Rocks from space at bottom of the world

It seems somehow appropriate to seek ancient rocks from the depths of space in one of the most alien environments on earth — the vast, trackless wilderness at the bottom of the world. American and Japanese scientists have now returned from just such a quest, their annual search for meteorites in the Antarctic wastes. This year's expedition was a particularly successful one, yielding 309 meteorites together weighing some 300 kilograms and including a number of significant finds:

- A single iron meteorite weighing some 136 kg, the largest of its type ever found on the continent.
- Four or five achondrites, a type rare among meteorites yet peculiarly akin to some types of terrestrial rocks.
- A pair of tiny, approximately five-gram carbonaceous chondrites, believed to represent some of the solar system's most primitive material but even rarer than the achondrites because of the readiness with which they succumb to the effects of atmospheric entry and weathering.

The bumper crop is in a sense a testimonial to the theories of the University of Pittsburgh's William A. Cassidy, leader of the U.S. team, who had proposed after the success of the expedition of two years ago that windswept, old-ice surfaces seemed to be the ideal places for the meteorite hunters to look. Snow would initially help keep the falling objects from shattering on impact; combined with the low temperatures it would then protect them from oxidation, sunlight and organic contamination. Underlying surfaces of old ice would give hope that the meteorites might still be accessible where they had fallen, rather than covered by successive freezings or dumped into crevasses. And the relentless winds, ever clearing away the snows of yesteryear, would improve the hunters' chances of actually being able to see what they sought.

This does not mean that it is now possible to go right to every waiting harvest of meteorites, says John O. Annexstad, associate curator of the Apollo lunar samples at the NASA Johnson Space Center in Houston (where the Antarctic meteorites are also stored) and a member of this season's expedition. But it does, he says, mean that the chances of success are much greater — as the latest return has proved.

The previous expedition, which yielded 303 meteorites including the best-preserved carbonaceous chondrites ever found to that time, had all of its luck in the Allan Hills region of Victoria land, just over 200 kilometers northwest of McMurdo Station, the main U.S. Antarctic research outpost. The latest trek, held during the Antarctic summer from November through January, found most of its prizes in the Allan Hills, but others came from a variety of scattered regions. About 100 to 120 km to the north, four samples were discovered near Reckling Peak by a party of geologists, headed by Philip Kyle of Ohio State University, who were not even looking for them. The record iron meteorite and eight others were found on Derrick Peak near Darwin Glacier, about 280 km southwest of McMurdo, after a New Zealand team radioed Cassidy about six finds of its own in the same area.

Since a major reason for looking in Antarctica is the well-preserved condition of the finds there, special care is taken to avoid contaminating the samples in the process of picking them up and packing them for the months'-long trip home by backpack, snowmobile, helicopter, truck, ship, plane and handcart. Individually wrapped in double layers of teflon, the samples are then sealed in airtight, refrigerated containers of the sort developed to store Apollo moonrocks on earth. Prompted in part, however, by the well-preserved carbonaceous chondrites recovered a year ago (later found to contain virtually no signs of human contamination), the recent hunt used even more stringent procedures. Before the participants spread out on their searches, Annexstad held a training session at McMurdo on such fine points as the best way to bag a tiny sample with the least fumbling, and how to improvise a forceps from a pair of scissors.

The samples are now packed in five containers in the freezer of the U.S. Navy cargo ship *Bland,* en route to a late-March arrival at the Navy Seabee base at Port Hueneme, Calif., from which they will make the air journey to the curatorial facility in Houston. That will still not be their final resting place, however. More than 50 samples from the previous batch have already been lent to scientists in numerous institutions, and the growing interest in the Antarctic finds may see even more widespread distribution.

Besides revealing their own secrets and providing increasingly important clues to the early history of the solar system, the Antarctic meteorites are also aiding studies of the southernmost continent itself. Recently published isotopic dating of four Allan Hills meteorites, for example, showed that one of them had been on earth for about 1.54 million years and three others for from 30,000 to 300,000 years. "Therefore," reported E.L. Fireman of the Smithsonian Astrophysical Observatory and colleagues (in the Feb. 2 SCIENCE), "the Antarctic ice sheet is older than . . . 1.54 x 10^6 years." Assuming that the meteorite fall rate is constant, they wrote, the distribution over the ice of different-aged samples reflects the history of the ice movement. The age distribution, the authors concluded, suggests that in the last 30,000 to 300,000 years, either ice began flowing into the region more rapidly or (and more likely) changes in the ice cover — with possible climatic implications — removed many of the accumulated older meteorites. If would not be unreasonable, Annexstad suggests, to hope that further studies of these rocks from space could bear on questions as fundamental as the true age of the world's southern cap. □

SAGE: Diagnosing the atmosphere

After repeated delays, a single-minded satellite called SAGE — the Stratospheric Aerosol and Gas Experiment — was successfully launched on Feb. 18 to study the quality of the earth's upper atmosphere. Part of a relatively low-cost satellite series known as the Applications Explorer Missions, SAGE carries basically a single experiment: a four-channel photometer that looks at the sun's light through the intervening layers of air, "reading" the concentrations of aerosols and gases — notably ozone — each time the device enters and leaves the earth's shadow.

Sent toward an orbit from which it will "see" about 15 sunrises and 15 sunsets every 24 hours, SAGE will record four color bands of light (1.0, 0.60, 0.45 and 0.38 microns) as the light fades in a sunset and brightens in a sunrise. Results, supported by "ground-truth" measurements from the United States, Europe and Japan, will bear on such questions as manmade reductions of the ozone layer and the yet-uncertain relative significance of natural versus anthropogenic influences. Fluorocarbons are a much-accused factor, but some researchers have asserted that natural

processes may be equally significant. Besides the effect of the ozone layer on solar ultraviolet radiation reaching the earth's surface, another concern of SAGE is the role of particulate aerosols such as manmade pollutants or volcanically derived dust on the earth's temperature balance, with arguments still raging about whether the planet is heating or cooling. SAGE's orbit is angled so that its sensor will be able to produce vertical profiles of the atmosphere from 79°S to 79°N latitude. □