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Progress Report
for FY 1984



Argonne National Laboratory, Argonne, Illinois 60439
operated by The University of Chicago
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ANALYTICAL CHEMISTRY LABORATORY
Progress Report for FY 1984

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March 1985

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I. INTRODUCTION

The purpose of this report is to summarize the technical and administrative activities of the Analytical Chemistry Laboratory (ACL) at Argonne National Laboratory (ANL) for Fiscal Year 1984 (October 1983 through September 1984).

The Analytical Chemistry Laboratory is a full-cost-recovery service center, with the primary mission of providing a broad range of technical support services to the scientific and engineering programs at ANL. In addition, ACL conducts a research program in analytical chemistry, works on instrumental and methods development, and provides analytical services for governmental, educational, and industrial organizations. The ACL handles a wide range of analytical problems, from routine standard analyses to unique problems that require significant development of methods and techniques.

The ACL is administratively within the Chemical Technology Division (CMT), the principal user, but provides technical support for all of the technical divisions and programs at ANL. The ACL has three technical groups -- Chemical Analysis, Instrumental Analysis, and Organic Analysis -- which together include about 30 to 35 technical staff members (see Fig. 1). Talents and interests of staff members cross the group lines, as do many of the projects with which the ACL staff deals.

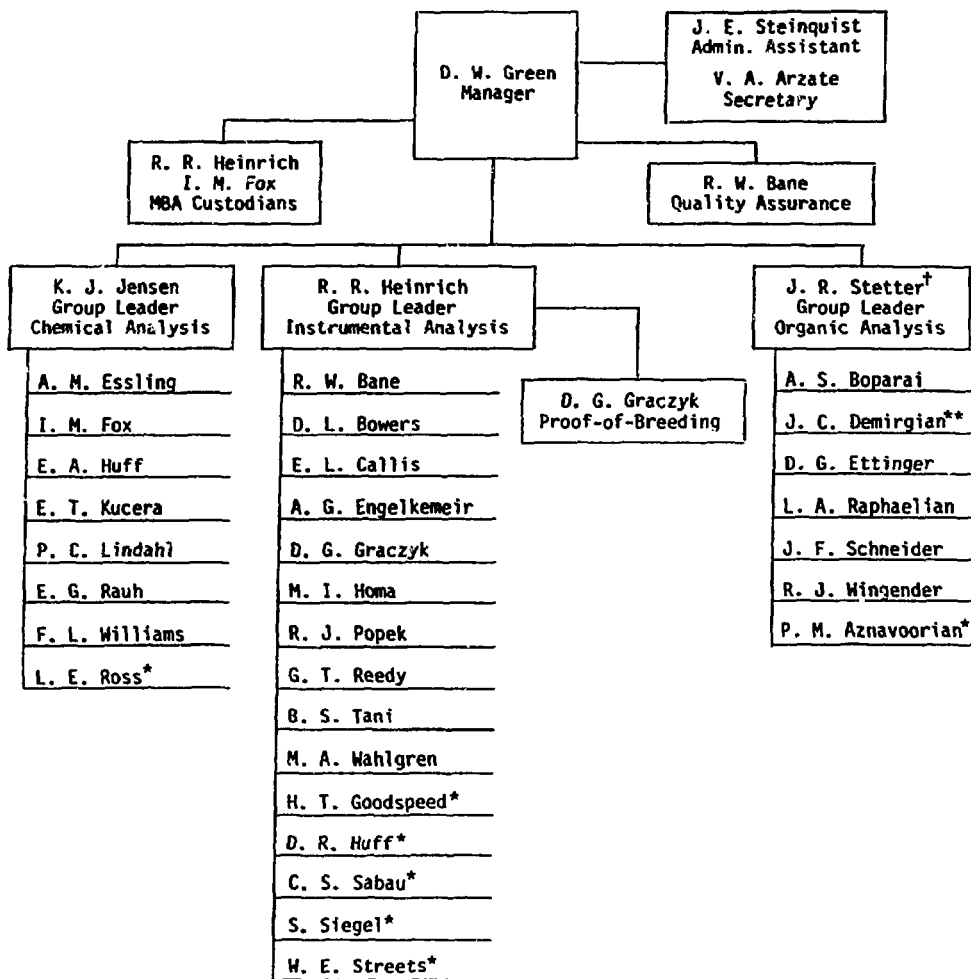
The Chemical Analysis Group performs wet-chemical analyses and instrumental analyses, does spectrochemical analyses and coal analyses, and provides specialized analytical support -- separations, preparations, advice, etc. Major instruments in this group include an ion chromatograph, an inductively coupled plasma/atomic emission spectrometer (ICP/AES), an automated carbon/hydrogen/nitrogen determinator, atomic absorption spectrometers, emission spectrographs, a sulfur determinator, fluorimeters, specific-ion electrodes, an X-ray fluorescence spectrometer, and a Leco carbon determinator.

Figure 1

12/1/84

ANALYTICAL CHEMISTRY LABORATORY

ORGANIZATION CHART



*Special Term Employee (STE)
**Term Employee
†) 1/2 Time ACL

The Instrumental Analysis Group uses nuclear decay counting techniques, performs mass spectrometric and gas chromatographic analyses of gases, analyzes solids with X-ray techniques, and does remote analysis of radioactive samples, dosimetry, neutron activation, inert gas fusion, and isotope analysis. Major instruments in this group include X-ray diffractometers, a variety of multichannel analyzers and associated counting equipment, a scanning electron microscope with X-ray energy dispersive capabilities, mass spectrometers including two thermal-ionization mass spectrometers, gas chromatographs, and a surface-area measuring apparatus.

The Organic Analysis Group uses a number of complementary techniques to separate and analyze complex organic mixtures and compounds, including synthetic fuels, toxic substances, fossil fuel residues and emissions, pollutants, biologically active compounds, pesticides, and drugs. Major instruments in this group include a large variety of gas chromatographs (GC), mass spectrometers (MS), combination GC/MS systems, infrared spectrometers including a Fourier Transform (FTIR) system, a combination gas chromatography/matrix-isolation/FTIR system, a combination GC/FTIR/MS system, and liquid chromatographs.

II. ADMINISTRATIVE HIGHLIGHTS

The major users of ACL services among ANL organizations for FY 1984 are listed in Table 1.

Table 1. Distribution of ACL Work Load for FY 1984 among the Major Divisional Users

ANL Organization	% ACL Work
Chemical Technology (CMT)	50.4
Energy and Environmental Systems (EES)	15.0
Chemistry (CHM)	9.6
Materials Science and Technology (MST)	6.5
Occupational Health and Safety (OHS)	3.9
Energy and Environmental Technology (EET)	1.5
Energy and Environmental Tech Prog Dir	1.0

The major user of ACL services continues to be CMT (see Fig. 2). The major program within CMT using ACL service is the Proof-of-Breeding Project, which has accounted for approximately half the CMT total in FY 1983 and FY 1984 and is expected to do so in FY 1985 as well. The usage of ACL services by other ANL divisions, shown in Fig. 3, has changed in recent years. Most decreases can be explained by the termination or substantial cutbacks of particular programs that were previously major users of ACL services [OHS decontamination and decommissioning, chemical toxicity programs in the Biological and Medical Research (BIM) Division, several Environmental Research (ER) Division sampling programs, etc.]. The increase in ACL usage by EES is partially due to administrative consolidation in 1981 and 1982.

