GLACIAL-BED TYPES AND THEIR RADAR-REFLECTION CHARACTERISTICS

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ABSTRACT. Studies of radar reflection characteristics can indicate much about the bed of an ice sheet and the associated ice motion. This contribution analyzes the relative significance to the ice flow of rough ice–rock, rough ice–water–rock, and flat ice–water–rock interfaces, and establishes criteria for distinguishing among these interface types under ice sheets using radar equipment of the type developed by the Technical University of Denmark.

The ice and heat-flow conditions that are needed to develop flat-surfaced subglacial lakes, such as those discovered by Oswald (1975), are analyzed. As the glacier moves onto a subglacial lake its underside retains much of the shape of the vertical relief at the lake edge. Differential heat transfer from the lake into the ice mass eventually flattens the interface by melting the downward projections or by freezing in the hollows, depending on the regional basal mass balance. This process typically requires about 1 000 years. Thus the down-glacier part of a subglacial lake can be flat-surfaced if the glacier takes longer than about 1 000 years to traverse the lake. Such a slow traverse time is expected near ice drainage divides, and it is there that these lakes were discovered.

Rough-surfaced lakes are expected elsewhere under wet-based ice sheets and model calculations of the expected radar reflection tail shape, horizontal fading, and echo strength are made for such lakes. Criteria are listed for distinguishing rough-surfaced lakes from ice–rock interfaces and from flat-topped lakes.

A map of subglacial hydrologic potential is presented for the Byrd Station strain network, Antarctica area and the probable locations for subglacial lakes noted. The radio echo characteristics of various sites in this area are compared and discussed in terms of the above theory. Rough-topped subglacial lakes grade into smooth-topped lakes where the lake is long and the bottom velocity slow.

These lakes are important to the distribution of the basal drag due to the motion of the ice sheet. Since the lakes cannot support shear stresses, the drag must be concentrated in non-lake areas. Further, as Robin and Weertman (1973) noted, the drainage of subglacial water is partly controlled by the basal drag, and this feedback mechanism between ice flow and lake size can result in important changes in ice-sheet configuration.

REFERENCES

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