THE ELECTRON MICROPROBE LABORATORY AT ARIZONA STATE UNIVERSITY.
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Introduction: In 2011, Arizona State University replaced their 25 year old electron microprobe with a state-of-the-art JEOL JXA-8530F field emission instrument. Our facility was partially funded by NASA and serves as an investigator facility instrument for NASA's Planetary Science Research Program.

Technical Capacities: The JEOL JXA-8530F HyperProbe is an electron microscope that has a nominal imaging resolution of 3 nm with a X-ray spectrometer for non-destructive X-ray microanalysis and imaging of solid materials.

The Schottky field-emission electron gun coupled with the electron optical system provide small probe diameters that are only 1/5 to 1/10 the size of that produced in a thermionic-emission electron gun in conventional electron microprobe instruments with tungsten filament or LaB6 tips, allowing for sub-micron analytical spatial resolution. Even at low acceleration voltages and large currents, small probe diameters are obtained that allow high X-ray spatial resolution (e.g., 40 nm at 10 na and 10 kV, or 100 nm at 100 na and 10 kV).

The instrument has 5 wavelength-dispersive spectrometers (WDS) with diffracting crystals that permit measurement of elements from B through U, and is set up for conventional microanalysis as well as light-element and trace-element analysis by means of layered-dispersive analyzing crystals and two high-intensity H-type spectrometers.

In addition, the HyperProbe is equipped with a silicon-drift energy-dispersive detector, which is capable of X-ray count rates in excess of 200,000 counts per second and has high-speed X-ray mapping and quantitative microanalytical capabilities that rival the WDS. Our instrument can acquire secondary-electron, backscattered-electron, cathodoluminescence, and X-ray digital maps via either beam or stage scanning of samples up to 10 cm in size.

Our HyperProbe is also equipped with a panchromatic cathodoluminescence system that allows the detection of cathodoluminescence in the wavelength range between 200-900 nm.

Excellent beam stability and a clean sample environment are maintained by a differential pumping system that uses two sputter ion pumps, two turbo molecular pumps, two rotary pumps and a reservoir tank.

For instrument control, we can utilize the customized JEOL system software and the PC-based Probe for Windows software.

Summary Analytical Capabilities: The electron microprobe laboratory at Arizona State University allows to determine the chemical composition of solid materials up to 10 cm in size that are stable under high vacuum. The non-destructive analytical technique does not require special sample preparation and produces spatially resolved (~1 µm-scale), high-quality data relatively fast:

- Samples can be imaged by high-resolution electron microscopy and cathodoluminescence spectroscopy;
- chemical composition can be qualitatively ascertained by energy dispersive spectrometry and X-ray intensity mapping;
- chemical compositions of sample components can be quantified for the elements from boron to uranium by wave-length dispersive spectrometry.

As an excellent tool for the characterization of solid materials, electron microprobe analysis is a basic method for the scientific study of extraterrestrial materials. To allow for more detailed exploration of sample properties, our electron microprobe laboratory is integrated with the analytical infrastructure of the John M Cowley Center for High Resolution Electron Microscopy (CHREM) in the LeRoy Eyring Center for Solid State Science (LE-CSSS). The CHREM houses two field-emission scanning electron microscopes (SEM), a dual-beam focused ion beam FIB-SEM and nine transmission electron microscopes (TEM) instruments including three aberration corrected TEMs . LE-CSSS also houses X-ray diffraction instruments, a Fourrier-Transform Infrared Spectrometer, and a Raman Spectrometer and a variety of other tools that are available for the study of extraterrestrial materials.

Current Projects: Some of the current research projects that utilize the electron microprobe laboratory at ASU are funded by various NASA programs, for example Cosmochemistry, LASER, Emerging Worlds, Nexus for Exoplanet System Science, Solar System Workings, and Field Investigations to Enable Solar System Science and Exploration (FINESSE) projects of the Solar System Exploration Research Virtual Institute.

Some of the specific research topics that use the LCSSS-ASU electron microprobe laboratory in NASA-related contexts include the geochronology of lunar [1] and vestean [2] impact melts, the petrology of lunar meteorites [3], shock metamorphosed plagioclase in martian meteorites [4], high-pressure polymorphs in L6-chondrites [5], refractory inclusions in CR2 chondrites [6].

Availability to the Planetary Science Community: We welcome inquiries about collaborations or service requests for analytical work on planetary materials that want to utilize our electron microprobe laboratory.

Acknowledgments: Henrietta Cathey; the electron microprobe laboratory at Arizona State University received substantial funding from NASA and the NSF.

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