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SAVANNAH RIVER LABORATORY QUARTERLY REPORT

HYDROGEOCHEMICAL AND STREAM SEDIMENT
RECONNAISSANCE - EASTERN UNITED STATES

NATIONAL URANIUM RESOURCE EVALUATION PROGRAM

OCTOBER - DECEMBER 1976



SAVANNAH RIVER LABORATORY
AIKEN, SOUTH CAROLINA 29801

PREPARED FOR THE U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION UNDER CONTRACT AT(07-2) 1

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Approved by:

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Analytical Chemistry Division


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**E. I. DU PONT DE NEMOURS AND COMPANY
SAVANNAH RIVER LABORATORY
AIKEN, SOUTH CAROLINA 29801**

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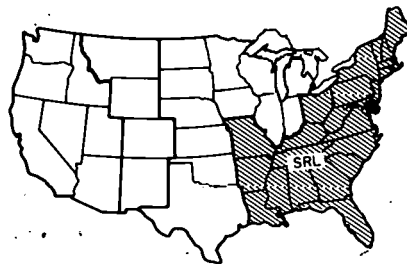


FOREWORD

This progress report is one of a series summarizing accomplishments, status, and program of the Savannah River Laboratory (SRL) contribution to the National Uranium Resource Evaluation (NURE) program. This report is intended for managerial review and for planning purposes. The results and conclusions reported here are preliminary. Formal detailed reports on specific topics will be issued when appropriate. Previous reports (DPST-75-138 and DPST-76-138 series) have been open-filed through the Grand Junction (Colorado) Office of the Energy Research and Development Administration (ERDA). The Grand Junction Office (GJO) has assigned open-file numbers to these documents.¹⁻⁷

The NURE program was begun in the spring of 1973 to evaluate domestic uranium resources in the continental United States and to identify areas favorable for commercial exploration in response to the rapidly increasing national demand for uranium. GJO is responsible for administering and coordinating NURE program efforts. Inputs to the NURE program come from ERDA prime contractors, ERDA-sponsored research and development, the uranium industry, U.S. Geological Survey (USGS), U.S. Bureau of Mines (BuMines), other government agencies, and independent sources.

In 1975, SRL accepted responsibility for hydrogeochemical and stream sediment reconnaissance (HSSR) of twenty-five states in the eastern United States. Oak Ridge Gaseous Diffusion Plant (ORGDP), Los Alamos Scientific Laboratory (LASL), and Lawrence Livermore Laboratory (LLL) have accepted responsibility for similar reconnaissance in the rest of the continental United States including Alaska.



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STATUS AND PROGRAM

HIGHLIGHTS OF FIRST QUARTER OF FY-1977 (OCTOBER-DECEMBER 1976)

Geological Programs

- Contracts were issued for collection of approximately 22,500 ground water samples. Supplies and instruments were checked out and packaged for field use. Training sessions for sampling personnel were completed, and reconnaissance sampling was begun in the Piedmont region of North and South Carolina.
- Final quality assurance evaluation of sampling subcontractor performance was completed. Quality of work was judged to be generally very good.
- Orientation sampling was completed in the Sussex County, New Jersey, area. Stream water and sediment, lake water and sediment, and ground water were collected.
- Thorium and hafnium analyses were shown to be very important in interpretation of uranium distribution in sediments from the Kings Mountain, North Carolina, area.
- A 15-month study of seasonal variability in Oconee, South Carolina, and Brush Creek, North Carolina, showed no effects outside the range of normal sampling and analytical uncertainty. Temporal variation was observed in water with higher uranium content (Kings Mountain, North Carolina, area) and further studies will be made there.
- Concentration of dissolved ions on specially prepared ion exchange resin was studied. Total sampling and analytical error was <25% for uranium concentrations >100 parts per trillion (ppt). Greater than 90% recovery was observed for the 17 elements analyzed.

Laboratory Analyses

- Routine preparation of sediment samples was begun by one subcontractor at a rate of 1500 samples per month. A contract was let for preparation of 20,000 neutron activation analysis (NAA) capsules containing ion exchange resin.

- Procedures were developed and tested for 24-hour daily automated operation of the NAA facility, and simulated malfunction tests were completed.
- The SEL 32/55 computer (Systems Engineering Laboratory, Fort Lauderdale, Florida) for upgrading the NAA facility was received and successfully checked out. Systems software design is proceeding on schedule.
- Recommended elemental values were established for sediment sample SRL-2, which will be used as a routine quality assurance standard. A preliminary list of "reliable elements" has been identified for NAA. Analyses of intersite comparison standards appear to be in reasonable agreement.
- A feasibility and systems study was written for obtaining an inductively coupled plasma and direct arc emission spectrograph.
- A contract was issued for the preparation and analysis of 1950 sediment samples and standards using direct reading emission spectroscopy.

Data Management, Analysis, and Interpretation

- The ARCHIVE module of the Sample Inventory and Control System (SICS) was completed; programming to write sample accounting reports is in progress.
- The digitizer for automatically calculating sample coordinates was interfaced with the SRL-NURE Data Management System (NDMS). Routine use of the digitizer was begun.
- Thirteen new scrub parameters were added to the INPUT module of NDMS.
- Programming was completed to a) expand the selection and extraction (QUERY) function and b) interface NDMS with ARTHUR (a pattern recognition program) and graphics output modules. Final testing is in progress. The interface for the reporting module is nearly complete.
- Full-size symbol plot map overlays (for 1° × 2° sheets) have been produced from computer-generated microfilm. Alternative output options are being evaluated.

Reporting

- Contracts were written for the production of updated geologic maps, which will cover about 30,000 square miles of the southern Appalachian Piedmont and Blue Ridge areas.
- A preliminary raw data release⁸ from an orientation study in the Kings Mountain, North Carolina, area was submitted to ERDA-GJO for open filing.
- Papers were presented at two technical meetings.

PROGRAM FOR SECOND THROUGH FOURTH QUARTERS OF FY-1977

In previous SRL Quarterly Reports, the Program section has dealt primarily with plans for technical development. As the SRL-NURE Program moves further into the production phase, it will be necessary to provide a more detailed outline of the "production schedule." The preliminary SRL-NURE schedule for January-December 1977 is given in Appendix A. It should be noted that development is still in progress, and elements of the schedule given in Appendix A depend on successful completion of the development work outlined in the following section.

Geological Programs

Second Quarter

- Complete ground water reconnaissance in the Piedmont provinces of Georgia, North and South Carolina, and Virginia.
- Prepare and issue specifications for surface sampling for June-September 1977. Review bids and select subcontractors.
- Select areas for orientation studies in Ouachita Mountains and the Ozark and Appalachian plateaus. Prepare and issue specifications; select subcontractors.
- Continue seasonal variability study in the Kings Mountain, North Carolina, area.

Third Quarter

- Complete ground water reconnaissance in eastern Alabama, western Georgia, western North Carolina, western Virginia, Maryland, eastern Pennsylvania, and northern New Jersey.

- Hold training sessions for surface sampling teams and for additional ground water sampling teams. Package supplies and equipment for field use.
- Begin orientation studies in Ozark-Ouachita area and Appalachian plateau. Begin reconnaissance surface sampling in the northern Appalachian, Piedmont, and Blue Ridge areas.

Fourth Quarter

- Complete all remaining reconnaissance sampling (ground water and surface samples) in crystalline rock areas of the eastern United States (except northern Maine which will be covered in FY-1978).
- Complete orientation studies in highland areas.

Laboratory Analyses

Second Quarter

- Review subcontractor procedures (including quality assurance tests) for preparation of ion exchange resin samples for irradiation; begin routine sample packaging.
- Begin daily 24-hour automated operation of the NAA facility.
- Complete analyses of orientation samples from FY-1976; analyze 6000 reconnaissance samples using neutron activation analysis (NAA).
- Complete detailed software design for the upgraded NAA facility.
- Complete preliminary quality assurance program to identify elements reliably determined by NAA. Initiate final quality assurance program for routine control of reconnaissance analyses.
- Begin acquisition of inductively coupled plasma and direct arc emission spectrograph (ICPES).
- Complete subcontracted analyses of 1950 standards and samples using direct reading emission spectroscopy.

Third Quarter

- Analyze 5000 reconnaissance samples using NAA.
- Complete programming for computer to upgrade NAA; test system.

Fourth Quarter

- Analyze 4000 reconnaissance samples using NAA.
- Install computer for high-capacity NAA facility.
- Develop techniques and begin supplementary analyses with ICPEs.

Data Management, Analysis, and Interpretation

Second Quarter

- Complete programming and debugging of Sample Inventory and Control System (SICS), including reports on sample history.
- Complete tests for the EXPANDED QUERY function and the General Purpose Interface (GPI) which will link the NDMS with ARTHUR, the graphics modules, and the reporting modules.
- Complete programs for producing scrubbed, tabular raw data routinely on microfiche for open-file reports.
- Specify the technique for producing map overlays from computer-generated microfilm.

Third Quarter

- Begin producing overlays of point value maps for open-filing.

Fourth Quarter

- Begin to refine NDMS and SICS as required, based on experience with early reconnaissance data.

Reporting

Second Quarter

- Report (for open-filing) raw data from orientation studies of the Crabtree Creek, Moore, and Johnson, North Carolina, areas.
- Issue background geochemical report on the North Harper Creek, North Carolina, area.

- Issue ground water reconnaissance field manual.⁹
- Present paper at the *Geological Society of America* meeting (March 1977) concerning Kings Mountain study; issue topical report on results of orientation study.

Third Quarter

- Report (for open-filing) raw data from sediment reconnaissance of the Winston-Salem, Knoxville, and Greenville USGS 1° × 2° sheets.
- Report (for open-filing) supplementary raw data from orientation studies and raw data from orientation studies in Sussex, New Jersey; Lake Sunapee, New Hampshire; and Wolcott, Vermont, areas.

Fourth Quarter

- Report (for open-filing) raw data from sediment and ground water reconnaissance of the Rome, Charlotte, Spartanburg, and Athens USGS 1° × 2° sheets.
- Issue final report on orientation studies in the Williamsport, Pennsylvania, area.
- Issue report on use of ion exchange resins for hydrogeochemical reconnaissance.
- Draft final report on results of orientation studies of the Spruce Pine, North Carolina, area.

PROPOSED PROGRAM THROUGH FY-1981

As part of the SRL semiannual program review, the operating plan reported in Reference 6 was revised. The revised plan is given in Appendix B. Major revisions in the projected program include:

- Earlier completion of priority areas.
- Reduced unit sampling cost.
- Need for increased surface sampling in some areas.
- Reduced NAA unit cost.
- Need for emission spectrographic analyses of some sediment samples.

Future revisions will be reported in the first and third quarterly reports of each calendar year.

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GEOLOGICAL PROGRAMS

RECONNAISSANCE

A training session was held at SRL for ground water sampling subcontractors and their field personnel on November 30 and December 1, 1976. A detailed manual for ground water sampling served as a text for the training session.⁹ Sampling is proceeding smoothly, and the Charlotte 1° × 2° USGS sheet should be completed on schedule. Samples are scheduled to be analyzed in time for ground water data to be incorporated with stream sediment data in a report to be released in July 1977.

ORIENTATION STUDIES

Samples are being analyzed from two study areas in New England and from one area in North Carolina. Plans for future orientation studies are being developed. Orientation sampling will be resumed in June 1977.

New Jersey Reading Prong

Field work was completed for an orientation study in northern New Jersey. Three hundred sites were sampled. Samples were taken of ground water, stream water and sediment, and lake water and sediment. The study area includes several small but high grade deposits in the Reading Prong. Sampling also covered an adjacent Valley and Ridge area to establish the geochemical contrast between these two geologic provinces.

North Carolina Slate Belt, Triassic, and Coastal Plain

Some data are available from an orientation study in the Slate Belt, Triassic Basin, and adjacent Coastal Plain areas of North Carolina. No uranium occurrences are reported in this area. The uranium content of ground waters from different geologic units in part of the area are summarized in Table 1. Formation names are from Conley, 1962.¹⁰

Most of the interformational variations are easy to explain. For example, the Pinehurst formation is an orthoquartzite rock layer capping hills. Wells in this unit would be expected to represent shallow ground water from a formation with no obvious source of dissolved uranium.

TABLE 1

Uranium Content of Ground Water from
Moore County, North Carolina

<i>Formation</i>	<i>Average Uranium Content of Ground Water, pptr</i>
Pinehurst Formation	15
Tuscaloosa Formation	55
Sanford Formation	550
Cumnock Formation	35
Pekin Formation	1800
Andesitic Tuff	20
Mafic Tuff	155
Felsic Tuff	75

Of considerable interest is the variation of uranium content of ground water in the three Triassic formations. Redbeds in the Pekin and Sanford formations yield ground water that is 15 to 50 times higher in dissolved uranium than ground water from the strongly reduced and organic-rich Cumnock formation.

Uranium content of stream sediments in this region seems to be highest (up to 500 ppm) from streams which are actively eroding the predominantly fluvial upper member of the Tuscaloosa formation. The uranium values may be related more to heavy mineral accumulations than to possible uranium ore concentrations. Detailed evaluation of supplementary elemental data is necessary to interpret uranium distribution.

