On Thin Ice?

BY ROBERT A. BINDSCHADLER AND CHARLES R. BENTLEY

Twelve thousand years ago, as the earth emerged from the last ice age,

vast armadas of *Titanic*-size icebergs invaded the North Atlantic. Purged vigorously from the enormous ice sheets that smothered half of North America and Europe at the time, those icebergs displaced enough water to raise global sea level more than a meter a year for decades.

As the frozen north melted, the ice gripping the planet's southernmost continent remained essentially intact and now represents 90 percent of the earth's solid water. But dozens of scientific studies conducted over the past 30 years have warned that the ice blanketing West Antarctica—the part lying mainly in the Western Hemisphere—could repeat the dramatic acts of its northern cousins. Holding more than three million cubic kilometers of freshwater in its frozen clutches, this ice sheet would raise global sea level five meters (about 16 feet) if it were to disintegrate completely, swamping myriad coastal lowlands and forcing many of their two billion inhabitants to retreat inland.

Most Antarctic scientists have long concurred that the continent's ice has shrunk in the past, contributing to a rise in sea level that continued even after the northern ice sheets were gone. The experts also agree that the ice covering the eastern side of the continent is remarkably stable relative to that in West Antarctica, where critical differences in the underlying terrain make it inherently more erratic. But until quite recently, they disagreed over the likelihood of a catastrophic breakup of the western ice sheet in the near future. Many, including one of us (Bindschadler), worried that streams of ice flowing from the continent's interior toward the Ross Sea might undermine the sheet's integrity, leading to its total collapse in a few centuries or less. Others (including Bentley) pointed to the sheet's recent persistence, concluding that the sheet is reasonably stable.

For a time it seemed the debate might never be resolved. Agreement was hampered by scant data and the challenge of studying a continent shrouded half the year in frigid darkness. In addition, although areas of the ice sheet have drained quickly in the past, it is difficult to determine whether changes in the size or speed of the ice seen today are a reflection of normal variability or the start of a dangerous trend. In the past few years, though, a variety of field and laboratory studies have yielded a growing consensus on the forces controlling West Antarctica's future, leading experts in both camps to conclude that the ice streams pointing toward the Ross Sea are not currently as threatening as some of us had feared.

We remain puzzled, however, over the ice sheet's ultimate fate. New studies have revealed thinning ice in a long-neglected sector of West Antarctica, suggesting that a destructive process other than ice streams is operating there. And another region—the peninsula that forms Antarctica's northernmost arm—has recently experienced warmer summer temperatures that are almost certainly the reason behind an ongoing breakup of ice along its coasts.

Around the world temperatures have risen gradually since the end of the last ice age, but the trend has accelerated markedly since the mid-1990s with the increase of heat-trapping greenhouse gases in the atmosphere. So far the peninsula seems to be the only part of Antarctica where this recent climate trend has left its mark; average temperatures elsewhere have risen less or even cooled slightly in the past 50 years. Researchers are now scrambling to determine whether global warming is poised to gain a broader foothold at the bottom of the world.

