For the first time, a complete vertical section of the ocean floor is being obtained

EXPLORERS OF THE OCEAN FLOOR

SEAN McCUTCHEON

May in Cyprus. In a river canyon in the southwest of the country, two geologists and some 20 scientists from a number of developing countries, Europe, and North America are disputing just how this bit of the Earth's crust, conveniently sliced open by centuries of running water, has been constructed. Downstream, on the banks of the river, a drill rig is biting down through the rocks. Hazy in the distance, the jagged summits of the Troodos massif, 3000 square kilometres of rock, are visible.

The fascination with the rocks of Troodos is with their origins. They came from the virtually inaccessible three-quarters of the Earth that lie beneath the sea.

The Cyprus expedition was organized by the International Crustal Research Drilling Group (ICRDG), an informal network of earth scientists all of whom have been — as one of its founders, Dr Jim Hall of Dalhousie University, Halifax, Canada — puts it, "bitten by the bug of the ocean floor." During the past decade they have set out in ships to dredge and drill rock samples from the ocean floor and have mounted drill rigs on islands such as Bermuda, the Azores, and Iceland. Their latest project is to sample a four-kilometre-deep sequence of ocean crust thrown on land in Cyprus.

Some of the funding for this work comes from IDRC and enables geologists from the Geological Surveys of a number of developing countries to join the project as trainees and collaborators. The first group of trainees were in Cyprus in May: Nick Baglow from Zimbabwe, Hassan Haroun from the Sudan, Miguel Haller from Argentina, Kewal Sarin from India, and Ibrahim Shalaby from Egypt.

During their eight weeks in Cyprus these trainees shared rooms and chores with the ICDRG scientists at the project headquarters, a mining company bunkhouse in a village near Nicosia. Here, they exchanged information about field work in other parts of the world.

For Third World geoscientists, whose work usually entails general mapping and mineral prospecting, the Cyprus project is a welcome chance to study fresh rocks in the kind of detail to which only a large team of specialists, pooling their knowledge and their elaborate analytical tools, can aspire. The rock cores obtained in Cyprus, for instance, will be analyzed using a X-ray fluoroscope, which at U.S. $250 000 is a prohibitively expensive tool for most developing countries.

In the Third World, scientists tend to be isolated from their fellows. The Cyprus project provides them with an opportunity to make stimulating and fruitful ties. Through practical experience and interactions with visiting scientists, they are being exposed to state-of-the-art knowledge and interpretation of important areas of ocean crust geology, hydrogeology, and drilling technology. Ibrahim Shalaby, chief of the Geological Survey of Egypt, says: "This is a chance to meet the experts. I already know them by name, from reading their papers. This experience will help modernize geology in my country." The high speed diamond drilling method and equipment used, for example, has been brought in from the mining fields of northern Quebec where the technology has been developed to its peak in support of the Canadian metal mining industry.

The countries from which the trainees were invited all have geological affinities with Cyprus. Some have shortages of water: There is a dam or a pump in every river in Cyprus; its groundwater has been exhausted; the lakes, coloured blue on its maps, are mostly dry. Some have similar mineral resources: the word "Cyprus" is synonomous with "copper"; the island is dotted with the black heaps of slag left when metal for the spears, helmets, and chariots used by Homeric warriors was smelted. Aside from such affinities, the Cyprus project is interesting because it is expected to produce significant new evidence regarding the nature of and processes associated with ocean crust formation.

In the 1950s geologists knew the ocean basins were deep and floored with heavy rock . . . and that was about all. Any answers to questions such as how the sea floors had formed had to be conjectural, for between geologist and geology lay an oceanic barrier, several kilometres deep. Then came the revolution. The theory of plate tectonics did for the earth sciences what relativity did for physics or what the double helix did for biology; it tersely and compellingly explained a wealth of observations. Continents and oceans once thought of as fixed, were now seen to ride the rigid slabs into which the Earth's outermost shell was broken. Where they collide, the crust crumples and mountains rise. Ocean floor, according the the new theory, is formed as mol-

Miguel Haller examines a sample of the Troodos massif. (Inset) Dr Jim Hall and one of the drill crew with a core: a piece of the ocean floor.

ten lava rises to fill the gaping fissures left as two plates move apart from one another. Welded to the trailing edge of the departing plates, new rock begins a slow journey away from its place of birth.

If this theory is correct, what should one see as one drills through the rocks of the ocean floor? At the top, a thin layer of sediments. Below, the pillow lavas whose rounded shapes declare these once-molten rocks to have been erupted underwater and then rapidly chilled. Below again, the sheeted dykes — fine-grained slices of lava which never reached water but froze in the fissures of a spreading seafloor. Next, greenish, coarse-grained gabbro, a crystal mush coughed up from deep below, which slowly hardened deep in the outer envelope of our planet. And, lying still deeper, the residue left in the Earth's bowels from which molten magma has been vomited to the surface.

Just this combination of rock types has been observed in many parts of the world. Because of their green-grey, mottled appearance, geologists named the heavy rocks at the bottom of the series "ophiolites", from the Greek for "snake-like", and then extended the term to signify the combination. But why lavas, gabbros, and so on should be found together no one could explain. According to Ian Gass, one of the ICDRG's principal scientists, no one even tried to explain it: "The nineteenth century geologists," he says, "would draw a line around anything green and dirty and altered, call it an ophiolite, and walk away."

Ophiolites are now recognized to be fragments of the floor of long-gone oceans somehow marooned on land. They attract geologists who wish to study the ocean floor without incurring the enormous technical difficulties and expense of probing beneath the ocean with submersibles or drill ships. In most ophiolites the junctions between constituent types of rocks, so significant for geologists, have been blurred or erased. Cyprus' ophiolite, the Troodos massif, is unusually well-preserved. Representatives of all the rock types, exposed by road cuts or rivers, are visible on this island. Now, for the first time, a complete vertical section — a sample showing all these rock types in sequence — is being obtained.

This drilling project will produce more than pure scientific information. It might suggest underground sources of water for parched Cyprus, or, by revealing more about how hot springs on the ocean floor deposited copper and other minerals, lead to new mineral exploration techniques.

And, as a result of the training, developing-country geologists and engineers will have an opportunity to apply the new scientific information obtained to resource development activities in their respective countries. □

Sean McCutcheon, a Montreal-based science writer, visited the site of the Cyprus crustal study earlier this year.

THE PROJECT

The Cyprus Crustal Study project is a collaborative research effort between Dalhousie University (Canada) and the Cyprus Geological Survey. It is the first venture supported by IDRC's Cooperative Programs Unit in the area of earth sciences, and specifically into resource assessments.

The fourth study to be carried out by the International Crustal Research Drilling Group (ICRDG), the overall project is financed by a number of countries and institutions, for a total of more than Cdn $1.6 million. The ICRDG itself has some 50 members drawn from universities, geological surveys, and energy departments of eight countries.

By producing significant new evidence on the formation and evolution of the oceanic crust and information of importance for resource assessment, the investigation will greatly benefit the Geological Survey of Cyprus. But because a number of developing countries have regions with strong geological similarity to the Troodos area, the results will assist them in the identification of copper ore deposits, sources of geothermal energy, and groundwater resources.