Cloud Conundrums

Satellites have spied strange plumes coming from the Soviet Arctic, including some rising from an island that served as a nuclear testing ground

By STEFI WEISBURD

In 1810, a Russian industrialist named Jacob Sannikov stood on the New Siberian Islands in the East Siberian Sea, looked to the north and thought he had discovered a new continent.

Sannikov's sighting and similar reports from 19th-century Arctic explorers fueled the belief of many geographers at the time (and of the U.S. Congress, which was eagerly financing Arctic expeditions) that a vast polar continent was just waiting to be conquered. Expeditions were mounted to search for Sannikov's Land. But it was never found, and two parties of explorers perished for their troubles.

Now, Pierre St. Amand, a consultant to the Naval Weapons Center in China Lake, Calif., and a number of other scientists think these continental mirages could have been large plumes rising from the sea – similar to clouds recently spotted on satellite images of Bennett Island, which lies 150 kilometers to the north of the New Siberian Islands.

These Bennett Island plumes were first discovered in infrared images from National Atmospheric and Oceanic Administration (NOAA) weather satellites. These cold clouds are hundreds of kilometers long and tens of kilometers wide, and appear to emerge from the sea, rising to altitudes of 1 to 2 kilometers, according to Michael Matson at NOAA's National Environmental Satellite, Data, and Information Service in Washington, D.C. More than 200 Bennett Island plumes have been spotted in random searches of NOAA imagery taken since 1973.

Most U.S. researchers who have thought about these plumes now suspect that they are caused by the escape of methane from the world's largest natural gas reservoir. But scientists are mystified by even more recently detected clouds that are lofted much higher into the atmosphere from an island on the other side of the Soviet Arctic. Partly because the island has been a Soviet nuclear testing site, some Western scientists have wondered whether these clouds are human-made.

In the Dec. 9 Eos, Matson reports that clouds similar to those above Bennett Island have been seen on satellite imagery of the northern of two islands called Novaya Zemlya, which lie about 2,000 kilometers to the west of Bennett Island. So far, random searches of images of that region have turned up 12 plumes in a seven-year period.

When the first Bennett Island plume was discovered in 1983, many scientists initially thought it had been spewed out by a volcano. But according to a number of researchers, the region has not experienced volcanism for nearly 80 million years. In a 1983 Eos article, Jurgen Kienle, Juan Roederer and Glenn Shaw of the Geophysical Institute at the University of Alaska in Fairbanks noted that the nearest known volcanic site lies 1,300 kilometers to the southwest, in Siberia, and last erupted in 1775. They write that the Geophysical Institute's seismic network could not find evidence for a volcano prior to the plume's appearance, and air samples taken at Barrow, on the northern end of Alaska, contained no traces of volcanic material.

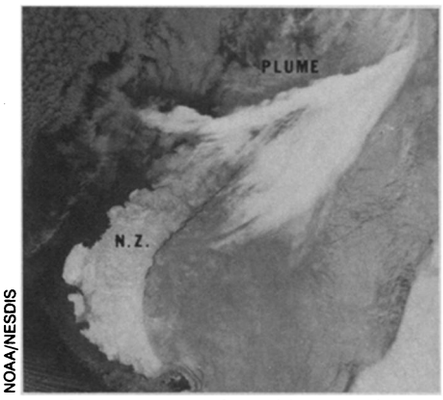
The Air Force Technical Applications Center also found no evidence for volcanism from either its airborne sampling or its seismic network, according to an Air Force spokesman in Washington, D.C.

Moreover, Soviet scientists who investigated the Bennett Island region after learning about the plumes, presumably from U.S. sources, told U.S. researchers that they could find no evidence for a recent eruption. And according to Yevgeni Korotkevich, vice-president of the Geographical Society of the USSR, whose remarks were conveyed to SCIENCE NEWS by Yuri Kupin at the Novosti Press Agency, the Soviet expedition also "did not find any gas plumes. Apparently the vertical streaks [that we see on space] photographs represented a meteorological phenomenon, or could be associated with ice domes in those regions. They cannot be man-made."

Back in the United States, researchers considered, and then discarded, a host of other possible sources, including Soviet cloud seeding experiments and burning coal beds. U.S. scientists investigating the Bennett Island plumes have now settled on the methane theory, which was suggested by geologist James Clarke at the U.S. Geological Survey in Reston, Va.

Clarke thinks the plumes are clouds of water or ice and methane that has escaped from coal beds beneath the sea. He says the beds formed from the decay of plants during the last 4 million years, before the Siberian shelf was covered by a thick layer of permafrost and later inundated by the sea.

The permafrost layer is thought to contain methane hydrates – ice-like compounds in which methane molecules are trapped in a cage formed by water molecules. Scientists believe that heat from the earth has been slowly melting the permafrost. Clarke suggests that as a result, pockets of methane gas build up near Bennett Island, and the methane is released explosively when a fault cracks through the overlying rocks and into the permafrost layer.



