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Using titanite petrochronology to monitor CO_2-degassing episodes from the Himalayas

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Metamorphic degassing from active collisional orogens supplies a significant fraction of CO_2 to the atmosphere, playing a fundamental role in the long-term (> 1 Ma) global carbon cycle (Gaillardet & Galy, 2008). The petro-chronologic study of the CO_2-source rocks (e.g. calc-silicate rocks) in collisional settings is therefore fundamental to understand the nature, timing, duration and magnitude of the orogenic carbon cycle. So far, the incomplete knowledge of these systems hindered a reliable quantitative modelling of metamorphic CO_2 fluxes.
A detailed petrological modelling of a clinopyroxene + scapolite + K-feldspar + plagioclase + biotite + zoisite ± calcite calc-silicate rock from central Nepal Himalaya allowed us to identify and fully characterize - for the first time - different metamorphic reactions that led to the simultaneous growth of titanite and production of CO_2. These reactions involve biotite (rather than rutile) as the Ti-bearing reactant counterpart of titanite. The results of petrological modelling combined with Zr-in-Ttn thermometry and U-Pb geochronology suggest that in the studied sample, most titanite grains grew during two nearly continuous episodes of titanite formation: a near-peak event at 730-740°C, 10 kbar, 25.5±1.5 Ma, and a peak event at 740-765°C, 10.5 kbar, 22±3 Ma. Both episodes of titanite growth are correlated to specific CO_2-producing reactions, thus allowing to constrain the timing, duration and P-T conditions of the main CO_2-producing events, as well as the amounts of CO_2 produced. Assuming that fluids released at a depth of ca. 30 km are able to reach the Earth's surface ∼10 Ma after their production, it is therefore possible to speculate on the role exerted by the Himalayan orogenesis on the climate in the past.

Gaillardet J. & Galy A. (2008): Himalaya-carbon sink or source? Science, 320, 1727–1728.