Icebergs and Oil Tankers Soon to Mix

Within a few years oil tankers may be at times unable to reach the terminus of the Trans-Alaska Pipeline system at Port Valdez—the shipping lane may be cluttered with chunks of ice from nearby Columbia Glacier. According to the U.S. Geological Survey (USGS), the glacier is on the verge of starting a catastrophic retreat, during which it could dump as much as 11 cubic kilometers of ice per year into the fjords near Valdez. On 17 June, Mark Meier of the USGS in Tacoma, Washington, warned the U.S. Coast Guard and other agencies that the retreat "is very likely to occur in the 1982 to 1985 period—most likely in 1983 or 1984," says Meier. The USGS issued an official hazard advisory on 25 June.

Even before oil started flowing through the pipeline, Columbia Glacier was recognized as a possible threat to tankers (*Science*, 14 November 1975, page 641). The glacier fills a fjord adjoining the Valdez shipping channel. Icebergs separating from the end of the glacier where it meets the water "tend to catch a current which takes them across the tanker lanes," says Joseph Ocken of Coast Guard headquarters in Washington, D.C. At present, icebergs calve from the end of the glacier at a moderate rate. Rarely do enough chunks of ice stray into the shipping lanes to block tanker traffic. In 1975, USGS glaciologists warned that Columbia Glacier might start to disintegrate, thereby dumping much more ice into the fjords, perhaps enough to interfere seriously with tanker traffic. According to Austin Post of the USGS in Tacoma, the glacier should let loose a total of 200 cubic kilometers of ice over 30 to 50 years.

To predict how soon Columbia Glacier might retreat and how rapidly it would dump debris into the path of tankers, the USGS in 1977 intensified monitoring Columbia Glacier and launched a study of calving glaciers in general.

The researchers discovered that the depth of water at the snout of a glacier controls how fast it erodes by calving. A glacier ending in deep water disintegrates faster than one ending in shallow water. Post says that glaciers ending in water shallower than 80 meters tend to have stationary snouts or ones that advance slowly as they are pushed forward by the flow of the glacier. Snouts ending in deeper water calve so prolifically that they are retreating rapidly. The tip of Columbia is now in about 75 meters of water, and it is backing slowly off a shoal into deeper water.

Al Rasmussen of the USGS in Tacoma and Robert Bindschadler of NASA's Goddard Space Flight Center in Greenbelt, Maryland, spent this spring using the Geological Survey's recent field data to develop computer models of the behavior of Columbia Glacier. The goal was to predict Columbia's future. Although the two models are very different, their predictions agree surprisingly well.

According to Rasmussen's model, the glacier should be receding fast by 1982 to 1985. Bindschadler's model predicts 1983. At the peak of the retreat, 8 to 11 cubic kilometers of ice per year should crumble from the snout, says Rasmussen. This is six to eight times greater than the current rate.

Columbia Glacier last August. [*Source: Austin Post, USGS*]

Rasmussen describes his approach as conceptually simple. He knows the shape (length and thickness) of the glacier now and makes reasonable guesses of its shape at many stages during the retreat. The computer calculates how much time the glacier takes to retreat from one profile to the next and how much ice calves off in the process.

Bindschadler's model mathematically simulates the flow of the glacier and keeps careful tabs on the effects of melting, evaporation, and calving. Both models use the new USGS result that calving eats into the glacier at a rate that is linearly proportional to the depth of the water at the snout.

"After the Columbia goes back 300 meters more, we'll be able to time the retreat much better," says Rasmussen. From photographs taken regularly by airborne survey cameras, the USGS is following the motion of the snout and the thinning of the glacier. As data come in, Rasmussen will use them to improve his model and its predictions.

"The Coast Guard is a bit concerned about our prediction," says Meier. Officers stationed at Valdez are alert to stray icebergs and "have standing orders to take measures should the ice conditions become hazardous," explains Captain Daniel Charter of the Coast Guard's Washington, D.C., office. Measures range from restricting tanker traffic at night to prohibiting it altogether as long as is necessary—an action that would not be popular with the refineries expecting to process the 1.6 million barrels of oil per day flowing from the North Slope. The Coast Guard expects calving during the retreat to be episodic, as it is now, and hopes to "be able to move tankers during slack ice periods," says Ocken.

At this point, no one can guess whether tanker traffic will be halted long enough to disrupt the flow of Alaskan oil. As much as 8 days worth of oil can be stored in Valdez, and the pipeline could be shut down for a day or two "without causing problems on the North Slope," says Mario Cardullo of the Department of Energy. Other than waiting out the icebergs and hoping that the wait is not too long, "there are very, very few alternatives," says Cardullo. "You can't let the tankers go through if there are too many icebergs." —BEVERLY KARPLUS HARTLINE

0036-8075/80/0718-0381$00.50/0