Kings Mountain, North Carolina

The Kings Mountain area was chosen³ for an orientation study primarily because abundant monazite of unusually high uranium content occurs in stream sediments.¹¹ The area also includes a variety of mineral occurrences and geologic terranes.¹²⁻¹⁶ No uranium mineralization other than the high uranium monazite was known to us at the time the sampling network was established.

Figure 1 is a graph of uranium versus thorium in sieved (-100 +200 mesh) stream sediment samples from this area. The uranium/thorium ratio varies from about 1 to 0.07 and decreases with increasing uranium and thorium values. Published data¹¹ indicate that monazite in this area has a uranium/thorium ratio in the range 0.15 to 0.02. Monazite can thus account for the uranium content of only about 35% of our samples. Data of Hurley

and Fairbairn¹⁷ indicate an average uranium/thorium ratio of about 2, with a range from about 0.5 to 15 for zircons in felsic plutonic rocks. Both the total (U + Th) and variations in the uranium/thorium ratio apparently can be accounted for by (1) variation in the ratio of zircon plus monazite to quartz (low uranium minerals), and (2) variation in the zircon/monazite ratio.

Zircon abundance must be considered a potentially strong factor influencing interpretation of uranium content of stream sediments. Figure 2 is a plot of uranium/hafnium ratios for the Kings Mountain area sediments. Samples from the Charlotte belt are uniformly lower in uranium/hafnium ratios than samples from the more-sialic Kings Mountain and Inner Piedmont belts. The line A-A' has been arbitrarily chosen by inspection of the graph as an anomaly break for uranium/hafnium ratios. Samples plotted above this line contain uranium from minerals other than zircon, or from zircons which are enriched in uranium. Silver¹⁸ argues that high uranium zircons are characteristic of granites which served as source rocks for uranium in Colorado Plateau deposits.

Figure 3 shows sites of samples with "anomalous" uranium/thorium and uranium/hafnium ratios. The uranium concentration in ground water is shown by the contour lines. Three samples have both anomalous uranium/thorium and uranium/hafnium ratios, and coincide with the area of highest uranium in ground water.

Proper interpretation of uranium concentrations in these sediments may well require consideration of other elemental ratios, or possibly even detailed mineralogical studies. Mineralogical studies are considered too costly for the initial reconnaissance effort, but may well be justified in later followup studies.

A literature search revealed a single report¹⁹ of uraninite occurring in a mica mine near the area of coinciding anomalies. It is suggested that the anomaly area might contain rare metal pegmatites, which were not investigated in the past because of their low mica content, but which may possibly contain concentrations of rare metals including uranium.

Surface water data yield an anomaly pattern similar to ground water data. However, these data are not considered conclusive because mining and milling operations in the area may have altered the natural distribution of uranium in surface water.

Only uranium/thorium and uranium/hafnium ratios are discussed above. Previous reference (Reference 6, p 27) was made to potentially useful correlations with lithium, beryllium, strontium, and phosphorus. No key element, ratio, or combination has been identified as universally useful for interpretation. Detailed interpretation of other analytical data is in progress.

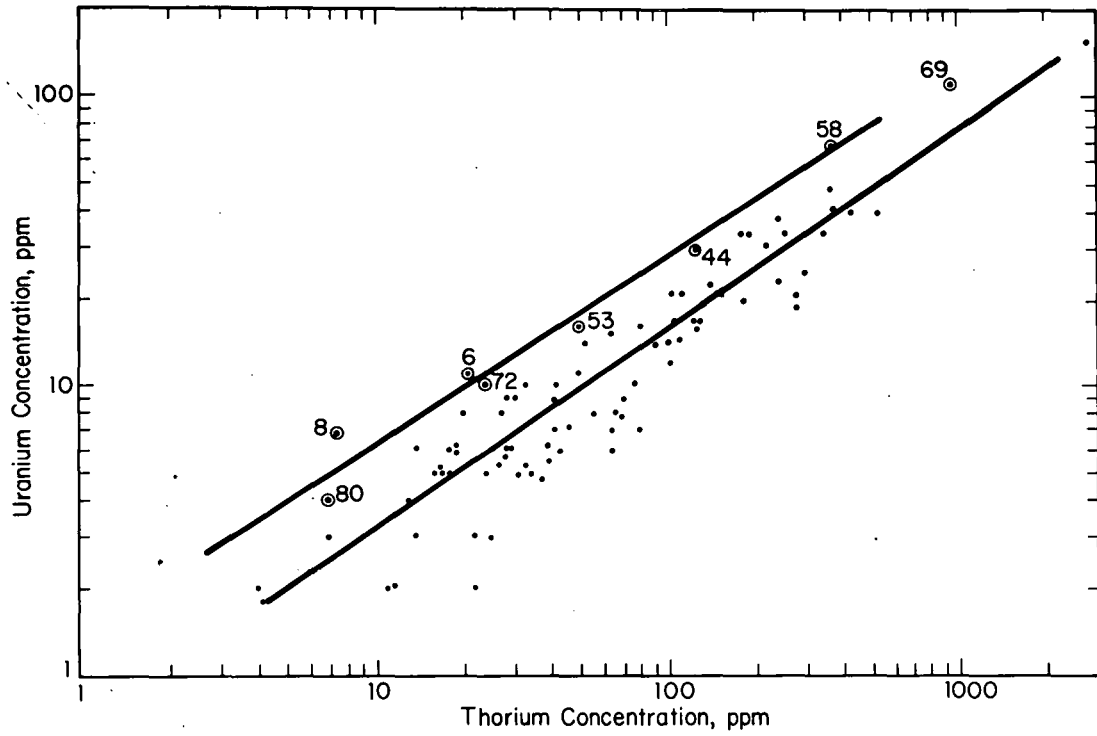


FIGURE 1. Uranium *versus* Thorium in Samples from the Kings Mountain, North Carolina, Area

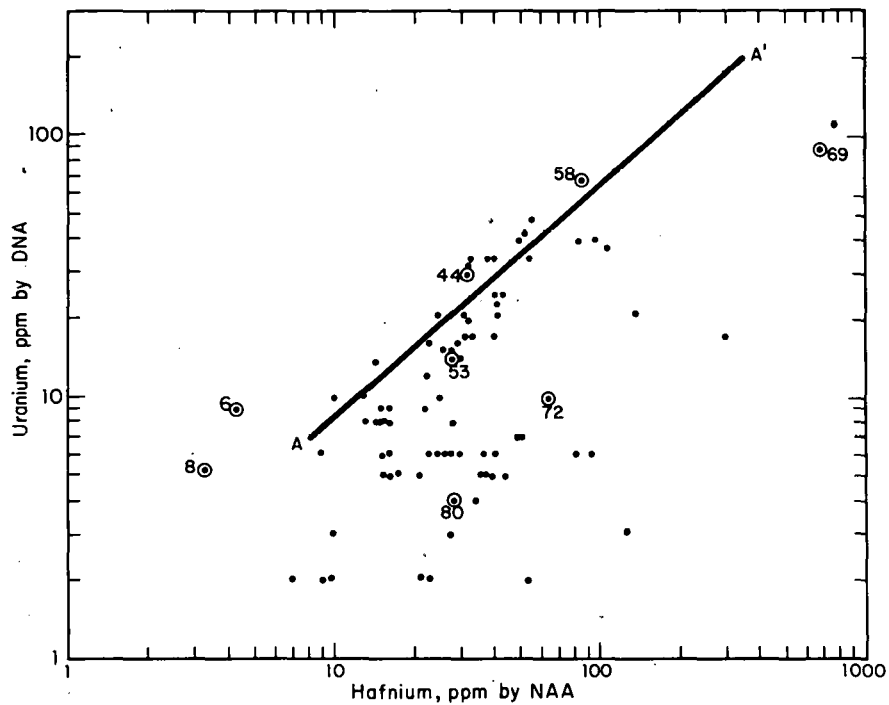


FIGURE 2. Uranium *versus* Hafnium in Samples from the Kings Mountain, North Carolina, Area

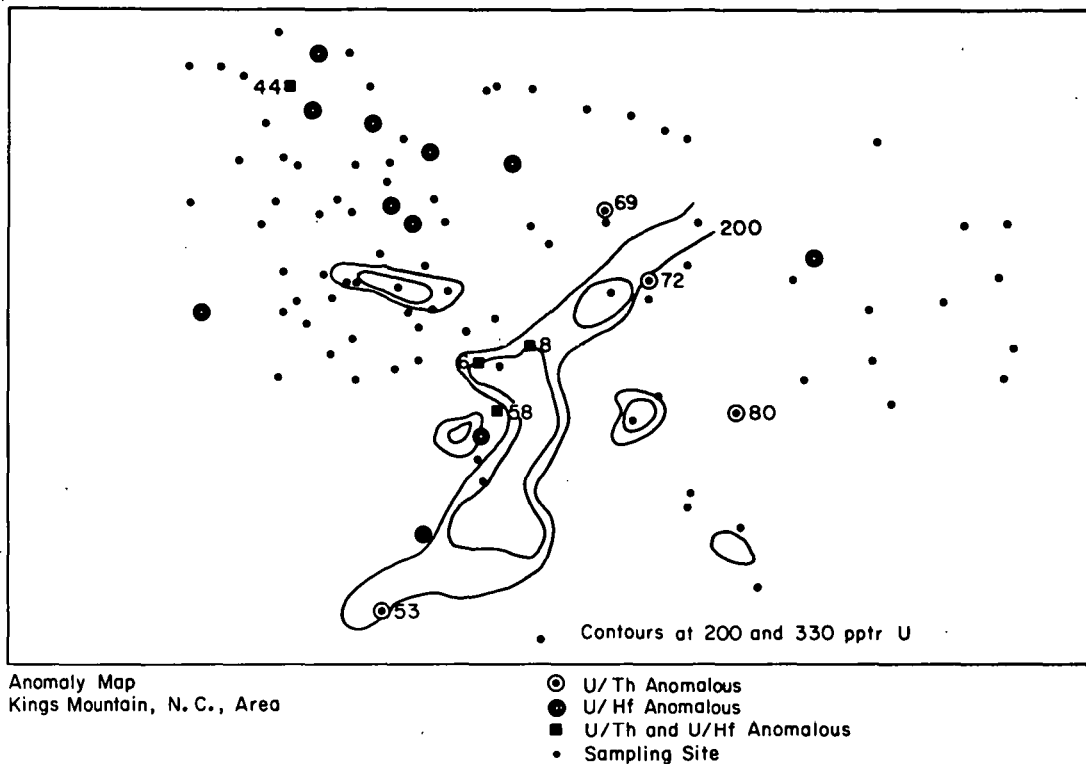


FIGURE 3. "Anomaly Map" for the Kings Mountain, North Carolina, Area

Other Studies

Sampling Error

The total analytical and sampling error is less than about 25% for samples with >100 pptr uranium. Figure 4 shows the coefficient of variation (V) *versus* the mean uranium content (\bar{X}) for ground water sites sampled in replicate (raw data are taken from Table 2).

Seasonal Variability

Six sites chosen earlier for seasonal variability studies all had average uranium concentrations of <100 pptr. No significant trends of variation could be demonstrated for these sites.

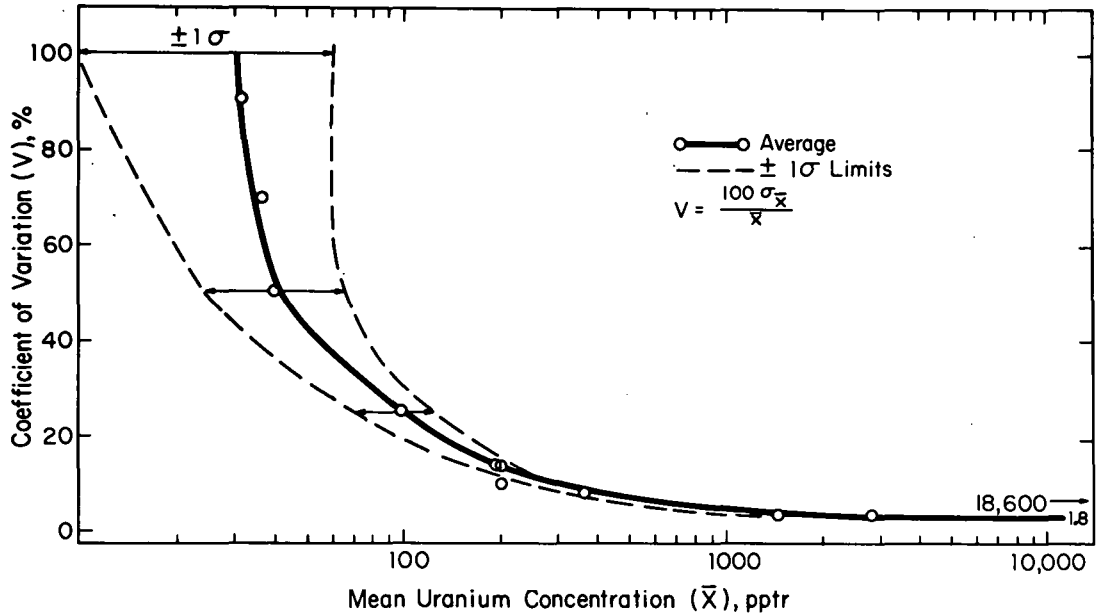


FIGURE 4. Coefficient of Variation *versus* Mean Uranium Content in Ground Water

Four sites from the Kings Mountain, North Carolina, area were sampled in replicate and the data are reported in Reference 8, Table 2. A variation of more than 3σ as estimated from Figure 4 was found between samples taken one year apart at each of these sites. Since this implies that significant temporal variations do exist, several new ground water sampling sites containing higher levels of dissolved uranium have been established to evaluate further any possible problems caused by seasonal variations.

