THE MICRO TOME

University of Vermont
College of Medicine

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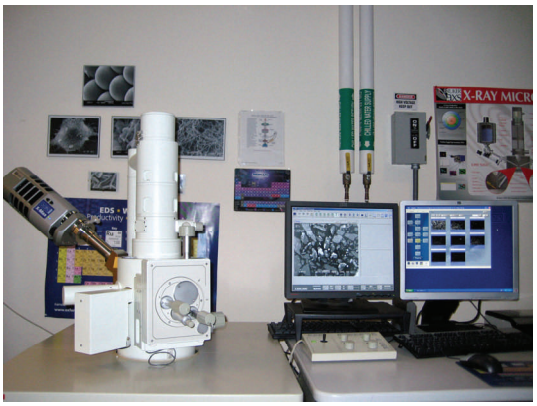
MICROSCOPY IMAGING CENTER
HTTP://WWW.UVM.EDU/MICROSCOPYIMAGING

Summer 2010

INCA Energy Brings Elemental Detection to the SEM



It's finally here! Thanks to an award in September 2009, to Dr. Greg Druschel, Geology Department, from the National Science Foundation's Major Research Instrumentation Program, a state of the art Energy Dispersive X-ray Microanalysis System from Oxford Instruments (High Wycombe, UK) has been installed on the scanning electron microscope in the MIC.

The hardware is comprised of:

- X-Max large area (50 mm^2) Peltier-cooled analytical silicon drift detector
- X-Stream X-ray acquisition system and detector control
- MICS (Microscope Image Capture System)
- Pentium IV PC, monitor, and printer

Oxford's INCA Energy 350 software package (Windows XP ™ platform) allows users to perform element analysis of points or line scans, as well as larger area element and phase mapping with image drift correction. Both qualitative and quantitative data can be attained.

It also includes:

- Navigator for step-by-step guidance
- Advisor for on-line help
- Information Management System for simple and logical data management
- Reporting for professional report generation with a few mouse clicks

Dr. Druschel and others will be using this new system to characterize materials such as asbestos minerals, zeolites, and other microporous mineral matrices, enhancing the understanding of physiochemical conditions controlled by mineralogical microstructure. The equipment will be incorporated into classes and workshops and his studies will serve as a foundation for education and training for environmental science, health, and engineering. (See article by Findlay in this newsletter)

This system is offered to assist other researchers and students on and off campus such as those in environmental pathology, geology, engineering, and chemistry. In addition, clients outside the university are welcome and already employing it for their materials analysis.

For inquiries or training contact Douglas Taatjes or Michele von Turkovich, 656-0813.

Reminder to MIC Users

The MIC will be hosting a workshop on stereology from July 21st to the 23rd. Instructors from Germany and Denmark will present lectures and lead hands-on exercises in stereological principles. A few spots still remain available for the course. Cost for the three day course is $600 for students and $800 for post-docs, technicians and principle investigators. Please visit our website at http://www.med.uvm.edu/microscopyimaging/ for details and registration.

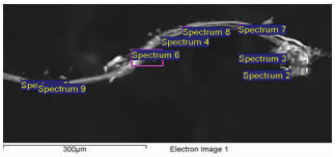
MIC adds ECIS Technology

An Electric Cell-Substrate Sensing (ECIS) system from Applied BioPhysics, Inc. has been added to the Microscopy Imaging Center. This system consists of an array holder housed in a cell-culture incubator, an electronics module, and a laptop computer. It is used to measure the physiologic response of cultured cells to experimental conditions. Cells are grown on 8-well culture slides containing gold foil electrodes in each well. The slides are placed into the array holder in the incubator, and temporal measurements of impedance (indicating cell-cell junctions) and capacitance (indicating cell-substrate interactions) are recorded over a variety of electrical frequencies. The cells may be treated with agents designed to perturb their physiology, whilst recording their electrical responses. The system is also designed to conduct wounding assays through electrically-induced wounds. The advantage to this method is that unlike scrape wounds, the matrix on which the cells are growing is not damaged by the electrical cell wound. The ECIS system is housed in room HSRF 209C, adjacent to the Olympus IX70 inverted microscope, for quick access to view the cells. Please contact Doug Taatjes for more information on the ECIS system.

In Love with Confocal!

The Zeiss confocal microscope schedule has been full for the past few months and we have just added some new users to the group. We would ask anyone who is scheduled to be sure to delete any remaining time if you are not going to use it, to increase the availability of the microscope. To those waiting to get on, keep the BioDesktop open on your toolbar and refresh before viewing to get the latest updates to the sign-up – that way you will be able to see any newly available slots. To those experienced users, you are welcome to come in during the evening at reduced rates. If you would like to have swipe card access to the imaging center, please email Marilyn Wadsworth.

SEM-EDS on the Rocks!



