

Sawyer Environmental Chemistry Research Laboratory



Sawyer Environmental Research Center
University of Maine



Mission Statement

The Sawyer Environmental Chemistry Research Laboratory is a multi-disciplinary facility for environmental research and education at the University of Maine. The lab provides hands-on training for graduate students, and high-quality chemical analysis of environmental samples. The facility supports research at the University of Maine, federal, state and local agencies, and private industry.

The Sawyer Environmental Chemistry Research Laboratory employs advanced analytical techniques and state of the art instrumentation to perform a variety of analyses. The SECRL strives to provide high quality data by adhering to appropriate quality assurance guidelines and quality control procedures and by participating in inter-laboratory comparison performance evaluation studies. Laboratory samples range widely from marine and lake sediments to biological tissue to natural waters. The following pages contain information about the instrumentation at SECRL. For each type of analytical equipment housed at the lab, applications which are currently in use with developed methods are listed. The extended capabilities of each instrument are listed and would require method development.

Contact Information:

John Cangelosi
Inorganic Laboratory Supervisor
Sawyer Environmental Chemistry Research Laboratory
Sawyer Environmental Research Center
University of Maine
Orono, ME 04469

(207) 581-3239
(207) 581-3288
Fax: (207) 581-3290

John.Cangelosi@umit.maine.edu

Performance Evaluation Studies

The Sawyer Environmental Chemistry Research Laboratory participates in various performance evaluation studies to enhance quality assurance of data produced. There are two ongoing evaluations and several invitational inter-laboratory comparisons. Detailed performance results can be furnished upon request.

1. National Water Research Institute, Environment Canada (NWRI)

a. Participants are evaluated through data comparisons with other laboratories throughout the United States and Canada. SECRL participates in biannual proficiency testing studies on natural waters through NWRI. The parameters assessed include almost all of the inorganic water chemistry procedures that are available at SECRL.

b. SECRL participates in the Ecosystem Performance Evaluation study for trace elements in sediment. The sediment study is a semiannual evaluation that began in 2001.

2. Norwegian Institute for Water Research (NIVA)

The International Cooperative Program on Assessment and Monitoring of Acidification of Rivers and Lakes is a NIVA program in which SECRL analytical results are evaluated against about 75 other laboratories. The reported analytes are those related to acidification: pH, alkalinity, anions, base cations and 7 trace metals. The NIVA inter-comparison study is once per year.

3. United States Geological Survey (USGS)

Required evaluations for standard reference samples (SRS) were performed biannually from 1991 to 2001 when SECRL had contracted projects with USGS. The SRS samples were measured for trace constituents, major constituents, nutrients, low ionic strength constituents and mercury.

4. National Institute for Standards Testing (NIST)

The Sawyer Environmental Chemistry Research Laboratory was invited to participate in an inter-laboratory comparison exercise in 2001 and 2003 for trace elements in marine animal reference material. The results from SECRL and 30 other laboratories are used to determine baseline trace metals data for a new whale liver QA material.

5. NIMT/University of Edinburgh

SECRL took part in an inter-comparison study on the elemental content of a candidate reference material for ombrotrophic peat. Several trace metals were reported, including mercury.

Sawyer Environmental Chemistry Research Laboratory Staff

- John Cangelosi** **Inorganic Laboratory Supervisor**
Areas of expertise: Acid neutralizing capacity and pH
Automated field sampling setup
Sediment processing
Mercury analysis by CVAAS
- Clive Devoy** **Research Assistant**
Areas of expertise: Organic and inorganic mercury speciation
Trace level mercury analysis by CVAFS
Instrument design and fabrication
Gas chromatography
- Mary Lou Friedman** **Scientific Technician II**
Areas of expertise: Turbidity
Conductivity
Chlorophyll 'a' analysis
Microwave digestion
Webmaster
Administrative assistant duties
- Karen Small** **Research Assistant**
Areas of expertise: Colorimetric analysis by ALPKEM auto analyzer
Carbon analysis (total, organic, and dissolved)
Ion chromatography
Trace level mercury analysis by CVAFS
Phosphorus analysis
- Tiffany Wilson** **Research Assistant**
Areas of expertise: Trace metals and base cations by ICP-AES
Trace metals by graphite furnace AAS
Mercury analysis by CVAAS
Education and outreach programs

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Analytical Instruments (pp. 6-14)

