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Geomorphic and climatic controls of the terrestrial organic carbon cycle - *R. Berner Lecture*

VALIER GALY

Woods Hole Oceanographic Institution

Presenting Author: vgaly@whoi.edu

The atmosphere is a small reservoir of carbon compared to rocks, the biosphere and the ocean. As such, its size is sensitive to small imbalance of carbon exchange with and between larger reservoirs. Over long timescales, the continental biosphere is mostly at equilibrium with the atmosphere, most of the net photosynthetic primary production being quickly returned to the atmosphere via respiration. However, surface processes transfer particulate organic carbon from continental to oceanic reservoirs, where organic carbon can be buried and stored over long timescales. This “leak” of biospheric carbon away from the biosphere-atmosphere loop represents a net sequestration of atmospheric carbon. Erosion also transfers organic carbon from the rock reservoir (petrogenic carbon) to marine sediments, thereby transferring carbon between two reservoirs disconnected from the atmosphere. Oxidation of petrogenic carbon represents another “leak’’ of carbon, in this case towards the atmosphere. The balance between biospheric organic carbon burial and petrogenic carbon oxidation controls the net transfer of carbon and oxygen between the atmosphere and the geosphere, thereby participating in the long term regulation of climate and atmopheric oxygenation. Yet, the mechanisms controlling organic carbon export, oxidation and burial have remained poorly defined, impeding our ability to make quantitative predictions of organic carbon fluxes under forcing scenarios. Here, I synthesize decades of detailed geochemical investigations of organic carbon composition and reactivity in river and marine sediments to gain new insights into how surface processes control the efficiency of biospheric organic carbon burial and petrogenic carbon oxidation. I will discuss the carbon cycle implications of this new mechanisctic understanding of organic carbon reactivity in the context of the evolution of geomorphic and climatic conditions.