

2-17-2003

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

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## Recommended Citation

Huges, Terence J.; Hooke, Roger; and Fastook, James, "Studying Byrd Glacier as a Rock-Floored Ice Stream Ending as a Calving Ice Shelf: Phase I" (2003). *University of Maine Office of Research and Sponsored Programs: Grant Reports*. 65.  
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**Final Report for Period:** 02/2001 - 01/2003

**Submitted on:** 02/17/2003

**Principal Investigator:** Hughes, Terence J.

**Award ID:** 0003616

**Organization:** University of Maine

**Title:**

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

**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 measurements included the zone of East Antarctic ice converging on Byrd Glacier fjord, 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 measured

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](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 identified 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 research 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 Byrd 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