The ACL recovered 97.2% of its total operating costs in FY 1984. This cost recovery is higher than the average of the last five years, as indicated by

Figure 2

ACL FUNDING

Total and CMT

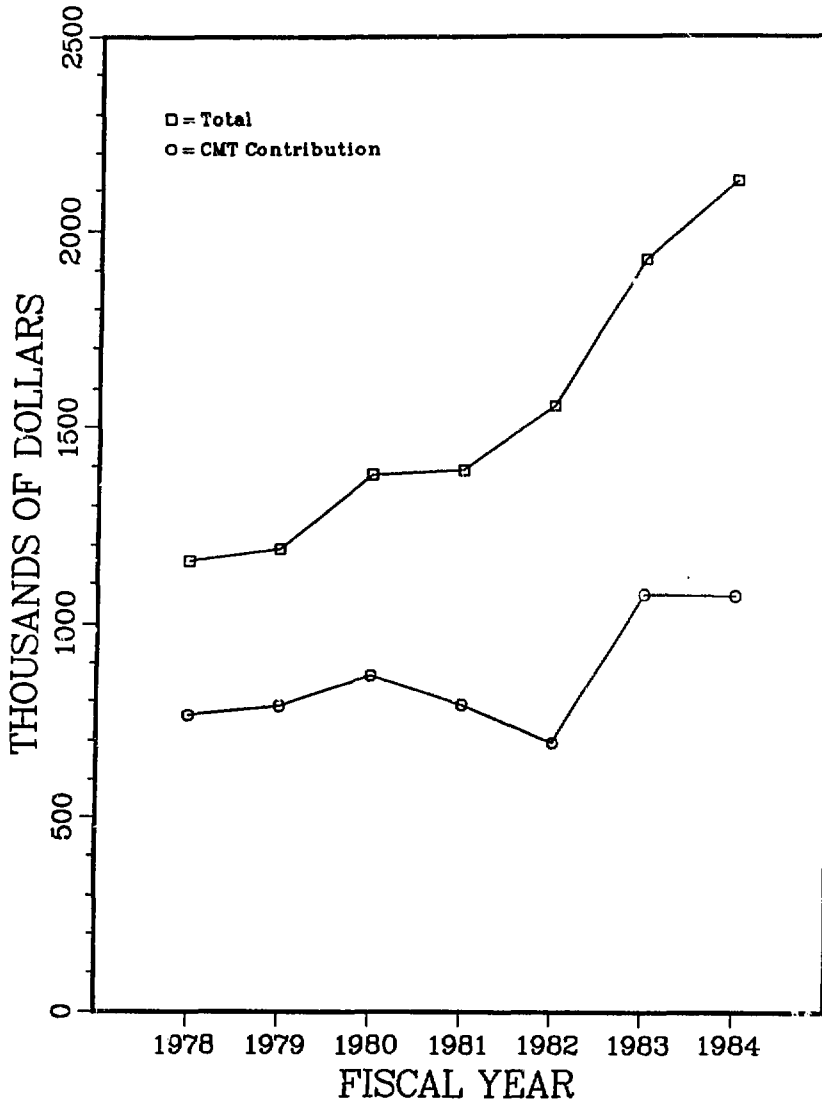


Figure 3

ACL FUNDING

Historical Major Users

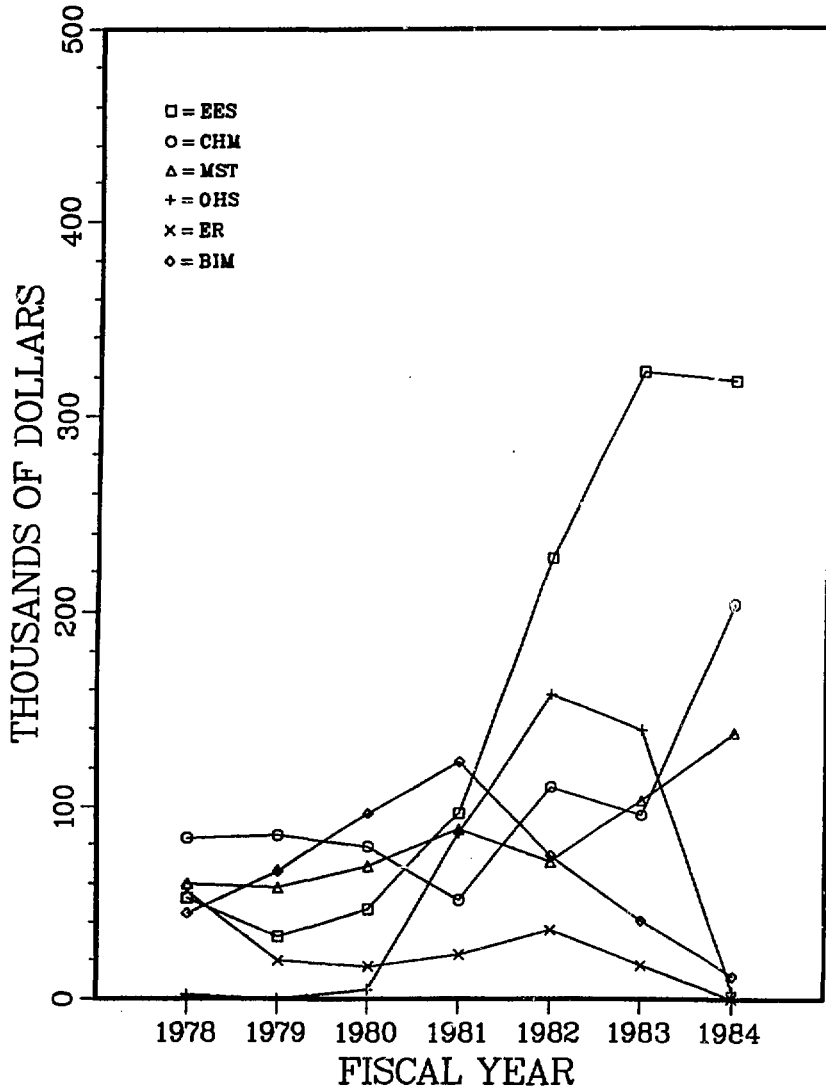


Fig. 4, but not as high as FY 1983. The ACL effort, including divisional administration, includes approximately one-half recoverable time (sales to users in Fig. 5). The total operating costs for FY 1984, shown in Fig. 6, are about two-thirds effort-related.

The ACL continued to obtain help from Special Term Employees (see Fig. 1) in FY 1984 to assist with load leveling. Approximately three full-time equivalents were used in FY 1984, and continued usage is anticipated in FY 1985. One staff member was added in the area of coal analyses. Two visiting faculty members and several students supplemented the regular ACL staff. One CMT staff member was loaned to ACL to assist in the ICSAM Project (described later).

The ACL continued a program to inform potential ANL users of the analytical services that are available. Thirty one-page summaries of analytical techniques, as shown in Table 2, have been issued to ANL staff. A summary of ACL capabilities for analyses related to fossil energy was prepared and distributed. A users guide for the scanning electron microscope has been prepared. Tours of ACL facilities have been regularly conducted for new CMT employees and other selected ANL users.

Personal contacts were made with the National Science Foundation, the DOE Office of Health and Environmental Research (OHER), the DOE Office of Energy Research (Chemical Sciences), the Illinois Center for Research on Sulfur in Coal, and Region V of the U.S. Environmental Protection Agency (EPA) in preparation for submitting research proposals.

The ACL established a small (\$24K in FY 1984) internal funding system to support selected projects leading to publication and development of new capabilities. Projects supported include development of iron isotopic standards, development of an alternative cleanup for analysis of soil for dioxin, a study of polychlorinated biphenyls using the GC/MI/FTIR apparatus, and the establishment of multidimensional GC capabilities in ACL.

