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Researchers Investigate Fate of Oceanic Plateaus at Subduction Zones

During a 32-day marine geophysical expedition aboard the R/V *Maurice Ewing*, scientists investigated the fate of the Ontong Java oceanic plateau (OJP) at the Solomon island arc (Figure 1). The purpose of the cruise was to examine whether oceanic plateaus subduct, obduct, or partially obduct at subduction zones. With an area of 1.86×106 km^2 and a crustal thickness of 25–43 km, the OJP is the largest and thickest oceanic plateau on Earth and one of the few Pacific oceanic plateaus that is actively converging on an island arc. Obducted remnants of the OJP may occur in a Neogene accretionary prism, the Malaita anticlinorium, which separates the Solomon Island volcanic arc from the OJP (Figure 1).

U.S. and Japanese researchers acquired 4050 km of multichannel seismic data in transects that include the Early Cretaceous-Tertiary OJP, Tertiary Solomon arc, Neogene oceanic crust of the Woodlark basin, and continental or oceanic plateau crust of unknown age beneath the Louisiade Plateau. A 20-airgun array and a 3-km-long seismic streamer were used to acquire the data. In addition, a 500-km-long coincident, wide-angle seismic line constrained by 17 ocean bottom seismometers was acquired along a central transect that spans all geologic provinces.

The dominantly basaltic, pre-Middle Eocene section of the Malaita anticlinorium shows striking similarities in age, lithology, and geochemical character to basalts drilled on the OJP. Previous work suggests that the OJP and the east-northeast facing Solomon arc collided about 10 Ma at the North Solomon trench and produced the 50–120 km-wide Malaita anticlinorium. The inability of the Solomon arc to consume the OJP resulted in backthrusting and subduction polarity reversal along the length of the Solomon arc. Subduction probably began along the San Cristobal trench in the past 10 m.y. Similar scenarios of eastern Pacific oceanic plateau obduction are thought to have preserved the Wrangellia terrane of the western Cordillera and smaller, mostly basaltic terranes of the circum-Caribbean.

In contrast to previous models that postulated an end to subduction at the North Solomon trench 10 Ma, earthquakes and new seismic reflection data suggest that subduction continues to the present day. On line Y-Y', which is roughly parallel to the central ocean bottom seismometer line, alignment of deep hypocenters suggests that the OJP, or oceanic crust that formerly flanked the OJP, subducts to a depth of about 500 km (Figure 2b). Curiously, deep intermediate and deep earthquakes are less apparent on line X-X' (Figure 2a). Localized convergence between the OJP and oceanic plateau or continental crust of the Louisiade Plateau may result in the larger and more intense seismic activity on line Z-Z' along with the narrow width, greater topography, deeper erosional level, and more rapid Quaternary uplift of the southwestern Solomon arc. This style of closure may be proceeding in a zipperlike fashion from southeast to northwest along the length of the arc.

Folds within the Malaita anticlinorium become more open and less numerous to the northwest and support the idea that OJP collision began in the southeast and progressed to the northwest. Preliminary, single trace plots from this cruise also support the idea of an actively subducting OJP at the North Solomon trench (Figure 2d). Thrust faulting and offscraping of a post-Middle Eocene pelagic carbonate section at the toe of slope indicates that convergence is ongoing and did not end 10 Ma as assumed in previous studies. The Malaita "anticlinorium," or accretionary prism, is still forming by accretion of shallow Tertiary pelagic sediment deposited

