

Duration and lifetime of LIPs: knowns and unknowns

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The relationships between the timing of emplacement of Large Igneous Provinces (LIPs), release of magmatic and thermogenic volatiles into the atmosphere, and associated climate and biodiversity changes have received significant scientific attention. This research field has benefited from increasingly precise and accurate geochronology data, potentially allowing for finer resolution of cause and feedback relationships through geologic history. However, holistic Earth system models are often based on simple temporal coincidence of processes in very diverse planetary subsystems, often applying geochemical proxies that are not unequivocal.

In this contribution we discuss some of the problems inherent with LIP geochronology, including: (1) mechanisms of zircon saturation in mafic melts and the consequences for U-Pb age interpretation; (2) the fidelity of alternative geochronometers, such as baddeleyite U-Pb and plagioclase ^{40}Ar - ^{39}Ar , in the light of alteration processes and resulting open system behavior; (3) the difficulty in blindly combining isotopic system complexities and analytical inaccuracy, resulting in excess variance of dates and overestimations of the durations of LIPs; (4) the statistical pitfall of insufficient and non-representative sampling, due to targeting of zircon-bearing lithologies, which hampers assessment of LIP duration and magma emplacement rates.

These complications render the statistically significant use of geochronological dates from LIPs very difficult. Any kind of uncertainty (analytical, data interpretation, real areal and temporal extents of any LIP) needs to be appropriately considered and verified before use of such data for statistical models. Without such verification, second order modelling attempts such as, e.g., Bayesian age depth profiling, using geochemical proxy records to estimate LIP emplacement, or feeding such data sets into machine learning and AI algorithms, will be biased by the underlying, selective chronological record.