Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.36242

Carbon cycling during ULT metamorphism inferred through analysis of accretionary slates

JOSHUA MURRAY[1], PETER B KELEMEN[1], DONALD FISHER[2] AND ANDREW SMYE[2]

[1]LDEO, Columbia University
[2]The Pennsylvania State University

The fate of subducting carbon is linked to the long-term evolution and stability of Earth's climate. Anywhere from 30–90% of subducting carbon is outgassed in arc volcanoes [1]. The remaining subducting carbon must be divided between diffuse degassing in arc systems, storage in the lithosphere, and subduction to the convecting mantle, each of which reflects a different residence time of carbon in surface reservoirs and has ramifications for petrologic processes in Earth's interior [2].

Models of fluids released from the subducting slab have focused on moderate- to high-temperature metamorphic reactions (>200°C) [3,4]. However, relevant mineral reactions, particularly the metamorphism of clay minerals, proceed in the range of 70–250°C [5]. Concurrently, organic carbon undergoes thermal degradation (catagenesis and metagenesis). The resultant changes during ultra-low-temperature (ULT) metamorphism thus release water, reduce mineral surface area, and increase the solubility of organic carbon. These combined effects may drive early losses of carbon into the forearc, as evidenced by methane cold seeps in accretionary prisms [6].

Here, we tighten the loop between subducting carbon, lithospheric storage, and diffuse degassing by analysing carbon mobilisation during ULT metamorphism. We study the mineralogy and geochemistry of low-grade metapelitic rocks from the Shimanto accretionary prism in southern Japan. We constrain the fraction of carbon that survives ULT metamorphic reactions and model the resulting mass balance.

References

1. P. B. Kelemen, C. E. Manning, PNAS **112**, E3997–E4006 (2015).
2. R. Dasgupta, M. M. Hirschmann, EPSL **298**, 1–13 (2010).
3. D. M. Kerrick, J. A. D. Connolly, Nature **411**, 293–296 (2001).
4. B. R. Hacker, GGG **9**, no. 3 (2008).
5. A. M. Pytte, R. C. Reynolds, Thermal History of Sedimentary Basins: Methods and Case Histories, 133–140 (1989).
6. J. Ashi, H. Tokuyama, A. Taira, Mar. Geol. **187**, 177–191 (2002).