Detrital zircons and the inclusions found therein are our only mineralogical constraints on geologic events that occurred on the Hadean Earth. These zircons are commonly small (ca. <100 μm in the longest dimension) and preserve micron to sub-micron chemical zonations indicative of a dynamic petrological history. Trace elements within zircon are of particular interest because concentrations of these elements can provide information regarding chemical and physical conditions during zircon growth. In this study, we analyzed Hadean-age detrital zircons from Archean metasediment in the Jack Hills (Western Australia) using the Caltech Microanalysis Center Cameca NanoSIMS 50L. Trace elements analyzed included Ti, P, Ce, and Y. Ti-thermometry [1,2,3] can potentially constrain growth and/or re-equilibration temperatures of zircons; phosphorus, cerium, and yttrium are known to enter the zircon lattice by the coupled xenotime-type substitution mechanism: (Y, REE)\(^{3+}\) + P\(^{5+}\) = Zr\(^{4+}\) + Si\(^{4+}\) [5]. The \(^{89}\text{Y}/^{28}\text{Si}\) ratio was observed to correlate with, and was used as a proxy for, cathodoluminescence (CL) banding. Growth features manifested in CL (e.g., sector, oscillatory zoning) were observed in all zircons analyzed. CL zones vary from <1 μm to several microns in width; therefore, the NanoSIMS—with an O\(^-\) beam diameter of ca. 250 nm on the sample surface for conditions of measurements made in this study—is uniquely suited for this scale of analysis. Regions displaying CL banding were imaged as 20 x 20 μm areas. All elements were normalized to \(^{28}\text{Si}\); \(^{49}\text{Ti}/^{28}\text{Si}\) ratios were converted to [Ti] via calibration based on analyses of synthetic, high-Ti zircons (provided by B. Watson) that were independently analyzed on Caltech’s JEOL JXA-8200 electron microprobe. We observe three types of relationships between trace element distribution and CL banding in the zircons imaged: 1) strong positive correlations between CL banding, P, Ce, and Ti; 2) subtle positive correlations between CL banding, P, Ce, and Ti; 3) no correlation between minor/trace elements and CL banding. Positive correlations between CL banding, 3+ cations, and [Ti] have previously been reported by Holden et al. [4]. In this study, gradients at least as sharp as a factor of ~3 in [Ti] are observed between adjacent CL bands in the strongly correlated images. These images also have the highest absolute concentrations of trace elements and display both sector and oscillatory zoning in CL. The correlations observed may be due to: temperature-dependent equilibrium partitioning of all trace elements during rapid cycles in growth temperature; episodic diffusion-limited enrichment of incompatible trace elements in the boundary layer melt adjacent to growing crystals; and/or kinetically controlled, non-equilibrium crystal-melt partitioning caused by trace element enrichments in the boundary layer melt.
surrounding fast-growing grains (e.g., [6]). We will discriminate between these alternatives based on quantitative relationships between relative enrichments of [Ti] and other trace elements.