- Perkin-Elmer Model 3300XL Inductively Coupled Plasma Atomic Emission Spectrometer (ICP-AES)
- Tekran 2600 Low Level Cold Vapor Atomic Fluorescence Mercury Analyzer System
- Brooks Rand Model III Mercury Speciation System, CVAFS
- Perkin-Elmer Flow Injection Mercury System (FIMS) Model 400
- Perkin-Elmer Graphite Furnace Atomic Absorption Spectrometer Model 4100ZL
- OI Analytical Total Organic Carbon Analyzer Model 1010
- OI Analytical ALPKEM Flow Solution IV Auto Analyzer
- Dionex Ion Chromatograph (IC)
- Radiometer TIM 900 Auto Titrator

Sample Preparation (p. 15)

- CEM Mars X Microwave Accelerated Reaction System

Other Instruments:

ThermoSpectronic Genesys 5 Spectrophotometer
Milton-Roy Spectronic 1201 Spectrophotometer
YSI 3200 Conductivity Instrument
Thermolyne Furnace 6000

SECRL Analytical Instruments

Perkin-Elmer Model 3300XL Inductively Coupled Plasma Atomic Emission Spectrometer (ICP-AES)

Composed of: Gemcone pneumatic nebulizer for use with high solute matrices
Ultrasonic nebulizer for use with aqueous matrices
Gilson 4-channel peristaltic pump
A/S 90 plus autosampler
WinLab32 instrument control and data management software

The advantage of ICP-AES analysis is its ability to do simultaneous multi-element analyses at low (ppb) concentrations for many elements.

Current Applications:

Aluminum	Cadmium	Lead	Silicon
Antimony	Calcium	Magnesium	Silver
Arsenic	Chromium	Manganese	Sodium
Barium	Cobalt	Nickel	Strontium
Beryllium	Copper	Phosphorus	Tin
Bismuth	Gold	Potassium	Vanadium
Boron	Iron	Selenium	Zinc

Extended Capabilities:

Carbon	Indium	Platinum	Terbium
Cerium	Iridium	Praseodymium	Thallium
Cesium	Lithium	Rhenium	Thorium
Dysprosium	Lanthanum	Rhodium	Thulium
Erbium	Lutetium	Rubidium	Titanium
Europium	Mercury	Ruthenium	Tungsten
Gadolinium	Molybdenum	Samarium	Uranium
Gallium	Neodymium	Scandium	Ytterbium
Germanium	Niobium	Sulfur	Yttrium
Hafnium	Osmium	Tantalum	Zirconium
Holmium	Palladium	Tellurium	

Sample Matrices:

Water (drinking water, natural waters)
Sediment
Biological tissue
Agricultural products
Food products

Tekran CVAFS Mercury Detection System (Model 2600)

Composed of: Detector / Control Module

Pump Stations

Gilson Random Access Autosampler

The Tekran is capable of detecting as little as 4 pg of elemental mercury, and as much as 4 ng without dilution. Elemental mercury is delivered to the detector following various chemical treatments which result in the ability to detect the following:

Current Applications:

Total mercury

Inorganic mercury

Extended Capabilities:

Elemental mercury

Sample Matrices:

Gas samples

Tissue

Sediment

Water

Brooks Rand Model III CVAFS Mercury Speciation System

Composed of: Elemental Mercury Detector
HP 5890 Series II GC
Pyrolysis module (custom built)
Purge and trap, thermal desorption system (custom built)
Chromatography Data System, PeakSimple software

The Brooks Rand is capable of separating mercury species and detecting as little as 2 pg of methyl mercury (as Hg), and as much as 200 pg without dilution.

Current Applications:

Methyl mercury

Extended Capabilities:

Elemental mercury

Inorganic mercury

Sample Matrices:

Tissue

Feathers

Sediment

Water

Perkin-Elmer FIMS-400 Atomic Absorption Spectrometer

Composed of: Flow Injection Mercury System
106 site autosampler
WinLab 32 software

The FIMS-400 is capable of detecting total mercury in the ppb range. Elemental mercury is delivered to the detector by a carrier gas and measured by cold vapor atomic absorption.

Current Applications:

Total mercury

Extended Capabilities:

Determination of hydride-forming elements when coupled with AA or ICP.

Sample matrices:

Soil

Water

Tissue

Plant material

**Perkin-Elmer Graphite Furnace Atomic Absorption Spectrometer
Model 4100ZL**

Composed of: Electrodeless discharge lamps with external power supply
Hollow cathode lamps with internal power supply
A/S 71 autosampler (40 or 80 site)
WinLab software

The GFAA uses an autosampler probe to dispense micro-quantities of liquid sample directly onto a graphite tube platform. The sample is heated on the graphite tube to temperatures which allow it to volatilize and atomize into a vapor. The element-containing vapor is contained in the tube long enough for the absorption of light at an element specific wavelength to be read by the spectrometer.