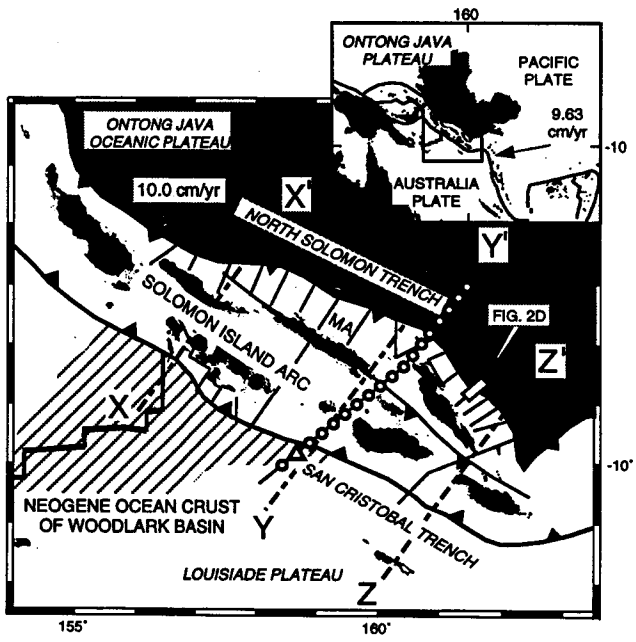

Fig. 1. Map of study area in Solomon island arc. Island areas are black, area of Ontong Java oceanic plateau is gray, and the barbs indicate the overriding sides of subduction plate boundaries. MA is the Malaita anticlinorium, an accretionary wedge formed by offscraping of basalt and pelagic sediment from the active subduction of the Ontong Java oceanic plateau at the North Solomon trench. Individual straight lines are multichannel seismic data lines, open circles are ocean bottom seismometers deployed and recovered on the long transect line, and the open triangle shows one ocean bottom seismometer that was not recovered. Earthquake hypocenters occurring in the area of the three rectangles are plotted on the dashed centerline as profiles in Figure 2. Inset map shows tectonic setting of the Solomon island arc formed on the obliquely convergent plate boundary between the Pacific and Australia plates. Rates and directions of the Pacific plate relative to the Australia-India plate are in centimeters per year.

