Partial melting of graphitic metasediments and implications for carbon dioxide transport by granitic magmas

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Graphite is a widespread phase in metapelitic rocks and forms as a result of decomposition of organic matter in their protoliths. When graphite is present, carbon species dissolve in the C-O-H fluid and lower the activity of water. We calculate phase diagrams in graphite-bearing systems that are either closed or that progressively lose fluid and/or melt. The diagrams incorporate a new model of CO2 solubility in felsic melts.

Along a typical orogenic geotherm, felsic melt dominates the CO2 budget of high-grade rocks. During cooling, the fluid that exsolves from such crystalizing melt is CO2-rich. If a large quantity of such felsic melt leaves the graphite-buffered source region and ascends, a considerable cumulative amount of CO2 will be brought to surface reservoirs. Consequently, orogenic metamorphism and associated magma generation provide a route to convert buried organic carbon to CO2 and are potential long-term factors in the global carbon cycle.

For example, in the Sierra Nevada batholith, up to 10% magma originated from graphite-buffered regions (Ague & Brimhall 1988). Crystallization of such magma would release 250 Gtn CO2. For comparison, the global CO2 degassing rate is about 0.3 Gtn/yr (Berner et al. 1993). If the emplacement of magma was episodic (Paterson et al. 2011), its contribution to global carbon budget could be non-trivial.