373096.83	4706785.9
1-168		42.502874	-76.545038	373054.65	4706768.8
1-169		42.495498	-76.540345	373425.35	4705942.7
1-170		42.499682	-76.543546	373170.75	4706412.1
1-171		42.491367	-76.557878	371976.15	4705510.4
1-172		42.492762	-76.554859	372227.1	4705660.7
1-173		42.494801	-76.543328	373178.81	4705869.7
1-174		42.409834	-76.513909	375428.01	4696391.3
1-175		42.400422	-76.512751	375504.76	4695344.5
1-176		42.418124	-76.518126	375097.53	4697318.1
1-177		42.415484	-76.519624	374968.99	4697027.1
1-178		42.44459	-76.516015	375323.67	4700253.7
1-179		42.595357	-76.673633	362691.56	4717238.9
1-180		42.59636	-76.671108	362900.92	4717346.2
1-181		42.598307	-76.675837	362517.17	4717570.2
1-182		42.599664	-76.67223	362816.1	4717715
1-183		42.602792	-76.679004	362267.27	4718073.3
1-184		42.603205	-76.6774	362399.7	4718116.6
1-185		42.603824	-76.675837	362529.3	4718182.8
1-186		42.457368	-76.52393	374698.2	4701684.3
1-188		42.456788	-76.541991	373211.98	4701646.8
1-189		42.513308	-76.586492	369670.23	4707990.3
1-190		42.424984	-76.507535	375982.37	4698064.3
1-191		42.412194	-76.517326	375151.55	4696658.4
1-194		42.659	-76.711032	359766.15	4724367.6
1-195		42.66003	-76.709193	359919.13	4724478.9
1-196		42.661961	-76.706611	360135.11	4724689.1
1-197		42.663506	-76.702978	360436.31	4724854.7
1-198		42.66415	-76.701359	360570.47	4724923.5
1-199		42.658775	-76.707224	360071.01	4724329.3
1-199A		42.658871	-76.706786	360114.44	4724347.5
1-205		42.530099	-76.637057	365552.31	4709933.7

1-206		42.529133	-76.625882	366468	4709808.9
1-207		42.530501	-76.62075	366892.42	4709952.7
1-208		42.533022	-76.616965	367208.65	4710226.7
1-209		42.538118	-76.606263	368098.3	4710775.9
1-210		42.540479	-76.604042	368285.64	4711034.5
1-211		42.542517	-76.60386	368304.87	4711260.6
1-212		42.545012	-76.616966	367233.96	4711558.1
1-212		42.559876	-76.635644	365732.18	4713238.1
1-213		42.546326	-76.616019	367314.46	4711702.5
1-214		42.546514	-76.615874	367326.82	4711723.1
1-214		42.559876	-76.635644	365732.18	4713238.1
1-215		42.546996	-76.6154	367366.7	4711776
1-215		42.546728	-76.615692	367342.22	4711746.7
1-216		42.547184	-76.615218	367382.05	4711796.6
1-217		42.549062	-76.623665	366692.51	4712018.3
1-221		42.549276	-76.623447	366710.91	4712041.8
1-222		42.550966	-76.621735	366854.99	4712226.8
1-223		42.552736	-76.621007	366918.54	4712422.2
1-224		42.553461	-76.633546	365890.68	4712522.4
1-225		42.553504	-76.628448	366309.28	4712519.1
1-226		42.548445	-76.614272	367462.43	4711935.1
1-227		42.542496	-76.661244	363592.81	4711349
1-228		42.530394	-76.639241	365373.58	4709970
1-228		42.58378	-76.659013	363865.84	4715929.8
1-229		42.532459	-76.642626	365100.02	4710204.7
1-230		42.532539	-76.644336	364959.69	4710216.4
1-231		42.530742	-76.651543	364363.93	4710028.3
1-232		42.565176	-76.644879	364985.47	4713841.4
1-233		42.592127	-76.669067	363057.69	4716873
1-233A		42.591977	-76.669213	363055.13	4716864.7
1-234		42.59172	-76.669767	363000.74	4716828.8
1-235		42.593458	-76.666444	363277.17	4717016.4
1-236		42.583652	-76.660178	363769.91	4715917.4
1-237		42.583673	-76.661461	363664.73	4715921.9
1-238		42.513925	-76.584746	369815	4708056.1
1-239		42.515025	-76.584309	369853.15	4708177.5
1-240		42.517063	-76.580124	370201.13	4708397.5
1-241		42.516688	-76.580634	370158.5	4708356.6
1-242		42.515481	-76.58329	369937.79	4708226.6
1-243		42.529616	-76.567096	371297.16	4709771.5
1-245		42.535302	-76.584348	369892.04	4710429.3
1-246		42.535704	-76.583839	369934.72	4710473.2
1-247		42.531145	-76.571209	370962.53	4709947.5
