

## A NEW TOOL FOR OLD ROCKS - CHARGE CONTRAST IMAGING OF MICROSTRUCTURES AND COMPOSITIONAL VARIATION IN GARNET AND OTHER HP/UHP MINERALS

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The environmental scanning electron microscope (ESEM) allows imaging of insulating materials without a conductive coating. Instead, the sample chamber is charged with a gas that is ionised by the electron beam or backscattered electrons (BSE), and attracted to the sample surface (the "ion flood"), thus neutralising charge accumulation. Secondary electrons (SE) generated during these interactions cascade to a positively-biased Gaseous Secondary Electron Detector (GSED), creating a GSE image dominated by the influence of specimen BSE. Under normal operating conditions, specimen SE emission is suppressed by the ion flood. However, under appropriate conditions of beam dosage, gas pressure and detector bias, SE originating within the specimen may escape and be collected at the GSED. Emission appears to be a function of the charge-trapping characteristics of the material. Within the same phase, charge-trapping and image brightness is thought to vary with the concentration of lattice defects. Exploiting this capability of the ESEM gives us a novel and rapid method – Charge Contrast Imaging (CCI) - for resolving compositional and microstructural features in insulating and semi-conducting materials (GRIFFIN, 1997; WATT et al., 2000; CUTHBERT & BUCKMAN, 2005). Image acquisition is reproducible, stable and rapid.

CCI patterns are very similar to cathodoluminescence (CL) suggesting a common cause. However, in luminescent materials such as zircon, CCI may also reveal features not visible in CL. Importantly, CCI shows patterns in non-luminescent materials, e.g. minerals rich in "quencher" ions like Fe. For example, CL images of UHP pyropes from Dora Maira quartzite show oscillatory zoning, but emission is suppressed by small increases in Fe. CCI gives identical image patterns. However, almandine-rich garnets in an eclogite from Norway give no detectable CL emission, but CCI images are rich in detail. In the latter example conventional BSE images are featureless, even though CCI patterns match major element variation, but abundances of P, Ti, Y, Zr and REE follow CCI grey-scale variation, suggesting a possible role for substitutions generating vacancy defects. Other candidates for generation of CCI are incorporation of "defect hydroxyl", growth faults, and dislocations due to crystal-plastic deformation. CCI patterns may be obscured by surface shear effects due to polishing. This may be overcome by more sophisticated polishing techniques, but these artefacts suggest that lattice strain may be resolvable by the CCI method. Thus, CCI offers a rapid, cost-effective method for reconnaissance exploration of mineral microstructure and compositional variation, offering similar insights to CL petrography, but is more effective than CL in Fe-rich phases such as garnet commonly found in HP/UHP rocks.

### References

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