Even though absolute levels of uranium in ground water are observed to change at a given site, the relative values at various sites retain their order; that is, clearly anomalous sites remain clearly anomalous. Furthermore, "anomaly-to-background ratios" in ground water have been large enough to persist in spite of temporal variations observed to date.

Coastal Plain Areas

Most SRL sampling to date has been in areas of predominantly oxidizing ground water, where uranium is expected to be relatively soluble. Large areas of the Atlantic and Gulf Coastal Plains may be underlain by formations in which uranium is not soluble in the ground water. Determination of dissolved uranium content may, by itself, be insufficient to yield results which can be related to the uranium resource potential in such areas.

An orientation study is planned in the South Carolina Coastal Plain to investigate the distribution of radon, radium, uranium, and perhaps other related elements. The study will deal with: (1) an area with known high amounts of dissolved radium, and (2) an area where the Coastal Plain formations contain significant amounts of phosphate rock relatively high in uranium. Subsurface conditions in Coastal Plain areas are quite different from other areas studied to date and may require application of different reconnaissance techniques. This study is being planned to provide enough lead time to develop alternative methods for Coastal Plain reconnaissance in FY-1979 if these are needed.

TABLE 2

Reproducibility of Uranium Analyses by Resin Concentration

<i>Site</i>	<i>U Conc., pptr</i>	<i>Standard Deviation, ±pptr</i>	<i>Site</i>	<i>U Conc., pptr</i>	<i>Standard Deviation, ±pptr</i>
1 ^a	183,000	3300	6	50	20
	187,000			20	
	191,000			20	
	183,000			70	
	<u>187,000</u>			<u>35</u>	
<i>Average</i>	186,000		<i>Average</i>	40	
2	180	32	7	390	30
	150			320	
	220			370	
	<u>210</u>			<u>390</u>	
<i>Average</i>	190		<i>Average</i>	<u>350</u>	
3	1,490	50	8	20	30
	1,410			10	
	1,400			<u>70</u>	
	<u>1,490</u>				
<i>Average</i>	1,450		<i>Average</i>	33	
4	2,700	100	9	230	30
	2,900			170	
	2,910			<u>185</u>	
	2,830				
	<u>2,720</u>				
<i>Average</i>	2,810		<i>Average</i>	195	
5	200	35	10	30	26
	205			65	
	230			<u>15</u>	
	<u>170</u>				
<i>Average</i>	200		<i>Average</i>	37	

a. Direct delayed neutron activation analysis of 10 ml of filtered water (not concentrated on resin) gave values of 184,000 pptr and 189,000 pptr.

DEVELOPMENT OF FIELD TECHNOLOGY

A special, high-purity, mixed anion-cation, ion exchange resin is used to concentrate the uranium from ground water samples as described in a previous report.³ Two detailed studies were undertaken to measure the reproducibility of uranium concentrations and analyses, and to determine multielement recovery efficiencies.

The results of the reproducibility test of uranium concentration and analysis are summarized in Table 2. Multiple samples were taken from ten ground water sites in North Carolina. The filtered ground water samples (one liter each) were concentrated on ion exchange resin in the field. The recovered resins were analyzed for uranium by delayed neutron activation analysis. A 10 ml sample of filtered ground water from Site 1 was also analyzed by direct delayed neutron activation analysis.

Table 3 summarizes the efficiency with which various elements were concentrated by the ion exchange resin. Samples (100 ml each) of filtered ground water before and after ion exchange were slowly evaporated to dryness on spark source mass spectrometry electrodes in Class 100 clean benches. Greater than 90% of all elements detected were removed by the resin.

QUALITY ASSURANCE

Five hundred forty-three (543) sampling sites were inspected by six different inspection teams. The sites inspected were in five states and included localities sampled by all three major subcontractors. Of the 543 sites inspected, a total of 17 errors were found. Nine of these errors were potential major errors; that is, the actual sampling sites were not located. Eight were minor errors; that is, actual sampling sites were in error by <0.8 mile. The errors were determined to have had no significant adverse effect on sampling validity. Table 4 summarizes the findings.

The overall rate of "major" error is <2% and is acceptable for a reconnaissance program. In addition, this rate assumes that all errors were on the part of samplers, not checkers. This may not be a valid assumption. The designation of errors as "major" is, of course, arbitrary. Most of the sites judged to be seriously in error were simply not found. They might well have been located nearby.

In the previous quarterly report,⁷ a five-point quality assurance program for SRL field subcontractors was described. An additional quality assurance measure (*viz.*, screening of field data cards) has proven to be a very valuable early warning signal of laxness on the part of field personnel. Field crews that were error prone in filling out field cards (e.g., omitted sampling date, transposed figures, etc.) were found to have the highest error rate in accurately reporting sampling site locations.

TABLE 3

Elements Removed from Ground Water Samples by Ion Exchange Concentration

Element	<i>Concentration of Elements in Ground Water, ppm^a</i>		
	<i>Before Ion Exchange</i>	<i>After Ion Exchange</i>	<i>% Removed by Resin</i>
B	3	0.003	99.9
F	1	<0.09	>91
Na	4	0.04	99
Mg	0.7	0.0008	99.9
Al	0.01	<0.001	>90
Si	0.07	0.002	97
P	0.007	0.0007	90
S	0.2	0.003	98
Cl	1	0.02	98
K	2	0.02	99
Ca	2	0.006	99.7
Cr	0.02	0.0002	99
Mn	0.07	0.001	98
Fe	0.3	0.02	93
Ni	0.05	<0.002	>96
Br	0.09	<0.003	>97

a. Analyses by spark source mass spectrometry of residue.

Subcontractor A (Table 4) was inspected most heavily because his field cards had a relatively high error rate. His rate of potentially serious field errors was over five times as high as that of the other subcontractors. Conversely, Subcontractors B and C had very low error rates in both field cards and site locations.

Data cards will be automatically screened in future field programs.

TABLE 4

Summary of Field Inspection Program, June - October 1976

<i>Contractor</i>	<i>Sites Sampled</i>	<i>Sites Inspected</i>	<i>Major Errors</i>	<i>Major Error Rate, %</i>	<i>Minor Errors</i>	<i>Minor Error Rate, %</i>
A	3,153	148	6	4.1	2	1.4
B	5,103	143	0	0	3	2.1
C	<u>8,160</u>	<u>252</u>	<u>3</u>	<u>1.2</u>	<u>3</u>	<u>1.2</u>
Total	16,415	543	9	1.7	8	1.5

LABORATORY ANALYSES

SAMPLE PREPARATION

Certification of the sediment preparation subcontractor was completed following a final quality assurance inspection. Routine preparation of neutron activation analysis (NAA) capsules was begun. Nominal preparation rate is at least 1500 samples per month, the minimum called for in the contract. The subcontractor has agreed to cooperate in determining his maximum production rate. (A rate of 2100 samples per month would meet program needs in peak years of FY-1978 and FY-1979.) The current backlog of prepared NAA capsules is ~4000.

A contract was written for preparation of 20,000 NAA capsules containing ion exchange resin. The contract calls for preparation of 5000 capsules by March 31, 1977, and 20,000 by December 31, 1977. A clean facility, being constructed to SRL specifications, will be operational in February 1977.

NEUTRON ACTIVATION ANALYSIS

The SEL Model 32/55 computer (Systems Engineering Laboratory, Fort Lauderdale, Florida) was received. All maintenance and demonstration programs for hardware and vendor-supplied software were successfully run. Control, data acquisition, and data reduction will be provided by this computer for the upgraded NAA facility. Detailed software design is scheduled for completion in the second quarter of FY-1977.

Elemental analysis data for approximately 1200 samples were reduced through the Neutron Activation Data System (NADS). Un-scheduled outages in the pilot NAA facility reduced the number of samples processed to only ~1500. Several alternative schemes are being evaluated for getting back on schedule.

Procedures were developed and tested to allow unattended activation of reconnaissance sediment samples. All pilot NAA facility hardware and computer programs for data acquisition and reduction are now operational. Exposure tests (simulated malfunction) have shown that integrity of sediment-containing capsules remains satisfactory under at least 16 hours of full flux exposure. Empty capsules, although discolored, retained structural integrity under hammer blows after 24 hours of full flux exposure.

QUALITY ASSURANCE

The precision and accuracy of NAA for uranium and supplementary elements are being determined by (1) analyses of standards and intersite comparison samples, and (2) sample crosschecks using independent analytical methods. Sample results are being examined closely for significant trends of spurious events. This phase of the quality assurance effort is progressing well and should be completed during the next quarter.

After the above examination is complete, bias corrections and/or improved calibration will be applied to the RICHES NAA data reduction program.⁷ (RICHES values reported below are preliminary and uncorrected.) Precision and accuracy values will be established for all measurements and standards will be run routinely. (Up to 8% standards and blanks will be run initially.) Results obtained for standards must agree with accepted values within specified limits before results on samples are considered to be valid and reportable.

A summary of uranium values obtained at SRL for intersite comparison samples and for Oak Ridge water and sediment standards is shown in Table 5. In general, SRL values appear reasonable.

A summary of multi-element values obtained on SRL-2 is given in Table 6. SRL-2 is an intersite comparison sample that will be used as one of several control standards at SRL. For the first 13 elements listed in Table 6, SRL values are based on two or more independent methods. Cross-checks between SRL and Los Alamos Scientific Laboratory (LASL) and/or Lawrence Livermore Laboratory (LLL) are available for 10 of the 13 elements. SRL values are in significant disagreement with LASL and LLL only for chromium.

For the last 12 elements listed in Table 6, SRL values are based on a single method. SRL values appear to be satisfactory for 8 of the 12 elements and appear to be in error for sodium and potassium. The SRL value for potassium (Table 6) was determined by plasma-emission spectroscopy, not NAA. Insufficient data are available to evaluate the accuracy of calcium and molybdenum values.

SRL values are based upon neutron activation, emission spectroscopy (direct current arc excitation), and direct reading emission spectroscopy (plasma source excitation). Analyses by the latter technique were done for SRL by Barringer Research Limited (Toronto, Canada).*

SRL neutron activation results are being compared with results from several other sources to verify the accuracy of specific elements by neutron activation analysis. Comparison data for vanadium are summarized in Table 7. The neutron activation values obtained for vanadium appear to be reasonable and valid, although final accuracy and precision values have not been determined. In general, considering comparison data reviewed to date, neutron activation analyses appear to be valid for V, Ti, Al, Mn, Hf, Th, K, and Sc. Verification of other elements is in progress.

OTHER ANALYTICAL TECHNIQUES

As a result of a feasibility and systems study, the acquisition of an automated spectrometer having D.C. arc and plasma-coupled excitation sources is recommended. This instrument will permit measurement of elements which cannot be determined reliably by NAA.

A subcontract was written with a local university to provide direct reading emission spectrographic analyses of 1950 samples and standards. The instrument was set up according to SRL specifications to analyze for 39 elements.

* No endorsement either by E. I. du Pont de Nemours and Co. or by USERDA is intended by this reference.

TABLE 5

Uranium Values for Intersite Comparison Samples and Oak Ridge Standards

A. Values Obtained on Intersite Comparison Samples

Laboratory	Uranium Concentrations, ppm							
	LLL-1	LLL-2	SRL-1	SRL-2	ORGDP-1	ORGDP-2	LASL-3	LASL-4
SRL	6.5	7.0	1.3	9.0	1.4	2.4	3.3	5.2
LASL ^a	6.7	7.3	1.7	9.1	2.0	2.6	3.5	4.9
LLL ^b	7	7.3	1.2	6.6	1.2	2.1	2.6	5.2
ORGDP ^c	-	6.8	-	8.0	-	2.4	-	5.0

B. Oak Ridge (Y-12) Water and Sediment Standards

Laboratory	Uranium Concentrations					
	Water Standards, ppb			Sediment Standards, ppm		
	A-1	B-1	C-1	R-1	S-1	T-1
Assumed as Nominal Value	0.82	7.8	100	5	10	95
SRL	0.87 ^d	7.4 ^e	94 ^f	5.1 ^g	11.1 ^g	95 ^g
LASL	0.76	7.2	-	5.4	-	93
LLL	0.86	8.6	-	5.3	12.0	-
ORGDP	-	-	-	5.3	10.6	-

- a. Los Alamos Scientific Laboratory; see Reference 20.
 b. Lawrence Livermore Laboratory; see Reference 21.
 c. Oak Ridge Gaseous Diffusion Plant; see Reference 22.
 d. Average of four runs.
 e. Average of two runs.
 f. One run.
 g. Average of three runs.

