Institute of Earth Sciences
EPMA laboratory

The Institute of Earth Sciences Electron Microprobe Laboratory is equipped with the state-of-the-art JEOL JXA 8230 superprobe, Electron Probe MicroAnalyzer (EPMA). Electron microprobe provides precise quantitative chemical analysis of elements inside very small volume of solid inorganic specimens.

The capabilities include:

- Full quantitative analysis. All detectable elements (from B to U) can be quantified on a spot of 200 nm to 1 μm diameter or larger. Detection limits range 40-100 ppm, depending on the element and the settings.
- Rapid qualitative analysis, in EDS or WDS mode and phase identification.
- Line analysis (rapid compositional profiles).
- High-resolution chemical mapping of specimens in a minimum resolution of 200 nm, quantitative element maps, phase map analysis.
- Imaging specimens at a micro-scale using backscattered electron (BSE), secondary electron (SE) signal and cathodoluminescence (CL).

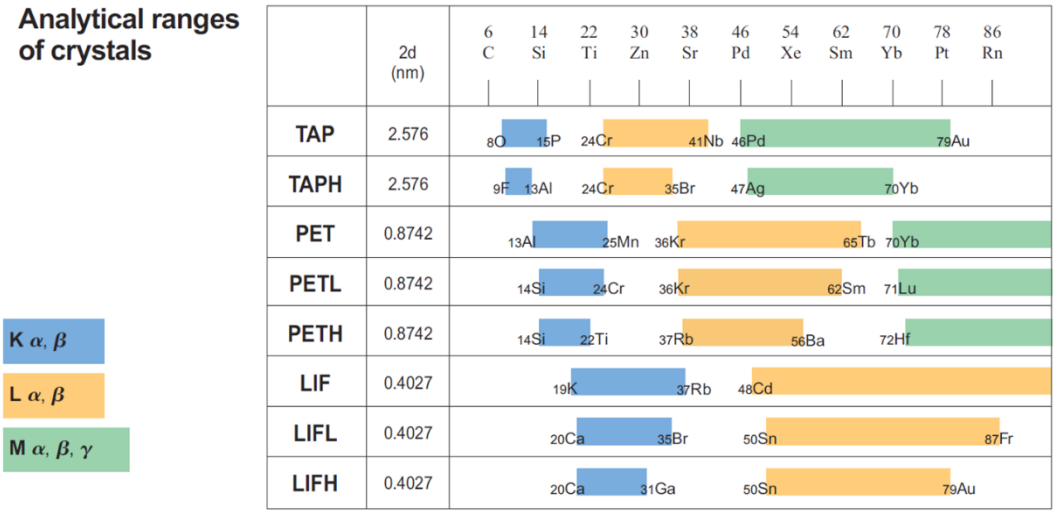
The EPMA facility is open to users from all departments of the University, as well as to external academic visitors, non-profit organizations, government agencies and local and national businesses.

The Jeol JXA 8230 superprobe is a fully automated, customized for various EPMA applications. It has a digital imaging capability and can acquire digital backscattered images (in compositional and topographic modes), as well as secondary electron images. High-resolution digital X-ray intensity (element distribution) maps can be acquired using stage (for large maps) or beam (for small maps) scanning mode.

The Jeol JXA 8230 is equipped with W and LaB6 filament Sources, four wavelength dispersive spectrometers (WDS), an integrated energy dispersive spectrometer (EDS) and a cathodoluminescence (CL) detector. Spectrometer #1 has four analyzing crystals, while spectrometers #2, #3 and #4 have two analyzing crystals, each. Spectrometer #2 is a L-type, with large analyzing crystals (PETL, LiFL), suitable for trace element analysis, giving high X-ray intensities (without sacrificing the peak/background ratio), and higher spectral resolution. Spectrometers #3 and #4 are H-type, with 100 mm radius of the Rawland circle, giving ~ three times higher count rates compared with an XCE spectrometer. The customized configuration of the four spectrometers and the element range for each analyzing crystal are shown in the table below.

Channel	Crystal	Counter	Roland cycle	Spectrometer	Comments
CH 1	TAP-J PET-J LIF-J LDE-1	Gas flow (p10)	140 mm	XCE - 4 Crystal	High resolution
CH 2	PET-L LIF-L	Xenon	140 mm	L - Type	Trace elements
CH 3	PET-Hs LIF-Hs	Xenon	100 mm	H - Type	High X-ray intensity (mapping)
CH 4	TAP-H LDE-2H	Gas flow (p10)	100 mm	H - Type	+ CL detector

Analytical ranges of crystals



	2d (nm)	Be	B	C	N	O	F
LDE1	Approx.6			△	◎	◎	◎
LDE2H	Approx.10		◎	◎			

◎ best
◎ better
○ good
△ possible

The EPMA is designed for chemical analysis of the characteristic X-Rays emitted from a sample when probed by an electron beam. An EPMA can quantify elemental concentration using electron dispersive spectroscopy (EDS) and wavelength dispersive spectroscopy (WDS) to detect and count characteristic X-Rays emitted from a sample. There are pros and cons to using the EDS and WDS detectors (mainly time and the necessity of experience using the techniques). We will be happy to discuss these options in person.

Chemical analysis in the EPMA:

- EDS Detector: Energy dispersive spectroscopy counts the number and energy of X-Rays emitted from a specimen. The energy spectrum of the X-Rays characterizes the atomic structure of the emitting element.
- WDS Detector: Wavelength dispersive spectroscopy counts the number of X-Rays of a specific wavelength diffracted by a crystal. In contrast to EDS, WDS detectors only count the X-Rays of a single wavelength at one time that characterize the atomic structure of the emitting element.

Imaging options in the EPMA:

- Back scattered electron imaging (BSE) is sensitive to the mean electron density (atomic weight). Back scattered electrons are a form of elastic scattering in which incoming incident electrons are bounced back off the sample to hit the detector (Electrons scattered by Columbic interaction with the charge of the atomic nucleus aka Rutherford scattering).
- Secondary electron imaging (SEI) reveals the sample topography due to the variation in SE production at different tilt angles. Secondary electrons are ejected from the k-shell by inelastic scattering interactions with the electron beam. They originate within a few nanometers of the surface.
- Cathodoluminescence – the promotion of valence band electrons to conducting band can emit photon of electromagnetic radiation in the visible light region.