NOAA/NESDIS

A NOAA satellite infrared image taken on Feb. 5, 1986, shows one of the plumes that have been spotted emerging from Novaya Zemlya in the Soviet Arctic. Such clouds range in length from 90 to 600 kilometers and are as cold as −60°C. Scientists are puzzled by the Novaya Zemlya plumes, which, unlike similar clouds seen rising offshore of Bennett Island to the east, emerge from land.

Clarke says the straight shoreline of Bennett Island suggests there is a fault there. Because methane is much lighter than air, he says, it probably shoots straight up into the atmosphere "like BBs coming from an air gun."

Clarke notes that explosive releases of methane are common in that part of the world. These "mud volcanoes," which can shoot hundreds of feet into the air, occur in Alaska, Canada and the Caspian region of the Soviet Union, he says. In every case, they appear to be related to a fault, according to Clarke.

Because methane cools as it expands,

the methane hypothesis would explain why the plumes are so cold (satellite infrared data suggest that they are colder than -40°C) and why, as some scientists believe, the plumes are much colder than the surrounding air. St. Amand also thinks this would explain why the plumes are not emitted continuously: With enough cooling, the hydrates would reform and the permafrost would refreeze, sealing off the flow of methane from the seafloor. Clarke suggests that the particles entrained in the rising methane plume would act as condensation nuclei for water vapor in the air and would cause ice crystals to form, just as condensation trails are left behind airplanes.

While researchers agree that the Novaya Zemlya plumes, like those from Bennett Island, are not due to volcanic eruptions, a few have been less comfortable with extending the methane hypothesis to these clouds. One reason is that the plumes over Novaya Zemlya reach much higher into the atmosphere, rising anywhere from 7.8 to 10 kilometers, depending on the technique used to calculate their height, according to Matson of NOAA. The force behind methane escape, he says, "is like putting your head below water and blowing bubbles — you're not going to get anything up [that] high into the atmosphere. [The methane theory] is a reasonable hypothesis, but there are some problems with it for the Novaya Zemlya case."

St. Amand is fairly convinced that the methane hypothesis cannot explain the Novaya Zemlya plumes, because "the [plumes] are coming right off the island and the rocks [there] are not the sort that you'd expect to have methane in them." He believes the plumes are artificially made. "But what [the Soviets] are doing or why they made them, I have no idea," he says.

Because Novaya Zemlya has been a Soviet nuclear testing site, a few U.S. scientists have wondered whether the plumes arise from some kind of military testing. An Air Force spokesman, however, stresses that, after considerable study, the Air Force has had no reason to think the clouds coming from either Novaya Zemlya or Bennett Island are due to any radioactivity-generating human process, such as nuclear testing. Adds one atmospheric scientist, "What got us excited was the idea that the Russians

A missing methane connection?

Are the Arctic plumes merely a geologic curiosity whose significance is limited to a single area of the globe? To at least one scientist, the clouds — if they are made of methane — hint at a more global importance.

When atmospheric chemist Charles Stevens at the Argonne (Ill.) National Laboratory saw the announcement in the December Eos about possible methane plumes coming from the Bennett and Novaya Zemlya islands, he thought he might have found the explanation for some unusual readings he had taken of methane in air samples from Illinois, Oregon and elsewhere. He had discovered that from 1978 through 1983 the isotopic ratio of carbon-13 to carbon-12 fell slightly in the Northern Hemisphere, while at the same time in the southern half of the globe, the relative abundance of carbon-13 grew.

Stevens could understand the Southern Hemisphere's increase in the percentage of carbon-13, since forest burning and other sources of carbon-13-rich methane have been increasing in that part of the world. But the Northern Hemisphere data were a puzzle.

"The effective decrease in carbon-13 was more than could be accounted for by the increasing fluxes of methane from rice and cattle," sources of methane that release relatively low amounts of carbon-13, he says. Moreover, in the fall and winter of 1984-85, Stevens obtained Northern Hemisphere samples that were much more depleted in carbon-13 than any other previous samples.

"Here were two pieces of evidence. The isotopic data said that funny things were going on in the Northern Hemisphere . . . and here were these data from the satellite that showed possible methane emissions from the ground," says Stevens. Perhaps the plumes — if they are indeed composed of methane — are responsible for changing the isotopic makeup of Northern Hemisphere methane. If so, Stevens estimates that they would have had to be increasing their output by several billion kilograms of methane per year to account for the 1978-83 observations.

The possible connection between the Arctic plumes and recent methane measurements is an interesting idea, but Stevens cautions that at this stage it is pure conjecture. However, if the clouds are shown to come from the release of methane, researchers may well wonder about their atmospheric impact. Perhaps the plumes we see today are, in some small way, signs of what some scientists believe might be in store in the distant future. According to one scenario, the global warming resulting from the human release of carbon dioxide, methane and other "greenhouse" gases will eventually melt the permafrost layer in the Soviet Arctic, free the methane from its icy prison and release it into the atmosphere, where it can warm the planet some more.

— S. Weisburd

were doing something nefarious, but to my knowledge there's no evidence whatsoever that that's what's going on."