TABLE 6

Recommended Values for SRL-2 Intersite Comparison Standard

Element	Concentration, ppm				% Error of SRL Value
	LLL Value ^a	LASL Value ^a	SRL Value ^b	Proposed Best Value	
V	-	32	28	30	7
Ni	-	-	3	3	-
Cu	<90	-	29	29	-
Zn	24	-	25	24	4
Cr	41	34	6	-	-
Co	2.0	3	<5	2.5	-
Be	-	-	0.9	0.9	-
Ba	-	55	38	46	17
Pb	-	-	18	18	-
Al	-	11,000	8300	9600	14
Ti	-	8400	6500	7400	12
Mn	-	140	100	120	17
Hf	40	72	53	55	4
Na	76	100	1900	88	>100
K	370	<1000	14,000	370	>100
Sc	2.5	3.4	3.0	3.0	0
Fe	5700	65,000	6000	5800	3
La	61	96	50	69	28
Mg	-	<5000	200	200	-
Ca	4000	-	130	-	-
Zr	1800	-	1000	1400	29
Mo	26	-	<5	-	-
W	0.9	-	<200	0.9	-
Dy	-	11	6.6	9	27
Sm	-	15	26	20	30

a. See footnotes a and b in Table 5.

b. Data reduction programs are being refined; consequently, final values may be changed slightly.

TABLE 7

Comparison of Vanadium Results

Sample ^a	Vanadium Concentrations, ppm			
	Neutron Activation at SRL ^b	Plasma Source Emission Spectroscopy by Barringer ^c	D.C. Arc Emission Spectroscopy at SRL	Neutron Activation at LASL ^d
54 PA Field Samples ^e	1.00	1.35		-
53 NC Field Samples ^e	1.00	0.95	-	-
SRL-2	26	32, 27 ^f	20	32
OR-2	45	-	55	-
LASL-3	58	-	80	79
NCCL-16	39	38	40	-
NCCL-19	28	27	25	-
NCCL-92	54	77	50	-
NCCL-94	190	40	125	-

- a. SRL-2, OR-2, and LASL-3 are intersite comparison samples; NCCL-16, -19, -92, and -94 are field samples from Cleveland County, North Carolina. These NCCL sites are singled out because they were expected to be especially troublesome.
- b. Values obtained by NAA using preliminary RICHES parameters.
- c. Barringer Research Ltd. (Toronto, Canada).
- d. See Reference 20.
- e. Relative values for Pennsylvania and North Carolina samples.
- f. Barringer Research Ltd. obtained an average of 32 ppm for SRL-2 samples analyzed along with the Pennsylvania field samples; and an average of 27 ppm for SRL-2 samples analyzed along with the North Carolina field samples.

DATA MANAGEMENT, ANALYSIS, AND INTERPRETATION

SAMPLE INVENTORY AND CONTROL SYSTEM (SICS)

Programming for the ARCHIVE module of the SICS has been completed. Checkout has begun on this coding, which moves data between disk file and tape file. Data will be archived from the SICS system after all movements of a sample have been completed.

Programming of the REPORT module (which prints several types of reports) is 60% complete. The design format of the various reports has been completed. Several report formats were modified to provide historical SICS data cumulatively and weekly.

INPUT AND DATA FILE PROCESSING

The Summagraphics (Fairchild, Connecticut) Model HW12 digitizing system, which was successfully coupled to a PDP-11/45 computer, has been transferred to the SRL-NURE map room. The four application programs which convert electronic digitizing signals to longitude and latitude⁷ are fully operational. Digitizing of reconnaissance sample sites has begun. Reproducibility to ± 0.0005 degree is routinely attainable on maps having a scale of one inch per mile.

The SRL-NURE Data Management System (NDMS) was modified to add thirteen new scrub parameters to the INPUT module. This modification allows tighter scrubbing of reconnaissance field data, c.g., pH range of 4-9 instead of 1-12, etc. This scrub modification required only minor programming changes because of the flexible design of the NDMS. These new parameters will aid in screening field cards for errors and will simplify reporting of field data.

Programming to expand selection and extraction ability of the QUERY module is completed pending final tests. The EXPANDED QUERY module can select site data based on any combination of up

to fifty selection parameters. The EXPANDED QUERY module recognizes six operators (AND, <, >, ≤, ≥, =). These operators are used to construct the selection question as illustrated below.

QUERY: Select data from North Carolina sites between 80°-82° longitude; 35°-36° latitude; pH greater than 7.0; conductivity less than or equal to 300; uranium concentration in sediments greater than 10 ppm; and thorium concentration less than 50 ppm.

CODING: NC (AND) ≥ 80° long. (AND) ≤ 82° long.
(AND) ≥ 35° Lat. (AND) ≤ 36° Lat. (AND) pH > 7.0
(AND) cond ≤ 300 (AND) U_{sed} > 10 (AND) Th_{sed} < 50 —

ANALYSIS AND OUTPUT

A module has been developed to interface the EXPANDED QUERY output with ARTHUR (a pattern recognition program), CUMFREQ (a program to calculate and plot cumulative frequency distributions), and MAP (a program to plot elemental concentration symbols on map overlays). This module reads the unformatted records written by QUERY and user-specified formats, and writes formatted card images to disk. These card images are then available for ARTHUR, CUMFREQ, and MAP to read.

This same interface is being expanded to allow printing of tabular reports based on user specified formats. The expanded module will be used to print reports for releasing raw data from reconnaissance surveys.

The MAP subroutine is being modified to draw maps using a Transverse Mercator projection. This modification is necessary so that full-size maps made from computer-generated microfilm will overlay a standard 1° × 2° USGS map more exactly than current rectangular plots.

A description of options being considered for map production is given in Appendix C.

REPORTING HSSR RESULTS

GEOLOGIC MAPS

Subcontracts were written for updated geologic maps to serve as base maps for four 1° x 2° USGS maps for data releases. These releases are planned for the second and third quarters of FY-1977. The areas are in the Appalachian Piedmont and Blue Ridge where most published maps are outdated. In addition to updating regional geology, the maps and explanatory texts will include occurrences of uranium minerals and other items thought pertinent to interpretation of SRL geochemical data. If these initial maps and explanatory texts are of high quality, additional subcontracts may be written for selected sheets where base maps are judged to be outdated and where qualified subcontractors can be found.

DATA RELEASES

Data from the Kings Mountain, North Carolina, area were submitted to the Grand Junction Office of ERDA for open-filing.⁸ This report includes multi-element results for sediment samples by plasma emission spectroscopy, in addition to uranium and thorium by NAA. This is the first SRL-NURE report to contain field data on microfiche, computer-generated cumulative frequency plots, and symbol plots of uranium concentration values.

PUBLICATIONS

A report on the background geology of the Spruce Pine, North Carolina, area was drafted and submitted for editorial processing. A topical report on the use of ion exchange resins for hydro-geochemical reconnaissance is in preparation.

A field manual for ground water sampling⁹ was completed and is being used by subcontractors in reconnaissance sampling now in progress. The manual will be released for external publication in January 1977.

Papers were presented at the *20th Conference on Analytical Chemistry in Energy and Environmental Technology* (Gatlinburg, Tennessee) and the *5th Geochautauqua of the International Association of Mathematical Geologists* (Syracuse, New York). Titles

were "Pilot Scale Reactor Activation Facility at SRL" and "Data Management and Analysis Systems for Large-Scale Hydrogeochemical Reconnaissance," respectively.

A detailed reporting plan for the SRL-NURE program was prepared. This preliminary plan is given in Appendix C.

APPENDIX A. SRL-NURE SCHEDULE FOR JANUARY THROUGH
DECEMBER 1977

SUMMARY

This Appendix outlines the preliminary SRL-NURE CY-1977 schedules for sample collection (Table A-1), preparation (Table A-2), and analysis (Table A-3). The reporting schedule is given in the Status and Program section of the text.

SAMPLE COLLECTION

The tentative schedule for ground water and surface sampling is given in Table A-1. A backlog of ground water samples will be collected in December 1976 for the resin preparation subcontractor who begins work in February. Ground water data should be available for open-filing with sediment data by the Fourth Quarter, FY-1977. As much as possible, having to open-file two sets of data from the same area will be avoided. Our first four reports will contain only sediment data. Supplementary ground water data will be reported in First Quarter, FY-1978. The ground water sampling plan (Figure A-1) considers the following factors:

- Open-filing ground water data with sediment data while maintaining the proper priority sequence.
- Sampling contiguous areas as near the same time as possible to avoid serious temporal effects.
- Availability of subcontractors.
- Weather

TABLE A-1

Sample Collection Schedule

	<i>On Hand</i>	<i>Number of Samples, in thousands</i>			<i>Total</i>	
		<i>FY-1977</i>	<i>FY-1978</i>			
		<i>2Q</i>	<i>3Q</i>	<i>4Q</i>	<i>1Q</i>	
Ground Water	2	5	8	10	4	29
Sediment	23	-	2	6	6	37

Sediment sampling will resume in May 1977 and continue through October. The sediment sampling schedule will not immediately affect other aspects of the program because of the 23,000 sediment sample backlog already on hand. Sampling during May-October 1977 will supply a backlog of samples for analysis during FY-1978 (Figure A-2).

Samples will begin arriving at SRL at a rapid rate in June 1977 (Figure A-2). It will be necessary to have all operating systems debugged and finalized by that date. Implementation of full-scale analytical systems will not be complete until October, however.

SAMPLE PREPARATION

The sample preparation schedule (Table A-2) is consistent with current contracts. The sediment preparation subcontractor has demonstrated a production rate of about 400 samples per week, which will enable them to fulfill the first phase of their contract (i.e., to supply 5000 prepared samples by December 31, 1976).

Table A-2

Sample Preparation Schedule

	<i>On Hand</i> ^a	<i>Number of Samples, in thousands.</i>					<i>Total</i>
		<i>FY-1977</i>			<i>FY-1978</i>		
		<i>2Q</i>	<i>3Q</i>	<i>4Q</i>	<i>1Q</i>		
Sediment ^b	5	5	5	5 ^c	5 ^c	25	
Resin ^d	-	4	6	6	6 ^c	22	

a. Through December 31, 1976.

b. Production rate of current subcontractor is nearly sufficient to meet peak demands through completion of the program.

c. An extension of current contracts will be required to maintain production.

d. Production rate of current subcontractor will have to be increased 60% to meet peak demand in FY-1978 and following years.

The resin preparation subcontractor was originally scheduled to begin operation January 3, 1977. Operation has been delayed 30 days due to a delay in delivery of clean benches. During January, the subcontractor should complete preparing quality assurance samples. Production should begin no later than February 1, 1977. Expected production rate is about 400 to 500 per week.

No problem is anticipated in keeping the NAA Reactor Activation Facility (RAF) supplied with capsules for activation.

ANALYSIS

The tentative NAA schedule is given in Table A-3. This schedule assumes Regime A (Reference 2) irradiation counts of 40 cycles (10 minutes) for resin samples and 20 cycles (5 minutes) for sediment samples.

TABLE A-3

Analytical Schedule

	<i>Number of Samples, in thousands</i>				
	<i>FY-1977</i>			<i>FY-1978</i>	<i>Total</i>
	<i>2Q</i>	<i>3Q</i>	<i>4Q</i>	<i>1Q</i>	
Sediments	5	4	2	6	17
Resins	1	1	2	4	8

The proposed schedule should keep the RAF fully occupied and supply the needed data for reports on the proper schedule.

By the end of FY-1977, production of analytical data should have outstripped our ability to report that data. A two-month shutdown to upgrade the RAF (late August to late October) should not adversely affect other aspects of the program. The backlog of samples collected by the end of FY-1977 plus the steady flow of ground water samples collected during the fall and winter should keep the RAF operating at full capacity after October 1977.

Small outside contracts will probably be written as needed for multi-element analysis using direct reading emission spectroscopy (DRES) until our own DRE spectrometer is operational.

REPORTING

The reporting schedule is given in the text. The schedule is optimistic. It assumes the following:

- Computer programming to output reports is complete by January 3, 1977.
- All analytical data are available on schedule.
- At least one additional geochemist is added to our staff.
- No significant unanticipated problems arise to divert personnel from work on the reports.

Further details of reporting are discussed in Appendix C.