	O	Mg	Si	Cr	Ni
Sum Spectrum	79.62	11.68	7.31	0.08	0.21
Spectrum 2	45.06	18.26	12.78	0.31	0.44
Spectrum 3	57.55	23.29	16.60	0.11	0.43
Spectrum 4	60.91	21.81	15.51	0.11	0.28
Spectrum 5	57.35	23.69	17.55	0.09	0.21
Spectrum 6	63.91	20.78	14.51	0.31	0.23
Spectrum 7	50.49	26.54	19.73	BD	2.53
Spectrum 8	56.31	25.68	17.84	BD	0.93
Spectrum 9	54.87	28.89	13.13	0.38	1.92

Figure 2: SEM-EDS analysis was also instrumental in characterizing chemical variation on small scales – here in single asbestos fibers from the mine.

Use of SEM-EDS in determining mineral phases containing nickel and chromium in Vermont Asbestos Group mine waste

The Vermont Asbestos Group (VAG) mine in Eden, Vermont was one of the largest national producers of chrysotile asbestos, and large piles of waste rock are currently present on the site. Nickel and chromium levels found in downstream sediments exceed regulatory limits for sediments and are due to erosion of these piles; however the mineral phases containing this nickel and chromium had not been investigated thoroughly, and were presumed to be predominantly chrysotile fibers. It is important to ascertain which phase these metals are associated with as the bioavailability of these metals can vary significantly between different mineral phases.

The new Oxford Instruments large area silicon drift detector (X-Max) Energy Dispersive Spectrometer installed on the JEOL 6060 Scanning Electron Microscope (SEM-EDS) was key to identifying discreet mineral phases present in samples from the VAG mine. This technique quantified distinct concentrations of nickel and chromium in individual mineral constituents (from major element concentrations as in Figure 1 to trace concentrations along individual chrysotile fibers as in figure 2). Elemental maps constructed using the INCA mapping software (see insets in Figure 1) show that nickel occurs in conjunction with sulfur, suggesting a nickel sulfide mineral (Millerite) as the dominant phase containing this metal. Chromium was found to be enriched in iron rich minerals such as magnetite.

Additionally, although large area chemical analysis by SEM-EDS of elutriated fiber samples showed high concentrations of nickel and chromium, closer analysis of those samples with the SEM-EDS revealed small particles of highly concentrated nickel and chromium that contributed significantly to the numbers obtained from the overall chemistry, indicating that these minerals, and not the chrysotile fibers, were the main source of high nickel and chromium levels. Since the transport and dissolution of nickel and chromium contained within separate minerals will occur via very different processes, multiple pathways must be considered when determining the potential for the release of metals into the environment.

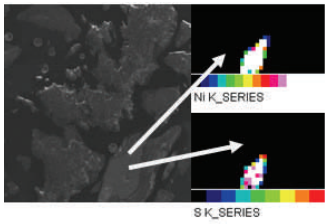


Figure 1: SEM image of a slide made from a rock sample from the mine with the quantified elemental map showing approximately 50 atomic percent nickel and sulfur.

5000 Strong and Counting

During this past academic year, the Microscopy Imaging Center was involved with numerous outreach endeavors. In addition to UVM medical students, UVM class tours / demos for Engineering, Botany, and Medical Laboratory and Radiation Sciences, we also hosted FAHC Pathology Residents, FAHC School of Cytotechnology and Bates College students, and gave tours to prospective UVM graduate students in Plant Biology, Pharmacology, and the CMB & MMG programs. At the high school level, we mentored students from South Burlington, Champlain Valley Union, and Colchester High Schools, and the Burlington Technical Center. We staffed the Pathology Teaching Lab ("Museum") for 3 weeks of MedQuest camps, UVM-COM Family Day, and the annual MVU 7th graders "College Visit Day". We "wo-manned" the digital microscopy (SEM and Dissecting microscope) component of the Governor's Institute for Science and Technology and the "Women Can Do" program at VT Technical College. Finally, we completed our 10th year with our Vermont middle school Project MICRO, reaching over 300 students, parents, and teachers (and "hitting" our 5,000th student since July 1999) and for the 1st time, facilitating a Project MICRO festival as part of the UVM College of Medicine's Reunion weekend.

Equipment Available:

- JEOL 1210 STEM
- JEOL JSM 6060 SEM with Oxford INCA EDS system
- BioRad MRC 1024 Confocal LSM
- Zeiss LSM 510 META Confocal
- Olympus IX70 Inverted Microscope
- Applied BioPhysics ECIS Zθ
- DI Atomic Force Microscope
- Arcturus PixCell II LCM
- Zeiss Axioplan 2 Microscope
- CompuCyte Laser Scanning Cytometer
- Olympus BX50 Microscope
- Universal Imaging MetaMorph Workstation
- Volocity 3D Software
- Multiple Dell Image Processing Workstations
- Olympus SZX12 Dissecting Microscope
- Leica MZ16F Fluorescence Dissecting Microscope
- MicroBrightField Stereo Investigator

MIC Services Provided:

- Morphologic services and consultation at the light and electron microscopy level
- Morphometry (semi-quantitative morphology)
- Light and electron microscopic immunocytochemistry
- Confocal scanning laser microscopy
- Laser scanning cytometry
- Atomic force microscopy
- Scanning and transmission electron microscopy
- Laser capture microdissection
- Preparation of paraffin and frozen sections
- Training for use of the above equipment
- Special histological stainings
- Testing of new antibodies and developing new staining techniques
- Computer-assisted digital imaging and analysis