Abstract ID : **66**

Vertical strain rate measurements of the Begguya (Mt. Hunter) summit plateau using the Autonomous Phase-Sensitive Radio Echo Sounder (ApRES)

Content

Ice cores extracted from the summit plateau of Begguya (Mt Hunter, Denali National Park), Alaska have produced a high-resolution climate record of Alaskan paleoclimate that is unparalleled in length, likely dating back 10,000 years. Analysis of the surface-to-bedrock ice cores extracted from the site in 2013 give records of precipitation, temperature, hydroclimate, and atmospheric pollutants that provide context for modern climate change. Still, complex ice flow regimes of the alpine ice core site make interpretation of data challenging near the bed where the oldest records of climate are preserved. Ice flow models can be used to aid data interpretation if adequate in situ measurements can be obtained to constrain modeled flow. Vertical strain rates provide a valuable constraint for ice flow modeling, but are difficult to obtain as their detection requires precise measurement of englacial layer thickness changes over time. Such precision is not possible with conventional ground-penetrating radar systems but has been achieved in polar environments using the Autonomous Phase-Sensitive Radio Echo Sounder (ApRES) system. ApRES has been used to measure changes in englacial features with millimeter precision; however, ApRES systems have received limited attention in alpine glacier environments. High accumulation rates and complex bed topography present challenges to the acquisition and interpretation of ApRES data in alpine areas. Here we present results from a two-week radar survey of Begguya. We deployed the ApRES at twenty-one locations along a north-south and an east-west transect on the Begguya summit plateau (approximately 600 square kilometer in area), repeating the measurements after two weeks. The instrument was deployed in autonomous mode throughout the 14-day period to collect hourly measurements at the location of the drill site for the 2013 surface-to-bedrock core. Resultant data show vertical compression within the ice at each deployment location. Vertical velocity is calculated from changes in depth of englacial layers between each measurement. Vertical strain rate profiles are derived from these measurements and will be used to constrain a working three-dimensional ice flow model of the site. Results of this field survey support the efficacy of the ApRES system to characterize ice deformation with high resolution in alpine glacier environments.

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Track Classification: High-alpine ice cores