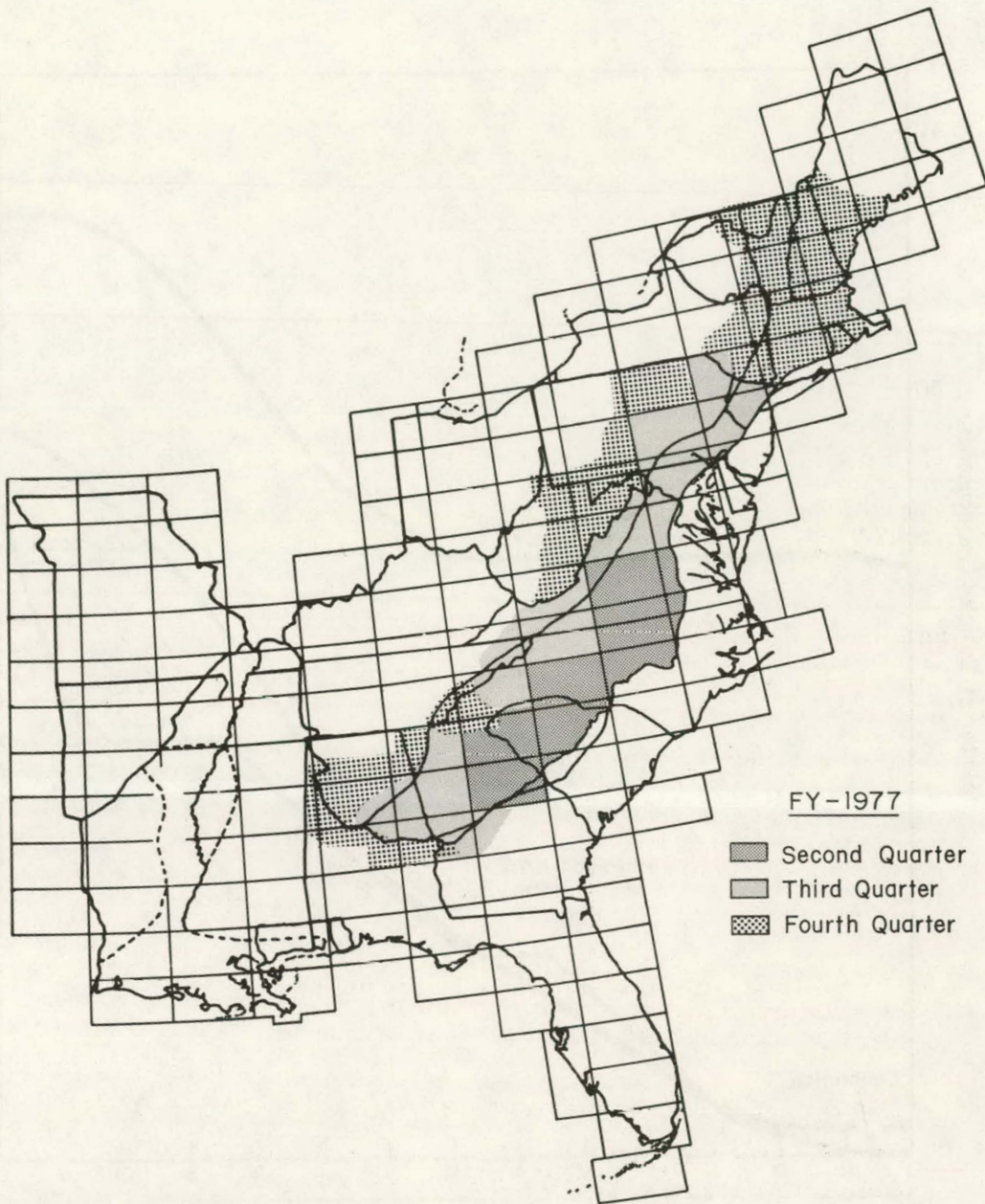


FIGURE A-1. Tentative Schedule for Water Sampling for 1977

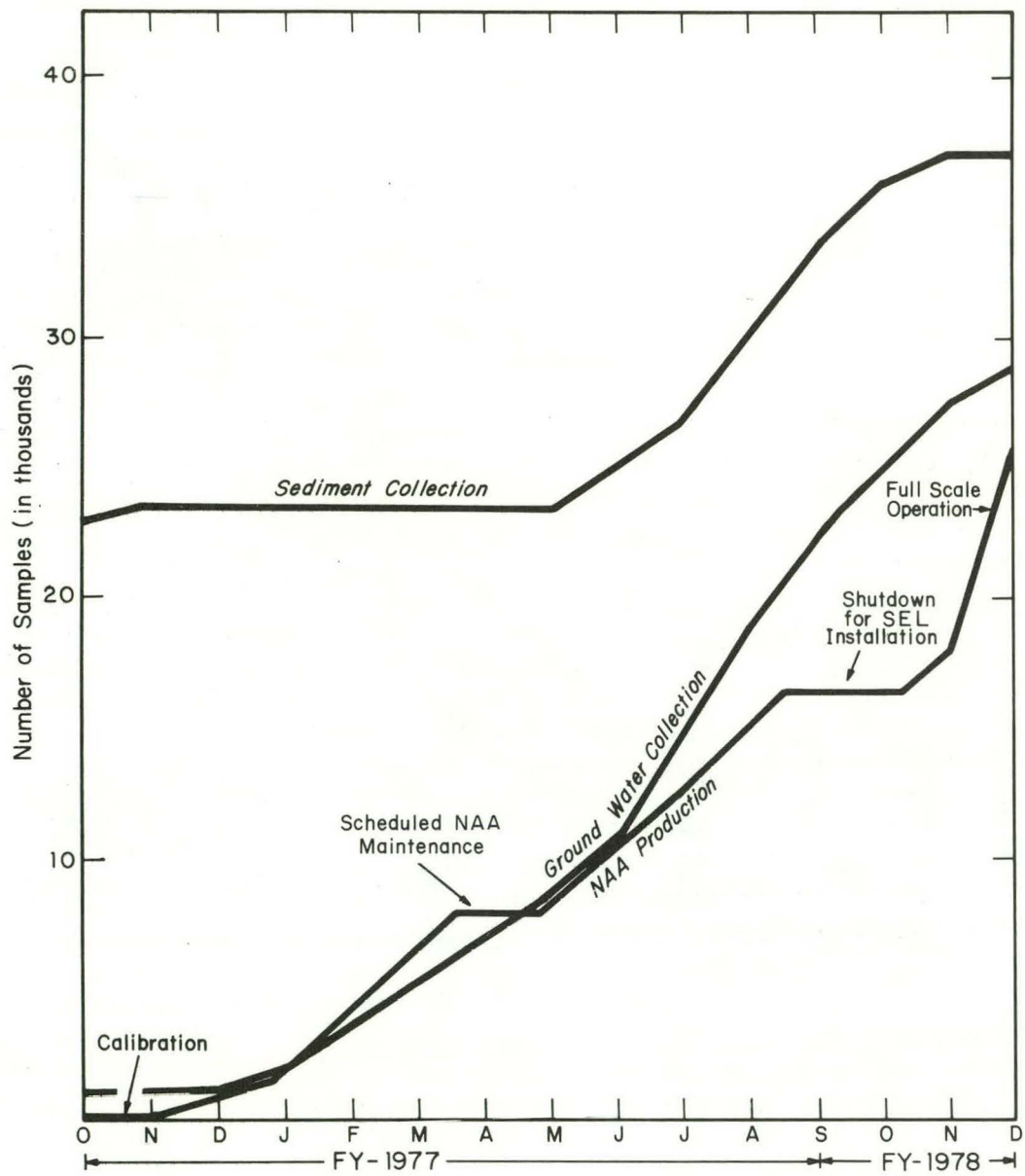


FIGURE A-2. Collection and NAA Schedule (October 1976 through December 1977)

APPENDIX B. SRL-NURE HSSR OPERATING PLAN FOR FY-1977 THROUGH FY-1981

SUMMARY

This Appendix revises the operating plan proposed for SRL participation in the NURE Hydrogeochemical and Stream Sediment Reconnaissance (HSSR) Program directed by ERDA-GJO.⁶ The plan allows SRL to reach its optimum level of effort in FY-1978. Completion of the reconnaissance is projected for March 1981.

INTRODUCTION

This plan is designed to obtain optimum areal coverage with minimum compromise of technical validity within program funding constraints. Geographic areas will be covered on a priority basis determined by geologic favorability, feasibility, and need for information. Priority will also be given to those program elements offering the earliest and most effective return in terms of the program objectives. Technical details of the SRL plan will be updated semiannually as information from orientation studies is analyzed to determine the minimum requirements for recognition of valid anomalies in each physiographic and geologic setting.

Meeting the HSSR objectives is the prime concern, but other items considered include: (1) minimum dislocation of professional personnel when HSSR is completed; (2) potential perturbation of the SRL support systems (particularly to Technical Information Service (TIS) and IBM 360/195 usage); (3) neutron activation capacity options; (4) the amount of planning required during FY-1977 using currently available staff; and (5) the availability of competent geochemists, consultants, and subcontractors.

The technical basis of this plan is to defer sampling in those areas thought less likely to produce commercial deposits and to collect only those sample types and analyze only those elements thought most likely to show uranium anomalies. Selection of priority areas and sample types was made on the basis of published articles, consultations with professionals in ERDA, USGS, state geological survey groups, and industry, together with results from SRL orientation studies.

The sampling program summarized below is projected in the absence of orientation study data from much of the 25-state area. For purposes of this estimate, conclusions from studies in the crystalline Appalachians and the Pennsylvania Plateau have been extrapolated to other areas. An average of one surface sediment site per five square miles will be sampled over 20% of the area. An average of one surface site (sediment and stream water) per ten square miles will be sampled over about 80% of the area. An average of one ground water site per ten square miles will be sampled over the entire area. The sampling density assumed is thought to be the lowest density likely to yield meaningful results. If complete analysis of future orientation data shows that more intensive sampling or a different type of sampling is required in certain areas, sampling density or types will be adjusted to provide technically meaningful data. Coverage of lower priority areas may then have to be deferred further.

FIELD DATA SAMPLE COLLECTION AND ANALYSIS

Areas Covered

Figure B-1 shows SRL's area of responsibility, which is divided into two principal regions: crystalline rock (Appalachian region) and sedimentary rock (Coastal Plain and Interior region).

Figures B-2 through B-7 show details of the projected yearly coverage from FY-1976 through FY-1981. The schedule, summarized in Table B-1, is tentative and subject to revision as orientation data and more detailed cost data become available. Figures B-3 through B-7 represent general plans for sampling coverage. Sampling is planned on a geologic basis, but detailed maps are often available on different bases. To avoid "faults" along 1° x 2° USGS sheets, we do not plan to stop sampling at sheet boundaries as might be inferred from Figures B-3 through B-7.

Sample Types

Approximately 110,000 sediment and 65,000 water samples will be collected from surface sites, including orientation studies and re-sampling for quality assurance. Sediment samples will be composited and screened in the field to -40 mesh, and the -100 mesh fraction will be analyzed. Field measurements will include total alkalinity by titration, pH, conductivity, and temperature. Field observations, such as industrial activity in the area, will also be recorded.

