FEI Quanta 200 FESEM Sole Source Justification (Univ of Oregon, 5-2006)

Over the past year John Donovan (and Kathy Cashman) have visited and tested variable pressure or environmental scanning electron microscope instruments at several sites including Portland State University, Albany Research Station, California Institute of Technology, Microscopy & Microanalysis 2006 convention in Honolulu, Smithsonian Institution and National Institute of Standards and Technology.

I evaluated instruments from Hitatchi, FEI, Zeiss and Jeol with several test samples with regard to our three main performance criteria: electron backscatter sensitivity, resolution and variable pressure performance. Test pictures were obtained from all instruments on samples of Mount St Helens rocks, Au-C resolution standards and styrofoam and popcorn materials. We summarize these findings below:

The Zeiss VPSEM is essentially the same instrument we already have (Zeiss Ultra) but with VP capability. Therefore it has excellent resolution in high vacuum mode. However, due to FEI patents Zeiss's VP performance is not equal to FEI. Specifically the gas amplified detection is far less impressive because Zeiss has to use the secondary induced CL signal from the ambient gas instead of the direct secondary electron signal. When we put a CL sample in the instrument the CL response from the sample swamped the topographic secondary image signal from the sample.

Additionally the Zeiss backscatter detector is only 10mm in diameter and significantly less sensitive than the 18mm FEI detector based on the MSH sample that we collected data on. Also the Zeiss environmental SEM is not available in thermal field emission mode and therefore suffers from low resolution. Since our original proposal did specify the need for an environmental SEM for bio-geo and biological studies the advantage is clearly to FEI. In fact there is no other manufacturer that offers a thermal field emission environmental microscope.

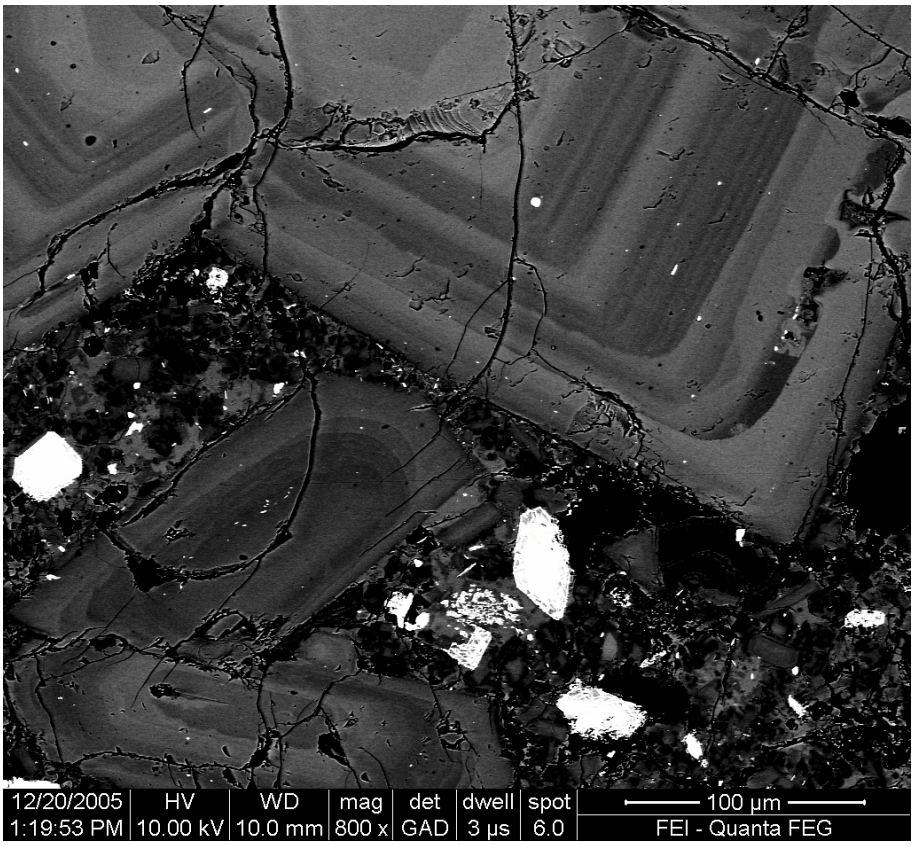
The Hitatchi instrument demonstrated poor backscatter sensitivity (the BSE image appeared to include a significant SE component) and was not able to contrast the subtle atomic number variation of the MSH sample. They also had a number of software issues that seem to prevent useful operation of the instrument (this was confirmed in subsequent discussion with the University of Wisconsin which recently bought the Hitatchi instrument).

The Jeol instrument had excellent BSE sensitivity (essentially as good as the FEI) however the spatial resolution was the worst of any instrument that we measured. Also Jeol is developing a new variable pressure instrument that is not yet available in the US and is essentially still under development.

These are the main differences we observed. Our recommendation is to sole source the FEI based on the above criteria. In summary FEI Company is the only manufacturer that can supply a Thermal Field Emission Scanning Electron Microscope (SEM) with true "Environmental" gas amplification vacuum and detector technology. This technology provides two unique and important capabilities for us. First, the instrument is designed to operate and produce secondary electron images and x-ray Energy Dispersive Spectra with up to 4000 Pa of water vapor pressure in the microscope chamber. Second, unlike other vendor instruments, it does in fact produce true, or direct, secondary electron (SE) imaging, with water vapor in the specimen chamber, to produce the best images from the imaging modes we most require.

Summary of other unique capabilities of FEI instrument:

- The Quanta FEG ESEM demonstrated the best image quality and atomic number difference using it's wide Solid State Backscattered Electron Detector (BSE). This system is the only microscope we evaluated that met or exceeded our expectations in this regard.



- Quanta FEG ESEM has the only secondary electron (SE) detector that works in the low-vac (LV) and higher pressure [wet] modes. Other LV type SEM detectors are ion current or photon types, not SE thus producing a mixed information signal. The Quanta LV type SE detectors can also be used in the presence of light. This means that the CCD camera that gives an inside view of the chamber can be left on while imaging in the LV and ESEM modes. It is a benefit for dynamic sample imaging and for moving irregular shaped samples. Our group will sometimes be working at wet sample conditions and requires the best imaging detectors available and proven to work at these higher specimen chamber pressures. When I (John Donovan) tested a CL sample at Cal Tech, the SE detector was dominated by the CL light from the sample rather than the secondary signal.

- With the auxiliary gas inlet, the Quanta ESEM is the only VP type SEM that has two gas inlets that allows for simultaneous connection of two different gases that can be switched via the system PC user interface. This will be important where different environmental gases that effect changes in materials, or where the dynamic study of morphology changes created by different gases at different pressures would be of interest.

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