Appendices/Supplementary

Appendix 1. Modelling methods

Mafic-ultramafic magmas in continental LIPs are derived from decompression melting of mantle beneath the rigid lithosphere. The geochemical characteristics of these mantle-derived magmas are mostly dependent on geochemical features, mineralogy and potential temperature) of the mantle source, as well as the melting degree which is determined by the thickness of lithosphere because the upwelling of mantle ceases at the base of rigid lithosphere. Given that the continental lithosphere is rarely thinned to below 80-100 km during the LIP event, the representative mantle-derived magma in the CLIP is adopted as the melt that is generated by the adiabatic decompression melting of the primary mantle (McDonough and Sun, 1995) with a hot potential temperature (1550 °C), and extracted from the source at 3 GPa (~100 km). This melt contains ~25 wt% MgO, 14 wt% FeO_t (total Fe expressed as FeO) and 1040 ppm Ni based on the model from Yao et al. (2018), and is used for a further model of fractional crystallization at the assumed condition. In order to account for the effect of mantle heterogeneity, this peridotite-derived melt is also mixed with the melt generated by a MORB-like pyroxenite mantle with the same decompression melting path (potential temperature, 1550 °C; terminal melting pressure, 3 GPa). The proportions of pyroxenite-derived melt in the mixed magmas are assumed as 10, 30 and 50%, respectively. The partition coefficient of Ni between the olivine and melt is calculated via the new equation that is calibrated on many 1-bar experiments spanning a wide range of melt and olivine compositions (Pu et al., 2017; Pu et al., 2021). The partition coefficients of Ni within the clinopyroxene-melt and orthopyroxene-melt pairs follow the equations from Matzen et al. (2017b). The olivine grains crystallized from the mixed magmas (especially contain 30-50% pyroxenite-derived melt) contain a higher Ni content than that of peridotite-derived melt at the high-Fo regime, but all modelled Ni trendlines become overlapped when the Fo value drops below 78 (Figure 12A). In general, the modelling results coincide with the trends and distributions of CLIP olivine dataset (Fig. 12A) and can be considered as the baseline to trace the influence of post-cumulus processes on the Ni content of olivines.

The petrogenesis of ultramafic-mafic intrusions in orogenic belts is extremely complex, and the associated magmatism may be generated in subduction, collision and post-collision periods. Hence, the partial melting process occurred in orogenic belt may involve the flux-melting of mantle wedge during subduction, the upwelling of asthenosphere due to slab break off or lithospheric delamination in syn- or post-collisional setting, and even the possible contributions of adiabatic decompression melting of hot plume material. In the models presented here (Fig. A1), partial melting processes in orogenic belt are simplified as the flux-melting of mantle wedge above the subducted slab. The details of this melting model can be found in Yao et al. (2018). The mantle source is simplified as the depleted MORB mantle (DMM) (Workman and Hart, 2005). We also set a relatively high temperature (1300 °C) that is close to the anhydrous solidus of mantle wedge peridotite at the crust-mantle boundary (~ 1 GPa), which corresponds to the subduction of a young oceanic lithosphere with slow convergence rate and low subduction angle. The melting products generated at different melting degree (5-25%) are adopted as the representative parental magmas in orogenic belt to model the subsequent fractional crystallization at 1 kbar pressure. The melts derived by flux-melting contain the relatively lower Ni contents (~245-273 ppm), and the melting degrees here show a slight influence on the Ni trendlines of olivine (Figure 12B).

Data Repository

A full listing of data compilation used in this study is available at https://zenodo.org/record/5787901 or via the CSIRO Data Access Portal at doi: https://doi.org/10.25919/75sx-jz22.