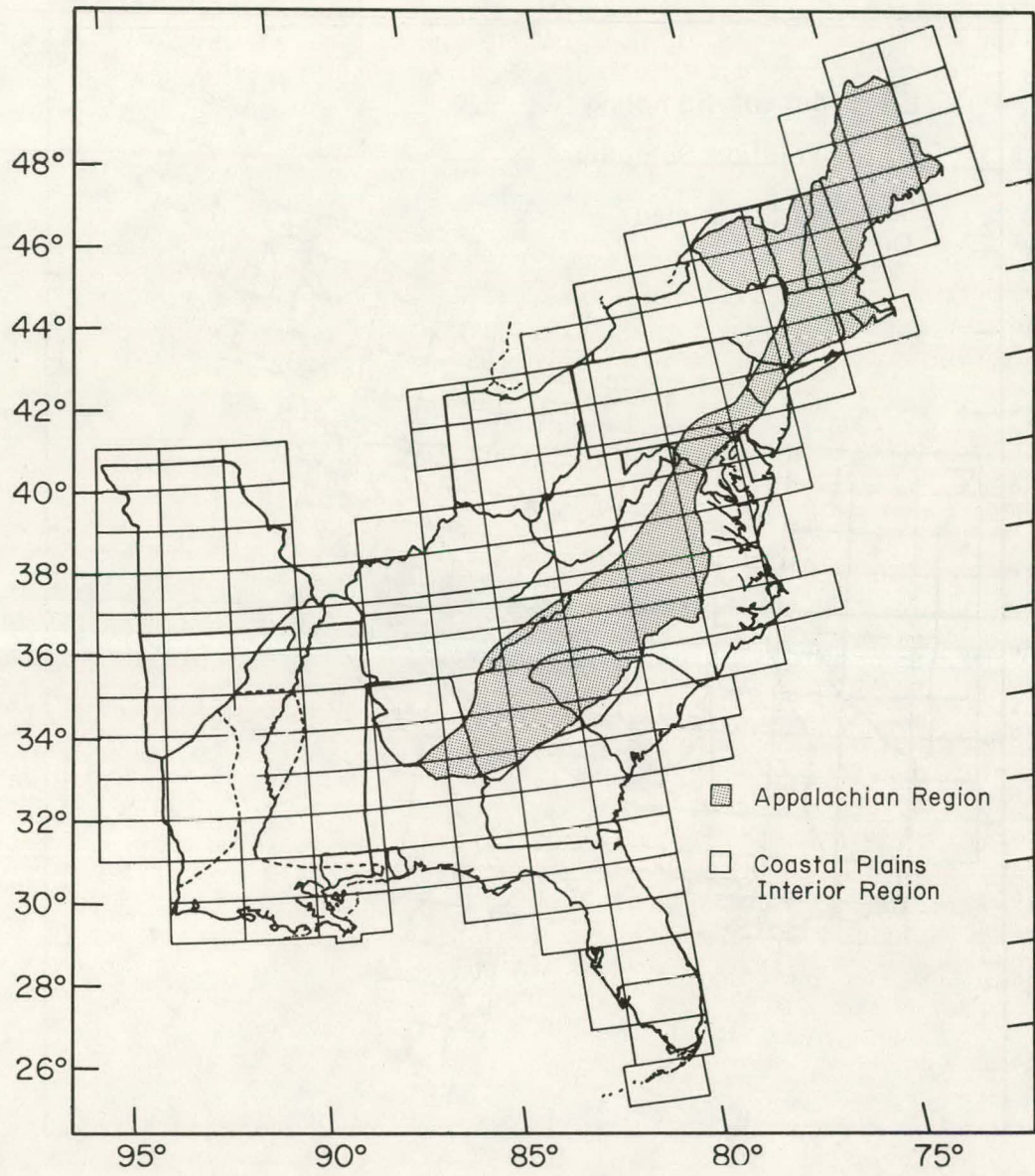


FIGURE B-1. SRL Area of Reconnaissance Responsibility

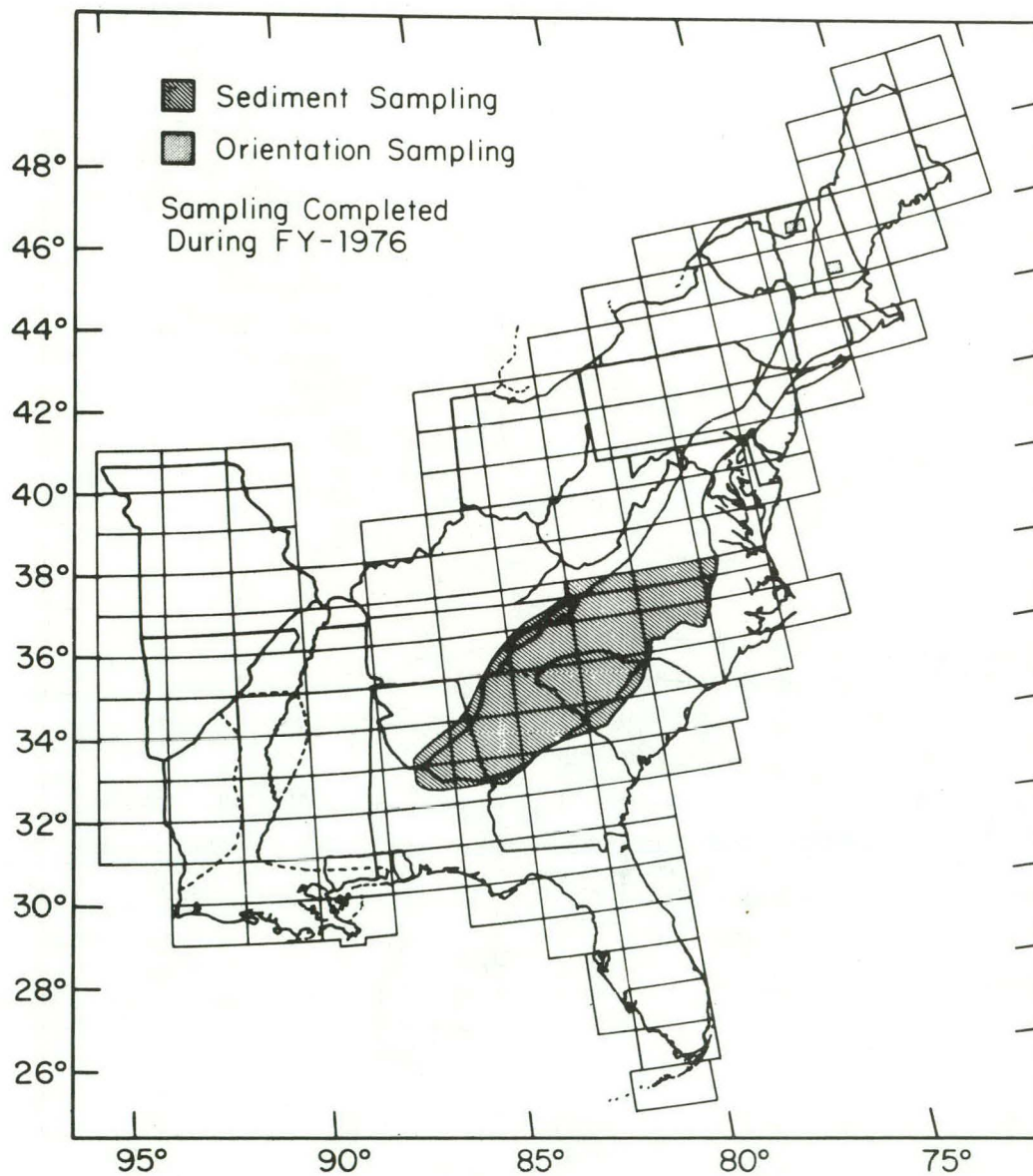


FIGURE B-2. Area Sampled During FY-1976

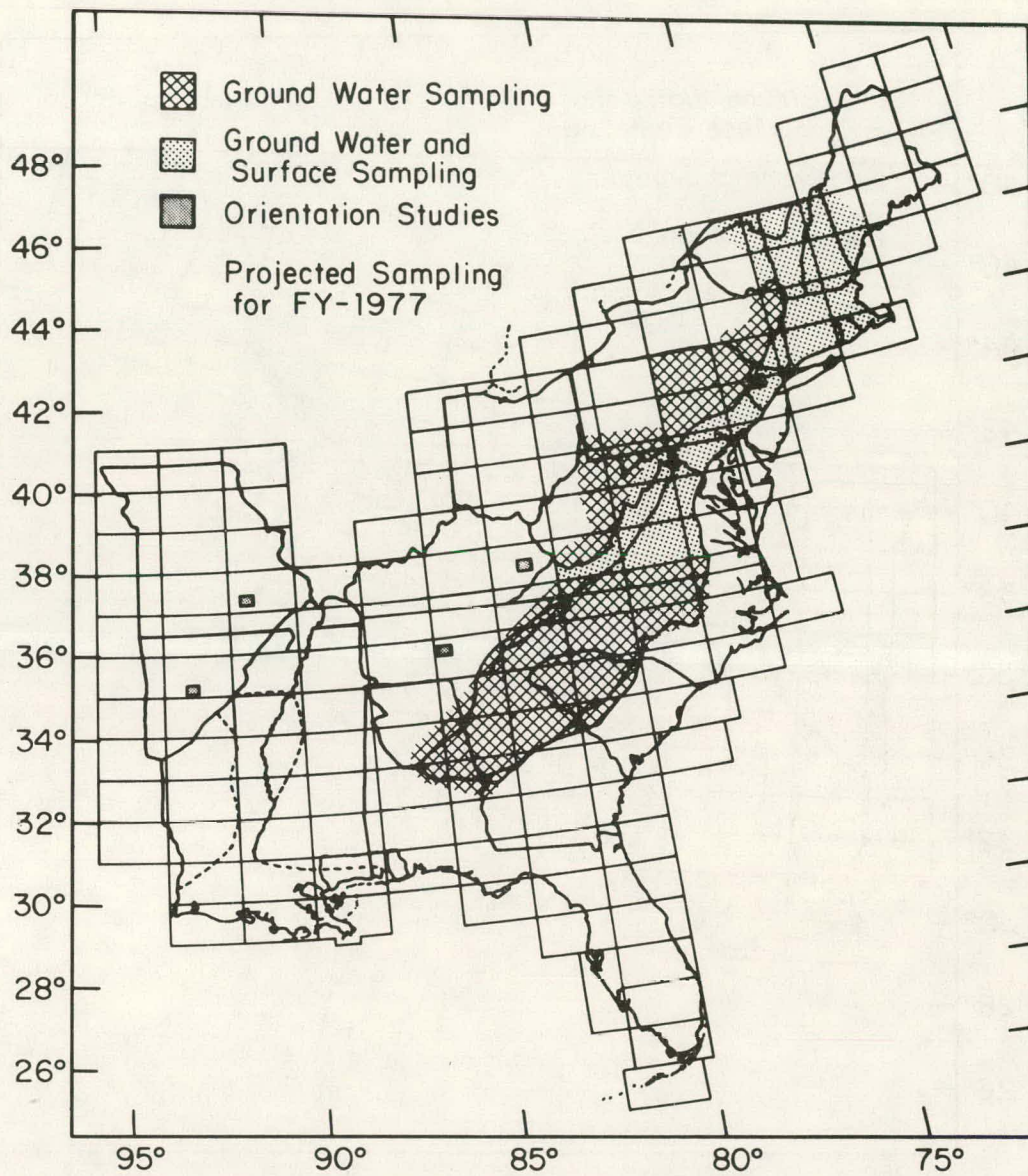


FIGURE B-3. Projected Sampling Area for FY-1977

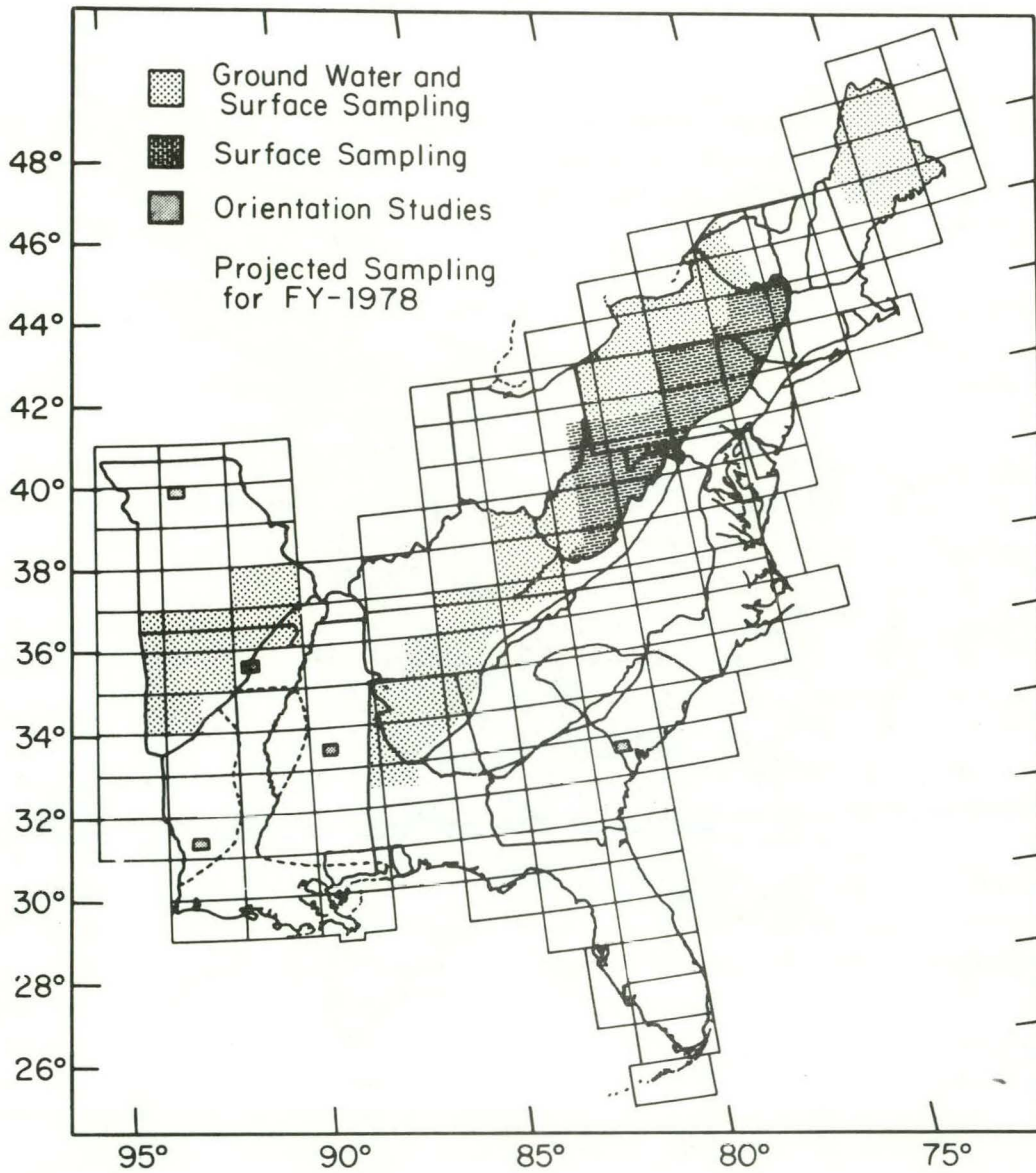


FIGURE B-4. Projected Sampling Area for FY-1978

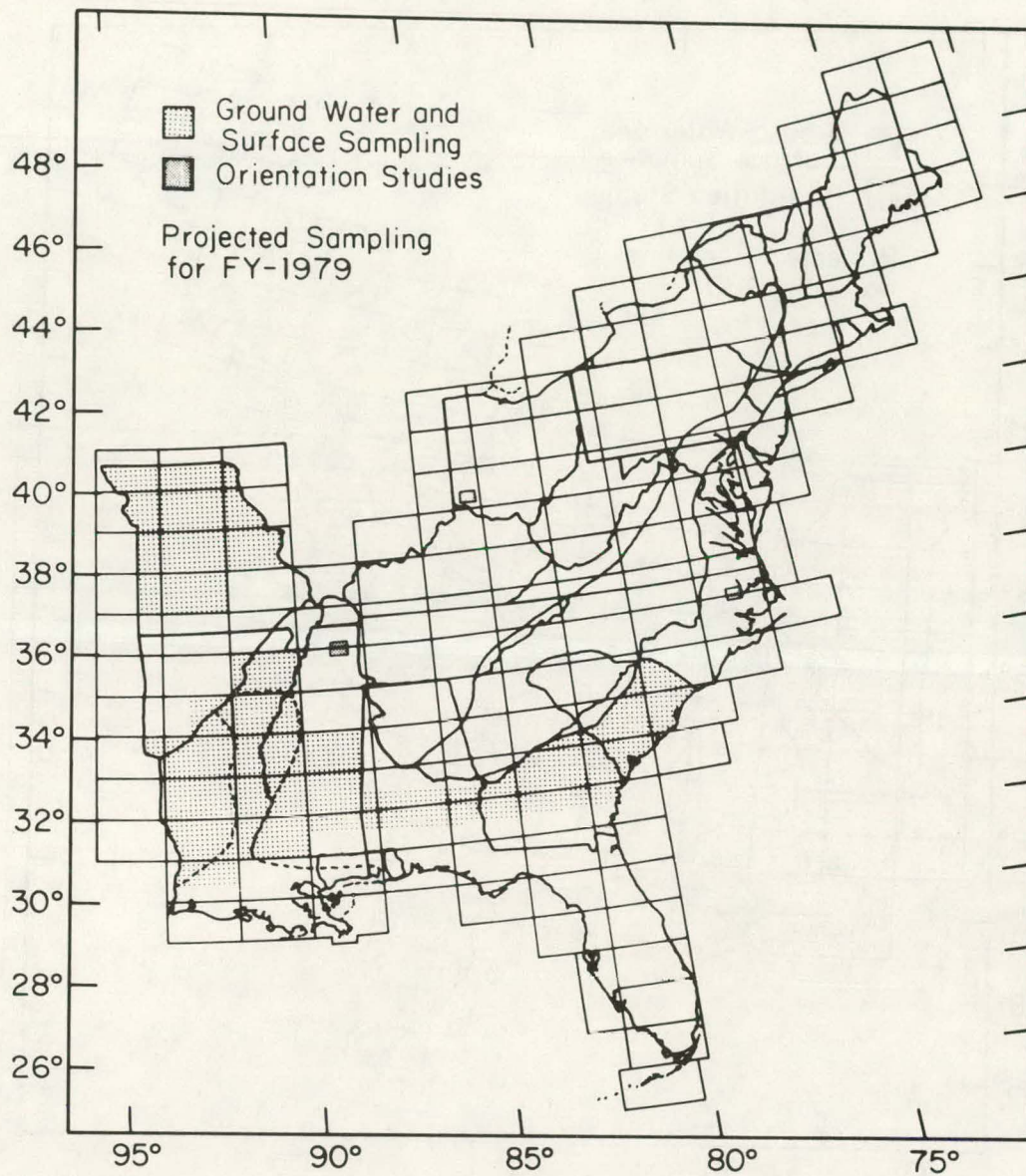


FIGURE B-5. Projected Sampling Area for FY-1979

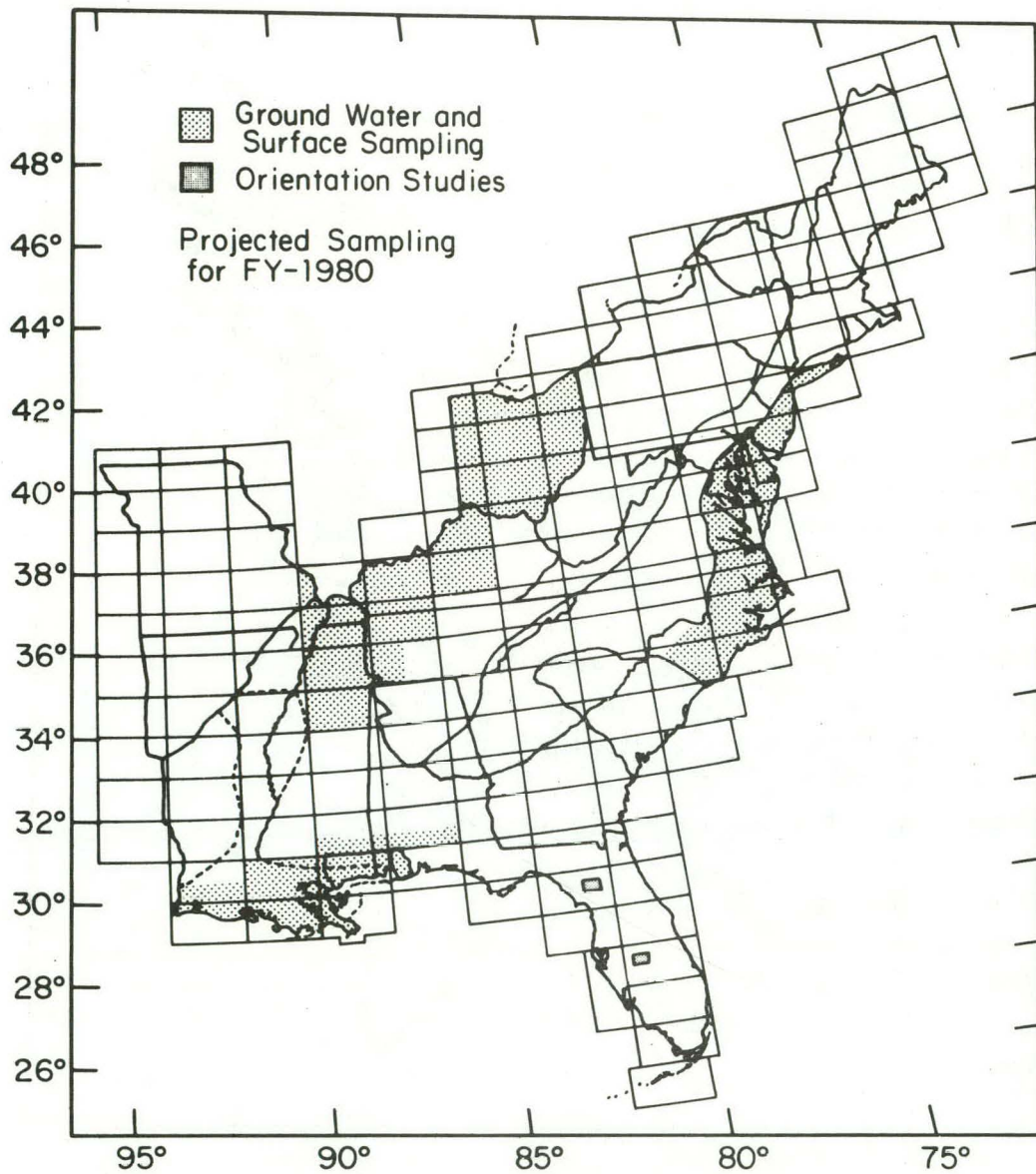


FIGURE B-6. Projected Sampling Area for FY-1980

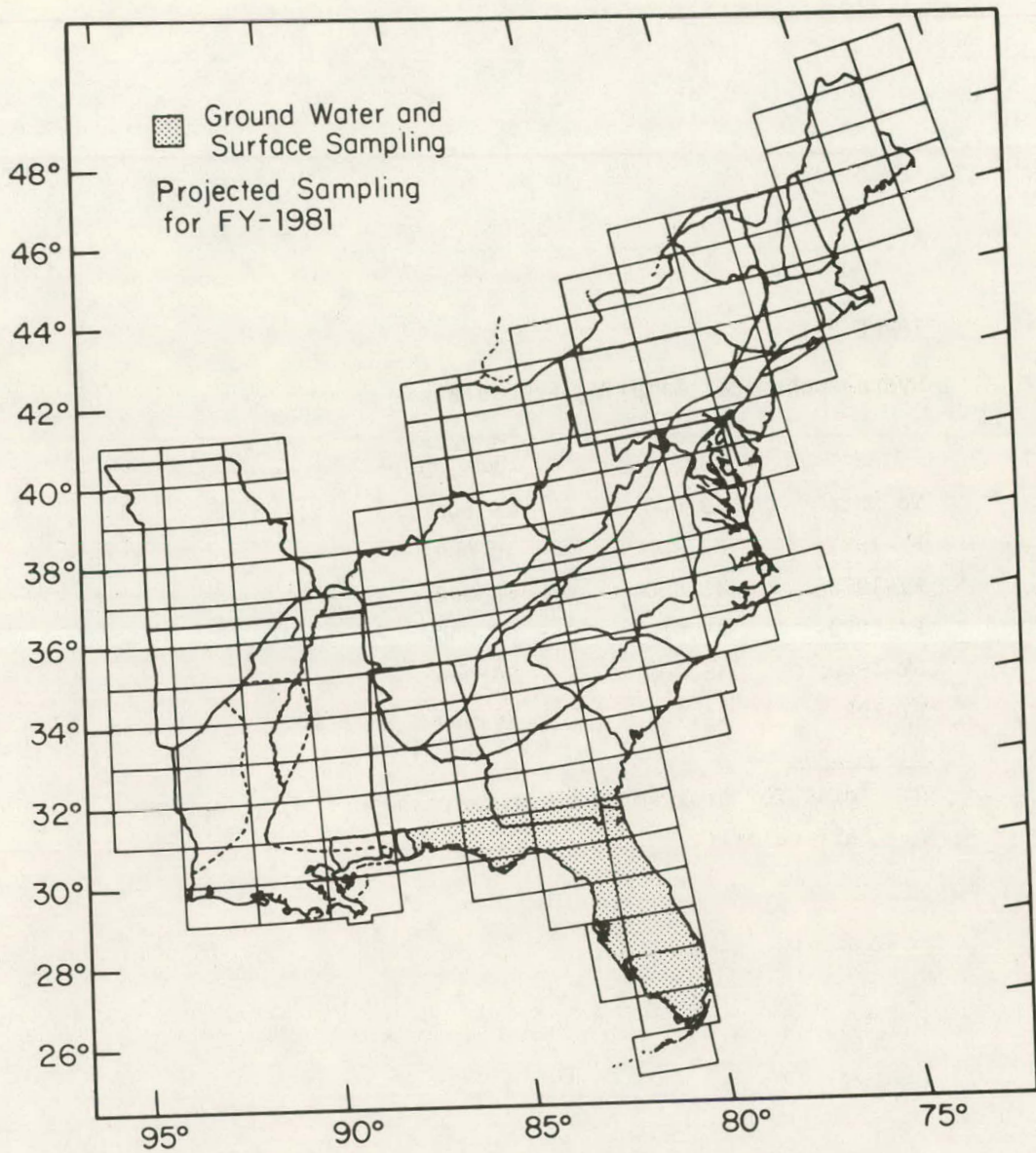


FIGURE B-7. Projected Sampling Area for FY-1981

TABLE B-1

Hydrogeochemical Sampling Schedule

	<i>Sites</i> (200,000) ^a	<i>Samples</i> (265,000) ^a	<i>Area</i> <i>Completed,</i> <i>Cumulative %</i>
To Date	19,000	25,000	11 ^b
FY-1977	32,000	40,000	19
FY-1978	45,000	60,000	44
FY-1979	45,000	60,000	68
FY-1980	45,000	60,000	92
FY-1981	14,000	20,000	100

a. Total for program shown in parentheses.

b. Surface only.

About 90,000 samples from ground water sites (including orientation studies and resampling for quality assurance) will be collected. Similar field measurements and observations, including the name and address of the well operator, will be made.

Collection Costs

Sample collection, preparation, and analytical costs have been estimated based on experience with orientation studies and subcontractor bids. Sample collection will be subcontracted. Collection cost includes depreciation of equipment; payment of samplers, supervision, and overheads; consumables (e.g., containers, resin, etc.); delineating sampling networks and selecting and digitizing sample locations; checking field data cards; organizing, logging and archiving samples; cost of orientation studies (including followup where necessary); quality assurance checks on subcontractor and quality assurance resampling; and miscellaneous (e.g., shipping costs).

Sample Preparation and Analysis

Sample preparation and analytical costs include all cataloging and storage costs and quality assurance programs. Supplementary elemental analyses are needed for interpretation of sediment data. Costs assumed include supplementary analyses for half the sediment samples using emission spectroscopy. The other sediment samples and resin samples will be analyzed for a less complete set of elements using NAA. These supplementary elements determined by NAA are measurable at very little additional cost.

