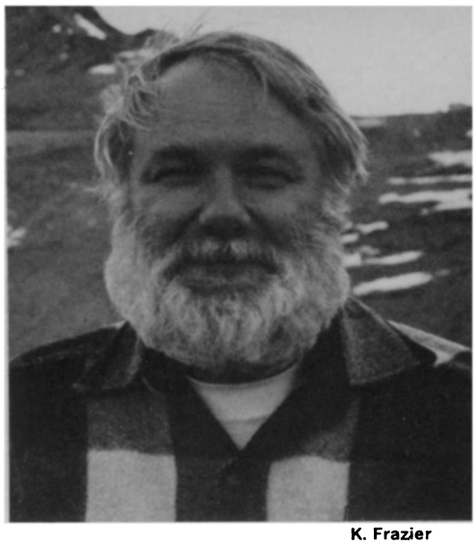
Ralph Payne, U.S. Navy

Drill site at Lake Vida: Penetrating 1,005 feet to study heat flow from below.



K. Frazier

Treves: Some 3-D on Antarctic geology.

The first probes beneath Antarctica

by Kendrick Frazier

In reporting this article, SCIENCE NEWS *editor Frazier visited lakes Vida, Vanda and Bonney in Antarctica's dry valley region. Third of a series.*

Scoured by long-vanished glaciers and kept free of ice and snow by processes still not totally understood, the so-called dry valleys of Antarctica are an open window into the continent's geologic and climatic past.

They also are the site of a historic scientific project this year, the first major effort to drill into the Antarctic continent. And that project has brought about an equally historic set of interactions between earth scientists who want to explore the record in the rocks below the surface and biological scientists who want to protect the unique and delicate valley ecosystems from any man-made disturbances.

Those interactions have resulted in the first environmental impact appraisal ever prepared for a research project in Antarctica. The appraisal may serve as a model for a planned future environmental impact statement on the entire program of research being carried out by the United States in Antarctica.

Ralph Payne, U.S. Navy

Nakai: Ice ages and magnetic reversals.

The recovery of continuous cores of hardrock and sedimentary rock by the Dry Valley Drilling Project (DVDP) should permit a detailed reconstruction of Antarctica's history from the time when it was a temperate-zone member of the giant supercontinent Gondwanaland to its present ice-bound condition.

But the project, important as it is, is operating under rigid environmental guidelines. Complex procedures have been established to minimize ecological disruption, and each drill site has assigned to it an environmental monitor to ensure that the precautions are being followed. It is the first monitoring plan ever set up for a research project in Antarctica.

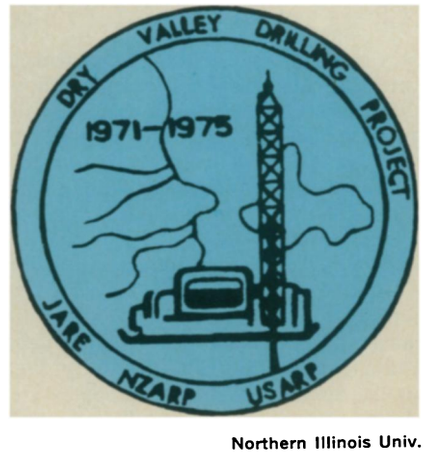
The guidelines are strict. All trash and human wastes of every sort have to be placed in containers and taken away by helicopters. Burning of any materials is prohibited. Any spilled fuel oil or drilling fluid has to be wiped up. Even cigarette ashes are to be placed in parka pockets, not flicked on the ground. One site, at Don Juan Pond, is so delicate that, according to one scientist, "If one thoughtless person urinated into the pond, it would ruin it ecologically for all time." At a biological research camp at pristine Lake Bonney in the Taylor Valley, a sign exhorts: "Don't do it in the lake." And of course the drilling operations themselves have severe guidelines.

Are they sensible restrictions? Says drilling chief Leon Oliver, a New Zealander: "I think so. They're a little tough on us. But we see the point."