1-248		42.538333	-76.594213	369088.27	4710781
1-249		42.5257	-76.569789	371067.92	4709340.7
1-250		42.523634	-76.561449	371748.74	4709098.8
1-251		42.520523	-76.555517	372229.62	4708744.3
1-252		42.519075	-76.5569	372113.07	4708585.6
1-253		42.517573	-76.560029	371852.92	4708423.5
1-254		42.517143	-76.560939	371777.31	4708377.2

1-255		42.502365	-76.543219	373203.08	4706709.5
1-256		42.495337	-76.541036	373368.23	4705925.9
1-257		42.496786	-76.540454	373418.99	4706085.8
1-258		42.498207	-76.542783	373230.54	4706247.2
1-259		42.498127	-76.543074	373206.47	4706238.7
1-260		42.491475	-76.557624	371997.3	4705521.9
1-261		42.491984	-76.557005	372049.15	4705577.5
1-262		42.492923	-76.554386	372266.29	4705677.8
1-263		42.494935	-76.542783	373223.92	4705883.8
1-264		42.410424	-76.514331	375394.5	4696457.5
1-265		42.400776	-76.51295	375489.01	4695384.1
1-266		42.409686	-76.508235	375894.63	4696366.6
1-267		42.417815	-76.517786	375124.86	4697283.2
1-268		42.415838	-76.520124	374928.59	4697067.1
1-269		42.42078	-76.510832	375702.84	4697602.3
1-270		42.444449	-76.516015	375323.39	4700238.1
1-271		42.59633	-76.671388	362877.83	4717343.4
1-272		42.596977	-76.669417	363040.96	4717412
1-273		42.598189	-76.676158	362490.6	4717557.6
1-274		42.599841	-76.671789	362852.66	4717734
1-277		42.60347	-76.676679	362459.47	4718144.9
1-279		42.605477	-76.679244	362253.47	4718371.8
1-280		42.605152	-76.680166	362177.12	4718337.3
1-281		42.604975	-76.681769	362045.19	4718320.3
1-282		42.602821	-76.679404	362234.45	4718077.2
1-283		42.602497	-76.680487	362144.96	4718043
1-284		42.602202	-76.682371	361989.77	4718013.3
1-285		42.607778	-76.679565	362232.23	4718627.9
1-286		42.60707	-76.68185	362043.24	4718553
1-287		42.607453	-76.682491	361991.47	4718596.6
1-288		42.475784	-76.537036	373657.64	4703748.7
1-289		42.476293	-76.535799	373760.29	4703803.4
1-290		42.457368	-76.524584	374644.39	4701685.3
1-291		42.457368	-76.524323	374665.92	4701684.9
1-292		42.457006	-76.527954	374366.57	4701650
1-293		42.457054	-76.528282	374339.76	4701655.9
1-294		42.457223	-76.530507	374157.15	4701677.9
1-295		42.45674	-76.534596	373819.9	4701630.4
1-296		42.456885	-76.535153	373774.45	4701647.3
1-297		42.456571	-76.54029	373351.44	4701620.1
1-299		42.410793	-76.515148	375327.97	4696499.6
1-300		42.411442	-76.516867	375187.87	4696574.2
1-302		42.658646	-76.712695	359629.03	4724331.1
1-303		42.659998	-76.710419	359818.62	4724477.4
1-304		42.661768	-76.708318	359994.78	4724670.5
1-305		42.663603	-76.702409	360483.16	4724864.4
1-306		42.657423	-76.70915	359916.86	4724189.4
1-308		42.659322	-76.701359	360559.64	4724387.3
1-309		42.647467	-76.696984	360891.81	4723063.7
1-311		42.6467	-76.701689	360502.69	4722984.5

1-314		42.641544	-76.707835	359988.96	4722423.9
1-315		42.643046	-76.697451	360843.68	4722573.6
1-316		42.642746	-76.701826	360484.3	4722547.4
1-317		42.642059	-76.705735	360162.3	4722477.6
1-319		42.628372	-76.689868	361432.78	4720931.6
1-320		42.627841	-76.694319	361066.63	4720879.9
1-321		42.627929	-76.696404	360895.84	4720893.2
1-322		42.627339	-76.698489	360723.54	4720831.1
1-323		42.630614	-76.69464	361046.47	4721188.4
1-324		42.630467	-76.696725	360875.16	4721175.5
1-325		42.629729	-76.690068	361419.34	4721082.6
1-326		42.630201	-76.691472	361305.31	4721137.3
1-327		42.424473	-76.536268	373617.59	4698049.9
1-328		42.443001	-76.524629	374612.04	4700090
1-329		42.443161	-76.525338	374554.06	4700108.9
1-330		42.443182	-76.526047	374495.82	4700112.2
1-331		42.441431	-76.52035	374960.91	4699909.4
1-333		42.450926	-76.522967	374764.59	4700967.6