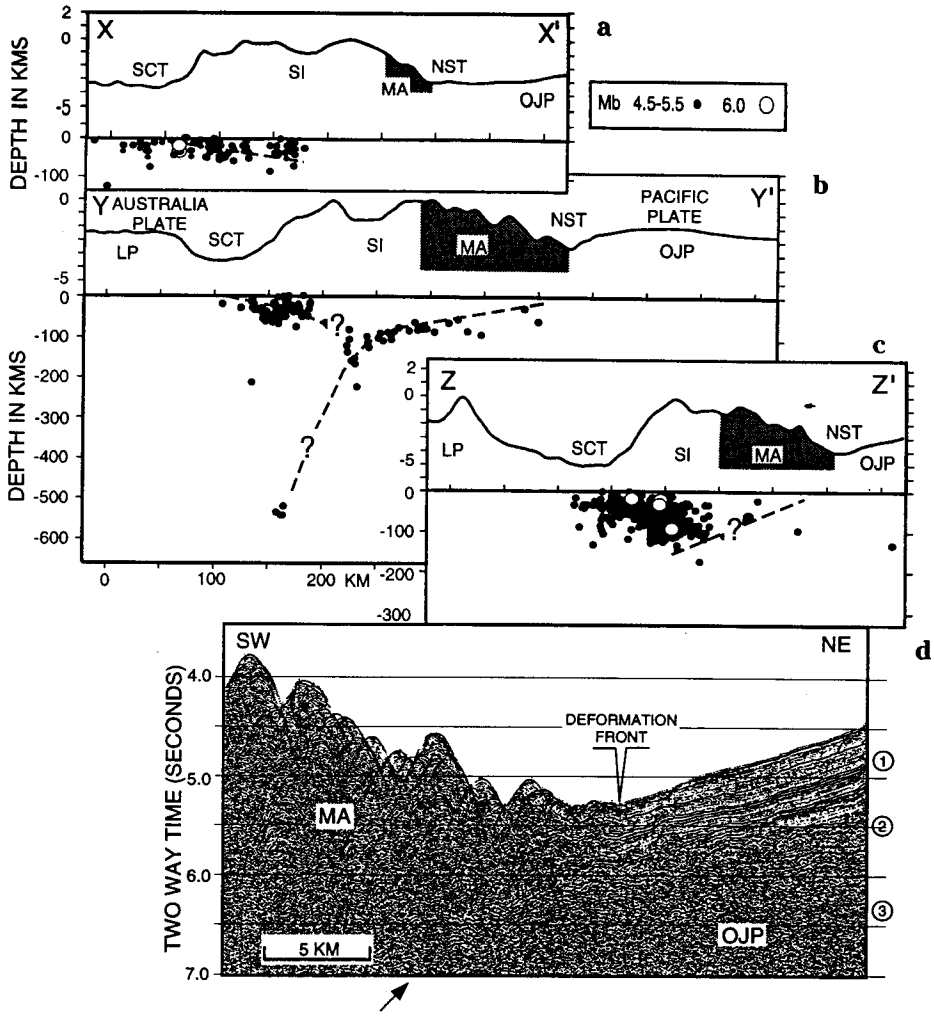

Fig. 2. a) Line X-X' shows earthquakes with Mb in the range of 4.5 to 5.5 occurring between 1964 and 1990 in the northern Solomon Islands (SI) (see Figure 1 for location of X-X', Y-Y', and Z-Z'). Larger open circles indicate earthquakes with magnitudes of 6.0. Dotted lines in all three sections indicate the inferred tops of subducting plates. Gray area in all three sections represents the approximate cross sectional area of the Malaita anticlinorium. b) Line Y-Y' is roughly parallel to the MCS/ocean bottom seismometer line that shows earthquakes in the central Solomon Islands. Incipient subduction of the Louisiade Plateau is occurring at the San Cristobal trench along the southeastern edge of the Solomon island arc. c) Line Z-Z' shows earthquakes in the southern Solomon Islands. Intense seismicity and higher relief is attributed to local convergence between Ontong Java and Louisiade Plateaus on opposite sides of the Solomon island arc. d) A near-trace plot of a multichannel seismic line collected during EW95-11 across the North Solomon trench (see Figure 1). Folds and active thrusts breaking seafloor sediments indicate ongoing subduction of the Ontong Java oceanic plateau (OJP). Parallel reflectors are inferred to be post-middle Eocene to recent pelagic sedimentary rocks. More discontinuous reflectors in the middle seismic stratigraphic unit numbered 2 are inferred to be Lower Cretaceous to Middle Eocene pelagic sediments, and the poorly resolved section in the lower seismic stratigraphic unit numbered 3 is inferred to be Lower Cretaceous basaltic basement of the Ontong Java oceanic plateau. The lower unit numbered 1 is being accreted to form the Malaita "anticlinorium" or accretionary prism, while the overlying units numbered 2 and 3 are subducted with the level of detachment near presumed Middle Eocene cherts above volcanic basement of the Ontong Java oceanic plateau.

on the OJP. The Malaita prism is unusual compared to other actively forming prisms in that it is composed almost entirely of pelagic carbonate deposited in an intraoceanic setting on the incoming OJP.

How did crystalline basement of the OJP become obducted to form the cores of large folds in the prism? The answer to this and more complex questions as well as details of the deformational features of the prism will require detailed processing and integration of the multichannel seismic (MCS) data at the University of Texas Institute for Geophysics and the ocean bottom seismometer data at the Ocean Research Institute of the University of Tokyo and Chiba University.

For a copy of the cruise report, contact P. Mann (fax 512-471-8844; e-mail paulm@utig.ig.utexas.edu). A special session on the tectonics and geochemistry of the Solomon Islands and Ontong Java Plateau is being planned for the AGU Fall Meeting; for more information, check the abstract supplement, which will be published late in October.—*EW95-11 Science Party (P. Mann, M. Coffin, T. Shipley, S. Cowley, E. Phinney, A. Teagan, K. Suyehiro, N. Takahashi, E. Araki, M. Shinohara, and S. Miura)*