Geophysical Research Abstracts
Vol. 20, EGU2018-1105, 2018
EGU General Assembly 2018

Links between climate and the oxidative weathering of organic matter and its carbon dioxide emissions

Kate Horan (1), Robert Hilton (2), David Selby (1), Mathieu Dellinger (2), Edward Tipper (3), and Kevin Burton (1)

(1) Department of Earth Sciences, Durham University, United Kingdom (kate.horan@durham.ac.uk), (2) Department of Geography, Durham University, United Kingdom , (3) Department of Earth Sciences, University of Cambridge, United Kingdom

The oxidation of organic carbon in sedimentary rocks (petrogenic organic carbon, OC_{petro}) releases CO_2 from long-term storage in the lithosphere, and consumes atmospheric O_2. Alongside volcanism, the oxidative weathering of OC_{petro} is the main source of $CO_2$to the atmosphere over millions of years. The balance between CO_2 release during the oxidation of sedimentary rocks and CO_2 drawdown by silicate weathering and organic carbon burial sets the net carbon budget during weathering and erosion. However, OC_{petro} oxidation is poorly understood, both in terms of the rate at which it releases CO_2 and the factors that interact to drive the reaction. Trace metals associated with organic matter in rocks, such as rhenium (Re), can be released to the dissolved load of rivers during oxidative weathering. Quantifying dissolved Re fluxes therefore has the potential to provide insight into the oxidative weathering processes involved. Here, we use Re to track the rate of OC_{petro} oxidation in the rapidly eroding mountain river catchments of the western Southern Alps, New Zealand; alongside river catchments that have lower erosion rates but drain rocks with higher organic carbon contents in the Mackenzie River Basin, Canada. In New Zealand, physical erosion is found to be a first order control on the oxidative weathering fluxes, but catchments dominated by valley glaciers and exposed to frost-shattering processes experience a further two to three times elevation in CO_2 emissions relative to catchments with less glacial cover. Data suggest that the modern-day Mackenzie River catchment presently acts as a CO_2 sink of $\sim$1.2 tC km^{-2} yr^{-1} as a result of the carbon transfers by weathering and erosion, driven by a large organic carbon burial flux. However, under glaciated conditions, this large basin may have operated as a CO_2 source, through enhanced OC_{petro} oxidation and reduced organic carbon burial fluxes. We propose that mountain glaciation can result in an atmospheric CO_2 source during weathering and erosion, as fresh minerals are exposed for weathering in an environment with high oxygen availability. This provides a previously unrecognised counter-mechanism against global cooling over geological timescales, which may have operated over the late Cenozoic and over multiple glacial-interglacial cycles.