The restrictions are far more than theoretical. In November and December drilling was terminated at two sites when adverse effects on the fragile local ecosystems seemed likely.

But despite the limitations the scientific work is going well. "The project is moving along quite nicely," says DVDP coordinator Lyle D. McGinnis of Northern Illinois University. The project, an international effort, is just now concluding its first main season of drilling. The work will be completed during the 1974-75 Antarctic summer.

"I think we've come up with a lot of good and exciting scientific data," says Mort D. Turner, program manager for earth sciences in the Office of Polar Programs at the National Science Foundation, which is funding the major part of the project. "We've been very pleased with what we've been getting." Science organizations in Japan



Northern Illinois Univ.

Logo for Dry Valley Drilling Project.

K. Frazier

Lake Vanda: Ice-focused solar rays heat bottom waters to nearly 80 degrees F.

Ralph Payne, U.S. Navy

Donlan: Environment is so simplified.

In an area of glacier-carved valleys and rare and fragile lakes, geologists and biologists are working together in a historic project to unravel a continent's history while protecting its delicate environment

and New Zealand are also contributing money, equipment and personnel.

The dry valleys are in a region of spectacular Antarctic scenery, some 60 miles northwest across ice-covered McMurdo Sound from McMurdo Station, the main U.S. research station in Antarctica.

A series of mountain ranges run parallel to each other east to west. Between each range is a valley. Huge glaciers block one or both ends of some valleys, and smaller glaciers slope down from the rocky mountain passes. But the valleys themselves are ice-free polar deserts. Snowfall brings only a few inches of precipitation a year to the valleys, and dry winds off the polar plateau cause a dominance of evaporation over precipitation.

Nestled in each of the valleys are glacier-fed lakes and ponds which are among the most scientifically important bodies of water in the world. Each of the lakes is a rare and delicate ecosystem, each with unique chemical and biological characteristics. For a decade, biologists and ecologists have been studying the lakes, using their simple biological systems as idealized models for more complex ecosystems elsewhere. Such scientific studies are expected to continue far into the future, and that is why biologists need so fervently to protect the lakes from any adverse consequences of the drilling project.

"The environment is so simplified that it has a very difficult time coping with anything introduced into it," Russell Donlan, the environmental monitor at the Lake Vida drilling site, told science reporters who visited the site in December.

Just how simplified the lakes can be is best illustrated by Don Juan Pond. Don Juan Pond, at the 600-meter elevation in the upper Wright Valley, is a brackish, perpetually ice-free body of water no more than a half acre in area and only 6 inches deep. Only one species of bacteria has been found to reside in its calcium-chloride-rich water.

"Don Juan Pond," states the environmental appraisal for the DVDP, "is considered to be the single aquatic body on earth most closely approximating the presumed environmental conditions for aquatic bodies on Mars.

"Exotic microorganisms from food, man, a visiting skua, or the equipment probably would be new to the area. . . . A new microbial community could result. . . . The introduction of exotic microorganisms . . . may irreversibly alter or destroy this rare and unique ecosystem, rendering it scientifically useless for certain scientific objectives."

Ralph Payne, U.S. Navy

Section of core retrieved at Vida.

Such a disaster almost struck when DVDP crews were drilling into Don Juan Pond in late November. Samuel B. Treves of the University of Nebraska, project scientist for the DVDP during the first half of the 1973-74 season, describes what happened: "About 10 feet down, we hit a boulder. We put a bit on and drilled about six inches into the boulder. Suddenly water from beneath the lake bottom started rising in the drill column. It rose to six feet. We had to stop. Frank Morelli [a biologist from the Jet Propulsion Laboratory] was the environmental monitor. He said the drilling couldn't be done safely. If the water had gotten into the lake it could have ruined its geochemical uniqueness."

"It was a disappointing decision," says hydrogeologist Keros Cartwright, one of the five authors of the environmental appraisal, "but it was one we understood had to be made." The earth scientists had hoped to penetrate 200 feet to the crystalline bedrock beneath Don Juan Pond to learn how the site's unique geothermal and geochemical features had evolved.

