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Studying Byrd Glacier as a Rock-Floored Ice Stream Ending as a Calving Ice Shelf: Phase I

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Principal Investigator: Hughes, Terence J. **Award ID:** 0003616
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Title:
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Project Participants

Senior Personnel

Name: Hughes, Terence
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Hooke, Roger
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Fastook, James
Worked for more than 160 Hours: Yes
Contribution to Project:

Post-doc

Graduate Student

Undergraduate Student

Technician, Programmer

Other Participant

Research Experience for Undergraduates

Organizational Partners

Other Collaborators or Contacts

Activities and Findings

Research and Education Activities:
Research
There were two major research activities. First, 19,004 velocities were measured on Bryd Glacier (80.3 S, 160 W) by tracking moving crevasses on Landsat images obtained on 22 February 1988 and 25 January 1990. This work was done by Christine Rosanova, under the supervision of Dr. Baerbel Lucchitta, on a subcontract to the United States Geological (USGS) in Flagstaff, Arizona. The measuremests included the zone of East Antarctic ice conveging on Byrd Glacier fjort, ice moving through the fjord, and ice leaving the fjord to merge with the Ross Ice Shelf. These measurements approximately doubled the area over which velocities have been measures

and are twenty times the number of previous velocity measurements. The new velocity measurements have been loaded into the metadata of the National Antarctic Data Coordination Center as a DIF, and can be viewed online at the following URL:
http://gcmd.nasa.gov/getdif.htm?Byrd_1988_1990
Second, a theoretical model of crevasse formation and propagation was developed by James Kenneally at the University of Maine, under the supervision of Dr. Terence J. Hughes. This model is being applied to the flowband from Byrd Glacier to the calving front of the Ross Ice Shelf, with the goal of understanding how giant tabular icebergs are released from the ice shelf.
Education
James Kenneally will be awarded a doctorate in physics in June 2003 as a result of this research.

Findings:

The major findings from this research from the velocity measurements is that several tributary ice streams converge on Byrd Glacier fjord to become Byrd Glacier in the fjord, and that Byrd Glacier retains its integrity as an ice stream for some 100 km beyond the fjord before it fully merges with the Ross Ice Shelf. Tributary ice streams are identifies by crevasse fields associated with separate flowbands and having separate velocities. Merger with the Ross Ice Shelf is identified by the gradual healing of lateral fracture zones, as seen by the smoothing of ice velocities with distance from Byrd Glacier fjord. The major finding from the theoretical research on crevasse nucleation and propagation is that standard principles of fracture mechanics can be used to determine the initial depth and spacing of transverse crevasses once Byrd Glacier becomes afloat. Rates of propagation downward for surface crevasses and upward for bottom crevasses are then compared with measured ice velocities to obtain the distance from the grounding line in Byrd Glacier fjord where these crevasses meet, to create the condition for calving a giant iceberg.

Training and Development:

The research skills employed by Christine Rosanova are skills she has acquired from many years of making velocity measurements on ice streams from Landsat images. James Kenneally has had his first experience in conducting sponsored researech on this project. His acquired skills include learning how to search the literature on calving dynamics (few publications) and fracture mechanics (many publications), understanding published previous research, taking courses in fracture mechanics at the University of Maine, and planning a successful research strategy for attaining the goal of linking crevassing to calving from Byrd Glacier to the calving front of the Ross Ice Shelf. Professor Hughes, the Principal Investigator, honed his skills on modeling transitions from sheet flow to stream flow to shelf flow, as applied to the Byd Glacier/Ross Ice Shelf system. In particular, this included relating variations in ice surface slope and ice thickness to basal water pressure for grounded ice and to ice-shelf buttressing for floating ice.

Outreach Activities:

Journal Publications

Kenneally, J.P., and Hughes, T.J., "The calving constraints on inception of Quaternary ice sheets.", Quaternary International, p. 43, vol. 95-96, (2002). Published

Books or Other One-time Publications

Web/Internet Site

Other Specific Products

Contributions

Contributions within Discipline:

Contributions to Other Disciplines:

Contributions to Human Resource Development:

Contributions to Resources for Research and Education:

Contributions Beyond Science and Engineering:

Categories for which nothing is reported:

Organizational Partners
Activities and Findings: Any Outreach Activities
Any Book
Any Web/Internet Site
Any Product
Contributions: To Any within Discipline
Contributions: To Any Other Disciplines
Contributions: To Any Human Resource Development
Contributions: To Any Resources for Research and Education
Contributions: To Any Beyond Science and Engineering