Letter of intent for the US Arctic GEOTRACES
collaborative proposal

Julie Granger (lead): Nitrate (NO_3^-) $\delta^{15}N$ and $\delta^{18}O$
Mark Altabet: Ammonium (NH_4^+) and nitrite (NO_2^-) $\delta^{15}N$, N_2/Ar, $\delta^{18}O$ of dissolved oxygen (O_2), and N_2O concentration and isotopomer composition ($\delta^{15}N$, $\delta^{18}O$, isotopologue site preference).

Scientific objectives

- Measure the natural abundance $\delta^{15}N$ and $\delta^{18}O$ of NO_3^- along the cruise line
- Survey the $\delta^{15}N_{NH4}$ of NH_4^+ (and NO_2^-, if present) at continental shelf stations
- Measure the N_2/Ar gas ratio and the $\delta^{18}O$ of dissolved O_2 along the cruise line
- Measure nitrous oxide (N_2O) concentrations and its $\delta^{15}N$ and $\delta^{18}O$ at continental shelf stations

Types of analyses planned

- $\delta^{15}N$ and $\delta^{18}O$ of NO_3^- with the 'denitrifier' method (Sigman *et al.*, 2001; Casciotti *et al.*, 2002)
- $\delta^{15}N$ of N_{H4}^+ and NO_2^- by hypobromite oxidation and azide methods, respectively (McIlvin & Altabet, 2005; Zhang *et al.*, 2007)
- Simultaneous analysis of the dissolved N_2/Ar gas ratio and the O_2/Ar and $\delta^{18}O_{O2}$ of O_2 by continuous flow IRMS
- N_2O concentration and $\delta^{15}N_{N2O}$ and $\delta^{18}O_{N2O}$ (as well as isotopologue 'site preference') analyses on a PT-IRMS

Number of berths required: one

Sampling can be done by a super tech: yes

Nature and amount of sample required

- NO_3^- isotopes: 2 x 100 mL including rinses, from the entire section; samples stored frozen at -10 to -20˚C in 60 mL square PP bottles
- NH_4^+ (and NO_2^-) isotopes: 100 mL including rinses, from continental shelf stations
- N_2/Ar and $\delta^{18}O_2$: 600mL including rinses, from all sections; stored in glass serum bottles
- [N_2O] and its isotopes: 600mL including rinses, from continental shelf stations; stored glass serum bottles
- Particle $\delta^{15}N$ from *in situ* pumps form entire section, if available
- All analyte samples are collected from standard Niskin bottles

The hydrographic survey of the western Arctic will traverse the very productive Chuckchi continental shelf and the western flank of the Beaufort Gyre. The fertility of the western Arctic, in light of decreasing ice cover, is then largely dependent on the fixed N mixed from shallow halocline to surface, given the limited concentration of DIN relative to P with reference to algal requirements. The measurements of nitrate isotopes and accompanying TEI's proposed here

will provide important insights into N cycling in the western Arctic in a number of regards: First, the proposed measurements will provide constraints on end-member compositions of Pacific waters entering the Arctic at Bering Strait. Second, they will record of the biological transformation of N species across the productive Chuckchi shelf. As recently evidenced by analogous measurements on the Bering Sea shelf (Granger *et al.*, 2011; Granger *et al.*, 2013), we anticipate that the DIN isotopologues in shelf waters will show evidence of the relative importance of benthic denitrification and remineralization of N on the shelf. Benthic N cycling will further be evidenced in the water column by N_2O and its isotope isotopic composition, and by the $\delta^{18}O$ of oxygen - from which the relative contribution of benthic to pelagic respiration can be assessed. Below the wind mixed surface on the shelf and into the Arctic basin, N_2/Ar ratios constitute an additional and direct measure of the fixed N lost to denitrification on the continental shelves. Finally, the nitrate isotope ratio measurements in the deeper basin will provide a means of discerning the entrainment of nitrate from Pacific waters throughout the surface western Arctic, as evidenced by recent measurements in the Beaufort Gyre from the Canada GEOTRACES cruise (Granger). Together, the proposed measurements will provide a comprehensive view of N cycling in the western Arctic.

References

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