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Collaborative Research: Paleoclimate and Glaciological Reconstructions in Central Asia

Karl J. Kreutz

Principal Investigator; University of Maine, Orono, karl.kreutz@maine.edu

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Final Report for Period: 07/2000 - 07/2001**Submitted on:** 09/12/2001**Principal Investigator:** Kreutz, Karl J.**Award ID:** 0096323**Organization:** University of Maine**Title:**

Collaborative Research: Paleoclimate and Glaciological Reconstructions in Central Asia

Project Participants**Senior Personnel****Name:** Sholkovitz, Edward**Worked for more than 160 Hours:** No**Contribution to Project:**

Dr. Sholkovitz was the PI's postdoctoral mentor at the Woods Hole Oceanographic Institution. When the PI and the award moved to the University of Maine, Dr. Sholkovitz remained involved in the project through discussion and providing advice and assistance with trace element measurements at WHOI. He did not, however, have any salary support in the original award.

Name: Kreutz, Karl**Worked for more than 160 Hours:** Yes**Contribution to Project:****Post-doc****Graduate Student****Undergraduate Student****Research Experience for Undergraduates****Organizational Partners**

University of New Hampshire

University of California-Santa Barbara

USGS - Idaho Falls

Other Collaborators or Contacts

We have had several other collaborators and contacts within and outside the U.S, including field work, analytical collaboration, or interpretation advice. They include Stanislav Nitikin (Glaciology, University of Tomsk), David Susong (USGS- Salt Lake City), Steve Norton (University of Maine), Jackie Mann (NIST), and Moire Wadleigh (Memorial University of Newfoundland).

Activities and Findings**Research and Education Activities:**

Research activities:

This project resulted in the collection of two intermediate-length (165 m) ice cores from the Inilchek Glacier, Central Tien Shan Mountains, Kyrgyzstan, during July/August 2000 with colleagues from UCSB, UNH, and the USGS. In addition, precipitation, fresh snow, surface snow, and aerosol samples were collected on the glacier and in the Inilchek Valley to assess atmospheric chemistry and deposition processes. The overall goal of the project (including a pending NSF/DOE proposal) is to develop high-resolution paleoclimatic records covering the last 1000-2000 years, which will be calibrated with meteorological data from the robust station network in the former Soviet Central Asian

countries.

Education activities:

The data and ideas generated in this project have already been used in one undergraduate level course (GES 315 Sedimentology and Stratigraphy), and one graduate level course (GES 602: Environmental Isotope Geochemistry) at the University of Maine. The data and ideas will also be used in an upcoming Spring 2002 course (GES 537 Isotope Geology).

Presentations:

Kreutz, K.J. et al., Spatial and elevational variability of precipitation isotopes in the Central Tien Shan Mountains, International Glaciological Society symposium, Ice Cores and Climate, Kangerlussac, Greenland, August 17-24, 2001.

Kreutz, K.J., Ice Core Records of Late Holocene Climate Variability in the Tien Shan Mountains, Central Asia, Institute for Quaternary and Climate Studies ninth annual Agassiz Symposium, Orono, ME, May 4-5, 2001.

Findings:

Major findings of the 2000 Inilchek program thus far include:

1. Detailed radio-echo sounding survey at over 150 GPS-surveyed sites on the glacier for ice thickness and basin morphology information using a light-weight ice-penetrating radar system (300 direction of aeriels, 700 MHz frequency, 10 Watt impulse, 50 NSC duration of impulse, -130 Decibel sensitivity of receiving signal, 1-2% error of measurement). Measured ice thickness ranges from 109 to 302 m, with depths at the Core 1 and 2 drill sites being 285-300 m and 250-260 m, respectively. Ice thickness at the two core sites were also verified using a separate mono-pulse radio echo sounding system.
2. Collection of samples for chemical and isotopic analysis from four snowpits, one crevasse, and seven fresh snowfall events over a range of elevations (4200-5250 m). The stable isotope ratios and major ion concentrations in the fresh snow samples show much larger variability between events compared to changes in concentration with elevation, suggesting there will be little if any influence on the glaciochemical record of snow that fell at a slightly higher elevation in the accumulation zone and transported with glacier flow down to the drill site.
3. Collection of core chips from every drill run from both cores. These have been analyzed for stable isotopes for preliminary comparison of the climate signals preserved in the two ice cores. Results indicate that down-core isotope variability is similar in both cores, suggesting that there are no significant ice-flow effects on the preserved climate record.
4. Measurement of surface elevation and velocity, using detailed GPS measurements at the beginning and end of the field season, were made at fourteen staked locations on the glacier surface. Surface movement of the glacier over the course of 21 days was undetectable (less than approximately 2 m), indicating a relatively slow moving body of ice.
5. Measurement of borehole temperatures from the surface to the bottom shows that at the lower boundary of the active ice layer (30 m depth), the temperature (≈ 17.4 oC) is close to the annual mean air temperature at this (5100 m) elevation. The temperature at the bottom of the borehole was -11.2 oC.
6. Meteorological measurements were recorded at 0.5 m and 2.0 m above the surface near the drill site at 5100 m a.s.l. using an automatic weather station. Each half hour, measurements of air temperature, relative humidity, wind speed and wind direction, net total radiation, total incoming radiation, reflected radiation, and atmospheric pressure were taken. These data will serve to validate altitudinal gradients of solar radiation, air temperature, and the differences between glacial and non-glacial surfaces initially calculated from data at the Tien Shan meteorological station and expeditionary observations.
7. Collection of ice core chips for radionuclide analysis. Innovative analytical techniques to measure Pu and Np isotopic composition are being tested on chip samples collected during each drill run. Samples from the outside of the core 1 from 2 m to 80 m depth were also collected in the field and transported frozen to Zurich for radionuclide analysis at ETH.
8. Logging the borehole for in situ gamma radiation. Using a portable borehole gamma spectrometer (Dunphy et al., 1994), we located a horizon with Cs-137 concentration well above background at 30 m depth. It appears as though this peak represents fallout from the 1986 Chernobyl nuclear reactor explosion and corresponds to an average accumulation rate of 1.18m water equivalent per year from 1986 to the present.