Figure 4

ACL COST RECOVERY

Recent History

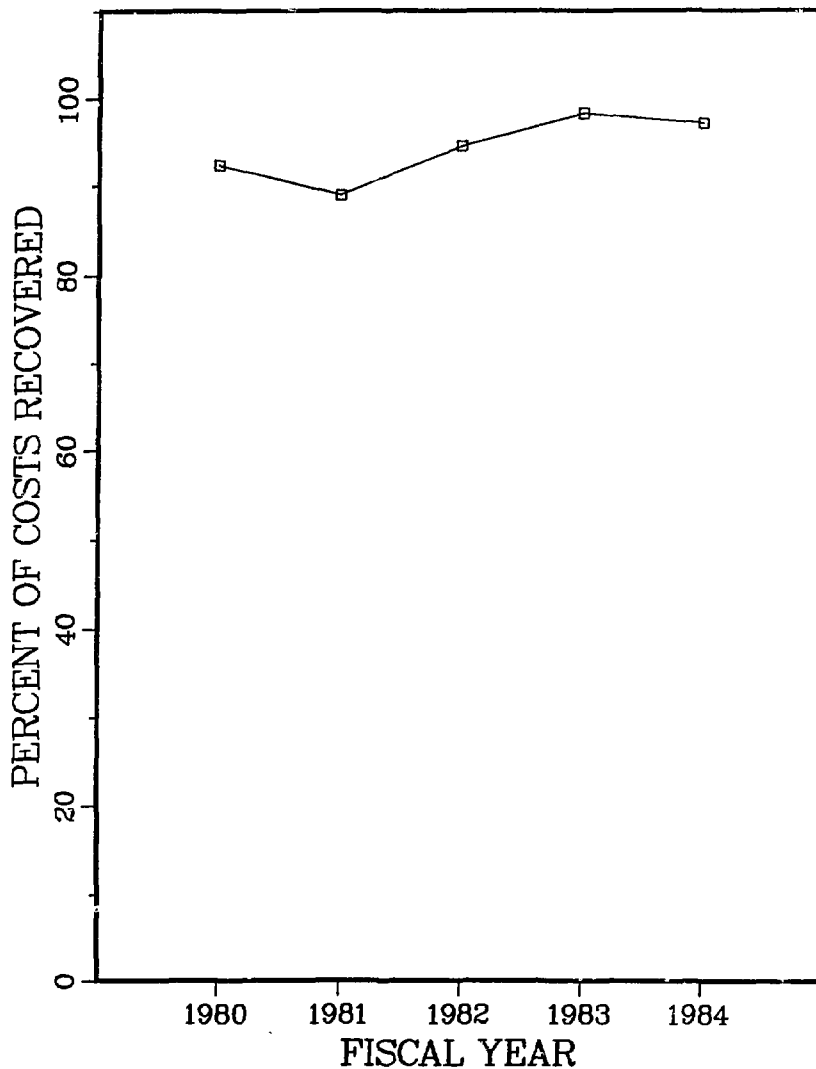


Table 2

INDEX OF ACL CAPABILITIES SUMMARIES

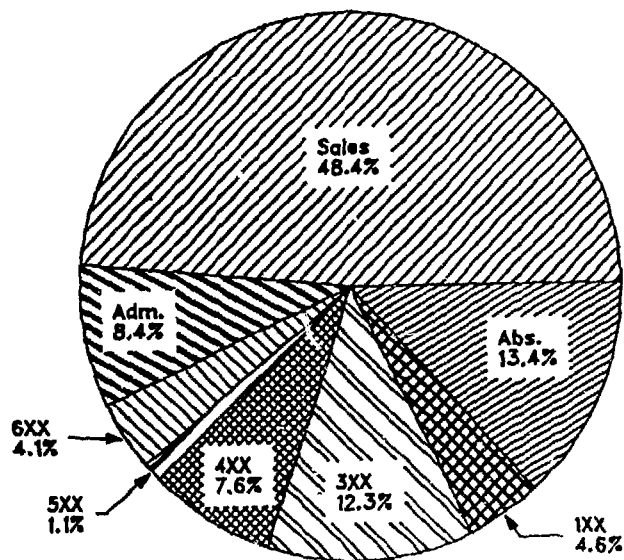
TITLE	Elements	Qualitative	Quantitative	Inorganic	Organic	Macro	Micro	Gas	Liquid	Solid
<u>Issued 7/31/84</u>										
BET Method of Surface Area Measurement			0	0	0	0				0
Gas Chromatography/Matrix Isolation/Infrared Spectroscopy (GC/MI/IR)		0	0		0	0	0	0	c	0
High Performance Liquid Chromatography (HPLC)		0	0		0	0	0		0	0
Ion Chromatography (IC)	0	0	0	0	0	0	0		0	0
Mercury in the Atmosphere -- Gold Amalgamation and Gas Phase Detection	0	0	0	0			0	0		
Total Carbon Using the 70-Second Leco Carbon Analyzer	0		0	0	0	0				0
X-Ray Diffraction	0	0		0		0				0
<u>Issued 10/8/84</u>										
Energy Dispersive X-ray Fluorescence (EDXRF)	0	0	0	0		0	0		0	0
Mercury in Water by Atomic Absorption	0	0	0	0	0		0		0	
Metals in Organic Matrices by Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES)	0	0	0		0	0	0		0	0
Plutonium and γ -Emitting Nuclides: Environmental Samples	0	0	0	0	0	0	0		0	0
Precision Isotope Ratio Measurement by Mass Spectrometer	0	0	0			0	0			
Analysis for Priority Pollutants		0	0		0	0	0		0	
Quantitative Analysis of Organic Mixtures Using GC/FTIR/MS		0	0		0	0	0	0		
Th, Pu, Am, and Np Analyses: Site Survey Samples	0	0	0	0	0	0	0		0	0

Table 2 (Cont'd.)

INDEX OF ACL CAPABILITIES SUMMARIES

TITLE	Elemental	Quantitative	Qualitative	Inorganic	Organic	Micro	Macro	Gas	Liquid	Solid
<u>Issued 11/1/83</u>										
Gas Chromatographic Analysis of the Permanent Gases, the Light Hydrocarbons, and the Sulfur Gases	0	0	0	0	0	0	0	0		
PCBs in Soil, Bottom Sediments, Aqueous Media, and Oils		0	0		0	0	0		0	0
Scanning Electron Microscopy	0	0	0	0		0	0			0
Thermal Ionization Mass Spectrometry	0		0	0		0	0		0	0
<u>Issued 2/1/84</u>										
Analytical Gas Mass Spectrometry	0	0	0	0	0	0		0		
Atomic Absorption Spectrometry (AAS)	0		0	0		0	0		0	0
Carbon, Hydrogen, Nitrogen (C/H/N) Analysis	0		0		0	0	0		0	0
Inert-Gas Fusion Method for Hydrogen, Oxygen and Nitrogen in Metals	0	0	0	0		0	0			0
Analysis of Organic Vapors		0	0		0	0	0			
Water Determination by Karl Fischer (KF)			0	0	0		0		0	0
<u>Issued 3/28/84</u>										
Atomic Emission Spectroscopy	0	0	0	0		0	0		0	0
Analysis for Dioxin		0	0		0	0	0		0	0
Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES)	0	0	0	0		0	0		0	0
Purgeable Organic Compounds from Water		0	0		0	0	0		0	
"Trace" Uranium Analysis	0		0	0		0			0	0

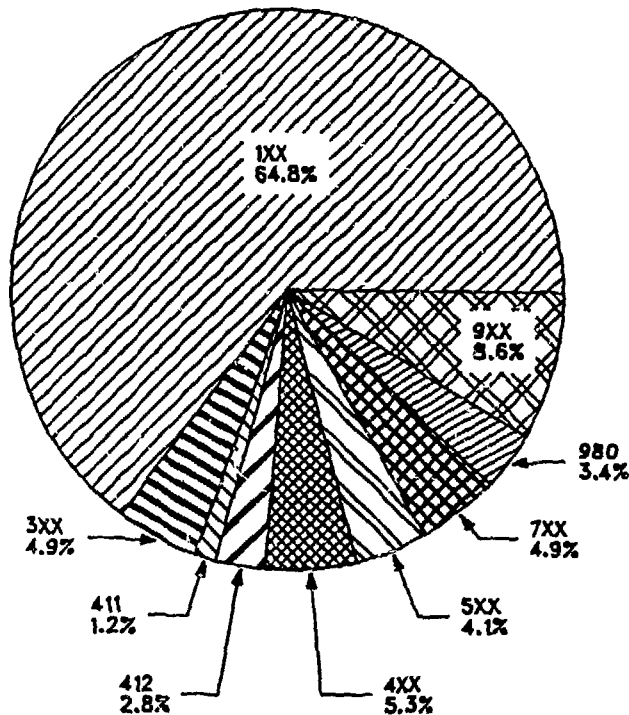
Figure 5



Analytical Chemistry Laboratory
FY 1984 Effort

Abs = paid absences
 1XX = operations administration
 3XX = internal overhead; e.g., instrument maintenance
 4XX = general overhead; e.g., safety
 5XX = technical and employee development
 6XX = experimentation

Figure 6



Analytical Chemistry Laboratory
FY 1984 Costs

1XX = salaries and fringes
 3XX = materials and supplies
 4XX = services, subcontracts, etc.
 5XX = shopwork and work projects
 7XX = redistributions
 9XX = indirect costs

The ACL continued to work with the Division of Educational Programs (DEP) in providing access by outsiders to ACL equipment and expertise. Three ACL staff participated in a DEP-sponsored summer program for gifted students from junior high schools.

A complete safety tour of all ACL laboratories was made during the summer with the CMT Safety Representative. Corrective actions were taken where indicated. An internal audit was made of the ability of ACL staff to retrieve information about samples. An audit was made by the Quality Assurance Division (QAD) of selected portions of the ACL Quality Assurance Plan. Some changes have been made in the ACL Quality Assurance Plan, and other changes are being considered.

Argonne hosted the first meeting of the DOE analytical laboratory managers. Problems of mutual interest were discussed, and ideas about solutions were exchanged.

ACL technical meetings were initiated in FY 1984; two meetings were held at which selected ACL staff gave presentations on their work to the other ACL staff. Other such meetings will be held in the future.

