

The same devices for definition of sea floor boundaries—the “transponder” geodetic bench marks—could be used for FAA type monitoring of surface or submerged vehicle movements first at ports, and then throughout coastlines and into the deep ocean waters.

The state of the art of technology with both battery powered transponders (for temporary fixes and short life) and atomic powered transponders (for long-life and long-range capability) makes the installation economical and reasonable at this time.

Areas such as the North Sea, the Black Sea, the Red Sea, the Adriatic, the Gulf of Aqaba, and others could be surveyed and temporarily zoned in a technically accurate manner. A plan for five or six such pilot surveys will be proposed to the United Nations.

D. SOLANAS, U.S. Geological Survey, Menlo Park, Calif.

#### WHAT'S AHEAD ON O.C.S. IN PACIFIC

(No abstract submitted)

A. J. FIELD, Global Marine, Inc., Los Angeles, Calif., and MELVIN N. A. PETERSON, Scripps Institute of Oceanography, La Jolla, Calif.

#### Glomar Challenger and DEEP-SEA DRILLING PROGRAM

*Glomar Challenger* has been engaged in its unique assignment of investigating the character of deep-ocean-floor sediments since August, 1968 and at year end was well into the third of four Atlantic Ocean segments. The very comprehensive documentation of this effort includes the film that is presented with this paper, which was taken during the sea trials and first leg of the voyage.

A geologic summary of the status and goals of the program and some of the findings developed during the *Challenger's* initial efforts is presented by courtesy of Scripps Institution of Oceanography, operators for the program. Both the technical and academic results of the coring program have been very gratifying to date.

DAVID W. SCHOLL, H. GARY GREENE, WARREN O. ADDICOTT, U.S. Geological Survey, Menlo Park, Calif., and Washington, D.C., WILLIAM R. EVITT, Department of Geology, Stanford University, Stanford, Calif., RICHARD L. PIERCE, SERGIUS H. MAMAY, and MICHAEL S. MARLOW, U.S. Geological Survey, Menlo Park, Calif., and Washington, D.C.

#### ADAK “PALEOZOIC” SITE, ALEUTIANS—IN FACT OF EOCENE AGE<sup>1</sup>

In 1946 several specimens of the plant genus *Annularia* [cf. *A. stellata* (Schlotheim) Wood], a primitive horsetail of Pennsylvanian or Permian age, were found by Robert R. Coats of the U.S. Geological Survey in tuffaceous sandstone exposed near Andrew Lake, northern Adak Island, Alaska. Because of the geographic position of these upper Paleozoic fossils near the middle of the Aleutian insular chain, it has been a challenging if not a vexing problem to fit the enclosing rocks into a structural scheme for the development of the Aleutian ridge. In view of this, the enigmatic upper Paleozoic section was restudied during

<sup>1</sup> Publication authorized by the Director, U.S. Geological Survey.

July 1968 to enlarge the fossil collection and to determine its depositional environment and stratigraphic setting.

The *Annularia*-bearing beds are associated with a sequence of sedimentary rocks that is more than 850 m thick, and that consists mainly of northwest dipping tuffaceous sandstone, siltstone, and shale, and siliceous and calcareous siltstone and shale interbedded with basaltic flows and/or penecontemporaneous sills a few tens of meters thick. Specimens of *Annularia* have been found only within the basal 5–10 m of this section, which lies with apparent depositional contact on the massive and intensely altered andesitic and basaltic flows and pyroclastic rocks of the Finger Bay Volcanics that form most of Atak Island. The top of the section is not exposed. The section is uncomplicated structurally and dips homoclinally northwestward between 40° and 65°; it is exposed across an area of about 2.5 km<sup>2</sup> (approximately 1 sq mi).

Mollusks, Foraminifera, sponge spicules, fish scales, and skeletal remains were found by the writers in the lower 350 m of the section just above the basal *Annularia*-bearing beds. Included in this fauna is the mud pecten *Propeamossium* [cf. *P. stanfordensis* (Arnold)], indicating a probable Eocene age; the associated foraminiferal fauna is of definite Eocene (most likely late Eocene) age, and the fish scales are similar to those found in the Refugian and Narizian (Eocene-Oligocene) of California. The microfossils imply a paleobathymetry of 1000 meters or deeper. In consideration of these new findings, the rock matrix surrounding specimens of *Annularia* was searched for microfossils. A substantial dinoflagellate flora was found—establishing that the *Annularia*-bearing beds are themselves marine units of early Tertiary age. The paleontologic and stratigraphic significance of *Annularia* is now being reevaluated.

The Adak findings clearly establish that at least a portion of the structural framework of the Aleutian Ridge was in existence by early Tertiary time.

DONALD M. BENN, Chief, Flight Analysis, Range Safety, U.S. Air Force, Los Angeles, Calif.

#### AIR FORCE WESTERN TEST RANGE OPERATIONS

(No abstract submitted)

ERK REIMNITZ, U.S. Geol. Survey, Menlo Park, Calif.

#### RAPID CHANGES IN HEAD OF RÍO BALSAS SUBMARINE CANYON, MEXICO

The Río Balsas submarine canyon heads in or near the surf zone of Mexico's Pacific coast, 280 km northwest of Acapulco. One of its tributaries is related directly to the main distributary of a large river of the same name. Seaward, the canyon terminates in the Middle America Trench.

The intricately bifurcated heads of the tributaries were investigated by divers. They are cut into poorly consolidated deltaic sediments. The walls commonly slope more than 30°, and are vertical to overhanging where sedimentary strata are exposed. The tributaries apparently are not controlled tectonically.

Shifts in river discharge cause formation of new tributaries and filling of old ones. The easternmost tributary heads in an embayment formerly associated with the main river discharge. Sediments exposed in three