CARBON IN MOR BASALTS, MANTLE, AND GLOBAL C CYCLING

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The carbon content of mid-ocean ridge (MOR) erupted magmas is well known from analysis of glassy rims on pillow basalts (1), is dissolved exclusively in the form of carbonate ion, and provides a measure of the minimum CO$_2$ content of pre-eruption MORB magmas. The solubility of CO$_2$ in MORB liquids is also well known (2) and shows that most MORB magmas were oversaturated in CO$_2$ at seafloor pressures (3) so the CO$_2$ content of MORB magma could be much greater than observed in MORB glasses. Possible hosts for C in MORB magma source regions are dolomite/magnesite or graphite/diamond depending on oxygen fugacity (4). Oxygen fugacities measured from MORB glasses (5) and mantle nodules (6) require that graphite/diamond is the C source (4). Assuming graphite as the source I constructed a model to calculate the CO$_2$ content of primary MORB magma and arrived at a probable value of 1800 ppm (7). That model predicts that $\leq 80$ ppm of graphite/diamond in the MORB source mantle is consumed. That is a surprisingly low value; however simple mass balance shows that if the integrated melt fraction is 15 wt.% the amount of graphite required to generate 1800 ppm CO$_2$ in primary MORB magma is 74 ppm. A new equation of state (8) yields CO$_2$ fugacities up to 50% greater than used in (7) but this results in only minor differences with the previous model calculations, e.g. a 0.2 log unit increase in calculated oxygen fugacity. The 1800 ppm value for the CO$_2$ content of primary MORB magma erupted at present-day rates for the last 3.3 AE equals estimates of the Earth’s global crustal, oceanic and atmospheric carbon content (7,9).