Improvements in ACL facilities and capabilities were made in FY 1984 (several of these are described in the "Technical Highlights" section). Work has begun on construction of a containment room to be located in Laboratory X-125 of Building 205. This room will allow the safe handling of potentially toxic samples from field studies. Samples prepared in the containment room can then be safely analyzed by existing GC and GC/MS systems. Funding for construction of the containment room originates from the EPA, who also uses this facility. Work was initiated on Room G-117 in Building 205 to prepare for handling and analysis of samples in the Integral Fast Reactor (IFR) Program. A new sulfur analyzer has been procured and is operating in Building 200.

A special containment fume hood for working with dioxin standards is available in Building 211. A communication link between the Finnigan GC/MS (Building 205, Room E-141) and the CMT VAX has been established to allow better data handling and data storage.

A new interface was installed in this GC/MS to allow for simultaneous data gathering and data analysis. A pyrolysis unit has been added to the Finnigan, which expands the capabilities for analysis, particularly for polymers. Work has continued to establish spark source mass spectrometry capability.

III. TECHNICAL HIGHLIGHTS

Loss of Cooling Accident Project (K. J. Jensen, E. A. Huff, I. M. Fox, A. M. Essling, and F. L. Williams)

Analytical chemistry support has been provided by the Chemical Analysis Group of ACL for experiments performed for the Loss of Cooling Accident (LOCA) Project in CMT (C. Johnson, I. Johnson). Revaporization of fission product elements is being studied. Experimental conditions are selected to simulate release of some elements from the core after a reactor accident. Samples taken from various locations of the vaporization apparatus were analyzed for Ag, In, Te, Cd, Mn, Sn, and Sr by ICP/AES. Cesium was determined by atomic emission spectroscopy; iodide was determined volumetrically or by ion chromatography.

Uranium Determination of TREAT-Upgrade Fuel (A. M. Essling, E. L. Callis, E. G. Rauh, and D. G. Graczyk)

Thirty samples for Transient Reactor Test Facility (TREAT)-upgrade fuel have been analyzed for uranium content by the Analytical Chemistry Laboratory. The samples were analyzed using a mass spectrometric isotope dilution technique by analysts from the Instrumental Analysis and Chemical Analysis Group. The purpose of the analyses was to provide the Safety Research Experiment Facility

(SAREF) Project with an overcheck of chemical analyses previously performed by Los Alamos National Laboratory (LANL) on adjacent samples of bars from various lots; LANL used the Davies and Gray titrimetric method.

Analysis of Materials of Interest to the Solid Breeder Blanket Development Program (E. L. Callis, A. M. Essling, E. A. Huff, E. T. Kucera, K. J. Jensen, E. G. Rauh, and F. L. Williams)

Samples analyzed included starting materials $\text{Li}_2\text{CO}_3\text{-Al}_2\text{O}_3$ powder, LiAlO_2 product powder, and pellets prepared from LiAlO_2 product that were fired at high temperature. The materials have been analyzed for Cl^- , CO_3^{2-} , Li, Al, metal impurities, and lithium isotopic abundance. Methods of analysis used included ion chromatography, gas chromatography, emission spectroscopy, gravimetry, and mass spectrometric isotope dilution.

The high-fired LiAlO_2 pellets (prepared at another laboratory) were very refractory and required a specialized dissolution technique wherein the sample is dissolved in a sealed tube at high temperature (300°C). This technique enabled ACL to provide an urgently needed overcheck analysis not immediately available at the preparation site.

Reduced Enrichment for Research on Test Reactors (RERTR) Program (A. M. Essling, E. L. Callis, E. A. Huff, M. I. Homa, E. G. Rauh, R. R. Heinrich, and K. J. Jensen)

A series of uranium alloys has been analyzed for the MST Division in support of the RERTR Program. Alloys of composition U_3Si , U_3SiAl , U_3Si_2 , U_6Fe , and UAl_2 with uranium isotopic composition ranging from 0 to 93% U-235 have been precisely characterized using a variety of analytical techniques. The major components have been determined by mass spectrometric isotope dilution and wet chemical procedures. Carbon was determined by a combustion-manometric procedure; hydrogen, oxygen, and nitrogen were determined by an inert gas-fusion method; and metallic impurities were measured by ICP/AES.

The final report was completed on heats of reaction between U_3Si and U_3Si_2 and aluminum plus 6061 matrix material for the RERTR Program. These data were also presented at the International RERTR Meeting held at ANL during October 15-18, 1984.

University of Utah Coal Analyses (I. M. Fox)

The ACL analyzed coal samples for the University of Utah's Coal Research Program. Knowledge of ACL's capabilities to perform analyses on milligram quantities of coal resulted from interactions between the University of Utah and programs in CHM. Fifty samples were analyzed for carbon, hydrogen, and nitrogen.

Work for Energy Research Corporation (A. M. Essling and E. A. Huff)

The Chemical Analysis Group has recently completed the analysis of 49 samples of Li_2CO_3 - K_2CO_3 fused salt for trace Cr, Fe, and Ni. The samples were analyzed at the request of Energy Research Corporation of Danbury, CT. Approval to perform the analyses was received from DOE. The technique for analyzing such samples was developed by the Chemical Analysis Group while similar analytical support was provided to T. Kaun in the Molten Carbonate Fuel Cell Program.

University of Chicago Sludge Analyses (A. M. Essling)

Low-level uranium analyses, using laser fluorescence, have been done on sludges obtained from the chemical laboratories at the University of Chicago. Decontamination and decommissioning work is being coordinated by OHS.

Purification of ^{44}Ti (M. A. Wahlgren, A. M. Essling, R. R. Heinrich, and K. J. Jensen)

A ^{44}Ti solution has been prepared by chemical separation from target materials used to produce the nuclide.

The ^{44}Ti was produced in a 30-g scandium metal shutter used in a cyclotron at NASA, Lewis Research Center, while irradiated with 43 MeV protons at 1500

microampere-hours. Separations and purifications were made by solvent extraction, ion exchange, and gravimetric methods. About 10^{-7} g of ^{44}Ti was separated and returned to the submitters (N. Peterson, S. Rothman, and K. Hoshino in MST) for use in their study of diffusion mechanisms in TiO_2 (rutile).

LINAC (K. J. Jensen)

Analytical chemistry support has been provided to a group of ANL physicists who are using the Tandem Super Conducting LINAC to make nuclide measurements.

Chemical support that has been provided includes preparation of the following:

1. Purified Fe_2O_3 powder doped with known concentrations of iron isotopes of mass 54, 56, and 58, as well as a series of Fe_2O_3 samples doped with varying concentrations of ^{60}Fe ;
2. Fe_2O_3 samples after chemical separation of iron from other constituents in iron meteorites and ore samples from different world-wide sources;
3. TiO_2 residues doped with varying concentrations of ^{44}Ti and ^{48}Ti ;
4. Co_3O_4 samples doped with known concentrations of ^{60}Co ; and
5. CaO samples doped with known concentrations of ^{41}Ca .

Upgrading of Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-AES)
(E. A. Huff)

The ICP-AES system has been upgraded in order to respond to identified user needs. The salient features of these modifications are as follows:

1. Installation of 19 additional channels on the polychromator. The elements added comprise duplicate wavelengths for abundant metals (Al, Ca, Fe, Mg), hydride-forming constituents (As, Se, Sb), and rare earths.
2. Exchange of the monochromator system to improve performance.
3. Installation of a 20-cm focal length monochromator to be used as an internal standard channel.

4. Installation of a sample uptake system that is compatible with hydrofluoric acid to allow for the measurement of low-level silicon concentrations and the analysis of samples stable only in this medium.

Completion of Upgrade of the Ion Chromatograph (F. L. Williams)

The ACL ion chromatograph has been upgraded. Modifications include the following:

1. Installation of an electrochemical detector to increase the sensitivity for trace concentrations of halides, cyanide, sulfide, bisulfide, thiosulfate, phenols, amines, and hypochlorite.
2. Installation of a fiber suppressor that allows for continuous regeneration of the suppressor column thereby avoiding shutdown time for suppressor regeneration.
3. Replumbing of the apparatus allowing for the analysis of large (25- to 50-mL) samples of conductivity-grade water so that sulfate ion can be determined at a concentration of 0.1 parts per billion.

