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Volcanic Gases and Diamonds: tracking carbon subduction

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The return of crustal carbon into the Earth's deep mantle enables continued outgassing of CO_2 from the mantle and through volcanism. The primary source and fate of this recycled crustal carbon, however, remains poorly constrained. Subducted oceanic lithosphere carries sedimentary and crustal carbon to the trench. Globally, carbonate from sediments dominates over the altered oceanic crust (AOC) and 5 x 10^{12} mol C/yr (±50%), from sediments arrive at the trench [1]. AOC from geographically diverse locations have $\delta^{13}C$ values as light as -24‰. The global C influx of this AOC-derived C to the trench is 1.5 ±03 x 10^{12} molC/yr [2]. Total flux of C from arc volcanoes is 1.1 x 10^{12} mol C/yr [3] and most $\delta^{13}C$ is heavier than -10‰ [4, 5]. Therefore, on a global scale, subducted carbonate sediment input with some organic sedimentary C can supply the C output and isotope composition of arc volcanoes. Essentially, volcanoes in subduction zones 'burn off' most of the sedimentary C, leaving AOC-derived C as the dominant flux delivered into the deeper mantle. The dominance of AOC-derived C that is being delivered into the deep mantle is consistent with the C (and N) isotope composition of eclogitic diamonds [2]. The flux of AOC-derived C is almost equal to flux from global MOR, 1.32 x 10^{12} mol C/yr [6], however, MORB CO_2 $\delta^{13}C$ is heavier but its short mean degassing duration [7] indicates efficient recycling between mantle and atmosphere. The amount of AOC-derived C that forms eclogitic diamonds is challenging to estimate. The continental lithosphere is a vast store for C that gets released during continental breakup [8] and other C gets transported deeper into the transition zone and lower mantle to form super-deep diamonds. Future work is needed to trace (in time and space) C and other volatiles from the surface into these reservoirs.

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