Overview/*Antarctic Ice*

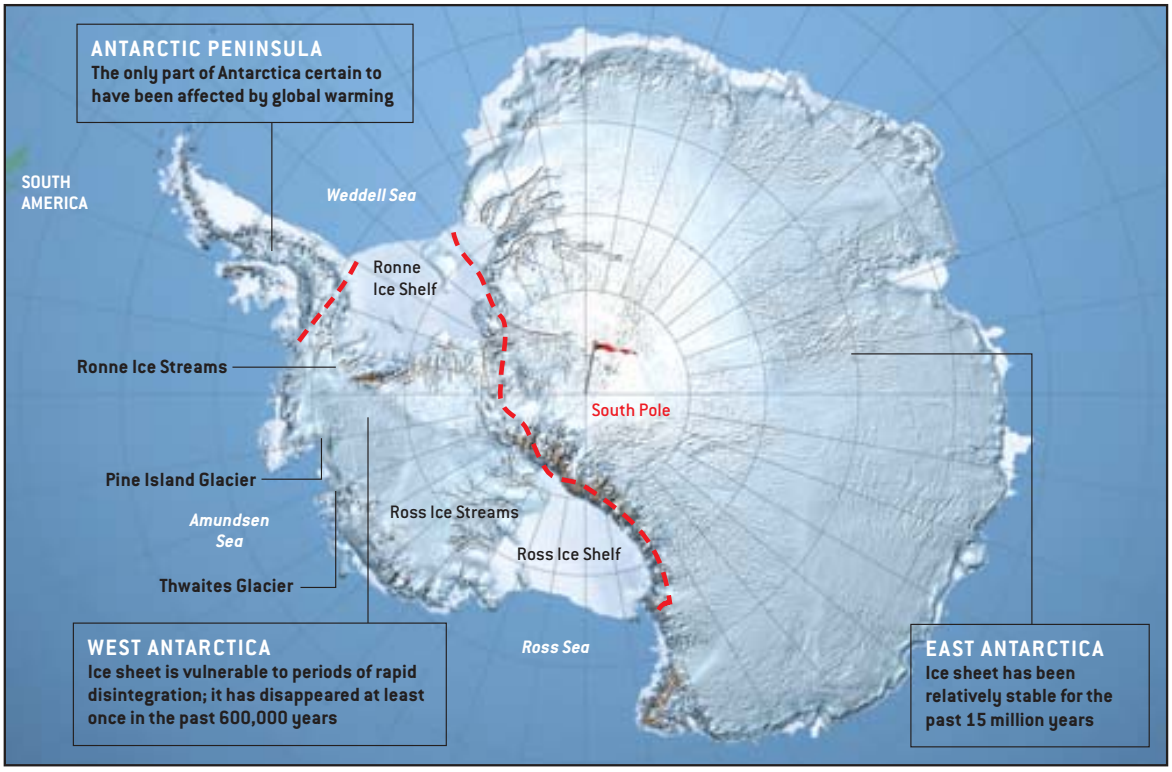
- For nearly three decades, numerous Antarctic experts warned that West Antarctica's ice sheet is in the midst of a rapid disintegration that could raise global sea level five meters in a few centuries or less.
- Many of those researchers now think that the ice sheet is shrinking much more slowly than they originally suspected and that sea level is more likely to rise half a meter or less in the next century.
- That consensus is not without its caveats. The ice sheet's poorly understood Amundsen sector now appears to be shrinking faster than previously thought.
- Global warming, which has so far played a negligible role in West Antarctica's fate, is bound to wield greater influence in the future.

Early Alarms

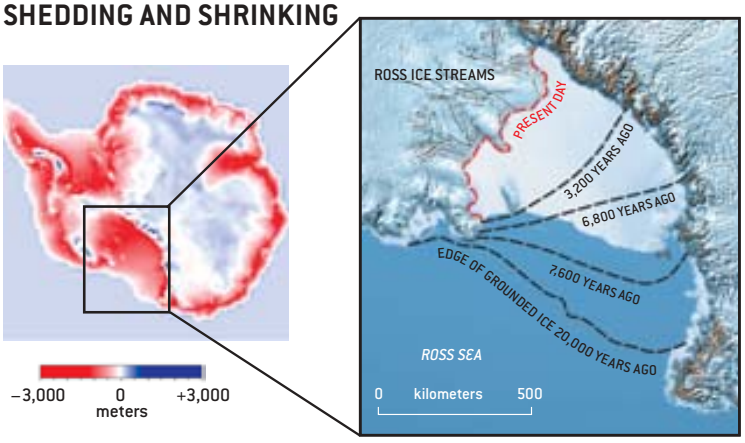
INDICATIONS THAT the West Antarctic ice sheet might be in the midst of a vanishing act first began cropping up about 30 years ago. In 1974 Johannes Weert-

PAST, PRESENT AND FUTURE?

ANTARCTICA'S THICK BLANKET OF ICE (*below*) has been contracting, mostly gradually but sometimes swiftly, since the height of the last ice age, 20,000 years ago. The greatest reduction has occurred in West Antarctica, where the ice sheet is considerably more fragile than its counterpart in the east. Because the western sheet has changed quickly in the past, scientists have been unsure whether recent dramatic ice losses reflect normal variability or the start of an ominous trend toward total collapse. In the wake of a catastrophic collapse, rapidly rising seas would flood coastal communities around the world. *—R.A.B. and C.R.B.*



SHEDDING AND SHRINKING



CHANGE IN ICE THICKNESS since the last ice age (*above left*) translates into a loss (*red*) of about 5.3 million cubic kilometers, much of it from West Antarctica. The ice sheet's grounded edge, that reaching the seafloor, has shrunk particularly rapidly in the Ross Sea (*detail, right*) over the past 7,000 years, retreating some 700 kilometers inland.

THE WORST-CASE SCENARIO

COMPLETE COLLAPSE of West Antarctica's ice sheet would raise sea level five meters. Among the casualties would be southern Florida (*above*), where about a third of the famous peninsula would disappear underwater. Today West Antarctica contributes about 10 percent of the average sea-level rise of two millimeters a year.

DAVID FIERSTEIN (*main Antarctica map and Ross Ice Shelf map*); ROBERT A. BINDSCHADLER (*ice thickness map*); WILLIAM F. HAXBY (*Florida map*)