

## Lead isotopes as tracers of crustal thickness

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Lead isotopes offer crucial insights into the geological mechanisms behind continental crust formation (e.g., melting, intracrustal fractionation, and magma mixing), uncovering details that are often challenging to obtain through other isotopic systems. While Lu-Hf (or Sm-Nd) and oxygen isotopes are typically used to trace mantle extraction or interactions with the hydrosphere, respectively, Pb isotopes are particularly sensitive to processes occurring within the crust. Here, we present new *in situ* LA-MC-ICP-MS K-feldspar and TIMS whole-rock Pb isotope data from I-, S-, and A-type granites from an east-west transect through southeastern Australia. Initial Pb isotopic ratios, recorded by K-feldspar, show no clear correlation with granite type nor with most whole-rock geochemical parameters (e.g., major and trace elements, Nd isotopes). Instead, Pb isotope ratios display spatial patterns that align with those shown by proxies for crustal thickness (gravity free-air anomalies, topographic elevation, and Moho depth) as well as proxies for melt extraction depths (whole-rock Sr/Y ratios and Eu anomalies). These findings support the concept that Pb isotope signatures are set in the intracrustal magma sources and remain largely unaffected by later-stage fractionation processes during the crystallisation of the granite. As a result, Pb isotopes effectively differentiate between U- and Th-depleted lower crustal sources and more enriched mid-to-upper-crustal sources. We conclude that Pb isotope signatures in granites primarily reflect the degree of intracrustal fractionation (i.e., multi-stage or more voluminous) which can be linked to crustal thickness.