Current Applications:

As, Al, Cu, Cr, Cd, Ni, Pb, Se, and Zn at ppb levels

Extended Capabilities:

Analyses of many other elements with available EDL or HCL lamps.

Sample matrices:

Soil/Sediment

Water

Biological material

Food products

Agricultural products

OI Analytical Model 1010 Wet Oxidation Total Organic Carbon Analyzer

Composed of: Infrared CO₂ detector
88 site autosampler
WinTOC software

The Carbon Analyzer is a totally automated system for analyzing aqueous samples using a persulfate oxidation method. Samples in the range of 2 ppb to 125 ppm can be analyzed without sample pretreatment, prepurging, or dilution.

Current Applications:

Total or dissolved organic carbon
Total or dissolved inorganic carbon

Extended Capabilities:

Carbon in sea water

Sample Matrices:

Drinking water
Ground water
Wastewater

OI Analytical ALPKEM Flow Solution IV Auto-Analyzer

Composed of: Extended-range detector

Four segmented flow analytical cartridges

Two flow injection analytical cartridges

502 peristaltic pump

270 site RA autosampler

The ALPKEM applies flow analysis techniques to ion analysis. This involves aspirating samples, adding reagents, measuring ion concentrations, and processing results all in one continuous process. The extended range detectors allow analysis in a range of ppb to ppm.

Current Applications:

Ammonium

Silica (molybdate-reactive)

Total Nitrogen

Nitrate + Nitrite

Total Phosphorus

Ortho-phosphate

Extended Capabilities:

Anionic Surfactants

Carbonate – Bicarbonate

Hardness

Nicotine

Phenol

Sample Matrices

Soil

Sediment

Water

Plant material

Dionex (DX 500) Ion Chromatograph (IC) System

Composed of: LC 20 Chromatography enclosure
CD 20 Conductivity Detector
AS4 Automated Sampler
PeakNet Software

The DX 500 IC system offers a fast and versatile method of chromatographic analysis that offers superior sensitivity, accuracy, and dynamic range. Ion chromatography can be used to determine an ever-expanding range of inorganic and organic ions in a variety of samples.

Current Applications:

Chloride
Nitrate
Sulfate
Bromide
Fluoride
Phosphate

Extended Capabilities:

Amino acids
Carbohydrates
Nucleic Acids
Proteins/ Peptides
Low MW ions
Low MW organic molecules and ions

Sample Matrices:

Fresh water
Salt water
Aqueous solutions containing particles not larger than 1-2 microns

Radiometer TIM 900 Autotitrator

Consists of: TIM 900 Titration Manager
ABU91 Auto burette
SAC 80 Sample changer
TimTalk 9 software version 1.4

The Autotitrator is capable of measuring pH, air-equilibrated pH, alkalinity or acid neutralizing capacity up to 2000 µeq/L before dilution.

Current Applications:

Alkalinity and ANC in Water
pH and air-equilibrated pH

Extended Capabilities:

Boric acid
Chloride
Calcium & magnesium
Chemical oxygen demand by permanganate
Chemical oxygen demand by dichromate
Sulfate, calcium & chloride
Dissolved oxygen
Total acid number of oil (ASTM D664)
Total base number of oil (ASTM D664)
Total base number of oil (ISO 3771, ASTM D2896)
Water in petroleum products (Karl Fischer Determination)
Sulfur dioxide
Vitamin C
Sulfonamides in pharmaceuticals

Sample Matrices:

Water
Oil
Food/ Beverage
Environmental samples
Biological

SECRL Sample Preparation

CEM Mars X Microwave Accelerated Reaction System

Composed of: Microwave instrument
Pressure and temperature sensors
Green-Chem extraction vessels
HP-500 digestion vessels

The CEM Mars X microwave greatly accelerates extraction or digestion of samples.

Current Applications:

Acid decomposition of samples for Hg and Trace metal analyses
Solvent extractions of samples for PAH, PCB, dioxin, methyl mercury, and pesticide analysis.

Extended Capabilities:

Microwave assisted drying of samples
Microwave assisted ashing of samples
Organic synthesis
Protein hydrolysis
Base hydrolysis
Fusions
Biomedical staining
Clinical extraction
Environmental sample preparation

Sample Matrices:

Aqueous samples (including wastewater samples)
Sludge
Soil
Sediments
Animal tissue, organs
Plant tissue
Siliceous compounds
Food/Agricultural Samples
Pulp and paper related samples
Plastic and polymer based samples
Environmental samples