Method for Organic Carbon Analysis for EPA Samples (I. M. Fox and P. C. Lindahl)

A method to analyze river and lake sediments for organic carbon was developed by I. Fox and P. Lindahl for the EPA Region V Laboratory. The samples were a heterogeneous mixture of snail shells, plant parts, sand, and clay; sample preparation was an important part of the procedure developed. The samples were dried, milled, sieved, and split prior to analysis. The dry, homogenized samples were treated with acid to remove carbonate carbon. The treated samples were analyzed for total organic carbon using an automated CHN analyzer. Twenty-four samples were analyzed in duplicate. Quality assurance requirements were defined, and accuracy and precision were determined.

Proof-of-Breeding (POB) Program (D. G. Graczyk, R. W. Bane, D. L. Bowers, E. L. Callis, A. G. Engelkemeir, A. M. Essling, R. R. Heinrich, K. J. Jensen, E. T. Kucera, R. J. Popek, E. G. Rauh, and M. A. Wahlgren)

The Light Water Breeder Reactor (LWBR) Proof-of-Breeding (POB) Program continues to be the largest user of ACL support from both the Instrumental Analysis and the Chemical Analysis Group.

Analytical chemistry operations with actual U-bearing dissolver solution samples were begun in the ACL laboratories in Building 200 during the first quarter of this year. Initial work was performed to demonstrate our ability to meet requirements for the dual dissolver system and for uranium analytical procedures. Analytical data indicated that the same high levels of precision and accuracy were maintained during work at a production pace as were achieved during development of the procedures. Over 100 samples were processed in a three-week period, with the critical uranium assays showing a relative standard deviation of less than 0.01%. This high precision provided confidence that the analysis was under control and that requirements regarding error limits and turnaround time for the end-of-life (EOL) fuel rods could be achieved.

The first irradiated fuel rod, a GRIP-II validation rod, arrived in December 1983, and chemical and radiometric measurements were completed in January 1984. This was the first rod processed from start to finish in the ANL POB facilities. All measurements proceeded smoothly with rapid turnaround of results and no equipment malfunctions during this two-month period.

The destructive analysis of the first EOL fuel rod began in mid-August after about a four-month delay in schedule. In general, the high performance of the ANL systems on this rod was comparable to operations performed on test rods processed earlier.

Isotope Correlation Studies and Measurements (ICSAM) Program (D. L. Bowers, R. J. Popek, and R. R. Heinrich)

The ACL started a new analytical effort for the Applied Physics Division in the area of isotope correlation studies and measurements during the third quarter of FY 1984. Isotope correlation studies on reactor fuel for this application are directed toward the area of safeguards, where material accountability is of primary importance. The isotope correlation functions that appear to be most effective are those having a linear or almost linear relationship among isotopes. These functions are independent of reactor operating conditions and burnup and, therefore, provide a means of verifying the input to a reprocessing plant. The most attractive isotopic correlations may be grouped into four categories: Pu/U, Pu isotopics, U isotopics, and U and Pu mixed isotopics.

The ACL responsibilities consist of providing adequate hot cell space for the irradiated fuel and equipping the cell for all the necessary analytical operations for removing fuel from cladding, dissolving the fuel, separating fission products from the fuel, and assaying U and Pu and their respective isotopic compositions.

Ten fuel specimens from the reactor in Zion, IL, were received in June of this year for analysis. Cell preparations and equipment installations have since been completed, and the first fuel specimen is currently being processed.

IDA-80 Program (E. L. Callis and D. L. Bowers)

During 1981 and 1982, the ACL participated in the IDA-80 Program, a comprehensive international measurement evaluation experiment, primarily directed toward nuclear safeguards. The program was designed to assess a participant's ability to perform uranium and plutonium measurements by mass spectrometry on

reactor fuel dissolver solutions. Thirty-one laboratories representing the United States, United Kingdom, Europe, Japan, and South America participated.

During March 27-30, 1984, E. L. Callis attended the IDA-80 Participants Meeting held in Karlsruhe, West Germany, for the purpose of reviewing and comparing the interlaboratory results. Of all the participating laboratories, the results of the ACL were the most accurate, with a mean standard deviation from the certified values of 0.07%.

Synfuel Analysis (J. C. Demirgian)

There has been considerable interest by DOE to characterize the products obtained during coal gasification and liquefaction. Coal-derived liquids are highly complex mixtures of organic and inorganic compounds. The Organic Analysis Group has concentrated on identifying the organic compounds present in coal-derived liquids. Thus, we have developed a computerized rapid analysis protocol for organic compounds present in synthetic fuel mixtures. This protocol is now available in a complete software package. A gas chromatograph, minicomputer data system, and the IBM mainframe computer have been linked to form a powerful network for analyzing complex samples and building data bases for suites of samples. This work was performed jointly with V. Stamoudis (EES).

Multidimensional Chromatography (J. C. Demirgian)

To obtain better separation using gas chromatography, we have developed a multidimensional chromatography system. In this procedure, a portion of eluent from the first GC column is applied to a second GC column using switching valves, thus enabling us to further separate the compounds in the eluent from the first column. This unique setup will allow determination of trace compounds in complex mixtures with a single injection, and thus eliminate the costly and complex extraction step now required to analyze many samples. This technique is suitable for analysis of complex mixtures, such as synthetic fuel mixtures.

Priority Pollutant Analysis (R. J. Wingender)

We have developed the capability to analyze for trace organic compounds from aqueous samples and can routinely analyze priority pollutants with an extended list of surrogate compounds. This technique, available in Building 205 on the Finnigan GC/MS, allows the environmental scientist to obtain priority pollutant analyses with additional information on hazardous but nonregulated pollutants at virtually the same cost as priority pollutants alone. In addition, volatile organic compounds can now be routinely analyzed by GC/MS, whereas PCBs are routinely analyzed by GC.

Dioxin Analysis (R. J. Wingender)

There is increasing interest by DOE and EPA in developing highly sensitive and specific analytical methods for determining low levels of dioxins and related compounds in the environment. We have established a novel dioxin cleanup method that can recover up to 81% of the 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) in a single column pass. This procedure eliminates the more costly extraction or high performance liquid chromatography (HPLC) cleanup techniques previously required for sample preparation before analysis for dioxin by GC/MS. When this method is fully operational, we expect to run samples for the Region V EPA and other groups.

PCB Analysis by Gas Chromatography/Matrix Isolation/Fourier Transform Infrared Spectroscopy (GC/MI/FTIR) (J. F. Schneider and G. T. Reedy)

The applicability of the GC/MI/FTIR technique has been demonstrated for analysis of PCBs. Using this scheme, one can analyze even difficult matrices (those impossible to analyze by GC or GC/MS techniques) with sensitivity equal to MS techniques. Other applications of this technique are expected in FY 1985.

EPA Work (R. J. Wingender, J. F. Schneider, and A. S. Boparai)

The Region V Office of EPA began sending samples to ACL for its "atmospheric loading" program. The objective is to analyze for trace organic compounds in rain samples so that the organic chemical loading of various areas of the Midwest can be determined as a function of time. Briefly, our procedure involves an extraction step followed by analysis by high resolution GC/MS and electron capture GC.

Cellulose Degradation (R. J. Wingender)

Collaborative studies in cellulose degradation with J. E. Helt and J. E. Young (CMT) have been initiated.

Plastic Pipe Program (D. G. Ettinger, E. A. Huff, and L. A. Raphaelian)

D. G. Ettinger replaced J. E. Battles (CMT) as project manager of the Plastic Pipe Program sponsored by the Gas Research Institute (GRI), increasing ACL involvement in this effort. The objective of this program is to characterize, on a chemical and molecular basis, the polyethylene pipe, resins, and other materials used in the manufacture of the pipe and to relate this characterization to the mechanical properties, such as long-term stability, crack resistance, degradation, and strength. Analyses, including C-13 nuclear magnetic resonance (NMR), ICP/AES, gel permeation, and differential scanning calorimetry, have been combined with mechanical tests done by D. Raske (MST).

DEP Instrument Survey (D. G. Ettinger)

An instrument survey of the ANL site was completed by Deon Ettinger for DEP. The purpose of this survey was to identify instruments that would be available for use by visitors to ANL.

Fluid Enhancement (A. S. Boparai)

In the EES Division, DOE has sponsored a project to determine the rate of degradation of candidate working fluids used in organic Rankine cycle systems. To develop fluids with minimal degradation at high temperature (up to 800°F),

a new analytical effort in the Fluid Enhancement Program was initiated. Degradation products of working fluids in organic Rankine cycle power generating model systems will be identified, and ways to minimize or eliminate the degradation will be proposed and tested.

