Geologically Derived Nitrogen & Stream Nitrate Concentrations in Interior Alaska

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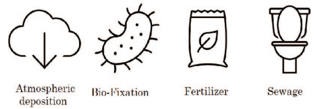
Nitrate in Streams of AK

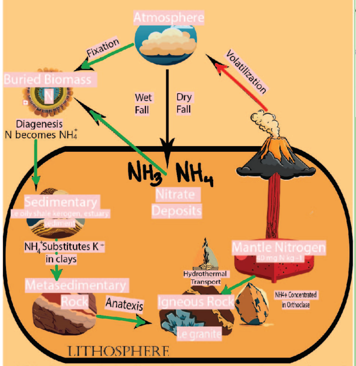
The high concentration of nitrate in Interior Alaskan streams cannot be explained by anthropogenic or environmental factors. I am examining the possibility of geologically sourced nitrogen through spatial correlation of nitrogen (N mg/L) and stable isotope values (d15N) of rocks from stream catchments with nitrate concentration of those streams.

Potential Sources Are Absent



Fairbanks is a Small City	Low Primary Productivity	No Large-scale Agriculture	Not Relative to Population flux

Source N in Rock


Atmosphere
Fixation
Volatilization
Buried Biomass
Wet Fall
Dry Fall
Diagenesis
N becomes NH4+
NH3 NH4
Sedimentary
Nitrate Deposits
NH4+ Substitutes K+ in clays
Mantle Nitrogen
Hydrothermal Transport
Metasedimentary Rock
Anatexis
Igneous Rock
NH4+ Concentrated in Orthoclase
LITHOSPHERE

This diagram depicts how nitrogen moves through the rock cycle, its sources and sinks. Model based on Holloway and Dahlgren, 2002

References

Holloway, J. M., & Dahlgren, R. A. (2002). Nitrogen in rock: Occurrences and biogeochemical implications. Global Biogeochemical Cycles, 16(4). https://doi.org/10.1029/2002gb001862
Morford, S. L., Houlton, B. Z., & Dahlgren, R. A. (2016). Direct quantification of long-term rock nitrogen inputs to temperate forest ecosystems. Ecology, 97(1), 54–64. https://doi.org/10.1890/15-0501.1
Holloway, J. M., Dahlgren, R. A., Hansen, B., & Casey, W. H. (1998). Contribution of bedrock nitrogen to high nitrate concentrations in stream water. Nature, 395(6704), 785–788. https://doi.org/10.1038/27410
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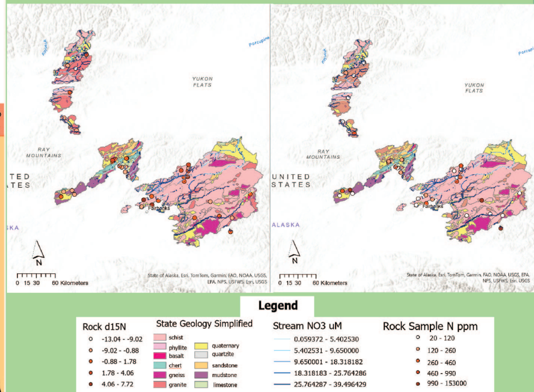
Geologic Sources

- Nitrogen cycles through geologic systems (Fig.2)
- Sedimentary and meta-sedimentary rocks are the most significant sources
  - Effect of rock nitrogen inputs in terrestrial and aquatic ecosystems have been studied in California forests and streams
- Most notable rock type bearing nitrogen is a mica-schist
- Mica-schist is a mudstone subjected to low-grade metamorphism

Rock Nitrogen Concentrations of Interior Alaska


YUKON FLATS
RAY MOUNTAINS
UNITED STATES
ALASKA
N
0 15 30 60 Kilometers
State of Alaska, Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, NPS, USFWS, Esri, USGS
Legend
Rock d15N
-13.04 - -9.02
-9.02 - -0.88
-0.88 - 1.78
1.78 - 4.06
4.06 - 7.72
State Geology Simplified
schist
phyllite
basalt
chert
gneiss
granite
quaternary
quartzite
sandstone
mudstone
limestone
Stream NO3 uM
0.059372 - 5.402530
5.402531 - 9.650000
9.650001 - 18.318182
18.318183 - 25.764286
25.764287 - 39.496429
Rock Sample N ppm
20 - 120
120 - 260
260 - 460
460 - 990
990 - 153000

- Samples with highest N ppm were within schist, gneiss, and mudstone
- Streams with the hights nitrate ran through granite and schist
- Low N ppm samples are also near streams with high nitrate concentrations

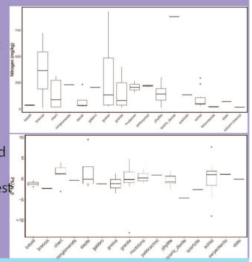
- Samples with highest d15N levels were within schist and granite
- Low concentrations of N ppm often associated w/ higher levels of d15N
- High variability between d15N and stream nitrate

Sampling Classification

- Rock samples were collected from the Alaska Geologic Materials Center representing stream catchement lithology.
- Samples were ground and weighed into 100 mg tins for isotope analysis
- Classified by rock type based on state geo data base as well as visual identification

Analysis

- Breccia has the highest median N ppm
- Gneiss has both the highest and lowest N ppm
- Schist has lower N values than phyllite and schist
- d15N highest and lowest values represented by schist and granite with in rock samples



Findings and Further Work

- Gneiss rock samples had the highest range in N ppm within our samples as well as within the state geology map.
- Schist samples with low N ppm values were located near streams with high nitrate concentration calling for more investgation into weathering rates within these catchements and how a low concentration substrate could still impact stream concentrations
- Higher levels of d15N in samples is associated with lower N ppm samples due to the fractionation that occurs during hydrothermal and metamorphic processses.

Excess Nitrogen Concentration in Fairbanks Drinking Water is Possibly Correlated to Geological Substrate