In late December drilling at Lake Fryxell in the lower end of the Taylor Valley also had to be terminated when calcium chloride drilling fluid began leaking up outside the drill case and contaminating the lake.

But these problems haven't significantly diminished the scientific gains being made.

A hole drilled in November into

Lake Bonney: Rigorous precautions against disturbing its pristine ecosystem.

Ralph Payne, U.S. Navy

the bottom of Lake Vanda, for instance, has solved a strange and long-standing mystery about the lake. Lake Vanda, farther down the Wright Valley from Don Juan Pond, is completely covered by a 10-foot-thick layer of ice. Yet the water at the bottom of the lake, 200 feet down, is at a temperature of 80 degrees F. For years scientists have debated the origin of this warmth. One theory was that the water was that it was heated from above by geothermal activity. A second theory was that it was heated from above by solar energy transmitted down through the ice.

So in November the DVDP's bright yellow drill rig was set up on the ice of Lake Vanda, and the drill stem penetrated deep into the sediments beneath the bottom. The bottom of the lake was warm. But the sediments were cold.

"So it looks like the solar people have won," says Treves.

NSF's Turner agrees: "This would seem to settle the argument. The lake is heated by solar energy."

Ian Curphey, leader of a permanent New Zealand research station on the shore of Lake Vanda, looks out over the beautiful view of Vanda and the surrounding mountains and echoes their comments: "The drilling shows pretty conclusively that it's solar heating. Apparently the ice acts as a big lens. The heat goes through and warms up the water."

The Lake Vanda cores contain a record of the entire history of the valley. Says Treves: "They recorded the entire period from when the valleys were marine fiords to the time when they became a dry desert."

Most of the scientific information in the cores retrieved so far this season is yet to be analyzed. Cores are temporarily stored in a refrigerated room in the earth science laboratory at McMurdo, then shipped to cold storage facilities at Florida State University and Northern Illinois University for dispersement to scientists for specific studies.

One such scientist is Nobuki Nakai, a geochemist from Nagoya University in Japan. He has a theory relating ice ages to the earth's magnetic reversals, and he was at the Lake Vida drilling site in the Victoria Valley in December checking on retrieval of cores that he hopes will help either confirm or disprove the idea. His theory ("It's just a theory; I'm not claiming it's true") starts with the disappearance of the Van Allen radiation belts above the earth at the time of a reversal of the earth's magnetic field. Such reversals have long been known. Why they occur is a mystery.

The disappearance of the radiation shield, he hypothesizes, allows cosmic rays to enter into the atmosphere, causing free hydrogen and oxygen to ionize and combine into enormous quantities of water vapor. The water vapor reduces the amount of sunlight reaching the earth, and this initiates a period of climatic cooling. Once the magnetic field has completed its reversal, the radiation shield is restored, atmospheric conditions return to normal, and a full amount of sunlight is once again allowed to reach the earth and warm things up.

Nakai will check the cores to see if the times of increased glaciation, which are evident in core samples, correlate with known times of magnetic reversals. He says a similar drilling project at Lake Biwa, the largest lake in Japan, has found "a very nice correlation."

He and other scientists whose studies depend on knowing the ages of events recorded in the Antarctic core samples are grateful for the discovery of microfossils in some of the cores. "This is quite exciting," says McGinnis. "It should allow us to date the sediments."

This jubilation at finally being able to physically probe into the past history of Antarctica has been a long time coming for the earth scientists. "There's been a certain kind of naiveness and prejudice against drilling holes on the part of some of the geologists," says Treves. Then there were all the difficulties working out the environmental protection procedures and the natural delays in organizing and funding a major international project.

"But only 5 to 10 percent of the land in Antarctica is exposed," notes Treves, "and this is the only way to get to it.

"Here's a chance to put some 3-D, or time dimension, on the geology of the continent." □