Leachates (L. A. Raphaelian)

Preparations for the analysis of a new set of organic leachate samples from solid wastes of emerging energy technologies were initiated. This work is a new program for ACL, funded by the Morgantown Energy Technology Center.

PCR and Chlorinated Pesticide Residues by Parallel Capillary GC (J. F. Schneider)

This method allows the analyst to very reliably identify and quantify polychlorinated biphenyls and chlorinated pesticides in a large variety of sample matrices. Over 900 samples have been analyzed for Region V of the EPA by this method.

Work for Others and External Interactions

Analyses have been done for some outside organizations, with DOE approval, including Fermilab, the University of Illinois, Illinois Institute of Technology, Commonwealth Edison, the University of Utah, Energy Research Corporation (Danbury, CT), Los Alamos National Laboratory, and the U.S. Environmental Protection Agency (Region V, Central Regional Laboratory). In addition, we have provided overcheck analyses on uranium-graphite fuel materials that confirmed prior U determinations done at the Los Alamos National Laboratory. Another form of ACL interaction with outside organizations is cooperation with the American Society for Testing and Materials (ASTM). P. C. Lindahl is chairman of Subcommittee D5.2901 on Atomic Absorption Methods, Committee D-5 on Coal and Coke. He has participated in an ASTM interlaboratory testing program on a proposed method for the determination of arsenic in coal. He is also conducting an interlaboratory testing program (involving about 20 coal testing laboratories) for the Premium Coal Sample Program.

Support Development Funds

The ACL received funding from Support Development Funds (from Laboratory indirect) for three projects for FY 1984.

E. A. Huff developed a procedure for the "Determination of Metals in Organic Matrices." A report giving results has been written. This new capability will allow for the direct determination of metals in organic materials and will be especially useful in providing analytical support to an ANL program studying the distribution of elements in diverse liquid-liquid extraction systems.

J. C. Demirgian developed and installed the capability for GC/FTIR/MS in Lab E334/356 in Building 362. Scientists can now obtain both mass spectral and infrared spectral data on the same complex organic sample as it is separated by high resolution gas chromatography. Samples were analyzed successfully for R. Winans (CHM), D. Haugen (BIM), and V. Stamoudis (EES).

D. G. Ettinger was funded to prepare a proposal for laser-based analytical chemistry. The proposed work would be funded by DOE Office of Energy Research.

IV. PROFESSIONAL ACTIVITIES

A. Publications and Reports

1984

Characterization and Optimization of Polyethylene Resins and Gas Pipe
James E. Battles, Leo A. Raphaelian, David T. Raske, and Deon G. Etinger
1983 Annual Report to Gas Research Institute (June 1984)

Chemical and Toxicological Evaluation of Synfuel Waters
V. C. Stamoudis, J. R. Stetter, R. D. Flotard, A. S. Boparai,
D. A. Haugen, M. J. Peak, and C. A. Reilly, Jr.
Proceedings of the Third Biennial Synfuels Wastewater Workshop,
Morgantown, WV, June 15-16, 1983, DOE/METC/84-5, pp. 186-194 (1984).

Computerized Rapid Analysis of Complex Mixtures by Gas Chromatography
Jack C. Demirgian
J. Chromat. Sci. 22, 153-160 (1984)

Determination of Aluminum in Hydrothermal Reaction Fluids by Graphite
Furnace Atomic Absorption Spectrophotometry
P. C. Lindahl, K. C. Voight, A. M. Bishop, G. M. Lafon, and W. L. Huang
At. Spectrosc. 5(4), 137-141 (1984)

Determination of Internal Cation Mobilities in the Molten System (Li-K)Cl
at 723 K
R. Takagi, H. Shimotake, and K. J. Jensen
J. Electrochem. Soc. 131(6), 1280-1283 (1984)

A Differential Analysis Study of U_3Si-Al and U_3Si_2-Al Reactions
R. F. Domagala, T. C. Wiencek, J. L. Snelgrove, M. I. Homa, and
R. R. Heinrich
Argonne National Laboratory Report No. ANL/RERTR/TM-7 (1984)

Evidence for the Long-Distance Atmospheric Transport of Polychlorinated
Terphenyl
R. J. Wingender and Richard M. Williams
Environ. Sci. Technol. 18, 625 (1984)

Factors Influencing Trace Element Variations in U.S. Coals
Peter C. Lindahl and Robert B. Finkelman
ACS Division of Fuel Chemistry Preprints of Papers Presented at the
188th ACS National Meeting, Philadelphia, PA, August 26-31, 1984,
Vol. 29(4), pp. 28-35 (1984)

Half-Life of ^{60}Fe
Walter Kutschera, Peter J. Billquist, Dieter Frekers, Walter Henning,
Kenneth J. Jensen, Ma Xizeng, Richard Pardo, Michael Paul, Karl E. Rehm,
Robert K. Smither, and Jan L. Yntema
Proceedings of the 3rd International Symposium on Accelerator Mass
Spectrometry, Zurich, Switzerland, April 10-13, 1984 (1984)

A Laser Raman Spectroscopic Study of Anodic Corrosion Films on Silver and Copper

C. Melendres, S. Xu, and B. Tani
J. Electroanal. Chem. 162, 343-349 (1984)

Parallel Capillary Column Gas Chromatography in the Determination of Chlorinated Pesticides and PCBs

John F. Schneider, Sid Bourne, and Amrit S. Boparai
J. Chromat. Sci. 22, 203-206 (1984)

Utilization of the Intense Pulsed Neutron Source (IPNS) at Argonne National Laboratory for Neutron Activation Analysis

R. R. Heinrich, L. R. Greenwood, R. J. Popek, and A. W. Schulke, Jr.
Proceedings of the 26th Conference on Analytical Chemistry in Energy Technology, Oak Ridge National Laboratory, Knoxville, TN, October 11-13, 1983, pp. 243-248 (1984)

1983

Analytical Measurements of Actinide Migration in a Laboratory Simulated Basalt HLW Repository

D. L. Bowers, T. J. Gerding, S. M. Fried, G. F. Vandegrift, and M. G. Seitz
Proceedings of the 26th Conference on Analytical Chemistry in Energy Technology, Oak Ridge National Laboratory, Knoxville, TN, October 11-13, 1983 (1983)

An Improved Procedure for Extraction of Aromatic Bases from Synfuel Materials

A. S. Boparai, D. A. Haugen, K. M. Suhrbier, and J. F. Schneider
Proceedings of the DOE/OHER Workshop on Chemical Characterization of Hazardous Substances in Synfuels, Seattle, WA, November 1983;
Advanced Techniques in Synfuels Analysis, ed. C. W. Wright, W. C. Weimer, and W. D. Felix, U.S. Department of Energy CONF-81-1160, Technical Information Center, Oak Ridge, TN, pp. 3-11 (1983)

Autoionization of Hg, Cd, and Zn Atoms by Electron Impact Ionization: Implications in Electron Energy Scale Calibrations

K. Douglas Carlson and Everett G. Rauh
High Temp. Sci. 16, 341-357 (1983)

Biological Oxidation of Organic Constituents in Tar Sand Combustion Process Water

M. F. Torpy, R. G. Luthy, and L. A. Raphaelian
Biotechnol. Bioeng. XXV(12), 3163 (1983)

Development of an Analytical Method for the Determination of Organic Compounds in Fossil Fuel Aqueous Leachates

M. Avery, W. Blanton, L. Hilpert, L. Jackson, G. Junk, M. Maskarinec, R. C. Paule, L. Raphaelian, J. Richard, J. Thomson, and C. White
U.S. DOE Report DOE-PETC-TR84-1 (October 1983)

**Impact of Aircraft Emissions on Air Quality in the Vicinity of Airports:
Vol. V, Nitrogen Dioxide and Hydrocarbons**

Kenneth L. Brubaker, Mehul Dave, Ronald J. Wingender, and
Richard D. Flotard

U.S. Department of Transportation, FAA Report DOT-FA77WAI-736 (1983)

**Infrared Spectra of the Matrix-Isolated Chlorides of Iron, Cobalt, and
Nickel**

D. W. Green, D. P. McDermott, and A. Bergman

J. Mol. Spectrosc. 98, 111-124 (1983)

**Influence of Coal Devolatilization Conditions on the Yield, Chemistry and
Toxicology of By-Product Oils and Tars**

Jack C. Demircian, Vassilios C. Stamoudis, Joseph R. Stetter, John Fillo,
and Vance Ed

