

Magma addition rates in continental arcs: A new protocol of calculation and global implications

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The transfer of mass, heat and geochemical constituents from the mantle to the atmosphere occurs via magma addition to the lithosphere. Calculation of magma addition rates (MARs) in continental arcs based on exposed proportions of igneous arc rocks is complex and rarely consistently determined.

This study outlines a new protocol to calculate MARs in continental arcs by studying three exposed arc crustal sections: the Famatinian arc section, the Sierra Nevada and the Coast Mountain batholith. Arcs are divided into fore-arc, main arc and back-arc sections. Within each section 'boxes' with a defined width, length and thickness spanning upper, middle and deep crustal levels are assigned. Representative exposed crustal slices for each crustal level are then used to calculate MARs based on outcrop proportions. Geochemical and structural data is used to infer total thickness of the arc during its active time. Results show a correlation between MARs, crustal level and lateral extent of magmatism. The highest MARs are observed in the deep crust and, significant differences exist between MARs in the main arc and foreland and rear-arc sections. However, average crustal column-wide MARs for each arc section are remarkably similar.

Global MARs over geologic timescales have the potential to investigate the volatile diffusive outgassing contribution of intrusive arc magmas to global element cycling. We address this question by combining a range of CO₂ contents in arc magmas and global estimates of arc footprints from 550 Ma until present (after Cao et al. 2017, EPSL) to scale to global MARs and CO₂ degassing in each earth period.