1-334		42.458301	-76.520266	375001.36	4701782.5
1-335		42.457641	-76.522709	374799.18	4701712.9
1-336		42.49059	-76.541146	373349.63	4705398.9
1-337		42.491287	-76.538564	373563.26	4705472.4
1-338		42.485681	-76.535472	373806.07	4704845.4
1-339		42.483321	-76.53649	373717.62	4704584.8
1-340		42.480344	-76.533108	373989.63	4704249.1
1-341		42.480263	-76.533836	373929.69	4704241.3
1-342		42.480209	-76.534308	373890.72	4704236
1-356		42.517009	-76.561267	371750.13	4708362.8
1-400		42.659032	-76.702366	360476.48	4724356.8
1-401		42.658743	-76.704204	360325.17	4724327.7
1-402		42.658968	-76.705736	360200.13	4724355.3
1-403		42.647488	-76.698626	360757.27	4723068.7
1-404		42.646887	-76.701229	360542.63	4723007.5
1-405		42.645085	-76.707968	359986.03	4722817.3
1-406		42.644672	-76.709295	359876.28	4722773.6
1-407		42.643175	-76.698909	360724.39	4722590.3
1-407		42.659258	-76.701753	360527.22	4724380.8
1-408		42.64266	-76.70381	360321.48	4722541.2
1-410		42.647375	-76.698115	360798.87	4723055.4
1-411		42.62908	-76.689266	361483.68	4721009.2
1-412		42.627929	-76.69492	361017.5	4720890.7
1-413		42.627841	-76.697206	360829.88	4720884.7
1-414		42.630231	-76.692194	361246.19	4721141.8
1-416		42.629729	-76.689146	361494.97	4721081.1
1-417		42.442337	-76.52283	374758.68	4700013.6
1-418		42.441351	-76.518578	375106.47	4699897.9
1-419		42.441291	-76.519832	375003.22	4699893
1-420		42.441331	-76.516479	375279.07	4699892.5
1-421		42.451329	-76.518577	375126.34	4701005.8
1-422		42.45149	-76.517814	375189.44	4701022.6

1-423		42.451228	-76.519286	375067.85	4700995.7
1-424		42.451067	-76.520322	374982.34	4700979.3
1-425		42.450906	-76.522339	374816.11	4700964.4
1-427		42.458156	-76.521094	374932.92	4701767.7
1-428		42.458076	-76.521552	374895.1	4701759.4
1-429		42.490348	-76.542637	373226.58	4705374.3
1-430		42.491502	-76.537618	373641.41	4705494.9
1-431		42.485708	-76.535181	373830.04	4704847.9
1-432		42.48552	-76.536381	373731.01	4704828.8
1-433		42.483106	-76.537218	373657.4	4704562
1-434		42.480183	-76.534563	373869.74	4704233.4
2-30		42.612705	-76.687301	361607.13	4719190.1
2-31		42.61241	-76.687863	361576.58	4719157.3
2-32		42.612528	-76.687582	361599.75	4719179.5
2-33		42.613295	-76.688183	361537.48	4719254.6
2-36		42.626484	-76.688063	361576.56	4720719
2-37		42.626395	-76.688504	361540.2	4720709.9
2-38		42.626395	-76.688945	361504.03	4720710.6
2-61		42.622973	-76.696805	360851.92	4720343.4
2-62		42.623681	-76.696484	360879.81	4720421.5
2-63		42.62371	-76.696163	360906.18	4720424.3
2-64		42.62371	-76.695241	360981.81	4720422.7
2-65		42.624094	-76.69488	361012.25	4720464.8
2-66		42.625185	-76.693517	361126.49	4720583.7
2-67		42.625333	-76.692875	361189.61	4720600.1
2-12		42.559876	-76.635644	365732.18	4713238.1
2-13		42.560263	-76.634857	365797.57	4713279.8
2-14		42.560842	-76.633605	365901.64	4713342.1
2-15		42.553589	-76.626555	366464.91	4712525.6
2-16		42.563567	-76.639519	365422.04	4713654.1
2-25		42.579317	-76.657322	363994.88	4715431.5
2-26		42.579446	-76.65703	364019.07	4715445.3
2-27		42.579596	-76.656593	364055.27	4715461.3
2-28		42.579982	-76.655661	364132.63	4715502.7
2-29		42.613384	-76.685578	361751.42	4719260.2
312,313		42.647075	-76.700719	360580.08	4723025.8
1st 0's		42.517224	-76.560684	371798.39	4708385.8
2-30 A		42.613118	-76.687141	361623.39	4719225.5
2-67A		42.625363	-76.692594	361205.2	4720602.1
276 (K)		42.602969	-76.678002	362349.87	4718091.3
277 (K)		42.60347	-76.676679	362459.47	4718144.9
278 (K)		42.605359	-76.678041	362351.86	4718356.8
SOS 174		42.408417	-76.511792	375599.48	4696231