DOE Report DOE/ET/14746-11, ANL/SER-2 (1983)

**Interaction of Groundwater and Basalt Fissure Surfaces and Its Effect on
the Migration of Actinides**

G. F. Vanderift, D. L. Bowers, T. J. Gerding, S. M. Fried, C. K. Wilbur,
and M. G. Seitz

Chapter in Geochemical Behavior of Disposed Radioactive Waste,
ed. G. S. Barney, J. D. Navratil, and W. W. Schulz, ACS Symp. Ser. 246,
229-247 (1983)

**Isolation of Mutagenic Polycyclic Aromatic Hydrocarbons from Tar
Produced during Coal Gasification**

D. A. Haugen, V. C. Stamoudis, M. J. Peak, and A. S. Boparai

Polynuclear Aromatic Hydrocarbons: Formation, Metabolism, and
Measurement, ed. Marcus Cooke and Anthony J. Dennis, Battelle Press,
Columbus, OH, pp. 607-620 (1983)

Novel Renin Inhibitors Containing the Amino Acid Statine

J. Boger, N. S. Lohr, E. H. Ulm, P. Poe, E. M. Blaine, G. M. Fanelli,
T. Y. Lin, L. S. Payne, T. W. Schorn, B. LaMont, T. C. Vassil,

I. I. Stabilito, D. V. Veber, D. H. Rich, and A. S. Boparai

Nature 303, 81 (1983)

Operation with Three Liquid Phases in a Staged Liquid-Liquid Contactor

R. A. Leonard, A. A. Ziegler, R. A. Wigeland, R. W. Bane, and
M. J. Steindler

Sep. Sci. Technol. 18(14&15), 1563-1579 (1983)

Oxygen-18 Study of Nonaqueous-Phase Oxidation of Sulfur Dioxide

B. D. Holt, P. T. Cunningham, A. G. Engelkemeir, D. G. Graczyk, and
R. Kumar

Atmos. Environ. 17(3), 625-632 (1983)

**Synthesis of Novel 3-methylstatine Analogs. Assignment of Absolute
Configuration**

M. Kawai, A. S. Boparai, M. S. Bernatowicz and D. H. Rich

J. Org. Chem. 48(11), 1876 (1983)

Vapor Pressures and Vapor Compositions in Equilibrium with Hypostoichiometric Plutonium Dioxide at High Temperatures

D. W. Green, J. K. Fink, and L. Leibowitz

Chapter 9 in Plutonium Chemistry, ed. W. T. Carnall and G. R. Chapin, ACS Symp. Ser. 216, 123-143 (1983)

Vapor Pressures and Vapor Compositions in Equilibrium with Hypostoichiometric Uranium-Plutonium Dioxide at High Temperatures

D. W. Green, J. K. Fink, and L. Leibowitz

High Temp.-High Pres. 15, 205-214 (1983)

X-Ray Diffraction Investigation of Atmospheric Aerosols in the 0.3-10 μm Aerodynamic Size Range

B. Tani, S. Siegel, S. A. Johnson, and R. Kumar

Atmos. Environ. 17(11), 2277-2283 (1983)

B. Oral Presentations

1984

Analyses in Which GC/Matrix Isolation/IR Outperforms GC/MS

Deon G. Ettinger, Gerald T. Reedy, Sidney Bourne, and Jack C. Demirgian

The Pittsburgh Conference and Exposition on Analytical Chemistry and Applied Spectroscopy, Atlantic City, NJ, March 5-9, 1984, presented by Deon G. Ettinger

Computerized Rapid Analysis of Complex Mixtures by Gas Chromatography

Jack C. Demirgian

Presented at The Pittsburgh Conference and Exposition on Analytical Chemistry and Applied Spectroscopy, Atlantic City, NJ, March 5-9, 1984

Factors Influencing Trace Element Variations in U.S. Coals

Peter C. Lindahl and Robert B. Finkelman

188th ACS National Meeting, Philadelphia, PA, August 26-31, 1984, presented by Peter C. Lindahl

Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES) in Support of Nuclear Waste Management

E. A. Huff and E. P. Horwitz

1984 Winter Conference on Plasma Spectrochemistry, San Diego, CA, January 2-6, 1984, presented by E. A. Huff

Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES) Overview and Analytical Applications

E. A. Huff

Presented at Northern Illinois University, De Kalb, IL, May 2, 1984

Infrared Spectral Search Routines in GC/Matrix Isolation/IR

Gerald T. Reedy, Deon G. Ettinger, and Sidney Bourne

The Pittsburgh Conference and Exposition on Analytical Chemistry and Applied Spectroscopy, Atlantic City, NJ, March 5-9, 1984, presented by Gerald T. Reedy

Sub-Nanogram Sensitivity and Other Figures of Merit for GC/Matrix
Isolation/IR

Gerald T. Reedy, Deon G. Ettinger, Sidney Bourne, and John F. Schneider
The Pittsburgh Conference and Exposition on Analytical Chemistry and
Applied Spectroscopy, Atlantic City, NJ, March 5-9, 1984, presented by
Gerald T. Reedy

Trace Organic Analysis Using GC/IR

Sidney Bourne, Gerald T. Reedy, and Deon G. Ettinger
The Pittsburgh Conference and Exposition on Analytical Chemistry and
Applied Spectroscopy, Atlantic City, NJ, March 5-9, 1984, presented by
Sidney Bourne

1983

Analytical Applications of Ion Chromatography

F. L. Williams

Presented at the Labcon Central '83, Third Annual Laboratory
Instrument and Equipment Conference and Exhibition, Rosemont, IL,
September 20-22, 1983

Analytical Measurements of Actinide Migration in a Laboratory Simulated
Basalt HLW Repository

D. L. Bowers, T. J. Gerding, S. M. Fried, G. F. Vandegrift, and
M. G. Seitz

26th Conference on Analytical Chemistry in Energy Technology, Oak Ridge
National Laboratory, Knoxville, TN, October 11-13, 1983, presented by
D. L. Bowers

Causes of Increasing Atmospheric Methane Fluxes Based on Carbon Isotopic
Studies

C. M. Stevens, A. Engelkemeir, and R. A. Rasmussen
World Meteorological Organization Technical Conference on Observation
and Measurement of Atmospheric Contaminants, Vienna, Austria,
October 17-21, 1983, presented by C. M. Stevens

The Design, Fabrication, and Testing of the Gas Analysis System for the
Tritium Recovery Experiment TRIO-01

P. A. Finn, G. T. Reedy, M. I. Homa, R. G. Clemmer, G. Pappas,
M. A. Slawicki, D. G. Graczyk, D. L. Bowers, and E. D. Clemmer
10th Symposium on Fusion Engineering, IEEE, Philadelphia, PA,
December 5-9, 1983, presented by P. A. Finn

Determination of Chlorinated Pesticides and Polychlorinated Biphenyls
Using Parallel Capillary Column Gas Chromatography

J. F. Schneider

Presented at the 1983 ACS Pacific Conference on Chemistry and
Spectroscopy, Pasadena, CA, October 26-28, 1983

Effect of "Aged" Waste Package and Basalt on Radioelement Release

M. G. Seitz, G. F. Vandegrift, D. L. Bowers, and T. J. Gerding
Symposium of NRC-Sponsored Research on Waste Management Geochemistry,
Reston, VA, August 30-September 1, 1983, presented by M. G. Seitz

Infrared Matrix Isolation/High Resolution Gas Chromatography

G. T. Reedy and D. G. Ettinger

The Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, Atlantic City, NJ, March 7-11, 1983, presented by Gerald T. Reedy

Infrared Spectra of the Matrix-Isolated Chlorides of Iron, Cobalt, and Nickel

D. W. Green, A. Bergman, and D. McDermott

38th Annual Symposium on Molecular Spectroscopy, Ohio State University, Columbus, OH, June 13-17, 1983, presented by D. W. Green

The Interaction of Groundwater and Fresh Basalt Fissure Surfaces and Its Effect on the Migration of Actinides

G. F. Vandegrift, D. L. Bowers, T. J. Gerding, S. M. Fried, C. K. Wilbur, and M. G. Seitz

ACS Conference on Geochemical Behavior of Disposed Radioactive Waste, Seattle, WA, March 20-25, 1983, presented by G. F. Vandegrift

Matrix Isolation and FTIR Spectroscopic Studies of RuO, RuO₂, RuO₃, and RuO₄

David W. Green, Jack G. Kay, Gerald T. Reedy, and George L. Zimmerman

38th Annual Symposium on Molecular Spectroscopy, Ohio State University, Columbus, OH, June 13-17, 1983, presented by Jack Kay

