Sources of sulfate in the Mekong River

K.E. RELPH[1]*, E.T. TIPPER[1], M.J. BICKLE[1],
A.V. TURCHYN[1], G. ANTLER[1], L. FENG[1], J.J.BARONAS[1]

[1]Dept. Earth Sciences, University of Cambridge, Cambridge, CB2 3EQ, UK (*correspondance: ker32@cam.ac.uk)

It is well understood that chemical weathering of silicate rocks with carbonic acid plays an important role in the consumption of atmospheric carbon dioxide and regulating global climate over long time-scales. However chemical weathering of carbonate rocks with sulfuric acid, a process that can release geologically stored carbon to the atmosphere, is not as thoroughly explored [1-4].

Quantifying carbonate weathering with sulfuric acid requires the source of riverine sulfate to be determined. This comes from predominantly two soureces, sedimentary sulfate and sulfide. Sulfate released from the weathering of gypsum and anthropogenic sources do not affect the carbon cycle. Sulfuric acid produced by the oxidative weathering of pyrite in carbonate terrains can release 1 mole of CO_2 for every 2 moles of Ca released to solution.

Here we discuss new coupled sulfur ($\delta^{34}S$) and oxygen ($\delta^{18}O_{SO4}$) isotope data on dissolved riverine sulfate and river water isotopes ($\delta^{18}O_W$) from one of the worlds, largest rivers, the Mekong in SE Asia which supplies 4% of the HCO_3 to the oceans [5].

Partitioning of dissolved inorganic carbon (DIC) sources, calculated using a forward model, suggests that the weathering of carbonates by carbonic acid accounts for 46% of the total carbon flux, whilst weathering via sulfuric acid accounts for a small but not insignifant 16%. In the headwater regions on the Tibetan Plateau and Yunnan Province, sulfate concentrations are high (~800µmol/L). Sulfate decreases downstream to ~10µmol/L at the mouth in Cambodia. Samples display up to 17.7‰ difference in $\delta^{18}O_{SO4}$- $\delta^{18}O_W$ and $\delta^{34}S$ ranges by ~10‰ over the basin. End-members such as the oxidative weathering of pyrite and sulfate dissolution will be discussed as well as processes such as bacterial sulfate reduction, which may cause fractionation trends in addition to mixing trends. Importantly, processes cannot be distinguished with $\delta^{34}S$ alone, and require $\delta^{18}O_{SO4}$ to be determined. Our data highlight the importance of determining the origin of sulfate in the worlds largest rivers for the global carbon cycle.

[1] Calmels, D. et al. (2007) Geology, 35 (11), 1003-1006. [2] Moon, S. et al. (2007). GCA, 71 (6), 1411-1430. [3] Turchyn, A.V. et al. (2013) EPSL, 374, 36-46. [4] Torres, M.A. et al. (2014) Nature, 507 (7492), 346. [5] Cai, W.J. et al. (2008). Continental Shelf Research, 28 (12), 1538-1549.