Groundwater Discharge and Base Flow Variability in the Brooks Range, North Slope, Alaska

Kenji Yoshikawa[1], Larry Hinzman[2] and Douglas Kane[3]

More than 30,000 liters/sec. of spring water discharge along the eastern part of foothills of the Brooks Range, North Slope, Alaska. These springs flow all year around and cover wide areas with aufeis every winter. Aufeis is among the biggest temporary storage of freshwater during winter period (more than 8 months). This study examines the historical volume of the aufeis using aerial photographs and satellites imagery as well as MODIS Airborne Simulator (MAS). The energy balance of the aufeis is also an important parameter for estimating perennial aufeis formations. We estimate the Holocene ice volume of aufeis using $CaCO_3$ deposits in the soil. Carbonate material distributions and ^{13}C isotope enrichment signals are indicative of the area occupied by aufeis. Thermal enrichment of the ^{13}C spring water was around 0 to -2 permil at the Hulahula River aufeis area. The ^{13}C isotope of the area immediately outside the aufeis field is around –25 permil and is also very low in carbonate content. The in-situ soil samples for $\delta^{13}C$ analysis aid to reveal previous aufeis distributions corporated with remote sensing technique. These carbon appears to possess a characteristic spectral signature that is evident in the 2300 and 2550 nm wavelength range (two absorption bands 2500-2550 nm and 2300-2350 nm and a band between those two at ~ 2400 nm (2375-2425nm). Aufeis was not much extended area during historical time such as Little Ice Age (LIA) or Last Glacial Maximum(LGM). However, some of the Aufeis and springs (at least Shubik and Sadlerochit springs) were survived during LGM. In the case of the Sadlerochit spring, total winter discharge (16,510,000 m3) had almost all turned to aufeis ice body (15,988,866 m3) reserved as the tundra terrain.

Questions of the spring water's ground residence time and infiltration processes are also examined in this study. We collected water from springs, wells, surface water, and precipitation samples for isotope (C, O, H, Sr) and chemical analyses. Preliminary results indicated most of the spring water might come from upper south-facing slopes of the Brooks Range (limestone area). Infiltrated meteoric water percolates along the fault between Paleozoic sedimentary rocks and Permo-Triassic sedimentary rocks. A multiple-member mixing model was used to estimate the residence time of groundwater. Their residence time were around 2500 years by statistical correction model. The Kuparuk aufeis (spring) may not follow the same path as other springs. Shallow intra permafrost groundwater system (<30m) was found at Kuparuk springs around aufeis field. The Kuparuk springs residence time was less than 700 years. Many of the intra permafrost water were already observed in this area (mean annual ground temperature is–7.8ºC at 2003-04). Climatic warming will activate shallower groundwater system in this area

[1] University of Alaska Fairbanks, Water and Environmental Research Center, ffky@uaf.edu.
[2] University of Alaska Fairbanks, Water and Environmental Research Center, ffldh@uaf.edu.
[3] University of Alaska Fairbanks, Water and Environmental Research Center, ffdlk@uaf.edu.