Matrix Isolation Spectroscopy of Ruthenium Oxide

David Green, Jack G. Kay, Gerald T. Reedy, and George L. Zimmerman

Tenth Midwest High Temperature Chemistry Conference, University of Kansas, Lawrence, KS, June 9-11, 1983, presented by Jack Kay

Operation with Three Liquid Phases in a Staged Liquid-Liquid Contactor

R. A. Leonard, A. A. Ziegler, R. A. Wigeland, R. W. Bane, and M. J. Steindler

Third Symposium on Separations Science and Technology for Energy Applications, Gatlinburg, TN, June 28-July 1, 1983, presented by R. A. Leonard

A Practical Charge-Integration Technique for Small Signal Measurements in Thermal Ionization Mass Spectrometry

E. L. Callis

Presented at the 31st Annual Conference on Mass Spectrometry and Allied Topics, Boston, MA, May 8-13, 1983

Utilization of the Intense Pulsed Neutron Source (IPNS) at Argonne National Laboratory for Neutron Activation Analysis

R. R. Heinrich, L. R. Greenwood, R. J. Popek, and A. W. Schulke, Jr.

26th Conference on Analytical Chemistry in Energy Technology, Oak Ridge, TN, October 11-13, 1983, presented by R. R. Heinrich

C. Awards

Kenneth J. Jensen

University of Chicago Distinguished Performance Award, 1984

D. Meetings Attended

1984

Amrit S. Boparai

GC/MS 4000/4500X Advanced Operation Course, Finnigan MAT Institute,
Cincinnati, OH, April 2-6, 1984

Sidney Bourne

The Pittsburgh Conference and Exposition on Analytical Chemistry and
Applied Spectroscopy, Atlantic City, NJ, March 5-9, 1984

Ernest L. Callis

Final Participants Meeting of the IDA-80 Program, Karlsruhe, West
Germany, March 27-30, 1984

Jack C. Demirgian

Training Course in GC/FTIR, Nicolet Instrument Company, Madison, WI,
August 6-10, 1984

Seminar on State-of-the-Art Instrumentation, Christopher Newport College,
Newport News, VA, March 9, 1984

The Pittsburgh Conference and Exposition on Analytical Chemistry and
Applied Spectroscopy, Atlantic City, NJ, March 5-8, 1984

Deon G. Ettinger

27th ORNL-DOE Conference on Analytical Chemistry in Energy Technology,
Knoxville, TN, October 2-4, 1984

DOE OHER Workshop, "Chemical Measurements Needs in Energy-Related
Health and Environmental Research," Battelle Conference Center, Seattle,
WA, May 15-17, 1984

The Pittsburgh Conference and Exposition on Analytical Chemistry and
Applied Spectroscopy, Atlantic City, NJ, March 5-9, 1984

David W. Green

27th ORNL-DOE Conference on Analytical Chemistry in Energy Technology
Knoxville, TN, October 2-4, 1984

DOE Analytical Chemistry Managers Working Group, Argonne National
Laboratory, Argonne, IL, December 12-13, 1983

Edmund A. Huff

1984 Winter Conference on Plasma Spectrochemistry, San Diego, CA,
January 2-6, 1984

Eugene T. Kucera

33rd Annual Denver X-Ray Conference, University of Denver, Denver, CO,
July 30-August 3, 1984

Peter C. Lindahl

American Chemical Society Meeting, Philadelphia, PA, August 27-31, 1984;
Premium Coal Sample Program Advisory Committee Meeting, Philadelphia, PA,
August 31, 1984

American Society for Testing and Materials Meeting, Committee D5 on Coal
and Coke, Myrtle Beach, SC, May 7-9, 1984

Leo A. Raphaelian

4500 Electronics Course, Finnigan MAT Institute, Cincinnati, OH,
September 10-14, 1984

American Chemical Society Short Course, "Advances in Polymer Chemistry,
Physical Chemistry of Polymeric Materials," University of Akron, Akron,
OH, May 2-4, 1984

Gerald T. Reedy

The Pittsburgh Conference and Exposition on Analytical Chemistry and
Applied Spectroscopy, Atlantic City, NJ, March 5-9, 1984

Florence L. Williams

National Organization of Black Chemists and Chemical Engineers
Meetings, Houston, TX, April 25-28, 1984

Ronald J. Wingender

Fortran Programming Course, Finnigan MAT Institute, Cincinnati, OH,
March 26-30, 1984

The American Society of Mechanical Engineers Environmental Standards
Workshop, Washington, DC, January 23-25, 1984

1983

Ralph W. Bane

American Society for Testing and Materials Meeting, D5 Committee on Coal
and Coke, Louisville, KY, May 8-11, 1983

Amrit S. Boparai

Chicago Chromatography Discussion Group Symposium on Optimization
Techniques in Chromatography, Naperville, IL, May 19, 1983

Delbert L. Bowers

26th Conference on Analytical Chemistry in Energy Technology, Oak Ridge
National Laboratory, Knoxville, TN, October 11-13, 1983

Ernest L. Callis

31st Annual Conference on Mass Spectrometry and Allied Topics, Boston,
MA, May 8-13, 1983

Jack C. Demirgian

The Pittsburgh Conference and Exposition on Analytical Chemistry and
Applied Spectroscopy, Atlantic City, NJ, March 7-12, 1983

Irene M. Fox

Corning Electrodes Conference, Oak Brook, IL, April 28, 1983

David W. Green

38th Annual Symposium on Molecular Spectroscopy, Ohio State University, Columbus, OH, June 13-17, 1983

Chemistry Division Review at Los Alamos National Laboratory, Los Alamos, NM, September 19-20, 1983

26th Oak Ridge National Laboratory Conference on Analytical Chemistry in Energy Technology, Knoxville, TN, October 11-13, 1983

Robert R. Heinrich

26th Conference on Analytical Chemistry in Energy Technology, Oak Ridge National Laboratory, Knoxville, TN, October 11-13, 1983

Kenneth J. Jensen

Labcon Central '83, Third Annual Laboratory Instrument and Equipment Conference and Exhibition, Rosemont, IL, September 20-22, 1983

Eugene T. Kucera

Labcon Central '83, Third Annual Laboratory Instrument and Equipment Conference and Exhibition, Rosemont, IL, September 20-22, 1983

Leo A. Raphaelian

Eighth Plastic Fuel Gas Pipe Symposium, American Gas Association, New Orleans, LA, November 28-December 1, 1983

Workshop on Selection of a Reference Standard Polyethylene Piping Material, Northwestern University, Evanston, IL, September 7-8, 1983

Users Workshop and American Society for Mass Spectroscopists Meeting, Boston, MA, May 6-13, 1983

Gerald T. Reedy

Labcon Central '83, Third Annual Laboratory Instrument and Equipment Conference and Exhibition, Rosemont, IL, September 20-22, 1983

The Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, Atlantic City, NJ, March 7-11, 1983

FTIR User Training Course, Nicolet Instrument Company, Madison, WI, January 31-February 4, 1983

John F. Schneider

1983 ACS Pacific Conference on Chemistry and Spectroscopy, Pasadena, CA, October 26-28, 1983

Chicago Chromatography Discussion Group Symposium on Optimization Techniques in Chromatography, Naperville, IL, May 19, 1983

Ben S. Tani

American Chemical Society Short Course, "Laboratory Automation: Micro-, Mini-, or Midicomputers?," Chicago, IL, October 4-5, 1983

Labcon Central '83, Third Annual Laboratory Instrument and Equipment Conference and Exhibition, Rosemont, IL, September 20-22, 1983

X-Ray Analysis Seminar, Philips Electronics Institute, Skokie, IL, April 28, 1983

Florence L. Williams

Labcon Central '83, Third Annual Laboratory Instrument and Equipment Conference and Exhibition, Rosemont, IL, September 20-22, 1983

National Organization of Black Chemists and Chemical Engineers Executive Board Meetings, Knoxville, TN, May 25-28, 1983

Ronald J. Wingender

Labcon Central '83, Third Annual Laboratory Instrument and Equipment Conference and Exhibition, Rosemont, IL, September 20-22, 1983

American Chemical Society Meeting; Second Symposium, "Chlorinated Dioxins and Dibenzofurans in the Total Environment," Washington, DC, August 28-September 2, 1983

INCOS Operation Course, Finnigan MAT Institute, Cincinnati, OH, January 24-28, 1983