Korotkevich's only comment to SCIENCE NEWS about the Novaya Zemlya plumes is somewhat cryptic: "Something like this could be observed in the vicinity of the Canadian Archipelago and Greenland, regions with almost the same geographic coordinates."

Matson, however, says NOAA images have not picked up any plumes coming from Greenland. "If this type of plume activity was occurring elsewhere we would have spotted it," he says. "Only these two cases have caught our eye."

Matson says he and a few other scientists are now kicking around the idea that the Novaya Zemlya plumes are caused by "orographic" effects, in which a mountain, or in this case a glacier, pushes air currents up, where they cool enough for water to condense into a cloud. He's testing this idea with the most recent plume, which was detected March 3 and which enabled NOAA scientists for the first time to monitor in real time the development of a cloud from either Novaya Zemlya or Bennett Island.

Clarke maintains that the methane hypothesis *could* explain the Novaya Zemlya clouds, although he says "it's less clear what the situation is [there]." In support of the methane idea, he notes that on the west coast of the northern island there is a very straight fjord, suggesting a fault, that runs right through the area where the plumes arise. But Gregory Ulmishek, a petroleum geologist at Argonne (Ill.) National Laboratory and a Soviet emigrant, says the region is very tectonically complex, with thousands of faults. "So why don't we see plumes elsewhere?" he asks.

Both the Novaya Zemlya and Bennett Island plumes have whetted the scientific appetites of U.S. researchers. And the fact that their Soviet colleagues appear to have little clue to the cause of the clouds — or, if they do, are reluctant to say — has only intensified this curiosity. "We have all these hypotheses and remote sensing data," says Matson, "but we're really not going to know anything until somebody gets to Bennett Island and takes some ground measurements during a plume event."

Matson, Clarke and others are itching to mount a joint U.S.-Soviet expedition to Bennett Island. (Matson thinks it's unlikely that U.S. scientists would ever be allowed to visit Novaya Zemlya because it is militarized.) But the Soviet Union's Korotkevich doesn't appear as tantalized by the prospect. "The study of such phenomena has no practical value," he says, "as they are of a local nature and, therefore, do not deserve to be an object of international scientific cooperation."

So, for U.S. scientists, the cause of the plumes may remain clouded. □

News of the week continued from p. 199

Coming — dietary aids to prevent cancer?

Many studies have shown that a diet high in vegetables may offer some protection against cancer (SN: 6/26/82, p.422). Although there are a number of potential anticancer agents in vegetables — among them antioxidants like beta-carotene (SN: 10/1/83, p.217) — a growing body of evidence now suggests that the most potent protective effect may come from protease inhibitors. New studies in cultured cells and rodents indicate that these compounds, found in certain plants, may hold enormous promise as a food additive or supplement to prevent the development of human cancer.

At the Second International Conference on Anticarcinogenesis and Radiation Protection, held earlier this month in Gaithersburg, Md., Ann Kennedy of the Harvard School of Public Health's department of cancer biology in Boston reported on an investigation of these compounds. She and her colleagues found that certain of these plant compounds may be capable of neutralizing the effects of a wide range of carcinogens, from radiation and steroid hormones to potent components of diesel exhaust.

Found in plants' reproductive parts — including beans, rice and potatoes — protease inhibitors are believed to provide these parts with natural protection against insect predation. But because they also block the activity of an enzyme responsible for the digestive breakdown of proteins, they gained the reputation of being antinutritious. Walter Troll of New York University Medical Center, a pioneer in protease-inhibitor cancer studies, notes with irony that "the Department of Agriculture has spent a lot of time removing protease inhibitors — from soybeans, for example — because they thought it [the removal] would make young children grow better."

Carcinogenesis is believed to be a multi-stage process. It's initiated with exposure to a carcinogen, which triggers long-lived changes in a cell. The process is advanced when the cell is subsequently exposed to a "promoting" agent — something that may or may not be carcinogenic by itself. Promoting agents that have been established in animals or in the lab, according to the researchers, include saccharine, dioxin and constituents of cigarette smoke. It is believed that cells that have been both initiated and promoted may at some future point, during cell division, undergo a spontaneous transformation to a cancer.

What Kennedy and her co-workers have found is that even brief exposure of initiated and/or promoted cells to minute quantities of certain protease inhibitors — such as the Bowman-Birk inhibitor derived from soybeans — not only prevented the transformation of those cells into cancers, but also "reprogrammed" their precancerous change back to the pre-initiation state. And the cells weren't fussy about the timing of treatment; anytime prior to cancer transformation blocked carcinogenesis. The only real limit to the effect appears to be the dose of the initiator/carcinogen. If it is too high, the protease inhibitor may reduce — not block altogether — tumor development.

Kennedy says some cancer researchers have labeled her findings "heresy," on the assumption that changes during cancer initiation were irreversible. Her research now suggests that both initiating and promoting changes are indeed reversible with protease inhibitors.

To understand how these compounds work, Kennedy and Troll are focusing on protease inhibitors' recently identified ability to inhibit the action of oncogenes. It is generally assumed that specific oncogenes must be activated for cancer to develop, Kennedy says. — *J. Raloff*