Organic Carbon export from Siberian permafrost tracked across the Arctic Shelf using Raman spectroscopy

ROBERT SPARKES[1], MELISSA MAHER[1], JEROME BLEWETT[2], BART VAN DONGEN[2], AYÇA DOĞRUL SELVER[3], ÖRJAN GUSTAFSSON[4], IGOR SEMILETOV[5]

[1]Manchester Metropolitan University, Manchester, UK. r.sparkes@mmu.ac.uk
[2]University of Manchester, Manchester, UK
[3]Balıkesir University, Turkey
[4]Stockholm University, Sweden
[5]Tomsk Research Polytechnic University, Tomsk, Russia

Rapid climate warming in Arctic regions is causing enhanced export of carbon from Siberian permafrost deposits. Arctic permafrost carbon represents approximately half of the global Soil Organic Carbon (OC) reservoir, with permafrost and terrestrial ice complexes containing about twice as much carbon as the atmospheric carbon pool. Fluvial and coastal erosion deliver this OC to the East Siberian Arctic Shelf (ESAS). Characterising/quantifying the amount, type and fate of this OC is critical for understanding the feedbacks between climate warming and the carbon cycle in permafrost regions.

Previous work focussed on bulk organic carbon, lipid biomarkers and macromolecular organic matter. We present Raman spectra analysing an alternative OC fraction, carbonaceous material, in sediments collected across the ESAS. Carbonaceous materials, consisting of µm sized graphite and disordered carbon particles, are formed via (partial) crystallisation of kerogen and organic matter within bedrock, and therefore represent both a recalcitrant portion of the carbon export from sediment erosion, and an opportunity to track individual erosion sources using the Raman characteristics of each major river.

Over 1000 Raman spectra were collected using a Renishaw inVia spectrometer, and analysed using an automated peak fitting procedure. Characteristic peaks for crystalline and disordered carbon were fitted, allowing spectra to be sorted into groups ranging from extremely disordered to extremely graphitised carbon. Each offshore sample contained carbon from a range of groups; the distribution of groups allowed erosion sources to be characterised and recognised offshore.

Our analysis shows that each of the major East Siberian rivers, Lena, Indigirka and Kolyma, has a distinguishable Raman signature that extends across the ESAS. Distal samples are generally richer in graphitic carbon, likely due to selective degradation of disordered carbon during transport.