REPORTING PLAN

Quarterly progress reports will continue to be issued. Raw data will be released as soon as convenient blocks are compiled. Data interpretation will be limited mainly to interpreting results of orientation studies and other activities that relate directly toward planning sampling or analytical strategy. Topical reports of a general nature will be issued as necessary to aid in interpretation of reconnaissance data. The primary thrust will be to produce meaningful concentration data in tabular form and as computer-generated map overlays on microfilm. A total of approximately 200 reports is projected. Details of the reporting plan are given in Appendix C.

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APPENDIX C. PRELIMINARY SRL-NURE REPORTING PLAN

SUMMARY

Approximately 200 major reports (averaging ~70 pages of hard copy plus 400 pages on microfiche) are anticipated for the SRL-NURE project during the next five fiscal years. During FY-1977, an average of one report every two weeks will be produced. In FY-1978 through FY-1981, one report every week will be produced.

This Appendix summarizes the preliminary SRL-NURE Reporting Plan. The purpose of this Appendix is (1) to inform program management of anticipated needs in the reporting effort; (2) to review the status of reporting mechanics; and (3) to set preliminary goals to keep the program on schedule. A description of the types and content of reports, a discussion of the mechanics of producing the reports, and a preliminary reporting schedule are given.

TYPES AND CONTENT OF REPORTS

Four types of reports will be produced for the SRL-NURE Program. Quarterly reports are considered top priority because they provide convenient, regular status reports for Du Pont Management, ERDA, and the geological community. Raw data releases are scheduled to provide data to the general public as soon as possible. Reports of orientation studies naturally precede reconnaissance data. Topical reports are useful to aid in interpretation of raw data, but they cannot be produced at the expense of raw data releases.

Approximately 150 copies of each report will be printed. Estimates of report volume and content are preliminary and are subject to change as more guidance is received from ERDA-GJO, and as experience dictates. Report types will be discussed in order of priority.