Training and Development:

Research skills:

Staff and students working in the U.Maine Stable Isotope Laboratory have been actively involved in developing new analytical methods for the analysis of stable hydrogen, oxygen, and sulfur isotopes in samples collected during the project. Staff and students have also been involved in developing innovative ICP-MS techniques through our collaboration with WHOI. In addition, several field situations required on-site development of innovative ice core drilling techniques, which will prove beneficial in future ice coring expeditions.

Teaching experience:

PI Kreutz has gained experience in incorporating new research ideas and topics in undergraduate and graduate level courses, which has allowed

Outreach Activities:

During May, 2001, the U. Maine Department of Geological Sciences hosted a one day K-12 Earth Science Teachers Workshop in Orono. PI Kreutz organized and ran the workshop, and the focus was on isotope geochemical methods in Earth Science research. Results from the Inilchek program were presented as an example of how stable water isotopes are used in paleoclimate research. Teachers were encouraged to bring local water samples collected with their K-12 students. The U. Maine stable isotope lab is running those samples, and will compare the Maine water results with those from precipitation in the Tien Shan to give K-12 students and teachers a better sense of isotope hydrology research.

Journal Publications

Karl J. Kreutz

Edward R. Sholkovitz

, "Major element, rare earth element, and sulfur isotopic composition of a high-elevation firn core: Sources and transport of mineral dust in Central Asia", *Geochemistry, Geophysics, Geosystems*, p. GC000082, vol. 1, (2000). Published

Karl J. Kreutz

Vladimir B. Aizen

L. DeWayne Cecil

Cameron P. Wake, "Oxygen isotopic and soluble ionic composition of precipitation recorded in a shallow firn core, Inylchek Glacier", *Journal of Glaciology*, p. , vol. , (2001). Accepted

Books or Other One-time Publications

Karl J. Kreutz

Cameron P. Wake

Vladimir P. Aizen

L. DeWayne Cecil , "Spatial and elevational variability of precipitation isotopes in the Central Tien Shan Mountains", (2002). Book, submission planned for Jan. 2002

Editor(s): L. DeWayne Cecil

Lonnie Thompson

Eric Steig

Collection: Earth Paleoenvironments: Records Preserved in Mid and Low Latitude Glaciers

Bibliography: Kluwer Publishers

Web/Internet Site

URL(s):

Description:

Other Specific Products**Contributions****Contributions within Discipline:**

Thus far, we have developed innovative techniques for the analysis of isotopic and trace element geochemistry in ice core samples. Use of data produced by these techniques has enabled interpretations of dust transport and atmospheric circulation in Central Asia which were previously not possible. We hope to apply these techniques to the deep ice cores recovered as part of this project, and thus extend interpretations of climate variability in the Tien Shan Mountains back several centuries.

Contributions to Other Disciplines:

We hope that our findings thus far are applicable to the general paleoclimate community, as detailed records of Central Asia climate variability during the Late Holocene are scarce. In addition, we have communicated with atmospheric scientists who are most interested in our results from an atmospheric dynamics perspective.

Contributions to Human Resource Development:

At least two undergraduate students and one full time technician at the University of Maine have benefited from participation in this project. These developments include professional preparation, improvement of writing and analytical skills, and mechanical and electronic instrumentation improvement.

Contributions to Resources for Research and Education:

Data from this program is already used in several courses at the University of Maine, and the data will remain an integral part of these classes in the near future.

Contributions Beyond Science and Engineering:

Categories for which nothing is reported:

Any Product

Contributions: To Any Beyond Science and Engineering