Zoned crystals are ubiquitous in volcanic rocks with their chemical heterogeneity and textural appearance providing an invaluable archive of magmatic processes that occur throughout the crystals growth. By using in-situ analytical techniques such as electron probe micro analyser (EPMA), secondary ion mass spectrometry (SIMS) and laser ablation inductively coupled mass spectrometry (LA-ICPMS), it is possible to analyses discrete chemical zones and decipher the magmatic processes that occur in the sub-volcanic plumbing system. Timescales of some of these magmatic processes can be assessed through the relaxation of chemical gradients across compositional zones through the application of diffusion modelling techniques. However, one of the current caveats of diffusion modeling is the micron scale spatial resolution of chemical profiles obtained by EPMA, SIMS and LA-ICPMS, which can limit the timescales that can be calculated depending on the mineral and element of interest. Here we present Time Of Flight (TOF)-SIMS data allied with secondary electron backscattered (BSE) images, EPMA and electron backscattered diffraction (EBSD) data for zoning of orthopyroxene crystals from the 1980-1986 eruptions of Mount St. Helens. TOF-SIMS has the advantage of being able to obtain relative concentrations of major, minor and trace elements of orthopyroxene at sub-micron resolution that cannot be achieved through conventional methods. Preliminary results suggest that changes in the oxygen fugacity of the melt affected and may have been the source of the zonation of orthopyroxene crystals at Mount St. Helens. Fe-Mg inter-diffusion of core-rim interfaces suggests crystal rims grew in the months-years prior to eruption.