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Statistical analysis of Europium anomalies in detrital zircons record major transitions in Earth geodynamics at 2.5 Ga and 0.9 Ga

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Trace elements in zircon are a promising proxy to quantitatively study long-term Earth's lithospheric processes and its geodynamic regimes. The zircon Eu anomaly reflects the crystallization environment of its felsic or intermediate parental magma. It specifically provides insight into the water content, magmatic redox conditions, and the extent of plagioclase fractionation in the source rock or its occurrence as a cogenetic crystallizing phase from the magma. We performed a statistical analysis of Eu anomaly from a global compilation of detrital zircons and display it as a timeseries and found a major decrease in Eu anomaly ca. 2.5 Ga and an important increase ca. 0.9 Ga. Combining these trends with thermodynamic modelling, we suggest that these variations could be due to long-term change in the chemical system of the mafic source from which the intermediate to felsic melt and derived zircons are produced. The 2.5 Ga drop was likely associated with an enrichment in incompatible elements in the mafic source, which extended the pressure-temperature field of plagioclase stability as a cogenetic melt phase. We interpret the 0.9 Ga rise to record increasing hydration of magmagenetic sites due to the general development of cold subduction systems, which would delay and/or suppress the saturation of plagioclase in hydrous magmagenetic sites.