SEM cathodoluminescence imaging of quartz phenoclasts in the Nepisiguit Falls Formation, Bathurst Mining Camp: evidence of explosive fragmentation

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Cathodoluminescense (CL) is a technique commonly employed in the geosciences to reveal internal structures, growth zoning and lattice defects of a variety of mineral specimens (feldspars, carbonate minerals, etc.). The conventional optical CL technique images photons emitted when a sample is irradiated by an electron beam. This type of CL works well for many minerals, but can only distinguish between detrital and non-detrital quartz grains. However, when used in conjunction with the scanning electron microscope (SEM), it can reveal internal structures, growth zoning, and lattice defect features in minerals that exhibit weak luminescence, i.e., in quartz grains such features are not discernible by means of other analytical techniques. In quartz, variations in luminescence intensity may result from trace elements present in the grain structure or from the ordering degree of the quartz lattice. These variations are a reflection of the P-T-t-x conditions that the quartz grains formed at, such that high-temperature volcanogenic quartz grains usually exhibit little zoning in the blue spectrum and low-temperature metamorphic quartz grains may exhibit complex zoning in the red spectrum.

Preliminary examination of quartz phenoclasts from the felsic tuffaceous rocks of the Nepisiguit Falls Formation was done using the JEOL JSM-5900LV SEM running at an accelerating voltage of 20 kV, fitted with a Gatan retractable MonoCL3 detector at Acadia University. SEM-CL techniques show zoning is present in some quartz phenoclasts from the Nepisiguit Falls Formation. Zoning in quartz grains from a volcanogenic source suggests there has been a change in composition, pressure or temperature within the magma chamber prior to eruption. The observed zoning does not correspond with the phenoclast grain boundaries suggesting these grains may have been explosively fragmented. Feldspar phenoclasts from these samples show patchy textures related to pervasive albitization, and do not provide evidence to support the cause of zonation in quartz phenoclasts.

Highly embayed quartz, from the massive megacrystic tufflava of the Nepisiguit Falls Formation, shows no zonation suggesting only one phase of quartz crystallization in the magma chamber prior to eruption. Petrographic examination of these highly embayed phenoclasts shows that they have sharp boundaries though they were not explosively fragmented. If explosive fragmentation had occurred in these phenoclasts, it would be expected that fragmentation would obliterate the embayments breaking the phenoclasts into smaller fragments. In addition, these embayments were preserved during ascent in the conduit indicating the system did not behave as a two-phase gas-pyroclast system, but rather as a one-phase mixture.