Quarterly Reports

Quarterly reports similar to those issued in the past will continue to be issued. None is expected to exceed 50 pages in length (excluding appendices). Twenty quarterly reports will be produced during FY-1977 through FY-1981.

Raw Data Releases

Results of the SRL-NURE Program will be released to the public in two phases: raw data releases and topical reports. This plan speeds release of raw data. Rapid reporting is important for three reasons:

- The data are sensitive and potentially of great economic value. Rapid release reduces the backlog of sensitive data and thus reduces security problems. Before the open-file date, all raw data, particularly uranium concentrations, will be handled as sensitive information and will be available only on a need-to-know basis.
- One of the main objectives of the program is to stimulate interest in uranium exploration. For the public benefit, sampling schedules are publicized, and analytical results are reported on a timely basis.
- The data may be needed to aid in interpretation of results given in previous reports.

Orientation Studies

There are two types of raw data releases: orientation studies and reconnaissance. The four SRL raw data releases prepared to date are from orientation studies. Twenty-one additional similar reports are planned. Requirements for editing and typing of future reports will be reduced when all computer systems are operational. Typical orientation raw data releases will include the following:

- 15 pages of text
- 5 figures
- 100 pages of detailed field data (on microfiche only)
- 5 pages of summary field data
- 10 pages of elemental data
- 6 oversized maps

The text will be fairly standard for all reports and should require a minimum of editing. One or two figures will require drafting, but the others will be computer-generated on microfiche or microfilm. The detailed field data tables and summary tables of field and elemental data will also be computer-generated on microfiche.

Six or more oversized maps will be produced with each orientation report. These maps will contain point-value symbols representing elemental concentrations (at least three per report), elemental ratios (at least one per report), and site locations with identification numbers (at least two per report). An example of a point-value map is shown in Figure C-1. To date we have used both "blue line" reproductions of map overlays and page-sized point-value maps. The latter are computer-generated on microfiche and photoenlarged to page-sized hard copy. Future reports will contain standard scale maps (e.g., 7-1/2-minute, 15-minute, 1° x 2°, etc.). Many of these are approximately 18-in. x 30-in.

Details regarding production of these reports are covered under the section on "Mechanics of Reporting."

Reconnaissance Data

About 123 raw data releases from reconnaissance will be produced. These reports may vary widely depending upon the geology of a given area and availability of data. For example, types of samples collected and sampling density will vary from one geologic province to the next. Reports will not be delayed by unavailability of data. For example, the first reconnaissance raw data release (scheduled for April 1977) will contain only sediment data because ground water data will not be available until August 1977. The report will not be delayed eight months to include the latter. A "typical" release will include the following:

- 25 pages of text
- 5 figures
- 500 pages of detailed field data (on microfiche only)
- 25 pages of summary data
- 25 pages of elemental data
- 6 - 18-in. x 30-in. data maps
- a geologic map (possibly in color)

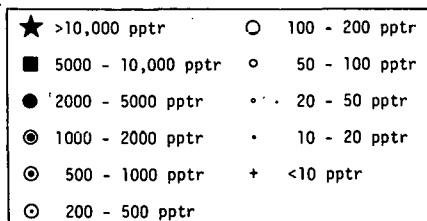
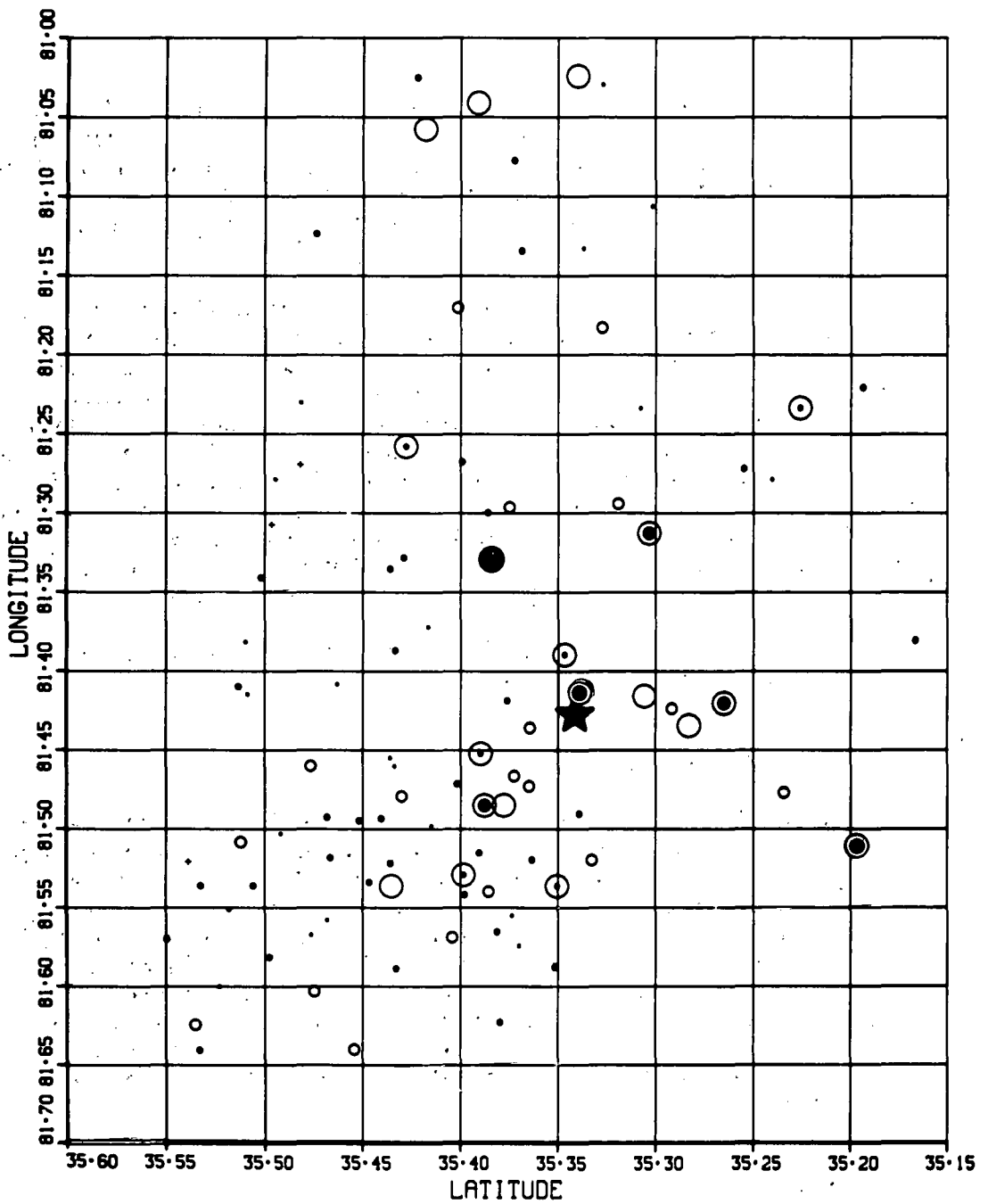


FIGURE C-1. An Example of a Point-Value Map.

The format and content of these releases (except for size) are quite similar to those of the orientation study releases. However, several differences are noteworthy. The summary data tables will contain both field data and elemental analyses. Reconnaissance releases may also contain geologic maps. These maps may be 18-in. x 30-in. but total size may be up to 30-in. x 48-in. to allow for the legend. Geologic maps may be multi-color.

Topical Reports

Approximately 28 topical reports are projected. These are technical reports relating the geology of 20,000 to 100,000 square miles to reconnaissance data from the area. These reports may include the following:

- Conclusions from orientation studies conducted in the area.
- Reasoning behind development of reconnaissance sampling patterns (i.e., sampling density and sample type).
- Results of quality assurance programs (e.g., resampling, relation to surrounding areas, seasonal effects).
- Results of mineralogical and other detailed or followup studies.
- General statements regarding uranium geochemistry in the area, including use of supplementary elemental analyses or field measurements.
- Conclusions from mathematical or statistical reduction of the data.
- General statements regarding uranium favorability in the area.
- Suggestions for followup studies in promising areas.

These topical reports may be expected to contain the following:

- 50 pages of text
- 10 figures

- 10 tables
- .5 oversized maps
- .2 geologic maps (in color)

The text for each report will be unique and will be processed through the normal SRL editorial channels. Perhaps half the figures will be computer-generated on microfiche (or 35-mm film); the rest will require drafting. Most of the tables will also be computer-generated. The oversized maps will be produced in the same manner as they are for raw data releases. (See following section on "Mechanics of Reporting.") Geologic maps will probably require drafting.

About 10 miscellaneous reports are projected. These will be typical technical reports describing details of the program, such as operation of the neutron activation system, development of field procedures, etc.

MECHANICS OF REPORTING

Programming

With a projected production rate of one report per week, report writing must be highly automated. Data must be automatically entered, sorted, and retrieved from the SRL-NURE Data Management System (NDMS).

Programming is being tested to interface NDMS with currently available output subroutines to automate production of figures and map overlays. Programming is in progress (1) to produce tables of elemental data for orientation study releases, (2) to produce summary tables for reconnaissance releases, and (3) to scrub obvious errors from the data. Work is nearing completion in each of these areas.

FR-80 COM Unit

A computer (FR-80 COM, Information International, Culver City, California) generates two- and three-dimensional displays on a cathode ray tube from which microfilm negatives are made.

The COM unit is vital for production of reports. SRL Raw Data Release IV⁸ contains computer-generated figures, page-sized point-value maps, summary tables, and detailed field data tables (the latter on microfiche only) obtained using the COM system. All figures, maps, and tables produced in this manner were of good quality.

In future raw data releases, all summary tables (15 pages for orientation studies and 50 pages for reconnaissance) will be produced on microfiche, which will be photo-enlarged to produce hard copy. The field data tables contain details of interest to only a small percentage of the readers. Because of sheer numbers (up to 500 pages per report), these tables are very costly to produce in hard copy (\$600,000 to \$900,000 for the program). The SRL Raw Data Release IV presents detailed field data only on microfiche.⁸

Map Production

Recently a 35-mm camera was obtained for use with the FR-80 COM unit. Point-value maps produced on 35-mm film have been good, and all viable options for map production begin with computer-generated plots on 35-mm film. There are several options for processing maps beyond the microfilm stage, and there are two major questions to be answered: (1) what type of maps to produce and (2) where to produce the maps.

Initial tests indicate that point-value plots on clear plastic are feasible using available equipment and are very convenient to use. The clear plastic maps can serve as masters for inexpensive "blue-line" copies. A sample map (18-in. x 30-in.) produced commercially was excellent and resolution was quite good. A similar map made at SRL was not quite as good. (The SRL map was made through an "inter-copy negative." That is, two-stage enlargement was required to produce a map of the desired dimensions, and some resolution was lost.) However, onsite development is at a very early stage and improvements in resolution are expected.

It is likely that clear plastic overlays will be made for use at SRL. However, copies are expected to cost on the order of \$3.00 to \$5.00 each, and supplying plastic overlays for 150 copies of each report seems impractical. (Total cost for orientation and reconnaissance: \$400,000 to \$1,200,000). Other alternatives are: (1) supplying plastic overlays to open-file repositories only (20 copies), (2) supplying overlays on "onion-skin" paper with all or part of the reports, (3) supplying "blue-line" hard copy overlays, (4) supplying photographically produced hard copy at a scale other than 1:250,000, and (5) supplying no hard copy overlays for distribution. In any event, microfilm copies of maps would be supplied with each report. The cost of each of the alternatives is being estimated.

Point-value maps can be produced at SRL or externally (i.e., commercially). The alternative chosen depends largely on the type of maps needed, cost, and the success of onsite development programs.

Geologic maps present a difficult problem since they cannot be computer-generated. Current plans call for subcontracting production of up-to-date geologic maps. Originals will probably be hand-drawn by the subcontractor, and some drafting at SRL will probably be required to bring these maps up to the desired quality. Then 150 copies must be made. These maps are likely to be 18-in. x 30-in., multi-colored, and highly complex.

REPORTING SCHEDULE

A preliminary reporting schedule for FY-1977 is given in the text (Program Section). Table C-1 gives the projected reporting schedule through FY-1981. Miscellaneous technical reports are not included.

Although SRL is just entering the "production" phase of NURE, many reports will have to be issued this year in order to remain on schedule in FY-1978 and following, when an average of one report every week will be produced.

TABLE C-1

Projected NURE Reporting Schedule Through FY-1981

<i>Fiscal Year</i>	<i>Topical Reports^a</i>	<i>Raw Data Releases</i>	
		<i>Orientation Studies</i>	<i>Reconnaissance</i>
1977	5	5	7
1978	5	5	26
1979	8	5	40
1980	8	5	40
1981	2	1	10
Totals	28	21	123

a. Quarterly reports will also be issued (a total of 20).

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No.	Quarter	SRL Doc. No.	ERDA-GJO Doc. No.*
1	January-March 1975	DPST-75-138-1	GJBX-5(76)
2	April-June 1975	DPST-75-138-2	GJBX-6(76)
3	July-September 1975	DPST-75-138-3	GJBX-7(76)
4	October-December 1975	DPST-75-138-4	GJBX-8(76)
5	January-March 1976	DPST-76-138-1	GJBX-17(76)
6	April-June 1976	DPST-76-138-2	GJBX-27(76)
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