Accepted Manuscript

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PII: S1873-9652(17)30073-7

DOI: 10.1016/j.polar.2017.09.004

Reference: POLAR 355

To appear in: *Polar Science*

Received Date: 16 June 2017

Revised Date: 13 August 2017

Accepted Date: 22 September 2017

Please cite this article as: Wang, R., An, L., Cao, P., Chen, B., Sysoev, M., Fan, D., Talalay, P.G., Rapid ice drilling with continual air transport of cuttings and cores: General concept, *Polar Science* (2017), doi: 10.1016/j.polar.2017.09.004.

RAPID ICE DRILLING WITH CONTINUAL AIR TRANSPORT OF CUTTINGS AND CORES: GENERAL CONCEPT

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Abstract

This article describes the investigation of the feasibility of rapid drilling in ice sheets and glaciers to depths of up to 600 m, with cuttings and cores continually transported by air reverse circulation. The method employs dual wall drill rods. The inner tubes provide a continuous pathway for the chips and cores from the drill bit face to the surface. To modify air reverse circulation drilling technology according to the conditions of a specific glacier, original cutter drill bits and air processing devices (air-cooled aftercoolers, air receivers, coalescing filters, desiccant dryers) should be used. The airflow velocity for conveying a 60-mm diameter and 200-mm long ice core should not be lower than 22.5 m/s, and the minimal airflow rate for continual chip and cores transport is 6.8 m^3/min at 2.3−2.6 MPa. Drilling of a 600-m deep hole can be accomplished within 1.5 days in the case of twenty-four hour drilling operations. However, to avoid sticking while drilling through ice, the drilling depth should to be limited to 540 m at a temperature of -20 °C and to 418 m at a temperature of -10 °C.

1. Introduction

Typically, rapid ice drilling systems can drill in glaciers and ice sheets during shortest time in order to get core and/or chips samples, produce boreholes, provide bed access, and sample subglacial material (bedrock, water, or sediments). Rapid ice drilling systems can be divided into three groups: (1) hot-water drilling systems, (2) unconventional drilling systems, and (3) conventional systems used in oil drilling or the mineral-exploration industry.

Hot-water drilling systems are a well-known access method and have been used since the 1970s (e.g., Iken et al., 1976). They can be considered one of the fastest type of ice drilling systems (30−60 m/h). Currently, hot-water drilling systems are actively used for observing ocean cavities under ice shelves, retrieving sub-ice seabed samples, studying internal ice structures, video